National Inventory Report

Greenhouse Gas Sources and Sinks
in the Republic of Moldova

1990-2019

Submission to the United Nations Framework
Convention on Climate Change

Chisinau,
30 April 2021

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FOREWORD

On March 16, 1995, the Republic of Moldova ratified the United Nations Framework Convention on Climate Change (UNFCCC). In conformity with Articles 4(1)(a) and 12(1)(a) of the Convention, the non-Annex I Parties shall provide information to the Conference of the Parties (COP) regarding emissions (by types of sources) and sinks (by types of storage) of all greenhouse gases (GHG) that do not come under the Montreal Protocol.

This Report has been developed within the "Republic of Moldova: Enabling Activities for the Preparation of the Third Biennial Update Report to the United Nations Framework Convention on Climate Change" Project, implemented by the Public Institution "Environmental Projects Implementation Unit" of the Ministry of Agriculture, Regional Development and Environment (MARDE) and United Nations Environment Programme (UNEP), with financial support of the Global Environment Facility (GEF), from January 2020 through December 2021.

The National Inventory Report reflects the efforts made by the National Inventory Team in 2020 year. In addition to the GHG emissions inventory results in the Republic of Moldova, the Report also contains relevant information such as the analysis of recent trends in GHG emissions and sinks, the analysis of key categories, additional sectoral data utilized in emission inventory, data regarding the activities related to inventory quality control and uncertainty management.

UNFCCC stipulates that greenhouse gas emissions shall be monitored through the application of a set of methodologies and guidelines developed by the Intergovernmental Panel on Climate Change (IPCC) and approved by the UNFCCC. These guidelines describe how to assess GHG emissions, as well as the structure of national communications, biennial update reports and national inventory reports. They serve as an effective tool for generating multiple indicators used to compare the performances of the Parties of UNFCCC.

The Convention also obliges its Parties to continuously improve the quality of national inventories. Through the series of initiatives, which are part of the answer that the Republic of Moldova has to offer to the phenomenon of climate change, the assessment of emissions increases its ability to monitor and report GHG emissions, both nationally and internationally.

Since the first national inventory for the period from 1990 through 1998 was published, an impressive number of persons in the Republic of Moldova have expressed interest for the climate change phenomenon, and particularly, for greenhouse gas emissions. Although this interest generated numerous research activities, only a limited number have focused on the process of quantitative evaluation of emissions and development of national emission factors.

Albeit there will always be uncertainties with respect to the assessment of emissions, the monitoring process will continue, both in the Republic of Moldova, and internationally, in order to improve inventory quality and reduce greenhouse gas associated uncertainties.

An independent internal audit of the quality of the national inventory of the Republic of Moldova for the period 1990-2019 was conducted from February to March 2021 by relevant national experts representing universities as well as research and development institutes, previously not involved in the national inventory compilation activities.

The findings of these audits have led to identification of the priority areas, both in view of improving the quality of activity data, as well as methodological approaches and emission factors used in the assessment of emissions (by types of sources) and sinks (by types of removals) within the greenhouse gas national inventory of the Republic of Moldova.

Veaceslav DERMENJI
Director of the Environment Agency of the Republic of Moldova

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LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

ABS	Acrilonitril Butadien Stiren
AEZ	Agro-Ecological Zones
$Area_{(T)}$	Total annual area harvested of crop T
Area burnt $_{(T)}$	Annual area of crop T burnt (stubble fields burning)
a.s.	Active substance
ASH	Ash content of the manure in per cent
ASM	Academy of Science of Moldova
ATD	Atmospheric Deposition
ATULBD	Administrative-Territorial Units on the Left Bank of Dniester
AR4	IPCC 4^{th} Assessment Report (IPCC, 2007)
AR5	IPCC 5^{th} Assessment Report (IPCC, 2014)
B	Billion
B_0	Maximum methane producing capacity
BEF_I	Biomass expansion factor for conversion of annual net increment to aboveground tree biomass increment
BOF	Basic Oxygen Furnaces
BUR	Biennial Update Report
BW	Average live body weight of animal
c	Flight cycle: cruise
^0C	Celsius degrees
C_a	Animal Feeding Situation Coefficient
CA	Hornbeam species (Carpinus ssp.)
C_f	Burning coefficient (used to keep account of incomplete burning related aspects)
CF	Carbon fraction in biomass
CHP	Combined Heat and Power Plant
CIS	Commonwealth of Independent States
CKD	Cement Kiln Dust
COP	Conference of the Parties
CORINAIR	Atmospheric Emission Inventory Guidebook, developed by European Environment Agency with support from United Nations Economic Commission for Europe
cm	Centimeter
cm^2	Square centimeter
CMIP5	Coupled Model Intercomparison Project Phase 5
CR	Crop Residues
$Crop_{(T)}$	Harvested annual dry matter yield for crop T
CS	Country Specific
D	Default
D_{ind}	Degradable organic component in wastewater
dal	Dekaliter
DE	Digestible energy
DOC	Degradable Organic Carbon
DOC_F	Dissimilated DOC fraction
dm	Dry matter
DRY	Dry matter fraction of harvested crop
DS	Fraction of organic component removed with sludge
EAF	Electric Arc Furnace
EB	Energy Balances
EE	Eastern Europe
EF	Emission Factor
eq	Equivalent
EU	European Union
EV_{milk}	Energy value for milk
f	Force
F	Methane fraction in biogas
F_{AM}	Quantity of nitrogen incorporated in soil with manure
F_{COMP}	Annual amount of total compost N applied to soils
F_{CR}	Annual amount of N in crop residues returned to soils
F_{ON}	Annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils

F_{OOA}	Annual amount of other organic amendments used as fertilizer
F_{PRP}	Annual amount of other organic amendments used as fertilizer
F_{SEW}	Annual amount of total sewage N that is applied to soils
F_{SOM}	Annual amount of N in mineral soils that is mineralized, in association with loss of soil C from soil organic matter as a result of changes to land use or management
F_{SN}	Annual amount of synthetic fertilizer N applied to soils
FAO	Food and Agriculture Organization of the United Nations
FG	Volume of fuel wood gathering
FNC	First National Communication
FOD	First Order Decay Method
FR	Species of ash tree (Fraxinus spp.)
Frac	Fraction
$Frac_{GASF}$	Fraction of synthetic fertilizer N that volatilizes as NH3 and NOx
$Frac_{GASM}$	Per cent of managed manure nitrogen that volatilizes as NH_3 and NO_x
$Frac_{LEACH}$	Per cent of managed manure nitrogen losses due to runoff and leaching
$Frac_{Renew (T)}$	Fraction of total area under crop T that is renewed annually
$Frac_{Remove (T)}$	Fraction of above-ground residues of crop T removed annually for purposes such as feed, fuel for heating and cooking, bedding and construction
FSV	Facilitative Sharing of Views
g	Grams
G_w	Average annual above and belowground biomass increment
Gcal	Gigacalory
GCM	Global Climate Models
GDP	Gross Domestic Product
g.e.c.	Grams coal equivalent
GE	Gross Energy
GEF	Global Environment Facility
Gg	Gigagram
GHG	Greenhouse Gas
GPG	Good Practice Guidance
GWP	Global Warming Potential
H	Annually extracted volume, round wood
ha	Hectare
HDP	High Density Polyethylene
HFC	Hydrofluorocarbons
hl	Hectoliter
HP	Heat plant
ICA	International Consultation and Analysis
I_v	Average annual net increment in volume suitable for industrial processing
IE	Included Elsewhere
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel for Climate Change
JSC	Joint Stock Company
k	Methane generation rate constant
kg	Kilogram
KCA	Key Category Analysis
km	Kilometer
km^2	Square kilometer
kPa	Kilopascal
kt	kiloton
kW	Kilowatt
kWh	Kilowatt-hour
l	Liter
L	Level
$L_{felling}$	Annual carbon loss due to commercial felling
L_0	Methane Generation Potential
LDP	Low Density Polyethylene
LDLP	Low Density Linear Polyethylene
LEDS	Low Emission Development Strategy
LULUCF	Land Use, Land Use Change and Forest

Ltd.	Limited Liability Company
LTO	Cycle: Landing/Take Off
m	Meter
m^2	Square meter
m^3	Cubic meter
MARDE	Ministry of Agriculture, Regional Development and Environment
MCF	Methane Correction Factor
MD	Moldova
ME	Municipal Enterprise
mg	Milligram
mil.	Million
MJ	Megajoule
MMS	Manure Management Systems
mm	Millimeters
MOP	Meeting of the Parties to the Kyoto Protocol
MR	Methane emissions recovered from wastewater treatment and sludge
$MS_{(T,S)}$	Fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management System S
MSU	Moldova State University
MSW	Municipal Solid Waste
Mt	Megatons = 10^6 tons
MTTP	Moldovan Thermal Power Plant in Dnestrovsk
MW_{anim}	Mature body weight of an adult animal
MW	Megawatt
N	Nitrogen
$N_{(T)}$	Number of head of livestock species/category T in the country
$N_{AG (T)}$	N content of above-ground residues for crop T
$N_{BG (T)}$	N content of below-ground residues for crop T
$N_{bedding\ MS}$	Amount of nitrogen from bedding to be applied for solid storage
$N_{MMS\ Avb}$	Amount of managed manure nitrogen available for application to managed soils
NA	Non Applicable
Nex	Nitrogen excretion rate
NAMA	Nationally Appropriate Mitigation Actions
NBS	National Bureau of Statistics
NC	National Communication
NC4	Fourth National Communication
NE	Non Estimated
NE_a	Net Energy for animal activity
NE_g	Net Energy needed for growth
NE_l	Net Energy for lactation
NE_m	Net Energy required by the animal for maintenance
NE_p	Net Energy required for pregnancy
NE_{work}	Net Energy for work
NE_{wool}	Net Energy required to produce a year of wool
NIR	National Inventory Report
ODP	Ozone-Depleting Potential
ODS	Ozone-Depleting Substances
OHF	Open-hearth furnace
p	p value – the value of a statistical test: the lowest value of the significance level for which the extracted information from the sample is significant (true H_0 is rejected); $p < 0.05$ is considered statistically significant
PA	Species of sycamore maple tree (Acer spp.)
P_{EQ}	Population equivalent number
P.	Page
FC	Perfluorocarbons
PI	Species of pine (Pinus spp.)
PJ	Petajoule
PL	Species of poplar (Populus spp.)
ppb	Parts per billion of volume
ppm	Parts per million of volume
ppt	Parts per trillion of volume

q	Quintal (100 kg)
QA	Quality Assurance
QC	Quality Control
QU	Species of oak (Quercus spp.)
R	Root-to-shoot ratio
$R_{AG (T)}$	Ratio of above-ground residues dry matter to harvested yield for crop T
$R_{BG (T)}$	Ratio of below-ground residues to harvested yield for crop T
RB	Species of Acacia (Robinia spp.)
RCP	Representative Concentration Pathway
REG	Ratio of net energy available for growth in a diet to digestible energy consumed
RM	Republic of Moldova
SA	Species of willow (Salix spp.)
SAR	Second Assessment Report (IPCC, 1996)
SAUM	State Agrarian University of Moldova
SEI	State Ecological Inspectorate
SHS	State Hydrometeorological Service
SM	Emissions from sludge treatment
SN	Synthetic Nitrogen Fertilizers
SNC	Second National Communication
SOE	State Owned Enterprise
SS_{ix}	Fraction of anaerobically treated sludge
σ	Standard Error
t	Ton
T	Trend
T1	Tier 1
T2	Tier 2
TAM	Typical animal mass
TAR	Third Assessment Report (IPCC, 2001)
t.c.e.	Tons of coal equivalent
TE	Species of linden tree (Tilia spp.)
TJ	Terajoule
TM	Emissions from wastewater and sludge treatment
TNC	Third National Communication
TOS	Total organic waste in sludge
TOW	Total organic waste in wastewater
TTE	Team of Technical Experts
TUM	Technical University of Moldova
UCTE	Union for the Coordination of Transmission of Electricity
UL	Species of elm tree (Ulmus spp.)
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
US EPA	United States Environmental Protection Agency
US $	US Dollar
VS	Volatile solid excretion per day
W	Animal Body Weight
W_{ind}	Amount of wastewater generated per unit of industrial output
WB	World Bank
WBTP	Wastewater Biological Treatment Plant
WE	Western Europe
WG	Daily weight gain
WM	Emissions from wastewater handling
WS_{ix}	Fraction of wastewater treated anaerobically
x	Average value
Y_m	Methane conversion factor
Yield Fresh $_{(T)}$	Harvested fresh yield for crop T
%	Per cent

Chemical formulas

Al_2O_3	Aluminium oxide
$CaCO_3$	Limestone
$CaCO_3 \bullet MgCO_3$	Dolomite
CaO	Lime
$CaO \bullet MgO$	Dolomitic lime
$CBrClF_2$	Halon 1211
$CBrClF_3$	Halon 1301
CCl_3F	CFC-11
CCl_2F_2	CFC-12
CCl_2CClF_2	CF-113
CCl_4	Carbon Tetrachloride
CF_4	Perfluoromethane
C_2F_6	Perfluoroethane
C_3F_8	Perfluoropropane
C_4F_{10}	Perfluorobutane
$c\text{-}C_4F_8$	Perfluorocyclobutane
C_5F_{12}	Perfluoropentane
C_6F_{14}	Perfluorohexane
CFC	Chlorofluorocarbons
CH_4	Methane
$C_6H_{12}O_6$	Glucose
C_2H_5OH	Ethanol
$CHClF_2$	HCFC-22
CH_2FCF_3	HFC-134a
CHF_3	HFC-23
CH_2F_3	HFC-32
C_2HF_5	HFC-125
CH_3CCl_2F	HCFC-141b
CH_3CClF_2	HCFC-142b
CF_3CH_3	HFC-143a
CH_3CHF_2	HFC-152a
CF_3CHFCF_3	HFC-227ea
$CF_3CH_2CF_3$	HFC-236fa
$CHF_2CH_2CF_3$	HFC-245fa
$CH_3CF_2CH_2CF_3$	HFC-365mfc
$CF_3CHFCHFCF_2CF_3$	HFC-43-10mee
CO	Carbon monoxide
CO_2	Carbon dioxide
$CO(NH_2)_2$	Urea (carbamide)
Fe_2O_3	Iron oxide
HFC	Hydrofluorocarbons
HNO_3	Nitric acid
MgO	Magnesium oxide
NF_3	Nitrogen trifluoride
Na_2CO_3	Sodium carbonate
NaOH	Sodium Hydroxide (caustic soda)
NH_3	Ammonia
NH_4^+	Ammonium
NH_4NO_3	Ammonia Nitrate
$NH_4H_2PO_4$	Monoammonium phosphate
$(NH_4)_2HPO_4$	Diammonium phosphate
NMVOC	Non methane volatile organic compounds

NO_x	Nitrogen Oxides
NO_3^-	Nitrate
N_2O	Nitrous oxide
N_2O_{ATD}	Indirect N_2O emissions produced from deposition of nitrogen as ammonia (NH_3), oxides of N (NO_x), and their products NH_4 + NH_3 onto soils and the surface of waters
N_2O_{CR}	N_2O emissions from crop residues returned to soils annually
N_2O_{DIR}	Direct N_2O emissions
N_2O_{IND}	Indirect N_2O emissions
N_2O_L	Indirect N_2O emissions due to leaching and runoff from manure management in the country
N_2O_{ON}	N_2O emissions from applied organic N fertilizer
N_2O_{PRP}	N_2O emissions from urine and manure inputs to grazed soils
N_2O_{SN}	N_2O emissions from synthetic fertilizer N
N_2O_{SOM}	N_2O emissions from nitrogen mineralization associated with loss of soil carbon due to land management change
O_3	Ozone
PFC	Perfluorocarbons
SF_6	Sulphur hexafluoride
SiO_2	Silicon oxide
SO_2	Sulphur dioxide

CONTENTS

EXECUTIVE SUMMARY

The Convention, Kyoto Protocol, Paris Agreement and the Party Commitments

The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is aimed "*to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*". To date, 196 countries are Parties to the Convention. The Republic of Moldova signed the UNFCCC on June 12, 1992 and it was ratified by the Parliament on March 16, 1995.

Article 4, paragraph 1(a) and Article 12, paragraph 1(a) of the UNFCCC stipulate that each Party has to make available to the Conference of the Parties (COP) "*a national inventory of anthropogenic emissions by sources and removals by sinks, of all greenhouse gases uncontrolled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be agreed upon by the Conference of the Parties; also a general description of steps taken or envisaged by the Party to implement the Convention; and any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, relevant data for calculations of global emission trends*".

The main mechanism for making this information available is National Communications (NCs). COP 2 (Geneva, 1996) adopted the Guidelines on national communications for non-Annex I Parties (Decision 10/CP 2). In conformity with the respective Guidelines, from 1998 to 2000, under the UNDP-GEF Project "*Enabling Activities for the preparation of the First National Communication to the UNFCCC*", the Republic of Moldova developed its First National Communication (NC1) to the UNFCCC, submitted to the COP 6 (The Hague, 2000).

The COP 8 (New Delhi, 2002) adopted new Guidelines in preparation NCs for non-Annex I Parties (Decision 17/CP.8). In conformity with these Guidelines, from 2005 to 2009, the Republic of Moldova prepared the Second National Communication (NC2); from 2010 to 2014 – the Third National Communication (NC3); from 2014 to 2018 – the Fourth National Communication (NC4) to the UNFCCC; and from 2019 to 2022, the Republic of Moldova is developing its Fifth National Communication (NC5) to the UNFCCC.

With reference to UNFCCC implementation instruments, it should be noted that the COP 3 (Kyoto, 1997) adopted the Kyoto Protocol, representing an instrument setting binding targets for the Parties under the Convention, by committing industrialized countries and economies in transition (37 industrialized countries and the European Union) included in Annex I to the Convention, to reduce total emissions of direct GHG by at least 5 per cent, against 1990 levels over the five-year period: January 1, 2008-December 31, 2012 (the first period of the Protocol commitment). The Republic of Moldova ratified the Kyoto Protocol on February 13, 2003. As a non-Annex I Party, the Republic of Moldova had no commitments to reduce GHG emissions under this Protocol.

According to the Bali Action Plan, adopted at the 13th Conference of Parties to the UNFCCC (2007), developing countries agreed for the first time to develop and implement National Appropriate Mitigation Actions in the context of sustainable development, supported by technology transfer, adequate financing and capacity-building actions.

The COP 15, held in Copenhagen in December 2009, approved and proposed for implementation a policy statement adopted in support of limiting global warming to no more than 2°C compared to pre-industrial level, in the context of equity and sustainable development. This statement, known as the Copenhagen Accord, reaffirms development issues in the context of climate change, including through the implementation of Low Emission Development Strategies (LEDS).

The Republic of Moldova associated itself to the Copenhagen Accord in January 2010 and submitted an emissions reduction target that is specified in Annex II of this Agreement: "*Nationally Appropriate Mitigation Actions in Developing Countries*". The target of mitigation actions for the Republic of

Moldova under this Agreement is "*to reduce the total national level of greenhouse gas emissions to no fewer than 25 per cent by 2020 compared to the base year (1990), by implementing economic mechanisms focused on global climate change mitigation, in accordance with the principles and provisions of the Convention*". This target is presented without indicating specific national appropriate mitigation actions, identified and quantified, and without further clarification of the necessary support to achieve it. Simultaneously, it is recognized that achieving this target will require significant financial, technological and capacity-building support, which can be provided through the UNFCCC mechanisms.

In the same context, from 2010 to 2012, the Low Emissions Development Strategy of the Republic of Moldova until 2020 was prepared, a strategic document that was to allow the country to adjust its development path towards a low carbon economy and to achieve a green sustainable development, based on the socio-economic and development priorities of the country. Also, LEDS was supposed to support overall objectives, provide strategic national context for the mitigation efforts, for which countries would receive international support. LEDS was developed in accordance with the Republic of Moldova's Governance Programme "*European Integration: Freedom, Democracy, Welfare*", Chapter "*Environment Protection*" (2011-2014) and the provisions of chapter "*Climate Change*" of the European Union Association Agreement.

The Strategy contained a set of measures that would reduce greenhouse gas emissions, quantifying the corresponding reduction of GHG emissions for each measure, and the financial requirements for their implementation. The measures proposed in the prioritized list of NAMAs, an Annex to LEDS, included national appropriate mitigation actions, as provided for non-Annex I Parties to the UNFCCC. LEDS also provided information on implementation procedures and timeframes, as well as provisions on monitoring, measurement, reporting and assessment of the results. The Strategy was prepared by the Ministry of Environment of the Republic of Moldova, the process being guided by the Inter-Ministerial Working Group on Climate Change with support from the UNDP country office. This process involved wide consultations with all parties, represented by ministries, research institutions, donor organizations, NGOs and civil society. It was anticipated that LEDS would be approved by the Government by the end of 2013, which did not happen until the end of 2016[1].

The COP 16 held in Cancun in December 2010, adopted the Cancun Agreements, which encourage developing countries to prepare Low Emission Development Strategies for sustainable development and to undertake National Appropriate Mitigation Actions. The Cancun Agreements highlight the fact that "stopping climate change requires a paradigm shift towards building a low-carbon emissions society, which offers substantial opportunities and ensures continued economic growth and sustainable development".

At COP 16, it was also established the periodicity of preparing national communications for non-Annex I countries (Decision 1/CP.16). In line with this, the non-Annex I Parties should prepare and submit National Communications to the UNFCCC Secretariat every four years as well as Biennial Update Reports (BUR) every two years. The inventory section of the BUR should consist of a National Inventory Report as a summary or as a technical annex, expected to present in a detailed and transparent manner the procedures of national inventory for anthropogenic GHG emissions by sources or removals of carbon dioxide through sequestration, including information on emissions trends, key categories, activity data, emissions factors, assessment methodologies, quality assurance and quality control, uncertainties, recalculations and planned improvements, for each source or sink category included in the national inventory.

The COP 17 held in Durban in 2011 adopted the UNFCCC biennial update reporting guidelines for Parties not included in Annex I to the Convention (Decision 2/CP.17 and Annex 3 to this Decision). According to this decision, developing countries, non-Annex I Parties, consistent with their capabilities and the level of support provided for reporting, were expected to submit their first BUR to the Secretariat of the UNFCCC by December, 2014. The Report should be submitted to the Secretariat

[1] <http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=369528>

every two years as a stand-alone report or as a summary of the National Communications, should their reporting years coincide.

The Republic of Moldova initiated the process of preparing the First Biennial Update Report in July 2014, and managed to present it to the Secretariat of the UNFCCC on April 5, 2016. The First Biennial Update Report of the RM to the UNFCCC (2016) was presented to the Secretariat of the UNFCCC together with two technical annexes – the National Inventory Report: 1990-2013, Sources of Greenhouse Gas Emissions and Sinks in the Republic of Moldova (2015) and the Report on the National GHG Inventory System in the Republic of Moldova (2015).

Regarding the non-Annex I Parties, the COP 17 in Durban approved (Decision 2/CP.17 and Annex IV) the Modalities and Guidelines for International Consultation and Analysis (ICA) consisting of two steps: (i) the Technical Analysis of BURs and (ii) a Facilitative Sharing of Views (FSV) among Parties on BURs content and the results of Technical Analysis. The process aims to enhance the transparency and accountability of information reported in BURs by non-Annex I Parties. The technical analysis will be conducted by a Team of Technical Experts (TTE) and will be initiated within six months of BUR submission to the Secretariat.

As for the First Biennial Update Report of the Republic of Moldova to the UNFCCC, its technical assessment by the TTE took place between 19th and 23rd of September 2016, with the summary report being published on the Secretariat of the UNFCCC web page on February 20, 2017[2]. The FSV among Parties on the BUR1 content and the results of technical analysis was carried out during the 3rd FSV workshop, organized by the UNFCCC Secretariat on 15 May 2017 in Bonn, Germany[3].

The COP 18 (Doha, 2012) adopted the Doha Amendment to the Kyoto Protocol which establishes a second commitment period (January 1, 2013-December 31, 2020) for the Parties included in Annex I to the Kyoto Protocol; adds a revised list of greenhouse gases to be reported; and a series of amendments to several articles of the Kyoto Protocol regarding the first commitment period. By December 21, 2012, the UN General Secretary, acting as depositary, presented the Doha Amendment to the Kyoto Protocol to all Parties of the UNFCCC, in accordance with provisions of Articles 20 and 21 of the Protocol. Under Doha Amendment, within the second commitment period, the developed countries should reduce their greenhouse gas emissions by at least 18 per cent compared to 1990 levels. By 28 October 2020[4], 147 countries had ratified the Doha Amendment to the KP, most of which are non-Annex I Parties to the UNFCCC and the KP. The Doha Amendment came into effect on December 31, 2020.

At COP 19 (Warsaw, 2013), the Parties agreed to communicate their intended nationally determined contributions (INDC) (Decision 1/CP.19), in order to include them in the new Climate Agreement to be considered and adopted by the COP 21 in 2015, in Paris. It is expected that the new climate agreement will establish a new commitment period (1st of January 2021-31st of December 2030) for the reduction of GHG emissions. Also, COP 19 in Warsaw adopted General guidelines for domestic measurement, reporting and verification of domestically supported nationally appropriate mitigation actions by developing country Parties (Decision 21/CP.19). This document provides a solid foundation for the new Paris Climate Agreement 2015.

At COP 20 which took place in Lima (2014), the Parties agreed over Lima Call for Climate Action and were repeatedly invited to communicate their intended nationally determined contributions to the UNFCCC Secretariat, in order to facilitate clarity, transparency and understanding. The INDC may include, as appropriate, inter alia: (i) quantifiable information on the reference point; (ii) time frames and/or periods for implementation; (iii) scope and coverage; (iv) planning processes; (v) assumptions and methodological approaches including those for estimating and accounting for anthropogenic gre-

[2] <http://unfccc.int/files/national_reports/non-annex_i_parties/biennial_update_reports/submitted_burs/application/pdf/mda.pdf>

[3] The conclusions of the 3rd FSV seminar regarding the BUR1 of the RM under the UNFCCC and the results of the technical assessment are available on the web page: <http://unfccc.int/files/national_reports/non-annex_i_parties/ica/facilitative_sharing_of_views/application/pdf/20170529_mda_v04.pdf>; RM's presentation at the 3rd FSV seminar is available on: <http://unfccc.int/files/national_reports/non-annex_i_parties/ica/facilitative_sharing_of_views/application/pdf/moldova_fsv_workshop_presentation_15.05.2017.pdf>, and the video recording of the presentation and the interventions of the Parties are available on: <https://www.youtube.com/playlist?list=PL-m2oy1bnLzpmdRpG2pTBzUeOH3qrXlZt>

[4] <https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment>

enhouse gas emissions and, as appropriate, removals; and (vi) how the Party considers that its national contributions will facilitate the achievement of the objective of the Convention as set out in Article 2.

According to Lima Call for Climate Action, countries were invited to communicate their intended nationally determined contributions by March 31, 2015, the deadline for the presentation being September 30, 2015. The request to the Secretariat was to prepare by November 1, 2015 a synthesis report on the aggregate effect of the INDC communicated by Parties.

The Republic of Moldova was fully committed to the UNFCCC negotiation process towards adopting at COP 21 of the Paris Agreement – a document with legal force under the Convention, applicable to all Parties, in line with keeping global warming below 2°C by 2100 compared to the preindustrial era.

The Paris Agreement was signed by the Prime Minister of the Republic of Moldova in New York on September 21, 2016, and was subsequently ratified by the Parliament through Law No. 78 of 04.05.2017 for the ratification of the Paris Agreement (Official Monitor No. 162-170 of 26.05.2017)[5].

On 25th of September 2015, the Republic of Moldova communicated its Intended Nationally Determined Contribution (INDC)[6] and the accompanying information to facilitate clarity, transparency, and understanding, with reference to decisions 1/CP.19 and 1/CP.20. According to its NDC, the Republic of Moldova intends to achieve an economy-wide unconditional target of reducing its greenhouse gas emissions by 64-67 per cent below its 1990 level in 2030 and to make best efforts to reduce its emissions by 67 per cent. The reduction commitment expressed above could be increased conditionally up to 78 per cent below 1990 level in accordance with this global agreement which addresses important topics including low-cost financial resources, technology transfer, and technical cooperation, accessible to all at a scale commensurate to the challenge of global climate change. GHG emissions reduction targets have been set in an emission budget covering the period from January 1, 2021 to December 31, 2030. The GHG emission reduction targets set out in the national contribution intentionally determined of the Republic of Moldova were subsequently officially approved at national level by the Government Decision No. 1470 of 30.12.2016 regarding the approval of the Low Emissions Development Strategy of the Republic of Moldova by 2030 and the Action Plan for its implementation (Official Monitor No. 85-91 of 24.03.2017)[7].

On March 4, 2020, the Republic of Moldova presented the updated version of its NDC the UNFCCC Secretariat[8]. According to it, the Republic of Moldova intends to step up with much more ambitious GHG emission reduction targets regarding by 2030. The unconditional target is thereby to increase from 64-67 per cent to 70 per cent compared to the base year (1990), and the conditional target is to increase from 78 per cent to circa 88 per cent compared to the base year (1990). The new GHG emission reduction targets are to be introduced into the Low Emissions Development Programme until 2030 and the Action Plan for its implementation, to be approve by the end of 2021 year.

Regarding the Second Biennial Update Report (BUR2) of the Republic of Moldova to the UNFCCC, the technical assessment by the TTE took place between the 27th and 31st of May 2019, the summary report being published on the Secretariat of the UNFCCC web page on October 28, 2019[9]. FSV among Parties on the BUR2 content and results of technical analysis was carried out during the 9th FSV workshop, organized by the UNFCCC Secretariat between November 24-27, 2020[10].

Inventory Process in the Republic of Moldova

The Ministry of Agriculture, Regional Development and Environment (MARDE) of the Republic of Moldova is the state authority responsible for development and promotion of policies and strategies addressing environment protection, rational use of natural resources and biodiversity conservation. On behalf of the Government of the Republic of Moldova, MARDE is in charge of the implementation of international environment treaties to which the Republic of Moldova is a Part (including Rio Con-

[5] <http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=370323>
[6] <http://www4.unfccc.int/submissions/INDC/Published%20Documents/Republic%20of%20Moldova/1/INDC_Republic_of_Moldova_25.09.2015.pdf>
[7] <http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=369528>
[8] <https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx>
[9] <https://unfccc.int/sites/default/files/resource/tasr2_2019_MDA.pdf>, <https://unfccc.int/ICA-cycle2>
[10] The conclusions to the 9th FSV seminar regarding the BUR2 of the RM under the UNFCCC and the results of the technical assessment are available on the web page: <https://unfccc.int/ICA-cycle2>, including RM's presentation at the 9th FSV seminar and the video recording of the presentation and the interventions of the Parties.

ventions). The representative of the Ministry of Agriculture, Regional Development and Environment is also the National Focal Point to the UNFCCC.

According to Government Decision No. 549 of 13.06.2018 on the creation, organizing and functioning of the Environment Agency[11], the latter has been recently assigned the following competencies *in the field of atmospheric air protection and climate change*: the implementation of provisions of policy documents and international environmental treaties to which the RM is a part in the field of protection of atmospheric air quality and ozone layer, *GHG emissions reduction and adaptation to climate change*, the elaboration and presentation of information on their implementation to the MARDE; participation to the works of the *National Commission for Climate Change*; ensuring the implementation of the *monitoring, reporting and verification system for GHG emissions*; performing *the process of collecting, centralizing, validating and processing data and required information for the inventories and reports on atmospheric pollutants and GHG emissions*; providing technical support to MARDE for the development of *national communications and biennial update reports* according to UNFCCC provisions.

At the same time, in accordance with Government Decision no. 1277 of 26.12.2018 on establishment and operation of the National Monitoring and Reporting System (NMRS) on greenhouse gas emissions and other information relevant to climate change, the Environmental Agency has been designated as the *competent authority* responsible for ensuring the operation of the NMRS on greenhouse gas emissions and other information relevant to climate change, provided that the operation of NMRS is carried out at the expense and within the resources approved in the state budget of the institutions party to the system, as well as other sources provided by law, including from external financing *(activities carried out on the basis of technical assistance and capacity building projects).*

In the above context, it is important to mention that, in accordance with Government Decision no. 1249 of 19.12.2018 on organization and operation of the Public Institution "Environmental Projects Implementation Unit" (PI "EPIU")[12], the latter has the mission to support MARDE and organizational units in its area of competence, in the purpose of efficient implementation of financial and technical assistance projects, external and internal, in the field of environmental protection and use of natural resources (protection of atmospheric air, ozone layer and climate change; waste and chemical management; prevention of environmental pollution; water resources management; biosecurity, biodiversity conservation and management of natural areas protected by the state), in accordance with the provisions of regulatory documents, on implementation of the requirements of international conventions to which the Republic of Moldova is party and alignment with international standards in the field of environmental protection.

As competent authority responsible for operation of the National Monitoring and Reporting System on greenhouse gas emissions and other information relevant to climate change, the Environmental Agency has requested by Letter no. 3471 of 25.09.2019 that Climate Change Office within the PI "EPIU" examines and identifies opportunities for providing the necessary support for the accomplishment of commitments in the field of climate change by organizing the entire process of developing the Third Biennial Update Report of the Republic of Moldova to UNFCCC, respectively of the Fifth National Communication of the Republic of Moldova to the UNFCCC, in accordance with the rules, procedures and decisions of the Conference of the Parties to the UNFCCC.

From February 2004 to December 2018, and recently (as of January 2019), the Climate Change Office within the PI "EPIU" was responsible for activities associated with the preparation of National Communications, Biennial Update Reports, National Inventory Reports and national inventories of GHG emissions.

The National Inventory Team within the PI "EPIU" is responsible for estimating emissions by source categories and removals by sink categories, key category analysis, quality assurance and quality control activities, uncertainty assessment, documentation and archiving of the information related to GHG inventory preparation process.

[11] <https://www.legis.md/cautare/getResults?doc_id=119162&lang=ro>
[12] <https://www.legis.md/cautare/getResults?doc_id=113696&lang=ro>.

In the process of preparing the national GHG inventory, the National Inventory Team employed a centralized approach consisting of the National Inventory Report (NIR) and the inventory itself reported by using a series of standardised Common Reporting Format (CRF) (Sectoral and Summary) Tables (according to Decision 24/CP.19[13]).

The Report was drafted in compliance with UNFCCC Reporting Guidelines on Annual Inventories and has the following structure: Summary, Chapter 1 'Introduction', Chapter 2 'Greenhouse Gas Emission Trends', Chapter 3 'Energy', Chapter 4 'Industrial Processes and Product Use', Chapter 5 'Agriculture', Chapter 6 'LULUCF', Chapter 7 'Waste', Chapter 8 'Recalculations and Planned Improvements'', 'Bibliography' and 'Annexes'.

Emissions of direct (CO_2, CH_4, N_2O, HFC, PFC, SF_6 and NF_3) greenhouse gases were estimated based on methodologies contained in the 2006 IPCC Guidelines, while indirect emissions (NO_x, CO, NMVOC and SO_2) were estimated based on methodologies according to the EEA/EMEP Air Pollutant Emission Inventory Guidebook (2019).

Activity data used in this report are based on officially published data, such as national and international statistic publications; scientific literature; national legislation acts; data provided by the ministries and subordinated institutions, central administrative authorities and economic agents.

The results of the key categories analysis (1990-2019) carried out following a Tier 1 methodological approach, by use of the Key Categories Analysis Tool v2.5[14], developed by the US Environment Protection Agency (US EPA), revealed: without LULUCF – 21 key categories by level (L) and 20 key categories by trend (T): based on a Tier 2 approach – 19 key categories by level (L) and 17 key categories by trend (T); with LULUCF, based on the Tier 1 methodological approach – 28 key categories by level (L) and 26 key categories by trend (T), respective, based on a Tier 2 approach – 26 key categories by level (L) and 22 key categories by trend (T).

As a part of continuous efforts to develop a transparent and reliable inventory, the Republic of Moldova has developed a "Quality Assurance and Quality Control Plan".

The key attributes of the Plan include detailed specific procedures and standard verification and quality control forms and checklists, by using Tier 1 (general procedures) and Tier 2 (source-specific procedures) methodological approaches, which serve to standardize the process of implementing quality assurance and quality control activities meant to ensure the quality of the national inventory; peer review carried out by experts not directly involved in the national inventory development process; data quality check including by comparing the sets of data obtained from different sources; inventory planning and coordination at an inter-institutional level; as well as the continuous documentation and archiving of all materials used in inventory preparation process.

Inventory quality assurance activities were supported by experts representing: the Institute of Power Engineering of the Academy of Sciences of Moldova – for Sector 1 'Energy'; the Technical University of Moldova – for Sector 2 'Industrial Processes and Product Use'; the Institute of Pedology, Agrochemistry and Soil Protection "Nicolae Dimo" – for Sector 3 'Agriculture'; State Agrarian University of Moldova – for Sector 4 'Land Use, Land-Use Change and Forestry'; independent consultant in the field of environmental protection – for Sector 5 'Waste'.

The National Inventory of the Republic of Moldova represents, mostly, a complete register of greenhouse gas emissions. Although the NIR is intended to be comprehensive, certain sources have been excluded from the estimates presented for various reasons. Generally speaking, sources not accounted for this inventory are excluded due to data limitations. The National Inventory Team is continuously seeking to find the data required to estimate related GHG emissions/removals.

Direct Greenhouse Gas Emission Trends

In comparison with the base year level (1990), by 2019, the Republic of Moldova had reduced its GHG emissions by circa 69.5 per cent (Table ES-1).

[13] <https://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf>, <https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-convention/greenhouse-gas-6>.
[14] <https://19january2017snapshot.epa.gov/climatechange/national-ghg-inventory-capacity-building_.html>

Table ES-1: Total GHG emissions and accompanying variables in the RM between 1990-2019

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Population, million inhabitants	**4.362**	**4.348**	**4.304**	**4.087**	**3.687**	**3.345**	**3.299**	**3.251**	**3.199**	**3.147**
Compared to 1990, %		-0.3	-1.3	-6.3	-15.5	-23.3	-24.4	-25.5	-26.6	-27.9
Inter-annual fluctuation, %		-0.1	-0.3	-3.4	-2.1	-0.9	-1.4	-1.5	-1.6	-1.6
Total GHG emissions, Mt CO_2 eq.	**45.349**	**17.767**	**11.039**	**13.025**	**13.333**	**13.200**	**13.503**	**13.244**	**13.908**	**13.810**
Compared to 1990, %		-60.8	-75.7	-71.3	-70.6	-70.9	-70.2	-70.8	-69.3	-69.5
Inter-annual fluctuation, %		-16.1	-7.6	3.1	5.2	0.2	2.3	-1.9	5.0	-0.7
Total GHG emissions, t CO_2 eq./ per capita	**10.4**	**4.1**	**2.6**	**3.2**	**3.6**	**3.9**	**4.1**	**4.1**	**4.3**	**4.4**
Compared to 1990, %		-60.7	-75.3	-69.4	-65.2	-62.1	-60.6	-60.8	-58.2	-57.8
Inter-annual fluctuation, %		-16.0	-7.4	6.7	7.5	1.1	3.7	-0.5	6.7	1.0
GDP, billion 2015 US $	**11.250**	**4.435**	**3.913**	**5.508**	**6.452**	**7.745**	**8.087**	**8.466**	**8.830**	**9.135**
Compared to 1990, %		-60.6	-65.2	-51.0	-42.6	-31.2	-28.1	-24.7	-21.5	-18.8
Inter-annual fluctuation, %		-1.4	2.1	7.5	7.1	-0.3	4.4	4.7	4.3	3.5
GHG intensity, kg CO_2 eq./2015 US $	**4.0**	**4.0**	**2.8**	**2.4**	**2.1**	**1.7**	**1.7**	**1.6**	**1.6**	**1.5**
Compared to 1990, %		-0.6	-30.0	-41.3	-48.7	-57.7	-58.6	-61.2	-60.9	-62.5
Inter-annual fluctuation, %		-14.9	-9.5	-4.1	-1.7	0.5	-2.0	-6.3	0.7	-4.0
Imported energy, million t.c.e.	**16.703**	**5.109**	**2.535**	**3.123**	**2.590**	**2.522**	**2.597**	**2.874**	**3.013**	**2.903**
Compared to 1990, %		-69.4	-84.8	-81.3	-84.5	-84.9	-84.5	-82.8	-82.0	-82.6
Inter-annual fluctuation, %		11.0	-18.0	4.2	-8.2	-2.1	3.0	10.7	4.8	-3.7
Consumed energy, million t.c.e.	**15.054**	**5.085**	**2.647**	**3.257**	**3.761**	**3.832**	**3.989**	**4.195**	**4.410**	**4.193**
Compared to 1990, %		-66.2	-82.4	-78.4	-75.0	-74.5	-73.5	-72.1	-70.7	-72.1
Inter-annual fluctuation, %		9.7	-20.2	6.3	27.1	0.4	4.1	5.2	5.1	-4.9
Produced electricity, billion kWh	**15.690**	**6.168**	**3.624**	**4.225**	**6.115**	**6.050**	**5.852**	**4.963**	**5.389**	**5.697**
Compared to 1990, %		-60.7	-76.9	-73.1	-61.0	-61.4	-62.7	-68.4	-65.7	-63.7
Inter-annual fluctuation, %		-25.8	-11.8	1.1	-1.3	12.5	-3.3	-15.2	8.6	5.7
Consumed electricity, billion kWh	**11.426**	**7.022**	**4.510**	**5.838**	**5.257**	**5.455**	**5.227**	**5.259**	**5.463**	**5.513**
Compared to 1990, %		-38.5	-60.5	-48.9	-54.0	-52.3	-54.3	-54.0	-52.2	-51.7
Inter-annual fluctuation, %		-3.9	-4.4	-3.1	-0.9	-8.7	-4.2	0.6	3.9	0.9
Produced heat, million Gcal	**22.212**	**9.827**	**4.986**	**5.324**	**4.601**	**3.979**	**4.125**	**4.084**	**4.137**	**3.884**
Compared to 1990, %		-55.8	-77.6	-76.0	-79.3	-82.1	-81.4	-81.6	-81.4	-82.5
Inter-annual fluctuation, %		30.9	-26.0	8.2	5.4	-2.1	3.7	-1.0	1.3	-6.1
Consumed heat, million Gcal	**20.983**	**8.796**	**4.501**	**4.765**	**3.988**	**3.473**	**3.628**	**3.551**	**3.697**	**3.441**
Compared to 1990, %		-58.1	-78.5	-77.3	-81.0	-83.4	-82.7	-83.1	-82.4	-83.6
Inter-annual fluctuation, %		32.1	-23.6	8.4	4.1	-3.1	4.5	-2.1	4.1	-6.9

References: [1]Economic Research Service US Department of Agriculture (<http://www.ers.usda.gov/data-products/international-macroeconomic-data-set.aspx>); [2]Statistical Yearbooks of the RM (<http://www.statistica.md/pageview.php?l=ro&idc=263&id=2193>) and ATULBD (<http://www.mepmr.org/pechatnye-izdaniya/statisticheskij-ezhegodnik-pmr>); [3]Energy Balances of the RM for 1990, 1993-2019 and Statistical Yearbooks of ATULBD.

Table ES-1 reveals that the decrease in GHG emissions over the last 30 years is in full consistency with a decrease in some important economic and social indicators: the real value of the GDP decreased by 18.8 per cent within this time periods, the population – by 27.9 per cent, the GHG intensity (CO_2eq/GDP) – by 62.5 per cent, consumption of primary energy resources – by 72.1 per cent, import of energy – by 82.6 per cent, electricity consumption – by 51.7 per cent, heat consumption – by 83.6 per cent.

The significant reduction of socio-economic indicators between 1990 and 2019 is a consequence of the profound transformation processes common for the transition from a centralized economy to a market economy, in particular after the breakup of the Soviet Union and the Declaration of Independence of the Republic of Moldova on August 27, 1991. In 1990, the country had medium-low incomes while today it is considered one of the countries with the lowest incomes in Europe.

Even before 1991, there were some tendencies of economic decline, but the separation from the USSR considerably accelerated the process. The real GDP level decreased continuously from 1990 to 1999 inclusively, when it fell down to as little as 34 per cent of the 1990 level. The reasons for the economic collapse were numerous. First, the country had been fully integrated in the USSR economic system, and the independence resulted, among other things, in the cessation of any subsidies or cash transfers from the centralized government. Second, the end of the Soviet Era with its well-established commercial links resulted in the emergence of numerous obstacles for free movement of goods, and in access restrictions introduced by the emerging markets. Third, the lack of domestic energy resources and raw materials in the country contributed considerably to the nation's strong dependence on other former Soviet Republics.

This dependence has affected consumers' capacity to pay for the energy used due to the increased prices of energy resources (e.g., from 1997 to 2019 the natural gas tariff increased by circa 9 times; electricity tariff increased by circa 7.4 times; gasoline, diesel and liquefied gases prices increased by circa

2.3-2.4 times), on condition that most energy resources were imported. On the other hand, without applying cross subsidizations policies, the current energy prices incentivized the population to take strong energy efficiency measures in the RM, which led to a significant decrease in energy intensity, declining since 2006 with an average annual negative growth of circa 2.5 per cent.

Simultaneously, in the period 2000-2019, the real GDP increased by 133.5 per cent, from about 3.9 to 9.1 billion US dollars updated in 2015, and the real GDP per capita increased by 219.3 per cent, from 909 to 2903 US dollars updated at the 2015 year level.

The considerable increase in real GDP achieved since 2000 seems to show that the economy has developed in the right direction, albeit we must remember that in 2019 the real GDP reached only 81.2 per cent of the level recorded in the base year (1990). We must mention that from 2000 to 2019, the consumption of primary energy resources had increased in the Republic of Moldova by 58.4 per cent; while the intensity of emissions (CO_2eq./GDP) decreased by 46.4 per cent, indicating signs of economic growth decoupling from the increase of GHG emissions by 25.1 per cent in the period 2000-2019 (Figure ES-1).

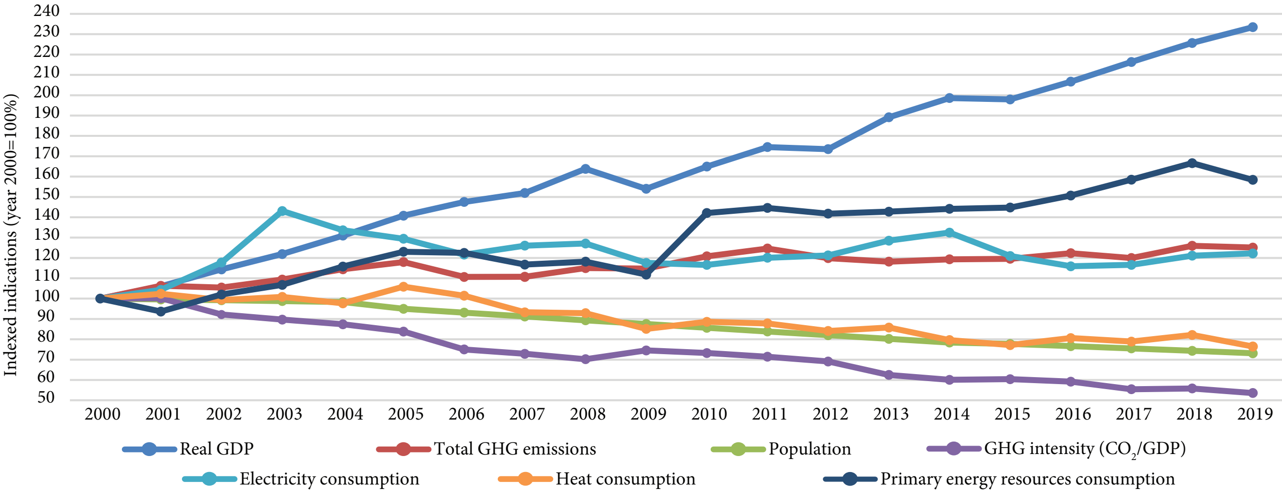

Figure ES-1: Trends in total GHG emissions and associated variables in the Republic of Moldova within 2000-2019.

Table ES-2 provides data on total and net GHG emissions in the Republic of Moldova in 2019.

The share of CO_2 emissions in the total direct GHG emissions was circa 68.0 per cent, CH_4 contributed with circa 18.9 per cent, N_2O emissions accounted for 11.4 per cent of the total, while the share of F-gases (HFCs, PFCs, SF_6) being totally insignificant, only circa 1.7 per cent of the total (Figure ES-2).

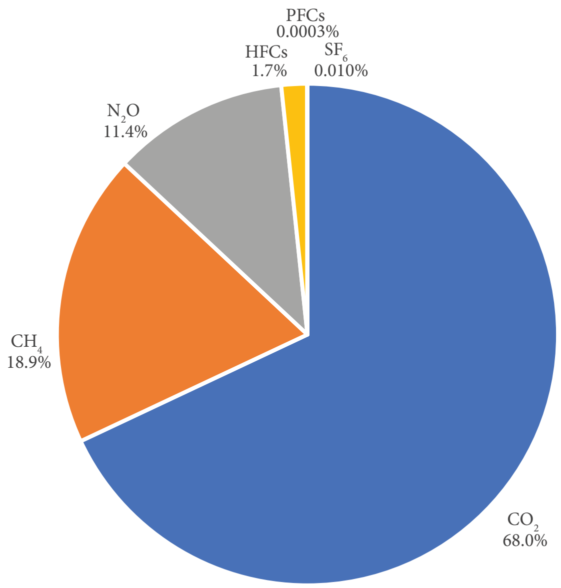

Figure ES-2: Republic of Moldova's Direct GHG Emissions by Gas in 2019.

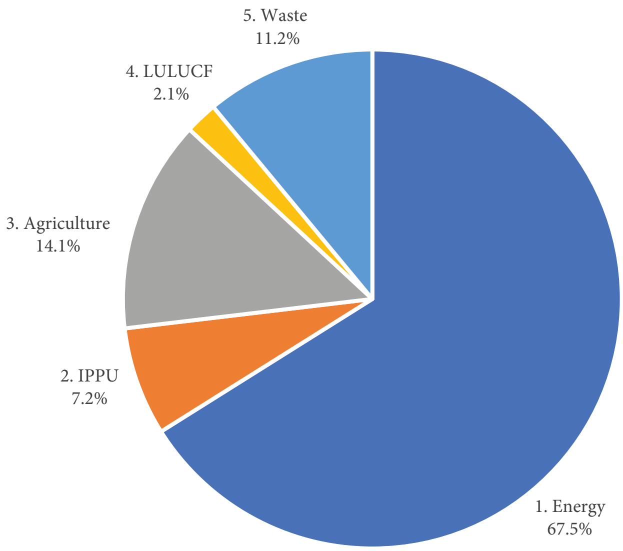

Figure ES-3: Sectoral Breakdown of the Total GHG Emissions in 2019.

In 2019, in the Republic of Moldova, approximately 67.5 per cent of the total national direct GHG emissions originated from the Sector 1 'Energy'. Other relevant direct GHG sources are represented by Sector 3 'Agriculture' (14.1 per cent of the total), Sector 5 'Waste' (11.2 per cent of the total), Sector 2 'Industrial Processes and Product Use' (7.2 per cent of the total), and Sector 4 'Land Use, Land-Use Change and Forestry' (2.1 per cent of the total) (Figure ES-3).

Table ES-2: Republic of Moldova's Total Direct GHG Emissions in 2019

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**9 526.1314**	**2 616.1543**	**1 732.0603**	**229.9469**	**0.0403**	**1.4306**	**NO**	**NO**	**14 105.7639**
1. Energy	**8 577.9507**	**629.7143**	**114.0029**						**9 321.6679**
A. Fuel Combustion (sectoral approach)	8 576.3417	233.8722	114.0002						8 924.2142
1. Energy Industries	3 120.4282	1.4026	1.6863						3 123.5171
2. Manufacturing Industries and Construction	715.9769	0.9489	1.5501						718.4760
3. Transport	2 611.5823	12.4582	41.4206						2 665.4611
4. Other Sectors	2 105.4914	219.0565	69.2351						2 393.7830
5. Other	22.8629	0.0060	0.1080						22.9770
B. Fugitive Emissions from Fuels	1.6090	395.8421	0.0027						397.4538
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.6090	395.8421	0.0027						397.4538
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**760.7727**	**NO**	**NO**	**229.9469**	**0.0403**	**1.4306**	**NO**	**NO**	**992.1906**
A. Mineral Industry	600.3437								600.3437
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	15.7926	NO	NO	NO	NO	NO	NO	NO	15.7926
D. Non-Energy Products from Fuels and Solvent Use	143.5292	NO	NO						143.5292
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				229.9469	NO	NO	NO	NO	229.9469
G. Other Product Manufacture and Use	1.1072	NO	NO	NO	0.0403	1.4306	NO	NO	2.5781
H. Other									
3. Agriculture	**39.6306**	**508.2390**	**1 395.6062**						**1 943.4759**
A. Enteric Fermentation		441.6456							441.6456
B. Manure Management		66.5935	278.4665						345.0599
C. Rice Cultivation		NO							NO
D. Agricultural Soils			1 117.1398						1 117.1398
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	39.6306								39.6306
I. Other Carbon-Containing Fertilizers	NO, NE								NO,NE
J. Other	NO	NO	NO						NO
4. LULUCF	**133.8653**	**0.3937**	**161.5278**						**295.7869**
A. Forest Land	-1 950.6476	0.3521	0.2322						-1 950.0633
B. Cropland	1 789.8845	0.0416	0.0129						1 789.9390
C. Grasslands	-293.2923	NE	NE						-293.2923
D. Wetlands	-82.8099	NE	NE						-82.8099
E. Settlements	116.5030	NO, NE	161.2828						277.7857
F. Other Land	611.7881	NE	NE						611.7881
G. Harvested Wood Products	-57.5604								-57.5604
H. Other	NE								NO
5. Waste	**13.9120**	**1 477.8072**	**60.9234**						**1 552.6426**
A. Solid Waste Disposal	NA, NO	1 231.5881							1 231.5881
B. Biological Treatment of Solid Waste		1.3965	0.9988						2.3952
C. Incineration and Open Burning of Waste	13.9120	7.1455	1.4945						22.5520
D. Wastewater Treatment and Discharge		237.6771	58.4302						296.1073
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:									
International Bunkers	**151.5015**	**0.1369**	**1.5333**						**153.1717**
International Aviation	151.5015	0.1369	1.5333						153.1717
International Navigation	NO	NO	NO						NO
Multilateral Operations	NO	NO	NO						NO
CO_2 Emissions from Biomass	2 963.2154								2 963.2154
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in waste disposal sites	NE								NO
Indirect N_2O			295.7271						295.7271
Indirect CO_2	136.1265								136.1265
Total (without LULUCF)									**13 809.9770**
Total (with LULUCF)									**14 105.7639**

Abbreviations: IE – Included Elsewhere; NE – Not Estimated; NO – Not Occurring.

Table ES-3: Republic of Moldova's Total Direct GHG Emissions within 1990-2019 periods

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
	CO_2 equivalent (kt)									
1. Energy	**36 895.2895**	**12 309.6523**	**6 876.1471**	**8 764.3809**	**9 327.7905**	**9 182.4782**	**9 334.9363**	**8 899.5284**	**9 409.2870**	**9 321.6679**
A. Fuel Combustion (sectoral approach)	36 082.4102	11 647.8448	6 275.1366	7 987.8235	8 746.6927	8 614.2156	8 722.1748	8 250.2463	8 805.1132	8 924.2142
1. Energy Industries	21 364.2413	7 192.4074	3 159.3286	3 235.4860	4 059.6277	3 689.9589	3 648.6333	2 886.8208	3 180.5484	3 123.5171
2. Manufacturing Industries and Construction	1 923.3779	382.2342	520.3009	575.2151	423.3105	654.1931	643.6290	661.1426	751.3852	718.4760
3. Transport	4 837.9155	1 660.4315	1 005.7542	1 867.0868	2 188.8720	2 307.9763	2 481.6237	2 463.4534	2 581.9145	2 665.4611
4. Other sectors	7 841.3054	2 286.2222	1 552.9485	2 283.7523	2 047.3623	1 939.2152	1 925.2983	2 175.9589	2 267.8044	2 393.7830
5. Other	115.5701	126.5495	36.8044	26.2833	27.5201	22.8721	22.9905	22.7351	23.4607	22.9770
B. Fugitive Emissions from Fuels	812.8794	661.8075	601.0105	776.5574	581.0977	568.2626	612.7641	649.2847	604.1765	397.4538
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	812.8794	661.8075	601.0105	776.5574	581.0977	568.2626	612.7641	649.2847	604.1765	397.4538
C. CO_2 Transport and Storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial Processes and Product Use	**1 603.6964**	**456.1769**	**314.4396**	**571.3202**	**559.9521**	**762.7907**	**747.9643**	**776.7911**	**959.2291**	**992.1906**
A. Mineral Industry	1 337.4142	351.1816	239.4427	437.4573	404.3936	505.0564	492.5454	476.0597	590.9800	600.3437
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Industry	28.5023	26.2369	36.2689	41.9358	9.6985	17.2792	5.2203	18.8842	20.2133	15.7926
D. Non-Energy Products from Fuels and Solvent Use	234.3591	76.5607	32.6395	68.1910	66.2398	84.5691	84.8044	97.0273	151.1808	143.5292
E. Electronic Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS	NO	1.0298	5.1199	22.5106	77.8936	153.8517	163.2067	182.4923	194.4750	229.9469
G. Other Product Manufacture and Use	3.4207	1.1679	0.9685	1.2255	1.7265	2.0343	2.1875	2.3277	2.3801	2.5781
H. Other	NA	NA	NA	NA	NA	NA	NA	0.0000	0.0000	0.0000
3. Agriculture	**5 335.4900**	**3 410.3147**	**2 312.1138**	**2 240.3387**	**1 966.7346**	**1 848.4464**	**1 987.5167**	**2 037.8912**	**1 992.9602**	**1 943.4759**
A. Enteric Fermentation	2 189.4276	1 618.0865	1 085.7826	924.0273	708.1752	629.2090	622.0031	577.9552	516.4012	441.6456
B. Manure Management	1 611.7134	939.2484	553.2206	556.5852	503.1437	425.0414	438.2849	419.1947	378.9195	345.0599
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	1 533.7671	852.9191	672.6709	759.5523	753.6714	782.9558	914.9539	1 014.5332	1 054.2771	1 117.1398
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Urea Application	0.5820	0.0607	0.4397	0.1739	1.7443	11.2402	12.2747	26.2081	43.3624	39.6306
I. Other Carbon-Containing Fertilizers	NO	NO	NO	NO	NO	NO	NO,NE	NO,NE	NO,NE	NO,NE
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. LULUCF	**-1 387.8169**	**-1 761.5693**	**-1 853.8990**	**-1 395.9594**	**-953.9285**	**-903.4922**	**-657.5580**	**-713.7989**	**-560.0883**	**295.7869**
A. Forest Land	-2 563.0889	-2 045.0615	-2 307.4358	-2 409.4945	-2 484.0285	-2 158.4241	-2 115.2503	-2 015.7307	-1 969.1152	-1 950.0633
B. Cropland	2 651.9328	1 589.1918	1 493.3603	1 543.5448	1 546.0900	1 391.1171	1 391.9811	1 369.1743	1 487.3885	1 789.9390
C. Grassland	-1 205.6938	-1 601.1004	-1 291.9495	-1 058.1239	-691.9874	-418.4569	-402.3693	-384.0392	-440.1513	-293.2923
D. Wetlands	-555.3798	-469.4389	-328.4245	-187.4101	-46.3958	-82.7917	-82.7917	-82.8162	-82.8253	-82.8099
E. Settlements	254.2294	357.7389	396.2187	340.1329	303.7123	229.0089	198.3556	248.8550	186.9048	277.7857
F. Other Land	152.3638	401.1281	178.5246	416.5012	441.4824	86.8192	351.6349	218.2055	321.2138	611.7881
G. Harvested Wood Products	-122.1804	5.9727	5.8073	-41.1098	-22.8014	49.2353	0.8816	-67.4476	-63.5037	-57.5604
H. Other	NO	NO	NO	NO	NO	NO	NO	NE	NE	NO
5. Waste	**1 514.2369**	**1 590.4195**	**1 536.3833**	**1 449.1911**	**1 478.6343**	**1 405.9127**	**1 433.0666**	**1 530.2502**	**1 546.2913**	**1 552.6426**
A. Solid Waste Disposal	1 046.7277	1 209.1757	1 169.5330	1 064.3081	1 137.8491	1 087.1715	1 115.1732	1 211.7264	1 223.5561	1 231.5881
B. Biological Treatment of Solid Waste	2.3322	1.0843	0.8984	1.0334	1.8439	2.1795	2.1665	2.4799	2.2360	2.3952
C. Incineration and Open Burning of Waste	24.2621	24.4574	24.2867	23.4100	20.8019	21.5422	21.0986	23.7193	23.1496	22.5520
D. Wastewater Treatment and Discharge	440.9149	355.7021	341.6652	360.4395	318.1393	295.0195	294.6284	292.3246	297.3497	296.1073
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:										
International Bunkers	**195.7347**	**42.5212**	**63.7967**	**38.3980**	**41.5312**	**57.4930**	**102.1063**	**149.8553**	**172.2996**	**153.1717**
International Aviation	195.7347	42.5212	63.7967	38.3980	41.5312	57.4930	102.1063	149.8553	172.2996	153.1717
International Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
		CO_2 equivalent (kt)								
CO_2 Emissions from Biomass	**232.8093**	**230.0480**	**272.3720**	**307.3920**	**341.0480**	**1 428.4386**	**1 600.9890**	**2 122.7228**	**3 567.9567**	**2 963.2154**
CO_2 Captured and Stored	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Long-term Storage of C in waste disposal sites	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Indirect N_2O	605.7468	324.3061	223.6470	244.3645	237.1044	233.7742	264.1134	282.4208	285.8518	295.7271
Indirect CO_2	207.5471	65.4471	28.5957	61.0627	59.3041	77.8743	77.9170	90.1477	143.8072	136.1265
Total (without LULUCF)	**45 348.7128**	**17 766.5634**	**11 039.0838**	**13 025.2310**	**13 333.1115**	**13 199.6280**	**13 503.4838**	**13 244.4609**	**13 907.7677**	**13 809.9770**
Total (with LULUCF)	**43 960.8959**	**16 004.9941**	**9 185.1849**	**11 629.2716**	**12 379.1830**	**12 296.1358**	**12 845.9258**	**12 530.6620**	**13 347.6794**	**14 105.7639**

Abbreviations: IE – Included Elsewhere; NE – Not Estimated; NO – Not Occurring.

Table ES-3 shows the evolution of total direct GHG emissions and removals in the Republic of Moldova for the period 1990-2019.

As it can be noted, the total national direct GHG emissions (without Sector 4 'LULUCF') had decreased during the period under review by 69.5 per cent, from 45.34 Mt CO_2 equivalent in 1990 to 13.81 Mt CO_2 equivalent in 2019 (GHG emissions had decreased by circa 0.7 per cent as compared to 2018 level).

At the same time, net direct GHG emissions (with Sector 4 'LULUCF') had decreased by 67.9 per cent in the same period, from 43.96 Mt CO_2 equivalent in 1990 to 14.11 Mt CO_2 equivalent in 2019 (net emissions, however, had increased by 5.7 per cent as compared to 2018 level).

To be noted that the GHG emissions from Sector 1 'Energy' had decreased in the period 1990-2019 by circa 74.7 per cent (in 2019, they decreased by 0.9 per cent as compared to 2018 level), emissions from Sector 2 'Industrial Processes and Product Use' had decreased by circa 38.1 per cent (in 2019, however, they increased by 3.4 per cent compared to 2018 level), emissions from Sector 3 'Agriculture' decreased by 63.6 per cent (in 2019, they decreased by 2.5 per cent as compared to 2018 level), net removals in Sector 4 'LULUCF' decreased by 121.3 per cent (in 2019, they decreased by 152.8 per cent as compared to 2018 level), respectively, emissions from Sector 5 'Waste' increased by 2.5 per cent (in 2019, they increased 0.4 per cent as compared to 2018 level).

The most significant reductions of direct GHG emissions by source categories had been registered in the period 1990-2019 in the following categories: 1A1 'Energy Industries' (-85.4%), 4D 'Wetlands' (-85.1%), 1A5 'Other' (-80.1%), 3A 'Enteric Fermentation' (-79.8%), 3B 'Manure Management' (-78.6%), 4C 'Grassland' (-75.7%), 1A4 'Other Sectors' (-69.5%), 1A2 'Manufacturing Industries and Construction' (-62.6%), 2A 'Mineral Industry' (-55.1%), 4G 'Harvested Wood Products' (-52.9%), 1B2 'Oil and Natural Gas' (-51.1%), 1A3 'Transport' (-44.9%), 2C 'Metal Industry' (-44.6%), 2D 'Non-Energy Products from Fuels and Solvent Use' (-38.8%), 5D 'Wastewater Treatment and Discharge' (-32.8%), 4B 'Cropland' (-32.5%), 2G 'Other Product Manufacture and Use' (-24.6%), 3D 'Agricultural Soils' (-27.2%) and 4A 'Forest Land' (-23.9%).

In the period 2018-2019, total direct GHG emissions increased by circa 5.7 per cent due to the increase of emissions from the following categories: 4F 'Other Land' (+90.5%), 4E 'Settlements' (+48.6%), 4B 'Cropland' (+20.3%), 2F 'Product Use as Substitutes for ODS' (+18.2%), 2G 'Other Product Manufacture and Use' (+8.3%), 5B 'Biological Treatment of Solid Waste' (+7.1%), 3D 'Agricultural Soils' (+6.0%), 1A4 'Other Sectors' (+5.6%), 1A3 'Transport' (+3.2%), 2A 'Mineral Industry' (+1.6%) and 5A 'Solid Waste Disposal' (+0.7%).

Indirect GHG Emission Trends

Though not considered greenhouse gases, photochemically active gases like carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC), have an indirect global warming effect. These gases are considered as ozone precursors influencing the formation and destruction of tropospheric and stratospheric ozone, which are particularly emitted from transportation, fossil fuel combustion, consumption of solvents and other household products, etc.

The national GHG inventory of the RM includes emissions of the following ozone and aerosol precursors: NO_x, CO, NMVOC and SO_2.

Between 1990 and 2019, total NO_x emissions had decreased by 79.5 per cent: from 89.65 kt in 1990 to 18.35 kt in 2019; total CO emissions decreased by 48.0 per cent: from 276.33 kt in 1990 to 143.72 kt in 2019; NMVOC emissions decreased by 34.9 per cent: from 138.79 kt in 1990 to 90.32 kt in 2019; while SO_2 emissions decreased by 96.5 per cent: from 150.10 kt in 1990 to 5.24 kt in 2019 (Figure ES-4).

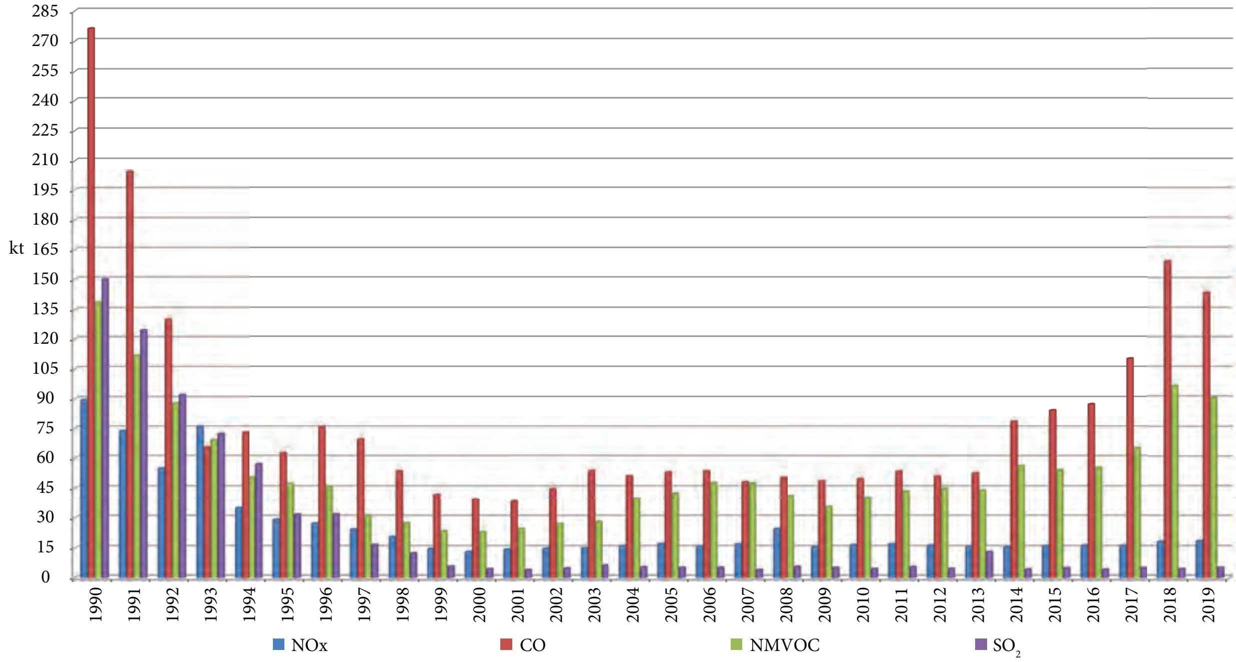

Figure ES-4: National indirect GHG emissions in the RM for the period 1990-2019.

1. INTRODUCTION

1.1. Climate Change Phenomenon

1.1.1. Climate Change and Greenhouse Effect

Under the UNFCCC, climate change is defined as *'a change of climate which is attributed directly or indirectly to human activity, which alters the composition of the global atmosphere being an additional effect to natural climate variability observed over comparable time periods'*. Human activities change atmospheric concentrations and distribution of greenhouse gases and aerosols. These changes can produce a radiant force by either changing the solar radiation reflection and absorption, or emission and absorption of terrestrial radiation.

Box 1-1: Climate change – definitions and evolution scenarios

To better understand the definition of climate change it is important to perceive the difference between the notions of weather and climate. Weather is a condition of the atmosphere at a certain time and in a certain place, perceived as a modification of temperature, air pressure, humidity, wind speed, nebulosity and precipitations. The notion of weather is used when the abovementioned conditions are related to short periods of time. The notion of climate usually refers to the average state of weather in a certain region of the world persisting a longer period of time (at least 30 years). So, climate may be defined as a weather pattern characteristic to a certain region of the world. Elements of the climate are: precipitations, temperature, humidity, solar radiation, wind speed and such phenomenon as fog, frost, hoarfrost, hail and other. Climate change refers to long term changes in weather patterns caused by both natural phenomena (astronomic: solar activity, influence of some planets, etc.; geological-geophysical: change of the Earth's axis angle, change of the Earth orbit and other; geographical: changes in the active surface structure – volcanic eruptions, massive landslides), and phenomena of anthropogenic nature (induced by humans), such as pollution of terrestrial atmosphere (change of the global atmosphere composition by generation of GHG).

In accordance with the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC, 2013), it is expected that the climate change phenomenon will have different impact in different regions of the world. In comparison with the reference period 1986-2005, it is expected that by the end of the 21st century (2081-2100) the average global air surface temperature will increase by circa 0.3-1.7°C according to RCP2.6, respectively by 1.1-2.6°C according to RCP4.5, by circa 1.4-3.1°C according to RCP6.0 and by 2.6-4.8°C according to RCP8.5. By contrast, between 1880 and 2012, the average global air surface temperature increased by 0.85°C, while for the period 1986-2005, the respective temperature was higher by 0.61°C (by a margin of 0.55-0.67°C) in comparison with the preindustrial era (1850-1900).

To be noted that between 1901 and 2010, the sea level had risen by 0.19 m while the ocean acidity had increased by 26 per cent. Simultaneously, between 1979 and 2012, the ice surface of the Arctic Ocean had decreased by 3.5-4.1 per cent/per decade. Towards the end of the 21st century, due to the pace of global warming, it is expected that the ocean acidity will increase by 15-17 per cent according to RCP2.6, by 38-41 per cent according to RCP4.5, by 58-62 per cent according to RCP6.0, by 100-109 per cent according to RCP8.5, respectively. Compared to the reference period 1986-2005, the overall volume of glaciers will decrease by the end of the 21st century by 15-55 per cent according to RCP2.6, by 35-85 per cent according to RCP8.5, respectively. The sea level is likely to continue to rise by circa 0.26-0.55 m according to RCP2.6, by 0.45-0.82 m according to RCP8.5, respectively.

Also, by the end of the 21st century, the frequency of natural disasters (floods, droughts, heat waves, hurricanes, tornados, etc.) is expected to grow. In some regions, their impact could be devastating, while other regions could benefit from climate change. The impact will depend on the form and magnitude of these changes, and in the case of adverse effects, of the ability of natural and anthropogenic systems to adapt to climate change.

In other words, the greenhouse effect of the atmosphere is similar to the effect that can be observed in greenhouses when the function of the glass or polyethylene is taken over by the greenhouse gases. Short-wave solar radiation freely penetrates the greenhouse gases, reaching the Earth's surface, and warming it. Long-wave radiation (infrared rays) emitted by the Earth's surface is captured by these gases and is partially sent back to the Earth's surface. As a consequence, the average atmospheric temperature is by 33°C warmer than it would be in the absence of the greenhouse effect. Basically, this phenomenon makes life on Earth possible.

1.1.2. Climate Change in the Republic of Moldova

In the Republic of Moldova, climate data, specifically changes in temperature and precipitation have been measured since the end of 19th century and continue today via the hydro-meteorological monitoring network managed by the State Hydrometeorological Service.

The nature of the observed changes to the Republic of Moldova's climate has been identified through the trends and variability of individual climatic variables. The average annual temperature and precipitation data recorded at Chisinau meteorological station, for which the continuous series of instrumental observation of climate data are available (temperature – since 1887, precipitation – since 1891), have shown that the average annual temperature has increased by 1.2°C during instrumental observation periods (Figure 1-1), while the average annual precipitation values by 55.6 mm, respectively (Figure 1-2).

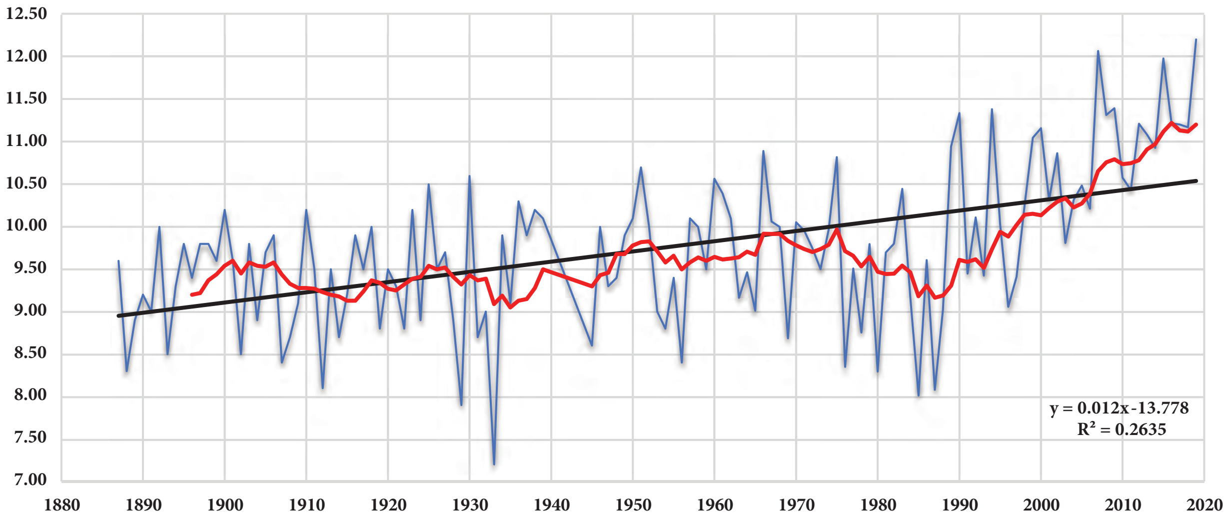

Figure 1-1: Trends of annual average air temperature change (°C) for 1887-2019: blue (actual course trend), black solid line (linear trend secular course) and red line (10 year moving average trend) at the meteorological station Chisinau, Central part of the Republic of Moldova.

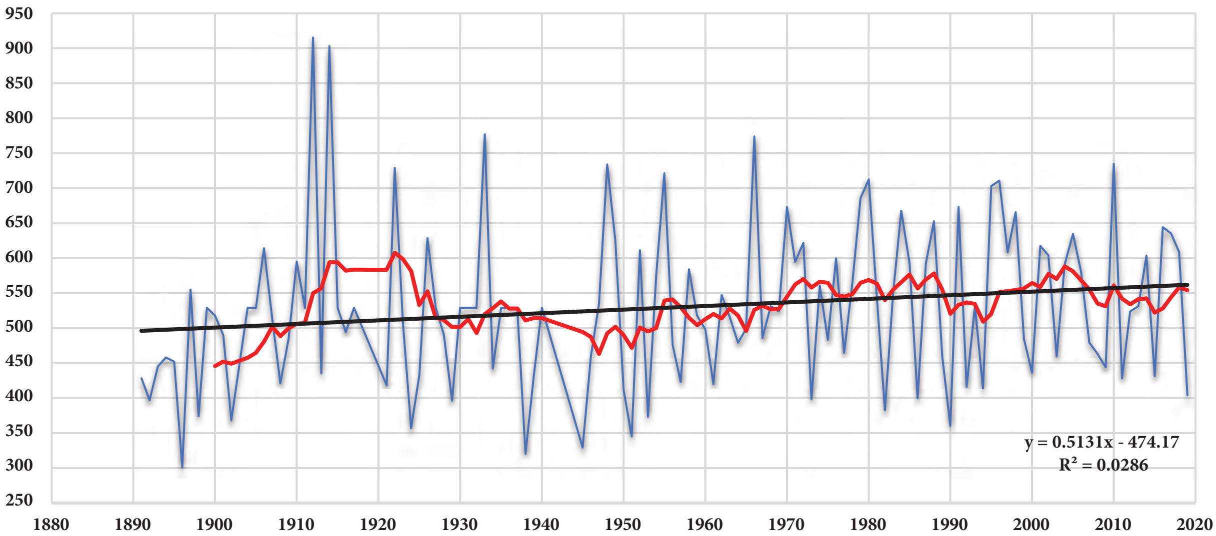

Figure 1-2: Trends of annual average precipitation (mm) for 1891-2019: blue (actual course trend), black solid line (linear trend secular course) and red line (10 year moving average trend) at the meteorological station Chisinau, Central part of the Republic of Moldova.

The Republic of Moldova has experienced an increased number of extreme weather events, such as droughts, heavy rains, hail, hoar frost, frosts, strong blizzards and floods. The socio-economic costs of climate change related to natural disasters such as droughts and floods are significant. Both their intensity and frequency are expected to further increase as a result of climate change.

In the period 1997-2019, a total number of 1990 exceptional natural disasters had been registered in the Republic of Moldova, as a result of which 115 people died, including 10 children; 244 people suffered, including 13 children, the material losses amounting to about 11 billion 372 million 249 thousand lei (Figure 1-3).

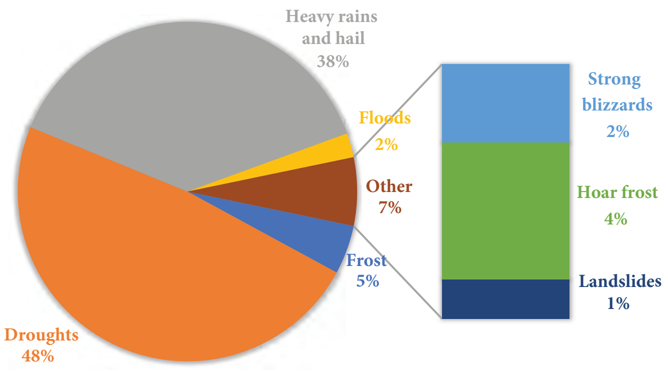

Figure 1-3: Material losses caused by the most important types of exceptional natural disasters during the years 1997-2019, in % of total.

Dangerous natural meteorological and agro-meteorological phenomena caused the most deaths and the greatest material losses. Thereby, 112 people died, and another 244 people had been hospitalised, and the material losses registered in the period 1997-2019 amounted to about 10 billion 347 million 179.4 thousand MDL. The worst exceptional situations caused by dangerous meteorological and agrometeorological phenomena were: hoar frost, droughts, heavy rains and hail, frosts and strong blizzards (Figure 1-4).

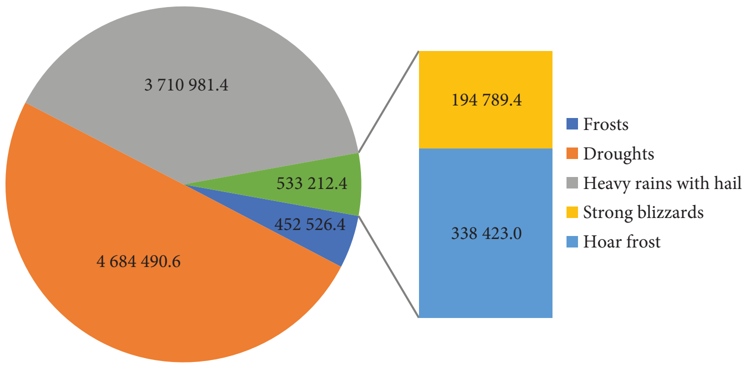

Figure 1-4: Material losses caused by the most dangerous meteorological and agro-meteorological phenomena in the period 1997-2019 , thousand MDL.

Droughts are a dangerous agro-meteorological phenomenon that have caused the most considerable material losses, including by event (4 billion 684 million 490.6 thousand MDL recorded for the last 6 cases). The analysis of national climate data has revealed that the frequency of droughts in the Republic of Moldova over a period of ten years is about 1-2 droughts in the northern part of the country; 2-3 droughts in the central part and 5-6 droughts in the southern part. The frequency of droughts has increased, especially over the last two decades. Eleven cases of droughts were recorded in this period (in 1990, 1992, 1994, 1996, 2000, 2001, 2003, 2007, 2012, 2015 and 2019)[15].

Floods also affect the Republic of Moldova repeatedly. Over the last 70 years, ten major floods of the Dniester River[16] and the Prut River[17] have been reported, three of which have already taken place in the 21st century (in 2006, 2008 and 2010). Floods caused by smaller rivers in the country are also widespread. Severe floods on rivers and small currents were observed in 1948, 1956, 1963, 1973, 1984, 1989, 1991, 1994, 1998, 1999[18]. The current total cost of inaction regarding adaptation to climate change in the Republic of Moldova (forestry, agriculture, water, health, energy, buildings) is estimated at US$ 600 million, which is equivalent to 6.5 per cent of the GDP. This value is expected to double in real terms by 2050 to about US$ 1.3 billion[19].

The patterns of future temperature and precipitation conditions were computed for the Republic of Moldova from the global climate model output gathered as part of the Coupled Model Intercomparison Project Phase 6 (CMIP6[20]). Previous CMIP ensembles were used as input data by IPCC for the preparation of the 4th Assessment Report (IPCC AR4, 2007[21]) and 5th Assessment Report (IPCC AR5,

[15] Taranu Lilia (2020), Profile of disasters/exceptional situations in the Republic of Moldova (based on the data provided by the General Inspectorate for Emergency Situations of the Ministry of Internal Affairs of the Republic of Moldova). Expert Report. Chisinau, December 2020.
[16] Periodic floods were registered in the years 1969, 1970, 1974, 1980, 1988, 1998, 2008 and 2010.
[17] During the observation period on the Prut River, there had been large floods, which led to significant damage; rare floods were observed in the years 1969, 1974, 1975, 1980, 1998, 2006, 2008, 2010.
[18] Government Decision No. 562 of 31.07.2020 on the approval of Flood Risk Management Plans. Published on 21.08.2020 in Official Monitor No. 212-220.
[19] International Bank for Reconstruction and Development / World Bank (2016), Republic of Moldova. Moldova Climate Adaptation Investment Planning Technical Assistance. Report No. ACS18562. October 2016. GEN03. Europe and Central Asia. 88 pages.
[20] Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E. (2016), Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, Geosci. Model Dev., Vol. 9, p. 1937– 1958.
[21] IPCC (2007). Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press.

2013[22]), and were used for modelling regional climate change projections for 3 Agro-Ecological Zones (AEZs) of the Republic of Moldova (North, Centre and South), complemented by climate projections based on CORDEX regional climate models (Taranu, 2014[23]; Taranu, 2018[24]).

Twenty-one global coupled atmosphere ocean general circulation models (GCMs) were used in this exercise for the preparation of new scenarios of climate change in the Republic of Moldova, the projections being made under the Representative Concentration Pathway (RCP) scenarios: SSP 1-2.6, SSP 2-4.5 and SSP 5-8.5, given that each simulation in CMIP6 is a combination of an RCP (Representative Concentration Pathway) and a shared socio-economic pathway scenario (SSP)[25].

The future climatic changes were assessed over the three Agro-Ecological Zones (AEZs) (North, Centre and South) of the Republic of Moldova for the periods 2021-2040, 2041-2060 and 2081-2100, given relative to the reference period (1995–2014).

It has been revealed that for temperature, the ensemble average changes consistently have the same tendency across shared socio-economic pathway scenarios and their magnitude increases from SSP 1-2.6 to SSP 2-4.5 and SSP 5-8.5, as moving into the later decades of the 21st century. The CMIP6 projections reveal warming in all seasons for the three AEZs, while precipitation projections are more variable across scenarios, sub-regions, and seasons.

Annual changes for temperatures are very homogeneous over the three AEZs. The rate of warming by 2100 is higher under SSP 5-8.5 scenario, averaging +5.7°C; varying from +2.7°C (South) to 2.9°C (North) under SSP 2-4.5; averaging +1.6°C under the SSP 1-2.6 scenario.

The ensemble, driven by SSP 5-8.5 emission scenario, estimates that the country will experience the most significant warming during summer compared to reference period (1995-2014): from +6.7°C in the North, to +7.1°C in the South by 2100. The pattern of change derived from the ensemble SSP 1-2.6 models is quite similar, but the magnitude of change is lower from +1.8°C to +1.9°C. The warming would be higher during winter – up to +5.9°C in the North, whereas in the Centre and South the temperature rise will be somewhat lower – up to +5.6°C and +5.3°C, respectively according to the SSP 5-8.5 scenario. The SSP 1-2.6 scenario reveals less intense warming during winter, compared to the reference period (1995-2014) over the 3 AEZs of the RM, from +1.9°C in the North, to +1.7°C in the South.

The ensemble projections from the SSP 5-8.5 forcing scenario show that the three AEZs would experience a general annual decrease in precipitation varying from -4.2 per cent in the North and -11.0 per cent in the South. At the same time, according to SSP 1-2.6 scenario, a moderate increase in precipitation is projected by 2100 from +4.0 per cent in the South, to +4.3-4.5 per cent in the North and Centre compared to the reference period (1995-2014). Winters have been estimated to be wetter in the Republic of Moldova by the end of the 21st century. The ensemble projections show the largest increase in precipitation during winter from +10.3 per cent (SSP 1-2.6) to +19.4 per cent (SSP 5-8.5) in the North and the lowest one in the South, from +8.7 per cent (SSP 5-8.5) to +11.7 per cent (SSP 1-2.6). Compared to the reference period (1995-2014), the precipitation decrease will be more noticeable in the 3 AEZs during summer by the end of the 21st century; varying from -12.3 per cent (SSP 2-4.5) to -27.7 per cent (SSP 5-8.5) in the South, and from -5.9 per cent (SSP 2-4.5) to -19.5 per cent (SSP 5-8.5) in the North, respectively.

1.1.3. Greenhouse Gases

The most important greenhouse gas in atmosphere is water vapours (H_2O), responsible for approximately 2/3 of the total greenhouse effect. The content of water in atmosphere is not directly influenced by anthropogenic activities, but rather is determined by the cycle of water in nature, expressed in a simpler way, as the difference between evaporation and precipitations.

[22] IPCC (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. T. F. Stocker, D. Qin, G.-K. Plattner et al. Cambridge, UK, and New York, NY, USA, Cambridge University Press.

[23] Taranu L., (2014), An Assessment of Climate Change Impact on the Republic of Moldova's Agriculture Sector: A Research Study Complementing the Vulnerability and Adaptation Chapter of the Third National Communication of the Republic of Moldova under the United Nations Framework Convention on Climate Change. Ed.: Vasile Scorpan, Marius Taranu; Climate Change Office, Min. of Environment of the Rep. of Moldova, United Nations Environment Programme, – Chisinau: S. n., 2014 (SOE PH 'Tipografia Centrala'), – 260 p.

[24] Taranu, L., Deveatii, D., Croitoru, C., Mironova,T et al. (2018), Vulnerability Assessment and Climate Change Impacts in the Republic of Moldova. Researches, Studies, Solutions. A Research Study Complimenting the Vulnerability and Climate Change Impacts Chapter of the Fourth National Communication of the Republic of Moldova under the United Nations Framework Convention on Climate Change. Ed.: Vasile Scorpan, Marius Taranu; Climate Change Office, Min. of Environment of the Rep. of Moldova, United Nations Environment Progr., – Ch.: „Bons Office' SRL, 2018 - 352 p. _

[25] Meinshausen, M., Nicholls, Z., Lewis, J., Gidden, M. J., Vogel, E., Freund, M., Beyerle, U., Gessner, C., Nauels, A., Bauer, N., Canadell, J. G., Daniel, J. S., John, A., Krummel, P., Luderer, G., Meinshausen, N., Montzka, S. A., Rayner, P., Reimann, S., Smith, S. J., van den Berg, M., Velders, G. J. M., Vollmer, M., and Wang, H. J. (2020), The shared socio-economic pathway (SSP) greenhouse gas concentrations and their extensions to 2500. Geoscientific Model Development, 13, 3571–3605.

Carbon dioxide (CO_2) has a 30 per cent share in the greenhouse effect, while methane (CH_4), nitrous oxide (N_2O) and ozone (O_3) taken together account for 3 per cent. The group of artificial substances (man-made): chlorofluorocarbons (CFC) and their substitute, hydrofluorocarbons (HCFC, HFC) and other substances, as well as perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are also attributed to direct GHG. There are other photochemically active gases, such as carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC) (include substances such as: propane, butane and ethane), which are not attributed to direct GHG, but have an indirect contribution to greenhouse effect. Such gases influence the formation and destruction of ozone in the atmosphere in the presence of solar rays (ultraviolet radiation) and are considered to be ozone precursors in the troposphere.

Though GHG are considered to be natural components of the air, their presence in atmosphere is strongly affected by anthropogenic activities. Increased concentrations of GHG in the atmosphere (caused by emissions of anthropogenic origin) contribute to strengthening of greenhouse effect, thus leading to additional warming of the atmosphere. The GHG concentration in atmosphere is determined by the difference between GHG emissions and removals. It has been stated with certainty that GHG concentration in atmosphere have increased significantly in comparison with pre-industrial level. Thereby, from 1750 to the end of 2020, the concentration of CO_2 had increased by circa 147.3 per cent, the concentration of CH_4 – by 262.1%, while N_2O concentration – by circa 123.6 per cent[26] (Table 1-1). To a great extent, these trends can be attributed to human activities – fossil fuels combustion and continuous deforestation of forest lands, in particular.

Table 1-1: Tropospheric concentration (in the Northern Hemisphere), concentration change rate and direct GHG lifetime in atmosphere

Greenhouse Gases	Preindustrial tropospheric concentration (1850-1900)	Recent tropospheric concentration (end of 2020)	GWP (100-yr time horizon) (IPCC, 2013)	Tropospheric lifetime (years)
Carbon dioxide (CO_2)	280 ppm	412.4 ppm	1	~ 50-200
Methane (CH_4)	722 ppb	1892.3 ppb	28	12.4
Nitrous oxide (N_2O)	270 ppb	333.6 ppb	265	121

Note: ppm – concentration in parts per million of volume; ppb - concentration in parts per billion of volume.

By the end of 2019, globally, the amount of annual carbon dioxide emissions represented circa 36.7 Gt[27], which in the past 45 years had increased more than significantly (over 5 times). The most important sources of carbon dioxide emissions are fossil fuel combustion, deforestation and industrial processes (for example, cement production). The carbon dioxide lifetime in the atmosphere varies between 50 and 200 years. It can be removed from atmosphere through a complex set of natural sinks mechanisms. Also, it is considered that circa 40 % of the emitted carbon dioxide can be absorbed by oceans. Photosynthesis, in particular in sea vegetation and plankton is an important, though transitory, mechanism of CO_2 emissions removal, because after the perishing of plants, carbon dioxide is again emitted into the atmosphere.

The concentration of methane in the atmosphere is affected in proportion of circa 60% by anthropogenic activities such as rice cultivation, animal breeding (enteric fermentation and manure management), coal, oil and natural gas extraction, transportation and distribution of natural gases, solid waste disposal on lands, biomass combustion, etc. The breakdown of methane in the atmosphere takes place through chemical reactions (by means of OH radicals). The lifetime of CH_4 in the atmosphere is circa 12.4 years. The annual CH_4 emissions into the atmosphere are about 29-30 Mt[28], from which approximately 60 per cent are generated from anthropogenic activities.

It has been stated that circa 40% of the atmospheric N_2O is of anthropogenic origin[29], coming from use of synthetic nitrogen fertiliser, soil cultivation, animal breeding (manure management), wastewater handling, adipic acid and nitric acid production, fossil fuels combustion, waste incineration and biomass burning. The other 60 per cent of the atmospheric N_2O comes from the soil and denitrification of water in anaerobic conditions. N_2O breaks down photochemically in the atmosphere. Global annual N_2O emissions from anthropogenic activities are estimated to be circa 7.3 Mt[30].

[26] <https://www.esrl.noaa.gov/gmd/ccgg/trends/>, <https://public.wmo.int/en/media/press-release/carbon-dioxide-levels-continue-record-levels-despite-covid-19-lockdown>
[27] <https://library.wmo.int/index.php?lvl=notice_display&id=21795#.YIKYFaFDOUk>
[28] <https://library.wmo.int/index.php?lvl=notice_display&id=21795#.YIKYFaFDOUk>
[29] <https://www.wmo.int/pages/mediacentre/press_releases/pr_1002_en.html>, <https://library.wmo.int/index.php?lvl=notice_display&id=21795#.YIKYFaFDOUk>
[30] <https://library.wmo.int/index.php?lvl=notice_display&id=21795#.YIKYFaFDOUk>

HFCs (hydrofluorocarbons), PFCs (perfluorocarbons), and SF_6 (sulphur hexafluoride) are GHG of anthropogenic origin. HFCs are preponderantly used to replace ozone depleting chemical substances, but it is also emitted in the process of HCFC-22 production. PFCs and SF_6 are emitted in various industrial processes, including aluminium and magnesia production, production of semiconductors, in transmission and distribution of electric power, etc. All these gases have a long lifetime in atmosphere and are characterised by a considerable infrared radiation absorption capacity, so that in the future it might have a considerable impact on global warming.

1.1.4. Global Warming Potential

The radiative forcing effect of a gas in the atmosphere is the reflection of its ability to cause atmospheric warming. Direct effects occur when the gas itself is a GHG, while indirect radiative forcing occurs when chemical transformation of the original gas produces a gas or gases that are GHGs or when a gas influences the atmospheric lifetimes of other gases.

The concept of 'Global Warming Potential' (GWP) has been developed to allow scientists and policy-makers to compare the ability of each GHG to trap heat in the atmosphere. By definition, a GWP is the time-integrated change in radiative forcing due to the instantaneous release of 1 kg of gas expressed relative to the radiative forcing from the release of 1 kg of CO_2. In other words, GWP is a relative measure of a warming effect that the emission of a radiant gas (i.e., GHG) might have on the troposphere. The 'Global Warming Potential' considers both the instantaneous radiative forcing due to an incremental concentration of GHG increase in the atmosphere and the lifetime of these gases in the atmosphere.

This report relates to the GWP for a period of 100 years recommended by the IPCC in IPCC Fourth Assessment Report (IPCC, 2007) for use in GHG emissions inventory under UNFCCC (Table 1-2).

Table 1-2: GWP for a Period of 100 Years and Direct GHG Atmospheric Lifetimes[31]

GHG	Chemical formula	Lifetime, according to AR5	SAR	TAR	AR4	AR5
Carbon dioxide	CO_2	50-200	1	1	1	1
Methane	CH_4	12.4	21	23	25	28
Nitrous oxide	N_2O	121	310	296	298	265
Nitrogen trifluoride	NF_3	500	NA	10800	17200	16100
Sulphur hexafluoride	SF_6	3200	23900	22200	22800	23500
Hydrofluorocarbons (HFC)						
HFC-23	CHF_3	222	11700	12000	14800	12140
HFC-32	CH_2F_3	5.2	650	550	675	677
HFC-125	C_2HF_5	28.2	2800	3400	3500	3170
HFC-134a	$C_2H_2F_2$ (CH_2FCF_3)	13.4	1300	1300	1430	1300
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	47.1	3800	4300	4470	4800
HFC-152a	C_2H4F_2 (CH_3CHF_2)	1.5	140	120	124	138
HFC-227ea	CF_3CHFCF_3	38.9	2900	3500	3220	3350
HFC-236fa	$CF_3CH_2CF_3$	242	6300	9400	9810	8060
HFC-245fa	$CHF_2CH_2CF_3$	7.7	NA	950	1030	858
HFC-365mfc	$CH_3CF_2CH_2CF_3$	8.7	NA	890	794	804
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	16.1	1300	1500	1640	1650
Perfluorocarbons (PFC)						
Perfluoromethane	CF_4	50000	6500	5700	7390	6630
Perfluoroethane	C_2F_6	10000	9200	11900	12200	11100
Perfluoropropane	C_3F_8	2600	7000	8600	8830	8900
Perfluorobutane	C_4F_{10}	2600	7000	8600	8860	9200
Perfluoropenthane	C_5F_{12}	4100	7500	8900	9160	8550
Perfluorohexane	C_6F_{14}	3100	7400	9000	9300	7910

Source: SAR – Second Assessment Report (IPCC, 1996), TAR – Third Assessment Report (IPCC, 2001) and AR4 – Fourth Assessment Report (IPCC, 2007) and AR5 – Fifth Assessment Report (IPCC, 2013).

1.1.5. Convention, Kyoto Protocol, Paris Agreement and Party's Commitments

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted on May 9, 1992 at the UN Conference on Environment and Sustainable Development in Rio de Janeiro, being regarded as a response of the international community to the global warming phenomenon caused by air pollution and the increased concentrations of greenhouse gases.

[31] <http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Annex-6-Additional-Information.pdf>

The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is aimed '*to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*'. To-date, 196 countries are Parties to the Convention. The Republic of Moldova signed the UNFCCC on June 12, 1992 and it was ratified by the Parliament on March 16, 1995.

Article 4, paragraph 1(a) and Article 12, paragraph 1(a) of the UNFCCC stipulate that each Party has to make available to the Conference of the Parties (COP) '*a national inventory of anthropogenic emissions by sources and removals by sinks, of all greenhouse gases uncontrolled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be agreed upon by the Conference of the Parties; also a general description of steps taken or envisaged by the Party to implement the Convention; and any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, relevant data for calculations of global emission trends*'.

The main mechanism for making this information available is national communications. COP 2 (Geneva, 1996) adopted the Guidelines on national communications for non-Annex I Parties (Decision 10/CP 2). In accordance with the respective Guidelines, from 1998 to 2000, under the UNDP-GEF Project '*Enabling Activities for the preparation of the First National Communication to the UNFCCC*', Republic of Moldova developed its First National Communication (NC1) to UNFCCC, submitted to the COP 6 (The Hague, 2000).

The COP 8 (New Delhi, 2002) adopted a new Guideline on national communications for non-Annex I Parties (Decision 17/CP 8). In conformity with these Guidelines, in the period 2005-2009, the Republic of Moldova developed its Second National Communication (NC2); in the period 2010-2014 – the Third National Communication (NC3); in the period 2014-2018 – the Fourth National Communication (NC4); and in the period 2019-2022 – the Republic of Moldova is developing its Fifth National Communication (NC5) to the UNFCCC.

With reference to UNFCCC implementation instruments it should be noted that the COP 3 (Kyoto, 1997) adopted the Kyoto Protocol[32], representing an instrument setting binding targets for the Parties under Convention, by committing industrialised countries and economies in transition (in total, 37 industrialised countries and the European Union) included in Annex I to Convention, to reduce total emissions of direct GHG by at least 5 per cent, against 1990 levels over the five-year period: January 1, 2008 – December 31, 2012 (the first period of the Protocol commitment). The Republic of Moldova ratified the Kyoto Protocol on February 13, 2003. As a non-Annex I Party, the Republic of Moldova had no commitments to reduce GHG emissions under this Protocol.

According to the Bali Action Plan, adopted at the 13th Conference of Parties to the UNFCCC (2007), developing countries agreed for the first time to develop and implement National Appropriate Mitigation Actions in the context of sustainable development, supported by technology transfer, adequate financing and capacity-building actions.

The COP 15 held in Copenhagen in December 2009 approved and proposed for implementation a policy statement adopted in support of limiting global warming to no more than 2°C compared to pre-industrial level, in the context of equity and sustainable development. This statement, known as the *Copenhagen Accord*, and it reaffirms development issues in the context of climate change, including through the implementation of Low Emission Development Strategies (LEDS).

The Republic of Moldova associated itself to the Copenhagen Accord on January 2010 and submitted an emissions reduction target that is specified in Annex II of this Agreement '*National Appropriate Mitigation Actions in Developing Countries*'. The target of mitigation actions for the Republic of Moldova under this Agreement is '*to reduce, to not less than 25 per cent compared to the base year (1990), the total national level of greenhouse gas emissions by 2020, by implementing economic mechanisms focused on global climate change mitigation, in accordance with the principles and provisions of the Convention*'. This target is presented without indicating specific national appropriate mitigation actions, identified

[32] The Kyoto Protocol entered into force on February 16, 2005, 90 days after its ratification by the Russian Federation in November 2004, thus covering at least 55 Parties to the Convention, including Annex I countries, which encompass 55 per cent of total carbon dioxide emissions recorded in 1990.

and quantified, and without further clarification of the necessary support to achieve it. Simultaneously, it is recognised that achieving this target will require significant financial, technological and capacity-building support, which can be provided through the UNFCCC mechanisms.

In the same context, during 2010-2012, the Low Emissions Development Strategy of the Republic of Moldova until 2020 was prepared – a strategic document that was to allow the country to adjust its development path towards a low carbon economy and to achieve a green sustainable development, based on the socio-economic and development priorities of the country. Also, LEDS was supposed to support overall objectives, provide strategic national context, for the mitigation efforts, for which countries would receive international support. LEDS was developed in accordance with the Republic of Moldova's Governance Programme 'European Integration: Freedom, Democracy, Welfare' (2011-2014) and the provisions of chapter 'Climate Change' of the EU Association Agreement.

The Strategy contained a set of measures that would reduce greenhouse gas emissions, quantifying the corresponding reduction of GHG emissions for each measure, and the financial requirements for their implementation. The measures proposed in the prioritised list of NAMAs, an Annex to LEDS, included national appropriate mitigation actions, as provided for non-Annex I Parties to the UNFCCC. LEDS also provided information on implementation procedures and timeframes, as well as provisions on monitoring, measurement, reporting and assessment of the results. The Strategy was drafted by the Ministry of Environment of the Republic of Moldova, the process being guided by the Inter-Ministerial Working Group on Climate Change with support from the UNDP country office. This process involved wide consultations with all parties, represented by ministries, research institutions, donor organizations, NGOs and civil society. It was anticipated that LEDS would be approved by the Government by the end of 2013, which had not happened until the end of 2016[33].

The COP 16 held in Cancun in December 2010, adopted the Cancun Agreements, which encourages developing countries to prepare Low Emission Development Strategies for sustainable development and to undertake National Appropriate Mitigation Actions. The Cancun Agreements highlights the fact that '*stopping climate change requires a paradigm shift towards building a low-carbon emissions society, which offers substantial opportunities and ensures continued economic growth and sustainable development*'.

The COP 16 that took place in Cancun, established the periodicity of national communications for non-Annex I countries (Decision 1/CP.16). In line with this, the non-Annex I Parties should prepare and submit to the UNFCCC Secretariat *National Communications* (NCs) every four years and *Biennial Update Reports* (BUR) every two years, respectively. The inventory section of the *Biennial Update Reports* should consist of a *National Inventory Report* (NIR) as a summary or a technical annex; this section is expected to present in a detailed and transparent manner the procedures of national inventory for anthropogenic GHG emissions by sources or removals of carbon dioxide through sequestration, including information on emissions trends, key categories, activity data, emissions factors, assessment methodologies, quality assurance and quality control, uncertainties, recalculations and planned improvements, for each source or sink category included in the national inventory.

The COP 17 that took place in Durban in 2011 adopted the *UNFCCC biennial update reporting guidelines for Parties not included in Annex I to the Convention* (Decision 2/CP.17 and Annex 3 to this Decision). According to this decision, developing countries, non-Annex I Parties, consistent with their capabilities and the level of international support provided for reporting, were expected to submit their first BUR to the Secretariat of the UNFCCC by December, 2014. The Report should be submitted to the Secretariat at every two years as a stand-alone report or as a summary of the National Communications, should their reporting years coincide.

The Republic of Moldova initiated the process of preparing the First Biennial Update Report in July 2014, and managed to present it to the Secretariat of the UNFCCC on April 5, 2016. The First Biennial Update Report of the RM under the UNFCCC (2016) was presented to the Secretariat of the UNFCCC together with two technical annexes – the National Inventory Report: 1990-2013, Greenhouse Gas Sources and Sinks in the Republic of Moldova (2015) and the Report on the National GHG Inventory System in the Republic of Moldova (2015).

[33] <http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=369528>

Regarding the non-Annex I Parties, the COP 17 in Durban approved (Decision 2/CP.17 and Annex IV) the Modalities and Guidelines for International Consultation and Analysis (ICA) consisting of two steps: (i) the technical analysis of BURs and (ii) a facilitative sharing of views among Parties on BURs content and the results of technical analysis. The process aims to enhance the transparency and accountability of information reported in BURs by non-Annex I Parties. The technical analysis is conducted by a team of technical experts (TTE) and is initiated within six months of BUR submission to the Secretariat.

As for the First Biennial Update Report of the RM to the UNFCCC, its technical analysis by the technical expert team took place between 19 and 23 of September 2016, with the summary report being published by the Secretariat on the UNFCCC web page on February 20, 2017[34]. The Facilitative Sharing of Views (FSV) among Parties on the BUR1 content and the results of technical analysis was carried out during the 3rd FSV workshop, organised by the UNFCCC Secretariat on 15th of May 2017 in Bonn, Germany[35].

The COP 18 (Doha, 2012) adopted the *Doha Amendment to the Kyoto Protocol* which establishes a second commitment period (January 1, 2013-December 31, 2020) for the Parties included in Annex I to the Kyoto Protocol; adds a revised list of greenhouse gases to be reported by Annex I countries in the second commitment period; and a series of amendments to several articles of the Kyoto Protocol regarding the first commitment period. By December 21, 2012, the UN General Secretary, acting as depositary, presented the Doha Amendment to the Kyoto Protocol to all Parties of the UNFCCC, in accordance with provisions of Articles 20 and 21 of the Protocol. Under Doha Amendment, within the second commitment period, the developed countries should reduce their greenhouse gas emissions by at least 18% compared to 1990 levels. By 28 October 2020[36], 147 countries had ratified the Doha Amendment to the KP, most of which are non-Annex I Parties to the UNFCCC and the KP. The Doha Amendment came into effect on December 31, 2020.

At COP 19 (Warsaw, 2013), the Parties agreed to communicate their intended nationally determined contributions (INDC) (Decision 1/CP.19), in order to include them in the new Climate Agreement to be considered and adopted by the COP 21 in 2015, in Paris. It is expected that the new climate agreement will establish a new commitment period (1st of January 2021-31st of December 2030) for the reduction of GHG emissions. Also, COP 19 in Warsaw *adopted General guidelines for domestic measurement, reporting and verification of domestically supported nationally appropriate mitigation actions by developing country Parties* (Decision 21/CP.19). This document provides a solid foundation for the new Paris Climate Agreement 2015.

At COP 20 which took place in Lima (2014), the Parties agreed over *Lima Call for Climate Action* and were repeatedly invited to communicate their intended nationally determined contributions to the UNFCCC Secretariat (Decision 1/CP.20), so as to achieve the objective of the Convention as set out in Article 2. The Parties agreed that in order to facilitate clarity, transparency and understanding, the INDC may include, as appropriate, inter alia: quantifiable information on the reference point; time frames and/or periods for implementation; scope and coverage; planning processes; assumptions and methodological approaches including those for estimating and accounting for anthropogenic greenhouse gas emissions and, as appropriate, removals; and information on the country's considerations on how fair and ambitious its intended nationally determined contribution is; and how the Party considers that its national contribution will facilitate the achievement of the objective of the Convention as set out in Article 2.

In accordance with the *Lima Call for Climate Action*, countries were invited to communicate their intended nationally determined contributions by March 31, 2015, the deadline for the presentation being September 30, 2015. The request to the Secretariat was to prepare by 1st of November 2015 a synthesis report on the aggregate effect of the INDC communicated by Parties.

[34] <http://unfccc.int/files/national_reports/non-annex_i_parties/biennial_update_reports/submitted_burs/application/pdf/mda.pdf>

[35] The conclusions of the 3rd FSV seminar regarding the BUR1 of the RM under the UNFCCC and the results of the technical assessment are available on the web page: <http://unfccc.int/files/national_reports/non-annex_i_parties/ica/facilitative_sharing_of_views/application/pdf/20170529_mda_v04.pdf>; RM's presentation at the 3rd FSV seminar is available on: <http://unfccc.int/files/national_reports/non-annex_i_parties/ica/facilitative_sharing_of_views/application/pdf/moldova_fsv_workshop_presentation_15.05.2017.pdf>, and the video recording of the presentation and the interventions of the Parties are available on: <https://www.youtube.com/playlist?list=PL-m2oy1bnLzpmdRpG2pTBzUeOH3qrXlZt>

[36] <https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment>

The Republic of Moldova was fully committed to the UNFCCC negotiation process towards adopting at COP 21 the Paris Agreement – a document with legal force under the Convention, applicable to all Parties, in line with keeping global warming below 2°C by 2100 compared to the preindustrial era. The Paris Agreement was signed by the Prime Minister of the Republic of Moldova in New York on September 21, 2016, and was subsequently ratified by the Parliament through Law No. 78 of 04.05.2017 for the ratification of the Paris Agreement (Official Monitor No. 162-170 of 26.05.2017)[37].

On the 25th of September 2015, the Republic of Moldova communicated its Intended Nationally Determined Contribution (INDC)[38] and the accompanying information to facilitate clarity, transparency, and understanding, with reference to decisions 1/CP.19 and 1/CP.20. According to its NDC, the Republic of Moldova intends to achieve an economy-wide unconditional target of reducing its greenhouse gas emissions by 64-67 per cent below its 1990 level in 2030 and to make best efforts to reduce its emissions by 67 per cent. The reduction commitment expressed above could be increased conditionally up to 78 per cent below 1990 level in accordance with this global agreement which addresses important topics including low-cost financial resources, technology transfer, and technical cooperation, accessible to all at a scale commensurate to the challenge of global climate change. GHG emissions reduction targets have been set in an emission budget covering the period from January 1, 2021 to December 31, 2030. The GHG emission reduction targets set out in the national contribution intentionally determined of the Republic of Moldova were subsequently officially approved at national level by the Government Decision No. 1470 of 30.12.2016 regarding the approval of the Low Emissions Development Strategy of the Republic of Moldova by 2030 and the Action Plan for its implementation (Official Monitor No. 85-91 of 24.03.2017)[39].

On March 4, 2020, the Republic of Moldova presented the updated version of its NDC to the UNFCCC Secretariat[40]. According to it, the Republic of Moldova intends to step up with much more ambitious GHG emission reduction targets regarding by 2030. The unconditional target is thereby to increase from 64-67 per cent to 70 per cent compared to the base year (1990), and the conditional target is to increase from 78 per cent to circa 88 per cent compared to the base year (1990). The new GHG emission reduction targets are to be introduced into the Low Emissions Development Programme until 2030 and the Action Plan for its implementation, to be approved by the end of 2021.

Regarding the Second Biennial Update Report (BUR2) of the Republic of Moldova to the UNFCCC, the technical assessment by the team of technical experts took place between the 27th and 31st of May 2019, the summary report being published on the Secretariat of the UNFCCC web page on October 28, 2019[41]. Facilitative Sharing of Views (FSV) among Parties on the BUR2 content and results of technical analysis was carried out during the 9th FSV workshop, organised by the UNFCCC Secretariat between 24 and 27 November 2020[42].

1.1.6. Republic of Moldova's Relative Contribution to Global Warming

The Republic of Moldova's historic contribution to global warming is low. In 2019, the country contributed with circa 13.8 Mt CO_2 equivalent (without LULUCF) and 14.1 Mt CO_2 equivalent (with LULUCF), representing less than 0.03 per cent of total global GHG emissions.

Total and net emissions per capita, respectively, were less than half of the global average (4.4 t CO_2 equivalent per capita compared to 6.4 t CO_2 equivalent per capita, 4.5 t CO_2 equivalent per capita compared to 6.8 t CO_2 equivalent per capita), respectively. Also, the RM's share in global GHG emissions recorded since 1990 is low, under 0.05 per cent (without LULUCF) and less than 0.04 per cent (with LULUCF). For example, in the period 1990-2018, the total national GHG emissions (without LULUCF) decreased by circa 69.3 per cent, which is much more than in most industrialised countries and economies in transition included in Annex I to Convention (Figure 1-5).

37 <http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=370323>
38 <http://www4.unfccc.int/submissions/INDC/Published%20Documents/Republic%20of%20Moldova/1/INDC_Republic_of_Moldova_25.09.2015.pdf>
39 <https://www.legis.md/cautare/getResults?doc_id=114408&lang=ro>
40 <https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx>
41 <https://unfccc.int/sites/default/files/resource/tasr2_2019_MDA.pdf>, <https://unfccc.int/ICA-cycle2>
42 The conclusions of the 9th FSV seminar regarding the BUR2 of the RM under the UNFCCC and the results of the technical assessment are available on the web page: <https://unfccc.int/ICA-cycle2>, including the RM's presentation at the 9th FSV seminar and the video recording of the presentation and the interventions of the Parties.

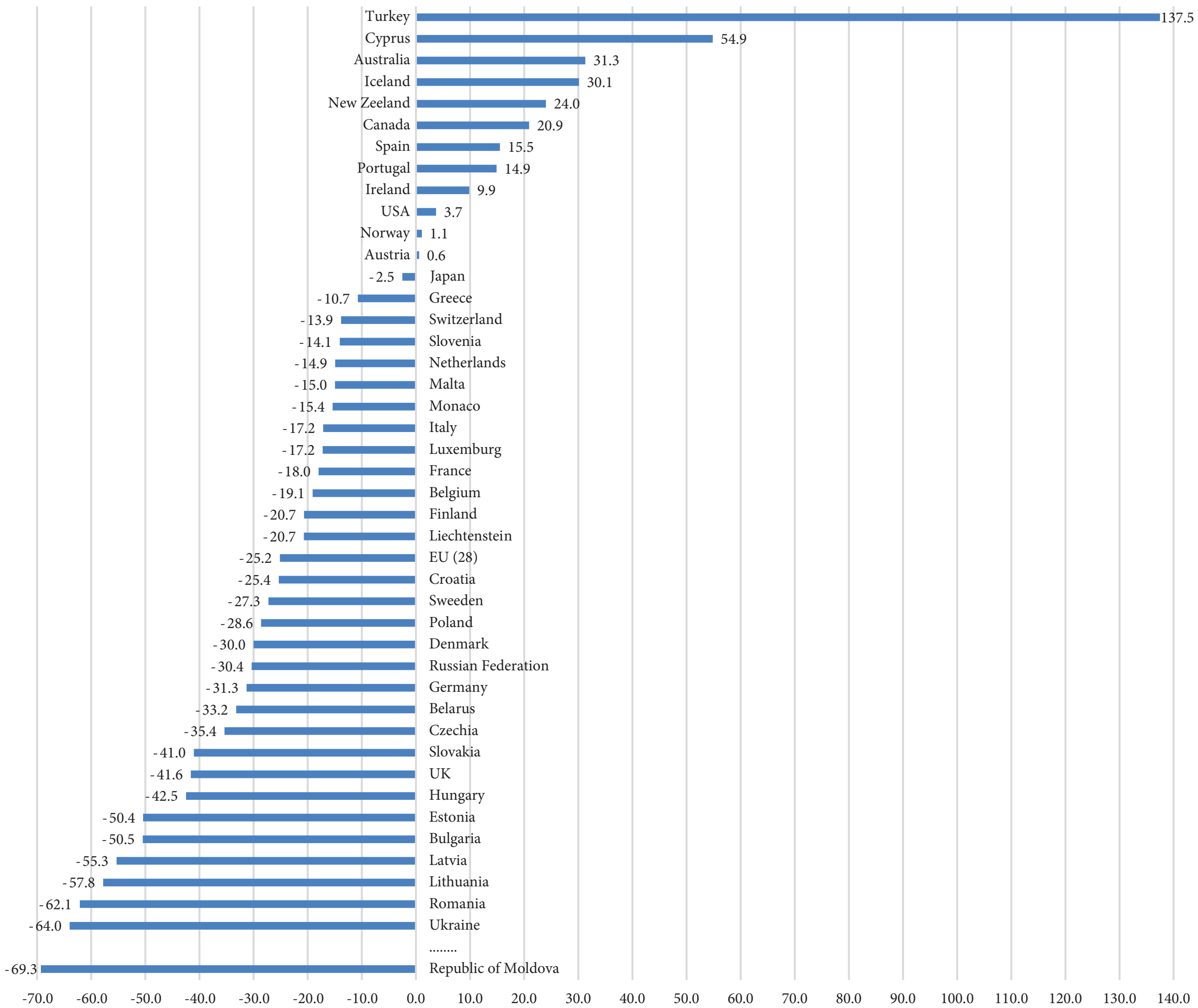

Figure 1-5: Total GHG Emissions in the Republic of Moldova (without LULUCF) and Annex I Parties to the Convention in 2018[43] (% compared to 1990).

1.2. Institutional and Legal Arrangements for Inventory Preparation

1.2.1. National Inventory System

The Ministry of Agriculture, Regional Development and Environment (MARDE) of the Republic of Moldova is the state authority responsible for development and promotion of policies and strategies addressing agriculture, food production and food safety, regional and rural development, use of territory, environment protection, climate change and natural resources.

On behalf of the Government of Republic of Moldova, MARDE is in charge of the implementation of international environment treaties to which the Republic of Moldova is a Part (including Rio Conventions). The representative of the MARDE is also the UNFCCC National Focal Point.

In accordance with Government Decision no. 549 of 13.06.2018 on establishment, organization and functioning of the Environmental Agency[44], it was assigned the following competencies *in the field of atmospheric air protection and climate change*: implementation of the provisions of policy documents and international environmental treaties to which Moldova is party in the field of atmospheric air quality and ozone layer protection, *in the field of reducing greenhouse gas emissions and adaptation to climate change*, development and submission to MARDE of information on their achievement; participation in the work of the *National Commission on Climate Change*; ensuring the implementation of the *system for monitoring, reporting and verifying greenhouse gas emissions; carrying out the process of collecting, aggregating, validating and processing the data and information necessary for development of inventories and reports on*

[43] <https://di.unfccc.int/time_series>
[44] <https://www.legis.md/cautare/getResults?doc_id=119162&lang=ro>

emissions of air pollutants and greenhouse gases; providing MARDE technical support for development of *national communications and biennial update reports*, according to the provisions of the UNFCCC.

At the same time, in accordance with Government Decision no. 1277 of 26.12.2018 on establishment and operation of the National Monitoring and Reporting System (NMRS) on greenhouse gas emissions and other information relevant to climate change, the Environmental Agency has been designated as the *competent authority* responsible for ensuring the operation of the NMRS on greenhouse gas emissions and other information relevant to climate change, provided that the operation of NMRS is carried out at the expense and within the resources approved in the state budget of the institutions party to the system, as well as other sources provided by law, including from external financing *(activities carried out on the basis of technical assistance and capacity building projects).*

In the above context, it is important to mention that, in accordance with Government Decision no. 1249 of 19.12.2018 on organization and operation of the Public Institution "Environmental Projects Implementation Unit" (PI "EPIU")[45], the latter has the mission to support MARDE and organizational units in its area of competence, in the purpose of efficient implementation of financial and technical assistance projects, external and internal, in the field of environmental protection and use of natural resources (protection of atmospheric air, ozone layer and climate change; waste and chemical management; prevention of environmental pollution; water resources management; biosecurity, biodiversity conservation and management of natural areas protected by the state), in accordance with the provisions of regulatory documents, on implementation of the requirements of international conventions to which the Republic of Moldova is party and alignment with international standards in the field of environmental protection, while tasks of PI "EPIU" consist in: efficient implementation of projects in its area of competence in accordance with established objectives; supervision and verification of quality of provided services, submission of works and provision of goods within established deadlines; management of financial resources allocated to projects in the area of its competence, in accordance with the assistance agreements and the approved budget; provision of support to the founder in development of project proposals in its field of competence; elaboration and presentation of progress reports in project implementation and use of funds for projects.

The management body of the PI "EPIU" includes the Director of the institution (executive body) and, respectively, a Supervisory Committee - a high level collegiate body which leads and supervises the activity of the institution. The committee consists of 5 members and it is appointed for a 4-year term. The nominal composition of the Committee members is established by Order of the MARDE, with mandatory inclusion of at least one representative each from State Chancellery, Ministry of Finance, and Ministry of Agriculture, Regional Development and Environment and civil society in the areas of competence of PI "EPIU". The position of Chairperson of the Committee is exercised by the Secretary of State for Protection of the Environment and Mineral Resources of the MARDE who chairs the meetings of the Committee and exercises other established duties. In the absence of the Chairperson of the Committee, the meeting shall be chaired by one of the members, elected by the members attending the meeting.

The National Monitoring and Reporting System (NMRS) for reporting greenhouse gas emissions and other information relevant to climate change to the UNFCCC, approved by GD no. 1277 of 26.12.2018, includes, as integral parts, two subsystems:

1. The national inventory system, which provides the institutional, legal and procedural framework established for estimating anthropogenic emissions by sources and removal by sinks by all greenhouse gases compiled in the national GHG emission inventory, and for reporting and archiving inventory information, in accordance with decisions taken under the UNFCCC and the Paris Agreement;
2. The national system for policies, measures and projections, which provides the institutional, legal and procedural framework for assessing progress in implementing climate change mitigation policies, for making projections of anthropogenic emissions by sources or removal of greenhouse gas emissions by sinks.

[45] <https://www.legis.md/cautare/getResults?doc_id=113696&lang=ro>.

By implementation of the NMRS appropriate collection, processing of data and information is done which is necessary for: (1) development and reporting of the national inventory and projections of anthropogenic emissions by sources or removal by sinks of greenhouse gases and (2) assessment and reporting: progress in implementing mitigation policies; vulnerability to climate change, impact of climate change and progress in implementing adaptation actions; and aggregate financial and technological support provided by industrially developed countries, listed in Annex I to the UNFCCC, for implementation of climate change mitigation and adaptation actions, technical assistance projects and climate change capacity building.

In the context of GD No. 1277 of 26.12.2018, the NMRS aims to ensure transparent, accurate, consistent and comprehensive monitoring and reporting of greenhouse gases to the UNFCCC Secretariat, through planned reporting tools, including actions taken to adapt to the consequences of climate change, respectively, to ensure evaluation, reporting and verification of information on national progress in meeting the commitments under the UNFCCC, the Paris Agreement and the decisions taken in accordance with them.

Regarding the National Inventory System (NIS), it is designed and managed in such a way as to assure adherence to transparency, consistency, comparability, completeness principles in preparation of the national inventory of greenhouse gas emissions, in accordance with the provisions of the 2006 IPCC Guidelines on development of national greenhouse gas inventories.

The Environmental Agency, as *competent authority*, in direct collaboration with responsible authorities and institutions that are part of the NMRS and with the support of the Central Authority for Natural Resources and Environment (MARDE), manages the organization and operation of the NIS, by periodically improving the institutional, legal and procedural framework, in accordance with the national and international legal framework.

Within the NIS, the competent authority shall develop every second year the national greenhouse gas emissions inventory. The data of the national inventory shall be presented according to the format set out in Table 1 of Annex No. 1 to GD no. 1277 of 26.12.2018.

In case of direct greenhouse gas emissions, the national inventory is compiled in accordance with the 2006 IPCC Guidelines, through the reporting software recommended by the UNFCCC, while in case of indirect greenhouse gas emissions, the national inventory is compiled in accordance with the updated editions of the EEA/EMEP Air Pollutant Emission Inventory Guidebook, the technical guideline for inventory of national emissions, published and regularly updated by the European Environment Agency under the European Monitoring and Assessment Program.

Based on the National Inventory of Greenhouse Gas Emissions, the competent authority shall be responsible for compiling, every two years, the National Inventory Report (NIR), in Romanian and in English, using the structure set out in the relevant decisions of the Conferences of Parties signatories to the UNFCCC, namely: (1) introduction; (2) trends in GHG emissions; (3) energy sector; (4) industrial processes and product use sector; (5) agriculture sector; (6) LULUCF sector; (7) waste sector; (8) recalculations and planned improvements; (9) references; and (10) annexes.

The competent authority shall publish every two years on its official website (<http://mediu.gov.md/>) the National Inventory Report (NIR), as well as the national inventory of greenhouse gas emissions in table format. The summation tables shall show the trends of greenhouse gas emissions by gas and by sector.

The competent authority ensures the quality of national inventories by implementing the planning, preparation and management stages, which include collection of activity data, appropriate selection of estimation methods and emission factors, estimation of anthropogenic greenhouse gas emissions, implementation of uncertainty analysis, activities for quality assurance and quality control, as well as data verification procedures included in the national inventory.

At the *planning* stage for the national inventory, the following activities are performed:

1. make available financial resources necessary for the development of the national inventory, as well as for collecting activity data, selection of emission factors and estimation methods, implementation of quality assurance and quality control measures, estimation of key categories,

uncertainties, envisioned recalculations and improvements, for each source category or sink included in the national inventory;

2. elaborate, approve and periodically update the QA/QC plan which describes specific QC procedures to be implemented during the inventory development process, facilitate the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establish quality objectives;
3. make available on the official website of the competent authority the postal and electronic addresses of the national competent authority responsible for the inventory;
4. establish processes for the official consideration and approval of the inventory, prior to its submission to the UNFCCC Secretariat.

At the stage of *preparation* of the national inventory, the following activities are to be performed:

1. identify key categories by following the methods described in the 2006 IPCC Guidelines;
2. collect sufficient activity data, process information and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks;
3. prepare estimates in accordance with the methods described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, and ensure that appropriate methods are used to estimate emissions from key categories;
4. make a quantitative estimate of inventory uncertainty for each source category and for the inventory in total, following the 2006 IPCC Guidelines;
5. ensure that any recalculations of previously submitted estimates of anthropogenic GHG emissions by sources and removals by sink are prepared in accordance with the 2006 IPCC Guidelines;
6. compile the national inventory in accordance with relevant decisions of the COP;
7. implement general inventory QC procedures (tier 1) in accordance with the approved QA/QC plan following the 2006 IPCC Guidelines;
8. apply category specific QC procedures (tier 2) for key categories and for those individual source categories in which significant methodological and/or data revisions have occurred, in accordance with the 2006 IPCC Guidelines;
9. provide for a basic review of the inventory by personnel that have not been involved in the inventory development, preferably an independent third party, before the submission of the inventory;
10. provide for a more extensive review of the inventory for key categories, as well as for categories in which significant changes in methods or data have been made;
11. re-evaluate the inventory planning process in order to meet the established quality objectives established in the QA/QC plan, taking into account recommendations from the actions laid down above in pt. 9) and 10), and of the results of periodic internal evaluations of the inventory preparation process.

At the *management* stage of the national inventory, the following activities are to be performed

1. periodically archive and store the inventory information for each inventory year, including:
   a. all disaggregated emission factors, activity data, and documentation about how these factors and data have been generated and aggregated for the preparation of the inventory;
   b. internal documentation on QA/QC procedures;
   c. documentation on external and internal reviews, documentation on annual key categories identification and planned inventory improvements;
2. provide the technical teams of experts (TTE) in the process of technical analysis of biennial update reports under the international consultation and analysis (ICA) with access to information used to develop the national inventory, as well as to information on the NSMR;
3. respond to requests for clarifying inventory information resulting from the different stages of the process of technical analysis of biennial update reports under the ICA in a timely manner, in accordance with UNFCCC decisions.

The competent authority shall communicate to the central authority for natural resources and the environment, by 15 December of the year in which the report is made (year X), the following data:

1. the level of anthropogenic emissions of direct greenhouse gases – carbon dioxide [CO_2], methane [CH_4], nitrous oxide [N_2O], hydrofluorocarbons [HFCs], perfluorocarbons [PFCs], sulfur hexafluoride [SF_6], nitrogen trifluoride [NF_3] – recorded two years prior to the year in which the reporting is done (year X-2);
2. the level of anthropogenic emissions of indirect greenhouse gases – carbon monoxide [CO], nitrogen oxides [NO_x], non-methane volatile organic compounds [NMVOCs] and sulfur dioxides [SO_2] – recorded 2 years prior to the year in which the reporting is done (year X-2);
3. accounting of emissions and removals from land use, land-use change and forestry sector, recorded two years prior to the year in which the reporting is done (year X-2);
4. any recalculations and/or modifications of information provided for in pt. 1) - 3), covering the period between the base year (1990) and three years prior to the year in which the reporting is done (X-3);
5. the elements comprised in the NIR, information on QA/QC plan, a general assessment of uncertainty and completeness of the inventory, as well as information on any other recalculations;
6. measures taken to improve GHG emissions estimates, mainly recalculated estimates.

The central authority for natural resources and environment shall submit to the UNFCCC Secretariat, based on data provided by the competent authority, prior to 31 December of the year in which the reporting is done (year X), the complete greenhouse gases national inventory for the period starting with base year (1990) and ending with the year X-2.

The competent authority shall make available to the public the information on greenhouse gas emissions, in accordance with the provisions of GD No. 1277 of 26.12.2018 on establishment and operation of the National Monitoring and Reporting System for greenhouse gas emissions and other information relevant to climate change.

1.2.2. Institutional Arrangements

The list of competent authorities and institutions which are part of the NMRS for greenhouse gas emissions, as well as other information relevant to climate changes in accordance with Annex No. 2 to GD No. 1277 of 26.12.2018, comprises:

1. Specialized central public authorities:
   1) Ministry of Agriculture, Regional Development and Environment;
   2) Ministry of Economy and Infrastructure;
   3) Ministry of Finance;
   4) Ministry of Health, Labor and Social Protection;
   5) Ministry of Defense;
   6) Ministry of Foreign Affairs and European Integration;
   7) Ministry of Education, Culture and Research.
2. Public authorities subordinated to ministries:
   1) Environmental Agency;
   2) Inspectorate for Environmental Protection;
   3) Civil Aeronautical Authority;
   4) Naval Agency of the Republic of Moldova;
   5) Customs Service;
   6) Agency for Energy Efficiency;
   7) National Agency for Public Health;
   8) Moldsilva Agency;
   9) State Hydrometeorological Service.

3. Central public authorities:

1) National Bureau for Statistics;
2) Agency for Land Relations and Cadaster;
3) Agency for Medicines and Medical Devices;
4) Public Services Agency;
5) National Agency for Food Safety;

4. State owned companies and joint stock companies subordinated to specialized public authorities and companies with shares of state owned capital:

1) State Enterprise "State Road Administration";
2) State Enterprise "Ungheni River Harbor";
3) State Enterprise "Molovata Ferry";
4) Forestry-Didactic Enterprise "Forestry Research and Management Institute" (subordinated to "Moldsilva" Agency);
5) State Enterprise "Moldovan Railways";
6) State Enterprise "Chisinau Glass Factory";
7) State Enterprise "Moldelectrica", Chisinau;
8) Joint Stock Company "RED-NORD";
9) Joint Stock Company "TERMOELECTRICA", Chisinau;
10) Joint Stock Company "CET-Nord", Balti;
11) Joint Stock Company "Moldovagaz".

As competent authority responsible for operation of the National Monitoring and Reporting System for greenhouse gas emissions and other information relevant to climate change, the Environmental Agency, by Letter no. 3471 of 25.09.2019 to the Office of Climate Change of the PI "EPIU", requested to examine and identify the possibility of providing the necessary support for carrying out of responsibilities in the field of climate change by organizing the entire process of developing the Third Biennial Update Report of the Republic of Moldova to UNFCCC, respectively, the Fifth National Communication of the Republic of Moldova to the UNFCCC, in accordance with the rules, procedures and decisions of the Conference of the Parties to the UNFCCC.

Towards this end, the Climate Change Office of the PI "EPIU" has been given the authority: to request and receive, directly or through the Environmental Agency, information from central public authorities, local public authorities, organizations and institutions, economic operators working in fields holding primary information needed to complete these two national reports; to collect, process and validate the data and information necessary for preparation of national inventory and reports on greenhouse gas emissions; to train specialists from the Environmental Agency in processes for working with collected data and information in order to develop their capacities in targeted fields.

It should be noted that the Climate Change Office, being within MARDE (February 2004 - December 2018), and more recently also under the PI "EPIU" (starting January 2019), held the responsibility for activities associated with the preparation of NCs, BURs, NIRs and national GHG emission inventories.

Figure 1-6 schematically defines the institutional arrangements for the NMRS of the Republic of Moldova. Thus, within the PI "EPIU", the inventory team is responsible for assessing emissions by source category and removals by sink category, analysis of key emission sources, activities for verification and control of the inventory quality, uncertainty analysis, documentation and archiving of information associated with the process of preparing the national inventory of GHG emissions, development of NCs, BURs and NIRs.

The functional responsibilities of the participants in the process are briefly described as follows:

- The Coordinator / Compiler of the National GHG Inventory is responsible for the inventory preparation process coordination, including supervision of estimating emissions by individual categories of sources and removals by individual categories of sinks, KCA, uncertainty analysis interpretation, QA&QC activities coordination, documentation and archiving the data used in the inventory preparation process, synthesis of sectoral reports – serving as basis for the NIR compilation, respectively Chapter 2 "GHG National Inventory" from the BURs and NCs;

- The national experts (hired on a contract basis) are responsible for estimating emissions by individual categories of sources and removals by individual categories of sinks at sectoral level (Sector 1 "Energy", Sector 2 "Industrial Processes and Product Use", Sector 3 "Agriculture", Sector 4 "LULUCF" and Sector 5 "Waste"); national experts are responsible for the activity data (AD) collection, application of decision trees in terms of selecting suitable assessment methods and EFs, estimating emission uncertainties by individual categories of sources, as well as for taking correction measures as a response to QA&QC activities.

The activity data necessary for compilation of the national inventory are available in the Statistical Annual Reports, Energy Balance, sectoral statistical publications, as well as in the online database[46] managed by the National Bureau for Statistics (NBS) of the Republic of Moldova.

For the period until 1992, the information is available for the whole territory of the Republic of the Moldova, while since 1993 only for the right bank of Dniester (without Transnistria, further referred as Administrative Territorial Units on the Left Bank of Dniester). The statistical data for the left bank of Dniester are available in the Statistical Yearbooks of the ATULBD[47] and in other relevant sectorial statistical publication, as compiled by the State Statistical Service beside the Ministry of Economy of the ATULBD[48].

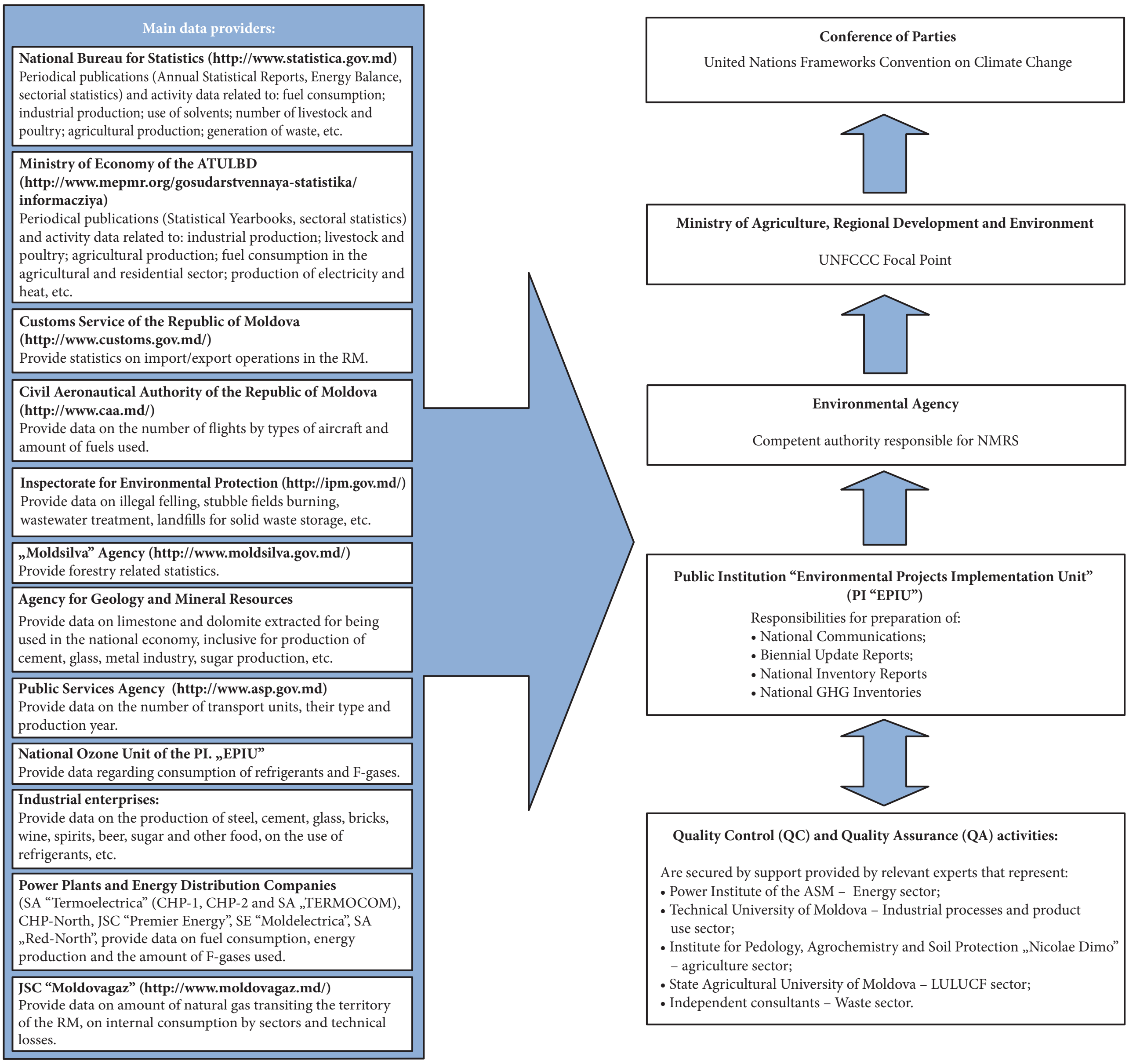

Figure 1-6: Institutional arrangements for the NMRS of the Republic of Moldova.

[46] National Bureau for Statistics of the RM, on-line database: <http://statbank.statistica.md/pxweb/Database/RO/databasetree.asp>
[47] CCO of the PI "EPIU" has copies of the Statistical Yearbooks of ATULBD for the years of 2000-2020, covering the statistical data for the 1990 year and 1995-2019 periods.
[48] Ministry of Economy of the ATULBD: <http://www.mepmr.org/gosudarstvennaya-statistika/informacziya>

Additional statistical information (unpublished) can be obtained upon request from a number of partner institutions, with the status of data providers, in accordance with provisions of GD No. 1277 of 26.12.2018 on establishment and operation of the National Monitoring and Reporting System of Greenhouse Gas Emissions and other information relevant to climate change, including:

- from the Ministry of Health, Labor and Social Protection and the Agency for Medicines and Medical Devices: data on use of dose pressurized aerosols made on the basis of HFCs as a propellant;
- from the Ministry of Defense: information on the amount of fuels used for military transportation;
- from the Customs Service: statistics on import/export operations in the Republic of Moldova;
- from the Public Services Agency: information on the number of transport units registered, their type and production year;
- from the Naval Agency of the Republic of Moldova and the State Enterprises "Ungheni Harbor" and the State Enterprise "Molovata Ferry": information on the amount of fuel used to ensure operation of naval transport;
- from the Civil Aviation Authority of the Republic of Moldova: information on the amount of fuels used in air transportation (civil and international aviation) and the number of flights by type of aircrafts;
- from the Agency for Land Relations and Cadaster: information on land use by categories type;
- from Moldsilva Agency: information on forestry related statistic;
- from the Agency for Geology and Mineral Resources: information on limestone and dolomite extraction and use;
- from the Inspectorate for Environmental Protection: information on illegal felling and stubble fields burning;
- from the National Ozone Unit of PI "EPIU": data on import and use of refrigerants in refrigeration and air conditioning equipment;
- from the State Owned Enterprise "State Road Administration": data on amount of asphalt produced and used in the Republic of Moldova;
- from the State Enterprise "Moldovan Railways": data on amount of fuel consumed for provision of railway transport services, as well as on the rolling stock used at the enterprise;
- from JSC "Moldovagaz": information on the amount of natural gas transited through the territory of the Republic of Moldova, on the consumption of natural gas in the national economy by sector, as well as on technical losses;
- from Power Plants ("TERMOELECTRICA" J.S.C. in Chisinau [CHP-1 J.S.C., CHP-2 J.S.C. and "TERMOCOM" J.S.C.], CHP-North J.S.C. in Balti: information on the amount of fuel used for electricity and heat production;
- from the enterprises specialized in transmission and distribution of electricity (JSC "Moldelectrica", JSC "Premier Energy", "Red-North" J.S.C.): data on amount of PFCs and SF_6 used as elegaz in electrical transformers;
- from a range of industrial enterprises ("Lafarge Cement (Moldova)" J.S.C., "Macon" J.S.C., Glass Factory No. 1 in Chisinau, "Glass-Container" Company in Chisinau, etc.) – information on the amount of fuel used, industrial output and amount of mineral resources used.

1.3. Process for Inventory Preparation

PI "EPIU" applies a top down approach in the process of preparing the national inventory, which consists of the National Inventory Report (NIR) and the standard evaluation and reporting tables as approved by Decision 24/CP.19 (see Annex 6). The process of preparing the national inventory is presented schematically in Figure 1-7.

The Coordinator / Compiler of the National GHG Inventory is responsible for compiling the estimations and ensuring consistency and quality of the inventory by producing the NIR and Chapters 2 "National GHG Inventory" from the Biennial Update Reports and the National Communications.

Estimation of emissions by individual source categories and removals by individual sink categories is the responsibility of national experts who have more competences about individual features of source/

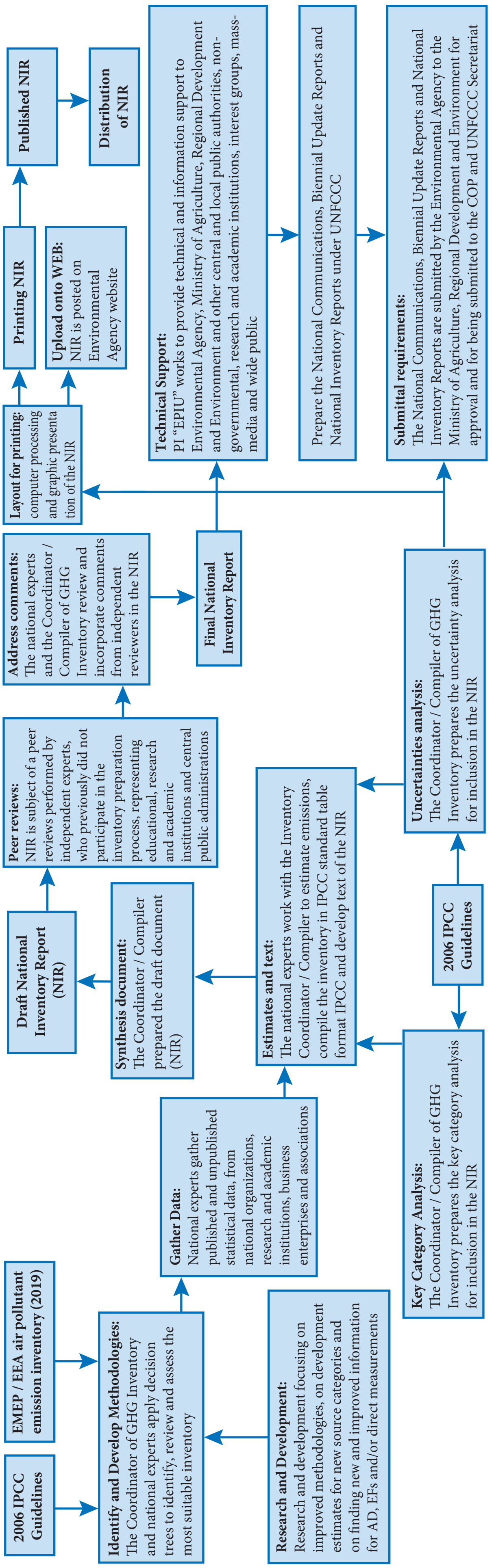

Figure 1-7: Inventory Process in the Republic of Moldova.

sink categories. The national experts, under direct guidance of the Coordinator of the National GHG Inventory, decide, by applying decision trees, on employing the best estimation methodology, and collect AD needed for emissions estimation. For most source and sink categories methodologies used in the previous inventory cycle are applied. It is needed to collect new AD for a more recent period under review or for the entire period under review if historical AD were amended or recalculated. If a new source/sink category was to be assessed, or a higher Tier methodology had to be used, then the Coordinator of the National GHG Inventory with the national experts would decide on which assessment methodology to use, collect most reasonable AD and EFs, calculate GHG emissions, assess uncertainties, ensured implementation of verification, QA/QC procedures acting on behalf of research and academic institutions, ministries and subordinated institutions, central administrative authorities and/or private sector. National experts produce explanatory texts for the research on estimation of emissions by individual source categories and removals by individual sink categories, as well as provided the bibliography used.

The Coordinator / Compiler of the National GHG Inventory is responsible for collecting and reviewing these materials, used in drafting the NIR sectoral chapters (Chapter 3 “Energy”, Chapter 4 “Industrial Processes and Product Use”, Chapter 5 “Agriculture”, Chapter 6 “LULUCF”, Chapter 7 “Waste”). The Coordinator / Compiler is also responsible for drafting other chapters (Executive Summary, Chapter 1 “Introduction”, Chapter 2 “Trends in National GHG Emissions”, Chapter 8 “Recalculations”, “Bibliography” and “Annexes”), as well as for checking the correctness of the key category analysis, compatible with the 2006 IPCC Guidelines.

The NIR is produced in compliance with the general structure of the National Inventory Reports, as was established in the Decision 24/CP.19. In addition to NIR, the Common Reporting Format (CRF) Tables are filled-in (see Annex 6). The Coordinator / Compiler of the National GHG Inventory has the task to monitor the process of producing the Sectoral and Summary CRF Tables, to ensure the consistency of results. The national experts accomplished the uncertainties analysis, as well as verification and QA/QC activities, in close cooperation with the Coordinator / Compiler of the National GHG Inventory.

The first *QA/QC Plan* was produced in 2006 within the UNDP-GEF Regional Project "*Capacity Building for Improving the Quality of the National GHG Inventories (Central Europe and CIS region)*", and complied with the 2006 IPCC Guidelines requirements. Subsequently, it was periodically updated during the national GHG inventory processes.

During the peer reviews, the draft version of the NIR is sent to a group of independent experts (who did not previously participate in the national inventory preparation). The purpose of the inventory peer reviews is to receive from relevant experts in the areas of major interest comments on quality of the work done, in particular on relevance of methodological approaches, EFs and AD used. The received comments are reviewed and estimations and explanatory notes to them are corrected.

Following the final review, after the incorporation of comments received in the process of peer reviews, the Climate Change Office of the PI "EPIU" prepares the MS Word final version of the National Inventory Report, which is then sent for approval to the Environmental Agency. When the Report is approved, the final version is electronically processed, printed and published.

Once published, the National Inventory Report, the Biennial Update Reports and/or the National Communications are submitted by the Environment Agency to the Ministry of Agriculture, Regional Development and Environment for approval, after which it is officially submitted to the UNFCCC Secretariat, in accordance with Moldova's international commitments to UNFCCC.

1.4. Methodologies and Data Sources

The national inventory is structured to match the reporting requirement of the UNFCCC and is divided into five main sectors: (1) Energy, (2) Industrial Processes and Product Use, (3) Agriculture, (4) Land Use, Land-Use Change and Forestry, and (5) Waste. Each of these sectors is further subdivided, within the inventory, by source categories (Table 1-3).

Emissions of direct (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) (no NF_3 emissions have been registered in the Republic of Moldova so far) greenhouse gases were estimated based on methodologies contained in the 2006 IPCC Guidelines, while the indirect emissions (NO_x, CO, NMVOC, and SO_2) were estimated based on methodologies according to the EEA/EMEP Air Pollutant Emission Inventory Guidebook (2019).

Table 1-3: Summary of methods and emission factors used for inventory preparation process in the Republic of Moldova

Greenhouse Gas Source and Sink Categories	CO_2		CH_4		N_2O		HFC		PFC		SF_6	
	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
1. Energy												
A. Fuel Combustion	T1	D, CS	T1	D	T1	D						
1. Energy Industries	T1	D, CS	T1	D	T1	D						
2. Manufacturing Industries and Construction	T1	D, CS	T1	D	T1	D						
3. Transport	T1	D, CS	T1	D	T1	D						
4. Other Sectors	T1	D, CS	T1	D	T1	D						
5. Other	T1	D, CS	T1	D	T1	D						
B. Fugitive Emissions from Fuels	T1	D, CS	T1	D	T1	D						
1. Solid Fuels	NO	NO	NO	NO	NO	NO						
2. Oil and Natural Gas	T1	D, CS	T1	D	T1	D						
C. CO_2 Transport and Storage	NO	NO										
2. Industrial Processes and Product Use												
A. Mineral Industry	T2, T1	D, CS	NA	NA	NA	NA						
B. Chemical Industry	NO	NO	NO	NO	NO	NO						
C. Metal Industry	T2	CS, D	NO	NO	NO	NO						
D. Non-Energy Products from Fuels and Solvent Use	T2, T1	D	NA	NA	NO	NO						
E. Electronic Industry	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
F. Product Use as Substitutes for ODS	NA	NA	NA	NA	NA	NA	T2, T1	CS, D	NA	NA	NA	NA
G. Other Product Manufacture and Use	T2, T1	D	NA	NA	T1	D	NA	NA	T1	D	T1	D
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture												
A. Enteric Fermentation			T2, T1	D, CS	NA	NA						
B. Manure Management			T2, T1	D, CS	T2, T1	D, CS						

Greenhouse Gas Source and Sink Categories	CO_2		CH_4		N_2O		HFC		PFC		SF_6	
	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
C. Rice Cultivation			NO	NO	NA	NA						
D. Agricultural Soils			NA	NA	T1, T3	D, CS						
E. Prescribed Burning of Savannas			NO	NO	NA	NA						
F. Field Burning of Agricultural Residues			IE	IE	IE	IE						
G. Liming	NO	NO	NA	NA	NA	NA						
H. Urea Application	T1	D	NA	NA	NA	NA						
I. Other Carbon-Containing Fertilisers	NO	NO	NA	NA	NA	NA						
J. Other	NO	NO	NO	NO	NO	NO						
4. LULUCF												
A. Forest Land	T3, T2, T1	D, CS	T1	D	T1	D						
B. Cropland	T2, T1	D, CS	T1	D	T1	D						
C. Grassland	T2	CS	NE	NE	NE	NE						
D. Wetlands	T2, T1	D, CS	NE	NE	NE	NE						
E. Settlements	T2, T1	D, CS	NE	NE	T1	D						
F. Other Land	T2, T1	D, CS	NE	NE	NE	NE						
G. Harvested Wood Products	T1	D	NA	NA	NA	NA						
H. Other	NO	NO	NO	NO	NO	NO						
5. Waste												
A. Solid Waste Disposal	NA	NA	T3	D, CS	NA	NA						
B. Biological Treatment of Solid Waste	NA	NA	T1	D	T1	D						
C. Incineration and Open Burning of Waste	T1	D	T1	D	T1	D						
D. Wastewater Treatment and Discharge	NA	NA	T1	D, CS	T1	D						
E. Other	NO	NO	NO	NO	NO	NO						
6. Other	NO	NO	NO	NO	NO	NO						
Memo Items												
International Bunkers	T2, T1	D, CS	T1	D	T1	D						
Multilateral Operations	NO	NO	NO	NO	NO	NO						
CO_2 Emissions from Biomass	T1	D, CS	IE	IE	IE	IE						
CO_2 Captured and Stored	NO	NO	NA	NA	NA	NA						

Abbreviations: T1 – Tier 1 Method; T2 – Tier 2 Method; C – EMEP/EEA; CS – Country Specific; D – Default; IE – Included Elsewhere; NA – Not Applicable; NE – Not Estimates; NO – Not Occurring.

Generally, a GHG inventory can be defined as a '*comprehensive account of anthropogenic sources of emissions and removals by sinks and associated data from source and sink categories within the inventory area over a specified time frame*'.

It can be prepared 'top-down', 'bottom-up', or using a combination approach. The Republic of Moldova's national inventory is prepared using a 'top-down' approach, providing estimates of GHG emissions at a national level. Ideally, a GHG inventory should be developed by using direct measurements of emissions and removals from individual categories of sources or sinks in the country, considering the methodological approach 'bottom-up'.

The inventory team is continuously working to improve accuracy, completeness and transparency of its inventory. Comprehensive bottom-up inventory is neither practicable nor possible at the present time, although for some sectors, estimates are derived from individual source specific data.

To the extent possible, AD used in this report are based on officially published data: national (Statistical Yearbooks of the RM, respectively of the Administrative-Territorial Units from the Left Bank of Dniester River (Transnistria), Energy Balances etc.) and international statistical publications (UN FAO on-line database), publications of academic, research and development institutions (Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo' of the ASM, Institute of Ecology and Geography of the ASM, Institute of Power Engineering of the ASM, Forest Research and Management Institute, etc.), AD provided by ministries and subordinated institutions (Ministry of Defence; Ministry of Health, Labour and Social Protection), AD provided by administrative authorities subordinated to ministries (Environment Agency, Inspectorate for Environmental Protection, Customs Service; Agency 'Moldsilva', State Hydrometeorological Service, Agency for Geology and Mineral Resources), data from central administrative authorities (National Bureau of Statistics, Agency for Land Relations and Cadastre, Public Services Agency, Naval Agency, Civil Aeronautical Authority, Medicines and Medical Devices Agency, National Food Safety Agency), data obtained from enterprises and businesses associations (SOE 'Moldova Railways', 'Moldovagaz' JSC, 'Lafarge Cement (Moldova)' JSC, 'Macon' JSC, SOE ' Glass Factory in Chisinau', 'Glass Container Company' JSC, etc.).

1.5. Key Categories

According to the 2006 IPCC Guidelines, it is good practice to identify key categories, so as to help prioritise efforts and improve the overall quality of the national inventory. A key category is defined as a 'source or sink category, which is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both'.

Table 1-4, respectively Annex 1, presents the key categories for the RM's National GHG Inventory, 1990-2019, without LULUCF – based on the Tier 1 methodological approach – 21 key categories by level (L) and 20 key categories by trend (T); based on a Tier 2 approach – 19 key categories by level (L) and 17 key categories by trend (T); with LULUCF, based on the Tier 1 methodological approach – 28 key categories by level (L) and 26 key categories by trend (T), respective, based on a Tier 2 approach – 26 key categories by level (L) and 22 key categories by trend (T).

Table 1-4: Summary Overview of the Republic of Moldova's Key Categories for 1990-2019, based on a Tier 1 and Tier 2 Approaches

IPCC classification	Key categories	Gas	Without LULUCF				With LULUCF			
			T1		T2		T1		T2	
			L	T	L	T	L	T	L	T
1A1	Energy industries - liquid fuels	CO_2	X	X	X	X	X	X	X	X
1A1	Energy industries - gaseous fuels	CO_2	X	X	X	X	X	X	X	X
1A1	Energy industries - solid fuels	CO_2	X	X	X	X	X	X	X	X
1A2	Manufacturing industries and construction	CO_2	X	X	X		X	X	X	
1A3b	Road transportation	CO_2	X	X	X	X	X	X	X	X
1A3c	Railways	CO_2	X	X			X	X		
1A4a	Commercial/institutional	CO_2	X	X			X	X	X	
1A4b	Residential	CO_2	X	X	X		X		X	
1A4b	Residential	CH_4	X	X	X	X	X	X	X	X
1A4c	Agriculture/forestry/fishing	CO_2	X	X	X		X	X	X	
1B2	Fugitive emissions from oil and natural gas	CH_4	X	X	X	X	X	X	X	X
2A1	Cement production	CO_2	X	X			X	X		
2D	Non-energy products from fuels and solvent use	CO_2	X		X	X	X		X	
2F1	Product Uses as Substitutes for ODS – Refrigeration and Air Conditioning	HFC	X	X	X	X	X	X	X	X
2F2	Product Uses as Substitutes for ODS – Foam Blowing	HFC		X		X				X
3A	Enteric fermentation	CH_4	X	X	X	X	X	X	X	X
3B	Manure management	CH_4	X	X	X	X	X		X	
3B1	Direct N_2O emissions from manure management	N_2O	X		X	X	X		X	X
3B5	Indirect N_2O emissions from manure management	N_2O			X	X			X	X
3Da	Direct N_2O emissions from managed soils	N_2O	X	X	X	X	X	X	X	X
3Db	Indirect N_2O emissions from managed soils	N_2O	X	X	X	X	X	X	X	X
4A1	Forest lands remaining forest lands	CO_2					X	X	X	X
4A2	Land converted to forest land	CO_2					X	X	X	X
4B1	Cropland remaining cropland	CO_2					X	X	X	X
4B2	Land converted to cropland	CO_2								
4C2	Land converted to grassland	CO_2					X	X	X	X
4D2	Land converted to wetlands	CO_2					X	X		X
4E2	Land converted to settlements	CO_2					X	X	X	
4F2	Land converted to other land	CO_2					X	X	X	X
4G	Harvested wood products	CO_2						X		X
5A	Solid waste disposal	CH_4	X	X	X	X	X	X	X	X
5D	Wastewater treatment and disposal	CH_4	X	X	X	X	X	X	X	X

Abbreviations L – Level Assessment; T – Trend Assessment; T1 – Tier 1; T2 – Tier 2.

Following the recommendations set in the 2006 IPCC Guidelines, the inventory was first disaggregated by source categories which further were used to identify key categories.

Source and sink categories were defined in conformity with the following guidelines: (1) emissions / removals from individual source/sink categories identified according to standard classification, were expressed CO_2 equivalent units, estimated by using the GWP; (2) a category should be identified for each gas emitted by the sources and sinks, since the methods, emission factors, and related uncertainties differ for each gas; (3) source and sink categories that use the same emission factors based on common assumptions were aggregated before analysis.

Key categories were identified from two perspectives: (1) the first analysis the emission contribution that each category makes to the national total; and (2) the second perspective analysis the trend of emission contributions from each category to identify where the greatest absolute changes (either increases or reductions) have taken place over a given time.

The per cent contributions to both levels (L), and trends (T), in emissions are calculated and sorted from greatest to least (see also Annex 1 of the NIR). When a Tier 1 approach was used, a 95 per cumulative contribution threshold has been used in this analysis to define an upper boundary for the key category identification, respectively when a Tier 2 approach was used (considering AD and EFs uncertainties used to estimate GHG emissions for individual source/sink categories), a 90 per cumulative contribution threshold has been used in this analysis to define an upper boundary for the key category identification.

The Key Category Analysis was carried out using the Key Category Calculation Tool developed by the United States Environment Protection Agency (US EPA v2.5)[49].

1.6. Quality Assurance and Quality Control

Following the recommendations from the 2006 IPCC Guidelines, national inventories have to be transparent, well documented, consistent, complete, comparable, assessed for uncertainties, subject to verification and QA/QC. The 2006 IPCC Guidelines defines the QA/QC terms as follows:

- *Quality Control* (QC) is a system of routine technical activities to measure and control the quality of the inventory as it is being developed. A basic QC system should provide routine and consistent checks to ensure data integrity, correctness, and completeness; identify and address errors and omissions; and document and archive inventory material and record all QC activities.
- *Quality Assurance* (QA) comprises a planned system of review procedures conducted by personnel not directly involved in the inventory compilation and development process.

As a part of continuous efforts to develop a transparent and reliable inventory, the Republic of Moldova developed a "*Quality Assurance and Quality Control Plan*". The key attributes of the "*Quality Assurance and Quality Control Plan*" include detailed specific procedures (Figure 1-8) and standard verification and quality control forms and checklists (see Annex 4 of the NIR), by using Tier 1 (general procedures) and Tier 2 (source-specific procedures), that serve to standardize the process of implementing quality assurance and quality control activities meant to ensure the quality of the national inventory; peer review carried out by experts not directly involved in the national inventory development process; data quality check including by comparing the sets of data obtained from different sources; inventory planning and coordination at an inter-institutional level; as well as the continuous documentation and archiving of all materials used in inventory preparation process.

It is well known that inventory development implies huge amounts of information that has to be gathered, handled and stored. The process sustainability is ensured through a good management and archiving of materials used along the inventory process.

In the Republic of Moldova, the National Inventory Working Group has a sufficiently transparent documentation allowing to fully reproducing the GHG emissions estimates. A standard system for documenting and archiving numeric and qualitative information, in compliance with the 2006 IPCC Guidelines recommendations was used. The activity data sources were documented by inserting references to these into the inventory document text. Estimation methods & emission factors sources and their selection justification are documented in the corresponding chapters of the NIR.

Recalculations made are documented and argued both in sectoral Chapters (3-7), as well as in the Chapter 8 "Recalculations and Improvements" of the NIR.

Individual source and sink categories related documentation include: (1) list of personnel responsible for estimates and individual responsibilities as per Terms of Reference; (2) reference sources for the activity data used; (3); justification of emission factors estimation methods selection; (4) samples of GHG emissions estimation process (in Excel format); (5) uncertainties analysis results by individual source and sink categories; (6) annexes; (7) references.

[49] <https://19january2017snapshot.epa.gov/climatechange/national-ghg-inventory-capacity-building_.html>

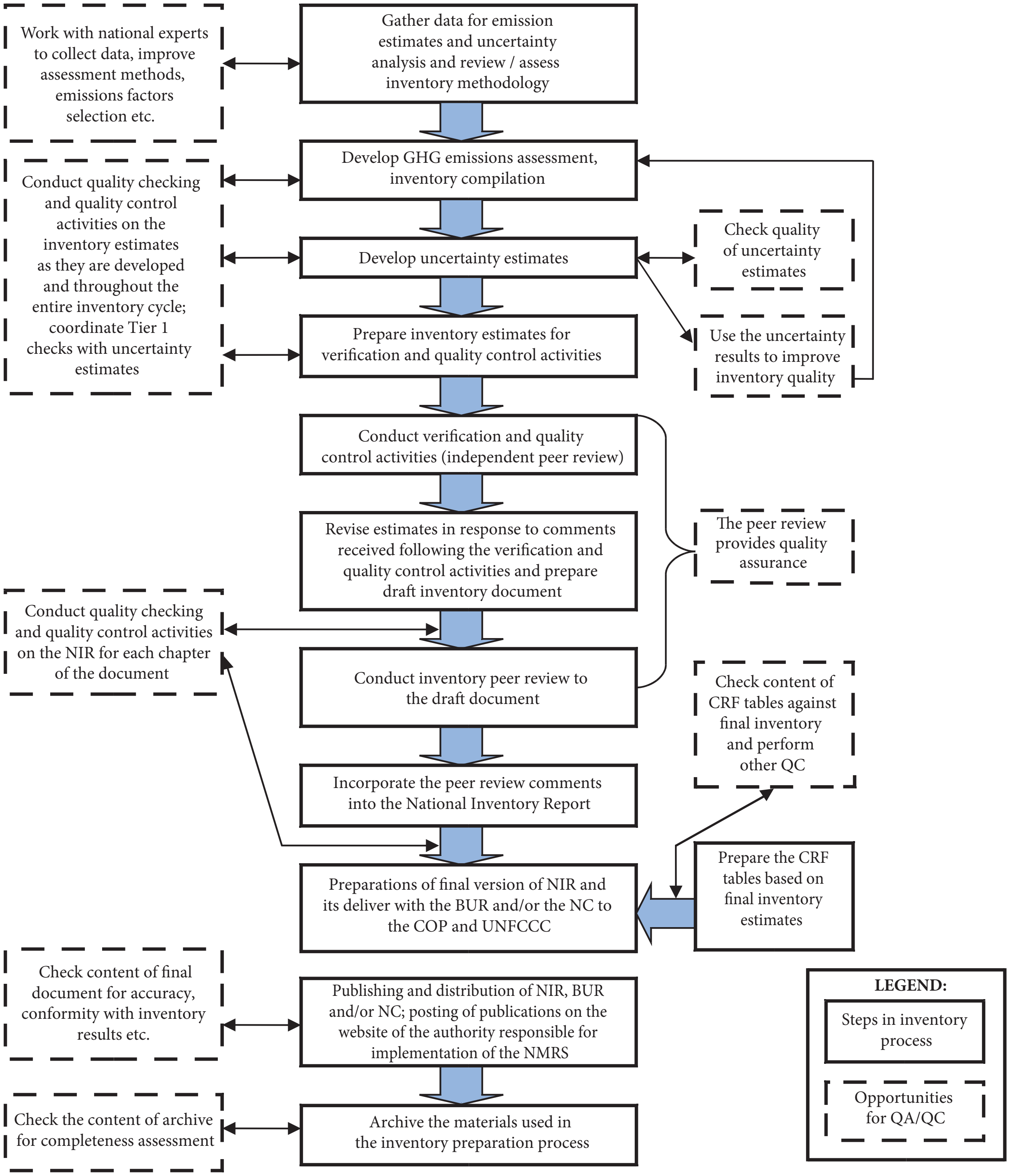

Figure 1-8: The Role of QA/QC Activities in the Inventory Preparing Process.

Materials used in the inventory development process were archived both electronically and on hard copies. As the entity responsible for the national inventory development, the Climate Change Office of the PI "EPIU" holds all documentation used for its compilation.

Summing up, one can assert that transparency and credibility of a national inventory are ensured through: (1) the ability to demonstrate, through appropriate documentation, transparency of inventory development process; (2) further improvements of the inventory process and its basic products; and (3) ensuring that the inventory process employed consistent approaches allowing to obtain comparable results for all source and sink categories.

It is obvious that in comparison with the previous inventory cycles, by continuous integration of QA/QC activities, the Republic of Moldova ensures a better-quality inventory.

1.7. Uncertainty Assessment

Uncertainty estimates are an essential element of a complete and transparent emissions inventory. Uncertainty information is not intended to challenge the validity of inventory estimates, but to help prioritize efforts to improve the accuracy of future inventories and guide future decisions on methodological choice. While the Republic of Moldova's National Inventory Team calculates the emission estimates with the highest possible accuracy, uncertainties are associated to a varying degree with the development of emission estimates for any inventory.

Some of current estimates, such as those for CO_2 emissions from fossil fuels combustion or from cement production are considered to have minimal uncertainty associated with them. For some other categories of emissions, however, a lack of data, the use of emission factors used by default or an incomplete understanding of how emissions are generated increases the uncertainty surrounding the estimates presented.

Additional research in the following areas could help reduce uncertainty in the RM's Inventory:

- *Incorporating excluded emission sources.* Quantitative estimates for some of the sources and sinks of GHG emissions are not available at this time.
- *Improving the accuracy of emission factors.* Further research is needed in some cases to improve the accuracy of emission factors used to calculate emissions from a variety of sources (for example, the accuracy of current emission factors applied to CH_4 fugitive emissions from oil and natural gas, emissions of CO_2 from solvents and other products, indirect N_2O emissions from manure management and indirect N_2O emissions from agricultural soils etc., is highly uncertain).
- *Collecting more detailed activity data.* Although methodologies for estimating emissions for some sources exist, problems arise in obtaining activity data at a level of detail in which aggregate emission factor can be applied, in particular the ability to estimate emissions of F-gases within Sector 2 "Industrial Processes and Product Use".

The overall inventory uncertainty was estimated using a Tier 1 methodological approach. An estimate of the overall quantitative uncertainty (±6.62 per cent level uncertainty and, respectively ±2.14 per cent trend uncertainty) are shown in Table 1-5, as well as in the Annex 5 of the NIR.

Table 1-5: Estimated Overall National Inventory Quantitative Uncertainty in the RM

	CO_2	CH_4	N_2O	Total
Level uncertainty	±5.12	±25.33	±25.09	±6.62
Trend uncertainty	±1.59	±12.31	±11.35	±2.14

Emissions evaluated under the RM's National GHG Inventory reflect current best estimates; in some cases, however, estimates are based on approximate methodologies, assumptions, and incomplete data. As new information become available in the future, the RM's inventory team will continue to improve, revise and recalculate its GHG emission estimates.

1.8. Completeness Assessment

Republic of Moldova's National GHG Inventory is, mostly, a complete inventory of the following direct GHG – CO_2, CH_4, N_2O, HFC, PFC and SF_6. The national inventory includes also the indirect GHGs such as: CO, NO_x, NMVOC and SO_2.

Despite the effort to cover all existent sources and sinks, the inventory still has some gaps, most being determined by lack of activity data needed to estimate certain emissions and removals, such as: HFC emissions from source categories 2F5 "Solvents" and 2F6 "Other uses".

As part of the inventory improvement plan, during the future inventory activities, the inventory team will continue the efforts to identify new and relevant data for the GHG emissions/removals assessment from the respective categories.

2. GREENHOUSE GAS EMISSION TRENDS

2.1. Summary of Direct GHG Emission Trends

Over the 1990-2019 period, the dynamics of total direct greenhouse gas emissions, expressed in CO_2 equivalent, shows a decreasing trend in the Republic of Moldova, emissions having decreased by about 69.5%: from 45.35 Mt CO_2 equivalent in 1990 to 13.81 Mt CO_2 equivalent in 2019, net greenhouse gas emissions having decreased for the same period by about 67.9%: from 43.96 Mt CO_2 equivalent in 1990 to 14.11 Mt CO_2 equivalent in 2019 (Figure 2-1).

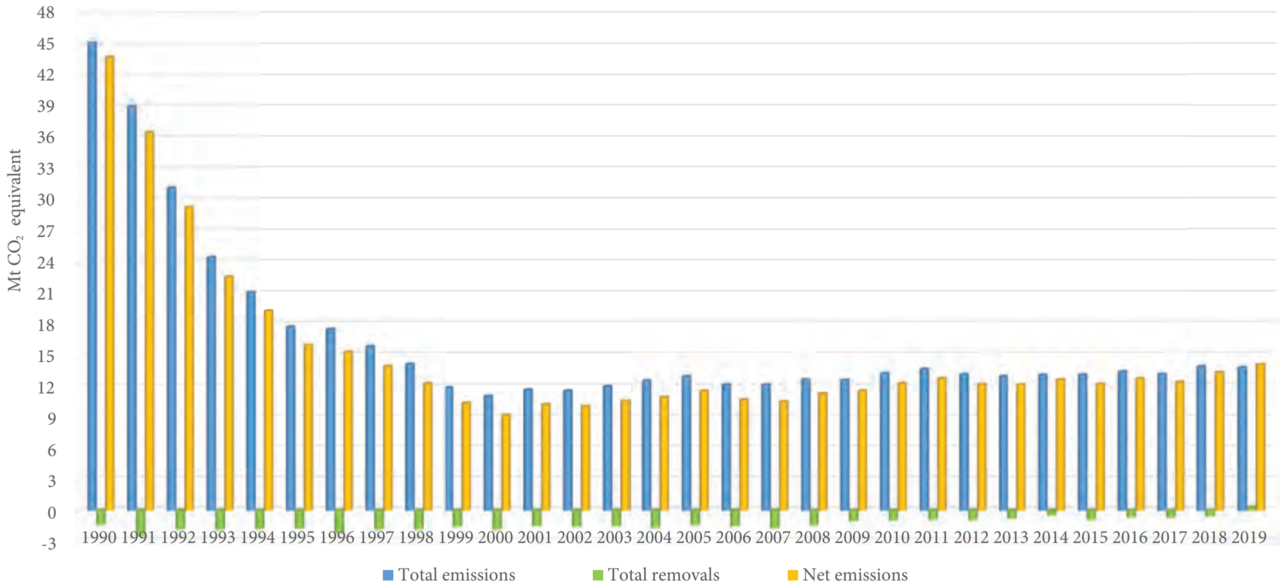

Figure 2-1: Greenhouse Gas Emission and Removals Trends within 1990-2019 time series.

The most significant reductions in direct GHG emissions by source category were recorded during the 1990-2019 period in the following categories: 1A1 "Energy industries" (-85.4%), 4C "Wetlands" (-85.1%), 1A5 "Other works and needs in energy" (-80.1%), 3A "Enteric fermentation" (-79.8%), 3B "Manure management" (-78.6%), 4C "Grassland" (-75.7%), 1A4 "Other sectors" (-69.5%), 1A2 "Manufacturing industries and construction" (-62.6%), 2A "Mineral industry" (-55.1%), 4G "Harvested wood products" (-52.9%), 1B2 "Fugitive emissions from oil and natural gas" (-51.1%), 1A3 "Transport" (-44.9%), 2C "Metal industry" (-44.6%), 2D "Non-energy products from fuels and solvent use" (-38.8%), 5D "Wastewater treatment and discharge" (-32.8%), 4B "Cropland" (-32.5%), 2G "Other Product Manufacture and Use" (-24.6%), 3D "Agricultural soils" (-27.2%) and 4A „Forest land" (-23.9%).

Between 2018 and 2019, total direct GHG emissions increased by about 5.7%, including due to increasing emissions from the following source categories: 4F "Other land" (+90.5%), 4E "Settlements" (+48.6%), 4B "Cropland" (+20.3%), 2F "Product Use as Substitutes for ODS" (+18.2%), 2G "Other Product Manufacture and Use" (+8.3%), 5B "Biological treatment of solid waste" (+7.1%), 3D "Agricultural soils" (+6.0%), 1A4 "Other sectors" (+5.6%), 1A3 "Transport" (+3.2%), 2A "Mineral industry" (+1.6%) and 5A "Solid waste disposal" (+0.7%).

2.2. Emission Trends by Gas

Over the 1990-2019 period, total CO_2 emissions (without LULUCF) have decreased by about 74.6% (from about 37.0 Mt in 1990 to 9.4 Mt in 2019). CH_4 and N_2O emissions have decreased by about 50.1% (from about 5.2 Mt CO_2 equivalent in 1990 to 2.6 Mt CO_2 equivalent in 2019) and by about 49.1% (respectively) from about 3.1 Mt CO_2 equivalent in 1990 to 1.6 Mt CO_2 equivalent in 2019) (Table 2-1).

Table 2-1: Direct GHG Emissions within 1990-2019, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 (without LULUCF)	37.0207	31.3644	24.1653	18.0878	15.0571	11.9418	11.8048	10.7263	9.2847	7.2566
CO_2 (with LULUCF)	35.4599	28.7250	22.1121	15.9931	13.0157	9.9265	9.3340	8.6068	7.1339	5.3876
CH_4 (without LULUCF)	5.2414	4.9009	4.6720	4.3560	4.2697	4.0389	3.9809	3.5856	3.4459	3.3372
CH_4 (with LULUCF)	5.2441	4.9033	4.6742	4.3590	4.2713	4.0411	3.9824	3.5883	3.4484	3.3396
N_2O (without LULUCF)	3.0866	2.8603	2.4326	2.0797	1.8478	1.7848	1.7660	1.5630	1.4955	1.3532
N_2O (with LULUCF)	3.2569	3.0442	2.6373	2.3022	2.0844	2.0363	2.0282	1.8351	1.7798	1.6471
HFCs	NO	NO	NO	NO	NO	0.0010	0.0017	0.0023	0.0031	0.0040
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	**45.3487**	**39.1255**	**31.2699**	**24.5235**	**21.1746**	**17.7666**	**17.5533**	**15.8773**	**14.2292**	**11.9511**
Total (with LULUCF)	**43.9609**	**36.6725**	**29.4236**	**22.6543**	**19.3714**	**16.0050**	**15.3463**	**14.0326**	**12.3653**	**10.3782**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
CO_2 (without LULUCF)	6.5133	7.1455	6.9116	7.5787	8.0989	8.4374	7.7735	8.1595	8.5354	8.5708
CO_2 (with LULUCF)	4.3622	5.3489	5.0282	5.7677	6.1184	6.7547	5.9716	6.1651	6.8531	7.2844
CH_4 (without LULUCF)	3.2594	3.2429	3.3177	3.2259	3.1935	3.2081	3.0796	2.9079	2.8936	2.8165
CH_4 (with LULUCF)	3.2603	3.2442	3.3180	3.2259	3.1937	3.2084	3.0799	2.9094	2.8944	2.8168
N_2O (without LULUCF)	1.2613	1.3412	1.4007	1.2565	1.3226	1.3571	1.3296	1.1093	1.2095	1.2144
N_2O (with LULUCF)	1.5576	1.6377	1.6977	1.5509	1.6127	1.6436	1.6122	1.3873	1.4815	1.4798
HFCs	0.0051	0.0069	0.0091	0.0122	0.0160	0.0225	0.0332	0.0448	0.0574	0.0675
PFCs	NO	NO	NO	NO	NO	NO	0.0000	0.0000	0.0000	0.0000
SF_6	NO	NO	NO	0.0000	0.0000	0.0000	0.0003	0.0004	0.0005	0.0005
Total (without LULUCF)	**11.0391**	**11.7365**	**11.6392**	**12.0733**	**12.6310**	**13.0252**	**12.2163**	**12.2220**	**12.6964**	**12.6698**
Total (with LULUCF)	**9.1852**	**10.2376**	**10.0530**	**10.5567**	**10.9408**	**11.6293**	**10.6973**	**10.5071**	**11.2869**	**11.6491**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
CO_2 (without LULUCF)	9.1281	9.5230	9.1163	8.8718	8.7605	9.0465	9.1156	8.6129	9.2479	9.3923
CO_2 (with LULUCF)	7.9158	8.3749	7.9549	7.8562	8.1091	7.9520	8.2785	7.7268	8.5222	9.5261
CH_4 (without LULUCF)	2.8291	2.8775	2.8168	2.7334	2.7714	2.7227	2.7984	2.9254	2.9258	2.6158
CH_4 (with LULUCF)	2.8292	2.8777	2.8180	2.7343	2.7716	2.7233	2.7987	2.9259	2.9260	2.6162
N_2O (without LULUCF)	1.2973	1.2681	1.2010	1.3293	1.5184	1.2755	1.4251	1.5225	1.5382	1.5705
N_2O (with LULUCF)	1.5555	1.5200	1.4344	1.5465	1.7209	1.4658	1.6044	1.6943	1.7036	1.7321
HFCs	0.0779	0.0901	0.1000	0.1084	0.1216	0.1539	0.1632	0.1825	0.1945	0.2299
PFCs	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SF_6	0.0007	0.0007	0.0008	0.0010	0.0011	0.0011	0.0011	0.0011	0.0013	0.0014
Total (without LULUCF)	**13.3331**	**13.7595**	**13.2349**	**13.0439**	**13.1730**	**13.1996**	**13.5035**	**13.2445**	**13.9078**	**13.8100**
Total (with LULUCF)	**12.3792**	**12.8635**	**12.3081**	**12.2463**	**12.7241**	**12.2961**	**12.8459**	**12.5307**	**13.3477**	**14.1058**

Abbreviations: NA – Not Applicable; NO – Not Occurring.

Halocarbons emissions (HFCs, PFCs) and sulphur hexafluoride (SF_6) emissions have been recorded beginning with 1995, considered as a starting year for monitoring F-gases (HFCs, PFCs and SF_6) (no NF_3 emissions were recorded so far in the Republic of Moldova). Evolution of these emissions denotes a steady trend towards increase in the last years, though their share in the total national emissions structure is insignificant for now.

CO_2 continues to be the most important source of total national direct greenhouse gas emissions in the Republic of Moldova. Figure 2-2 reveals the variation of direct GHG emissions share by gas in the structure of total national emissions in 1990 and 2019.

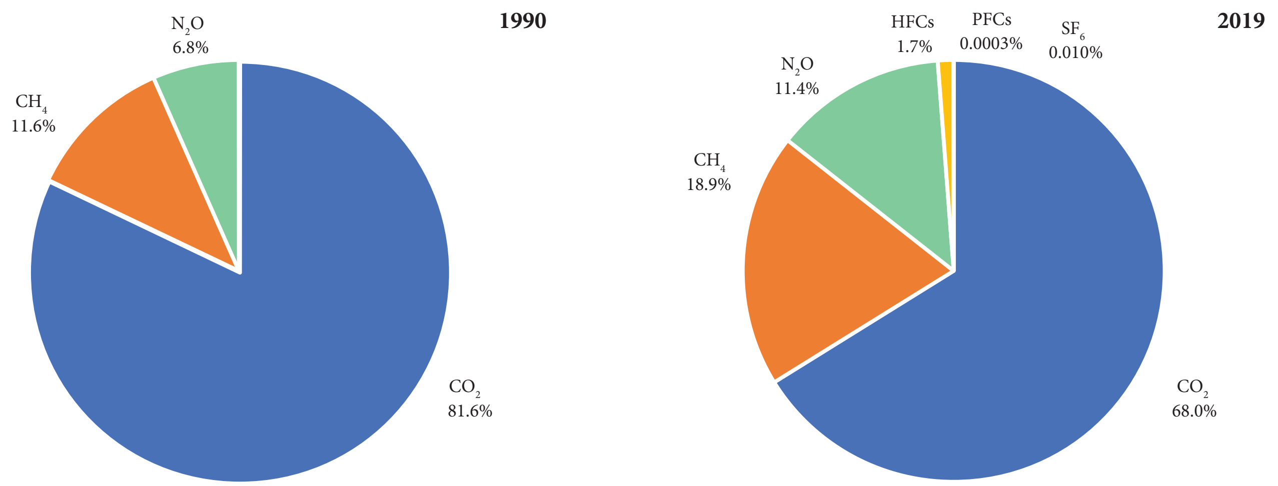

Figure 2-2: Direct GHGs share in the structure of total national GHG emissions in 1990 and 2019 years.

In 2019, the categories of sources with the highest share in the structure of total carbon dioxide emissions were: 1A1 “Energy industries” (32.8% of the total), 1A3 “Transport” (27.4% of the total), 1A4 “Other sectors” (22.1% of the total), 4A”Forest land” (-20.5% of the total), 4B “Cropland” (18.8% of the total), 1A2 “Manufacturing industries and construction” (7.5% of the total), 4F “Other land” (6.4% of the total), 2A “Mineral industry” (6.3% of the total), 4C “Grassland” (-3.1% of the total), 2D “Non-energy products from fuels and solvent use” (1.5% of the total), 4E “Settlements” (1.2% of the total) and 4D “Wetlands” (-0.9% of the total) (Figure 2-3).

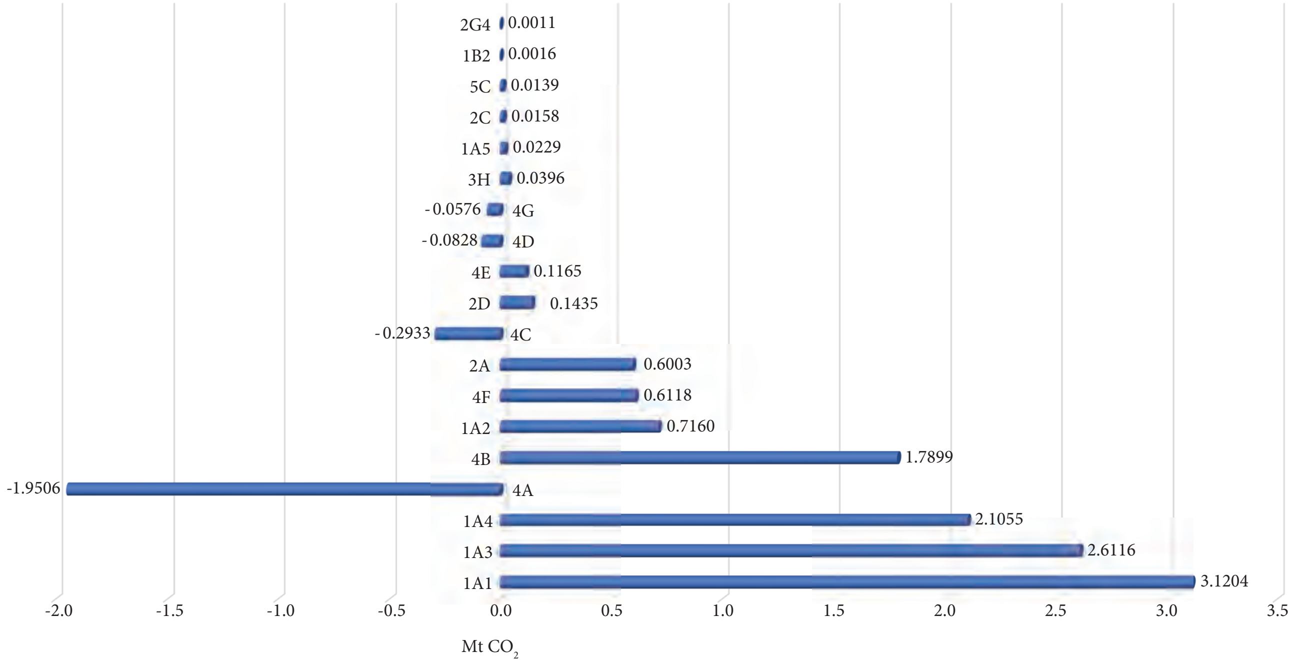

Figure 2-3: Source categories of CO_2 in the Republic of Moldova in 2019.

The source categories with the highest share in the structure of total methane emissions in 2019 were: 5A “Solid waste disposal” (47.1% of the total), 3A “Enteric fermentation” (16.9% of the total), 1B2 “Fugitive emissions from oil and natural gas” (15.1% of the total), 5D “Wastewater treatment and discharge” (9.1% of the total), 1A4 “Other sectors” (8.4% of the total), 3B “Manure management” (2.5% of the total) and 1A3 “Transport” (0.5% of the total) (Figure 2-4).

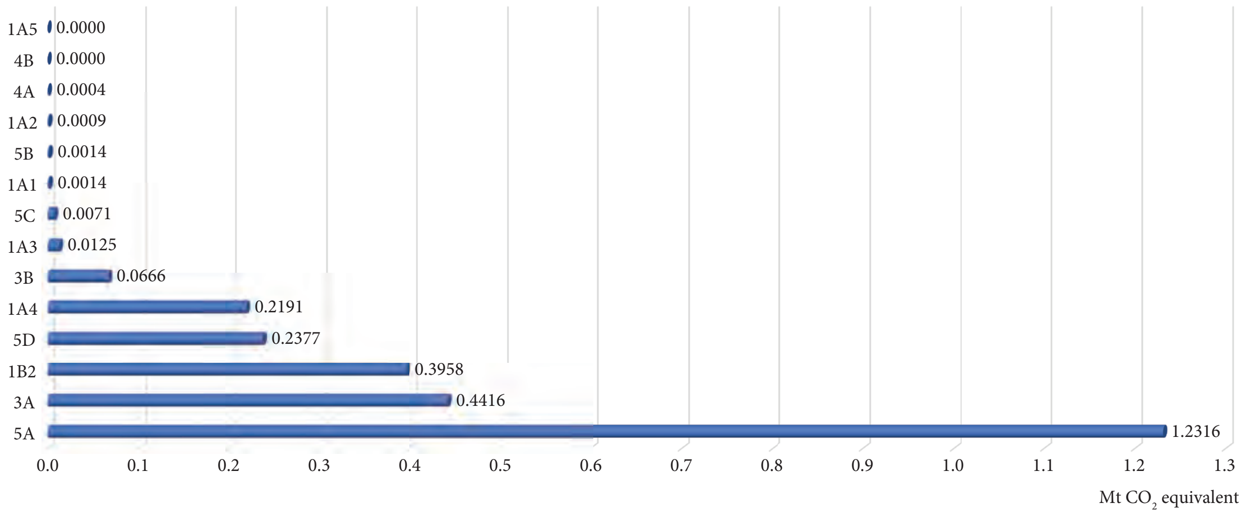

Figure 2-4: Source categories of CH_4 in the Republic of Moldova in 2019.

In 2019, the source categories with the highest share in the structure of total N_2O emissions were: 3D “Agricultural soils” (64.5% of the total), 3B “Manure management” (16.1% of the total), 4E “Settlements” (9.3% of the total), 1A4 “Other sectors” (4.0% of the total), 5D “Wastewater treatment and discharge” (3.4% of the total) and 1A3 “Transport” (2.4% of the total) (Figure 2-5).

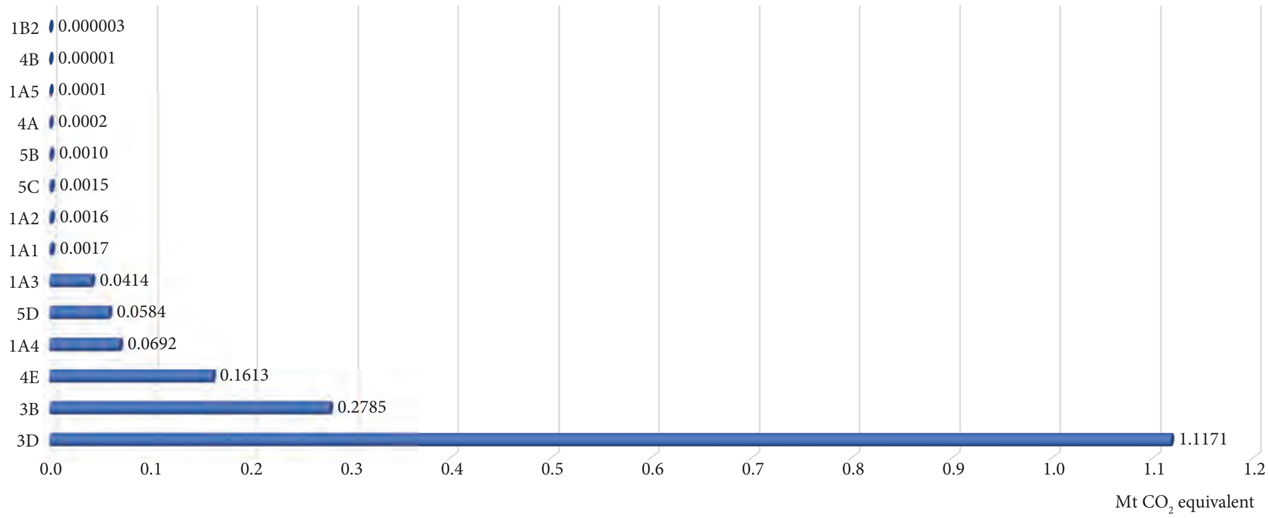

Figure 2-5: Source categories of N_2O in the Republic of Moldova in 2019.

2.3. Emission Trends by Sources

Emissions estimates were grouped into five sectors: (1) "Energy", (2) "Industrial Processes and Product Use", (3) "Agriculture", (4) "Land Use, Land-Use Change and Forestry" (LULUCF) and (5) "Waste". Interpretation of GHG emissions inventory results under LULUCF Sector is different from other sectors: positive figures indicate that this sector is a net source of emissions, while negative figures state that the sector is a net sink of CO_2 removals.

Over the 1990-2019 period, total GHG emissions tended to decrease, thus, emissions from the energy sector decreased by about 74.7%, those from the IPPU sector - by about 38.1%, in the agriculture sector - by 63.6%, in the LULUCF sector - by 121.3%, and those in the waste sector increased by 2.5% (Table 2-2).

Table 2-2: Direct GHG emissions by sector between 1990-2019, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Energy	36.8953	31.2043	24.3515	18.1696	15.2946	12.3097	12.2798	11.0094	9.5700	7.5571
2. Industrial Processes and Product Use	1.6037	1.4098	0.8216	0.7371	0.5562	0.4562	0.4163	0.4544	0.3782	0.3419
3. Agriculture	5.3355	4.9634	4.5461	4.0067	3.7312	3.4103	3.2641	2.8258	2.7171	2.4927
4. LULUCF	-1.3878	-2.4531	-1.8464	-1.8691	-1.8032	-1.7616	-2.2070	-1.8447	-1.8639	-1.5728
5. Waste	1.5142	1.5480	1.5508	1.6101	1.5925	1.5904	1.5931	1.5876	1.5639	1.5594
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	6.8761	7.4994	7.2925	7.9740	8.4757	8.7644	7.9199	8.0885	8.3876	8.8010
2. Industrial Processes and Product Use	0.3144	0.3186	0.3688	0.3971	0.4707	0.5713	0.6775	0.9361	1.0242	0.5295
3. Agriculture	2.3121	2.4080	2.4778	2.2347	2.2340	2.2403	2.1819	1.7714	1.8428	1.8844
4. LULUCF	-1.8539	-1.4988	-1.5862	-1.5166	-1.6902	-1.3960	-1.5190	-1.7149	-1.4094	-1.0207
5. Waste	1.5364	1.5105	1.5001	1.4674	1.4506	1.4492	1.4370	1.4260	1.4417	1.4548
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Energy	9.3278	9.7144	9.2874	8.9802	8.8830	9.1825	9.3349	8.8995	9.4093	9.3217
2. Industrial Processes and Product Use	0.5600	0.6649	0.6829	0.7326	0.7605	0.7628	0.7480	0.7768	0.9592	0.9922
3. Agriculture	1.9667	1.8915	1.7906	1.9148	2.1240	1.8484	1.9875	2.0379	1.9930	1.9435
4. LULUCF	-0.9539	-0.8960	-0.9268	-0.7976	-0.4489	-0.9035	-0.6576	-0.7138	-0.5601	0.2958
5. Waste	1.4786	1.4887	1.4741	1.4163	1.4055	1.4059	1.4331	1.5303	1.5463	1.5526

Energy sector is the most important source of total national direct greenhouse gas emissions, its share varying during the 1990-2019 period between 81.4% and 67.5%. Other relevant sources of direct greenhouse gas emissions are represented by the agriculture, waste and IPPU sectors (Figure 2-6). Throughout the study period, except for 2019, the LULUCF sector was a net source of carbon removal. With the reduction of direct greenhouse gas emissions at the national level, the relevance of this sector in the structure of net greenhouse gas emissions at national level showed a similar trend: in 1990 about 3.1% of total GHG emissions were removed at national level, while in 2019 the sector has already contributed 2.1% of total GHG emissions at national level.

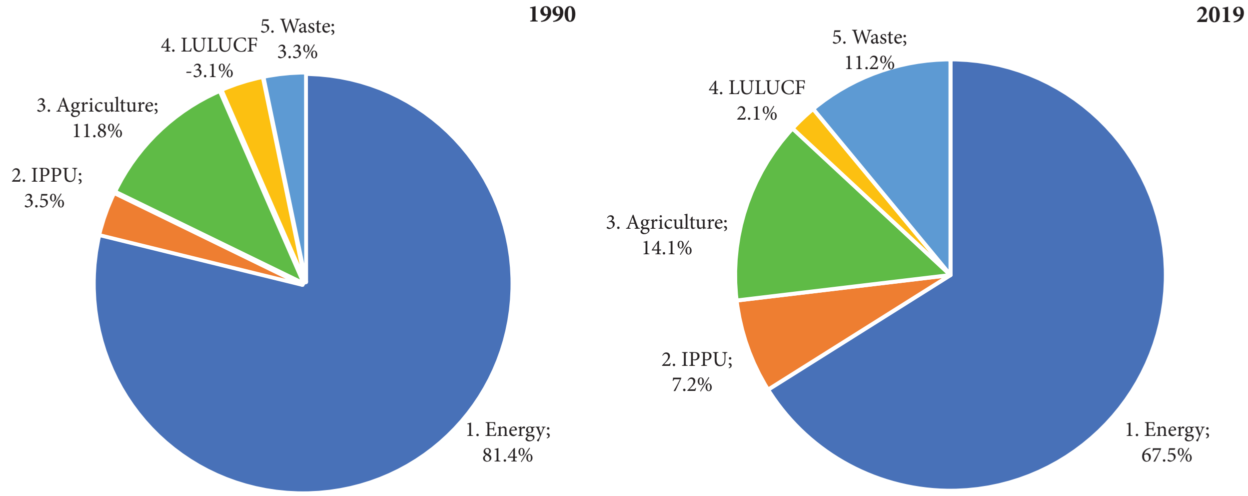

Figure 2-6: Sectoral breakdown of total GHG emissions in 1990 and 2019.

2.3.1. Energy Sector

In the Republic of Moldova, energy sector is the most important source of greenhouse gas emissions. The sector includes emissions from stationary and mobile combustion of fuels for energy (95.7% of total emissions per sector in 2019), as well as fugitive emissions from oil and natural gas production, processing, transportation, storage, delivery and distribution (4.3% of total emissions by sector in 2019) (Figure 2-7, Table 2-3).

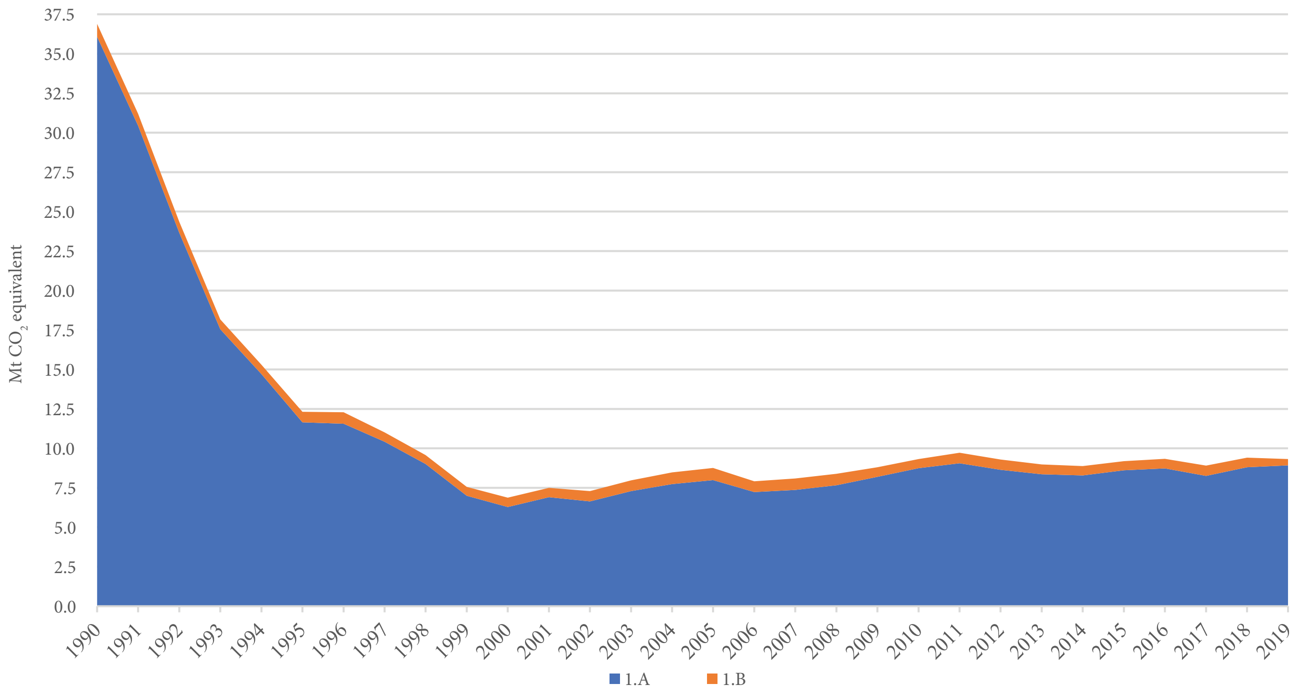

Figure 2-7: GHG Emissions from Energy Sector within 1990-2019 periods.

Overall, these emissions have accounted for about 67.5% of total national direct GHG emissions in 2019. During the 1990-2019 period, total direct GHG emissions from the energy sector have decreased by about 74.7%: from 36.9 Mt CO_2 equivalent in 1990 to 9.3 Mt CO_2 equivalent in 2019.

Table 2-3: GHG Emissions from Energy Sector within 1990-2019 periods, Mt CO_2 equivalent

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
1. Energy	**36.8953**	**12.3097**	**6.8761**	**8.7644**	**9.3278**	**9.1825**	**9.3349**	**8.8995**	**9.4093**	**9.3217**
1A. Fuel Combustion	**36.0824**	**11.6478**	**6.2751**	**7.9878**	**8.7467**	**8.6142**	**8.7222**	**8.2502**	**8.8051**	**8.9242**
1A.1. Energy Industries	21.3642	7.1924	3.1593	3.2355	4.0596	3.6900	3.6486	2.8868	3.1805	3.1235
1A.2. Manufacturing Industries and Construction	1.9234	0.3822	0.5203	0.5752	0.4233	0.6542	0.6436	0.6611	0.7514	0.7185
1A.3. Transport	4.8379	1.6604	1.0058	1.8671	2.1889	2.3080	2.4816	2.4635	2.5819	2.6655
1A.4. Other Sectors	7.8413	2.2862	1.5529	2.2838	2.0474	1.9392	1.9253	2.1760	2.2678	2.3938
1A.5. Other	0.1156	0.1265	0.0368	0.0263	0.0275	0.0229	0.0230	0.0227	0.0235	0.0230
1B. Fugitive Emissions from Fuels	**0.8129**	**0.6618**	**0.6010**	**0.7766**	**0.5811**	**0.5683**	**0.6128**	**0.6493**	**0.6042**	**0.3975**

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
1B.1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B.2. Oil and Natural Gas	0.8129	0.6618	0.6010	0.7766	0.5811	0.5683	0.6128	0.6493	0.6042	0.3975
1C. CO_2 Transport and Storage	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Abbreviations: NO – Not Occurring.

Within energy sector the most important source category is 1A1 "Energy industries", with a share of about 33.5% of the total in the sector, in 2019 (57.9% in 1990). Other relevant sources are represented by source category 1A3 "Transport" with a share of 28.6% of the total (13.1% in 1990), the category 1A4 "Other sectors" with a share of about 25.7% of the total (21.3% in 1990) and the source category 1A2 "Manufacturing industries and construction" with a share of about 7.7% of the total (5.2% in 1990) (Figure 2-8).

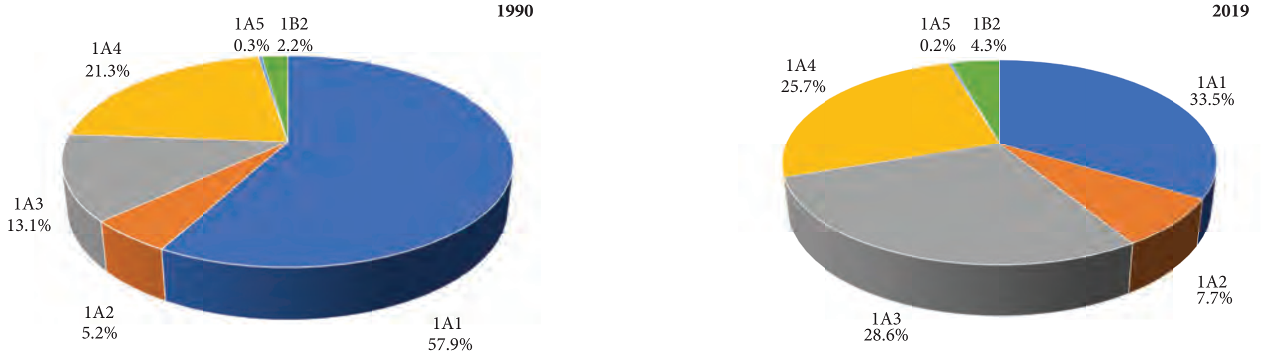

Figure 2-8: Energy Sector Greenhouse Gas Sources in 1990 and 2019 years.

2.3.2. Industrial Processes and Product Use Sector

IPPU Sector is a relevant source of GHG emissions and it includes emissions from non-energy industrial activities. In 2019, this sector had a share of about 7.2% of total national GHG emissions (3.5% in 1990). Over the 1990-2019 period, total GHG emissions from the sector decreased by about 38.1%: from 1.6 Mt CO_2 equivalent in 1990 to 1.0 Mt CO_2 equivalent in 2019 (Figure 2-9).

Between 2008 and 2009, these emissions have decreased by 48% because of the economic crisis that significantly affected the industrial sector of the Republic of Moldova. Subsequently, during the 2010-2019 period, direct GHG emissions from the sector showed a slight increasing trend, mainly due to increase in production of cement, lime, glass, steel, as well as due to increase in halocarbon consumption. Between 2018 and 2019, total GHG emissions from the sector increased by 3.4% (Table 2-4).

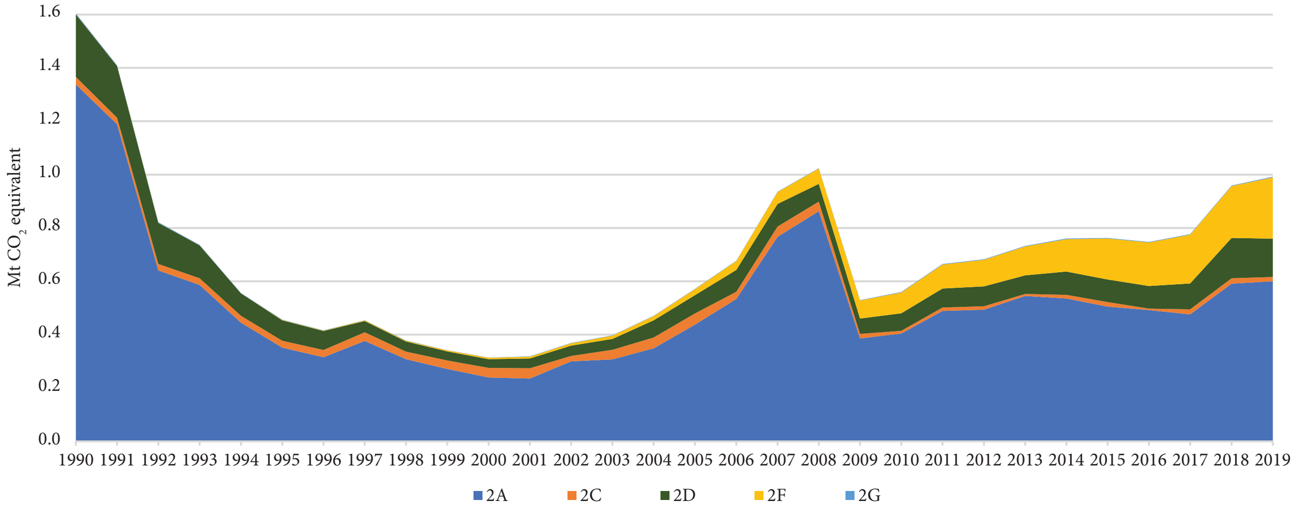

Figure 2-9: Total GHG Emissions from IPPU within 1990-2019 periods.

Table 2-4: Direct GHG Emissions from IPPU within 1990-2019, Mt CO_2 equivalent

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
2. Industrial Processes and Product Use	**1.6037**	**0.4562**	**0.3144**	**0.5713**	**0.5600**	**0.7628**	**0.7480**	**0.7768**	**0.9592**	**0.9922**
A. Mineral Industry	1.3374	0.3512	0.2394	0.4375	0.4044	0.5051	0.4925	0.4761	0.5910	0.6003
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Industry	0.0285	0.0262	0.0363	0.0419	0.0097	0.0173	0.0052	0.0189	0.0202	0.0158

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
D. Non-Energy Products from Fuels and Solvent Use	0.2344	0.0766	0.0326	0.0682	0.0662	0.0846	0.0848	0.0970	0.1512	0.1435
E. Electronic Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS	NO	0.0010	0.0051	0.0225	0.0779	0.1539	0.1632	0.1825	0.1945	0.2299
G. Other Product Manufacture and Use	0.0034	0.0012	0.0010	0.0012	0.0017	0.0020	0.0022	0.0023	0.0024	0.0026
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Abbreviations: NA – Not Applicable; NO – Not Occurring.

Within IPPU sector, the most important source category is 2A1 "Cement Production", with a share of about 52.8% of the total sector in 2019 (60.6% in 1990). Other relevant source categories in 2019 were 2F1 "Refrigeration and Air Conditioning" with a share of about 14.0% of the total, 2D3 "Solvent use" with a share of 13.6% of the total (12.7% in 1990) , 2F2 "Foam Blowing Agents" with a share of 9.0% of the total, 2A3 "Glass production" with a share of 3.3% of the total (1.6% in 1990), 2A2 "Lime production" with a share of 2.8% of the total (16.5% in 1990), 2A4 "Other Process Uses of Carbonates" with a share of 1.6% of the total (4.7% in 1990) and 2C1 "Iron and steel production" with a share of 1.6% of the total (1.8% in 1990) (Figure 2-10).

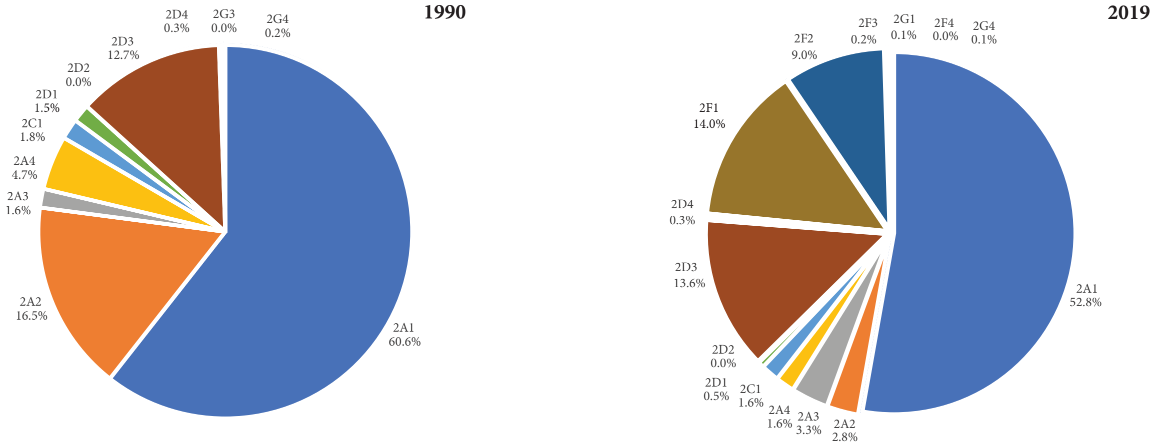

Figure 2-10: Breakdown of IPPU's GHG Emissions by Category in 1990 and 2019 years.

2.3.3. Agriculture Sector

Agriculture sector represents an important source of direct GHG emissions in the Republic of Moldova: CH_4 emissions, in particular from "Enteric fermentation" (category 3A) and "Manure management" (category 3B); N_2O emissions from "Manure management" (category 3B) and "Agricultural soils" (category 3D), respectively CO_2 emissions from "Urea application" (category 3H). In the Republic of Moldova there are no registered emissions from 3C "Rice cultivation", 3E "Prescribed burning of savannas", 3G "Liming", 3I "Other carbon-containing fertilizers" and 3J "Other", as for the emissions from 3F "Field burning of agricultural residues", these are monitored in the LULUCF Sector, under the category 4B "Cropland".

In 2019, agriculture sector had a share of about 14.1% of total national direct GHG emissions (11.8% in 1990). Over the 1990-2019 period, total direct GHG emissions from the respective sector decreased by about 63.6%: from 5.3 Mt CO_2 equivalent in 1990 to 1.9 Mt CO_2 equivalent in 2019 (Table 2-5), mainly due to the decrease in such indicators as: livestock and poultry population, the amount of synthetic nitrogen and organic fertilizers applied to soils, the amount of agricultural crop residues returned to soils and the increase in carbon losses from mineral soils and changes of tillage practices.

Table 2-5: Direct GHG Emissions from Agriculture Sector within 1990-2019, Mt CO_2 equivalent

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
3. Agriculture	**5.3355**	**3.4103**	**2.3121**	**2.2403**	**1.9667**	**1.8484**	**1.9875**	**2.0379**	**1.9930**	**1.9435**
A. Enteric Fermentation	2.1894	1.6181	1.0858	0.9240	0.7082	0.6292	0.6220	0.5780	0.5164	0.4416
B. Manure Management	1.6117	0.9392	0.5532	0.5566	0.5031	0.4250	0.4383	0.4192	0.3789	0.3451
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	1.5338	0.8529	0.6727	0.7596	0.7537	0.7830	0.9150	1.0145	1.0543	1.1171
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Urea Application	0.0006	0.0001	0.0004	0.0002	0.0017	0.0112	0.0123	0.0262	0.0434	0.0396
I. Other Carbon-Containing Fertilisers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Abbreviations: IE – Included Elsewhere; NO – Not Occurring.

Between 2018 and 2019, direct greenhouse gas emissions from agriculture sector decreased by about 2.5% (Figure 2-11), mainly due to the reduction of livestock and poultry population.

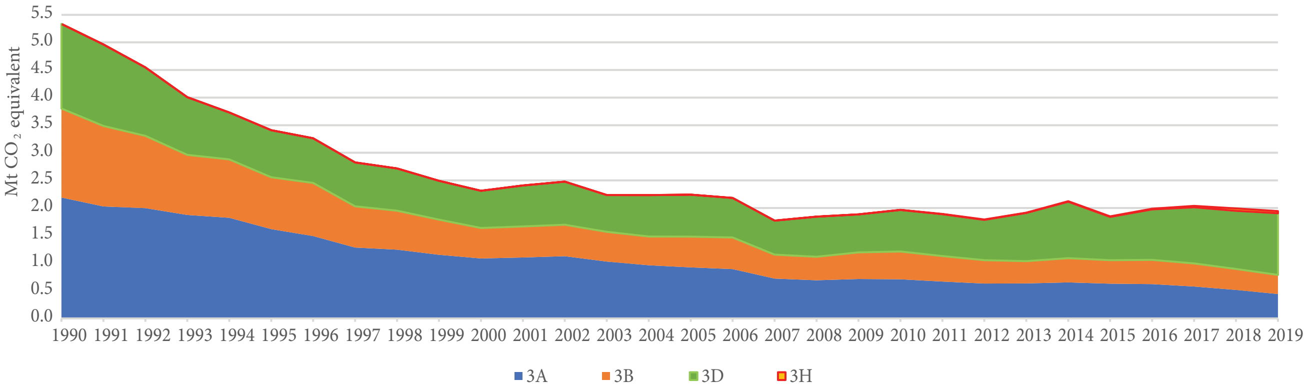

Figure 2-11: Total Direct GHG Emissions from Agriculture Sector within 1990-2019 periods.

In 2019, the most important category of sources was 3D "Agricultural soils", with a share of about 57.5% of the total sector (28.7% in 1990) (Figure 2-12). Other relevant source categories are represented by 3A "Enteric fermentation" with a share of 22.7% of the total (41.0% in 1990) and 3B "Manure management" with a share of about 17.8% of the total (30.2% in 1990). The share of category 3H "Urea application" for the time being is insignificant within the sector, however, it shows a trend towards steady growth.

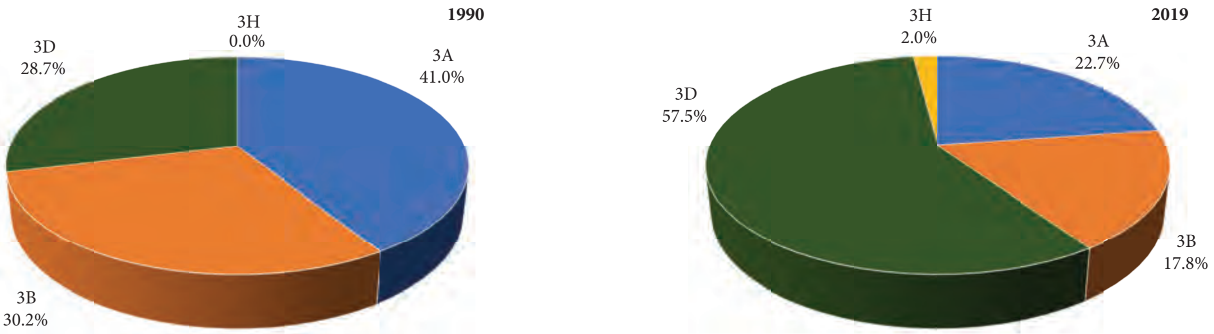

Figure 2-12: Breakdown of Agriculture GHG Emissions by Category in 1990 and 2019 years.

2.3.4. Land Use, Land-Use Change and Forestry Sector

During the period 1990-2018, LULUCF sector was a source of net carbon removal in the Republic of Moldova. In 2019, for the first time the sector has become a net source of emissions nationwide. During the 1990-2019 period, the dynamics of net CO_2 removals/emissions registered a decreasing trend, reducing by about 121.3%, from -1.4 Mt CO_2 equivalent recorded in 1990 to +0.3 Mt CO_2 equivalent in 2019 (Table 2-6, Figure 2-13).

Table 2-6: Emissions and removals in LULUCF sector in 1990-2019 periods, Mt CO_2 equivalent

Source Category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
4. LULUCF	**-1.3878**	**-1.7616**	**-1.8539**	**-1.3960**	**-0.9539**	**-0.9035**	**-0.6576**	**-0.7138**	**-0.5601**	**0.2958**
A. Forest Land	-2.5631	-2.0451	-2.3074	-2.4095	-2.4840	-2.1584	-2.1153	-2.0157	-1.9691	-1.9501
B. Cropland	2.6519	1.5892	1.4934	1.5435	1.5461	1.3911	1.3920	1.3692	1.4874	1.7899
C. Grassland	-1.2057	-1.6011	-1.2919	-1.0581	-0.6920	-0.4185	-0.4024	-0.3840	-0.4402	-0.2933
D. Wetlands	-0.5554	-0.4694	-0.3284	-0.1874	-0.0464	-0.0828	-0.0828	-0.0828	-0.0828	-0.0828
E. Settlements	0.2542	0.3577	0.3962	0.3401	0.3037	0.2290	0.1984	0.2489	0.1869	0.2778
F. Other Land	0.1524	0.4011	0.1785	0.4165	0.4415	0.0868	0.3516	0.2182	0.3212	0.6118
G. Harvested Wood Products	-0.1222	0.0060	0.0058	-0.0411	-0.0228	0.0492	0.0009	-0.0674	-0.0635	-0.0576
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Abbreviations: IE – Included Elsewhere; NO – Not Occurring.

This is mainly due to changes in the use and management practices of cropland (category 4B), which have led to a significant reduction in organic carbon reserves in agricultural soils[50], thus changing the

[50] The organic carbon and nitrogen in soil are highly dependent within the humus content in soil; carbon losses through the oxidation process due to changes in the use and management of agricultural soils are accompanied by the simultaneous mineralization (biochemical decomposition) of nitrogen.

humus balance from positive to negative and/or to deeply negative. The process was also influenced by some changes in forest management and use (category 4A), such as increase in the volume of authorized harvesting of timber, substantial increase in the volume of illegal logging, increase in conversion of cropland to forest land, etc.

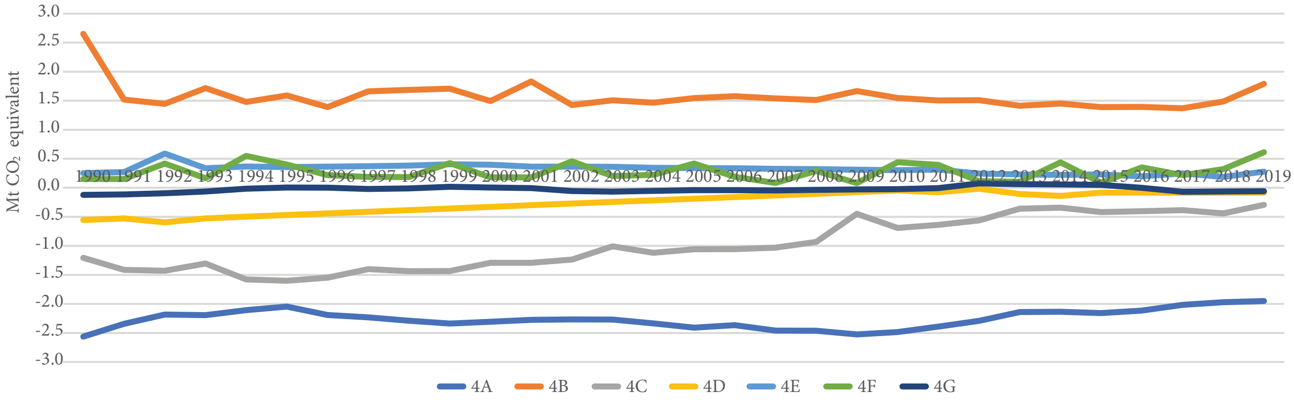

Figure 2-13: Direct GHG Emissions/Removals in LULUCF Sector by Source/Sink Categories within 1990-2019 period.

In the Republic of Moldova, in 2019, the main source of CO_2 emission removal in LULUCF sector was 4A "Forest lands" (forests, forest belts, etc.) with a share of 38.5% of the total (34.2% in 1990), followed by 4C "Grassland" with a share of about 5.8 percent (16.1 percent in 1990) and 4D "Wetlands" with a share of about 1.6 percent (7.4 percent in 1990). Category 4B "Cropland" is a net source of emissions, with a share of 35.4% (35.3% in 1990), followed by category 4F "Other land", with a share of about 12.1 percent (2.0 percent in 1990) and category 4E "Settlements", with a share of about 5.5 percent (3.4 percent in 1990) (Figure 2-14).

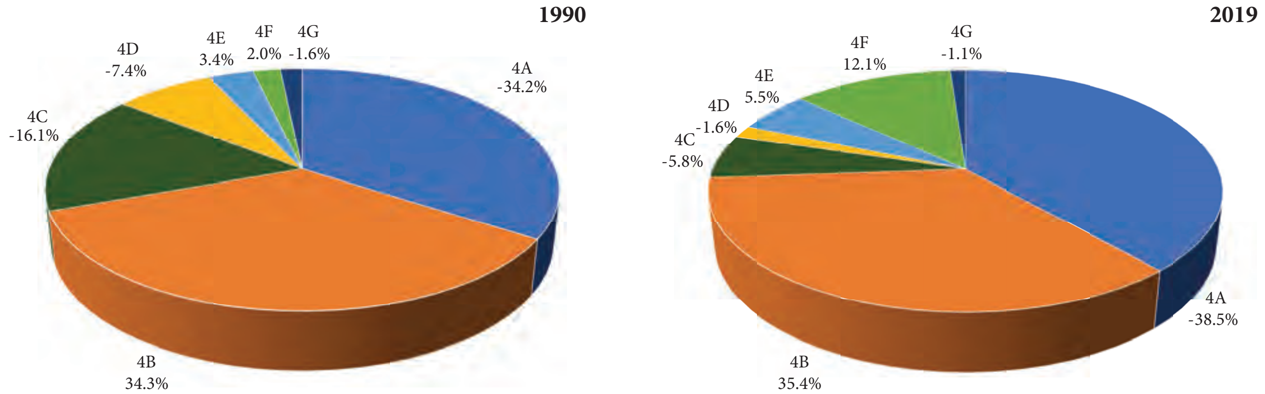

Figure 2-14: Breakdown of GHG Emissions and Removals by Source and Sink Categories in LULUCF Sector in 1990 and 2019 years.

2.3.5. Waste Sector

Waste sector is an important source of GHG emissions in the Republic of Moldova: CO_2 emissions from Incineration and Open Burning of Waste (category 5C), methane emissions from "Solid Waste Disposal" (category 5A), "Biological Treatment of Solid Waste" (category 5B), "Incineration and Open Burning of Waste" (category 5C) and "Wastewater Treatment and Discharge" (category 5D), respectively N_2O emissions from "Biological Treatment of Solid Waste" (category 5B), "Incineration and Open Burning of Waste" (category 5C) and "Wastewater Treatment and Discharge" (human manure) (category 5D). At the moment, in RM there are no any emissions registered in category 5E "Other".

In 2019, waste sector had a share of about 11.2% of total national GHG emissions (3.3% in 1990). During the 1990-2019 period, total direct GHG emissions from the sector increased by about 2.5%: from 1.51 Mt CO_2 equivalent in 1990 to 1.55 Mt CO_2 equivalent in 2019 (Table 2-7). Between 2018 and 2019, GHG emissions directly generated by waste sector increased by about 0.4%.

Table 2-7: GHG Emissions from Waste Sector within 1990-2019 periods, Mt CO_2 equivalent

Source Category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
5. Waste	**1.5142**	**1.5904**	**1.5364**	**1.4492**	**1.4786**	**1.4059**	**1.4331**	**1.5303**	**1.5463**	**1.5526**
A. Solid Waste Disposal	1.0467	1.2092	1.1695	1.0643	1.1378	1.0872	1.1152	1.2117	1.2236	1.2316
B. Biological Treatment of Solid Waste	0.0023	0.0011	0.0009	0.0010	0.0018	0.0022	0.0022	0.0025	0.0022	0.0024
C. Incineration and Open Burning of Waste	0.0243	0.0245	0.0243	0.0234	0.0208	0.0215	0.0211	0.0237	0.0231	0.0226
D. Wastewater Treatment and Discharge	0.4409	0.3557	0.3417	0.3604	0.3181	0.2950	0.2946	0.2923	0.2973	0.2961
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Abbreviations: NE – Not Estimated; NO – Not Occurring.

Reduction of total GHG emissions from the waste sector, in particular until 2000, could be explained by the economic decline that occurred in the Republic of Moldova during the respective period, by a significant drop in the wellbeing of population, and respectively, capacity to generate wastes. At the same time, starting with 2006, there has been a slight growing trend of direct GHG emissions from the waste sector (Figure 2-15).

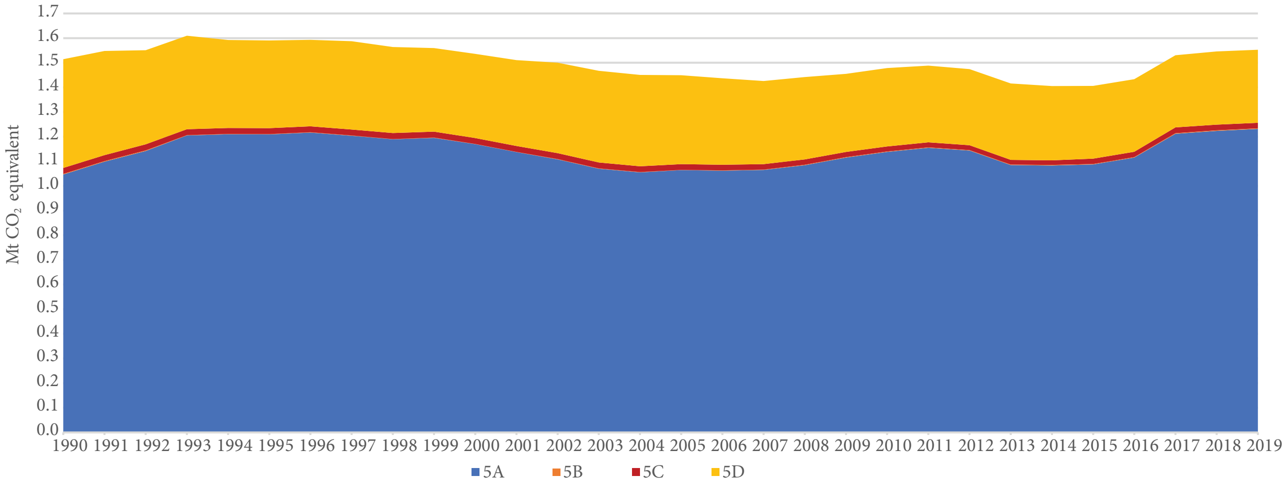

Figure 2-15: Total Waste Sector GHG Emissions Trends within 1990-2019 period.

In 2019, the most important source category in this sector was category 5A "Solid waste disposal", with a share of about 79.3% of the total sectoral emissions (69.1% in 1990), followed by category 5D "Wastewater treatment and discharge", with a share of about 19.1% of total (29.1% in 1990), respectively, by category 5C "Incineration and open burning of waste", with a share of about 1.5% of total (1.6% in 1990) (Figure 2-16).

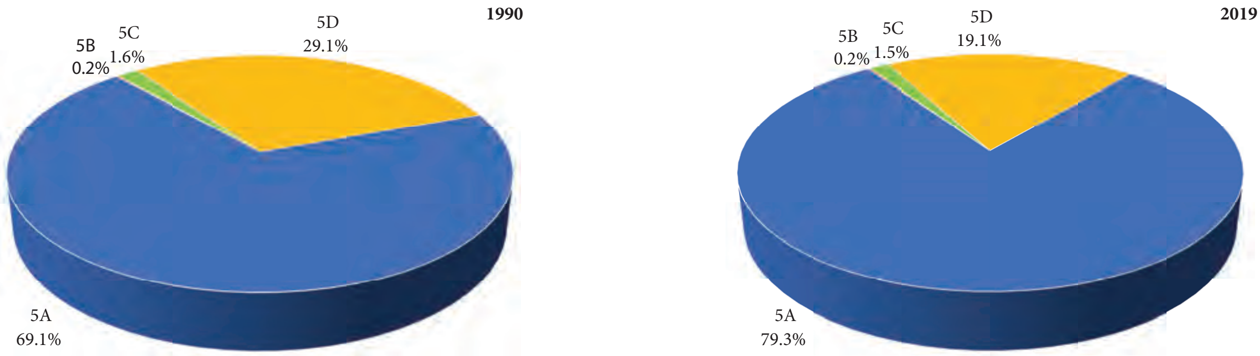

Figure 2-16: Breakdown of Waste GHG Emissions by Category in 1990 and 2019 years.

2.4. Emission Trends for Ozone and Aerosol Precursors

Though not considered greenhouse gases, photochemically active gases like carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC), have an indirect global warming effect. These gases are considered as ozone precursors influencing the formation and destruction of tropospheric and stratospheric ozone. In particular, they are emitted from transportation, fossil fuel combustion, consumption of solvents and other household products, etc. Thus, the national GHG inventory of the Republic of Moldova includes emissions of the following ozone and aerosol precursors: NOx, CO, NMVOC and SO_2.

Over the 1990-2019 period, total nitrogen oxides emissions had decreased by about 79.5%: from 89.65 kt in 1990 to 18.35 kt in 2019, total carbon monoxide emissions decreased by about 48.0%: from 276.33 kt in 1990 to 143.72 kt in 2019, non-methane volatile organic compounds emissions decreased by about 34.9%: from 138.79 kt in 1990 to 90.32 kt in 2019, and sulphur dioxide emissions decreased by about 96.5%: from 150.10 kt in 1990 to 5.24 kt in 2019 (Table 2-8).

Table 2-8: Ozone and Aerosol Precursors (NO_x, CO and NMVOC) and SO_2 Emission Trends in the RM within 1990-2019 period, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	89.6454	73.8289	55.1200	76.0499	35.0342	29.0746	27.1974	24.2386	20.4127	14.6476
CO	276.3349	204.1325	130.2957	65.5835	73.0763	62.6580	75.8546	69.5933	53.7625	41.7150
NMVOC	138.7872	111.8032	87.9944	69.2095	50.6096	47.3142	45.8441	31.2793	27.4305	23.2289
SO_2	150.0997	124.8723	92.0640	72.3599	57.3452	31.7701	31.9482	16.7211	12.4779	5.8630
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NO_x	13.1615	14.3963	14.7933	15.0274	16.1240	17.1389	15.9969	17.0241	24.4397	15.5890
CO	39.4335	38.4124	44.7257	53.9554	51.2589	53.1523	53.7269	48.2494	50.4998	48.7510
NMVOC	22.7982	24.5445	27.0803	28.0904	39.7519	42.3738	47.7740	47.5842	41.0900	35.6733
SO_2	4.4903	3.9993	4.8266	6.3041	5.4639	5.1702	5.3193	4.0356	5.6582	5.1965
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	16.6163	17.0452	16.4326	15.9387	15.4756	16.1663	16.4033	16.3541	18.0524	18.3535
CO	49.8489	53.6658	51.0761	52.7260	78.5976	84.4305	87.4851	110.2489	159.4791	143.7154
NMVOC	40.1884	43.3979	44.8018	43.9545	56.3898	54.3331	55.5414	65.0590	96.4462	90.3206
SO_2	4.5204	5.5519	4.6501	13.2050	4.3062	5.0062	4.2279	5.0951	4.5109	5.2391

In 2019, the source categories with the highest share in the structure of total nitrogen oxides emissions were: 1A4 "Other sectors" (35.8% of the total), 1A1 "Energy industries" (27.0% of the total), 1A3 "Transport" (18.8% of the total), 2A "Mineral industry" (10.0% of the total) and 1A2 "Manufacturing industries and construction" (6.9% of the total) (Figure 2-17).

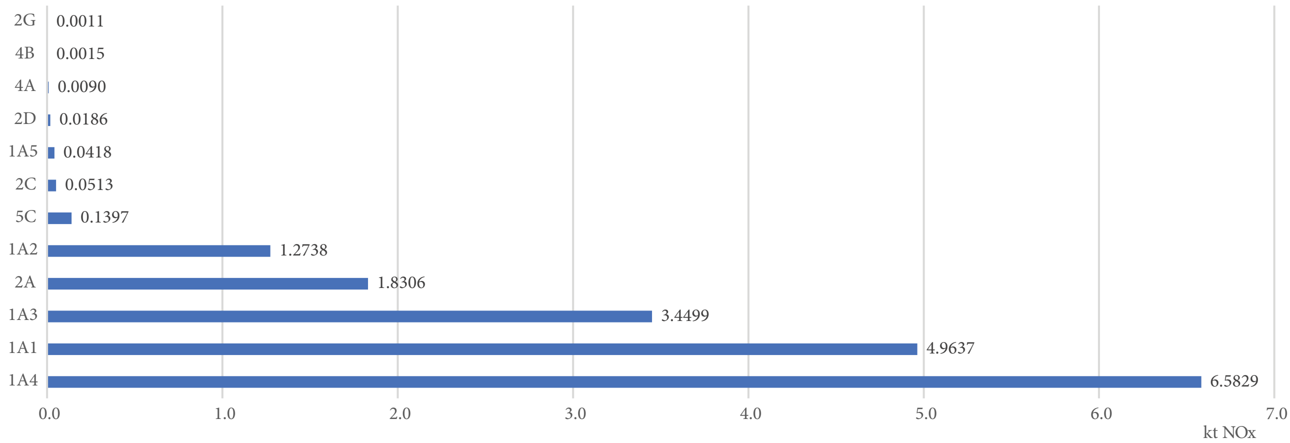

Figure 2-17: Source categories of NO_x in the Republic of Moldova in 2019.

The source categories with the highest in the total carbon monoxide emissions in 2019 were: 1A4 "Other sectors" (81.3% of the total), 1A3 "Transport" (12.4% of the total), 5C "Incineration and open burning of waste" (1.7% of the total), 1A1 "Energy industries" (1.5% of the total), 2A "Mineral industry" (1.1% of the total) and 1A2 "Manufacturing industries and construction" (1.1% of the total) (Figure 2-18).

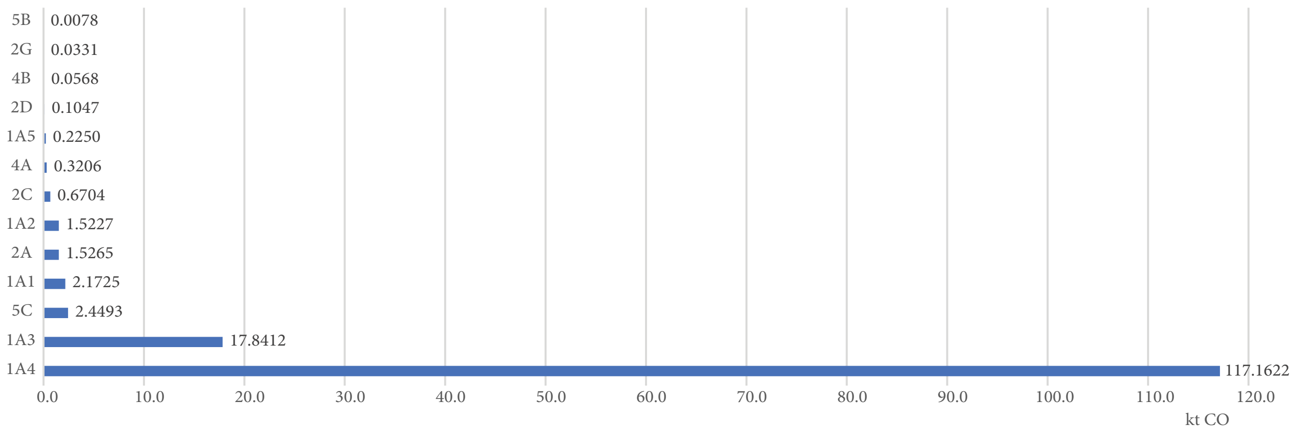

Figure 2-18: Source categories of CO in the Republic of Moldova in 2019.

In 2019, the source categories with the highest share in the total non-methane volatile organic compounds emissions were: 2D "Non-energy Products from Fuels and Solvent Use" (67.9% of the total), 1A4 "Other sectors" (19.2% of the total), 2H "Other" (food and alcoholic beverages) (5.2% of the total), 5A "Solid waste disposal" (3.3% of the total) and 1A3 "Transport" (2.4% of the total) (Figure 2-19).

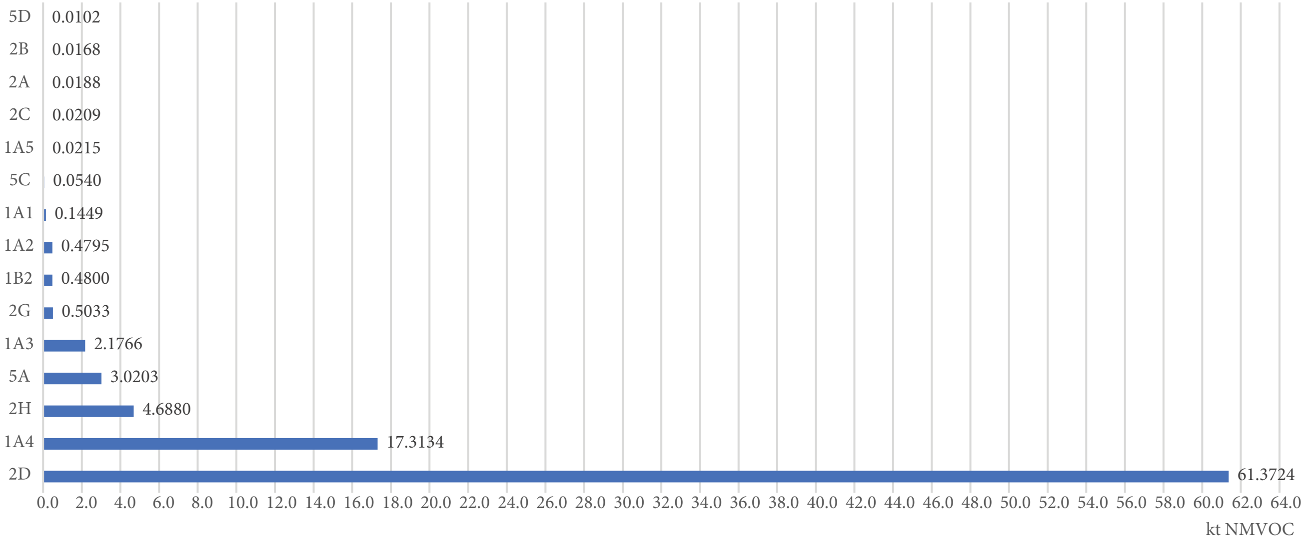

Figure 2-19: Source categories of NMVOC in the Republic of Moldova in 2019.

The source categories with the highest share in the total sulphur dioxide emissions in 2019 were: 1A4 "Other sectors" (62.6% of the total), 1A2 "Manufacturing industries and construction" (17.6% of the total), 2A "Mineral industry" (14.2% of the total), 1A5 "Other works and needs in energy" (3.9% of the total) and 1A1 "Energy industries" (0.9% of the total) (Figure 2-20).

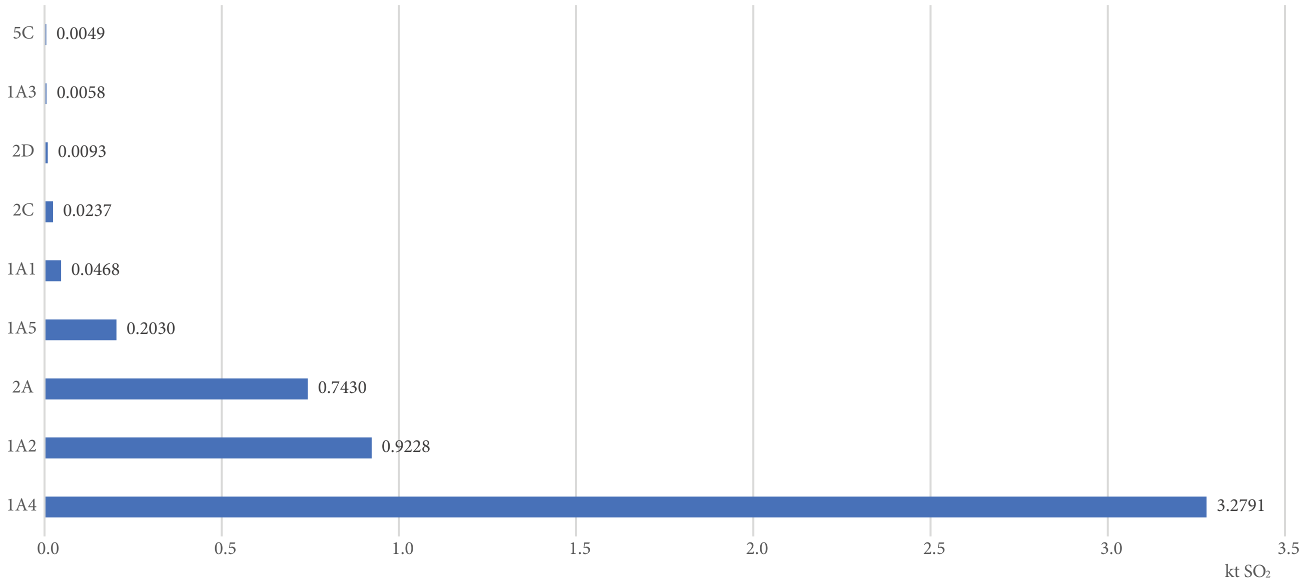

Figure 2-20: Source categories of SO_2 in the Republic of Moldova in 2019.

3. ENERGY SECTOR

3.1. Overview

Sector 1 'Energy' includes GHG emissions resulting from electricity and heat production activities, and fuel combustion for energy generation purposes. Methodological guidance used includes the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) (in particular, for estimating direct GHG emissions) and EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) (in particular, for estimating non-CO_2 emissions).

Under the Republic of Moldova's GHG Inventory, the Sector 1 'Energy' covers GHG emissions generated by the following source categories:

Sector 1 'Energy'

1A 'Fuel Combustion'

- 1A1 'Energy Industries' (1A1a 'Main Activity Electricity and Heat Production', 1A1b 'Petroleum Refining');
- 1A2 'Manufacturing Industries and Construction' (12 industries);
- 1A3 'Transport' (1A3a 'Civil Aviation', 1A3b 'Road Transportation', 1A3c 'Railways', 1A3d 'Navigation', 1A3e 'Other Transportation');
- 1A4 'Other Sectors' (1A4a 'Commercial/Institutional', 1A4b 'Residential', 1A4c 'Agriculture/Forestry/Fishing');
- 1A5 'Other'.

1B 'Fugitive Emissions from Fuels'

- 1B2 'Oil and Natural Gas'.

'Memo items'

- 'International Aviation';
- 'CO_2 Emissions from Biomass'.

A brief overview, methodological issues, uncertainties assessment and times-series consistency, QA/QC and verification, and information regarding recalculations made and planned improvements are described for each source category in this sector.

GHG emissions in Sector 1 'Energy' result from fuel combustion for power generation (electricity and heat); industrial production (for energy purposes); transport; residential sector; agriculture, forestry, fishing; and other sources.

3.1.1. Summary of Emission Trends

Between 1990 and 2019, the total GHG emissions from Sector 1 'Energy' tended to lower values, decreasing by 74.7 per cent (Table 3-1, Figure 3-1).

Table 3-1: Total direct GHG emissions from Sector 1 'Energy' in the Republic of Moldova for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sector 1 'Energy', kt CO_2 equivalent	36,895.29	31,204.34	24,351.49	18,169.62	15,294.37	12,309.65	12,279.84	11,009.45	9,569.97	7,557.05
in %, compared to 1990	100.0	84.6	66.0	49.2	41.5	33.4	33.3	29.8	25.9	20.5
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sector 1 'Energy', kt CO_2 equivalent	6,876.15	7,499.41	7,292.48	7,973.96	8,475.72	8,764.38	7,919.89	8,088.51	8,387.58	8,801.01
in %, compared to 1990	18.6	20.3	19.8	21.6	23.0	23.8	21.5	21.9	22.7	23.9
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sector 1 'Energy', kt CO_2 equivalent	9,327.79	9,714.36	9,287.38	8,980.15	8,883.05	9,182.48	9,334.94	8,899.53	9,409.29	9,321.67
in %, compared to 1990	25.3	26.3	25.2	24.3	24.1	24.9	25.3	24.1	25.5	25.3

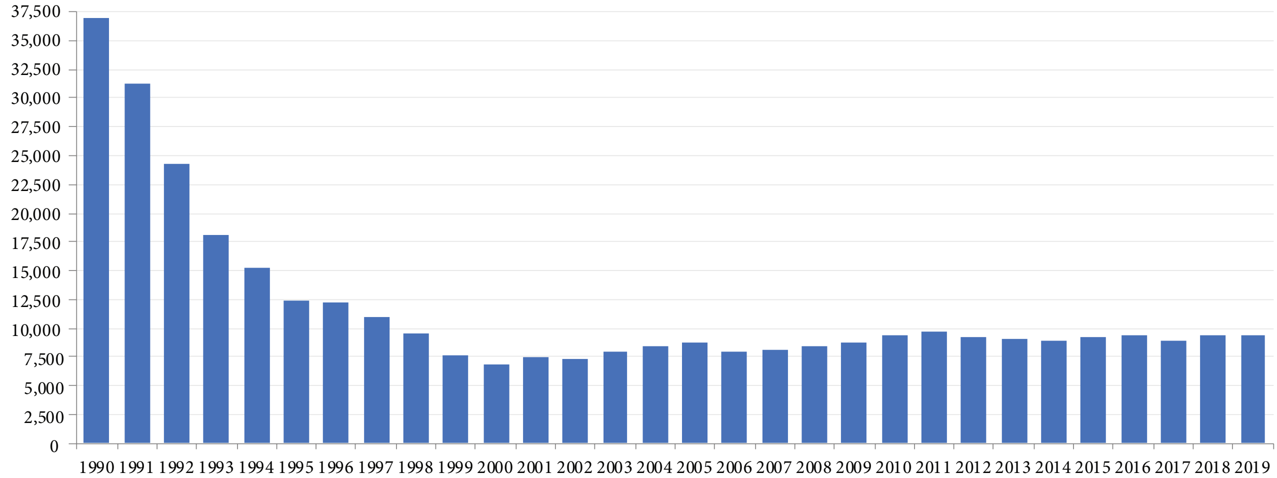

Figure 3-1: Total direct GHG emissions from Sector 1 'Energy' in the Republic of Moldova for the period 1990-2019, kt CO_2 equivalent.

Direct GHG emissions had decreased significantly within 1990-2019 periods: CO_2 emissions represented only circa 24.2 per cent of the base year (1990) level, CH_4 emissions – 54.8 per cent, N_2O emissions – 33.0 per cent, and direct GHG emissions – 25.3 per cent (Table 3-2, Figure 3-2).

Table 3-2: Total direct GHG emissions from Sector 1 'Energy' for the period 1990-2019

	Sector 1 'Energy', kt CO_2 equivalent				% of the total			in %, compared to 1990			
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
1990	35,401.51	1,148.14	345.64	36,895.29	96.0	3.1	0.9	100.0	100.0	100.0	100.0
1991	29,939.07	1,007.64	257.63	31204,34	95.9	3.2	0.8	84.6	87.8	74.5	84.6
1992	23,328.31	843.35	179.83	24,351.49	95.8	3.5	0.7	65.9	73.5	52.0	66.0
1993	17,335.55	685.05	149.01	18,169.62	95.4	3.8	0.8	49.0	59.7	43.1	49.2
1994	14,485.67	674.06	135.14	15,294.87	94.7	4.4	0.9	40.9	58.7	39.1	41.5
1995	11,471.54	709.84	128.27	12,309.65	93.2	5.8	1.0	32.4	61.8	37.1	33.4
1996	11,375.02	793.24	111.58	12,279.84	92.6	6.5	0.9	32.1	69.1	32.3	33.3
1997	10,258.15	649.11	102.19	11,009.45	93.2	5.9	0.9	29.0	56.5	29.6	29.8
1998	8,894.28	596.02	79.67	9,569.97	92.9	6.2	0.8	25.1	51.9	23.1	25.9
1999	6,903.72	598.98	54.35	7,557.05	91.4	7.9	0.7	19.5	52.2	15.7	20.5
2000	6,188.58	639.08	48.48	6,876.15	90.0	9.3	0.7	17.5	55.7	14.0	18.6
2001	6,818.66	630.88	49.87	7,499.41	90.9	8.4	0.7	19.3	54.9	14.4	20.3
2002	6,537.04	691.48	63.96	7,292.48	89.6	9.5	0.9	18.5	60.2	18.5	19.8
2003	7,178.59	733.18	62.18	7,973.96	90.0	9.2	0.8	20.3	63.9	18.0	21.6
2004	7,629.01	783.73	62.98	8,475.72	90.0	9.2	0.7	21.5	68.3	18.2	23.0
2005	7,874.05	827.36	62.98	8,764.38	89.8	9.4	0.7	22.2	72.1	18.2	23.8
2006	7,115.33	740.06	64.50	7,919.89	89.8	9.3	0.8	20.1	64.5	18.7	21.5
2007	7,254.62	771.54	62.36	8,088.51	89.7	9.5	0.8	20.5	67.2	18.0	21.9
2008	7,554.70	769.46	63.42	8,387.58	90.1	9.2	0.8	21.3	67.0	18.3	22.7
2009	8,095.56	647.85	57.60	8,801.01	92.0	7.4	0.7	22.9	56.4	16.7	23.9
2010	8,632.16	633.32	62.31	9,327.79	92.5	6.8	0.7	24.4	55.2	18.0	25.3
2011	8,932.68	717.18	64.50	9,714.36	92.0	7.4	0.7	25.2	62.5	18.7	26.3
2012	8,516.33	711.37	59.68	9,287.38	91.7	7.7	0.6	24.1	62.0	17.3	25.2
2013	8,232.53	682.23	65.39	8,980.15	91.7	7.6	0.7	23.3	59.4	18.9	24.3
2014	8,100.98	709.87	72.19	8,883.05	91.2	8.0	0.8	22.9	61.8	20.9	24.1
2015	8,414.06	688.56	79.86	9,182.48	91.6	7.5	0.9	23.8	60.0	23.1	24.9
2016	8,506.69	742.58	85.67	9,334.94	91.1	8.0	0.9	24.0	64.7	24.8	25.3
2017	7,978.90	821.37	99.27	8,899.53	89.7	9.2	1.1	22.5	71.5	28.7	24.1
2018	8,426.84	868.30	114.15	9,409.29	89.6	9.2	1.2	23.8	75.6	33.0	25.1
2019	8,577.95	629.71	114.00	9,321.67	92.0	6.8	1.2	24.2	54.8	33.0	25.3

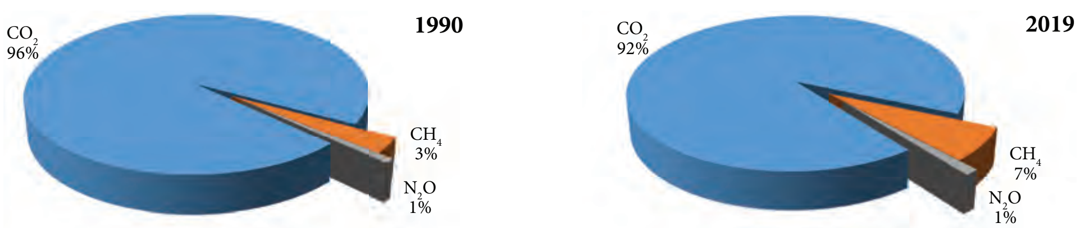

Figure 3-2: The share of direct GHG emissions from Sector 1 'Energy' in the total direct GHG emissions in 1990 and 2019, in % of total.

Compared to the reference year (1990), by 2019, GHG emissions in the Republic of Moldova had decreased significantly: CO_2 emissions represented 24.2 per cent of the 1990 level, CH_4 and N_2O emissions – 33.0 per cent, NO_x emissions – 19.0 per cent, CO emissions – 51.8 per cent, NMVOC emissions – 60.2 per cent, and SO_2 emissions – 34.9 per cent (Table 3-3).

Table 3-3: GHG emissions from Sector 1 'Energy' for the period 1990-2019

	Sector 1 'Energy', kt							in %, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	35,401.51	45.93	1.16	85.77	268.20	31.37	148.74	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	29,939.07	40.31	0.86	70.28	196.58	23.01	123.59	84.6	74.5	74.5	81.9	73.3	73.7	83.1
1992	23,328.31	33.73	0.60	53.14	124.24	14.87	91.39	65.9	52.0	52.0	62.0	46.3	48.0	61.4
1993	17,335.55	27.40	0.50	42.16	59.70	7.94	71.70	49.0	43.1	43.1	49.1	22.3	26.4	48.2
1994	14,485.67	26.96	0.45	33.51	67.59	8.66	56.82	40.9	39.1	39.1	39.1	25.2	28.2	38.2
1995	11,471.54	28.39	0.43	27.74	57.45	7.11	31.29	32.4	37.1	37.1	32.3	21.4	24.2	21.0
1996	11,375.02	31.73	0.37	26.01	70.56	8.57	31.54	32.1	32.3	32.3	30.3	26.3	28.0	21.2
1997	10,258.15	25.96	0.34	22.85	63.96	7.76	16.23	29.0	29.6	29.6	26.6	23.8	26.7	10.9
1998	8,894.28	23.84	0.27	19.17	48.60	6.24	12.02	25.1	23.1	23.1	22.4	18.1	21.6	8.1
1999	6,903.72	23.96	0.18	13.54	36.44	4.89	5.47	19.5	15.7	15.7	15.8	13.6	16.0	3.7
2000	6,188.58	25.56	0.16	11.91	34.07	4.78	3.97	17.5	14.0	14.0	13.9	12.7	15.6	2.7
2001	6,818.66	25.24	0.17	13.19	32.94	4.68	3.51	19.3	14.4	14.4	15.4	12.3	15.6	2.4
2002	6,537.04	27.66	0.21	13.43	40.06	5.74	4.27	18.5	18.5	18.5	15.7	14.9	19.3	2.9
2003	7,178.59	29.33	0.21	13.63	48.54	6.79	5.74	20.3	18.0	18.0	15.9	18.1	22.8	3.9
2004	7,629.01	31.35	0.21	14.35	45.47	6.84	4.84	21.5	18.2	18.2	16.7	17.0	23.3	3.3
2005	7,874.05	33.09	0.21	14.70	47.14	6.94	4.44	22.2	18.2	18.2	17.1	17.6	23.9	3.0
2006	7,115.33	29.60	0.22	13.77	48.15	7.06	4.57	20.1	18.7	18.7	16.1	18.0	23.8	3.1
2007	7,254.62	30.86	0.21	13.86	41.54	6.43	3.13	20.5	18.0	18.0	16.2	15.5	22.1	2.1
2008	7,554.70	30.78	0.21	14.16	43.82	6.96	4.71	21.3	18.3	18.3	16.5	16.3	23.7	3.2
2009	8,095.56	25.91	0.19	14.18	44.11	6.82	4.68	22.9	16.7	16.7	16.5	16.4	23.3	3.1
2010	8,632.16	25.33	0.21	14.83	45.43	6.68	3.96	24.4	18.0	18.0	17.3	16.9	22.6	2.7
2011	8,932.68	28.69	0.22	15.01	48.95	7.40	4.85	25.2	18.7	18.7	17.5	18.2	24.8	3.3
2012	8,516.33	28.45	0.20	14.22	46.57	7.08	4.02	24.1	17.3	17.3	16.6	17.4	23.0	2.7
2013	8,232.53	27.29	0.22	14.08	48.51	7.10	12.49	23.3	18.9	18.9	16.4	18.1	23.0	8.4
2014	8,100.98	28.39	0.24	13.63	74.23	11.11	3.59	22.9	20.9	20.9	15.9	27.7	33.9	2.4
2015	8,414.06	27.54	0.27	14.38	79.70	11.91	4.32	23.8	23.1	23.1	16.8	29.7	35.6	2.9
2016	8,506.09	29.70	0.29	14.70	83.39	12.63	3.57	24.0	24.0	24.8	17.1	31.1	38.2	2.4
2017	7,978.90	32.85	0.33	14.67	105.38	15.83	4.46	22.5	28.7	28.7	17.1	39.3	46.8	3.0
2018	8,426.84	34.73	0.38	15.98	154.45	23.36	3.70	23.8	33.0	33.0	18.6	57.6	67.6	2.5
2019	8,577.95	25.19	0.38	16.31	138.92	20.62	4.46	24.2	33.0	33.0	19.0	51.8	60.2	3.0

Table 3-4, Figures 3-3 and 3.4 show the evolution of GHG emissions by source categories in Sector 1 'Energy' between 1990 and 2019, and the share of each source category from the total per sector for the same period, respectively.

Table 3-4: Breakdown of direct GHG emissions by category from Sector 1 'Energy' for the period 1990-2019

	Sector 1 'Energy', kt CO_2 equivalent							share of each category, % of total					
	1A1	1A2	1A3	1A4	1A5	1B2	Total	1A1	1A2	1A3	1A4	1A5	1B2
1990	21,364.24	1,923.38	4,837.92	7,841.31	115.57	812.88	36,895.29	57.9	5.2	13.1	21.3	0.3	2.2
1991	18,984.17	1,282.16	3,768.77	6,298.74	107.57	762.93	31,204.34	60.8	4.1	12.1	20.2	0.3	2.4
1992	15,706.26	929.85	2,699.49	4,246.74	78.53	690.62	24,351.49	64.5	3.8	11.1	17.4	0.3	2.8
1993	12,679.18	614.15	1,921.24	2,240.23	94.33	620.50	18,169.62	69.8	3.4	10.6	12.3	0.5	3.4
1994	9,992.56	732.12	1,656.37	2,227.11	89.02	597.19	15,294.37	65.3	4.8	10.8	14.6	0.6	3.9
1995	7,192.41	382.23	1,660.43	2,286.22	126.55	661.81	12,309.65	58.4	3.1	13.5	18.6	1.0	5.4
1996	7,124.41	322.04	1,619.51	2,411.71	82.80	719.36	12,279.84	58.0	2.6	13.2	19.6	0.7	5.9
1997	5,625.67	548.04	1,555.10	2,611.65	77.46	591.53	11,009.45	51.1	5.0	14.1	23.7	0.7	5.4
1998	4,844.68	543.84	1,397.80	2,156.43	73.68	553.55	9,569.97	50.6	5.7	14.6	22.5	0.8	5.8
1999	3,664.69	474.61	932.21	1,875.25	49.80	560.51	7,557.05	48.5	6.3	12.3	24.8	0.7	7.4
2000	3,159.33	520.30	1,005.75	1,552.95	36.80	601.01	6,876.15	45.9	7.6	14.6	22.6	0.5	8.7
2001	3,681.93	602.09	1,087.43	1,488.15	43.88	595.93	7,499.41	49.1	8.0	14.5	19.8	0.6	7.9
2002	2,936.80	410.97	1,442.54	1,814.59	40.13	647.45	7,292.48	40.3	5.6	19.8	24.9	0.6	8.9
2003	3,040.38	439.46	1,626.01	2,161.78	28.81	677.52	7,973.96	38.1	5.5	20.4	27.1	0.4	8.5
2004	3,112.76	444.61	1,829.71	2,325.26	28.02	735.35	8,475.72	36.7	5.2	21.6	27.4	0.3	8.7
2005	3,235.49	575.22	1,867.09	2,283.75	26.28	776.56	8,764.38	36.9	6.6	21.3	26.1	0.3	8.9
2006	2,497.54	635.49	1,788.00	2,274.88	39.49	684.49	7,919.89	31.5	8.0	22.6	28.7	0.5	8.6
2007	2,897.83	801.73	1,894.86	1,721.37	45.12	727.61	8,088.51	35.8	9.9	23.4	21.3	0.6	9.0
2008	3,001.16	887.19	1,999.24	1,732.08	44.17	723.74	8,387.58	35.8	10.6	23.8	20.7	0.5	8.6
2009	3,849.75	495.65	1,964.30	1,881.51	10.60	599.21	8,801.01	43.7	5.6	22.3	21.4	0.1	6.8
2010	4,059.63	423.31	2,188.87	2,047.36	27.52	581.10	9,327.79	43.5	4.5	23.5	21.9	0.3	6.2

	Sector 1 'Energy', kt CO_2 equivalent							share of each category, % of total						
	1A1	1A2	1A3	1A4	1A5	1B2	Total	1A1	1A2	1A3	1A4	1A5	1B2
2011	3,757.18	577.25	2,322.59	2,375.67	19.95	661.72	9,714.36	38.7	5.9	23.9	24.5	0.2	6.8
2012	3,814.55	434.60	2,037.04	2,341.96	7.01	652.23	9,287.38	41.1	4.7	21.9	25.2	0.1	7.0
2013	3,610.98	577.63	2,145.89	2,021.66	2.39	621.60	8,980.15	40.2	6.4	23.9	22.5	0.0	6.9
2014	3,566.52	444.69	2,182.61	2,067.07	25.16	597.00	8,883.05	40.1	5.0	24.6	23.3	0.3	6.7
2015	3,689.96	654.19	2,307.98	1,939.22	22.87	568.26	9,182.48	40.8	7.1	25.5	21.4	0.3	6.3
2016	3,648.63	643.63	2,481.62	1,925.30	22.99	612.76	9,334.94	39.8	6.9	27.0	21.0	0.3	6.7
2017	2,886.82	661.14	2,503.59	2,175.96	22.74	649.28	8,899.53	33.0	7.4	28.7	24.9	0.3	7.4
2018	3,180.55	751.39	2,581.91	2,267.80	23.46	604.18	9,409.29	34.4	8.0	27.9	24.5	0.3	6.5
2019	3,123.52	718.48	2,665.46	2,393.78	22.98	397.45	9,321.67	33.5	7.7	28.6	25.7	0.2	4.3

The source category with the largest share in the national direct GHG emissions from Sector 1 'Energy' is 1A1 'Energy Industries', varying over the review period between a maximum of 69.8 per cent and a minimum of 31.5 per cent. Other major emission sources are represented by 1A2 'Manufacturing Industries and Construction' with a share varying between a maximum of 10.6 per cent and a minimum of 2.6 per cent; 1A3 'Transport' with a share varying between a maximum of 28.6 per cent and a minimum of 10.6 per cent; 1A4 'Other Sectors' with a share varying between a maximum of 28.7 per cent and a minimum of 12.3 per cent; 1B2 'Fugitive Emissions from Oil and Natural Gas' with a share varying between a maximum of 9.0 per cent and a minimum of 2.2 per cent.

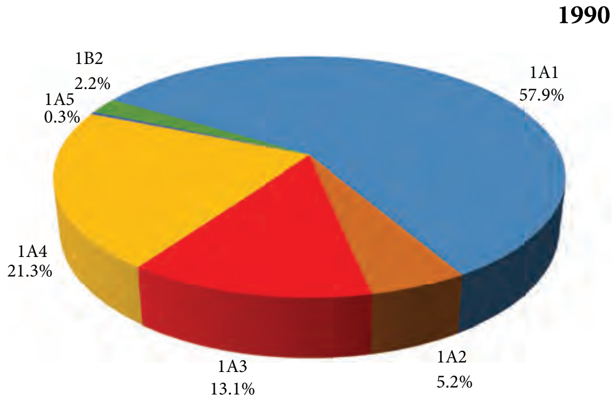

Figure 3-3: The share of different source categories in the structure of total direct GHG emissions from Sector 1 'Energy' in 1990, % of total.

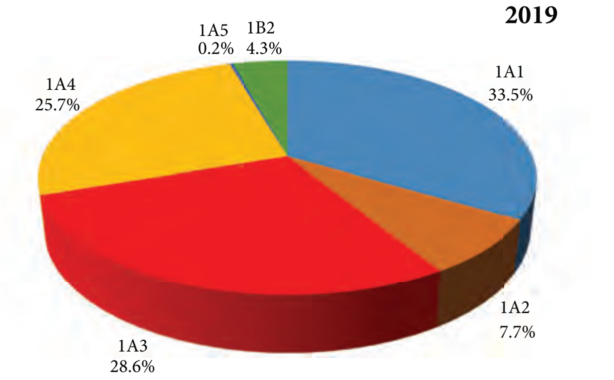

Figure 3-4: The share of different source categories in the structure of total direct GHG emissions from Sector 1 'Energy' in 2019, % of total.

Compared to the level registered in 1990, by 2019, the share of certain categories had increased in the structure of total sectoral direct GHG emissions: 1A2 'Manufacturing Industries and Construction' (from 5.2 per cent to 7.7 per cent), 1A3 'Transport' (from 13 per cent to 29 per cent), 1A4 'Other Sectors' (from 21 per cent to 26 per cent), and 1B2 'Fugitive Emissions from Oil and Natural Gas' (from 2 per cent to 4 per cent) (Table 3-4, Figure 3-5, 3-6).

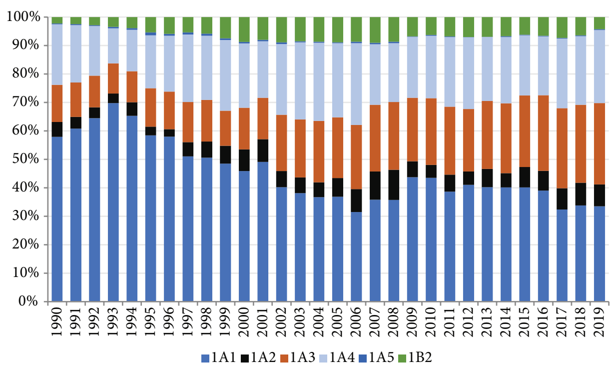

Figure 3-5: The share of different source categories in the structure of total direct GHG emissions from Sector 1 'Energy' for the period 1990-2019, % of total.

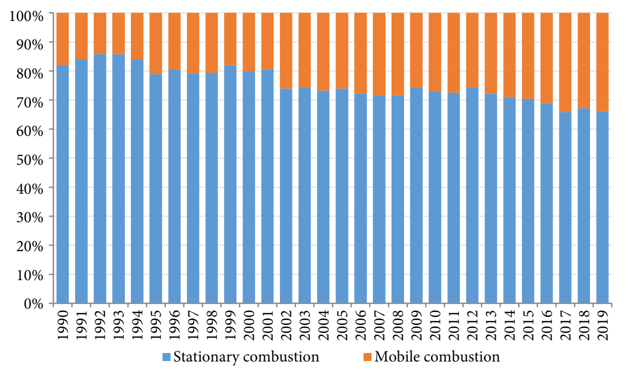

Figure 3-6: The share of direct GHG emissions from 'Stationary Combustion' and 'Mobile Combustion' in Sector 1 'Energy', % of total from sub-sector 1A.

The share of GHG emissions originating from sub-sector 'Stationary Combustion', source categories 1A1, 1A2, 1A4 and 1A5, significantly varied during the reference period, from a minimum of 65.9 per cent of the total sub-sectoral GHG emissions in 2017 to a maximum of 85.9 per cent in 1992. Respectively, the share of GHG emissions originating from sub-sector 'Mobile Combustion', source categories 1A3, 1A4 and 1A5, varied from a minimum of 14.1 per cent of the total in 1992, to a maximum of 34.1 per cent in 2017 (Table 3-5).

Table 3-5: GHG emissions from 'Stationary Combustion' and 'Mobile Combustion' within Sector 1 'Energy'

	Sector 1 'Energy', kt CO_2 equivalent			% of total		% compared to 1990	
	Stationary	Mobile	Total	Stationary	Mobile	Stationary	Mobile
1990	29,623.77	6,458.64	36,082.41	82.1	17.9	100.0	100.0
1991	25,621.16	4,820.26	30,441.41	84.2	15.8	86.5	74.6
1992	20,315.03	3,345.84	23,660.86	85.9	14.1	68.6	51.8
1993	15,051.58	2,497.53	17,549.12	85.8	14.2	50.8	38.7
1994	12,344.39	2,352.78	14,697.18	84.0	16.0	41.7	36.4
1995	9,199.06	2,448.79	11,647.84	79.0	21.0	31.1	37.9
1996	9,309.95	2,250.53	11,560.48	80.5	19.5	31.4	34.8
1997	8,235.30	2,182.62	10,417.91	79.0	21.0	27.8	33.8
1998	7,157.12	1,859.30	9,016.42	79.4	20.6	24.2	28.8
1999	5,735.11	1,261.44	6,996.55	82.0	18.0	19.4	19.5
2000	5,019.25	1,255.89	6,275.14	80.0	20.0	16.9	19.4
2001	5,568.47	1,335.00	6,903.48	80.7	19.3	18.8	20.7
2002	4,915.59	1,729.44	6,645.03	74.0	26.0	16.6	26.8
2003	5,410.68	1,885.76	7,296.43	74.2	25.8	18.3	29.2
2004	5,669.11	2,069.28	7,738.39	73.3	26.7	19.1	32.0
2005	5,906.37	2,079.23	7,985.60	74.0	26.0	19.9	32.2
2006	5,233.21	2,000.57	7,233.78	72.3	27.7	17.7	31.0
2007	5,266.87	2,090.02	7,356.89	71.6	28.4	17.8	32.4
2008	5,474.15	2,183.14	7,657.29	71.5	28.5	18.5	33.8
2009	6,074.96	2,117.43	8,192.39	74.2	25.8	20.5	32.8
2010	6,380.42	2,359.61	8,740.04	73.0	27.0	21.5	36.5
2011	6,556.47	2,489.72	9,046.19	72.5	27.5	22.1	38.5
2012	6,431.43	2,197.02	8,628.45	74.5	25.5	21.7	34.0
2013	6,030.84	2,320.75	8,351.59	72.2	27.8	20.4	35.9
2014	5,880.38	2,399.45	8,279.83	71.0	29.0	19.9	37.2
2015	6,063.55	2,544.84	8,608.38	70.4	29.6	20.5	39.4
2016	6,008.95	2,709.19	8,718.17	68.9	31.1	20.3	41.9
2017	5,433.46	2,812.85	8,246.31	65.9	34.1	18.3	43.6
2018	5,912.87	2,889.14	8,802.01	67.2	32.8	20.0	44.7
2019	5,907.45	3,015.42	8,922.87	66.2	33.8	19.9	46.7

In the structure of the total GHG emissions originating from the Sector 1 'Energy', the share of fugitive emissions from sub-sector 1B 'Fugitive Emissions from Fuels' tended to grow from a minimum of 2.2 per cent in 1990 to maximum of 7.0 per cent in 2007. Respectively, the share of GHG emissions originating from the sub-sector 1A 'Fuel Combustion' tended to decrease from a maximum of 98.0 per cent in 1990 to a minimum of 93.0 per cent in 2007. In recent years, the share of GHG emissions from sub-sector 1A 'Fuel Combustion' tended to grow (Figure 3-7, Table 3-6).

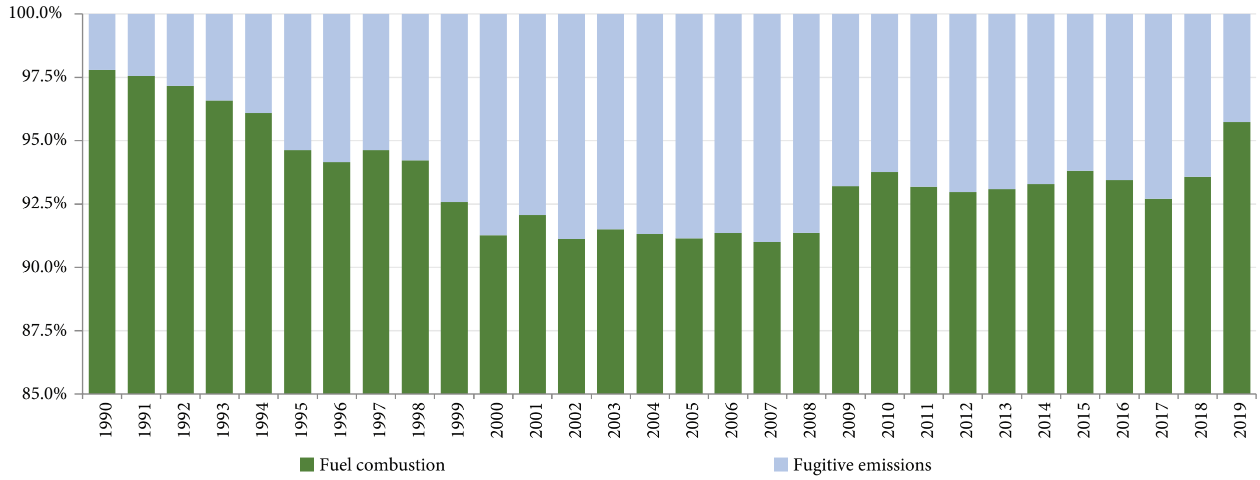

Figure 3-7: The share of GHG emissions from sub-sectors 1A 'Fuel Combustion' and 1B 'Fugitive Emissions from Fuels' within Sector 1 'Energy' for the period 1990-2019, % of total.

Table 3-6: Direct GHG emissions from subsectors 1A 'Fuel Combustion' and 1B 'Fugitive Emissions from Fuels' within Sector 1 'Energy' for the period 1990-2019

	Sector 1 'Energy', kt CO_2 equivalent			% of total		%, compared to 1990		
	1A Fuel Combustion	1B Fugitive Emissions	Total	1A Fuel Combustion	1B Fugitive Emissions	1A Fuel Combustion	1B Fugitive Emissions	Total
1990	36,082.41	812.88	36,895.29	97.8	2.2	100.0	100.0	100.0
1991	30,441.41	762.93	31,204.34	97.6	2.4	84.4	93.9	84.6
1992	23,660.86	690.62	24,351.49	97.2	2.8	65.6	85.0	66.0
1993	17,549.12	620.50	18,169.62	96.6	3.4	48.6	76.3	49.2
1994	14,697.18	597.19	15,294.37	96.1	3.9	40.7	73.5	41.5
1995	11,647.84	661.81	12,309.65	94.6	5.4	32.3	81.4	33.4
1996	11,560.48	719.36	12,279.84	94.1	5.9	32.0	88.5	33.3
1997	10,417.91	591.53	11,009.45	94.6	5.4	28.9	72.8	29.8
1998	9,016.42	553.55	9,569.97	94.2	5.8	25.0	68.1	25.9
1999	6,996.55	560.51	7,557.05	92.6	7.4	19.4	69.0	20.5
2000	6,275.14	601.01	6,876.15	91.3	8.7	17.4	73.9	18.6
2001	6,903.48	595.93	7,499.41	92.1	7.9	19.1	73.3	20.3
2002	6,645.03	647.45	7,292.48	91.1	8.9	18.4	79.6	19.8
2003	7,296.44	677.52	7,973.96	91.5	8.5	20.2	83.3	21.6
2004	7,740.37	735.35	8,475.72	91.3	8.7	21.5	90.5	23.0
2005	7,987.82	776.56	8,764.38	91.1	8.9	22.1	95.5	23.8
2006	7,235.40	684.49	7,919.89	91.4	8.6	20.1	84.2	21.5
2007	7,360.90	727.61	8,088.51	91.0	9.0	20.4	89.5	21.9
2008	7,663.84	723.74	8,387.58	91.4	8.6	21.2	89.0	22.7
2009	8,201.80	599.21	8,801.01	93.2	6.8	22.7	73.7	23.9
2010	8,746.69	581.10	9,327.79	93.8	6.2	24.2	71.5	25.3
2011	9,052.64	661.72	9,714.36	93.2	6.8	25.1	81.4	26.3
2012	8,635.16	652.23	9,287.38	93.0	7.0	23.9	80.2	25.2
2013	8,358.55	621.60	8,980.15	93.1	6.9	23.2	76.5	24.3
2014	8,286.05	597.00	8,883.05	93.3	6.7	23.0	73.4	24.1
2015	8,614.22	568.26	9,182.48	93.8	6.2	23.9	69.9	24.5
2016	8,722.17	612.76	9,334.94	93.4	6.6	24.2	75.5	24.9
2017	8,250.25	649.28	8,899.53	92.7	7.3	22.9	79.9	23.7
2018	8,805.11	604.18	9,409.29	93.6	6.4	24.4	74.3	25.1
2019	8,924.21	397.45	9,321.67	95.7	4.3	24.7	48.9	25.3

3.1.2. Key Categories

The results of key category analysis (with LULUCF), which were carried out following a Tier 1 approach are provided in Chapter 1.5 of this Report. Table 3-7 provides information on identified key categories (assessment by level – L, and trend – T) in Sector 1 'Energy'.

Table 3-7: Key categories in Sector 1 'Energy'

IPCC Categories	GHG	Source Categories	Key Categories
1.A.1	CO_2	CO_2 Emissions from Energy Industries – Liquid Fuels	Yes (L, T)
1.A.1	CO_2	CO_2 Emissions from Energy Industries – Gaseous Fuels	Yes (L, T)
1.A.1	CO_2	CO_2 Emissions from Energy Industries – Solid Fuels	Yes (L, T)
1.A.1	CH_4	CH_4 Emissions from Energy Industries – Liquid Fuels	No
1.A.1	CH_4	CH_4 Emissions from Energy Industries – Gaseous Fuels	No
1.A.1	CH_4	CH_4 Emissions from Energy Industries – Solid Fuels	No
1.A.1	N_2O	N_2O Emissions from Energy Industries – Liquid Fuels	No
1.A.1	N_2O	N_2O Emissions from Energy Industries – Gaseous Fuels	No
1.A.1	N_2O	N_2O Emissions from Energy Industries – Solid Fuels	No
1.A.2	CO_2	CO_2 Emissions from Manufacturing Industries and Construction	Yes (L, T)
1.A.2	CH_4	CH_4 Emissions from Manufacturing Industries and Construction	No
1.A.2	N_2O	N_2O Emissions from Manufacturing Industries and Construction	No
1.A.3a	CO_2	CO_2 Emissions from Civil Aviation	No
1.A.3a	CH_4	CH_4 Emissions from Civil Aviation	No
1.A.3a	N_2O	N_2O Emissions from Civil Aviation	No
1.A.3b	CO_2	CO_2 Emissions from Road Transportation	Yes (L, T)
1.A.3b	CH_4	CH_4 Emissions from Road Transportation	No
1.A.3b	N_2O	N_2O Emissions from Road Transportation	No
1.A.3c	CO_2	CO_2 Emissions from Railways	Yes (L, T)
1.A.3c	CH_4	CH_4 Emissions from Railways	No
1.A.3c	N_2O	N_2O Emissions from Railways	No
1.A.3d	CO_2	CO_2 Emissions from Water-borne Navigation	No
1.A.3d	CH_4	CH_4 Emissions from Water-borne Navigation	No
1.A.3d	N_2O	N_2O Emissions from Water-borne Navigation	No
1.A.3e	CO_2	CO_2 Emissions from Other Transportation	No
1.A.3e	CH_4	CH_4 Emissions from Other Transportation	No

IPCC Categories	GHG	Source Categories	Key Categories
1.A.3e	N_2O	N_2O Emissions from Other Transportation	No
1.A.4a	CO_2	CO_2 Emissions from the Commercial/Institutional Sector	Yes (L, T)
1.A.4a	CH_4	CH_4 Emissions from the Commercial/Institutional Sector	No
1.A.4a	N_2O	N_2O Emissions from the Commercial/Institutional Sector	No
1.A.4b	CO_2	CO_2 Emissions from the Residential Sector	Yes (L, T)
1.A.4b	CH_4	CH_4 Emissions from the Residential Sector	Yes (L, T)
1.A.4b	N_2O	N_2O Emissions from the Residential Sector	No
1.A.4c	CO_2	CO_2 Emissions from Agriculture/Forestry/Fishing	Yes (L, T)
1.A.4c	CH_4	CH_4 Emissions from Agriculture/Forestry/Fishing	No
1.A.4c	N_2O	N_2O Emissions from Agriculture/Forestry/Fishing	No
1.A.5	CO_2	CO_2 Emissions from Other Transportation	No
1.A.5	CH_4	CH_4 Emissions from Other Transportation	No
1.A.5	N_2O	N_2O Emissions from Other Transportation	No
1.B.2	CO_2	CO_2 Fugitive Emissions from Oil and Natural Gas	No
1.B.2	CH_4	CH_4 Fugitive Emissions from Oil and Natural Gas	Yes (L, T)
1.B.2	N_2O	N_2O Fugitive Emissions from Oil and Natural Gas	No

3.1.3. Methodological Issues

Under Sector 1 'Energy', there were estimated GHG emissions originating from 5 source categories within sub-sector 1A 'Fuel Combustion' (1A1, 1A2, 1A3, 1A4 and 1A5), one source category within sub-sector 1B 'Fugitive Emissions from Fuels' (1B2) and 2 source categories under Memo Items ('International Aviation', and 'CO_2 Emissions from Biomass'). GHG emissions originating from Sector 1 'Energy' were estimated following a Tier 1 approach except 'International Aviation', for which a Tier 2 methodology was applied (Table 3-8).

Table 3-8: Methods used to estimate GHG emissions from Sector 1 'Energy'

IPCC Categories	Source Category	Method	EF
1.A.1	Energy Industries	T1	D, CS
1.A.2	Manufacturing Industries and Construction	T1	D, CS
1.A.3	Transport (Civil Aviation, Road Transportation, Railways, Navigation, Pipeline Transport)	T1, T3	D, CS
1.A.4	Other Sectors (Commercial/Institutional, Residential, Agriculture/Forestry/Fishing)	T1	D, CS
1.A.5	Other (Stationary/Mobile)	T1	D, CS
1.B.2	Fugitive Emissions from Oil and Natural Gas	T1	D
Memo Items	International Aviation	T2	D, CS
Memo Items	CO_2 Emissions from Biomass	T1	D, CS

Abbreviations: T1 – Tier 1; T2 – Tier 2; EF – Emission Factors; D – Default Values; CS – Country Specific.

For natural gas, country specific net annual average caloric values were used, thus emissions from combustion of this particular type of fuel were estimated using a Tier 2 approach. For Road Transportation, GHG emissions were estimated using a Tier 3 approach (the COPERT 4.9 model program was tested); this change, however, was possible only for the years 1990, 1995, 2004-2019, but the results obtained are still preliminary. The basic equation used to estimate GHG emissions under Sector 1 'Energy' is described below (the emissions estimation of SO_2 is described in Annex 3-1.1 of this Report):

$$GHG\ Emissions = \Sigma\ (Fuel\ Consumption_j \bullet Emission\ Factor_j),$$

where: j – type of fuel.

The main source of reference for activity data used for estimating GHG emissions under the Sector 1 'Energy' is the National Bureau of Statistics (NBS), through its annual publication – Energy Balances of the Republic of Moldova for the years 1990, 1993-2019 (the Energy Balances for 2019 is presented in Annex 2) and Statistical Yearbooks, including those of ATULBD (activity data regarding fuel consumption on the territory on the Left Bank of the Dniester River are available in Annex 3-1.2).

In order to estimate emissions from all source categories within this sector, a large amount of detailed information on fuel consumption is needed. The main source of information are the Energy Balances of the Republic of Moldova, provided annually by the National Bureau of Statistics (NBS). At the same time, the information provided directly by enterprises in the field of energy, transport, as well as ministries and agencies is also useful. The legal base for data requests is assured by the Law No. 93 as of 26.05.2017 on Official Statistics, as well as Law No. 982 as of 11.05.2000 on access to information. The list of organisations that provide primary data for Sector 1 'Energy' is presented below:

1. National Bureau of Statistics, Direction for Industry, Energy and Construction Statistics;
2. "Termoelectrica" JSC (subdivisions "CHP-1", "CHP-2" and "Termoservice");
3. JSC "CHP-North";
4. Ministry of Economy and Infrastructure of the Republic of Moldova;
5. Ministry of Defence, Service for Ecology and Environment Protection;
6. Customs Service of the Republic of Moldova;
7. Public Services Agency;
8. Civil Aeronautical Authority of the Republic of Moldova;
9. SOE "Moldova Railways";
10. "Ungheni River Port", "Giurgiulesti International Free Port", SOE "Bacul Molovata";
11. "Moldovagaz" JSC;
12. Inspectorate for Environmental Protection of the Republic of Moldova;
13. Institute of Power Engineering of the Ministry of Education, Culture and Research.

To be noted that the Energy Balance for the year 1990 ensures geographical coverage of the whole country, while the Energy Balances for the time period 1993-2019 covered only the territory on the right bank of the Dniester River (in 1991-1992, the Energy Balances were not published; it should also be noted that for 1990 and 1993-2014, the Energy Balances were generated by the NBS in a MS DOS format, and only since 2015 they were generated and provided to users in an MS Excel form, which facilitates the data analysis and information use). The estimation of GHG emissions was based on country specific values (Table 3-9).

Table 3-9: Emission factors and other relevant parameters used to estimate GHG emissions from Sector 1 'Energy'

Fuel Type	Net Caloric Value (CS Values), TJ/kt		Net Caloric Value, TJ/kt		Emission Factors, t C/TJ		Carbon oxidation fraction	
	Ranges according to the BNS	Value used	IPCC, 1997	IPCC, 2006	IPCC, 1997	IPCC, 2006	IPCC, 1997	IPCC, 2006
Coal	15.40 - 29.13		18.58				0.98	1
Anthracite	22.83 - 29.13		18.58	26.7	26.8	26.8	0.98	1
Brown Coal, including:	6.31 - 15.37		14.65	11.9	27.6	27.6	0.98	1
from Donetsk Coal Basin	25.70	25.70			26.8		0.98	1
from Kuznetsk Coal Basin	25.44	25.44			26.8		0.98	1
from Ukrainian Coal Basin	6.31 - 11.68	11.68			27.6		0.98	1
from Kansk-Acinsk Coal Basin	15.14	15.14			25.8		0.98	1
Coal Briquettes	17.75	17.75		20.7	25.8	26.6	0.98	1
Coking Coal	26.41 - 29.05	26.41	18.58	28.2	25.8	25.8	0.98	1
Diesel Oil	42.54	42.54	43.33	43.0	20.2	20.2	0.99	1
Fuel for Oven	42.54	42.54			21.1		0.99	1
Residual Fuel Oil	39.02 - 40.20	40.20	40.19	40.4	21.1	21.1	0.99	1
Fuel for Engines	41.96	41.96			20.0		0.99	1
Including Jet engines	43.13				19.5		0.99	1
Aviation Gasoline	43.72	43.72	44.80	44.3	18.9	19.1	0.99	1
Gasoline	43.72	43.72	44.80	44.3	18.9	18.9	0.99	1
Kerosene	43.13	43.13	44.75	43.8	19.6	19.6	0.99	1
Lubricants	42.19	42.19	40.19	40.2	20.0	20.0	0.99	1
Bitumen	39.61	39.61	40.19	40.2	22.0	22.0	0.99	1
Other Oil Products	40.19	40.19	40.19	40.2	20.0	20.0	0.99	1
Natural Gas	33.15 - 34.03	33.86	33.70	48.0	15.3	15.3	0.995	1
Liquefied Petroleum Gases	46.06	46.06	47.31	47.3	17.2	17.2	0.99	1
Fuel Wood	12.32	12.32	15	15.6	29.9	30.5	0.98	1
Agricultural Residues	14.67	14.67	15.2		29.9		0.98	1

Source: Instructions for Compiling the Statistical Report nr.1-EBs "Energy Balance", approved through Order No. 88 from 03.10.2012 of the National Bureau of Statistics of the RM (<http://www.statistica.md/public/files/Formulare_statistice/2013/industrie_energetica/1_BE.pdf>

In the Statistical Report No. 1-BE "Energy Balance", respectively in the "Instructions for drafting the Statistical Report No. 1-BE" average caloric values are available for converting quantitative indicators for fuel from natural units to coal equivalent units (Table 3-10).

Table 3-10: The method of calculating the average caloric values based on the instructions for drafting the Statistical Report No. 1-BE "Energy Balance"

Fuel Type	Unit	Average caloric values for converting natural fuels to coal equivalent units	Average caloric values, TJ/kt (estimated using the conversion coefficient 29.31 TJ/ktce)
Coal – total (from 0.778 to 0.993 kcal/t)			
Donetsk Coal	t	0.876	25.70
Coal rich in volatile matter	t	0.816	23.94
Long Flame Coal	t	0.782	22.94
Anthracite AS	t	0.888	26.05
Anthracite AK	t	0.993	29.13
Kuznetsk Coal	t	0.867	25.44
Lignite (from 0.215 to 0.524 kcal/t)			
Kansk-Acinsk Coal	t	0.516	15.14
Podmoskovnii Lignite	t	0.335	9.83
Ukrainian Brown Lignite	t	0.307	9.01
Brown Coal Briquettes	t	0.605	17.75
Coking Coal	t	0.990	29.05
Petroleum	t	1.430	41.96
Diesel Oil	t	1.450	42.54
Fuel for Oven	t	1.450	42.54
Residual Fuel Oil	t	1.370	40.20
Fuel for Jet Engines	t	1.470	43.13
Fuel for Diesel Engines	t	1.430	41.96
Aviation Gasoline	t	1.490	43.72
Gasoline	t	1.490	43.72
Kerosene for Tractors	t	1.470	43.13
Kerosene for lighting	t	1.470	43.13
Kerosene for Aviation	t	1.470	43.13
Lubricants	t	1.438	42.19
Bitumen	t	1.350	39.61
White-Spirit	t	1.474	43.25
Paraffin	t	1.479	43.39
Processed Oils	t c.e.	1.000	29.34
Other Oil Products	t	1.000	29.34
Natural Gas	1000 m^3 stand.	1.154	33.86
Liquefied Petroleum Gases	t	1.570	46.06
Fuel Wood	1000 m^3 comp.	0.266	7.80
Wood Waste	t c.e.	1.000	29.31
Agricultural Fuel Residues	t c.e.	1.000	29.31
Other types of fuel	t c.e.	1.000	29.31
Electricity	million kWh	0.123	3.61
Heat	thousand Gcal	0.143	4.20

Source: http://www.statistica.md/

The table below presents source categories in Sector 1 'Energy' for which statistical data regarding the territory on the left bank of Dniester River are available (Table 3-11).

Table 3-11: Source Categories in Sector 1 'Energy' for which statistical data regarding the territory on the LBDR are available

Source Categories	RBDR	LBDR	Statistical data for the LBDR, by fuels and the period for which data are available
1A1. Energy Industries	*	*	
1A1a. Main Activity Electricity and Heat Production	*	*	
1A1ai Electricity Generation	*	*	Coal, Residual Fuel Oil:1990-1998, 2008-2019; Natural Gas: 1990-2019
1A1aii Heat and Power Generation	*	NO	Not Occurring
1A1aiii Heat Plants	*	*	Coal, Residual Fuel Oil: 1990-1998, 2008-2019; Natural Gas: 1994-2019
1A1b Petroleum Refining	*	NO	Not Occurring
1A1c Manufacture of Solid Fuels and Other Energy Industries	*	NO	Not Occurring
1A2. Manufacturing Industries and Construction	*	*	Natural Gas: 1994-2019; Coal, Residual Fuel Oil: 2008-2019; LPG: 2011-2019
a. Iron and Steel	*	*	
b. Non-Ferrous Metals	*	*	
c. Chemicals	*	*	
d. Pulp, Paper and Print	*	*	
e. Food Processing, Beverages and Tobacco	*	*	
f. Non-Metallic Minerals	*	*	
g. Transport Equipment	*	*	

Source Categories	RBDR	LBDR	Statistical data for the LBDR, by fuels and the period for which data are available
h. Machinery	*	*	
i. Mining and Quarrying	*	*	
j. Wood and Wood Products	*	*	
k. Construction	*	*	
l. Textile and Leather	*	*	
m. Non-specified Industries	*	*	
1A3. Transport	*	*	
a. Civil Aviation	*	NO	Not Occurring
b. Road Transportation	*	*	Natural Gas, LPG: 2009-2019
c. Railways	*	*	
d. Water-borne Navigation	*	*	
e i. Pipeline Transport	*	*	
e ii Transport Off-road Transport	NA	NA	
e iii Other Transport	NO	NO	
1A4. Other Sectors	*	*	
a. Commercial/Institutional	*	*	Natural Gas: 1999-2019, LPG: 2011-2019; Coal, Residual Fuel Oil: 2008-2019
b. Residential	*	*	Natural Gas, LPG: 1995-2019; Fuel Wood: 2008-2019
c i. Agriculture/Forestry/Fishing (stationary)	*	*	Coal, Residual Fuel Oil: 2008-2019
c ii. Agriculture/Forestry/Fishing (mobile)	*	*	Gasoline, Diesel Oil: 1995-2019
1A5. Other	*	*	
a. Mobile	*	*	Coal, Residual Fuel Oil: 2008-2019
b. Stationary	*	NO	Not Occurring
1B. Fugitive Emissions from Fuels	*	*	
1B1. Solid Fuels	NO	NO	
a. Coal mining	NO	NO	
b. Solid Fuel Transformation	NO	NO	
c. Other	NO	NO	
1B2. Oil, Natural Gas and Fugitive Emissions from Energy Production	*	*	
a. Oil	*	NO	Not Occurring
b. Natural Gas	*	*	
c. Venting and Flaring	*	*	
d. Other	NO	NO	
1C. CO_2 Transport and Storage	**NO**	**NO**	
1. CO_2 Transport	NO	NO	
2. CO_2 Transport Injection and Storage	NO	NO	
3. Other	NO	NO	
Memo Items: (1)	*	**NO**	
International Bunkers	*	NO	
International Aviation	*	NO	Not Occurring
International Marine Navigation	NO	NO	
Multilateral Operations	NO	NO	
CO2 Emissions from Biomass	*	*	Fuel Wood: 2008-2019
CO2 Captured and Stored	NO	NO	
For storage at national level	NO	NO	
For storage in other countries	NO	NO	

Abbreviations: RBDR – Right Bank of Dniester River; LBDR – Left Bank of Dniester River; NA – Not Available, NO – Not Occurring.

3.1.4. Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the Sector 1 'Energy' (by source categories) is described in detail in the sub-chapters 3.2-3.9 of the NIR, as well as in the Annex 5-3.1 according to the 2006 IPCC Guidelines. Combined uncertainties as a percentage of total direct GHG emissions from Sector 1 'Energy' were estimated at circa 4.03 per cent. The uncertainties introduced in trend in sectoral emissions were estimated at circa 1.06 per cent. In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

3.1.5. Quality Assurance and Quality Control

Tier 1 and Tier 2 procedures associated with the quality assurance and quality control process in the Sector 1 'Energy' include the following:

- according to the description of each source category, representative information was collected, AD used in the previous inventory cycle were updated and specified;
- the sources of reference for collected data were updated and specified;

- with the full transition to the methodologies available in the 2006 IPCC Guidelines, the default EFs used to estimate GHG emissions from each source category were updated and specified; these are available in spreadsheets as tables and can be imported automatically into calculation sheets;
- for SO_x, a special calculation formula according to EMEP/EEA 2019 was applied for mobile source categories;
- standard internal documentation procedures are provided for each source category; separate calculation files were developed identical to the CRF tables used by Annex I countries (Decision 24/CP.19[51]);
- the same estimation method was used for the entire period under review at individual source category level; for a better view of the results, charts showing the GHG trends at category level are created automatically;
- the procedures for data archiving used to estimate sectoral GHG emissions have been updated and improved, and a special file naming system has been introduced;
- in order to ensure the completeness of the inventory, including from the territorial point of view, various reference sources for AD regarding fossil fuel consumption on the LBDR were used; data on natural gas were provided by SOE "Moldovagaz", periodic statistical publications produced by the State Service for Statistical Analysis attached to the Ministry of Economic Development of ATULBD, as well as "Press Releases regarding housing and utilities" and "Press Releases from MTPP in Dnestrovsk";
- as far as possible, the recommendations of the international expert who carried out the inventory quality expertise in the previous inventory cycle, associated with the preparation of the BUR2 of the Republic of Moldova to the UNFCCC (2019), including:
  - use of constant net calorific value for natural gas;
  - use of available data in the Energy Balances of the RM for international aviation instead of data provided in official letters from economic agents;
  - restoration of data series for civil aviation in accordance with the available data in the Energy Balances of the RM;
  - restoring the data series for the region on the LBDR, for the categories not previously covered;
  - reallocation of motor fuel consumption from category 1A2 'Manufacturing Industries and Construction' to 1A3b 'Transport';
  - division of AD on fuel consumption in the years 1990-1992, presented in aggregate at national level, by regions (right and left bank of the Dniester River);
  - specification of data series associated with fuel consumption in categories 1A1b and 1A1c;
  - mechanical errors related to entering activity data were eliminated, in most cases the respective errors were associated with line routing and incomplete summary;
  - the database for the Sector 1 'Energy' was changed according to the CRF tables used by Annex I countries (Decision 24/CP.19), thus becoming decidedly easier to utilise;
  - for each source category where problems were identified regarding collecting AD, an additional verification of the AD sources was carried out, and the AD rows were updated, respectively;
  - the current inventory cycle includes more fuels and source categories, compared to the previous one.

3.1.6. Recalculations

Since a series of improvements were adopted within the current inventory cycle, it was necessary to recalculate GHG emissions from all categories included in Sector 1 'Energy'. The main causes of these recalculations are:

- a series of mechanical errors from the manual data entry of AD were eliminated;

[51] <https://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf>, <https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-convention/greenhouse-gas-6>

- for each category AD pertaining to fuel consumption were updated, while for those subcategories included for the first time, AD was collected from the official reference sources.
- the use of constant net calorific values for natural gas was resumed;
- the use the activity data available in the Energy Balances of the Republic of Moldova for international aviation was adopted, instead of using the data collected by official letters from economic agents; the data series for domestic aviation were restored in accordance with the information available in the Energy Balances of the Republic of Moldova;
- the restoration of data series for the LBDR, for previously uncovered categories; for the years 1990-1992, the information was previously presented in aggregate by country, in the current inventory cycle being disaggregated by regions (right and left bank of the Dniester River);
- the reallocation of car fuel consumption from category 1A2 'Manufacturing Industries and Construction' to 1A3b 'Road Transportation';
- data series for categories 1A1b and 1A1c were updated and specified;
- for the calculation of indirect GHG emissions, methodological approaches and implicit emission factors available in the EMEP/EEA Guidebook Air Pollutant Emission Inventory (2019) were applied.

In comparison to results included in the BUR2 of the Republic of Moldova to the UNFCCC (2019), the changes made in the current inventory cycle have resulted in an insignificant increase in direct GHG emissions in the years 1990, 1994-1998, varying from a minimum increase by 0.7 per cent in 1997, up to a maximum of circa 1.3 per cent in the years 1995 and 1998; and, respectively, in a decrease tendency in the years 1991-1993 and 1999-2016, varying from a minimum decrease by 0.02 per cent in 1993, up to a maximum decrease by 11.3 per cent in 2009 (Table 3-12). Between 1990 and 2019, total direct GHG emissions from Sector 1 'Energy' had decreased by circa 74.1 per cent.

Table 3-12: Recalculated GHG emissions for the period 1990-2016, included in the BUR2 of the RM under the UNFCCC (Sector 1 'Energy'), Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	36.6105	32.9696	26.1405	18.1730	15.1473	12.1574	12.1291	10.9364	9.4505	7.9883
BUR3	36.8953	31.2043	24.3515	18.1696	15.2946	12.3097	12.2798	11.0094	9.5700	7.5571
Difference, %	0.8	-5.4	-6.8	0.0	1.0	1.3	1.2	0.7	1.3	-5.4
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	7.2889	7.8927	7.5977	8.2968	9.0248	9.2488	8.3586	8.6524	9.1322	9.9117
BUR3	6.8761	7.4994	7.2925	7.9740	8.4757	8.7644	7.9199	8.0885	8.3876	8.8010
Difference, %	-5.7	-5.0	-4.0	-3.9	-6.1	-5.2	-5.2	-6.5	-8.2	-11.2
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	10.1950	10.4985	10.0362	9.0257	9.6569	10.0638	9.9272			
BUR3	9.3278	9.7144	9.2874	8.9802	8.8830	9.1825	9.3349	8.8995	9.4093	9.3217
Difference, %	-8.5	-7.5	-7.5	-0.5	-8.0	-8.8	-6.0			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR2 – Third Biennial Update Report of the RM to the UNFCCC.

3.1.7. Assessment of Completeness

Under the current inventory cycle within Sector 1 'Energy', direct GHG emissions originating from 8 source categories were estimated (Table 3-13). As no coal mining exists in the country, no GHG emissions from the category 1B1 'Fugitive Emissions from Coal Mining and Handling' were registered, respectively.

Table 3-13: Assessment of completeness under the Sector 1 'Energy'

IPCC Category	Source Category	CO_2	CH_4	N_2O
1.A.1	Energy Industries	X	X	X
1.A.2	Manufacturing Industries and Construction	X	X	X
1.A.3	Transport (Civil Aviation, Road Transportation, Railways, Domestic Navigation, Pipeline Transport)	X	X	X
1.A.4	Other Sectors (Commercial/Institutional, Residential, Agriculture/Forestry/Fishing)	X	X	X
1.A.5	Other (other works and needs)	X	X	X
1.B.1	Fugitive Emissions from Coal Mining and Handling	NO	NO	NO
1.B.2	Fugitive Emissions from Oil and Natural Gas	X	X	X
Memo Items	International Aviation	X	X	X
Memo Items	CO_2 Emissions from Biomass	X	X	X

Abbreviations: X – Source Categories Included in GHG Inventory; NO – Not Occurring.

3.1.8. Planned Improvements

Planned improvements at source categories level within the Sector 1 'Energy' are described in more detail in sub-chapters 3.2-3.9 of this report.

3.2. Energy Industries (Category 1A1)

3.2.1. Source Category Description

The emission sources monitored in the Republic of Moldova under the category 1A1 'Energy Industries' are as following:

- 1A1a Main Activity Electricity and Heat Production
  - o *1A1ai Electricity Generation*
  - o *1A1aii Combined Heat and Power Generation*
  - o *1A1aiii Heat Plants*
- 1A1b Petroleum Refining

Between 1990 and 2019, GHG emissions from category 1A1 'Energy Industries' tended to decrease to 14.6 per cent compared to the reference year 1990 (Table 3-14).

Table 3-14: GHG emissions from category 1A1 'Energy Industries' in the Republic of Moldova between 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A1, kt CO_2 equivalent	21,364.24	18,984.17	15,706.26	12,679.18	9,992.56	7,192.41	7,124.41	5,625.67	4,844.68	3,664.69
%, compared to 1990	100.0	88.9	73.5	59.3	46.8	33.7	33.3	26.3	22.7	17.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A1, kt CO_2 equivalent	3,159.33	3,681.93	2,936.80	3,040.38	3,112.76	3,235.49	2,497.54	2,897.83	3,001.16	3,849.75
%, compared to 1990	14.8	17.2	13.7	14.2	14.6	15.1	11.7	13.6	14.0	18.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A1, kt CO_2 equivalent	4,059.63	3,757.18	3,814.55	3,610.98	3,566.52	3,689.96	3,648.63	2,886.82	3,180.55	3,123.52
%, compared to 1990	19.0	17.6	17.9	16.9	16.7	17.3	17.1	13.5	14.9	14.6

Total direct GHG emissions from 1A1 'Energy Industries' category decreased from circa 21364.2 kt CO_2 equivalent in 1990 to circa 3123.5 kt CO_2 equivalent in 2019 (Table 3-15). CO_2 has the largest share in the total structure of direct GHG emissions.

Table 3-15: Direct GHG emissions from category 1A1 'Energy Industries' in the Republic of Moldova for the period 1990-2019

	1A1, kt CO_2 equivalent				share of total, %			%, compared to 1990			
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
1990	21,300.2929	12.2813	51.6671	21,364.2413	99.70	0.06	0.24	100.0	100.0	100.0	100.0
1991	18,927.0336	10.5744	46.5622	18,984.1702	99.70	0.06	0.25	88.9	86.1	90.1	88.9
1992	15,660.9863	8.9470	36.3227	15,706.2560	99.71	0.06	0.23	73.5	72.9	70.3	73.5
1993	12,640.6006	7.0580	31.5167	12,679.1754	99.70	0.06	0.25	59.3	57.5	61.0	59.3
1994	9,961.8515	4.7207	25.9879	9,992.5601	99.69	0.05	0.26	46.8	38.4	50.3	46.8
1995	7,174.0286	3.4249	14.9539	7,192.4074	99.74	0.05	0.21	33.7	27.9	28.9	33.7
1996	7,107.0544	3.3821	13.9743	7,124.4109	99.76	0.05	0.20	33.4	27.5	27.0	33.3
1997	5,615.6123	2.7692	7.2856	5,625.6671	99.82	0.05	0.13	26.4	22.5	14.1	26.3
1998	4,836.6106	2.4047	5.6624	4,844.6778	99.83	0.05	0.12	22.7	19.6	11.0	22.7
1999	3,660.2540	1.8165	2.6146	3,664.6852	99.88	0.05	0.07	17.2	14.8	5.1	17.2
2000	3,155.7517	1.5249	2.0520	3,159.3286	99.89	0.05	0.06	14.8	12.4	4.0	14.8
2001	3,677.7189	1.8154	2.3940	3,681.9284	99.89	0.05	0.07	17.3	14.8	4.6	17.2
2002	2,933.2101	1.5342	2.0510	2,936.7953	99.88	0.05	0.07	13.8	12.5	4.0	13.7
2003	3,036.7494	1.5649	2.0677	3,040.3820	99.88	0.05	0.07	14.3	12.7	4.0	14.2
2004	3,109.0519	1.6004	2.1117	3,112.7641	99.88	0.05	0.07	14.6	13.0	4.1	14.6
2005	3,231.6708	1.6527	2.1625	3,235.4860	99.88	0.05	0.07	15.2	13.5	4.2	15.1
2006	2,494.5441	1.2952	1.6998	2,497.5390	99.88	0.05	0.07	11.7	10.5	3.3	11.7
2007	2,894.4441	1.4837	1.9002	2,897.8280	99.88	0.05	0.07	13.6	12.1	3.7	13.6
2008	2,997.3662	1.6371	2.1525	3,001.1558	99.87	0.05	0.07	14.1	13.3	4.2	14.0
2009	3,844.8870	2.0870	2.7733	3,849.7472	99.87	0.05	0.07	18.1	17.0	5.4	18.0
2010	4,054.4452	2.2345	2.9480	4,059.6277	99.87	0.06	0.07	19.0	18.2	5.7	19.0
2011	3,752.5675	2.0035	2.6063	3,757.1773	99.88	0.05	0.07	17.6	16.3	5.0	17.6

	1A1, kt CO_2 equivalent				share of total, %			%, compared to 1990			
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
2012	3,810.0873	1.8944	2.5658	3,814.5475	99.88	0.05	0.07	17.9	15.4	5.0	17.9
2013	3,603.6566	1.6985	5.6270	3,610.9821	99.80	0.05	0.16	16.9	13.8	10.9	16.9
2014	3,562.1775	1.8805	2.4669	3,566.5248	99.88	0.05	0.07	16.7	15.3	4.8	16.7
2015	3,686.3133	1.6479	1.9977	3,689.9589	99.90	0.04	0.05	17.3	13.4	3.9	17.3
2016	3,644.9312	1.6434	2.0586	3,648.6333	99.90	0.05	0.06	17.1	13.4	4.0	17.1
2017	2,883.9360	1.3082	1.5765	2,886.8208	99.90	0.05	0.05	13.5	10.7	3.1	13.5
2018	3,177.3538	1.4469	1.7477	3,180.5484	99.90	0.05	0.05	14.9	11.8	3.4	14.9
2019	3,120.4282	1.4026	1.6863	3,123.5171	99.90	0.04	0.05	14.6	11.4	3.3	14.6

In Table 3-16, is presented the dynamic of direct GHG emissions from category 1A1 'Energy Industries' by source (1A1a and 1A1b). The contribution of GHG emissions from 1A1b in the structure of total GHG emissions from category 1A1 is relatively low.

Table 3-16: Dynamic of direct GHG emissions from category 1A1 'Energy Industries' by sources for the period, 1990-2019, kt CO_2 equivalent

	1A1ai	1A1aii	1A1aiii	1A1b	1A1	1A1a	1A1b	1A1
1990	11,779.8626	1,966.2536	7,618.1252	NO	21,364.2413	21,364.2413	NO	21,364.2413
1991	10,512.4534	2,184.3363	6,287.3805	NO	18,984.1702	18,984.1702	NO	18,984.1702
1992	8,864.8180	1,854.7694	4,986.6686	NO	15,706.2560	15,706.2560	NO	15,706.2560
1993	7,472.5226	1,590.8395	3,615.8134	NO	12,679.1754	12,679.1754	NO	12,679.1754
1994	6,749.4514	342.9810	2,900.1276	NO	9,992.5601	9,992.5601	NO	9,992.5601
1995	4,305.3853	313.4214	2,573.6008	NO	7,192.4074	7,192.4074	NO	7,192.4074
1996	4,366.0527	444.7600	2,313.5981	NO	7,124.4109	7,124.4109	NO	7,124.4109
1997	2,817.4791	516.0840	2,292.1039	NO	5,625.6671	5,625.6671	NO	5,625.6671
1998	2,153.9727	358.2230	2,332.4821	NO	4,844.6778	4,844.6778	NO	4,844.6778
1999	1,599.4590	361.2374	1,703.9888	NO	3,664.6852	3,664.6852	NO	3,664.6852
2000	1,461.0369	385.9338	1,312.3578	NO	3,159.3286	3,159.3286	NO	3,159.3286
2001	1,782.3738	583.8622	1,315.6924	NO	3,681.9284	3,681.9284	NO	3,681.9284
2002	1,367.6781	492.8533	1,076.2639	NO	2,936.7953	2,936.7953	NO	2,936.7953
2003	1,437.8398	451.2426	1,151.2933	0.0062	3,040.3820	3,040.3758	0.0062	3,040.3820
2004	1,594.7055	474.5035	1,041.5780	1.9771	3,112.7641	3,110.7870	1.9771	3,112.7641
2005	1,531.3888	544.2083	1,157.6608	2.2281	3,235.4860	3,233.2579	2.2281	3,235.4860
2006	816.4618	525.0423	1,154.4163	1.6186	2,497.5390	2,495.9204	1.6186	2,497.5390
2007	1,367.1077	512.8196	1,013.8911	4.0096	2,897.8280	2,893.8184	4.0096	2,897.8280
2008	1,456.8539	461.3959	1,076.3596	6.5465	3,001.1558	2,994.6093	6.5465	3,001.1558
2009	2,409.4560	447.9544	982.9291	9.4077	3,849.7472	3,840.3395	9.4077	3,849.7472
2010	2,549.4779	422.8277	1,080.6652	6.6569	4,059.6277	4,052.9708	6.6569	4,059.6277
2011	2,321.6841	399.0442	1,030.0042	6.4448	3,757.1773	3,750.7325	6.4448	3,757.1773
2012	2,428.7802	381.4285	997.6368	6.7021	3,814.5475	3,807.8454	6.7021	3,814.5475
2013	2,197.4510	360.4051	1,046.1637	6.9623	3,610.9821	3,604.0198	6.9623	3,610.9821
2014	2,224.4686	356.5504	979.2832	6.2226	3,566.5248	3,560.3022	6.2226	3,566.5248
2015	2,572.6397	656.2250	455.2616	5.8327	3,689.9589	3,684.1263	5.8327	3,689.9589
2016	2,519.3827	658.7966	466.4151	4.0389	3,648.6333	3,644.5943	4.0389	3,648.6333
2017	1,902.9491	611.1327	368.8024	3.9365	2,886.8208	2,882.8842	3.9365	2,886.8208
2018	2,117.7533	670.9937	388.6986	3.1029	3,180.5484	3,177.4455	3.1029	3,180.5484
2019	2,086.5242	587.4915	448.1561	1.3453	3,123.5171	3,122.1718	1.3453	3,123.5171

Table 3-17 shows the evolution of direct and indirect GHG emission from category 1A1 'Energy Industries'. The level of direct and indirect GHG emissions in the RM from category 1A1 'Energy Industries' by 2019 reached: for CO_2 – circa 14.6 per cent of the reference year level, CH_4 – 11.4 per cent, N_2O – 3.3 per cent, NO_x – 12.6 per cent, CO – 30.1 per cent, NMVOC – 23.0 per cent and SO_2 – 0.05 per cent.

Table 3-17: Direct and indirect GHG emissions from category 1A1 'Energy Industries' between 1990-2019

	1A1, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	21,300.2929	0.4913	0.1734	39.4664	7.2099	0.6297	102.3606	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	18,927.0336	0.4230	0.1562	35.0660	6.4107	0.5515	90.5225	88.9	86.1	90.1	88.9	88.9	87.6	88.4
1992	15,660.9863	0.3579	0.1219	28.7536	5.5760	0.4762	71.2477	73.5	72.9	70.3	72.9	77.3	75.6	69.6
1993	12,640.6006	0.2823	0.1058	23.6435	4.2355	0.3687	62.2743	59.3	57.5	61.0	59.9	58.7	58.6	60.8
1994	9,961.8515	0.1888	0.0872	18.8108	3.5570	0.2847	47.1207	46.8	38.4	50.3	47.7	49.3	45.2	46.0
1995	7,174.0286	0.1370	0.0502	12.9854	3.1484	0.2369	25.5949	33.7	27.9	28.9	32.9	43.7	37.6	25.0
1996	7,107.0544	0.1353	0.0469	12.7474	3.2595	0.2422	23.4411	33.4	27.5	27.0	32.3	45.2	38.5	22.9
1997	5,615.6123	0.1108	0.0244	9.5174	3.1362	0.2233	10.5370	26.4	22.5	14.1	24.1	43.5	35.5	10.3
1998	4,836.6106	0.0962	0.0190	8.1103	2.7791	0.1972	7.9288	22.7	19.6	11.0	20.5	38.5	31.3	7.7
1999	3,660.2540	0.0727	0.0088	5.8881	2.3787	0.1638	2.1288	17.2	14.8	5.1	14.9	33.0	26.0	2.1

	1A1, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
2000	3,155.7517	0.0610	0.0069	5.0439	2.1204	0.1437	0.9753	14.8	12.4	4.0	12.8	29.4	22.8	1.0
2001	3,677.7189	0.0726	0.0080	5.8773	2.5004	0.1689	0.8801	17.3	14.8	4.6	14.9	34.7	26.8	0.9
2002	2,933.2101	0.0614	0.0069	4.6959	2.0055	0.1356	0.6884	13.8	12.5	4.0	11.9	27.8	21.5	0.7
2003	3,036.7494	0.0626	0.0069	4.8529	2.0895	0.1407	0.5251	14.3	12.7	4.0	12.3	29.0	22.3	0.5
2004	3,109.0519	0.0640	0.0071	4.9687	2.1439	0.1442	0.4936	14.6	13.0	4.1	12.6	29.7	22.9	0.5
2005	3,231.6708	0.0661	0.0073	5.1612	2.2323	0.1500	0.4532	15.2	13.5	4.2	13.1	31.0	23.8	0.4
2006	2,494.5441	0.0518	0.0057	3.9870	1.7266	0.1161	0.3443	11.7	10.5	3.3	10.1	23.9	18.4	0.3
2007	2,894.4441	0.0593	0.0064	4.6191	2.0159	0.1351	0.2335	13.6	12.1	3.7	11.7	28.0	21.5	0.2
2008	2,997.3662	0.0655	0.0072	4.7979	2.0911	0.1406	0.3428	14.1	13.3	4.2	12.2	29.0	22.3	0.3
2009	3,844.8870	0.0835	0.0093	6.1595	2.6604	0.1794	0.6695	18.1	17.0	5.4	15.6	36.9	28.5	0.7
2010	4,054.4452	0.0894	0.0099	6.4930	2.8209	0.1900	0.5660	19.0	18.2	5.7	16.5	39.1	30.2	0.6
2011	3,752.5675	0.0801	0.0087	5.9997	2.6109	0.1755	0.4345	17.6	16.3	5.0	15.2	36.2	27.9	0.4
2012	3,810.0873	0.0758	0.0086	6.0970	2.6166	0.1758	0.7051	17.9	15.4	5.0	15.4	36.3	27.9	0.7
2013	3,603.6566	0.0679	0.0189	6.2373	2.0266	0.1399	7.1687	16.9	13.8	10.9	15.8	28.1	22.2	7.0
2014	3,562.1775	0.0752	0.0083	5.7085	2.4794	0.1666	0.4461	16.7	15.3	4.8	14.5	34.4	26.5	0.4
2015	3,686.3133	0.0659	0.0067	5.8546	2.5551	0.1705	0.1241	17.3	13.4	3.9	14.8	35.4	27.1	0.1
2016	3,644.9312	0.0657	0.0069	5.7964	2.5196	0.1682	0.2330	17.1	13.4	4.0	14.7	34.9	26.7	0.2
2017	2,883.9360	0.0523	0.0053	4.5840	2.0066	0.1339	0.0467	13.5	10.7	3.1	11.6	27.8	21.3	0.0
2018	3,177.3538	0.0579	0.0059	5.0572	2.2137	0.1477	0.0567	14.9	11.8	3.4	12.8	30.7	23.5	0.1
2019	3,120.4282	0.0561	0.0057	4.9637	2.1725	0.1449	0.0468	14.6	11.4	3.3	12.6	30.1	23.0	0.0

1A1a Main Activity Electricity and Heat Production

1A1a 'Main Activity Electricity and Heat Production' is disaggregated into three other emission sources: 1A1ai 'Electricity Generation', 1A1aii 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants'. Between 1990 and 2019, total direct GHG emissions from 1A1a 'Main Activity Electricity and Heat Production' decreased from circa 21364.24 kt CO_2 equivalent to circa 3122.17 kt CO_2 equivalent (Table 3-18).

Table 3-18: Direct GHG emissions from 1A1a 'Main Activity Electricity and Heat Production' in the Republic of Moldova for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A1a, kt CO_2 equivalent	21,364.24	18,984.17	15,706.26	12,679.18	9,992.56	7,192.41	7,124.41	5,625.67	4,844.68	3,664.69
%, compared to 1990	100.0	88.9	73.5	59.3	46.8	33.7	33.3	26.3	22.7	17.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A1a, kt CO_2 equivalent	3,159.33	3,681.93	2,936.80	3,040.38	3,110.79	3,233.26	2,495.92	2,893.82	2,994.61	3,840.34
%, compared to 1990	14.8	17.2	13.7	14.2	14.6	15.1	11.7	13.5	14.0	18.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A1a, kt CO_2 equivalent	4,052.97	3,750.73	3,807.85	3,604.02	3,560.30	3,684.13	3,644.59	2,882.88	3,177.45	3,122.17
%, compared to 1990	19.0	17.6	17.8	16.9	16.7	17.2	17.1	13.5	14.9	14.6

CO_2 emissions had the largest share in the total structure of direct GHG emissions from 1A1a 'Main Activity Electricity and Heat Production' between 1990 and 2019 (Table 3-19).

Table 3-19: Direct GHG emissions from 1A1a 'Main Activity Electricity and Heat Production' for the period 1990-2019 and the share of each gas in the total structure of GHG emissions

	1A1a, kt CO_2 equivalent				% of total			%, compared to 1990			
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
1990	21,300.2929	12.2813	51.6671	21,364.2413	99.70	0.06	0.24	100.0	100.0	100.0	100.0
1991	18,927.0336	10.5744	46.5622	18,984.1702	99.70	0.06	0.25	88.9	86.1	90.1	88.9
1992	15,660.9863	8.9470	36.3227	15,706.2560	99.71	0.06	0.23	73.5	72.9	70.3	73.5
1993	12,640.6006	7.0580	31.5167	12,679.1754	99.70	0.06	0.25	59.3	57.5	61.0	59.3
1994	9,961.8515	4.7207	25.9879	9,992.5601	99.69	0.05	0.26	46.8	38.4	50.3	46.8
1995	7,174.0286	3.4249	14.9539	7,192.4074	99.74	0.05	0.21	33.7	27.9	28.9	33.7
1996	7,107.0544	3.3821	13.9743	7,124.4109	99.76	0.05	0.20	33.4	27.5	27.0	33.3
1997	5,615.6123	2.7692	7.2856	5,625.6671	99.82	0.05	0.13	26.4	22.5	14.1	26.3
1998	4,836.6106	2.4047	5.6624	4,844.6778	99.83	0.05	0.12	22.7	19.6	11.0	22.7
1999	3,660.2540	1.8165	2.6146	3,664.6852	99.88	0.05	0.07	17.2	14.8	5.1	17.2
2000	3,155.7517	1.5249	2.0520	3,159.3286	99.89	0.05	0.06	14.8	12.4	4.0	14.8
2001	3,677.7189	1.8154	2.3940	3,681.9284	99.89	0.05	0.07	17.3	14.8	4.6	17.2
2002	2,933.2101	1.5342	2.0510	2,936.7953	99.88	0.05	0.07	13.8	12.5	4.0	13.7
2003	3,036.7432	1.5649	2.0677	3,040.3758	99.88	0.05	0.07	14.3	12.7	4.0	14.2
2004	3,107.0816	1.5984	2.1069	3,110.7870	99.88	0.05	0.07	14.6	13.0	4.1	14.6
2005	3,229.4503	1.6505	2.1572	3,233.2579	99.88	0.05	0.07	15.2	13.4	4.2	15.1
2006	2,492.9310	1.2935	1.6959	2,495.9204	99.88	0.05	0.07	11.7	10.5	3.3	11.7
2007	2,890.4481	1.4797	1.8906	2,893.8184	99.88	0.05	0.07	13.6	12.0	3.7	13.5

	1A1a, kt CO_2 equivalent				% of total			%, compared to 1990			
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
2008	2,990.8419	1.6305	2.1369	2,994.6093	99.87	0.05	0.07	14.0	13.3	4.1	14.0
2009	3,835.5110	2.0776	2.7509	3,840.3395	99.87	0.05	0.07	18.0	16.9	5.3	18.0
2010	4,047.8107	2.2279	2.9322	4,052.9708	99.87	0.05	0.07	19.0	18.1	5.7	19.0
2011	3,746.1444	1.9971	2.5910	3,750.7325	99.88	0.05	0.07	17.6	16.3	5.0	17.6
2012	3,803.4077	1.8878	2.5499	3,807.8454	99.88	0.05	0.07	17.9	15.4	4.9	17.8
2013	3,596.7176	1.6916	5.6106	3,604.0198	99.80	0.05	0.16	16.9	13.8	10.9	16.9
2014	3,555.9756	1.8743	2.4523	3,560.3022	99.88	0.05	0.07	16.7	15.3	4.7	16.7
2015	3,680.5003	1.6421	1.9838	3,684.1263	99.90	0.04	0.05	17.3	13.4	3.8	17.2
2016	3,640.9061	1.6393	2.0490	3,644.5943	99.90	0.04	0.06	17.1	13.3	4.0	17.1
2017	2,880.0130	1.3042	1.5670	2,882.8842	99.90	0.05	0.05	13.5	10.6	3.0	13.5
2018	3,174.2616	1.4438	1.7402	3,177.4455	99.90	0.05	0.05	14.9	11.8	3.4	14.9
2019	3,119.0875	1.4012	1.6830	3,122.1718	99.90	0.04	0.05	14.6	11.4	3.3	14.6

In Table 3-20 and Figure 3-8 is presented the evolution of direct GHG emissions from 1A1a 'Main Activity Electricity and Heat Production' by sources for the period 1990-2019.

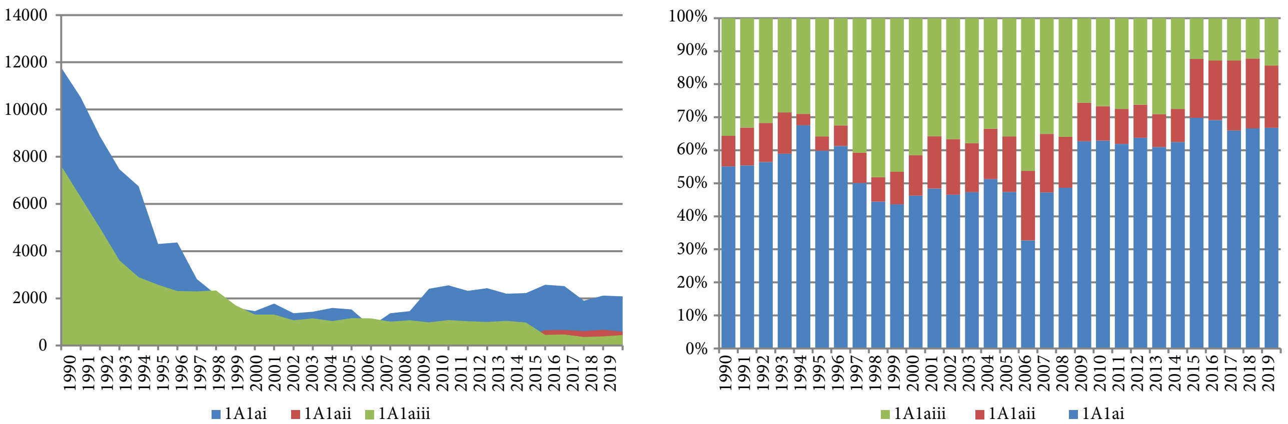

Figure 3-8: GHG emissions by source from category 1A1a 'Main Activity Electricity and Heat Production' for the period 1990-2019, kt CO2 equivalent.

Table 3-20: Direct GHG emissions from category 1A1a 'Main Activity Electricity and Heat Production' by source for the period 1990-2019, kt CO_2 equivalent

	1A1a, kt CO_2 equivalent				% of total		
	1A1ai	1A1aii	1A1aiii	1A1a	1A1ai	1A1aii	1A1aiii
1990	11,779.8626	1,966.2536	7,618.1252	21,364.2413	55.14	9.20	35.66
1991	10,512.4534	2,184.3363	6,287.3805	18,984.1702	55.37	11.51	33.12
1992	8,864.8180	1,854.7694	4,986.6686	15,706.2560	56.44	11.81	31.75
1993	7,472.5226	1,590.8395	3,615.8134	12,679.1754	58.94	12.55	28.52
1994	6,749.4514	342.9810	2,900.1276	9,992.5601	67.54	3.43	29.02
1995	4,305.3853	313.4214	2,573.6008	7,192.4074	59.86	4.36	35.78
1996	4,366.0527	444.7600	2,313.5981	7,124.4109	61.28	6.24	32.47
1997	2,817.4791	516.0840	2,292.1039	5,625.6671	50.08	9.17	40.74
1998	2,153.9727	358.2230	2,332.4821	4,844.6778	44.46	7.39	48.15
1999	1,599.4590	361.2374	1,703.9888	3,664.6852	43.65	9.86	46.50
2000	1,461.0369	385.9338	1,312.3578	3,159.3286	46.25	12.22	41.54
2001	1,782.3738	583.8622	1,315.6924	3,681.9284	48.41	15.86	35.73
2002	1,367.6781	492.8533	1,076.2639	2,936.7953	46.57	16.78	36.65
2003	1,437.8398	451.2426	1,151.2933	3,040.3758	47.29	14.84	37.87
2004	1,594.7055	474.5035	1,041.5780	3,110.7870	51.26	15.25	33.48
2005	1,531.3888	544.2083	1,157.6608	3,233.2579	47.36	16.83	35.80
2006	816.4618	525.0423	1,154.4163	2,495.9204	32.71	21.04	46.25
2007	1,367.1077	512.8196	1,013.8911	2,893.8184	47.24	17.72	35.04
2008	1,456.8539	461.3959	1,076.3596	2,994.6093	48.65	15.41	35.94
2009	2,409.4560	447.9544	982.9291	3,840.3395	62.74	11.66	25.59
2010	2,549.4779	422.8277	1,080.6652	4,052.9708	62.90	10.43	26.66
2011	2,321.6841	399.0442	1,030.0042	3,750.7325	61.90	10.64	27.46
2012	2,428.7802	381.4285	997.6368	3,807.8454	63.78	10.02	26.20
2013	2,197.4510	360.4051	1,046.1637	3,604.0198	60.97	10.00	29.03
2014	2,224.4686	356.5504	979.2832	3,560.3022	62.48	10.01	27.51
2015	2,572.6397	656.2250	455.2616	3,684.1263	69.83	17.81	12.36
2016	2,519.3827	658.7966	466.4151	3,644.5943	69.13	18.08	12.80
2017	1,902.9491	611.1327	368.8024	2,882.8842	66.01	21.20	12.79
2018	2,117.7533	670.9937	388.6986	3,177.4455	66.65	21.12	12.23
2019	2,086.5242	587.4915	448.1561	3,122.1718	66.83	18.82	14.35

1A1ai Electricity Generation

In the Republic of Moldova, electricity generation capacity includes: Moldavian Thermal Power Plant (MTPP) in Dnestrovsk (on the left bank of the Dniester River) with an installed capacity of 2,520 MW, built between 1964-1982, and other Power Plants, including CHPs owned by sugar plants.

In recent years, renewable energy sources of small power capacity are developed. Their total capacity in 2019 represented circa 41.8 MW, while in 2016 – circa 6.9 MW[52]. Out of the total energy produced from renewable sources, the largest share is electric power generated from wind power (55%).

The Moldavian Thermal Power Plant (MTPP) in Dnestrovsk has an installed capacity of 2520 MW, equipped with eight energy groups on coal, with an electric power of 200 MW, in service from 1964-1971, 2 energy groups on residual fuel oil and natural gas with an electric power of 210 MW (in service since 1973-1974) and two energy groups on natural gas, operating on gas-steam combined cycle, with an installed capacity of 250 MW each (in service since 1980).

The MTPP can operate on coal, residual fuel oil and natural gas. Currently, the main fuel type is represented by natural gas with a volume that varied from circa 1,206.6 million m^3 (1990) to 1,095.5 million m^3 (2019). Consumption of other two types of fuel (residual fuel oil and coal) varied significantly.

To be noted that official statistical data on residual fuel oil and coal consumption within the MTTP are available only for 1990-1998 and 2008-2019. AD are published in natural values; in order to convert it into energy values the following conversion factors were used: for coal – 25.44 TJ/kt, for residual fuel oil – 40.2 TJ/kt, for natural gas – 33.86 TJ/million.m^3, (Table 3-9).

Data regarding fuel consumption for electricity generation in the Republic of Moldova for the period 1990-2019 is presented in Table 3-21.

Table 3-21: Fuel consumption for electricity generation for the period 1990-2019

	Bituminous Coal, TJ	Diesel Oil, TJ	Residual Fuel Oil, TJ	Natural Gas, TJ	Biogas, TJ
1990	64,643	NO	43,010	40,855	NO
1991	61,539	NO	30,484	40,862	NO
1992	44,774	NO	27,855	43,541	NO
1993	41,900	NO	24,422	28,361	NO
1994	42,907	NO	9,166	34,876	NO
1995	22,461	NO	1,049	37,192	NO
1996	20,513	NO	949	41,709	NO
1997	7,171	NO	243	37,696	NO
1998	4,641	NO	1,082	29,004	NO
1999	NO	NO	NO	28,483	NO
2000	NO	NO	NO	26,018	NO
2001	NO	NO	NO	31,740	NO
2002	NO	NO	NO	24,355	NO
2003	NO	NO	NO	25,605	NO
2004	NO	NO	NO	28,398	NO
2005	NO	NO	NO	27,271	NO
2006	NO	NO	NO	14,539	NO
2007	NO	NO	NO	24,345	NO
2008	NO	NO	NO	25,944	NO
2009	NO	NO	NO	42,907	NO
2010	NO	21	NO	45,373	NO
2011	NO	19	NO	41,319	NO
2012	335	10	103	42,528	NO
2013	7,942	10	74	25,571	10
2014	67	9	59	39,406	18
2015	50	6	55	45,644	14
2016	188	8	80	44,425	2
2017	NO	11	27	33,835	84
2018	11	8	34	37,636	150
2019	19	8	15	37,094	126

Source: Energy Balances of the RM 1990-2019; for MTPP: natural gas – JSC "Moldovagaz"; residual fuel oil – for the period 1990-1998: NC1 of the RM under UNFCCC (2000), for the period 2012-2019: Press Releases of MTTP in Dnestrovsk (<www.moldgres.com>).

Figure 3-9 and Table 3-22 show data on fuel consumption (in TJ) by type for electricity generation within 1A1ai 'Electricity Generation', and their share (in %) in the structure of total fuel consumption, respectively.

[52] Annual Activity Report, National Agency for Energy Regulation, 2019, p. 26.

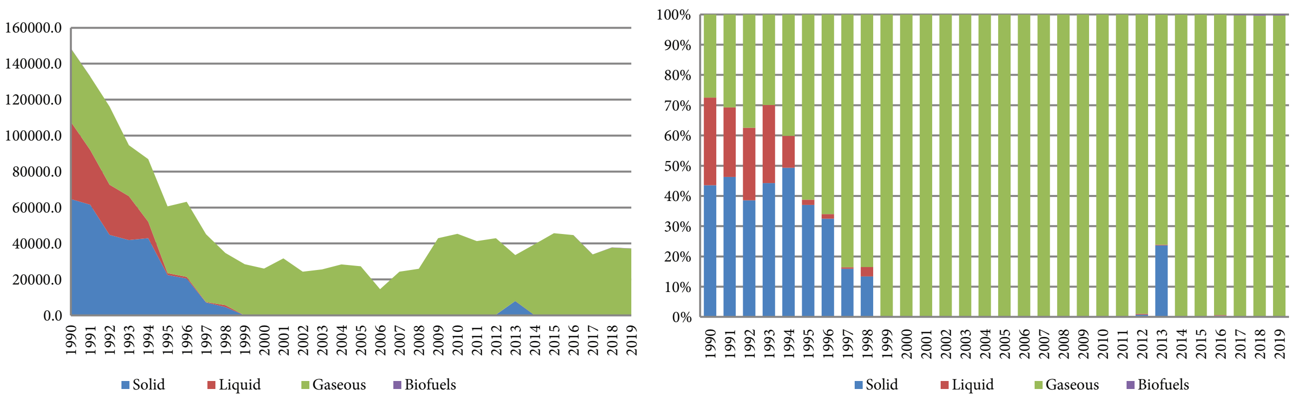

Figure 3-9: Fuel consumption by type for electricity generation within 1A1ai 'Electricity Generation', TJ.

For the year 2013, coal consumption at MTPP constituted 23 per cent of the total amount of fuels utilised, which has contributed to the increase in their share that year.

Table 3-22: Fuel consumption by category for electricity generation within 1A1ai 'Electricity Generation' and their share in the total consumption structure

	1A1ai, TJ					1A1ai, % of total			
	Solid	Liquid	Gaseous	Biofuels	Total	Solid	Liquid	Gaseous	Biofuels
1990	64,643	43,010	40,855	NO	148,508	43.5	29.0	27.5	NO
1991	61,539	30,484	40,862	NO	132,885	46.3	22.9	30.8	NO
1992	44,774	27,855	43,541	NO	116,170	38.5	24.0	37.5	NO
1993	41,900	24,422	28,361	NO	94,682	44.3	25.8	30.0	NO
1994	42,907	9,166	34,876	NO	86,949	49.3	10.5	40.1	NO
1995	22,461	1,049	37,192	NO	60,702	37.0	1.7	61.3	NO
1996	20,513	949	41,709	NO	63,171	32.5	1.5	66.0	NO
1997	7,171	243	37,696	NO	45,111	15.9	0.5	83.6	NO
1998	4,641	1,082	29,004	NO	34,727	13.4	3.1	83.5	NO
1999	NO	NO	28,483	NO	28,483	NO	NO	100.0	NO
2000	NO	NO	26,018	NO	26,018	NO	NO	100.0	NO
2001	NO	NO	31,740	NO	31,740	NO	NO	100.0	NO
2002	NO	NO	24,355	NO	24,355	NO	NO	100.0	NO
2003	NO	NO	25,605	NO	25,605	NO	NO	100.0	NO
2004	NO	NO	28,398	NO	28,398	NO	NO	100.0	NO
2005	NO	NO	27,271	NO	27,271	NO	NO	100.0	NO
2006	NO	NO	14,539	NO	14,539	NO	NO	100.0	NO
2007	NO	NO	24,345	NO	24,345	NO	NO	100.0	NO
2008	NO	NO	25,944	NO	25,944	NO	NO	100.0	NO
2009	NO	NO	42,907	NO	42,907	NO	NO	100.0	NO
2010	NO	21	45,373	NO	45,394	NO	0.0	100.0	NO
2011	NO	19	41,319	NO	41,338	NO	0.0	100.0	NO
2012	335	113	42,528	NO	42,977	0.8	0.3	99.0	NO
2013	7,942	84	25,571	10	33,606	23.6	0.2	76.1	0.0
2014	67	68	39,406	18	39,559	0.2	0.2	99.6	0.0
2015	50	61	45,644	14	45,770	0.1	0.1	99.7	0.0
2016	188	88	44,425	2	44,703	0.4	0.2	99.4	0.0
2017	*NO*	38	33,835	84	33,958	NO	0.1	99.6	0.2
2018	11	42	37,636	150	37,839	0.0	0.1	99.5	0.4
2019	19	23	37,094	126	37,261	0.0	0.1	99.6	0.3

1A1aii 'Combined Heat and Power Generation'

On the RBDR there are 3 Combined Heat and Power (CHP) Plants: in Chisinau municipality the CHP-1 and the CHP-2, and in Balti municipality: the CHP-North. Also, there are some small power plants with cogeneration at sugar plants. Total electricity generation on the RBDR on 2019 constituted circa 0.893 billion kWh (Table 3-23).

Table 3-23: Electricity generation, import and consumption for the period 2004-2019, million kWh

	2004	2005	2006	2007	2008	2009	2010	2011
Electricity generation	952	1 127	1 080	1 051	985	970	972	933
Electricity import	1 836	1 600	2 881	2 931	2 961	2 941	2 662	3 142
Electricity consumption	3 455	3 686	3 871	4 030	4 065	3 979	4 106	4 161
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Electricity generation	890	849	889	934	897	885	931	893
Electricity import	3 279	3 244	3 341	3 322	3 322	3 458	3 920	3 464
Electricity consumption	4 211	4 236	4 305	4 256	4 219	4 343	4 852	4 356

Source: for the period 2004-2014: SOE "Moldelectrica"; for the period 2015-2019: www.statbank.md.

In the context of the recent upward trend in electricity consumption, this is a negative factor, including from the energy security point of view. More detailed information on fuel consumption, electricity and heat generation from the three CHPs in the Republic of Moldova (CHP-1 and CHP-2 in Chisinau, respectively CHP-North in Balti) is presented in Table 3-24.

Table 3-24: Fuel consumption, electricity and heat generation at the CHPs in the Republic of Moldova for the period 1990-2019

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CHP-1	Residual Fuel Oil, kt	13.4	26.1	14.2	14.0	6.2	4.7	8.5	3.7	4.6	4.1
	Natural Gas, million m^3	271.2	290.0	245.8	184.2	161.0	137.6	118.6	113.4	135.2	73.0
	Electricity, million kWh	207.5	207.0	196.3	150.2	136.5	106.4	114.6	93.2	138.6	115.0
	Heat, thousands Gcal	2 249.2	2 618.7	2 178.1	1 023.7	1 308.5	1 035.1	1 006.3	882.1	1 045.9	448.3
CHP-2	Residual Fuel Oil, kt	76.4	135.9	164.9	120.4	53.1	57.3	67.5	49.9	34.3	22.3
	Natural Gas, million m^3	486.1	419.0	337.1	318.4	315.2	270.7	323.2	386.5	313.5	312.2
	Electricity, million kWh	1 150.0	951.4	923.4	883.4	751.2	670.9	838.8	896.2	723.3	801.0
	Heat, thousands Gcal	2 544.7	2 775.8	2 577.6	2 021.6	1 631.6	1 518.2	1 515.0	1 524.6	1 296.0	1 286.5
CHP-North	Residual Fuel Oil, kt	40.0	35.0	31.9	19.6	3.8	8.1	1.4	1.1	6.8	10.1
	Natural Gas, million m^3	15.7	87.6	136.3	102.0	98.5	86.9	107.2	93.6	70.1	39.3
	Electricity, million kWh	121.0	100.0	102.0	75.0	87.0	81.0	100.0	96.0	75.0	50.7
	Heat, thousands Gcal	1 360.0	1 450.0	1 144.0	834.0	625.0	596.0	642.0	500.0	416.0	247.0
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
CHP-1	Residual Fuel Oil, kt	1.2	0.4	0.0	0.1	0.1	0.9	0.0	0.0	0.0	1.2
	Natural Gas, million m^3	65.2	82.3	85.7	81.3	76.3	84.8	83.5	81.1	78.3	70.0
	Electricity, million kWh	100.8	138.5	142.1	138.8	136.5	154.9	148.0	151.9	140.3	135.6
	Heat, thousands Gcal	387.4	408.8	386.3	405.9	335.6	375.6	378.8	329.1	319.6	271.9
CHP-2	Residual Fuel Oil, kt	3.7	3.1	1.2	1.9	0.0	2.9	0.0	0.0	0.0	9.6
	Natural Gas, million m^3	267.4	365.1	313.0	286.0	278.9	326.8	316.3	308.5	294.8	284.6
	Electricity, million kWh	658.1	942.2	804.7	741.9	714.3	854.4	818.4	805.4	755.3	754.6
	Heat, thousands Gcal	947.0	1 068.4	1 069.2	1 018.6	885.7	1 198.1	1 204.2	1 159.3	1 153.8	1 126.8
CHP-North	Residual Fuel Oil, kt	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
	Natural Gas, million m^3	25.0	40.5	38.0	44.6	41.6	44.3	44.4	38.0	37.8	38.0
	Electricity, million kWh	27.3	44.4	40.6	52.5	57.7	67.8	74.7	67.7	67.4	66.5
	Heat, thousands Gcal	125.7	206.1	198.5	246.0	229.6	232.6	222.7	193.5	199.1	205.8
		2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
CHP-1	Residual Fuel Oil, kt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural Gas, million m^3	51.2	40.3	33.8	33.1	35.9	25.6	24.5	23.9	26.2	19.1
	Electricity, million kWh	94.9	70.2	56.7	59.5	67.4	47.2	43.9	32.4	35.7	25.6
	Heat, thousands Gcal	245.4	203.5	184.6	170.9	167.8	195.3	186.0	181.2	199.7	144.6
CHP-2	Residual Fuel Oil, kt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural Gas, million m^3	304.2	295.3	288.9	267.2	268.7	274.7	275.6	266.7	280.3	260.5
	Electricity, million kWh	782.4	765.2	742.9	649.8	702.3	731.6	708.3	692.8	725.2	681.8
	Heat, thousands Gcal	1 193.4	1 166.0	1 135.7	1 047.5	1 049.7	1 095.8	2 101.3	1110.2	1156.7	1081.6
CHP-North	Residual Fuel Oil, kt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coal, t	0.0	0.0	0.0	0.0	0.0	0.0	0.0	182.6	129.1	27.3
	Pellets, t	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	91.2	160.2
	Natural Gas, million m^3	41.5	39.1	38.9	33.5	34.4	36.0	37.1	34.52	38.03	33.9
	Electricity, million kWh	70.0	69.9	66.3	60.2	61.5	66.6	67.5	-	-	19.2
	Heat, thousands Gcal	227.5	225.9	227.7	253.9	259.9	275.5	285.2	265.2	595.2	237.1

Source: SOE "Termoelectrica" through Letter No. 79/3114 of 26.05.2016 answer to Letter No. 512/2016-05-01 of 10.05.2016, contains information for the year 2015; Subdivision "Termoservice" of JSC CHP-2 through Letter No. 79/823 of 19.02.2015, answer to Letter No. 497/2015-01-11 of 31.01.2015, contains information for the period 2010-2014; CHP-1 though Letter No. 01-11/6-56 of 22.02.2011 answer to Letter No.03-07/175 of 02.02.2011, contains information for the period 2000-2010; Letter No. 01-11/6-10 of 13.01.2014 answer to Letter No. 320/2014-01-01 of 03.01.2014, contains information for the period 2011-2012; Letter No. 18/215 of 16.02.2015 answer to Letter No. 408/2015-01-10 of 31.01.2015, contains information for the period 2010-2014; Letter from 02.03.2020 answer to Letter No. 08-310/1 of 11.02.2020, contains information for the period 2017-2019; CHP-2 through Letter No. 43/195 of 14.02.2011 answer to Letter No. 03-07/175 of 02.02.2011, contains information for the period 2000-2010; Letter No. 18/37 of 13.01.2014 answer to Letter No. 320/2014-01-01 of 03.01.2014, contains information for the period 2011-2012; Letter No. 18/188 of 10.02.2015 answer to Letter No. 408/2015-01-10 of 31.01.2015, contains information for the period 2010-2014; Letter from 02.03.2020 answer to Letter No. 08-310/1 of 11.02.2020, contains information for the period 2017-2019; CHP-North through Letter No. 04/14-119 of 28.02.2011 answer to Letter No. 03-07/175 of 02.02.2011, contains information for the period 2000-2010; Letter No. 04-14/34 of 22.01.2014 answer to Letter No. 320/2014-01-01 of 03.01.2014, contains information for the period 2011-2012; Letter No. 04-14/71 of 06.02.2015 answer to Letter No. 497/2015-01-11 of 31.01.2015, contains information for the period 2010-2014; Letter No. 04-14/316 of 17.05.2016 answer to Letter No. 512/2016-05-01 of 10.05.2016, contains information for the year 2015; Letter No. 79/68 of 18.01.18 answer to Letter from 22.12.2017; Letter No. 221/333 of 24.02.2020 answer to Letter No. 08-310/1 of 11.02.2020, contains information for 2017-2019 years.

More information on fuel consumption from the CHPs in the RM is presented in Table 3-25.

Table 3-25: Fuel consumption by type of fuels for the combined heat and power generation within the 1990-2019 period, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Anthracite	NO	NO	NO	129	NO	NO	NO	NO	NO	NO
Diesel Oil	43	2127	1276	12	NO	29	29	29	29	59
Residual Fuel Oil	5215	7918	8482	6189	1086	1144	1350	1144	851	352
Natural Gas	27774	25133	19610	19528	4606	3961	6015	7570	5164	5868

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel Oil	29	29	NO	NO	11	21	17	12	16	18
Residual Fuel Oil	147	235	88	88	61	116	35	14	40	309
Natural Gas	6631	10034	8655	7914	8351	9503	9279	9097	8140	7526
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Anthracite	NO	NO	NO	NO	NO	NO	5	NO	NO	NO
Diesel Oil	20	19	10	10	9	NO	NO	NO	NO	NO
Residual Fuel Oil	105	94	58	57	64	NO	NO	NO	NO	NO
Natural Gas	7358	6951	6699	6326	6249	11686	11723	10883	11949	10462

Note: for the period 1990-1993, AD represent aggregated data on fuel consumption within subcategories 1A1ai and 1A1aiii; for 1990-1992, AD available only in natural units were converted to energy units by applying heat values accepted in the current inventory cycle; for 1993-2019, AD in energy units were taken directly from the Energy Balances of the RM.

Information on fuel consumption by type of fuel (solid, liquid, gaseous and biofuels) at CHPs is presented in Table 3-26 and Figure 3-10.

Table 3-26: Fuel consumption by type of fuel at the CHPs within 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Solid Fuels	NO	NO	NO	129	NO	NO	NO	NO	NO	NO
Liquid Fuels	5,257	10,045	9,759	6,201	1,086	1,173	1,379	1,173	880	411
Gaseous Fuels	27,374	24,795	19,346	19,265	4,606	3,961	6,015	7,570	5,164	5,868
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Liquid Fuels	176	264	88	88	72	137	52	26	56	327
Gaseous Fuels	6,631	10,034	8,655	7,914	8,351	9,503	9,279	9,097	8,140	7,526
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Solid Fuels	NO	NO	NO	NO	NO	NO	5	NO	NO	NO
Liquid Fuels	125	113	68	67	73	NO	NO	NO	NO	NO
Gaseous Fuels	7,358	6,951	6,699	6,326	6,249	11,686	11,723	10,883	11,949	10,462

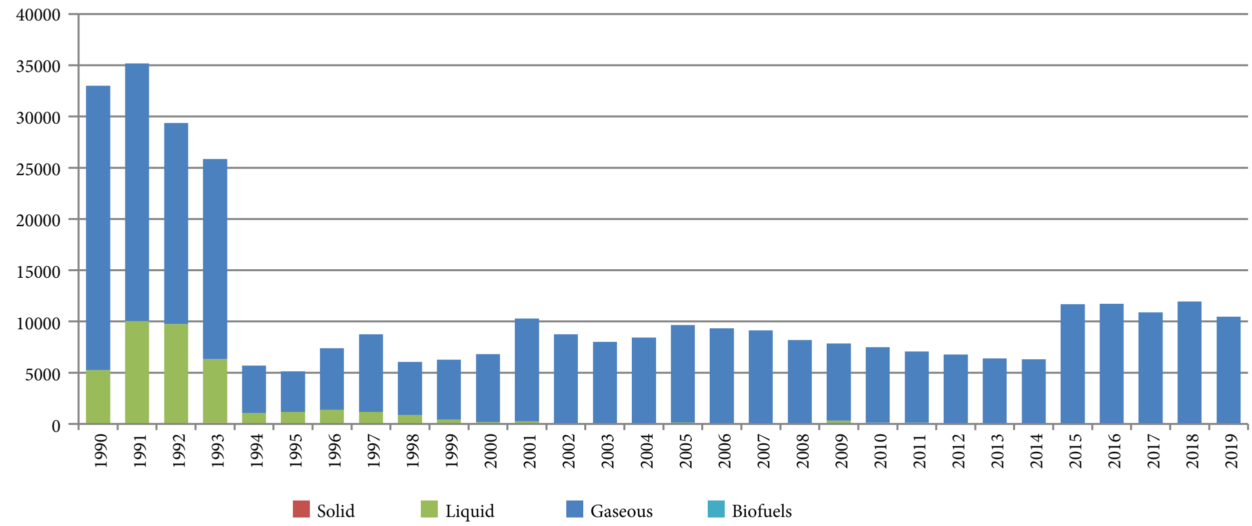

Figure 3-10: Fuel consumption by type of fuel at CHPs for the period 1990-2019, TJ.

1A1aiii 'Heat Plants'

There are many heat plants (HPs) in the Republic of Moldova, mainly operating on natural gases and residual fuel oil, and fewer on coal and biomass. Information regarding the amount of fuel consumption is accounted in the Energy Balances of the Republic of Moldova. AD on fuel consumption for heat generation on the Left Bank of Dniester River are provided by JSC "Moldovagaz". These were considered as the difference between total fuel consumption in the energy sector of the ATULBD and fuel consumption at MTTP in Dnestrovsk. AD is available in natural units (million m^3), being converted in energy units (TJ) by applying the conversion factor (33.86 TJ/million m^3). AD on fuel consumption (including in energy units) regarding fuel consumption for heat generation on the RBDR is available in the Energy Balances of the Republic of Moldova (see rubric 'Heat Production'.

The table below presents aggregated AD on fuel consumption for heat production in the Republic of Moldova (Table 3-27).

Table 3-27: Fuel consumption for heat production for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Anthracite	NO	NO	NO	373	176	117	29	29	29	NO
Brown Coal (lignite)	35	NO	NO	202	59	29	29	29	29	NO
Other types of Bituminous Coal	3,384	2,732	2,081	1,418	675	441	499	411	323	176
Diesel Oil	2,595	1,811	1,028	244	293	323	205	147	59	29
Kerosene for Oven	43	NO	NO	100	59	NO	29	29	59	59
Residual Fuel Oil	45,426	37,564	29,703	21,841	12,176	11,208	10,034	7,130	5,663	3,609
Natural Gas	63,508	52,995	42,844	30,273	32,780	28,896	26,065	29,925	32,900	24,941
Liquefied Petroleum Gases	46	NO	NO	35	NO	NO	NO	NO	NO	NO
Fuel Wood	9	NO	NO	6	NO	NO	NO	NO	NO	NO
Wood Waste	59	NO	NO	50	147	88	NO	59	29	29
Agricultural Residues	NO	NO	NO	NO	NO	NO	88	NO	NO	NO
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anthracite	NO	NO	59	59	59	81	44	39	71	113
Other types of Bituminous Coal	117	88	29	58	78	42	56	26	28	9
Diesel Oil	59	29	59	88	75	73	42	21	22	31
Kerosene for Oven	59	29	29	29	15	NO	NO	NO	NO	3
Residual Fuel Oil	1,584	1,350	1,115	733	637	523	439	268	372	679
Natural Gas	20,826	21,301	17,348	19,125	17,299	19,563	19,706	17,531	18,436	16,283
Liquefied Petroleum Gases	NO	29	NO	NO	5	9	8	4	3	7
Fuel Wood	NO	NO	NO	NO	3	3	2	NO	1	1
Wood Waste	59	147	NO	29	16	16	1	1	1	2
Agricultural Residues	NO	NO	235	205	226	226	214	239	373	435
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Anthracite	91	61	67	264	52	NO	NO	5	3	NO
Other types of Bituminous Coal	5	8	7	64	28	NO	NO	NO	NO	NO
Diesel Oil	28	19	18	33	20	NO	NO	NO	NO	NO
Kerosene for Oven	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	745	544	460	528	408	NO	NO	NO	NO	NO
Natural Gas	NO	NO	17	1	NO	NO	NO	NO	NO	NO
Liquefied Petroleum Gases	17,990	17,429	16,946	17,273	16,697	8,107	8,305	6,558	6,916	7,980
Fuel Wood	1	1	NO	NO	NO	NO	NO	NO	NO	NO
Wood Waste	2	1	1	37	29	NO	NO	NO	NO	NO
Agricultural Residues	2	1	3	3	5	NO	NO	NO	NO	NO
Other types of Bituminous Coal	514	399	226	229	321	NO	NO	NO	NO	NO
Pellets and briquettes from vegetable waste	NO	NO	NO	NO	NO	NO	22	23	32	10
Biogas	NO	NO	NO	7	99	NO	NO	NO	NO	NO

Fuel consumption by type for heat production between 1990 and 2019 is presented in Table 3-28.

Table 3-28: Fuel consumption by type of fuel for heat production within 1990-2019 periods

	Fuel consumption by category, TJ					%, compared to 1990				
	Coal	Petroleum Products	Natural Gases	Biofuels	Total	Coal	Petroleum Products	Natural Gases	Biofuels	Total
1990	3,419	48,064	63,554	68	115,105	100	100	100	100	100
1991	2,732	39,376	52,995	NA	95,103	80	82	83	NA	82
1992	2,081	30,730	42,844	NA	75,655	61	64	67	NA	64
1993	1,993	22,185	30,308	56	54,542	58	46	48	82	46
1994	910	12,528	32,780	147	46,365	27	26	52	216	34
1995	587	11,531	28,896	88	41,102	17	24	45	129	33
1996	557	10,268	26,065	88	36,978	16	21	41	129	32
1997	469	7,306	29,925	59	37,759	14	15	47	87	30
1998	381	5,781	32,900	29	39,091	11	12	52	43	29
1999	176	3,697	24,941	29	28,843	5	8	39	43	21
2000	117	1,702	20,826	59	22,704	3	4	33	87	13
2001	88	1,408	21,330	147	22,973	3	3	34	216	13
2002	88	1,203	17,348	235	18,874	3	3	27	346	13
2003	117	850	19,125	234	20,326	3	2	30	344	13
2004	137	727	17,304	245	18,413	4	2	27	360	12
2005	123	596	19,572	245	20,536	4	1	31	360	14
2006	100	481	19,714	217	20,512	3	1	31	319	13
2007	65	289	17,535	240	18,129	2	1	28	353	11
2008	99	394	18,439	375	19,307	3	1	29	551	12
2009	122	713	16,290	438	17,563	4	1	26	644	10
2010	96	773	17,991	518	19,378	3	2	28	762	11
2011	69	563	17,430	401	18,463	2	1	27	590	10
2012	74	495	16,946	230	17,745	2	1	27	338	10
2013	328	562	17,273	276	18,439	10	1	27	406	11
2014	80	428	16,697	454	17,659	2	1	26	668	10
2015	NA	NA	8,107	NA	8,107	NA	NA	13	NA	1
2016	NA	NA	8,305	22	8,327	NA	NA	13	32	2

	Fuel consumption by category, TJ					%, compared to 1990				
	Coal	Petroleum Products	Natural Gases	Biofuels	Total	Coal	Petroleum Products	Natural Gases	Biofuels	Total
2017	5	NA	6,558	23	6,586	0	NA	10	34	2
2018	3	NA	6,916	32	6,951	0	NA	11	47	2
2019	NA	NA	7,980	10	7,990	NA	NA	13	15	2

In recent years, the largest share in the structure of total fuel consumption for heat generation was represented by natural gas (Figure 3-11).

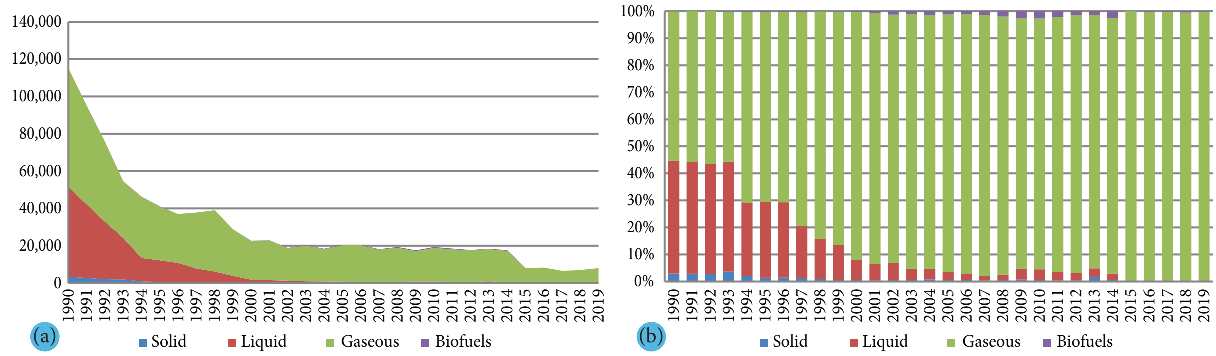

Figure 3-11: Fuel consumption within 1A1aiii Heat Plants, where: (a) Fuel consumption by type of fuel, TJ; and (b) Fuel consumption by type of fuel, in % of the total.

Fuel consumption by sources within the 1A1a 'Main Activity Electricity and Heat Production'

Fuel consumption by sources within 1A1a 'Main Activity Electricity and Heat Production', as well as the share of each source are presented in Table 3-29.

Table 3-29: Fuel consumption (TJ) by source within 1A1a 'Main Activity Electricity and Heat Production' and the share of each source (%) in the structure of total emissions within 1990-2019

	Fuel consumption by source, TJ				Share, % of total		
	1A1ai	1A1aii	1A1aiii	1A1a	1A1ai	1A1aii	1A1aiii
1990	148,508.5	33,004.6	115,104.7	296,617.8	50.1	11.1	38.8
1991	132,885.3	35,177.7	95,102.9	263,165.9	50.5	13.4	36.1
1992	116,169.6	29,368.5	75,655.4	221,193.4	52.5	13.3	34.2
1993	94,682.3	25,858.2	54,541.5	175,082.0	54.1	14.8	31.2
1994	86,948.5	5,692.0	46,364.8	139,005.3	62.6	4.1	33.4
1995	60,702.0	5,134.0	41,101.9	106,937.9	56.8	4.8	38.4
1996	63,170.7	7,394.0	36,977.8	107,542.5	58.7	6.9	34.4
1997	45,110.6	8,743.0	37,758.7	91,612.3	49.2	9.5	41.2
1998	34,727.3	6,044.0	39,091.4	79,862.7	43.5	7.6	48.9
1999	28,483.0	6,279.0	28,842.6	63,604.6	44.8	9.9	45.3
2000	26,018.0	6,807.0	22,703.9	55,528.9	46.9	12.3	40.9
2001	31,740.4	10,298.0	22,972.5	65,010.9	48.8	15.8	35.3
2002	24,355.5	8,743.0	18,873.8	51,972.3	46.9	16.8	36.3
2003	25,604.9	8,002.0	20,325.7	53,932.6	47.5	14.8	37.7
2004	28,398.4	8,423.0	18,412.9	55,234.3	51.4	15.2	33.3
2005	27,270.8	9,640.0	20,536.5	57,447.3	47.5	16.8	35.7
2006	14,539.5	9,331.0	20,512.4	44,382.8	32.8	21.0	46.2
2007	24,345.3	9,123.0	18,129.5	51,597.8	47.2	17.7	35.1
2008	25,943.5	8,196.0	19,306.5	53,446.1	48.5	15.3	36.1
2009	42,907.4	7,853.0	17,563.0	68,323.4	62.8	11.5	25.7
2010	45,394.1	7,483.0	19,377.5	72,254.6	62.8	10.4	26.8
2011	41,338.2	7,064.0	18,463.0	66,865.2	61.8	10.6	27.6
2012	42,976.6	6,767.0	17,745.0	67,488.5	63.7	10.0	26.3
2013	33,606.4	6,393.0	18,438.8	58,438.3	57.5	10.9	31.6
2014	39,559.0	6,322.0	17,659.1	63,540.1	62.3	9.9	27.8
2015	45,769.5	11,686.0	8,107.3	65,562.8	69.8	17.8	12.4
2016	44,703.5	11,728.0	8,327.1	64,758.6	69.0	18.1	12.9
2017	33,957.5	10,883.0	6,586.0	51,426.6	66.0	21.2	12.8
2018	37,839.2	11,949.0	6,950.5	56,738.7	66.7	21.1	12.3
2019	37,261.4	10,462.0	7,990.4	55,713.8	66.9	18.8	14.3

Fuel consumption within 1A1a 'Main Activity Electricity and Heat Production'

The evolution of fuel consumption by sources under 1A1a 'Main Activity Electricity and Heat Production' between 1990 and 2019 is presented in Table 3-30 and Figure 3-12.

Table 3-30: Fuel consumption by category within 1A1a 'Main Activity Electricity and Heat Production' the period 1990-2019

	Fuel Consumption, TJ					Share, % of total				% compared to 1990				
	Coal	Petroleum Products	Natural Gases	Biofuels	Total	Coal	Petroleum Products	Natural Gases	Biofuels	Coal	Petroleum Products	Natural Gases	Biofuels	Total
1990	68,062	96,331	132,156	68	296,618	22.9	32.5	44.6	0.02	100.0	100.0	100.0	100.0	100.0
1991	64,272	79,904	118,990	0	263,166	24.4	30.4	45.2	0.00	94.4	82.9	90.0	0.0	88.7
1992	46,855	68,344	105,995	0	221,193	21.2	30.9	47.9	0.00	68.8	70.9	80.2	0.0	74.6
1993	44,022	52,808	78,197	56	175,082	25.1	30.2	44.7	0.03	64.7	54.8	59.2	82.4	59.0
1994	43,817	22,780	72,262	147	139,005	31.5	16.4	52.0	0.11	64.4	23.6	54.7	216.2	46.9
1995	23,048	13,753	70,049	88	106,938	21.6	12.9	65.5	0.08	33.9	14.3	53.0	129.4	36.1
1996	21,070	12,596	73,789	88	107,543	19.6	11.7	68.6	0.08	31.0	13.1	55.8	129.4	36.3
1997	7,640	8,722	75,191	59	91,612	8.3	9.5	82.1	0.06	11.2	9.1	56.9	86.8	30.9
1998	5,022	7,743	67,069	29	79,863	6.3	9.7	84.0	0.04	7.4	8.0	50.7	42.6	26.9
1999	176	4,108	59,292	29	63,605	0.3	6.5	93.2	0.05	0.3	4.3	44.9	42.6	21.4
2000	117	1,878	53,475	59	55,529	0.2	3.4	96.3	0.11	0.2	1.9	40.5	86.8	18.7
2001	88	1,672	63,104	147	65,011	0.1	2.6	97.1	0.23	0.1	1.7	47.7	216.2	21.9
2002	88	1,291	50,358	235	51,972	0.2	2.5	96.9	0.45	0.1	1.3	38.1	345.6	17.5
2003	117	938	52,644	234	53,933	0.2	1.7	97.6	0.43	0.2	1.0	39.8	344.1	18.2
2004	137	799	54,053	245	55,234	0.2	1.4	97.9	0.44	0.2	0.8	40.9	360.3	18.6
2005	123	733	56,346	245	57,447	0.2	1.3	98.1	0.43	0.2	0.8	42.6	360.3	19.4
2006	100	533	43,533	217	44,383	0.2	1.2	98.1	0.49	0.1	0.6	32.9	319.1	15.0
2007	65	315	50,978	240	51,598	0.1	0.6	98.8	0.47	0.1	0.3	38.6	352.9	17.4
2008	99	450	52,522	375	53,446	0.2	0.8	98.3	0.70	0.1	0.5	39.7	551.5	18.0
2009	122	1,040	66,723	438	68,323	0.2	1.5	97.7	0.64	0.2	1.1	50.5	644.1	23.0
2010	96	919	70,722	518	72,255	0.1	1.3	97.9	0.72	0.1	1.0	53.5	761.8	24.4
2011	69	695	65,700	401	66,865	0.1	1.0	98.3	0.60	0.1	0.7	49.7	589.7	22.5
2012	409	676	66,173	230	67,489	0.6	1.0	98.1	0.34	0.6	0.7	50.1	338.2	22.8
2013	8,270	713	49,169	286	58,438	14.2	1.2	84.1	0.49	12.2	0.7	37.2	420.6	19.7
2014	147	569	62,352	472	63,540	0.2	0.9	98.1	0.74	0.2	0.6	47.2	694.1	21.4
2015	50	61	65,438	14	65,563	0.1	0.1	99.8	0.02	0.1	0.1	49.5	20.6	22.1
2016	193	88	64,453	24	64,759	0.3	0.1	99.5	0.04	0.3	0.1	48.8	35.3	21.8
2017	5	38	51,276	107	51,427	0.01	0.1	99.7	0.21	0.0	0.0	38.8	157.4	17.3
2018	14	42	56,501	182	56,739	0.03	0.1	99.6	0.32	0.0	0.0	42.8	267.6	19.1
2019	19	23	55,536	136	55,714	0.03	0.04	99.7	0.24	0.0	0.0	42.0	200.0	18.8

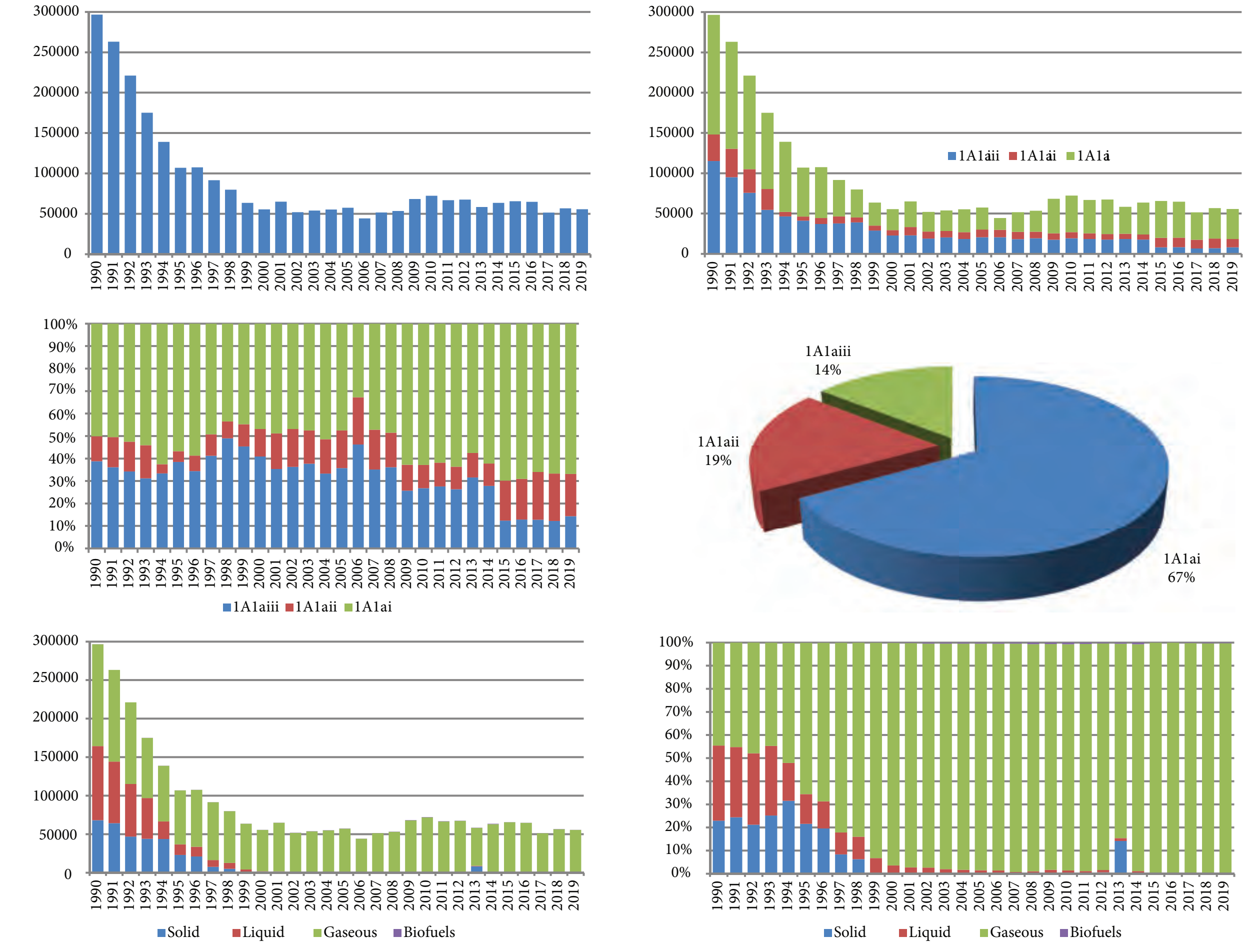

Figure 3-12: Fuel consumption by sources and fuel types within 1A1a 'Main Activity Electricity and Heat Production' for the period 1990-2019, TJ and per cent from the total.

During the respective period, the share of solid fuels (coal) decreased from 22.9 per cent to 0.03 per cent; the share of liquid fuels (petroleum products) decreased from 44.4 per cent to circa 0.04 per cent; the share of gaseous fuels (natural gases) increased from 44.6 per cent to 99.7 per cent; and the share of biofuels increased from 0.02 per cent to 0.24 per cent of the total (biofuel consumption recorded a significant growth, in particular between 2000-2014, from circa 59 TJ to 472 TJ). In total, in 2019, fuel consumption within 1A1a 'Main Activity Electricity and Heat Production' represented only circa 18.8 per cent compared to the reference year level (1990).

Trends in GHG emissions within 1A1a 'Main Activity Electricity and Heat Production'

1A1ai 'Electricity Generation'

Direct GHG emissions from 1A1ai 'Electricity Generation' in the Republic of Moldova between 1990 and 2019 are presented in Figure 3-13.

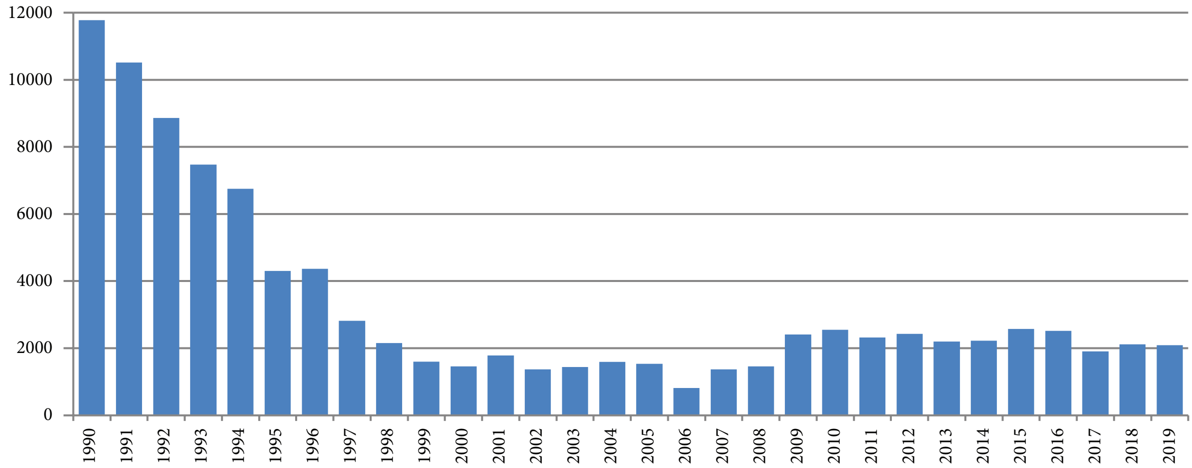

Figure 3-13: Direct GHG emissions from 1A1ai 'Electricity Generation' in the Republic of Moldova within 1990-2019, kt CO_2 equivalent.

During the respective period, GHG emissions from this source category presented a significant decrease, accounting in 2019 only circa 17.7 per cent compared to the reference year (Table 3-31).

Table 3-31: Direct GHG emissions from 1A1ai 'Electricity Generation' within 1990-2019 periods

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A1ai, RM, kt CO_2 equivalent	11,779.86	10,512.45	8,864.82	7,472.52	6,749.45	4,305.39	4,366.05	2,817.48	2,153.97	1,599.46
%, compared to 1990	100.0	89.2	75.3	63.4	57.3	36.5	37.1	23.9	18.3	13.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A1ai, RM, kt CO_2 equivalent	1,461.04	1,782.37	1,367.68	1,437.84	1,594.71	1,531.39	816.46	1,367.11	1,456.85	2,409.46
%, compared to 1990	12.4	15.1	11.6	12.2	13.5	13.0	6.9	11.6	12.4	20.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A1ai, RM, kt CO_2 equivalent	2,549.48	2,321.68	2,428.78	2,197.45	2,224.47	2,572.64	2,519.38	1,902.95	2,117.75	2,086.52
%, compared to 1990	21.6	19.7	20.6	18.7	18.9	21.8	21.4	16.2	18.0	17.7

CO_2 constituted the largest share in the structure of total direct GHG emissions from 1A1ai 'Electricity Generation' between 1990 and 2019 (Table 3-32).

Table 3-32: Direct GHG emissions from 1A1ai 'Electricity Generation' within 1990-2019 periods and the share of each gas in the total structure at category level

	1A1ai, kt CO_2 equivalent				% of total		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	11,736.1962	5.8632	37.8031	11,779.8626	99.63	0.05	0.32
1991	10,473.4309	4.8463	34.1763	10,512.4534	99.63	0.05	0.33
1992	8,834.2289	4.2970	26.2921	8,864.8180	99.65	0.05	0.30
1993	7,444.9936	3.5881	23.9409	7,472.5226	99.63	0.05	0.32
1994	6,724.9619	2.6320	21.8576	6,749.4514	99.64	0.04	0.32
1995	4,292.4793	1.5700	11.3360	4,305.3853	99.70	0.04	0.26
1996	4,353.8441	1.6267	10.5820	4,366.0527	99.72	0.04	0.24
1997	2,811.9669	1.1399	4.3722	2,817.4791	99.80	0.04	0.16
1998	2,149.9182	0.9223	3.1322	2,153.9727	99.81	0.04	0.15

	1A1ai, kt CO_2 equivalent				% of total		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1999	1,597.8981	0.7121	0.8488	1,599.4590	99.90	0.04	0.05
2000	1,459.6111	0.6505	0.7753	1,461.0369	99.90	0.04	0.05
2001	1,780.6344	0.7935	0.9459	1,782.3738	99.90	0.04	0.05
2002	1,366.3434	0.6089	0.7258	1,367.6781	99.90	0.04	0.05
2003	1,436.4367	0.6401	0.7630	1,437.8398	99.90	0.04	0.05
2004	1,593.1492	0.7100	0.8463	1,594.7055	99.90	0.04	0.05
2005	1,529.8943	0.6818	0.8127	1,531.3888	99.90	0.04	0.05
2006	815.6651	0.3635	0.4333	816.4618	99.90	0.04	0.05
2007	1,365.7736	0.6086	0.7255	1,367.1077	99.90	0.04	0.05
2008	1,455.4321	0.6486	0.7731	1,456.8539	99.90	0.04	0.05
2009	2,407.1047	1.0727	1.2786	2,409.4560	99.90	0.04	0.05
2010	2,546.9861	1.1359	1.3559	2,549.4779	99.90	0.04	0.05
2011	2,319.4150	1.0344	1.2347	2,321.6841	99.90	0.04	0.05
2012	2,426.2627	1.0801	1.4374	2,428.7802	99.90	0.04	0.06
2013	2,192.2793	0.8444	4.3274	2,197.4510	99.76	0.04	0.20
2014	2,222.2592	0.9924	1.2170	2,224.4686	99.90	0.04	0.05
2015	2,570.0984	1.1473	1.3940	2,572.6397	99.90	0.04	0.05
2016	2,516.8370	1.1220	1.4237	2,519.3827	99.90	0.04	0.06
2017	1,901.0807	0.8508	1.0176	1,902.9491	99.90	0.04	0.05
2018	2,115.6666	0.9481	1.1386	2,117.7533	99.90	0.04	0.05
2019	2,084.4700	0.9327	1.1215	2,086.5242	99.90	0.04	0.05

Table 3-33 presents direct and indirect GHG emissions from the respective source category between 1990 and 2019.

Table 3-33: Direct and indirect GHG emissions from 1A1ai 'Electricity Generation' in the Republic of Moldova within 1990-2019 periods

	1A1ai, kt							% compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	11,736.1962	0.2345	0.1269	23.2539	2.8052	0.2698	74.3087	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	10,473.4309	0.1939	0.1147	20.8271	2.5893	0.2379	65.5632	89.2	82.7	90.4	89.6	92.3	88.2	88.2
1992	8,834.2289	0.1719	0.0882	17.1883	2.5082	0.2220	50.5153	75.3	73.3	69.5	73.9	89.4	82.3	68.0
1993	7,444.9936	0.1435	0.0803	14.7490	1.8394	0.1718	46.4543	63.4	61.2	63.3	63.4	65.6	63.7	62.5
1994	6,724.9619	0.1053	0.0733	13.3730	1.8718	0.1547	39.7306	57.3	44.9	57.8	57.5	66.7	57.3	53.5
1995	4,292.4793	0.0628	0.0380	8.1534	1.6617	0.1216	18.9478	36.6	26.8	30.0	35.1	59.2	45.1	25.5
1996	4,353.8441	0.0651	0.0355	8.1341	1.8194	0.1311	17.3022	37.1	27.7	28.0	35.0	64.9	48.6	23.3
1997	2,811.9669	0.0456	0.0147	4.8882	1.5362	0.1057	6.0112	24.0	19.4	11.6	21.0	54.8	39.2	8.1
1998	2,149.9182	0.0369	0.0105	3.7050	1.1879	0.0825	4.3492	18.3	15.7	8.3	15.9	42.3	30.6	5.9
1999	1,597.8981	0.0285	0.0028	2.5350	1.1108	0.0741	0.0080	13.6	12.1	2.2	10.9	39.6	27.4	0.0
2000	1,459.6111	0.0260	0.0026	2.3156	1.0147	0.0676	0.0073	12.4	11.1	2.1	10.0	36.2	25.1	0.0
2001	1,780.6344	0.0317	0.0032	2.8249	1.2379	0.0825	0.0089	15.2	13.5	2.5	12.1	44.1	30.6	0.0
2002	1,366.3434	0.0244	0.0024	2.1676	0.9499	0.0633	0.0068	11.6	10.4	1.9	9.3	33.9	23.5	0.0
2003	1,436.4367	0.0256	0.0026	2.2788	0.9986	0.0666	0.0072	12.2	10.9	2.0	9.8	35.6	24.7	0.0
2004	1,593.1492	0.0284	0.0028	2.5275	1.1075	0.0738	0.0080	13.6	12.1	2.2	10.9	39.5	27.4	0.0
2005	1,529.8943	0.0273	0.0027	2.4271	1.0636	0.0709	0.0077	13.0	11.6	2.1	10.4	37.9	26.3	0.0
2006	815.6651	0.0145	0.0015	1.2940	0.5670	0.0378	0.0041	6.9	6.2	1.1	5.6	20.2	14.0	0.0
2007	1,365.7736	0.0243	0.0024	2.1667	0.9495	0.0633	0.0068	11.6	10.4	1.9	9.3	33.8	23.5	0.0
2008	1,455.4321	0.0259	0.0026	2.3090	1.0118	0.0675	0.0073	12.4	11.1	2.0	9.9	36.1	25.0	0.0
2009	2,407.1047	0.0429	0.0043	3.8188	1.6734	0.1116	0.0121	20.5	18.3	3.4	16.4	59.7	41.4	0.0
2010	2,546.9861	0.0454	0.0045	4.0396	1.7699	0.1180	0.0137	21.7	19.4	3.6	17.4	63.1	43.7	0.0
2011	2,319.4150	0.0414	0.0041	3.6786	1.6118	0.1074	0.0125	19.8	17.6	3.3	15.8	57.5	39.8	0.0
2012	2,426.2627	0.0432	0.0048	3.8703	1.6632	0.1112	0.3382	20.7	18.4	3.8	16.6	59.3	41.2	0.5
2013	2,192.2793	0.0338	0.0145	3.9477	1.0680	0.0746	6.5566	18.7	14.4	11.4	17.0	38.1	27.7	8.8
2014	2,222.2592	0.0397	0.0041	3.5317	1.5391	0.1027	0.0959	18.9	16.9	3.2	15.2	54.9	38.1	0.1
2015	2,570.0984	0.0459	0.0047	4.0823	1.7820	0.1189	0.0815	21.9	19.6	3.7	17.6	63.5	44.1	0.1
2016	2,516.8370	0.0449	0.0048	4.0052	1.7356	0.1159	0.2066	21.4	19.1	3.8	17.2	61.9	43.0	0.3
2017	1,901.0807	0.0340	0.0034	3.0234	1.3234	0.0883	0.0235	16.2	14.5	2.7	13.0	47.2	32.7	0.0
2018	2,115.6666	0.0379	0.0038	3.3707	1.4744	0.0983	0.0370	18.0	16.2	3.0	14.5	52.6	36.5	0.0
2019	2,084.4700	0.0373	0.0038	3.3191	1.4521	0.0968	0.0334	17.8	15.9	3.0	14.3	51.8	35.9	0.0

1A1aii 'Combined Heat and Power Generation'

Direct GHG emissions from 1A1aii 'Combined Heat and Power Generation' in the RM between 1990 and 2016 is presented in Figure 3-14.

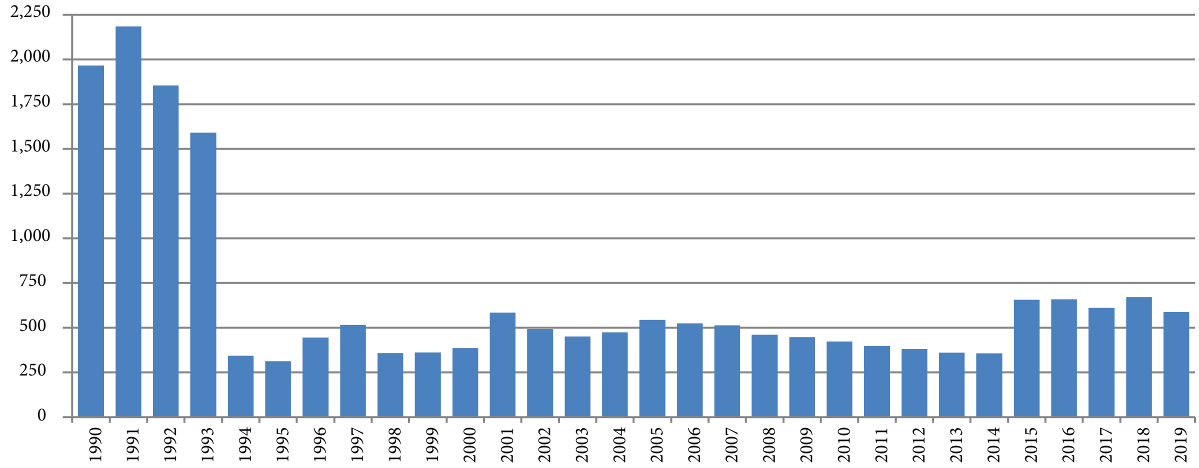

Figure 3-14: Direct GHG emissions from 1A1aii 'Combined Heat and Power Generation' within 1990-2019 periods, kt CO_2 equivalent.

During the respective period, GHG emissions from this source registered a significant decrease, constituting 2019 only circa 29.9 per cent of the reference year level (Table 3-34).

Table 3-34: Direct GHG emissions from 1A1aii 'Combined Heat and Power Generation' in the Republic of Moldova within 1990-2019 periods

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A1aii, kt CO_2 equivalent	1,966.25	2,184.34	1,854.77	1,590.84	342.98	313.42	444.76	516.08	358.22	361.24
%, compared to 1990	100.0	111.1	94.3	80.9	17.4	15.9	22.6	26.2	18.2	18.4
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A1aii, kt CO_2 equivalent	385.93	583.86	492.85	451.24	474.50	544.21	525.04	512.82	461.40	447.95
%, compared to 1990	19.6	29.7	25.1	22.9	24.1	27.7	26.7	26.1	23.5	22.8
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A1aii, kt CO_2 equivalent	422.83	399.04	381.43	360.41	356.55	656.23	658.80	611.13	670.99	587.49
%, compared to 1990	21.5	20.3	19.4	18.3	18.1	33.4	33.5	31.1	34.1	29.9

Table 3-35 presents direct GHG emissions from the respective source between 1990 and 2019, the share of each gas in the total structure at category level, as well as the evolution of these emissions expressed in % compared to the reference year level.

Table 3-35: Direct GHG emissions from 1A1aii 'Combined Heat and Power Generation' in the RM within 1990-2019 periods and the share of each gas in the total structure at category level

	1A1aii, kt CO_2 equivalent				Share of total, %			%, compared to 1990		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
1990	1,963.3987	1.0880	1.7669	1,966.2536	99.85	0.06	0.09	100.0	100.0	100.0
1991	2,180.4097	1.3817	2.5450	2,184.3363	99.82	0.06	0.12	111.1	127.0	144.0
1992	1,851.2180	1.2221	2.3292	1,854.7694	99.81	0.07	0.13	94.3	112.3	131.8
1993	1,588.1346	0.9565	1.7484	1,590.8395	99.83	0.06	0.11	80.9	87.9	99.0
1994	342.4530	0.1966	0.3314	342.9810	99.85	0.06	0.10	17.4	18.1	18.8
1995	312.9066	0.1870	0.3278	313.4214	99.84	0.06	0.10	15.9	17.2	18.6
1996	444.0804	0.2538	0.4258	444.7600	99.85	0.06	0.10	22.6	23.3	24.1
1997	515.3715	0.2772	0.4353	516.0840	99.86	0.05	0.08	26.2	25.5	24.6
1998	357.7167	0.1951	0.3112	358.2230	99.86	0.05	0.09	18.2	17.9	17.6
1999	360.8115	0.1775	0.2484	361.2374	99.88	0.05	0.07	18.4	16.3	14.1
2000	385.5258	0.1790	0.2291	385.9338	99.89	0.05	0.06	19.6	16.5	13.0
2001	583.2453	0.2707	0.3462	583.8622	99.89	0.05	0.06	29.7	24.9	19.6
2002	492.3567	0.2230	0.2737	492.8533	99.90	0.05	0.06	25.1	20.5	15.5
2003	450.7866	0.2045	0.2516	451.2426	99.90	0.05	0.06	23.0	18.8	14.2
2004	474.0276	0.2142	0.2617	474.5035	99.90	0.05	0.06	24.1	19.7	14.8
2005	543.6528	0.2479	0.3077	544.2083	99.90	0.05	0.06	27.7	22.8	17.4
2006	524.5206	0.2359	0.2858	525.0423	99.90	0.04	0.05	26.7	21.7	16.2
2007	512.3145	0.2294	0.2757	512.8196	99.90	0.04	0.05	26.1	21.1	15.6
2008	460.9356	0.2077	0.2526	461.3959	99.90	0.05	0.05	23.5	19.1	14.3
2009	447.4590	0.2127	0.2827	447.9544	99.89	0.05	0.06	22.8	19.5	16.0
2010	422.3928	0.1933	0.2416	422.8277	99.90	0.05	0.06	21.5	17.8	13.7
2011	398.6346	0.1823	0.2273	399.0442	99.90	0.05	0.06	20.3	16.8	12.9
2012	381.0441	0.1726	0.2118	381.4285	99.90	0.05	0.06	19.4	15.9	12.0
2013	360.0414	0.1632	0.2005	360.4051	99.90	0.05	0.06	18.3	15.0	11.3
2014	356.1894	0.1617	0.1993	356.5504	99.90	0.05	0.06	18.1	14.9	11.3
2015	655.5846	0.2922	0.3482	656.2250	99.90	0.04	0.05	33.4	26.9	19.7
2016	658.1518	0.2932	0.3516	658.7966	99.90	0.04	0.05	33.5	26.9	19.9

	1A1aii, kt CO_2 equivalent				Share of total, %			%, compared to 1990		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
2017	610.5363	0.2721	0.3243	611.1327	99.90	0.04	0.05	31.1	25.0	18.4
2018	670.3389	0.2987	0.3561	670.9937	99.90	0.04	0.05	34.1	27.5	20.2
2019	586.9182	0.2616	0.3118	587.4915	99.90	0.04	0.05	29.9	24.0	17.6

Direct and indirect GHG emissions from 1A1aii 'Combined Heat and Power Generation' in the Republic of Moldova within 1990-2019 periods are presented in Table 3-36. In this period, GHG emissions from this source registered a significant decrease, in 2019, CO_2 emissions constituted circa 29.9 per cent compared to 1990 level, whereas CH_4 – 24.0 per cent, N_2O – 17.6 per cent, NO_x – 29.0 per cent, CO – 35.1 per cent, NMVOC – 32.3 per cent and SO_2 – 0.1 per cent.

Table 3-36: Direct and indirect GHG emissions from 1A1aii 'Combined Heat and Power Generation' in the Republic of Moldova within 1990-2019 periods

	1A1aii, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	1,963.3987	0.0435	0.0059	3.2128	1.1616	0.0842	2.5911	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1991	2,180.4097	0.0553	0.0085	3.4994	1.1342	0.0853	4.0254	111.05	127.00	144.04	108.92	97.64	101.29	155.35
1992	1,851.2180	0.0489	0.0078	3.0327	0.9135	0.0715	4.2637	94.29	112.33	131.83	94.40	78.65	84.97	164.55
1993	1,588.1346	0.0383	0.0059	2.6446	0.8564	0.0651	3.1755	80.89	87.92	98.95	82.32	73.72	77.40	122.55
1994	342.4530	0.0079	0.0011	0.5641	0.1960	0.0145	0.5389	17.44	18.07	18.76	17.56	16.88	17.20	20.80
1995	312.9066	0.0075	0.0011	0.5169	0.1722	0.0130	0.5687	15.94	17.19	18.55	16.09	14.83	15.39	21.95
1996	444.0804	0.0102	0.0014	0.7289	0.2554	0.0188	0.6713	22.62	23.33	24.10	22.69	21.99	22.30	25.91
1997	515.3715	0.0111	0.0015	0.8381	0.3130	0.0223	0.5698	26.25	25.48	24.64	26.09	26.94	26.54	21.99
1998	357.7167	0.0078	0.0010	0.5823	0.2147	0.0154	0.4240	18.22	17.93	17.61	18.13	18.48	18.30	16.37
1999	360.8115	0.0071	0.0008	0.5761	0.2351	0.0161	0.1786	18.38	16.32	14.06	17.93	20.24	19.14	6.89
2000	385.5258	0.0072	0.0008	0.6129	0.2613	0.0176	0.0760	19.64	16.45	12.96	19.08	22.50	20.91	2.93
2001	583.2453	0.0108	0.0012	0.9283	0.3953	0.0267	0.1205	29.71	24.88	19.59	28.89	34.04	31.66	4.65
2002	492.3567	0.0089	0.0009	0.7828	0.3389	0.0227	0.0460	25.08	20.49	15.49	24.36	29.17	26.98	1.77
2003	450.7866	0.0082	0.0008	0.7168	0.3100	0.0208	0.0458	22.96	18.79	14.24	22.31	26.69	24.69	1.77
2004	474.0276	0.0086	0.0009	0.7526	0.3268	0.0219	0.0331	24.14	19.69	14.81	23.43	28.13	25.97	1.28
2005	543.6528	0.0099	0.0010	0.8636	0.3727	0.0250	0.0611	27.69	22.78	17.41	26.88	32.09	29.69	2.36
2006	524.5206	0.0094	0.0010	0.8319	0.3627	0.0242	0.0207	26.71	21.68	16.18	25.89	31.22	28.77	0.80
2007	512.3145	0.0092	0.0009	0.8124	0.3552	0.0237	0.0100	26.09	21.08	15.61	25.29	30.58	28.15	0.39
2008	460.9356	0.0083	0.0008	0.7312	0.3183	0.0213	0.0228	23.48	19.09	14.30	22.76	27.40	25.27	0.88
2009	447.4590	0.0085	0.0009	0.7149	0.2985	0.0203	0.1559	22.79	19.55	16.00	22.25	25.70	24.11	6.02
2010	422.3928	0.0077	0.0008	0.6711	0.2889	0.0194	0.0550	21.51	17.77	13.67	20.89	24.87	23.03	2.12
2011	398.6346	0.0073	0.0008	0.6332	0.2728	0.0183	0.0494	20.30	16.75	12.87	19.71	23.49	21.75	1.91
2012	381.0441	0.0069	0.0007	0.6051	0.2623	0.0176	0.0311	19.41	15.86	11.99	18.83	22.58	20.86	1.20
2013	360.0414	0.0065	0.0007	0.5718	0.2477	0.0166	0.0305	18.34	15.00	11.35	17.80	21.33	19.71	1.18
2014	356.1894	0.0065	0.0007	0.5658	0.2448	0.0164	0.0339	18.14	14.86	11.28	17.61	21.08	19.49	1.31
2015	655.5846	0.0117	0.0012	1.0401	0.4558	0.0304	0.0033	33.39	26.85	19.71	32.37	39.24	36.10	0.13
2016	658.1518	0.0117	0.0012	1.0444	0.4572	0.0305	0.0074	33.52	26.95	19.90	32.51	39.36	36.22	0.29
2017	610.5363	0.0109	0.0011	0.9686	0.4244	0.0283	0.0031	31.10	25.01	18.36	30.15	36.54	33.62	0.12
2018	670.3389	0.0119	0.0012	1.0635	0.4660	0.0311	0.0034	34.14	27.46	20.15	33.10	40.12	36.91	0.13
2019	586.9182	0.0105	0.0010	0.9311	0.4080	0.0272	0.0029	29.89	24.04	17.65	28.98	35.13	32.32	0.11

1A1aiii 'Heat Plants'

Direct GHG emissions from 1A1aiii 'Heat Plants' in the RM between 1990 and 2019 are presented in Figure 3-15.

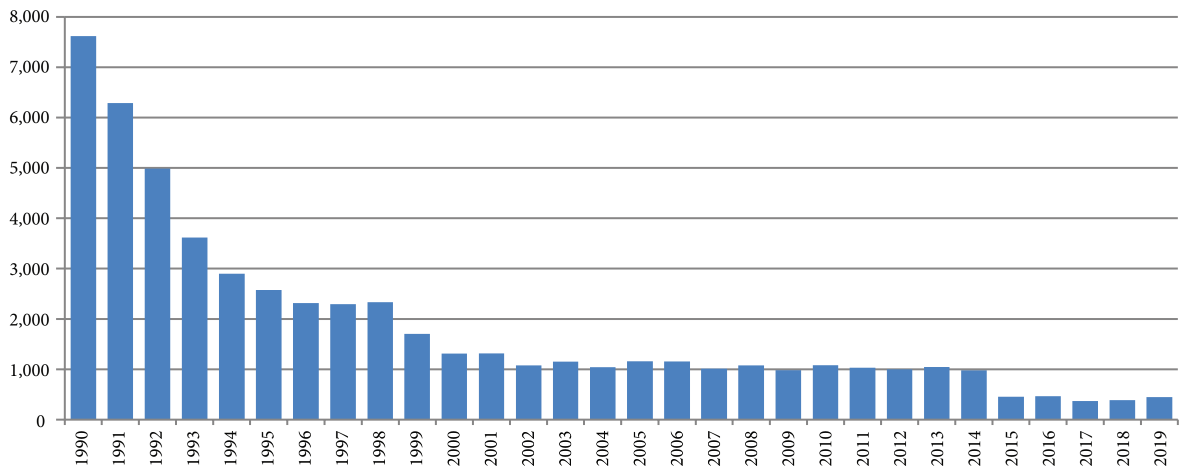

Figure 3-15: Direct GHG emissions from 1A1aiii 'Heat Plants' within 1990-2019 periods, kt CO_2 equivalent.

During the respective period, GHG emissions had significantly decreased, constituting in 2019 only circa 5.9 per cent compared to the reference year (Table 3-37).

Table 3-37: Direct GHG emissions from 1A1aiii 'Heat Plants' within 1990-2019 periods

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A1aiii, kt CO_2 equivalent	7,618.13	6,287.38	4,986.67	3,615.81	2,900.13	2,573.60	2,313.60	2,292.10	2,332.48	1,703.99
%, compared to 1990	100.0	82.5	65.5	47.5	38.1	33.8	30.4	30.1	30.6	22.4
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A1aiii, kt CO_2 equivalent	1,312.36	1,315.69	1,076.26	1,151.29	1,041.58	1,157.66	1,154.42	1,013.89	1,076.36	982.93
%, compared to 1990	17.2	17.3	14.1	15.1	13.7	15.2	15.2	13.3	14.1	12.9
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A1aiii, kt CO_2 equivalent	1,080.67	1,030.00	997.64	1,046.16	979.28	455.26	466.42	368.80	388.70	448.16
%, compared to 1990	14.2	13.5	13.1	13.7	12.9	6.0	6.1	4.8	5.1	5.9

Direct and indirect GHG emissions from 1A1aiii 'Heat Plants' within 1990-2019 periods are presented in Table 3-38. In this period, GHG emissions from this source registered a significant decrease: in 2019, CO_2 emissions constituted circa 5.9 per cent compared to 1990 level, whereas CH_4 – 3.9 per cent, N_2O – 2.1 per cent, NO_x – 5.5 per cent, CO – 9.6 per cent, NMVOC – 7.5 per cent and SO_2 – 0.01 per cent.

Table 3-38: Direct and indirect GHG emissions from 1A1aiii 'Heat Plants' within 1990-2019 periods

	1A1aiii, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	7,600.6980	0.2132	0.0406	12.9996	3.2431	0.2758	25.4608	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1991	6,273.1931	0.1739	0.0330	10.7395	2.6871	0.2284	20.9340	82.53	81.54	81.35	82.61	82.86	82.81	82.22
1992	4,975.5393	0.1371	0.0258	8.5326	2.1542	0.1826	16.4688	65.46	64.31	63.66	65.64	66.42	66.22	64.68
1993	3,607.4725	0.1005	0.0196	6.2499	1.5397	0.1318	12.6444	47.46	47.15	48.17	48.08	47.48	47.79	49.66
1994	2,894.4367	0.0757	0.0127	4.8736	1.4891	0.1155	6.8512	38.08	35.50	31.40	37.49	45.92	41.89	26.91
1995	2,568.6427	0.0667	0.0110	4.3152	1.3144	0.1024	6.0783	33.79	31.29	27.20	33.19	40.53	37.14	23.87
1996	2,309.1299	0.0601	0.0100	3.8845	1.1846	0.0922	5.4677	30.38	28.17	24.52	29.88	36.53	33.45	21.47
1997	2,288.2739	0.0541	0.0083	3.7911	1.2870	0.0953	3.9561	30.11	25.37	20.48	29.16	39.68	34.54	15.54
1998	2,328.9758	0.0515	0.0074	3.8230	1.3765	0.0993	3.1556	30.64	24.15	18.34	29.41	42.44	36.00	12.39
1999	1,701.5444	0.0371	0.0051	2.7770	1.0327	0.0736	1.9422	22.39	17.39	12.54	21.36	31.84	26.69	7.63
2000	1,310.6148	0.0278	0.0035	2.1153	0.8444	0.0584	0.8920	17.24	13.05	8.66	16.27	26.04	21.19	3.50
2001	1,313.8392	0.0301	0.0037	2.1241	0.8672	0.0598	0.7507	17.29	14.10	9.11	16.34	26.74	21.67	2.95
2002	1,074.5100	0.0281	0.0035	1.7454	0.7167	0.0495	0.6356	14.14	13.18	8.69	13.43	22.10	17.97	2.50
2003	1,149.5199	0.0288	0.0035	1.8572	0.7809	0.0533	0.4721	15.12	13.51	8.71	14.29	24.08	19.34	1.85
2004	1,039.9048	0.0270	0.0034	1.6848	0.7092	0.0485	0.4393	13.68	12.65	8.26	12.96	21.87	17.57	1.73
2005	1,155.9031	0.0288	0.0035	1.8665	0.7955	0.0541	0.3713	15.21	13.52	8.57	14.36	24.53	19.61	1.46
2006	1,152.7453	0.0278	0.0033	1.8581	0.7966	0.0540	0.3091	15.17	13.02	8.08	14.29	24.56	19.58	1.21
2007	1,012.3600	0.0257	0.0030	1.6331	0.7104	0.0480	0.1945	13.32	12.04	7.35	12.56	21.91	17.42	0.76
2008	1,074.4742	0.0310	0.0037	1.7464	0.7597	0.0517	0.2756	14.14	14.53	9.19	13.43	23.42	18.73	1.08
2009	980.9473	0.0317	0.0040	1.6094	0.6866	0.0473	0.4470	12.91	14.86	9.83	12.38	21.17	17.14	1.76
2010	1,078.4318	0.0359	0.0045	1.7708	0.7608	0.0524	0.4594	14.19	16.86	11.03	13.62	23.46	19.00	1.80
2011	1,028.0948	0.0312	0.0038	1.6767	0.7250	0.0496	0.3360	13.53	14.64	9.33	12.90	22.35	17.98	1.32
2012	996.1009	0.0254	0.0030	1.6099	0.6897	0.0469	0.2973	13.11	11.92	7.45	12.38	21.27	17.01	1.17
2013	1,044.3969	0.0274	0.0036	1.7054	0.7095	0.0485	0.5397	13.74	12.83	8.95	13.12	21.88	17.57	2.12
2014	977.5270	0.0288	0.0035	1.5996	0.6942	0.0473	0.2770	12.86	13.51	8.56	12.30	21.40	17.15	1.09
2015	454.8173	0.0081	0.0008	0.7215	0.3162	0.0211	0.0023	5.98	3.80	2.00	5.55	9.75	7.64	0.01
2016	465.9172	0.0090	0.0009	0.7409	0.3259	0.0218	0.0026	6.13	4.20	2.26	5.70	10.05	7.89	0.01
2017	368.3960	0.0073	0.0008	0.5866	0.2579	0.0172	0.0062	4.85	3.40	1.86	4.51	7.95	6.25	0.02
2018	388.2560	0.0079	0.0008	0.6187	0.2726	0.0182	0.0047	5.11	3.70	2.03	4.76	8.41	6.61	0.02
2019	447.6993	0.0083	0.0008	0.7111	0.3121	0.0208	0.0024	5.89	3.88	2.06	5.47	9.62	7.55	0.01

Table 3-39 presents direct GHG emissions from the respective source between 1990 and 2019, the share of each gas in the total structure at category level, as well as the evolution of these emissions expressed in % compared to the reference year level.

Table 3-39: Evolution of direct GHG emissions from 1A1aiii 'Heat Plants' for the period 1990-2019

	1A1aiii, kt CO_2 equivalent				Share of total, %			%, compared to 1990		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
1990	7,600.6980	5.3301	12.0971	7,618.1252	99.77	0.07	0.16	100.0	100.0	100.0
1991	6,273.1931	4.3464	9.8410	6,287.3805	99.77	0.07	0.16	82.5	81.5	81.3
1992	4,975.5393	3.4279	7.7014	4,986.6686	99.78	0.07	0.15	65.5	64.3	63.7
1993	3,607.4725	2.5134	5.8275	3,615.8134	99.77	0.07	0.16	47.5	47.2	48.2
1994	2,894.4367	1.8921	3.7988	2,900.1276	99.80	0.07	0.13	38.1	35.5	31.4
1995	2,568.6427	1.6679	3.2901	2,573.6008	99.81	0.06	0.13	33.8	31.3	27.2
1996	2,309.1299	1.5016	2.9665	2,313.5981	99.81	0.06	0.13	30.4	28.2	24.5
1997	2,288.2739	1.3520	2.4780	2,292.1039	99.83	0.06	0.11	30.1	25.4	20.5
1998	2,328.9758	1.2874	2.2189	2,332.4821	99.85	0.06	0.10	30.6	24.2	18.3
1999	1,701.5444	0.9269	1.5175	1,703.9888	99.86	0.05	0.09	22.4	17.4	12.5
2000	1,310.6148	0.6955	1.0476	1,312.3578	99.87	0.05	0.08	17.2	13.0	8.7
2001	1,313.8392	0.7513	1.1019	1,315.6924	99.86	0.06	0.08	17.3	14.1	9.1

	1A1aiii, kt CO_2 equivalent				Share of total, %			%, compared to 1990		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
2002	1,074.5100	0.7024	1.0515	1,076.2639	99.84	0.07	0.10	14.1	13.2	8.7
2003	1,149.5199	0.7203	1.0531	1,151.2933	99.85	0.06	0.09	15.1	13.5	8.7
2004	1,039.9048	0.6743	0.9989	1,041.5780	99.84	0.06	0.10	13.7	12.7	8.3
2005	1,155.9031	0.7208	1.0368	1,157.6608	99.85	0.06	0.09	15.2	13.5	8.6
2006	1,152.7453	0.6942	0.9769	1,154.4163	99.86	0.06	0.08	15.2	13.0	8.1
2007	1,012.3600	0.6417	0.8894	1,013.8911	99.85	0.06	0.09	13.3	12.0	7.4
2008	1,074.4742	0.7742	1.1112	1,076.3596	99.82	0.07	0.10	14.1	14.5	9.2
2009	980.9473	0.7923	1.1896	982.9291	99.80	0.08	0.12	12.9	14.9	9.8
2010	1,078.4318	0.8986	1.3347	1,080.6652	99.79	0.08	0.12	14.2	16.9	11.0
2011	1,028.0948	0.7804	1.1289	1,030.0042	99.81	0.08	0.11	13.5	14.6	9.3
2012	996.1009	0.6351	0.9007	997.6368	99.85	0.06	0.09	13.1	11.9	7.4
2013	1,044.3969	0.6841	1.0827	1,046.1637	99.83	0.07	0.10	13.7	12.8	8.9
2014	977.5270	0.7203	1.0360	979.2832	99.82	0.07	0.11	12.9	13.5	8.6
2015	454.8173	0.2027	0.2416	455.2616	99.90	0.04	0.05	6.0	3.8	2.0
2016	465.9172	0.2241	0.2737	466.4151	99.89	0.05	0.06	6.1	4.2	2.3
2017	368.3960	0.1813	0.2251	368.8024	99.89	0.05	0.06	4.8	3.4	1.9
2018	388.2560	0.1970	0.2456	388.6986	99.89	0.05	0.06	5.1	3.7	2.0
2019	447.6993	0.2070	0.2497	448.1561	99.90	0.05	0.06	5.9	3.9	2.1

1A1b 'Petroleum Refining'

GHG emissions from source category 1A1b 'Petroleum Refining' were estimated within Sector 1 'Energy' in the current inventory cycle, taking into consideration that the amount of products consumed for energy purposes in oil refineries constitutes only 8 per cent of the total amount of fuel utilised[53]. The AD for 2003-2019 are available in the EBs of the RM in energy units (TJ) for 5 types of fuel: petroleum, gasoline, diesel oil, residual fuel oil, other petroleum products and other hydrocarbons (Figure 3-16, Table 3-40).

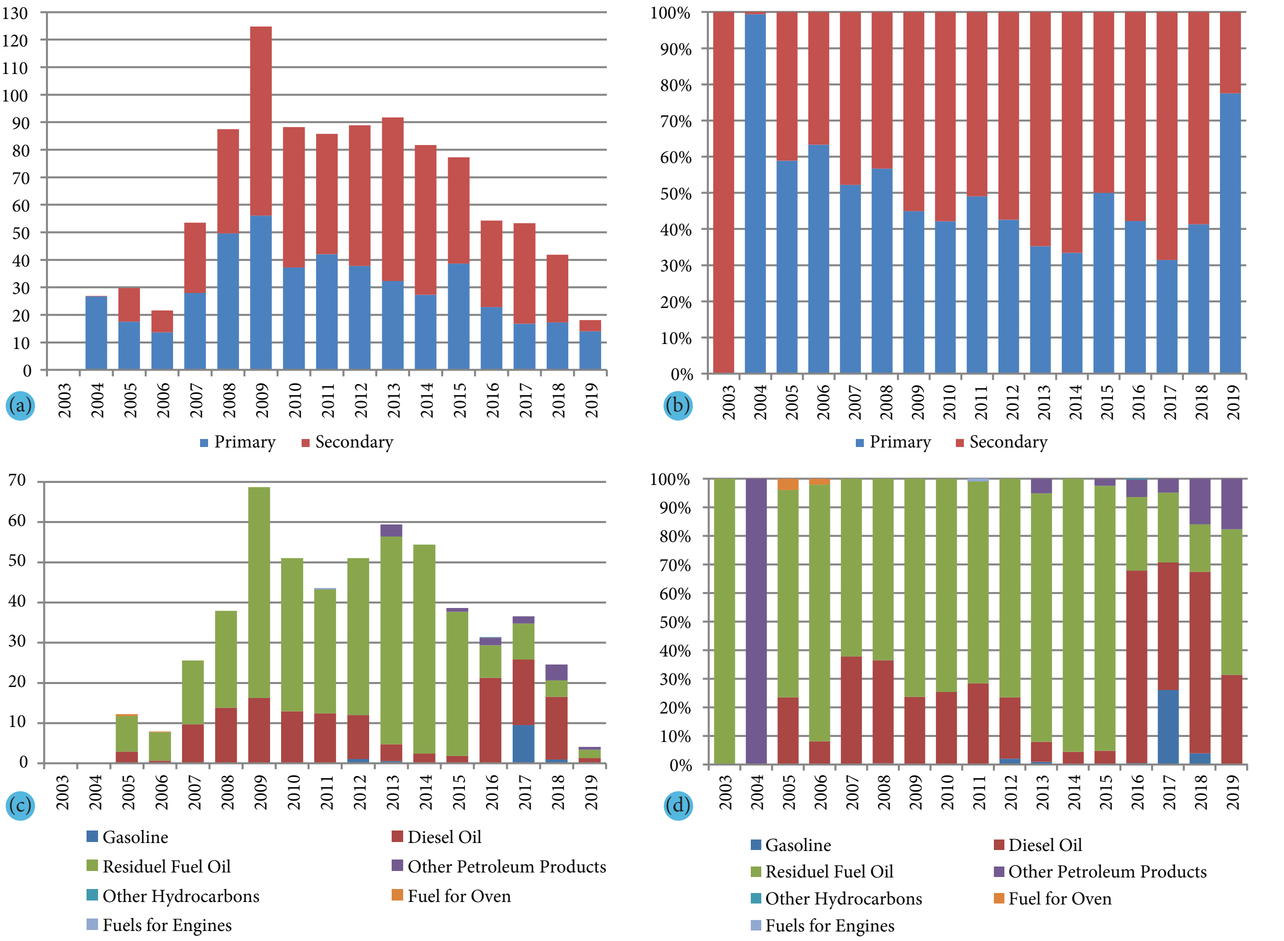

Figure 3-16: Primary and secondary petroleum products under source category 1A1b 'Petroleum Refining' in the Republic of Moldova within 2003-2019 periods, when: (a) production of primary and secondary petroleum products within 2003-2019, TJ; (b) production of primary and secondary products within 2003-2019, % of the total; (c) production of secondary petroleum products within 2003-2019, TJ; (d) production of secondary petroleum products within 2003-2019, % of the total.

[53] **2006 IPCC Guidelines, Chapter 2: Stationary Combustion, p. 2.32**

Table 3-40: Activity data for source category 1A1b 'Petroleum Refining', TJ

Production Type		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Primary	Petroleum	NO	26.72	17.52	13.68	27.92	49.6	56.08	37.2	42.08	37.84	32.32	27.28	38.64	22.88	16.8	17.28	14.08
Secondary	Gasoline	NO	NO	NO	NO	NO	0.16	NO	NO	NO	1.04	0.56	0.08	NO	0.16	9.52	0.96	NO
	Diesel Oil	NO	NO	2.88	0.64	9.68	13.68	16.24	12.96	12.4	10.96	4.16	2.32	1.84	21.12	16.32	15.6	1.28
	Residual Fuel Oil	0.08	NO	8.88	7.12	15.92	24.08	52.48	38.08	30.88	39.04	51.68	52	35.84	8.08	8.96	4.08	2.08
	Other petroleum products	NO	0.16	NO	NO	NO	NO	NO	NO	NO	NO	3.04	NO	0.96	1.92	1.76	3.92	0.72
	Other hydrocar-bons	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.08	NO	NO	NO
	Fuel for Oven	NO	NO	0.48	0.16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Engine Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.4	NO	NO	NO	NO	NO	NO	NO	NO

The Energy Balances of the RM for 2015-2019 are published in MS Excel format. The required information is available within Chapter 'Transformation', categories 'Petroleum installations' and 'Petrol Refineries'.

In the Republic of Moldova there are two companies involved in this sector: "Valiexchimp" Ltd. is involved in oil extraction on oil fields near Valeni village, Cahul district, and Arnaut Petrol JSC owns a small capacity oil refinery located in Comrat (ATU Gagauzia).

The values of direct GHG emissions were taken from the 2006 IPCC Guidelines, while for indirect GHG emissions – from the 2019 EMEP/EEA Guidebook (Table 3-41).

Table 3-41: Emission factors for source category 1A1b 'Petroleum Refining', kg/TJ

Fuel type	Emission Factors						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Petroleum	73 300	3	0.6	142	15.1	2.3	495
Gasoline	69 300	3	0.6	65	16.2	0.8	46.5
Diesel Oil	74 100	3	0.6	65	16.2	0.8	46.5
Residual Fuel Oil	77 400	3	0.6	142	15.1	2.3	495
Other Petroleum Products	73 300	3	0.6	65	16.2	0.8	46.5
Other hydrocarbons	73 300	3	0.6	65	16.2	0.8	46.5
Fuel for Oven	74 100	3	0.6	65	16.2	0.8	46.5
Engine Fuels	74 100	3	0.6	65	16.2	0.8	46.5
Source of reference:	2006 IPCC Guidelines			2019 EMEP/EEA Guidebook			

Direct GHG emissions from this category between 2003 and 2019 are presented in Table 3-42.

Table 3-42: Direct GHG emissions from source category 1A1b 'Petroleum Refining' within 2003-2019 periods

	2003	2004	2005	2006	2007	2008	2009	2010	2011
1A1b, kt CO_2 equivalent	0.0062	1.9771	2.2281	1.6186	4.0096	6.5465	9.4077	6.6569	6.4448
	2012	2013	2014	2015	2016	2017	2018	2019	2020
1A1b, kt CO_2 equivalent	6.7021	6.9623	6.2226	5.8327	4.0389	3.9365	3.1029	1.3453	N/A

Table 3-43 shows direct and indirect GHG emissions under 1A1b 'Petroleum Refining' source category from 2003 through 2019.

Table 3-43: GHG emissions from source category 1A1b 'Petroleum Refining' in the Republic of Moldova within 2003-2019 periods, kt

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
2003	0.0062	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	1.9703	0.0001	0.0000	0.0038	0.0004	0.0001	0.0132
2005	2.2205	0.0001	0.0000	0.0040	0.0005	0.0001	0.0132
2006	1.6131	0.0001	0.0000	0.0030	0.0003	0.0000	0.0103
2007	3.9960	0.0002	0.0000	0.0069	0.0008	0.0001	0.0222
2008	6.5242	0.0003	0.0001	0.0114	0.0013	0.0002	0.0371
2009	9.3760	0.0004	0.0001	0.0165	0.0019	0.0003	0.0545
2010	6.6345	0.0003	0.0001	0.0115	0.0013	0.0002	0.0379
2011	6.4231	0.0003	0.0001	0.0112	0.0013	0.0002	0.0367
2012	6.6796	0.0003	0.0001	0.0117	0.0014	0.0002	0.0386

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
2013	6.9390	0.0003	0.0001	0.0124	0.0014	0.0002	0.0419
2014	6.2019	0.0002	0.0000	0.0114	0.0012	0.0002	0.0394
2015	5.8130	0.0002	0.0000	0.0108	0.0012	0.0002	0.0370
2016	4.0252	0.0002	0.0000	0.0059	0.0008	0.0001	0.0164
2017	3.9230	0.0002	0.0000	0.0055	0.0008	0.0001	0.0140
2018	3.0922	0.0001	0.0000	0.0044	0.0007	0.0001	0.0115
2019	1.3407	0.0001	0.0000	0.0024	0.0003	0.0000	0.0081

Direct GHG emissions from the respective source category between 2003 and 2019 as well as the share of each gas in the total structure at category level are presented in Table 3-44.

Table 3-44: Direct GHG emissions from source category 1A1b 'Petroleum Refining' within 2003-2019 periods and the share of each gas in the total structure at category level

	GHG emissions, kt CO_2 equivalent				the share of GHG in the total structure of emissions, %		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
2003	0.0062	0.0000	0.0000	0.0062	99.67	0.10	0.23
2004	1.9703	0.0020	0.0048	1.9771	99.65	0.10	0.24
2005	2.2205	0.0022	0.0053	2.2281	99.66	0.10	0.24
2006	1.6131	0.0016	0.0039	1.6186	99.66	0.10	0.24
2007	3.9960	0.0040	0.0096	4.0096	99.66	0.10	0.24
2008	6.5242	0.0066	0.0156	6.5465	99.66	0.10	0.24
2009	9.3760	0.0094	0.0223	9.4077	99.66	0.10	0.24
2010	6.6345	0.0066	0.0158	6.6569	99.66	0.10	0.24
2011	6.4231	0.0064	0.0153	6.4448	99.66	0.10	0.24
2012	6.6796	0.0067	0.0159	6.7021	99.66	0.10	0.24
2013	6.9390	0.0069	0.0164	6.9623	99.67	0.10	0.24
2014	6.2019	0.0061	0.0146	6.2226	99.67	0.10	0.23
2015	5.8130	0.0058	0.0138	5.8327	99.66	0.10	0.24
2016	4.0252	0.0041	0.0097	4.0389	99.66	0.10	0.24
2017	3.9230	0.0040	0.0095	3.9365	99.66	0.10	0.24
2018	3.0922	0.0031	0.0075	3.1029	99.66	0.10	0.24
2019	1.3407	0.0014	0.0032	1.3453	99.66	0.10	0.24

1A1c 'Manufacture of Solid Fuels and Other Energy Industries'

The source category 1A1c 'Manufacture of Solid Fuels and Other Energy Industries' has first been taken into consideration in the previous inventory cycle. The Energy Balances for the 2012-2019, includes information regarding charcoal production, but because the amount of fuel used directly for energy purposes for charcoal production is unknown, this category was not considered in the current GHG inventory cycle.

3.2.2. Methodological Issues and Emission Factors

GHG emissions originating from category 1A1 'Energy Industries' were estimated following a Tier 1 methodology (Table 3-45), using default emission factors. To ensure the natural conversion from natural units to energy units, CS NCVs were used. The carbon oxidation fraction values used were those recommended by the 2006 IPCC Guidelines.

Table 3-45: Methods, EFs and parameters used to estimate direct GHG emissions originating from 1A1 'Energy Industries' category

Category	CO_2				CH_4		N_2O	
	Method	Net Calorific Value, TJ/kt	Carbon Oxidation Fraction	EF, t C/TJ	Method	EF, kg/TJ	Method	EF, kg/TJ
1A1 Energy Industries	T1, T3	CS	1	D	T1	D	T1	D

Abbreviations: T1 – Tier 1; EF – Emission Factor; D – Default; CS – Country Specific.

In the present inventory cycle, CO_2 emissions from the source category 1A1aii 'Combined Heat and Power Generation', were estimated following a Tier 3 methodology. The difference between the Tier 1 and Tier 3 estimation methodologies proved to be insignificant (up to 1%), thereby it has been taken the decision to continue the use of Tier 1 estimation methodology. The estimation of non-CO_2 emissions was made using EFs used by default, available in the 2019 EMEP/EEA Guidebook (Table 3-46).

Table 3-46: Emission factors used for estimating GHG emissions originated from 1A1 'Energy Industries' category, kg/TJ

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Sources of references – 2019 EMEP/EEA Guidebook
Anthracite	98 300	1	1.5	209	8.7	1	820	Table 3.2 (coal)
Brown Coal (lignite)	101 000	1	1.5	247	8.7	1.4	1680	Table 3.3 (brown coal)
Other types of bituminous coal	94 600	1	1.5	209	8.7	1	820	Table 3.2 (coal)
Diesel Oil	74 100	3	0.6	65	16.2	0.8	46.5	Table 3-6 (diesel oil)
Gasoline	69 300	3	0.6	65	16.2	0.8	46.5	Table 3-6 (diesel oil)
Fuel for oven	71 900	3	0.6	65	16.2	0.8	46.5	Table 3-6 (diesel oil)
Residual Fuel Oil	77 400	3	0.6	142	15.1	2.3	495	Table 3-5 (Residual fuel oil)
Other Petroleum Products	73 300	3	0.6	65	16.2	0.8	46.5	Table 3-6 (diesel oil)
Natural Gas	56 100	1	0.1	89	39	2.6	0.281	Table 3-4 (gaseous fuel)
Liquefied Petroleum Gases	63 100	1	0.1	89	39	2.6	0.281	Table 3-4 (gaseous fuel)
Fuel Wood	112 000	30	4	81	90	7.31	10.8	Table 3-7 (biomass)
Wood Waste	112 000	30	4	81	90	7.31	10.8	Table 3-7 (biomass)
Agricultural Residues	100 000	30	4	81	90	7.31	10.8	Table 3-7 (biomass)
Charcoal	112 000	200	4	81	90	7.31	10.8	Table 3-7 (biomass)
Pellets and Briquettes*	100 000	30	4	81	90	7.31	10.8	Table 3-7 (biomass)
Biogas	54 600	1	0.1	89	39	2.6	0.281	Table 3-4 (gaseous fuel)
Source:	2006 IPCC Guidelines, Volume 2, Chapter 2, Table 2.2, p. 2.16-2.17.			2019 EMEP/EEA Guidebook, Category 1A1 Energy Industries				

3.2.3. Uncertainties Assessment and Time-Series Consistency

The primary factors that affect inventory uncertainties are largely dependent on the methodology, and emission factors used to calculate the GHG emissions from category 1A1 'Energy Industries' and they also depend on the quality of activity data available.

Uncertainties associated with EFs used to estimate CO_2 emissions were estimated at circa 5 per cent; while those pertaining to EFs used to estimate CH_4 and N_2O emissions reach up to ±50 per cent, respectively. Uncertainties pertaining to AD regarding fuel consumption within Sector 1 'Energy' were estimated at circa 5 per cent for CO_2 and CH_4 emissions, and ±3 per cent for N_2O emissions, respectively. The combined uncertainties presented as a percentage of total direct GHG emissions from Sector 1A1 'Energy Industries' were estimated at about 7.1 per cent. Uncertainties in the trend of total direct GHG emissions from sector 1A1 were estimated at about 1.0 per cent (Annex 5-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

3.2.4. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for 1A1 'Energy Industries', following a Tier 1 approach. To be noted that AD and methods used for estimating GHG emissions under the category 1A1 'Energy Industries' were documented and archived both in hard copies and electronically.

The quality control and verification procedures applied in the calculation process for category 1A1 'Energy Industries' included:

- Verification of AD collecting and manipulation procedures, including: verifying whether disaggregation of AD collected for each source category included in 1A1 'Energy Industries' complies with the requirements set out in the description of each source category in the 2006 IPCC Guidelines; verifying the correctness of EFs use for each source category; verifying if the primary reference sources are correctly indicated; the accuracy of calculations for subcategories included in 1A1 category are verified randomly;
- Implementation of error minimization procedures for manual entry of AD, with all the spreadsheets provided with the initial sources of activity data in tabular format;
- In the calculation files, the EFs are specified in tabular formats for each source category, the import of the respective values into calculation formulas is ensured by automatic connections;

- The consistency of calculations is also ensured by verifying the correctness of applying conversion factors of natural units into energy units for all source categories and the entire range of years covered by the inventory;
- Verification whether the same method is used for the entire range of years covered by the inventory;
- Verifying whether GHG emissions calculations have been made for all years and for all types of fuels mentioned in the Energy Balances of the RM and the relevant reference sources;
- Verifying to what extent the full geographical coverage of the national GHG inventory of the RM is ensured;
- Verifying the inter-annual evolution trends of emissions by creating representative charts, while unusual fluctuations are explained;
- Regarding recalculations, their need is explained, including by drawing attention to the implemented recommendations resulting from the audit carried out by national and international experts in the previous inventory cycle;
- Verifying maintenance and completion of the national inventory of GHG emissions archive.

Following the recommendations included in the 2006 IPCC Guidelines, GHG emissions were estimated using AD and CS NCVs available in the official sources of information.

3.2.5. Recalculations

The GHG emissions from 1A1 'Energy Industries' category were recalculated within the current inventory cycle due to the following causes:

- The transition from an average NCV for natural gases to a constant NCV for the entire period 1990-2019 (33.86 TJ/mil. m^3);
- The AD on coal and residual fuel oil consumption at the MTPP Dnestrovsk for the period 2008-2016 were updated based on the information available in in press releases on the company's official web-page;
- With the publication of the EBs of the RM in a MS Excel form for 2015 and 2016, it became easier to monitor and allocate fuel consumption within 1Alaii 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants' sources, thus avoiding the misallocation in other categories of the sector (for example, within 1A2);
- in 2015 and 2016, when considering the fuel consumption from sources 1Alaii 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants', only the fuel consumption for 'Energy Producers for public purposes' was accounted for. Data on fuel consumption under 'Autoproducers' have been reallocated to category 1A2 'Manufacturing Industries and Construction';
- With the publication of the EBs of the RM in a MS Excel form for 2015 and 2016, it became easier to monitor and allocate fuel consumption within 1A1b and 1A1c sources, thus avoiding the misallocation in other categories of the sector;
- for 1A1b 'Petroleum Refining' only 8 per cent of the total fuel consumption indicated in the Chapter 'Transformation', categories 'Petroleum Installations' and 'Oil Refineries' were taken into account;
- for source 1A1b 'Petroleum Refining', the emission factor for CO_2 has been updated;
- Source 1A1c 'Manufacture of Solid Fuels and Other Energy Industries' (charcoal production) was excluded from the inventory due to the lack of information associated with energy consumption (exclusion of category 1A1c from the national inventory contributed to the significant reduction of GHG emissions from category 1A1 for the period 2004-2016);
- liquefied petroleum gases were reallocated to gaseous fuels (in the previous inventory cycle, LPG was allocated to liquid fuels).

In comparison with the results included into the BUR2 of the RM to the UNFCCC (2019), the recalculation performed in the current inventory cycle resulted in a slight increase of direct GHG emissions between 1990 and 2003, varying from a minimum increase by 0.2 per cent in 1992, to a maximum increase by circa 0.9 per cent in 2001; and a decrease of direct GHG emissions between 2004 and 2016, varying from a minimum decrease by 2.1 per cent in 2013 to a maximum decrease by 30.8 per cent in 2009 (Table 3-47).

Table 3-47: Recalculation results of GHG emissions from 1A1 'Energy Industries' category included into the BUR2 of the RM to the UNFCCC (2019), within 1990-2016 periods, kt CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	21,308.2056	18,946.2276	15,676.6204	12,640.0753	9,959.3444	7,160.4871	7,091.6162	5,593.3867	4,814.4638	3,637.4006
BUR3	21,364.2413	18,984.1702	15,706.2560	12,679.1754	9,992.5601	7,192.4074	7,124.4109	5,625.6671	4,844.6778	3,664.6852
Difference, %	0.3	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	3,132.4649	3,649.2979	2,917.1561	3,022.5275	3,339.5735	3,391.2173	2,621.2236	3,163.5834	3,777.6673	5,035.4915
BUR3	3,159.3286	3,681.9284	2,936.7953	3,040.3820	3,112.7641	3,235.4860	2,497.5390	2,897.8280	3,001.1558	3,849.7472
Difference, %	0.9	0.9	0.7	0.6	-7.3	-4.8	-5.0	-9.2	-25.9	-30.8
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	4,983.8288	4,614.9116	4,603.3054	3,686.7824	4,358.3979	4,744.8255	4,526.0607			
BUR3	4,059.6277	3,757.1773	3,814.5475	3,610.9821	3,566.5248	3,689.9589	3,648.6333	2,886.8208	3,180.5484	3,123.5171
Difference, %	-22.8	-22.8	-20.7	-2.1	-22.2	-28.6	-24.0			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR3 – Third Biennial Update Report of the RM under the UNFCCC.

Between 2017 and 2019, direct GHG emissions from source category 1A1 were estimated for the first time. The direct GHG emissions from category 1A1 'Energy Industries' had decreased within 1990-2019 periods by circa 85.4 per cent.

3.2.6. Planned Improvements

Potential improvements within the 1A1 'Energy Industries' category could be possible once new AD regarding the fuel consumption for electricity and heat generation on the territory of the LBDR are available (filling the gaps for certain years). Also, another potential improvement could be identifying additional AD sources or updating AD from official statistical publications.

3.3. Manufacturing Industries and Construction (Category 1A2)

3.3.1. Source Category Description

GHG emissions from 1A2 'Manufacturing Industries and Construction' are a result of fuel combustion within the manufacturing industries of the Republic of Moldova (except for emissions from technological processes taken into account under the Sector 2 'IPPU').

Direct GHG emissions from 1A2 'Manufacturing Industries and Construction' are monitored within the following source categories (which, correspond to the ISIC Rev. 3.1[54]):

1A2a 'Iron and Steel' (ISIC Group 271, Class 2731);

1A2b 'Non-Ferrous Metals' (ISIC Group 272, Class 2732);

1A2c 'Chemicals' (ISIC Division 24);

1A2d 'Pulp, Paper and Print' (ISIC Divisions 21 and 22);

1A2e 'Food Processing, Beverages and Tobacco' (ISIC Divisions 15 and 16);

1A2f 'Non-Metallic Minerals' (glass, ceramic, cement) (ISIC Division 26);

1A2g 'Transport Equipment' (ISIC Divisions 34 and 35);

1A2h 'Machinery' (ISIC Divisions 28, 29, 30, 31 and 32);

1A2i 'Mining (excluding fuels) and Quarrying' (ISIC Divisions 13 and 14);

1A2j 'Wood and Wood Products' (ISIC Division 20);

1A2k 'Construction' (ISIC Division 45);

1A2l 'Textile and Leather' (ISIC Divisions 17, 18 and 19);

1A2m 'Non-specified Industry' (not included above) (ISIC Divisions 25, 33, 36 and 37), as well as the activity on the LBDR.

Between 1990 and 2019, the GHG emissions from category 1A2 'Manufacturing Industries and Construction' tended to decrease by circa 67.5 per cent: from circa 1923.38 kt CO_2 equivalent recorded in 1990, to circa 718.48 kt CO_2 equivalent in 2019 (Table 3-48, Figure 3-17).

[54] ISIC Rev.3.1 (International Standard Industrial Classification of All Economic Activities, Rev.3.1) (<https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=17>)

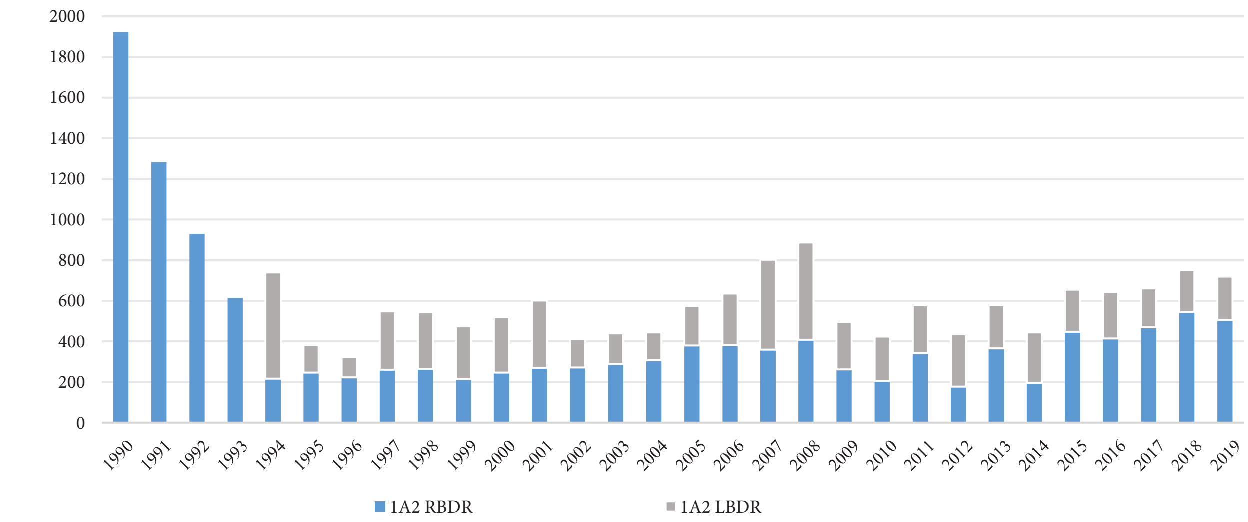

Figure 3-17: GHG emissions from 1A2 'Manufacturing Industries and Construction' category in the RM, by regions, within 1990-2019 periods, kt CO_2 equivalent.

Table 3-48: GHG emissions from 1A2 'Manufacturing Industries and Construction' category in the RM by regions, within 1990-2019 periods, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A2 RB	1923.38	1282.16	929.85	614.15	216.08	245.87	222.96	259.98	265.28	215.83
1A2 LB	IE	IE	IE	IE	523.08	136.37	99.08	288.06	278.56	258.78
1A2 RM	**1923.38**	**1282.16**	**929.85**	**614.15**	**739.16**	**382.23**	**322.04**	**548.04**	**543.84**	**474.61**
1A2 RB, %	100.0	100.0	100.0	100.0	29.2	64.3	69.2	47.4	48.8	45.5
1A2 LB, %	IE	IE	IE	IE	70.8	35.7	30.8	52.6	51.2	54.5
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
1A2 RB	246.69	270.29	271.79	289.25	307.90	380.32	380.89	359.46	408.56	261.73
1A2 LB	273.61	331.79	139.18	150.21	136.71	194.89	254.60	442.27	478.63	233.92
1A2 RM	**520.30**	**602.09**	**410.97**	**439.46**	**444.61**	**575.22**	**635.49**	**801.73**	**887.19**	**495.65**
1A2 RB, %	47.4	44.9	66.1	65.8	69.3	66.1	59.9	44.8	46.1	52.8
1A2 LB, %	52.6	55.1	33.9	34.2	30.7	33.9	40.1	55.2	53.9	47.2
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1A2 RB	206.23	341.98	176.99	365.63	196.66	307.56	257.43	307.52	384.60	505.05
1A2 LB	217.08	235.27	257.61	212.00	248.03	206.73	229.54	192.10	206.15	213.43
1A2 RM	**423.31**	**577.25**	**434.60**	**577.63**	**444.69**	**514.28**	**486.97**	**499.62**	**590.75**	**718.48**
1A2 RB, %	48.7	59.2	40.7	63.3	44.2	59.8	52.9	61.6	65.1	70.3
1A2 LB, %	51.3	40.8	59.3	36.7	55.8	40.2	47.1	38.4	34.9	29.7

Abbreviations: RB – Right Bank of the Dniester River; LB – Left Bank of the Dniester River; RM – aggregate for the Republic of Moldova; IE – included elsewhere.

GHG emission trends from category 1A2 'Manufacturing Industries and Construction' for the period 1990-2019 for each industry are presented in Table 3-49.

Table 3-49: GHG emissions from 1A2 'Manufacturing Industries and Construction' category for the RBDR, by industries, within 1990-2019 periods, kt CO_2 equivalent

	1A2a	1A2c	1A2d	1A2e	1A2f	1A2g	1A2h	1A2i	1A2j	1A2k	1A2l	1A2m	1A2
1990	140.6568	19.5532	NO	214.5734	1419.9593	NO	80.4099	8.6644	9.1108	10.0462	20.4039	NO	1,923.3779
1991	NO	NO	NO	174.2189	1024.8992	NO	65.8768	NO	7.6492	9.5189	NO	NO	1,282.1630
1992	NO	NO	NO	133.8644	729.4423	NO	51.361	NO	6.1877	8.9916	NO	NO	929.8471
1993	0.9693	NO	NO	94.2018	433.9853	NO	37.255	NO	4.7261	10.1017	0.5940	32.3149	614.1484
1994	NO	NO	NO	61.1426	138.5284	NO	10.146	NO	0.0563	6.2101	NO	NO	739.1596
1995	37.3650	0.1364	3.6819	94.0572	160.0848	NO	31.197	NO	1.9092	13.9831	20.1825	19.6371	382.2342
1996	27.9411	0.0991	1.9816	97.6775	127.1931	NO	17.568	NO	0.8917	13.4161	19.8164	15.4568	322.0417
1997	101.6860	0.2881	5.1851	118.2599	173.3511	NO	41.425	NO	1.4403	22.5771	45.8019	38.0242	548.0393
1998	91.6447	5.5711	4.1783	130.1451	161.5925	NO	28.061	NO	1.3928	19.3022	63.2321	38.7192	543.8396
1999	94.7138	4.9168	3.1054	86.2915	153.3218	NO	21.762	NO	1.0351	16.3019	57.7081	35.4530	474.6097
2000	97.6794	5.1986	4.9250	80.6927	185.0696	NO	25.749	NO	1.6417	9.6263	80.7154	29.0028	520.3009
2001	117.7871	4.3133	7.9631	85.9993	201.9861	NO	29.856	NO	3.6497	11.1799	98.5430	40.8107	602.0890
2002	27.2798	1.6702	0.5567	60.5383	219.2179	NO	11.226	NO	1.8094	8.5026	41.4764	38.6928	410.9707
2003	47.0160	1.8025	2.2855	87.4103	216.8802	NO	13.645	NO	1.8025	5.8344	26.4371	36.3510	439.4649
2004	45.9845	2.4726	2.5367	68.4748	241.7923	NO	13.646	NO	1.5575	9.3788	25.7320	33.0389	444.6143
2005	67.1921	3.3682	3.1645	76.3172	311.4929	NO	18.8296	0.2246	2.1143	7.9688	38.6981	45.8448	575.2151
2006	76.2617	4.7540	3.9984	90.6463	309.2993	0.5054	25.9219	NO	1.9461	16.7199	59.8435	45.5894	635.4857
2007	206.1922	4.8802	3.7345	86.2114	304.3629	NO	32.835	0.1123	1.2742	46.3646	60.2408	55.5183	801.7268
2008	215.2922	5.5404	4.2436	98.1884	338.7939	NO	31.796	0.0562	0.7846	58.0943	59.2849	75.1141	887.1888

	1A2a	1A2c	1A2d	1A2e	1A2f	1A2g	1A2h	1A2i	1A2j	1A2k	1A2l	1A2m	1A2
2009	74.8546	3.7728	2.8371	54.5964	220.3261	NO	13.597	NO	0.2339	9.3773	38.8609	77.1938	495.6502
2010	40.9169	3.9150	3.0107	69.1545	147.6620	NO	17.777	NO	0.6509	17.0491	48.8394	74.3346	423.3105
2011	53.5394	5.8573	5.6232	73.4904	277.4338	NO	19.524	NO	0.6402	16.2316	48.4439	76.4697	577.2543
2012	65.1756	5.8822	3.5244	80.9129	112.5034	NO	18.864	NO	1.2633	18.9315	46.9123	80.6308	434.6008
2013	31.8033	7.4597	3.6684	82.4977	303.8729	NO	17.753	NO	4.6356	14.9037	51.6729	59.3598	577.6270
2014	67.4647	6.5891	3.8092	92.4696	122.3674	NO	10.913	NO	2.4037	23.9394	34.8648	79.8663	444.6875
2015	49.8211	4.5225	4.1221	81.6245	240.5578	0.0019	9.3983	NO	0.2320	13.6166	27.0195	83.3669	514.2832
2016	41.7760	6.1805	3.4402	94.0420	180.7082	0.6362	11.336	NO	0.2392	15.7188	33.6584	99.2297	486.9655
2017	60.5114	4.8981	1.0019	91.8461	231.4392	0.1143	10.117	NO	0.2624	14.3459	25.0488	60.0337	499.6196
2018	65.7615	6.2899	3.0778	103.7051	293.0296	0.3950	11.393	0.0645	0.2803	16.0844	27.3414	63.3245	590.7479
2019	56.1733	7.4266	3.1631	91.9510	282.4785	0.7901	14.196	0.2808	0.1967	16.1377	28.0760	217.6057	718.4760

Note: For the year 1994, the value for the LBDR is presented in aggregate, as disaggregation by industry has been available only since 1995.

Shares in the structure of total direct GHG emissions are the following: CO_2 – 37.4 per cent, CH_4 – 43.9 per cent, and N_2O – 2.6 per cent, total – 37.3 per cent compared to 1990 level (Table 3-50).

Table 3-50: Direct GHG emissions from 1A2 'Manufacturing Industries and Construction' for the period 1990-2019

	1A2, kt CO_2 equivalent				%, compared to 1990			
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total
1990	1 923.38	2.16	4.39	1,929.93	100.0	100.0	100.0	100.0
1991	1 282.16	1.36	2.85	1,286.38	66.7	63.1	65.0	66.7
1992	929.85	1.00	2.06	932.90	48.3	46.2	46.9	48.3
1993	614.15	0.67	1.35	616.17	31.9	31.0	30.9	31.9
1994	216.08	0.22	0.38	216.67	11.2	10.0	8.6	11.2
1995	382.23	0.29	0.44	382.96	19.9	13.2	10.1	19.8
1996	322.04	0.29	0.47	322.80	16.7	13.2	10.7	16.7
1997	548.04	0.45	0.68	549.17	28.5	21.0	15.5	28.5
1998	543.84	0.47	0.71	545.02	28.3	21.5	16.3	28.2
1999	474.61	0.32	0.46	475.39	24.7	14.9	10.5	24.6
2000	520.30	0.30	0.41	521.01	27.1	13.8	9.5	27.0
2001	602.09	0.37	0.55	603.01	31.3	17.0	12.6	31.2
2002	410.97	0.24	0.33	411.54	21.4	11.1	7.6	21.3
2003	439.46	0.24	0.33	440.04	22.8	11.1	7.5	22.8
2004	444.61	0.29	0.41	445.31	23.1	13.3	9.4	23.1
2005	575.22	0.33	0.46	576.00	29.9	15.4	10.4	29.8
2006	635.49	0.33	0.45	636.27	33.0	15.4	10.2	33.0
2007	801.73	0.39	0.50	802.62	41.7	18.1	11.3	41.6
2008	887.19	0.84	1.33	889.36	46.1	38.9	30.4	46.1
2009	495.65	0.54	0.87	497.06	25.8	24.8	19.9	25.8
2010	423.31	0.30	0.44	424.06	22.0	13.9	10.1	22.0
2011	577.25	0.66	1.07	578.98	30.0	30.4	24.4	30.0
2012	434.60	0.28	0.39	435.27	22.6	12.9	8.8	22.6
2013	577.63	0.75	1.24	579.62	30.0	34.6	28.3	30.0
2014	444.69	0.35	0.53	445.56	23.1	16.1	12.0	23.1
2015	514.28	0.63	1.03	515.95	26.7	29.3	23.6	26.7
2016	486.97	0.48	0.77	488.21	25.3	22.3	17.5	25.3
2017	499.62	0.53	0.87	501.02	26.0	24.5	19.9	26.0
2018	590.75	0.56	0.93	592.24	30.7	25.9	21.3	30.7
2019	718.48	0.95	0.11	719.54	37.4	43.9	2.6	37.3

Compared to the year 1990, the level of GHG emissions from 1A2 'Manufacturing Industries and Construction' constituted, towards 2019, regarding direct GHG emissions: CO_2 – 37.4 per cent; CH_4 – 43.9 per cent; NO_x – only 17.2 per cent compared to the reference year; whereas indirect GHG emissions: N_2O – 35.3 per cent; CO – 43.8 per cent; NMVOC – 54.6 per cent; SO_x – 34.3 per cent. (Table 3-51).

Table 3-51: Direct and indirect GHG emissions from category 1A2 'Manufacturing Industries and Construction' for the period 1990-2019

	1A2, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1990	1,916.8273	0.0866	0.0147	9.0489	3.4763	0.8788	2.6881	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	1,277.9476	0.0546	0.0096	6.5424	1.7479	0.5482	1.2265	66.7	63.1	65.0	72.3	50.3	62.4	45.6
1992	926.7893	0.0399	0.0069	4.5977	1.3236	0.4070	0.9321	48.4	46.2	46.9	50.8	38.1	46.3	34.7
1993	612.1245	0.0268	0.0045	2.8759	0.9478	0.2790	0.6765	31.9	31.0	30.9	31.8	27.3	31.7	25.2
1994	738.0581	0.0179	0.0022	1.2535	0.7234	0.3230	0.3553	38.5	20.7	14.9	13.9	20.8	36.8	13.2
1995	381.5061	0.0114	0.0015	0.6870	0.5581	0.1795	0.3662	19.9	13.2	10.1	7.6	16.1	20.4	13.6
1996	321.2863	0.0115	0.0016	0.6490	0.6323	0.1600	0.4747	16.8	13.2	10.7	7.2	18.2	18.2	17.7
1997	546.9038	0.0181	0.0023	0.9180	0.7370	0.2841	0.3965	28.5	21.0	15.5	10.1	21.2	32.3	14.7

	1A2, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1998	542.6603	0.0186	0.0024	1.0266	0.7118	0.3020	0.3295	28.3	21.5	16.3	11.3	20.5	34.4	12.3
1999	473.8274	0.0129	0.0015	0.7360	0.4969	0.2249	0.2275	24.7	14.9	10.5	8.1	14.3	25.6	8.5
2000	519.5881	0.0119	0.0014	0.7914	0.4871	0.2261	0.2274	27.1	13.8	9.5	8.7	14.0	25.7	8.5
2001	601.1675	0.0147	0.0019	1.1500	0.5744	0.2598	0.2825	31.4	17.0	12.6	12.7	16.5	29.6	10.5
2002	410.3969	0.0096	0.0011	0.6019	0.4089	0.1809	0.2019	21.4	11.1	7.6	6.7	11.8	20.6	7.5
2003	438.8946	0.0096	0.0011	0.6697	0.3867	0.1868	0.1729	22.9	11.1	7.5	7.4	11.1	21.3	6.4
2004	443.9172	0.0115	0.0014	0.7048	0.4457	0.2047	0.2038	23.2	13.3	9.4	7.8	12.8	23.3	7.6
2005	574.4257	0.0133	0.0015	0.8636	0.4932	0.2545	0.1904	30.0	15.4	10.4	9.5	14.2	29.0	7.1
2006	634.7036	0.0134	0.0015	0.9501	0.4873	0.2692	0.1704	33.1	15.4	10.2	10.5	14.0	30.6	6.3
2007	800.8383	0.0156	0.0017	1.1306	0.5048	0.3350	0.0992	41.8	18.1	11.3	12.5	14.5	38.1	3.7
2008	885.0132	0.0337	0.0045	1.3642	2.2677	0.4690	1.8481	46.2	38.9	30.4	15.1	65.2	53.4	68.8
2009	494.2397	0.0215	0.0029	0.7591	1.5897	0.2773	1.3676	25.8	24.8	19.9	8.4	45.7	31.6	50.9
2010	422.5661	0.0120	0.0015	0.6693	0.5900	0.1993	0.3732	22.0	13.9	10.1	7.4	17.0	22.7	13.9
2011	575.5238	0.0263	0.0036	0.9067	1.8629	0.3338	1.5813	30.0	30.4	24.4	10.0	53.6	38.0	58.8
2012	433.9361	0.0111	0.0013	0.6347	0.4237	0.2029	0.1794	22.6	12.9	8.8	7.0	12.2	23.1	6.7
2013	575.6355	0.0299	0.0042	0.8821	2.2984	0.3553	2.0310	30.0	34.6	28.3	9.7	66.1	40.4	75.6
2014	443.8148	0.0139	0.0018	0.6822	0.7672	0.2183	0.5408	23.2	16.1	12.0	7.5	22.1	24.8	20.1
2015	512.6156	0.0253	0.0035	0.7978	1.8079	0.3136	1.5446	26.7	29.3	23.6	8.8	52.0	35.7	57.5
2016	485.7169	0.0193	0.0026	0.7463	1.2679	0.2653	1.0236	25.3	22.3	17.5	8.2	36.5	30.2	38.1
2017	498.2146	0.0212	0.0029	0.9414	1.3692	0.2706	1.1302	26.0	24.5	19.9	10.4	39.4	30.8	42.0
2018	589.2532	0.0224	0.0031	1.2750	1.2408	0.2948	0.9570	30.7	25.9	21.3	14.1	35.7	33.5	35.6
2019	715.9769	0.0380	0.0052	1.5592	1.5227	0.4795	0.9228	37.4	43.9	35.3	17.2	43.8	54.6	34.3

3.3.2. Methodological Issues, Emissions Factor and Activity Data

GHG emissions originating from category 1A2 'Manufacturing Industries and Construction' were estimated following a Tier 1 methodology (Table 3-52).

Table 3-52: Methods and coefficients used for assessing direct GHG emissions originating from 1A2 'Manufacturing Industries and Construction' category

Category	CO_2				CH_4		N_2O	
	Method	Net Caloric Value, TJ/kt	Carbon Oxidation Fraction	EF, tC/TJ	Method	EF, kg/TJ	Method	EF, kg/TJ
1A2 Manufacturing Industries and Construction	T1	CS	1	D	T1	D	T1	D

Abbreviations: T1 – Tier 1; EF – Emission Factors; D - Default; CS – Country Specific.

Default EFs used in the 2006 IPCC Guidelines for the National Inventory of Greenhouse Gas Emissions (for the estimation of direct greenhouse gas emissions) and the EMEP/EEA Air Pollutant Emission Inventory re (2019) (for the estimation of indirect greenhouse gas emissions).

To ensure the natural conversion from natural measure units to energy units, country specific net calorific values were used. The value used for carbon oxidation fraction is recommended by the 2006 IPCC Guidelines. Default EFs available in the 2019 EMEP/EEA Guidebook were used for estimating non-CO_2 emissions (Table 3-53).

Table 3-53: Emission Factors used for the estimation of GHG emissions from 1A2 'Manufacturing Industries and Construction', kg/TJ

Fuel Categories	Fuels	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Biofuels	Fuel Wood and Wood Waste	112,000	30	4	91	570	300	11
	Other types of Solid Biomass	100,000	30	4	91	570	300	11
	Charcoal	112,000	200	4	91	570	300	11
Liquid Fuels	Aviation Gasoline	70,000	3	0.6	513	66	25	47
	Motor Gasoline	69,300	3	0.6	513	66	25	47
	Jet Kerosen	71,500	3	0.6	513	66	25	47
	Other Kerosene	71,900	3	0.6	513	66	25	47
	LPG	64,200	3	0.6	513	66	25	47
	Diesel Oil	74,100	3	0.6	513	66	25	47
	Residual Fuel Oil	77,400	3	0.6	513	66	25	47
	Other Petroleum Products	73,300	3	0.6	513	66	25	47
Gaseous Fuels	Natural Gas	56,100	1	0.1	74	29	23	0.67
Solid Fuels	Anthracite	98,300	10	1.5	173	931	88.8	900
	Other Bituminous Coal	94,600	10	1.5	173	931	88.8	900
	Lignite	101,000	10	1.5	173	931	88.8	900
	Brown Coal Briquettes	97,500	10	1.5	173	931	88.8	900
	Oven Coke and Lignite Coke	107,000	10	1.5	173	931	88.8	900

Source: CO_2, CH_4, N_2O – 2006 IPCC Guidelines, Chapter 'Stationary Combustion', Table 2.3; NO_x, CO, NMVOC, SO_x - EMEP/EEA Air Pollutant Emission Inventory (2019), Category 1.A.2, Tables 3-2, 3-3, 3-4 and 3-5.

Activity Data

The AD related to fuel consumption with energy purposes within the 1A2 'Manufacturing Industries and Construction' category were collected from the Energy Balances of the Republic of Moldova for the years 1990, 1993-2019, as well as from the statistical publications of the ATULBD (Table 3-54) for the entire sector.

Table 3-54: Fuel consumption for energy purposes within 1A2 'Manufacturing Industries and Construction' on the LBDR for the period 1994-2019

	1994	1995	1996	1997	1998	1999	2000	2001	2002
Natural Gas, million m³	275.10	71.72	52.11	151.50	146.50	136.10	143.90	174.50	73.20
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Natural Gas, million m³	79.00	71.90	102.50	133.90	232.60	250.50	121.90	113.50	123
Residual Fuel Oil, kt	NO	NO	NO	NO	NO	0.8715	0.5705	0.3208	0.3098
Bituminous Coal, kt	NO	NO	NO	NO	NO	0.0737	0.1473	0.1108	0.1102
Liquefied Petroleum Gases (LPG), kt	NO	NO	NO	NO	NO	NO	NO	NO	0.057
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
Natural Gas, million m³	134.90	110.8	129.7	108	120	100	108	112	-59.3
Residual Fuel Oil, kt	0.2581	0.3713	0.3713	0.3713	0.3713	0.3606	0.289	0.1269	-85.4
Bituminous Coal, kt	0.0840	0.0324	0.0722	0.0641	0.0622	0.335	0.0206	0.0151	-79.5
Liquefied Petroleum Gases (LPG), kt	0.0346	0.0291	0.0249	0.0204	0.0204	0.0133	0.011	0.0121	-78.8

Source: JSC "Moldovagaz" Letter to No. 06-1253 of 27.09.2006 and No. 02/1476 of 23.02.2011; 2011-2012 – JSC "Moldovagaz" Letter to No. 02/1-288 of 22.02.2014; 2013-2014 – JSC "Moldovagaz" Letter to No. 02/1-507 of 10.02.2015; 2015 – JSC "Moldovagaz" Letter to No. 02/1-2183 of 03.06.2016, answer to Letter No. 512/2016-05-01 of 10.05.2016; 2016 – "Moldovagaz" Letter to No. 03/2-74 of 12.01.2018, answer to Letter No. 601/2017-12-03 of 14.12.2017; 2017, 2018 – JSC "Moldovagaz" Letter to No. 03/4-676 of 03.03.2020, Letter to No. 08-310/1 of 11.02.2020.

Information regarding fuel consumption for each industry within the sector for RBDR is shown in Tables 3-55 – 3-59.

Table 3-55: Fuel consumption for energy purposes within 1A2a 'Iron and Steel' for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Coke	158	NO	NO	9	NO	NO	NO	NO	NO	NO
Natural Gas	2171	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Coke	NO	NO	NO	NO	3	5	6	5	3	NO
Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	1	NO
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Coke	3	5	NO	NO	NO	NO	NO	NO	NO	NO
Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	2
LPG	NO	1	NO	NO	NO	NO	NO	NO	NO	NO

Table 3-56: Fuel consumption for energy purposes within 1A2c 'Chemicals', including the pharmaceutical industry for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Residual Fuel Oil	80	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Petroleum Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural Gas	234	NO	NO	NO	NO	NO	NO	NO	NO	NO
Liquefied Petroleum Gases	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fuel Wood	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Residual Fuel Oil	NO	NO	NO	NO	1	1	NO	NO	NO	NO
Other Petroleum Products	NO	NO	NO	NO	NO	8	12	NO	NO	NO
Natural Gas	NO	NO	NO	NO	11	3	10	7	39	34
Liquefied Petroleum Gases	NO	NO	NO	NO	NO	NO	NO	1	NO	NO
Fuel Wood	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Residual Fuel Oil	NO	18	NO	18	NO	NO	NO	NO	NO	NO
Other Petroleum Products	NO	NO	NO	NO	NO	6	1	NO	NO	NO
Natural Gas	4	4	13	2	29	21	27	29	30	42
Liquefied Petroleum Gases	NO	NO	NO	NO	NO	NO	NO	NO	1	NO
Fuel Wood	NO	NO	NO	7	NO	NO	NO	NO	NO	NO
Agricultural Residues	NO	NO	NO	NO	NO	4	NO	2	3	2

Table 3-57: Fuel consumption for energy purposes within 1A2d 'Pulp, Paper and Print', for the period 1990-2019, TJ

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Jet Kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural Gas	NO	NO	NO	30	33	39	44	35	50	34
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	1
Jet Kerosene	1	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural Gas	33	75	49		59	55	49	11	51	47
Wood Waste	NO	NO	NO	NO	NO	NO	NO	NO	4	NO

Table 3-58: Fuel consumption for energy purposes within 1A2e 'Food Processing, Beverages and Tobacco', for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Anthracite	80	56	33	9	NO	NO	NO	NO	29	NO
Other types of Bituminous Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coke	634	549	463	378	323	352	381	323	264	205
Fuel for oven	468	329	189	50	59	29	88	117	59	117
Residual Fuel Oil	563	499	434	370	235	264	264	147	205	88
Jet Kerosene	647	494	341	188	29	NO	NO	NO	29	NO
Other Petroleum Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural Gas	67	70	73	76	29	117	235	323	352	293
Liquefied Petroleum Gases	NO	NO	NO	6	NO	NO	NO	NO	NO	NO
Fuel Wood	126	105	83	62	NO	29	29	29	24.64	12.32
Wood Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other types of fuel	NO	NO	NO	NO	NO	NO	NO	117	59	59
Pellets and Briquettes from Vegetable Waste	NO	NO	NO	NO	NO	NO	NO	NO	59	NO
Biogas	NO	NO	NO	NO	NO	NO	NO	NO	29	NO
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anthracite	29	29	28	29	133	167	156	77	78	53.4
Other types of Bituminous Coal	NO	NO	NO	NO	NO	1	NO	NO	NO	NO
Coke	176	235	184.87	147	51	1	NO	NO	2	NO
Fuel for oven	117	117	86	29	25	16	8	4	15	NO
Residual Fuel Oil	88	117	NO	117	140	121	122	54	90	NO
Jet Kerosene	NO	NO	NO	NO	5	10	NO	NO	NO	NO
Other Petroleum Products	NO	NO	NO	NO	4	NO	NO	NO	NO	NO
Liquefied Petroleum Gases	NO	NO	NO	29	5	7	18	5	5	NO
Fuel Wood	12.32	12.32	12.32	NO	7	10	5	3	2	NO
Wood Waste	NO	NO	NO	NO	33	20	NO	3	3	NO
Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other types of fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Pellets and Briquettes from Vegetable Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Anthracite	70	78	94	78	117	56	63	49	60	38
Other types of Bituminous Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fuel for oven	6	4	2	NO	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	6	9	6	NO	35	17	67	29	17	5
Jet Kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Liquefied Petroleum Gases	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural Gas	565	644	710	676	705	869	909	1021	1186	974
Liquefied Petroleum Gases	48	2	11	5	71	7	8	7	17	17
Fuel Wood	2	3	6	7	12	15	10	8	16	9
Wood Waste	2	2	1	NO	NO	1	NO	NO	NO	NO
Agricultural Residues	NO	1	1	8	NO	NO	NO	5	4	3
Other types of fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Pellets and Briquettes from Vegetable Waste	NO	NO	NO	NO	NO	27	18	20	29	3

Table 3-59: Fuel consumption for energy purposes within 1A2f 'Non-Metallic Minerals', for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Anthracite	828	NO	NO	NO	NO	NO	29	29	29	29
Lignite	12	16	20	25	29	NO	NO	NO	NO	NO
Other Bituminous Coal	NO	NO	NO	NO	NO	NO	59	30	NO	NO
Coke	79	NO	NO	NO	NO	29	29	29	NO	NO
Fuel for oven	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	13266	9994	6721	3449	176	59	59	59	59	NO
Natural Gas	5077	4351	3624	2898	2171	2699	1966	2817	2729	2670
Liquefied Petroleum Gases	46	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fuel Wood	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Wood Waste	29	NO	NO	NO	NO	NO	NO	NO	NO	NO
Pellets and Briquettes from Vegetable Waste	NO	NO	NO	NO	NO	NO	NO	NO	29	NO
Biogas	NO	NO	NO	NO	NO	NO	NO	NO	29	NO

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	148	27
Lignite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Bituminous Coal	29	NO	NO	NO	14	14	NO	NO	1795	1374
Coke	NO	NO	NO	NO	NO	NO	1	2	NO	53
Fuel for oven	NO	NO	NO	NO	1	5	3	3	1	NO
Residual Fuel Oil	NO	NO	NO	30	22	25	27	30	19	40
Natural Gas	3227	2934	3894	3810	4242	5474	5450	5346	2695	1388
Liquefied Petroleum Gases	NO	557	NO	NO	3	1	1	1	3	NO
Fuel Wood	NO	NO	NO	NO	NO	NO	NO	NO	2	NO
Wood Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Pellets and Briquettes from Vegetable Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Anthracite	199	1655	60	2166	416	2	1	NO	3	NO
Lignite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Bituminous Coal	NO	NO	NO	NO	NO	1646	915	1161	926	866
Coke	121	NO	28	2	52	NO	141	NO	NO	NO
Other Coal Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	27
Fuel for oven	3	NO	NO	NO	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	38	28	7	NO	NO	13	8	7	NO	8
Natural Gas	1989	1983	1832	1589	1346	1469	1382	1318	1777	1528
Liquefied Petroleum Gases	1	1	2	NO	NO	NO	NO	NO	NO	NO
Fuel Wood	NO	NO	NO	NO	NO	NO	NO	NO	NO	1
Wood Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Pellets and Briquettes from Vegetable Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Charcoal	NO	NO	NO	NO	NO	NO	NO	1	1	NO
Petroleum coke	NO	NO	NO	NO	NO	NO	NO	473	1071	1135

Aggregate fuel consumption data for industries within source categories 1A2g 'Transport Equipment', 1A2h 'Machinery', 1A2i 'Mining and Quarrying' (excluding fuels), 1A2j 'Wood and Wood Products', 1A2k 'Construction', 1A2l 'Textile and Leather', and 1A2m 'Non-specified Industry', which are not included in the above categories or for which no individual data is available, fuel consumption is transferred from source category 1A1aii 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants' – energy producers for own consumption for the RBDR between 2015 and 2019, as well as fuel consumption on the LBDR, are shown in Table 3-60. The analysis of the total quantities indicates an increase in fuel consumption in this aggregate category, in particular with reference to the consumption of natural gas and residual fuel oil.

Table 3-60: Aggregate fuel consumption for energy purposes within 1A2 'Manufacturing Industries' for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Anthracite	214	NO	NO	9	NO	NO	NO	NO	NO	NO
Other Bituminous Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coke	158	124	90	56	NO	NO	NO	NO	NO	NO
Natural Gas	1201.81	827.54	485.27	176	9402.89	2692.44	1910.44	5275.79	5077.49	4725.35
Liquefied Petroleum Gases	46	NO	NO	3	3	NO	NO	NO	NO	NO
Jet Kerosene	NO	NO	NO	3	NO	NO	NO	NO	NO	NO
Fuel for oven	NO	NO	NO	12	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	160.4	258.93	359.47	851	147	59	88	88	59	29
Other Petroleum Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Pellets and Briquettes from Vegetable Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fuel Wood	9	NO	NO	NO	NO	NO	NO	NO	NO	NO
Wood Waste	147	120	94	70	29	NO	NO	NO	NO	NO
Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anthracite	NO	NO	NO	NO	2	2	1	1	NO	2
Other Bituminous Coal	NO	NO	NO	NO	NO	NO	NO	NO	1.87	3.77
Coke	NO	NO	NO	NO	4	2	4	4	4	NO
Natural Gas	4960.45	5996.57	2546.27	2732.94	2509.53	3564.65	4653.85	7975.84	8662.77	4167.39
Liquefied Petroleum Gases	NO	NO	NO	NO	4	11	9	15	21	12
Jet Kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fuel for oven	NO	NO	NO	NO	NO	NO	5	4	2	NO
Residual Fuel Oil	29	29	40.2	NO	40	17	48	55	72.04	59.93
Other Petroleum Products	NO	NO	NO	NO	NO	1	NO	NO	NO	NO
Pellets and Briquettes from Vegetable Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fuel Wood	NO	NO	NO	NO	2	1	2	3	3	NO
Wood Waste	NO	NO	NO	NO	11	10	7	10	23	NO
Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Anthracite	NO	NO	NO	NO	1	59	58	64	112	5
Other Bituminous Coal	2.82	2.80	2.14	0.82	1.96	12.63	13.58	15.17	33.35	0.38
Coke	2	2	2	NO	NO	1	2	1	1	NO
Natural Gas	3927.11	4270.78	4660.71	3950.69	4515.64	5715.88	6153.2	5632	5375.88	6303.32
Liquefied Petroleum Gases	17	62.6	59.6	47.34	13.15	12.94	17.94	15.61	15.51	12.56
Jet Kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fuel for oven	17	NO	NO	NO	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	49.90	49.42	47.38	51.93	51.93	51.93	560.93	484.47	336.83	160.1
Other Petroleum Products	NO	NO	NO	NO	NO	1	1	3	1	1
Pellets and Briquettes from Vegetable Waste	NO	NO	NO	NO	NO	34	64	125	110	135
Fuel Wood	9	12	10	8	2	18	23	6	5	3
Wood Waste	69	79	81	17	27	17	2	7	26	2
Agricultural Residues	NO	4		2	1	341	290	234	385	362
Biogas	NO	NO	NO	NO	NO	387	359	198	163	166

Table 3-61 shows the share of industrial branches in the structure of industrial production on the LBDR, in % from the total.

Table 3-61: Share of industrial branches in the structure of industrial production on the LBDR, in % from the total

	1994	1995	1996	1997	1998	1999	2000	2001	2002
1A2a Iron and Steel	N/A	27.4	28.2	35.3	32.9	36.6	35.7	35.5	19.6
1A2c Chemicals	N/A	0.1	0.1	0.1	2	1.9	1.9	1.3	1.2
1A2d Pulp, Paper and Print	N/A	2.7	2	1.8	1.5	1.2	1.8	2.4	0.4
1A2e Food Processing, beverages and Tobacco	N/A	19.7	16.5	15.6	13.2	12.4	9.2	7.1	10.3
1A2f Non-Metallic Minerals	N/A	0.6	0.6	0.6	0.3	0.2	0.4	0.4	0.4
1A2h Machinery	N/A	13.2	11.1	12.1	8.3	6.5	8.2	8	6.7
1A2j Wood and Wood Products	N/A	1.4	0.9	0.5	0.5	0.4	0.6	1.1	1.3
1A2k Construction	N/A	5.7	5	4.9	4.7	4.8	2.1	2.2	2.5
1A2l Textile and leather	N/A	14.8	20	15.9	22.7	22.3	29.5	29.7	29.8
1A2m Energy Industries	N/A	14.4	15.6	13.2	13.9	13.7	10.6	12.3	27.8
	2003	2004	2005	2006	2007	2008	2009	2010	2011
1A2a Iron and Steel	31.3	33.4	34.2	29.7	46.5	44.9	32	18.7	22.5
1A2c Chemicals	1.2	1.3	1.3	1.3	1	0.7	0.8	1.7	1.8
1A2d Pulp, Paper and Print	0.4	0.5	0.5	0.6	0.4	0.3	0.4	0.5	
1A2e Food Processing, beverages and Tobacco	12.9	10.5	9.9	13.5	10	10.5	9.7	12.2	12.1
1A2f Non-Metallic Minerals	0.4	0.2	0.2	0.3	0.3	0	0	0	0
1A2h Machinery	8	8.1	8.4	9.3	6.8	6.1	5	7.3	7
1A2j Wood and Wood Products	1.2	1	0.8	0.6	0.2	0.1	0.1	0.1	0.1
1A2k Construction	2.8	2.8	2.1	3.5	8.9	11.1	3.2	3.6	4.2
1A2l Textile and leather	17.6	18.2	19.4	23.4	13.5	12.2	15.8	21.8	19.3
1A2m Energy Industries	24.2	24	23.2	17.8	12.4	14.1	33	34.1	32.4
	2012	2013	2014	2015	2016	2017	2018	2019	2020
1A2a Iron and Steel	25.3	14.9	27.2	24.1	18.2	31.5	31.9	26.3	N/A
1A2c Chemicals	2	2.8	2	1.4	2	1.7	2.2	2.4	N/A
1A2d Pulp, Paper and Print	0.3	0.3	0.2	0.5	0.3	0.2	0.1	0.2	N/A
1A2e Food Processing, beverages and Tobacco	11.8	17.2	13.7	12.3	13.5	14.0	13.9	15.0	N/A
1A2f Non-Metallic Minerals	0	0	0	0	0	0	0	0	N/A
1A2h Machinery	6.8	7.5	4.4	4.3	4.4	4.8	4.7	6.1	N/A
1A2j Wood and Wood Products	0.2	0.4	0.3	0.1	0.1	0.1	0.1	0.1	N/A
1A2k Construction	4.7	5.4	6.6	4.8	6	5.4	5.5	5.0	N/A
1A2l Textile and leather	17.8	23.5	13.4	12.2	14.1	12.6	11.9	11.7	N/A
1A2m Energy Industries	31.1	28	32.2	40.3	41.4	29.7	29.7	33.4	N/A

AD on total fuel consumption within 1A2 'Manufacturing Industries and Construction' for the Right Bank of the Dniester River and reallocated data from the categories 1A1aii 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants' is available in Table 3-62.

Table 3-62: Total consumption by fuel groups for energy purposes within category 1A2 'Manufacturing Industries and Construction' on the RBDR for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Solid Fuels	2,163.0	745.0	606.0	489.0	352.0	381.0	498.0	411.0	322.0	234.0
Gaseous Fuels	8,751.0	5,249.0	4,182.0	3,150.0	2,288.0	3,080.0	2,347.0	3,286.0	3,198.0	3,080.0
Liquid Fuels	15,276.4	11,574.3	8,045.1	4,935.0	646.0	411.0	499.0	528.0	470.0	293.0
Biofuels	311.0	224.7	177.3	132.0	29.0	29.0	29.0	29.0	170.6	12.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Solid Fuels	234.0	264.0	212.9	176.0	207.0	192.0	168.0	89.0	2,030.0	1,509.4
Gaseous Fuels	3,638.0	3,315.0	4,266.4	4,543.0	4,747.0	6,117.0	6,151.0	6,014.0	3,537.0	1,969.9
Liquid Fuels	234.0	820.0	126.2	205.0	256.0	223.0	255.0	174.0	198.0	40.0
Biofuels	12.3	12.3	12.3	NO	53.0	41.0	14.0	19.0	33.0	NO

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Solid Fuels	15,184.4	11,574.3	8,045.1	4,923.0	646.0	411.0	499.0	411.0	411.0	234.0
Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO	NO	88.0	NO
Liquid Fuels	4,329.0	2,856.0	2,692.0	2,552.0	2,375.0	2,376.0	2,494.0	2,408.0	2,378.0	2,233.0
Biofuels	21,693.4	18,198.9	14,829.9	11,994.0	7,889.0	8,977.0	9,108.0	8,841.0	8,413.6	5,833.6

Primary data associated with aviation gasoline and jet gasoline, previously assigned to category 1A2 'Manufacturing Industries and Construction', has been reallocated in the current inventory cycle to category 1A3a 'Civil Aviation', as well as quantities of motor diesel and gasoline, originally under category 1A2, have been reallocated to category 1A3b 'Road Transportation' (Table 3-63).

Table 3-63: Reallocated fuels from category 1A2 'Manufacturing Industries and Construction' to category 1A3a 'Civil Aviation', TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Aviation gasoline	NO	NO	NO	12	NO	NO	NO	NO	NO	NO	NO	NO	NO
Jet Gasoline	299	121	73	27	NO	NO	NO	NO	NO	NO	NO	NO	NO
Kerosene	647	494	341	191	29	NO	NO	NO	29	NO	NO	NO	NO
Motor gasoline	NO	NO	NO	NO	NO	NO	NO	NO	264	NO	NO	NO	NO
Total	**946**	**615**	**414**	**230**	**29**	**NO**	**NO**	**NO**	**293**	**NO**	**NO**	**NO**	**NO**
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Aviation gasoline	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Jet Gasoline	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Kerosene	NO	5	10	NO	NO	NO	NO	1	NO	NO	NO	NO	NO
Motor gasoline	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	2	NO
Total	**NO**	**5**	**10**	**NO**	**NO**	**NO**	**NO**	**1**	**NO**	**NO**	**NO**	**2**	**NO**

3.3.3. Uncertainties Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the category 1A2 'Manufacturing Industries and Construction', and quality of available activity data.

Uncertainties associated with EFs are estimated at circa 5 per cent for CO_2 emissions, and up to ±50 per cent for CH_4 and N_2O emissions, respectively. Uncertainties associated with statistical data regarding fuel consumption within the 'Manufacturing Industries and Construction' represent circa 5 per cent for CO_2 and CH_4 emissions, and circa 3 per cent for N_2O emissions. The combined uncertainties presented as a percentage of the total direct GHG from 1A2 'Manufacturing Industries and Construction', were estimated at around 7.1 per cent. Uncertainties in the trend of total direct GHG emissions from sector 1A2 were estimated at around 2.6 per cent (Annex 5-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

3.3.4. Quality Assurance and Quality Control

A standard verification and quality control form and check-list were filled in for the 1A2 'Manufacturing Industries and Construction' following the Tier 1 approach.

The AD and methods used to estimate GHG emissions under category 1A2 'Manufacturing Industries and Construction' are documented and archived both in hard copies and electronically. To identify the data entry and emission estimation process related errors regarding the assessment of GHG emissions, there were applied verifications and quality control procedures and EFs, including:

- Verification of AD collecting and manipulation procedures, including: verifying whether disaggregation of AD collected for each source included in 1A2 'Manufacturing Industries and Construction' complies with the requirements set out in the description of each source in the 2006 IPCC Guidelines (in the current inventory cycle, GHG emissions were calculated separately for 12 industrial branches, when 7 subcategories were aggregated into a single subcategory due to the reduced fuel consumption from year to year);
- For each source, the AD is available in separate files in energy units; GHG emissions were initially calculated for each source even if statistical evidence of fuel consumption within each source revealed uneven and fragmented trends associated with the consumption of certain limited types

of fuels during the period under review; it has thereby been decided to present aggregated GHG emissions at source category level;

- Verifying the correctness of EFs use for each subcategory;
- Verifying whether the primary reference sources are correctly indicated;
- The accuracy of calculations for sources included in 1A2 category are verified randomly;
- Implementation of error minimization procedures for manual entry of AD, with all the spreadsheets provided with the initial sources of activity data in tabular format;
- In the calculation files the EFs are specified in tabular formats for each source, the import of the respective values into calculation formulas is ensured by automatic connections;
- The consistency of the calculations is also ensured by verifying the correctness of applying conversion factors of natural units to energy units for all sources and the entire range of years covered by the inventory;
- Verification whether the same method is used for the entire range of years covered by the inventory;
- Verifying whether GHG emissions calculations have been made for all years and for all types of fuels mentioned in the Energy Balances of the RM and the relevant reference sources;
- Verifying to what extent the full geographical coverage of the national GHG inventory of the RM is ensured;
- Verifying the inter-annual evolution trends of emissions by creating representative charts, while unusual fluctuations are explained;
- Regarding recalculations, their need is explained, including by drawing attention to the implemented recommendations resulting from the audit carried out by national and international experts in the previous inventory cycle;
- Verifying maintenance and completion of the national inventory of GHG emissions archive.

Following the recommendations included into the 2006 IPCC Guidelines, GHG emissions were estimated using AD and CS EFs from official sources of information. In the current cycle, when preparing the activity data series, the following alterations have been made:

- the information regarding primary activity data for the years 2017-2019 was collected and specified;
- the primary activity data from EBs of the RM associated with the consumption of aviation gasoline, jet gasoline, previously allocated to category 1A2 'Manufacturing Industries and Construction', was reallocated to 1A3a 'Civil Aviation', and the activity data associated with the consumption of motor gasoline, which was previously allocated to category 1A2 'Manufacturing Industries and Construction', was reallocated to category 1A3b 'Road Transportation';
- the consumption of liquefied petroleum gases was presented in aggregate with the consumption of natural gas, being attributed to gaseous fuels;
- for the LBDR, with reference to source category 1A2 'Manufacturing Industries and Construction', activity data for the years 2017-2019 was collected, including by accounting for a new fuel for the first time (LPG);
- the primary activity data from the EBs of the RM associated with the consumption of fuels previously allocated to source category 1A1aii 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants' – producers of energy for own consumption, were reallocated to category 1A2m 'Non-specified Industry'; the reallocation has been carried out since 2015, as for the previous years the disaggregated information by source categories is missing;
- to confirm the final results obtained, control checks of the calculation formulas are performed in the work files;
- when calculating emissions for each category of the entire time series, the same calculation method has been used, and graphs in Excel files are presented for analysis and visualisation;
- to ensure the coverage of the inventory from a territorial point of view, for all source categories, activity data collected for the territory on the LBDR are included; various statistical publications

of the ATULBD were used, including the Statistical Report "The State of Housing and Communal Services of the ATULBD"; for a number of categories, the historical time series was re-established, utilising indirect methods, due to the absence of statistical information;

- recommendations of the international consultant who carried out the quality assurance and quality control activity of the national GHG inventory for Sector 1 'Energy' in the previous inventory cycle were implemented (the verification took place in February 2019), including:
  - for natural gas, the constant emission factor was returned for the entire time series – *the recommendation has been implemented*;
  - for the territory on the Left Bank of the Dniester River, activity data was collected and GHG emissions from all 12 industries were calculated; also, the consumption of motor gasoline and diesel was transferred to category 1A3b 'Road Transportation', and aviation gasoline to category 1A3a 'Civil Aviation', respectively – *the recommendation has been implemented*;
  - the primary activity data associated with fuel consumption allocated to the source category 1A1aii 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants' – producers of energy for own consumption were reallocated to category 1A2m 'Non-specified Industry' – *the recommendation has been implemented*.

3.3.5. Recalculations

In the current inventory cycle, a number of measures have been taken to improve the quality of the national GHG inventory and this implied to recalculate GHG emissions from 1A2 'Manufacturing Industries and Construction' category. The main causes of these recalculations are, as follows:

- the constant net calorific value for natural gas was used for the entire time series covered by the national GHG inventory;
- the distribution of activity data for the territory on the Left Bank of the Dniester River by industrial branches was performed through indirect methods;
- since 2015, alterations have been made associated with the reallocation of activity data from the source categories 1A1aii 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants' – producers of energy for own consumption to source category 1A2m 'Non-specified Industry';
- for the source category 1A2e 'Food Processing, beverages and Tobacco' the correction of the primary activity data associated with the consumption of anthracite in the year 1994 was made (from 13 TJ it was corrected to 59 TJ);
- there have been recorded new fuel sources in several subcategories: for 1A2d 'Pulp, Paper and Print' – wood waste; and for 1A2f 'Non-Metallic Minerals' – coal, petroleum coke, and charcoal.

In comparison with the results included into the BUR2 of the RM under the UNFCCC (2019), the performed recalculations resulted in a decrease of direct GHG emissions in the period 1990-2014, varying from a minimum decrease by 2.2 per cent in 2000, to a maximum decrease by circa 14.0 per cent in the years 1991 and 2001; and, respectively, an increase in direct GHG emissions in the years 2015-2016, varying from a minimum increase by 22.4 per cent in 2015, to a maximum increase by circa 28.2 per cent in 2016 (Table 3-64). For the period 2017-2019, direct GHG emissions from 1A2 were estimated for the first time. Between 1990 and 2019, direct GHG emissions from category 1A2 'Manufacturing Industries and Construction' had decreased by circa 67.5 per cent.

Table 3-64: Recalculation results of GHG emissions from 1A2 'Manufacturing Industries and Construction' category included into the BUR2 of the RM under the UNFCCC (2019) for 1990-2016 periods, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	2,212.4085	1,490.7200	1,068.3480	684.9689	792.0811	440.6772	370.3100	589.6544	568.0101	489.1123
BUR3	1,923.3779	1,282.1630	929.8471	614.1484	739.1596	382.2342	322.0417	548.0393	543.8396	474.6097
Difference, %	-13.1	-14.0	-13.0	-10.3	-6.7	-13.3	-13.0	-7.1	-4.3	-3.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	531.7932	612.5378	425.1190	453.2059	465.8858	599.2226	662.2557	824.7942	909.8553	516.3518
BUR3	520.3009	602.0890	410.9707	439.4649	444.6143	575.2151	635.4857	801.7268	887.1888	495.6502
Difference, %	-2.2	-14.0	-13.0	-10.3	-6.7	-13.3	-13.0	-7.1	-4.3	-3.0

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	443.8184	598.2152	457.4388	599.3992	468.8030	534.6373	501.9962			
BUR3	423.3105	577.2543	434.6008	577.6270	444.6875	654.1931	643.6290	661.1426	751.3852	718.4760
Difference, %	-4.6	-3.5	-5.0	-3.6	-5.1	22.4	28.2			

3.3.6. Planned Improvements

Potential improvements within category 1A2 'Manufacturing Industries and Construction' regarding fuel consumption for energy purposes could be possible once the updated AD regarding the fuel consumption for the territory on the LBDR is available, thus filling the gaps for certain years. In particular, another approach to restore activity data for the territory on the LBDR is possible.

3.4. Transport (Category 1A3)

3.4.1. Source Category Description

Source category 1A3 'Transport' includes the following sources: 1A3a 'Civil Aviation' (1A3ai 'International Aviation' and 1A3aii 'Domestic Aviation'), 1A3b 'Road Transportation', 1A3c 'Railways', 1A3d 'Water-borne Navigation' and 1A3e 'Other Transportation'.

Total GHG emissions from category 1A3 'Transport'

Total GHG emissions from category 1A3 'Transport' recorded a downward trend between 1990-2019, from 4,837.92 kt CO_2 equivalent in 1990 to 2665.46 kt CO_2 equivalent in 2019 or by 44.9 per cent (Table 3-65).

Table 3-65: GHG emissions from 1A3 'Transport' category within 1990-2019 periods

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A3, kt CO_2 equivalent	4,837.92	3,768.77	2,699.49	1,921.24	1,656.37	1,660.43	1,619.51	1,555.10	1,397.80	932.21
%, compared to 1990	100.0	77.9	55.8	39.7	34.2	34.3	33.5	32.1	28.9	19.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A3, kt CO_2 equivalent	1,005.75	1,087.43	1,442.54	1,626.01	1,829.71	1,867.09	1,788.00	1,894.86	1,999.24	1,964.30
%, compared to 1990	20.8	22.5	29.8	33.6	37.8	38.6	37.0	39.2	41.3	40.6
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A3, kt CO_2 equivalent	2,188.87	2,322.59	2,037.04	2,145.89	2,182.61	2,307.98	2,481.62	2,503.59	2,581.91	2,665.46
%, compared to 1990	45.2	48.0	42.1	44.4	45.1	47.7	51.3	51.7	53.4	55.1

In the current inventory cycle, GHG emissions from 1A3 'Transport' category were estimated separately for the territory on the RBDR (according to real AD available in the EBs of the RM), respectively for the LBDR (based on specific fuels per capita) (for 1990-1992 time series, the information is presented for the entire territory of the country, while since 1993, separately for the RBDR and LBDR).

The level of direct and indirect GHG emissions from 1A3 'Transport' constituted in 2019, regarding CO_2 emissions – circa 55.6 per cent of emissions registered in the refence year 1990; whereas the emissions of CH_4 – 37.0 per cent, N_2O – 38.8 per cent, NO_x – 23.2 per cent, CO – 26.1 per cent, NMVOC – 25.3 per cent and SO_2 – 0.7 per cent (Table 3-66).

Table 3-66: Direct and indirect GHG emissions from 1A3 'Transport' category within 1990-2019 periods

	1A3, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1990	4,697.5183	1.3467	0.3582	14.9012	68.3923	8.6079	0.7843	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	3,655.5565	1.0343	0.2931	11.9958	52.0755	6.5987	0.6152	77.8	76.8	81.8	80.5	76.1	76.7	78.4
1992	2,614.8520	0.7228	0.2234	9.0885	35.7574	4.5881	0.4462	55.7	53.7	62.4	61.0	52.3	53.3	56.9
1993	1,855.0176	0.4932	0.1808	7.3893	23.2766	3.0794	0.3241	39.5	36.6	50.5	49.6	34.0	35.8	41.3
1994	1,612.7695	0.4373	0.1096	4.5224	21.4510	2.7103	0.2180	34.3	32.5	30.6	30.3	31.4	31.5	27.8
1995	1,617.7816	0.4448	0.1058	4.4098	22.5934	2.8292	0.2340	34.4	33.0	29.5	29.6	33.0	32.9	29.8
1996	1,578.6670	0.4313	0.1009	4.2800	21.5297	2.7137	0.2207	33.6	32.0	28.2	28.7	31.5	31.5	28.1
1997	1,515.9813	0.4010	0.0976	4.2427	23.8049	2.9428	0.2299	32.3	29.8	27.3	28.5	34.8	34.2	29.3
1998	1,363.0743	0.4035	0.0827	3.4803	20.7338	2.5523	0.1945	29.0	30.0	23.1	23.4	30.3	29.7	24.8
1999	910.6886	0.2475	0.0514	2.0599	11.9843	1.4854	0.1366	19.4	18.4	14.4	13.8	17.5	17.3	17.4
2000	982.3588	0.2520	0.0574	2.1165	11.8853	1.4687	0.1582	20.9	18.7	16.0	14.2	17.4	17.1	20.2
2001	1,061.8643	0.2668	0.0634	2.2613	12.7722	1.5702	0.1332	22.6	19.8	17.7	15.2	18.7	18.2	17.0
2002	1,405.7644	0.3418	0.0947	3.5165	16.6121	2.0849	0.1735	29.9	25.4	26.4	23.6	24.3	24.2	22.1

	1A3, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
2003	1,588.8147	0.4004	0.0912	3.2350	19.3977	2.3730	0.2110	33.8	29.7	25.5	21.7	28.4	27.6	26.9
2004	1,787.2739	0.4316	0.1062	3.7615	21.1158	2.6011	0.2464	38.0	32.0	29.6	25.2	30.9	30.2	31.4
2005	1,821.8133	0.4397	0.1150	4.1042	21.5603	2.6742	0.0452	38.8	32.7	32.1	27.5	31.5	31.1	5.8
2006	1,742.1498	0.4060	0.1198	4.2102	19.7807	2.4731	0.0436	37.1	30.1	33.4	28.3	28.9	28.7	5.6
2007	1,846.8209	0.4275	0.1253	4.3251	20.3245	2.5389	0.0462	39.3	31.7	35.0	29.0	29.7	29.5	5.9
2008	1,950.0498	0.4512	0.1272	4.3022	20.8778	2.5997	0.0485	41.5	33.5	35.5	28.9	30.5	30.2	6.2
2009	1,919.7221	0.4576	0.1112	3.6631	20.7880	2.5446	0.0046	40.9	34.0	31.0	24.6	30.4	29.6	0.6
2010	2,140.5856	0.4708	0.1225	3.7759	19.9436	2.4515	0.0052	45.6	35.0	34.2	25.3	29.2	28.5	0.7
2011	2,272.7076	0.4687	0.1281	3.8091	20.7693	2.5479	0.0056	48.4	34.8	35.8	25.6	30.4	29.6	0.7
2012	1,992.5907	0.4049	0.1152	3.4048	17.0098	2.1022	0.0048	42.4	30.1	32.2	22.8	24.9	24.4	0.6
2013	2,101.3096	0.4086	0.1153	3.1411	16.4003	2.0085	0.0049	44.7	30.3	32.2	21.1	24.0	23.3	0.6
2014	2,140.5749	0.4056	0.1070	2.6984	16.1489	1.9476	0.0049	45.6	30.1	29.9	18.1	23.6	22.6	0.6
2015	2,261.5959	0.4285	0.1197	3.1090	16.5574	2.0183	0.0051	48.1	31.8	33.4	20.9	24.2	23.4	0.7
2016	2,428.3819	0.4966	0.1370	3.5658	16.9243	2.0880	0.0054	51.7	36.9	38.3	23.9	24.7	24.3	0.7
2017	2,451.2514	0.4838	0.0004	3.3935	16.3018	2.0056	0.0054	52.2	35.9	0.1	22.8	23.8	23.3	0.7
2018	2,529.5979	0.5024	0.1334	3.2503	17.1884	2.0927	0.0056	53.8	37.3	37.3	21.8	25.1	24.3	0.7
2019	2,611.5823	0.4983	0.1390	3.4499	17.8412	2.1766	0.0058	55.6	37.0	38.8	23.2	26.1	25.3	0.7

Further are presented GHG emissions from category 1A3 'Transport' for the period 1990-2019 by source. The largest share in the structure of total direct GHG emissions from this category between 1990-2019 is represented by 1A3b 'Road Transportation', followed by 1A3c 'Railways' and 1A3e 'Other Transportation' (pipeline transport), while the share of sources like 1A3a 'Civil Aviation' and 1A3d 'Water-borne Navigation' being insignificant (Figure 3-18, Table 3-67).

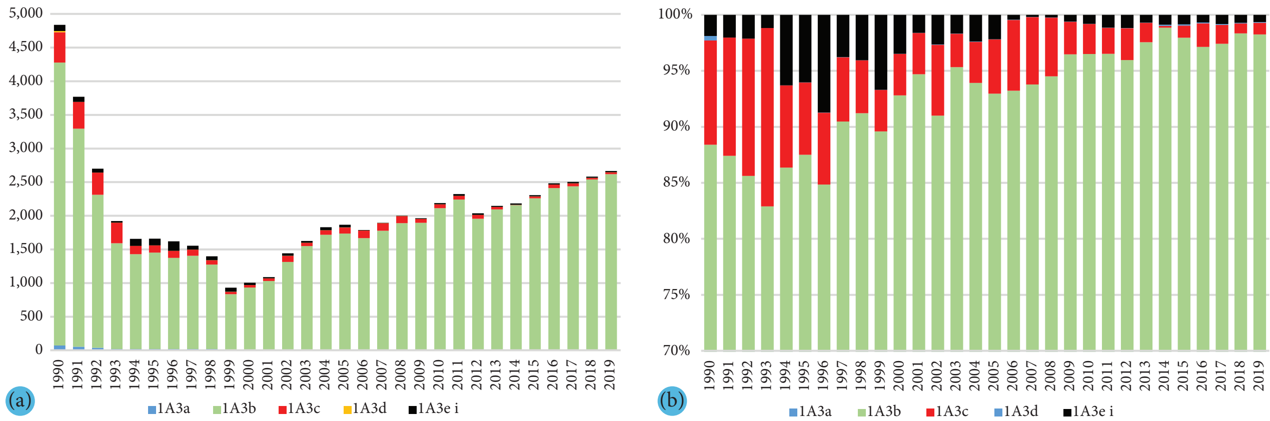

Figure 3-18: Breakdown of direct GHG emissions from category 1A3 'Transport', by sources, within 1990-2019 periods, in kt CO_2 equivalent (a); and their share in the structure of total direct GHG emissions within the respective category, in % from the total (b).

In 2019, GHG emissions from 1A3a 'Civil Aviation' had a share of only 0.01 per cent of the total per category, whereas 1A3b 'Road Transportation' – 98.25 per cent, 1A3c 'Railways' – 1.03 per cent, 1A3d 'Water-borne Navigation' – 0.07 per cent, and 1A3e 'Other Transportation' – 0.65 per cent of the total.

Table 3-67: Breakdown of direct GHG emissions from 1A3 'Transport' category, by sources, within 1990-2019 periods

	1A3, kt						% of total				
	1A3a	1A3b	1A3c	1A3d	1A3e i	1A3 Total	1A3a	1A3b	1A3c	1A3d	1A3e i
1990	72.2379	4,204.8572	450.4461	19.1071	91.2673	4,837.9155	1.49	86.91	9.31	0.39	1.89
1991	54.6771	3,239.5975	398.1451	0.2907	76.0561	3,768.7665	1.45	85.96	10.56	0.01	2.02
1992	37.1163	2,274.3236	330.7604	0.2487	57.0420	2,699.4911	1.37	84.25	12.25	0.01	2.11
1993	19.5555	1,573.0160	305.9782	0.2870	22.4028	1,921.2395	1.02	81.88	15.93	0.01	1.17
1994	19.7410	1,410.7428	121.5340	0.2241	104.1260	1,656.3679	1.19	85.17	7.34	0.01	6.29
1995	19.8895	1,433.0203	107.1307	0.2165	100.1746	1,660.4315	1.20	86.30	6.45	0.01	6.03
1996	20.0082	1,354.2098	103.9447	0.2350	141.1154	1,619.5131	1.24	83.62	6.42	0.01	8.71
1997	20.1032	1,386.7893	89.3226	0.2532	58.6333	1,555.1016	1.29	89.18	5.74	0.02	3.77
1998	20.4832	1,254.5081	66.0888	0.1583	56.5582	1,397.7966	1.47	89.75	4.73	0.01	4.05
1999	2.0273	833.1358	34.4317	0.2636	62.3482	932.2067	0.22	89.37	3.69	0.03	6.69
2000	2.0273	931.3613	37.2283	0.1166	35.0206	1,005.7542	0.20	92.60	3.70	0.01	3.48
2001	0.0980	1,029.6355	40.0201	0.2103	17.4636	1,087.4276	0.01	94.69	3.68	0.02	1.61
2002	0.0848	1,312.7527	91.1362	0.4874	38.0746	1,442.5357	0.01	91.00	6.32	0.03	2.64

	1A3, kt						% of total				
	1A3a	1A3b	1A3c	1A3d	1A3e i	1A3 Total	1A3a	1A3b	1A3c	1A3d	1A3e i
2003	0.6549	1,549.4400	48.4132	0.4417	27.0558	1,626.0055	0.04	95.29	2.98	0.03	1.66
2004	0.3495	1,718.2850	66.9536	0.4483	43.6697	1,829.7061	0.02	93.91	3.66	0.02	2.39
2005	1.6778	1,733.9712	90.4439	0.2599	40.7340	1,867.0868	0.09	92.87	4.84	0.01	2.18
2006	0.1970	1,666.6066	113.0672	0.5203	7.6100	1,788.0010	0.01	93.21	6.32	0.03	0.43
2007	1.0486	1,776.1668	113.7805	0.3473	3.5166	1,894.8597	0.06	93.74	6.00	0.02	0.19
2008	0.1513	1,889.4471	104.6019	0.3477	4.6945	1,999.2424	0.01	94.51	5.23	0.02	0.23
2009	0.0759	1,894.8904	57.2949	0.3483	11.6892	1,964.2987	0.00	96.47	2.92	0.02	0.60
2010	0.3495	2,112.2159	58.3140	0.2617	17.7308	2,188.8720	0.02	96.50	2.66	0.01	0.81
2011	0.0699	2,241.8367	53.8020	0.2623	26.6202	2,322.5910	0.00	96.52	2.32	0.01	1.15
2012	0.1398	1,954.7978	57.9864	0.2628	23.8533	2,037.0401	0.01	95.96	2.85	0.01	1.17
2013	0.1963	2,093.4434	37.1689	0.2635	14.8220	2,145.8940	0.01	97.56	1.73	0.01	0.69
2014	0.1398	2,157.6253	3.1133	2.3774	19.3501	2,182.6059	0.01	98.86	0.14	0.11	0.89
2015	0.3109	2,260.4866	25.1001	2.4654	19.6134	2,307.9763	0.01	97.94	1.09	0.11	0.85
2016	0.2298	2,410.3305	52.3706	1.8364	16.8563	2,481.6237	0.01	97.13	2.11	0.07	0.68
2017	0.5860	2,438.3632	42.2714	1.7509	20.6175	2,503.5890	0.02	97.39	1.69	0.07	0.82
2018	0.1533	2,539.1440	22.8770	1.5792	18.1610	2,581.9145	0.01	98.34	0.89	0.06	0.70
2019	0.2831	2,618.7522	27.3825	1.8450	17.1983	2,665.4611	0.01	98.25	1.03	0.07	0.65

3.4.2. Methodological Issues, Emission Factors and Activity Data

GHG emissions from 1A3 'Transport' category were estimated following a Tier 1 methodological approach available in the 2006 IPCC Guidelines, based on activity data on fuel consumption and default values of emission factors. In order to estimate non-CO_2 emissions, there were used default EFs available in the EMEP/EEA Air Pollutant Emission Inventory (2019) (Table 3-68).

Table 3-68: Emission factors used for the estimation of GHG emissions from 1A3 'Transport', kg/TJ

Category	Fuel type	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	Sources of reference for: CO_2, CH_4, N_2O	Sources of reference for: NO_x, CO and NMVOC
1A3a	Aviation Gasoline	69300	0.5	2	4	1200	19	1	2006 IPCC Guidelines, Volume 2, Chapter 3, Tables 3.6.4 and 3.6.5	EMEP/EEA Guidebook 2019, Categories 1.A.3.a, 1.A.5.b, Table 3-3
1A3b	Gasoline	69300	33.0	3.2	8.7	84.7	10.1		2006 IPCC Guidelines, Volume 2, Chapter 3, Tables 3.2.1 and 3.2.2	EMEP/EEA Guidebook 2019, Categories 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv, Tables 3-5 and 3-6
	Diesel Oil	74100	3.9	3.9	13.0	3.3	0.7			
	Natural Gas	56100	92.0	3.0	13.0	5.7	0.3	0.0		
	LPG	63100	62.0	0.2	15.2	84.7	13.6	0.0		
1A3c	Diesel Oil	74100	4.15	28.6	52.4	10.7	4.65		2006 IPCC Guidelines, Volume 2, Chapter 3, Table 3.4.1	EMEP/EEA Guidebook 2019, Category 1.A.3.c, Table 3-1
1A3d	Diesel Oil	74100	7	2	79.3	7.4	2.7	20	2006 IPCC Guidelines, Volume 2, Chapter 3, Tables 3.5.2 and 3.5.3	EMEP/EEA Guidebook 2019, Categories 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii, Table 3-1
1A3e	Natural Gas	56100	1	0.1	74	29	23	0.67	2006 IPCC Guidelines, Volume 2, Chapter 3, Table 2.2	EMEP/EEA Guidebook 2019, Categories 1.A.4.a.i, 1.A.4.b.i, 1.A.4.c.i, 1.A.5.a, Table 3-8

For the years 1990, 1995 and 2004-2019, an assessment method for estimating GHG emissions for category 1A3 'Transport' was applied by using the COPERT model, ver. 4.9, the equivalent of a Tier 3 methodological approach. The calculations performed are still preliminary and have not been included into this Report.

The calculation of SO_2 emissions from 1A3b 'Road Transportation' and 1A3c 'Railways' were applied in accordance with the estimation methods available in the EMEP/EEA Air Pollutant Emission Inventory (2019).

For the LBDR, there are incomplete AD on diesel oil and gasoline consumption by transport units in the agricultural sector, and incomplete data on natural gas consumption by transport units in the region, respectively. The information received from JSC "Moldovagaz" as well as the statistical publications from "The State of Housing and Communal Services of the ATULBD" (generated and published in the period 2011-2019) serve as reference sources. All missing data have been restored and the methods applied are described below.

For the RBDR, the main reference sources regarding fuel consumption for the transport sector between 1993-2019 are the information provided by the Energy Balances of the Republic of Moldova, both in natural units (kt and million m^3), as well as in energy units (TJ). In the Energy Balances for the year 1990, AD are available in natural units, as well as in kt of conventional fuel (in the years 1991 and 1992 the Energy Balances were not published). For the year 1990, available data in natural units was converted to energy units (TJ) by using country specific NCVs. For the period 1991-1992, the data was reconstructed by the interpolation method based on the values available for the years 1990 and 1993.

Additionally, for water-borne navigation and civil aviation, there was used AD provided through official letters by the Ministry of Transport and Roads Infrastructure, the SOE 'Moldova Railways', and by the Civil Aeronautical Authority of the Republic of Moldova, respectively.

The main types of fuels within category 1A3 'Transport' are aviation gasoline, motor gasoline, natural gases, liquefied petroleum gases, kerosene and other petroleum products. It was accepted that part of the diesel oil consumption in the agricultural sector is made on roads of national importance, and the largest share in agricultural fields (the ratio for 1990-1993 was 30 and 70 per cent; and for period 1994-2019 – 10 and 90 per cent). Fuel consumption on roads of national importance was considered in the estimation of GHG emissions from source category 1A3 'Transport', and fuel consumed by transport units in agricultural fields was considered in the estimation of GHG emissions from source category 1A4c 'Agriculture/forestry/fishing'.

Consumption of engine lubricants and greases, in accordance with the estimation methodologies available in the 2006 IPCC Guidelines, is included in the 'IPPU' sector.

1A3 'Transport'

1A3a Civil Aviation (1A3aii 'Domestic Aviation')

The civil aviation sector is represented by light aircraft and helicopters.

GHG emissions trends in source category 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation')

Compared to the reference year, emissions from this category decreased towards 2019 by circa 99.6 per cent (Table 3-69).

Table 3-69: Direct GHG emissions from source category 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation') and their share compared to the reference year 1990

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A3a, kt CO_2 equivalent	72.2379	54.6771	37.1163	19.5555	19.7410	19.8895	20.0082	20.1032	20.4832	2.0273
%, compared to 1990	100.0	75.7	51.4	27.1	27.3	27.5	27.7	27.8	28.4	2.8
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A3a, kt CO_2 equivalent	2.0273	0.0980	0.0848	0.6549	0.3495	1.6778	0.1970	1.0486	0.1513	0.0759
%, compared to 1990	2.8	0.1	0.1	0.9	0.5	2.3	0.3	1.5	0.2	0.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A3a, kt CO_2 equivalent	0.3495	0.0699	0.1398	0.1963	0.1398	0.3109	0.2298	0.5860	0.1533	0.2831
%, compared to 1990	0.5	0.1	0.2	0.3	0.2	0.4	0.3	0.8	0.2	0.4

Direct and indirect GHG emissions for the period 1990-2019 from source category 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation') are shown in Table 3-70.

Table 3-70: Direct and indirect GHG emissions from source category 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation') and their share compared to the level of reference year 1990

	1A3a, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1990	71.6091	0.0005	0.0021	0.0001	0.0284	0.0004	0.0000	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	54.2011	0.0004	0.0016	0.0001	0.0215	0.0003	0.0000	75.7	75.7	75.7	75.7	75.7	75.7	75.7
1992	36.7932	0.0003	0.0011	0.0000	0.0146	0.0002	0.0000	51.4	51.4	51.4	51.4	51.4	51.4	51.4
1993	19.3853	0.0001	0.0006	0.0000	0.0077	0.0001	0.0000	27.1	27.1	27.1	27.1	27.1	27.1	27.1
1994	19.5692	0.0001	0.0006	0.0000	0.0078	0.0001	0.0000	27.3	27.3	27.3	27.3	27.3	27.3	27.3
1995	19.7163	0.0001	0.0006	0.0000	0.0078	0.0001	0.0000	27.5	27.5	27.5	27.5	27.5	27.5	27.5
1996	19.8341	0.0001	0.0006	0.0000	0.0079	0.0001	0.0000	27.7	27.7	27.7	27.7	27.7	27.7	27.7
1997	19.9282	0.0001	0.0006	0.0000	0.0079	0.0001	0.0000	27.8	27.8	27.8	27.8	27.8	27.8	27.8
1998	20.3049	0.0001	0.0006	0.0000	0.0081	0.0001	0.0000	28.4	28.4	28.4	28.4	28.4	28.4	28.4
1999	2.0097	0.0000	0.0001	0.0000	0.0008	0.0000	0.0000	2.8	2.8	2.8	2.8	2.8	2.8	2.8
2000	2.0097	0.0000	0.0001	0.0000	0.0008	0.0000	0.0000	2.8	2.8	2.8	2.8	2.8	2.8	2.8
2001	0.0972	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2002	0.0841	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2003	0.6492	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.9	0.9	0.9	0.9	0.9	0.9	0.9

	1A3a, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
2004	0.3465	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2005	1.6632	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	2.3	2.3	2.3	2.3	2.3	2.3	2.3
2006	0.1952	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.3	0.3	0.3	0.3	0.3	0.3	0.3
2007	1.0395	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	1.5	1.5	1.5	1.5	1.5	1.5	1.5
2008	0.1500	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2009	0.0752	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2010	0.3465	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2011	0.0693	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2012	0.1386	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2013	0.1945	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.3	0.3	0.3	0.3	0.3	0.3	0.3
2014	0.1386	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2015	0.3082	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2016	0.2278	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.3	0.3	0.3	0.3	0.3	0.3	0.3
2017	0.5809	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.8	0.8	0.8	0.8	0.8	0.8	0.8
2018	0.1520	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2019	0.2806	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Direct GHG emissions and the contribution of each gas in the share of total emissions from the respective source for the period 1990-2019 are shown in Table 3-71.

Table 3-71: Direct GHG emissions from 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation') and the share of each GHG of total

	1A3a, kt CO_2 equivalent				Share of total, %		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	71.61	0.01	0.62	72.24	99.13	0.02	0.85
1991	54.20	0.01	0.47	54.68	99.13	0.02	0.85
1992	36.79	0.01	0.32	37.12	99.13	0.02	0.85
1993	19.39	0.00	0.17	19.56	99.13	0.02	0.85
1994	19.57	0.00	0.17	19.74	99.13	0.02	0.85
1995	19.72	0.00	0.17	19.89	99.13	0.02	0.85
1996	19.83	0.00	0.17	20.01	99.13	0.02	0.85
1997	19.93	0.00	0.17	20.10	99.13	0.02	0.85
1998	20.31	0.00	0.18	20.48	99.13	0.02	0.85
1999	2.01	0.00	0.02	2.03	99.13	0.02	0.85
2000	2.01	0.00	0.02	2.03	99.13	0.02	0.85
2001	0.10	0.00	0.00	0.10	99.13	0.02	0.85
2002	0.08	0.00	0.00	0.09	99.13	0.02	0.85
2003	0.65	0.00	0.01	0.66	99.13	0.02	0.85
2004	0.35	0.00	0.00	0.35	99.13	0.02	0.85
2005	1.66	0.00	0.01	1.68	99.13	0.02	0.85
2006	0.20	0.00	0.00	0.20	99.13	0.02	0.85
2007	1.04	0.00	0.01	1.05	99.13	0.02	0.85
2008	0.15	0.00	0.00	0.15	99.13	0.02	0.85
2009	0.08	0.00	0.00	0.08	99.13	0.02	0.85
2010	0.35	0.00	0.00	0.35	99.13	0.02	0.85
2011	0.07	0.00	0.00	0.07	99.13	0.02	0.85
2012	0.14	0.00	0.00	0.14	99.13	0.02	0.85
2013	0.20	0.00	0.00	0.20	99.13	0.02	0.85
2014	0.14	0.00	0.00	0.14	99.13	0.02	0.85
2015	0.31	0.00	0.00	0.31	99.13	0.02	0.85
2016	0.23	0.00	0.00	0.23	99.13	0.02	0.85
2017	0.58	0.00	0.01	0.59	99.13	0.02	0.85
2018	0.15	0.00	0.00	0.15	99.13	0.02	0.85
2019	0.28	0.00	0.00	0.28	99.13	0.02	0.85

Methodological Issues, Emissions Factor and Activity Data

Direct GHG emissions were estimated following a Tier 1 methodology. EFs are available in the 2006 IPCC Guidelines, whereas in order to estimate non-CO_2 emissions, there were used default EFs available in the EMEP/EEA Air Pollutant Emission Inventory (2019) (Table 3-72).

Table 3-72: Emission factors utilised for the estimation of GHG emissions from source category 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation')

Fuel type	Emission Factor						
	kg/TJ			kg/t fuel			
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
Aviation gasoline	69,300	0.5	2	4	1,200	19	1
References:	2006 IPCC Guidelines, Chapter 'Mobile Combustion'			EMEP/EEA Guidebook 2019, Category 1.A.3.a.			

Activity Data

Compared to the previous inventory cycle, in the current one there have been the following improvements:

- The aviation fuels found in the Energy Balances of the Republic of Moldova in source categories 1A2 and 1A3b have been reallocated to source category 1A3a;
- The activity data for three time series 1991-1992, 1994-1997 and 1999-2000 were restored by using interpolation method;
- The series of activity data was extended by another three years (2017-2019).

In the Energy Balances of the Republic of Moldova, the values available for aviation gasoline in chapter 'Aviation' are only for the years 1990, 1993 and 1998. Therefore, in previous inventory cycles the activity data was collected by official letters requested from the Ministry of Transport and Roads Infrastructure, and from the Civil Aeronautical Authority, respectively, but such information could only be collected for the period 2001-2019

The following approaches have been applied in order to restore the time series for this category:

- Recommendations were received from the international expert on the reallocation of fuels that could be used in domestic aviation (kerosene, jet fuel, motor gasoline, aviation gasoline) from source category 1A2 to source category 1A3a – *the recommendation has been implemented*;
- In accordance with the EBs of the Republic of Moldova published between 1990 and 1999, aviation fuel consumption existed only in 1990, 1993 and 1998; based on these values, the activity data for the years 1991-1992 and 1994-1997 was restored by interpolation;
- For the years 2001-2019, the activity data is available from the official letters provided by the Civil Aeronautical Authority of the Republic of Moldova;
- For the period 2001-2019, in EBs of the RM, in category 1A2, aviation fuel consumption was detected in the years 2004-2005, 2010 and 2014, which was reallocated to source category 1A3a;
- Similarly, such fuels as kerosene (1999, 2000, 2005, 2007, 2010, 2011) and 'Other Petroleum Products' (2010 and 2012), previously allocated to category 1A3b 'Road Transportation', were reallocated to source category 1A3a 'Civil Aviation' (Table 3-73).

Table 3-73: Activity data associated with the consumption of aviation fuel in the EBs of the RM reallocated to source category 1A3a 'Civil Aviation' from source categories 1A2 and 1A3b, TJ

	Activity data associated with fuel consumption reallocated to source category 1A3a 'Civil Aviation'								
	From source category 1A2 'Manufacturing Industries and Construction'					From source category 1A3b 'Road Transportation' and 1A3e 'Other Transportation'			
	Aviation Gasoline	Jet Fuel	Residual Fuel Oil	Gasoline	Total, TJ	1A3b Kerosene	1A3b Other Petroleum Products	1A3eii Kerosene	Total, TJ
1990		299	647		946				
1991		121	494		615				
1992		73	341		414				
1993	12	27	191		230	15		26	41
1994			29		29				
1998			29	264	293				
1999								29	29
2000								29	29
2004			5		5				
2005			10		10	14			14
2007						3		12	15
2010			1		1	3	1		4
2011						1			1
2012							2		2
2014				2	2				

Based on the above-mentioned, fuel consumption has been restored for source category 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation') (Table 3-74).

Table 3-74: Fuel consumption for source category 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation') for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Aviation Gasoline	87	61	35	9						
Reallocated data from category 1A2	946	615	414	230	29				293	
Reallocated data from category 1A3b				41						29
Total	**1033**	**782**	**531**	**280**	**282**	**285**	**286**	**288**	**293**	**29**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Aviation Gasoline		1	1	9	6	2	3	2	2	1
Reallocated data from category 1A2					5	10				
Reallocated data from category 1A3b	29					14		15		
Total	**29**	**1**	**1**	**9**	**11**	**26**	**3**	**17**	**2**	**1**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Aviation Gasoline	2	2	3	3	2	4	3	8	2	4
Reallocated data from category 1A2	1				2					
Reallocated data from category 1A3b	4	1	2							
Total	**7**	**3**	**5**	**3**	**4**	**4**	**3**	**8**	**2**	**4**

The data collected through official letters from the Civil Aeronautical Authority for 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation') between 2001 and 2019 is presented in Table 3-75.

Table 3-75: Data collected through official letters from the Civil Aeronautical Authority associated with aviation gasoline for the period 2001-2019

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1A3a, kt	0.0321	0.0278	0.2146	0.1352	0.0369	0.0645	0.0411	0.0496	0.0249	0.0383
1A3a, TJ	1.4022	1.2133	9.3684	5.9030	1.6105	2.8173	1.7957	2.1643	1.0854	1.6704
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
1A3a, kt	0.0395	0.0676	0.0643	0.0390	0.1019	0.0753	0.1900	0.0502	0.0927	N/A
1A3a, TJ	1.7246	2.9514	2.8073	1.7027	4.4468	3.2876	8.1947	2.1930	4.0490	N/A

Recalculations

In the current inventory cycle, a number of measures have been taken in order to improve the quality of the national GHG inventory, as a result of which it was necessary to recalculate GHG emissions from source category 1A3a 'Civil Aviation' (1A3aii 'Domestic Aviation'). The main causes of these recalculations are reported as follows:

- The information associated with the consumption of aviation gasoline within source category 1A3 was restored based on the Energy Balances of the Republic of Moldova. In the years 2001-2003, 2006, 2008-2009, 2013 and 2015-2019, data collected through official letters from the Civil Aeronautical Authority remain relevant, in the absence of the respective information in the Energy Balances;
- The consumption of some fuels has been reallocated, which was most likely used in domestic aviation (kerosene, jet fuel, motor gasoline, aviation gasoline) from source category 1A2 to 1A3a;
- In accordance with the EBs of the RM for the years 1990, 1993 and 1998, activity data for the years 1991-1992 and 1994-1997 was restored by interpolation.

Compared to the results recorded in BUR2 of the RM to the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in an upward trend in direct GHG emissions in the period 1990-1993, 2005, 2007, 2010 and 2014, and in a downward trend in direct GHG emissions in 2004 and 2011-2012, respectively (Table 3-76). Between 2017 and 2019, direct GHG emissions from source category 1A3a were estimated for the first time. In the period 1990-2019, direct GHG emissions from that category decreased by about 99.6 per cent.

Table 3-76: Recalculation results of GHG emissions from 1A3a 'Civil Aviation' source category included in the BUR2 of the RM to the UNFCCC (2019) for the period 1990-2016, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	6.1044	4.2730	2.4417	0.6103						
BUR3	72.2379	54.6771	37.1163	19.5555	19.7410	19.8895	20.0082	20.1032	20.4832	2.0273
Difference, %	1083.4	1179.6	1420.1	3104.2						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
BUR2		0.0980	0.0848	0.6549	0.4127	0.1126	0.1970	0.1255	0.1513	0.0759
BUR3	2.0273	0.0980	0.0848	0.6549	0.3495	1.6778	0.1970	1.0486	0.1513	0.0759
Difference, %		0.0	0.0	0.0	-15.3	1390.2	0.0	735.3	0.0	0.0
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
BUR2	0.1168	0.1206	0.2063	0.1963	0.1190	0.3109	0.2298			
BUR3	0.3495	0.0699	0.1398	0.1963	0.1398	0.3109	0.2298	0.5860	0.1533	0.2831
Difference, %	199.3	-42.0	-32.2	0.0	17.5	0.0	0.0			

Planned Improvements

For 1A3a 'Civil Aviation' source category in the EBs of the RM, the consumption of aviation gasoline can be found expressly only for the years 1990, 1993 and 1998. At the same time, the consumption of fuels such as: aviation gasoline, kerosene, motor gasoline and other petroleum products can be found within source categories 1A2 'Manufacturing Industries and Construction' and 1A3b 'Road Transportation'; which is usually assigned to source category 1A3a 'Civil Aviation'. There are also a series of activity data associated with aviation gasoline consumption for the years 2011-2019, provided by the Civil Aeronautical Authority of the Republic of Moldova. This has allowed the reconstruction by the interpolation method and/or by reallocations of fuel consumption within source category 1A3a 'Civil Aviation' from other source categories. The national inventory team is aware of the inconsistency of activity data associated with aviation gasoline consumption (data being collected from two separate reference sources); however, this inconsistency would be difficult to eliminate at the moment. In the next inventory cycle, various options shall be analysed in order to improve the quality of the national greenhouse gas inventory from the respective source category.

'Road Transportation'

The categories of vehicles considered under source 1A3b 'Road Transportation' include the following means of transport:

1A3bi Cars (M1):

- 1A3b i 1 – Passenger cars with 3-way catalysts
- 1A3b i 2 – Passenger cars without 3-way catalysts

1A3bii Light duty trucks (N1):

- 1A3b ii 1 – Light duty trucks with 3-way catalysts
- 1A3b ii 2 – Light duty trucks without 3-way catalysts
- 1A3b iii Heavy duty trucks (N2-N3) and buses (M2-M3)
- 1A3b iv Motorcycles (L1-L7) weighing less than 680 kg

GHG emission trends in source category 1A3b 'Road Transportation'

Aggregated emissions of direct GHG from source category 1A3b 'Road Transportation' had decreased between 1990 and 2019 by circa 37.7 per cent (Table 3-77).

Table 3-77: Direct GHG emissions from source category 1A3b 'Road Transportation' for the period 1990-2019 and their share compared to the year 1990

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A3b, kt CO_2 equivalent	4,204.86	3,239.60	2,274.32	1,573.02	1,410.74	1,433.02	1,354.21	1,386.79	1,254.51	833.14
%, compared to 1990	100.0	77.0	54.1	37.4	33.6	34.1	32.2	33.0	29.8	19.8
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A3b, kt CO_2 equivalent	931.36	1,029.64	1,312.75	1,549.44	1,718.29	1,733.97	1,666.61	1,776.17	1,889.45	1,894.89
%, compared to 1990	22.1	24.5	31.2	36.8	40.9	41.2	39.6	42.2	44.9	45.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A3b, kt CO_2 equivalent	2,112.22	2,241.84	1,954.80	2,093.44	2,157.63	2,260.49	2,410.33	2,438.36	2,539.14	2,618.75
%, compared to 1990	50.2	53.3	46.5	49.8	51.3	53.8	57.3	58.0	60.4	62.3

Direct and indirect GHG emissions from source category 1A3b 'Road Transportation' had significantly decreased between 1990 and 2019. In 2019, emissions of CO_2 constituted 62.4 per cent compared to 1990 level, whereas for emissions of CH_4 – 37.6 per cent; N_2O – 64.8 per cent; NO_x – 37.2 per cent; CO – 26.5 per cent; NMVOC – 26.7 per cent; and SO_x – 0.8 per cent of the reference year level (Table 3-78).

Table 3-78: Direct and indirect GHG emissions from source category 1A3b 'Road Transportation' compared to the level in the reference year 1990

	1A3b, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1990	4,112.3462	1.3202	0.1997	8.0733	66.9472	7.9749	0.6806	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	3,168.4585	1.0125	0.1538	6.1603	50.8436	6.0583	0.5267	77.0	76.7	77.0	76.3	75.9	76.0	77.4
1992	2,224.5569	0.7049	0.1079	4.2499	34.7407	4.1418	0.3728	54.1	53.4	54.0	52.6	51.9	51.9	54.8
1993	1,538.8959	0.4773	0.0745	2.8038	22.3270	2.6658	0.2543	37.4	36.2	37.3	34.7	33.4	33.4	37.4
1994	1,380.0934	0.4292	0.0668	2.5755	21.0200	2.5069	0.1891	33.6	32.5	33.5	31.9	31.4	31.4	27.8
1995	1,401.8149	0.4375	0.0680	2.6826	22.2081	2.6465	0.2084	34.1	33.1	34.1	33.2	33.2	33.2	30.6
1996	1,324.5171	0.4234	0.0641	2.5463	21.1329	2.5185	0.1954	32.2	32.1	32.1	31.5	31.6	31.6	28.7

	1A3b, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1997	1,357.2181	0.3953	0.0661	2.8354	23.4951	2.8006	0.2089	33.0	29.9	33.1	35.1	35.1	35.1	30.7
1998	1,226.9125	0.3990	0.0591	2.4217	20.4956	2.4417	0.1788	29.8	30.2	29.6	30.0	30.6	30.6	26.3
1999	815.2894	0.2447	0.0394	1.4651	11.8466	1.4144	0.1281	19.8	18.5	19.7	18.1	17.7	17.7	18.8
2000	911.9010	0.2495	0.0444	1.5160	11.7532	1.4052	0.1514	22.2	18.9	22.2	18.8	17.6	17.6	22.2
2001	1,008.2654	0.2644	0.0495	1.6424	12.6415	1.5102	0.1262	24.5	20.0	24.8	20.3	18.9	18.9	18.5
2002	1,285.5278	0.3365	0.0631	2.1094	16.3153	1.9489	0.1575	31.3	25.5	31.6	26.1	24.4	24.4	23.1
2003	1,517.3343	0.3974	0.0744	2.4785	19.2363	2.2979	0.2024	36.9	30.1	37.3	30.7	28.7	28.8	29.7
2004	1,682.8848	0.4274	0.0829	2.7070	20.8895	2.4947	0.2344	40.9	32.4	41.5	33.5	31.2	31.3	34.4
2005	1,698.1860	0.4344	0.0836	2.7038	21.2636	2.5380	0.0427	41.3	32.9	41.9	33.5	31.8	31.8	6.3
2006	1,632.5602	0.4002	0.0807	2.5166	19.4329	2.3206	0.0409	39.7	30.3	40.4	31.2	29.0	29.1	6.0
2007	1,740.0088	0.4217	0.0860	2.6263	19.9763	2.3871	0.0436	42.3	31.9	43.0	32.5	29.8	29.9	6.4
2008	1,851.1715	0.4458	0.0910	2.7385	20.5573	2.4596	0.0461	45.0	33.8	45.6	33.9	30.7	30.8	6.8
2009	1,856.3041	0.4544	0.0914	2.7946	20.6078	2.4641	0.0043	45.1	34.4	45.8	34.6	30.8	30.9	0.6
2010	2,070.0334	0.4676	0.1023	2.8843	19.7570	2.3672	0.0048	50.3	35.4	51.2	35.7	29.5	29.7	0.7
2011	2,197.5929	0.4655	0.1094	2.9729	20.5920	2.4659	0.0052	53.4	35.3	54.8	36.8	30.8	30.9	0.8
2012	1,916.4223	0.4016	0.0951	2.5099	16.8211	2.0158	0.0044	46.6	30.4	47.6	31.1	25.1	25.3	0.7
2013	2,052.7538	0.4065	0.1024	2.5682	16.2795	1.9533	0.0046	49.9	30.8	51.3	31.8	24.3	24.5	0.7
2014	2,115.9635	0.4049	0.1058	2.6265	16.1294	1.9356	0.0047	51.5	30.7	53.0	32.5	24.1	24.3	0.7
2015	2,216.7708	0.4267	0.1109	2.7094	16.4708	1.9771	0.0048	53.9	32.3	55.5	33.6	24.6	24.8	0.7
2016	2,362.5871	0.4935	0.1188	2.7637	16.7562	2.0119	0.0051	57.5	37.4	59.5	34.2	25.0	25.2	0.7
2017	2,390.4768	0.4811	0.1203	2.7369	16.1624	1.9413	0.0051	58.1	36.4	60.3	33.9	24.1	24.3	0.7
2018	2,489.2483	0.5008	0.1254	2.8857	17.1094	2.0550	0.0053	60.5	37.9	62.8	35.7	25.6	25.8	0.8
2019	2,567.7670	0.4965	0.1294	3.0002	17.7450	2.1317	0.0055	62.4	37.6	64.8	37.2	26.5	26.7	0.8

Between 1990 and 2019, the share of CO_2 emissions in the structure of GHG emissions at source category level 1A3b varied between 97.80 and 98.07 per cent of the total, whereas CH_4 – between 0.47 and 0.78 per cent of the total, N_2O – between 1.40 and1.47 per cent of the total (Table 3-79).

Table 3-79: Direct GHG emissions from source category 1A3b 'Road Transportation' and their share in the total structure at source category level

	1A3b, kt CO_2 equivalent				Share, % of total		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	4,112.3462	33.0050	59.5106	4,204.8618	97.80	0.78	1.42
1991	3,168.4585	25.3125	45.8324	3,239.6034	97.80	0.78	1.41
1992	2,224.5569	17.6225	32.1542	2,274.3336	97.81	0.77	1.41
1993	1,538.8959	11.9325	22.2010	1,573.0294	97.83	0.76	1.41
1994	1,380.0934	10.7300	19.9064	1,410.7298	97.83	0.76	1.41
1995	1,401.8149	10.9375	20.2640	1,433.0164	97.82	0.76	1.41
1996	1,324.5171	10.5850	19.1018	1,354.2039	97.81	0.78	1.41
1997	1,357.2181	9.8825	19.6978	1,386.7984	97.87	0.71	1.42
1998	1,226.9125	9.9750	17.6118	1,254.4993	97.80	0.80	1.40
1999	815.2894	6.1175	11.7412	833.1481	97.86	0.73	1.41
2000	911.9010	6.2375	13.2312	931.3697	97.91	0.67	1.42
2001	1,008.2654	6.6100	14.7510	1,029.6264	97.93	0.64	1.43
2002	1,285.5278	8.4125	18.8038	1,312.7441	97.93	0.64	1.43
2003	1,517.3343	9.9350	22.1712	1,549.4405	97.93	0.64	1.43
2004	1,682.8848	10.6850	24.7042	1,718.2740	97.94	0.62	1.44
2005	1,698.1860	10.8600	24.9128	1,733.9588	97.94	0.63	1.44
2006	1,632.5602	10.0050	24.0486	1,666.6138	97.96	0.60	1.44
2007	1,740.0088	10.5425	25.6280	1,776.1793	97.96	0.59	1.44
2008	1,851.1715	11.1450	27.1180	1,889.4345	97.97	0.59	1.44
2009	1,856.3041	11.3600	27.2372	1,894.9013	97.96	0.60	1.44
2010	2,070.0334	11.6900	30.4854	2,112.2088	98.00	0.55	1.44
2011	2,197.5929	11.6375	32.6012	2,241.8316	98.03	0.52	1.45
2012	1,916.4223	10.0400	28.3398	1,954.8021	98.04	0.51	1.45
2013	2,052.7538	10.1625	30.5152	2,093.4315	98.06	0.49	1.46
2014	2,115.9635	10.1225	31.5284	2,157.6144	98.07	0.47	1.46
2015	2,216.7708	10.6675	33.0482	2,260.4865	98.07	0.47	1.46
2016	2,362.5871	12.3375	35.4024	2,410.3270	98.02	0.51	1.47
2017	2,390.4768	12.0275	35.8494	2,438.3537	98.04	0.49	1.47
2018	2,489.2483	12.5200	37.3692	2,539.1375	98.04	0.49	1.47
2019	2,567.7670	12.4125	38.5612	2,618.7407	98.05	0.47	1.47

Methodological Issues, Emission Factors and Activity Data

GHG emissions from fuel consumption (gasoline, diesel oil, natural gas and liquefied petroleum) under category 1A3b 'Road Transportation' were estimated following a Tier 1 methodological approach (Equation 3.2.1, p. 3.12, 2006 IPCC Guidelines, Volume 1 'Mobile Combustion'):

$$Emisii = \Sigma\ [Fuel_a \bullet EF_a]$$

where:

Emissions – GHG emissions (kt);

Fuel $_a$ – fuel sold (TJ);

EF_a – emission factor (kg/TJ);

a – type of fuel (gasoline, gasoline, natural gas, LPG, etc.).

Emission factors for direct greenhouse gases were taken from the 2006 IPCC Guidelines, and for indirect greenhouse gases from the EMEP/EEA Air Pollutant Emission Inventory (2019)

Table 3-80: EFs for direct and indirect GHG from source category 1A3b 'Road Transportation'

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
	kg/TJ			kg/t			kg/TJ
Gasoline	69,300	33.0	3.2	8.7	84.7	10.1	formula
Diesel Oil	74,100	3.9	3.9	13.0	3.3	0.7	formula
Natural Gas	56,100	92.0	3.0	13.0	5.7	0.3	
LPG	63,100	62.0	0.2	15.2	84.7	13.6	
References:	2006 IPCC Guidelines, Chapter 'Mobile Combustion'			EMEP/EEA Guidebook 2019, Chapter 1. A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv			

Activity Data

The main sources of data for the category 1A3b 'Road Transportation' on the territory on the RBDR are the EBs of the RM for the years 1990 and 1993-2019. Additionally, information received from JSC "Moldovagaz" based on official letters to the Ministry of Agriculture, Regional Development and Environment and/or to the Environment Agency are used. For the territory on the LBDR, statistical data associated with fuel consumption are quite fragmentary. There is information associated with the consumption of natural gas and liquefied gas, as published in the ATULBD Communal Services Press Releases (available only for 2011-2019). Unfortunately, the information associated with the consumption of gasoline and diesel oil for source category 1A3b 'Road Transportation' for the territory on the LBDR is missing.

In the previous inventory cycle, fuel consumption for the territory on the Left Bank of the Dniester River was restored by taking into account the specific fuel consumption per capita on the Right Bank of the Dniester River. The same approach was applied in the current inventory cycle, but the availability of updated information regarding the population of the RM because of the recent recalculation of population census results conducted in 2014 was taken into account (Table 3-81).

Table 3-81: Population, presented separately for the RBDR and LBDR for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
LBDR, thousand people	731.0	730.7	730.3	729.6	702.5	701.7	691.6	679.1	670.8	665.7
RBDR, thousand people	3 630.6	3 635.6	3 628.8	3 618.2	3 650.2	3 646.2	3 642.8	3 640.9	3 655.0	3 649.3
RM, thousand people	4 361.6	4 366.3	4 359.1	4 347.8	4 352.7	4 347.9	4 334.4	4 320.0	4 325.8	4 315.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LBDR, thousand people	660.0	651.8	642.5	633.6	623.8	554.4	547.5	540.6	533.5	527.5
RBDR, thousand people	3 643.5	3 634.5	3 627.2	3 617.7	3 606.8	3 533.0	3 459.3	3 385.5	3 311.8	3 238.0
RM, thousand people	4 303.5	4 286.3	4 269.7	4 251.3	4 230.6	4 087.4	4 006.8	3 926.1	3 845.3	3 765.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
LBDR, thousand people	522.5	518.0	513.4	509.4	505.2	500.7	474.5	470.6	469.0	465.1
RBDR, thousand people	3 164.3	3 090.5	3 016.7	2 943.0	2 869.2	2 844.7	2 824.4	2 780.0	2 730.4	2 681.7
RM, thousand people	3 686.8	3 608.5	3 530.1	3 452.4	3 374.4	3 345.4	3 298.9	3 250.6	3 199.4	3 146.8

Table 3-82: Diesel oil consumption in the RM in 1A3b 'Road Transportation', presented separately for the RBDR and LBDR

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM: diesel oil, TJ*	22,419	17,555	12,691							
Specific consumption, MJ/per capita	5.1	4.0	2.9	2.2	1.9	1.8	1.7	2.0	1.5	1.2
RBDR: diesel oil, TJ	18,661	14,617	10,565	7,828	6,787	6,632	6,187	7,223	5,440	4,291
LBDR: diesel oil, TJ	3,757	2,938	2,126	1,578	1,306	1,276	1,175	1,347	998	783
RM: diesel oil, TJ	**22,418**	**17,555**	**12,691**	**9,406**	**8,093**	**7,908**	**7,362**	**8,570**	**6,438**	**5,074**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Specific consumption, MJ/per capita	1.5	1.7	2.2	2.6	2.9	3.0	3.1	3.5	3.8	3.9
RBDR: diesel oil, TJ	5,437	6,190	7,907	9,297	10,579	10,766	10,751	11,705	12,632	12,607
LBDR: diesel oil, TJ	985	1,110	1,401	1,628	1,830	1,689	1,701	1,869	2,035	2,054
RM: diesel oil, TJ	**6,422**	**7,300**	**9,308**	**10,925**	**12,409**	**12,455**	**12,452**	**13,574**	**14,667**	**14,661**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Specific consumption, MJ/per capita	4.8	5.4	4.9	5.6	6.0	6.4	6.9	7.2	7.6	7.7
RBDR: diesel oil, TJ	15,282	16,535	14,735	16,478	17,252	18,125	19,474	20,047	20,760	20,665
LBDR: diesel oil, TJ	2,523	2,771	2,508	2,852	3,037	3,190	3,272	3,394	3,566	3,584
RM: diesel oil, TJ	**17,805**	**19,306**	**17,243**	**19,330**	**20,289**	**21,315**	**22,746**	**23,441**	**24,326**	**24,249**

Note: for the years 1990-1992 the information is aggregated by country.

Table 3-83: Gasoline consumption in the RM in 1A3b 'Road Transportation', presented separately for the RBDR and LBDR

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM: gasoline, TJ*	34,320	26,047	17,774							
Specific consumption, MJ/per capita	7.9	6.0	4.1	2.6	2.5	2.6	2.5	2.3	2.4	1.4
RBDR: gasoline, TJ	28,568	21,688	14,796	9,501	9,037	9,593	9,095	8,474	8,861	5,076
LBDR: gasoline, TJ	5,752	4,359	2,978	1,916	1,739	1,846	1,727	1,581	1,626	926
RM: gasoline, TJ	**34,320**	**26,047**	**17,774**	**11,417**	**10,776**	**11,439**	**10,822**	**10,055**	**10,487**	**6,002**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Specific consumption, MJ/per capita	1.4	1.5	1.9	2.3	2.5	2.7	2.5	2.6	2.7	2.8
RBDR: gasoline, TJ	5,016	5,487	7,012	8,353	9,106	9,363	8,584	8,778	8,992	8,990
LBDR: gasoline, TJ	909	984	1,242	1,463	1,575	1,469	1,359	1,402	1,449	1,465
RM: gasoline, TJ	**5,925**	**6,471**	**8,254**	**9,816**	**10,681**	**10,832**	**9,943**	**10,180**	**10,441**	**10,455**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Specific consumption, MJ/per capita	2.7	2.9	2.4	2.4	2.4	2.5	2.6	2.5	2.7	2.8
RBDR: gasoline, TJ	8,557	8,993	7,280	6,982	6,889	7,112	7,238	6,966	7,373	7,637
LBDR: gasoline, TJ	1,413	1,507	1,239	1,209	1,213	1,252	1,216	1,179	1,266	1,325
RM: gasoline, TJ	**9,970**	**10,500**	**8,519**	**8,191**	**8,102**	**8,364**	**8,454**	**8,145**	**8,639**	**8,962**

Note: for the years 1990-1992 the information is on aggregate.

Table 3-84: Natural gas consumption in the RM in 1A3b 'Road Transportation', presented separately for the RBDR and LBDR

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM, kt	**13.0**	**9.5**	**9.1**	**13.7**	**8.5**	**7.6**	**10.6**	**11.1**	**11.5**	**11.3**
LBDR	3.9	3.1	2.6	1.9	1.2	0.8	1.1	0.6	0.6	0.5
RBDR	9.1	6.4	6.5	11.8	7.3	6.8	9.4	10.5	10.9	10.8
RM, TJ	**779**	**625**	**522**	**381**	**244**	**175**	**244**	**139**	**138**	**104**
LBDR	131	105	87	64	39	28	39	22	21	16
RBDR	648	520	435	317	205	147	205	117	117	88
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
RM, kt	**12.8**	**13.2**	**14.2**	**13.5**	**12.4**	**12.5**	**2.3**	**3.5**	**7.5**	**13.0**
LBDR	0.5	0.5	0.5	0.5	0.4	0.5	0.3	0.5	0.4	4.1
RBDR	12.3	12.7	13.7	13	12	12	2	3	7.1	8.9
RM, TJ	**104**	**104**	**120**	**103**	**102**	**115**	**82**	**125**	**107**	**207**
LBDR	16	16	18	15	15	16	11	17	15	139
RBDR	88	88	102	88	87	99	71	108	92	68
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
RM, kt	**8.9**	**3.8**	**4.2**	**5.2**	**6.8**	**17.0**	**29.0**	**26.0**	**28.0**	**22.0**
LBDR	6.9	1.8	2.2	3.2	4.8	5.0	5.0	5.0	5.0	5.0
RBDR	2.0	2.0	2.0	2.0	2.0	12.0	24.0	21.0	23.0	17.0
RM, TJ	**282**	**139**	**152**	**173**	**222**	**293**	**979**	**907**	**931**	**738**
LBDR	234	61	74	108	163	169	169	169	169	169
RBDR	48	78	78	65	59	124	810	738	762	569

Table 3-85: Liquefied petroleum gas consumption in the RM in 1A3b 'Road Transportation', presented separately for the RBDR and LBDR

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM, kt	**13.00**	**9.00**	**9.00**	**10.09**	**7.10**	**4.74**	**4.84**	**3.59**	**3.48**	**3.31**
LBDR	1.68	1.58	1.53	1.69	1.10	0.74	0.84	0.95	0.82	0.93
RBDR	11.32	7.88	7.59	8.40	6.00	4.00	4.00	2.64	2.66	2.38
RM, TJ	**461**	**436**	**420**	**465**	**315**	**210**	**244**	**279**	**243**	**278**
LBDR	77	73	70	78	51	34	39	44	38	43
RBDR	383	363	349	387	264	176	205	235	205	235
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
RM, kt	**2.49**	**1.51**	**2.17**	**7.11**	**5.89**	**5.85**	**5.76**	**7.03**	**11.66**	**11.63**
LBDR	1.04	0.69	0.88	1.11	0.89	0.85	0.76	1.03	1.66	1.63
RBDR	1.45	0.82	1.29	6.00	5.00	5.00	5.00	6.00	10.00	10.00
RM, TJ	**312**	**208**	**271**	**344**	**277**	**288**	**257**	**343**	**553**	**536**
LBDR	48	32	41	51	41	39	35	47	77	75
RBDR	264	176	230	293	236	249	222	296	476	461

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
RM, kt	**15.14**	**10.96**	**13.79**	**13.71**	**13.56**	**14.54**	**13.66**	**13.37**	**12.40**	**12.42**
LBDR	2.14	0.96	0.79	0.71	0.56	0.54	0.66	0.37	0.40	0.42
RBDR	13.00	10.00	13.00	13.00	13.00	14.00	13.00	13.00	12.00	12.00
RM, TJ	**697**	**499**	**632**	**623**	**613**	**654**	**575**	**604**	**566**	**555**
LBDR	99	44	37	33	26	25	30	17	18	20
RBDR	598	455	595	590	587	629	545	587	548	535

Aggregated fuel consumption within source category 1A3b 'Road Transportation' between 1990 and 2019 is shown in energy units in Table 3-86.

Table 3-86: Aggregated fuel consumption within source category 1A3b 'Road Transportation' for the period 1990-2019, TJ

	RBDR				LBDR				Republic of Moldova				
	Gasoline	Diesel Oil	Natural Gas	LPG	Gasoline	Diesel Oil	Natural Gas	LPG	Gasoline	Diesel Oil	Natural Gas	LPG	Total
1990	28,568	18,661	648	383	5,752	3,757	131	77	34,320	22,419	779	461	57,979
1991	21,688	14,617	520	363	4,359	2,938	105	73	26,047	17,555	625	436	44,663
1992	14,796	10,565	392	343	2,978	2,126	79	69	17,774	12,691	471	412	31,348
1993	9,501	7,828	317	387	1,916	1,578	64	78	11,417	9,406	381	465	21,669
1994	9,037	6,787	205	264	1,739	1,306	39	51	10,776	8,093	244	315	19,428
1995	9,593	6,632	147	176	1,846	1,276	28	34	11,439	7,908	175	210	19,732
1996	9,095	6,187	205	205	1,727	1,175	39	39	10,822	7,362	244	244	18,672
1997	8,474	7,223	117	235	1,581	1,347	22	44	10,055	8,570	139	279	19,043
1998	8,861	5,440	117	205	1,626	998	21	38	10,487	6,438	138	243	17,306
1999	5,076	4,291	88	235	926	783	16	43	6,002	5,074	104	278	11,458
2000	5,016	5,437	88	264	909	985	16	48	5,925	6,421	104	312	12,762
2001	5,487	6,190	88	176	984	1,110	16	32	6,471	7,300	104	208	14,083
2002	7,012	7,907	102	230	1,242	1,401	18	41	8,254	9,308	120	271	17,953
2003	8,353	9,297	88	293	1,463	1,628	15	51	9,816	10,925	103	344	21,188
2004	9,106	10,579	87	236	1,575	1,830	15	41	10,681	12,409	102	277	23,469
2005	9,363	10,766	99	249	1,469	1,689	16	39	10,832	12,455	115	288	23,690
2006	8,584	10,751	71	222	1,359	1,701	11	35	9,943	12,452	82	257	22,734
2007	8,778	11,705	108	296	1,402	1,869	17	47	10,180	13,575	125	343	24,223
2008	8,992	12,632	92	476	1,449	2,035	15	77	10,441	14,666	107	553	25,767
2009	8,990	12,607	68	461	1,465	2,054	139	75	10,455	14,661	207	536	25,859
2010	8,557	15,282	48	598	1,413	2,523	234	99	9,970	17,805	282	697	28,754
2011	8,993	16,535	78	455	1,507	2,771	61	44	10,500	19,307	139	499	30,445
2012	7,280	14,735	78	595	1,239	2,508	74	37	8,519	17,242	152	632	26,545
2013	6,982	16,478	65	590	1,209	2,852	176	33	8,191	19,330	241	623	28,385
2014	6,889	17,252	59	587	1,213	3,037	163	26	8,102	20,289	222	613	29,226
2015	7,112	18,125	124	629	1,252	3,190	169	25	8,364	21,315	293	654	30,626
2016	7,238	19,474	810	545	1,216	3,272	169	30	8,454	22,746	979	575	32,754
2017	6,966	20,047	738	587	1,179	3,394	169	17	8,145	23,441	907	604	33,097
2018	7,373	20,760	762	548	1,266	3,566	169	18	8,639	24,326	931	566	34,462
2019	7,637	21,510	569	535	1,325	3,731	169	20	8,962	25,241	738	555	35,496

Aggregated fuel consumption within source category 1A3b 'Road Transportation' between 1990 and 2019 is shown in natural units in Table 3-87.

Table 3-87: Aggregated fuel consumption within source category 1A3b 'Road Transportation' for the period 1990-2019, kt/million m^3 (for Natural Gas)

	RBDR				LBDR				Republic of Moldova			
	Gasoline	Diesel Oil	Natural Gas	LPG	Gasoline	Diesel Oil	Natural Gas	LPG	Gasoline	Diesel Oil	Natural Gas	LPG
1990	653	439	9.2	11.3	132	88	3.9	1.7	785	527	13.0	15.2
1991	496	344	6.4	7.9	100	69	3.1	1.6	596	413	9.5	7.9
1992	338	248	6.6	7.4	68	50	2.3	1.5	407	298	8.9	7.4
1993	217	173	11.8	8.4	44	37	1.9	1.7	260	211	13.7	10.1
1994	206	104	7.3	6.0	40	31	1.2	1.1	246	135	8.5	7.1
1995	218	123	6.8	4.0	42	30	0.8	0.7	260	153	7.7	4.7
1996	208	115	9.4	4.0	39	28	1.2	0.8	247	142	10.6	4.8
1997	239	116	10.5	2.6	36	32	0.6	1.0	275	148	11.1	3.6
1998	203	101	10.9	2.7	37	23	0.6	0.8	240	124	11.5	3.5
1999	117	85	10.8	2.4	21	18	0.5	0.9	138	103	11.3	3.3
2000	116	110	12.3	1.5	21	23	0.5	1.0	137	133	12.8	2.5
2001	125	120	12.7	0.8	23	26	0.5	0.7	148	146	13.2	1.5
2002	162	147	13.7	1.3	28	33	0.5	0.9	190	180	14.2	2.2
2003	191	202	13.0	6.0	33	38	0.5	1.1	224	240	13.5	7.1

	RBDR				LBDR				Republic of Moldova			
	Gasoline	Diesel Oil	Natural Gas	LPG	Gasoline	Diesel Oil	Natural Gas	LPG	Gasoline	Diesel Oil	Natural Gas	LPG
2004	208	242	12.0	5.0	36	43	0.4	0.9	244	285	12.4	5.9
2005	215	245	12.0	5.0	34	40	0.5	0.9	249	285	12.5	5.9
2006	196	244	2.0	5.0	31	40	0.3	0.8	227	284	2.3	5.8
2007	201	268	3.0	6.0	32	44	0.5	1.0	233	312	3.5	7.0
2008	206	289	7.1	10.0	33	48	0.4	2.0	239	337	7.5	12.0
2009	206	277	8.9	10.0	33	48	4.1	2.0	239	325	13.0	12.0
2010	196	367	2.0	13.0	32	59	7.0	2.0	228	427	9.0	15.0
2011	205	396	2.0	10.0	34	65	2.0	1.0	239	461	4.0	10.0
2012	167	355	2.0	13.0	28	59	2.0	1.0	195	414	4.0	13.0
2013	161	390	2.0	13.0	28	67	3.2	0.7	189	457	5.0	13.0
2014	159	393	2.0	13.0	28	71	4.8	0.6	187	464	7.0	13.0
2015	162	414	12.0	14.0	29	75	5.0	0.5	191	489	17.0	14.0
2016	166	444	24.0	13.0	28	77	5.0	0.7	194	521	29.0	13.0
2017	160	457	21.0	13.0	27	80	5.0	0.4	187	537	26.0	13.0
2018	169	467	23.0	12.0	29	84	5.0	0.4	198	551	28.0	12.0
2019	175	485	17.0	12.0	30	88	5.0	0.4	205	573	22.0	12.0

Gasoline and diesel oil consumption allocated in the Energy Balances to source category 1A2 'Manufacturing Industries and Construction' has been reallocated to source category 1A3b 'Road Transportation' as they are consumed on national roads for transportation purposes (Table 3-88).

Table 3-88: Gasoline and diesel oil consumption reallocated from source category 1A2 'Manufacturing Industries and Construction' to category 1A3b 'Road Transportation'

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gasoline, TJ	568	390	211	33	29	29	29	29		
Diesel Oil, TJ	3446	2566	1687	807	754	765	623	557	353	205
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gasoline, TJ					16	23	18	21	20	13
Diesel Oil, TJ	205	205	205	205	287	322	366	328	324	217
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Gasoline, TJ	12	16	9		11	14	16	12	13	8
Diesel Oil, TJ	271	270	291	313	264	207	213	201	407	376

Kerosene consumption and other petroleum products has been reallocated from source category 1A3b 'Road Transportation' to source category 1A3a 'Civil Aviation' (Table 3-89)

Table 3-89: Kerosene consumption and other petroleum products reallocated from source category 1A3b 'Road Transportation' to source category 1A3a 'Civil Aviation'

	1993	1999	2000	2005	2007	2010	2011	2012
Kerosene, TJ	41	29	29	14	15	3	1	
Other petroleum products, TJ						1		2

Recalculations

In the current inventory cycle, a number of measures have been taken in order to improve the quality of the national GHG inventory, as a result of which it was necessary to recalculate GHG emissions from source category 1A3b 'Road Transportation'. The main causes for these recalculations are reported as follows:

- Reallocation of diesel oil and gasoline consumption from source category 1A2 'Manufacturing Industries and Construction' to source category 1A3b 'Road Transportation';
- Reallocation of kerosene consumption and other petroleum products from source category 1A3b 'Road Transportation' to source category 1A3a 'Civil Aviation';
- Restoring gasoline and diesel oil consumption for the territory on the LBDR, based on the specific consumption per capita on the RBDR, taking into account the updated data of the 2014 population census;
- Restoring natural gas and liquefied petroleum gas consumption for the territory on LBDR based on specific consumption per capita on the RBDR, taking into account the updated data of the 2014 population census.

Compared to the results recorded in BUR2 of the RM to the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in an increase in direct GHG emission trend in the period 1990-2016 (Table 3-90). Between 2017and 2019, direct GHG emissions from source category 1A3b 'Road Transportation' were estimated for the first time. In the period 1990-2019, direct GHG emissions from this category decreased by about 37.7 per cent.

Table 3-90: Recalculation results of GHG emissions from 1A3b 'Road Transportation' category included in the BUR2 of the RM to the UNFCCC (2019) for the period 1990-2016, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	3,913.7449	2,940.9757	2,020.9486	1,439.7046	1,318.3903	1,348.2574	1,268.2947	1,370.9687	1,193.0746	788.7795
BUR3	4,204.8572	3,239.5975	2,274.3236	1,573.0160	1,410.7428	1,433.0203	1,354.2098	1,386.7893	1,254.5081	833.1358
Difference, %	7.4	10.2	12.5	9.3	7.0	6.3	6.8	1.2	5.1	5.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	876.0511	964.8860	1,172.2436	1,440.1173	1,604.9795	1,641.4074	1,576.4394	1,687.5140	1,787.5681	1,746.7485
BUR3	931.3613	1,029.6355	1,312.7527	1,549.4400	1,718.2850	1,733.9712	1,666.6066	1,776.1668	1,889.4471	1,894.8904
Difference, %	6.3	6.7	12.0	7.6	7.1	5.6	5.7	5.3	5.7	8.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	1,994.3103	2,111.8501	1,844.7477	1,972.4785	2,070.1128	2,161.8956	2,317.2707			
BUR3	2,112.2159	2,241.8367	1,954.7978	2,093.4434	2,157.6253	2,260.4866	2,410.3305	2,438.3632	2,539.1440	2,618.7522
Difference, %	5.9	6.2	6.0	6.1	4.2	4.6	4.0			

1A3c 'Railways'

GHG emission trends from source category 1A3c 'Railways'

Aggregated direct GHG emissions from source category 1A3c 'Railways' had decreased between 1990 and 2019 by circa 93.9 per cent (Table 3-91).

Table 3-91: Direct GHG emissions from source category 1A3c 'Railways' for the period 1990-2019 and their share compared to the year 1990

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A3c, kt CO_2 equivalent	450.4461	398.1451	330.7604	305.9782	121.5340	107.1307	103.9447	89.3226	66.0888	34.4317
%, compared to 1990	100.0	88.4	73.4	67.9	27.0	23.8	23.1	19.8	14.7	7.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A3c, kt CO_2 equivalent	37.2283	40.0201	91.1362	48.4132	66.9536	90.4439	113.0672	113.7805	104.6019	57.2949
%, compared to 1990	8.3	8.9	20.2	10.7	14.9	20.1	25.1	25.3	23.2	12.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A3c, kt CO_2 equivalent	58.3140	53.8020	57.9864	37.1689	3.1133	25.1001	52.3706	42.2714	22.8770	27.3825
%, compared to 1990	12.9	11.9	12.9	8.3	0.7	5.6	11.6	9.4	5.1	6.1

Direct and indirect GHG emissions for the period 1990-2019 from source category 1A3c 'Railways' compared to the level in the reference year 1990 are shown in Table 3-92.

Table 3-92: Direct and indirect GHG emissions from source category 1A3c 'Railways' and their share compared to the level in the reference year 1990

	1A3c, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1990	403.4745	0.0226	0.1557	6.7071	1.3696	0.5952	0.1024	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	356.6274	0.0200	0.1376	5.7352	1.1711	0.5089	0.0876	88.4	88.4	88.4	85.5	85.5	85.5	85.5
1992	296.2694	0.0166	0.1143	4.7633	0.9727	0.4227	0.0727	73.4	73.4	73.4	71.0	71.0	71.0	71.0
1993	274.0715	0.0153	0.1058	4.5560	0.9303	0.4043	0.0696	67.9	67.9	67.9	67.9	67.9	67.9	67.9
1994	108.8607	0.0061	0.0420	1.8096	0.3695	0.1606	0.0276	27.0	27.0	27.0	27.0	27.0	27.0	27.0
1995	95.9593	0.0054	0.0370	1.5952	0.3257	0.1416	0.0244	23.8	23.8	23.8	23.8	23.8	23.8	23.8
1996	93.1056	0.0052	0.0359	1.5477	0.3160	0.1373	0.0236	23.1	23.1	23.1	23.1	23.1	23.1	23.1
1997	80.0082	0.0045	0.0309	1.3300	0.2716	0.1180	0.0203	19.8	19.8	19.8	19.8	19.8	19.8	19.8
1998	59.1972	0.0033	0.0228	0.9840	0.2009	0.0873	0.0150	14.7	14.7	14.7	14.7	14.7	14.7	14.7
1999	30.8413	0.0017	0.0119	0.5127	0.1047	0.0455	0.0078	7.6	7.6	7.6	7.6	7.6	7.6	7.6
2000	33.3462	0.0019	0.0129	0.5543	0.1132	0.0492	0.0063	8.3	8.3	8.3	8.3	8.3	8.3	6.2
2001	35.8469	0.0020	0.0138	0.5959	0.1217	0.0529	0.0068	8.9	8.9	8.9	8.9	8.9	8.9	6.7
2002	81.6327	0.0046	0.0315	1.3570	0.2771	0.1204	0.0155	20.2	20.2	20.2	20.2	20.2	20.2	15.2
2003	43.3647	0.0024	0.0167	0.7209	0.1472	0.0640	0.0083	10.7	10.7	10.7	10.7	10.7	10.7	8.1
2004	59.9718	0.0034	0.0231	0.9969	0.2036	0.0885	0.0114	14.9	14.9	14.9	14.9	14.9	14.9	11.1
2005	81.0126	0.0045	0.0313	1.3467	0.2750	0.1195	0.0021	20.1	20.1	20.1	20.1	20.1	20.1	2.0
2006	101.2768	0.0057	0.0391	1.6835	0.3438	0.1494	0.0026	25.1	25.1	25.1	25.1	25.1	25.1	2.5
2007	101.9157	0.0057	0.0393	1.6942	0.3459	0.1503	0.0026	25.3	25.3	25.3	25.3	25.3	25.3	2.5

	1A3c, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
2008	93.6942	0.0052	0.0362	1.5575	0.3180	0.1382	0.0024	23.2	23.2	23.2	23.2	23.2	23.2	2.3
2009	51.3203	0.0029	0.0198	0.8531	0.1742	0.0757	0.0001	12.7	12.7	12.7	12.7	12.7	12.7	0.1
2010	52.2332	0.0029	0.0202	0.8683	0.1773	0.0771	0.0001	12.9	12.9	12.9	12.9	12.9	12.9	0.1
2011	48.1916	0.0027	0.0186	0.8011	0.1636	0.0711	0.0001	11.9	11.9	11.9	11.9	11.9	11.9	0.1
2012	51.9397	0.0029	0.0200	0.8634	0.1763	0.0766	0.0001	12.9	12.9	12.9	12.9	12.9	12.9	0.1
2013	33.2930	0.0019	0.0128	0.5534	0.1130	0.0491	0.0001	8.3	8.3	8.3	8.3	8.3	8.3	0.1
2014	2.7887	0.0002	0.0011	0.0464	0.0095	0.0041	0.0000	0.7	0.7	0.7	0.7	0.7	0.7	0.0
2015	22.4827	0.0013	0.0087	0.3737	0.0763	0.0332	0.0000	5.6	5.6	5.6	5.6	5.6	5.6	0.0
2016	46.9095	0.0026	0.0181	0.7798	0.1592	0.0692	0.0001	11.6	11.6	11.6	11.6	11.6	11.6	0.1
2017	37.8634	0.0021	0.0146	0.6294	0.1285	0.0559	0.0001	9.4	9.4	9.4	9.4	9.4	9.4	0.1
2018	20.4915	0.0011	0.0079	0.3406	0.0696	0.0302	0.0000	5.1	5.1	5.1	5.1	5.1	5.1	0.0
2019	24.5271	0.0014	0.0095	0.4270	0.0872	0.0379	0.0000	6.1	6.1	6.1	6.4	6.4	6.4	0.0

Direct GHG emission trend from source category 1A3c 'Railways' for the period 1990-2019 and the contribution of each direct GHG is shown in Table 3-93.

Table 3-93: Direct GHG emissions from source category 1A3c 'Railways' for the period 1990-2019 and the contribution of each gas in structure of emissions at source category level

	1A3c, kt CO_2 equivalent				Share, % of total		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	403.4745	0.5649	46.4066	450.4461	89.6	0.1	10.3
1991	356.6274	0.4993	41.0184	398.1451	89.6	0.1	10.3
1992	296.2694	0.4148	34.0762	330.7604	89.6	0.1	10.3
1993	274.0715	0.3837	31.5230	305.9782	89.6	0.1	10.3
1994	108.8607	0.1524	12.5209	121.5340	89.6	0.1	10.3
1995	95.9593	0.1344	11.0370	107.1307	89.6	0.1	10.3
1996	93.1056	0.1304	10.7088	103.9447	89.6	0.1	10.3
1997	80.0082	0.1120	9.2023	89.3226	89.6	0.1	10.3
1998	59.1972	0.0829	6.8087	66.0888	89.6	0.1	10.3
1999	30.8413	0.0432	3.5473	34.4317	89.6	0.1	10.3
2000	33.3462	0.0467	3.8354	37.2283	89.6	0.1	10.3
2001	35.8469	0.0502	4.1230	40.0201	89.6	0.1	10.3
2002	81.6327	0.1143	9.3892	91.1362	89.6	0.1	10.3
2003	43.3647	0.0607	4.9877	48.4132	89.6	0.1	10.3
2004	59.9718	0.0840	6.8978	66.9536	89.6	0.1	10.3
2005	81.0126	0.1134	9.3179	90.4439	89.6	0.1	10.3
2006	101.2768	0.1418	11.6486	113.0672	89.6	0.1	10.3
2007	101.9157	0.1427	11.7221	113.7805	89.6	0.1	10.3
2008	93.6942	0.1312	10.7765	104.6019	89.6	0.1	10.3
2009	51.3203	0.0719	5.9027	57.2949	89.6	0.1	10.3
2010	52.2332	0.0731	6.0077	58.3140	89.6	0.1	10.3
2011	48.1916	0.0675	5.5429	53.8020	89.6	0.1	10.3
2012	51.9397	0.0727	5.9740	57.9864	89.6	0.1	10.3
2013	33.2930	0.0466	3.8293	37.1689	89.6	0.1	10.3
2014	2.7887	0.0039	0.3207	3.1133	89.6	0.1	10.3
2015	22.4827	0.0315	2.5859	25.1001	89.6	0.1	10.3
2016	46.9095	0.0657	5.3954	52.3706	89.6	0.1	10.3
2017	37.8634	0.0530	4.3550	42.2714	89.6	0.1	10.3
2018	20.4915	0.0287	2.3569	22.8770	89.6	0.1	10.3
2019	24.5271	0.0343	2.8210	27.3825	89.6	0.1	10.3

Methodological Issues, Emission Factors and Activity Data

Direct GHG emissions originating from category 1A3c 'Railways' were estimated following a Tier 1 methodology available in the 2006 IPCC Guidelines, based on AD on default emission factors. In order to estimate non-CO_2 emissions, default emission factors were used, available in the EMEP/EEA Guidebook (2019) (Table 3-94).

Table 3-94: Emission factors used to estimate GHG emissions from 1A3 'Railways'

Fuel type	kg/TJ			kg/t			
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
Diesel Oil	74100	4.15	28.6	52.4	10.7	4.65	formula
References	2006 IPCC Guidelines, Chapter 1A 'Mobile Combustion' – CO_2, CH_4, Table 3.4.1, p. 3.43			EMEP/EEA Guidebook 2019, Chapter 1.A.3.c 'Railways', Table 3-1, p. 8			

Activity Data

Compared to the previous inventory cycle, the following changes occurred in the current cycle:

- Activity data for the period 1991-1992 for the territory for the LBDR was restored by the interpolation method based on the specific fuel consumption for the RBDR;
- The series of activity data was extended by another three years (2017-2019).

For category 1A3c 'Railways', fuel consumption for the territory on the RBDR is available in the EBs of the RM. For the territory on the LBDR, fuel consumption was restored based on the specific consumption per capita on the RBDR. The same approach was applied in the current inventory cycle, but the availability of updated information on the population of the Republic of Moldova because of the recent recalculation of the 2014 population census results (Table 3-95) was taken into account.

Table 3-95: Aggregate diesel oil consumption for source category 1A3c 'Railways' for the period 1990-2019, as well as separate for the RBDR and LBDR, TJ

Years	RBDR	LBDR	RM – total	Years	RBDR	LBDR	RM – total
1990	4533	912	5445	2005	945	144	1089
1991	3877	779	4656	2006	1180	178	1358
1992	3220	647	3867	2007	1186	177	1363
1993	3078	593	3671	2008	1089	161	1250
1994	1232	237	1469	2009	596	87	683
1995	1086	206	1292	2010	605	88	693
1996	1056	196	1252	2011	557	80	637
1997	910	167	1077	2012	599	86	685
1998	675	123	798	2013	383	54	437
1999	352	64	416	2014	32	5	37
2000	381	68	449	2015	258	34	292
2001	410	73	483	2016	542	72	614
2002	936	163	1099	2017	437	58	495
2003	498	86	584	2018	236	31	267
2004	690	106	796	2019	282	41	331

Calculation methodology of SO_2 emissions

SO_2 emissions have been calculated based on the estimation methodology available in the EMEP/EEA Air Pollutant Emission Inventory (2019) applying the following equation:

$$E_{SO2} = 2 \bullet k \bullet AD,$$

where:

k - sulphur content in type m fuel [g/g fuel] (EMEP/EEA Guidebook 2019, source category 1A3bi, Table 3-13, p. 24), when:

- for the period 1990-1995 and 1996-2000, the value k – 165 / 1000000 grams of sulphur / grams of gasoline and k – 400 / 1000000 grams of sulphur / grams of diesel;
- for the period 2001-2005, the value k – 130 / 1000000 grams of sulphur / grams of gasoline and k – 300/1000000 grams of sulphur / grams of diesel;
- for the period 2006-2009, the value k – 40 / 1000000 grams of sulphur / grams of gasoline and k – 40 / 1000000 grams of sulphur / grams of diesel;
- for the period 2010-2019, the value k – 40 / 1000000 grams of sulphur / grams of gasoline and k – 8 /1000000 grams of sulphur / grams of diesel.

SO_2 emissions from source category 1A3c 'Railways' for the period 1990-2019, are shown on aggregate as well as separately for the RBDR and LBDR in Table 3-96.

Table 3-96: SO_2 emissions from source category 1A3c 'Railways' for the period 1990-2019, shown on aggregate as well as separately for the RBDR and LBDR, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RBDR	0.0852	0.0729	0.0605	0.0579	0.0232	0.0204	0.0199	0.0171	0.0127	0.0066
LBDR	0.0172	0.0147	0.0122	0.0117	0.0045	0.0039	0.0038	0.0032	0.0023	0.0012
Total, Republic of Moldova	**0.1024**	**0.0876**	**0.0727**	**0.0696**	**0.0276**	**0.0244**	**0.0236**	**0.0203**	**0.0150**	**0.0078**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
RBDR	0.0054	0.0058	0.0132	0.0070	0.0097	0.0018	0.0022	0.0022	0.0020	0.0001
LBDR	0.0010	0.0010	0.0023	0.0012	0.0017	0.0003	0.0004	0.0004	0.0003	0.0000
Total, Republic of Moldova	**0.0063**	**0.0068**	**0.0155**	**0.0083**	**0.0114**	**0.0021**	**0.0026**	**0.0026**	**0.0024**	**0.0001**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
RBDR	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000
LBDR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total, Republic of Moldova	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0000**	**0.0000**	**0.0001**	**0.0001**	**0.0000**	**0.0000**

It should be noted that in the current inventory cycle no recalculations of direct greenhouse gas emissions directly from source category 1A3c 'Railways' have been made.

1A3d 'Water-borne Navigation'

GHG emission trends within source category 1A3d 'Water-borne Navigation'

Compared to the reference year, emissions from this source category had decreased towards 2019 by circa 90.3 per cent (Table 3-97).

Table 3-97: Aggregated direct GHG emissions from source category 1A3d 'Water-borne Navigation' for the period 1990-2019 and their share compared to 1990 level, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A3d, kt CO_2 equivalent	19.1071	0.2907	0.2487	0.2870	0.2241	0.2165	0.2350	0.2532	0.1583	0.2636
%, compared to 1990	100.0	1.5	1.3	1.5	1.2	1.1	1.2	1.3	0.8	1.4
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
1A3d, kt CO_2 equivalent	0.1166	0.2103	0.4874	0.4417	0.4483	0.2599	0.5203	0.3473	0.3477	0.3483
%, compared to 1990	0.6	1.1	2.6	2.3	2.3	1.4	2.7	1.8	1.8	1.8
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1A3d, kt CO_2 equivalent	0.2617	0.2623	0.2628	0.2635	2.3774	2.4654	1.8364	1.7509	1.5792	1.8450
%, compared to 1990	1.4	1.4	1.4	1.4	12.4	12.9	9.6	9.2	8.3	9.7

Direct and indirect GHG emissions for the period 1990-2019 from source category 1A3d 'Water-borne Navigation' for the period 1990-2019 compared to 1990 levels are shown in Table 3-98.

Table 3-98: Direct and indirect GHG emissions from source category 1A3d 'Water-borne Navigation' and their share compared to the level in the reference year 1990

	1A3d, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1990	18.9103	0.0018	0.0005	0.0005	0.0000	0.0000	0.0001	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	0.2877	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.52	1.52	1.52	1.52	1.52	1.52	1.52
1992	0.2461	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.30	1.30	1.30	1.30	1.30	1.30	1.30
1993	0.2841	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.50	1.50	1.50	1.50	1.50	1.50	1.50
1994	0.2218	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.17	1.17	1.17	1.17	1.17	1.17	1.17
1995	0.2143	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.13	1.13	1.13	1.13	1.13	1.13	1.13
1996	0.2325	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.23	1.23	1.23	1.23	1.23	1.23	1.23
1997	0.2506	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.33	1.33	1.33	1.33	1.33	1.33	1.33
1998	0.1567	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.83	0.83	0.83	0.83	0.83	0.83	0.83
1999	0.2609	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.38	1.38	1.38	1.38	1.38	1.38	1.38
2000	0.1154	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.61	0.61	0.61	0.61	0.61	0.61	0.61
2001	0.2082	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.10	1.10	1.10	1.10	1.10	1.10	1.10
2002	0.4824	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.55	2.55	2.55	2.55	2.55	2.55	2.55
2003	0.4371	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.31	2.31	2.31	2.31	2.31	2.31	2.31
2004	0.4437	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.35	2.35	2.35	2.35	2.35	2.35	2.35
2005	0.2572	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.36	1.36	1.36	1.36	1.36	1.36	1.36
2006	0.5150	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.72	2.72	2.72	2.72	2.72	2.72	2.72
2007	0.3437	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.82	1.82	1.82	1.82	1.82	1.82	1.82
2008	0.3441	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.82	1.82	1.82	1.82	1.82	1.82	1.82
2009	0.3447	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.82	1.82	1.82	1.82	1.82	1.82	1.82
2010	0.2590	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.37	1.37	1.37	1.37	1.37	1.37	1.37
2011	0.2596	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.37	1.37	1.37	1.37	1.37	1.37	1.37
2012	0.2601	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.38	1.38	1.38	1.38	1.38	1.38	1.38
2013	0.2608	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.38	1.38	1.38	1.38	1.38	1.38	1.38
2014	2.3529	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	12.44	12.44	12.44	12.44	12.44	12.44	12.44
2015	2.4400	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	12.90	12.90	12.90	12.90	12.90	12.90	12.90
2016	1.8175	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	9.61	9.61	9.61	9.61	9.61	9.61	9.61
2017	1.7329	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	9.16	9.16	9.16	9.16	9.16	9.16	9.16
2018	1.5629	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	8.26	8.26	8.26	8.26	8.26	8.26	8.26
2019	1.8260	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	9.66	9.66	9.66	7.37	7.37	7.37	7.37

Direct GHG emissions from source category 1A3d 'Water-borne Navigation' between 1990 and 2019 are shown in Table 3-99.

Table 3-99: Direct GHG emissions from source category 1A3d 'Water-borne Navigation' for the Republic of Moldova, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	18.9103	0.2877	0.2461	0.2841	0.2218	0.2143	0.2325	0.2506	0.1567	0.2609
N_2O	0.1521	0.0023	0.0020	0.0023	0.0018	0.0017	0.0019	0.0020	0.0013	0.0021
CH_4	0.0447	0.0007	0.0006	0.0007	0.0005	0.0005	0.0005	0.0006	0.0004	0.0006
Total	**19.1071**	**0.2907**	**0.2487**	**0.2870**	**0.2241**	**0.2165**	**0.2350**	**0.2532**	**0.1583**	**0.2636**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2	0.1154	0.2082	0.4824	0.4371	0.4437	0.2572	0.5150	0.3437	0.3441	0.3447
N_2O	0.0009	0.0017	0.0039	0.0035	0.0036	0.0021	0.0041	0.0028	0.0028	0.0028
CH_4	0.0003	0.0005	0.0011	0.0010	0.0010	0.0006	0.0012	0.0008	0.0008	0.0008
Total	**0.1166**	**0.2103**	**0.4874**	**0.4417**	**0.4483**	**0.2599**	**0.5203**	**0.3473**	**0.3477**	**0.3483**
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CO_2	0.2590	0.2596	0.2601	0.2608	2.3529	2.4400	1.8175	1.7329	1.5629	1.8260
N_2O	0.0021	0.0021	0.0021	0.0021	0.0189	0.0196	0.0146	0.0139	0.0126	0.0147
CH_4	0.0006	0.0006	0.0006	0.0006	0.0056	0.0058	0.0043	0.0041	0.0037	0.0043
Total	**0.2617**	**0.2623**	**0.2628**	**0.2635**	**2.3774**	**2.4654**	**1.8364**	**1.7509**	**1.5792**	**1.8450**

Methodological Issues, Emission Factors and Activity Data

Direct GHG emissions originating from category 1A3d 'Water-borne Navigation' were estimated following a Tier 1 methodology available in the 2006 IPCC Guidelines, based on AD on default emission factors. In order to estimate non-CO_2 emissions, default emission factors were used, available in the EMEP/EEA Guidebook (2019) (Table 3-100).

Table 3-100: Emission factors for direct and indirect GHG from source category 1A3d 'Water-borne Navigation'

	kg/ TJ			kg/tone			
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
Diesel Oil	74100	7	2	79.3	7.4	2.7	20
References	2006 IPCC Guidelines, for CO_2, CH_4, N_2O, Chapter 'Mobile Combustion', Chapter 3.5.2-3, p. 3.50			EMEP/EEA Guidebook 2019, for NO_x, CO, NMVOC, source category 1A3d 'Water-borne Navigation', Table 3-1			

Activity Data

Compared to the previous inventory cycle, the following changes occurred in the current cycle:

- The consumption of diesel oil for water-borne navigation in the years 1990-1992 was distributed among the regions, separately for the territory on the Right and Left Banks of the Dniester River;
- For the territory on the Right Bank of the Dniester River, the activity data associated with the consumption of diesel oil for water-borne navigation were updated, using two reference sources: for the years 1990 and 2005-2019 – the activity data available in the Energy Balances of the Republic of Moldova was applied, and for the years 1991-2004 – the activity data obtained by official letters was applied at the requests of the MARDE;
- For the territory on the Left Bank of the Dniester River, the consumption of diesel oil for water-borne navigation for the period 1993-2019 was restored by indirect methods (based on the specific consumption per capita for the territory on the Right Bank of the Dniester River);
- The series of activity data was extended by another three years (2017-2019).

Table 3-101: Fuel consumption for source category 1A3d 'Water-borne Navigation' for the period 1990-2019

	TJ			kt			%	
	Right Bank	Left Bank	RM – total	Right Bank	Left Bank	RM – total	Right Bank	Left Bank
1990	212.4	42.8	255.2	4.994	1.005	5.999	83.2	16.8
1991	3.2	0.6	3.9	0.076	0.015	0.091	83.3	16.7
1992	2.8	0.6	3.3	0.065	0.013	0.078	83.2	16.8
1993	3.2	0.6	3.8	0.075	0.015	0.090	83.2	16.8
1994	2.5	0.5	3.0	0.059	0.011	0.070	83.9	16.1
1995	2.4	0.5	2.9	0.057	0.011	0.068	83.9	16.1
1996	2.6	0.5	3.1	0.062	0.012	0.074	84.0	16.0
1997	2.9	0.5	3.4	0.067	0.012	0.079	84.3	15.7
1998	1.8	0.3	2.1	0.042	0.008	0.050	84.5	15.5
1999	3.0	0.5	3.5	0.070	0.013	0.083	84.6	15.4
2000	1.3	0.2	1.6	0.031	0.006	0.037	84.7	15.3

	TJ			kt			%	
	Right Bank	Left Bank	RM – total	Right Bank	Left Bank	RM – total	Right Bank	Left Bank
2001	2.4	0.4	2.8	0.056	0.010	0.066	84.8	15.2
2002	5.5	1.0	6.5	0.130	0.023	0.153	85.0	15.0
2003	5.0	0.9	5.9	0.118	0.021	0.139	85.1	14.9
2004	5.1	0.9	6.0	0.120	0.021	0.141	85.3	14.7
2005	3.0	0.5	3.5	0.071	0.011	0.082	86.4	13.6
2006	6.0	0.9	6.9	0.141	0.022	0.163	86.3	13.7
2007	4.0	0.6	4.6	0.094	0.015	0.109	86.2	13.8
2008	4.0	0.6	4.6	0.094	0.015	0.109	86.1	13.9
2009	4.0	0.7	4.7	0.094	0.015	0.109	86.0	14.0
2010	3.0	0.5	3.5	0.071	0.012	0.082	85.8	14.2
2011	3.0	0.5	3.5	0.071	0.012	0.082	85.6	14.4
2012	3.0	0.5	3.5	0.071	0.012	0.083	85.5	14.5
2013	3.0	0.5	3.5	0.071	0.012	0.083	85.2	14.8
2014	27.0	4.8	31.8	0.635	0.112	0.746	85.0	15.0
2015	28.0	4.9	32.9	0.658	0.116	0.774	85.0	15.0
2016	21.0	3.5	24.5	0.494	0.083	0.577	85.6	14.4
2017	20.0	3.4	23.4	0.470	0.080	0.550	85.5	14.5
2018	18.0	3.1	21.1	0.423	0.073	0.496	85.3	14.7
2019	21.0	3.6	24.6	0.494	0.086	0.579	85.2	14.8

Recalculations

In the current inventory cycle, a number of measures have been taken in order to improve the quality of the national GHG inventory, as a result of which it is necessary to recalculate GHG emissions from source category 1A3d 'Water-borne Navigation'. The main causes of these recalculations have been reported above.

Compared to the results recorded in the BUR2 of the RM under the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in an upward trend in direct GHG emissions in the period 1991-2004, 2006-2011 and 2014-2016, and a downward trend in direct GHG emissions in 1990, 2005 and 2012-2013 (Table 3-102).

Table 3-102: Recalculation results of GHG emissions from 1A3d 'Water-borne Navigation' category included in the BUR2 of the RM to the UNFCCC (2019) for the period 1990-2016, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	19.1101	0.2421	0.2070	0.2389	0.1879	0.1815	0.1975	0.2134	0.1338	0.2230
BUR3	19.1071	0.2907	0.2487	0.2870	0.2241	0.2165	0.2350	0.2532	0.1583	0.2636
Difference, %	-0.02	20.1	20.1	20.2	19.3	19.3	19.0	18.6	18.3	18.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.0987	0.1784	0.4141	0.3758	0.3822	0.3249	0.2739	0.3153	0.3472	0.2739
BUR3	0.1166	0.2103	0.4874	0.4417	0.4483	0.2599	0.5203	0.3473	0.3477	0.3483
Difference, %	18.2	17.9	17.7	17.5	17.3	-20.0	90.0	10.2	0.2	27.2
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.2325	0.2389	0.2729	0.2747	0.3480	0.2495	0.2174			
BUR3	0.2617	0.2623	0.2628	0.2635	2.3774	2.4654	1.8364	1.7509	1.5792	1.8450
Difference, %	12.6	9.8	-3.7	-4.1	583.2	888.1	744.7			

Between 2017 and 2019, direct GHG emissions originating from source category 1A3d 'Water-borne Navigation' were assessed for the first time. Between 1990 and 2019, direct GHG emissions from this category had decreased by circa 90.3 per cent.

1A3e 'Other Transportation' (Pipeline Transport)

GHG emission trends from source category 1A3e 'Other Transportation' (Pipeline Transport)

Between 1990 and 2019, aggregated GHG emissions from source category 1A3e 'Other Transportation' (Pipeline Transport) had decreased by circa 81.2 per cent (Table 3-103).

Table 3-103: Direct GHG emissions from source category 1A3e 'Other Transportation' (Pipeline Transport) for the period 1990-2019 and their share compared to 1990 level

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A3e, kt CO_2 equivalent	91.2673	76.0561	57.0420	22.4028	104.1260	100.1746	141.1154	58.6333	56.5582	62.3482
%, compared to 1990	100.0	83.3	62.5	24.5	114.1	109.8	154.6	64.2	62.0	68.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A3e, kt CO_2 equivalent	35.0206	17.4636	38.0746	27.0558	43.6697	40.7340	7.6100	3.5166	4.6945	11.6892
%, compared to 1990	38.4	19.1	41.7	29.6	47.8	44.6	8.3	3.9	5.1	12.8

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A3e, kt CO_2 equivalent	17.7308	26.6202	23.8533	14.8220	19.3501	19.6134	16.8563	20.6175	18.1610	17.1983
%, compared to 1990	19.4	29.2	26.1	16.2	21.2	21.5	18.5	22.6	19.9	18.8

Direct and indirect GHG emissions from source category 1A3e 'Other Transportation' (Pipeline Transport) had decreased significantly between 1990 and 2019, in 2019 constituting only circa 18.8 per cent of the level in the reference year 1990 (Table 3-104).

Table 3-104: Direct and indirect GHG emissions from source category 1A3e 'Other Transportation' (Pipeline Transport) for the period 1990-2019, kt

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1990	91.1782	0.0016	0.0002	0.1203	0.0471	0.0374	0.0011
1991	75.9818	0.0014	0.0001	0.1002	0.0393	0.0312	0.0009
1992	56.9864	0.0010	0.0001	0.0752	0.0295	0.0234	0.0007
1993	22.3809	0.0004	0.0000	0.0295	0.0116	0.0092	0.0003
1994	104.0244	0.0019	0.0002	0.1372	0.0538	0.0426	0.0012
1995	100.0768	0.0018	0.0002	0.1320	0.0517	0.0410	0.0012
1996	140.9777	0.0025	0.0003	0.1860	0.0729	0.0578	0.0017
1997	58.5761	0.0010	0.0001	0.0773	0.0303	0.0240	0.0007
1998	56.5030	0.0010	0.0001	0.0745	0.0292	0.0232	0.0007
1999	62.2873	0.0011	0.0001	0.0822	0.0322	0.0255	0.0007
2000	34.9864	0.0006	0.0001	0.0461	0.0181	0.0143	0.0004
2001	17.4466	0.0003	0.0000	0.0230	0.0090	0.0072	0.0002
2002	38.0374	0.0007	0.0001	0.0502	0.0197	0.0156	0.0005
2003	27.0294	0.0005	0.0000	0.0357	0.0140	0.0111	0.0003
2004	43.6271	0.0008	0.0001	0.0575	0.0226	0.0179	0.0005
2005	40.6943	0.0007	0.0001	0.0537	0.0210	0.0167	0.0005
2006	7.6025	0.0001	0.0000	0.0100	0.0039	0.0031	0.0001
2007	3.5131	0.0001	0.0000	0.0046	0.0018	0.0014	0.0000
2008	4.6899	0.0001	0.0000	0.0062	0.0024	0.0019	0.0001
2009	11.6778	0.0002	0.0000	0.0154	0.0060	0.0048	0.0001
2010	17.7135	0.0003	0.0000	0.0234	0.0092	0.0073	0.0002
2011	26.5942	0.0005	0.0000	0.0351	0.0137	0.0109	0.0003
2012	23.8300	0.0004	0.0000	0.0314	0.0123	0.0098	0.0003
2013	14.8075	0.0003	0.0000	0.0195	0.0077	0.0061	0.0002
2014	19.3312	0.0003	0.0000	0.0255	0.0100	0.0079	0.0002
2015	19.5943	0.0003	0.0000	0.0258	0.0101	0.0080	0.0002
2016	16.8399	0.0003	0.0000	0.0222	0.0087	0.0069	0.0002
2017	20.5974	0.0004	0.0000	0.0272	0.0106	0.0084	0.0002
2018	18.1432	0.0003	0.0000	0.0239	0.0094	0.0074	0.0002
2019	17.1815	0.0003	0.0000	0.0227	0.0089	0.0070	0.0002

Direct GHG emissions from source category 1A3e 'Other Transportation' (Pipeline Transport) and the contribution of each gas for the period 1990-2019 are shown in Table 3-105.

Table 3-105: Direct GHG emissions from source category 1A3e 'Other Transportation' (Pipeline Transport) and their share in the total structure at source category level

	1A3e, kt CO_2 equivalent				Share, % of total		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	91.1782	0.0406	0.0484	91.2673	99.9	0.0	0.1
1991	75.9818	0.0339	0.0404	76.0561	99.9	0.0	0.1
1992	56.9864	0.0254	0.0303	57.0420	99.9	0.0	0.1
1993	22.3809	0.0100	0.0119	22.4028	99.9	0.0	0.1
1994	104.0244	0.0464	0.0553	104.1260	99.9	0.0	0.1
1995	100.0768	0.0446	0.0532	100.1746	99.9	0.0	0.1
1996	140.9777	0.0628	0.0749	141.1154	99.9	0.0	0.1
1997	58.5761	0.0261	0.0311	58.6333	99.9	0.0	0.1
1998	56.5030	0.0252	0.0300	56.5582	99.9	0.0	0.1
1999	62.2873	0.0278	0.0331	62.3482	99.9	0.0	0.1
2000	34.9864	0.0156	0.0186	35.0206	99.9	0.0	0.1
2001	17.4466	0.0078	0.0093	17.4636	99.9	0.0	0.1
2002	38.0374	0.0170	0.0202	38.0746	99.9	0.0	0.1
2003	27.0294	0.0120	0.0144	27.0558	99.9	0.0	0.1
2004	43.6271	0.0194	0.0232	43.6697	99.9	0.0	0.1
2005	40.6943	0.0181	0.0216	40.7340	99.9	0.0	0.1
2006	7.6025	0.0034	0.0040	7.6100	99.9	0.0	0.1
2007	3.5131	0.0016	0.0019	3.5166	99.9	0.0	0.1

	1A3e, kt CO_2 equivalent				Share, % of total		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
2008	4.6899	0.0021	0.0025	4.6945	99.9	0.0	0.1
2009	11.6778	0.0052	0.0062	11.6892	99.9	0.0	0.1
2010	17.7135	0.0079	0.0094	17.7308	99.9	0.0	0.1
2011	26.5942	0.0119	0.0141	26.6202	99.9	0.0	0.1
2012	23.8300	0.0106	0.0127	23.8533	99.9	0.0	0.1
2013	14.8075	0.0066	0.0079	14.8220	99.9	0.0	0.1
2014	19.3312	0.0086	0.0103	19.3501	99.9	0.0	0.1
2015	19.5943	0.0087	0.0104	19.6134	99.9	0.0	0.1
2016	16.8399	0.0075	0.0089	16.8563	99.9	0.0	0.1
2017	20.5974	0.0092	0.0109	20.6175	99.90	0.04	0.05
2018	18.1432	0.0081	0.0096	18.1610	99.90	0.04	0.05
2019	17.1815	0.0077	0.0091	17.1983	99.90	0.04	0.05

Methodological Issues, Emission Factors and Activity Data

A Tier 1 methodology was used for the estimation of GHG emissions from 1A3e 'Other Transportation' (Pipeline Transport).

Emission factors for national direct GHG emissions were taken from the 2006 IPCC Guidelines for the inventory of national direct GHG emissions, whereas the emission factors for indirect GHG emissions were taken from the EMEP/EEA Air Pollutant Emission Inventory (2009) (Table 3-106).

Table 3-106: Emission factors for direct and indirect GHG emissions from source category 1A3e 'Other Transportation' (Pipeline Transport)

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
	kg/TJ						
Natural Gas	56,100	1	0.1	74	29	23	0.67
References	2006 IPCC Guidelines, Chapter 'Mobile Combustion'			EMEP/EEA Guidebook 2019, Chapters 1.A.4.a/c, 1.A.5.a, 1.A.4.a.i, 1.A.4.b.i, 1.A.4.c.i, 1.A.5.a, Table 3.8.			

Activity Data

The main source of activity data for source category 1A3e 'Other Transportation' (Pipeline Transport) is the EBs of the RM for the territory on the Right Bank of the Dniester River. For the territory on the Left Bank of the Dniester River, the activity data was restored based on the specific consumption per capita on the Right Bank of the Dniester (Table 3-107).

Table 3-107: Fuel consumption in source category 1A3e 'Other Transportation' (Pipeline Transport) for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Right Bank of the Dniester River	1353	1128	846	332	1555	1496	2112	880	851	939
Left Bank of the Dniester River	272	227	170	67	299	288	401	164	156	171
Republic of Moldova - total	**1625**	**1354**	**1016**	**399**	**1854**	**1784**	**2513**	**1044**	**1007**	**1110**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Right Bank of the Dniester River	528	264	576	410	663	627	117	54	72	179
Left Bank of the Dniester River	96	47	102	72	115	98	19	9	12	29
Republic of Moldova - total	**624**	**311**	**678**	**482**	**778**	**725**	**136**	**63**	**84**	**208**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Right Bank of the Dniester River	271	406	363	225	293	297	257	314	276	261
Left Bank of the Dniester River	45	68	62	39	52	52	43	53	47	45
Republic of Moldova - total	**316**	**474**	**425**	**264**	**345**	**349**	**300**	**367**	**323**	**306**

Source: for the territory on the Right Bank of the Dniester River – EBs of the RM for the years 1990, 1993-2019; for the territory on the Left Bank of the Dniester River – activity data was restored based on the specific consumption per capita on the Right Bank of the Dniester

Recalculations

In the current inventory cycle, a number of measures have been taken in order to improve the quality of the national GHG inventory, as a result of which it is necessary to recalculate GHG emissions from source category 1A3e 'Other Transportation' (Pipeline Transport). The main causes of these recalculations are reported as follows:

- Restoring the natural gas consumption for the territory on the LBDR, based on the specific consumption per capita on the RBDR, taking into consideration the updated data of the 2014 population census;

– For the territory on the RBDR, activity data for the years 2010-2012 was specified based on the information available in the EBs of the RM for 2013 (statistical collection);
– For the entire period of time, a constant net caloric value was utilised (33.86 TJ/million m^3).

Compared to the results recorded in the BUR2 of the RM under the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in an upward trend of direct GHG emissions over the period between 1990-2016 (Table 3-108).

Table 3-108: Recalculation results of GHG emissions from 1A3e 'Other Transportation' category included in the BUR2 of the RM to the UNFCCC (2019) for the period 1990-2016, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	90.0389	75.0324	56.2743	18.6434	87.3207	84.0076	118.5989	49.4162	47.7877	52.7294
BUR3	91.2673	76.0561	57.0420	22.4028	104.1260	100.1746	141.1154	58.6333	56.5582	62.3482
Difference, %	1.4	1.4	1.4	20.2	19.2	19.2	19.0	18.7	18.4	18.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	29.6497	14.8080	31.9367	23.0235	37.2306	35.2091	6.5701	3.0324	4.0431	10.0517
BUR3	35.0206	17.4636	38.0746	27.0558	43.6697	40.7340	7.6100	3.5166	4.6945	11.6892
Difference, %	18.1	17.9	19.2	17.5	17.3	15.7	15.8	16.0	16.1	16.3
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	2.1339	NO	NO	12.6348	16.4534	16.6780	14.4318			
BUR3	17.7308	26.6202	23.8533	14.8220	19.3501	19.6134	16.8563	20.6175	18.1610	17.1983
Difference, %	730.9	100.0	100.0	17.3	17.6	17.6	16.8			

Between 2017 and 2019, direct GHG emissions from 1A3e 'Other Transportation' (Pipeline Transport) were assessed for the first time. For the period between 1990 and 2019, direct GHG emissions from the respective category had decreased by circa 81.2 per cent.

3.4.3. Uncertainties Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to assessment methodology, emission factors used to estimate GHG emissions covered by category 1A3 'Transport', and the quality of activity data available.

Uncertainties associated with EFs used to estimate CO_2 emissions were estimated at about 5 per cent, CH_4 emissions – circa 40 per cent, and N_2O emissions – circa 50 per cent. Uncertainties associated with statistical data regarding fuel consumption within the Transport Sector in the Republic of Moldova can be considered relatively low (±5 per cent). The combined uncertainties presented as a percentage of the total direct GHG emissions from source category 1A3 'Transport' were estimated at about 6.97 per cent. The uncertainties introduced in the trend of total direct GHG emissions from the respective source category were estimated at about 3.82 per cent.

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in accordance with the recommendations included in the 2006 IPCC Guidelines.

3.4.4. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for category 1A3 'Transport', following the Tier 1 approach. To be noted, that the AD and methods used for estimating GHG emissions under category 1A3 'Transport' were documented and archived both in hard copies and electronically.

In order to identify the data entry and emission estimation process related errors, verifications and quality control procedures were applied, including:

- Verification of AD collecting and manipulation procedures, including: verifying if disaggregation of AD collected for each source category included in 1A3 'Transport' category complies with the requirements set out in the description of each source category in the 2006 IPCC Guidelines; verifying the correctness of EFs use for each source; verifying if the primary reference sources are correctly indicated; the accuracy of calculations for sources included in 1A3 category are verified randomly;

- Implementation of error minimization procedures for manual entry of AD, with all the spreadsheets provided with the initial sources of activity data in tabular format;
- In the calculation files the EFs are specified in tabular formats for each source, the import of the respective values into calculation formulas is ensured by automatic connections;
- The consistency of the calculations is also ensured by verifying the correctness of applying conversion factors of natural units to energy units for all sources and the entire range of years covered by the inventory;
- Verification if the same method is used for the entire range of years covered by the inventory;
- Verifying if GHG emissions calculations have been made for all years and for all types of fuels mentioned in the Energy Balances of the RM and the relevant reference sources;
- Verifying to what extent the full geographical coverage of the national GHG inventory of the RM is ensured;
- Verifying the inter-annual evolution trends of emissions by creating representative charts, while unusual fluctuations are explained;
- Regarding recalculations, their need is explained, including by drawing attention to the implemented recommendations resulting from the audit carried out by national and international experts in the previous inventory cycle;
- Verifying maintenance and completion of the national inventory of GHG emissions archive.

3.4.5. Recalculations

Compared to the results recorded in BUR2 of the RM under the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in an upward trend in direct GHG emissions between 1990 and 2016, ranging from a minimum increase of 3.0 per cent in 1997, to a maximum increase of circa 12.5 per cent in 1992 (Table 3-109).

Table 3-109: Recalculation results of GHG emissions from 1A3 'Transport' category included in the BUR2 of the RM to the UNFCCC (2019) for the period 1990-2016, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	4,479.4542	3,405.6396	2,399.6485	1,762.9007	1,527.4063	1,539.2813	1,490.6804	1,509.7178	1,307.0517	876.1417
BUR3	4,837.9155	3,768.7665	2,699.4911	1,921.2395	1,656.3679	1,660.4315	1,619.5131	1,555.1016	1,397.7966	932.2067
Difference, %	8.0	10.7	12.5	9.0	8.4	7.9	8.6	3.0	6.9	6.4
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
BUR2	942.9727	1,019.9028	1,295.6232	1,512.4719	1,708.8588	1,767.1186	1,695.7978	1,803.7175	1,895.5003	1,813.6345
BUR3	1,005.7542	1,087.4276	1,442.5357	1,626.0055	1,829.7061	1,867.0868	1,788.0010	1,894.8597	1,999.2424	1,964.2987
Difference, %	6.7	6.6	11.3	7.5	7.1	5.7	5.4	5.1	5.5	8.3
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
BUR2	2,054.1180	2,164.9327	1,901.8722	2,021.7651	2,090.0531	2,203.3296	2,382.9261			
BUR3	2,188.8720	2,322.5910	2,037.0401	2,145.8940	2,182.6059	2,307.9763	2,481.6237	2,503.5890	2,581.9145	2,665.4611
Difference, %	6.6	7.3	7.1	6.1	4.4	4.7	4.1			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR2 – Third Biennial Update Report of the RM under the UNFCCC.

Direct GHG emissions for the period 2017-2019 were estimated for the first time. Between 1990 and 2019, direct GHG emissions from category 1A3 'Transport' decreased in the Republic of Moldova by circa 44.9 per cent.

3.4.6. Planned Improvements

Potential improvements within category 1A3 'Transport' could be possible once updating the available AD on real fuel consumption in the ATULBD for each source of emissions. Regarding source category 1A3b 'Road Transportation', potential improvements could be regarding the collection of additional AD necessary for the use of the COPERT 4.9 model for the entire period (1990-2019).

Also, for source categories 1A3a 'Civil Aviation' and 1A3c 'Railways', it would be possible to use higher-tier methods (Tier 2b, and Tier 2, respectively), but since these sources are not key categories, this activity is not cost-efficient and cost-effective for the national inventory team.

3.5. Other Sectors (category 1A4)

3.5.1. Source Category Description

Category 1A4 'Other Sectors' includes the following sources: 1A4a 'Commercial/Institutional'; 1A4b 'Residential'; 1A4c 'Agriculture/Forestry/Fishing' (1A4ci 'Stationary' and 1A4cii 'Mobile' (off-road vehicles and other machinery)).

Between 1990-2019, GHG emissions from category 1A4 'Other Sectors' tended to decrease by circa 69.5 per cent: from 7,841.31 kt CO_2 equivalent recorded in 1990, to circa 2,393.78 kt CO_2 equivalent in 2019 (Table 3-110).

Table 3-110: GHG emissions from category 1A4 'Other Sectors' for the 1990-2019 periods

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A4, kt CO_2 equivalent	7,841.3054	6,298.7414	4,246.7365	2,240.2258	2,227.1082	2,286.2222	2,411.7076	2,611.6491	2,156.4269	1,875.2453
%, compared to 1990	100.0	80.3	54.2	28.6	28.4	29.2	30.8	33.3	27.5	23.9
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
1A4, kt CO_2 equivalent	1,552.9485	1,488.1507	1,814.5940	2,161.7781	2,325.2628	2,283.7523	2,274.8849	1,721.3685	1,732.0776	1,881.5086
%, compared to 1990	19.8	19.0	23.1	27.6	29.7	29.1	29.0	22.0	22.1	24.0
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1A4, kt CO_2 equivalent	2,047.3623	2,375.6672	2,341.9613	2,021.6567	2,067.0698	1,939.2152	1,925.2983	2,175.9589	2,267.8044	2,393.7830
%, compared to 1990	26.1	30.3	29.9	25.8	26.4	24.7	24.6	27.7	28.9	30.5

Compared to the year 1990, the level of GHG emissions from category 1A4 'Other Sectors' constituted in 2019, for CO_2 – 28.6 per cent of the reference year level, CH_4 – 76.2 per cent, N_2O – 38.1 per cent, NO_x – 30.5 per cent, CO – 62.2 per cent, NMVOC – 84.3 per cent, SO_x – 7.7 per cent (Table 3-111).

Table 3-111: Direct and indirect GHG emissions from category 1A4 'Other Sectors' for the period 1990-2019

	1A4, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1990	7,372.2624	11.5005	0.6092	21.5980	188.2917	20.5488	42.5973	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	5,971.5518	8.2940	0.4021	16.0136	135.7317	14.6862	30.9518	81.0	72.1	66.0	74.1	72.1	71.5	72.7
1992	4,047.4223	5.0044	0.2490	10.2209	81.2407	8.8561	18.6039	54.9	43.5	40.9	47.3	43.1	43.1	43.7
1993	2,133.9212	1.7913	0.2065	7.7876	30.6143	3.6883	8.0858	28.9	15.6	33.9	36.1	16.3	17.9	19.0
1994	2,090.7472	2.4402	0.2529	8.6031	41.2528	4.8276	8.8679	28.4	21.2	41.5	39.8	21.9	23.5	20.8
1995	2,172.1646	1.3343	0.2708	9.1456	30.5187	3.2884	4.8320	29.5	11.6	44.5	42.3	16.2	16.0	11.3
1996	2,285.6997	2.3850	0.2228	7.8951	44.6759	4.8360	7.2025	31.0	20.7	36.6	36.6	23.7	23.5	16.9
1997	2,502.5306	1.7835	0.2165	7.8855	35.7839	3.8166	4.8638	33.9	15.5	35.5	36.5	19.0	18.6	11.4
1998	2,078.6760	1.1889	0.1612	6.1632	23.7935	2.6926	3.3628	28.2	10.3	26.5	28.5	12.6	13.1	7.9
1999	1,809.4024	1.2151	0.1190	4.7057	21.2190	2.5511	2.8154	24.5	10.6	19.5	21.8	11.3	12.4	6.6
2000	1,494.1182	1.2084	0.0960	3.8246	19.3419	2.4620	2.4553	20.3	10.5	15.8	17.7	10.3	12.0	5.8
2001	1,434.1009	1.0554	0.0928	3.7425	16.7367	2.1939	2.1063	19.5	9.2	15.2	17.3	8.9	10.7	4.9
2002	1,747.8245	1.3555	0.1103	4.4782	20.7434	2.8052	3.0494	23.7	11.8	18.1	20.7	11.0	13.7	7.2
2003	2,084.6537	1.7920	0.1085	4.7321	26.3815	3.5078	4.7236	28.3	15.6	17.8	21.9	14.0	17.1	11.1
2004	2,260.0278	1.4692	0.0957	4.7005	21.4786	2.9899	3.8578	30.7	12.8	15.7	21.8	11.4	14.6	9.1
2005	2,219.0765	1.5553	0.0866	4.3367	22.7299	3.0691	3.7081	30.1	13.5	14.2	20.1	12.1	14.9	8.7
2006	2,203.6648	1.7981	0.0881	4.2950	25.7482	3.4823	3.8856	29.9	15.6	14.5	19.9	13.7	16.9	9.1
2007	1,666.7458	1.3012	0.0741	3.3949	18.3862	2.5173	2.6494	22.6	11.3	12.2	15.7	9.8	12.3	6.2
2008	1,677.3708	1.3260	0.0723	3.3719	18.2724	2.5708	2.3550	22.8	11.5	11.9	15.6	9.7	12.5	5.5
2009	1,824.9424	1.4331	0.0696	3.4994	18.9129	2.6852	2.6186	24.8	12.5	11.4	16.2	10.0	13.1	6.1
2010	1,985.9921	1.5654	0.0746	3.7644	21.8247	2.9363	2.9155	26.9	13.6	12.2	17.4	11.6	14.3	6.8
2011	2,310.7777	1.6944	0.0756	4.1423	23.3551	3.2990	2.7405	31.3	14.7	12.4	19.2	12.4	16.1	6.4
2012	2,271.4679	1.9260	0.0750	4.0329	26.3885	3.6707	3.1225	30.8	16.7	12.3	18.7	14.0	17.9	7.3
2013	1,947.9381	1.9842	0.0809	3.7783	27.7557	3.7434	3.2852	26.4	17.3	13.3	17.5	14.7	18.2	7.7
2014	1,927.7357	4.0868	0.1247	4.4921	54.5828	8.0026	2.4012	26.1	35.5	20.5	20.8	29.0	38.9	5.6
2015	1,790.2120	4.3428	0.1357	4.5595	58.1877	8.5261	2.3805	24.3	37.8	22.3	21.1	30.9	41.5	5.6
2016	1,767.4874	4.6624	0.1384	4.5317	62.0479	9.2199	1.9853	24.0	40.5	22.7	21.0	33.0	44.9	4.7
2017	1,960.6971	6.3772	0.1874	5.7093	85.0674	12.5450	2.9370	26.6	55.5	30.8	26.4	45.2	61.0	6.9
2018	1,946.2502	10.0301	0.2376	6.3540	133.0922	19.9404	2.3520	26.4	87.2	39.0	29.4	70.7	97.0	5.5
2019	2,105.4914	8.7623	0.2323	6.5829	117.1622	17.3134	3.2791	28.6	76.2	38.1	30.5	62.2	84.3	7.7

In the structure of total GHG emissions from category 1A4 'Other Sectors' for the period 1990-2019, the share of direct GHG emissions varied as follows: CO_2 – from 85.82 per cent (2018), to 97.27 per cent (2011); CH_4 – from 1.38 per cent (1998) to 11.06 per cent (2018) and N_2O – from 0.95 per cent (2011, 2012) to 3.53 per cent (1995) (Table 3-112).

Table 3-112: Direct GHG emissions from category 1A4 'Other Sectors' for the period 1990-2019

	1A4, kt CO_2 equivalent				% of total			%, compared to 1990		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
1990	7,372.2624	287.5113	181.5317	7,841.3054	94.02	3.67	2.32	100.00	100.00	100.00
1991	5,971.5518	207.3507	119.8389	6,298.7414	94.81	3.29	1.90	81.00	72.12	66.02
1992	4,047.4223	125.1098	74.2043	4,246.7365	95.31	2.95	1.75	54.90	43.51	40.88
1993	2,133.9212	44.7823	61.5223	2,240.2258	95.25	2.00	2.75	28.95	15.58	33.89
1994	2,090.7472	61.0059	75.3551	2,227.1082	93.88	2.74	3.38	28.36	21.22	41.51
1995	2,172.1646	33.3580	80.6996	2,286.2222	95.01	1.46	3.53	29.46	11.60	44.45
1996	2,285.6997	59.6255	66.3824	2,411.7076	94.78	2.47	2.75	31.00	20.74	36.57
1997	2,502.5306	44.5872	64.5312	2,611.6491	95.82	1.71	2.47	33.95	15.51	35.55
1998	2,078.6760	29.7213	48.0295	2,156.4269	96.39	1.38	2.23	28.20	10.34	26.46
1999	1,809.4024	30.3769	35.4659	1,875.2453	96.49	1.62	1.89	24.54	10.57	19.54
2000	1,494.1182	30.2106	28.6196	1,552.9485	96.21	1.95	1.84	20.27	10.51	15.77
2001	1,434.1009	26.3857	27.6641	1,488.1507	96.37	1.77	1.86	19.45	9.18	15.24
2002	1,747.8245	33.8864	32.8830	1,814.5940	96.32	1.87	1.81	23.71	11.79	18.11
2003	2,084.6537	44.7997	32.3247	2,161.7781	96.43	2.07	1.50	28.28	15.58	17.81
2004	2,260.0278	36.7303	28.5047	2,325.2628	97.19	1.58	1.23	30.66	12.78	15.70
2005	2,219.0765	38.8835	25.7923	2,283.7523	97.17	1.70	1.13	30.10	13.52	14.21
2006	2,203.6648	44.9525	26.2676	2,274.8849	96.87	1.98	1.15	29.89	15.64	14.47
2007	1,666.7458	32.5309	22.0918	1,721.3685	96.83	1.89	1.28	22.61	11.31	12.17
2008	1,677.3708	33.1490	21.5577	1,732.0776	96.84	1.91	1.24	22.75	11.53	11.88
2009	1,824.9424	35.8275	20.7387	1,881.5086	96.99	1.90	1.10	24.75	12.46	11.42
2010	1,985.9921	39.1358	22.2344	2,047.3623	97.00	1.91	1.09	26.94	13.61	12.25
2011	2,310.7777	42.3603	22.5291	2,375.6672	97.27	1.78	0.95	31.34	14.73	12.41
2012	2,271.4679	48.1511	22.3422	2,341.9613	96.99	2.06	0.95	30.81	16.75	12.31
2013	1,947.9381	49.6054	24.1133	2,021.6567	96.35	2.45	1.19	26.42	17.25	13.28
2014	1,927.7357	102.1699	37.1642	2,067.0698	93.26	4.94	1.80	26.15	35.54	20.47
2015	1,790.2120	108.5694	40.4338	1,939.2152	92.32	5.60	2.09	24.28	37.76	22.27
2016	1,767.4874	116.5604	41.2504	1,925.2983	91.80	6.05	2.14	23.97	40.54	22.72
2017	1,960.6971	159.4299	55.8319	2,175.9589	90.11	7.33	2.57	26.60	55.45	30.76
2018	1,946.2502	250.7521	70.8021	2,267.8044	85.82	11.06	3.12	26.40	87.21	39.00
2019	2,105.4914	219.0565	69.2351	2,393.7830	87.96	9.15	2.89	28.56	76.19	38.14

Trends in the evolution of GHG emissions disaggregated by emission source within category 1A4 'Other Sectors' are shown below (Table 3-113).

Table 3-113: Breakdown of direct GHG emissions by sources within 1A4 'Other Sectors' category within 1990-2019 periods, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A4a 'Commercial/Institutional'	1,426.11	1,010.66	669.18	594.67	390.57	399.10	366.36	310.28	308.61	230.62
1A4b 'Institutional'	4,701.86	4,129.81	2,853.32	1,021.91	1,123.43	1,100.71	1,409.59	1,666.25	1,369.76	1,315.30
1A4ci 'Agriculture/Forestry/Fishing' (Stationary)	165.95	162.64	113.67	79.25	34.09	19.75	28.26	32.97	39.38	18.62
1A4ci 'Agriculture/Forestry/Fishing' (Mobile)	1,547.38	995.64	610.56	544.40	679.02	766.67	607.50	602.15	438.67	310.71
1A4 'Other Sectors'	**7,841.31**	**6,298.74**	**4,246.74**	**2,240.23**	**2,227.11**	**2,286.22**	**2,411.71**	**2,611.65**	**2,156.43**	**1,875.25**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
1A4a 'Commercial/Institutional'	207.23	239.08	430.10	588.02	829.08	707.38	649.60	366.07	375.14	483.58
1A4b 'Institutional'	1,084.74	994.29	1,100.99	1,309.79	1,255.90	1,370.64	1,425.81	1,185.35	1,190.40	1,243.04
1A4ci 'Agriculture/Forestry/Fishing' (Stationary)	20.86	22.11	10.98	12.40	17.25	8.08	4.77	1.97	6.33	4.82
1A4ci 'Agriculture/Forestry/Fishing' (Mobile)	240.13	232.67	272.52	251.58	223.04	197.65	194.70	167.98	160.21	150.06
1A4 'Other Sectors'	**1,552.95**	**1,488.15**	**1,814.59**	**2,161.78**	**2,325.26**	**2,283.75**	**2,274.88**	**1,721.37**	**1,732.08**	**1,881.51**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1A4a 'Commercial/Institutional'	481.51	811.05	782.63	475.30	488.84	344.60	342.38	340.62	349.06	336.30
1A4b 'Institutional'	1,392.58	1,395.42	1,393.98	1,362.68	1,357.36	1,350.96	1,348.10	1,515.28	1,599.79	1,694.93
1A4ci 'Agriculture/Forestry/Fishing' (Stationary)	6.11	6.01	8.78	11.00	6.27	8.48	8.47	10.79	11.73	12.60
1A4ci 'Agriculture/Forestry/Fishing' (Mobile)	167.17	163.19	156.57	172.67	214.60	235.19	226.34	309.26	307.23	349.96
1A4 'Other Sectors'	**2,047.36**	**2,375.67**	**2,341.96**	**2,021.66**	**2,067.07**	**1,939.22**	**1,925.30**	**2,175.96**	**2,267.80**	**2,393.78**

The emission source with the largest share in the structure of total GHG emissions from category 1A4 'Other Sectors' is represented by category 1A4b 'Residential', with a share varying during the reference period between 45.6 per cent (1993) and 70.8 per cent (2019). The next, is 1A4a 'Commercial/Institutional', with a share varying between 11.9 per cent (1997) and 35.7 per cent (2004), followed by 1A4cii 'Agriculture/Forestry/Fishing' (Mobile), with a share varying between 6.7 per cent (2012) and 33.5 per cent (1995) (Figure 3-19, Table 3-114).

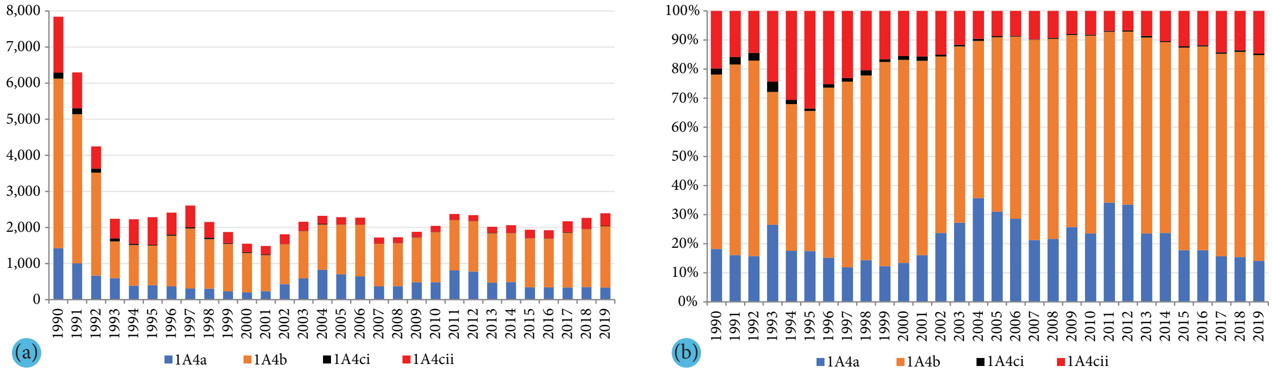

Figure 3-19: Breakdown of direct GHG emissions by sources within 1A4 'Other Sectors' category within 1990-2019 periods, in kt CO_2 equivalent (a); and their share in the structure of total direct GHG emissions within the respective category, in % from the total (b).

Table 3-114: The share of different sources in the structure of total direct GHG emissions from 1A4 'Other Sectors' category, % from the total

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A4a	18.2	16.0	15.8	26.5	17.5	17.5	15.2	11.9	14.3	12.3
1A4b	60.0	65.6	67.2	45.6	50.4	48.1	58.4	63.8	63.5	70.1
1A4ci	2.1	2.6	2.7	3.5	1.5	0.9	1.2	1.3	1.8	1.0
1A4cii	19.7	15.8	14.4	24.3	30.5	33.5	25.2	23.1	20.3	16.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A4a	13.3	16.1	23.7	27.2	35.7	31.0	28.6	21.3	21.7	25.7
1A4b	69.9	66.8	60.7	60.6	54.0	60.0	62.7	68.9	68.7	66.1
1A4ci	1.3	1.5	0.6	0.6	0.7	0.4	0.2	0.1	0.4	0.3
1A4cii	15.5	15.6	15.0	11.6	9.6	8.7	8.6	9.8	9.2	8.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A4a	23.5	34.1	33.4	23.5	23.6	17.8	17.8	15.7	15.4	14.0
1A4b	68.0	58.7	59.5	67.4	65.7	69.7	70.0	69.6	70.5	70.8
1A4ci	0.3	0.3	0.4	0.5	0.3	0.4	0.4	0.5	0.5	0.5
A4cii	8.2	6.9	6.7	8.5	10.4	12.1	11.8	14.2	13.5	14.6

3.5.2. Methodological Issues, Emission Factors and Activity Data

Direct GHG emissions originating from category 1A4 'Other Sectors' were estimated following a Tier 1 methodology available in the 2006 IPCC Guidelines, based on AD on fuel consumption and default emission factors.

In order to estimate non-CO_2 emissions, default emission factors were used available in the EMEP/EEA Air Pollutant Emission Inventory (2019) (Tables 3-115, 3-116, 3-117 and 3-118).

Table 3-115: Emission factors utilised for the estimation of GHG emissions from 1A4a 'Commercial/ Institutional', kg/TJ

Fuel Type	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Gasoline	69300	10	0.6	306	93	20	94
Diesel Oil	74100	10	0.6	306	93	20	94
Residual Fuel Oil	77400	10	0.6	306	93	20	94
Kerosene	71900	10	0.6	306	93	20	94
LPG	63100	5	0.1	74	29	23	0,67
Other Petroleum Products	73300	10	0.6	306	93	20	94
Anthracite	98300	10	1.5	173	931	88.8	840
Bituminous Coal	94600	10	1.5	173	931	88.8	840
Lignite	101000	10	1.5	173	931	88.8	840
Brown Coal – briquettes	97500	10	1.5	173	931	88.8	840
Coke	107000	10	1.5	173	931	88.8	840
Natural Gas	56100	5	0.1	74	29	23	0,67
Fuel Wood and Wood Waste	112000	300	4	91	570	300	11
Other Solid Biomass	100000	300	4	91	570	300	11
Charcoal	112000	200	1	91	570	300	11

Source: for CO_2 CH_4, N_2O – 2006 IPCC Guidelines, Volume 2, Chapter 2, Table 2.4, 2.20-2.21; for NO_x, CO, NMVOC and SO_2 – EMEP/EEA Air Pollutant Emission Inventory (2019), Table 3.7-3.10, p. 36-39, Category 1.A.4.a.

Table 3-116: Emission factors utilised for the estimation of GHG emissions from 1A4b 'Residential', kg/TJ

Fuel Type	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Residual Fuel Oil	77400	10	0.6	51	57	0,69	70
Kerosene	71900	10	0.6	51	57	0,69	70
LPG	63100	5	0.1	51	26	1,9	0,3
Other Petroleum Products	73300	10	0.6	51	57	0,69	70
Anthracite	98300	300	1.5	110	4600	484	900
Bituminous Coal	94600	300	1.5	110	4600	484	900
Lignite	101000	300	1.5	110	4600	484	900
Coke	107000	300	1.5	110	4600	484	900
Peat	106000	300	1.4	110	4600	484	900
Natural Gas	56100	5	0.1	51	26	1,9	0,3
Fuel Wood and Wood Waste	112000	300	4	50	4000	600	11
Other Solid Biomass	100000	300	4	50	4000	600	11
Charcoal	112000	200	1	50	4000	600	11

Source: for CO_2,CH_4, N_2O – 2006 IPCC Guidelines, Volume 2, Chapter 2, Table 2.5, 2.22-2.23, for NO_x, CO, NMVOC and SO_2 – EMEP/EEA Air Pollutant Emission Inventory (2019), Table 3.3-3.6, p.32-35, Category 1.A.4.b.

Table 3-117: Emission factors utilised for the estimation of GHG emissions from 1A4ci 'Agriculture/Forestry/Fishing' (Stationary), kg/TJ

Fuel Type	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Diesel Oil	74100	10	0.6	306	93	20	94
Residual Fuel Oil	77400	10	0.6	306	93	20	94
Kerosene	71900	10	0.6	306	93	20	94
Other Petroleum Products	73300	10	0.6	306	93	20	94
Anthracite	98300	300	1.5	173	931	88.8	840
Bituminous Coal	94600	300	1.5	173	931	88.8	840
Lignite	101000	300	1.5	173	931	88.8	840
Natural Gas	56100	5	0.1	74	29	23	0,67
Fuel Wood and Wood Waste	112000	300	4	91	570	300	11
Other Solid Biomass	100000	300	4	91	570	300	11

Source: for CO_2, CH_4, N_2O emissions – 2006 IPCC Guidelines, Volume. 2, Chapter. 2, Table 2.5, 2.22-2.23; for NO_x, CO, NMVOC and SO_2 emissions – EMEP/EEA Air Pollutant Emission Inventory (2019), Table 3.7-3.10, p. 36-39.

Table 3-118: Emission factors utilised for the estimation of GHG emissions from 1A4ci 'Agriculture/Forestry/Fishing' (Mobile)

Fuel	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	kg/TJ			kg/kt		
Gasoline	69300	80	2	7117	770368	18893
Diesel Oil	74100	4.15	28.6	34457	11469	3542
LPG	63100	62	0.2	28571	4823	6720

Source: for CO_2 – 2006 IPCC Guidelines, Volume 3, Chapter 3, Table 3.2.1; for CH_4, N_2O (gasoline, diesel) – 2006 IPCC Guidelines, Volume 3, Chapter 3, Table 3.3.1; for CH_4, N_2O (LPG) – 2006 IPCC Guidelines, Volume 3, Chapter 3, Table 3.2.2; for NO_x, CO and NMVOC – EMEP/EEA Air Pollutant Emission Inventory (2019), Table 3-1, p. 23.

SO_2 emissions were estimated utilising the data associated with the sulphur content in used fuels applying the following equation:

$$E_{SO_{2,m}} = 2 \sum k_{s,m} b_{j,m} 10^{-6}$$

where:

$E_{SO_{2,m}}$ – SO_2 emissions by type of fuel m [kt];

$k_{s,m}$ – weight of the sulphur content in type *m* fuel [kg / kg] (see Table 3-119);

$b_{j,m}$ – annual type *m* fuel consumption [kg], by source *j*;

10^{-6} – conversion coefficient from kg into kt.

Table 3-119: Typical sulphur content of fuels used

Fuel	1990-1999	2000-2004	2005-2008	2009-2019
Gasoline	165 ppm	130 ppm	40 ppm	5 ppm
Diesel Oil	400 ppm	300 ppm	40 ppm	3 ppm

Source: EMEP/EEA Air Pollutant Emission Inventory (2019), Table 3-14, p. 22, Category 1.A.3.b.i-iv.

AD on fuel consumption within 1A4 'Other Sectors' are available in the EBs of the RM and the statistical publications "Socio-economic development of the ATULBD". A part of the information used was provided by the JSC "Moldovagaz". To be noted that in the current inventory cycle, the activity data used were taken from the EBs of the RM directly in energy units (TJ), avoiding the conversion from natural units to energy units.

For the territory on the RBDR, the information associated with fuel consumption during the years 1990 and 1993-2019 in the EBs of the RM is available as follows: activity data for source category

'Commercial/Institutional Sector' are presented on aggregate; and for the 'Residential Sector', respectively the 'Agriculture/Forestry/Fishing Sector" – separately.

The AD associated with fuel consumption from the 'Agriculture/Forestry/Fishing' were disaggregated into two sources: 1A4ci 'Stationary' (it includes consumption of coal, residual fuel oil, natural gas and others) and 1A4cii 'Mobile' (Off-road Vehicles and Other Machinery) (it includes consumption of diesel oil, gasoline and LPG). The AD associated with fuel consumption from the LBDR are available only in natural units, being recalculated in energy units (TJ) by using country specific caloric factors.

The activity data available for each source considered under Category 1A4 'Other Sectors' is examined below. To be noted that in the current inventory cycle, LPG was allocated to gaseous and not liquid fuels, as in the previous inventory cycle.

1A4a 'Commercial/Institutional'

With reference to 1A4a 'Commercial/Institutional' source category, activity data on natural gas consumption for the territory on the LBDR is available for the period 1999-2019, and data on LPG consumption in the period 2011-2019, respectively (Table 3-120).

Table 3-120: Fuel consumption under the 1A4a 'Commercial/Institutional' source category on the LBDR for the period 1999-2019, TJ

	1999	2000	2001	2002	2003	2004	2005
Natural Gas, TJ	230	315	460	2770	2959	7754	6149
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Natural Gas, TJ	5143	488	670	545	1277	7084	6850
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
LPG, TJ	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Natural Gas, TJ	3383	3559	914	599	643	745	636

Source: Press Release "The State of Housing and Communal Services of the ATULBD" for the years 2011-2019.

Table 3-121: Fuel consumption under the 1A4a 'Commercial/Institutional' source category on the RBDR for the period 1999-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gasoline	NO	NO	NO	3	NO	NO	NO	NO	NO	NO
Diesel Oil	468	360	252	144	88	117	88	59	59	88
Kerosene	NO	NO	NO	47	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	844	732	620	508	235	235	205	59	29	29
Fuel for Oven	733	NO	NO	50	29	NO	NO	NO	29	29
Fuel for Engines	43	NO	NO	12	NO	NO	NO	NO	NO	NO
LPG	276	199	121	44	NO	59	59	29	NO	NO
Other Petroleum Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anthracite	11616	8260	4903	1546	675	440	440	352	323	323
Bituminous Coal	NO	NO	NO	2363	2200	2553	2171	1966	2200	1437
Lignite	12	193	375	557	411	352	352	205	176	88
Coal-briquettes	36	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coke	NO	NO	NO	3	NO	NO	NO	NO	NO	NO
Natural Gas	1422	1327	1233	1138	616	557	734	734	616	499
Fuel Wood	333	258	184	109	117	117	147	117	117	88
Wood Waste	NO	NO	NO	6	NO	NO	29	NO	NO	NO
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Gasoline	NO	NO	NO	NO	2	1	3	36	34	6
Diesel Oil	59	29	29	59	50	46	29	29	26	35
Kerosene	NO	NO	NO	NO	2	NO	NO	NO	96	177
Residual Fuel Oil	29	59	30	58	47	19	7	6	19	17
Fuel for Oven	147	205	58	29	70	11	15	19	42	382
LPG	NO	29	NO	29	32	72	32	41	2	28
Other Petroleum Products	NO	NO	NO	NO	NO	NO	NO	NO	801	1191
Anthracite	645	264	675	1846	1788	1358	1136	1016	673	315
Bituminous Coal	734	1203	1174	1115	745	732	859	570	NO	NO
Lignite	59	59	29	29	1	NO	NO	NO	3105	4535
Coke	NO	NO	NO	NO	NO	NO	NO	1	268	240
Natural Gas	557	734	1467	1993	2257	2572	2799	3056	15	36
Fuel Wood	88	117	147	381	242	210	254	247	28	NO
Wood Waste	NO	NO	NO	146	78	31	26	18	15	36
Agricultural Residues	NO	NO	NO	NO	14	5	2	14	28	300
Other types of Fuel	NO	29	NO	NO	NO	NO	NO	3	2	NO

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Gasoline	3	6	NO	NO	NO	NO	5	5	NO	NO
Diesel Oil	130	121	15	NO	NO	153	59	44	22	25
Residual Fuel Oil	30	10	1	6	NO	5	1	1	NO	NO
Fuel for Oven	59	15	5	1	4	1	NO	NO	NO	NO
LPG	291	82	125	135	193	70	56	46	26	24
Other Petroleum Products	7	NO	NO	1	NO	3	3	2	NO	2
Anthracite	828	867	898	1032	587	672	655	689	711	655
Bituminous Coal	243	217	100	67	197	77	106	84	42	23
Coal-briquettes	NO	NO	1	NO	NO	NO	NO	NO	NO	NO
Natural Gas	4722	5094	5061	2925	3462	3545	3949	3860	4001	4019
Fuel Wood	209	219	244	185	232	220	237	226	235	216
Wood Waste	36	17	18	35	26	14	13	16	16	11
Agricultural Residues	41	31	88	68	118	50	58	130	77	60
Other types of Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Charcoal	NO	NO	NO	3	21	16	13	11	32	44
Pellets and Briquettes	NO	NO	NO	NO	94	83	NO	112	150	127

Source: EBs of the RM for the years 1990 and 1993-2019.

As mentioned above, within source category 1A3c 'Railways', fuel consumption (residual fuel oil, anthracite, lignite, bituminous coal) was reallocated to source category 1A4a 'Commercial/ Institutional' (Table 3-122).

Table 3-122: Consumption of fuels reallocated from source category 1A3c 'Railways' to 1A4a 'Commercial/ Institutional' source category, TJ

	1990	1993	1994	1995	1996	1997	1998	2005	2007	2008	2009
Residual Fuel Oil	NO	300	88	59	29	29	59	NO	NO	3.5	5.5
Anthracite	80.1	NO	NO	NO	59	59	NO	1	1	2	NO
Bituminous Coal	NO	103	29	29	NO	NO	NO	NO	NO	1.6	1.6
Lignite	46.72	NO	NO	59	29	59	NO	NO	NO	NO	NO
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Residual Fuel Oil	8.3	6.6	9.6	1.7	3.3	1.14	3.1	0.7	NO	0.1	N/A
Anthracite	2	NO	NO	NO	NO	NO	NO	NO	NO	NO	N/A
Bituminous Coal	0.3	1.1	8.2	0.9	0.3	0.1	0.1	0.1	0.8	0.5	N/A

Source: EBs of the RM for the years 1990 and 1993-2019.

Below is presented the fuel consumption by type of fuel under 1A4a 'Commercial/Institutional' between 1990 and 2019. We may observe that the consumption of liquid fuels decreased in the respective period by 98.7 per cent (from 2,088 TJ in 1990 to 27 TJ in 2019); consumption of solid fuels decreased by 94.2 per cent (from 11,790 TJ in 1990 to 679 TJ in 2019); consumption of gaseous fuels increased by circa 2.8 times (from 1,698 TJ in 1990 to 4,679 TJ in 2019), and biofuel consumption increased by 36 per cent (from 333 TJ in 1990 to 458 TJ in 2019) (Table 3-123) (Figure 3-20).

Table 3-123: Consumption by type of fuel within 1A4a 'Commercial/Institutional' source category for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Liquid Fuels	2088	1092	872	1064	440	411	322	147	176	146
Solid Fuels	11790	8453	5278	4572	3315	3433	3051	2641	2699	1848
Gaseous Fuels	1698	1526	1354	1182	616	616	793	763	616	729
Biofuels	333	258	184	115	117	117	176	117	117	88
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Liquid Fuels	235	293	117	146	171	77	54	90	181	269
Solid Fuels	1438	1526	1878	2990	2534	2091	1995	1588	1478	1508
Gaseous Fuels	872	1223	4237	4981	10043	8793	7974	3585	3817	5462
Biofuels	88	146	147	527	334	246	282	282	313	576
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Liquid Fuels	237	159	31	10	7	163	71	53	22	27
Solid Fuels	1073	1085	1007	1100	784	749	761	773	754	679
Gaseous Fuels	6290	12260	12036	6443	7214	4529	4604	4549	4772	4679
Biofuels	286	267	350	291	491	383	321	495	510	458

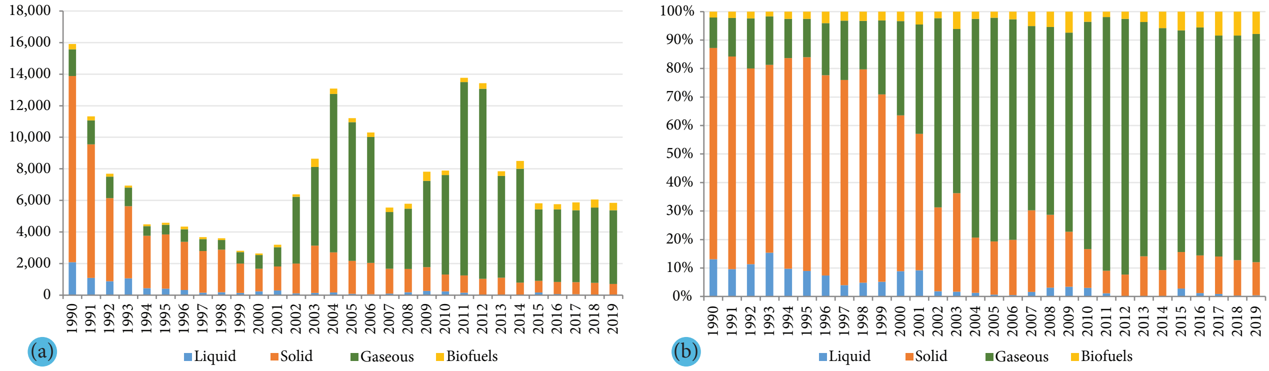

Figure 3-20: Fuel consumption under 1A4a 'Commercial/Institutional' in the Republic of Moldova within 1990-2019 periods, where: (a) Fuel consumption by type of fuel, TJ; and (b) Fuel consumption by type of fuel, in % of the total.

The total fuel consumption within source category 1A4a 'Commercial/Institutional' in the Republic of Moldova for the period 1990-2019 is shown in Table 3-124.

Table 3-124: Fuel consumption within 1A4a 'Commercial/Institutional' source category for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A4a, LBDR	NO	NO	NO	NO	NO	NO	NO	NO	NO	230
1A4a, RBDR	15910	11330	7688	6933	4488	4577	4342	3668	3608	2581
1A4a, Republic of Moldova – total	15910	11330	7688	6933	4488	4577	4342	3668	3608	2811
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A4a, LBDR	315	460	2770	2959	7754	6149	5143	488	675	552
1A4a, RBDR	2318	2728	3609	5685	5328	5058	5162	5057	5113	7262
1A4a, Republic of Moldova – total	2633	3188	6379	8644	13082	11207	10305	5545	5788	7814
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A4a, LBDR	1282	7087	6852	3386	3563	915	602	644	746	636
1A4a, RBDR	6605	6684	6572	4458	4934	4909	5155	5226	5312	5206
1A4a, Republic of Moldova – total	7887	13771	13424	7844	8497	5824	5757	5870	6058	5842

1A4b 'Residential'

The activity data for 1A4b 'Residential' on the LBDR are available for natural gas and LPG consumption between 1995 and 2019, and for fuel wood consumption between 2009 and 2019, respectively (Table 3-125).

Table 3-125: Fuel consumption within 1A4b 'Residential' source category on the LBDR for the period 1995-2019, TJ

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LPG	115	106	64	60	37	18	14	18	23	23	23	23	21
Natural Gas	7334	5533	12014	10889	9928	7378	6650	5939	5980	5512	5580	5458	5106
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
LPG	23	18	27	28	22	18	16	13	11	7	7	5	N/A
Natural Gas	5079	5282	5902	6247	6234	6115	6098	5939	6288	6456	6742	6218	N/A
Fuel Wood	NO	92	97	90	48	42	69	98	62	48	42	74	N/A

Source: for fuel wood – "Socio-economic development of the TMR", Chapter "Material and energy resources"; for LPG – Statistical Yearbooks of the ATULBD; for natural gas – J.S.C. "Moldovagaz" through Official Letters No. 07-730 of 06.06.2007; No. 02/1-476 of 23.02.2011; No. 02/1-288 of 22.01.2014; No. 02/1-507 of 10.02.2015; No. 02/1-2183 of 03.06.2016, No. 03/2-74 of 12.01.2018. Press Release "The State of Housing and Communal Services of the ATULBD" for the years 2011-2019.

Fuel consumption within 1A4b 'Residential' source category on the RBDR between 1990 and 2019 is shown in Table 3-126.

Table 3-126: Fuel consumption within 1A4b 'Residential' source category on the RBDR for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Residual Fuel Oil	NO	1065	7714	NO	29	NO	NO	NO	NO	NO
Kerosene	431	NO	NO	26	NO	NO	NO	NO	NO	NO
Diesel Oil	1191	8593	553	15	NO	NO	29	NO	29	29
LPG	5758	4277	2797	1317	557	528	704	910	910	1144
Anthracite	32485	22481	12477	2473	3491	1350	1584	1936	440	939
Bituminous Coal	25	998	1233	1468	2847	440	3199	734	558	323
Lignite	1916	1348	781	214	29	29	29	29	NO	NO
Coke	NO	NO	NO	6	NO	NO	29	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Natural Gas	8702	8707	8712	8717	7306	7834	9301	11120	10152	9389
Fuel Wood/Wood Waste	1052	957	861	766	822	1526	1848	1907	1966	1848
Other Solid Biomass	234	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Residual Fuel Oil	NO	NO	NO	NO	NO	2	NO	NO	NO	NO
Kerosene	NO	NO	NO	NO	NO	1	NO	NO	NO	NO
Diesel Oil	59	29	NO	NO	NO	NO	NO	NO	NO	2
LPG	1320	1232	1936	1934	2098	2079	1977	2070	1982	1913
Other Petroleum Products	NO	NO	NO	NO	NO	9	1	3	1	1
Anthracite	1115	763	1526	2286	1749	2012	2345	1334	1127	1409
Bituminous Coal	147	21	NO	59	57	92	45	73	42	17
Natural Gas	7599	7775	8186	10288	10693	12096	12708	10620	11240	11599
Fuel Wood/Wood Waste	1731	1555	1878	1964	1673	1704	2123	1716	1942	1767
Other Solid Biomass	29	NO	NO	17	130	214	245	197	212	NO
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Diesel Oil	NO	11	NO	NO	NO	NO	NO	NO	NO	NO
LPG	1849	2486	2591	2659	2664	2722	2912	2642	2610	2410
Other Petroleum Products	NO	2	NO	NO	NO	NO	NO	NO	NO	NO
Anthracite	2161	1885	2446	2538	1758	1584	1271	2235	1426	2615
Bituminous Coal	7	70	17	10	9	149	10	18	48	19
Lignite	NO	NO	NO	NO	NO	NO	1	NO	NO	1
Peat	NO	NO	NO	NO	NO	8	NO	1	NO	NO
Natural Gas	12308	11597	10498	9788	10012	9893	9899	10476	11204	12276
Fuel Wood/Wood Waste	1808	2134	2543	2880	10425	11439	13131	17722	29650	24908
Other Solid Biomass	66	419	96	134	181	244	115	155	1172	539
Charcoal	NO	NO	17	11	NO	2	4	2	5	9

Source: EBs of the RM for the year 1990 and 1993-2019.

Below (Table 3.127 and Figure 3-35) is presented the fuel consumption by type of fuel under 1A4b 'Residential' source category between 1990 and 2019. We may observe a significant decrease in liquid fuel consumption in the respective period (from 1,622 TJ in 1990 to 13 TJ in 2011, for the period 2012-2019 the consumption of the respective fuels was not recorded); solid fuel consumption decreased by 92.4 per cent (from 34,941 TJ in 1990 to 2,635 TJ in 2019); gaseous fuel consumption increased by 44.6 per cent (from 14,460 TJ in 1990 to 20,909 TJ in 2019); and biofuel consumption increased by circa 20 times (from 1,287 TJ in 1990 to 25,530 TJ in 2019).

Table 3-127: Consumption by type of fuel within 1A4b 'Residential' source category for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Liquid Fuels	1622	9658	8267	41	29	NO	29	NO	29	29
Solid Fuels	34941	24827	14491	4161	6367	1819	4841	2699	998	1262
Gaseous Fuels	14460	12984	11509	10034	7863	15811	15644	24108	22011	20498
Biofuels	1287	957	861	913	1027	1731	2171	2200	2142	2171
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Liquid Fuels	59	29	NO	NO	NO	12	1	3	1	3
Solid Fuels	1262	784	1526	2345	1806	2104	2390	1407	1169	1426
Gaseous Fuels	16315	15671	16079	18225	18326	19778	20166	17817	18324	18812
Biofuels	2259	2142	2377	2521	2123	2212	2708	2184	2466	2254
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Liquid Fuels	NO	13	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	2168	1955	2463	2548	1767	1741	1282	2254	1474	2635
Gaseous Fuels	20086	20358	19345	18580	18790	18567	19110	19581	20563	20909
Biofuels	2208	2780	2977	3231	10799	11835	13401	17927	30868	25530

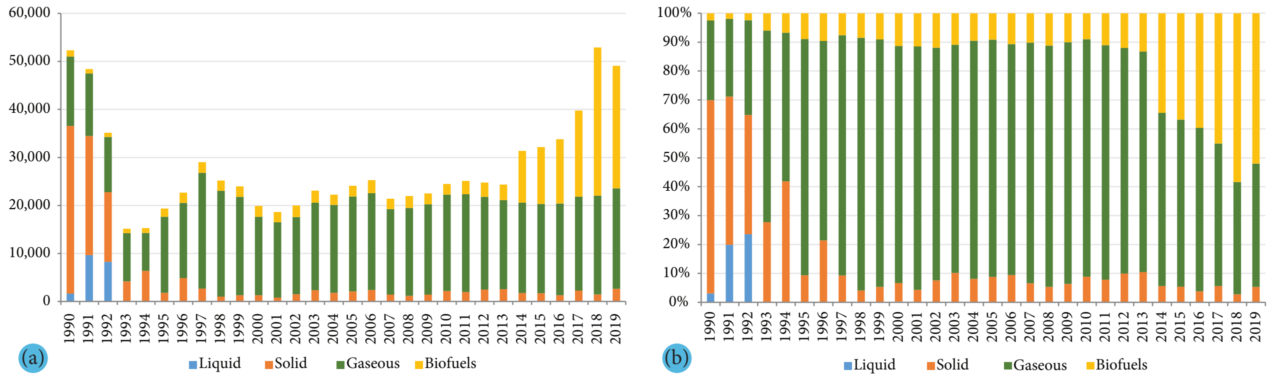

Figure 3-21: Fuel Consumption under the 1A4b 'Residential' source category in the Republic of Moldova within 1990-2019 periods, where: (a) Fuel consumption by type of fuel, TJ; and (b) Fuel consumption by type of fuel, in % of the total.

1A4c 'Agriculture/Forestry/Fishing'

Fuel consumption from 1A4c 'Agriculture/Forestry/Fishing' was considered under two sources lA4ci 'Stationary' and 1A4cii 'Mobile' (Off-road Vehicles and Other Machinery).

1A4ci 'Stationary'

The activity data related to fuel consumption in 1A4ci 'Stationary' source category on the LBDR is available for natural gas, residual fuel oil, and bituminous coal (Table 3-128).

Table 3-128: Fuel consumption within source category 1A4c 'Agriculture/Forestry/Fishing' – lA4ci 'Stationary' on the LBDR for the period 2003-2019, TJ

	2003	2004	2005	2006	2008	2009	2010	2011
Residual Fuel Oil, TJ	NO	NO	NO	NO	0.1	0.1	0.1	0.1
Natural Gas, TJ	30.5	23.7	13.5	3.4	3.4	NO	3.4	3.4
Bituminous Coal, TJ	NO	NO	NO	NO	0.4	0.3	0.2	0.8
	2012	2013	2014	2015	2016	2017	2018	2019
Residual Fuel Oil, TJ	0.1	0.1	NO	NO	NO	NO	NO	NO
Natural Gas, TJ	6.8	NO	NO	NO	NO	NO	NO	NO
Bituminous Coal, TJ	0.6	0.6	0.6	0.6	0.95	0,36	0,36	0,15

Sources: for residual fuel oil – "Socio-economic development of the TMR", Chapter "Material and energy resources"; for natural gas – JSC "Moldovagaz" through Letter No. 07-730 of 06.06.2007; No. 02/1-476 of 23.02.2011; No. 02/1-288 of 22.01.2014; No. 02/1-507 of 10.02.2015; and No. 02/1-2183 of 03.06.2016, No. 03/2-74 No. 12.01.2018, answer to Letter No. 601/2017-12-03 of 14.12.2017. Press Release "The State of Housing and Communal Services of the ATULBD" for the years 2011-2019.

Table 3-129: Fuel consumption within lA4ci 'Stationary' source category on the RBDR for the period 2003-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Diesel Oil	1078	1206	720	235	59	NO	117	88	264	117
Residual Fuel Oil	241	1005	683	200	88	NO	NO	29	NO	NO
Kerosene	43	3429	2428	246	29	29	NO	NO	NO	NO
Anthracite	561	405	250	94	59	29	29	29	NO	NO
Bituminous Coal	NO	3910	3834	120	88	59	59	NO	29	NO
Lignite	NO	NO	NO	18	NO	NO	NO	NO	NO	NO
Natural Gas	68	67	67	67	88	147	176	352	293	176
Fuel Wood/Wood Waste	36	27	18	12	29	29	29	29	NO	NO
Other Solid Biomass	NO	NO	NO	29	29	NO	29	117	29	NO
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Diesel Oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	1
Residual Fuel Oil	NO	NO	NO	NO	1	3	2	NO	2	1
Kerosene	147	205	59	29	20	9	2	NO	NO	NO
Other Petroleum Products	NO	NO	NO	NO	NO	2	NO	NO	NO	1
Anthracite	NO	NO	NO	NO	7	4	3	NO	1	2
Bituminous Coal	NO	NO	NO	NO	3	2	2	2	1	NO
Natural Gas	176	117	117	177	259	111	65	29	100	74
Fuel Wood/Wood Waste	NO	29	NO	29	8	15	18	13	10	19
Other Solid Biomass	NO	NO	NO	NO	2	7	12	2	1	2
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel Oil	NO	2	NO	NO	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	NO	1	NO	3	NO	NO	NO	NO	NO	NO
Kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	3
Other Petroleum Products	NO	NO	NO	NO	NO	1	2	4	2	NO
Anthracite	2	5	NO	11	12	29	28	44	40	45
Bituminous Coal	NO	NO	6	9	6	NO	NO	4	NO	NO
Natural Gas	96	86	132	148	70	89	86	88	122	128
Fuel Wood/Wood Waste	25	15	31	29	39	27	42	44	41	38
Other Solid Biomass	6	NO	2	3	5	2	6	5	6	6

Source: EBs of the RM for the year 1990 and 1993-2019.

Below (Table 3.130 and Figure 3-22) is presented the fuel consumption by type of fuel under 1A4ci 'Stationary' within 1A4c 'Agriculture/Forestry/Fishing' source category between 1990 and 2019.

We may observe that the consumption of liquid fuels decreased in the respective period by 99.8 per cent (from 1,363 TJ in 1990 to 3 TJ in 2019); the consumption of solid fuels decreased by 92 per cent (from 561 TJ in 1990 to 45 TJ in 2019); the consumption of gaseous fuels increased by circa 2 times (from 68 TJ in 1990 to 128 TJ in 2019); and the consumption of biofuels increased by 22.3 per cent (from 36 TJ in 1990 to 44 TJ in 2019).

Table 3-130: Consumption by type of fuel within 1A4ci 'Stationary' source category for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Liquid Fuels	1363	1544	1112	681	176	29	117	117	264	117
Solid Fuels	561	405	250	232	147	88	88	29	29	NO
Gaseous Fuels	68	67	67	67	88	147	176	352	293	176
Biofuels	36	27	18	41	58	29	58	146	29	NO
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Liquid Fuels	147	205	59	29	21	14	4	NO	2	3
Solid Fuels	NO	NO	NO	NO	10	6	5	2	2	2
Gaseous Fuels	176	117	117	177	259	111	65	29	103	74
Biofuels	NO	29	NO	29	10	22	30	15	11	21
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Liquid Fuels	NO	3	NO	3	NO	1	2	4	2	3
Solid Fuels	2	6	7	21	19	30	29	48	40	45
Gaseous Fuels	99	89	139	148	70	89	86	88	122	128
Biofuels	31	15	33	32	44	29	48	49	51	44

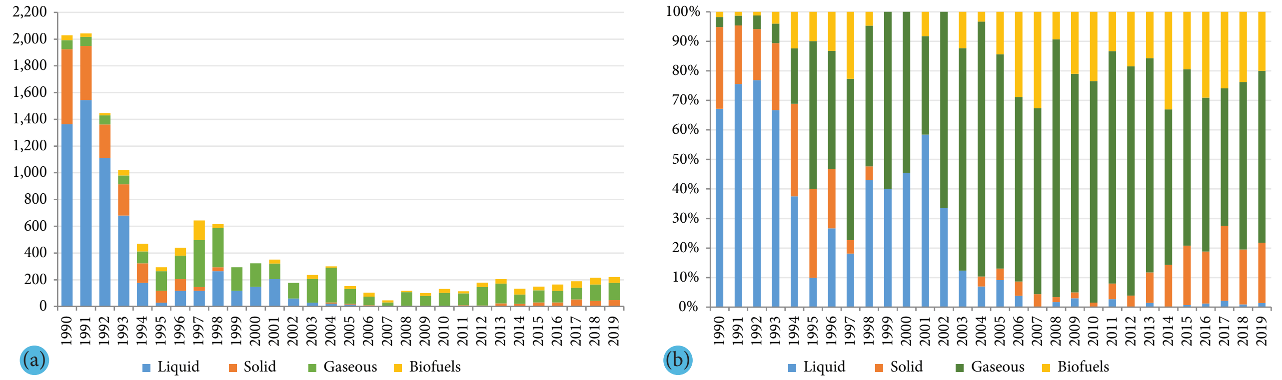

Figure 3-22: Fuel consumption under the 1A4ci 'Agriculture/Forestry/Fishing' ('Stationary') in the Republic of Moldova within 1990-2019 periods, where: (a) Fuel consumption by type of fuel, TJ; and (b) Fuel consumption by type of fuel, in % of the total.

1A4cii 'Mobile' ('Off-Road Vehicles and Other Machinery')

For the LBDR, activity data related to fuel consumption in 1A4cii 'Mobile' – 'Off-road Vehicles and Other Machinery' is available for diesel oil and gasoline consumption (Table 3-131).

Table 3-131: Fuel consumption in 1A4cii 'Mobile' – 'Off-road Vehicles and Other Machinery' on the LBDR for the period 1995-2015, kt

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Diesel Oil	26.8	21.4	28.6	22.1	20.4	14.6	14.4	11.2	7.7	6.9	4.9
Gasoline	9.7	6.1	8.9	5.8	3.1	1.8	1.7	1.2	1.3	0.8	0.6
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016-2019
Diesel Oil	4.0	2.9	2.7	3.5	7.4	8.4	9.2	10.5	10.2	9.7	NO
Gasoline	0.6	0.4	0.3	0.4	0.6	0.6	0.6	0.8	0.7	0.6	NO

Source: Press Release "The State of Housing and Communal Services of the ATULBD" for the years 2011-2019.

Activity data on the consumption of diesel oil, gasoline and liquefied petroleum gases is available for the RBDR (Table 3-132).

Table 3-132: Fuel consumption within IA4cii 'Mobile' – 'Off-road Vehicles and Other Machinery' on the RBDR for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Diesel Oil	18403	11792	7236	6518	8106	7684	6021	5598	4066	2720
Gasoline	306	280	166	59	117	88	205	147	88	59
LPG	46	NO	NO	15	NO	NO	NO	NO	NO	NO
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Diesel Oil	2192	2112	2773	2664	2370	2147	2156	1885	1805	1639
Gasoline	29	29	NO	NO	NO	12	3	6	5	6
LPG	NO	NO	NO	NO	2	2	2	1	3	6
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel Oil	1670	1578	1464	1604	2112	2401	2722	3721	3707	4221
Gasoline	4	11	9	NO	15	NO	13	15	5	8
LPG	9	8	5	6	7	5	4	6	3	3

Below is presented the fuel consumption by type of fuel under 1A4cii 'Mobile' ('Off-Road Vehicles and Other Machinery') within 1A4c 'Agriculture/Forestry/Fishing' source category between 1990 and 2019 in the Republic of Moldova. We may observe that the consumption of gasoline decreased in the respective period – circa 38 times, LPC consumption – circa 15 times, and diesel oil – circa 4 times (Table 3-133).

Table 3-133: Total fuel consumption within IA4cii 'Mobile' ('Off-Road Vehicles and Other Machinery') sources category in the RM for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Diesel Oil	18403	11792	7236	6518	8106	8823	6933	6814	5006	3588
Gasoline	306	280	166	59	117	511	472	534	341	193
LPG	46	NO	NO	15	NO	NO	NO	NO	NO	NO
Total	18755	12072	7402	6592	8223	9334	7405	7349	5347	3781
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Diesel Oil	2811	2723	3248	2993	2665	2354	2328	2009	1917	1788
Gasoline	106	103	53	55	34	39	28	23	20	24
LPG	NO	NO	NO	NO	2	2	2	1	3	6
Total	2916	2826	3301	3048	2701	2395	2358	2034	1940	1818
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel Oil	1986	1935	1858	2050	2548	2815	2722	3721	3707	4221
Gasoline	32	36	36	37	47	28	13	15	5	8
LPG	9	8	5	6	7	5	4	6	3	3
Total	2027	1979	1898	2093	2602	2848	2739	3742	3715	4232

3.5.3. Uncertainties Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by category 1A4 'Other Sectors', and the quality of activity data available.

Uncertainties associated with EFs used to estimate CO_2 emissions from 1A4 'Other Sectors' category, were estimated at circa 5 per cent, while those related to EFs used to estimate CH_4 and N_2O emissions reach up to ±50 per cent. Uncertainties associated with activity data regarding fuel consumption within 1A4 'Other Sectors' category in the RM represent circa 5 per cent for CO_2 and CH_4 emissions, and circa 3 per cent for N_2O emissions, respectively. The combined uncertainties presented as a percentage of the total direct GHG emissions from 1A4 'Other Sectors' category were estimated at about 7.9 per cent. The uncertainties introduced in the trend of total direct GHG emissions from the respective source category were estimated at about 2.1 per cent.

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

3.5.4. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for 1A4 'Other Sectors' category, following the Tier 1 approach. To be noted, that the AD and methods used for estimating GHG emissions under 1A4 'Other Sectors' category were documented and archived both in hard copies and electronically.

In order to identify the data entry and emission estimation process related errors, verifications and quality control procedures were applied, including:

- Verification of AD collecting and manipulation procedures, including: verifying if disaggregation of AD collected for each source category included in 1A4 'Other Sectors' category complies with the requirements set out in the description of each source category in the 2006 IPCC Guidelines; verifying the correctness of EFs use for each source; verifying if the primary reference sources are correctly indicated; the accuracy of calculations for sources included in 1A4 'Other Sectors' category are verified randomly;
- Implementation of error minimization procedures for manual entry of AD, with all the spreadsheets provided with the initial sources of activity data in tabular format;
- In the calculation files the EFs are specified in tabular formats for each source, the import of the respective values into calculation formulas is ensured by automatic connections;

- The consistency of the calculations is also ensured by verifying the correctness of applying conversion factors of natural units to energy units for all sources and the entire range of years covered by the inventory;
- Verification if the same method is used for the entire range of years covered by the inventory;
- Verifying if GHG emissions calculations have been made for all years and for all types of fuels mentioned in the Energy Balances of the RM and the relevant reference sources;
- Verifying to what extent the full geographical coverage of the national GHG inventory of the RM is ensured;
- Verifying the inter-annual evolution trends of emissions by creating representative charts, while unusual fluctuations are explained;
- Regarding recalculations, their need is explained, including by drawing attention to the implemented recommendations resulting from the audit carried out by national and international experts in the previous inventory cycle;
- Verifying maintenance and completion of the national inventory of GHG emissions archive.

3.5.5. Recalculations

In the current inventory cycle, a number of measures have been taken in order to improve the quality of the national GHG inventory, as a result of which it is necessary to recalculate GHG emissions from 1A4 'Other sectors' category. The main causes of these recalculations are reported as follows:

- Extension of activity data associated with fuel consumption for the territory on the LBDR;
- A constant net caloric value was used for the entire period of time (33.86 TJ/million m^3);
- Updated emission factors for methane and nitrous oxide were used for 1A4cii 'Agriculture/Forestry/Fishing' ('Mobile') source category;
- LPG consumption has been reallocated from liquid fuels to the category of gaseous fuels.

Compared to the results recorded in BUR2 of the RM under the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in an upward trend in direct GHG emissions from 1A4 'Other Sectors' category, for the year 1990 and 1994-2016 and in a downward trend in direct GHG emissions for the period 1991-1993 (Table 3-134). Between 2017 and 2019, direct GHG emissions from 1A4 'Other Sectors' category were estimated for the first time. Between 1990 and 2019, GHG emissions from the respective category had decreased by circa 69.5 per cent.

Table 3-134: Recalculation results of GHG emissions for the period 1990-2016, included in the BUR2 of the RM under the UNFCCC (1A4 'Other Sectors'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	7,689.71	8,128.96	6,164.66	2,325.44	2,160.40	2,207.24	2,349.64	2,545.51	2,105.67	1,837.59
BUR3	7,841.31	6,298.74	4,246.74	2,240.23	2,227.11	2,286.22	2,411.71	2,611.65	2,156.43	1,875.25
Difference, %	2.0	-22.5	-31.1	-3.7	3.1	3.6	2.6	2.6	2.4	2.1
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1,523.74	1,459.85	1,781.97	2,132.01	2,296.90	2,259.24	2,251.80	1,702.85	1,714.42	1,866.20
BUR3	1,552.95	1,488.15	1,814.59	2,161.78	2,325.26	2,283.75	2,274.88	1,721.37	1,732.08	1,881.51
Difference, %	1.9	1.9	1.8	1.4	1.2	1.1	1.0	1.1	1.0	0.8
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	2,030.07	2,358.97	2,328.28	2,007.92	2,051.85	1,923.58	1,812.79			
BUR3	2,047.36	2,375.67	2,341.96	2,021.66	2,067.07	1,939.22	1,925.30	2,175.96	2,267.80	2,393.78
Difference, %	0.9	0.7	0.6	0.7	0.7	0.8	6.2			

Below are presented recalculation results at source level within 1A4 'Other Sectors' category (Tables 3-135, 3-136, 3-137 and 3-138).

Table 3-135: Recalculation results of GHG emissions for the period 1990-2016, included in the BUR2 of the RM under the UNFCCC (1A4a 'Commercial/Institutional'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1,426.11	1,106.77	807.23	594.67	390.57	399.10	366.36	310.28	308.61	230.46
BUR3	1,426.11	1,010.66	669.18	594.67	390.57	399.10	366.36	310.28	308.61	230.62
Difference, %	0.0	-8.7	-17.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	206.98	238.73	428.22	586.35	825.31	704.69	647.70	365.88	374.94	483.53
BUR3	207.23	239.08	430.10	588.02	829.08	707.38	649.60	366.07	375.14	483.58
Difference, %	0.1	0.2	0.4	0.3	0.5	0.4	0.3	0.1	0.1	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	481.33	810.63	783.49	476.41	490.96	345.61	342.99			
BUR3	481.51	811.05	782.63	475.30	488.84	344.60	342.38	340.62	349.06	336.30
Difference, %	0.0	0.1	-0.1	-0.2	-0.4	-0.3	-0.2			

Table 3-136: Recalculation results of GHG emissions for the period 1990-2016, included in the BUR2 of the RM under the UNFCCC (1A4b 'Residential'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	4,701.86	5,134.16	3,984.89	1,021.91	1,123.43	1,095.16	1,405.38	1,657.13	1,360.78	1,307.63
BUR3	4,701.86	4,129.81	2,853.32	1,021.91	1,123.43	1,100.71	1,409.59	1,666.25	1,369.76	1,315.30
Difference, %	0.0	-19.6	-28.4	0.0	0.0	0.5	0.3	0.6	0.7	0.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1,079.05	988.89	1,096.99	1,306.36	1,253.24	1,368.21	1,423.78	1,183.55	1,188.71	1,242.51
BUR3	1,084.74	994.29	1,100.99	1,309.79	1,255.90	1,370.64	1,425.81	1,185.35	1,190.40	1,243.04
Difference, %	0.5	0.6	0.4	0.3	0.2	0.2	0.1	0.2	0.1	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	1,391.83	1,395.09	1,394.75	1,364.73	1,361.02	1,357.45	1,257.33			
BUR3	1,392.58	1,395.42	1,393.98	1,362.68	1,357.36	1,350.96	1,348.10	1,515.28	1,599.79	1,694.93
Difference, %	0.1	0.0	-0.1	-0.2	-0.3	-0.5	7.2			

Table 3-137: Recalculation results of GHG emissions for the period 1990-2016, included in the BUR2 of the RM under the UNFCCC (1A4c 'Agriculture/Forestry/Fishing' – 'Stationary'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	165.95	864.12	706.10	79.25	34.09	19.75	28.26	32.97	39.38	18.62
BUR3	165.95	162.64	113.67	79.25	34.09	19.75	28.26	32.97	39.38	18.62
Difference, %	0.0	-81.2	-83.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	20.86	22.11	10.98	12.38	17.24	8.07	4.77	1.97	6.32	4.82
BUR3	20.86	22.11	10.98	12.40	17.25	8.08	4.77	1.97	6.33	4.82
Difference, %	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	6.11	6.01	8.78	11.00	6.27	8.48	8.47			
BUR3	6.11	6.01	8.78	11.00	6.27	8.48	8.47	10.79	11.73	12.60
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0			

Table 3-138: Recalculation results of GHG emissions for the period 1990-2016, included in the BUR2 of the RM under the UNFCCC (1A4c 'Agriculture/Forestry/Fishing' – 'Mobile'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1,395.79	1,023.91	666.44	629.61	612.31	693.23	549.65	545.13	396.89	280.88
BUR3	1,547.38	995.64	610.56	544.40	679.02	766.67	607.50	602.15	438.67	310.71
Difference, %	10.9	-2.8	-8.4	-13.5	10.9	10.6	10.5	10.5	10.5	10.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	216.86	210.12	245.78	226.92	201.11	178.26	175.56	151.45	144.45	135.34
BUR3	240.13	232.67	272.52	251.58	223.04	197.65	194.70	167.98	160.21	150.06
Difference, %	10.7	10.7	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	150.81	147.24	141.26	155.78	193.60	212.04	204.00			
BUR3	167.17	163.19	156.57	172.67	214.60	235.19	226.34	309.26	307.23	349.96
Difference, %	10.9	10.8	10.8	10.9	10.9	10.9	11.0			

3.5.6. Planned Improvements

Potential improvements within the 1A4 'Other Sectors' category could be possible by updating the available AD on fuel consumption on the territory of the LBDR and filling the existing gaps for certain years.

3.6. Other (Category 1A5)

3.6.1. Source Category Description

Category 1A5 'Other' ('Non-Specified') includes GHG emissions from fuel combustion for other works and needs within the Sector 1 'Energy', including military transport.

The respective category includes two sources: 1A5a 'Stationary' (all types of fuels, with the exception of diesel oil, gasoline, aviation gasoline and kerosene) and 1A5b 'Mobile', including 1A5bi 'Mobile' ('Aviation component') (aviation gasoline and kerosene), and 1A5biii 'Mobile' (Other) (diesel oil and gasoline).

Between 1990-2019, GHG emissions from 1A5 'Other' category registered a downward trend, decreasing by circa 80.1 per cent: from circa 115.57 kt CO_2 equivalent in 1990 to circa 22.98 kt CO_2 equivalent in 2019 (Table 3-144).

Table 3-139: Total direct GHG emissions from 1A5 'Other' category within 1990-2019 periods

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A5, kt CO_2 equivalent	115.5701	107.5724	78.5337	94.3265	89.0194	126.5495	82.8034	77.4557	73.6783	49.8010
%, compared to 1990	100.0	93.1	68.0	81.6	77.0	109.5	71.6	67.0	63.8	43.1
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A5, kt CO_2 equivalent	36.8044	43.8813	40.1303	28.8076	28.0207	26.2833	39.4920	45.1203	44.1742	10.5966
%, compared to 1990	31.8	38.0	34.7	24.9	24.2	22.7	34.2	39.0	38.2	9.2
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A5, kt CO_2 equivalent	27.5201	19.9471	7.0060	2.3899	25.1618	22.8721	22.9905	22.7351	23.4607	22.9770
%, compared to 1990	23.8	17.3	6.1	2.1	21.8	19.8	19.9	19.7	20.3	19.9

The table below shows the evolution of direct and indirect GHG emissions from 1A5 'Other' (Table 3-140).

Table 3-140: Direct and indirect GHG emissions from 1A5 'Other' category in the Republic of Moldova within 1990-2019 periods

	1A5, kt							%, compared to 1990						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	113.9722	0.0109	0.0044	0.7597	0.8286	0.1226	0.3055	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	106.3685	0.0072	0.0034	0.6579	0.6170	0.0855	0.2778	93.3	66.4	77.2	86.6	74.5	69.8	90.9
1992	77.7474	0.0046	0.0023	0.4776	0.3429	0.0514	0.1606	68.2	42.3	50.6	62.9	41.4	42.0	52.6
1993	93.4518	0.0058	0.0024	0.4591	0.6253	0.0853	0.3437	82.0	53.4	55.0	60.4	75.5	69.6	112.5
1994	88.3648	0.0069	0.0016	0.3325	0.6071	0.0863	0.2592	77.5	63.0	36.4	43.8	73.3	70.4	84.8
1995	125.6438	0.0104	0.0022	0.5138	0.6299	0.1015	0.2639	110.2	95.0	48.8	67.6	76.0	82.8	86.4
1996	81.8376	0.0109	0.0023	0.4423	0.4659	0.0987	0.2016	71.8	100,1	52,3	58,2	56,2	80,6	66,0
1997	76.6587	0.0081	0.0020	0.2875	0.4997	0.0785	0.2051	67.3	74.0	44.9	37.8	60.3	64.1	67.1
1998	72.8283	0.0088	0.0021	0.3919	0.5862	0.1041	0.2088	63.9	81.1	47.4	51.6	70.7	84.9	68.3
1999	49.1563	0.0065	0.0016	0.1458	0.3630	0.0640	0.1625	43.1	59.6	36.4	19.2	43.8	52.3	53.2
2000	36.3881	0.0046	0.0010	0.1311	0.2320	0.0421	0.1523	31.9	42.0	22.8	17.2	28.0	34.4	49.8
2001	43.3961	0.0050	0.0012	0.1565	0.3569	0.0605	0.1061	38.1	46.0	27.2	20.6	43.1	49.4	34.7
2002	39.4529	0.0083	0.0016	0.1411	0.2860	0.0683	0.1543	34.6	76.2	35.4	18.6	34.5	55.7	50.5
2003	28.4228	0.0043	0.0009	0.1427	0.2811	0.0524	0.1085	24.9	39.0	21.0	18.8	33.9	42.8	35.5
2004	27.6373	0.0031	0.0010	0.2161	0.2875	0.0472	0.0392	24.2	28.7	23.0	28.4	34.7	38.5	12.8
2005	25.9403	0.0024	0.0010	0.2301	0.1272	0.0300	0.0418	22.8	21.8	21.4	30.3	15.3	24.5	13.7
2006	39.0397	0.0029	0.0013	0.3325	0.4037	0.0635	0.1212	34.3	26.5	28.7	43.8	48.7	51.8	39.7
2007	44.5097	0.0039	0.0017	0.3855	0.3075	0.0552	0.0983	39.1	35.8	38.7	50.7	37.1	45.1	32.2
2008	43.6263	0.0036	0.0015	0.3223	0.3060	0.0503	0.1167	38.3	33.1	34.5	42.4	36.9	41.0	38.2
2009	10.4909	0.0011	0.0003	0.1018	0.1540	0.0251	0.0182	9.2	10.5	5.8	13.4	18.6	20.5	5.9
2010	27.2976	0.0023	0.0006	0.1245	0.2519	0.0434	0.0991	24.0	21.3	12.4	16.4	30.4	35.4	32.4
2011	19.7881	0.0013	0.0004	0.1531	0.3469	0.0449	0.0879	17.4	11.7	9.6	20.2	41.9	36.7	28.8
2012	6.9350	0.0006	0.0002	0.0536	0.1342	0.0157	0.0047	6.1	5.5	4.2	7.1	16.2	12.8	1.5
2013	2.3497	0.0003	0.0001	0.0403	0.0297	0.0037	0.0003	2.1	2.6	2.5	5.3	3.6	3.0	0.1
2014	25.0067	0.0006	0.0005	0.0516	0.2560	0.0237	0.2011	21.9	5.3	10.6	6.8	30.9	19.4	65.8
2015	22.7360	0.0005	0.0004	0.0475	0.2309	0.0216	0.1861	19.9	4.4	9.4	6.3	27.9	17.6	60.9
2016	22.8586	0.0005	0.0004	0.0476	0.2260	0.0221	0.1923	20.1	4.2	9.1	6.3	27.3	18.0	63.0
2017	22.6223	0.0002	0.0004	0.0414	0.2226	0.0212	0.2009	19.8	2.2	8.1	5.4	26.9	17.3	65.7
2018	23.3443	0.0002	0.0004	0.0427	0.2297	0.0219	0.2073	20.5	2.3	8.3	5.6	27.7	17.9	67.8
2019	22.8629	0.0002	0.0004	0.0418	0.2250	0.0215	0.2030	20.1	2.2	8.2	5.5	27.2	17.5	66.4

Direct and indirect GHG emissions from 1A5 'Other' source category in 2019, varied as follows: CO_2 emissions – circa 20.1 percent of the level recorded in the reference year, whereas emissions of CH_4– 2.2 per cent, N_2O – 8.2 per cent, NO_x – 5.5 per cent, CO – 27.2 per cent, NMVOC – 17.5 per cent and SO_2 – 66.4 per cent. Carbon dioxide emissions represent the biggest share in the structure of total direct GHG emissions, followed by nitrous oxide and methane (Table 3-141).

Table 3-141: Direct GHG emissions from 1A5 'Other' category within 1990-2019 periods

	1A5, kt CO_2 equivalent				Share of total, %		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	113.9722	0.2726	1.3253	115.5701	98.6	0.2	1.1
1991	106.3685	0.1809	1.0231	107.5724	98.9	0.2	1.0
1992	77.7474	0.1152	0.6712	78.5337	99.0	0.1	0.9
1993	93.4518	0.1456	0.7291	94.3265	99.1	0.2	0.8
1994	88.3648	0.1716	0.4830	89.0194	99.3	0.2	0.5
1995	125.6438	0.2589	0.6468	126.5495	99.3	0.2	0.5
1996	81.8376	0.2730	0.6929	82.8034	98.8	0.3	0.8
1997	76.6587	0.2017	0.5953	77.4557	99.0	0.3	0.8

	1A5, kt CO_2 equivalent				Share of total, %		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1998	72.8283	0.2211	0.6289	73.6783	98.8	0.3	0.9
1999	49.1563	0.1623	0.4823	49.8010	98.7	0.3	1.0
2000	36.3881	0.1145	0.3018	36.8044	98.9	0.3	0.8
2001	43.3961	0.1253	0.3599	43.8813	98.9	0.3	0.8
2002	39.4529	0.2076	0.4698	40.1303	98.3	0.5	1.2
2003	28.4228	0.1063	0.2785	28.8076	98.7	0.4	1.0
2004	27.6373	0.0782	0.3052	28.0207	98.6	0.3	1.1
2005	25.9403	0.0595	0.2836	26.2833	98.7	0.2	1.1
2006	39.0397	0.0722	0.3801	39.4920	98.9	0.2	1.0
2007	44.5097	0.0975	0.5132	45.1203	98.6	0.2	1.1
2008	43.6263	0.0901	0.4578	44.1742	98.8	0.2	1.0
2009	10.4909	0.0286	0.0771	10.5966	99.0	0.3	0.7
2010	27.2976	0.0579	0.1646	27.5201	99.2	0.2	0.6
2011	19.7881	0.0318	0.1273	19.9471	99.2	0.2	0.6
2012	6.9350	0.0149	0.0562	7.0060	99.0	0.2	0.8
2013	2.3497	0.0071	0.0332	2.3899	98.3	0.3	1.4
2014	25.0067	0.0145	0.1406	25.1618	99.4	0.1	0.6
2015	22.7360	0.0120	0.1241	22.8721	99.4	0.1	0.5
2016	22.8586	0.0116	0.1204	22.9905	99.4	0.1	0.5
2017	22.6223	0.0060	0.1069	22.7351	99.5	0.0	0.5
2018	23.3443	0.0062	0.1103	23.4607	99.5	0.0	0.5
2019	22.8629	0.0060	0.1080	22.9770	99.5	0.0	0.5

The table and figure below show the evolution of GHG emissions from 1A5 'Other' (1A5a 'Stationary' and 1A5b 'Mobile') for the period 1990-2019. If in the reference year, circa 36.5 per cent of the total emissions originated from the stationary combustion of fuels and circa 63.5 per cent from the mobile combustion of fuels; by 2019, the share of emissions from stationary combustion increased 100 per cent, while the share of emissions from mobile combustion decreased to circa 0 per cent (Table 3-142, Figure 3-37).

Table 3-142: Direct GHG emissions from 1A5 'Other' category in the Republic of Moldova, by source categories, within 1990-2019 periods

	1A5a 'Stationary', kt				1A5b 'Mobile', kt				1A5, kt	Share, % of total		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	Total	1A5a	1A5b	1A5
1990	41.9609	0.0495	0.2192	42.2296	72.0113	0.2231	1.1061	73.3405	115.5701	36.5	63.5	100.0
1991	51.5108	0.0285	0.1772	51.7165	54.8577	0.1524	0.8458	55.8559	107.5724	48.1	51.9	100.0
1992	42.5895	0.0304	0.1268	42.7466	35.1579	0.0848	0.5444	35.7871	78.5337	54.4	45.6	100.0
1993	62.1343	0.0514	0.2476	62.4333	31.3175	0.0942	0.4816	31.8933	94.3265	66.2	33.8	100.0
1994	71.3256	0.0658	0.2309	71.6223	17.0392	0.1058	0.2521	17.3971	89.0194	80.5	19.5	100.0
1995	104.4054	0.1242	0.3331	104.8627	21.2384	0.1347	0.3137	21.6868	126.5495	82.9	17.1	100.0
1996	58.7906	0.1551	0.3473	59.2930	23.0470	0.1179	0.3456	23.5105	82.8034	71.6	28.4	100.0
1997	51.7920	0.0769	0.2220	52.0909	24.8668	0.1247	0.3733	25.3648	77.4557	67.3	32.7	100.0
1998	50.4380	0.1194	0.2908	50.8482	22.3903	0.1018	0.3380	22.8301	73.6783	69.0	31.0	100.0
1999	30.9893	0.0815	0.2077	31.2785	18.1670	0.0809	0.2746	18.5225	49.8010	62.8	37.2	100.0
2000	26.5856	0.0532	0.1569	26.7957	9.8025	0.0613	0.1450	10.0087	36.8044	72.8	27.2	100.0
2001	28.7767	0.0569	0.1395	28.9731	14.6194	0.0684	0.2204	14.9082	43.8813	66.0	34.0	100.0
2002	25.3685	0.1186	0.2617	25.7488	14.0844	0.0890	0.2081	14.3815	40.1303	64.2	35.8	100.0
2003	20.4111	0.0668	0.1581	20.6360	8.0117	0.0395	0.1204	8.1716	28.8076	71.6	28.4	100.0
2004	11.3982	0.0249	0.0563	11.4794	16.2391	0.0534	0.2489	16.5414	28.0207	41.0	59.0	100.0
2005	11.6992	0.0278	0.0626	11.7896	14.2411	0.0317	0.2210	14.4938	26.2833	44.9	55.1	100.0
2006	21.4826	0.0322	0.1078	21.6226	17.5571	0.0400	0.2723	17.8694	39.4920	54.8	45.2	100.0
2007	17.7980	0.0339	0.0994	17.9313	26.7117	0.0636	0.4138	27.1890	45.1203	39.7	60.3	100.0
2008	20.3604	0.0277	0.0986	20.4867	23.2659	0.0625	0.3591	23.6875	44.1742	46.4	53.6	100.0
2009	7.4748	0.0147	0.0316	7.5211	3.0161	0.0139	0.0455	3.0755	10.5966	71.0	29.0	100.0
2010	23.7958	0.0413	0.1118	23.9490	3.5018	0.0166	0.0527	3.5712	27.5201	87.0	13.0	100.0
2011	15.9259	0.0173	0.0690	16.0122	3.8622	0.0145	0.0583	3.9350	19.9471	80.3	19.7	100.0
2012	3.5864	0.0024	0.0056	3.5943	3.3486	0.0125	0.0506	3.4116	7.0060	51.3	48.7	100.0
2013	0.2064	0.0002	0.0005	0.2071	2.1433	0.0069	0.0327	2.1828	2.3899	8.7	91.3	100.0
2014	22.8029	0.0062	0.1073	22.9163	2.2039	0.0084	0.0332	2.2455	25.1618	91.1	8.9	100.0
2015	21.0924	0.0057	0.0993	21.1974	1.6436	0.0063	0.0248	1.6747	22.8721	92.7	7.3	100.0
2016	21.6596	0.0057	0.1023	21.7677	1.1989	0.0058	0.0180	1.2228	22.9905	94.7	5.3	100.0
2017	22.6223	0.0060	0.1069	22.7351	NO	NO	NO	NO	22.7351	100.0	NO	100.0
2018	23.3443	0.0062	0.1103	23.4607	NO	NO	NO	NO	23.4607	100.0	NO	100.0
2019	22.8629	0.0060	0.1080	22.9770	NO	NO	NO	NO	22.9770	100.0	NO	100.0

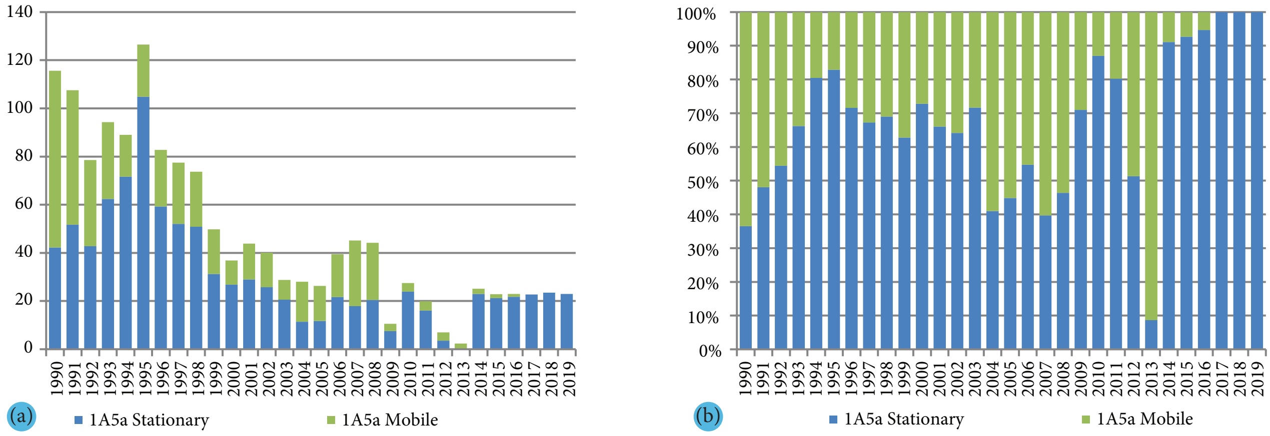

Figure 3-23: Direct GHG emissions from 1A5 'Other' category in the RM within 1990-2019 periods, when: (a) direct GHG emissions by sources, kt CO_2 equivalent; (b) direct GHG emissions by sources, in % of the total.

Table 3-143: Direct and indirect GHG emissions from 1A5 'Other' category in the Republic of Moldova, by subcategories, within1990-2019 periods

	1A5a 'Stationary'							1A5b 'Mobile'						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	41.9609	0.0020	0.0007	0.0908	0.3458	0.0459	0.2890	72.0113	0.0089	0.0037	0.6690	0.4828	0.0767	0.0165
1991	51.5108	0.0011	0.0006	0.1355	0.2916	0.0316	0.2649	54.8577	0.0061	0.0028	0.5224	0.3255	0.0539	0.0128
1992	42.5895	0.0012	0.0004	0.1334	0.1655	0.0202	0.1522	35.1579	0.0034	0.0018	0.3442	0.1774	0.0313	0.0084
1993	62.1343	0.0021	0.0008	0.1586	0.3875	0.0485	0.3369	31.3175	0.0038	0.0016	0.3005	0.2378	0.0369	0.0068
1994	71.3256	0.0026	0.0008	0.1867	0.3052	0.0469	0.2561	17.0392	0.0042	0.0008	0.1458	0.3020	0.0394	0.0031
1995	104.4054	0.0050	0.0011	0.3366	0.3173	0.0599	0.2593	21.2384	0.0054	0.0011	0.1771	0.3125	0.0416	0.0046
1996	58.7906	0.0062	0.0012	0.2011	0.2969	0.0717	0.1964	23.0470	0.0047	0.0012	0.2412	0.1689	0.0271	0.0051
1997	51.7920	0.0031	0.0007	0.1428	0.2585	0.0462	0.2014	24.8668	0.0050	0.0013	0.1447	0.2412	0.0324	0.0038
1998	50.4380	0.0048	0.0010	0.1495	0.2909	0.0624	0.2034	22.3903	0.0041	0.0011	0.2424	0.2953	0.0417	0.0054
1999	30.9893	0.0033	0.0007	0.0812	0.2285	0.0465	0.1608	18.1670	0.0032	0.0009	0.0645	0.1345	0.0175	0.0017
2000	26.5856	0.0021	0.0005	0.0540	0.2033	0.0364	0.1515	9.8025	0.0025	0.0005	0.0770	0.0287	0.0057	0.0008
2001	28.7767	0.0023	0.0005	0.0593	0.1541	0.0341	0.1047	14.6194	0.0027	0.0007	0.0973	0.2027	0.0264	0.0014
2002	25.3685	0.0047	0.0009	0.0632	0.2530	0.0620	0.1534	14.0844	0.0036	0.0007	0.0779	0.0330	0.0063	0.0008
2003	20.4111	0.0027	0.0005	0.0565	0.1610	0.0359	0.1069	8.0117	0.0016	0.0004	0.0862	0.1201	0.0166	0.0017
2004	11.3982	0.0010	0.0002	0.0210	0.0596	0.0148	0.0372	16.2391	0.0021	0.0008	0.1951	0.2280	0.0324	0.0019
2005	11.6992	0.0011	0.0002	0.0215	0.0654	0.0163	0.0405	14.2411	0.0013	0.0007	0.2086	0.0618	0.0137	0.0013
2006	21.4826	0.0013	0.0004	0.0397	0.1547	0.0256	0.1197	17.5571	0.0016	0.0009	0.2928	0.2491	0.0379	0.0015
2007	17.7980	0.0014	0.0003	0.0335	0.1302	0.0238	0.0962	26.7117	0.0025	0.0014	0.3520	0.1773	0.0315	0.0020
2008	20.3604	0.0011	0.0003	0.0393	0.1450	0.0228	0.1147	23.2659	0.0025	0.0012	0.2830	0.1610	0.0274	0.0020
2009	7.4748	0.0006	0.0001	0.0162	0.0299	0.0081	0.0181	3.0161	0.0006	0.0002	0.0856	0.1241	0.0170	0.0000
2010	23.7958	0.0017	0.0004	0.0438	0.1389	0.0278	0.0991	3.5018	0.0007	0.0002	0.0806	0.1130	0.0156	0.0000
2011	15.9259	0.0007	0.0002	0.0276	0.1091	0.0164	0.0878	3.8622	0.0006	0.0002	0.1255	0.2378	0.0285	0.0001
2012	3.5864	0.0001	0.0000	0.0057	0.0070	0.0019	0.0046	3.3486	0.0005	0.0002	0.0479	0.1273	0.0138	0.0000
2013	0.2064	0.0000	0.0000	0.0008	0.0002	0.0001	0.0003	2.1433	0.0003	0.0001	0.0395	0.0295	0.0036	0.0000
2014	22.8029	0.0002	0.0004	0.0421	0.2229	0.0213	0.2011	2.2039	0.0003	0.0001	0.0095	0.0331	0.0025	0.0000
2015	21.0924	0.0002	0.0003	0.0389	0.2062	0.0197	0.1861	1.6436	0.0003	0.0001	0.0086	0.0247	0.0019	0.0000
2016	21.6596	0.0002	0.0003	0.0396	0.2132	0.0203	0.1923	1.1989	0.0002	0.0001	0.0080	0.0128	0.0017	0.0000
2017	22.6223	0.0002	0.0004	0.0414	0.2226	0.0212	0.2009	NO	NO	NO	NO	NO	NO	NO
2018	23.3443	0.0002	0.0004	0.0427	0.2297	0.0219	0.2073	NO	NO	NO	NO	NO	NO	NO
2019	22.8629	0.0002	0.0004	0.0418	0.2250	0.0215	0.2030	NO	NO	NO	NO	NO	NO	NO

3.6.2. Methodological Issues, Emission Factors and Activity Data

Direct GHG emissions originating from 1A5 'Other' category were estimated following a Tier 1 methodology available in the 2006 IPCC Guidelines, based on AD on fuel consumption and default emission factors. In order to estimate non-CO_2 emissions, default emission factors were used available in the EMEP/EEA Air Pollutant Emission Inventory (2019) (Table 3-144).

Table 3-144: Emission factors utilised for the estimation of GHG emissions within 1A5 'Other' source category, kg/TJ for direct GHGs and kg/t fuel for indirect GHGs

	Emission Factors							Reference sources for:	
	kg/TJ			kg/t fuel					
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2, CH_4, N_2O	NO_x, CO, NMVOC and SO_2
1A5a 'Stationary'									
Anthracite	98300	1	1.5	173	931	88.8	840	2006 IPCC Guidelines, Volume 2, Table 2.2	EMEP/EEA Guidebook (2019), Categories 1.A.4.a/c, 1.A.5.a, Table 3.7
Brown Coal, Lignite	101000	1	1.5	173	931	88.8	840		
Other Bituminous Coal	94600	1	1.5	173	931	88.8	840		
Coke	107 000	1	1.5	173	931	88.8	840		
Fuel for Oven	71900	3	0.6	306	93	20	94		EMEP/EEA Guidebook (2019), Categories 1.A.4.a/c, 1.A.5.a, Table 3.9
Residual Fuel Oil	77400	3	0.6	306	93	20	94		
Kerosene	71900	3	0.6	306	93	20	94		
Other Petroleum Products	73300	3	0.6	306	93	20	94		
Natural Gas	56100	1	0.1	74	29	23	0.67		EMEP/EEA Guidebook (2019), Categories 1.A.4.a/c, 1.A.5.a, Table 3.8
LPG	63100	1	0.1	74	29	23	0.67		
Fuel Wood	112000	30	4	91	570	300	11		EMEP/EEA Guidebook (2019), Categories 1.A.4.a/c, 1.A.5.a, Table 3.10
Other types of Fuel	112000	30	4	91	570	300	11		
Wood Waste	100000	30	4	91	570	300	11		
Agricultural Residues	100000	30	4	91	570	300	11		
Charcoal	112000	30	4	91	570	300	11		
Pellets and Briquettes and other Vegetable Waste	100000	30	4	91	570	300	11		
Biogas	54600	1	0.1	74	29	23	0.67		EMEP/EEA Guidebook (2019), Categories 1.A.4.a/c, 1.A.5.a, Table 3.8
1A5bi 'Mobile' ('Aviation component')									
Aviation Gasoline	71500	0.5	2	4	1200	19	1	2006 IPCC Guidelines, Volume 2, Table 3.6.4 and Table 3.6.5	EMEP/EEA Guidebook (2019), Categories 1.A.3.a, 1.A.5.b, 1.A.3.a.ii.(i), Table 3.3
Kerosene	69300	0.5	2	4	1200	19	1		
1A5biii 'Mobile' ('Other')									
Gasoline	69300	33	3.2	8.73	84.7	10.05	-	2006 IPCC Guidelines, Volume 2, Table 3.2.1 and Table 3.2.2	EMEP/EEA Guidebook (2019), Categories 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv Table 3.5 and Table. 3.6. SO_2 emissions are calculated for each year separately based on formula No. 2 and Table 3-14
Diesel Oil	74100	3.9	3.9	33.37	7.58	1.92	-		

The Energy Balances of the RM (Chapter S.2.1 "Consumed as Fuel or Energy" and columns: "For Other Works and Needs" and "Used for other purposes") represented the main source of reference for AD associated to fuel consumption on the territory of the RBDR. Another relevant source of reference was the Ministry of Defence of the RM, which provides information on fuel combustion for military transport.

The activity data associated with fuel consumption on the territory of the LBDR was collected from the Statistical Publications of the ATULBD (available for a single type of fuel – coal) for the period 2014-2019 (Table 3-150).

Table 3-145: Fuel consumption within 1A5 'Other' category on the LBDR for the period 2014-2019

	2014	2015	2016	2017	2018	2019
Other Bituminous Coal, TJ	239.136	221.328	228.960	239.136	246.768	241.680
Other Bituminous Coal, kt	9.4	8.7	9.0	9.4	9.7	9.5

Activity data associated with fuel consumption within 1A5 'Other' category, by emission source, is available in Tables 3-146, 3-147, 3-148 and Figure 3-24.

Table 3-146: Fuel consumption within 1A5 'Other' ('Stationary') source category between 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Anthracite	334.1	238.1	142	46	59	88	60	60	30	30
Brown Coal	NO	46.7	NO	91	29	29	30	30	59	29
Other Bituminous Coal	NO	NO	NO	230	144.5	59	85	116	88	118
Coke	NO	NO	NO	3	29	30	1	NO	29	NO
Kerosene for Oven	43.1	NO	NO	NO	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	40.2	273.4	349.7	27	264	850	411	264	161.5	59
Kerosene	NO	NO	NO	247	118	59	88	29	147	59
Other Petroleum Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural Gas	NO	NO	NO	100	235	118	30	117	59	59
LPG	46.1	35.4	24.7	14	59	117	30	44.5	59	29
Fuel Wood	45	NO	NO	13	30	30	89	30	88	59
Other types of Fuel	NO	NO	NO	NO	NO	NO	30	1	NO	NO
Wood Waste	NO	NO	NO	12	1	30	30	30	29.5	29
Agriculture Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	**508.5**	**593.5**	**516.5**	**783**	**968.5**	**1410**	**884**	**721.5**	**750**	**471**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anthracite	30	59	58	1	16	27	33	98	49	13
Brown Coal	29	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Bituminous Coal	88	58	118	116	26	20	108	15	85.0	5
Coke	29	NO	NO	NO	1	NO	NO	NO	NO	1
Residual Fuel Oil	30	59	41	23	5	3	7	7	18.0	20
Kerosene	1	1	1	59	2	2	1	1	1	1
Other Petroleum Products	NO	NO	NO	NO	1	1	1	1	NO	NO
Natural Gas	89	30	60	58	104	106	115	90	93	60
LPG	30	177	30	1	13	12	14	16	13	10
Fuel Wood	29	30	87	59	24	24	27	26	23	9
Other types of Fuel	NO	NO	29	NO	NO	NO	NO	NO	NO	NO
Wood Waste	29	29	29	16	3	7	4	10	3	5.5
Agriculture Residues	NO	NO	NO	NO	NO	NO	2	1	1	NO
Total	**384**	**443**	**453**	**333**	**195**	**202**	**312**	**265**	**286**	**124.5**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Anthracite	25	30	5	NO	NO	NO	NO	NO	NO	NO
Other Bituminous Coal	90	74	NO	NO	239.1	221.3	229	239.1	246.8	241.7
Coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Residual Fuel Oil	19	1	3	2.7	2.3	2	NO	NO	NO	NO
Kerosene	1	1	1	NO	NO	NO	NO	NO	NO	NO
Natural Gas	83	87	34	NO	NO	NO	NO	NO	NO	NO
LPG	105	15	14	NO	NO	NO	NO	NO	NO	NO
Fuel Wood	28	12	NO	NO	NO	NO	NO	NO	NO	NO
Wood Waste	8	2	1	NO	NO	NO	NO	NO	NO	NO
Agriculture Residues	7	2	NO	NO	NO	NO	NO	NO	NO	NO
Total	**366**	**224**	**58**	**2.7**	**241.5**	**223.3**	**229**	**239.1**	**246.8**	**241.7**

Table 3-147: Fuel consumption within 1A5bi 'Mobile' ('Aviation component') source category for the period 2011-2019

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Aviation Gasoline, TJ	0.9169	0.7859	0.3297	0.5175	0.4366	NO	NO	NO	NO
Aviation Gasoline, kt	0.0210	0.0180	0.0080	0.0120	0.0100	NO	NO	NO	NO
Kerosene, TJ	0.1294	0.0863	0.0346	0.0910	NO	NO	NO	NO	NO
Kerosene, kt	0.0030	0.0020	0.0010	0.0020	NO	NO	NO	NO	NO

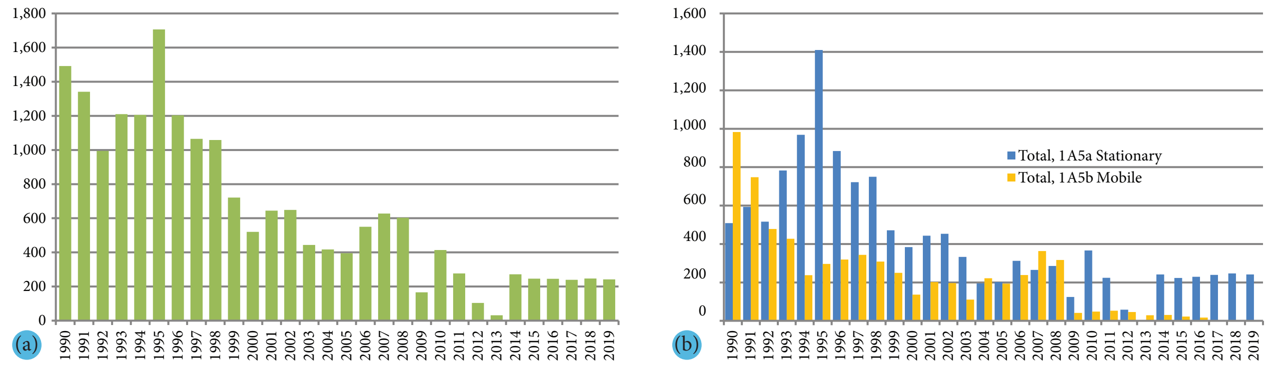

Figure 3-24: Fuel consumption under 1A5 'Other' category in the RM within 1990-2019 periods, where: (a) Total fuel consumption, TJ; and (b) Fuel consumption by sources, TJ.

Table 3-148: Fuel consumption within 1A5biii 'Mobile' (Other) source category for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gasoline, TJ	174.88	109.30	52.46	72.28	113.65	145.49	119.33	125.41	98.52	77.63
Gasoline, kt	4.00	2.50	1.20	2.05	3.25	3.29	1.38	2.52	2.90	1.45
Diesel Oil (including for 'Fuel for Oven' and 'Fuel for Engines'), TJ	808.26	638.10	425.40	355.04	123.66	150.56	199.42	218.30	210.02	172.57
Diesel Oil (including for 'Fuel for Oven' and 'Fuel for Engines'), kt	19.00	15.00	10.00	8.47	3.52	4.45	6.87	3.68	6.51	1.55
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Gasoline, TJ	65.95	67.04	96.09	39.40	43.62	17.61	23.05	38.74	43.39	13.59
Gasoline, kt	0.14	2.18	0.19	1.22	2.22	0.17	2.21	1.18	1.17	1.27
Diesel Oil (including for 'Fuel for Oven' and 'Fuel for Engines'), TJ	70.61	134.59	100.21	71.27	178.36	175.72	215.38	324.25	273.40	28.00
Diesel Oil (including for 'Fuel for Oven' and 'Fuel for Engines'), kt	2.27	2.34	2.29	2.27	5.27	6.21	8.20	10.24	8.17	2.24

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Gasoline, TJ	16.34	12.96	11.12	5.55	7.52	5.68	5.81	-	-	-
Gasoline, kt	1.15	2.18	1.12	0.13	0.17	0.13	0.13	-	-	-
Diesel Oil (including for 'Fuel for Oven' and 'Fuel for Engines'), TJ	31.98	39.00	33.96	23.38	22.12	16.44	10.74	-	-	-
Diesel Oil (including for 'Fuel for Oven' and 'Fuel for Engines'), kt	2.12	3.19	1.14	1.15	0.24	0.22	0.21	-	-	-

The table and figure below show activity data associated with the consumption of fuels by type within 1A5 'Other' category. Compared to the level recorded in the reference year, by 2019, the share of liquid fuels had decreased, and the share of solid fuels in the structure of total fuel consumption at category level had increased, respectively (Table 3-149 and Figure 3-25).

Table 3-149: Total fuel consumption under the 1A5 'Other' category by fuel types within 1990-2019

	Consumption by type of fuel, TJ					Share of total, %			
	Solid	Liquid	Gaseous	Biofuels	Total	Solid	Liquid	Gaseous	Biofuels
1990	334.10	1066.47	46.06	44.97	1491.60	22.4	71.5	3.1	3.0
1991	284.79	1020.76	35.37	NA	1340.92	21.2	76.1	2.6	NA
1992	142.03	827.60	24.69	NA	994.32	14.3	83.2	2.5	NA
1993	370.00	701.32	114.00	25.00	1210.32	30.6	57.9	9.4	2.1
1994	261.50	619.31	294.00	31.00	1205.81	21.7	51.4	24.4	2.6
1995	206.00	1205.04	235.00	60.00	1706.04	12.1	70.6	13.8	3.5
1996	176.00	817.76	60.00	149.00	1202.76	14.6	68.0	5.0	12.4
1997	206.00	636.71	161.50	61.00	1065.21	19.3	59.8	15.2	5.7
1998	206.00	617.05	118.00	117.50	1058.55	19.5	58.3	11.1	11.1
1999	177.00	368.20	88.00	88.00	721.20	24.5	51.1	12.2	12.2
2000	176.00	167.56	119.00	58.00	520.56	33.8	32.2	22.9	11.1
2001	117.00	261.64	207.00	59.00	644.64	18.1	40.6	32.1	9.2
2002	176.00	238.30	90.00	145.00	649.30	27.1	36.7	13.9	22.3
2003	117.00	192.67	59.00	75.00	443.67	26.4	43.4	13.3	16.9
2004	43.00	229.98	117.00	27.00	416.98	10.3	55.2	28.1	6.5
2005	47.00	199.33	118.00	31.00	395.33	11.9	50.4	29.8	7.8
2006	141.00	247.43	129.00	33.00	550.43	25.6	45.0	23.4	6.0
2007	113.00	371.99	106.00	37.00	627.99	18.0	59.2	16.9	5.9
2008	134.00	335.79	106.00	27.00	602.79	22.2	55.7	17.6	4.5
2009	19.00	62.58	70.00	14.50	166.08	11.4	37.7	42.1	8.7
2010	115.00	68.32	188.00	43.00	414.32	27.8	16.5	45.4	10.4
2011	104.00	55.00	102.00	16.00	277.00	37.5	19.9	36.8	5.8
2012	5.00	49.94	48.00	1.00	103.94	4.8	48.0	46.2	1.0
2013	NO	31.96	NO	NO	31.96	NO	100.0	NO	NO
2014	239.14	32.59	NO	NO	271.72	88.0	12.0	NO	NO
2015	221.33	24.56	NO	NO	245.89	90.0	10.0	NO	NO
2016	228.96	16.56	NO	NO	245.52	93.3	6.7	NO	NO
2017	239.14	NO	NO	NO	239.14	100.0	NO	NO	NO
2018	246.77	NO	NO	NO	246.77	100.0	NO	NO	NO
2019	241.68	NO	NO	NO	241.68	100.0	NO	NO	NO

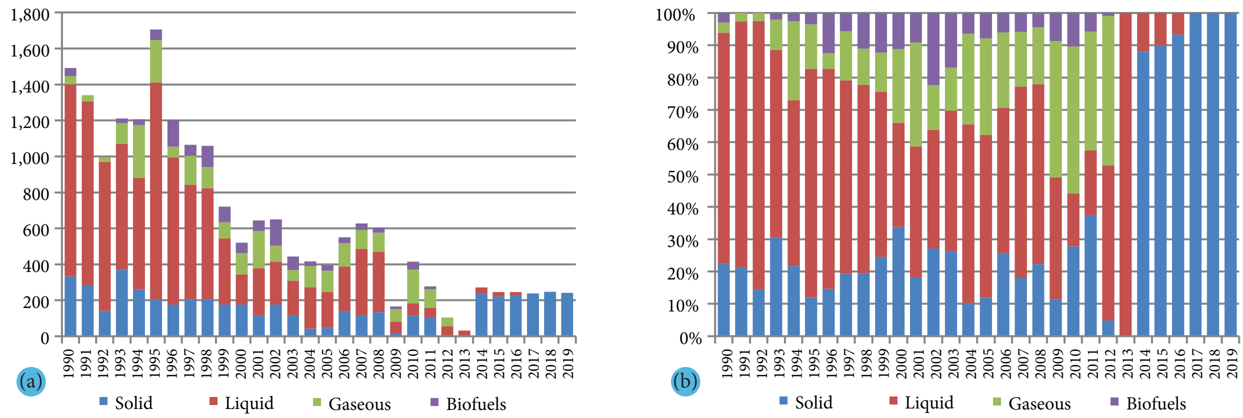

Figure 3-25: Total fuel consumption under 1A5 'Other' category in the Republic of Moldova within 1990-2019 periods, where: (a) fuel consumption by type of fuel, TJ; and (b) fuel consumption by type of fuel, in % of the total.

3.6.3. Uncertainties Assessment and Time-Series Consistency

The primary factors which affect uncertainties relate to the assessment methodology, emission factors utilised to calculate GHG emissions from 1A5 'Other' source category and the quality of the available activity data.

Uncertainties of activity data associated with fuel consumption in 1A5 'Other' source category are circa 5 per cent for CO_2 and CH_4 emissions, and circa 3 per cent for N_2O emissions, respectively. The combined uncertainties presented as a percentage of the total direct GHG emissions from 1A5 'Other' source category were estimated at circa 7.0 per cent. Uncertainties in the trend of total direct GHG emissions from the respective sector were estimated at circa 1.4 per cent.

In order to ensure the stability over time of the results obtained, the same methodology was used for the entire study period in accordance with sustainable practices applied to the inventory of GHG emissions.

3.6.4. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for 1A5 'Other' category, following the Tier 1 approach. To be noted, that the AD and methods used for estimating GHG emissions under category 1A4 'Other' were documented and archived both in hard copies and electronically.

In order to identify the data entry and emission estimation process related errors, verifications and quality control procedures were applied, including:

- Verification of AD collecting and manipulation procedures, including: verifying if disaggregation of AD collected for each source category included in 1A5 'Other' category complies with the requirements set out in the description of each source category in the 2006 IPCC Guidelines; (in the current inventory cycle, GHG emissions have been calculated separately for two emission sources (1A5a 'Stationary' and 1A5b 'Mobile' (including 'aviation component' and 'all other mobile sources not included elsewhere'); for each source, the AD is available in separate files in natural units and in energy units; verifying the correctness of EFs use for each source; verifying if the primary reference sources are correctly indicated; the accuracy of calculations for sources included in 1A5 'Other' category are verified randomly;
- Implementation of error minimization procedures for manual entry of AD, with all the spreadsheets provided with the initial sources of activity data in tabular format;
- In the calculation files the EFs are specified in tabular formats for each source, the import of the respective values into calculation formulas is ensured by automatic connections;
- The consistency of the calculations is also ensured by verifying the correctness of applying conversion factors of natural units to energy units for all sources and the entire range of years covered by the inventory;
- Verification if the same method is used for the entire range of years covered by the inventory;
- Verifying if GHG emissions calculations have been made for all years and for all types of fuels mentioned in the Energy Balances of the RM;
- The consumption of lubricants was reallocated to source category 2D1 from IPPU sector;
- Verifying to what extent the full geographical coverage of the national GHG inventory of the RM is ensured (for the years 2014-2019, emission assessment was performed for the entire territory of the country; whereas for 1990-2014, only for the territory on the RBDR);
- Verifying the inter-annual evolution trends of emissions by creating representative charts, while unusual fluctuations are explained;
- Verifying maintenance and completion of the national inventory of GHG emissions archive.

3.6.5. Recalculations

In the current inventory cycle, a number of measures have been taken to improve the quality of the national GHG inventory and this implied to recalculate GHG emissions from 1A5 'Other' category. The main causes of these recalculations are, as follows:

- LPG has been reallocated from 'liquid fuel' to 'gaseous fuel' category;
- Activity data associated with fuel consumption for the LBDR for the period between 2008-2019 have been updated;
- Also, for the territory on the LBDR, a switch was made to another source of information (statistical publications "Socio-economic development of the ATULBD" section "Use of material and energy resources") available since 2014, in which fuel consumption is directly indicated, not the fuel remaining in stock at the end of the year.

Compared to the results recorded in the BUR2 of the RM under the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in a downward trend in direct GHG emissions for period 2008-2013, and an upward trend in direct GHG emissions for the years 2014-2016 (Table 3-150). Direct GHG emissions for the period 2017-2019 were estimated for the first time. Between 1990 and 2019, direct GHG emissions from category 1A5 'Other' decreased in the Republic of Moldova by circa 80.1 per cent.

Table 3-150: Recalculation results of GHG emissions for the period 1990-2019, included in the BUR2 of the RM under the UNFCCC (1A5 'Other'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	115.5701	107.5724	78.5337	94.3265	89.0194	126.5495	82.8034	77.4557	73.6783	49.8010
BUR3	115.5701	107.5724	78.5337	94.3265	89.0194	126.5495	82.8034	77.4557	73.6783	49.8010
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	36.8044	43.8813	40.1303	28.8076	28.0207	26.2833	39.4920	45.1203	49.2337	13.4527
BUR3	36.8044	43.8813	40.1303	28.8076	28.0207	26.2833	39.4920	45.1203	44.1742	10.5966
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-11.5	-27.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	30.2051	21.5974	8.5786	3.9478	3.3383	2.9147	2.1288			
BUR3	27.5201	19.9471	7.0060	2.3899	25.1618	22.8721	22.9905	22.7351	23.4607	22.9770
Difference, %	-9.8	-8.3	-22.4	-65.2	86.7	87.3	90.7			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR3 – Third Biennial Update Report of the RM under the UNFCCC.

3.6.6. Planned Improvements

Potential improvements in 1A5 'Other' category could be made should new AD be available regarding fuel consumption on the LBDR and additional information provided by the Ministry of Defence on fuel combustion for the operation of military transport for the years 2017-2019.

3.7. Fugitive Emissions from Oil and Natural Gas (Category 1B2)

3.7.1. Source Category Description

The 1B2 'Fugitive Emissions from Oil and Natural Gas' source category includes GHG emissions originating from oil and natural gas distribution systems, except distribution systems of energy resources, which are combusted as fuel.

Distribution systems include the entire infrastructure needed to produce, collect, process, refine and distribute oil products and natural gases to final consumers. The system begins at the well heads and ends at the final sales point to the consumer.

The sources of fugitive emissions on oil and gas systems include equipment leaks, evaporation losses, venting, flaring, incineration and accidental releases (e.g., pipeline dig-ins, well blow-outs and spills, etc.).

In the Republic of Moldova, oil extraction is performed nearby Valeni village, Cahul district, on the territory of national reservation "Prutul de Jos". The estimated amount of oil reserves in oil fields of Valeni is circa 2-3 million tons, of which about 0.5-1.0 million tons are available reserves.

After removing water, oil is pumped through pipelines into storage tanks, from where it is transported in tanks to the refinery owned by Arnaut Petrol JSC (Comrat, ATU Gagauzia), with a processing capacity of about 35 kt annually. The following types of secondary fuels are produced at the respective refinery: gasoline, diesel oil, residual fuel oil and other petroleum products.

About 30 wells were drilled in the oil fields of Valeni. Extraction takes place only on some of them, the rest being preserved. Between 2003 and 2005, 8 wells were operational, 5 being in service. In the period 2006-2012, 10 wells were servicing, while starting with 2013 – circa 15 wells. During this period, the amount of extracted oil varied between 1 and 17 kt annually or between 1 or 18 thousand m^3 annually (Table 3-151 and Figure 3-26).

Table 3-151: Oil extraction in the Republic of Moldova for the period 2003-2019

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oil, kt	1	8	5	4	8	15	17	11	13	11	10	8	7	6	5	5	5
Oil, thousand m^3	1.000	8.502	5.313	4.251	8.502	15.940	18.066	11.690	13.815	11.690	10.627	8.502	7.439	6.376	5.313	5.313	5.313

Source: Energy Balances of the RM for the years 2003-2019.

The specific density of the oil extracted in Valeni is circa 0.941 t/m^3 (according to the information from the "Norms on Limited Permitted Pollutant Emissions in Atmospheric Air Report at Oil Exploration Valeni", 2015).

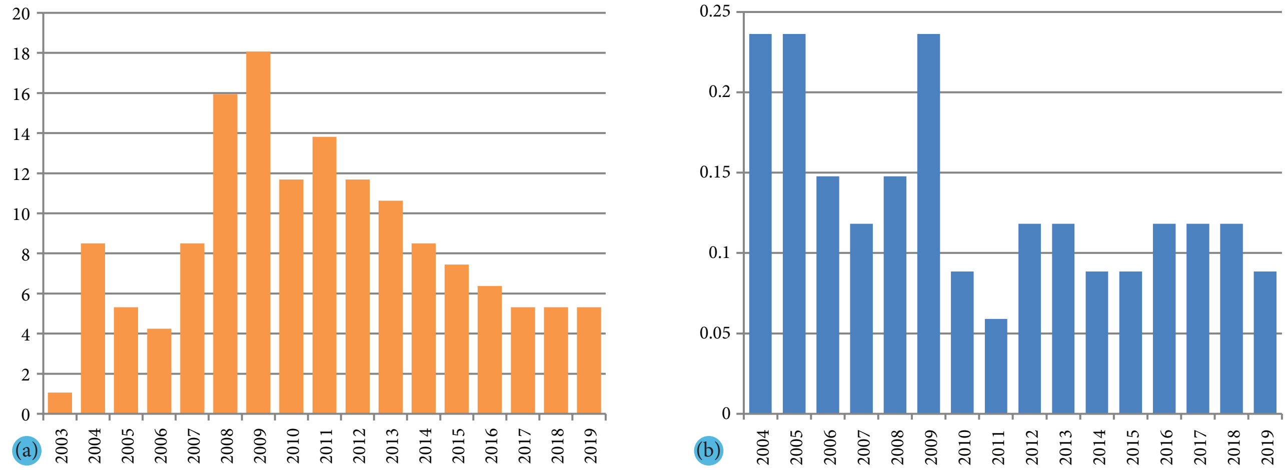

Figure 3-26: Oil and natural gas extracted in the Republic of Moldova within 2003-2019 periods, when: (a) Oil extraction, thousand m^3; (b) Natural gas extraction, million m^3.

Natural gas and oil resources were initially extracted (between 1995 and 2007) by an American company Redeco Ltd, and since 2007, by Valiexchimp Ltd Company. In 2016, the right to extract the resources in Valeni was granted to the American company "Fontera Resources Corporation". Natural gas extraction is currently being carried out at about six wells in the natural gas field in the vicinity of Victorovca village (Table 3-152, Figure 3-26).

Table 3-152: Natural gas extraction for the period 2004-2019

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Natural Gas, TJ	8	8	5	4	5	8	3	2	4	4	3	3	4	4	4	3
Natural Gas, million m^3	0.2363	0.2363	0.1477	0.1181	0.1477	0.2363	0.0886	0.0591	0.1181	0.1181	0.0886	0.0886	0.1181	0.1181	0.1181	0.0886

Source: Energy Balances of the RM for the years 2004-2019.

The methane content reaches circa 86-92 per cent. The natural gas explored at Victorovca field is supplied to the following nearby settlements: Ciobaclia, Suhata, Baimaclia, Flocoasa and Victorovca.

The supply is made both from the natural gas fields in Victorovca, in particular during the warm period of the year, when the natural gas consumption in the respective localities is reduced, as well as through the national gas distribution and transportation network, especially during the cold season of the year, when natural gas consumption is increased (during this time of the year, the capacities of the Victorovca reservoir cannot meet the needs of the population in these localities).

The natural gas transport system in the RM currently includes: high, medium and low-pressure main gas pipelines. Natural gas supply is operated by the JSC "Moldovagaz", which distributes natural gas to consumers in the country and performs the transit of Russian natural gas to South-Eastern European countries. Information on natural gas consumption is available separately for the RBDR and LBDR. The total natural gas consumption is presented in (Table 3-153 and Figure 3-27).

Table 3-153: Natural gas consumption in the RM and natural gas transiting the territory of the RM for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Natural gas transiting the RM, billion m^3	25.0000	23.0000	21.0000	19.0000	18.2650	20.9090	22.3960	16.9340	16.0210	17.1424
Natural gas consumption in the RM, million m^3	3813.7	3843.1	3377.38	2959.8	2861.0	2791.0	3222.0	3491.9	3168.58	2685.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Natural gas transiting the RM, billion m^3	19.3649	18.6248	21.3323	22.1319	23.8727	25.3129	22.3388	23.6928	23.2902	17.8911
Natural gas consumption in the RM, million m^3	2320.2	2628.0	2231.6	2405.4	2565.7	2715.6	2376.2	2489.9	2505.0	2775.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Natural gas transiting the RM, billion m^3	17.0343	19.8895	19.6200	19.6511	17.9859	16.9700	18.706	20.4878	18.2985	10.2295
Natural gas consumption in the RM, million m^3	2970.9	3099.5	3078.1	2386.0	2823.5	2782.0	2799.0	2615.6	2859.7	2865.9

Source: JSC "Moldovagaz" through Letter No. 604 of 01.04.1999, answer to Letter No. 02-541 of 28.05.2001; No. 02-156 of 06.02.2004, answer to Letter No. 257-01-07 of 26.01.2004; No. 06-1253 of 27.09.2006, answer to Letter No. 01-07/1400 of 25.08.2006; No. 07-730 of 06.06.2007, answer to Letter No. 47/21-103 of 31.05.2007; No. 02/1-476 of 23.02.2011, answer to Letter No. 03-07/175 of 02.02.2011; No. 02/1-288 of 22.01.2014, answer to Letter No. 320/2014-01-01 of 03.01.2014; No. 02/1-507 of 10.02.2015, answer to Letter No. 407/2015-01-09 of 29.01.2015; No. 02/1-2183 of 03.06.2016, answer to Letter No. 512/2016-05-01 of 10.05.2016; No. 03/2-74 of 12.01.2018, answer to Letter No. 601/2017-12-03 of 14.12.2017; No. 03/4-676 of 03.03.2020, answer to Letter No. 08-310/1 of 11.02.2020.

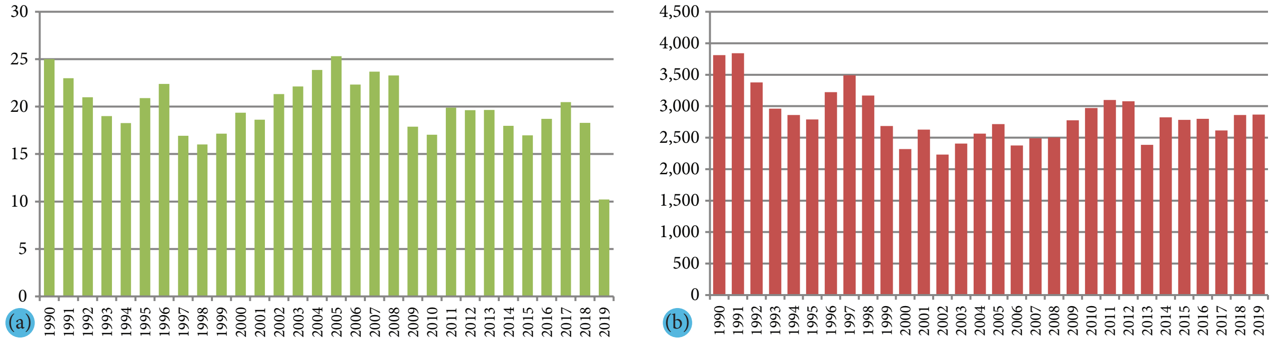

Figure 3-27: Natural gas consumption in the RM **(a)**, in million m^3; and natural gas transiting the RM **(b)**, in billion m^3, to be delivered to South-Eastern European countries for the period 1990-2019

Information on LPG amounts are available for the territory on the RBDR for the entire period under review, while for the LBDR only for the period 2011-2019 (Table 3-154, Figure 3-28).

Table 3-154: Liquefied Petroleum Gas consumption for the period 1990-2019

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RBDR	kt	146	128	75.4	39.9	19	19	22	26	25	31
	thousand m^3	250.00	219.18	129.11	68.32	32.53	32.53	37.67	44.52	42.81	53.08
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LBDR	kt	35	47	48	50	52	53	50	53	55	60
	thousand m^3	59.93	80.48	82.19	85.62	89.04	90.75	85.62	90.75	94.18	102.74
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
RBDR	kt	64	67	74	74	77	76	78	72	71	66
	thousand m^3	109.59	114.73	126.71	126.71	131.85	130.14	133.56	123.29	121.58	113.01
LBDR	thousand m^3	NA	2.68	2.18	1.87	1.56	1.41	1.52	0.890	0.938	0.916
Republic of Moldova	thousand m^3	109.59	117.41	128.89	128.59	133.41	131.54	135.08	124.18	122.51	113.93

Sources: Energy Balances of the RM for 1990, 1993-2019 for the RBDR; Press Release "The State of Housing and Communal Services of the Republic" for 2011-2019 for the LBDR.

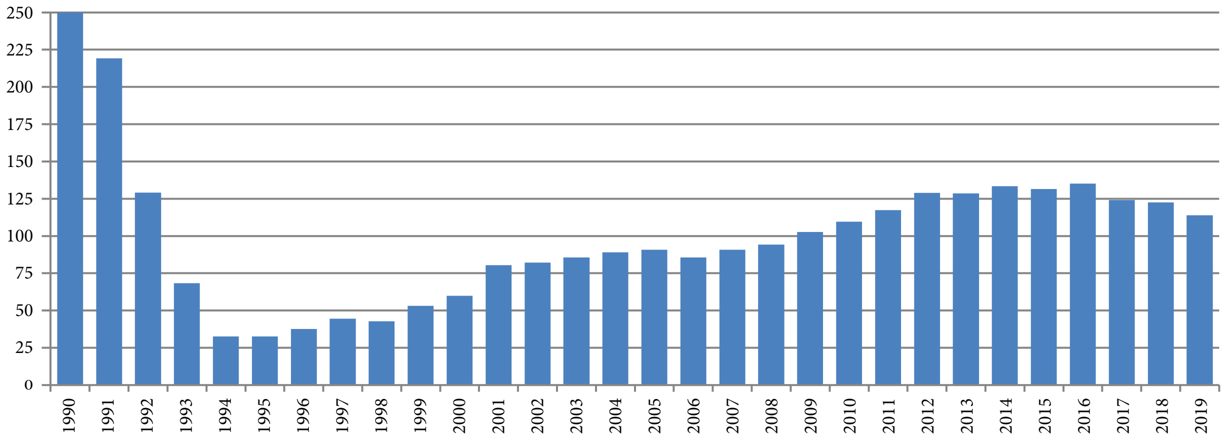

Figure 3-28: Liquefied Petroleum Gas consumption for the period 1990-2019, thousand m^3.

Trends in GHG emissions

Between 1990 and 2019, GHG emissions from source category 1B2 'Fugitive Emissions from Oil and Natural Gas' tended to decrease by circa 51.1 per cent: from 812.88 kt CO_2 equivalent recorded in 1990 to 397.45 kt CO_2 equivalent in 2019 (Table 3-155, Figure. 3-29).

Table 3-155: GHG emissions from source category 1B2 'Fugitive Emissions from Oil and Natural Gas' for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2, kt	0.6377	0.6140	0.5175	0.4382	0.4085	0.4194	0.4726	0.4651	0.4274	0.3931
CH_4, kt	32.4897	30.4926	27.6043	24.8026	23.8714	26.4555	28.7555	23.6428	22.1250	22.4045
N_2O, kt	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total, kt CO_2 equivalent	**812.8794**	**762.9286**	**690.6247**	**620.5042**	**597.1941**	**661.8075**	**719.3601**	**591.5343**	**553.5516**	**560.5056**
NMVOC	0.5817	0.5438	0.4931	0.4437	0.4269	0.4761	0.5160	0.4176	0.3916	0.4007
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2, kt	0.3759	0.4092	0.3901	1.0592	1.1045	1.1219	1.2260	1.2577	1.2748	1.2732
CH_4, kt	24.0254	23.8208	25.8825	27.0585	29.3699	31.0174	27.3303	29.0539	28.8986	23.9173
N_2O, kt	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total, kt CO_2 equivalent	**601.0105**	**595.9298**	**647.4523**	**677.5233**	**735.3524**	**776.5574**	**684.4863**	**727.6057**	**723.7417**	**599.2072**
NMVOC	0.4341	0.4278	0.4697	0.5320	0.8554	0.7651	0.6592	0.8509	1.1281	1.1123

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CO_2, kt	1.2747	1.3141	1.3104	1.6441	1.6721	1.6581	1.6704	1.6576	1.6657	1.6090
CH_4, kt	23.1928	26.4162	26.0365	24.7983	23.8129	22.6641	24.4436	25.9050	24.1003	15.8337
N_2O, kt	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total, kt CO_2 equivalent	**581.0977**	**661.7217**	**652.2250**	**621.6037**	**596.9975**	**568.2626**	**612.7641**	**649.2847**	**604.1765**	**397.4538**
NMVOC	0.8568	0.9966	0.9095	0.8528	0.7507	0.6894	0.6827	0.6716	0.6357	0.4800

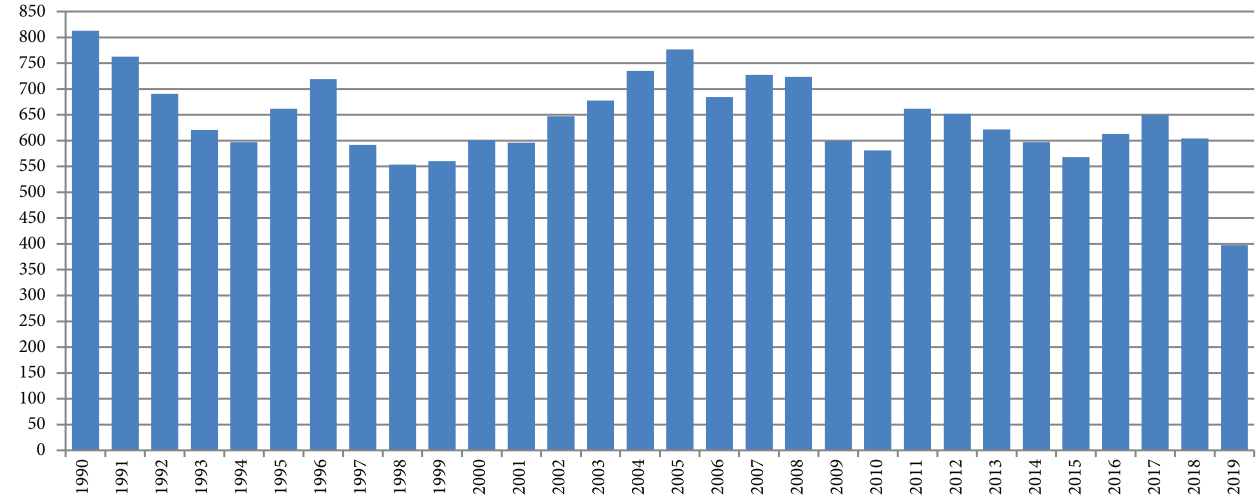

Figure 3-29: Direct GHG emissions from source category 1B2 'Fugitive Emissions from Oil and Natural Gas' for the period 1990-2019, kt CO_2 equivalent.

3.7.2. Methodological Issues, Emission Factors and Data Sources

GHG emissions originated from source category 1B2 'Fugitive Emissions from Oil and Natural Gas' were estimated following a Tier 1 methodology (2006 IPCC Guidelines). Fugitive emissions of CH_4, N_2O, CO_2 and NMVOC were monitored.

The basic equations used to estimate GHG emissions under this source category are:

$$E_{gas,\ industry\ segment} = A_{industry\ segment} \bullet EF_{gas,\ industry\ segment}$$

$$E_{gas} = \Sigma E_{gas,\ gas,\ industry\ segment}$$

where:

$E_{gas,\ industry\ segment}$ – annual emissions (kt);

$A_{industry\ segment}$ – activity data for the respective industry segment;

$EF_{activity\ data\ for\ the\ respective\ industry\ segment}$ – emission factor (kt/activity unit).

Average default EF values were used to estimate GHG emission according to 2006 IPCC Guidelines (Tables 3-156, 3-157, 3-158 and 3-159).

Table 3-156: Default EF values from 'Well Drilling, Testing and Servicing'

Category	IPCC Code	CO_2	CH_4	N_2O	NMVOC
		Ranges and Average for EFs Values Used			
Oil and Natural Gas well drilling, kg/well/yr	1B2a ii, 1B2b ii	100-1700	33-560	-	0.87-15.0
		900	**296.5**		**7.935**
Oil and Natural Gas well testing, kg/well/yr	1B2a ii, 1B2b ii	9000-150000	51-850	0.068-1.1	12-200
		79500	**450.5**	**0.584**	**106**
Oil and Natural Gas well servicing, kg/well/yr	1B2a ii, 1B2b ii	1.9-32.0	110-1800	-	17-280
		17	**955**		**148.5**

Table 3-157: Default EF values from 'Oil Extraction, Transportation and Storage in Tanks'

Category	IPCC Code	CO_2	CH_4	N_2O	NMVOC
		Ranges and Average for EFs Values Used			
Fugitive emissions from oil production, kg/1000 m^3/yr	1B2a iii 2	0.1-4300	1,5-60000	-	1.8-75000
		2150	**30000.8**		**37500.9**
Ventilation at oil extraction, kg/1000 m^3/yr	1B2a i	95-130	720-990	-	430-590
		112.5	**855**		**510**
Flaring at oil production, kg/1000 m^3/yr	1B2a ii	41000-56000	25-34	0.64-0.88	21-29
		48500	**30**	**0.76**	**25**
Oil transportation in tanks, kg/1000 m^3/yr	1B2a i	**2.30**	**25**	-	**250**

Table 3-158: Default EF values from 'Natural Gas Extraction, Transportation and Distribution'

Category	IPCC Code	CO_2	CH_4	N_2O	NMVOC
		Ranges and Average for EFs Values Used			
Fugitive emissions from natural gas production, kg/million m³/yr	1B2b iii 2	14-180	380-24000	-	91-1200
		97	**12190**		**645.5**
Fugitive emissions from natural gas transportation, kg/million m³/yr	1B2b iii 4	0.88-2.00	166-1100	-	7.0-16.0
		1.44	**633**		**11.50**
Fugitive emissions from natural gas distribution, kg/million m³/yr	1B2b iii 5	51-140	1100-2500	-	16-36
		95.5	**1800**		**26**
Flaring at natural gas production, kg/million m³/yr	1B2b ii	1200-1600	0.76-1.00	0.021-0.029	0.62-0.85
		1400	**0.88**	**0.025**	**0.74**
Ventilation at natural gas transportation, kg/million m³/yr	1B2b i	3.1-7.3	44-740	-	4.6-11.0
		5.20	**392**		**7.80**

Table 3-159: Default EF values from 'LPG Transportation'

Category	IPCC Code	CO_2	CH_4	N_2O	NMVOC
Fugitive emissions from liquefied petroleum gas transportation, kg/1000 m³/yr	1B2a iii 3	430	-	0.0022	-

The activity data related to amounts of natural gas transited across the Republic of Moldova, as well as data regarding amounts of natural gas sold in the Republic of Moldova were provided by JSC "Moldovagaz" (Table 3-160).

Table 3-160: Natural Gas transited, imported and consumed in the RM for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Natural gas imported, million m³	**3844**	**3873**	**3435**	**3093**	**3012**	**3005**	**3489**	**3676**	**3333**	**2856.8**
Net caloric values for natural gas, kcal/m³	NA	NA	NA	NA	NA	NA	NA	7980	7970	7976
Net caloric values for natural gas, TJ/million m³	NA	NA	NA	NA	NA	NA	NA	33.404	33.362	33.388
Methane density, kg/m³	NA	NA	NA	NA	NA	NA	NA	0.683	0.683	0.683
Share of methane in natural gas imported, %	NA	NA	NA	NA	NA	NA	NA	97.9	97.9	97.9
Technological losses, including:	30	30	58	133	151	214	267	184	164	154.7
in distribution networks	30	30	58	133	52	71	112	68	107	102.5
in main networks	0	0	0	0	98	143	155	116	58	52.2
Natural gas transited, billion m³	**25.000**	**23.000**	**21.000**	**19.000**	**18.265**	**20.909**	**22.396**	**16.934**	**16.021**	**17.1424**
Natural gas sold in the RM:	**3813.7**	**3843.1**	**3377.4**	**2959.8**	**2861.0**	**2791.0**	**3222.0**	**3491.9**	**3168.6**	**2685.3**
On the Right Bank of the Dniester River	NA	NA	NA	NA	1149.95	1557.88	1769.61	1882.9	1699.58	1219.8
On the Left Bank of Dniester River	NA	NA	NA	NA	1711.05	1233.12	1452.39	1609.00	1469.00	1465.5
Technological losses, % of the total	0.78	0.77	1.69	4.30	5.01	7.12	7.65	5.01	4.92	5.42
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Natural gas imported, million m³	**2477.5**	**2732.1**	**2419.8**	**2614.6**	**2687.2**	**2819.2**	**2472.3**	**2714.7**	**2725.5**	**2979.4**
Net caloric values for natural gas, kcal/m³	7978	7972	7992	8007	8019	8026	8035	8038	8041	8074
Net caloric values for natural gas, TJ/million m³	33.396	33.371	33.455	33.517	33.568	33.597	33.635	33.647	33.660	33.798
Methane density, kg/m³	0.683	0.683	0.683	0.683	0.683	0.683	0.683	0.683	0.683	0.683
Share of methane in natural gas imported, %	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9
Technological losses, including:	116.9	90.1	92.6	103.3	73.3	102.8	94	96.2	94.7	93.9
in distribution networks	79.4	72.8	65.5	66.1	52.9	54.2	55.6	54.5	55.5	55.7
in main networks	37.5	17.3	27.0	37.2	20.4	48.6	38.4	41.7	39.2	38.2
Natural gas transited, billion m³	**19.3649**	**18.6248**	**21.3323**	**22.1319**	**23.8727**	**25.3129**	**22.3388**	**23.6928**	**23.2902**	**17.8911**
Natural gas sold in the RM:	**2320.2**	**2628.0**	**2231.6**	**2405.4**	**2565.7**	**2715.6**	**2376.2**	**2489.9**	**2505.0**	**2775.0**
On the Right Bank of the Dniester River	918.3	1055.7	1050.6	1129.9	1141.5	1314.9	1322.0	1208.0	1130.8	1029.9
On the Left Bank of Dniester River	1401.9	1572.3	1181	1275.5	1424.2	1400.7	1054.2	1281.9	1374.2	1745.1
Technological losses, % of the total	4.72	3.30	3.83	3.95	2.73	3.65	3.80	3.54	3.47	3.15
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Natural gas imported, million m³	**3176.2**	**3213.1**	**3182.5**	**2472.5**	**2915.6**	**2926**	**2956**	**2771.8**	**2936.6**	**2889.8**
Net caloric values for natural gas, kcal/m³	8071	8081	8107	8137	8175	8246	8237	8205	8186	8203
Net caloric values for natural gas, TJ/million m³	33.785	33.827	33.936	34.061	34.221	34.518	34.480	34.33	34.25	34.32
Methane density, kg/m³	0.683	0.6914	0.6906	0.6946	0.6992	0.705	0.706	-	-	-
Share of methane in natural gas imported, %	97.9	96.9	97.0	96.5	96.1	95.5	95.34	-	-	-
Technological losses, including:	98.6	113.6	104.4	86.5	92.1	144.0	155.0	69.3	56.1	42.6
in distribution networks	57.9	54.4	52.1	49.8	48.3	43.0	49.0	38.3	35.2	31.2
in main networks	40.7	59.2	52.3	36.7	43.8	101.0	106.0	31	20.9	11.4
Natural gas transited, billion m³	**17.0343**	**19.8895**	**19.6200**	**19.6511**	**17.9859**	**16.9700**	**18.7080**	**20.4878**	**18.2985**	**10.2295**
Natural gas sold in the RM:	**2970.9**	**3099.5**	**3078.1**	**2386.0**	**2823.5**	**2782.0**	**2799.0**	**2615.6**	**2859.7**	**2865.9**
On the Right Bank of the Dniester River	1089.8	1152.1	1095.5	1031.2	1053.1	928.0	965.0	1004.4	1105.9	1047.9
On the Left Bank of Dniester River	1881.1	1974.4	1982.6	1354.8	1770.4	1854.0	1834.0	1611.2	1753.8	1818.0
Technological losses, % of the total	3.10	3.54	3.28	3.50	3.16	4.92	5.20	2.50	1.91	1.47

Source: JSC "Moldovagaz" through Letters No. 604 of 01.04.1999, answer to Letter No. 02-541 of 28.05.2001; No. 02-156 of 06.02.2004, answer to Letter No. 257-01-07 of 26.01.2004; No. 06-1253 of 27.09.2006, answer to Letter No.01-07/1400 of 25.08.2006; No. 07-730 of 6.6.2007, answer to Letter No. 47/21-103 of 31.05.2007; No. 02/1-476 of 23.02.2011, answer to Letter No. 03-07/175 of 02.02.2011; No. 02/1-288 of 22.01.2014, answer to Letter No. 320/2014-01-01 of 03.01.2014; No. 02/1-507 of 10.02.2015, answer to Letter No. 407/2015-01-09 of 29.01.2015; No. 02/1-2183 of 03.06.2016, answer to Letter No. 512/2016-05-01 of 10.05.2016; No. 03/2-74 of 12.01.2018, answer to Letter No. 601/2017-12-03 of 14.12.2017; No. 03/4-676 of 03.03.2020, answer to Letter No. 08-310/1 of 11.02.2020.

The activity data related to the exploration of oil and natural gas, and on LPG consumption, respectively, are available in the Energy Balances of the Republic of Moldova. The AD on imported LPG (information is used for quality assurance and quality control procedures) are available in the Annual Reports on the Activity of the National Energy Regulatory Agency (2009-2019)[55].

3.7.3. Uncertainties assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the 1B2 'Fugitive Emissions from Oil and Natural Gas' source category, and quality of available activity data. Thus, uncertainties associated with emission factors used to estimate direct GHG emissions were estimated at circa 25 per cent. Uncertainties related to activity data pertaining to fuel consumption in the industrial sector is considered quite significant, up to 25 per cent. The combined uncertainties from sector 1B2 represent circa 35.2 per cent. Uncertainties in the trend of total GHG emissions directly from sector 1B2 were estimated at around 17.2 per cent.

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

3.7.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for 1B2 'Fugitive Emissions from Oil and Natural Gas' source category, following the Tier 1 approach.

The AD and methods used for estimating GHG emissions under this category were documented and archived both in hard copies and electronically. In order to identify the data entry and emission estimation process related errors verifications and quality control procedures were applied. Following the recommendations included into the 2006 IPCC Guidelines, GHG emissions originating from source category 1B2 'Fugitive Emissions from Oil and Natural Gas' were estimated based on AD and CS NCVs from official sources of information.

The specific verifications and quality control procedures applied for this category included:

- Verification of AD collecting and manipulation procedures, including: verifying if disaggregation of AD collected for each source included in 1B2 'Fugitive Emissions from Oil and Natural Gas' source category complies with the requirements set out in the description of each source in the 2006 IPCC Guidelines (1B2a 'Oil', 1B2b 'Natural Gas', 1B2c 'Venting', 1B2d 'Other'); for each source AD are available in separate files in natural and energy units; verifying the correctness of EFs use for each source; verifying if the primary reference sources are correctly indicated; the accuracy of calculations for sources included in 1B2 source category are verified randomly;
- Implementation of error minimization procedures for manual entry of AD, with all the spreadsheets provided with the initial sources of activity data in tabular format;
- In the calculation files the EFs are specified in tabular formats for each source, the import of the respective values into calculation formulas is ensured by automatic connections;
- The consistency of the calculations is also ensured by verifying the correctness of applying conversion factors of natural units to energy units for all subcategories and the entire range of years covered by the inventory;
- Verification if the same method is used for the entire range of years covered by the inventory;
- Verifying if GHG emissions calculations have been made for all years and for all types of fuels mentioned in the Energy Balances of the RM;
- Verifying to what extent the full geographical coverage of the national GHG inventory of the RM is ensured;
- Verifying the inter-annual evolution trends of emissions by creating representative charts, while unusual fluctuations are explained;

[55] <http:// http://anre.md/raport-de-activitate-3-10>

- In the case of recalculations, their need is explained, including by drawing attention to the implemented recommendations resulting from the audit carried out by national and international experts in the previous inventory cycle;
- Verifying maintenance and completion of the national inventory of GHG emissions archive.

In accordance with sustainable practices, national emission activity data and factors from official reference sources were used to assess GHG emissions.

3.7.5. Recalculations

In the current inventory cycle, a number of measures have been taken to improve the quality of the national GHG inventory and this implied to recalculate emissions from source category 1B2 'Fugitive Emissions from Oil and Natural Gas'. The main causes of these recalculations are, as follows:

The main causes of these recalculations are reported as follows: the emission factors have been updated; activity data associated with fuel consumption and units of measurement have been updated; likewise, the transition from an average annual net caloric value to the use of constant net calorific values for natural gas (33.86 TJ/million m^3) for the entire period of time was achieved.

Compared to the results recorded in BUR2 of the RM under the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in a downward trend in direct GHG emissions during the years 1991-2016, respectively an insignificant increase in direct GHG emissions in 1990 (Table 3-161). Direct GHG emissions for 2017-2019 have been estimated for the first time. In the period 1990-2019, direct GHG emissions from category 1B2 'Fugitive Emissions from Oil and Natural Gas' decreased in the Republic of Moldova by circa 51.1 per cent.

Table 3-161: Recalculation results of GHG emissions for the period 1990-2019, included in the BUR2 of the RM under the UNFCCC (1B2 'Fugitive Emissions from Oil and Natural Gas'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	805.1627	906.6216	775.2688	665.2960	618.5236	683.1370	744.0574	620.7220	581.6167	595.3063
BUR3	812.8794	762.9286	690.6247	620.5042	597.1941	661.8075	719.3601	591.5343	553.5516	560.5056
Difference, %	1.0	-15.9	-10.9	-6.7	-3.5	-3.1	-3.3	-4.7	-4.8	-5.9
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	640.3016	648.6921	701.3372	733.6534	793.7282	836.0558	740.6166	787.1037	785.4848	666.5632
BUR3	601.0105	595.9298	647.4523	677.5233	735.3524	776.5574	684.4863	727.6057	723.7417	599.2072
Difference, %	-6.1	-8.1	-7.7	-7.7	-7.4	-7.1	-7.6	-7.6	-7.9	-10.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	652.9440	739.9111	736.7248	705.9040	684.4601	654.5013	701.3244			
BUR3	581.0977	661.7217	652.2250	621.6037	596.9975	568.2626	612.7641	649.2847	604.1765	397.4538
Difference, %	-11.0	-10.6	-11.5	-11.9	-12.8	-13.2	-12.6			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR3 – Third Biennial Update Report of the RM under the UNFCCC.

3.7.6. Planned Improvements

Potential improvements within source category 1B2 'Fugitive Emissions from Oil and Natural Gas' could be possible should new data related to fugitive leaks from oil and natural gas distribution networks be available (from the infrastructure needed to produce, collect, process, refine and distribute oil products and natural gases to final consumers; from equipment functioning, evaporation and flashing losses, flaring, accidental releases from pipeline dig-ins, etc.); respectively, in the case of adopting a higher-ranking assessment methodology. The possibility to obtain AD associated to LPG consumption on the LBDR for the entire period under review will also be estimated.

3.8. International Aviation (Memo Items)

3.8.1. Source Category Description

GHG emissions from 'International Aviation' (Memo Items) comes from the combustion of jet fuel used in the international air transport (in case of aircraft which operate international flights, emissions are allocated to the country in which the aircraft was fuelled). In the Republic of Moldova, international aviation includes jet propelled aircraft using jet kerosene.

In 2017-2019, international flights were operated by the following aircraft: (1) productions from CIS countries: IL-76, AN-26, Mi-2, Mi-8, Mi-17, Ka-2; (2) production from other countries: large commercial jet aircraft - A-319 (320, 321); Boeing-707 (737, 739, 747, 757), EMB-190, A-300-600; small aircraft – Cessna C-150F, C-150M (domestic flights only).

In previous years, flights were operated with other types of aircraft: (a) large commercial jet aircraft: A-319 (320, 321); Boeing-707 (737, 739, 747,757), EMB-190 (120, 135, 145, 170), Fokker 70 and Fokker 100, MD-81 (82, 83) RJ-85, RJ-100, CRJ, Rombac-561 Rc; A-300-600; (b) short and medium range turboprop aircraft: Saab-340 (SF-340), Saab-2000 (SF-2000), L410, DHC8, ATR-42; (c) light turboprop aircraft – X-32 Becas; (d) small jet aircraft: Falcon-2000EX, Learjet-35; (e) aircraft produced in CIS countries are represented by a group of aircraft such as TU-134, TU-154, AN-2 (12, 24, 26, 28, 32, 72, 74), IL-18, IL-76 , YAK-18 (40, 42); (k) Mi-8 (2, 17, 26), Ka-26 and Ka-32, Robinson 44 helicopters (partly domestic flights).

The total number of flights with aircraft produced in other countries in the period 1995-2019 had an upward trend, whereas flights with aircraft produced in CIS countries – a downward trend (Figure 3-30).

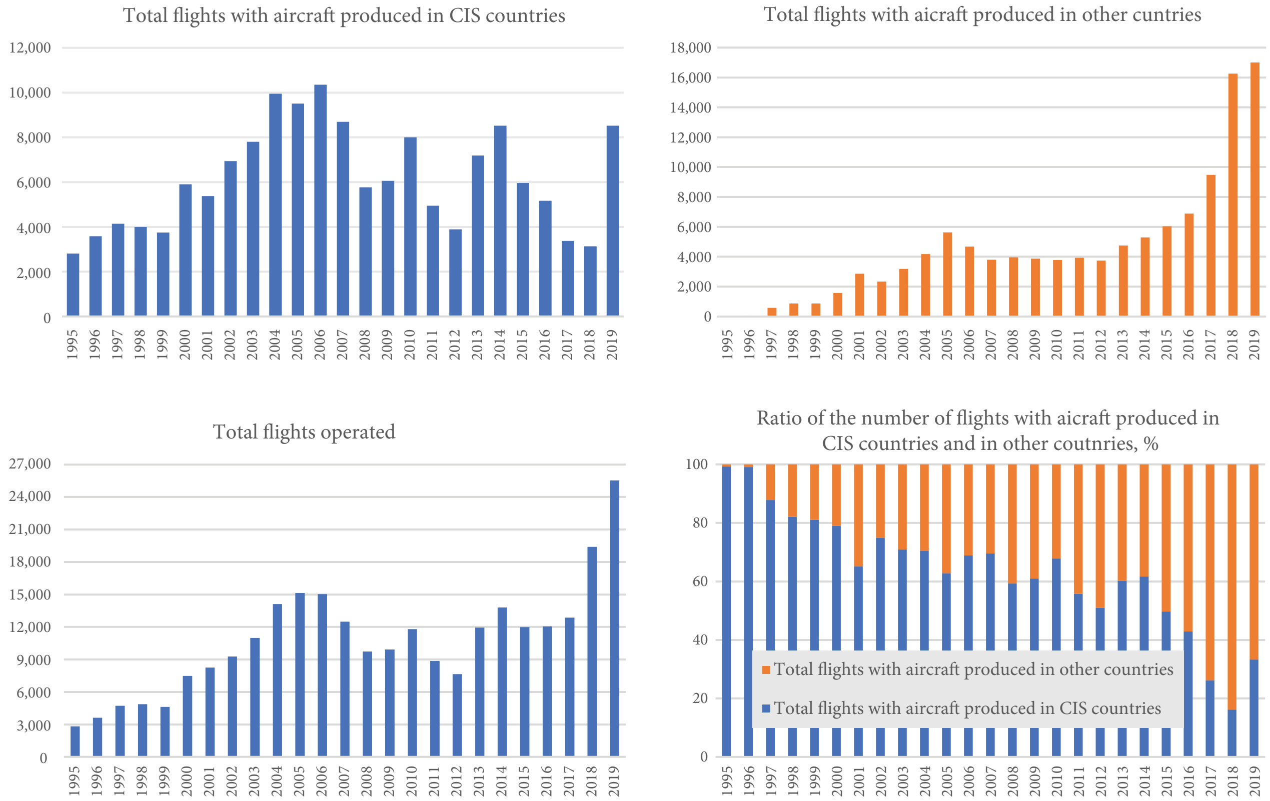

Figure 3-30: Total number of flights operated under the 'International Aviation' (Memo Items) source category in the RM within 1995-2019 periods and the ratio of flights with aircrafts produced in CIS countries and other countries, in % from the total number of flights operated.

The largest share in the total GHG emissions from international aviation is covered by CO_2 (circa 70 per cent), less than 30 per cent of the total emissions are covered by water vapours and as little as circa 1 per cent by other gases (NO_x, CO, SO_2, NMVOC). The share of methane and nitrous oxide emissions is insignificant (it is considered that modern engines emit little or no CH_4, in particular, during the cruise cycle).

The aircraft flight is divided into two cycles: (i) the landing/take-off cycle (LTO), produced at altitudes lower than 914 metres and (ii) the cruise flight cycle (c), produced at altitudes higher than 914 metres. It is estimated that only about 10 per cent of the emissions recorded during the flight come from the LTO cycle, the remaining 90 per cent from the cruise cycle. Exceptions are CO and NMVOC emissions: 30 per cent are emissions recorded during the LTO cycle, the remaining 70 per cent come from the cruise cycle.

The evolution of GHG emissions from source category 'International Aviation' (Memo Items) is shown in Table 3-162.

Table 3-162: GHG emissions from 'International Aviation' (Memo Items) in the Republic of Moldova within 1990-2019 periods, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
C_O2	193.4599	147.3846	108.5369	55.2342	30.8414	41.9508	56.7300	66.1918	53.5923	63.0390
CH_4	0.0153	0.0117	0.0086	0.0044	0.0024	0.0066	0.0048	0.0054	0.0041	0.0040
N_2O	0.0063	0.0048	0.0036	0.0018	0.0010	0.0014	0.0018	0.0021	0.0017	0.0020
NO_x	0.7651	0.5829	0.4293	0.2184	0.1220	0.1676	0.2197	0.2640	0.2144	0.2517
CO	0.5859	0.4464	0.3287	0.1673	0.0934	0.1539	0.1539	0.1777	0.1439	0.1574
NMVOC	0.2298	0.1751	0.1289	0.0656	0.0366	0.0809	0.0822	0.0937	0.0721	0.0796
SO_2	0.0613	0.0467	0.0344	0.0175	0.0098	0.0133	0.0180	0.0210	0.0170	0.0200
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2	63.0779	50.4863	59.9541	34.7676	34.7903	37.9260	37.9241	44.2052	44.1680	44.1719
CH_4	0.0043	0.0039	0.0036	0.0035	0.0035	0.0035	0.0039	0.0027	0.0016	0.0017
N_2O	0.0020	0.0016	0.0020	0.0012	0.0012	0.0013	0.0013	0.0015	0.0014	0.0014
NO_x	0.2591	0.1936	0.2413	0.1317	0.1283	0.1433	0.1428	0.1782	0.1855	0.1878
CO	0.1688	0.1468	0.1619	0.1223	0.1296	0.1362	0.1424	0.1296	0.1080	0.1094
NMVOC	0.0773	0.0630	0.0653	0.0403	0.0344	0.0373	0.0397	0.0393	0.0365	0.0380
SO_2	0.0200	0.0160	0.0190	0.0110	0.0110	0.0120	0.0120	0.0140	0.0140	0.0140
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CO_2	41.0593	41.0082	47.3142	41.0717	53.6855	56.8077	100.9698	148.2788	170.4060	151.5015
CH_4	0.0026	0.0028	0.0028	0.0046	0.0034	0.0056	0.0062	0.0058	0.0071	0.0055
N_2O	0.0014	0.0013	0.0015	0.0013	0.0018	0.0018	0.0033	0.0048	0.0058	0.0051
NO_x	0.1667	0.1611	0.1806	0.1592	0.2110	0.2255	0.4139	0.5821	0.6507	0.6236
CO	0.1218	0.1246	0.1322	0.1584	0.1599	0.1841	0.2665	0.3478	0.5113	0.4162
NMVOC	0.0377	0.0496	0.0558	0.0571	0.0553	0.0817	0.1113	0.1423	0.1537	0.1199
SO_2	0.0130	0.0130	0.0150	0.0130	0.0170	0.0180	0.0320	0.0470	0.0540	0.0480

For 1990-1994 time series, the results were restored using the partial overlapping method, while for 1995-2019 – by using a Tier 2b approach available in the 2006 IPCC Guidelines.

In comparison with the reference year level (1990), by 2019, the GHG emissions from 'International Aviation' (Memo Items) source category represented: for CO_2 – circa 78.3 per cent, CH_4 – 35.8 per cent, N_2O – 81.0 per cent, NOx – 81.5 per cent, CO – 71.0 per cent, NMVOC – 52.5 per cent, and SO_2 – 78.3 per cent, respectively (Table 3-163).

Table 3-163: GHG emissions from 'International Aviation' (Memo Items) in the Republic of Moldova within 1990-2019 periods, where 1990 represents 100 per cent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
C_O2	100.0	76.2	56.1	28.6	15.9	21.7	29.3	34.2	27.7	32.6	32.6	26.1	31.0	18.0	18.0
CH_4	100.0	76.2	56.1	28.6	15.9	42.8	31.2	35.0	26.8	26.0	28.4	25.5	23.7	22.8	22.6
N_2O	100.0	76.2	56.1	28.6	15.9	21.5	28.7	33.5	27.2	31.9	32.2	26.0	30.9	18.4	18.8
NO_x	100.0	76.2	56.1	28.6	15.9	21.9	28.7	34.5	28.0	32.9	33.9	25.3	31.5	17.2	16.8
CO	100.0	76.2	56.1	28.6	15.9	26.3	26.3	30.3	24.6	26.9	28.8	25.0	27.6	20.9	22.1
NMVOC	100.0	76.2	56.1	28.6	15.9	35.2	35.8	40.8	31.4	34.6	33.6	27.4	28.4	17.5	15.0
SO_2	100.0	76.2	56.1	28.6	15.9	21.7	29.4	34.3	27.7	32.6	32.6	26.1	31.0	17.9	17.9
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CO_2	19.6	19.6	22.8	22.8	22.8	21.2	21.2	24.5	21.2	27.8	29.4	52.2	76.6	88.1	78.3
CH_4	22.8	25.6	17.8	10.7	11.2	16.9	18.2	18.3	30.0	22.3	36.4	40.2	38.0	46.6	35.8
N_2O	20.3	20.4	23.3	22.8	22.8	21.5	20.7	23.9	21.1	27.9	28.8	51.9	75.6	90.7	81.0
NO_x	18.7	18.7	23.3	24.2	24.5	21.8	21.1	23.6	20.8	27.6	29.5	54.1	76.1	85.0	81.5
CO	23.3	24.3	22.1	18.4	18.7	20.8	21.3	22.6	27.0	27.3	31.4	45.5	59.4	87.3	71.0
NMVOC	16.2	17.3	17.1	15.9	16.5	16.4	21.6	24.3	24.8	24.1	35.5	48.4	61.9	66.9	52.2
SO_2	19.6	19.6	22.8	22.8	22.8	21.2	21.2	24.5	21.2	27.7	29.4	52.2	76.7	88.1	78.3

Regarding the evolution of direct GHG emissions from source category 'International Aviation' (Memo Items), the amount of these emissions recorded a downward trend from circa 195.73 kt CO_2 equivalent in 1990, to circa 153.17 kt CO_2 equivalent in 2019 (Table 3-164).

Table 3-164: Direct GHG emissions from 'International Aviation' (Memo Items) in the Republic of Moldova within 1990-2019 periods

	direct GHG emissions, kt CO_2 equivalent				%, compared to 1990				Share, % of total		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	193.4599	0.3828	1.8920	195.7347	100.0	100.0	100.0	100.0	98.8	0.2	1.0
1991	147.3846	0.2917	1.4414	149.1177	76.2	76.2	76.2	76.2	98.8	0.2	1.0
1992	108.5369	0.2148	1.0615	109.8132	56.1	56.1	56.1	56.1	98.8	0.2	1.0
1993	55.2342	0.1093	0.5402	55.8837	28.6	28.6	28.6	28.6	98.8	0.2	1.0
1994	30.8414	0.0610	0.3016	31.2041	15.9	15.9	15.9	15.9	98.8	0.2	1.0
1995	41.9508	0.1638	0.4066	42.5212	21.7	42.8	21.5	21.7	98.7	0.4	1.0

	direct GHG emissions, kt CO_2 equivalent				%, compared to 1990				Share, % of total		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1996	56.7300	0.1196	0.5436	57.3932	29.3	31.2	28.7	29.3	98.8	0.2	0.9
1997	66.1918	0.1341	0.6341	66.9600	34.2	35.0	33.5	34.2	98.9	0.2	0.9
1998	53.5923	0.1025	0.5152	54.2100	27.7	26.8	27.2	27.7	98.9	0.2	1.0
1999	63.0390	0.0994	0.6040	63.7425	32.6	26.0	31.9	32.6	98.9	0.2	0.9
2000	63.0779	0.1086	0.6101	63.7967	32.6	28.4	32.2	32.6	98.9	0.2	1.0
2001	50.4863	0.0977	0.4911	51.0751	26.1	25.5	26.0	26.1	98.8	0.2	1.0
2002	59.9541	0.0909	0.5847	60.6297	31.0	23.7	30.9	31.0	98.9	0.1	1.0
2003	34.7676	0.0873	0.3479	35.2028	18.0	22.8	18.4	18.0	98.8	0.2	1.0
2004	34.7903	0.0863	0.3548	35.2315	18.0	22.6	18.8	18.0	98.7	0.2	1.0
2005	37.9260	0.0872	0.3848	38.3980	19.6	22.8	20.3	19.6	98.8	0.2	1.0
2006	37.9241	0.0979	0.3865	38.4085	19.6	25.6	20.4	19.6	98.7	0.3	1.0
2007	44.2052	0.0681	0.4402	44.7135	22.8	17.8	23.3	22.8	98.9	0.2	1.0
2008	44.1680	0.0409	0.4319	44.6408	22.8	10.7	22.8	22.8	98.9	0.1	1.0
2009	44.1719	0.0429	0.4319	44.6466	22.8	11.2	22.8	22.8	98.9	0.1	1.0
2010	41.0593	0.0648	0.4071	41.5312	21.2	16.9	21.5	21.2	98.9	0.2	1.0
2011	41.0082	0.0696	0.3921	41.4700	21.2	18.2	20.7	21.2	98.9	0.2	0.9
2012	47.3142	0.0701	0.4520	47.8362	24.5	18.3	23.9	24.4	98.9	0.1	0.9
2013	41.0717	0.1149	0.3986	41.5852	21.2	30.0	21.1	21.2	98.8	0.3	1.0
2014	53.6855	0.0852	0.5281	54.2988	27.8	22.3	27.9	27.7	98.9	0.2	1.0
2015	56.8077	0.1395	0.5458	57.4930	29.4	36.4	28.8	29.4	98.8	0.2	0.9
2016	100.9698	0.1538	0.9827	102.1063	52.2	40.2	51.9	52.2	98.9	0.2	1.0
2017	148.2788	0.1454	1.4311	149.8553	76.6	38.0	75.6	76.6	98.9	0.1	1.0
2018	170.4060	0.1782	1.7154	172.2996	88.1	46.6	90.7	88.0	98.9	0.1	1.0
2019	151.5015	0.1369	1.5333	153.1717	78.3	35.8	81.0	78.3	98.9	0.1	1.0

3.8.2. Methodological Issues, Emission Factors and Data Sources

GHG emissions from the 'International Aviation' (Memo Items) were estimated using a Tier 2 methodological approach. Unlike Tier 1 methodology requiring only activity data on fuel consumption and default EFs values, the Tier 2 methodology can be applied only on the availability of activity data on the number of flights by each type of aircraft used in the international air transportation, and the amount of fuels used for 'LTO' and 'Cruise' phases of the flights.

The basic equations used to estimate emissions are as follows:

$$Total\ Emissions = LTO\ Emissions + Cruise\ Emissions$$

where:

$$LTO\ Emissions = Number\ of\ LTOs \bullet Emission\ Factor_{LTO}$$

$$LTO\ Fuel\ Consumption = Number\ of\ LTOs \bullet Fuel\ Consumption\ per\ LTO$$

$$Cruise\ Emissions = (Total\ Fuel\ Consumption - LTO\ Fuel\ Consumption) \bullet Emission\ Factor_{Cruise}$$

Emission factors available both in the Revised 1996 IPCC Guidelines, as well as in the 2006 IPCC Guidelines were used to estimate GHG emissions originating from this category (Table 3-165).

Table 3-165: Default EFs used to estimate GHG emissions from 'International Aviation' (Memo Items) source category

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
New Aircraft Types: LTO, kg/LTO	7,900	1.5	0.2	41	50	15	2.5
Old aircraft types: LTO (kg/LTO)	7,560	7	0.2	23.6	101	66	2.4
All aircraft types: cruise phase of flight (kg/t)	3,150	0	0.1	17	5	2.7	1.0

Source: Revised 1996 IPCC Guidelines, Volume 3, Tables 1-52, 1.98.

Thus, in order to estimate GHG emissions from the cruise phase of the flight, emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997) were used, while for NO_x and for the LTO phase of the flight – EFs available in the 2006 IPCC Guidelines.

For a number of aircraft, EFs are available in the 2006 IPCC Guidelines (Volume 2, Chapter 3, Tables 3.69-3.71). In the process of selecting emission factors, information on the suitability of different types of aircraft to representative classes can be useful (2006 IPCC Guidelines, Volume 2, Chapter 3, Tables 3.6.3, 3.63). Where EFs for a given type of aircraft are missing, the emission factors characteristic to the representative classes are used. For the types of aircraft operating international flights in the RM, a table of their correspondence to the representative classes was completed, with a short description of their technical characteristics (Table 3-166).

Table 3-166: The correspondence between the most representative aircraft and the aircraft operating international flights in the Republic of Moldova

Generic name of the aircraft	Aircraft Class	Aircraft operating international flights in the RM	Short technical description of aircraft
Large commercial jet aircraft			
Airbus A319 Airbus A320 Airbus A321	Large commercial jet aircraft	A319, A320, A321	A320: length – 37.6 m; weight –73.5 t; maximum speed – 890 km/h; number of passengers – 320; flight interval – 5500 km.
Boeing 707	Large commercial jet aircraft	B707	B707: length – 37.6 м; weight –151.3 t; maximum speed – 890 km/h; number of passengers – 189 (economy); flight interval – 6000 km; engines: P&WJT.
Boeing 737	Large commercial jet aircraft	B737 (EFs similar for B737-300/400/500)	B737: length – 31 m, weight – 60 t, maximum speed – 910 km/h, number of passengers – 132, flight interval – 3400 km.
Boeing 747	Large commercial jet aircraft	B747 (EFs similar for B-747/400 and 281F)	
Boeing 757	Large commercial jet aircraft	B757 (EFs similar for B757/4300)	
Fokker 70 and Fokker 100	Regional jet aircraft	Fokker 70 and Fokker 100	Fokker 100: length 35 m, weight – 45 t, number of passengers – 109, flight interval – 2390 km.
McDonnell Douglas MD-80	Aircraft with medium haul	MD-81, MD-82, MD-83 (EFs similar for MD-80)	MD-82: length 45 m, weight -67 t, maximum speed – 925 km/h, number of passengers – 135/155/172, flight interval – 3100 km, engines: 2 x 9455 kgc.
Avro RJ-85	Jet aircraft with medium haul (similar to RJ-70, RJ-80, RJ-100, BAE 146-200)	RJ-85, RJ-100 (EFs similar for RJ-85)	RJ-85: length – 26 m, weight – 44 t, maximum speed – 831 km/h, number of passengers – 85 or 100, flight interval – 2963 km, engines: 4 turbo-propelled jet engines.
Embraer 190	Aircraft family E-Jet, with 4 types (E170, E175, E190, E195)	E190	E190: length 36 m, weight – 50.3 t, maximum speed – 890 km/h, number of passengers – 98/106, flight interval – 2963 km, engines: 2 turbo-propelled jet engines.
Embraer 170	Regional aircraft, the smallest type of E-Jet class, extended name E175	E170	E170: length 29.9 m, weight – 21.1 t, maximum speed – 890 km/h, number of passengers – 70/110, flight interval – 2963 km, engines: 2 turbo-propelled jet engines.
BAC-111	Large commercial jet aircraft for regional lines	Rombac-561 Rc	BAC-111: length 21 m, weight – 47.4 t, maximum speed – 850 km/h, number of passengers – 119, flight interval – 2780 km.
Bombardier CRJ-100/200	Jet aircraft for regional lines	CRJ	CRJ-100/200: length – 26.8 m, weight – 21 t, maximum speed – 860 km/h, number of passengers – 50, flight interval – 1800/2500/3150 km, engines: 2 x 4180 kgc.
A-300-600	Large commercial jet aircraft for medium and long haul	A-300-600	French aircraft A-300-600: length – 54,08 m, 2 engines Pratt & Whitney JT9D-7R4H1 or General Electric2 (turbofan engines 249-273,6 kgc, Pratt & Whitney JT9D-7R4H1, PW 4156, General Electric CF6-80-C2A1 or CF6-80-C2A5), number of passengers – 361, flight interval – 7000 km maximum speed – 890 km / h, cruise speed – 875 km / h. Until 2005, world airlines used 407 Airbus A300 aircraft of all models. In 2015, these have been decommissioned by the largest airline companies in the world and Europe and have been replaced by a more recent Airbus A330 model
Medium turbo-propelled aircraft			
Saab-340	Jet aircraft for regional lines with short haul	Saab-340 (SF-340) (EFs similar for DHC8-100)	Saab-340 (SF-340): length - 19 m, weight – 13 t, maximum speed – 525 km/h, number of passengers – 37, flight interval – 1500 km, engines: 2 x 1870 shp.
Saab-2000	Turbo-propelled aircraft for regional lines	Saab-2000 (SF-2000) (EFs similar for ATR-42)	Saab-2000 (SF-2000): length – 27 m, weight – 23 t, maximum speed – 560 km/h, number of passengers – 50, flight interval – 2300 km, engines: 2 x 4155 shp.
ATR-42 (ATR-42-320, ATR-42-500)	Turbo-propelled aircraft for regional lines	L410 – Turbo-propelled aircraft for 20 passengers (EFs similar for ATR-42)	ATR-42: length – 22 m, weight –16,700 t, maximum speed – 860 km/h, number of passengers – 50, flight interval – 1950 km, engines: 2 x 2400 shp.
DHC8-100	Turbo-propelled aircraft produced in Canada with Pratt & Whitney engines	SA-227 (EFs similar for DHC8)	DHC8-100: length – 33 m, maximum speed – 650 km/h, number of passengers – 80, flight interval – 2430 km, engines: 2 x 1115 shp.
Beech King Air	Light turbo-propelled aircraft for private and corporate flights	X-32 Becas (EFs similar for Beech King Air)	Beech King Air: length – 12 m, weight - 6800 kg, maximum speed – 580 km/h, number of passengers – 7, flight interval – 2430 km, engines: 2 x 1050 shp. X-32 Becas: length – 6.5 m, weight – 450 kg, maximum speed – 168 km/h, number of passengers – 1, flight interval – 300-400 km, engines: 1 x 100 shp.
Light turbo-propelled aircraft			
Cessna 525/560	Light turbo-propelled jet aircraft	Falcon-2000EX Turbo-propelled jet aircraft for 10-19 passengers (engines 2 x TRDD Pratt & Whitney Canada) (EFs similar for Cessna 525/560); Learjet-35 aircraft for 8 passengers (engines - General Electric CJ610-8) (EFs similar for Cessna 525/560)	Cessna 525/560: length –13.26 m, weight – 5.3 t, maximum speed – 650 km/h, number of passengers – 5, flight interval – 300-400 km, engines: 2 x 9.77 кH.

Notes: Conversion factors for the engine power: 1kW=1.36 shp; 1 shp = 735 W (shp. metric); 1 kgc = 0.0098 кH; 1 shp = 75 kgc (www.covert-me.com). Since light and medium aircraft have very different characteristics, for these the 2006 IPCC Guidelines does not provide specific EFs; in that case, for these aircraft the representative EFs will be selected (ATR-42; DHC8-100; Beech Kipr Air). For light turbo-propelled aircraft, in case of missing EFs, emission factors characteristic for aircraft model Cesna 525/560 will be applied.

Emission factors used by default, available in the 2006 IPCC Guidelines, used to estimate GHG emissions from 'International Aviation' (Memo Items) (Table 3-167 and Table 3-168).

Table 3-167: Default EFs for CO_2, CH_4, N_2O and NO_x available in the 2006 IPCC Guidelines, used to estimate GHG emissions from 'International Aviation' (Memo Items)

Generic name of aircraft	Representative aircraft (according to the 2006 IPCC Guidelines, V.2, Ch. 3, Table 3.6.3, 3.6.9)	Consumption, t per LTO	Emission Factor							
			CO_2		CH_4		N_2O		NO_x	
			kg / LTO	kg / C	kg / LTO	kg / C	kg / LTO	kg / C	kg / LTO	kg / C
TU-154	TU-154B	2.23	7030	3150	11.9	0	0.2	0.1	14.33	9.1
TU-134	TU-134	0.93	2930	3150	1.8	0	0.1	0.1	8.68	8.5
YAK-40	YAK-42M	0.91	2880	3150	0.25	0	0.1	0.1	10.66	15.6
YAK-42	YAK-42M	0.91	2880	3150	0.25	0	0.1	0.1	10.66	15.6
IL-18		2.31	7300	3150	7.4	0	0.2	0.1	31.64	15.7
IL-76		2.31	7300	3150	7.4	0	0.2	0.1	31.64	15.7
AN-12 - AN-74	YAK-42M	0.91	2880	3150	0.25	0	0.1	0.1	10.66	15.6
A319	A319	0.73	2310	3150	0.06	0	0.1	0.1	8.73	11.6
A320	A320	0.77	2440	3150	0.06	0	0.1	0.1	9.01	12.9
A321	A321	0.96	3020	3150	0.14	0	0.1	0.1	16.72	16.1
B707	B707	1.86	5890	3150	9.75	0	0.2	0.1	10.96	5.9
B737	B737/300/400/500	0.78	2480	3150	0.08	0	0.1	0.1	7.19	11
B739	B737/800/900	0.8	2780	3150	0.07	0	0.1	0.1	12.3	14
B747	B747/400 and 281F	3.24	10240	3150	0.22	0	0.3	0.1	42.88	12.4
B747	B747/200	3.6	11370	3150	1.82	0	0.4	0.1	49.52	12.8
B757	B-757/300	1.46	4630	3150	0.01	0	0.1	0.1	17.85	9.8
L-410	DHC-8-400	0.2	640	3150	0	0	0.02	0.1	1.51	12.8
MD-83, MD-81, MD-82	MD-80	1.01	3180	3150	0.19	0	0.1	0.1	11.97	12.4
RJ-85, RJ-70, RJ-100	RJ-RJ85	0.6	1910	3150	0.13	0	0.1	0.1	4.34	15.6
BAE-146	BAE-146	0.57	1800	3150	0.14	0	0.1	0.1	4.07	8.4
E-120ER	ERJ-145	0.31	990	3150	0.06	0	0.03	0.1	2.69	7.9
E145, E135	E145	0.31	990	3150	0.06	0	0.03	0.1	2.69	7.9
Fokker-70	Fokker 100/70/28	0.76	2390	3150	0.14	0	0.1	0.1	5.75	8.4
Fokker-100	Fokker 100/70/28	0.76	2390	3150	0.14	0	0.1	0.1	5.75	8.4
CRJ-2	CRJ-100ER	0.33	1060	3150	0.06	0	0.03	0.1	2.27	8
ATR-42	ATR-42	0.2	620	3150	0.03	0	0.02	0.1	1.82	14.2
SF-340B	DHC8-100	0.2	640	3150	0	0	0.02	0.1	1.51	12.8
SF-2000	ATR-42	0.2	620	3150	0.03	0	0.02	0.1	1.82	14.2
DHC-8	DHC-8-400	0.2	640	3150	0	0	0.02	0.1	1.51	12.8
E190	E145	0.31	990	3150	0.06	0	0.03	0.1	2.69	7.9
HS-25	Cessna-525/500	0.34	1070	3150	0.33	0	0.03	0.1	0.74	7.2
Learjet-35	Cessna 525/500	0.34	1070	3150	0.33	0	0.03	0.1	0.74	7.2
Rom Bac 561R	BAC111	0.8	2520	3150	0.15	0	0.10	0.1	7.40	12
SA-227	DHC-8-400	0.2	640	3150	0.00	0	0.02	0.1	1.51	12.8
Falcon 2000EX	Cessna 525/500	0.34	1070	3150	0.33	0	0.03	0.1	0.74	7.2
X32-912 Becas	Beech King Air	0.07	230	3150	0.06	0	0.01	0.1	0.3	8.5
CRJ	CRJ-100ER	0.33	1060	3150	0.06	0	0.03	0.1	2.27	8
A-300-600	A-300	1.72	5450	3150	0.12	0	0.2	0.1	25.86	14.8

Table 3-168: Default EFs for CO, NMVOC and SO_2 available in the 2006 IPCC Guidelines, used to estimate GHG emissions from 'International Aviation' (Memo Items)

Generic name of aircraft	Representative aircraft (according to the 2006 IPCC Guidelines, V.2, Ch. 3, Table 3.6.3, 3.6.9)	Consumption, t per LTO	Emission Factor					
			CO		NMVOC		SO_x	
			kg / LTO	kg / C	kg / LTO	kg / C	kg / LTO	kg / C
TU-154	TY-154B	2.23	143.05	5	107.13	2.7	2.22	1
TU-134	TY-134	0.93	27.98	5	16.19	2.7	0.93	1
YAK-40	YAK-42M	0.91	10.22	5	2.27	2.7	0.91	1
YAK-42	YAK-42M	0.91	10.22	5	2.27	2.7	0.91	1
IL-18		2.31	103.33	5	66.56	2.7	2.31	1
IL-76		2.31	103.33	5	66.56	2.7	2.31	1
AN-12 - AN-74	YAK-42M	0.91	10.22	5	2.27	2.7	0.91	1
A319	A-319	0.73	6.35	5	0.54	2.7	0.73	1
A320	A-320	0.77	6.19	5	0.51	2.7	0.77	1
A321	A-321	0.96	7.55	5	1.27	2.7	0.96	1
B707	B-707	1.86	92.37	5	87.81	2.7	1.86	1

Generic name of aircraft	Representative aircraft (according to the 2006 IPCC Guidelines, V.2, Ch. 3, Table 3.6.3, 3.6.9)	Consumption, t per LTO	Emission Factor					
			CO		NMVOC		SO_x	
			kg / LTO	kg / C	kg / LTO	kg / C	kg / LTO	kg / C
B737	B737/300/400/500	0.78	13.03	5	0.75	2.7	0.78	1
B739	B737/800/900	0.8	7.07	5	0.65	2.7	0.88	1
B747	B747/400 and 281F	3.24	26.72	5	2.02	2.7	3.24	1
B747	B747/200	3.6	79.78	5	16.41	2.7	3.6	1
B757	B757/300	1.46	11.62	5	0.1	2.7	1.46	1
L-410	DHC-8-400	0.2	2.24	5	0	2.7	0.2	1
MD-83, MD-81,MD-82	MD-80	1.01	6.46	5	1.69	2.7	1.01	1
RJ-85,RJ-70,RJ-100	RJ-RJ85	0.6	11.21	5	1.21	2.7	0.6	1
BAE-146	BAE-146	0.57	11.18	5	1.27	2.7	0.57	1
E120ER	E145	0.31	6.18	5	0.5	2.7	0.31	1
E145, E135	E145	0.31	6.18	5	0.5	2.7	0.31	1
Fokker-70	Fokker100/70/28	0.76	13.84	5	1.29	2.7	0.76	1
Fokker-100	Fokker100/70/28	0.76	13.84	5	1.29	2.7	0.76	1
CRJ-2	CRJ-100ER	0.33	6.7	5	0.56	2.7	0.33	1
ATR-42	ATR-42	0.2	2.33	5	0.26	2.7	0.2	1
SF-340B	DHC8-100	0.2	2.24	5	0	2.7	0.2	1
SF-2000	ATR-42	0.2	2.33	5	0.26	2.7	0.2	1
DHC-8	DHC-8-400	0.2	2.24	5	0	2.7	0.2	1
E190	E145	0.31	6.18	5	0.5	2.7	0.31	1
HS-25	Cessna-525/500	0.34	34.07	5	3.01	2.7	0.34	1
Learjet-35	Cessna 525/500	0.34	34.07	5	3.01	2.7	0.34	1
Rom Bac 561R	BAC111	0.8	13.07	5	1.36	2.7	0.8	1
SA-227	DHC-8-400	0.2	2.24	5	0	2.7	0.2	1
Falcon 2000EX	Cessna 525/500	0.34	34.07	5	3.01	2.7	0.34	1
X32-912 Becas	Beech King Air	0.07	2.97	5	0.58	2.7	0.07	1
CRJ	CRJ-100ER	0.33	6.7	5	0.56	2.7	0.33	1
A300-600	A300	1.72	14.8	5	1.12	2.7	1.72	1

In the RM, large commercial jet aircraft produced in CIS countries were less exploited for the period 2005-2019, compared to 1995-2004. Of the contrary, foreign produced aircraft were distinctly more intensely used for the operation of international flights between 2005 and 2019 (Table 3-169 and Table 3-170). It is also worth mentioning that during the reference period, the fleet of aircraft used in the Republic of Moldova for international air transportation has essentially changed its structure.

Table 3-169: Number of international flights operated by aircraft for the period 1995-2005 from the Republic of Moldova

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AN-2											1
AN-12			23	9	13	15	7	25	27	197	111
AN-24	729	929	950	1037	755	976	749	562	124	3241	2811
AN-26	3			12	7	570	182	1	6	243	861
AN-28					1	6	6		3	2	3
AN-32				55	95	964	968	850	250	1131	1038
AN-72	23	15	19	17	21	49	53	24	28	27	87
AN-74	31	7	5	11	7	4	1	2	1	2	1
Il-18	15	23	23	45	71	62	18			10	98
Il-76	22	23		20	28	20		7	8	2	5
Mi-8						688	1300	3294	5375	3906	3375
Mi-26											4
TU134	1001	1395	1261	1299	1325	1268	1329	1024	887	403	15
TU154	287	114	189	53	23	26	25	16	5	12	14
YAK-40	169	561	779	662	770	655	283	289	304	230	94
YAK-42	371	342	527	642	531	499	367	668	638	283	518
Other	158	176	366	137	104	102	91	178	142	255	475
Total flights with aircrafts of CIS production	2809	3585	4142	3999	3751	5904	5379	6940	7798	9944	9511

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
A320					15				142	924	1256
ATR-42			58	131	141	141	151	145	159	198	199
BAE-146										115	253
B-MD-83										16	10
B707	9	7									1
B737		27	84	128	110	16	35	102	201	341	311
B747								2			
B757				7				2	2	5	1
CRJ-2							96	103	218	350	356
CRJ					36	100					
DHC-8			45								
E120							667	627	495	842	821
E145							323	208	1	2	2
Fokker-70					23						7
HS-25			9								
L410	11			56	45	19		7	7	37	3
Learjet-35			8								
RJ-70						7	10	22	5	2	
RJ-85											36
RJ-100					2	25	118	51	19	10	
RomBac-561RC								39			
SAAB-340			372	550	505	1259	1467	1024	1671	369	132
SAAB-2000									269	970	2238
Total flights with aircraft produced in other countries	**20**	**34**	**576**	**872**	**877**	**1567**	**2867**	**2332**	**3189**	**4181**	**5626**
Total flights	**2829**	**3619**	**4718**	**4871**	**4628**	**7471**	**8246**	**9272**	**10987**	**14125**	**15137**

Table 3-170: Number of international flights operated by aircraft for the period 2006-2019 from the Republic of Moldova

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AN-2	144	126	145	227	202									
AN-12	194	149	1											
AN-24	2782	1573	5											
AN-26	3085	1690	264	1175	863	463	652	689	302	765	383	216	166	285
AN-32	672	379	47											
AN-72	68	198												
Il-18	155	12	1	31	78	247	128	6	0					
Il-76							52	377	216	577	622	567	86	
Ka-32	42	283	126	126	139	300	284	309	268	171	193	144	287	303
Mi-2						1297	1022			1249	796		675	923
Mi-8	3088	3974	5032	4321	6720	2315	1264	3462	4133	2661	3021	2413	1921	7007
Mi-17						320	493	1129	969	376	153	34		
Mi-26	3	64	84	84										
TU134	65	236	52	1										
YAK-18		2	16	88	5									
YAK-40	52	3	1											
YAK-42								3	3	161				
Total flights with aircrafts of CIS production	**10350**	**8689**	**5774**	**6053**	**8007**	**4942**	**3895**	**5975**	**5891**	**5960**	**5168**	**2705**	**2374**	**7595**
A319										445	965	1620	3850	4023
A320	1679	1340	1517	1935	1779	1524	1399	1041.5	1239	1955	2701	3574	1615	3913
A321	2									640	473	63	34	1300
B-MD-81		9	134											
B-MD-82		196	182		11	20	35	3.50	157.5				36	22
B-MD-83		28	54	31		6								
B707							58							
B737		61	1				6	22	6	104	40			
B-737-800/900												92	24	15
B-737-300/400/500												53	847	762

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
B739									1					
B747										361	614			
B747-400												1447		299
B747-200												80	2783	1461
BAE-146												2		
DHC-8		11												
EMB-120	525	600	614	622	555	604	767	779	828	131				
EMB-135								0	16	306				
EMB-190					458	711	744	1500.5	1559	1654	1839	2483	4023	1667
Fokker-70	455	85	10	12	13	3,5	3							
Fokker-100	58			5	4	26	25	8	2					
L410	1	2				117	258	144,5						
Learjet-35						415	399	425	215	149				
SAAB-340	21	2				12								
SAAB-2000	1934	1469	1442	1269	969	486	48							
SA-227								95						
Falcon 2000EX								350	298					
X32-912 BECAS										228				
F28F Enstrom										21				
A-300-600											251	5	38	229
Total flights with aircraft produced in other countries	2994	2402	2436	1939	2010	2400	2337	2955	4016	5930	6890	9419	16250	13691
Total flights with aircraft produced in other countries (except domestic flights)	2994	2402	2436	1939	2010	2400	2337	2221	2745	5395	6690	9357	16240	10370
Total flights	**13175**	**10946**	**8035**	**7657**	**9768**	**5521**	**5198**	**9322**	**10195**	**10882**	**11449**	**12691**	**18710**	**21286**

Source: Civil Aviation State Administration of the RM through Official Letters No. 3978 of 02.10.2006, No. 1328 of 13.09.2011; Civil Aeronautical Authority of the RM through Official Letters No. 474 of 13.02.2014, No. 366 of 02.03.2015, No. 1156 of 27.05.2016, No. 4040 of 28.12.2017 and No. 1871 of 18.07.2020.

Domestic flights in the current cycle are excluded from the table above as there had been a double counting of fuel for domestic aviation (from 2001 to 2016) in category 1A3a and in this category. The flights of all aircraft were taken into consideration when estimating emissions from international aviation. Domestic aviation fuel consumption is extremely low (in 2019 – 92.7 tons), and double-track records led to a marginal increase in total emissions. But according to the 2006 IPCC Guidelines, flights need to be departmentalised. Table 3-171 presents the information associated with the number of domestic aircraft flights

Table 3-171: Number of domestic flights operate for the period 2001-2019 in the RM

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Mi-8	8	3	29	41	31	169	145	175	335	249
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Ka-32	204									
Mi-2	1297	1022	822	2338	1008	609		675	923	
Mi-8							102			
Mi-17	320	12								
A-319								1	8	
A-320								4	1	
A-321									1	
EMB-190							7	5	3	
Falcon 2000EX			350	298	535	200				
Robinson R44				19			55			
X32-912 BECAS			384	865						
F28F Enstrom				89						
Cessna-150F									2215	
Cessna C-150M									1093	

Source: Civil Aviation State Administration of the RM through Official Letters No. 3978 of 02.10.2006 and No. 1328 of 13.09.2011; Civil Aeronautical Authority of the RM through Official Letters No. 474 of 13.02.2014, No. 366 of 02.03.2015, No. 1156 of 27.05.2016, No. 4040 of 28.12.2017, No. 1871 of 18.07.2020.

AD related to the consumption of jet kerosene for international aviation was provided by the Civil Aeronautical Authority (CAA) of the RM. To be noted that there were revealed certain discrepancies regarding data on jet kerosene consumption for international aviation included in the Energy Balances of the Republic of Moldova for years 1990 and 1993-2019 and data provided by the CAA (for 2003-2019 there being a significant difference) (Table 3-172). The international expert who carried out the quality expertise of the national inventory in the previous inventory cycle, recommended that the emission calculations be performed using data available in the EBs of the RM on kerosene consumption for the operation of international aviation (the recommendation has been implemented).

Table 3-172: Jet kerosene consumption for the operation of international aviation in the RM between 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Data available in the EBs	69.00	N/A	N/A	19.70	11.00	11.00	18.00	21.00	17.00	20.00
Data provided by CAA	68.69	73.85	30.54	19.70	12.00	13.30	20.90	24.00	23.00	23.00
Difference, %	-0.4	N/A	N/A	0.0	9.1	20.9	16.1	14.3	35.3	15.0
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Data available in the EBs	20.00	16.00	19.00	11.00	11.00	12.00	12.00	14.00	14.00	14.00
Data provided by CAA	21.00	19.62	19.67	22.22	21.33	21.44	24.07	25.33	28.32	26.22
Difference, %	5.0	22.6	3.5	102.0	93.9	78.6	100.6	80.9	102.3	87.3
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Data available in the EBs	13.00	13.00	15.00	13.00	17.00	18.00	32.00	47.00	54.00	48.00
Data provided by CAA	26.21	30.26	34.16	41.38	49.01	69.30	99.50	149.0	217.1	177.8
Difference, %	101.7	132.8	127.7	218.3	188.3	285.0	210.9	216.9	302.1	270.3

Source: EBs of the RM for years 1990 and 1993-2019; Civil Aviation State Administration of the RM through Official Letters No. 3978 of 02.10.2006 and No. 1328 of 13.09.2011; Civil Aeronautical Authority through Official Letters No. 474 of 13.02.2014, No. 366 of 02.03.2015, No. 1156 of 27.05.2016, No. 4040 of 28.12.2017 and No. 1871 of 18.07.2020.

3.8.3. Uncertainties Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by source category 'International Aviation' (Memo Items) and quality of AD available.

Uncertainties associated with EFs used to estimate CO_2 emissions are around 5 per cent, those pertaining to EFs used to estimate CH_4 emissions – circa 10 per cent, while those related to EFs used to estimate N_2O emissions – circa 100 per cent. Uncertainties associated with the AD regarding fuel consumption for international air transportation – circa 5 per cent. Combined uncertainties from the 'International Aviation' sector were estimated at about 7.1 per cent. Uncertainties in the trend of total direct GHG emissions from the 'International Aviation' sector were estimated at about 5.5 per cent (Annex 5-3.1).

In order to ensure stability of obtained results over time, the same methodology was used for the entire study period in accordance with sustainable practices applied to the inventory of GHG emissions.

3.8.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for 'International Aviation' source category, following a Tier 1 approach. The AD and methods used for estimating GHG emissions under this source category were documented and archived both in hard copies and electronically. In order to identify the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included in the 2006 IPCC Guidelines, GHG emissions originating from the 'International Aviation' source category were estimated based on AD and EF available in the official sources of reference.

3.8.5. Recalculations

In the current inventory cycle, a number of measures have been taken to improve the quality of the national GHG inventory and this implied to recalculate GHG emissions from 'International Aviation' source category. The main causes of these recalculations are, as follows:

- The total amount of kerosene was used as presented in the Energy Balances of the Republic of Moldova (previously, AD provided by the CAA of the RM was used);
- Domestic flights were reallocated to category 1A3a 'Civil Aviation' ('Domestic aviation'), in order to avoid double counting (as happened in the previous inventory cycle);
- AD for the years 1990-1994 was reconstituted using the partial coincidence method (to obtain the complete set of values following the Tier 2 approach).

Compared to the results recorded in the BUR2 of the RM under the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in a downward trend in direct GHG emissions for 1990-1991, 1993-1994 and 1996-2016 (except years 1992 and 1995) (Table 3-173).

Table 3-173: Recalculation results of GHG emissions for the period 1990-2016, included into the BUR2 of the RM under the UNFCCC ('International Aviation'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	218.9336	235.3800	97.3393	62.7892	38.2473	42.4672	66.6146	76.4994	73.2888	73.2819
BUR3	195.7347	149.1177	109.8132	55.8837	31.2041	42.5212	57.3932	66.9600	54.2100	63.7425
Difference, %	-10.6	-36.7	12.8	-11.0	-18.4	0.1	-13.8	-12.5	-26.0	-13.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	66.9765	62.5861	62.7602	70.8808	68.0797	68.4023	76.8068	80.7471	90.1750	83.4996
BUR3	63.7967	51.0751	60.6297	35.2028	35.2315	38.3980	38.4085	44.7135	44.6408	44.6466
Difference, %	-4.8	-18.4	-3.4	-50.3	-48.3	-43.9	-50.0	-44.6	-50.5	-46.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	83.5573	96.4069	108.7812	131.8213	156.0913	220.6372	316.1867			
BUR3	41.5312	41.4700	47.8362	41.5852	54.2988	57.4930	102.1063	149.8553	172.2996	153.1717
Difference, %	-50.3	-57.0	-56.0	-68.5	-65.2	-73.9	-67.7			

Between 2017 and 2019, direct GHG emissions from source category 'International Aviation' category were estimated for the first time. In the period 1990-2019, direct GHG emissions from that category decreased by about 21.7 per cent.

3.8.6. Planned Improvements

Within source category 'International Aviation' (Memo Items), potential improvements could be achieved once a higher methodology is used (for example, a Tier 3 approach available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), which considers the real values of emissions for each type of aircraft depending on the flight distance.

3.9. CO_2 Emissions from Biomass (Memo Items)

3.9.1. Source Category Description

Under the 'Memo Items' there are also monitored the 'CO_2 emissions from Biomass'. In conformity with recommendations provided in the 2006 IPCC Guidelines, GHG emissions from biomass shall be estimated under each individual source category of Sector 1 'Energy': non-CO_2 emissions shall be reported under the respective source category, while CO_2 emissions shall be reported separately, under 'Memo Items', not being included into the national total.

In comparison with the reference year level (1990), by 2019, the CO_2 emissions from source category 'CO_2 Emissions from Biomass' increased by circa 13 times (Table 3-174, Figure 3-46).

Table 3-174: CO_2 Emissions from Biomass in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 Emissions from Biomass	232.8	201.2	169.6	143.2	157.5	230.0	294.0	291.1	269.0	266.1
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2 Emissions from Biomass	272.4	282.2	322.1	373.6	307.7	307.4	361.4	304.7	352.5	362.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CO_2 Emissions from Biomass	341.0	384.6	403.4	429.3	1314.5	1428.4	1601.0	2122.7	3568.0	2963.2

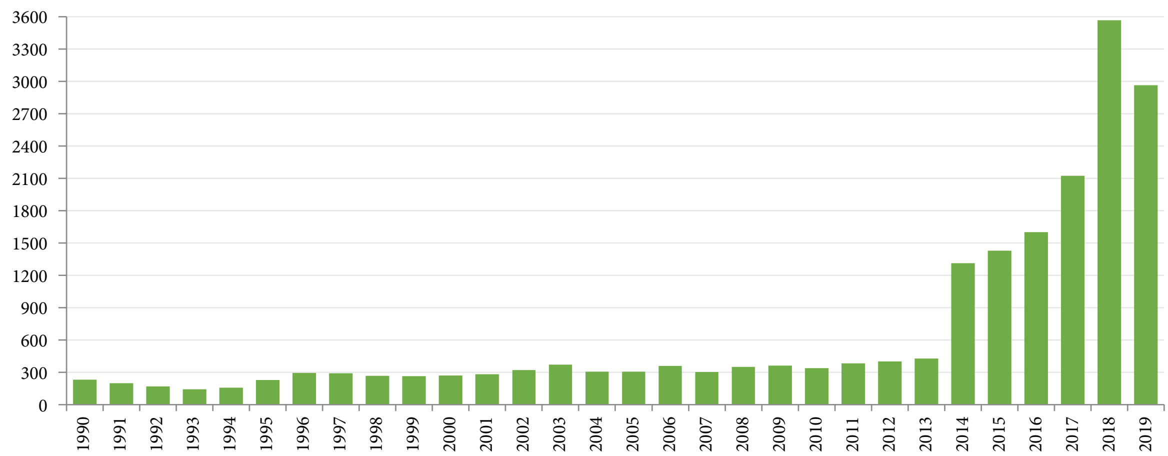

Figure 3-31: CO_2 Emissions from Biomass in the RM for the period 1990-2019, kt

3.9.2. Methodological Issues, Emission Factors and Data Sources

CO_2 emissions from biomass were estimated following a Tier 1 methodological approach, available in the 2006 IPCC Guidelines.

The basic equations used to estimate CO_2 emissions from biomass are:

$$CO_2 \text{ emissions (kt)} = \text{amount of biomass (TJ)} \bullet CO_2 \text{ emission factor (kg /TJ)} \bullet 10^{(-6)},$$

$$CO_2 \text{ emissions (fuel wood), kt} = \text{fuel consumption (thousand m}^3 \text{ comp.)} \bullet \text{conversion factor in natural units (kt/thousand m}^3 \text{ comp.)} \bullet \text{conversion factor in energy units (TJ/kt)} \bullet CO_2 \text{ emission factor (kg/TJ)} \bullet 10^{(-6)}$$

AD for the RBDR is taken from the EBs of the RM in energy units (TJ). For the LBDR, regarding source category 14Ab 'Residential', AD is available in natural units (thousand m^3 comp.), thereby conversion into energy units has been made by applying conversion factors from Table 3-175.

Table 3-175: Conversion factors from natural units into energy units

Fuel	Caloric Value	UM
Fuel Wood, thousand m^3 comp.	0.73	mii tone/mii m^3 comp.
Fuel Wood, kt	12.32	TJ/mii tone

EFs used by default, available in Tables 2.2-2.5, Chapter 2, Volume 2 of the 2006 IPCC Guidelines (Table 3-176 and 3-177).

Table 3-176: CO_2 emission factors (kg/TJ) by type of biomass for categories 1A1, 1A2, 1A4a, 1A4b, 1A4c and 1A5

	Fuel Wood/ Wood Waste	Charcoal	Agricultural Residues	Pellets and Briquettes / Other types of Biomass	Biogas
CO_2	112,000	112,000	100,000	100,000	54,600

Source: 2006 IPCC Guidelines, Volume 2, Chapter 2, Table 2.2-2.5, pages 17, 19, 21 and 23.

Table 3-177: CH_4 and N_2O emission factors (kg/TJ) by type of biomass for categories 1A1, 1A2, 1A4a, 1A4b, 1A4ci and 1A5

Category		Fuel Wood	Wood Waste	Agricultural Residues	Charcoal	Pellets and Briquettes	Biogas	Other types of solid Biomass
1A1,1A2,1A5	CH_4	30	30	30	200	30	1	30
	N_2O	4	4	4	4	4	0.1	4
1A4a,1A4b, 1A4c	CH_4	300	300	300	200	300	5	300
	N_2O	4	4	4	1	4	0.1	4

Source: 2006 IPCC Guidelines, Volume 2, Chapter 2, Table 2.2-2.5, pages 17, 19, 21 and 23.

Emission factors for non-CO_2 gases from biomass consumption are taken from the EMEP/EEA Guidebook (2019) (Table 3-178).

Table 3-178: Emission factors utilised in the estimation of indirect GHG emissions from biomass consumption by source category within Sector 1 'Energy', kg/TJ

Category	Fuel	NO_x	CO	NMVOC	SO_x
1A1	biomass	81	90	7.31	10.8
	biogas	89	39	2.6	0.281
1A2, 1A4a, 1A4ci, 1A5	biomass	91	570	300	11
	biogas	74	29	23	0.67
1A4b	biomass	50	4000	600	11
	biogas	51	26	1.9	0.3

Source: for NO_x, CO, NMVOC, SO_x emissions –EMEP/EEA Guidebook 2019, category 1A1 - Table 3-4, 3-7; category 1.A.2 - Table 3-3, 3-5; categories 1.A.4.a.i, 1.A.4.c.i and 1.A.5.a - Table 3-8 and 3-10; category 1.A.4.b.i - Table 3-4 and 3-6.

In the sectoral statistical publications of the ATULBD, information associated with biomass consumption – fuel wood in the residential sector, is available in natural units (thousand m^3 comp.), but only for the period 2009-2019 (Table 3-179).

Table 3-179: Fuel wood consumption on the LBDR within source category 1A4b 'Residential' for the period 2009-2019

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Fuel Wood, thousand m^3 comp.	10.2	10.8	10.0	5.4	4.7	7.7	10.9	6.9	5.4	4.6	8.2
Fuel Wood, TJ	92	97	90	48	42	69	98	62	48	41	74

For the territory on the RBDR, with reference to the types of biomass included in the national GHG inventory, in the EBs for the years 1990 and 1993-2002 there is information on the consumption of fuel wood and wood waste; in the EBs for the years 2003-2012 there is information on the consumption of fuel wool, wood waste and agricultural residues (Table 3-180), and AD in the EBs for the years 2003-2019 is available on the consumption of biogas, pellets and briquettes (Table 3-181). For a number of years there are also numerical values for 'Other types of Fuel'.

Table 3-180: Biomass consumption in the RM for the period 1990-2003, TJ

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1A1a iii	Fuel Wood	9	8	7	6										
	Wood Waste	59	56	53	50	147	88		59	29	29	59	147		29
	Agricultural Residues							88						235	205
1A2	Fuel Wood	135	112	88	65		29	29	29						
	Wood Waste / Agricultural Residues	176	140	103	67	29									
1A4a	Fuel Wood	333	258	184	109	117	117	147	117	117	88	88	117	147	381
	Wood Waste / Agricultural Residues				6			29							146
	Other Primary Solid Biomass												29		
1A4b	Fuel Wood	1052	957	861	766	822	1526	1848	1907	1966	1848	1731	1555	1878	1964
	Wood Waste	234	205	176	147	205	205	323	293	176	323	499	587	499	440
	Agricultural Residues											29			117
	Other Primary Solid Biomass				29	29		29	117	29					
1A4c	Fuel Wood	36	27	18	9	29	29	29	29				29		29
	Wood Waste / Agricultural Residues				3										
	Other Primary Solid Biomass				29	29		29	117	29					
1A5	Fuel Wood	45	34	24	13	30	30	89	30	88	59	29	30	87	59
	Wood Waste / Agricultural Residues				12	1	30		30		29		29	29	
	Other Primary Solid Biomass							30	1					29	
1A	**Total, TJ**	**2079**	**1823**	**1567**	**1311**	**1438**	**2054**	**2670**	**2729**	**2434**	**2376**	**2435**	**2523**	**2904**	**3370**

Table 3-181: Biomass consumption in the RM for the period 2004-2019, TJ

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A1ai	Biogas										10	18	14	2	84	150	126
1A1aii	Biogas										29	79					
1A1aiii	Fuel Wood	3	3	2		1	1	2	1	1	37	29					
	Wood Waste	16	16	1	1	1	2	2	1	3	3	5					
	Agricultural Residues	226	226	214	239	373	435	514	399	226	229	321					
	Pellets and Briquettes														23	32	
	Biogas										7	99	387	359			
1A2	Fuel Wood	9	11	7	6	7	4	11	17	17	20	13	33	33	14	21	16
	Wood Waste	39	26	1	5	14	10	16	25	36	5	16	11	2	7	30	2
	Agricultural Residues								5	2	10		345	290	241	241	367
	Charcoal														1	1	16
	Pellets and Briquettes												62	83	145	144	
	Biogas												387	359	198	163	166
1A4a	Fuel Wood	242	210	254	247	268	240	209	219	244	185	232	220	237	226	235	216
	Wood Waste	78	31	26	18	15	36	36	17	18	35	26	14	13	16	16	11
	Agricultural Residues	14	5	2	14	28	300	41	31	88	68	118	50	58	130	77	60
	Charcoal										3	21	16	13	11	32	44
	Pellets and Briquettes											94	83		112	150	127
1A4b	Fuel Wood	1673	1704	2123	1716	1942	1767	1808	2134	2543	2880	10425	11439	13131	17474	27599	23098
	Wood Waste	320	294	340	271	312	395	237	137	273	164	124	52	89	248	2051	1810
	Agricultural Residues	130	214	245	197	212		66	419	96	134	105	135	53	46	1030	370
	Charcoal									17	11		2	4	2	5	9
	Pellets and Briquettes											76	109	62	109	142	169
	Fuel Wood						92	97	90	48	42	69	98	62	48	41	74
1A4c	Fuel Wood	8	12	18	12	10	17	25	15	31	28	37	27	42	44	41	38
	Wood Waste		3		1		2				1	2					
	Agricultural Residues	2	7	12	2	1	2	6		2	3	5	1	2		3	2
	Charcoal															4	
	Pellets and Briquettes												1	4	5	4	4

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1A5	Fuel Wood	24	24	27	26	23	9	28	12								
	Wood Waste	3	7	4	10	3		8	2	1							
	Agricultural Residues			2	1	1		7	2								
1A	Total, TJ	2787	2793	3278	2769	3213	3312	3113	3526	3646	3904	11914	13099	14539	19184	32212	26725

3.9.3. Uncertainties Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate CO_2 emissions from biomass, and quality of available activity data. Uncertainties associated with EFs represent circa 80 per cent while those related to AD – 20 per cent. Combined uncertainties were estimated at circa 82.5 per cent. In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

3.9.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for 'CO_2 emissions from biomass' (Memo Items), following a Tier 1 approach. The specific quality control and control procedures applied in the calculation process for category 'CO_2 Emissions from Biomass' included:

- Verification of AD collection procedures;
- Implementation of error minimization procedures for manual entry of AD, with all the spreadsheets provided with the initial sources of activity data in tabular format;
- In the calculation files the EFs are specified in tabular formats for each category, the import of the respective values into calculation formulas is ensured by automatic connections;
- The consistency of the calculations is also ensured by verifying the correctness of applying conversion factors of natural units to energy units for all categories and the entire range of years covered by the inventory;
- Verification if the same method is used for the entire range of years covered by the inventory;
- In the case of recalculations, their need is explained;
- Verifying if GHG emissions calculations have been made for all years and for all types of fuels mentioned in the Energy Balances of the RM;
- Verifying maintenance and completion of the national inventory of GHG emissions archive.

Following the recommendations included into the 2006 IPCC Guidelines, the 'CO_2 emissions from biomass' (Memo Items) were estimated based on AD and EFs from official sources of reference.

3.9.5. Recalculations

In the current inventory cycle, a series of measures have been implemented in order to improve the quality of the national inventory, as a result of which it is necessary to recalculate CO_2 emissions from biomass consumption. The main causes of these recalculations are as follows: (1) fuel consumption (fuel wood, wood waste, agricultural residues, biogas, pellets and briquettes, charcoal) has been reallocated from source category 1A1 to source category 1A2; (2) AD for 2015 and 2016 has been corrected.

Compared to the results recorded in BUR2 of the RM under the UNFCCC (2019), the changes undertaken in the current inventory cycle have resulted in an insignificant decrease in CO_2 emissions from biomass consumption in 2015, and a minimum increase of 2.5 per cent in 2016, respectively (Table 3-182). CO_2 emissions from biomass consumption for the years 2017-2019 were estimated for the first time. Between 1990 and 2019, the respective emissions increased about 13 times. The significant increase in CO_2 emissions from biomass consumption in recent years is caused, on the one hand, by a stricter documentation of biomass consumption and, on the other hand, by the application of a more efficient method of recording energy consumption in households, but only for the period 2015-2019.

Table 3-182: Recalculation results of GHG emissions for the period 1990-2019, included in the BUR2 of the RM under the UNFCCC (CO_2 Emissions from Biomass), kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	232.8093	201.2009	169.5924	143.2360	157.4600	230.0480	294.0280	291.1280	269.0120	266.1120
BUR3	232.8093	201.2009	169.5924	143.2360	157.4600	230.0480	294.0280	291.1280	269.0120	266.1120
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	272.3720	282.2280	322.0800	373.5760	307.6800	307.3920	361.4360	304.6560	352.4520	362.1000
BUR3	272.3720	282.2280	322.0800	373.5760	307.6800	307.3920	361.4360	304.6560	352.4520	362.1000
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	341.0480	384.6400	403.3840	429.2796	1,314.4896	1,439.5226	1,561.9690			
BUR3	341.0480	384.6400	403.3840	429.2796	1,314.4896	1,428.4386	1,600.9890	2,122.7228	3,567.9567	2,963.2154
Difference, %	0.0	0.0	0.0	0.0	0.0	-0.8	2.5			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR3 – Third Second Biennial Update Report of the RM under the UNFCCC.

3.9.6. Planned Improvements

Potential improvements within the 'CO_2 emissions from biomass' (Memo Items) could be achieved by collecting new available AD on fuel consumption on the territory of the LBDR and filling the existing gaps for certain years.

To be noted that beginning with 2015, the Energy Balances of the Republic of Moldova are published in a new format – according to the common framework for the production, transmission, assessment and dissemination of comparable statistics in the energy sector within the Energy Community, as established at the international level by (EC) Regulation No.1099/2008 of the European Parliament and the Council from October, 22, 2008 on energy statistics, with further amendments, while at the national level, by the Decision of the National Bureau of Statistics College No. 6/3 from December, 23 2014. In the Energy Balances for 2015/2016, the AD on biofuels consumption and waste in the residential sector (by population) were revised. The recalculation was carried out with the support of the Energy Community experts and the results were obtained within the 'Research on household energy consumption' developed by the NBS of the Republic of Moldova in 2015.

The significant increase of CO_2 emissions from biomass in recent years is due, on one hand, to a more strict evidence of biomass consumption, while on the other hand, to the use of a different method of recording the energy consumption in households, but only for 2014-2019 time series. Expanding this method for the remaining years (1990-2013) covered by the national inventory would allow for more substantial improvements within the category 'CO_2 emissions from biomass' (Memo Items).

3.10. Comparison of CO_2 Emissions Estimated by using Reference and Sectoral Approaches

In accordance with the recommendations provided in the 2006 IPCC Guidelines, CO_2 emissions calculated by using two distinct approaches: the reference approach (top-down) and the sectoral approach (bottom-up) were compared. It may be observed that the differences between the two methodological approaches do not exceed the allowable 2.0 per cent threshold (Table 3-183).

Table 3-183: Comparison of CO_2 emissions estimated by using reference (RA) and sectoral (SA) approaches in the Republic of Moldova for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RA	35,188.09	29,776.35	23,208.42	17,274.37	14,451.34	11,437.20	11,319.04	10,192.93	8,841.43	6,841.65
SA	35,400.87	29,938.46	23,327.80	17,335.12	14,485.26	11,471.12	11,374.55	10,257.69	8,893.85	6,903.33
Difference, %	0.6	0.5	0.5	0.4	0.2	0.3	0.5	0.6	0.6	0.9
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
RA	6,126.53	6,768.91	6,478.06	7,143.61	7,593.99	7,835.92	7,077.10	7,210.19	7,510.25	8,051.11
SA	6,188.20	6,818.25	6,536.65	7,177.54	7,627.91	7,872.93	7,114.10	7,253.36	7,553.43	8,094.28
Difference, %	1.0	0.7	0.9	0.5	0.4	0.5	0.5	0.6	0.6	0.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
RA	8,590.80	8,891.28	8,468.76	8,190.80	8,046.89	8,356.89	8,406.34	7,832.30	8,258.65	8,428.32
SA	8,630.89	8,931.36	8,515.02	8,230.89	8,099.31	8,412.40	8,505.02	7,977.24	8,425.17	8,576.34
Difference, %	0.5	0.5	0.5	0.5	0.7	0.7	1.2	1.9	2.0	1.8

4. INDUSTRIAL PROCESSES AND PRODUCT USE

4.1. Overview

Sector 2 'Industrial Processes and Product Use' (IPPU) includes greenhouse gas emissions generated directly from non-energy industrial activities, inventoried using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019).

In the Republic of Moldova, the source categories covered by this sector are: 2A 'Mineral Industry' (*2A1 'Cement Production', 2A2 'Lime Production', 2A3 'Glass Production', 2A4 'Other Process Uses of Carbonates'[2A4a 'Ceramics', 2A4b 'Other Uses of Soda Ashes']),* 2B 'Chemical Industry' (*2B10 'Other' [Polyethylene, Acrylonitrile Butadiene Styrene Resins and Polystyrene Production]),* 2C 'Metal Production' (*2C1 'Iron and Steel Production'*), 2D 'Non-energy Products from Fuels and Solvent Use' (*2D1 'Lubricant Use', 2D2 'Paraffin Wax Use', 2D3 'Solvent Use' [domestic solvent use, road paving with asphalt, asphalt roofing, paint application, degreasing, dry cleaning, chemical products, printing, other solvent and product use (seed oil extraction, uses of glues and adhesives, preservation of wood, vehicle underseal treatment and vehicle dewaxing)], 2D4* 'Other' (*urea-based catalysts*), 2F 'Product uses as substitutes for ODS' (*2F1 'Refrigeration and Air Conditioning', 2F2 'Foam Blowing Agents', 2F3 'Fire Protection', 2F4 'Aerosols'*), 2G 'Other Products Manufacture and Use'(*2G1 'Electrical Equipment', 2G3 'N_2O from Product Uses' (medical applications), 2G4 'Other' (Use of Tobacco, Use of Shoes)* and 2H 'Other' (*2H2 'Food and Beverages Industry'*).

A brief overview, methodological issues and data sources, key categories, uncertainties assessment and times-series consistency, quality assurance and quality control, recalculations made and planned improvements are described for each source category in this sector.

4.1.1. Summary of Emission Trends

In 2019, Sector 2 'IPPU' accounted for circa 7.2 per cent of total national direct GHG emissions (without LULUCF), being a relevant source of GHG emissions in the country. This sector represented an important source of CO_2 national emissions (8.1 per cent of the national total) and F-gas emissions (HFC, PFC and SF_6).

Table 4-1: Direct GHG Emissions from Sector 2 'IPPU' within 1990-2019, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	1603.6767	1409.7794	821.5621	737.0521	556.2338	455.1469	414.5995	452.0431	375.0205	337.9064
N_2O	0.0197	0.0164	0.0149	0.0179	0.0149	0.0003	0.0006	0.0009	0.0015	0.0128
HFC	NO	NO	NO	NO	NO	1.0298	1.6593	2.3137	3.1372	4.0002
PFC	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	**1603.6964**	**1409.7958**	**821.5770**	**737.0699**	**556.2487**	**456.1769**	**416.2595**	**454.3577**	**378.1683**	**341.9290**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
CO_2	309.3065	311.7431	359.6162	384.9507	454.6376	548.7488	643.8927	890.8914	966.3539	461.4652
N_2O	0.0131	0.0131	0.0131	0.0131	0.0149	0.0182	0.0176	0.0000	0.0000	0.0000
HFC	5.1199	6.8681	9.1227	12.1632	16.0027	22.5106	33.2493	44.7889	57.3627	67.4807
PFC	NO	NO	NO	NO	NO	NO	0.0231	0.0231	0.0288	0.0288
SF_6	NO	NO	NO	0.0071	0.0071	0.0427	0.3088	0.4084	0.4988	0.5422
Total	**314.4396**	**318.6243**	**368.7520**	**397.1342**	**470.6623**	**571.3202**	**677.4915**	**936.1118**	**1024.2442**	**529.5169**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
CO_2	481.3565	574.0527	582.0682	623.2187	637.7956	607.8444	583.6350	593.1469	763.3854	760.7727
N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC	77.8936	90.1296	100.0227	108.3873	121.5640	153.8517	163.2067	182.4923	194.4750	229.9469
PFC	0.0403	0.0403	0.0403	0.0403	0.0403	0.0403	0.0403	0.0403	0.0403	0.0403
SF_6	0.6616	0.7043	0.7646	0.9651	1.0540	1.0542	1.0822	1.1116	1.3284	1.4306
Total	**559.9521**	**664.9270**	**682.8958**	**732.6114**	**760.4540**	**762.7907**	**747.9643**	**776.7911**	**959.2291**	**992.1906**

Abbreviations: NO – Not Occurring.

Between 1990 and 2019, the total GHG emissions originating from Sector 2 'IPPU' tended to decrease, by circa 38.1 per cent, from 1.6 Mt CO_2 equivalent in 1990 to 0.99 Mt CO_2 equivalent in 2019 (Table 4-1, Figure 4-1), in particular due to reduced industrial output, such as mineral products (for example, cement production decreased by 48.6 per cent; clinker production – by 46.8 per cent; lime production – by 89.5 per cent; glass production – by 25.6 per cent; bricks production – by 81.6 per cent; soda ash use – by 50.5 per cent), steel production – by 44.6 per cent, rolling mills production – by 36.0 per cent and non-energy products from fuels and solvent use (lubricants use decreased by 79.8 per cent, etc.

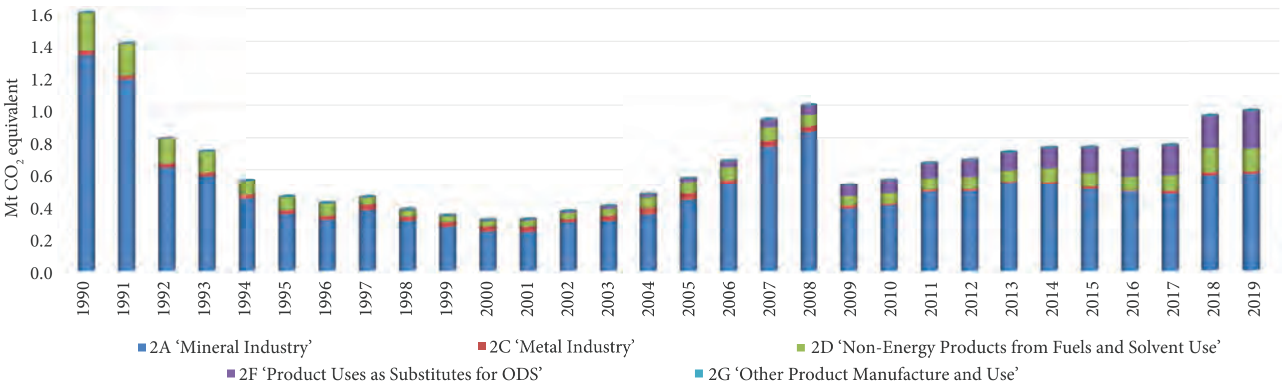

Figure 4-1: Total Direct GHG Emissions from Sector 2 ‘IPPU’ within 1990-2019.

In 1990, there were registered only CO_2 and N_2O emissions within this sector, whereas in 2019, the share in the total GHG emissions covered by Sector 2 ‘IPPU’ represented: CO_2 – 76.7 per cent, HFC – 23.2 per cent, PFC – 0.004 per cent and SF_6 – 0.144 per cent.

It should be noted that categories 2A ‘Mineral Industry’, 2D ‘Non-Energy Products from Fuels and Solvent Use’, and 2F ‘Product Uses as Substitutes for Ozone Depleting Substances’ (Table 4-2 and 4-3) represent major sources of direct GHG emissions under Sector 2 ‘IPPU’, with shares varying from a minimum of 60.5 per cent (2019) and a maxim of 84.3 per cent (1991), between a minimum of 6.5 per cent (2008) and a maximum of 18.8 per cent (1992), and a minimum of 0.2 per cent (1995) and a maximum of 23.5 per cent (2017) of the total.

Table 4-2: Total Direct GHG Emissions from the Sector 2 ‘IPPU’ by Category within 1990-2019, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2A. Mineral industry	1337.4142	1188.6687	640.8940	586.7703	444.9885	351.1816	315.6974	376.6116	307.9930	271.3959
2C. Metal industry	28.5023	24.7297	23.9922	24.4250	25.3289	26.2369	26.7261	32.3806	28.6822	31.7942
2D. Non-energy products from fuel and solvent use	234.3591	193.3185	154.2628	123.8759	84.4738	76.5607	71.0712	42.0528	37.6084	34.0839
2F. Product uses as substitutes for ODS	NO	NO	NO	NO	NO	1.0298	1.6593	2.3137	3.1372	4.0002
2G. Other products manufacture and use	3.4207	3.0789	2.4281	1.9988	1.4575	1.1679	1.1056	0.9991	0.7475	0.6549
2. IPPU	**1603.6964**	**1409.7958**	**821.5770**	**737.0699**	**556.2487**	**456.1769**	**416.2595**	**454.3577**	**378.1683**	**341.9290**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2A. Mineral industry	239.4427	235.8758	299.9546	307.6352	348.9485	437.4573	533.8283	766.4702	863.1338	386.0179
2C. Metal industry	36.2689	38.6274	20.5030	35.4283	40.5084	41.9358	27.0182	38.6127	35.4118	17.0619
2D. Non-energy products from fuel and solvent use	32.6395	36.4195	38.3743	40.9252	64.1303	68.1910	81.9807	84.7433	66.7047	57.5805
2F. Product uses as substitutes for ODS	5.1199	6.8681	9.1227	12.1632	16.0027	22.5106	33.2493	44.7889	57.3627	67.4807
2G. Other products manufacture and use	0.9685	0.8335	0.7974	0.9823	1.0724	1.2255	1.4150	1.4967	1.6312	1.3759
2. IPPU	**314.4396**	**318.6243**	**368.7520**	**397.1342**	**470.6623**	**571.3202**	**677.4915**	**936.1118**	**1024.2442**	**529.5169**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
2A. Mineral industry	404.3936	488.6436	493.5610	544.9842	535.5064	505.0564	492.5454	476.0597	590.9800	600.3437
2C. Metal industry	9.6985	12.8556	12.6973	7.6569	13.8464	17.2792	5.2203	18.8842	20.2133	15.7926
2D. Non-energy products from fuel and solvent use	66.2398	71.3244	74.6523	69.4810	87.2367	84.5691	84.8044	97.0273	151.1808	143.5292
2F. Product uses as substitutes for ODS	77.8936	90.1296	100.0227	108.3873	121.5640	153.8517	163.2067	182.4923	194.4750	229.9469
2G. Other products manufacture and use	1.7265	1.9738	1.9625	2.1020	2.3005	2.0343	2.1875	2.3277	2.3801	2.5781
2. IPPU	**559.9521**	**664.9270**	**682.8958**	**732.6114**	**760.4540**	**762.7907**	**747.9643**	**776.7911**	**959.2291**	**992.1906**

Abbreviations: NO – Not Occurring.

It should be noted that the share of 2F ‘Product Uses as Substitutes for ODS’ source category in the total direct GHG emissions from Sector 2 ‘IPPU’ tends to significantly increase lately (Table 4-3).

Table 4-3: Breakdown of Sector 2 ‘IPPU’ total direct GHG emissions for the period 1990-2019, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2A. Mineral industry	83.4	84.3	78.0	79.6	80.0	77.0	75.8	82.9	81.4	79.4
2C. Metal industry	1.8	1.8	2.9	3.3	4.6	5.8	6.4	7.1	7.6	9.3
2D. Non-energy products from fuel and solvent use	14.6	13.7	18.8	16.8	15.2	16.8	17.1	9.3	9.9	10.0
2F. Product uses as substitutes for ODS	NO	NO	NO	NO	NO	0.2	0.4	0.5	0.8	1.2
2G. Other products manufacture and use	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2A. Mineral industry	76.1	74.0	81.3	77.5	74.1	76.6	78.8	81.9	84.3	72.9
2C. Metal industry	11.5	12.1	5.6	8.9	8.6	7.3	4.0	4.1	3.5	3.2
2D. Non-energy products from fuel and solvent use	10.4	11.4	10.4	10.3	13.6	11.9	12.1	9.1	6.5	10.9
2F. Product uses as substitutes for ODS	1.6	2.2	2.5	3.1	3.4	3.9	4.9	4.8	5.6	12.7
2G. Other products manufacture and use	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2A. Mineral industry	72.2	73.5	72.3	74.4	70.4	66.2	65.9	61.3	61.6	60.5
2C. Metal industry	1.7	1.9	1.9	1.0	1.8	2.3	0.7	2.4	2.1	1.6
2D. Non-energy products from fuel and solvent use	11.8	10.7	10.9	9.5	11.5	11.1	11.3	12.5	15.8	14.5
2F. Product uses as substitutes for ODS	13.9	13.6	14.6	14.8	16.0	20.2	21.8	23.5	20.3	23.2
2G. Other products manufacture and use	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3

Abbreviations: NO – Not Occurring.

4.1.2. Key Categories

The results of key category analysis carried out following a Tier 1 approach are provided in Chapter 1.5 of this Report, as well as in the Annex 1-2. Table 4-4 provides information on identified key categories by level (L) and trend (T) under the Sector 2 'IPPU'.

Table 4-4: Key Categories Identified under the Sector 2 'IPPU'

IPCC Codes	GHG	IPCC Categories	Key Categories
2A1	CO_2	Cement Production	Yes (L, T)
2A2	CO_2	Lime Production	No
2A3	CO_2	Glass Production	No
2A4	CO_2	Other Process Uses of Carbonates	No
2C1	CO_2	Iron and Steel Production	No
2D1	CO_2	Lubricants Use	No
2D2	CO_2	Paraffin Waxes Use	No
2D3	CO_2	Solvents Use	Yes (L)
2D4	CO_2	Other (Urea-Based Catalysts)	No
2F1	HFC	Refrigeration and Air Conditioning Equipment	Yes (L, T)
2F2	HFC	Foam Blowing	Yes (T)
2F4	HFC	Aerosols	No
2G1	PFC	Electrical Equipment	No
2G1	SF_6	Electrical Equipment	No
2G3	N_2O	N_2O from Product Uses (Medical Applications)	No
2G4	CO_2	Other (Tobacco Burning and Use of Shoes)	No

4.1.3. Methodological Issues

Emissions from source categories 2A 'Mineral Industry', 2C 'Metal Industry', 2D 'Non-Energy Products from Fuels and Solvent Use', 2F 'Product Uses as Substitutes for ODS', 2G 'Other Products Manufacture and Use' and 2H 'Other' were estimated using both the Tier 1 methodological approach and default EFs values, as well as the Tier 2 methodological approach and country-specific emission factors. A summary description of methods used to estimate emissions by source categories is provided in Table 4-5, while a more detailed description is available in the respective sub-chapters of this report (4.2-4.8).

Table 4-5: Summary of Methods and Emission Factors Used to Estimate GHG Emissions from the Sector 2 'IPPU'

IPCC Codes	Source Category	CO_2		N_2O		HFC		PFC		SF_6	
		Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
2A.	Mineral Industry	T2, T1	CS, D	NA	NA	NA	NA	NA	NA	NA	NA
2B.	Chemical Industry	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA
2C.	Metal Industry	T2	CS, D	NA	NA	NA	NA	NA	NA	NO	NO
2D.	Non-Energy Products from Fuels and Solvent Use	T2, T1	D	NO	NO	NA	NA	NA	NA	NA	NA
2E.	Electronics Industry	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2F.	Product Uses as Substitutes for ODS	NA	NA	NA	NA	T2, T1	CS, D	NO	NO	NO	NO
2G.	Other Product Manufacture and Use	T2, T1	D	T1	D	NA	NA	T1	D	T1	D
2H.	Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Abbreviations: T1 – Tier 1; T2 – Tier 2; CS – Country-Specific; D – Default; NA – Not Applicable; NO – Not Occurring.

4.1.4. Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of GHG emissions from Sector 2 'IPPU' (by categories) is described in detail in sub-chapters (4.2-4.8) of the NIR, as well as in Annex 5-3.2.

Combined uncertainties as a percentage of total sectoral emissions were estimated at circa 10.27 per cent. Uncertainties introduced in the trend of total GHG emissions from this sector were estimated at circa 6.33 per cent.

In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

4.1.5. Quality Assurance and Quality Control

Standard verification and quality control check-lists were filled in for each source category, following a Tier 1 approach. It should be noted that the AD and methods used for estimating GHG emissions originating from this sector were documented and archived both in hard copies and electronically. In order to identify the data entry and emission estimation process related errors, verifications and quality control procedures were applied. Following the recommendations included into the 2006 IPCC Guidelines, GHG emissions were estimated using AD and national emission coefficients from official sources of reference.

4.1.6. Recalculations

GHG emission recalculations under Sector 2 'IPPU' were carried out utilising an updated set of AD available in the Statistical Yearbooks of the Republic of Moldova and of the ATULBD, as well as in the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019', respectively due to use of updated EFs, coefficients, and CS parameters.

In comparison with the results included into the BUR2 of the RM to the UNFCCC (2019), the performed recalculation resulted in an insignificant increase of direct GHG emissions between 1990 and 2000, varying from a minimum of 0.1 per cent in 2000, to a maximum of 2.0 per cent in 1990; and a decrease in direct GHG emissions between 2011-2016 varying from a minimum of 0.1 per cent, to a maximum of 5.5 per cent in 2010, respectively (Table 4-6).

Table 4-6: Recalculation results of GHG emissions for the years 1990-2016, included in the BUR2 of the RM to the UNFCCC (Sector 2 'IPPU'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1572.3005	1394.6516	808.9145	724.8904	548.7594	450.5308	409.6875	451.4163	377.1376	340.9518
BUR3	1603.6964	1409.7958	821.5770	737.0699	556.2487	456.1769	416.2595	454.3577	378.1683	341.9290
Difference, %	2.0	1.1	1.6	1.7	1.4	1.3	1.6	0.7	0.3	0.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	314.1033	319.0500	372.3123	406.4693	485.4217	591.9260	702.0487	961.6041	1055.3117	555.8433
BUR3	314.4396	318.6243	368.7520	397.1342	470.6623	571.3202	677.4915	936.1118	1024.2442	529.5169
Difference, %	0.1	-0.1	-1.0	-2.3	-3.0	-3.5	-3.5	-2.7	-2.9	-4.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	592.3056	695.9553	713.2218	762.6073	794.8503	784.2010	761.8649			
BUR3	559.9521	664.9270	682.8958	732.6114	760.4540	762.7907	747.9643	776.7911	959.2291	992.1906
Difference, %	-5.5	-4.5	-4.3	-3.9	-4.3	-2.7	-1.8			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR3 – Third Biennial Update Report of the RM under the UNFCCC.

4.1.7. Assessment of Completeness

The current inventory covers GHG emissions from 7 source categories of the 8 included in Sector 2 'IPPU' (Table 4-7).

Table 4-7: Assessment of Completeness under the Sector 2 'IPPU'

IPCC Code	Source Category	CO_2	N_2O	HFC	PFC	SF_6	NF_3
2A	Mineral Industry	X	NO	NA	NA	NA	NA
2B	Chemical Industry	NO	NO	NA	NA	NA	NA
2C	Metal Industry	X	NO	NA	NA	NO	NA
2D	Non-Energy Products from Fuels and Solvent Use	X	NO	NA	NA	NA	NA
2E	Electronics Industry	NA	NA	NA	NO	NO	NO
2F	Product Uses as Substitutes for ODS	NA	NA	X	NA	NA	NA
2G	Other Product Manufacture and Use	X	X	NA	X	X	NA
2H	Other	NO	NO	NA	NA	NA	NA

Abbreviations: X – source categories included into the inventory; NO – Not Occurring; NA – Not Applicable.

4.1.8. Planned Improvements

Planned improvements at the source category level in Sector 2 'IPPU' are described more in-depth in sub-chapters (4.2-4.8) of the Report.

4.2. Mineral Industry (Category 2A)

4.2.1. Source Category Description

Category 2A 'Mineral Industry' includes GHG emissions from the following sources: 2A1 'Cement Production', 2A2 'Lime Production', 2A3 'Glass Production', 2A4 'Other Process Uses of Carbonates' (bricks, expanded clay and ceramics production). Over the period under review, 1990-2019, direct GHG emissions originating from category 2A 'Mineral Industry' decreased by circa 55.1 per cent (Table 4-8).

Table 4-8: Total Direct GHG Emissions from the Category 2A 'Mineral Industry' by Source within 1990-2019, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2A1. Cement Production	971.6967	900.7877	474.3138	405.7165	328.4361	248.5258	193.1220	270.1273	215.0572	210.8122
2A2. Lime Production	264.3143	192.2260	116.1612	112.7887	83.8378	78.0227	97.7677	81.2988	68.5945	37.8903
2A3. Glass Production	26.0951	25.8454	12.7167	11.4809	4.0547	5.1447	7.6130	5.0803	5.4490	3.6841
2A4. Other Process Uses of Carbonates	75.3080	69.8096	37.7023	56.7842	28.6600	19.4885	17.1947	20.1052	18.8923	19.0092
2A. Mineral Industry	**1337.4142**	**1188.6687**	**640.8940**	**586.7703**	**444.9885**	**351.1816**	**315.6974**	**376.6116**	**307.9930**	**271.3959**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2A1. Cement Production	172.7600	173.8847	219.1917	245.6276	282.5765	365.0817	457.0753	702.6656	789.9160	340.5679
2A2. Lime Production	31.4020	28.4519	38.2546	20.5213	20.5790	27.8408	30.1048	21.9382	29.1378	8.4641
2A3. Glass Production	16.8043	15.2214	20.4783	18.8812	19.5625	22.4939	23.3604	20.3570	22.8439	17.2425
2A4. Other Process Uses of Carbonates	18.4764	18.3178	22.0299	22.6051	26.2305	22.0409	23.2878	21.5093	21.2360	19.7434
2A. Mineral Industry	**239.4427**	**235.8758**	**299.9546**	**307.6352**	**348.9485**	**437.4573**	**533.8283**	**766.4702**	**863.1338**	**386.0179**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
2A1. Cement Production	349.8333	427.2624	442.1615	476.9104	464.6082	443.2441	433.9022	404.9290	511.1209	523.8755
2A2. Lime Production	15.3644	16.6236	15.5304	20.7696	23.8218	15.7407	13.6470	28.8043	27.7944	27.5851
2A3. Glass Production	20.2715	26.3926	21.2592	27.8304	27.8833	28.3000	28.3761	27.1229	36.2388	32.5310
2A4. Other Process Uses of Carbonates	18.9244	18.3651	14.6099	19.4739	19.1931	17.7716	16.6202	15.2034	15.8259	16.3521
2A. Mineral Industry	**404.3936**	**488.6436**	**493.5610**	**544.9842**	**535.5064**	**505.0564**	**492.5454**	**476.0597**	**590.9800**	**600.3437**

The significant decrease in emissions recorded in 2008 and 2009 can be explained by the effects of the global economic crisis in 2009 that affected the national economy, including the industrial sector, in particular due to a sharp decrease in customer purchasing power from the traditional markets. The subsequent economic recovery of the industrial sector had slow growth rates. Between 2018 and 2019, there was an increase in GHG emissions from category 2A 'Mineral Industry', mainly due to the increase in cement and glass production (Figure 4-2).

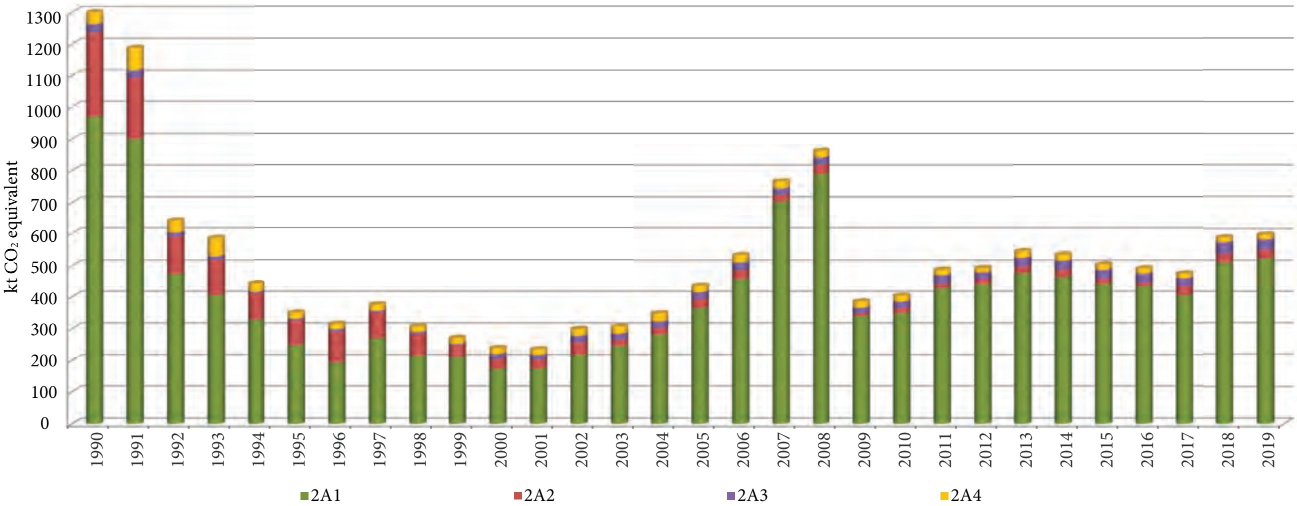

Figure 4-2: Direct GHG Emissions from the Category 2A 'Mineral Industry' by Source, 1990-2019.

The same trends were recorded for indirect GHG emissions (NO_x, CO, NMVOC) and SO_2 from the respective category. (Table 4-9).

Table 4-9: Indirect GHG Emissions and SO_2 from the Category 2A 'Mineral Industry' by Gas in the Republic of Moldova within 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	3.5653	3.2662	1.7039	1.6117	1.2556	1.0679	0.9126	1.1071	0.9767	0.8365
CO	3.4372	3.0431	1.6459	1.4853	1.1521	0.9044	0.8037	0.9721	0.7878	0.6973
NMVOC	0.0339	0.0315	0.0165	0.0143	0.0116	0.0090	0.0070	0.0096	0.0078	0.0076
SO_2	1.2943	1.2182	0.6171	0.6015	0.4736	0.4277	0.3560	0.4327	0.4034	0.3375

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NO_x	0.9636	0.9098	1.1263	1.1103	1.2390	1.5114	1.6951	2.1999	2.4014	1.1937
CO	0.5762	0.5713	0.7266	0.7495	0.8629	1.1045	1.3597	1.9983	2.2832	0.9874
NMVOC	0.0068	0.0067	0.0084	0.0091	0.0105	0.0134	0.0164	0.0245	0.0277	0.0123
SO_2	0.4607	0.4262	0.5216	0.5032	0.5529	0.6594	0.7025	0.8394	0.8853	0.4849
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	1.2908	1.5970	1.5088	1.6947	1.6590	1.5734	1.5410	1.4599	1.8391	1.8306
CO	1.0242	1.2450	1.2782	1.3902	1.3602	1.2767	1.2375	1.2025	1.4895	1.5265
NMVOC	0.0127	0.0156	0.0159	0.0172	0.0167	0.0160	0.0156	0.0146	0.0185	0.0188
SO_2	0.5387	0.6742	0.6054	0.6943	0.6799	0.6490	0.6398	0.5970	0.7607	0.7430

2A1 'Cement Production'

CO_2 is generated in the process of clinker production, an intermediary product used to produce cement. $CaCO_3$ from limestone and other calcium rich materials, as well as $MgCO_3$ from dolomite, is heated at high temperatures in a kiln, to form the lime (CaO) and/or dolomite lime (CaO • MgO) and carbon dioxide (CO_2) in a process called 'calcination'.

$$CaCO_3 \text{ (limestone)} + \text{heat} \rightarrow CaO \text{ (lime)} + CO_2$$

$$CaMg(CO_3)_2 \text{ (dolomite)} + \text{heat} \rightarrow CaO \bullet MgO \text{ (dolomitic lime)} + 2CO_2$$

Lime and/or dolomite lime is then combined with silicon containing materials (SiO_2), aluminium (Al_2O_3) and iron oxide (Fe_2O_3) to produce clinker (greyish-black pellets about the size of 12 mm-diameter marbles). The clinker is then removed from the kiln, chilled and pulverised, and added to gypsum to obtain 'Portland Cement', which is currently all cement produced in the Republic of Moldova, in which, according to ORTECH Corporation (1994), CaO content varies between 60-67 per cent, and MgO content is around 2 per cent.

It should be noted that two cement producing plants are currently operating in the RM: Lafarge Cement (Moldova) JSC in Rezina and Cement and Slate Combined Works in Ribnita (ATULBD). CO_2 emissions from cement production are directly proportionate to CaO fraction from the clinker used in its production. GHG emissions resulting from the combustion of fossil fuels used to produce heat which induces reaction in the oven are covered by the Energy Sector and are not discussed in this sector.

2A2 'Lime Production'

Lime (CaO) is formed by heating limestone to decompose the carbonates. This reaction takes place at high temperatures, usually in a rotating kiln, and CO_2 is emitted in the process of calcination. Primary limestone (calcite) is processed from the rock mined in the quarry to produce caustic lime (quicklime) using the above-mentioned reaction (see *'Cement Production'* section). Dolomite limestone can also be heated at high temperatures to obtain dolomite lime, consequently, producing CO_2 emissions as a result of the chemical reaction described above.

2A3 'Glass Production'

This source category includes GHG emissions from glass production divided into several main categories: flat glass for windows, containers, glassware and tableware, and specialty glass. The glass is obtained from a mixture of raw materials consisting of silica (SiO_2), sodium (Na_2O), lime (CaO) or other carbonates ($CaCO_3$, $CaMg(CO_3)_2$, Na_2CO_3, $BaCO_3$, K_2CO_3, $SrCO_3$, etc.), with small amounts of alumina (Al_2O_3), and other alkalis and alkaline earths, plus some minor ingredients. A certain amount of recycled scrap glass can also be used in the production process (its share may vary between 10-80 per cent of the total raw material used). The process of glass melting for different purposes is similar. The process of glass production consists of the following steps: selection and preparation of raw material, melting, moulding, hardening, quenching and finishing. During this process, the main pollutants emitted are CO_2, as well as NO_x, CO and SO_x. CO_2 emissions result from lime and other carbonates calcination at high temperature. The main mechanisms for NO_x emissions are those related to fuel combustion and emission of NO_x, as well as those resulting from the use of nitrates within the raw materials for some types of glass. The SO_x emitted in the process of glass production is determined in particular by the sulphur content of the molten dose and the sulphur absorption capacity, the excess air and the combustion temperature.

2A4 'Other Process Uses of Carbonates'

a. Ceramics

Ceramics production includes mining, processing and refining raw materials (clays) using additives such as kaolin or limestone, forming, cutting, drying and burning the final product in the kiln. The main pollutants resulting from the calcination of carbonates at high temperatures in the process of ceramics production are CO_2 and SO_x.

b. Other Uses of Soda Ash

Other from the glass production, soda ash or sodium carbonate (Na_2CO_3) is used as raw material in a number of industries, such as: soap and detergent production, paper production, as well as in wastewater treatment. CO_2 emissions are produced by the use of sodium carbonate, as well as during the production process, depending on its type (tit should be noted that in the RM, no sodium carbonate is produced).

4.2.2 Methodological Issues, Emission Factors and Data Sources

2A1 'Cement Production'

GHG emissions from cement production were estimated using a Tier 2 methodology (2006 IPCC Guidelines), based on activity data on clinker production. Data obtained directly from the producer on CaO and MgO ratio in clinker and cement were used for calculating the CO_2 emission factors.

$$EF_{clinker} = CaO\ Content \bullet mass\ ratio\ CO_2/CaO + MgO\ Content \bullet mass\ ratio\ CO_2/MgO$$

$$CO_2\ emissions = clinker\ production \bullet EF_{clinker} \bullet CKD\ correction\ factor$$

This approach involves that all the CaO and MgO from the clinker is from $CaCO_3$ (limestone) and $CaMg(CO_3)_2$ (dolomite). Since no data on other non-carbonate sources were available, it was no need to adjust (reduce) the emission factors.

The value of CKD correction factor was also considered. Cement Kiln Dust (CKD) is a mixture of raw materials, the state of which varies from uncalcined to completely calcined. Practically, all cement kilns produce CKD, its quantity depending on the technologies used by the respective plant. It should be noted that cement kiln dust may be recovered via electrostatic precipitation or filtration from the exhaust stacks; the recovered CKD may be recycled in the kiln as a raw material. Any CKD not recycled in the kiln is lost to the cement system in terms of CO_2 emissions. The default CKD correction factor is 1.02, and in the Republic of Moldova its value varied during 1990-2019 from a maximum of 1.013 to a minimum of 1.0002.

Country-specific CO_2 emission factors were estimated based on information obtained directly from the producers on the CaO and MgO fractions in the produced clinker, mass ratio on CO_2/CaO and CO_2/MgO and CKD correction factor values (Table 4-10).

Table 4-10: Country-Specific Emission Factors used to estimate CO_2 emissions from Clinker Production in the Republic of Moldova, 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CaO fraction	0.6576	0.6576	0.6576	0.6566	0.6566	0.6577	0.6577	0.6577	0.6577	0.6577
CO_2/CaO mass ratio	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
MgO fraction	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160
CO_2/MgO mass ratio	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
CKD fraction	1.0110	1.0130	1.0110	1.0120	1.0130	1.0130	1.0130	1.0120	1.0130	1.0120
$EF_{clinker}$	**0.5394**	**0.5405**	**0.5394**	**0.5392**	**0.5397**	**0.5406**	**0.5406**	**0.5400**	**0.5406**	**0.5400**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
CaO fraction	0.6569	0.6599	0.6602	0.6621	0.6586	0.6591	0.6605	0.6570	0.6570	0.6510
CO_2/CaO mass ratio	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
MgO fraction	0.0160	0.0160	0.0160	0.0181	0.0160	0.0160	0.0140	0.0190	0.0120	0.0170
CO_2/MgO mass ratio	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
CKD fraction	1.0120	1.0090	1.0060	1.0060	1.0060	1.0060	1.0070	1.0060	1.0050	1.0030
$EF_{clinker}$	**0.5394**	**0.5402**	**0.5388**	**0.5426**	**0.5376**	**0.5379**	**0.5374**	**0.5396**	**0.5314**	**0.5311**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CaO fraction	0.6550	0.6529	0.6521	0.6551	0.6569	0.6565	0.6602	0.6565	0.6565	0.6565
CO_2/CaO mass ratio	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
MgO fraction	0.0160	0.0166	0.0168	0.0156	0.0158	0.0166	0.0166	0.0166	0.0166	0.0166
CO_2/MgO mass ratio	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
CKD fraction	1.0040	1.0008	1.0015	1.0003	1.0002	1.0002	1.0002	1.0002	1.0002	1.0002
$EF_{clinker}$	**0.5336**	**0.5310**	**0.5309**	**0.5313**	**0.5329**	**0.5335**	**0.5363**	**0.5334**	**0.5334**	**0.5334**

Table 4-11 shows the default EFs utilised to calculate indirect GHG emissions (NO_x, CO, NMVOC) and SO_2 from cement production.

Table 4-11: Default Emission Factors used to Estimate Indirect GHG and SO_2 Emissions from 2A1 'Cement Production' Source Category

Category	Process Description	NO_x	CO	NMVOC	SO_x
		g/t clinker			
Mineral Industry	Cement production	1241	1455	18	374

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook, 2019, SNAP Code 030311 Cement, Category 1.A.2.f.i, Table 3-24.

Information on clinker production at the plant 'Lafarge Cement (Moldova)' JSC in Rezina was obtained directly from the manufacturer. As for the Cement and Slate Combined Works in Ribnita, activity data on clinker production are available in the statistical publications of the ATULBD only since 2009[56] (for the period 2007-2019).

For the period between 1990 and 2006, following the 2006 IPCC Guidelines recommendations, activity data on clinker production at Cement and Slate Combined Works in Ribnita were inferred from statistical data on cement production, by using the equation below:

$$\textit{Clinker Production} = \textit{Cement Production} \bullet \textit{Clinker Fraction in Cement}$$

In accordance with the technological documentation for Portland type cement production, in order to produce one tone of cement, cement plants in the Republic of Moldova use 786.9 kg of clinker (Annex 3-2).

The information provided by Lafarge Cement (Moldova) JSC in Rezina through Official Letter No. 74 as of 02.03.2011 and No. 67 of 06.02.2014 was qualified as '*trade secret with commercial value*', which is in accordance with the stipulations of the Articles 1, 2 and 5, paragraph (1) of the Law on 'Commercial Secrets' No. 171-XII dated 06.07.1994. In these circumstances, the activity data used to calculate GHG emissions from source category 2A1 'Cement Production' is presented below only on aggregate at national level (Table 4-12).

Table 4-12: Activity Data on Cement and Clinker Production in the RM, 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cement Production, kt	2288.0	1800.0	1088.2	960.3	769.1	518.8	494.4	611.8	493.0	462.0
Clinker Production, kt	1801.3	1666.6	879.3	752.5	608.6	459.7	357.3	500.2	397.8	390.4
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cement Production, kt	431.9	402.1	477.0	484.4	667.6	772.8	1051.1	1531.0	1775.9	869.4
Clinker Production, kt	320.3	321.9	406.8	452.7	525.7	678.7	850.6	1302.2	1486.6	641.3
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cement Production, kt	861.4	1018.0	1051.4	1095.3	1086.2	1122.8	900.2	1045.9	1174.9	1220.2
Clinker Production, kt	655.6	804.7	832.8	897.6	871.9	830.9	809.0	759.1	958.2	982.1

Source: 'Lafarge Cement (Moldova)' JSC in Rezina through Letter No. 114 dated 02.03.2020, as a response to the request from the Climate Change Office of the Ministry of Environment No. 08-310/1 dated 11.02.2020; Letter No. 780 dated 22.12.2017, as a response to the request from the Climate Change Office of the Ministry of Environment No. 601/2017-12-03 dated 14.12.2017; Letter No. 395 dated 24.05.2016, as a response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 82 dated 18.02.2015, as a response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 67 dated 06.02.2014, as a response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 74 dated 02.03.2011, as a response to the request from the Climate Change Office of the Ministry of Environment No. 03-07/175 dated 02.02.2011; and Letter No. 186 dated 18.04.2007, as a response to the request from the Institute of Ecology and Geography No. 84 dated 26.03.2007; Statistical Yearbooks of the ATULBD for 1998 (page 176), 2000 (page 99), 2002 (page 103), 2005 (page 94), 2006 (page 93), 2007 (page 92), 2009 (page 92), 2010 (page 93), 2011 (page 94), 2012 (page 98), 2013 (page 99), 2014 (page 88), 2015 (page 88), 2016 (page 98), 2017 (page 101), 2019 (page 99), 2020 (page 102).

2A2 'Lime Production'

The mass of CO_2 produced per unit of lime manufactured was estimated from the molecular weights and the lime content of products (ORTECH, 1991). On the basis of calcination reaction, one mole of carbon dioxide is formed for each mole of quicklime produced from burning calcium carbonate, and two moles of CO_2 is formed for each mole of dolomitic quicklime. This principle was used to calculate emission factors according to the equations below:

[56] Express Information, Key Performance Indicators for the Industry Sector in the Republic for 2009-2019 (other than the small industries). State Statistical Service of the Transnistrian Moldovan Republic – Tiraspol.

$$EF_{quicklime} = Mass\ Ratio\ (CO_2/CaO) \cdot CaO\ Content$$

$$EF_{dolomitic\ lime} = MASS\ Ratio\ (CO_2/CaO \cdot MgO) \cdot (CaO \cdot MgO)\ Content$$

It should be noted that there are three types of lime: high-calcium lime (CaO + impurities); dolomitic lime (CaO • MgO + impurities); hydraulic lime (CaO + calcium silicates), which is a substance between lime and cement (the first two types have different mass ratios, and the third has a reduced CaO content). Considering these types of lime, it allows an improved emission estimates.

As there is no statistic information on lime production by type in the Republic of Moldova, following the good practice, the AD on lime production was disaggregated for the breakdown of lime types according to the default values for high-calcium/dolomitic lime (85 per cent high calcium lime and 15 per cent dolomitic lime), the proportion of hydraulic lime being assumed as zero.

The basic parameters used for estimating CO_2 emission factors from lime production are shown in Table 4-13.

Table 4-13: Basic Parameters for Estimating EFs from 2A2 'Lime Production'

Type of lime	Stoichiometric Ratio (1)	Range of CaO Content (%)	Range of MgO Content (%)	Default Values for CaO/CaO·MgO Content (2)	Default EF, t CO_2/t lime (1) · (2)
High-calcium lime	0.7848	93-98	0.3-2.5	0.95	0.7456
Dolomitic lime	0.9132	55-57	38-41	0.85	0.7763
Hydraulic lime	0.7848	65-92		0.75	0.5886

Source: 2006 IPCC Guidelines, Chapter 2.3 'Lime Production', Table 2.4, page. 2.22.

Emission factors values for indirect GHG emissions and SO_2 originating from 2A2 'Lime Production' are available below in Table 4-14.

Table 4-14: Default Emission Factors used to Estimate Indirect GHG and SO_2 Emissions from 2A2 'Lime Production' Source Category

Category	Process Description	NO_x	CO	SO_2
		g/t lime		
Mineral Industry	Lime Production	1369	1940	316

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook, 2019, SNAP Code 030312 Lime, Category 1.A.2.f.i, Table 3-23.

Statistical Yearbooks of the RM contain aggregate AD on lime production for the period until 1992. From 1993 to 2019, AD on lime production are available separately for the right and left bank of Dniester, in the Statistical Yearbooks of the Republic of Moldova and ATULBD (Table 4-15).

Table 4-15: Activity Data on Lime Production in the Republic of Moldova within 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM: left bank of Dniester River	90.00	78.60	55.00	48.00	45.00	28.00	34.00	39.00	26.00	19.00
RM: right bank of Dniester River	114.30	100.00	32.80	30.00	15.90	10.80	19.90	9.70	12.70	5.20
RM: total	**204.30**	**178.60**	**87.80**	**78.00**	**60.90**	**38.80**	**53.90**	**48.70**	**38.70**	**24.20**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
RM: left bank of Dniester River	12.00	2.00	8.00	0.00	1.00	7.00	8.00	14.00	14.00	4.28
RM: right bank of Dniester River	3.10	3.30	3.30	2.90	2.10	2.08	2.15	1.14	0.34	0.33
RM: total	**15.10**	**5.30**	**11.30**	**2.90**	**3.10**	**9.08**	**10.15**	**15.14**	**14.34**	**4.61**
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
RM: left bank of Dniester River	3.18	7.44	6.84	5.49	8.33	8.01	4.02	22.26	24.73	27.90
RM: right bank of Dniester River	0.19	0.18	0.13	0.08	0.05	0.17	0.05	0.13	0.09	0.04
RM: total	**3.37**	**7.61**	**6.97**	**5.57**	**8.38**	**8.18**	**4.07**	**22.38**	**24.81**	**27.94**

Source: National Bureau of Statistics of the Republic of Moldova through the Statistical Yearbooks for the years 1994 (page 286), 1999 (page 302), 2003 (page 392), 2006 (page 312); Statistical Reports PRODMOLD-A „Total production, as a natural expression, in the Republic, by product type for the years 2005-2019'; Statistical Yearbooks of the ATULBD for the years 1998 (page 176), 2000 (page 99), 2002 (page 103), 2005 (page 94), 2006 (page 93), 2007 (page 92), 2009 (page 92), 2011 (page 94), 2012 (page 98), 2013 (page 99), 2014 (page 88), 2015 (page 88), 2016 (page 98), 2017 (page 101), 2019 (page 99), 2020 (page 102).

As revealed in Table 4-15, lime production plunged drastically in the RM in recent years (Right Bank of the Dniester River). In this context, the amount of lime needed for domestic consumption is imported. Table 4-16 provides statistical data on lime imports during 1995-2019. According to this data, lime imports increased by circa 117 times in this time period.

Table 4-16: Lime imports in the RM (RBDR), for the period 1995-2019, kt

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Lime imports in the RM, kt	0.063	0.234	0.336	0.515	0.405	0.603	1.783	2.109	3.243	3.662	3.953	5.121	6.423
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Lime imports in the RM, kt	7.540	3.798	4.826	4.699	5.053	4.256	5.260	4.657	5.330	6.527	6.803	7.390	N/A

Source: Customs Service of the RM, Official Letter No. 28/07-1893 dated 23.02.2011, as a response to Letter No. 03-07/175 dated 02.02.2011 from the Ministry of Environment; Letter No. 15-03-05 dated 24.01.2014, as a response to Letter No. 320/2014-01-01 dated 03.01.2014, from the Climate Change Office of the Ministry of Environment; Letter No. 28/07-2231 dated 26.02.2015, Letter No. 407/2015-01-09 dated 29.01. 2015, from the Climate Change Office of the Ministry of Environment; Letter No. 28/07-8785 dated 26.05.2016, as a response to Letter No. 512/2016-05-01 dated 10.05.2016, from the Climate Change Office of the Ministry of Environment; Letter No. 28/07-612 dated 12.01.2018, as a response to Letter No. 601/2017-12-03 dated 14.12.2017, from the Climate Change Office of the Ministry of Environment; Letter No. 28/07-3025 dated 28.02.2020, as a response to Letter No. 08-310/1 dated 11.02.2020, from the Environment Agency.

According to the 2006 IPCC Guidelines (Volume 3, Chapter 2.5, Table 2-7), emissions from lime production at sugar factories should be reported under 2A2 'Lime production'. As the amount of lime produced and utilised by producers is not accounted for by the statistical system, this information was requested from sugar producing enterprises in the Republic of Moldova (during the current inventory cycle, the information was submitted by two enterprises: Sudzucker-Moldova Ltd. and Moldova Sugar Ltd., the market share of these two enterprises varied in the period 2013-2019 between 92.6 and 99.9 per cent of the total amount of sugar produced in the Republic of Moldova).

Table 4-17: Activity Data on Lime Production at Sugar Mills, 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Granulated sugar from sugar beet[1]	435.800	236.900	208.000	230.200	166.700	218.700	264.500	213.300	194.500	100.500
Specific consumption of quicklime, kg/t produced sugar	348.4	339.3	330.3	321.3	312.3	303.3	294.2	285.2	276.2	267.2
Amount of lime used in sugar production, kt[2]	151.8144	80.3888	68.7056	73.9618	52.0558	66.3210	77.8238	60.8349	53.7184	26.8501
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Granulated sugar from sugar beet[1]	105.400	132.600	167.600	107.100	110.900	133.472	149.046	73.964	133.966	38.373
Specific consumption of quicklime, kg/t produced sugar	258.1	249.1	240.1	231.1	222.1	213.0	204.0	195.0	186.0	177.0
Amount of lime used in sugar production, kt[2]	27.2084	33.0337	40.2410	24.7487	24.6263	28.4345	30.4078	14.4226	24.9141	6.7902
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Granulated sugar from sugar beet[1]	103.209	88.436	83.440	140.297	177.695	84.519	99.999	128.980	73.906	86.925
Specific consumption of quicklime, kg/t produced sugar	167.9	169.8	175.0	167.3	148.3	155.4	153.4	129.2	199.2	112.1
Amount of lime used in sugar production, kt[2]	17.3320	14.7827	13.9536	22.4142	23.7175	13.0270	14.3120	16.4270	12.6335	9.2278

Source: [1]Statistical Yearbooks of the Republic of Moldova for the years 1994 (page 289), 1999 (page 304), 2003 (page 393), 2006 (page 310), Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the RM, by product type, for the years 2005-2019'; Statistical Yearbooks of the ATULBD for the years 1998 (page 177), 2000 (page 100), 2002 (page 104), 2005 (page 94); [2]Sudzucker-Moldova Ltd., through Letter No. 03-1-191 dated 19.04.2011, as a response to the interpellation of the Letter of the Ministry of Agriculture and Food Industry No. 19/348 dated 15.04.2011; Letter from February 28, 2020, as a response to the interpellation of the Environment Agency No. 08-310/1 dated 11.02.2020; Moldova Sugar Ltd., Letter from August 14, 2020, as a response to the interpellation of the Environment Agency No. 08-310/1 dated 11.02.2020.

The total amount of lime produced in the country between 1990 and 2019 (commercial lime and the lime produced by auto-producers, particularly at sugar mills) is presented below (Table 4-18).

Table 4-18: Activity Data on Lime Production,1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Commercial lime, kt	204.300	178.600	87.800	78.000	60.900	38.800	53.900	48.700	38.700	24.200
Lime produced at sugar mills, kt	151.814	80.389	68.706	73.962	52.056	66.321	77.824	60.835	53.718	26.850
Total lime produced, kt	**356.114**	**258.989**	**156.506**	**151.962**	**112.956**	**105.121**	**131.724**	**109.535**	**92.418**	**51.050**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Commercial lime, kt	15.100	5.300	11.300	2.900	3.100	9.076	10.153	15.135	14.344	4.614
Lime produced at sugar mills, kt	27.208	33.034	40.241	24.749	24.626	28.435	30.408	14.423	24.914	6.790
Total lime produced, kt	**42.308**	**38.334**	**51.541**	**27.649**	**27.726**	**37.510**	**40.561**	**29.558**	**39.258**	**11.404**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Commercial lime, kt	3.369	7.615	6.971	5.569	8.378	8.181	4.075	22.382	24.814	27.938
Lime produced at sugar mills, kt	17.332	14.783	13.954	22.414	23.717	13.027	14.312	16.427	12.634	9.228
Total lime produced, kt	**20.701**	**22.397**	**20.924**	**27.983**	**32.095**	**21.208**	**18.387**	**38.808**	**37.448**	**37.166**

As the produced amount of hydrated lime (by means of slaking, lime is disaggregated into hydrated lime, that is $Ca(OH)_2$ or $Ca(OH)_2 \cdot Mg(OH)_2$) is unknown in the country, following the good practices, this value was inferred from AD on total amount of lime produced in the RM (Table 4-18), by multiplying it by a correction factor (the default value being 0.97). At the same time, the amount of high-calcium lime and dolomitic lime was inferred from AD on the amount of slaking lime by using the default value for high calcium/dolomitic lime 85/15 (Table 4-19).

Table 4-19: Activity Data on Hydrated Lime Production, 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
High-calcium lime	302.6972	220.1405	133.0297	129.1676	96.0124	89.3529	111.9652	93.1047	78.5556	43.3926
Dolomitic lime	53.4172	38.8483	23.4758	22.7943	16.9434	15.7682	19.7586	16.4302	13.8628	7.6575
Total hydrated lime produced	**356.1144**	**258.9888**	**156.5056**	**151.9618**	**112.9558**	**105.1210**	**131.7238**	**109.5349**	**92.4184**	**51.0501**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
High-calcium lime	35.9621	32.5836	43.8099	23.5014	23.5674	31.8838	34.4765	25.1240	33.3691	9.6932
Dolomitic lime	6.3463	5.7501	7.7312	4.1473	4.1589	5.6266	6.0841	4.4337	5.8887	1.7106
Total hydrated lime produced	**42.3084**	**38.3337**	**51.5410**	**27.6487**	**27.7263**	**37.5103**	**40.5606**	**29.5577**	**39.2578**	**11.4038**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
High-calcium lime	17.5956	19.0376	17.7857	23.7857	27.2811	18.0265	15.6287	32.9872	31.8306	31.5909
Dolomitic lime	3.1051	3.3596	3.1387	4.1975	4.8143	3.1811	2.7580	5.8213	5.6172	5.5749
Total hydrated lime produced	**20.7007**	**22.3972**	**20.9243**	**27.9832**	**32.0955**	**21.2076**	**18.3868**	**38.8085**	**37.4478**	**37.1658**

CO_2 emissions were estimated following a Tier 2 methodological approach available in the 2006 IPCC Guidelines, by multiplying the above-mentioned emission factors to annual activity data on hydrated lime production considering the type of lime produced, the correction factor or the amount of lime kiln dust, LKD representing a mixture of raw materials varying from an uncalcined state to a completely calcined state. Virtually, all types of kilns used to produce lime generate such dust, but the amount depends on the technology applied within the respective factory. It should be noted that the lime kiln dust can be retained by electrostatic precipitation or filtration, and it is possible to return it to the kiln as raw material. Related to CO_2 emissions, any amount of dust that is not returned to the kiln is considered to be a system loss.

$$Total_{l} = P_{i} \bullet EF_{lime,\, i} \bullet correction\ factor\ (LKD)$$

Where:

Total $_{l}$ – CO_2 emissions from type *i* lime production (Kt/yr);

EF $_{lime,\, i}$ – emission factor for type *i* lime (0.7456 t CO_2/t high-calcium lime and 0.7763 t CO_2/t dolomitic lime);

P $_{i}$ – type *i* lime production (kt/yr);

LKD – correction factor, the default value used is 1.02, the country-specific value is unknown.

2A3 'Glass Production'

Under this source category are covered GHG emissions originated from the production of different types of glass (flat window glass, multi-layer insulating glass, mirrors, glassware, tableware, specialty glass, etc.). Glass is produced from a raw material mix containing silica (SiO_2), sodium (Na_2O), lime (CaO) or other carbonates ($CaCO_3$, $CaMg(CO_3)_2$, Na_2CO_3, $BaCO_3$, K_2CO_3, $SrCO_3$, etc.), with small admixture of aluminium (Al_2O_3) and alkaline substances, plus other minor ingredients. The process of glass production allows for a small quantity of recycled glass (cullet) to be used (its share can vary between 10-80 per cent of the total raw material used). The melting process for different types of glass is similar. The process of glass production implies the following phases: selection and preparation of the raw material, melting, moulding, hardening, quenching, and finishing.

Methodological issues regarding the estimation of indirect GHG emissions from glass production are addressed in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, as well as in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019).

CO_2 emissions were estimated following a Tier 2 methodological approach available in the 2006 IPCC Guidelines.

$$Total\ CO_2\ emissions = \Sigma\ [M_{g,i} \bullet FE_{g,\, i} \bullet (1 - CR_i)]$$

Where:

Total – CO_2 emissions from glass production (kt/yr);

M $_{g,\, i}$ – mass of melted type *i* glass (kt/yr);

EF $_{i}$ – emission factor for type *i* glass (t CO_2/t melted glass);

CR $_{i}$ – cullet ratio for manufacturing of type *i* glass, fraction.

Default EFs used to estimate CO_2, respectively the cullet ratio for manufacturing different types of glass are provided in Table 4-20.

Table 4-20: Default EFs used to estimate CO_2 emissions from glass production

Type of glass	Default EF, t CO_2 / t glass	CR for manufacturing glass	Average CR value in glass production
Flat glass production for windows	0.21	10%-25%	17.5%
Glass for flint type containers	0.21	30%-60%	45.0%
Glass for green or amber containers	0.21	30%-80%	55.0%
Fiberglass (type E-glass)	0.19	0%-15%	7.5%
Fiberglass for insulation	0.25	10%-50%	30.0%
Specialty glass (TV panels)	0.18	20%-75%	47.5%
Specialty glass (TV funnels)	0.13	20%-70%	45.0%
Glass for glassware and tableware	0.10	20%-60%	35.0%
Lab/Pharma Glass	0.03	30%-75%	52.5%
Glass for lighting	0.20	40%-70%	55.0%

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, Chapter 2.4, Table 2.6, Page 2.30.

Four glass plants used to produce glass in the RM: SOE 'Chisinau Glass Factory' and 'Glass Container Company' (since 1997) in Chisinau, 'Cristal-Flor' Glass Factory in Floresti and the Glass Factory in Tiraspol (ATULBD), but the last two plants ceased their activity. Activity data on glass production are available in the Statistical Yearbooks of the RM and of the ATULBD, as well as in the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic, by product type' (Table 4-21).

Table 4-21: Activity Data on Glass Production, 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Flat glass for windows, thousand m^2	226.000	287.000	184.000	NO	NO	NO	NO	NO	NO	NO
Glass jars, mill. conventional units	657.600	693.700	187.400	248.900	152.700	87.400	39.600	86.400	84.200	104.600
Glass containers and bottles, mill. units	165.500	153.000	138.800	138.200	133.400	184.000	165.200	172.200	189.100	125.200
Fiberglass products, tonnes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other products not included elsewhere, tonnes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Flat glass for windows, thousand m^2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Glass jars, mill. conventional units	156.200	148.800	137.400	107.400	98.900	103.100	121.300	98.700	80.700	92.200
Glass containers and bottles, mill. units	260.500	228.300	296.100	281.400	308.000	354.639	321.450	302.716	284.707	201.299
Fiberglass products, tonnes	NO	NO	NO	NO	NO	0.055	0.011	40.638	32.612	14.785
Other products not included elsewhere, tonnes	NO	NO	NO	NO	NO	141.184	291.123	77.990	87.905	61.682
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Flat glass for windows, thousand m^2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Glass jars, mill. conventional units	99.800	107.408	145.204	170.493	212.537	216.521	236.326	198.240	324.870	308.010
Glass containers and bottles, mill. units	246.213	326.270	223.109	272.534	243.722	228.942	218.546	205.973	235.067	215.025
Fiberglass products, tonnes	18.148	26.365	392.821	1711.140	1917.709	2124.277	2330.846	2537.415	2743.983	2755.532
Other products not included elsewhere, tonnes	35.988	51.108	63.127	89.829	147.435	182.205	150.750	69.392	6.884	21.751

Source: Statistical Yearbooks of the RM for the years 1988 (page 228), 1994 (page 287), 1999 (page 303), 2003 (page 393), 2004 (page 443), 2005 (pages 321-322), 2006 (page 312); Statistical Yearbooks of the ATULBD for the years 1998 (page 180), 2000 (page 100), 2002 (page 104), 2005 (page 94), 2007 (page 93), 2010 (page 93). Statistical Reports PRODMOLD-A „Total production, as a natural expression, in the Republic, by product type, for 2005-2019'.

With reference to the national specific values of the share of recyclable glass in the production process of sterilized jars, containers and glass bottles, the information was received through questionnaires from the state enterprise 'Chisinau Glass Factory', and from the 'Glass Container Company' in Chisinau, respectively. The share of these enterprises in the total glass production at national level was taken into account, thus determining the weighted average value of the CR coefficient.

The default EF for glass used to produce jars, glass containers and bottles represents 210 kg CO_2 per ton of glass produced. Country-specific (CS) emission factors (EF) were calculated considering the annual country-specific CR values (Table 4-22).

Table 4-22: Country Specific Emission Factors Used to Estimate CO_2 Emissions from Glass Production (glass jars, glass containers and bottles), 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Average value of CR in the production process of glass jars, glass containers and bottles, %	49.7	51.0	47.8	57.5	81.1	77.8	59.4	76.8	76.8	79.7
CS EF, kg CO_2/t glass used for the production of glass jars, glass containers and bottles	105.6	102.9	109.6	89.3	39.7	46.7	85.4	48.7	48.7	42.7
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Average value of CR in the production process of glass jars, glass containers and bottles, %	51.2	50.6	44.7	44.5	46.0	45.4	39.8	43.0	30.7	31.4
CS EF, kg CO_2/t glass used for the production of glass jars, glass containers and bottles	102.4	103.7	116.0	116.6	113.4	114.7	126.4	119.7	145.6	144.0
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Average value of CR in the production process of glass jars, glass containers and bottles, %	32.6	31.5	29.6	24.4	22.9	19.0	18.8	14.4	12.3	15.3
CS EF, kg CO_2/t glass used for the production of glass jars, glass containers and bottles	141.6	143.8	147.8	158.7	161.9	170.2	170.5	179.7	184.3	177.8

Source: SOE 'Chisinau Glass Factory', Official Letter No. 31 dated 21.02.2011, as a response to request No. 03-07/175 dated 02.02.2011; Letter No. 9/01-01 dated 16.01.2014, as a response to request No. 320/2014-01-01 dated 03.01.2014; Letter No. 16 dated 12.02.2015 as a response to request No. 407/2015-01-09 dated 29.01.2015; Letter No. 86 dated 19.05.2016, as a response to request No. 512/2016-05-01 dated 10.05.2016; Letter from 20.02.2018, as a response to request No. 601/2017-12-03 dated 14.12.2017; Letter from 28.02.2020, as a response to request No. 08-310/1 dated 11.02.2020; Glass Container Company Chisinau, Letter from 28.02.2011, as a response to request No. 03-07/175 dated 02.02.2011; Letter No. 01-1C-78 dated 19.02.2014, as a response to request No. 320/2014-01-01 dated 03.01.2014; Letter No. 01-3C-63 dated 30.03.2015, as a response to request No. 407/2015-01-09 dated 29.01.2015; Letter from 23.05.2016, as a response to request No. 512/2016-05-01 dated 10.05.2016; Letter from 23.02.2018, as a response to request No. 601/2017-12-03 dated 14.12.2017; Letter from 02.06.2020, as a response to request No. 08-310/1 dated 11.02.2020.

As for other types of glass produced in the Republic of Moldova, default EF values available in the 2006 IPCC Guidelines were used (Volume 3, Chapter 2.4, Table 2.6, Page 2.30).

In order to convert the AD in metric mass units (kilotons), a series of conversion coefficients were used: the specific density of flat glass for windows used in the construction sector[57] – 2.5 g/cm^3; the

[57] National Report of the Russian Federation on the Inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for 1990-2014, developed and in accordance with the obligations of the Russian Federation under the United Nations Framework Convention on Climate Change and the Kyoto Protocol to the United Nations Framework Convention on Climate Change. Moscow, 2016. 476 p.

average thickness of flat glass for windows used in the construction sector – 3.5 mm; the average thickness of multi-layer insulating glass used in construction – 6.75 mm[58]; the average weight of a conventional glass container – 0.43 kg; the average weight of a glass jar – 0.25 kg[59].

It should be noted that since 1993, flat glass is no longer produced in the Republic of Moldova, glass bottles for the wine industry are produced only on the right bank of the Dniester River while the production of glass jars for the canning industry on the left bank of Dniester River was stopped in 2009. AD on glass production in the Republic of Moldova, is available below (Table 4-23).

Table 4-23: AD on Glass Production within 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Flat glass for windows	1.978	2.511	1.610	NO	NO	NO	NO	NO	NO	NO
Glass jars	164.400	173.425	46.850	62.225	38.175	21.850	9.900	21.600	21.050	26.150
Glass containers and bottles	79.440	73.440	66.624	66.336	64.032	88.320	79.296	82.656	90.768	60.096
Fiberglass products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other products not included elsewhere	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total glass produced in the RM	**245.818**	**249.376**	**115.084**	**128.561**	**102.207**	**110.170**	**89.196**	**104.256**	**111.818**	**86.246**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Flat glass for windows	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Glass jars	39.050	37.200	34.350	26.850	24.725	25.775	30.325	24.675	20.175	23.050
Glass containers and bottles	125.040	109.584	142.128	135.072	147.840	170.227	154.296	145.304	136.659	96.624
Fiberglass products	NO	NO	NO	NO	NO	0.00006	0.00001	0.041	0.033	0.015
Other products not included elsewhere	NO	NO	NO	NO	NO	0.141	0.291	0.078	0.088	0.062
Total glass produced in the RM	**164.090**	**146.784**	**176.478**	**161.922**	**172.565**	**196.143**	**184.912**	**170.097**	**156.955**	**119.750**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Flat glass for windows	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Glass jars	24.950	26.852	36.301	42.623	53.134	54.130	59.082	49.560	81.218	77.003
Glass containers and bottles	118.182	156.610	107.092	130.816	116.987	109.892	104.902	98.867	112.832	103.212
Fiberglass products	0.018	0.026	0.393	1.711	1.918	2.124	2.331	2.537	2.744	2.756
Other products not included elsewhere	0.036	0.051	0.063	0.090	0.147	0.182	0.151	0.069	0.007	0.022
Total glass produced in the RM	**143.186**	**183.539**	**143.849**	**175.240**	**172.186**	**166.329**	**166.465**	**151.034**	**196.801**	**182.992**

For comparison, the table below presents AD on glass production at two glass factories in Chisinau municipality (Table 4-24). The share of glass produced at the respective factories varies in time between 70 and 94 per cent of the total glass production in the Republic of Moldova.

Table 4-24: AD on glass production at two glass factories in Chisinau for the period 2002-2019, kt

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Glass Factory No.1, Chisinau	84.706	81.837	88.121	80.579	69.956	60.240	48.026	47.267	47.143
"Glass Container Factory", Chisinau	59.096	56.358	50.264	61.122	59.028	62.741	61.174	59.265	60.110
Total	**143.802**	**138.195**	**138.385**	**141.701**	**128.984**	**122.981**	**109.200**	**106.532**	**107.254**
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Glass Factory No.1, Chisinau	34.932	47.040	61.566	59.792	57.407	35.661	28.185	60.159	60.860
"Glass Container Factory", Chisinau	97.119	84.381	59.108	57.869	94.101	96.685	119.373	123.347	104.869
Total	**132.051**	**131.421**	**120.674**	**117.661**	**151.508**	**132.346**	**147.558**	**183.506**	**165.729**

Source: SOE Glass Factory, Chisinau, Letter No. 31 dated 21.02.2011, as a response to request No. 03-07/175 dated 02.02.2011; Letter No. 9/01-01 dated 16.01.2014, as a response to request No. 320/2014-01-01 dated 03.01.2014; Letter No. 16 dated 12.02.2015, as a response to request No. 407/2015-01-09 dated 29.01.2015; Letter No. 86 dated 19.05.2016, as a response to request No. 512/2016-05-01 dated 10.05.2016; Letter from 20.02.2018, as a response to request No. 601/2017-12-03 dated 14.12.2017; Letter from 28.02.2020, as a response to request No. 08-310/1 dated 11.02.2020; Glass Container Company Chisinau, Letter from 28.02.2011, as a response to request No. 03-07/175 dated 02.02.2011; Letter No. 01-1C-78 dated 19.02.2014, as a response to request No. 320/2014-01-01 dated 03.01.2014; Letter No. 01-3C-63 dated 30.03.2015, as a response to request No. 407/2015-01-09 dated 29.01.2015; Letter from 23.05.2016, as a response to request No. 512/2016-05-01 dated 10.05.2016; Letter from 23.02.2018, as a response to request No. 601/2017-12-03 dated 14.12.2017; Letter from 02.06.2020, as a response to request No. 08-310/1 dated 11.02.2020.

Default EF values used for NO_x, NMVOC and SO_2 are shown in Table 4-25.

Table 4-25: Default EFs used to estimate indirect GHG emissions from glass production

Category	Process Description	NO_x	NMVOC	SO_2
		g/t		
Mineral Industry	Glass Production (flat glass for windows, glass containers, specialty glass, glass for glassware and tableware, fiberglass, etc.)	2930	6.13	1960

Source: : EMEP/EEA Atmospheric Emissions Inventory Guidebook, November, 2019, SNAP Code 030314-030317 Glass, Category 1.A.2.f.i, Table 3-26.

2A4 'Other Process Uses of Carbonates'

2A4a 'Ceramics'

Methodological issues regarding the estimation of CO_2 emissions resulting from the production of bricks, expanded clay and ceramics are addressed in the 2006 IPCC Guidelines for National Green-

[58] Airapetov G.A., Bezrodnii O.C., Jolobov A.L. (2005), Building materials: teaching handbook. – Rostov-on-Don, Phoenix, 2005.

[59] Methodological recommendations for the voluntary inventory of Greenhouse Gas Emissions in the constituent entities of the Russian Federation. Appendix 1. Reference guide for conducting voluntary inventory of GHG emissions in the constituent entities of the Russian Federation. Part III. Industrial Processes and Product Use. Ministry of Natural Recourses and Ecology of the Russian Federation. Moscow 2015. <http://www.mnr.gov.ru/regulatory/detail.php?ID=140995>.

house Gas Inventories (Volume 3, Chapter 2.5, Pages 2.32-2.40, respectively by considering the data available in Volume 3, Chapter 2.1, Table 2.1, Page 2.7).

In the process of ceramics production, CO_2 emissions result from the calcination of the raw material used. Similar to the cement and lime production processes, carbonates are heated to high temperatures in a kiln, producing CO_2 emissions, which can be estimated by multiplying the annual data on the amount of carbonates used with a specific emission factor that takes into account the CaO and MgO content.

$$CO_2\ emissions = M_c \bullet EF_{c,}$$

Where:

M_c – mass of carbonate consumed for bricks and ceramics production (tonnes);

EF_c – emission factor for carbonates calcination (t CO_2/t).

In the calcination of the carbonates in the clay, each mole of CaO and MgO respectively, forms one mole of CO_2. This principle was used for the development of specific values of emission factors.

$$EF = Mass\ Ratio\ (CO_2/CaO) \bullet CaO\ Content\ in\ clay + Mass\ Ratio\ (CO_2/MgO) \bullet MgO\ Content\ in\ clay$$

It should be noted that the content of CaO in clay varies between 6-9 per cent, whereas the content of MgO between 2-4 per cent, respectively[60]. The data provided by the main national producer of bricks (the share of bricks production from 'MACON' JSC between 1998 and 2019 varied from a minimum of 46.2 per cent in 2004 to a maximum of 83.7 per cent in 2018 from the national total) was used to calculate the annual values of the country-specific EF used to estimate CO_2 emissions from bricks and ceramics production in the RM in Table 4-26, according to which the annual emission factor values varied in the period 1990-2019 between a minimum of 72.9 kg of CO_2 per ton of clay consumed (in 2007) and a maximum of 103.8 kg of CO_2 per ton of clay consumed (in 2016). According to the information available in the 2006 IPCC Guidelines (Volume 3, Chapter 2.5, page 2.34), the value of the default emission factor utilised is 100 kg of CO_2 per ton of clay consumed or 10 per cent of the mass of carbonates used as raw material.

Table 4-26: Country Specific Emission Factors Used to Estimate CO_2 Emissions from Bricks, Expanded Clay and Ceramics Production, 1990-2019

Indicators	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Content of CaO in clay used	0.0844	0.0844	0.0844	0.0844	0.0844	0.0844	0.0844	0.0822	0.0822	0.0822
Mass Ratio CO_2/CaO	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
EF, t CO_2/t clay used (only CaO)	0.0662	0.0662	0.0662	0.0662	0.0662	0.0662	0.0662	0.0645	0.0645	0.0645
Content of MgO in clay used	0.0303	0.0303	0.0303	0.0303	0.0303	0.0303	0.0303	0.0357	0.0357	0.0357
Mass Ratio CO_2/MgO	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
EF, t CO_2/t clay used (only MgO)	0.0331	0.0331	0.0331	0.0331	0.0331	0.0331	0.0331	0.0390	0.0390	0.0390
EF, t CO_2/t clay used (total)	**0.0993**	**0.0993**	**0.0993**	**0.0993**	**0.0993**	**0.0993**	**0.0993**	**0.1035**	**0.1035**	**0.1035**
Indicators	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Content of CaO in clay used	0.0822	0.0800	0.0787	0.0753	0.0710	0.0534	0.0606	0.0509	0.0529	0.0757
Mass Ratio CO_2/CaO	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
EF, t CO_2/t clay used (only CaO)	0.0645	0.0628	0.0618	0.0591	0.0557	0.0419	0.0476	0.0399	0.0415	0.0594
Content of MgO in clay used	0.0357	0.0355	0.0354	0.0351	0.0321	0.0302	0.0304	0.0302	0.0305	0.0319
Mass Ratio CO_2/MgO	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
EF, t CO_2/t clay used (only MgO)	0.0390	0.0388	0.0387	0.0383	0.0351	0.0330	0.0332	0.0330	0.0334	0.0349
EF, t CO_2/t clay used (total)	**0.1035**	**0.1015**	**0.1005**	**0.0974**	**0.0908**	**0.0749**	**0.0808**	**0.0729**	**0.0748**	**0.0943**
Indicators	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Content of CaO in clay used	0.0773	0.0733	0.0669	0.0889	0.0898	0.0909	0.0922	0.0874	0.0885	0.0814
Mass Ratio CO_2/CaO	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
EF, t CO_2/t clay used (only CaO)	0.0607	0.0575	0.0525	0.0698	0.0705	0.0713	0.0723	0.0686	0.0695	0.0638
Content of MgO in clay used	0.0326	0.0314	0.0283	0.0285	0.0286	0.0288	0.0289	0.0289	0.0299	0.0291
Mass Ratio CO_2/MgO	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
EF, t CO_2/t clay used (only MgO)	0.0356	0.0343	0.0310	0.0311	0.0312	0.0315	0.0315	0.0316	0.0327	0.0318
EF, t CO_2/t clay used (total)	**0.0963**	**0.0918**	**0.0834**	**0.1009**	**0.1017**	**0.1028**	**0.1038**	**0.1002**	**0.1022**	**0.0957**

Source: MACON JSC, through Letter No. 01/01-R dated 17.01.2014, as a response to the Climate Change Office's interpellation No. 320/2014-01-01 dated 03.01.2014; Letter No. 17/01-G dated 09.02.2015, as a response to the Climate Change Office's interpellation No.407/2015-01-09 dated 29.01.2015; Letter No. 28/01-V dated 28.06.2016, as a response to the Climate Change Office's interpellation No. 512/2016-05-01 dated 10.05.2016; Letter from 07.08.2020, as a response to the Environment Agency's interpellation No. 08-310/1 dated 11.02.2020.

Activity data on brick production (*expressed in million conventional unit)* are available in the Statistical Yearbooks of the Republic of Moldova and those of the ATULBD (Table 4-27).

[60] In conformity with the information provided by 'MACON' JSC, the average content of CaO in clay extracted in Purcel quarry is circa 8.44 per cent, in Pruncul quarry – 8.22 per cent, in Micauti – 6.70 per cent, in Haruza Mica – 6.66 per cent; while the average content of MgO in clay extracted in Purcel quarry is 3.03 per cent, in Pruncul – 3.57 per cent, in Micautil – 2.93 per cent, and in Haruza Mica – 2.60 per cent.

Table 4-27: AD on Brick Production within 1990-2019, million conventional units

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM: right bank of Dniester River	190.500	177.500	83.200	149.700	64.300	39.200	37.200	47.700	48.700	44.800
RM: left bank of Dniester River	45.000	40.000	35.000	30.000	25.000	20.000	16.000	12.000	7.000	12.000
RM: total	**235.500**	**217.500**	**118.200**	**179.700**	**89.300**	**59.200**	**53.200**	**59.700**	**55.700**	**56.800**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
RM: right bank of Dniester River	39.900	38.100	45.800	52.200	54.900	55.700	52.800	55.900	53.000	38.100
RM: left bank of Dniester River	13.000	15.000	17.000	16.000	21.000	18.000	18.000	19.000	20.697	13.523
RM: total	**52.900**	**53.100**	**62.800**	**68.200**	**75.900**	**73.700**	**70.800**	**74.900**	**73.697**	**51.623**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
RM: right bank of Dniester River	37.373	40.995	28.325	35.765	35.895	37.775	34.571	30.600	33.008	36.544
RM: left bank of Dniester River	11.582	13.010	14.657	14.618	14.669	9.063	9.305	8.521	5.529	6.750
RM: total	**48.955**	**54.005**	**42.982**	**50.383**	**50.564**	**46.838**	**43.876**	**39.121**	**38.537**	**43.294**

Source: Statistical Yearbooks for the years 1988 (page 228), 1994 (page 287), 1999 (page 303), 2005 (page 322), 2010 (page 305); Statistical Yearbooks of the ATULBD for the years 1998 (page 177), 2000 (page 99), 2002 (page 103), 2005 (page 94), 2006 (page 93), 2007 (page 92), 2009 (page 92), 2010 (page 93), 2011 (page 94), 2012 (page 98), 2013 (page 99), 2014 (page 88), 2015 (page 88), 2016 (page 98), 2017 (page 101), 2019 (page 99), 2020 (page 102); Statistical Reports PRODMOLD-A „Total production, as a natural expression, in the Republic, by product type, for 2005-2019".

To convert the AD in metric mass units (kilotons), conversion coefficients were used based on the data available on the web pages of national and foreign construction companies[61]. According to them, the standard size of a conventional brick is: 250 x 120 x 65 mm, with a specific density variation between 1500 and 1900 kg/m^3 (in the RM – between 1020 and 1869 kg/m^3). Under these circumstances, the volume of a conventional brick is – 0.25 • 0.12 • 0.065 = 0.00195 m^3; the minimum weight – 1020 • 0.00195/1 = 1.989 kg; the maximum weight – 1869 • 0.00195/1 = 3.644 kg; the average weight – 1444.5 • 0.00195/1 = 2.817 kg; this particular value was used in order to calculate the weight in tonnes in the national production of bricks. At the same time, in order to estimate the mass of carbonates used for brick production, the method recommended by the 2006 IPCC Guidelines was utilised; the mass of clay used for brick production is determined by multiplying total brick production (in kilotons) by the default factor – 1.1 (Volume 3, Chapter 2.5, Page 2.36) (Table 4-28).

Table 4-28: AD on the amount of clay used in brick production in the RM between 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total brick production, kt	663.3505	612.6486	332.9428	506.1745	251.5380	166.7531	149.8524	168.1615	156.8944	159.9928
Clay used in brick production, kt	729.6856	673.9134	366.2371	556.7919	276.6918	183.4284	164.8377	184.9776	172.5838	175.9921
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Total brick production, kt	149.0074	149.5708	176.8935	192.1041	213.7932	207.5963	199.4277	210.9764	207.5879	145.4104
Clay used in brick production, kt	163.9081	164.5278	194.5828	211.3145	235.1725	228.3559	219.3704	232.0741	228.3467	159.9514
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Total brick production, kt	137.8941	152.1211	121.0700	141.9181	142.4287	131.9335	123.5886	110.1951	108.5489	121.9488
Clay used in brick production, kt	151.6835	167.3332	133.1770	156.1100	156.6715	145.1268	135.9475	121.2146	119.4038	134.1437

AD regarding expanded clay production between 2001 and 2019 (*expressed in thousand m^3*) was provided directly by MACON JSC, the only expanded clay producer in the RM (Table 4-29).

Table 4-29: Activity Data on the Amount of Clay Used in Expanded Clay Production, 2001-2019

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Expanded clay production, thousand m^3	3.5958	17.1730	12.7545	55.0500	63.4000	72.2000	80.5550	64.9630	61.1990	61.4200
Specific weight, kg/m^3	390.1	388.9	387.3	371.1	392.9	399.7	385.4	376.2	399.4	353.3
Expanded clay production, kt	1.4028	6.6791	4.9394	20.4307	24.9067	28.8591	31.0435	24.4384	24.4404	21.6991
Clay used, t/m^3 expanded clay	0.715	0.711	0.717	0.731	0.710	0.711	0.550	0.624	0.629	0.572
Clay used in expanded clay production, kt	**2.5710**	**12.2100**	**9.1450**	**40.2416**	**45.0140**	**51.3342**	**44.3053**	**40.5369**	**38.4942**	**35.1322**
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Expanded clay production, thousand m^3	30.3630	38.1500	42.0110	34.5680	22.9780	19.5810	26.7040	30.4175	34.1310	NA
Specific weight, kg/m^3	324.8	403.5	376.9	375.7	389.8	368.1	377.5	375.9	374.3	NA
Expanded clay production, kt	9.8631	15.3939	15.8331	12.9875	8.9568	7.2078	10.0808	11.4339	12.7752	NA
Clay used, t/m^3 expanded clay	0.617	0.717	0.639	0.639	0.680	0.703	0.673	0.658	0.642	NA
Clay used in expanded clay production, kt	**18.7340**	**27.3536**	**26.8450**	**22.0890**	**15.6250**	**13.7654**	**17.9718**	**19.9995**	**21.9121**	**NA**

Source: MACON JSC, through Letter No. 01/01-R dated 17.01.2014, as a response to the Climate Change Office's interpellation No. 320/2014-01-01 dated 03.01.2014; Letter No. 17/01-G dated 09.02.2015, as a response to the Climate Change Office's interpellation No. 407/2015-01-09 dated 29.01.2015; Letter No. 28/01-V dated 28.06.2016, as a response to the Climate Change Office's interpellation No. 512/2016-05-01 dated 10.05.2016; Letter from 07.08.2020, as a response to the Environment Agency's interpellation No. 08-310/1 dated 11.02.2020.

Activity data on ceramics production for the period 2005-2019 was provided by National Bureau of Statistics, the information being available in the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic, by product type' in Table 4-30, according to which AD regarding roof tile production is available in pieces. In order to transform this data into tonnes, the

[61] <http://aquagroup.ru/articles/ves-kirpicha.html>, <http://www.lucceram.ro/index.php/products>.

following conversion factor was used: one piece of roof tile has an average weight of circa 4 kg. The value of the conversion factor is determined by the National Standard of the Russian Federation GOST R 56688-2015[62]. According to this, the mass of 1 m^2 of roof tile varies between 54 and 74 kg, while 1 m^2 of light roof tile contains circa 14.8-16.6 pieces with an average weight of circa 3.4 kg, and 1 m^2 of heavy roof tile contains circa 15-17 pieces with an average weight of circa 4.6 kg. As a comparison, web pages of companies importing roof tiles in the Republic of Moldova and Romania were consulted[63], and similar values of the conversion factors were found.

Table 4-30: AD regarding the amount of clay utilised in ceramics production, 2005-2019

	2005	2006	2007	2008	2009	2010	2011	2012
Roof tiles, pieces	243.510	182.978	288.253	223.355	86.665	7.210	66.870	4.550
Non-refractory ceramics for construction, tonnes	303.800	260.800	201.300	150.500	138.800	68.900	55.400	12.700
Table and ornamental ware (household ceramics), tonnes	579.719	478.955	838.189	276.802	188.722	169.089	136.854	118.369
Wall and floor tiles, thousand m^2	625.200	734.000	1248.500	808.700	9.800	1.900	1.600	0.700
Total ceramics produced, kt	1.8906	1.5105	2.2586	1.3635	0.6747	0.2669	0.4598	0.1493
Total clay used to produce ceramics, kt	**2.0797**	**1.6616**	**2.4844**	**1.4999**	**0.7422**	**0.2936**	**0.5058**	**0.1642**
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Roof tiles, pieces	1.890	3.220	4.550	5.880	7.210	8.540	9.870	NA
Non-refractory ceramics for construction, tonnes	24.400	35.525	46.650	57.775	68.900	80.025	91.150	NA
Table and ornamental ware (household ceramics), tonnes	89.630	105.969	89.866	92.231	57.242	38.246	47.744	NA
Wall and floor tiles, thousand m^2	0.500	0.600	1.500	248.200	1248.500	834.185	557.361	NA
Total ceramics produced, kt	0.1216	0.1544	0.1548	0.1867	0.2210	0.1966	0.2079	NA
Total clay used to produce ceramics, kt	**0.1338**	**0.1698**	**0.1703**	**0.2053**	**0.2431**	**0.2162**	**0.2287**	**NA**

Source: Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic, by product type for 2005-2019'.

AD regarding the production of wall and floor tiles is available in thousand m^2. In order to transform this data, the following conversion factor was used: 18.9 kg for 1 m^2 of wall and floor tiles (Table 4-31), determined after consulting the web pages of those companies that sell these product[64]. In comparison, similar conversion factors used in the Russian Federation are 19 kg for 1 m^2 of floor tiles and 14 kg for 1 m^2 of wall tiles[65].

Table 4-31: Data used to determine the average value of the conversion factor used to transform AD from thousand m^2 into kilotons for wall and floor tiles

Size of one floor tile, cm	Weight, kg per 1 m^2	Size of a wall tile, cm	Weight, kg per 1 m^2
14.7 x 44.5	20.7	10 x 10	13.5
15.0 x 44.5	19.9	20 x 30	12.1
30 x 30	15.9	25 x 40	13.6
33 x 33	17.0		
33.3 x 33.3	16.3	20.2 x 40.2	11.7
33.5 x 33.5	16.1		
30 x 60	22.7	25.2 x 40.2	13.8
42 x 42	20.4		
45 x 45	20.7	25.0 x 50.3	17.2
Average	**18.9**	**Average**	**13.6**

In order to estimate the mass of carbonates used in the production of ceramics, the methodological approach recommended by the 2006 IPCC Guidelines was utilised; the mass of clay used for ceramics production is determined by multiplying total production (kt) by the default factor – 1.1 (Volume 3, Chapter 2.5, Page 2.36)

The methodology for the estimation of indirect GHG emissions from brick and ceramics production is available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019) (Table 4-32).

Table 4-32: EF Used to Estimate Indirect GHG Emissions from Brick and Ceramics Production

Category	Process Description	NO_x	CO	SO_2
		g/t		
Mineral Industry	Brick and Ceramics Production	184	189	39.6

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook, 2019, SNAP Code 030319 Brick and Ceramics, Category 1.A.2.f.i, Table 3-28.

[62] Federal Agency for Technical Regulation and Metrology, National Standard of the Russian Federation, GOST R 56688—2015, Ceramic tiles. Specifications. <http://allgosts.ru/91/100/gost_r_56688-2015>.
[63] <http://www.acoperisuldetigla.ro/tigla-ceramica-tondach/>, <https://acoperisuldetigla.wordpress.com/tigla-ceramica-siceram/>.
[64] <http://www.cesarom.ro/calculator-placi-gresie-si-faianta>.
[65] National Report of the Russian Federation on the Inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for 1990-2014, developed and in accordance with the obligations of the Russian Federation under the United Nations Framework Convention on Climate Change and the Kyoto Protocol to the United Nations Framework Convention on Climate Change. Moscow, 2016. 476 p.

2A4b 'Other Uses of Soda Ash'

Methodological issues regarding the estimation of CO_2 emissions from soda ash production and use are addressed in the 2006 IPCC Guidelines (Volume 3, Chapter 2.1, Table 2.1, Page 2.7; and in Chapter 2.5, Pages 2.32-2.40, respectively). Soda ash is used as raw material in a variety of industries, including glass production, soaps and detergents, pulp and paper, as well as in wastewater treatment. According to 2006 IPCC Guidelines, CO_2 emissions from other uses of soda ash should be reported in the respective end use sector where it is used. In other circumstances, in order to avoid double counting, the amount of soda ash used in the glass production industry was excluded from the calculation of CO_2 emissions within source category 2A4b 'Other Uses of Soda Ash'. Activity data on soda ash imports for 1990-2019 is available in Table 4-33, and were provided by the Customs Service (no exports were recorded during the respective time period). There is no information regarding the years 1990-1994 and, in order to fill this gap, data was reconstructed based on the evolution of glass production during the respective period. The amount of imported soda ash is not fully used in the same calendar year, some of which is kept in stock for use in the following years. The imported quantities do not thereby correspond to the annual consumption of soda ash.

Table 4-33: AD on Soda Ash Imports within 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Soda ash import, kt	67.8693	69.0646	30.8983	34.7574	27.2963	28.8486	19.6869	25.2708	20.2975	16.1479
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Soda ash import, kt	33.7542	34.6490	34.2346	30.4387	38.4227	43.7608	38.6980	34.1175	33.7002	24.2468
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Soda ash import, kt	29.0280	37.0516	22.5167	37.4016	33.8123	26.3379	25.7534	26.1895	31.4446	31.8334

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, as a response to the Climate Change Office's interpellation No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, as a response to request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, as a response to request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, as a response to request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, as a response to request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, as a response to request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

By enquiring the glass producing companies in the Republic of Moldova (SOE 'Chisinau Glass Factory No.1' and 'Glass Container Company' in Chisinau), it was identified that during the reference period, circa 90 per cent of the imported soda ash was used in glass production. The average specific consumption of soda ash in the production of one ton of glass during the reference period ranged from circa 250 kg of soda ash per ton of glass produced between 1990 and 1995 (world average consumption of soda ash in the glass industry[66]); to 200 kg of soda ash per ton of glass produced between 1996 and 2001; between a maximum of 181.1 kg and a minimum of 124.4 kg of soda ash per ton of glass produced during the period 2002-2019, respectively. These values were used to reconstruct the activity data regarding the consumption of soda ash in glass production in the Republic of Moldova for the period 1990-2019 (Table 4-34).

Table 4-34: AD on Soda Ash Consumption within 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Average soda ash consumption, kt	68.2826	69.2712	31.9678	35.7114	28.3908	30.6028	19.8213	23.1680	24.8484	19.1658
Soda ash used in the glass industry, kt	61.4544	62.3441	28.7710	32.1403	25.5518	27.5425	17.8392	20.8512	22.3636	17.2492
Soda ash used in other industries	**6.8283**	**6.9271**	**3.1968**	**3.5711**	**2.8391**	**3.0603**	**1.9821**	**2.3168**	**2.4848**	**1.9166**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Average soda ash consumption, kt	36.4644	32.6187	30.2909	27.0857	29.7078	33.6574	30.7796	28.4338	24.0916	23.3657
Soda ash used in the glass industry, kt	32.8180	29.3568	27.2618	24.3771	26.7370	30.2917	27.7016	25.5905	21.6824	21.0291
Soda ash used in other industries	**3.6464**	**3.2619**	**3.0291**	**2.7086**	**2.9708**	**3.3657**	**3.0780**	**2.8434**	**2.4092**	**2.3366**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Average soda ash consumption, kt	21.8837	29.6320	28.9443	24.2299	24.1749	29.6334	25.3664	29.8372	37.6472	33.7714
Soda ash used in the glass industry, kt	19.6954	26.6688	26.0498	21.8070	21.7574	26.6701	22.8298	26.8534	33.8825	30.3943
Soda ash used in other industries	**2.1884**	**2.9632**	**2.8944**	**2.4230**	**2.4175**	**2.9633**	**2.5366**	**2.9837**	**3.7647**	**3.3771**

Source: SOE 'Chisinau Glass Factory', Letter No. 31 dated 21.02.2011, as a response to request No. 03-07/175 dated 02.02.2011; Letter No. 9/01-01 dated 16.01.2014, as a response to request No. 320/2014-01-01 dated 03.01.2014; Letter No. 16 dated 12.02.2015, as a response to request No. 407/2015-01-09 dated 29.01.2015; Letter No. 86 dated 19.05.2016, as a response to request No. 512/2016-05-01 dated 10.05.2016; Letter from 20.02.2018, as a response to request No. 601/2017-12-03 dated 14.12.2017; Letter from 28.02.2020, as a response to request No. 08-310/1 dated 11.02.2020; Glass Container Company Chisinau, Letter from 28.02.2011, as a response to request No. 03-07/175 dated 02.02.2011; Letter No. 01-1C-78 dated 19.02.2014, as a response to request No. 320/2014-01-01 dated 03.01.2014; Letter No. 01-3C-63 dated 30.03.2015, as a response to request No. 407/2015-01-09 dated 29.01.2015; Letter from 23.05.2016, as a response to request No. 512/2016-05-01 dated 10.05.2016; Letter No from 23.02.2018, as a response to request No. 601/2017-12-03 dated 14.12.2017; Letter from 02.06.2020, as a response to request No. 08-310/1 dated 11.02.2020.

The emission factor used to calculate CO_2 emissions from soda ash use is estimated using the stoichiometry of the chemical process according to the following equation:

[66] Russian Center for Foreign Trade. Conjuncture, goods and markets. Soda ash on the international market. <http://www.rusimpex.ru/Content/Economics/Conjuncture/99_11002.htm>.

$$EF_{sa} = 44.0099\ g/mole\ CO_2 / 106.0685\ g/mole\ Na_2CO_3 = 0.41492\ t\ CO_2 / t\ Na_2CO_3$$

CO_2 emissions from soda ash use are estimated using the following equation:

$$Total_{sa} = A_{sa} \bullet EF_{sa}$$

Where:

- $Total_{sa}$ – CO_2 emissions from soda ash use (kt);
- A_{sa} – soda ash consumption (kt);
- EF_{sa} – default emission factor used (0.41492 t CO_2/t of soda ash).

4.2.3. Uncertainties Assessment and Time-Series Consistency

2A1 'Cement Production'

The EF related uncertainties are considered to be circa 3 per cent. The activity data related uncertainties was also estimated as being low (±2 per cent), in the case of AD provided by Lafarge Cement (Moldova) JSC, uncertainties account for circa 1 per cent and are provided directly by the producer, while in the case of Cement and Slake Integrated Works in Ribnita, uncertainties reach up to circa 3 per cent and are collected from statistical publications. Combined uncertainties related to GHG emissions from source category 2A1 'Cement Production' are thereby considered to represent circa 3.61 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

2A2 'Lime Production'

The EF related uncertainties are considered to account for circa 2 per cent. The activity data related uncertainties was estimated at circa 10 per cent, as a result of indirect generation of activity data on lime production directly by auto-producers (sugar factories) as well as due to the correction factor used for hydrated lime. Combined uncertainties related to GHG emissions from source category 2A2 'Lime Production' thereby account for circa 10.20 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

2A3 'Glass Production'

The EF related uncertainties used within the Tier 2 method account for circa 10 per cent (2006 IPCC Guidelines). The activity data related uncertainties was estimated at circa 15 per cent, including due to the conversion in other units (from thousand m^2 and million conventional pieces to kilotons, respectively due to the use of an average value for glass containers within the conversion process from a specific unit to another type. Combined uncertainties related to GHG emissions from source category 2A3 'Glass Production' thereby account for circa 18.03 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

2A4 'Other Process Uses of Carbonates'

The EF related uncertainties used within the Tier 2 method account for circa 5 per cent (2006 IPCC Guidelines). The activity data related uncertainties was estimated at circa 20 per cent, including due to the conversion in other units (from thousand m^3, thousand m^2 and pieces to kilotons, respectively due to the indirect assessment of carbonate consumption in the production processes by using default factors, 1.1 tonnes of clay to 1.0 ton of production). Combined uncertainties related to GHG emissions from source category 2A4 'Other Process Uses of Carbonates' thereby account for circa 20.62 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

4.2.4. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for the respective source category, following a Tier 1 approach. Also, verification was focused on ensuring correct use of the emission factors, including default EF, available in the 2006 IPCC Guidelines; verification was also focused on correct use of AD obtained from different sources of reference, including official sources, especially in case of converting AD into mass units compatible with GHG emissions estimation methods; comparing the results obtained by using different estimating methodologies and explaining the identified discrepancies, etc. AD and methods used for estimating GHG emissions under category 2A 'Mineral Industry' were documented and archived both in hard copies and electronically.

4.2.5. Recalculations

2A1 'Cement Production'

Compared to the results included into the BUR2 of the RM under UNFCCC (2019), GHG emissions from the clinker production were not recalculated in the current inventory cycle. For the period 2017-2019, the respective emissions were estimated for the first time. Between 1990 and 2019, GHG emissions from cement production decreased by circa 47 per cent (Table 4-35).

Table 4-35: GHG emissions from the 2A1 'Cement Production' in the RM, 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	971.6967	900.7877	474.3138	405.7165	328.4361	248.5258	193.1220	270.1273	215.0572	210.8122
NO_x	2.2355	2.0682	1.0912	0.9338	0.7552	0.5705	0.4434	0.6207	0.4937	0.4844
CO	2.6210	2.4249	1.2794	1.0949	0.8854	0.6689	0.5198	0.7278	0.5788	0.5680
NMVOC	0.0324	0.0300	0.0158	0.0135	0.0110	0.0083	0.0064	0.0090	0.0072	0.0070
SO_2	0.6737	0.6233	0.3289	0.2814	0.2276	0.1719	0.1336	0.1871	0.1488	0.1460
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2	172.7600	173.8847	219.1917	245.6276	282.5765	365.0817	457.0753	702.6656	789.9160	340.5679
NO_x	0.3975	0.3995	0.5048	0.5618	0.6524	0.8422	1.0555	1.6161	1.8448	0.7959
CO	0.4660	0.4684	0.5919	0.6586	0.7649	0.9874	1.2376	1.8948	2.1630	0.9331
NMVOC	0.0058	0.0058	0.0073	0.0081	0.0095	0.0122	0.0153	0.0234	0.0268	0.0115
SO_2	0.1198	0.1204	0.1521	0.1693	0.1966	0.2538	0.3181	0.4870	0.5560	0.2398
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CO_2	349.8333	427.2624	442.1615	476.9104	464.6082	443.2441	433.9022	404.9290	511.1209	523.8755
NO_x	0.8135	0.9986	1.0335	1.1139	1.0820	1.0311	1.0040	0.9420	1.1891	1.2187
CO	0.9538	1.1709	1.2118	1.3060	1.2686	1.2089	1.1771	1.1045	1.3941	1.4289
NMVOC	0.0118	0.0145	0.0150	0.0162	0.0157	0.0150	0.0146	0.0137	0.0172	0.0177
SO_2	0.2452	0.3010	0.3115	0.3357	0.3261	0.3107	0.3026	0.2839	0.3584	0.3673

2A2 'Lime Production'

CO_2 emissions from lime production were recalculated for the period 1990-2016 as a result of updating the activity data on the amount of lime produced by auto-producers (in the current inventory cycle, information from sugar factories Sudzucker-Moldova SRL and Moldova-Sugar Ltd. were received, the market share of these two enterprises varied in the period 2013-2019 between 92.6 and 99.9 per cent of the total amount of sugar produced in the Republic of Moldova). Compared to the values recorded in BUR2 of the RM to the UNFCCC (2019), the changes undertaken resulted in an upward trend in CO_2 emissions in the period 1990-2000, ranging from a minimum increase of 2.1 per cent in 2000 to a maximum increase of 13.7 per cent in 1990; respectively, in a tendency to reduce CO_2 emissions in the period 2001-2016, varying from a minimum decrease of 0.3 per cent in 2001 to a maximum decrease of 39.2 per cent in 2014. CO_2 emissions from lime production for the years 2017-2019 were calculated for the first time. In the period 1990-2019, CO_2 emissions from lime production decreased by about 89.6 per cent (Table 4-36).

Table 4-36: Comparative results of inventoried CO_2 emissions from lime production included in the BUR2 and the BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	232.4996	176.5179	103.7620	100.6076	76.1330	69.3788	89.0847	75.7247	64.8141	36.6099
BUR3	264.3143	192.2260	116.1612	112.7887	83.8378	78.0227	97.7677	81.2988	68.5945	37.8903
Difference, %	13.7	8.9	11.9	12.1	10.1	12.5	9.7	7.4	5.8	3.5
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	30.7649	28.5383	39.4860	22.0253	22.8789	31.5025	35.1917	24.9579	35.5041	10.5446
BUR3	31.4020	28.4519	38.2546	20.5213	20.5790	27.8408	30.1048	21.9382	29.1378	8.4641
Difference, %	2.1	-0.3	-3.1	-6.8	-10.1	-11.6	-14.5	-12.1	-17.9	-19.7

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	21.6512	22.0613	20.6563	30.1662	39.1904	21.7547	21.5797			
BUR3	15.3644	16.6236	15.5304	20.7696	23.8218	15.7407	13.6470	28.8043	27.7944	27.5851
Difference, %	-29.0	-24.6	-24.8	-31.1	-39.2	-27.6	-36.8			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Indirect GHG emissions from lime production for the period 1990-2019 are shown in Table 4-37. In the period 1990-2019, indirect GHG emissions from lime production had decreased by circa 89.6 per cent, as a result of the decrease in lime production in the RM.

Table 4-37: Indirect GHG emissions from source category 2A2 'Lime Production' for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	0.4875	0.3546	0.2143	0.2080	0.1546	0.1439	0.1803	0.1500	0.1265	0.0699
CO	0.6909	0.5024	0.3036	0.2948	0.2191	0.2039	0.2555	0.2125	0.1793	0.0990
SO_2	0.1125	0.0818	0.0495	0.0480	0.0357	0.0332	0.0416	0.0346	0.0292	0.0161
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NO_x	0.0579	0.0525	0.0706	0.0379	0.0380	0.0514	0.0555	0.0405	0.0537	0.0156
CO	0.0821	0.0744	0.1000	0.0536	0.0538	0.0728	0.0787	0.0573	0.0762	0.0221
SO_2	0.0134	0.0121	0.0163	0.0087	0.0088	0.0119	0.0128	0.0093	0.0124	0.0036
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	0.0283	0.0307	0.0286	0.0383	0.0439	0.0290	0.0252	0.0531	0.0513	0.0509
CO	0.0402	0.0435	0.0406	0.0543	0.0623	0.0411	0.0357	0.0753	0.0726	0.0721
SO_2	0.0065	0.0071	0.0066	0.0088	0.0101	0.0067	0.0058	0.0123	0.0118	0.0117

2A3 'Glass Production'

CO_2 emissions from glass production were recalculated for the period 1990-2016 as a result of updating activity data regarding the amount of glass produced. In the current inventory cycle, the quantities of insulating glass with multiple layers were not included in the calculation (on the grounds that the glass used in its production is imported), nor the quantities of glass mirrors (also imported). At the same time, the conversion factor associated with the average weight of a conventional glass container was updated (as a result of the survey of glass container producers, the average weight of a conventional glass container was changed from 0.43 kg to 0.48 kg). Compared to the values recorded in the BUR2 of the RM to the UNFCCC (2019), the alterations undertaken resulted in an upward trend in CO_2 emissions, varying from a minimum increase of 2.4 per cent in 2012 to a maximum increase of 10.2 per cent in 1996, except for 2015 and 2016, when a downward trend in CO_2 emissions from this source category was recorded.

Table 4-38: Comparative results of inventoried CO_2 emissions from glass production included in the BUR2 and the BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	25.2212	25.0580	11.9560	10.8638	3.7901	4.7151	6.9080	4.6608	4.9882	3.4167
BUR3	26.0951	25.8454	12.7167	11.4809	4.0547	5.1447	7.6130	5.0803	5.4490	3.6841
Difference, %	3.5	3.1	6.4	5.7	7.0	9.1	10.2	9.0	9.2	7.8
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	15.4704	14.0377	18.7603	17.2567	17.8332	20.5674	21.5950	18.7981	21.5408	16.3507
BUR3	16.8043	15.2214	20.4783	18.8812	19.5625	22.4939	23.3604	20.3570	22.8439	17.2425
Difference, %	8.6	8.4	9.2	9.4	9.7	9.4	8.2	8.3	6.0	5.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	19.5231	25.0779	20.7542	26.9857	27.1317	30.3969	30.1307			
BUR3	20.2715	26.3926	21.2592	27.8304	27.8833	28.3000	28.3761	27.1229	36.2388	32.5310
Difference, %	3.8	5.2	2.4	3.1	2.8	-6.9	-5.8			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

CO_2 emissions from glass production for the years 2017-2019 were calculated in the Republic of Moldova for the first time. In the period 1990-2019, CO_2 emissions from glass production increased by about 24.7 per cent (Table 4-38), mainly due to the decrease in the share of glass bits in batch, respectively the increase of the country-specific EF value by circa 68.4 per cent, from 105.6 kg CO_2/t of glass in 1990 to 177.8 kg CO_2/t of glass in 2019.

Table 4-39 shows indirect GHG emissions from glass production for the period 1990-2019, during which indirect GHG emissions from glass production had decreased by 25.6 per cent as a result of the decrease in glass production in the RM.

Table 4-39: Indirect GHG emissions from 2A3 'Glass Production' between 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	0.7202	0.7307	0.3372	0.3767	0.2995	0.3228	0.2613	0.3055	0.3276	0.2527
NMVOC	0.0015	0.0015	0.0007	0.0008	0.0006	0.0007	0.0005	0.0006	0.0007	0.0005
SO_2	0.4818	0.4888	0.2256	0.2520	0.2003	0.2159	0.1748	0.2043	0.2192	0.1690
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NO_x	0.4808	0.4301	0.5171	0.4744	0.5056	0.5747	0.5418	0.4984	0.4599	0.3509
NMVOC	0.0010	0.0009	0.0011	0.0010	0.0011	0.0012	0.0011	0.0010	0.0010	0.0007
SO_2	0.3216	0.2877	0.3459	0.3174	0.3382	0.3844	0.3624	0.3334	0.3076	0.2347
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	0.4195	0.5378	0.4215	0.5135	0.5045	0.4873	0.4877	0.4425	0.5766	0.5362
NMVOC	0.0009	0.0011	0.0009	0.0011	0.0011	0.0010	0.0010	0.0009	0.0012	0.0011
SO_2	0.2806	0.3597	0.2819	0.3435	0.3375	0.3260	0.3263	0.2960	0.3857	0.3587

2A4 'Other Process Uses of Carbonates'

'Brick Production'

The CO_2 emissions from brick production were recalculated for the period 2004-2016 as a result of updating the annual values of country-specific EFs, having received updated information for that period 'MACON' JSC. Compared to the values recorded in the BUR2 of the RM to the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in an insignificant downward trend in CO_2 emissions from brick production between 2004 and 2010, and in an upward trend in the aforementioned emissions during the years 2011-2016, respectively (Tab. 4-40). Between 2017 and 2019, CO_2 emissions from brick production were estimated for the first time. In this period, CO_2 emissions from brick production were decreased in the Republic of Moldova by circa 82.3 per cent due to the decrease in the amount produced in the Republic of Moldova.

Table 4-40: Comparative results of inventoried CO_2 emissions from brick production included in the BUR2 and the BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	72.4748	66.9354	36.3759	55.3025	27.4820	18.2187	16.3722	19.1439	17.8613	18.2140
BUR3	72.4748	66.9354	36.3759	55.3025	27.4820	18.2187	16.3722	19.1439	17.8613	18.2140
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	16.9634	16.7033	19.5466	20.5902	21.5493	17.1333	17.7914	16.9186	17.1157	15.2312
BUR3	16.9634	16.7033	19.5466	20.5902	21.3454	17.1148	17.7279	16.9185	17.0902	15.0758
Difference, %	0.0	0.0	0.0	0.0	-0.9	-0.1	-0.4	0.0	-0.1	-1.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	14.7756	14.0452	11.0946	13.0326	13.1012	12.1516	11.3756			
BUR3	14.6053	15.3686	11.1127	15.7471	15.9272	14.9184	14.1169	12.1409	12.1986	12.8328
Difference, %	-1.2	9.4	0.2	20.8	21.6	22.8	24.1			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Indirect GHG emissions from brick production for the period 1990-2019 are presented below (Table 4-41). In the period 1990-2019, indirect GHG emissions from brick production decreased by circa 81.6 per cent due to the decrease in the amount produced in the Republic of Moldova.

Table 4-41: Indirect GHG emissions from brick production in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	0.1221	0.1127	0.0613	0.0931	0.0463	0.0307	0.0276	0.0309	0.0289	0.0294
CO	0.1254	0.1158	0.0629	0.0957	0.0475	0.0315	0.0283	0.0318	0.0297	0.0302
SO_2	0.0263	0.0243	0.0132	0.0200	0.0100	0.0066	0.0059	0.0067	0.0062	0.0063
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NO_x	0.0274	0.0275	0.0325	0.0353	0.0393	0.0382	0.0367	0.0388	0.0382	0.0268
CO	0.0282	0.0283	0.0334	0.0363	0.0404	0.0392	0.0377	0.0399	0.0392	0.0275
SO_2	0.0059	0.0059	0.0070	0.0076	0.0085	0.0082	0.0079	0.0084	0.0082	0.0058
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	0.0254	0.0280	0.0223	0.0261	0.0262	0.0243	0.0227	0.0203	0.0200	0.0224
CO	0.0261	0.0288	0.0229	0.0268	0.0269	0.0249	0.0234	0.0208	0.0205	0.0230
SO_2	0.0055	0.0060	0.0048	0.0056	0.0056	0.0052	0.0049	0.0044	0.0043	0.0048

'Expanded Clay Production'

GHG emissions from expanded clay production were not recalculated for the period 2001-2016. For the years 2017-2019, the respective emissions were estimated in the Republic of Moldova for the first time (Table 4-42). In the period 2001-2019, CO_2 emissions from the production of expanded clay increased circa 8 times, and indirect GHG emissions – 9 times due to the increase in the amount produced in the Republic of Moldova.

Table 4-42: GHG emissions from expanded clay production for the period 2001-2019, kt

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CO_2	0.2610	1.2265	0.8911	3.6525	3.3737	4.1485	3.2299	3.0339	3.6282	3.3828
NO_x	0.0003	0.0012	0.0009	0.0038	0.0046	0.0053	0.0057	0.0045	0.0045	0.0040
CO	0.0003	0.0013	0.0009	0.0039	0.0047	0.0055	0.0059	0.0046	0.0046	0.0041
SO_2	0.0001	0.0003	0.0002	0.0008	0.0010	0.0011	0.0012	0.0010	0.0010	0.0009
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
CO_2	1.7206	2.2825	2.7079	2.2456	1.6062	1.4294	1.8001	2.0432	2.0962	NA
NO_x	0.0018	0.0028	0.0029	0.0024	0.0016	0.0013	0.0019	0.0021	0.0024	NA
CO	0.0019	0.0029	0.0030	0.0025	0.0017	0.0014	0.0019	0.0022	0.0024	NA
SO_2	0.0004	0.0006	0.0006	0.0005	0.0004	0.0003	0.0004	0.0005	0.0005	NA

'Ceramics Production'

GHG emissions from ceramics production were not recalculated for the period 2005-2016. For the years 2017-2019, the respective emissions were estimated in the Republic of Moldova for the first time (Table 4-43). Between 2005 and 2019, CO_2 emissions from ceramics production decreased by circa 86 per cent, and indirect GHG emissions, by circa 89 per cent due to the decrease in the amount produced in the Republic of Moldova.

Table 4-43: GHG emissions from ceramics production for the period 2005-2019, kt

	2005	2006	2007	2008	2009	2010	2011	2012
CO_2	0.15587	0.13427	0.18112	0.11225	0.06995	0.02827	0.04645	0.01370
NO_x	0.00035	0.00028	0.00042	0.00025	0.00012	0.00005	0.00008	0.00003
CO	0.00036	0.00029	0.00043	0.00026	0.00013	0.00005	0.00009	0.00003
SO_2	0.00007	0.00006	0.00009	0.00005	0.00003	0.00001	0.00002	0.00001
	2013	2014	2015	2016	2017	2018	2019	2020
CO_2	0.01349	0.01727	0.01750	0.02132	0.02435	0.02209	0.02187	NA
NO_x	0.00002	0.00003	0.00003	0.00003	0.00004	0.00004	0.00004	NA
CO	0.00002	0.00003	0.00003	0.00004	0.00004	0.00004	0.00004	NA
SO_2	0.00000	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	NA

'Other Uses of Soda Ash'

CO_2 emissions from the other uses of soda ash were recalculated for the period 1990-2016 due to updating information on annual consumption of soda ash in glass industry (in the current inventory cycle it is considered that circa 90 per cent of the annual consumption of soda ash is recorded in glass production, while during the previous inventory cycle – 85 per cent, considering that soda ash use in glass production represented 250 kg of soda ash per ton of glass produced[67] between 1990-1994, 200 kg of soda ash per ton of glass produced between 1995-2001, varying between 181.1 kg and 124.4 kg of soda ash per ton of glass produced between 2002-2019, the respective values being identified having enquired glass factories), and as a result of updating the information on glass production in the period 1990-2016, respectively. Compared to the values recorded in BUR2, the changes undertaken in the current inventory cycle have resulted in a downward trend in CO_2 emissions from other uses of soda ash, varying from a minimum decrease by circa 24.0 per cent in 1996 to a maximum decrease by circa 50.3 per cent in 2010. For the years 2017-2019, the respective emissions were estimated in the RM for the first time. In the period 1990-2019, CO_2 emissions from other uses of soda ash decreased by circa 50.5 per cent due to the decrease in consumption of soda ash in uses other than glass production (Table 4-44).

Table 4-44: Comparative Results of CO_2 Emissions from Other Uses of Soda Ash included into the BUR2 and the BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	4.3483	4.4249	1.9796	2.2269	1.7488	1.8483	1.0827	1.2795	1.3694	1.0700
BUR3	2.8332	2.8742	1.3264	1.4817	1.1780	1.2698	0.8224	0.9613	1.0310	0.7952
Difference, %	-34.8	-35.0	-33.0	-33.5	-32.6	-31.3	-24.0	-24.9	-24.7	-25.7
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	2.0209	1.8109	2.1628	1.9791	2.1038	2.3950	2.2793	2.0925	1.9686	1.5104
BUR3	1.5130	1.3534	1.2568	1.1238	1.2326	1.3965	1.2771	1.1798	0.9996	0.9695
Difference, %	-25.1	-25.3	-41.9	-43.2	-41.4	-41.7	-44.0	-43.6	-49.2	-35.8

[67] Russian Centre for Foreign Trade. Conjuncture. Goods and Markets. Soda Ash on the World Market. http://www.rusimpex.ru/Content/Economics/Conjuncture/99_11002.htm>.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	1.8276	2.3167	1.6064	1.9515	1.9267	1.9612	1.9523			
BUR3	0.9080	1.2295	1.2010	1.0053	1.0031	1.2296	1.0525	1.2380	1.5621	1.4012
Difference, %	-50.3	-46.9	-25.2	-48.5	-47.9	-37.3	-46.1			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

4.2.6. Planned Improvements

Possible improvements under category 2A 'Mineral Industry' aim at updating the activity data used to estimate GHG emissions within this category for the reporting period within the previous inventory cycles.

4.3. Chemical Industry (Category 2B)

4.3.1. Source Category Description

Category 2B 'Chemical Industry' comprises the following emission sources: 2B1 'Ammonia Production', 2B2 'Nitric Acid Production', 2B3 'Adipic Acid Production', 2B4 'Caprolactam, Glyoxal and Glyoxylic Acid Production', 2B5 'Carbide Production', 2B6 'Titanium Dioxide Production', 2B7 'Soda Ash Production', 2B8 'Petrochemical and Carbon Black Production', 2B9 'Fluorochemical Production' and 2B10 'Other'. Between 1990 and 2019, no emissions were registered in the Republic of Moldova under the categories 2B1-2B9 (NO). Within 2B10 'Other', NMVOC emissions in the RM were monitored from the following sources: polyethylene, acrylonitrile butadiene styrene (ABS) resins and polystyrene production.

Between 1990 and 2019, NMVOC emissions from 2B 'Chemical Industry' decreased by circa 76.2 per cent, from circa 0.0650 kt in 1990 to 0.0170 kt in 2019 (Table 4-45).

Table 4-45: NMVOC emissions from 2B10 'Other', in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Polyethylene Production	0.0125	0.0106	0.0063	0.0055	0.0028	0.0017	0.0044	0.0030	0.0030	0.0016
ABS Resins Production	0.0525	0.0438	0.0175	0.0144	0.0045	0.0043	0.0040	0.0038	0.0036	0.0034
Polystyrene Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10 'Other'	**0.0650**	**0.0544**	**0.0238**	**0.0199**	**0.0074**	**0.0060**	**0.0085**	**0.0068**	**0.0066**	**0.0050**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Polyethylene Production	0.0041	0.0050	0.0080	0.0102	0.0102	0.0111	0.0094	0.0096	0.0088	0.0070
ABS Resins Production	0.0032	0.0029	0.0023	0.0021	0.0027	0.0031	0.0025	0.0031	0.0029	0.0023
Polystyrene Production	NO	NO	NO	NO	NO	0.0007	0.0012	0.0012	0.0006	0.0007
2B10 'Other'	**0.0073**	**0.0080**	**0.0104**	**0.0123**	**0.0129**	**0.0149**	**0.0130**	**0.0139**	**0.0122**	**0.0100**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Polyethylene Production	0.0092	0.0101	0.0090	0.0098	0.0109	0.0086	0.0085	0.0080	0.0088	0.0093
ABS Resins Production	0.0045	0.0050	0.0053	0.0055	0.0052	0.0028	0.0044	0.0040	0.0064	0.0074
Polystyrene Production	0.0005	0.0006	0.0007	0.0005	0.0005	0.0005	0.0003	0.0003	0.0003	0.0002
2B10 'Other'	**0.0143**	**0.0157**	**0.0150**	**0.0159**	**0.0166**	**0.0119**	**0.0131**	**0.0123**	**0.0155**	**0.0170**

2B10 'Other'

a) *Polyethylene Production*

There are three types of polyethylene: low density polyethylene (LDPE), linear low-density polyethylene (LLDPE) and high-density polyethylene (HDPE). Polyethylene is a polymer of ethylene and has the general empirical formula $(-CH_2CH_2-)_n$. The manufacturing process used depends on the type of polymer produced. LDPE is a tough waxy polymer, with approximately 2 per cent branching between polymer chains and has a density of about 0.92 t/m^3. LDPE is generally produced by high pressure and high temperature catalytic polymerization of ethylene in a tubular or autoclave reactor. LLDPE is a crystalline polymer with no chain branching and a density comparable to that of LDPE. A low-pressure method is generally used in which ethylene and a co-monomer such as butane or hexane is catalytically polymerized. HDPE is a crystalline polymer with no chain branching and a density of about 0.96t/m^3. HDPE is produced by low pressure polymerization of ethylene in a reactor containing a liquid hydrocarbon diluent and in the presence of Ziegler catalysts. The polymer produces slurry as it forms and is filtered from the solvent. NMVOC emissions are produced primarily through leakages, and depend on the duration of the production process. Control techniques are mainly the replacement of leaking valves etc., and regular maintenance.

b) *Acrylonitrile Butadiene Styrene Resins (ABS) Production*

Acrylonitrile Butadiene Styrene (ABS) is a combination of a graft copolymer and a polymer mixture (graft copolymer – a polymer with a 'backbone' of one type of monomer and with 'ribs' of copolymers of two other monomers). ABS can be produced in three ways: (1) emulsion polymerization: it is a two-step process; in the first step a rubber latex is made, usually in a furnace; in the second step, which can be operated continuously in the furnace, styrene and acrylonitrile are polymerized in the rubber latex solution to form an ABS latex; the ABS polymer is recovered through coagulation of the ABS latex by adding a destabilising agent; the resulting slurry is filtered or centrifuged to recover the ABS resin; the ABS resin is then dried; (2) mass polymerization: two or more continuous flow reactors are used in this process; rubber is dissolved in the monomers: styrene and acrylonitrile; during the reaction, the dissolved rubber is replaced by the Styrene Acrylonitrile Copolymer (SAN) and forms rubber particles; part of the SAN is grafted onto the rubber particles; the reaction mixture contains several additives, needed in the polymerization process; the product is devolatilized to remove the unreacted monomer; (3) mass suspension: this batch process starts with a mass polymerization which is stopped at a monomer conversion of 15-30 per cent; then a suspension reaction completes the polymerization; for this reaction, the mixture of polymer and monomer is suspended in water using a suspending agent and then the polymerization process is continued; unreacted monomers are then separated, then the product is centrifuged and dried. NMVOC emissions at plants which produce acrylonitrile butadiene styrene resins can be subdivided as follows: leakage losses from use, pumps, and other leakage. The losses due to leakage can be limited by use of certain types of seals, including pumps.

c) *Polystyrene Production*

Polystyrene is a rigid plastic material, transparent or opaque, having a high refractive index (1.59) and a specific low weight (1.054). It is a polymer in which the high molecular weight hydrocarbon (C_8H_8) n is predominant, with the value of n between 500 and 2000. The polymer also contains small amounts of styrene, ethyl-benzene, traces of catalysts and low molecular weight polymers, in shares that vary according to the polymerization process used. The styrene homopolymer, the copolymers and their components are thermoplastic materials with a predominantly amorphous structure. The molecular weight distribution influences polystyrene properties and in particular the tensile strength, shock resistance, viscosity and the so important flow during moulding through injection or extrusion. The low molecular weight component of the polymer also influences the flow, light stability, electrical properties, chemical stability, etc. Low molecular weight components can be: unpolymerized styrene, saturated or non-polymerizable substances such as aldehydes, ethyl-benzene and di-, tri-, tetramers, etc. Styrene polymerization at industrial scale is carried out on the basis of the radical mechanism. The conjugated double vinyl bond and benzene nucleus give the styrene a particular reactivity as a monomer in the radical polymerization and, at the same time, a low activity of the respective radical. The initiation of radical styrene polymerization can be done thermally, photochemically, radiochemically or with initiators. Thermal polymerization is a consequence of the high reactivity of this monomer. Styrene polymerization can also be initiated by a large number of substances capable of decomposing into radicals under the action of heat. Peroxides, hydroperoxides or nitrocombinations are commonly used. Styrene polymerization can be carried out in bulk, solution, emulsion and suspension. Bulk polymerization is more widespread and can be conducted in the presence of initiators or under the influence of temperature. The use of initiators can lead to an uncontrolled process or to oxidation reactions, which lead to the yellowing of the polymer. For this reason, on an industrial scale, thermal initiation is applied, at 150-260°C. Such high temperatures are due to the fact that at 100°C, the reaction rate is low (conversions of 2 per cent per hour), and at the end (at conversions higher than 90 per cent) the polymerization rate drops greatly and only when temperature reach 220-260°C, it can lead to a polymer with a monomer content of less than 1 per cent. On industrial scale, bulk polymerization can take place in discontinuous or continuous installations, the latter being the most used. The main difficulty in this process is to increase the viscosity of the environment, making it difficult to remove the reaction heat. Discontinuous mass polymerization consists in introducing previously purified styrene in glass forms, which, under heat, in the presence or absence of initiators, in the air or inert gas environment is transformed into a hard mass taking the container's shape. The continuous mass polymerization allows the production of a polymer free of monomer traces, characterised by a high molecular mass. This is carried out in polymerization towers or vacuum drying chambers. In order to overcome certain drawbacks, different types of reactors were used, with the following bulk polymerization installations being known: with a tubular displacement reactor, with shaking tubular reactors, rolling mill and horizontal reactors.

4.3.2. Methodological Issues, Emission Factors and Data Sources

2B10 'Other'

a) *Polyethylene Production*

Methodological issues for estimating the NMVOC emissions from polyethylene production are addressed in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019). The methodology used relied on the use of an emission factor for the type of polyethylene produced in the RM – linear low-density polyethylene (LLDPE) (Table 4-46) combined with activity data from Statistical Yearbooks of the Republic of Moldova and those of the ATULBD (Table 4-47).

Table 4-46: Default EFs used to estimate NMVOC emissions from polyethylene production

Source	SNAP Code	Description	NMVOC Emissions, kg/t
Other Chemical Products	040506 040507	LDPE Production HDPE Production	2.4 2.3

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook, 2019, SNAP Code 040506 LDPE Production, Category 2.B.5.a, Table 3.39. SNAP Code 040507 HDPE Production, Category 2.B.5.a, Table 3.40.

Table 4-47: AD on Polyethylene Production in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM: right bank of Dniester River	3.519	3.100	1.715	1.601	0.878	0.717	1.552	1.168	1.170	0.683
RM: left bank of Dniester River	1.681	1.300	0.900	0.700	0.300	0.012	0.296	0.085	0.068	0.001
RM: total	**5.200**	**4.400**	**2.615**	**2.301**	**1.178**	**0.729**	**1.848**	**1.253**	**1.238**	**0.684**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
RM: right bank of Dniester River	1.689	2.050	3.324	4.225	3.595	4.254	3.514	3.637	3.417	2.795
RM: left bank of Dniester River	0.034	0.041	0.024	0.011	0.188	0.364	0.385	0.353	0.234	0.131
RM: total	**1.723**	**2.091**	**3.348**	**4.236**	**3.783**	**4.618**	**3.899**	**3.990**	**3.651**	**2.926**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
RM: right bank of Dniester River	3.626	4.105	3.635	3.987	4.196	3.290	3.242	2.939	3.246	3.355
RM: left bank of Dniester River	0.201	0.116	0.125	0.112	0.336	0.291	0.285	0.412	0.428	0.539
RM: total	**3.827**	**4.221**	**3.760**	**4.099**	**4.532**	**3.581**	**3.527**	**3.351**	**3.673**	**3.894**

Source: National Bureau of Statistics through the Statistical Yearbooks of the RM for 1994 (page 284), 1999 (page 302), 2005 (page 391), 2011 (page 305); Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; Statistical Yearbooks of the ATULBD for 1998 (page 176), 2002 (page 103), 2005 (page 94), 2007 (page 92), 2010 (page 95), 2012 (page 100), 2014 (page 90), 2017 (page 103), 2019 (page 101), 2020 (page 104)

b) *Acrylonitrile Butadiene Styrene Resins (ABS) Production*

Methodological issues for estimating NMVOC emissions from synthetic resins (ABS) production are addressed in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019).

The methodology used relied on the use of a default emission factor (Table 4-48), combined with activity data from the national statistics (Table 4-49).

Table 4-48: Default EF used to estimate NMVOC emissions from Acrylonitrile Butadiene Styrene Resins (ABS) Production

Source	SNAP Code	Description	NMVOC Emissions, kg/t
Other Chemical Products	040515	Production of ABS Resins	3.0

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook, 2016, SNAP Code 040515 Production of ABS resins, Category 2.B.5.a, Table 3.51.

Table 4-49: AD on Acrylonitrile Butadiene Styrene Resins (ABS) production in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Production of ABS Resins	17.500	14.600	5.839	4.792	1.510	1.424	1.350	1.276	1.202	1.127
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Production of ABS Resins	1.053	0.979	0.776	0.708	0.910	1.048	0.825	1.026	0.961	0.777
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Production of ABS Resins	1.516	1.657	1.774	1.842	1.739	0.929	1.453	1.346	2.128	2.470

Source: Statistical Yearbooks of the RM for 1994 (page 284); Statistical Yearbooks of the ATULBD for 1998 (page 176), 2002 (page 103), 2005 (page 94), 2007 (page 92), 2010 (page 95), 2012 (page 100), 2014 (page 90), 2017 (page 101), 2019 (page 99), 2020 (page 102)

c) *Polystyrene Production*

Methodological issues for estimating NMVOC emissions from polystyrene production are addressed in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019). The methodology used relied on the use of a default emission factor (Table 4-50), combined with activity data from the national statistics (Table 4-51).

Table 4-50: Default EF used to estimate NMVOC emissions from Polystyrene Production

Source	SNAP Code	Description	NMVOC Emissions, kg/t
Other Chemical Products	040511	Production of general-purpose polystyrene (GPPS)	0.12
		Production of high impact polystyrene (HIPS)	0.12
		Production of expandable polystyrene (EPS)	3.20

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook, 2019, SNAP Code 040511 Polystyrene Production, Category 2.B.5.a, Tables 3.45-3.47, page 42.

Table 4-51: AD on Polystyrene Production for the period 2005-2019, kt

	2005	2006	2007	2008	2009	2010	2011	2012
Polystyrene plates, sheets and alveolar strips	0.249	0.706	0.804	0.559	1.582	1.876	2.169	2.013
Polystyrenes, copolymers and other styrene polymers in primary forms	0.210	0.425	0.437	0.235	0.255	0.099	0.093	0.143
Total polystyrene production	**0.459**	**1.131**	**1.242**	**0.794**	**1.837**	**1.975**	**2.262**	**2.155**
	2013	2014	2015	2016	2017	2018	2019	2020
Polystyrene plates, sheets and alveolar strips	2.119	2.471	2.806	2.474	2.054	2.042	1.921	NA
Polystyrenes, copolymers and other styrene polymers in primary forms	0.075	0.060	0.038	NO	NO	NO	NO	NA
Total polystyrene production	**2.194**	**2.532**	**2.844**	**2.474**	**2.054**	**2.042**	**1.921**	**NA**

Source: Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the RM, by product type, for 2005-2019'.

4.3.3. Uncertainty Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate NMVOC emissions from category 2B 'Chemical Industry', as well as the quality of activity data available. Uncertainty of the default emission factors values were considered as being of circa 100 per cent, while those of activity data of circa 5 per cent, respectively.

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

4.3.4. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for the respective category, following a Tier 1 approach. Also, verification was focused on ensuring correct use of the emission factors, including default EF, available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019); verification was also focused on correct use of AD obtained from different reference sources, including official sources, etc.

AD and methods used for estimating GHG emissions under category 2B 'Chemical Industry' were documented and archived both in hard copies and electronically.

4.3.5. Recalculations

NMVOC emissions from source category 2B10 'Other' (polyethylene, acrylonitrile butadiene styrene (ABS) resins and polystyrene production) were recalculated for the 1995-2000, 2004 and 2015-2016 due to updating the AD regarding ABS resins production on the left bank of the Dniester River, as well as due to updating the AD regarding polyethylene and polystyrene production on the right bank of the Dniester River.

In comparison with the results obtained in the BUR2 of the RM to the UNFCCC (2019), the recalculations made in the current inventory cycle resulted in an upward trend in NMVOC emissions from category 2B10 'Other' (Table 4-52). For the years 2017-2019, NMVOC emissions from source category 2B10 'Other' in the RM were estimated for the first time.

Table 4-52: Comparative results of NMVOC emissions inventory from source category 2B10 'Other' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	0.0650	0.0544	0.0238	0.0199	0.0074	0.0051	0.0046	0.0037	0.0042	0.0035
BUR3	0.0650	0.0544	0.0238	0.0199	0.0074	0.0060	0.0085	0.0068	0.0066	0.0050
Difference, %	0.0	0.0	0.0	0.0	0.0	19.0	86.3	85.2	55.9	45.5

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.0065	0.0080	0.0104	0.0123	0.0118	0.0149	0.0130	0.0139	0.0122	0.0100
BUR3	0.0073	0.0080	0.0104	0.0123	0.0129	0.0149	0.0130	0.0139	0.0122	0.0100
Difference, %	12.1	0.0	0.0	0.0	9.3	0.0	0.0	0.0	0.0	0.0
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
BUR2	0.0143	0.0157	0.0150	0.0159	0.0166	0.0118	0.0131			
BUR3	0.0143	0.0157	0.0150	0.0159	0.0166	0.0119	0.0131	0.0123	0.0155	0.0170
Difference, %	0.0	0.0	0.0	0.0	0.0	0.1	0.1			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Between 1990 and 2019, NMVOC emissions from the respective category had decreased by circa 74.2 per cent, as a result of the decrease in polyethylene, ABS resins and polystyrene production.

4.3.6. Planned Improvements

Possible improvements under category 2B 'Chemical Industry' aim at updating the activity data used to estimate NMVOC emissions within this category for the reporting period within the previous inventory cycles.

4.4. Metal Industry (Category 2C)

4.4.1. Source Category Description

Category 2C 'Metal Industry' covers GHG emissions from the following emission sources: 2C1 'Iron and Steel Production', 2C2 'Ferroalloys Production', 2C3 'Aluminium Production', 2C4 'Magnesium Production', 2C5 'Lead Production', 2C6 'Zinc Production' and 2C7 'Other'. Currently, 2C1 'Iron and Steel Production' is the only source category relevant for the Republic of Moldova in terms of GHG emissions originating from category 2C 'Metal Industry'.

Iron and steel production can occur at primary integrated facilities, by reducing the iron ore with metallurgical coke; and at secondary facilities, in particular, by melting the recycled steel scrap using electrical energy imparted to the charge through carbon electrodes. Primary facilities are: open hearth furnaces (OHFs) accounting for circa 4 per cent of the world iron and steel production, and basic oxygen steelmaking furnaces (BOFs), accounting for circa 63 per cent of the world iron and steel production. The metallurgical coke used in furnaces and ovens is oxidized to CO_2 and then emitted into the atmosphere (a certain amount of carbon is retained in iron).

Secondary steelmaking most often occurs in electric arc furnaces (EAFs) accounting for circa 33 per cent of the world iron and steel production. It should be noted that the technology used in the Republic of Moldova to produce steel is exclusively electric arc furnaces (EAFs) of different capacities. Electric arc furnaces are equipped with carbon electrodes (usually made from graphite with a carbon content of circa 97 per cent[68]), when a high voltage is applied between the electrodes. The resulting electric arc leads to the melting of iron pieces at temperatures up to 1700°C. Lime stone, or lime with high calcium and dolomite content, coke, cast iron and other metals (chromium, magnesium, molybdenum or vanadium compounds) are added in the molten metal, depending on the desired quality of the steel.

CO_2 emissions from steel production in electric arc furnaces are determined by carbon losses in electrodes, as well as from carbonates use. When electrodes are placed above the electric arc furnace, the electric arc oxidises the carbon to CO or CO_2. Also, electrodes are immersed in the molten metal to increase carbon concentration in steel, thus contributing to additional CO_2 emissions.

Between 1990 and 2019 years, CO_2 emissions from category 2C 'Metal Industry' decreased in the Republic of Moldova by circa 32.0 per cent (Table 4-53).

Table 4-53: CO_2 emissions from category 2C 'Metal Industry' for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM: Left Bank of Dniester River	28.2916	24.5575	23.8586	24.3298	25.2723	26.2189	26.7141	32.3652	28.6750	31.7901
RM: Right Bank of Dniester River	0.2107	0.1722	0.1337	0.0951	0.0566	0.0180	0.0120	0.0154	0.0072	0.0040
RM: Total	**28.5023**	**24.7297**	**23.9922**	**24.4250**	**25.3289**	**26.2369**	**26.7261**	**32.3806**	**28.6822**	**31.7942**

[68] <http://ukrgrafit.zp.ua/elektrody>, <http://tdvial.ru/ge.htm>, <http://www.ruscastings.ru/work/168/441/449/4785>

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
RM: Left Bank of Dniester River	36.2631	38.6194	20.4879	35.3845	40.4565	41.8543	26.9577	38.5395	35.3429	17.0110
RM: Right Bank of Dniester River	0.0058	0.0080	0.0152	0.0438	0.0519	0.0815	0.0605	0.0732	0.0689	0.0509
RM: Total	**36.2689**	**38.6274**	**20.5030**	**35.4283**	**40.5084**	**41.9358**	**27.0182**	**38.6127**	**35.4118**	**17.0619**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
RM: Left Bank of Dniester River	9.6449	12.8029	12.6474	7.5915	13.7620	17.1721	5.0940	18.7484	20.0837	19.2558
RM: Right Bank of Dniester River	0.0536	0.0527	0.0499	0.0654	0.0844	0.1071	0.1263	0.1358	0.1295	0.1315
RM: Total	**9.6985**	**12.8556**	**12.6973**	**7.6569**	**13.8464**	**17.2792**	**5.2203**	**18.8842**	**20.2133**	**19.3873**

4.4.2. Methodological Issues, Emission Factors and Data Sources

CO_2 emissions from source category 2C1 'Iron and Steel Production' were estimated using a Tier 2 methodology (2006 IPCC Guidelines), based on carbon track throughout the production process.

Total CO_2 emission from source category 2C1 'Iron and Steel Production' were estimated using equation 4.9 from the 2006 IPCC Guidelines (Volume 3, Chapter 4.2, page 4.22). The simplified version of this equation is presented below, adapted to national circumstances.

$$E_{CO2} = [L \bullet C_L + D \bullet C_D + CE \bullet C_{CE} - S \bullet C_S] \bullet 44/12$$

Where:

E_{CO2} – total CO_2 emissions from steel production, tonnes;

L – quantity of limestone consumed in steel production, tonnes;

C_L – carbon content in limestone consumed in steel production, tC/t limestone;

D – quantity of dolomite consumed in steel production, tonnes;

C_D – carbon content in dolomite consumed in steel production, tC/t dolomite;

CE – quantity of carbon electrodes consumed in EAFs, tonnes;

C_{CE} – carbon content in electrodes consumed in EAFs, tC/t electrodes;

S – quantity of steel produced, tonnes;

C_S – carbon content in steel produced, tC/t steel;

44/12 – mass ratio CO_2/C.

In the Republic of Moldova, the content of carbon in steel represents circa 0.25 per cent (according to the information provided by the producer, the content of carbon in steel varies between 0.17 and 0.33 per cent)[69]. According to the 2006 IPCC Guidelines, depending on the type and quality of steel, the content of carbon in steel varies between 0.5 and 2 per cent, the default value used is 1 per cent (Volume 3, Chapter 4.2, Table 4.3, page 4.27). Other relevant coefficients used to estimate CO_2 emissions from steel production are presented below (Table 4-54).

Table 4-54: Carbon content of various materials used in steel production

Raw Material	Carbon content, default values, t C / t	Raw Material	Carbon content values used at national level, t C / t
Limestone	0.12	Lime with high calcium content	0.2142
Dolomite	0.13	Dolomite lime	0.2492
Carbon electrodes from petroleum coke for EAF	0.82		
Carbon electrodes from coal coke for EAF	0.83	Graphite electrodes for EAF	0.97
Scrap metal	0.04		
Steel	0.01	Steel	0.0025

In order to estimate CO_2 emissions from steel production, the specific consumption of raw materials and graphite electrodes for producing 1 ton of steel was also considered, this information being identified in the literature in the field and on the web pages of metallurgical companies. Thus, for example, the consumption of graphite electrodes in electric arc furnaces with a capacity of 30-50 tonnes, specific to enterprises on the right bank of Dniester River, was agreed to be 7 kg/t of steel produced[70]. The specific consumption of graphite electrodes in electric furnaces with higher capacity (such as that from the Metal Integrated Works in Ribnita with a capacity of 120 tonnes[71]) was agreed to be 1.3 kg/t of steel produced[72]. The specific consumption of lime with high calcium content and/or dolomite lime

[69] Metal Integrated Works in Ribnita, <http://www.aommz.com/pls/webus/webus.main.show>.
[70] <http://metal-archive.ru/tyazhelye-metally/1468-vyplavka-stali-v-dugovyh-pechah.html>.
[71] <http://www.aommz.com/pls/web/web.main.show?main_id=10&m_id=11>.
[72] <http://elar.urfu.ru/bitstream/10995/40661/1/978-5-7996-1725-7_2016.pdf>.

is considered to be 55 kg/ton of steel produced[73] (representing 45 kg of lime with high calcium content, and 10 kg of dolomite lime, respectively).

Metal Integrated Works in Ribnita is situated on the left bank of the Dniester River, which is one of the two mini-metallurgical works (the second is located in Jlobino, Belarus) bought by the USSR in the early 1980s of the twentieth century. These plants were, at the time, at the level of Western European plants, well provided with advanced equipment and efficient technologies. Production capacity at the launch in 1985 year represented about 684 kt of steel and 500 kt of rolling mills. Between 2004 and 2005, steel production reached 1 million tonnes of steel and 800 thousand tonnes of rolling mills. The Metal Integrated Works in Ribnita uses scrap metal collected mainly in the Republic of Moldova, but also from Ukraine. Concomitantly, there are several enterprises on the right bank of the Dniester River (such as: 'Incomas' JSC, Plant 'Fiting' JSC, Pipe Plant 'Protos' JSC owned by the company ME 'Orvento Metall Trading Co' Ltd., etc.) which use low-capacity electric arc furnaces (less than 50 tonnes). Steel production of these enterprises is insignificant compared to that of the Metal Integrated Works in Ribnita.

AD related to steel (Table 4-55) and rolling mills production (Table 4-56) in the Republic of Moldova is available in the statistical publications of the RM and those of the ATULBD.

Table 4-55: Activity Data on Steel Production within 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM: Right Bank of Dniester River	3.500	2.860	2.220	1.580	0.940	0.299	0.199	0.255	0.120	0.067
RM: Left Bank of Dniester River	708.400	614.900	597.400	609.200	632.800	656.500	668.900	810.400	718.000	796.000
RM: Total	**711.900**	**617.760**	**599.620**	**610.780**	**633.740**	**656.799**	**669.099**	**810.655**	**718.120**	**796.067**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
RM: Right Bank of Dniester River	0.097	0.133	0.252	0.727	0.862	1.354	1.005	1.215	1.145	0.845
RM: Left Bank of Dniester River	908.000	967.000	513.000	886.000	1013.000	1048.000	675.000	965.000	884.958	425.943
RM: Total	**908.097**	**967.133**	**513.252**	**886.727**	**1013.862**	**1049.354**	**676.005**	**966.215**	**886.103**	**426.788**
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
RM: Right Bank of Dniester River	0.890	0.876	0.828	1.087	1.401	1.778	2.098	2.255	2.151	2.183
RM: Left Bank of Dniester River	241.501	320.574	316.682	190.086	344.590	429.976	127.549	469.446	502.881	392.144
RM: Total	**242.391**	**321.450**	**317.510**	**191.173**	**345.991**	**431.754**	**129.647**	**471.701**	**505.032**	**394.327**

Source: Statistical Yearbooks of the RM for 1994 (page 224), 1999 (page 302), 2003 (page 391), 2004 (page 441), 2010 (page 305); Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the RM, by product type, for 2005-2019'; Statistical Yearbooks of the ATULBD for 1998 (page 178), 2000 (page 99), 2002 (page 103), 2006 (page 93), 2007 (page 92), 2010 (page 93), 2013 (page 99), 2017 (page 101), 2019 (page 99), 2020 (page 102).

Methodological issues related to estimating non-CO_2 emissions from steel production in electric arc furnaces are addressed in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019).

Table 4-56: AD regarding rolling mills production for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Rolling Mills Production	614.200	561.300	547.600	487.200	438.000	357.000	341.000	407.000	588.000	593.000
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Rolling Mills Production	636.000	791.000	381.000	693.000	791.000	890.000	633.000	914.000	818.035	437.515
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Rolling Mills Production	237.710	302.162	360.402	173.146	389.260	318.840	222.489	451.393	497.899	393.108

Source: Statistical Yearbooks of the RM for 1994 (page 224); Statistical Yearbooks of the ATULBD for 1998 (page 178), 2000 (page 99), 2002 (page 103), 2006 (page 93), 2007 (page 92), 2010 (page 93), 2013 (page 99), 2017 (page 101), 2019 (page 99), 2020 (page 102).

The assessment method used is based on default emission factors (Table 4-57), combined with activity data from the national statistics (Table 4-55 and 4-56).

Table 4-57: Default EFs used to estimate Non-CO_2 emissions from Steel Production in EAFs

Source	Description	NO_x	CO	NMVOC	SO_2
		g/t			
Steel Production in Electric Arc Furnaces (EAF)	Steel Production[1]	130	1700	46	60
	Rolling Mills Production[2]			7	

Source: : EMEP/EEA Atmospheric Emissions Inventory Guidebook, 2019, [1]2.C.1 Steel Production, 040207 – Steel Production in Electric Arc Furnaces, Table 3.19, page 44; [2]2.C.1 Steel Production, 040208 – Production of Rolling Mills, Table 3.22, page 47.

4.4.3. Uncertainties Assessment and Time-Series Consistency

Uncertainties associated with EFs used to estimate CO_2 emissions from this category, were estimated using a Tier 2 method and is considered to represent circa 10 per cent (2006 IPCC Guidelines).

[73] <https://rep.bntu.by/bitstream/handle/data/6984/%D0%A1.%20128-130.pdf?sequence=1>.

Uncertainties associated with activity data on steel and rolling mills production in the RM are low (circa 1-2 per cent), but considering that in the assessment process, AD regarding the consumption of electrodes, lime and dolomite is also used, estimated according to the specific consumption per specific sector; total uncertainties associated with AD could increase to circa 5 per cent. Thus, combined uncertainties of total sectoral emissions represent circa 11.18 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

4.4.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category, following a Tier 1 approach. Verification was focused on ensuring correct use of the emission factors, including default EFs, available in the 2006 IPCC Guidelines and the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019); verification was also focused on correct use of AD obtained from different reference sources, including official sources (NBS of the RM through Statistical Yearbooks of the RM and the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the RM, by product type', Statistical Yearbooks of the ATULBD, as well as web pages of national and foreign enterprises in the field), etc.

It should be noted that AD and methods used for the estimation of GHG emissions under source category 2C1 'Iron and Steel Production' was documented and archived both in hard copies and electronically.

4.4.5. Recalculations

CO_2 emissions from source category 2C1 'Iron and Steel Production' were not recalculated for the years 1990-2016 (Table 4-58).

Table 4-58: Comparative results of CO_2 emissions from 2C1 'Iron and Steel Production' source category included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	28.5023	24.7297	23.9922	24.4250	25.3289	26.2369	26.7261	32.3806	28.6822	31.7942
BUR3	28.5023	24.7297	23.9922	24.4250	25.3289	26.2369	26.7261	32.3806	28.6822	31.7942
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	36.2689	38.6274	20.5030	35.4283	40.5084	41.9358	27.0182	38.6127	35.4118	17.0619
BUR3	36.2689	38.6274	20.5030	35.4283	40.5084	41.9358	27.0182	38.6127	35.4118	17.0619
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	9.6985	12.8556	12.6973	7.6569	13.8464	17.2792	5.2203			
BUR3	9.6985	12.8556	12.6973	7.6569	13.8464	17.2792	5.2203	18.8842	20.2133	19.3873
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the years 2017-2019, CO_2 emissions from steel production were estimated for the first time. The obtained results show that between 1990 and 2019 the respective emissions had decreased in the Republic of Moldova by circa 32.0 per cent as a result of a decrease in production.

The table below shows the non-CO_2 emissions from source category 2C1 'Iron and Steel Production' for the period 1990-2019 (Table 4-59). During the period under review, the respective emissions followed a similar trend to CO_2 emissions.

Table 4-59: Non-CO_2 Emissions from the 2C1 'Iron and Steel Production' source category in the Republic of Moldova within 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	0.0925	0.0803	0.0780	0.0794	0.0824	0.0854	0.0870	0.1054	0.0934	0.1035
CO	1.2102	1.0502	1.0194	1.0383	1.0774	1.1166	1.1375	1.3781	1.2208	1.3533
NMVOC	0.0370	0.0323	0.0314	0.0315	0.0322	0.0327	0.0332	0.0401	0.0371	0.0408
SO_2	0.0427	0.0371	0.0360	0.0366	0.0380	0.0394	0.0401	0.0486	0.0431	0.0478
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NO_x	0.1181	0.1257	0.0667	0.1153	0.1318	0.1364	0.0879	0.1256	0.1152	0.0555
CO	1.5438	1.6441	0.8725	1.5074	1.7236	1.7839	1.1492	1.6426	1.5064	0.7255
NMVOC	0.0462	0.0500	0.0263	0.0456	0.0522	0.0545	0.0355	0.0508	0.0465	0.0227
SO_2	0.0545	0.0580	0.0308	0.0532	0.0608	0.0630	0.0406	0.0580	0.0532	0.0256

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	0.0315	0.0418	0.0413	0.0249	0.0450	0.0561	0.0169	0.0613	0.0657	0.0513
CO	0.4121	0.5465	0.5398	0.3250	0.5882	0.7340	0.2204	0.8019	0.8586	0.6704
NMVOC	0.0128	0.0169	0.0171	0.0100	0.0186	0.0221	0.0075	0.0249	0.0267	0.0209
SO_2	0.0145	0.0193	0.0191	0.0115	0.0208	0.0259	0.0078	0.0283	0.0303	0.0237

4.4.6. Planned Improvements

Possible improvements under category 2C ‘Metal Industry’ might include updating activity data on raw material consumption per ton of production, as well as the specific electrode consumption per ton of steel produced by enterprises in the Republic of Moldova. Should new country-specific data be available, uncertainties associated with GHG emissions from category 2C1 ‘Iron and Steel Production’ could be reduced in the following inventory cycles.

4.5. Non-Energy Products from Fuels and Solvent Use (Category 2D)

4.5.1. Source Category Description

Category 2D ‘Non-Energy Products from Fuels and Solvent Use’ covers GHG emissions generated from the following emission sources: 2D1 ‘Lubricant Use’, 2D2 ‘Paraffin Wax Use’, 2D3 ‘Solvent Use’, 2D4 ‘Other’.

2D1 ‘Lubricant Use’

Lubricants are mostly used in the industrial and transportation sectors. The use of lubricants in internal combustion engines is primarily for their lubricating properties and associated CO_2 emissions from these substances are therefore considered as non-combustion emissions to be reported in Sector 2 ‘IPPU’ and not in Sector 1 ‘Energy’.

2D2 ‘Paraffin Wax Use’

Within this category, CO_2 emissions from the use of products are monitored: petroleum jelly, paraffin waxes and other waxes, including ozokerite. Waxes are used in a number of various applications. Paraffin waxes are used in applications such as candles, corrugated boxes, paper coating, food production, wax polishes, surfactants (detergents) and many others.

2D3 ‘Solvent Use’

This category includes indirect GHG and CO_2 emissions from domestic solvent use, road paving with asphalt, asphalt roofing manufacture, paint/coating application, degreasing, dry cleaning, chemical products manufacturing, printing and other solvent use (fat, edible and non-edible oil extraction, preservation of wood, vehicle underseal treatment and vehicle dewaxing).

2D4 ‘Other’ (Use of Urea-Based Catalysts)

This category includes CO_2 emissions from the use of urea-based catalysts. Between 1990 and 2019, direct CO_2 emissions from category 2D ‘Non-energy Products from Fuels and Solvent Use’ decreased by circa 38.8 per cent (Table 4-60).

Table 4-60: CO_2 emissions from 2D ‘Non-energy Products from Fuels and Solvent Use’ category, by source, for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2D1 Lubricant Use	24.7987	20.7617	12.1110	10.9576	10.1022	10.1316	9.7676	9.2153	7.0105	4.9998
2D2 Paraffin Wax Use	0.1138	0.0953	0.0556	0.0503	0.0464	0.0465	0.0448	0.0423	0.0322	0.0230
2D3 Solvent Use	204.1460	167.7797	138.5232	110.2218	72.1539	64.2795	59.4608	31.0929	29.1892	28.0692
2D4 Other	5.3005	4.6818	3.5730	2.6463	2.1713	2.1031	1.7979	1.7024	1.3765	0.9920
2D Non-energy Products from Fuels and Solvent Use	**234.3591**	**193.3185**	**154.2628**	**123.8759**	**84.4738**	**76.5607**	**71.0712**	**42.0528**	**37.6084**	**34.0839**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2D1 Lubricant Use	3.9115	4.3872	4.3239	6.5825	6.5622	6.4692	6.9861	5.7679	6.1481	5.0916
2D2 Paraffin Wax Use	0.0180	0.0201	0.0198	0.0302	0.0301	0.0149	0.0594	0.0595	0.0295	0.0742
2D3 Solvent Use	27.6403	30.8429	32.6053	32.7216	55.7321	59.8981	73.0967	76.9812	58.4959	50.5522
2D4 Other	1.0697	1.1693	1.4252	1.5908	1.8059	1.8088	1.8385	1.9347	2.0312	1.8625
2D Non-energy Products from Fuels and Solvent Use	**32.6395**	**36.4195**	**38.3743**	**40.9252**	**64.1303**	**68.1910**	**81.9807**	**84.7433**	**66.7047**	**57.5805**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2D1 Lubricant Use	5.4648	5.7762	4.9418	4.8461	4.7832	4.8165	4.9177	4.8128	5.0145	5.0561
2D2 Paraffin Wax Use	0.1795	0.0747	0.1351	0.0751	0.0301	0.0600	0.0449	0.0600	0.1198	0.1348
2D3 Solvent Use	58.2796	63.0079	67.3666	62.1274	79.8615	76.9346	76.8520	88.9719	142.7958	135.0194
2D4 Other	2.3159	2.4656	2.2088	2.4324	2.5619	2.7580	2.9897	3.1825	3.2507	3.3189
2D Non-energy Products from Fuels and Solvent Use	**66.2398**	**71.3244**	**74.6523**	**69.4810**	**87.2367**	**84.5691**	**84.8044**	**97.0273**	**151.1808**	**143.5292**

A similar trend was recorded for indirect GHG emissions (NO_x, CO, NMVOC) and SO_2 from this category (Table 4-61).

Table 4-61: Indirect GHG emissions from 2D 'Non-energy Products from Fuels and Solvent Use' category for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	0.0434	0.0361	0.0304	0.0241	0.0146	0.0132	0.0119	0.0040	0.0033	0.0031
CO	0.2441	0.2030	0.1706	0.1356	0.0820	0.0740	0.0671	0.0227	0.0185	0.0172
NMVOC	92.7937	76.2635	62.9651	50.1008	32.7972	29.2180	27.0276	14.1331	13.2678	12.7587
SO_2	0.0216	0.0180	0.0151	0.0120	0.0073	0.0065	0.0059	0.0020	0.0016	0.0015
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NO_x	0.0025	0.0031	0.0027	0.0026	0.0082	0.0077	0.0124	0.0130	0.0075	0.0056
CO	0.0139	0.0174	0.0153	0.0145	0.0459	0.0431	0.0697	0.0732	0.0427	0.0316
NMVOC	12.5638	14.0195	14.8206	14.8735	25.3328	27.2264	33.2258	34.9915	26.5891	22.9783
SO_2	0.0012	0.0015	0.0013	0.0013	0.0041	0.0038	0.0062	0.0065	0.0037	0.0028
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	0.0069	0.0078	0.0088	0.0088	0.0128	0.0089	0.0076	0.0097	0.0273	0.0186
CO	0.0392	0.0443	0.0500	0.0501	0.0723	0.0501	0.0429	0.0547	0.1534	0.1047
NMVOC	26.4907	28.6400	30.6212	28.2397	36.3007	34.9703	34.9327	40.4418	64.9072	61.3724
SO_2	0.0034	0.0039	0.0044	0.0044	0.0064	0.0044	0.0038	0.0048	0.0136	0.0093

4.5.2. Methodological Issues, Emission Factors and Data Sources

2D1 'Lubricant Use'

The methodology used to estimate CO_2 emissions from lubricant use is a Tier 1 methodological approach provided by the 2006 IPCC Guidelines, based on AD on lubricant consumption available in the Energy Balances of the Republic of Moldova and the statistical publication Social-Economical Development of ATULBD.

CO_2 emissions from lubricant use are calculated according to Equation 5.2 (2006 IPCC Guidelines, Volume 3, Chapter 5.2, page 5.7).

$$CO_2\ Emissions = LC \bullet CC_{Lubricant} \bullet ODU_{Lubricant} \bullet 44/12$$

Where:

CO_2 Emissions – emissions from lubricants, tonne CO_2;

LC – total lubricant consumption, TJ;

$CC_{Lubricant}$ – carbon content of lubricant, t C/TJ; the default value used represents 20 t C/TJ (2006 IPCC Guidelines, Volume 3, Chapter 5.2, page 5.9);

$ODU_{Lubricant}$ – ODU factor (oxidized during use); the default value used represents 20 per cent for oil and 5 per cent for grease (2006 IPCC Guidelines, Vol. 3, Chapter 5.2, Tab. 5.2, P. 5.9);

44/12 – mass ratio of CO_2/C.

In accordance with the recommendations of the 2006 IPCC Guidelines, if statistical data on lubricant consumption is on aggregate without the possibility of delimiting oil and grease consumption, it is recommended to consider that 90 per cent of total lubricants are oils and 10 per cent – grease. AD used to estimate CO_2 emissions from this source category 2D1 'Lubricant Use' is presented below (Table 4-62).

Table 4-62: AD regarding Lubricant Use for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total lubricant used. of which:	1827.9	1530.3	892.7	807.7	744.6	746.8	720.0	679.3	516.7	368.5
Oil	1645.1	1377.3	803.4	726.9	670.2	672.1	648.0	611.3	465.1	331.7
Grease	182.8	153.0	89.3	80.8	74.5	74.7	72.0	67.9	51.7	36.9

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total lubricant used. of which:	288.3	323.4	318.7	485.2	483.7	476.8	514.9	425.1	453.2	375.3
Oil	259.5	291.0	286.8	436.7	435.3	429.2	463.5	382.6	407.9	337.8
Grease	28.8	32.3	31.9	48.5	48.4	47.7	51.5	42.5	45.3	37.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total lubricant used. of which:	402.8	425.8	364.3	357.2	352.6	355.0	362.5	354.8	369.6	372.7
Oil	362.5	383.2	327.8	321.5	317.3	319.5	326.2	319.3	332.7	335.4
Grease	40.3	42.6	36.4	35.7	35.3	35.5	36.2	35.5	37.0	37.3

Source: Energy Balances of the RM for the years 1990, 1993-2019; Socio-economic Development of the TMR for the years 2009-2019.

2D2 'Paraffin Wax Use'

The methodology used to estimate CO_2 emissions from paraffin wax use is a Tier 1 methodological approach provided by the 2006 IPCC Guidelines, based on AD regarding paraffin wax consumption available in the Energy Balances of the Republic of Moldova (since 2004; for the period 1990-2003, paraffin wax consumption was estimated indirectly based on lubricants consumption). In contrast to the previous inventory cycle, in the current cycle paraffin wax use on the left bank of the Dniester River was also estimated indirectly: it was considered that the share of paraffin was consumption on the left bank of Dniester River from the total national consumption is similar to the share of lubricants consumption in the ATULBD from the total national.

CO_2 emissions from paraffin wax use are calculated according to Equation 5.4 (2006 IPCC Guidelines, Volume 3, Chapter 5.3, page 5.11).

$$CO_2\ Emissions = PW \bullet CC_{Wax} \bullet ODU_{Wax} \bullet 44/12$$

Where:

CO_2 Emissions – emissions from waxes, tonne CO_2;

PW – total wax consumption, TJ;

CC_{Wax} – carbon content of paraffin wax (default), tonne C/TJ; the default value used represents 20 tonne C/TJ (2006 IPCC Guidelines, Volume 3, Chapter 5.3, page 5.12);

ODU_{Wax} – ODU factor for paraffin wax, fraction; the default value used represents 20 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.3, page 5.12);

44/12 – mass ratio of CO_2/C.

AD used to estimate CO_2 emissions from source category 2D2 'Paraffin Wax Use' is presented below (Table 4-63).

Table 4-63: AD on Paraffin Wax Use in the Republic of Moldova for the period 1990-2019, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Paraffin Wax Used	7.8	6.5	3.8	3.4	3.2	3.2	3.1	2.9	2.2	1.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Paraffin Wax Used	1.2	1.4	1.4	2.1	2.1	1.0	4.0	4.1	2.0	5.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Paraffin Wax Used	12.2	5.1	9.2	5.1	2.0	4.1	3.1	4.1	8.2	9.2

2D3 'Solvent Use'

Between 1990 and 2019, indirect CO_2 emissions from source category 2D3 'Solvent Use' decreased by circa 33.9 per cent (Table 4-64). Similar trends were recorded for indirect GHG emissions (NO_x, CO, NMVOC) and SO_2 from the respective category (Table 4-61).

Table 4-64: Indirect CO_2 emissions from category 2D3 'Solvent Use' by source for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2D3a. Domestic Solvent Use	11.5146	11.5270	11.5080	11.4782	11.4911	11.4785	11.4428	11.4048	11.4201	11.3916
2D3b. Production and Use of Asphalt for Road Paving	80.5401	66.9773	56.2980	44.7480	27.0600	24.4200	22.1496	7.5060	6.0936	5.6777
2D3c. Asphalt Roofing	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2D3d. Paint Application	22.0667	16.1929	11.3743	7.1827	4.0437	1.5391	1.9353	1.2475	1.2211	1.2900
2D3e. Degreasing	2.6034	1.4818	0.8383	0.5482	0.4094	0.4626	0.1545	0.2217	0.4572	0.3971
2D3f. Dry Cleaning	1.4018	0.7979	0.4514	0.2952	0.2204	0.2491	0.0832	0.1194	0.2462	0.2138
2D3g. Chemical Products Manufacturing and Processing	78.6836	65.5702	54.3484	42.8017	25.9697	23.3207	21.1118	7.7410	6.3694	6.1214
2D3h. Printing	0.5406	0.3631	0.2489	0.1796	0.1349	0.0782	0.0961	0.0703	0.0872	0.0645
2D3i. Other Solvent Use	6.7953	4.8695	3.4559	2.9881	2.8247	2.7315	2.4875	2.7822	3.2943	2.9131
2D3. Solvent Use	**204.1460**	**167.7797**	**138.5232**	**110.2218**	**72.1539**	**64.2795**	**59.4608**	**31.0929**	**29.1892**	**28.0692**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2D3a. Domestic Solvent Use	11.3612	11.3158	11.2720	11.2234	11.1688	10.7908	10.5779	10.3650	10.1515	9.9410
2D3b. Production and Use of Asphalt for Road Paving	4.5942	5.7518	5.0328	4.7652	15.1338	14.1948	22.9614	24.1157	13.8172	10.3574
2D3c. Asphalt Roofing	NO	NO	NO	0.0025	0.0019	0.0020	0.0030	0.0032	0.0259	0.0050
2D3d. Paint Application	2.8430	3.6133	5.8351	6.1180	8.1444	13.5648	9.1459	11.3119	11.1305	10.6405
2D3e. Degreasing	0.3982	0.4081	0.5864	0.3329	0.4382	0.4186	0.5858	0.5388	0.5382	0.4990
2D3f. Dry Cleaning	0.2144	0.2198	0.3157	0.1793	0.2360	0.2254	0.3154	0.2901	0.2898	0.2687
2D3g. Chemical Products Manufacturing and Processing	5.2725	6.3463	5.8998	5.7279	15.3565	15.0309	23.2269	24.8340	17.2385	13.9175
2D3h. Printing	0.0776	0.1103	0.1412	0.1599	0.2088	0.2823	0.2160	0.2509	0.2652	0.2378
2D3i. Other Solvent Use	2.8792	3.0775	3.5224	4.2125	5.0437	5.3883	6.0645	5.2716	5.0392	4.6854
2D3. Solvent Use	**27.6403**	**30.8429**	**32.6053**	**32.7216**	**55.7321**	**59.8981**	**73.0967**	**76.9812**	**58.4959**	**50.5522**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
2D3a. Domestic Solvent Use	9.7330	9.5264	9.3196	9.1144	8.9084	8.8317	8.7091	8.5815	8.4463	8.3076
2D3b. Production and Use of Asphalt for Road Paving	12.8330	14.5076	16.3806	16.3904	23.7660	16.5279	14.1464	18.0620	50.6226	34.5472
2D3c. Asphalt Roofing	0.0107	0.0098	0.0113	0.0117	0.0092	NO	NO	NO	NO	NO
2D3d. Paint Application	11.6314	14.5764	14.0092	10.6746	13.8369	18.8792	22.6164	21.0754	21.5945	21.8157
2D3e. Degreasing	0.6128	0.6838	1.9442	1.2663	1.1002	0.9206	0.7758	1.0541	1.2783	1.2922
2D3f. Dry Cleaning	0.3300	0.3682	1.0469	0.6819	0.5924	0.4957	0.4177	0.5676	0.6883	0.6958
2D3g. Chemical Products Manufacturing and Processing	17.2798	17.9677	19.7555	19.4641	26.7433	20.5848	18.0659	21.9635	50.8160	36.8531
2D3h. Printing	0.2957	0.2786	0.2569	0.2894	0.3099	0.4044	0.3280	0.3369	0.3681	0.3747
2D3i. Other Solvent Use	5.5533	5.0894	4.6425	4.2347	4.5953	10.2903	11.7928	17.3310	8.9816	31.1330
2D3. Solvent Use	**58.2796**	**63.0079**	**67.3666**	**62.1274**	**79.8615**	**76.9346**	**76.8520**	**88.9719**	**142.7958**	**135.0194**

2D3a 'Domestic Solvent Use'

In the Republic of Moldova there are no recorded statistical data on domestic solvent use. AD for certain applications can be generated indirectly based on the information on production, import and export of domestic products containing solvents. It should be noted that their production within the country is insignificant.

The Customs Service of the Republic of Moldova is a primary source of information on national import operations (Table 4-65). Albeit AD on the production and imports of certain household products is available, the solvent share in these products is unknown.

Table 4-65: AD on domestic solvent use for the period 1995-2019

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Perfumes and eau de toilette, kt	0.0925	0.1429	0.1454	0.0068	0.0170	0.0991	0.1585	0.2607	0.2364	0.2087	0.2404	0.2858	0.4660
Beauty or make-up products and skin care, manicure or pedicure products, kt	0.0667	0.0713	0.1068	0.0580	0.0532	0.0800	0.1974	0.3326	0.5557	0.5567	0.7338	0.8086	0.9913
Hair care products, kt	0.2130	0.3283	0.3816	0.3358	0.5573	1.0675	1.2892	1.5030	1.8767	1.9802	2.3080	2.4143	2.8395
Pre-shave, shave or after-shave products, deodorants, bath products, depilatories, other perfumery or toiletries and other cosmetics, air freshener, kt	0.0399	0.0397	0.0807	0.0687	0.0478	0.0864	0.1897	0.4108	0.6529	0.7696	1.2069	1.3931	1.6538
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Perfumes and eau de toilette, kt	0.2012	0.1323	0.1114	0.0918	0.1441	0.1502	0.1122	0.1006	0.1103	0.1959	0.1436	0.1479	NA
Beauty or make-up products and skin care, manicure or pedicure products, kt	1.0283	0.8313	0.8856	0.9429	0.9405	1.0121	1.0180	0.9784	0.1409	1.0518	1.1811	1.3333	NA
Hair care products, kt	2.6788	2.6876	2.7463	2.8667	3.0558	2.9765	3.1153	1.1279	1.1515	3.0687	2.2181	3.9899	NA
Pre-shave, shave or after-shave products, deodorants, bath products, depilatories, other perfumery or toiletries and other cosmetics, air freshener, kt	1.8950	1.5354	1.6036	1.8711	2.1028	2.2754	2.2930	1.3670	2.0612	2.0584	2.4312	2.8181	NA

Source: Customs Service of the RM, Official Letter No. 28/07-3025 dated 28.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, as a response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, as a response to the request from the Climate Change Office of the MARDE No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, as a response to the request from the Climate Change Office of the MARDE No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, as a response to the request from the Climate Change Office of the MARDE No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, as a response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

The methodology used to estimate NMVOC emissions from source category 2D3a 'Domestic Solvent Use' is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), represented by the following equation:

$$E_{pollutant} = (P \bullet EF_{pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – emissions from domestic solvent use, t/an;

P – population, thousand inhabitants/yr (Table 4-66);

$EF_{pollutant}$ – Emission Factor for this pollutant gas, kg/person/yr.

Table 4-66: Population of the Republic of Moldova (including ATULBD) for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total population, thousand inhabitants	4 361.6	4 366.3	4 359.1	4 347.8	4 352.7	4 347.9	4 334.4	4 320.0	4 325.8	4 315.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total population, thousand inhabitants	4 303.5	4 286.3	4 269.7	4 251.3	4 230.6	4 087.4	4 006.8	3 926.1	3 845.3	3 765.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total population, thousand inhabitants	3 686.8	3 608.5	3 530.1	3 452.4	3 374.4	3 345.4	3 298.9	3 250.6	3 199.4	3 146.8

Source: Statistical Yearbooks of the RM for 1991-2020; Statistical Yearbooks of the ATULBD for 1998-2020.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs and a Tier 1 methodological approach (Table 4-67).

Table 4-67: Tier 1 Default EF used to Estimate NMVOC Emissions from category 2D3a 'Domestic Solvent Use'

Source	NMVOC Emission Factor	Unit
'Domestic Solvent Use'	1.2	kg/person/yr

Source: EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), Category 2.D.3.a 'Domestic Solvent Use' (including fungicides), Chapter 3.1, Table 3.1, page 9.

Indirect CO_2 emissions were estimated based on the carbon content in NMVOC emissions. The default value used represents 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon converts into CO_2 in the atmosphere (it is assumed that all solvents from household waste products are of fossil origin).

CO_2 emissions from domestic solvent use were estimated using the following equation:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 emissions – CO_2 emissions from domestic solvent use, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

2D3b 'Road Paving with Asphalt'

The methodology used to estimate GHG emissions from road paving with asphalt is a Tier 1 methodological approach provided by the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019).

Default emission factor values are presented in Table 4-68, while the annual data related to asphalt production was provided by the Ministry of Transport and Roads Infrastructure for the period 1990-2002, the National Bureau of Statistics for 2003-2015, and the State Road Administration for 2016-2019, respectively (Table 4-69).

Table 4-68: Default EFs used to estimate GHG Emissions from Road Paving with Asphalt

Description	NO_x	CO	SO_2	NMVOC
	g/t			kg / t
Asphalt Plants[1] Asphalt Use for Road Paving[2]	35.6	200	17.7	30

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook, 2019. [1]SNAP Code 030313 Asphalt Plants, Category 1.A.2.f.i, Table 3-25, page 32. [2]SNAP Code 040611 Road Paving with Asphalt, Category 2.D.3.b, Table 3.4, page 12.

Table 4-69: AD regarding Road Paving with Asphalt for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Road paving with asphalt	1220.305	1014.808	853.000	678.000	410.000	370.000	335.600	113.727	92.328	66.477
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Road paving with asphalt	53.791	67.343	58.925	72.200	229.300	215.073	347.899	365.390	209.351	156.931
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Road paving with asphalt kt	194.440	219.812	248.191	248.339	360.090	250.423	214.339	273.666	767.009	523.443

Source: Ministry of Transport and Roads Infrastructure, through Letter No. 03-5-2/2-32 dated 31.03.1999, as a response to the request from the Ministry of Environment No. 01-7/172 dated 12.03.1999; Letter No. 04-02-3/101 dated 18.02.2004, as a response to the request from the Ministry of Ecology No. 257-01-07 dated 26.01.2004; Letter No. 04-01-3/754 dated 2.10.2006, as a response to the request from the Ministry of Ecology and Natural Resources No. 01-07/1400 dated 25.08.2006; National Bureau of Statistics of the RM, through Letter No. 06-39/08 dated 23.02.2011, as a response to Letter No. 03-07/175 dated 02.02.2011 from the Ministry of Environment; Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; State Road Administration through Letter No. 09-02/43, as a response to Letter No. 601/2017-12-03 dated 14.12.2017; Letter No. 09-02/768 dated 27.02.2020, as a response to Letter No. 08-310/1 dated 11.02.2020.

GHG emissions were estimated using the following equation:

$$E_{pollutant} = (A \bullet EF_{pollutant}) / 10^6$$

Where:

$E_{pollutant}$ – NMVOC, CO, NO_x and SO_x emissions, kt/yr;

A – Annual production of asphalt, kt/an;

$EF_{pollutant}$ – Default Emission Factor, g/t.

Indirect CO_2 emissions were estimated considering the carbon content in NMVOC emissions. The default value used represents 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in atmosphere (it is assumed that all solvents from asphalt are of fossil origin).

In order to estimate indirect CO_2 emissions from asphalt production, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from road paving with asphalt, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/an;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; IPCC 2006 Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

2D3c 'Asphalt Roofing'

The methodology used to estimate GHG emissions from asphalt roofing is a Tier 1 methodological approach provided by the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019). Default EF value (for production technologies and typical or medium mitigation measures) are presented below (Table 4-70).

Table 4-70: Default EF used to estimate GHG Emissions from Asphalt Roofing

Description	CO	NMVOC
	g / t	
Asphalt Roofing	9.5	130

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook, 2019, SNAP Code 040610 Asphalt Roofing, Category 2.D.3.c, Table 3.1, page 7.

Activity Data regarding asphalt roofing production was provided by the National Bureau of Statistics of the Republic of Moldova only for the period 2003-2014 (Table 4-71). According to this data, until 2003, domestic asphalt roofing production was recorded only in the period 2003-2014, after which the production being imported.

Table 4-71: AD on asphalt roofing production for the period 2003-2014, kt

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Production of asphalt or similar materials, in rolls exclusively	8.8	6.7	6.9	10.4	11.2	90.5	17.6	37.3	34.2	39.6	40.9	32.2

Source: National Bureau of Statistics, Letter No. 06-39/08 dated 23.02.2011, as a response to the request No. 03-07/175 dated 02.02.2011 from the Ministry of Environment; Statistical Reports PROD-MOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2015'.

Total GHG emissions from asphalt roofing production are estimated using the following equation:

$$E_{pollutant} = (A \bullet EF_{pollutant}) / 10^6$$

Where:

$E_{pollutant}$ – GHG emissions from asphalt roofing, kt/yr;

A – Annual production of asphalt roofing, kt/yr;

$EF_{pollutant}$ – Default Emission Factor, g/t.

Indirect CO_2 emissions were estimated considering the carbon content in NMVOC emissions. The default value used represents 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in atmosphere (it is assumed that all solvents from asphalt are of fossil origin).

In order to estimate indirect CO_2 emissions from asphalt roofing, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from asphalt roofing, kt/yr;

NMVOC – total NMVOC emissions from the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

2D3d 'Paint Application'

Under this category there are reported emissions from decorative coating application, particularly in construction (SNAP 060103) and domestic paint application (SNAP 060104); industrial coating application, particularly in automobile manufacture (SNAP 060101), car repairing (SNAP 060102), coil coating (SNAP 060105), painting ships and boats (SNAP 060106), wood treatment and painting (SNAP 060107), other industrial application (painting aircrafts, carriages, steel bridges, military vehicles, engines, pumps, tanks, office equipment, plastic articles, toys, etc.) (SNAP 060108); respectively, other non-industrial paint application (paint or varnish application to protect large metal constructions from corrosion, road marking, etc.) (SNAP 060109). Because the breakdown of activity data on paint and varnish consumption in the RM by sector was not possible, the respective emissions were reported on aggregate at national level.

It is known from the literature in the field that the share of solvents in different types of paints varies according to the technology applied during their production (Table 4-72).

Table 4-72: Carbon and solvent content in different types of products

Products Containing Solvents	Carbon Content, %[1]	Solvent Content, %[2]
Varnishes and paints based on polyesters and polymers dissolved in a non-aqueous solution	60	40-70
Varnishes and paints based on polymers dispersed or dissolved in an aqueous solution		<20

Source: [1]2006 IPCC Guidelines, Volume 3, Chapter 5.4, page 5.17; [2]EMEP/EEA Atmospheric Emissions Inventory Guidebook, (2019), Source Category 2.D.3.d 'Paint Application', (NFR) Table 2-1, page 9.

The methodology used to estimate NMVOC emissions from paint application is provided by the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) and uses the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from paint application, kt/yr;

$AR_{product}$ – activity rate for the coating application (consumption of paint), t/yr;

$EF_{pollutant}$ – the emission factor for the pollutant, kg/t.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs for Tier 1 approach (Table 4-73).

Table 4-73: Default Tier 1 EFs for the 2D3d 'Paint Application'

Source	NMVOC Emission Factor	Unit
Decorative Coating Application	150	g/kg paint applied
Industrial Coating Application	400	g/kg paint applied
Other Coating Application	200	g/kg paint applied

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2.D.3.d 'Coating Application', Tables 3-1, 3-2 and 3-3, page 17.

Mitigation actions for NMVOC emission from paint producing plants were taken into consideration in order to determine the EF values.

The total consumption of varnishes and paints was estimated considering internal production and statistical data on import and export of such substances in the RM. Statistical Yearbooks of the RM contain aggregated data on total production of varnishes and paints in the country (Table 4-74). The NBS also provides disaggregated activity data on production of different types of varnishes and paints.

Table 4-74: AD on the production of varnishes and paints for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Production of conventional solvent paints	10.100	8.250	5.549	2.714	1.131	0.738	0.664	0.451	0.350	0.674
Production of waterborne paints	1.600	0.550	0.451	0.386	0.069	0.062	0.036	0.058	0.020	0.000
Total paints production	**11.700**	**8.800**	**6.000**	**3.100**	**1.200**	**0.800**	**0.700**	**0.509**	**0.370**	**0.674**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Production of conventional solvent paints	2.025	2.701	3.379	2.417	3.872	5.085	6.693	8.793	8.768	8.270
Production of waterborne paints	0.029	0.169	0.716	1.026	1.264	1.184	1.626	2.252	2.789	3.553
Total paints production	**2.054**	**2.870**	**4.095**	**3.443**	**5.136**	**6.269**	**8.319**	**11.045**	**11.557**	**11.822**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Production of conventional solvent paints	9.657	12.915	13.673	9.474	13.540	20.573	25.626	21.877	20.314	21.858
Production of waterborne paints	3.208	5.097	4.234	2.857	4.131	6.268	7.104	7.648	9.189	7.403
Total paints production	**12.864**	**18.011**	**17.907**	**12.345**	**17.685**	**26.858**	**32.746**	**29.555**	**29.598**	**29.358**

Source: NBS through Letter No. 06-39/08 dated 23.02.2011, as a response to Letter No. 03-07/175 dated 02.02.2011, from the Ministry of Environment of the RM; Letter No. 06-39/38 dated 22.09.2011, as a response to Letter No. 101/2011-09-01 dated 02.09.2011, from the Climate Change Office, Ministry of Environment of the RM; Letter No. 15-03/05 dated 24.01.2014, as a response to Letter No. 320/2014-01-01 dated 03.01.2014, from the Climate Change Office, Ministry of Environment of the RM; Letter No. 15-03-09 dated 13.02.2015, as a response to Letter No. 407/2015-01-09 dated 29.01.2015, from the Climate Change Office, Ministry of Environment of the RM; Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'.

The Customs Service of the Republic of Moldova is a primary source of information on varnish and paint import-export operations (varnishes and paints based on synthetic polymers or modified natural polymers, dispersed or dissolved in a non-aqueous solution, code 3208; varnishes and paints based on synthetic polymers or modified natural polymers, dispersed or dissolved in an aqueous solution, code 3209; other paints and varnishes, prepared water pigments, e.g. used for leather coating, code 3210; prepared driers, code 3211; pigment dispersed in a non-aqueous solution as liquid or paste used in paint manufacture, code 3212) undertaken by economic agents (Table 4-75).

Table 4-75: AD on import and export of varnishes and paints between 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Imports of conventional solvent paints	16.522	12.189	9.122	6.703	4.522	1.694	2.462	1.401	1.381	1.063
Imports of waterborne paints	11.112	7.875	5.153	3.000	1.486	0.250	0.288	0.313	0.426	0.563
Total paints import	**27.635**	**20.064**	**14.275**	**9.703**	**6.008**	**1.943**	**2.750**	**1.715**	**1.807**	**1.625**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Imports of conventional solvent paints	1.853	1.678	3.718	4.688	7.131	15.642	5.582	6.264	5.197	4.634
Imports of waterborne paints	1.161	1.892	2.588	2.774	2.251	2.268	2.402	2.854	3.087	2.511
Total paints import	**3.014**	**3.571**	**6.306**	**7.463**	**9.382**	**17.911**	**7.984**	**9.118**	**8.283**	**7.145**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Imports of conventional solvent paints	5.142	4.888	3.892	3.668	3.904	3.673	4.214	4.349	4.701	4.850
Imports of waterborne paints	2.726	3.084	3.172	3.028	3.090	3.138	3.371	3.693	4.289	4.775
Total paints import	**7.869**	**7.972**	**7.064**	**6.696**	**6.994**	**6.811**	**7.585**	**8.042**	**8.990**	**9.626**

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, as a response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, as a response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015 as a response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, as a response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, as a response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

AD on national consumption of varnishes and paints in the RM (Table 4-76) was inferred from information on national production (Table 4-74) and import (Table 4-75) of these products (within the reference period, no exports of these products were registered).

Table 4-76: AD on consumption of varnishes and paints between 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Consumption of conventional solvent paints	26.622	20.439	14.671	9.417	5.653	2.432	3.126	1.852	1.731	1.737
Consumption of waterborne paints	12.712	8.425	5.604	3.386	1.555	0.312	0.324	0.371	0.446	0.563
Total paints consumption	**39.335**	**28.864**	**20.275**	**12.803**	**7.208**	**2.743**	**3.450**	**2.224**	**2.177**	**2.299**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Consumption of conventional solvent paints	3.878	4.379	7.097	7.105	11.003	20.728	12.275	15.058	13.964	12.904
Consumption of waterborne paints	1.190	2.061	3.304	3.800	3.515	3.452	4.028	5.106	5.876	6.063
Total paints consumption	**5.068**	**6.441**	**10.401**	**10.906**	**14.518**	**24.180**	**16.303**	**20.164**	**19.840**	**18.967**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Consumption of conventional solvent paints	14.799	17.802	17.565	13.142	17.444	24.246	29.839	26.226	25.016	26.709
Consumption of waterborne paints	5.934	8.181	7.406	5.886	7.221	9.407	10.475	11.342	13.477	12.179
Total paints consumption	**20.733**	**25.983**	**24.972**	**19.028**	**24.665**	**33.653**	**40.314**	**37.567**	**38.493**	**38.887**

No statistical data regarding the consumption of varnishes and paints in various applications is available. Under such circumstances, it was considered that the share of paints in decorative coating application constitutes 50 per cent of the total national consumption, the share of varnishes and paints in the industrial sector – 40 per cent, while the share of other coating application – 10 per cent (Table 4-77).

Table 4-77: AD on the consumption of varnishes and paints in various applications for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Decorative Coating Application	19.667	14.432	10.137	6.402	3.604	1.372	1.725	1.112	1.088	1.150
Industrial Coating Application	15.734	11.546	8.110	5.121	2.883	1.097	1.380	0.890	0.871	0.920
Other Coating Application	3.933	2.886	2.027	1.280	0.721	0.274	0.345	0.222	0.218	0.230
Total consumption	**39.335**	**28.864**	**20.275**	**12.803**	**7.208**	**2.743**	**3.450**	**2.224**	**2.177**	**2.299**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Decorative Coating Application	2.534	3.220	5.201	5.453	7.259	12.090	8.151	10.082	9.920	9.483
Industrial Coating Application	2.027	2.576	4.160	4.362	5.807	9.672	6.521	8.065	7.936	7.587
Other Coating Application	0.507	0.644	1.040	1.091	1.452	2.418	1.630	2.016	1.984	1.897
Total consumption	**5.068**	**6.441**	**10.401**	**10.906**	**14.518**	**24.180**	**16.303**	**20.164**	**19.840**	**18.967**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Decorative Coating Application	10.367	12.991	12.486	9.514	12.332	16.826	20.157	18.784	19.246	19.444
Industrial Coating Application	8.293	10.393	9.989	7.611	9.866	13.461	16.126	15.027	15.397	15.555
Other Coating Application	2.073	2.598	2.497	1.903	2.466	3.365	4.031	3.757	3.849	3.889
Total consumption	**20.733**	**25.983**	**24.972**	**19.028**	**24.665**	**33.653**	**40.314**	**37.567**	**38.493**	**38.887**

Indirect CO_2 emissions were estimated taking into consideration the content of carbon in NMVOC emissions. The default value used represents 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in atmosphere (it is assumed that all solvents from paint application are of fossil origin).

In order to estimate indirect CO_2 emissions from paint application, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from paint application, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

2D3e 'Degreasing'

Within category 2D3e 'Degreasing' there are monitored the GHG emissions from solvent use in industry, especially for metal degreasing – SNAP 060201; manufacturing of electronic components – SNAP 060203, as well as other industrial cleaning – SNAP 060204. Typically, solvents used for degreasing are obtained by distillation of fossil fuels. For example, chlorinated solvents, including trichloroethylene (TRI) (code 2903 22 000), tetrachloroethylene (PER) (code 2903 23 000) and dichloromethane (MC) (code 2903 12 000) are widely used in the industrial sector for cleaning metal articles, electronic products and other industrial products (in closed type cleaning equipment). Previously, 1,1,1-trichloroethane (TCA) (2903 19 100) was particularly used until recently when it was replaced by trichloroethylene (TRI). As for the open type cleaning equipment, the most commonly used solvents are those obtained from white-spirit (code 2710 11 210) and alcohols, such as propylene glycol 2905 32 000).

The methodology used to estimate NMVOC emissions from solvent use for degreasing is provided by the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) and uses the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – emissions from solvent application for degreasing, t/yr;

$AR_{product}$ – activity rate for the use of solvents for degreasing, t/yr;

$EF_{pollutant}$ – emission factor for this pollutant technology, kg/t.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs for Tier 1 approach (Table 4-78).

Table 4-78: Tier 1 default EF for estimating NMVOC emissions from 2D3e 'Degreasing'

Source	NMVOC Emission Factor	Unit
'Degreasing'	460	g/kg of degreased products

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2.D.3.e 'Degreasing', Table 3-1, page 8.

Because no AD breakdown on solvent consumption for degreasing in various industrial applications is available in the Republic of Moldova, an alternative approach was used, represented by the following formula:

$$E_{pollutant} = AR_{product} \bullet EF_{pollutant}$$

Where:

$E_{pollutant}$ – emissions from the use of solvent application for degreasing, t/yr;

$AR_{product}$ – activity rate for the use of solvents for degreasing (consumption), t/yr;

$EF_{pollutant}$ – the emission factor for this pollutant technology.

According to the available methodology, the content of organic solvents in substances used in degreasing and dry cleaning is considered to be 100 per cent (EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), Category 2D3e 'Degreasing', Table 3-5, page 12).

It is considered that the total amount of solvents for degreasing evaporate into the atmosphere, NMVOC emissions being equal thus to the quantity of solvent used.

Total consumption of organic solvents for degreasing is estimated following the equation:

$$Total\ Consumption = Production + Import - Export$$

There is no statistical data for activities involving the use of solvents for degreasing in the RM. Under such circumstances, the total consumption of solvents used for degreasing was estimated based on information on import of solvents (internal production of solvents is insignificant; also, it was assumed that such substances are not re-exported). The Customs Service is a primary source of information on solvent import-export operations by enterprises and economic agents in the Republic of Moldova.

Table 4-79: AD on consumption of solvents used in degreasing between 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cyclic and Acyclic Hydrocarbons	1.2254	0.7601	0.4932	0.3530	0.2559	0.2852	0.0586	0.1109	0.1241	0.0282
Alcohols	0.5952	0.2761	0.0930	0.0304	0.0304	0.0383	0.0494	0.0441	0.1956	0.2495
Total solvents	**1.8205**	**1.0363**	**0.5862**	**0.3834**	**0.2863**	**0.3235**	**0.1080**	**0.1550**	**0.3197**	**0.2777**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cyclic and Acyclic Hydrocarbons	0.1537	0.0604	0.1700	0.1197	0.1907	0.1089	0.1259	0.1273	0.1115	0.1165
Alcohols	0.1247	0.2251	0.2401	0.1131	0.1158	0.1838	0.2837	0.2495	0.2649	0.2325
Total solvents	**0.2784**	**0.2854**	**0.4101**	**0.2328**	**0.3064**	**0.2927**	**0.4096**	**0.3768**	**0.3764**	**0.3489**
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cyclic and Acyclic Hydrocarbons	0.1752	0.2036	0.9318	0.3641	0.1567	0.1937	0.1173	0.1499	0.3563	0.2617
Alcohols	0.2534	0.2746	0.4277	0.5214	0.6126	0.4500	0.4253	0.5872	0.5376	0.6419
Total solvents	**0.4285**	**0.4782**	**1.3596**	**0.8855**	**0.7694**	**0.6438**	**0.5425**	**0.7372**	**0.8939**	**0.9037**

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, as a response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, as a response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, as a response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, as a response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, as a response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

Since the same substances are widely used for both degreasing and dry cleaning, it was accepted that out of the total amount consumed, 65 per cent were used for degreasing, whereas 35 per cent – for dry cleaning.

Table 4-80: AD on consumption of solvents used in degreasing between 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cyclic and Acyclic Hydrocarbons	0.7965	0.4941	0.3206	0.2294	0.1663	0.1854	0.0381	0.0721	0.0807	0.0183
Alcohols	0.3869	0.1795	0.0604	0.0198	0.0198	0.0249	0.0321	0.0287	0.1272	0.1622
Total solvents	**1.1834**	**0.6736**	**0.3811**	**0.2492**	**0.1861**	**0.2103**	**0.0702**	**0.1008**	**0.2078**	**0.1805**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cyclic and Acyclic Hydrocarbons	0.0999	0.0392	0.1105	0.0778	0.1239	0.0708	0.0819	0.0827	0.0725	0.0757
Alcohols	0.0811	0.1463	0.1561	0.0735	0.0753	0.1195	0.1844	0.1622	0.1722	0.1511
Total solvents	**0.1810**	**0.1855**	**0.2665**	**0.1513**	**0.1992**	**0.1903**	**0.2663**	**0.2449**	**0.2446**	**0.2268**
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cyclic and Acyclic Hydrocarbons	0.1138	0.1323	0.6057	0.2367	0.1019	0.1259	0.0762	0.0974	0.2316	0.1701
Alcohols	0.1647	0.1785	0.2780	0.3389	0.3982	0.2925	0.2764	0.3817	0.3495	0.4173
Total solvents	**0.2785**	**0.3108**	**0.8837**	**0.5756**	**0.5001**	**0.4185**	**0.3526**	**0.4792**	**0.5811**	**0.5874**

Indirect CO_2 emissions were estimated taking into consideration the content of carbon in NMVOC emissions. The default value used represents 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in the atmosphere (it is assumed that all solvents are of fossil origin).

In order to estimate indirect CO_2 emissions from solvents used in degreasing, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from degreasing, kt/yr;

NMVOC – total NMVOC emissions from the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

2D3f 'Dry Cleaning'

Within category 2D3f 'Dry Cleaning' there are monitored GHG emissions from solvent use in dry cleaning of clothes and other textiles of animal grease, oils, wax, tar, etc. (SNAP 060202).

Tetrachloroethylene (PER) (code 2903 23 000) is the most widely used solvent for dry cleaning. Previously, 1,1,1-trichloroethane (TCA) (2903 19 100) was particularly used until recently when it was replaced by trichloroethylene (TRI).

The methodology used to estimate NMVOC emissions from solvent use for dry cleaning is provided by the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) and uses the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – emissions from the use of solvents for dry cleaning, kt/yr;

$AR_{product}$ – activity rate for the use of solvents for dry cleaning, kt/yr;

$EF_{pollutant}$ – emission factor for this pollutant technology, kg/t.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs for Tier 1 approach (Table 4-81).

Table 4-81: Tier 1 default EF for estimating NMVOC emissions from 2D3f 'Dry Cleaning'

Source	NMVOC Emission Factor	Unit
2D3f 'Dry Cleaning'	40	g/kg treated textiles

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2.D.3.f 'Dry Cleaning', Table 3-1, page 7.

Because there is no AD breakdown on solvent consumption for dry cleaning, an alternative approach was used, represented by the following formula:

$$E_{pollutant} = AR_{product} \bullet EF_{pollutant}$$

Where:

$E_{pollutant}$ – emissions from the use of solvents for dry cleaning, kt/yr;

$AR_{product}$ – activity rate for the use of solvents for dry cleaning (consumption), kt/yr;

$EF_{pollutant}$ – emission factor for this pollutant technology.

According to the available methodology, the content of organic solvents in substances used in degreasing and dry cleaning is considered to be 100 per cent (EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), Source Category 2D3f 'Dry Cleaning', page 10).

It is considered that the total amount of solvents for degreasing evaporate into the atmosphere, NMVOC emissions being thereby equal to the quantity of solvents used. For dry cleaning of clothes and other textiles, it is assumed that the solvents used are emitted directly into the atmosphere or retained in clothes and textiles, with subsequent evaporation into the atmosphere.

Total consumption of organic solvents for dry cleaning is estimated following the equation:

$$Total\ Consumption = Production + Import - Export$$

It should be noted that for most activities involving use of organic solvents for dry cleaning in the RM there is no statistical data. Under such circumstances, the total consumption of solvents used for dry cleaning was estimated based on information on import of solvents in the RM (internal production of solvents is insignificant; also, it was assumed that such substances are not re-exported).

Because the same substances are widely used for both degreasing and dry cleaning, it was accepted that out of the total amount consumed (Table 4-79), 65 per cent were used for degreasing (Table 4-80), and 35 per cent – for dry cleaning (Table 4-82).

Table 4-82: AD on consumption of solvents used in dry cleaning of textiles for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cyclic and Acyclic Hydrocarbons	0.4289	0.2660	0.1726	0.1235	0.0896	0.0998	0.0205	0.0388	0.0434	0.0099
Alcohols	0.2083	0.0966	0.0325	0.0106	0.0106	0.0134	0.0173	0.0154	0.0685	0.0873
Total solvents	**0.6372**	**0.3627**	**0.2052**	**0.1342**	**0.1002**	**0.1132**	**0.0378**	**0.0543**	**0.1119**	**0.0972**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Cyclic and Acyclic Hydrocarbons	0.0538	0.0211	0.0595	0.0419	0.0667	0.0381	0.0441	0.0445	0.0390	0.0408
Alcohols	0.0436	0.0788	0.0840	0.0396	0.0405	0.0643	0.0993	0.0873	0.0927	0.0814
Total solvents	**0.0975**	**0.0999**	**0.1435**	**0.0815**	**0.1073**	**0.1025**	**0.1434**	**0.1319**	**0.1317**	**0.1221**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Cyclic and Acyclic Hydrocarbons	0.0613	0.0712	0.3261	0.1274	0.0549	0.0678	0.0410	0.0525	0.1247	0.0916
Alcohols	0.0887	0.0961	0.1497	0.1825	0.2144	0.1575	0.1488	0.2055	0.1882	0.2247
Total solvents	**0.1500**	**0.1674**	**0.4758**	**0.3099**	**0.2693**	**0.2253**	**0.1899**	**0.2580**	**0.3129**	**0.3163**

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in atmosphere (it is assumed that all solvents are of fossil origin).

In order to estimate indirect CO_2 emissions, the following equation was used

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from solvent consumption in dry cleaning, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

2D3g 'Chemical Products'

Under source category 2D3g 'Chemical Products', there are reported NMVOC emissions from polyester processing (SNAP 060301); polyurethane foam processing (SNAP 060303) and polystyrene foam processing (SNAP 060304); rubber processing (SNAP 060305); pharmaceutical products manufacturing (SNAP 060306); paints manufacture (SNAP 060307); inks manufacture (SNAP 060308); glues manufacturing (SNAP 060309); asphalt blowing (SNAP 060310); adhesive, magnetic tapes, film and photographs manufacturing (SNAP 060311); textile finishing (SNAP 060312); leather tanning (SNAP 060313).

The methodology used to estimate NMVOC emissions from chemical products is provided by the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) and uses the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – emissions of the specified pollutant, kt/yr;

$AR_{product}$ – activity rate for the use of solvents for manufacture and processing of chemical products, kt/yr;

$EF_{pollutant}$ – emission factor for this pollutant technology, kg/t.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs for Tier 2 approach (Table 4-83).

Table 4-83: Tier 2 default EFs for estimating emissions from 2D3g 'Chemical Products'

Source	NMVOC Emission Factor	Unit
SNAP 060301, Polystyrene processing	50	g/kg monomer
SNAP 060303, Polyurethane foam processing	120	g/kg foam
SNAP 060304, Polystyrene foam processing	60	g/kg foam
SNAP 060305, Rubber processing	8	g/kg rubber
SNAP 060306, Pharmaceutical products manufacturing	300	g/kg solvent
SNAP 060307, Paints manufacturing	11	g/kg product
SNAP 060308, Inks manufacturing	11	g/kg product
SNAP 060309, Glues manufacturing	11	g/kg product
SNAP 060310, Asphalt blowing	27.2	kg/t asphalt
SNAP 060310, Saturated asphalt blowing	0.66	kg/t asphalt
SNAP 060310, Asphalt (in layers) blowing	1.71	kg/t asphalt
SNAP 060314, Tire production	10	g/kg tire
Adhesive tapes manufacturing	3	g/m^2
Shoe manufacture	0.045	kg/pair of shoes

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2.D.3.g 'Chemical Products', Tables 3-2 – 3-13, pages 17-23.

Statistical publications of the RM provide activity data on manufacturing different industrial products, including: polyurethane and polystyrene products, refurbished tires and rubber soles, varnishes and paints, glues, inks, pharmaceutical products, shoes (Table 4-84).

The Customs Service of the Republic of Moldova is the primary source of information on import-export operations regarding primary polyurethane products (code 3909 50); alveolar polyurethane products (code 3921 13); primary polystyrene products (code 3903 11), and styrene polymer products (code 3921 11), respectively. In order to convert AD into mass metric units (tonnes), the following conversion coefficients were used: a car tire weighs circa 7.1 kg; a minibus and small tonnage truck tire – circa 11.1 kg; bus and heavy truck tire – circa 46.0 kg; a tractor tire – circa 69.9 kg).

Table 4-84: AD on manufacturing industrial commodities for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Polyurethane Processing, kt	0.830	0.699	0.589	0.496	0.418	0.352	0.286	0.179	0.116	0.154
Polystyrene Processing, kt	5.917	3.707	2.323	1.455	0.912	0.571	0.231	0.206	0.216	0.187
Rubber Processing, kt	46.900	44.300	20.700	4.200	0.900	1.400	1.512	1.361	1.234	0.853
Pharmaceutical Products Manufacturing, kt	1.853	1.648	1.069	0.683	0.334	0.321	0.289	0.315	0.450	0.760
Paints Manufacturing, kt	11.700	8.800	6.000	3.100	1.200	0.800	0.700	0.509	0.370	0.674
Asphalt Production, kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Refurbished Tires, thousand pieces	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Refurbished Tires, kt	1220.305	1014.808	853.000	678.000	410.000	370.000	335.600	113.727	92.328	86.026
Shoes, mill. pairs	75.300	73.100	40.100	1.500	4.500	6.600	8.000	9.800	7.100	10.200
Polyurethane Processing, kt	1.443	1.401	0.768	0.029	0.086	0.126	0.153	0.188	0.136	0.195
Polystyrene Processing, kt	23.200	20.800	16.268	13.197	9.467	7.606	6.929	6.193	4.591	3.747
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Polyurethane Processing, kt	0.187	0.225	0.438	0.596	0.755	1.536	1.691	2.215	2.551	2.134
Polystyrene Processing, kt	0.410	0.391	0.750	1.290	1.388	2.881	4.141	4.494	4.449	4.889
Rubber Processing, kt	1.598	1.801	3.071	2.425	2.259	0.061	0.296	0.511	0.189	0.036
Pharmaceutical Products Manufacturing, kt	0.512	0.646	0.726	0.522	0.628	0.701	0.760	1.261	3.713	3.832
Paints Manufacturing, kt	2.054	2.870	4.095	3.443	5.136	6.269	8.319	11.045	11.557	11.822
Asphalt Production, kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Refurbished Tires, thousand pieces	NO	NO	NO	NO	0.361	0.655	0.853	1.465	0.580	0.921
Refurbished Tires, kt	69.609	87.148	76.254	72.200	229.300	215.073	347.899	365.390	209.351	156.931
Shoes, mill. pairs	7.000	9.200	4.600	6.000	4.600	3.200	2.800	2.600	2.252	5.829
Polyurethane Processing, kt	0.134	0.176	0.088	0.115	0.088	0.061	0.054	0.050	0.055	0.080
Polystyrene Processing, kt	5.912	4.944	4.925	6.038	6.633	7.450	6.774	6.696	7.083	4.829
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Polyurethane Processing, kt	2.376	2.220	1.583	1.593	1.320	1.979	0.951	1.208	1.467	1.424
Polystyrene Processing, kt	5.711	5.944	6.141	6.209	7.019	7.932	7.496	6.969	7.067	8.101
Rubber Processing, kt	0.058	0.063	0.070	0.072	0.066	0.049	0.048	0.042	0.123	0.110
Pharmaceutical Products Manufacturing, kt	4.994	3.347	3.745	3.347	4.101	4.063	3.800	4.353	3.524	3.644
Paints Manufacturing, kt	12.864	18.011	17.907	12.345	17.685	26.858	32.746	29.555	29.598	29.358
Asphalt Production, kt	NO	0.010	0.016	0.027	NO	NO	NO	NO	NO	NO
Refurbished Tires, thousand pieces	1.373	1.323	1.077	0.953	1.118	5.997	7.607	12.263	4.937	23.871
Refurbished Tires, kt	194.440	219.812	248.191	248.339	360.090	250.423	214.339	273.666	767.009	523.443
Shoes, mill. pairs	6.735	6.852	18.361	17.299	11.947	6.035	7.272	7.423	8.555	8.123
Polyurethane Processing, kt	0.161	0.157	0.248	0.268	0.200	0.139	0.156	0.137	0.168	0.138
Polystyrene Processing, kt	6.247	7.692	7.448	8.329	7.607	5.547	5.156	4.647	4.352	3.910

Source: National Bureau of Statistics of the RM through Statistical Yearbooks for the years 1994 (pages 284, 288, 291), 1995 (pages 253, 257, 260), 1997 (pages 320, 322, 324), 1999 (pages 302, 304, 306), 2003 (pages 391, 393, 395), 2006 (page 311), 2011 (page 305), 2014 (pages 302); Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; Customs Service of the RM, Letter No. 28/07-3025 dated 28.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, as a response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, as a response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, as a response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, as a response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, as a response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in the atmosphere (it is assumed that all solvents are of fossil origin).

In order to estimate indirect CO_2 emissions from solvent use in chemical products, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from solvents used in chemical products, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

2D3h 'Printing'

The methodology used to estimate NMVOC emissions from printing is provided by the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) and uses the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF) / 10^3$$

Where:

$E_{pollutant}$ – emissions of the specified pollutant from ink consumption for printing, kt/yr;

$AR_{product}$ – activity rate for the use of inks for printing, kt/;

EF – default emission factor (Table 4-85), kg/t.

Table 4-85: Tier 1 default EF for category 2D3h 'Printing'

Source	NMVOC Emission Factor	Unit
Printing	500	kg/t ink

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2.D.3.h 'Printing', Table 3-1, page 11.

No statistical data on solvents and/or printing inks used are available in the RM. Under such circumstances, the total ink consumption was estimated considering statistical data on production (Table 4-84), import and export (Table 4-86) (according to the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, by product type, for 2005-2019' inks were produced only during 2011-2013; there are no information on the export of inks during the reference period).

The Customs Service of the RM is the primary source of information on import-export operations (including for 'printing, writing or drawing', as well as 'other inks' – code 3215 10-90; as well as paints for 'artistic painting, educational use, firms painting, amusement, as well as similar paints' – code 3213 10-90).

Table 4-86: AD on ink import for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Inks for printing, writing and drawing, as well as other inks	0.3557	0.2214	0.1427	0.1026	0.0788	0.0405	0.0577	0.0604	0.0596	0.0444
Paints for artistic painting, for educational use, firms painting, amusement as well as similar paints	0.1358	0.1086	0.0836	0.0607	0.0438	0.0306	0.0297	0.0035	0.0197	0.0142
Total inks	**0.4914**	**0.3301**	**0.2262**	**0.1633**	**0.1226**	**0.0711**	**0.0874**	**0.0639**	**0.0793**	**0.0586**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Inks for printing, writing and drawing, as well as other inks	0.0553	0.0838	0.1024	0.1175	0.1568	0.2260	0.1502	0.1925	0.1906	0.1721
Paints for artistic painting, for educational use, firms painting, amusement as well as similar paints	0.0152	0.0164	0.0259	0.0278	0.0330	0.0306	0.0462	0.0356	0.0505	0.0441
Total inks	**0.0706**	**0.1002**	**0.1284**	**0.1453**	**0.1898**	**0.2566**	**0.1964**	**0.2281**	**0.2411**	**0.2162**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Inks for printing, writing and drawing, as well as other inks	0.2209	0.2009	0.1789	0.2008	0.2112	0.2979	0.2207	0.2209	0.2455	0.2402
Paints for artistic painting, for educational use, firms painting, amusement as well as similar paints	0.0479	0.0524	0.0546	0.0623	0.0706	0.0698	0.0774	0.0854	0.0892	0.1004
Total inks	**0.2688**	**0.2533**	**0.2335**	**0.2631**	**0.2818**	**0.3677**	**0.2981**	**0.3063**	**0.3346**	**0.3406**

Source: Customs Service of the RM, Letter No. 28/07-3025 dated 28.02.2020, response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in the atmosphere (it is assumed that all solvents are of fossil origin).

In order to estimate indirect CO_2 emissions from solvent use in inks, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from solvents used in printing, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; IPCC 2006 Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

2D3i 'Other Solvent and Product Use'

'Seed Oil Extraction'

A certain amount of solvents, hexane in particular, is used in the extraction of oil from seeds (mechanical extraction does not require the solvent use). The cleaned and prepared seeds are washed several times in warm hexane solvent until all oil is extracted, while the remaining seeds residue is treated with steam to capture the solvent and oil that remains in it. After drying, the remaining seed residue may be used as animal feed (having a content rich in proteins and mineral salts). The oil is separated from the oil-enriched wash solvent and from the steamed-out solvent. The solvent (hexane) is recovered and re-used. Recovery efficiency is quite high, although it is dictated by some economic aspects specific to enterprises in this branch. The obtained oil is further refined.

The methodology used to estimate NMVOC emissions from 2D3i 'Other Solvent and Product Use' (SNAP 060404 'Fat, edible and non-edible oil extraction'), available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), is represented by the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – emission of the specified pollutant, kt/yr;

$AR_{product}$ – activity rate for the use of solvents in seed oil extraction, kt/yr;

$EF_{pollutant}$ – emission factor for this pollutant technology, kg/t.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs for Tier 2 approach (Table 4-87).

Table 4-87: Tier 2 default EF for estimating NMVOC emissions from seed oil extraction

Source	NMVOC Emission Factor	Unit
Seed Oil Extraction	1.57	g/kg seeds

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2.D.3.i 'Other Solvent and Product Use', SNAP 060404, Table 3-4, page 16.

In order to estimate NMVOC emissions, statistical data on the amount of oil extracted at the Moldovan enterprises is used. At national level, there are over 100 enterprises specialised in oil production, the largest being 'Floarea-Soarelui' JSC in Balti. Current technologies used in seed oil extraction in the RM by use of solvents involve obtaining circa 450 kg of oil per one tone of seeds. This particular conversion factor was used to estimate the quantity of seeds consumed for oil extraction (Table 4-88).

Table 4-88: AD on oil production and quantity of seeds used for oil extraction for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total crude oil non-chemically modified	125.600	117.900	57.317	60.271	50.439	50.715	39.374	35.168	28.747	125.600
Total refined oil non-chemically modified	57.525	53.998	26.251	27.604	23.101	23.227	18.033	16.107	13.166	57.525
Seeds from which refined oils were extracted	127.833	119.996	58.336	61.342	51.336	51.617	40.074	35.793	29.258	127.833
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total crude oil non-chemically modified	117.900	57.317	60.271	50.439	50.715	39.374	35.168	28.747	79.307	83.881
Total refined oil non-chemically modified	53.998	26.251	27.604	23.101	23.227	18.033	16.107	13.166	34.578	28.446
Seeds from which refined oils were extracted	119.996	58.336	61.342	51.336	51.617	40.074	35.793	29.258	76.840	63.213

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total crude oil non-chemically modified	80.705	89.787	96.828	65.502	113.223	109.534	79.963	86.811	106.306	124.662
Total refined oil non-chemically modified	26.506	20.942	20.618	14.418	16.197	16.697	25.722	13.748	13.852	11.251
Seeds from which refined oils were extracted	58.901	46.539	45.817	32.039	35.992	37.105	57.161	30.550	30.782	25.003

Source: National Bureau of Statistics of the RM through Letter No. 06-39/08 dated 23.02.2011, response to letter No. 03-07/175 dated 02.02.2011 from the Ministry of Environment of the RM; Letter No. 06-39/38 dated 22.09.2011, response to Letter No. 101/2011-09-01 dated 02.09.2011 from the Climate Change Office of the Ministry of Environment of the RM; Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; Statistical Yearbooks of the ATULBD for 1998 (page 183), 2000 (page 100), 2002 (page 104), 2003 (page 99), 2006 (page 94), 2007 (page 93), 2009 (page 93), 2011 (page 95), 2013 (page 100), 2017 (page 102), 2020 (page 103).

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in the atmosphere (it is assumed that all solvents are of fossil origin).

In order to estimate indirect CO_2 emissions from solvent use seed oil extraction, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from seed oil extraction, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

'Use of Glues and Other Adhesives'

The methodology used to estimate NMVOC emissions from use of glues and other adhesives (SNAP 060405), available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), is represented by the following equation:

$$E_{pollutant} = (AR \bullet EF_{pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – emission of the specified pollutant from use of glues and other adhesives, t/yr;

AR – activity rate for the use of glues and other adhesives, t/yr;

$EF_{pollutant}$ – emission factor for this pollutant technology, kg/t (Table 4-89).

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs for Tier 2 approach.

Table 4-89: Tier 2 default EF for 2D3i 'Use of Glues and Other Adhesives'

Source	NMVOC Emission Factor	Unit
Use of Glues and Other Adhesives	522	g/kg glue

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2.D.3.i 'Other Solvent and Product Use', SNAP 060405, Table 3-11, page 20.

For most activities related to other solvent use in the Republic of Moldova, there are no reliable statistical reference sources. Under such circumstances, the total consumption of glues and other adhesives was estimated based on information on production, import and export. It should be noted that the production of glues and other adhesives in the Republic of Moldova was insignificant and is recorded only since 2003, albeit it increased in recent years (Table 4-90). The Customs Service of the RM is the primary source of information on national import operations (no data on glue and other adhesives exports from the RM was recorded during the period under review).

Table 4-90: AD on glues and other adhesives production, import and consumption for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Glues and Other Adhesives Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Glues and Other Adhesives Import	3.2508	1.7106	0.9162	0.6208	0.5598	0.4962	0.3323	0.6172	1.0852	0.7549
Glues and Other Adhesives Consumption	**3.2508**	**1.7106**	**0.9162**	**0.6208**	**0.5598**	**0.4962**	**0.3323**	**0.6172**	**1.0852**	**0.7549**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Glues and Other Adhesives Production	NO	NO	NO	0.3611	0.6552	0.8533	1.4646	0.7735	0.5797	0.9211
Glues and Other Adhesives Import	0.7264	0.8643	1.2217	1.3874	1.7522	1.9457	1.9679	1.9609	1.9713	1.4342
Glues and Other Adhesives Consumption	**0.7264**	**0.8643**	**1.2217**	**1.7485**	**2.4074**	**2.7990**	**3.4326**	**2.7344**	**2.5509**	**2.3552**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Glues and Other Adhesives Production	1.3725	1.3234	1.0774	0.9527	1.1179	5.9971	7.6074	12.2625	4.9374	23.8708
Glues and Other Adhesives Import	1.8004	1.5226	1.4106	1.2544	1.4043	1.4872	1.1646	1.4187	1.4758	1.8719
Glues and Other Adhesives Consumption	**3.1729**	**2.8460**	**2.4880**	**2.2070**	**2.5222**	**7.4843**	**8.7719**	**13.6813**	**6.4132**	**25.7427**

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, response to request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, response to request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, response to request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, response to request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, response to request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, response to request from the Ministry of Environment No. 03-07/175 dated 02.02.2011; Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'.

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in the atmosphere (it is assumed that all solvents are of fossil origin).

In order to estimate indirect CO_2 emissions from solvent use in glues and other adhesives, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from solvent used in glues and other adhesives, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

'Preservation of Wood'

The methodology used to estimate NMVOC emissions from 2D3i 'Other Solvent and Product Use' (SNAP 060406 preservation of wood), available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), is represented by the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – emission of the specified pollutant from solvent use in preservation of wood, t/yr;

$AR_{product}$ – activity rate for preservation of wood, t/yr;

$EF_{pollutant}$ – emission factor for this pollutant technology, kg/t.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs for Tier 2 approach (Table 4-91).

Table 4-91: Tier 2 default EF for estimating NMVOC emissions from 'Preservation of Wood'

Source	NMVOC Emission Factor	Unit
Preservation of Wood	105	g/kg creosote
	945	g/kg preservative based on organic solvents
	5	g/kg preservatives based on aqueous solutions

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2.D.3.i 'Other Solvent and Product Use', SNAP 060406, Tables 3-5, 3-6 and 3-7, pages 17-18.

In order to estimate NMVOC emissions, statistical data on the total amount of timber produced at Moldovan enterprises is used (Table 4-92).

Table 4-92: AD on timber production for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total timber production, thousand m^3	265.0	215.0	106.0	55.0	32.0	25.1	21.2	17.2	15.2	21.2
Timber treated with creosote-based preservatives, thousand m^3	39.8	32.3	15.9	8.3	4.8	3.8	3.2	2.6	2.3	3.2
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Total timber production, thousand m^3	14.9	16.2	17.1	17.2	24.1	23.1	27.0	31.8	46.5	34.0
Timber treated with creosote-based preservatives, thousand m^3	2.2	2.4	2.6	2.6	3.6	3.5	4.0	4.8	7.0	5.1
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Total timber production, thousand m^3	25.6	18.5	19.4	16.8	15.8	16.5	14.3	17.1	18.5	13.4
Timber treated with creosote-based preservatives, thousand m^3	3.8	2.8	2.9	2.5	2.4	2.5	2.1	2.6	2.8	2.0

Source: Statistical Yearbooks of the RM for 1994 (page 273), 1999 (page 273), 2003 (page 273), 2006 (page 273); Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; Statistical Yearbooks of the ATULBD for 2000 (page 99), 2003 (page 98), 2006 (page 93), 2009 (page 92), 2011 (page 95), 2012 (page 98), 2017 (page 101), 2019 (page 99), 2020 (page 102).

The literature in the field reveals that about 50 per cent of the total timber is used in construction, 15 per cent in the furniture industry and other finished wood products, 15 per cent in the packaging industry and 20 per cent in other uses. Since the share of timber treated with preservatives is unknown (it is assumed that preservatives in the RM are creosote based) it is admitted that this corresponds to the share of timber used in the furniture industry and other finished wood products (15 per cent of the total).

Current technologies for preservation of wood by creosote impregnation imply the use of circa 75 kg of creosote in order to treat one cubic metre of wood, while for the same volume of wood, 24 kg of organic solvents can be used (EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), source category 2D3i 'Other Solvent and Product Use', SNAP 060406 'Preservation of Wood', page 16). The respective conversion factor was used to estimate the amount of creosote used in timber treatment at Moldovan enterprises (Table 4-93).

Table 4-93: AD on creosote use in preservation of wood for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Creosote use in preservation of wood	2.9813	2.4188	1.1925	0.6188	0.3600	0.2824	0.2385	0.1935	0.1710	0.2385
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Creosote use in preservation of wood	0.1676	0.1823	0.1924	0.1935	0.2711	0.2596	0.3032	0.3580	0.5228	0.3822
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Creosote use in preservation of wood	0.2880	0.2081	0.2183	0.1885	0.1779	0.1851	0.1611	0.1929	0.2082	0.1511

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidization, this carbon is converted into CO_2 in the atmosphere (it is assumed that all solvents are of fossil origin).

In order to estimate indirect CO_2 emissions from solvent use in preservation of wood, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from solvent used in preservation of wood, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

'Underseal Treatment and Conservation of Vehicles'

The methodology used to estimate NMVOC emissions from 'Underseal Treatment and Conservation of Vehicles' (SNAP 060407), available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), is represented by the following equation:

$$E_{pollutant} = (AR \bullet EF) / 10^3$$

Where:

$E_{pollutant}$ – emission of the specified pollutant from underseal treatment and conservation of vehicles', t/yr;

AR – activity rate, population;

EF – emission factor, kg/person.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs for Tier 2 approach (Table 4-94).

Table 4-94: Tier 2 default EF for estimating NMVOC emissions from 'Underseal Treatment and Conservation of Vehicles'

Source	NMVOC Emission Factor	Unit
'Underseal Treatment and Conservation of Vehicles'	0.2	kg/person
	636	g/kg underseal agent
	950	g/kg organic solvent

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2D3i 'Other Solvent and Product Use', SNAP 060407, Table 3-10, page 19-20.

Since the amount of underseal agent and/or solvent used for underseal treatment and conservation of vehicles is unknown, AD on the number of the population was used (Table 4-66).

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in atmosphere (it is assumed that all solvents are of fossil origin).

In order to estimate indirect CO_2 emissions from solvent use in underseal treatment and conservation of vehicles, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from solvent use in underseal treatment and conservation of vehicles, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

'Vehicles Dewaxing'

The methodology used to estimate NMVOC emissions from vehicles dewaxing after long storage and long-distance transport (SNAP 060409), available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), is represented by the following equation:

$$E_{pollutant} = (AR \bullet EF) / 10^3$$

Where:

$E_{pollutant}$ – the emission of the specified pollutant from vehicles dewaxing, kt/yr;

AR – the activity rate on vehicles import, units;

EF – the emission factor, kg/vehicle.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default EFs for Tier 2 approach (Table 4-95).

Table 4-95: Tier 2 default EF for category 2D3i 'Vehicles Dewaxing'

Source	NMVOC Emission Factor	Unit
'Vehicles Dewaxing'	1.0	kg/vehicle

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Category 2D3i 'Other Solvent and Product Use', SNAP 060409, Table 3-9, page 19.

No vehicles are produced in the Republic of Moldova. The Customs Service is a primary source of information on national import operations (Table 4-96).

Table 4-96: AD on new imported vehicles for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Imported vehicles – total, units	5 803	4 836	4 030	3 358	2 798	2 332	2 334	1 922	1 947	3 281
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Imported vehicles – total, units	1 161	1 841	3 503	8 431	7 768	10 030	7 477	10 523	14 368	7 832
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Imported vehicles – total, units	7 923	11 126	10 604	12 233	22 103	23 844	14 951	17 764	24 780	29 140

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, response to request from the Environment Agency No. 08-310/1 dared 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, response to request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, response to request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, response to request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, response to request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, response to request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in the atmosphere (it is assumed that all solvents are of fossil origin).

In order to estimate indirect CO_2 emissions from solvent use in vehicles dewaxing, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from solvent use in vehicles dewaxing, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

2D4 'Other' (Urea-Based Catalysts)

The methodology used to estimate CO_2 emissions from use of urea-based catalysts, available in the 2006 IPCC Guidebook (Volume 2, Chapter 3.2, page 3.12), is represented by the following equation:

$$E = A \bullet 12/60 \bullet Purity \bullet 44/12$$

Where:

E – CO_2 emissions from urea-based additive in catalytic converters, kt/yr;

A – Amount of urea-based additive consumed for use in catalytic converters, kt/yr;

12/60 – mass ratio of carbon (C) and urea ($CO(NH_2)_2$;

Purity – Mass fraction of urea in the urea-based additive (the default value used represents 32.5 per cent);

44/12 – mass ratio of carbon (C) and carbon dioxide (CO_2).

AD on the amount of urea-based additive used in catalytic converters is determined indirectly from diesel oil consumption at national level (additives consumed is between 1 and 3 per cent of the diesel oil consumption).

Activity data on diesel oil consumption is available in the EBs of the RM for 1990 and 1993-2019 (in 1991 and 1992 the EBs were not elaborated, but the information for the respective years was provided to the Ministry of Environment by the NBS through Official Letter No. 05-96-08 dated 10.03.1999, as a response to the request from the Ministry of Environment No. 01-7/138 dated 24.02.1999. The statistical information is available for the entire territory of the country only for 1990 and 1991, while for the rest of the period, it covers only the right bank of the Dniester River.

The table below shows data on the population number between 1990 and 2019, separately for the two banks of the Dniester River (Table 4-97).

Table 4-97: Population of the RM for the period 1990-2019, million people

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM: Right Bank of Dniester River	3.6306	3.6356	3.6288	3.6182	3.6502	3.6462	3.6428	3.6409	3.6550	3.6493
RM: Left Bank of Dniester River	0.7310	0.7307	0.7303	0.7296	0.7025	0.7017	0.6916	0.6791	0.6708	0.6657
RM: Total	**4.3616**	**4.3663**	**4.3591**	**4.3478**	**4.3527**	**4.3479**	**4.3344**	**4.3200**	**4.3258**	**4.3150**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
RM: Right Bank of Dniester River	3.6435	3.6345	3.6272	3.6177	3.6068	3.5330	3.4593	3.3855	3.3118	3.2380
RM: Left Bank of Dniester River	0.6600	0.6518	0.6425	0.6336	0.6238	0.5544	0.5475	0.5406	0.5335	0.5275
RM: Total	**4.3035**	**4.2863**	**4.2697**	**4.2513**	**4.2306**	**4.0874**	**4.0068**	**3.9261**	**3.8453**	**3.7655**
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
RM: Right Bank of Dniester River	3.1643	3.0905	3.0167	2.9430	2.8692	2.8447	2.8244	2.7800	2.7304	2.6817
RM: Left Bank of Dniester River	0.5225	0.5180	0.5134	0.5094	0.5052	0.5007	0.4745	0.4706	0.4690	0.4651
RM: Total	**3.6868**	**3.6085**	**3.5301**	**3.4524**	**3.3744**	**3.3454**	**3.2989**	**3.2506**	**3.1994**	**3.1468**

Source: Statistical Yearbooks of the RM for the years 1991-2020. Statistical Yearbooks of the ATULBD for the years 1998-2020.

In order to generate data on diesel oil consumption on the ATULBD, information on specific consumption of diesel oil per capita for the territory to the right of the Dniester was used: the population number in the ATULBD was multiplied by the specific consumption of diesel oil per capita (for 1990 and 1991 the information was representative for the entire country) (Table 4-98).

Table 4-98: Specific consumption of diesel oil for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Specific consumption of diesel oil, kg/per capita/yr	255.0	225.0	172.0	127.7	104.7	101.5	87.0	82.7	66.8	48.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Specific consumption of diesel oil, kg/per capita/yr	52.1	57.2	70.0	78.5	89.6	92.8	96.3	103.4	110.8	103.8
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Specific consumption of diesel oil, kg/per capita/yr	131.8	143.3	131.3	147.8	159.3	173.0	190.1	205.4	213.2	221.1

Table 4-99 shows the total consumption of diesel oil in the RM between 1990 and 2019.

Table 4-99: Total consumption of diesel oil as energy and fuel between 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RM: Right Bank of Dniester River	925.6	817.8	624.0	462.0	382.0	370.0	317.0	301.0	244.0	176.0
RM: Left Bank of Dniester River	186.4	164.4	125.6	93.2	73.5	71.2	60.2	56.1	44.8	32.1
RM: Total	**1 112.0**	**982.2**	**749.6**	**555.2**	**455.5**	**441.2**	**377.2**	**357.1**	**288.8**	**208.1**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
RM: Right Bank of Dniester River	190.0	208.0	254.0	284.0	323.0	328.0	333.0	350.0	367.0	336.0
RM: Left Bank of Dniester River	34.4	37.3	45.0	49.7	55.9	51.5	52.7	55.9	59.1	54.7
RM: Total	**224.4**	**245.3**	**299.0**	**333.7**	**378.9**	**379.5**	**385.7**	**405.9**	**426.1**	**390.7**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
RM: Right Bank of Dniester River	417.0	443.0	396.0	435.0	457.0	492.0	537.0	571.0	582.0	593.0
RM: Left Bank of Dniester River	68.9	74.3	67.4	75.3	80.5	86.6	90.2	96.7	100.0	103.3
RM: Total	**485.9**	**517.3**	**463.4**	**510.3**	**537.5**	**578.6**	**627.2**	**667.7**	**682.0**	**696.3**

Source: National Bureau of Statistics, Energy Balances of the RM for the years 1990, 1993-2019.

The amount of urea-based additives in catalytic converters was determined indirectly based on the total consumption of diesel oil as energy and fuel, considering that additive consumption represents 2 per cent of the total amount of diesel oil consumed in the Republic of Moldova (Table 4-100).

Table 4-100: Urea-Based Catalyst Used in the Republic of Moldova, 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Urea-based additive use, kt	22.2	19.6	15.0	11.1	9.1	8.8	7.5	7.1	5.8	4.2
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Urea-based additive use, kt	4.5	4.9	6.0	6.7	7.6	7.6	7.7	8.1	8.5	7.8
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Urea-based additive use, kt	9.7	10.3	9.3	10.2	10.7	11.6	12.5	13.4	13.6	13.9

4.5.3. Uncertainties Assessment and Time-Series Consistency

2D1 'Lubricant Use'

Uncertainties related to emission factors used to calculate CO_2 emissions from source category 2D1 'Lubricant Use' following a Tier 1 approach reach up to circa 50 per cent (2006 IPCC Guidelines). Uncertainties related to activity data on lubricant use in the RM are low (circa 5 per cent). Thus, the combined uncertainties related to GHG emissions from 2D1 'Lubricant Use' represent circa 50.25 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in accordance with the recommendations included in the 2006 IPCC Guidelines.

2D2 'Paraffin Wax Use'

Uncertainties related to emission factors used to calculate CO_2 emissions from source category 2D2 'Paraffin Wax Use' following a Tier 1 approach reach up to circa 100 per cent (2006 IPCC Guidelines). Uncertainties related to activity data on paraffin wax use in the RM can be considered moderate (circa 20 per cent). Thus, the combined uncertainties related to GHG emissions from 2D2 'Paraffin Wax Use' represent circa 101.98 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

2D3 'Solvent Use'

Uncertainties related to emission factors used to calculate indirect CO_2 emissions from source category 2D3 'Solvent Use' were estimated at circa 35 per cent (2006 IPCC Guidelines). Uncertainties related to activity data on solvent use in the RM can be considered moderate (circa 20 per cent). Thus, the combined uncertainties related to GHG emissions from 2D3 'Solvent Use' represent circa 40.31 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

2D4 'Other' (Urea-Based Catalysts)

Uncertainties related to emission factors used to calculate CO_2 emissions from source category 2D4 'Other' (Urea-Based Catalysts) are low (circa 2 per cent). Uncertainties related to activity data on use of urea catalysts in the RM can be considered moderate (circa 20 per cent). Thus, the combined uncertainties related to GHG emissions from 2D4 'Other' (urea-based catalysts) represent circa 20.10 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

4.5.4. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for the respective source category, following a Tier 1 approach. Verification was focused on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories; verification was also focused on correct use of AD obtained from different reference sources, including official sources, especially in case of converting AD into mass units compatible with GHG emissions estimation methods; comparing the results obtained by using different estimating methodologies and explaining the identified discrepancies.

AD and methods used for estimating GHG emissions under the category 2D 'Non-energy Products from Fuels and Solvent Use', were documented and archived both in hard copies and electronically.

4.5.5. Recalculations

2D1 'Lubricant Use'

CO_2 emissions from source category 2D1 'Lubricant Use' were not recalculated. For the years 2017-2019, CO_2 emissions from lubricant use were estimated for the first time. The obtained results show that between 1990 and 2019 the respective emissions had decreased by circa 79.6 per cent as a result of the decrease in consumption (Table 4-101).

Table 4-101: Comparative results of CO_2 emissions inventory from source category 2D1 'Lubricant Use' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	24.7987	20.7617	12.1110	10.9576	10.1022	10.1316	9.7676	9.2153	7.0105	4.9998
BUR3	24.7987	20.7617	12.1110	10.9576	10.1022	10.1316	9.7676	9.2153	7.0105	4.9998
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	3.9115	4.3872	4.3239	6.5825	6.5622	6.4692	6.9861	5.7679	6.1481	5.0916
BUR3	3.9115	4.3872	4.3239	6.5825	6.5622	6.4692	6.9861	5.7679	6.1481	5.0916
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	5.4648	5.7762	4.9418	4.8461	4.7832	4.8165	4.9177			
BUR3	5.4648	5.7762	4.9418	4.8461	4.7832	4.8165	4.9177	4.8128	5.0145	5.0561
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0			

Abbreviations: BUR2 – Second Biennial Update Report and BUR3 – Third Biennial Update Report.

2D2 'Paraffin Wax Use'

CO_2 emissions from source category 2D2 'Paraffin Wax Use' were not recalculated. For the years 2017-2019, CO_2 emissions from paraffin wax use were estimated for the first time. The obtained results show that between 1990 and 2019 the respective emissions had increased by circa 18.4 per cent as a result of the increase in consumption (Table 4-102).

Table 4-102: Comparative results of CO_2 emissions inventory from source category 2D2 'Paraffin Wax Use' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	0.1138	0.0953	0.0556	0.0503	0.0464	0.0465	0.0448	0.0423	0.0322	0.0230
BUR3	0.1138	0.0953	0.0556	0.0503	0.0464	0.0465	0.0448	0.0423	0.0322	0.0230
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.0180	0.0201	0.0198	0.0302	0.0301	0.0149	0.0594	0.0595	0.0295	0.0742
BUR3	0.0180	0.0201	0.0198	0.0302	0.0301	0.0149	0.0594	0.0595	0.0295	0.0742
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.1795	0.0747	0.1351	0.0751	0.0301	0.0600	0.0449			
BUR3	0.1795	0.0747	0.1351	0.0751	0.0301	0.0600	0.0449	0.0600	0.1198	0.1348
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0			

Abbreviations: BUR2 – Second Biennial Update Report and BUR3 – Third Biennial Update Report.

2D3 'Solvent Use'

GHG emissions from source category 2D3 'Solvent Use' were recalculated for the period 1999-2016 due to the updated activity data available in the Statistical Yearbooks of the ATULBD and of the RM, as well as in the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic, by product type for 2005-2019'; particularly updated AD on asphalt production in 1999-2002, production of paints in 2016, production of timber in 2015-2016, import of vehicles in 2011-2016 and the population number in 2005-2016 (the results of the 2004 and 2014 population censuses, conducted in parallel on both banks of the Dniester River, were re-evaluated). Compared to the values of indirect CO_2 emissions reported in the BUR2 of the RM to the UNFCCC (2019), the changes resulted in an upward trend in CO_2 emissions from source category 2D3 'Solvent Use' in 1999-2006 and 2016, and in a trend to reduce these emissions in the period 2007-2015, respectively (Table 4-103).

Table 4-103: Comparative results of CO_2 emissions inventory from source category 2D3 'Solvent Use' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	204.1460	167.7797	138.5232	110.2218	72.1539	64.2796	59.4607	31.0928	29.1801	26.9099
BUR3	204.1460	167.7797	138.5232	110.2218	72.1539	64.2795	59.4608	31.0929	29.1892	28.0692
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	26.7005	29.6744	31.5827	32.7176	55.7018	59.5365	72.9830	77.1889	58.9055	51.1739
BUR3	27.6403	30.8429	32.6053	32.7216	55.7321	59.8981	73.0967	76.9812	58.4959	50.5522
Difference, %	3.5	3.9	3.2	0.0	0.1	0.6	0.2	-0.3	-0.7	-1.2
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	59.1169	64.0577	68.6412	63.6359	81.6487	78.8008	70.7297			
BUR3	58.2796	63.0079	67.3666	62.1274	79.8615	76.9346	76.8520	88.9719	142.7958	135.0194
Difference, %	-1.4	-1.6	-1.9	-2.4	-2.2	-2.4	8.7			

Abbreviations: BUR2 – Second Biennial Update Report and BUR3 – Third Biennial Update Report.

Between 2017 and 2019, CO_2 emissions from solvent use were estimated for the first time. The obtained results show that between 1990 and 2019 the respective emissions had decreased by circa 33.9 per cent as a result of the decrease in consumption.

The same trends were noticed in the case of NMVOC emissions from source category 2D3 'Solvent Use' (Table 4-104). Between 2017-2019, NMVOC emissions from solvent use were estimated for the first time. The obtained results show that between 1990 and 2019 the respective emissions had decreased in the Republic of Moldova by circa 33.9 per cent.

Table 4-104: Comparative results of NMVOC emissions inventory from source category 2D3 'Solvent Use' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	92.7937	76.2635	62.9651	50.1008	32.7972	29.2180	27.0276	14.1331	13.2679	12.2362
BUR3	92.7937	76.2635	62.9651	50.1008	32.7972	29.2180	27.0276	14.1331	13.2678	12.7587
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	12.1410	13.4901	14.3574	14.8735	25.3328	27.0205	33.1366	35.0576	26.7467	23.2322
BUR3	12.5638	14.0195	14.8206	14.8735	25.3328	27.2264	33.2258	34.9915	26.5891	22.9783
Difference, %	3.5	3.9	3.2	0.0	0.0	0.8	0.3	-0.2	-0.6	-1.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	26.8426	29.0886	31.1720	28.8972	37.0850	35.8008	32.3531			
BUR3	26.4907	28.6400	30.6212	28.2397	36.3007	34.9703	34.9327	40.4418	64.9072	61.3724
Difference, %	-1.3	-1.5	-1.8	-2.3	-2.1	-2.3	8.0			

Abbreviations: BUR2 – Second Biennial Update Report and BUR3 – Third Biennial Update Report.

2D4 'Other' (Urea-Based Catalysts)

GHG emissions from urea-based catalysts were recalculated for the period 2005-2016 due to the updated activity data associated with diesel oil consumption on the Left Bank of the Dniester River. Compared to the values of indirect CO_2 emissions reported in the BUR2 of the RM to the UNFCCC (2019), the changes resulted in an downward trend in CO_2 emissions from source category 2D4 'Other' (Urea-Based Catalysts) in 2005-2006, and in a upward trend in the respective emissions in the years 2007-2016 (Table 4-105).

Table 4-105: Comparative results of CO_2 emissions inventory from source category 2D4 'Other' (Urea-Based Catalysts) included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	5.3005	4.6818	3.5730	2.6463	2.1713	2.1031	1.7979	1.7024	1.3765	0.9920
BUR3	5.3005	4.6818	3.5730	2.6463	2.1713	2.1031	1.7979	1.7024	1.3765	0.9920
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1.0697	1.1693	1.4252	1.5908	1.8059	1.8195	1.8432	1.9311	2.0219	1.8487
BUR3	1.0697	1.1693	1.4252	1.5908	1.8059	1.8088	1.8385	1.9347	2.0312	1.8625
Difference, %	0.0	0.0	0.0	0.0	0.0	-0.6	-0.3	0.2	0.5	0.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	2.2918	2.4321	2.1716	2.3829	2.5008	2.6922	2.9202			
BUR3	2.3159	2.4656	2.2088	2.4324	2.5619	2.7580	2.9897	3.1825	3.2507	3.3189
Difference, %	1.1	1.4	1.7	2.1	2.4	2.4	2.4			

Abbreviations: BUR2 – Second Biennial Update Report and BUR3 – Third Biennial Update Report.

Between 2017-2019, CO_2 emissions from urea-based catalysts were estimated for the first time. The obtained results show that between 1990 and 2019 the respective emissions had decreased in the RM by circa 37.4 per cent as a result of the decrease in diesel oil consumption.

4.5.6. Planned Improvements

Possible improvements under category 2D 'Non-Energy Products from Fuels and Solvent Use' aim at updating the activity data used to estimate GHG emissions within this category for the period 1990-2019.

4.6. Product Uses as Substitutes for ODS (Category 2F)

4.6.1. Source Category Description

A large number of hydrofluorocarbons are used to substitute ozone depleting substances (ODS) (Table 4-106).

Globally, wide scale production of halocarbons started in 1991, as alternative substances to chlorofluorocarbons (ozone layer depleting substances). According to the Montreal Protocol, the Parties to this treaty committed to phase out the import and domestic consumption of ODS, with further complete elimination starting with 2008 (because halocarbons do not contain chlorine atoms, they do not have any impact on the ozone layer).

Table 4-106: GWP for 100 years and the atmospheric lifetime of hydrofluorocarbons used to substitute ozone depleting substances[74]

GHG	Chemical Formula	Atmospheric Lifetime, according to AR5	SAR	TAR	AR4	AR5
HFC-23	CHF_3	222	11700	12000	14800	12140
HFC-32	CH_2F_3	5.2	650	550	675	677
HFC-125	C_2HF_5	28.2	2800	3400	3500	3170
HFC-134a	$C_2H_2F_2$ (CH_2FCF_3)	13.4	1300	1300	1430	1300
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	47.1	3800	4300	4470	4800
HFC-152a	C_2H4F_2 (CH_3CHF_2)	1.5	140	120	124	138
HFC-227ea	CF_3CHFCF_3	38.9	2900	3500	3220	3350
HFC-236fa	$CF_3CH_2CF_3$	242	6300	9400	9810	8060
HFC-245fa	$CHF_2CH_2CF_3$	7.7	NA	950	1030	858
HFC-365mfc	$CH_3CF_2CH_2CF_3$	8.7	NA	890	794	804
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	16.1	1300	1500	1640	1650

Sources: SAR – Second Assessment Report (IPCC, 1996), TAR – Third Assessment Report (IPCC, 2001), AR4 – Fourth Assessment Report (IPCC, 2007), AR5 – Fifth Assessment Report (IPCC, 2013).

Category 2F 'Product Uses as Substitutes for ODS' includes GHG emissions from the following emission sources: 2F1 'Refrigeration and Air Conditioning', 2F2 'Foam Blowing Agents', 2F3 'Fire Protection', 2F4 'Aerosols', 2F5 'Solvents' and 2F6 'Other Applications'.

Under the current inventory cycle, the Republic of Moldova monitored emissions generated by the consumption of HFCs from source categories 2F1, 2F2, 2F3 and 2F4. Emissions from source categories 2F5 and 2F6 were not estimated due to lack of activity data.

[74] < http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Annex-6-Additional-Information.pdf>.

It should be noted that the process of collecting activity data on the consumption of alternative substances to ODS is extremely difficult at national level. The primary difficulty is due to the fact that import, export, re-export and circulation of these substances on the market is not regulated at national level (for example, the ODS[75] since 01.01.2013). Import of substitutes for ODS in bulk, as well as products and equipment charged with halocarbons do not require a license and/or environmental authorization, being allowed to almost any legal entity or natural person. Secondly, there are difficulties in monitoring the import of disaggregated HFCs by type of substance, as ODS and their alternatives are on aggregate in the Nomenclature of Goods of the RM in several tariff positions (2903 3919-2903 3990; 2903 7900-2903 7919; 3824 7100; 3824 7400, 3824 7800 and 3824 7900). Another difficulty is that halocarbons may be imported both in 'standard' packaging of 10-15 kg, and in small containers (300-500 g), which can be imported by almost any natural person.

Under these circumstances, HFC emissions from category 2F 'Product Uses as Substitutes for ODS' were estimated based on assessment methodologies available in 2006 IPCC Guidelines, considering data on import and consumption of halocarbons provided by economic agents, including through the Annual Reports submitted by enterprises to the Ozone Office (to be noted that between 2003-2019, only a limited number of enterprises were licensed to import, export, re-export, transit and placing ODS and equipment containing ODS on the market: 'Ecolux' Ltd., 'Frigoinds' Ltd., 'Frio-Dins' Ltd., 'York Refrigerent' Ltd., 'Dina Cociug' Ltd.).

In addition, the Generalised Reports were also used on the production, consumption, import/export of ozone-depleting substances, regulated by the Montreal Protocol, in the RM between 2001 and 2008 according to the Statistical Report No. 1-Ozone, provided by the NBS (from 2009 through 2016, the responsibility for collecting statistical information according to the Statistical Report No. 1-Ozone was kept by the Inspectorate for Environmental Protection, but due to the lack of capacities, the respective information was not collected).

It should be noted that the Republic of Moldova does not produce HFCs; and before 1995, these substances had a relatively narrow use, being imported in insignificant amounts.

2F1 'Refrigeration and Air Conditioning'

Refrigeration equipment (refrigerators, freezers, refrigerated display cases, industrial refrigeration equipment) and air conditioning equipment (stationary and mobile air conditioners) are a primary source of HFC emissions in the Republic of Moldova.

Because since 1995, in accordance with the Montreal Protocol, developed countries are not supposed to produce CFCs and equipment using CFCs, the RM uses R-22 and R-600a refrigerants as transit substances, and R-134a, R-404a, R-407c, R-410a and R-507a, as alternative refrigerants to CFCs (Table 4-107).

Table 4-107: Composition of refrigerants preponderantly used in the RM

Commercial Name	Sector of Use	Composition
R-32	Commercial Refrigerant, Air Conditioning	HFC-32 (100%)
R-134a	Transport, commercial, industrial refrigerant	HFC-134a (100%)
R-404a	Commercial, industrial refrigerant	HFC-125 (44%)/HFC-143a (52%)/HFC-134a (4%)
R-406a	Commercial refrigerant	HCFC-22 (55%)/HC-600a (14%)/HCFC-142B (41%)
R-407a	Commercial, industrial refrigerant	HFC-32 (20%)/HFC-125 (40%)/HFC-134a (40%)
R-407b	Commercial refrigerant	HFC-32 (10%)/HFC-125 (70%)/HFC-134a (20%)
R-407c	Commercial refrigerant, Air Conditioning	HFC-32 (23%)/HFC-125 (25%)/HFC-134a (52%)
R-407d	Transport refrigerant	HFC-32 (15%)/HFC-125 (15%)/HFC-134a (70%)
R-407f	Commercial, industrial refrigerant	HFC-32 (30%)/HFC-125 (40%)/HFC-134a (40%)
R-408a	Commercial refrigerant	HCFC-22 (47%)/HFC-143a (46%)/HFC-125 (7%)
R-410a	Air Conditioning	HFC-32 (50%)/HFC-125 (50%)
R-422d	Commercial, industrial refrigerant	HFC-125 (65.1%)/HFC-134a (31.5%)/R-600a (3.4%)
R-507a	Transport, commercial, industrial refrigerant	HFC-125 (50%)/HFC-143a (50%)

Since 2017, relatively large amounts (circa 1.7 tonnes) of R-407f were introduced on the domestic market as an alternative substance for the refrigerant agent R-404a, respectively (circa 13.0 tonnes) of R-422d as an alternative substance for the refrigerant agent R-22.

[75] <http://mediu.gov.md/index.php/activitate/autorizatii>.

2F2 'Foam Blowing Agents'

Since 1995, hydrofluorocarbons have been also used to replace CFCs and HCFCs used in foam blowing agents (closed and opened cell foams), used in insulation, cushioning and packaging. The basic components for the production of these foams are: HFC-245f, HFC-365mfc, HFC-134a, HFC-152a, HCFC-22, HCFC-141b, HCFC-142b, Pentane (C,I,N) and CO_2+ethanol. In the Republic of Moldova, foams have been produced since 2005. Foams produced as well as imported ones are mostly closed cell foams (the emissions from these last longer, circa 20 years).

2F3 'Fire Protection'

There are two types of fire extinguishers: which use HFCs (mainly HFC-227ea and HFC-236fa) as halon substitutes (halon-1211 or bromoclorodifluoromethane; halon-1301 or bromotrifluoromethane and halon-2402 or dibromotetrafluoroethane): (1) portable fire extinguishing systems and (2) fixed fire extinguishing systems. According to the information received from General Inspectorate for Emergency Situations of the Ministry of Internal Affairs, only CO_2 had been used in fixed fire extinguishing systems as an extinguishing agent until 2016 (halon and HFC based fixed and portable extinguishing systems were not in use) (Table 4-108).

Table 4-108: Import of portable fire extinguishers for the period 1995-2019

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Portable Fire Extinguishers	12 195	11 086	10 078	9 162	8 329	7 572	4 178	9 247	13 806	20 913	18 494	26 666	41 232
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
Portable Fire Extinguishers	46 428	154 462	43 347	29 374	42 465	51 143	51 942	42 613	42 601	58 547	90 623	87 879	620.6

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

The import of HFC-227ea for use in fire protection systems has been registered in the Republic of Moldova since 2017 (Table 4-109).

Table 4-109: Import and export of HFC-227ea for the period 2017-2019, tonnes

	2017	2018	2019
Import of HFC-227ea, t	2.0	20.0	22.0
Export of HFC-227ea, t	0.0	14.5	9.3
Total amount of HFC-227ea utilised in domestic fire protection systems, t	2.0	5.5	12.7

Source: Customs Service of the RM, Letter No. 28/07-3025 dated 28.02.2020, response to Letter No. 08-310/1 dated 11.02.2020 from the Environment Agency.

2F4 'Aerosols' (Metered Dose Aerosols)

In most aerosol products, HFCs are used as propellants. Emissions from aerosols are usually released shortly after production, on average 1-2 years after sale. When used, the entire amount of propellant is considered to be emitted into the atmosphere. Most frequently, HFC-134a is used as a propellant (less commonly, HFC-227ea and HFC-152a).

In the Republic of Moldova, aerosols containing chemical substances included in Annex A, Group I of the Montreal Protocol cannot be imported, exported, re-exported, transited and put into circulation on the market. The interdiction does not extend on medical care goods: pharmaceutical aerosols in the form of sprays used in treatment of chronic lung obstructions, cardiac conditions and treatment substances that can be used as aerosols only; as well as goods needed to ensure public order (special products manufactured commissioned and used by the Ministry of Internal Affairs or other organisations entitled to ensure public order, and used in cases stipulated by legislation).

HFC emissions from category 2F 'Product Uses as Substitutes for ODS' had increased in the RM between 1995 and 2019 by circa 223.3 times, from 1.03 kt CO_2 equivalent in 1995 to 229.95 kt CO_2 equivalent in 2019 (Table 4-110, Figure 4-3).

Table 4-110: HFC emissions from source category 2F 'Product Uses as Substitutes for ODS' in the RM for the period 1995-2019, kt CO_2 equivalent

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
HFCs	1.0298	1.6593	2.3137	3.1372	4.0002	5.1199	6.8681	9.1227	12.1632	16.0027	22.5106	33.2493	44.7889
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
HFCs	57.3627	67.4807	77.8936	90.1296	100.0227	108.3873	121.5640	153.8517	163.2067	182.4923	194.4750	229.9469	22229.0

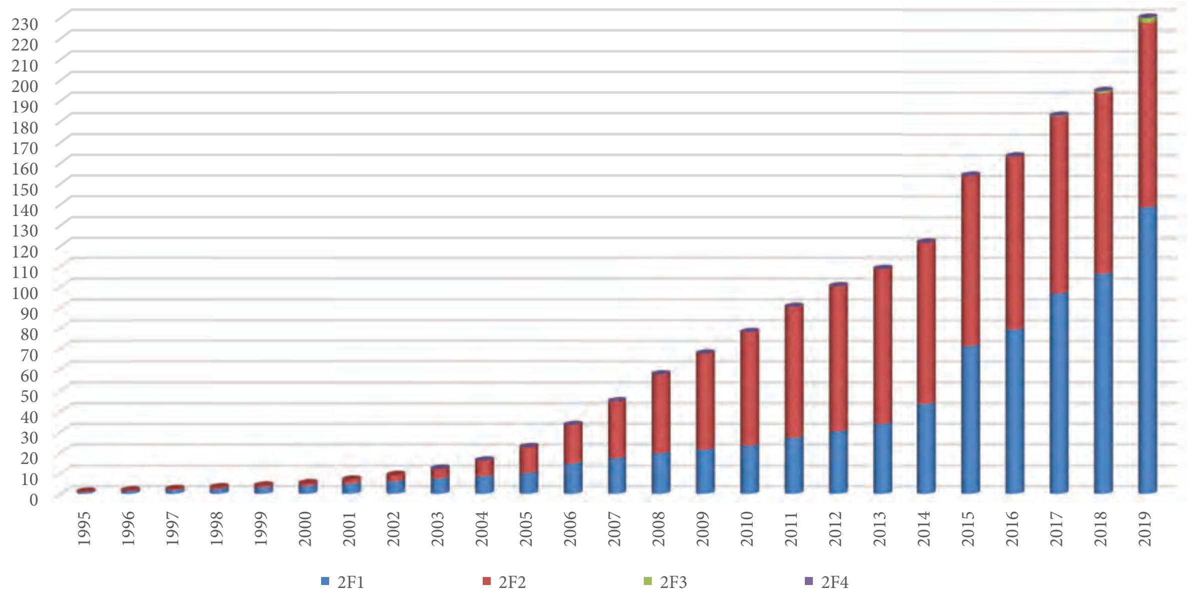

Figure 4-3: F-gases Emissions from 2F 'Product Uses as Substitutes for ODS' Category, by Source, within 1995-2019 periods, kt CO_2 equivalent

Categories 2F1 'Refrigeration and Air Conditioning' and 2F2 'Foam Blowing Agents' had the largest share in the total HFC emissions from category 2F 'Product Uses as Substitutes for ODS'.

4.6.2. Methodological Issues, Emission Factors and Data Sources

2F1 'Refrigeration and Air Conditioning'

Refrigeration equipment (refrigerators, freezers, refrigerated display cases, industrial refrigeration equipment) and air conditioning equipment (stationary and mobile air conditioners) are a primary source of HFC emissions in the Republic of Moldova

GHG emissions from the consumption of halocarbons in this category were estimated using a Tier 2 approach (2006 IPCC Guidelines, Volume 3, Chapter 7.5, Equation 7.10, page 7.49).

$$E_{total,\,t} = E_{containers,\,t} + E_{Charge,\,t} + E_{lifetime,\,t} + E_{end\text{-}of\text{-}life,\,t}$$

Where:

$E_{containers,\,t}$ – emissions related to the management of refrigerant containers;

$E_{charge,\,t}$ – emissions related to the refrigerant charge: connection and disconnection of the refrigerant container and the new equipment to be charged;

$E_{lifetime,\,t}$ – annual emissions from the banks of refrigerants associated with the six sub-applications during operation (fugitive emissions and ruptures) and servicing;

$E_{end\text{-}of\text{-}life,\,t}$ – emissions at system disposal.

The assessment process involves several steps, using the following equations.

Step 1: Refrigerant management of containers

The emissions related to the refrigerant container comprises all the emissions related to the refrigerant transfer from bulk containers (typically 40 tonnes) down to small capacities (from 0.5 kg to 1 tonne). Emissions are estimated using Equation 7.11 from the 2006 IPCC Guidelines (Volume 3, Chapter 7.5, page 7.49).

$$E_{container,\,t} = RM_t \bullet (c / 100)$$

Where:

RM_t – HFC market for new equipment and servicing of all refrigeration application in year *t*, kg;

c – emission factor of HFC container management of the current refrigerant market, percent (varies between 2 and 10 per cent of the refrigerant market; on average, circa 6 per cent).

Step 2: Refrigerant charge emissions of new equipment

The emissions of refrigerant due to the charging process of new equipment are related to the process of connecting and disconnecting the refrigerant container to and from the equipment when it is initially charged. The respective emissions are estimated using Equation 7.12 from the 2006 IPCC Guidelines (Volume 3, Chapter 7.5, page 7.50).

$$E_{charge,\ t} = M_t \bullet (k / 100)$$

Where:

M_t – amount of HFC charged into new equipment in year t (per sub-application), kg; it should be noted that systems that are imported pre-charged are not been taking into consideration;

k – emission factor of assembly losses of the HFC charged into new equipment (per sub-application),

percent, (varies between 0.1 per cent and 3 per cent).

Step 3: Emissions during lifetime (operation and servicing)

Annual leakage from the refrigerant bank during lifetime represent fugitive emissions and are estimated using Equation 7.13 from the 2006 IPCC Guidelines (Volume 3, Chapter 7.5, page. 7.50).

$$E_{lifetime,\ t} = B_t \bullet (x / 100)$$

Where:

B_t – amount of HFC banked in existing systems in year t (per sub-application), kg;

x – annual emission rate (i.e., emission factor) of HFC of each sub-application bank during operation, accounting for average annual leakage and average annual emissions during servicing, percent.

Step 4: Emissions at end-of-life

Emissions at system disposal are estimated using Equation 7.14 from the 2006 IPCC Guidelines (Volume 3, Chapter 7.5, page 7.51).

$$E_{end\text{-}of\text{-}life,\ t} = M_{t\text{-}d} \bullet (p / 100) \bullet (1 - \eta_{rec,\ d} / 100)$$

Where:

M_{t-d} – = amount of HFC initially charged into new systems installed in year (*t-d*), kg;

p – residual charge of HFC in equipment being disposed of expressed in percentage of full charge, percent;

$\eta_{rec,\ d}$ – recovery efficiency at disposal, which is the ratio of recovered HFC referred to the HFC contained in the system, percent.

During the assessment process, default EF available in the 2006 IPCC Guidelines were used, as well as country-specific EFs provided by the members of the Republican Association of Refrigeration Technicians, and from the reports submitted by companies to the Ozone Office of the Ministry of Agriculture, Regional Development and Environment, respectively (Table 4-111).

Table 4-111: EFs and parameters used to estimate HFC emissions from refrigeration and air conditioning equipment imported into the Republic of Moldova

Equipment Type (sub-application)	Charge, kg (margin and value used)	Lifetime, years (margin and value used)	Emission Factor (% of the initial charge/year)		End-of-Life Emissions (%)	
			Initial Emissions	Lifetime Emissions	Recovery Efficiency	Residual Charge
Factors in Equations	(M)	(d)	(k)	(x)	($\eta_{rec,\ d}$)	(p)
Domestic refrigeration	$0.05 \le M \le 0.5$ **0.10**	$12 \le d \le 20$ **16**	$0.2 \le k \le 1$ **0.6**	$0.1 \le x \le 0.5$ **0.5**	$0 < \eta_{rec,\ d} < 70$ **0**	$0 < p < 80$ **50**
Chest freezers	$0.05 \le M \le 0.5$ **0.20**	$12 \le d \le 20$ **16**	$0.2 \le k \le 1$ **0.6**	$0.1 \le x \le 0.5$ **0.5**	$0 < \eta_{rec,\ d} < 70$ **0**	$0 < p < 80$ **50**
Upright freezers	$0.05 \le M \le 0.5$ **0.18**	$12 \le d \le 20$ **16**	$0.2 \le k \le 1$ **0.6**	$0.1 \le x \le 0.5$ **0.5**	$0 < \eta_{rec,\ d} < 70$ **0**	$0 < p < 80$ **50**
Stand-alone commercial application	$0.2 \le M \le 6$ **0.4**	$10 \le d \le 15$ **12**	$0.5 \le k \le 3$ **1.5**	$1 \le x \le 15$ **16.8**	$0 < \eta_{rec,\ d} < 70$ **30**	$0 < p < 80$ **50**
Medium commercial refrigeration	$3 \le M \le 30$ **6**	$10 \le d \le 15$ **12**	$0.5 \le k \le 3$ **1.5**	$1 \le x \le 15$ **16.8**	$0 < \eta_{rec,\ d} < 70$ **30**	$0 < p < 80$ **50**
Large commercial refrigeration	$100 \le M \le 200$ **150**	$10 \le d \le 15$ **12**	$0.5 \le k \le 3$ **1.5**	$1 \le x \le 15$ **16.8**	$0 < \eta_{rec,\ d} < 70$ **50**	$0 < p < 80$ **50**
Industrial refrigeration	$10 \le M \le 10000$ **150**	$15 \le d \le 30$ **20**	$0.5 \le k \le 3$ **1.5**	$7 \le x \le 25$ **16**	$0 < \eta_{rec,\ d} < 90$ **50**	$50 < p < 100$ **75**

Equipment Type (sub-application)	Charge, kg (margin and value used)	Lifetime, years (margin and value used)	Emission Factor (% of the initial charge/year)		End-of-Life Emissions (%)	
			Initial Emissions	Lifetime Emissions	Recovery Efficiency	Residual Charge
Factors in Equations	(M)	(d)	(k)	(x)	($\eta_{rec, d}$)	(p)
Residential and Commercial A/C, including Heat Pumps	$0.5 \le M \le 100$ **0.6**	$10 \le d \le 20$ **12**	$0.2 \le k \le 1$ **0.6**	$1 \le x \le 10$ **5**	$0 < \eta_{rec, d} < 80$ **0**	$0 < p < 80$ **50**
Mobile A/C – personal cars	$0.4 \le M \le 0.8$ **0.6**	$9 \le d \le 16$ **16**	$0.2 \le k \le 0.5$ **0.5**	$10 \le x \le 20$ **15**	$0 < \eta_{rec, d} < 50$ **0**	$0 < p < 50$ **50**
Mobile A/C – buses, trains, passenger carriages	$10 \le M \le 20$ **12**	$9 \le d \le 16$ **12**	$0.2 \le k \le 0.5$ **0.5**	$10 \le x \le 20$ **15**	$0 < \eta_{rec, d} < 50$ **30**	$0 < p < 50$ **50**
Mobile A/C – minibuses	$0.5 \le M \le 1.5$ **1.2**	$9 \le d \le 16$ **12**	$0.2 \le k \le 0.5$ **0.5**	$10 \le x \le 20$ **15**	$0 < \eta_{rec, d} < 50$ **30**	$0 < p < 50$ **50**
Mobile A/C – trucks	$0.5 \le M \le 1.5$ **1**	$9 \le d \le 16$ **12**	$0.2 \le k \le 0.5$ **0.5**	$10 \le x \le 20$ **15**	$0 < \eta_{rec, d} < 50$ **30**	$0 < p < 50$ **50**
Refrigeration vehicles	$3 \le M \le 8$ **7**	$6 \le d \le 9$ **9**	$0.2 \le k \le 1$ **0.6**	$15 \le x \le 50$ **30**	$0 < \eta_{rec, d} < 70$ **30**	$0 < p < 50$ **50**

Source: 2006 IPCC Guidelines, Volume 3, Chapter 7.5, Table 7.9, page 7.52. Republican Association of Refrigeration Technicians of the Republic of Moldova and reports submitted by companies to the Ozone Office of the Ministry of Environment

I) Domestic Refrigeration

The refrigerator plant in Chisinau was founded in November 1964 and had produced between 1965 and 1998 a series of refrigerator models ('Nistru', 'Iarna', 'Iarna-2', 'Iarna-3', 'Iarna-4', 'Codru') and one freezer model 'Ghiocel'. The plant production had been exhibited at international fairs and exhibitions, enjoying popularity in the RM, other union republics of the former USSR as well as in socialist countries. Once the transition to the market economy began, the production did not resist the competition with the imports and, as a result, in 1997, the company went bankrupt. Since 1998, in the Republic of Moldova, no domestic refrigerators and freezers have been produced (Table 4-112). Refrigerant R-12 was used in the production process at the respective plant.

Table 4-112: AD on refrigerator and freezers production for the period 1990-1998, thousand units

Refrigeration Equipment	1990	1991	1992	1993	1994	1995	1996	1997	1998
Refrigerators	2.6	1.3	1.1	1.0	0.9	0.8	0.2	0.2	0.0
Freezers	131.0	118.0	55.0	58.0	53.0	23.0	0.9	1.5	0.1

AD used to estimate HFC emissions from consumption of hydrofluorocarbons charged into domestic refrigeration equipment (refrigerators and freezers) were provided by the Customs Service of the RM. Between 1995 and 2019, the import of domestic refrigerators increased by circa 4.9 times, while for domestic freezers – by circa 464 times (Table 4-113).

Table 4-113: AD on import of domestic refrigeration equipment for the period 1995-2019, units

Equipment	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Refrigerators	18 958	8 376	11 597	15 230	8 498	12 092	19 937	30 689	42 524	52 694	70 412	87 034	112 982
Chest freezers	36	243	100	148	96	242	428	97	442	457	1 265	1 713	1 549
Upright freezers	43	337	22	320	200	393	558	995	2 033	1 481	1 965	5 180	9 574
Equipment	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
Refrigerators	78 880	65 306	72 824	66 900	63 433	55 638	60 963	55 713	51 245	60 255	77 510	93 196	391.6
Chest freezers	2 834	2 529	2 492	3 395	2 107	2 870	3 151	5 413	6 822	10 142	15 188	25 608	71 033.3
Upright freezers	3 169	4 323	8 825	9 239	7 994	6 164	8 242	7 482	5 660	6 115	6 783	11 090	25 690.7

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

The share of refrigerants charged into domestic refrigeration equipment in the RM varied from one year to another (Table 4-114).

Table 4-114: Share of refrigerants charged into domestic refrigeration equipment for the period 1995-2020, %

Equipment	Refrigerant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Refrigerators	R-134a	0	0	0	0	0	0	0	0	30	40	55	65	70
	R-600a	0	0	0	0	0	0	0	0	0	0	0	0	0
	R-12	100	100	100	100	100	100	100	100	70	60	45	35	30
Freezers	R-134a	0	0	0	0	0	0	0	0	20	30	40	50	50
	R-404a	0	0	0	0	0	0	0	0	15	25	35	40	45
	R-290	0	0	0	0	0	0	0	0	0	0	0	0	0
	R-12	100	100	100	100	100	100	100	100	65	45	25	10	5

Equipment	Refrigerant	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Refrigerators	R-134a	75	70	65	55	45	30	20	10	0	0	0	0	0
	R-600a	0	30	35	45	55	40	80	90	100	100	100	100	100
	R-12	25	0	0	0	0	0	0	0	0	0	0	0	0
Freezers	R-134a	45	40	35	35	35	30	25	15	5	0	0	0	0
	R-404a	50	60	65	65	65	65	70	80	90	95	95	95	95
	R-290	0	0	0	0	0	5	5	5	5	5	5	5	5
	R-12	5	0	0	0	0	0	0	0	0	0	0	0	0

Source: Republican Association of Refrigeration Technicians of the Republic of Moldova.

The information on the share of refrigerants charged into the refrigeration equipment imported into the country (Table 4-107), the share of refrigerants charged into the refrigeration equipment imported into the country for the period 1995-2019 (Table 4-114), the average charge of equipment with refrigerant (Table 4-111) and statistical data on import of domestic refrigeration equipment (Table 4-113), was used to estimate the total amount of refrigerants imported into the country and the domestic refrigeration equipment (Table 4-115) and the cumulative amount of refrigerants used in the domestic refrigeration equipment imported into the Republic of Moldova (Table 4-116).

Table 4-115: AD on import of refrigerants charged into domestic refrigeration equipment for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-134a	1.3666	2.2152	4.1153	6.2947	8.9253	6.4277	5.0850	5.4640	4.4992
R-404a	0.0682	0.0895	0.2123	0.5100	0.9149	0.5686	0.7704	1.3565	1.5223
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-134a	3.5056	2.1742	1.7477	0.9215	0.1192	0.0000	0.0000	0.0000	-100.0
R-404a	1.2092	1.0943	1.4796	1.9435	2.1449	2.9726	4.0456	6.7619	9 822.0

Activity data on the total amount of refrigerants imported into the country were provided through reports submitted by companies to the Ministry of Agriculture, Regional Development and Environment and to Environment Agency, respectively. However, this information is on aggregate across the country, without specifying the share used for domestic refrigeration equipment service.

Table 4-116: Cumulative amount of refrigerants charged into domestic refrigeration equipment imported for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-134a	1.3666	3.5817	7.6971	13.9918	22.9171	29.3448	34.4298	39.8938	44.3930
R-404a	0.0682	0.1576	0.3700	0.8800	1.7949	2.3635	3.1339	4.4904	6.0127
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-134a	47.8986	50.0728	51.8205	52.7420	52.8612	52.8612	52.8612	51.4946	3 668.1
R-404a	7.2219	8.3162	9.7958	11.7393	13.8842	16.8568	20.9024	27.5962	40 392.7

In order to identify this information (Table 4-117), it is admitted that about 0.5 per cent of the total amount of refrigerants charged into domestic refrigeration equipment is used for the service of this equipment, considering that circa 6 per cent (margin used by default: from 2 to 10 per cent) of the total amount of imported refrigerant is lost through fugitive emissions during refrigerant containers management.

Table 4-117: AD on imported refrigerants for domestic refrigeration equipment service for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-134a	0.0072	0.0190	0.0408	0.0742	0.1215	0.1555	0.1825	0.2114	0.2353
R-404a	0.0004	0.0008	0.0020	0.0047	0.0095	0.0125	0.0166	0.0238	0.0319
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-134a	0.2539	0.2654	0.2746	0.2795	0.2802	0.2802	0.2802	0.2729	3 668.1
R-404a	0.0383	0.0441	0.0519	0.0622	0.0736	0.0893	0.1108	0.1463	40 392.7

II) Commercial Refrigeration

AD used to estimate HFC emissions from consumption of hydrofluorocarbons charged into commercial refrigeration equipment (refrigerated display cases, chests and upright freezers as well as other similar equipment) was provided by the Customs Service. Between 1995 and 2019, the import of commercial refrigeration equipment increased by circa 160 per cent (Table 4-118).

Table 4-118: AD on import of commercial refrigeration equipment for the period 1995-2019, units

Equipment	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Refrigerated display cases for frozen products	102	583	558	2 286	622	822	977	1 122	1 605	1 260	1 173	1 246	1 436
Showcases and industrial refrigerated counters	2 696	1 037	1 411	2 714	913	1 195	1 696	3 153	1 803	2 465	2 830	3 621	8 978
Industrial refrigerated cabinets	652	775	446	305	669	587	1 796	1 695	1 434	1 213	1 001	1 851	3 808
Total showcases, counters, crates, cabinets and other similar furniture for producing the cold	**3 450**	**2 395**	**2 415**	**5 305**	**2 204**	**2 604**	**4 469**	**5 970**	**4 842**	**4 938**	**5 004**	**6 718**	**14 222**
Equipment	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
Refrigerated display cases for frozen products	478	422	403	441	224	343	252	837	675	821	1 121	796	680.4
Showcases and industrial refrigerated counters	8 692	4 908	4 296	4 997	4 000	5 333	3 961	3 565	3 079	4 423	6 464	6 365	136.1
Industrial refrigerated cabinets	2 675	1 054	1 273	1 777	570	566	780	1 038	753	2 215	1 143	1 804	176.7
Total showcases, counters, crates, cabinets and other similar furniture for producing the cold	**11 845**	**6 384**	**5 972**	**7 215**	**4 794**	**6 242**	**4 993**	**5 440**	**4 507**	**7 459**	**8 728**	**8 965**	**159.9**

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011 response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

The share of refrigerants charged into the domestic refrigeration equipment in the Republic of Moldova varied from one year to another (Table 4-119).

Table 4-119: Share of refrigerants charged into commercial refrigeration equipment imported for the period 1995-2020, %

Equipment	Refrigerant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Commercial refrigeration equipment	R-12	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	35.0	25.0	20.0	12.0
	R-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	45.0	50.0	55.0	55.0
	R-134a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	12.0	12.0	12.0	18.0
	R-404a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	5.7
	R-407c	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	2.0	3.0
	R-408a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.3
	R-507a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0
	R-290	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Equipment	**Refrigerant**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Commercial refrigeration equipment	R-12	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	R-22	56.5	60.5	57.5	54.5	52.5	52.0	52.0	49.0	48.0	47.0	47.0	46.0	45.0
	R-134a	21.0	23.0	25.0	24.0	23.5	23.0	22.0	21.5	20.5	19.5	18.0	16.0	15.0
	R-404a	6.0	6.0	6.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0
	R-407c	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.5	4.5	4.5
	R-408a	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	R-507a	5.0	6.0	7.0	9.0	10.0	10.5	11.0	12.0	13.5	14.0	14.5	15.0	15.5
	R-290	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	3.0	3.0	5.0	6.0

Source: Republican Association of Refrigeration Technicians of the Republic of Moldova.

The information on the share of refrigerants charged into the refrigeration equipment imported into the country (Table 4-107), the share of refrigerants charged into the commercial refrigeration equipment imported into the country for the period 1997-2019 (Table 4-120), the average charge of equipment with refrigerant (Table 4-111) and statistical data on import of commercial refrigeration equipment (Table 4-118), was used to estimate the total amount of refrigerants imported into the country within the commercial refrigeration equipment (Table 4-120) and the cumulative amount of refrigerants used in the commercial refrigeration equipment imported into the Republic of Moldova (Table 4-121).

Table 4-120: AD on imported refrigerants charged into commercial refrigeration equipment for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-134a	2.4077	2.7086	2.8146	3.9996	13.9123	14.3626	8.2664	8.3938	9.7969
R-404a	1.0032	1.1286	1.1728	1.6665	4.4056	4.1036	2.1564	2.0145	3.0615
R-407c	0.4013	0.4514	0.4691	0.6666	2.3187	2.0518	1.0782	1.0073	1.2246
R-408a	0.2006	0.2257	0.2346	0.3333	1.0048	1.0259	0.5391	0.5036	0.8164
R-507a	NO	NO	1.1728	1.6665	3.8645	3.4197	2.1564	2.3503	3.6738
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-134a	6.4648	8.1722	6.2803	6.0099	4.7687	7.8305	8.2963	7.8932	227.8
R-404a	2.2008	3.0202	2.5692	2.6555	2.3262	4.2164	5.0699	5.6732	465.5
R-407c	1.1004	1.4212	1.1419	1.1181	0.9305	1.6063	2.0741	2.2200	453.2
R-408a	0.5502	0.7106	0.5709	0.5591	0.4652	0.8031	0.9218	0.9866	391.8
R-507a	2.7510	3.7308	3.1401	3.3543	3.1404	5.6219	6.6831	7.3999	531.0

Table 4-121: Cumulative amount of refrigerants charged into commercial refrigeration equipment imported for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-134a	2.4077	5.1163	7.9309	11.9306	25.8429	40.2054	48.4718	56.8656	66.6625
R-404a	1.0032	2.1318	3.3046	4.9711	9.3766	13.4802	15.6367	17.6512	20.7127
R-407c	0.4013	0.8527	1.3218	1.9884	4.3071	6.3589	7.4372	8.4444	9.6690
R-408a	0.2006	0.4264	0.6609	0.9942	1.9990	3.0249	3.5640	4.0676	4.8840
R-507a	NO	NO	1.1728	2.8393	6.7038	10.1235	12.2799	14.6302	18.3040
	2012	2013	2014	2015	2016	2017	2018	2019	%
R-134a	73.1273	81.2994	87.5797	91.1819	93.2420	98.2579	102.5545	96.5354	3909.5
R-404a	22.9135	25.9336	28.5028	30.1552	31.3528	34.3964	37.7998	39.0675	3794.3
R-407c	10.7694	12.1907	13.3325	14.0494	14.5284	15.6656	17.0730	16.9743	4130.0
R-408a	5.4342	6.1449	6.7158	7.0742	7.3137	7.8823	8.4708	8.4527	4112.9
R-507a	21.0550	24.7857	27.9259	31.2802	34.4206	38.8697	43.8863	47.4217	3943.6

Activity data on the total amount of refrigerants imported into the country (Table 4-122) was provided through reports submitted by the companies to the MARDE, and the Environment Agency, respectively. However, this information is on aggregate across the country, without specifying the share used for commercial refrigeration equipment service. In order to identify this information, it is admitted that about 16.8 per cent of the total amount of refrigerants charged into commercial refrigeration equipment (a value provided by the economic agents in the field covering the period 2011-2015), taking into account that circa 6 per cent (margin used by default: between 2 and 10 per cent) of the total amount of imported refrigerants for refrigeration equipment service is lost through fugitive emissions during refrigerant containers management.

Table 4-122: AD on imported refrigerants for commercial refrigeration equipment service for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-134a	0.4288	0.9111	1.4123	2.1246	4.6021	7.1598	8.6319	10.1266	11.8713
R-404a	0.1786	0.3796	0.5885	0.8852	1.6698	2.4006	2.7846	3.1433	3.6885
R-407c	0.0715	0.1519	0.2354	0.3541	0.7670	1.1324	1.3244	1.5038	1.7219
R-408a	0.0357	0.0759	0.1177	0.1770	0.3560	0.5387	0.6347	0.7244	0.8697
R-507a	NO	NO	0.2088	0.5056	1.1938	1.8028	2.1868	2.6053	3.2596
	2012	2013	2014	2015	2016	2017	2018	2019	%
R-134a	13.0225	14.4778	15.5962	16.2377	16.6045	17.4978	18.2629	17.1910	3909.5
R-404a	4.0804	4.6183	5.0758	5.3700	5.5833	6.1253	6.7314	6.9571	3794.3
R-407c	1.9178	2.1709	2.3743	2.5019	2.5872	2.7897	3.0404	3.0228	4130.0
R-408a	0.9677	1.0943	1.1959	1.2598	1.3024	1.4037	1.5085	1.5053	4112.9
R-507a	3.7495	4.4138	4.9730	5.5704	6.1296	6.9219	7.8153	8.4448	3943.6

III) Industrial Refrigeration

Activity data used to estimate HFC emissions from consumption of hydrofluorocarbons charged into industrial refrigeration equipment (Table 4-123) was identified through questionnaires to the economic agents in the field, as well as on the web-page of the Ministry of Agriculture, Regional Development and Environment (http://madrm.gov.md/ro/content/depozite-frigorifice), and by using other public sources of information, respectively.

Table 4-123: AD on use of industrial refrigeration equipment for the period 1995-2019

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Agro-industrial refrigerated warehouses	208	216	217	221	222	225	227	228	230	236	241	253	264
Enterprises in the milk processing industry with industrial refrigeration equipment	23	23	23	23	23	23	23	23	23	23	23	23	23
Enterprises in the meat and sausage processing industry with industrial refrigeration equipment	76	76	76	76	76	76	76	76	76	76	76	76	76
Enterprises in the wine industry with industrial refrigeration equipment	196	196	196	196	196	196	196	196	196	196	192	188	184
Total enterprises that own industrial refrigerators	503	511	512	516	517	520	522	523	525	531	532	540	547
Amount of refrigerant charged into industrial refrigeration equipment, t	75.5	76.7	76.8	77.4	77.6	78.0	78.3	78.5	78.8	79.7	79.8	81.0	82.1

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
Agro-industrial refrigerated warehouses	285	306	337	370	414	450	498	539	564	586	626	666	220.2
Enterprises in the milk processing industry with industrial refrigeration equipment	23	23	23	23	20	20	20	20	20	20	20	20	-13.0
Enterprises in the meat and sausage processing industry with industrial refrigeration equipment	76	76	76	76	76	76	76	76	76	76	76	76	0.0
Enterprises in the wine industry with industrial refrigeration equipment	180	176	172	168	164	160	156	152	148	144	140	140	-28.6
Total enterprises that own industrial refrigerators	564	581	608	637	674	706	750	787	808	826	862	902	79.3
Amount of refrigerant charged into industrial refrigeration equipment, t	84.6	87.2	91.2	95.6	101.1	105.9	112.5	118.1	121.2	123.9	129.3	135.3	79.3

Source: Republican Association of Refrigeration Technicians of the Republic of Moldova, Ministry of Agriculture, Regional Development and Environment.

The share of refrigerants charged into the industrial refrigeration equipment in the Republic of Moldova varied from one year to another (Table 4-124).

Table 4-124: Share of refrigerants charged into the industrial refrigeration equipment imported for the period 1995-2020, %

Equipment	Refrigerant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Industrial refrigeration equipment	R-134a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0
	R-404a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.5	2.5	2.5	3.0
	R-407c	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.0
	R-410a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	R-507c	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.5	2.0	2.5	3.0
	R-22	0.0	0.0	0.0	0.0	0.0	5.0	10.0	20.0	37.0	46.0	49.0	53.0	62.0
	R-422d	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	R-290	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	R-717	100.0	100.0	100.0	100.0	100.0	95.0	90.0	80.0	60.0	50.0	45.0	40.0	30.0
Equipment	**Refrigerant**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Industrial refrigeration equipment	R-134a	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	R-404a	3.5	4.0	4.5	5.0	5.5	6.0	6.0	6.5	6.5	7.0	7.0	7.5	7.5
	R-407c	1.0	1.0	1.5	1.5	2.0	2.5	2.5	3.0	3.5	3.5	4.0	4.0	4.0
	R-410a	0.0	0.0	1.0	1.0	2.0	2.0	3.0	3.0	3.0	3.5	3.5	4.0	4.0
	R-507c	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0	9.0	9.5	10.0	10.5	11.0
	R-22	63.0	62.5	60.5	59.5	57.0	55.5	55.0	53.0	45.5	44.0	42.5	41.0	40.0
	R-422d	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	6.0	6.5	6.5	7.0
	R-290	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	R-717	27.5	27.0	26.5	26.5	26.5	26.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0

Source: Republican Association of Refrigeration Technicians of the Republic of Moldova.

The information on the share of refrigerants charged into refrigeration equipment imported into the country (Table 4-107), the share of refrigerants charged into industrial refrigeration equipment imported into the country over the period between 1995 and 2019 (Table 4-124) and activity data on the charge of industrial equipment with refrigerant (Table 4-123), were used to estimate the total amount of refrigerants depending on the type of refrigerant used within the industrial refrigeration equipment (Table 4-125) and the cumulative amount of refrigerants used in industrial refrigeration equipment in the Republic of Moldova (Table 4-126).

Table 4-125: AD on the amount of refrigerants charged into industrial refrigeration equipment for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-134a	0.7875	0.7965	0.7980	0.8100	0.8205	1.2690	1.3073	1.3680	1.4333
R-404a	0.7875	1.1948	1.9950	2.0250	2.4615	2.9610	3.4860	4.1040	4.7775
R-407c	NO	NO	0.3990	0.8100	0.8205	0.8460	0.8715	1.3680	1.4333
R-410a	NO	NO	NO	NO	NO	NO	NO	0.9120	0.9555
R-422d	NO	NO	NO	NO	NO	NO	NO	NO	NO
R-507c	0.7875	1.1948	1.5960	2.0250	2.4615	2.9610	3.4860	4.1040	4.7775
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-134a	1.5165	1.5885	1.6875	1.7708	1.8180	1.8585	1.9395	2.0295	157.7
R-404a	5.5605	6.3540	6.7500	7.6733	7.8780	8.6730	9.0510	10.1475	1188.6
R-407c	2.0220	2.6475	2.8125	3.5415	4.2420	4.3365	5.1720	5.4120	1256.4
R-410a	2.0220	2.1180	3.3750	3.5415	3.6360	4.3365	4.5255	5.4120	493.4
R-422d	NO	NO	NO	NO	7.2720	7.4340	8.4045	8.7945	NA
R-507c	5.5605	6.3540	7.8750	9.4440	10.9080	11.7705	12.9300	14.2065	1704.0

Table 4-126: Cumulative amount of refrigerants charged into industrial refrigeration equipment for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-134a	0.7875	1.5840	2.3820	3.1920	4.0125	5.2815	6.5888	7.9568	9.3900
R-404a	0.7875	1.9823	3.9773	6.0023	8.4638	11.4248	14.9108	19.0148	23.7923
R-407c	NO	NO	0.3990	1.2090	2.0295	2.8755	3.7470	5.1150	6.5483
R-410a	NO	NO	NO	NO	NO	NO	NO	0.9120	1.8675
R-422d	NO	NO	NO	NO	NO	NO	NO	NO	NO
R-507c	0.7875	1.9823	3.5783	5.6033	8.0648	11.0258	14.5118	18.6158	23.3933
	2012	2013	2014	2015	2016	2017	2018	2019	%
R-134a	10.9065	12.4950	14.1825	15.9533	17.7713	19.6298	21.5693	23.5988	2896.7
R-404a	29.3528	35.7068	42.4568	50.1300	58.0080	66.6810	75.7320	85.8795	10805.3
R-407c	8.5703	11.2178	14.0303	17.5718	21.8138	26.1503	31.3223	36.7343	9106.6
R-410a	3.8895	6.0075	9.3825	12.9240	16.5600	20.8965	25.4220	30.8340	3280.9
R-422d	NO	NO	NO	NO	7.2720	14.7060	23.1105	31.9050	NA
R-507c	28.9538	35.3078	43.1828	52.6268	63.5348	75.3053	88.2353	102.4418	12908.5

Activity data on the total amount of refrigerants imported into the country for industrial refrigeration equipment service (Table 4-127) was provided through reports submitted periodically by companies to the Ministry of Agriculture, Regional Development and Environment, and to the Environment Agency, respectively. However, this information is on aggregate across the country, without specifying the share used for industrial refrigeration equipment service. In order to identify this information, it is admitted that about 16 per cent of the total amount of refrigerants charged into industrial refrigeration is used for the service of this equipment, considering that circa 6 per cent (margin used by default: between 2 and 10 per cent) of the total amount of imported refrigerants is lost through fugitive emissions during refrigerant containers management.

Table 4-127: AD on imported refrigerants for industrial refrigeration equipment service for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-134a	0.1336	0.2686	0.4040	0.5414	0.6805	0.8957	1.1175	1.3495	1.5925
R-404a	0.1336	0.3362	0.6745	1.0180	1.4355	1.9376	2.5289	3.2249	4.0352
R-407c	NO	NO	0.0677	0.2050	0.3442	0.4877	0.6355	0.8675	1.1106
R-410a	NO	NO	NO	NO	NO	NO	NO	0.1547	0.3167
R-422d	NO	NO	NO	NO	NO	NO	NO	NO	NO
R-507c	0.1336	0.3362	0.6069	0.9503	1.3678	1.8700	2.4612	3.1572	3.9675
	2012	2013	2014	2015	2016	2017	2018	2019	%
R-134a	1.8497	2.1192	2.4054	2.7057	3.0140	3.3292	3.6581	4.0023	2896.7
R-404a	4.9782	6.0559	7.2007	8.5020	9.8382	11.3091	12.8441	14.5652	10805.3
R-407c	1.4535	1.9025	2.3795	2.9802	3.6996	4.4351	5.3123	6.2301	9106.6
R-410a	0.6597	1.0189	1.5913	2.1919	2.8086	3.5440	4.3116	5.2294	3280.9
R-422d	NO	NO	NO	NO	1.2333	2.4941	3.9195	5.4111	NA
R-507c	4.9106	5.9882	7.3238	8.9255	10.7755	12.7718	14.9647	17.3741	12908.5

IV) Stationary Air Conditioning

AD used to estimate HFC emissions from hydrofluorocarbons charged into stationary air conditioning equipment was provided by the Customs Service of the RM. Between 1995 and 2019, the imports of this type of equipment increased by circa 23.5 times (Table 4-128).

Table 4-128: AD on imported stationary air conditioning equipment for the period 1995-2019, units

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Air conditioning equipment	2 245	424	1 247	1 177	794	1 654	1 212	2 160	5 767	5 750	7 843	11 284	38 256
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
Air conditioning equipment	36 130	8 199	17 429	28 010	25 820	32 545	17 149	12 091	30 889	36 780	44 924	52 702	2247.5

Source: Customs Service of the RM, Letter No. 28/07-3025 dated 28.02.2020, response to request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, response to request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, response to request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015 response to request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, response to request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, response to request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

The share of refrigerants charged into stationary air conditioning equipment in the Republic of Moldova varied from one year to another (Table 4-129).

Table 4-129: Share of refrigerants charged into stationary air conditioning equipment imported for the period 1995-2020, %

Equipment	Refrigerant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Air conditioning equipment	R-410a	0	0	0	0	0	0	0	0	35	65	70	70	75
	R-22	100	100	100	100	100	100	100	100	65	35	30	30	25
	R-32	0	0	0	0	0	0	0	0	0	0	0	0	0
Equipment	**Refrigerant**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Air conditioning equipment	R-410a	80	80	85	85	85	83	80	80	75	70	65	60	50
	R-22	20	20	15	15	10	9	5	0	0	0	0	0	0
	R-32	0	0	0	0	5	8	15	20	25	30	35	40	50

Source: Republican Association of Refrigeration Technicians of the Republic of Moldova.

The information on the share of refrigerants charged into refrigeration equipment imported into the country (Table 4-107), the share of refrigerants charged into stationary air conditioning equipment imported into the country between 1995-2019 (Table 4-129), the average charge of equipment with refrigerant (Table 4-111), and statistical data on import of stationary air conditioning equipment (Table 4-128), were used to estimate the total amount of refrigerants imported into the country within the stationary air conditioning equipment (Table 4-128) and the cumulative amount of refrigerants charged into stationary air conditioning equipment imported (Table 4-131).

Table 4-130: AD on imported refrigerants charged into stationary air conditioning equipment for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-410a	1.2111	2.2425	3.2941	4.7393	17.2152	16.2585	3.9355	8.3659	14.2851
R-32	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-410a	13.1682	16.2074	8.2315	5.8037	13.9001	15.4476	17.5204	18.9727	1466.6
R-32	0.7746	1.5622	1.5434	1.4509	4.6334	6.6204	9.4340	12.6485	NA

Table 4-131: Cumulative amount of refrigerants charged into stationary air conditioning equipment imported for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-410a	1.2111	3.4536	6.7476	11.4869	28.7021	46.0445	49.9800	58.8688	73.1539
R-32	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-410a	86.3221	102.5295	110.7611	115.3537	127.0112	139.1648	151.9458	153.7034	12591.5
R-32	0.7746	2.3368	3.8802	5.3311	9.9644	16.5848	26.0189	38.6674	NA

Activity data on the total amount of refrigerants imported into the country for stationary air conditioning equipment service (Table 4-132) was identified through reports submitted by companies periodically to the Ministry of Agriculture, Regional Development and Environment, and to the Environment Agency, respectively.

Table 4-132: AD on imported refrigerants for stationary air conditioning equipment service for the period 2003-2019, t/yr

	2003	2004	2005	2006	2007	2008	2009	2010	2011
R-410a	0.0642	0.1830	0.3576	0.6088	1.5212	2.4404	2.6489	3.1200	3.8772
R-32	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-410a	4.5751	5.4341	5.8703	6.1137	6.7316	7.3757	8.0531	8.1463	12591.5
R-32	0.0411	0.1238	0.2056	0.2825	0.5281	0.8790	1.3790	2.0494	NA

However, this information is on aggregate across the country, without specifying the amount used for stationary air conditioning equipment service. In order to identify this information, it is admitted that circa 5 per cent of the cumulative amount of refrigerants charged into stationary air conditioning equipment is used for the service of this equipment, considering that circa 6 per cent (margin used by default: between 2 and 10 per cent) of the total amount of imported refrigerants is lost through fugitive emissions during refrigerant containers management.

V) Mobile Air-Conditioning Systems

AD used to estimate HFCs emissions from consumption of hydrofluorocarbons charged into mobile air-conditioning equipment was provided by the NBS of the RM (Statistical Yearbooks of the RM before 2000, and the Bank for Statistical Data after 2000, respectively), as well as by the State Enterprise 'State Information Resources Centre 'Register' (SE CRIS 'Register') (for the period 1995-2013), respectively by the Public Services Agency of the RM (for 2014-2019) based on the information included in the State Transport Register. In order to estimate the amount of HFCs used in mobile air-conditioning equipment, the information on the total number of transportation units registered in the country was considered (Tables 4-133 and 4-134), as well as the share of transportation units charged with air conditioning equipment (Table 4-135).

Table 4-133: Vehicles registered for the period 1995-2019 (end of calendar year total), units

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Passenger cars	165 941	173 618	205 973	222 769	232 278	238 380	256 459	268 882	265 841	269 551	292 994	319 311	338 944
Buses and Minibuses	9 181	9 798	11 169	12 917	13 582	12 769	14 703	15 777	15 723	19 741	19 825	21 056	21 095
Trucks	59 888	57 138	56 924	57 404	52 430	46 351	45 809	46 277	46 905	73 774	81 798	84 087	94 828
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
Passenger cars	366 351	386 365	404 290	426 973	456 379	487 418	512 561	529 813	546 781	588 119	616 800	648 780	291.0
Buses and Minibuses	21 491	21 346	21 395	21 349	21 433	21 344	21 359	21 134	20 968	20 944	21 050	21 087	129.7
Trucks	115 967	120 174	131 243	141 696	151 830	154 163	160 199	164 533	168 618	173 384	179 392	191 380	219.6

Source: Statistical Yearbooks of the RM for 1999 (page 390), 2003 (pages 515-516), 2005 (page 407), 2008 (pages 399); Bank for Statistical Data of the RM: <http://statbank.statistica.md/PxWeb/pxweb/ro/40%20Statistica%20economica/40%20Statistica%20economica__19%20TRA__TRA020/TRA020100.px/table/tableViewLayout1/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774>

For passenger cars, the number of units produced after 1993 was considered (particularly Euro-1, Euro-2, Euro-3, Euro-4 and Euro-5); whereas for trains, it was considered that these transportation units are charged with air conditioning equipment in proportion of 100 per cent.

Table 4-134: Railway transportation vehicles inventoried for the period 1995-2019 (end of calendar year total), units

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Diesel locomotives	163	163	162	162	162	162	162	160	159	156	156	154	154
Locomotives for manoeuvring	114	100	75	72	50	42	44	48	54	50	56	56	56
Diesel trains	29	28	26	26	24	22	22	22	22	18	20	20	20
Passengers carriages	463	463	462	462	460	460	440	460	452	452	440	436	416
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
Diesel locomotives	152	152	152	150	139	138	138	138	138	138	138	138	-15.3
Locomotives for manoeuvring	53	39	39	67	67	67	67	67	67	67	67	67	-41.2
Diesel trains	18	15	15	21	21	21	21	21	21	21	21	21	-27.6
Passengers carriages	398	423	411	399	399	388	381	381	346	346	346	346	-25.3

Source: Statistical Yearbooks of the RM for 1999 (page 390), 2003 (pages 515-516), 2005 (page 407), 2008 (page 399); Bank for Statistical Data of the RM: <http://statbank.statistica.md/PxWeb/pxweb/ro/40%20Statistica%20economica/40%20Statistica%20economica__19%20TRA__TRA020/TRA020300.px/table/tableViewLayout1/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774>

Table 4-135: Transportation units charged with air conditioning equipment for the period 1995-2019 (end of calendar year total), % of the total

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Passenger cars	2.9	5.9	8.9	11.9	14.9	17.9	22.1	25.3	27.6	31.2	35.6	39.1	41.6
Buses and Minibuses	2.4	5.4	8.4	11.4	14.4	17.4	20.1	21.8	22.6	28.7	30.8	31.9	33.1
Trucks	2.9	8.9	14.9	20.9	26.9	32.9	41.8	49.6	51.0	48.1	49.2	50.0	50.8
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
Passenger cars	43.7	44.6	45.1	45.8	46.2	46.5	46.9	48.3	49.7	55.4	55.8	56.0	1 830.3
Buses and Minibuses	34.0	34.2	34.5	34.7	34.9	35.0	35.4	36.1	36.7	38.6	38.9	39.0	1 525.0
Trucks	51.2	51.3	51.4	51.5	51.6	51.7	51.7	52.7	53.5	56.5	56.6	56.7	1 855.2

Based on the information on the average refrigerant charge (HFC-134a in proportion of 100 per cent) of air conditioning equipment in mobile sources (Table 4-111), information on the total number of transportation units registered in the Republic of Moldova equipped with air conditioning systems (Table 4-136), the total amount of HFC-134a charged into mobile air-conditioning equipment in the Republic of Moldova was estimated (Table 4-137).

Table 4-136: Estimated number of transportation units charged with air conditioning equipment for the period 1995-2019 (end of year total), units

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Passenger cars	7 124	15 125	23 768	33 053	42 979	53 547	70 353	85 228	98 502	117 402	145 006	169 401	189 976
Buses and Minibuses	331	777	1 257	1 772	2 322	2 906	3 491	3 922	4 228	5 557	6 139	6 464	6 826
Trucks	2 077	7 001	12 770	19 383	26 840	35 141	49 535	64 648	72 434	73 947	77 911	80 717	83 369
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
Passenger cars	208 354	216 552	222 205	228 990	232 842	236 829	240 338	256 057	271 640	353 777	359 535	363 187	4 997.9
Buses and Minibuses	7 112	7 177	7 265	7 329	7 402	7 436	7 567	7 637	7 705	8 078	8 186	8 224	2 383.1
Trucks	85 095	85 494	85 839	86 209	86 516	86 845	86 943	90 541	93 876	107 658	108 131	108 512	5 123.7

In order to estimate the cumulative amount of refrigerants charged into air-conditioning equipment, it was considered that all transportation units are imported and the share of second-hand vehicles is dominant; under these circumstances, it can be considered that mobile air-conditioning systems were partially functional: between 2003 and 2019, 90 per cent of passenger cars and trucks.

Table 4-137: AD on cumulative amount of HFC-134a charged into mobile air-conditioning systems registered for the period 1995-2019, t

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
HFC-134a	3.3028	5.4629	7.8549	10.5749	13.5052	16.7394	21.9214	27.0249	30.3406	33.6344	38.0581	41.7155	44.8708
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
HFC-134a	47.5232	48.6424	49.4107	50.3830	50.9213	51.4562	77.9309	163.7971	171.2715	209.7414	212.2807	213.8881	6376.0

Activity data on the total amount of refrigerants imported into the country for mobile air-conditioning equipment service (Table 4-138) was provided through reports submitted by companies annually to the Ministry of Agriculture, Regional Development and Environment and the Environment Agency, respectively. However, this information is on aggregate across the country, without being specifying the share used for mobile air-conditioning equipment service. In order to identify this information, it is admitted that about 15 per cent of the cumulative amount of refrigerants charged into mobile air-conditioning equipment is used for the service of this equipment, considering that circa 6 per cent (margin used by default: between 2 and 10 per cent) of the total amount of imported refrigerant used for mobile air-conditioning equipment service is lost through fugitive emissions during refrigerant containers management.

Table 4-138: AD on imported refrigerants for mobile air conditioning systems service for the period 1995-2019, t/yr

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
HFC-134a	0.5251	0.8686	1.2489	1.6814	2.1473	2.6616	3.4855	4.2970	4.8242	5.3479	6.0512	6.6328	7.1345
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
HFC-134a	7.5562	7.7341	7.8563	8.0109	8.0965	8.1815	12.3910	26.0437	27.2322	33.3489	33.7526	34.0082	6376.0

VI) Transport Refrigeration

Equipment used in transport refrigeration include: refrigerated trucks, containers, reefers and wagons. The respective equipment and systems use refrigerant R-404a (average charge 7 kg/unit), specific to refrigerated trucks with a capacity of 20 tonnes and more, and with capacity less than 5 tonnes, respectively. AD used to estimate HFC emissions from consumption of hydrofluorocarbons charged into transport refrigeration systems was provided by the State Enterprise 'State Information Resources Centre 'Register' (SE 'CRIS 'Register') (for the period 1995-2013), and by the Public Services Agency of the RM (for 2014-2019) based on the information included in the State Transport Register.

In order to estimate the amount of R-404a used in transport refrigeration systems, the information on the total number of transportation means used for transport refrigeration of fresh and frozen food was considered (Table 4-139). According to the information received from the International Association of Road Haulers of Moldova (AITA), about 60-65 enterprises in the country own refrigerators with a capacity of 20 tonnes and more (the cooling capacity is circa 10 kw per unit), which are used predominantly for international freight transport. Refrigerators with a capacity up to 5 tonnes (the cooling capacity is circa 5 kw per unit) are used predominantly on the domestic market of transport refrigeration for fresh and frozen food and there are a number of companies such as Incomlac, Drancor, Sandriliona, Amir, Carmez, Basarabia-Nord, Rogob, Pegas and others with a truck fleet of about 10-50 units each.

Table 4-139: Number of refrigerators for the period 1995-2019 (end of calendar year total), units

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Refrigerators ≥ 20 t	897	1 060	1 223	1 386	1 549	1 712	1 887	2 061	2 236	2 410	2 490	2 566	2 686
Refrigerators 5-20 t	451	454	457	459	462	465	467	469	470	472	473	473	476
Refrigerators < 5 t	396	398	399	401	402	404	406	408	409	411	411	415	416
Total	**1 744**	**1 912**	**2 079**	**2 246**	**2 413**	**2 581**	**2 760**	**2 938**	**3 115**	**3 293**	**3 374**	**3 454**	**3 578**
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
Refrigerators ≥ 20 t	2 756	2 760	2 791	2 814	2 822	2 828	2 836	2 844	2 798	2 832	2 567	2 303	156.7
Refrigerators 5-20 t	476	476	476	476	476	476	476	480	471	484	462	452	0.2
Refrigerators < 5 t	416	418	418	419	419	419	419	399	411	418	403	401	1.3
Total	**3 648**	**3 654**	**3 685**	**3 709**	**3 717**	**3 723**	**3 731**	**3 723**	**3 680**	**3 734**	**3 432**	**3 156**	**81.0**

The share of refrigerants used in food transport refrigeration equipment in the Republic of Moldova varied from one year to another (Table 4-410).

Table 4-140: Share of refrigerants charged into food transport refrigeration equipment for the period 1995-2019, %

	Refrigerant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Refrigerators	R-22	100	100	100	100	100	100	100	100	100	100	100	63.1	60.1
	R-404a	0	0	0	0	0	0	0	0	0	0	0	36.9	39.9
	Refrigerant	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Refrigerators	R-22	56.7	52.9	49.2	45.5	41.8	38.0	34.2	30.6	26.6	22.8	18.7	11.5	N/A
	R-404a	43.3	47.1	50.8	54.5	58.2	62.0	65.8	69.4	73.4	77.2	81.3	88.5	N/A

Source: Republican Association of Refrigeration Technicians of the Republic of Moldova.

Based on the information on the share of refrigerants used in refrigeration equipment imported into the country (Table 4-107), the share of refrigerants charged into the equipment for refrigerated transport of food for the period 1995-2019 (Table 4-140), the average refrigerant charge of the respective equipment (Table 4-111) and statistical data on the import of refrigerated food transport equipment (Table 4-139), the cumulative amount of R-404a charged into transport refrigeration in the Republic of Moldova was estimated (Table 4-141).

Table 4-141: AD on the cumulative amount of R-404a charged into food transport refrigeration equipment for the period 1995-2019, t

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
R-404a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	8.9103	10.0044
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-404a	11.0670	12.0540	13.0960	14.1442	15.1543	16.1630	17.1836	18.0978	18.9049	20.1908	19.5318	19.5529	N/A

Activity data on the total amount of refrigerants imported into the country for transport refrigeration equipment service (Table 4-142) were provided through reports submitted annually by companies to the Ministry of Agriculture, Regional Development and Environment and the Environment Agency, respectively.

Table 4-142: AD on refrigerants imported for food transport refrigeration equipment service for the period 1995-2019, t/yr

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
R-404a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.4167	1.5907
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
R-404a	1.7597	1.9166	2.0823	2.2489	2.4095	2.5699	2.7322	2.8776	3.0059	3.2103	3.1055	3.1089	N/A

However, this information is on aggregate across the country, without specifying the share used for transport refrigeration equipment service. In order to identify this information, it is admitted that about 15 per cent of the total amount of refrigerants charged into transport refrigeration equipment is used for the service of this equipment, considering that circa 6 per cent (margin used by default: between 2 and 10 per cent) of the total amount of imported refrigerant is lost through fugitive emissions during refrigerant containers management.

VII) Refrigeration and Air Conditioning – Total

Based on the above information, regarding the estimates of refrigerant import for refrigeration and air conditioning equipment (domestic, commercial, industrial, transportation refrigeration, and stationary and mobile air-conditioning equipment, respectively), the amount of refrigerants imported into the RM for the period 1995-2019 was calculated (Table 4-143).

Table 4-143: Imported refrigerants for refrigeration and air conditioning for 1995-2019, t/yr

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
R-32	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R-134a	0.5251	0.8686	1.2489	1.6814	2.1473	2.6616	3.4855	4.2970	5.3937	6.5466	7.9084	9.3729	12.5385
R-404a	NO	NO	NO	NO	NO	NO	NO	NO	0.3126	0.7167	1.2650	3.3246	4.7055
R-407c	NO	NO	NO	NO	NO	NO	NO	NO	0.0715	0.1519	0.3031	0.5591	1.1112
R-408a	NO	NO	NO	NO	NO	NO	NO	NO	0.0357	0.0759	0.1177	0.1770	0.3560
R-410a	NO	NO	NO	NO	NO	NO	NO	NO	0.0642	0.1830	0.3576	0.6088	1.5212
R-422d	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R-507a	NO	NO	NO	NO	NO	NO	NO	NO	0.1336	0.3362	0.8157	1.4559	2.5616
TOTAL	**0.5251**	**0.8686**	**1.2489**	**1.6814**	**2.1473**	**2.6616**	**3.4855**	**4.2970**	**6.0112**	**8.0103**	**10.7674**	**15.4985**	**22.7940**

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
R-32	NO	NO	NO	NO	NO	NO	0.2056	0.2825	0.5281	0.8790	1.3790	2.0494	5.3237
R-134a	15.7672	17.6659	19.5438	21.7100	23.2226	25.0439	30.6672	45.2666	47.1309	54.4560	55.9538	55.4745	470.5781
R-404a	6.1104	7.2466	8.4743	10.0045	11.5065	13.2881	15.0606	16.8118	18.5009	20.7341	22.7919	24.7775	185.6314
R-407c	1.6201	1.9599	2.3713	2.8324	3.3713	4.0734	4.7538	5.4821	6.2868	7.2248	8.3526	9.2529	59.7783
R-408a	0.5387	0.6347	0.7244	0.8697	0.9677	1.0943	1.1959	1.2598	1.3024	1.4037	1.5085	1.5053	13.7674
R-410a	2.4404	2.6489	3.2747	4.1939	5.2347	6.4529	7.4616	8.3057	9.5402	10.9198	12.3647	13.3757	88.9481
R-422d	NO	NO	NO	NO	NO	NO	NO	NO	1.2333	2.4941	3.9195	5.4111	13.0581
R-507a	3.6728	4.6480	5.7626	7.2271	8.6600	10.4020	12.2968	14.4959	16.9051	19.6937	22.7800	25.8190	157.6659
TOTAL	**30.1495**	**34.8041**	**40.1511**	**46.8376**	**52.9629**	**60.3547**	**71.6416**	**91.9044**	**101.4278**	**117.8052**	**129.0500**	**137.6653**	**994.7510**

Between 2009 and 2019, there had been submitted periodical questionnaires to economic agents with a license for import, export, re-export, transit and circulation of ozone layer depleting substances (ODS) and ODS equipment. The number of these companies was relatively low and varies insignificantly during the period under review. The Ministry of Agriculture, Regional Development and Environment, and the Environment Agency, respectively, has information on refrigerants imported into the country for the period 2003-2019, but due to the low level of responses to these questionnaires from economic agents (Coral Ltd. reported information for 2004-2005, 'Frigoinds' Ltd. – for 2003-2019, 'Ecolux' Ltd. – for 2003-2019, 'Frio-Dins' Ltd. – for 2010-2019, 'York Regrigerent' Ltd. – for 2011-2019, CS Dina-Cociug Ltd. – for 2013-2019), this information is considered incomplete. For the last 7 years (2013-2019), available information is considered more complete, including the fact that starting with 01.01.2013, the former Ministry of Environment (since July 2017 – Ministry of Agriculture, Regional Development and Environment) has established the procedure for granting the import, export and re-export authorizations for chemical substances depleting ozone layer as well as for the equipment and products charged with such substances. The respective companies report annually to the National Ozone Unit of the Public Institution "Environmental Projects Implementation Unit" (PI "EPIU"), including information on the following indicators: stock at the beginning of the year, imports during the reporting year, the amount of substances purchased within the country during the reporting year, the amount sold and used during the reporting year and the stock at the end of the year.

Below, for comparison, is presented AD on actual refrigerants imported for refrigeration and air conditioning service in the country for the period 1995-2019 (Table 4-142). As it can be seen from the information presented above, the differences between the total amount of the main types of refrigerants actually imported into the Republic of Moldova in the period 2003-2019 (as previously explained, as the information was collected through questionnaires, there is no certainty that the data is complete) (Table 4-144) and those calculated for the same period following the assessment methodology available in the 2006 IPCC Guidelines (Table 4-143) are relatively small.

Table 4-144: Amount of main types of refrigerants actually imported within 2003-2019, t

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
R-32	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R-134a	0.1124	0.1730	0.2662	0.4095	0.6299	0.9692	1.4910	2.2939	3.5293	2.6596	2.4480	2.3360	4.3760
R-404a	NO	NO	NO	NO	NO	NO	NO	NO	0.4496	1.1095	2.2890	2.5060	2.8460
R-407c	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.2885	1.4490	0.5200	0.4520
R-408a	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.4473	0.3350	NO	0.4360
R-410a	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0113	NO	0.4520	NO
R-422d	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R-507a	NO	NO	NO	NO	NO	NO	NO	NO	0.0565	3.5990	1.6008	0.8840	0.4068
TOTAL	**0.1124**	**0.1730**	**0.2662**	**0.4095**	**0.6299**	**0.9692**	**1.4910**	**2.2939**	**4.0354**	**8.1152**	**8.1218**	**6.6980**	**8.5168**

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
R-32	NO	NO	NO	NO	NO	NO	0.0900	NO	NO	0.5900	1.5000	3.1880	5.3680
R-134a	9.7940	3.5360	15.3600	12.0440	9.0240	65.5928	49.9577	36.2990	32.0140	27.6080	125.3212	62.3590	470.6036
R-404a	7.1920	4.3600	1.6350	15.5849	5.7770	12.6220	21.2758	29.6480	18.5300	18.5739	44.8426	44.2110	233.4523
R-407c	1.2430	3.0510	NO	2.0340	2.2600	1.4690	2.1490	2.9945	3.7490	9.2670	20.1140	8.7640	59.8040
R-408a	0.4360	0.4360	0.2180	0.2180	0.2180	0.2180	0.3815	0.2180	NO	NO	10.2830	NO	13.8448
R-410a	0.4540	2.5990	0.5650	1.1300	1.1300	5.4240	3.3920	4.5200	7.5060	7.3881	41.8033	12.6057	88.9803
R-422d	NO	NO	NO	NO	NO	NO	NO	NO	NO	4.7970	2.3600	5.8500	13.0070
R-507a	6.1140	2.9380	0.0000	3.9650	2.7120	5.3110	6.2570	18.1400	16.5500	26.7240	38.5330	25.8092	159.6003
TOTAL	**25.2330**	**16.9200**	**17.7780**	**34.9759**	**21.1210**	**90.6368**	**83.5030**	**91.8195**	**78.3490**	**94.9480**	**284.7571**	**162.7869**	**1044.6603**

2F2 'Foam Blowing Agents'

HFC emissions from foam blowing consumption (particularly closed-cell foams) used in insulation, cushioning and packaging, with blowing agents such as HFC-245fa, HFC-365mfc, HFC-134a and HFC-152a, were estimated using a Tier 2 approach.

The IPCC 2006 Guidelines suggests that HFC emissions from closed-cell foams should be calculated separately from open-cell foams.

Hydrofluorocarbons used in the production of expanded foams with open cells are emitted into the atmosphere instantly, all emissions being generated during their production. Since no open-cell foams are produced in the Republic of Moldova, no emissions are recorded from this category, respectively.

Emissions from closed-cell foam occur at three distinct points:

1. First year losses from foam manufacture and installation, these emissions occur where the product is manufactured;
2. Annual losses (in situ losses from foam use); closed-cells foam will lose a fraction of their initial charge each year until decommissioning;
3. Decommissioning losses: emissions upon decommissioning also occur where the product is used.

Emissions from closed-cell foam were estimated following Equation 7.7 in the 2006 IPCC Guidelines (Volume 3, Chapter 7.4, page 7.38).

$$Emissions_t = M_t \bullet EF_{FYL} + Bank \bullet EF_{AL} + DL_t - RD_t$$

Where:

$Emissions_t$ – emissions from closed-cell foam in year *t*, tonnes;

M_t – total HFC used in manufacturing new closed-cell foam in year *t*, tonnes;

EF_{FYL} – first year loss emission factor, fraction (%);

$Bank_t$ – HFC charge blown into closed-cell foam manufacturing between year *t* and *year t-n*, tonnes;

EF_{AL} – annual loss emission factor, fraction (%);

DL_t – decommissioning losses in year *t* = remaining losses of chemical at the end of service life that occur when the product/equipment is scrapped, calculated from the amount of remaining chemical and the end-of-life loss factor which depends on the type of end-of-life treatment adopted, tonnes;

RD_t – HFC emissions prevented by recovery and destruction of foams and their blowing agents in year *t*, tonnes;

n – product lifetime of closed-cell foam;

t – Current year;

(*t-n*) – The total period over which HFCs used in foams could still be present.

This equation is applied to each chemical and major foam application individually. Total emissions expressed in CO_2 equivalent are equal to the sum of CO_2 equivalent emissions of each combination of chemical type and foam application. If country-specific data is not available, default emission factors can be used (Table 4-145).

Table 4-145: Default emission factors for source category 2F2 'Foam Blowing Agents'

Emission Factor	Default Value
Product lifetime of closed-cell foam	n = 20 years
First Year Losses	10% of the original HFC charge/year
Annual Losses	4.5% of the original HFC charge/year

Source: 2006 IPCC Guidelines, Volume 3, Chapter 7.4, Table 7.5, page 7.35.

In the RM, foam blowing production has been recorded since 2005. AD on the production of foam blowing is available in the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type' (Table 4-146).

Table 4-146: Produced foam blowing products for the period 2005-2019, kt

	2005	2006	2007	2008	2009	2010	2011	2012
Polystyrene in primary forms	0.2102	0.3471	0.3428	0.1605	0.1538	0.0992	0.0932	0.1425
Cellular products of polystyrene	0.2485	0.7064	0.8043	0.5590	1.5819	1.8756	2.1692	2.0126
Polyurethane in primary forms	0.4901	0.3787	0.1472	0.5350	0.8896	0.8318	0.6823	0.3711
Cellular products of polyurethane	NO	NO	NO	NO	NO	NO	NO	0.0016

	2013	2014	2015	2016	2017	2018	2019	2020
Polystyrene in primary forms	0.0748	0.0601	0.0382	NO	NO	NO	NO	NO
Cellular products of polystyrene	2.1187	2.4715	2.8987	2.5468	2.1178	2.0968	1.9339	2.1187
Polyurethane in primary forms	0.2805	NO	NO	NO	NO	NO	NO	NO
Cellular products of polyurethane	0.2064	0.3429	NO	NO	NO	NO	NO	NO

Source: Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'.

It is unknown which blowing agents are used in the production of foam blowing products, but since the production is relatively recent, it was considered that the polystyrene in primary forms are ethanol and CO_2 based, while the polyurethane in primary forms are based on pentane (C,I,N)

AD on imported foam blowing products in the country is provided by the Customs Service of the Republic of Moldova (Table 4-147).

Table 4-147: Import of foam blowing products for the period 1995-2019, kt

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Polystyrene in primary forms, kt (product code: 3903 11)	0.5536	0.2219	0.1566	0.1699	0.1664	0.3989	0.2947	0.5041	0.8946	0.8966	1.8168	2.4757	2.7488
Cellular products of polystyrene, kt (product code: 3921 11)	0.0178	0.0090	0.0494	0.0462	0.0210	0.0112	0.0959	0.2456	0.3957	0.4913	0.6055	0.6123	0.5979
Polyurethane in primary forms, kt (product code: 3909 50)	0.2163	0.1401	0.0660	0.0290	0.0408	0.0394	0.0222	0.0142	0.0679	0.1815	0.3647	0.3061	0.5404
Cellular products of polyurethane, kt (product code: 3921 13)	0.1360	0.1463	0.1128	0.0869	0.1130	0.1472	0.2024	0.4243	0.5286	0.5734	0.6816	1.0061	1.5276
Total foam blowing products, kt	**0.9237**	**0.5173**	**0.3848**	**0.3320**	**0.3411**	**0.5968**	**0.6151**	**1.1882**	**1.8867**	**2.1428**	**3.4687**	**4.4001**	**5.4147**
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
Polystyrene in primary forms, kt (product code: 3903 11)	3.0178	2.5255	3.0971	3.1368	3.2978	3.3007	3.6391	3.9539	3.6553	3.5936	3.6205	4.4201	698.4
Cellular products of polystyrene, kt (product code: 3921 11)	0.7121	0.6277	0.6388	0.5445	0.6879	0.7153	0.8484	1.0409	1.2934	1.2578	1.3496	1.5463	8597.1
Polyurethane in primary forms, kt (product code: 3909 50)	0.7696	0.5989	0.6841	0.7048	0.3633	0.1630	0.1642	1.0715	0.1328	0.2489	0.3566	0.3571	65.1
Cellular products of polyurethane, kt (product code: 3921 13)	1.2466	0.6455	0.8602	0.8332	0.8468	0.9430	0.8133	0.9074	0.8186	0.9586	1.1100	1.0666	684.5
Total foam blowing products, kt	**5.7461**	**4.3975**	**5.2802**	**5.2193**	**5.1958**	**5.1220**	**5.4650**	**6.9737**	**5.9002**	**6.0589**	**6.4367**	**7.3901**	**700.1**

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, as a response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, as a response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, as a response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, as a response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, as a response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

The most frequently used blowing agents in polyurethane and polystyrene foam manufacturing can be considered HFC-134a, HFC-152a, HFC-245fa, HFC-365mfc, Pentane (C,I,N) and CO_2/ethanol.

Since the share of blowing agents in foam products in total imports is unknown, it has been determined considering expert opinions (Table 4-148 and Table 4-149), taking into consideration the European and international experience regarding HFC emissions inventory process within the respective category, as well as the recent trend among the producers of foam blowing products to decrease the use of HFCs as blowing agents, following the international commitments to phasing out F-gas consumption, especially when there already are competitive alternative technologies on the foam blowing market[76],[77].

Table 4-148: Share of blowing agents charged into polyurethane products imported for the period 1995-2020, %

	Blowing Agent	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Polyurethane in primary forms	HCFC-22	50	50	50	50	50	50	45	45	45	40	30	25	20
	HCFC-141b	45	45	45	40	40	40	40	40	40	40	30	30	25
	HFC-134a	5	5	5	10	10	10	15	15	15	20	20	20	25
	HFC-365mfc	0	0	0	0	0	0	0	0	0	0	5	5	5
	HFC-245fa	0	0	0	0	0	0	0	0	0	0	5	5	5
	Pentane (C,I,N)	0	0	0	0	0	0	0	0	0	0	10	15	20
	Blowing Agent	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Polyurethane in primary forms	HCFC-22	15	5	0	0	0	0	0	0	0	0	0	0	0
	HCFC-141b	15	5	0	0	0	0	0	0	0	0	0	0	0
	HFC-134a	20	20	15	15	10	10	5	5	0	0	0	0	0
	HFC-365mfc	10	15	15	15	15	15	20	20	15	15	15	15	15
	HFC-245fa	10	15	15	15	15	10	10	10	10	10	10	10	10
	Pentane (C,I,N)	30	40	55	55	60	65	65	65	75	75	75	75	75

[76] Natural Foam Blowing Agents, Sustainable Ozone- and Climate-Friendly Alternatives to HCFCs (2012), PROKLIMA International Programme of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, commissioned by the Federal Ministry for Economic Cooperation and Development (BMZ) Environment and Sustainable Use of Natural Resources Division. Eschborn, September 2012. page 178.

[77] Danish Ministry of the Environment, Environment Protection Agency (2010), Greenhouse Gases HFCs, PFCs and SF6, Danish Consumption and Emissions, 2008, Environmental Project No. 1323 2010, <http://www2.mst.dk/udgiv/publications/2010/978-87-92617-66-8/pdf/978-87-92617-67-5.pdf>.

The volume of blowing agents in foam products imported into the RM was identified based on the information available in the literature in the field, with the assumption that for the polyurethane products HCFC-22, HCFC-141b and HFC-134a have a volume of circa 6 per cent of the total[78], HFC-365mfc – 9 per cent, HFC-254fa – 10 per cent, and Pentane (C,I,N) – 7.5 per cent; as for the polystyrene products HFC-134a has a volume of circa 13 per cent of the total, HFC-152a – 8 per cent, HCFC-22 and HFCF-142b – 12 per cent, and CO_2 + ethanol – 6 per cent of the total[79].

Table 4-149: Share of blowing agents charged into polystyrene products imported for the period 1995-2020, %

	Blowing Agent	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Polystyrene in primary forms	HCFC-22	50	50	50	45	45	40	35	35	35	30	25	20	15
	HCFC-142b	45	45	45	45	45	45	45	45	40	40	35	30	25
	HFC-134a	5	5	5	10	10	10	15	15	15	20	20	20	25
	HFC-152a	0	0	0	0	0	5	5	5	10	10	10	15	15
	CO_2 / ethanol	0	0	0	0	0	0	0	0	0	0	10	15	20
	Blowing Agent	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Polystyrene in primary forms	HCFC-22	10	5	0	0	0	0	0	0	0	0	0	0	0
	HCFC-142b	20	10	0	0	0	0	0	0	0	0	0	0	0
	HFC-134a	25	25	20	20	15	10	5	5	0	0	0	0	0
	HFC-152a	20	25	30	30	30	30	35	35	35	35	30	30	30
	CO_2 / ethanol	25	35	50	50	55	55	60	60	65	65	70	70	70

Considering the AD provided in Table 4-147 as well as the share of different blowing agents used in foam products imported into the Republic of Moldova between 1995 and 2019 (Tables 4-148 and 4-149), respectively considering the volume of blowing agents in foams, the share of blowing agents contained in polyurethane products (Table 4-150) and polystyrene products (Table 4-151) imported into the country was estimated for the period 1995-2019.

Table 4-150: AD on import of blowing agents charged into polyurethane products for the period 1995-2019, kt

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
HCFC-22	0.0095	0.0077	0.0048	0.0031	0.0042	0.0050	0.0055	0.0107	0.0145	0.0163	0.0170	0.0177	0.0223
HCFC-141b	0.0086	0.0070	0.0043	0.0025	0.0033	0.0040	0.0048	0.0095	0.0129	0.0163	0.0170	0.0213	0.0279
HFC-134a	0.0010	0.0008	0.0005	0.0006	0.0008	0.0010	0.0018	0.0036	0.0048	0.0082	0.0113	0.0142	0.0279
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0042	0.0053	0.0084
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0047	0.0059	0.0093
Pentane (C,I,N)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0071	0.0133	0.0279
Total	**0.0190**	**0.0155**	**0.0097**	**0.0063**	**0.0083**	**0.0101**	**0.0121**	**0.0237**	**0.0322**	**0.0408**	**0.0612**	**0.0776**	**0.1238**
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
HCFC-22	0.0163	0.0034	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HCFC-141b	0.0163	0.0034	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HFC-134a	0.0218	0.0134	0.0125	0.0125	0.0065	0.0060	0.0026	0.0053	NO	NO	NO	NO	NA
HFC-365mfc	0.0163	0.0151	0.0188	0.0187	0.0147	0.0134	0.0158	0.0321	0.0116	0.0147	0.0178	0.0173	NA
HFC-245fa	0.0181	0.0168	0.0208	0.0208	0.0163	0.0100	0.0088	0.0178	0.0086	0.0109	0.0132	0.0128	NA
Pentane (C,I,N)	0.0408	0.0336	0.0573	0.0571	0.0490	0.0485	0.0429	0.0868	0.0482	0.0611	0.0742	0.0721	NA
Total	**0.1297**	**0.0857**	**0.1094**	**0.1090**	**0.0866**	**0.0779**	**0.0702**	**0.1420**	**0.0683**	**0.0867**	**0.1053**	**0.1022**	**NA**

Table 4-151: AD on import of blowing agents charged into polystyrene products in the RM for the period 1995-2019, kt

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
HCFC-22	0.0309	0.0125	0.0111	0.0105	0.0091	0.0177	0.0148	0.0283	0.0488	0.0450	0.0654	0.0667	0.0542
HCFC-142b	0.0278	0.0112	0.0100	0.0105	0.0091	0.0199	0.0190	0.0364	0.0557	0.0600	0.0916	0.1000	0.0904
HFC-134a	0.0033	0.0014	0.0012	0.0025	0.0022	0.0048	0.0069	0.0132	0.0226	0.0325	0.0567	0.0723	0.0979
HFC-152a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0014	0.0027	0.0093	0.0100	0.0174	0.0333	0.0361
CO_2+ethanol	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0131	0.0250	0.0361
Total	**0.0620**	**0.0250**	**0.0223**	**0.0235**	**0.0204**	**0.0439**	**0.0420**	**0.0806**	**0.1364**	**0.1474**	**0.2442**	**0.2974**	**0.3148**
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
HCFC-22	0.0403	0.0170	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HCFC-142b	0.0806	0.0341	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HFC-134a	0.1091	0.0922	0.0874	0.0861	0.0699	0.0470	0.0263	0.0292	NO	NO	NO	NO	NA
HFC-152a	0.0537	0.0568	0.0807	0.0795	0.0861	0.0867	0.1131	0.1259	0.1247	0.1223	0.1074	0.1289	NA
CO_2+ethanol	0.0504	0.0596	0.1009	0.0994	0.1184	0.1193	0.1454	0.1618	0.1737	0.1703	0.1879	0.2255	NA
Total	**0.3340**	**0.2597**	**0.2690**	**0.2651**	**0.2744**	**0.2530**	**0.2847**	**0.3169**	**0.2984**	**0.2925**	**0.2952**	**0.3544**	**NA**

[78] EMEP/EEA Emission Inventory Guidebook 2009, Category 3.C, Chemical products', 3.3.2.2 'Polyurethane foam processing' and Chapter 3.3.2.3 'Polystyrene processing', page 17.

[79] Natural Foam Blowing Agents, Sustainable Ozone- and Climate-Friendly Alternatives to HCFCs (2012), PROKLIMA International Programme of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, commissioned by the Federal Ministry for Economic Cooperation and Development (BMZ) Environment and Sustainable Use of Natural Resources Division. Eschborn, September 2012. page 178.

Activity data on the cumulative amount of blowing agents charged into foam blowing products imported between 1995 and 2015 are presented below (Tables 4-152 and 4-153).

Table 4-152: AD on the cumulative amount (bank) of blowing agents charged into polyurethane products imported for the period 1995-2019, kt

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
HCFC-22	0.0095	0.0172	0.0221	0.0252	0.0294	0.0344	0.0398	0.0505	0.0650	0.0813	0.0983	0.1160	0.1383
HCFC-141b	0.0086	0.0155	0.0199	0.0224	0.0257	0.0297	0.0346	0.0440	0.0569	0.0732	0.0902	0.1114	0.1394
HFC-134a	0.0010	0.0017	0.0022	0.0028	0.0037	0.0047	0.0065	0.0100	0.0149	0.0230	0.0343	0.0485	0.0764
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0042	0.0096	0.0179
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0047	0.0106	0.0199
Pentane (C,I,N)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0071	0.0203	0.0483
Total	**0.0190**	**0.0345**	**0.0441**	**0.0504**	**0.0587**	**0.0688**	**0.0809**	**0.1046**	**0.1368**	**0.1776**	**0.2388**	**0.3164**	**0.4402**
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
HCFC-22	0.1546	0.1580	0.1580	0.1580	0.1580	0.1580	0.1580	0.1485	0.1408	0.1359	0.1328	0.1286	NA
HCFC-141b	0.1557	0.1590	0.1590	0.1590	0.1590	0.1590	0.1590	0.1505	0.1435	0.1392	0.1367	0.1334	NA
HFC-134a	0.0982	0.1116	0.1241	0.1366	0.1431	0.1491	0.1517	0.1561	0.1554	0.1549	0.1543	0.1534	NA
HFC-365mfc	0.0343	0.0494	0.0681	0.0868	0.1015	0.1150	0.1308	0.1629	0.1744	0.1891	0.2069	0.2242	NA
HFC-245fa	0.0381	0.0549	0.0757	0.0965	0.1128	0.1228	0.1316	0.1494	0.1579	0.1688	0.1820	0.1948	NA
Pentane (C,I,N)	0.0891	0.1227	0.1800	0.2371	0.2861	0.3347	0.3775	0.4644	0.5125	0.5737	0.6479	0.7200	NA
Total	**0.5699**	**0.6556**	**0.7651**	**0.8741**	**0.9606**	**1.0385**	**1.1087**	**1.2317**	**1.2845**	**1.3616**	**1.4606**	**1.5544**	**NA**

Table 4-153: AD on the cumulative amount (bank) of blowing agents charged into polystyrene products imported for the period 1995-2019, kt

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
HCFC-22	0.0309	0.0433	0.0544	0.0650	0.0741	0.0918	0.1065	0.1349	0.1836	0.2286	0.2940	0.3607	0.4149
HCFC-142b	0.0278	0.0390	0.0490	0.0595	0.0686	0.0885	0.1075	0.1440	0.1997	0.2597	0.3512	0.4513	0.5416
HFC-134a	0.0033	0.0047	0.0059	0.0084	0.0106	0.0154	0.0223	0.0354	0.0581	0.0905	0.1472	0.2195	0.3174
HFC-152a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0029	0.0056	0.0149	0.0249	0.0423	0.0757	0.1118
CO_2+ethanol	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0131	0.0381	0.0742
Total	**0.0620**	**0.0870**	**0.1094**	**0.1329**	**0.1533**	**0.1972**	**0.2392**	**0.3198**	**0.4563**	**0.6037**	**0.8479**	**1.1452**	**1.4600**
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
HCFC-22	0.4552	0.4722	0.4722	0.4722	0.4722	0.4722	0.4722	0.4414	0.4289	0.4178	0.4073	0.3982	NA
HCFC-142b	0.6222	0.6562	0.6562	0.6562	0.6562	0.6562	0.6562	0.6285	0.6173	0.6072	0.5967	0.5876	NA
HFC-134a	0.4265	0.5187	0.6061	0.6923	0.7622	0.8092	0.8355	0.8613	0.8600	0.8588	0.8563	0.8541	NA
HFC-152a	0.1655	0.2223	0.3030	0.3825	0.4686	0.5553	0.6684	0.7943	0.9190	1.0412	1.1486	1.2775	NA
CO_2+ethanol	0.1246	0.1842	0.2851	0.3844	0.5028	0.6221	0.7675	0.9293	1.1030	1.2733	1.4612	1.6867	NA
Total	**1.7940**	**2.0536**	**2.3226**	**2.5877**	**2.8621**	**3.1151**	**3.3998**	**3.6548**	**3.9282**	**4.1983**	**4.4700**	**4.8040**	**NA**

2F3 'Fire Protection'

HFC emissions from fire protection were estimated using a Tier 1 methodology, based on a default emission factor. The respective emissions were estimated using Equation 7.17 in the 2006 IPCC Guidelines (Volume 3, Chapter 7.6, page 7.61).

$$Emissions_{\,t} = Bank_{\,t} \bullet EF + RRL_{\,t}$$

and

$$Bank_{\,t} = \Sigma_{\,i\text{-}t0}\,(Production_{\,t} + Import_{\,t} - Export_{\,t} - Destruction_{\,t} - Emissions_{\,t}) - RRL_{\,t}$$

Where:

Emissions $_t$ – emissions of agent from fire protection equipment in year *t*, tonnes;

Bank $_t$ – bank of agent in fire protection equipment in year *t*, tonnes;

EF – fraction of agent in equipment emitted each year (excluding emissions from retired equipment or otherwise removed from service), dimensionless, (%);

RRL $_t$ – Recovery Release or Loss: emissions of agent during recovery, recycling or disposal at the time of removal from use of existing fire protection equipment in year *t*, tonnes;

Production $_t$ – amount of newly supplied agent (i.e., excluding recycled agent) in fire protection equipment produced in year *t*, tonnes;

Import $_t$ – amount of agent in fire protection equipment imported in year *t*, tonnes;

Export $_t$ – amount of agent in fire protection equipment exported in year *t*, tonnes;

Destruction $_t$ – amount of agent from retired fire protection equipment that is collected and destroyed, tonnes;

t – year for which emissions are being estimated;

t_0 – first year of chemical production and/or use;

i – counter from first year of chemical production and/or use t_0 to current year t.

AD regarding the amount of extinguishing agent imported and re-exported from the Republic of Moldova was provided by the Customs Service for the period 2017-2019 (Table 4-109). The year in which the extinguishing agent HFC-227ea was introduced into the Republic of Moldova is considered the year 2017. Based on the respective information, the cumulative extinguishing agent bank for the period 2017-2019 was calculated (Table 4-154).

Table 4-154: Extinguishing agent HFC-227ea used in fire protection for the period 2017-2019, t

	2017	2018	2019
Production of HFC-227ea, t	NO	NO	NO
Import of HFC-227ea, t	2.0000	20.0000	22.0000
Export of HFC-227ea, t	NO	14.5438	9.2834
Total amount of HFC-227ea used in domestic fire protection systems, t	2.0000	5.4562	12.7166
Bank of extinguishing agent used in domestic fire protection systems, t	2.0000	7.3762	17.8777

2F4 'Aerosols' (Metered Dose Aerosols)

HFC emissions aerosol consumption (particularly – metered dose aerosols, where HFC-134a is used as propellant) were estimated using a Tier 2 methodology. It is considered that during the use of aerosols, 100 per cent of the chemical is emitted into the atmosphere. The respective emissions occur within 1-2 years after sales and should be estimated using Equation 7.6 in the 2006 IPCC Guidelines (Volume 3, Chapter 7.3, page 7.28).

$$Emissions_t = S_t \bullet EF + S_{t-1} \bullet (1 - EF)$$

Where:

Emissions $_t$ – emissions in year t, tonnes;

S_t – quantity of HFC and PFC contained in aerosol products sold in year t, tonnes;

S_{t-1} – quantity of HFC and PFC contained in aerosol products sold in year t–1, tonnes;

EF – emission factor (= fraction of chemical emitted during the first year), fraction (%).

AD on the amount of medical substances imported into the Republic of Moldova (metered dose inhalers used in asthma and chronicle pulmonary diseases treatment, including tuberculosis) was provided by the former Ministry of Health for the period 2003-2019 (Table 4-155).

Table 4-155: Import of metered dose inhalers using HFC-134a as propellant for the period 2003-2019, flacons

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Salbutamol sulphate - Salbutamol pressurized inhalation suspension, 100 mcg/dose, 200 doses	-	-	-	87 200	60 640	68 960	109 500	100 184	118 779
Salbutamol sulphate - Ventolin Inhaler 100 mcg/dose, 200 doses	-	4 500	7 923	12 206	5 448	12 800	13 236	19 450	14 500
Fenoterol hydrobromide - Berotec N pressurized inhalation solution 100 mcg/dose, 200 doses	3 014	6 548	4 320	3 524	4 363	1 558	5 138	4 164	7 984
Ipratropium bromide/Fenoterol hydrobromide - Berodual N pressurized inhalation solution 0.25 mg/dose, 200 doses	-	-	-	200	500	586	1 300	1 726	4 248
Ipratropium bromide / Fenoterol hydrobromide - Berodual N pressurized inhalation solution 20+50mcg/dose 10 ml	-	-	-	-	-	-	-	-	-
Fluticasone propionate - Flixotide 50 Evohaler 50 µg/dose, 120 doses	-	500	1 630	1 690	1 160	1 200	300	1 150	1 896
Fluticasone propionate - Flixotide 125 Evohaler 125 µg/dose, 60 doses	-	-	-	-	-	612	800	250	
Fluticasone propionate - Flixotide 125 Evohaler 125 µg/dose, 120 doses	-	282	3 170	2 650	1 370	-	1 933	1 400	1 650
Fluticasone propionate - Flixotide 250 Evohaler 250 µg/dose, 60 doses	-	250	950	1 330	2 170	-	2 990	620	
Fluticasone propionate - Flixotide 250 Evohaler 250 µg/dose, 120 doses	-	-	-	-	-	850	480	2 750	3 018
Salmeterol xinafoate / Fluticasone propionate - Seretide™/Diskus ™ Inhaler - pressurized inhalation suspension 50 mcg + 100 mcg/dose, 60 doses	-	-	-	-	-	-	-	-	-
Salmeterol xinafoate / Fluticasone propionate - Seretide™/Diskus ™ Inhaler - pressurized inhalation suspension 50 mcg + 250 mcg/dose, 60 doses	-	-	-	-	-	-	-	-	-
Salmeterol xinafoate / Fluticasone propionate - Seretide™/Diskus ™ Inhaler - pressurized inhalation suspension 50 mcg + 500 mcg/dose, 60 doses	-	-	-	-	-	-	-	-	-
Salmeterol xinafoate / Fluticasone propionate - Seretide Inhaler 25 µg + 50 µg, 120 doses	-	-	-	-	-	250	299	530	-
Salmeterol xinafoate / Fluticasone propionate - Seretide Inhaler 25 µg + 125 µg, 120 doses	-	-	-	-	-	-	-	-	-
Salmeterol xinafoate / Fluticasone propionate - Seretide Inhaler 25 µg + 250 µg, 120 doses	-	-	-	-	-	-	-	-	-
Salmeterol xinafoate - Serevente Inhaler 25 µg 120 doses	-	-	-	-	-	1 200	1 637	2 100	-

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Combiwave SF 125 pressurized inhalation solution 25+125 mcg/dose, 120 doses (DCI - Salmeterol + Fluticasone)	-	-	-	-	-	-	-	-	-
Combiwave SF 250 pressurized inhalation solution 25+250 mcg/dose, 120 doses N1 (DCI - Salmeterol + Fluticasone)	-	-	-	-	-	-	-	-	-
Beclomethasone Dipropionate inhaler pressurized inhalation suspension 50 mcg/dose, 200 doses N1 (DCI - Beclomethasone)	-	-	-	-	-	-	-	-	-
Pefsal pressurized inhalation suspension 25 + 125 mcg/dose, 120 doses (DCI - Salmeterol + Fluticasone)	-	-	-	-	-	-	-	-	-
Pefsal pressurized inhalation suspension 25 + 250 mcg/dose, 120 doses (DCI - Salmeterol + Fluticasone)	-	-	-	-	-	-	-	-	-
Total Metered Dose Inhalers using HFC-134a as propellant	**3 014**	**12 080**	**17 993**	**108 800**	**75 651**	**88 016**	**137 613**	**134 324**	**152 075**
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Salbutamol sulphate - Salbutamol pressurized inhalation suspension, 100 mcg/dose, 200 doses	109 144	85 200	90 840	-	-	900	-	-	NA
Salbutamol sulphate - Ventolin Inhaler 100 mcg/dose, 200 doses	10 885	14 741	33 400	132 852	142 000	149 110	158 530	192 971	NA
Fenoterol hydrobromide - Berotec N pressurized inhalation solution 100 mcg/dose, 200 doses	11 348	18 576	17 926		7 136	12 424	17 382	6 624	NA
Ipratropium bromide / Fenoterol hydrobromide - Berodual N pressurized inhalation solution 0.25 mg/dose – 200 doses	5 096	-	-	14 736	-	-	-	-	NA
Ipratropium bromide / Fenoterol hydrobromide - Berodual N pressurized inhalation solution 20+50mcg/dose 10 ml	-	6 568	5 712	7 212	7 428	8 209	10 948	12 078	NA
Fluticasone propionate - Flixotide 50 Evohaler 50 µg /dose, 120 doses	3 116	2 400	2 930	3 230	7 973	3 891	4 350	3 596	NA
Fluticasone propionate - Flixotide 125 Evohaler 125 µg/dose, 60 doses	300	496	820	930	10 598	8 458	8 650	9 803	NA
Fluticasone propionate - Flixotide 125 Evohaler 125 µg/dose, 120 doses	600	3 108	4 739	5 715	7 375	323	-	-	NA
Fluticasone propionate - Flixotide 250 Evohaler 250 µg/dose, 60 doses	300	200	400	-	-	-	-	-	NA
Fluticasone propionate - Flixotide 250 Evohaler 250 µg/dose ,120 doses	-	-	-	-	-	-	-	-	NA
Salmeterol xinafoate / Fluticasone propionate - Seretide™/Diskus ™ Inhaler - pressurized inhalation suspension 50 mcg + 100 mcg/dose, 60 doses	-	-	-	4 207	6 049	2 476	2 346	5 042	NA
Salmeterol xinafoate / Fluticasone propionate - Seretide™/Diskus ™ Inhaler - pressurized inhalation suspension 50 mcg + 250 mcg/dose, 60 doses	-	-	-	7 475	18 870	9 160	6 731	14 558	NA
Salmeterol xinafoate / Fluticasone propionate - Seretide™/Diskus ™ Inhaler - pressurized inhalation suspension 50 mcg + 500 mcg/dose, 60 doses	-	-	-	2 710	13 480	6 860	6 150	11 494	NA
Salmeterol xinafoate / Fluticasone propionate - Seretide Inhaler 25 µg + 50 µg, 120 doses	-	-	-	-	-	-	-	-	NA
Salmeterol xinafoate / Fluticasone propionate - Seretide Inhaler 25 µg + 125 µg, 120 doses	-	50	50	-	-	-	-	-	NA
Salmeterol xinafoate / Fluticasone propionate - Seretide Inhaler 25 µg + 250 µg, 120 doses	-	-	100	-	-	-	-	-	NA
Salmeterol xinafoate - Serevente Inhaler 25 µg, 120 doze	-	-	-	-	-	-	-	-	NA
Combiwave SF 125 pressurized inhalation solution 25+125 mcg/dose, 120 doses (DCI - Salmeterol + Fluticasone)	-	-	-	-	-	-	5 000	-	NA
Combiwave SF 250 pressurized inhalation solution 25+250 mcg/dose, 120 doses N1 (DCI - Salmeterol + Fluticasone)	-	-	-	-	-	-	12 836	-	NA
Beclomethasone Dipropionate inhaler pressurized inhalation suspension 50 mcg/dose, 200 doses N1 (DCI - Beclomethasone)	-	-	-	-	-	600	-	-	NA
Pefsal pressurized inhalation suspension 25 + 125 mcg/dose, 120 doses (DCI - Salmeterol + Fluticasone)	-	-	-	-	-	-	-	1 527	NA
Pefsal pressurized inhalation suspension 25 + 250 mcg/dose, 120 doses (DCI - Salmeterol + Fluticasone)	-	-	-	-	-	-	-	903	NA
Total Metered Dose Inhalers using HFC-134a as propellant	**140 789**	**131 339**	**156 917**	**179 067**	**220 909**	**202 411**	**232 923**	**258 596**	**NA**

Sources: Ministry of Health of the RM: through Letter No. 019/550 dated March 1, 2011, as a response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011; Letter No. 019/2045, dated September 14, 2011, as a response to the request from the Ministry of Environment No. 05-07/1321 dated 05.08.2011; Letter No. 01-9/220, dated 05.02.2014, as a response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 01-10/315, dated 04.03.2015, as a response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 01-10/483, dated 30.05.2016, as a response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Agency for Medicines and Medical Devices: Letter No. Rg 02-359, dated 26.01.2018, as a response to the request from the Climate Change Office of the MARDE No. 612/2018-01-02 dated 10.01.2018; and Letter No. Rg 02-002625 dated 15.07.2020, as a response to the request from the MARDE No. 13-07/3044 dated 13.07.2020.

It should be noted that metered dose inhalers are not produced in the Republic of Moldova and, in the past, these substances were imported mainly from Ukraine, the Russian Federation, India and China, whereas recently they have been imported from EU member states such as Spain, France, Germany, Poland and Great Britain. The amount of HFC-134a contained in metered dose aerosols was estimated based on activity data presented above (Table 4-156).

Table 4-156: AD on HFC-134a incorporated in metered dose aerosols imported for the period 2003-2019, kg

	2003	2004	2005	2006	2007	2008	2009	2010	2011
HFC-134a	0.0603	0.2319	0.3164	2.1384	1.4941	1.7696	2.8184	2.7135	3.1643
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
HFC-134a	2.9168	2.7674	3.2339	4.1284	4.4310	4.1523	5.0154	5.4349	8916.1

4.6.3. Uncertainty Assessment and Time-Series Consistency

2F1 'Refrigeration and Air Conditioning'

Uncertainties associated with emission factors used to estimate HFC emissions from source category 2F1 'Refrigeration and Air Conditioning' reach up to circa 50 per cent. Uncertainties associated with activity data on the use of refrigeration and air conditioning equipment is considered moderate (circa 20 per cent). Thus, combined uncertainties for this source category represent circa 53.85 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

2F2 'Foam Blowing Agents'

Uncertainties associated with emission factors used to estimate HFC from source category 2F2 'Foam Blowing Agents' were estimated to be circa 30 per cent (2006 IPCC Guidelines). Uncertainties associated with activity data on the use of foams in the RM are considered relatively large (circa 30 per cent), including due to the fact that current statistical system do not offer the possibility to disaggregate activity data by the type of foams (open-cell or closed-cell), it is thereby not possible to know all types of blowing agents used. Thus, combined uncertainties for this source category represent circa 42.43 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

2F3 'Fire Protection'

Uncertainties associated with emission factors used to estimate HFC from source category 2F3 'Fire Protection' were estimated to be 5 per cent (2006 IPCC Guidelines). Uncertainties associated with activity data on the use of HFC-227ea in fire protection systems in the RM are considered moderate (circa 15 per cent). Thus, combined uncertainties for source category 2F3 'Fire Protection' represent circa 15.81 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

2F4 'Aerosols'

Uncertainties associated with emission factors used to estimate HFC emissions covered by the source category 2F4 'Aerosols' were estimated to be circa 5 per cent (2006 IPCC Guidelines). Uncertainties associated with activity data on the use of metered dose aerosols using HFC-134a as propellant in the RM are considered low (circa 10 per cent). Thus, combined uncertainties for source category 2F4 'Aerosols' represent circa 7.07 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

4.6.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category following the Tier 1 approach. For category 2F 'Product Uses as Substitutes for ODS', comparison and verification was focused on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines; on correct use of AD obtained from different reference sources, including official sources (i.e., National Bureau of Statistics, Customs Service, former Ministries of Health, Republican Association of Refrigeration Technicians of the Republic of Moldova, and Annual Reports submitted by individual companies to the Ministry of Agriculture, Regional Development and Environment, and the Environment Agency, respectively), etc. It should be noted that AD and methods used for estimating GHG emissions under category 2F 'Product Uses as Substitutes for ODS' were documented and archived both in hard copies and electronically.

4.6.5. Recalculations

2F1 'Refrigeration and Air Conditioning'

HFC emissions from source category 2F1 'Refrigeration and Air Conditioning' were recalculated for the period 1995-2016 due to: (a) updating and completing information on the import and consumption of HFCs in the Republic of Moldova for the period until 2008, as a result of using the Generalized Reports on the production, consumption, import/export of ozone-depleting substances regulated by the Montreal Protocol in the RM between 2001 and 2008 according to the Statistical Report No. 1-Ozone, provided by the NBS (since 2009, the responsibility for collecting statistical information, according to the Statistical Report No. 1-Ozone, was kept by the State Ecological Inspectorate of the RM, but due to the lack of capacities, this information was not collected), respectively, as a result of the use of information from the Automated System for Customs Data ASYCUDA World, which ensured the management and processing of customs forms and documents, used in the customs clearance procedures between 2013 and 2019; (b) completing the list of refrigerants used mostly in the RM; (c) updating the share of refrigerants charged into refrigeration and air conditioning equipment in the RM; (d) updating the information on the total number of transportation units registered in the country for the period 1995-2019, as well as the share of transportation units charged with air conditioning equipment, provided by the Public Services Agency of the Republic of Moldova, based on the information included in the State Transport Register for the period 1995-2019.

In comparison with the results registered in the BUR2 of the RM to the UNFCCC (2019), the recalculations resulted in a downward trend in HFC emissions from source category 2F1 'Refrigeration and Air Conditioning' for the period 1995-2000 and 2011-2014, and an upward trend in HFC emissions from source category 2F1 'Refrigeration and Air Conditioning' for the period 2001-2019 and 2015-2016, respectively (Table 4-157).

Table 4-157: Comparative results of HFC emissions from source category 2F1 'Refrigeration and Air Conditioning' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 eq.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
BUR2	3.6751	3.5951	3.8776	4.1996	4.1971	4.1151	4.5048	5.0760	5.7491	8.0196	9.5679	10.9815	13.1757
BUR3	0.7535	1.2463	1.7920	2.4126	3.0811	3.8190	5.0012	6.1655	7.3862	8.5552	10.2213	14.7472	17.2579
Difference, %	-79.5	-65.3	-53.8	-42.6	-26.6	-7.2	11.0	21.5	28.5	6.7	6.8	34.3	31.0
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
BUR2	16.3707	18.5147	23.1089	31.5903	34.2235	37.1211	45.1294	66.2081	70.7568				
BUR3	19.6858	21.3675	23.2625	27.0796	30.2879	33.8193	43.5320	71.1976	79.1826	96.6091	106.2543	138.6362	18298.9
Difference, %	20.3	15.4	0.7	-14.3	-11.5	-8.9	-3.5	7.5	11.9				

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the years 2017-2019, HFC emissions from the respective category were estimated for the first time. The obtained results show that between 1995-2019, HFCs emissions from source category 2F1 'Refrigeration and Air Conditioning' had increased by circa 184 times (Table 4-158).

Table 4-158: HFC emissions from source category 2F1 'Refrigeration and Air Conditioning' in the RM for the period 1995-2019

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	2F1a 'Domestic Refrigeration Equipment'												
HFC-125, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0002	0.0004	0.0009	0.0021	0.0042
HFC-134a, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0073	0.0191	0.0410	0.0746	0.1223
HFC-143a, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0002	0.0004	0.0010	0.0024	0.0050
2F1a, kt CO_2 eq.	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0118**	**0.0305**	**0.0663**	**0.1248**	**0.2117**
	2F1b 'Commercial Refrigeration Equipment'												
HFC-32, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0012	0.0026	0.0040	0.0060	0.0131
HFC-125, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0073	0.0156	0.0319	0.0551	0.1148
HFC-134a, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0351	0.0745	0.1155	0.1738	0.3758
HFC-143a, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0081	0.0172	0.0344	0.0589	0.1208
2F1b, kt CO_2 eq.	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1129**	**0.2399**	**0.4336**	**0.7089**	**1.4879**
	2F1c 'Industrial Refrigeration Equipment'												
HFC-32, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0000	0.0000	0.0041	0.0098	0.0127
HFC-125, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0333	0.0616	0.1078	0.1492	0.1993
HFC-134a, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0368	0.0502	0.0737	0.1002	0.1213
HFC-143a, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0361	0.0668	0.1128	0.1507	0.2016
2F1c, kt CO_2 eq.	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.3307**	**0.5862**	**0.9897**	**1.3456**	**1.7809**
	2F1d 'Stationary Air Conditioning Equipment'												
HFC-32, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0021	0.0060	0.0117	0.0200	0.0499
HFC-125, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0021	0.0060	0.0117	0.0200	0.0499
2F1d, kt CO_2 eq.	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0088**	**0.0251**	**0.0490**	**0.0834**	**0.2085**
	2F1e 'Mobile Air Conditioning Equipment'												
HFC-134a, t	0.5269	0.8716	1.2532	1.6871	2.1546	2.6706	3.4973	4.3116	4.8405	5.3660	6.0718	6.6553	7.1587
2F1e, kt CO_2 eq.	**0.7535**	**1.2463**	**1.7920**	**2.4126**	**3.0811**	**3.8190**	**5.0012**	**6.1655**	**6.9220**	**7.6734**	**8.6827**	**9.5171**	**10.2369**
	2F1f 'Transport Refrigeration'												
HFC-32, t	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.7108	0.7981
HFC-125, t	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.7108	0.7981
2F1f, kt CO_2 eq.	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**2.9675**	**3.3319**
	2F1 'Refrigeration and Air Conditioning'												
2F1, kt CO_2 eq.	**0.7535**	**1.2463**	**1.7920**	**2.4126**	**3.0811**	**3.8190**	**5.0012**	**6.1655**	**7.3862**	**8.5552**	**10.2213**	**14.7472**	**17.2579**

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
	2F1a 'Domestic Refrigeration Equipment'												
HFC-125, t	0.0055	0.0073	0.0105	0.0141	0.0169	0.0195	0.0229	0.0275	0.0325	0.0394	0.0489	0.0797	N/A
HFC-134a, t	0.1566	0.1838	0.2131	0.2374	0.2563	0.2681	0.2777	0.2830	0.2841	0.2847	0.2856	0.9712	N/A
HFC-143a, t	0.0065	0.0087	0.0124	0.0166	0.0200	0.0230	0.0271	0.0325	0.0384	0.0466	0.0578	0.0942	N/A
2F1a, kt CO_2 eq.	**0.2725**	**0.3272**	**0.3970**	**0.4630**	**0.5149**	**0.5542**	**0.5984**	**0.6459**	**0.6916**	**0.7535**	**0.8379**	**2.0889**	**N/A**
	2F1b 'Commercial Refrigeration Equipment'												
HFC-32, t	0.0193	0.0226	0.0256	0.0294	0.0327	0.0370	0.0405	0.0750	0.0805	0.0853	0.1055	0.2382	N/A
HFC-125, t	0.1689	0.1998	0.2308	0.2776	0.3127	0.3602	0.4002	0.6292	0.6830	0.9481	1.1883	2.1862	N/A
HFC-134a, t	0.5817	0.6994	0.8182	0.9576	1.0517	1.1709	1.2631	2.2462	2.3935	2.5101	3.0359	6.7649	N/A
HFC-143a, t	0.1778	0.2101	0.2425	0.2927	0.3294	0.3790	0.4209	0.6714	0.7287	0.9971	1.2494	2.2726	N/A
2F1b, kt CO_2 eq.	**2.2308**	**2.6537**	**3.0791**	**3.6694**	**4.0927**	**4.6546**	**5.1156**	**8.4661**	**9.1249**	**11.4227**	**14.1565**	**27.6446**	**N/A**
	2F1c 'Industrial Refrigeration Equipment'												
HFC-32, t	0.0157	0.0189	0.0476	0.0608	0.1029	0.1337	0.1886	0.2349	0.2829	0.3415	0.4018	0.4759	N/A
HFC-125, t	0.2585	0.3258	0.4303	0.5303	0.6737	0.8175	1.0048	1.2096	1.6305	1.9348	2.2769	2.6530	N/A
HFC-134a, t	0.1632	0.1938	0.2377	0.2770	0.3314	0.3925	0.4497	0.5234	0.7040	0.8110	0.9505	1.0820	N/A
HFC-143a, t	0.2621	0.3315	0.4131	0.5066	0.6155	0.7369	0.8774	1.0458	1.2140	1.3950	1.5856	1.8073	N/A
2F1c, kt CO_2 eq.	**2.3203**	**2.9117**	**3.7246**	**4.5577**	**5.6529**	**6.8064**	**8.2094**	**9.8153**	**12.3312**	**14.3979**	**16.6873**	**19.2327**	**N/A**
	2F1d 'Stationary Air Conditioning Equipment'												
HFC-32, t	0.0801	0.0870	0.1024	0.1273	0.1529	0.1865	0.2062	0.5220	0.8163	1.1234	1.5398	4.7058	N/A
HFC-125, t	0.0801	0.0870	0.1024	0.1273	0.1502	0.1784	0.1927	0.5035	0.7816	1.0657	1.4492	4.5712	N/A
2F1d, kt CO_2 eq.	**0.3345**	**0.3631**	**0.4277**	**0.5314**	**0.6289**	**0.7503**	**0.8137**	**2.1146**	**3.2867**	**4.4881**	**6.1116**	**19.1758**	**N/A**
	2F1e 'Mobile Air Conditioning Equipment'												
HFC-134a, t	7.5819	7.7604	7.8830	9.1941	10.0360	10.9586	16.1343	30.8590	33.1834	41.1346	43.3260	44.7429	8391.3
2F1e, kt CO_2 eq.	**10.8420**	**11.0974**	**11.2727**	**13.1475**	**14.3515**	**15.6707**	**23.0721**	**44.1284**	**47.4523**	**58.8225**	**61.9562**	**63.9824**	**8391.3**
	2F1f 'Transport Refrigeration'												
HFC-32, t	0.8828	0.9615	1.0447	1.1283	1.2089	1.2893	1.3707	1.4437	1.5080	1.6106	1.5580	1.5597	N/A
HFC-125, t	0.8828	0.9615	1.0447	1.1283	1.2089	1.2893	1.3707	1.4437	1.5080	1.6106	1.5580	1.5597	N/A
2F1f, kt CO_2 eq.	**3.6858**	**4.0145**	**4.3615**	**4.7106**	**5.0470**	**5.3829**	**5.7228**	**6.0273**	**6.2961**	**6.7243**	**6.5048**	**6.5119**	**N/A**
	2F1 'Refrigeration and Air Conditioning'												
2F1, kt CO_2 eq.	**19.6858**	**21.3675**	**23.2625**	**27.0796**	**30.2879**	**33.8193**	**43.5320**	**71.1976**	**79.1826**	**96.6091**	**106.2543**	**138.6362**	**18298.9**

2F2 'Foam Blowing Agents'

HFCs emissions from source category 2F2 'Foam Blowing Agents' for the period 1995-2016 were recalculated as a result of updating and completing the information on the import of foam blowing products into the RM, having used information from ASYCUDA World Automated System for Customs Data, which ensured the management and processing of customs forms and documents used in customs clearance procedures for the period 2013-2019; and as a result of updating the share of blowing agents in foam blowing products imported into the RM, respectively. In comparison with the emission values registered in the BUR2 of the RM to the UNFCCC (2019), the recalculations resulted in a downward trend in HFCs emissions from source category 2F2 'Foam Blowing Agents' for the period 1996-2016 (Table 4-159). For the years 2017-2019, HFC emissions from the respective category were estimated for the first time. The obtained results show that between 1995-2019, HFC emissions from source category 2F2 'Foam Blowing Agents' had increased by 322 times.

Table 4-159: Comparative results of HFC emissions from source category 2F2 'Foam Blowing Agents included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 eq.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
BUR2	0.2763	0.6864	1.2294	1.8628	2.6045	4.1887	5.9723	9.4256	15.0924	21.1768	31.2305	42.6149	54.6209
BUR3	0.2763	0.4130	0.5216	0.7246	0.9191	1.3010	1.8669	2.9571	4.7770	7.4473	12.2889	18.5004	27.5284
Difference, %	0.0	-39.8	-57.6	-61.1	-64.7	-68.9	-68.7	-68.6	-68.3	-64.8	-60.7	-56.6	-49.6
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
BUR2	65.6924	72.8440	79.7528	84.9304	89.9845	93.4254	96.9516	101.5988	104.8218				
BUR3	37.6745	46.1098	54.6272	63.0458	69.7304	74.5640	78.0278	82.6488	84.0180	85.6195	87.2640	89.0005	32110.6
Difference, %	-42.7	-36.7	-31.5	-25.8	-22.5	-20.2	-19.5	-18.7	-19.8				

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

2F3 'Fire Protection'

HFC emissions from source category 2F3 'Fire Protection' were estimated for the first time for the period 2017-2019 (Table 4-160).

Table 4-160: Comparative results of HFC emissions from source category 2F3 'Fire Protection' included into the BUR3 of the RM under the UNFCCC, kt CO_2 eq.

	2017	2018	2019
HFC-227ea Emissions, t	0.0800	0.2950	0.7151
HFC-227ea Emissions, kt CO_2 equivalent	**0.2576**	**0.9500**	**2.3026**

2F4 'Aerosols'

HFCs emissions from source category 2F4 'Aerosols' for the period 2003-2016 were not recalculated. For the period 2017-2019 HFC emissions from the respective category were estimated for the first time. The obtained results show that between 2003-2019, HFC emissions from source category 2F4 'Aerosols' had increased by circa 115.6 times (Table 4-161).

Table 4-161: Comparative results of HFCs emissions from source category 2F4 'Aerosols' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 eq.

	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2	0.0001	0.0002	0.0004	0.0018	0.0026	0.0023	0.0033	0.0040	0.0042
BUR3	0.0001	0.0002	0.0004	0.0018	0.0026	0.0023	0.0033	0.0040	0.0042
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
BUR2	0.0043	0.0041	0.0043	0.0053	0.0061				
BUR3	0.0043	0.0041	0.0043	0.0053	0.0061	0.0061	0.0066	0.0075	11457.5
Difference, %	0.0	0.0	0.0	0.0	0.0				

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

2F 'Product Uses as Substitutes for ODS'

HFC emissions from source category 2F 'Product Uses as Substitutes for ODS' were recalculated for the period 1995-2016, as a result of the previously-mentioned reasons. In comparison with the emission values registered in the BUR2 of the RM to the UNFCCC (2019), the recalculations resulted in a downward trend in HFC emissions from category 2F 'Product Uses as Substitutes for ODS' for the period 1995-2006, varying from a minimum of 7.0 per cent in 2016 to a maximum of 73.9 per cent in 1995 (Table 4-162). For the period 2017-2019, HFC emissions from the respective category were estimated for the first time. The obtained results show that between 1995-2019, HFC emissions from 2F 'Product Uses as Substitutes for ODS' had increased by 223 times.

Table 4-162: Comparative results of HFC emissions from category 2F 'Product Uses as Substitutes for ODS' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 eq.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
BUR2	3.9514	4.2815	5.1070	6.0624	6.8017	8.3038	10.4771	14.5015	20.8415	29.1966	40.7988	53.5982	67.7992
BUR3	1.0298	1.6593	2.3137	3.1372	4.0002	5.1199	6.8681	9.1227	12.1632	16.0027	22.5106	33.2493	44.7889
Difference, %	-73.9	-61.2	-54.7	-48.3	-41.2	-38.3	-34.4	-37.1	-41.6	-45.2	-44.8	-38.0	-33.9
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**%**
BUR2	82.0655	91.3620	102.8657	116.5249	124.2123	130.5506	142.0853	167.8122	175.5848				
BUR3	57.3627	67.4807	77.8936	90.1296	100.0227	108.3873	121.5640	153.8517	163.2067	182.4923	194.4750	229.9469	22229.0
Difference, %	-30.1	-26.1	-24.3	-22.7	-19.5	-17.0	-14.4	-8.3	-7.0				

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Table 4-163 below shows HFC emissions by substances and sources.

Table 4-163: HFC emissions from category 2F 'Product Uses as Substitutes for ODS' for the period 1995-2019

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	2F1 'Refrigeration and Air Conditioning'												
HFC-32, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0033	0.0086	0.0199	0.7466	0.8737
HFC-125, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0429	0.0836	0.1523	0.9371	1.1663
HFC-134a, t	0.5269	0.8716	1.2532	1.6871	2.1546	2.6706	3.4973	4.3116	4.9197	5.5099	6.3021	7.0039	7.7781
HFC-143a, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0444	0.0845	0.1483	0.2120	0.3274
2F1, kt CO_2 eq.	**0.7535**	**1.2463**	**1.7920**	**2.4126**	**3.0811**	**3.8190**	**5.0012**	**6.1655**	**7.3862**	**8.5552**	**10.2213**	**14.7472**	**17.2579**
	2F2 'Foam Blowing Agents'												
HFC-134a, t	0.1932	0.2888	0.3648	0.5067	0.6427	0.9040	1.2943	2.0462	3.2825	5.1109	8.1701	12.0594	17.7208
HFC-152a, t	NO	NO	NO	NO	NO	0.0664	0.1297	0.2512	0.6692	1.1189	1.9037	3.4044	5.0309
HFC-365mfc, t	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.1907	0.4298	0.8067
HFC-245fa, t	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.2119	0.4776	0.8964
2F2, kt CO_2 eq.	**0.2763**	**0.4130**	**0.5216**	**0.7246**	**0.9191**	**1.3010**	**1.8669**	**2.9571**	**4.7770**	**7.4473**	**12.2889**	**18.5004**	**27.5284**
	2F3 'Fire Protection'												
HFC-227ea, t	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2F3, kt CO_2 eq.	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
	2F4 'Aerosols'												
HFC-134a, t	NO	NO	NO	NO	NO	NO	NO	NO	0.0000	0.0001	0.0003	0.0012	0.0018
2F4, kt CO_2 eq.	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0001**	**0.0002**	**0.0004**	**0.0018**	**0.0026**
	2F 'Product Uses as Substitutes for ODS'												
2F, kt CO_2 eq.	**1.0298**	**1.6593**	**2.3137**	**3.1372**	**4.0002**	**5.1199**	**6.8681**	**9.1227**	**12.1632**	**16.0027**	**22.5106**	**33.2493**	**44.7889**

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	%
	2F1 'Refrigeration and Air Conditioning'												
HFC-32, t	0.9980	1.0900	1.2203	1.3457	1.4974	1.6465	1.8061	2.2755	2.6878	3.1609	3.6051	6.9797	N/A
HFC-125, t	1.3959	1.5814	1.8187	2.0775	2.3624	2.6649	2.9914	3.8134	4.6357	5.5987	6.5214	11.0499	N/A
HFC-134a, t	8.4833	8.8373	9.1520	10.6660	11.6753	12.7900	18.1247	33.9115	36.5650	44.7405	47.5980	53.5610	10064.8
HFC-143a, t	0.4464	0.5502	0.6680	0.8160	0.9649	1.1389	1.3254	1.7497	1.9811	2.4388	2.8928	4.1740	N/A
2F1, kt CO_2 eq.	**19.6858**	**21.3675**	**23.2625**	**27.0796**	**30.2879**	**33.8193**	**43.5320**	**71.1976**	**79.1826**	**96.6091**	**106.2543**	**138.6362**	**18298.9**
	2F2 'Foam Blowing Agents'												
HFC-134a, t	23.6102	28.3653	32.8621	37.2991	40.7408	43.1240	44.4241	45.7862	45.6906	45.6146	45.4727	45.3367	23363.5
HFC-152a, t	7.4479	10.0019	13.6333	17.2115	21.0856	24.9891	30.0779	35.7419	41.3538	46.8552	51.6862	57.4856	NA
HFC-365mfc, t	1.5417	2.2220	3.0663	3.9072	4.5689	5.1736	5.8862	7.3289	7.8491	8.5093	9.3112	10.0895	NA
HFC-245fa, t	1.7129	2.4689	3.4070	4.3414	5.0765	5.5245	5.9204	6.7218	7.1072	7.5962	8.1902	8.7668	NA
2F2, kt CO_2 eq.	**37.6745**	**46.1098**	**54.6272**	**63.0458**	**69.7304**	**74.5640**	**78.0278**	**82.6488**	**84.0180**	**85.6195**	**87.2640**	**89.0005**	**32110.6**
	2F3 'Fire Protection'												
HFC-227ea, t	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0800	0.2950	0.7151	NA
2F4, kt CO_2 eq.	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.2576**	**0.9500**	**2.3026**	NA
	2F4 'Aerosols'												
HFC-134a, t	0.0016	0.0023	0.0028	0.0029	0.0030	0.0028	0.0030	0.0037	0.0043	0.0043	0.0046	0.0052	NA
2F4, kt CO_2 eq.	**0.0023**	**0.0033**	**0.0040**	**0.0042**	**0.0043**	**0.0041**	**0.0043**	**0.0053**	**0.0061**	**0.0061**	**0.0066**	**0.0075**	**NA**
	2F 'Product Uses as Substitutes for ODS'												
2F, kt CO_2 eq.	**57.3627**	**67.4807**	**77.8936**	**90.1296**	**100.0227**	**108.3873**	**121.5640**	**153.8517**	**163.2067**	**182.4923**	**194.4750**	**229.9469**	**22229.0**

4.6.6. Planned Improvements

Potential improvements could include capacity building activities by setting up an on-line information system for collecting AD from companies that import, use, dispose, recover and recycle refrigerants and refrigerant equipment. This information system will provide the Ministry of Agriculture, Regional Development and Environment, the Environment Agency, and the National Agency on Regulation of Nuclear, Radiological and Chemical activities with more accurate AD, which could potentially contribute to reducing uncertainties in the assessment of GHG emissions from category 2F 'Product Uses as Substitutes for ODS' in the Republic of Moldova.

4.7. Other Product Manufacture and Use (category 2G)

4.7.1. Source Category Description

Category 2G 'Other Product Manufacture and Use', covers GHG emissions generated from the following emission sources: 2G1 'Electrical Equipment', 2G3 'N_2O from Product Uses' and 2G4 'Other' ('Use of Tobacco' and 'Use of Shoes').

2G1 'Electrical Equipment'

Sulphur hexafluoride (SF_6) and perfluorocarbons (particularly CF_4) are used as an insulation in medium and high tension electrical equipment. SF_6 is also used in gas insulated switchgear, chemical lasers and circuit breakers.

In order to determine how sulphur hexafluoride and PFC are used in the Republic of Moldova, a series of enterprises subordinated to the current Ministry of Economy and Infrastructure ('Moldelectrica' SOE), Premier Energy Ltd., as well as the Ministry of Health, Labour and Social Protection and the Academy of Sciences of Moldova were surveyed.

The survey of the above-mentioned organisations revealed the following: no activity data is available on the application of SF_6 in gas insulated chemical lasers at the Academy of Sciences of Moldova and the Ministry of Health, Labour and Social Protection for the time period 1990-2019; at the Ministry of Economy and Infrastructure ('Moldelectrica' SOE) and Premier Energy Ltd., by 2019, SF_6 was used in 121 medium tension circuit breakers, varying from 0.95 kg and 2.6 kg of SF_6, respectively 193 high tension circuit breakers, varying from 6 kg and 45 kg of SF_6. As one can see, the use of PFCs in the Republic of Moldova, particularly CF_4 is being recorded currently only as an insulation medium in high tension electrical equipment.

The share of SF_6 and CF_4 emissions in the total GHG emissions generated from source category 2G1 'Electrical Equipment' is insignificant, such emissions being recorded only since 2003, and 2006, respectively.

2G3 'N_2O from Product Uses'

Under this category, N_2O emissions from medical applications for anaesthetic use are estimated (SNAP 060508 – N_2O for anaesthetic use in medical application).

2G4. 'Other'

Under this category, NO_x, CO, NMVOC and indirect CO_2 emissions from use of tobacco (SNAP 060602 – use of tobacco) and use of shoes (SNAP 060603 – use of shoes), and use of fireworks (SNAP 060601) are estimated.

Between 1990 and 2019, direct GHG emissions from the 2G 'Other Product Manufacture and Use' decreased by circa 24.6 per cent (Table 4-164).

Table 4-164: Direct GHG emissions from category 2G 'Other Product Manufacture and Use', by sources, for the period 1990-2019, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2G1. Electrical equipment	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2G3. N_2O from product uses	0.0197	0.0164	0.0149	0.0179	0.0149	0.0003	0.0006	0.0009	0.0015	0.0128
2G4. Other	3.4010	3.0625	2.4132	1.9809	1.4426	1.1676	1.1050	0.9982	0.7460	0.6421
2G. Other product manufacture and use	**3.4207**	**3.0789**	**2.4281**	**1.9988**	**1.4575**	**1.1679**	**1.1056**	**0.9991**	**0.7475**	**0.6549**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2G1. Electrical equipment	NO	NO	NO	0.0071	0.0071	0.0427	0.3319	0.4315	0.5277	0.5710
2G3. N_2O from product uses	0.0131	0.0131	0.0131	0.0131	0.0149	0.0182	0.0176	NO	NO	NO
2G4. Other	0.9554	0.8204	0.7843	0.9620	1.0504	1.1646	1.0655	1.0652	1.1036	0.8048
2G. Other product manufacture and use	**0.9685**	**0.8335**	**0.7974**	**0.9823**	**1.0724**	**1.2255**	**1.4150**	**1.4967**	**1.6312**	**1.3759**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
2G1. Electrical equipment	0.7020	0.7447	0.8050	1.0055	1.0943	1.0946	1.1226	1.1520	1.3687	1.4710
2G3. N_2O from product uses	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2G4. Other	1.0245	1.2291	1.1575	1.0965	1.2062	0.9397	1.0649	1.1757	1.0114	1.1072
2G. Other product manufacture and use	**1.7265**	**1.9738**	**1.9625**	**2.1020**	**2.3005**	**2.0343**	**2.1875**	**2.3277**	**2.3801**	**2.5781**

The table below shows the evolution of indirect GHG emissions (NO_x, CO, NMVOC) from the respective category (Table 4-165).

Table 4-165: Evolution of indirect GHG emissions from category 2G 'Other Product Manufacture and Use' for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	0.0197	0.0199	0.0186	0.0190	0.0173	0.0153	0.0210	0.0205	0.0162	0.0189
CO	0.6017	0.6083	0.5686	0.5819	0.5290	0.4695	0.6414	0.6281	0.4967	0.5773
NMVOC	1.5459	1.3920	1.0969	0.9004	0.6557	0.5307	0.5023	0.4537	0.3391	0.2919
SO_x	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
NO_x	0.0200	0.0203	0.0147	0.0181	0.0188	0.0186	0.0180	0.0198	0.0170	0.0205
CO	0.6124	0.6229	0.4503	0.5545	0.5759	0.5683	0.5508	0.6066	0.5217	0.6267
NMVOC	0.4343	0.3729	0.3565	0.4373	0.4774	0.5294	0.4843	0.4842	0.5016	0.3658
SO_x	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
NO_x	0.0237	0.0237	0.0174	0.0133	0.0117	0.0116	0.0105	0.0078	0.0004	0.0011
CO	0.7247	0.7248	0.5326	0.4062	0.3565	0.3561	0.3198	0.2396	0.0132	0.0331
NMVOC	0.4657	0.5587	0.5261	0.4984	0.5483	0.4271	0.4841	0.5344	0.4597	0.5033
SO_x	NE	NE	NE	0.0003	0.0007	0.0003	0.0003	0.0003	0.0007	0.0008

4.7.2. Methodological Issues, Emission Factors and Data Sources

2G1 'Electrical Equipment'

SF_6 and PFC emissions from use of sulphur hexafluoride as insulation medium in high and medium tension electrical circuit breakers were estimated based on Tier 1 estimation methodology (2006 IPCC Guidelines, Volume 3, Chapter 8.1, Equation 8.1, page 8.8).

$$Total\ Emissions = M \bullet EF + EI \bullet EF + EU \bullet EF + ED \bullet EF$$

Where:

Total Emissions – emissions from use of SF6 and PFC as insulation medium in high and medium tension electrical circuit breakers, tonnes;

M – manufacturing emissions, tonnes;

EF – manufacturing EF, fraction SF_6 and PFC consumption by manufacturers; default emission factors: 7 per cent for sealed pressure electrical equipment (MV switchgear) containing SF_6 (2006 IPCC Guidelines, Volume 3, Chapter 8.1, Table 8.2, page 8.15) and 8.5 per cent for closed pressure electrical equipment (HV switchgear) containing SF_6 (2006 IPCC Guidelines, Volume 3, Chapter 8.1, Table 8.3, page 8.16);

EI – installation emissions, tonnes;

EF – installation EF, total nameplate capacity of new equipment filled on site;

EU – equipment use emissions, tonnes;

EF – equipment use EF; total nameplate capacity of installed equipment (includes emissions due to leakage, servicing, and maintenance as well as failures); default emission factors: 0.2 per cent for sealed pressure electrical equipment (MV switchgear) containing SF_6 (2006 IPCC Guidelines, Volume 3, Chapter 8.1, Table 8.2, page 8.15) and 2.6 per cent for closed pressure electrical equipment (HV switchgear) containing SF_6 (2006 IPCC Guidelines, Volume 3, Chapter 8.1, Table 8.3, page 8.16);

ED – equipment disposal emissions, tonnes;

EF – equipment disposal EF; total nameplate capacity of retiring equipment, fraction of SF6 and PFC remaining at retirement (the life expectancy of the equipment in European countries is over 35 years); default emission factors: 93 per cent for sealed pressure electrical equipment (MV switchgear) containing SF6 (2006 IPCC Guidelines, Volume 3, Chapter 8.1, Table 8.2, page 8.15) and 95 per cent for closed pressure electrical equipment (HV switchgear) containing SF6 (2006 IPCC Guidelines, Volume 3, Chapter 8.1, Table 8.3, page 8.16).

Only since 2003 have Moldovan companies initiated the use of medium-tension electrical circuit breakers (10 and 35 kV) and high-tension electrical circuit breakers (110 kV, 330 kV and 400 kV), the SF_6 charge in each case varying between 0.95 and 45.0 kg. In accordance with the manufacturer's technical log, the first repairs shall take place after 35 years of operation.

The dynamic of high-tension electrical circuit breakers installation process, as well as the number of available units in bulk at the end of calendar year is provided in Table 4-166, and in Tables 4-167 and 4-168, respectively.

Table 4-166: Dynamic of medium and high-tension electrical circuit breakers installation process using SF_6 and CF_4 for the period 2003-2019, units installed per year

Enterprises	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Moldelectrica SOE	1	0	5	28	8	2	0	8	1	3	4	0	0	0	0	45	20
Premier Energy Ltd.	0	0	0	6	6	34	11	5	34	48	25	26	5	44	16	23	6
Total	**1**	**0**	**5**	**34**	**14**	**36**	**11**	**13**	**35**	**51**	**29**	**26**	**5**	**44**	**16**	**68**	**26**

Sources: Red Union Fenosa JSC through Letter No. 0201/65392 dated 15.08.2011, as a response to the request from the Ministry of Environment No. 03-07/1337 dated 08.08.2011; Letter from 13.01.2014, as a response to the request from the Climate Change Office No. 320/2014-01-01 dated 03.01.2014; Letter from 10.05.2016, as a response to the request from the Climate Change Office No. 512/2016-05-09 dated 10.05.2016; Letter from 23.01.2018, as a response to the request from the Climate Change Office No. 601/2017-12-03 dated 14.12.2017; Premier Energy Ltd. through Letter from 19.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; SOE 'MOLDELECTRICA' through Letter No. 46-47/1795 dated 23.08.2011, as a response to the request from the Ministry of Environment No. 03-07/1337 dated 08.08.2011; Letter No. 46-47/112 dated 17.01.2014, as a response to the request from the Climate Change Office No. 320/2014-01-01 dated 03.01.2014; Letter No. 46-74/937 dated 25.05.2016, as a response to the request from the Climate Change Office No. 512/2016-05-01 dated 10.05.2016; Letter No. 46-74/1 dated 03.01.2018, as a response to the request from the Climate Change Office No. 601/2017-12-03 dated 14.12.2017; Letter No. 46-74/333 dated 28.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020.

Table 4-167: Total medium-tension electrical circuit breakers available in bulk at the end of calendar year for the period 2006-2019, units

	2006	2007	2008	2009	2010	2011	2012
Circuit breaker 10 kV, PT COMPACT 3L1P, 0.605 kg SF_6	0	0	0	0	0	0	0
Circuit breaker 10 kV, THO 24/SO5/E/THO-T1, 0.98 kg SF_6	0	0	0	0	0	28	52
Circuit breaker 10 kV, PT COMPACT 1P, 1.25 kg SF_6	0	0	0	0	0	0	0
Circuit breaker 10 kV, AUGUSTE 2012/1.5 kg SF_6	0	0	0	0	0	0	0
Circuit breaker 10 kV, PT COMPACT 1P (ZPUE), 1.6 kg SF_6	0	0	0	0	0	0	0
Circuit breaker 10 kV, GMA-24 / 2.2 kg SF_6	0	0	24	24	24	24	36
Circuit breaker 10 kV, PT COMPACT 2L1P (ZPUE), 2.25 kg SF_6	0	0	0	0	0	0	0
Circuit breaker 10 kV, PT COMPACT 2L1P, 2.46 kg SF_6	0	0	0	0	0	0	3
Circuit breaker 10 kV, PT COMPACT 3L1P (ZPUE), 2.9 kg SF_6	0	0	0	0	0	0	0
Circuit breaker 10 kV, PT COMPACT 2L2P (ZPUE), 3.2 kg SF_6	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012
Circuit breaker 35 kV, THO 36/0.98 kg SF_6	0	0	0	0	0	0	0
Circuit breaker 35 kV, GL-107X (2012)/2.4 kg SF_6	0	0	0	0	0	0	1
Circuit breaker 35 kV, GL-107X (2005) / 2.6 kg SF_6	5	5	5	5	5	5	5
Circuit breaker 35 kV, VOX 36/2.9 kg SF_6	0	0	2	7	7	7	12
Total circuit breakers installed	**5**	**5**	**31**	**36**	**36**	**64**	**109**
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Circuit breaker 10 kV, PT COMPACT 3L1P, 0.605 kg SF_6	1	2	2	2	2	2	2
Circuit breaker 10 kV, THO 24/SO5/E/THO-T1, 0.98 kg SF_6	52	59	64	65	65	67	67
Circuit breaker 10 kV, PT COMPACT 1P, 1.25 kg SF_6	1	1	1	1	1	1	1
Circuit breaker 10 kV, AUGUSTE 2012/1.5 kg SF_6	0	0	0	29	36	44	45
Circuit breaker 10 kV, PT COMPACT 1P (ZPUE), 1.6 kg SF_6	0	0	0	1	1	3	3
Circuit breaker 10 kV, GMA-24/2.2 kg SF_6	36	36	36	36	36	36	36
Circuit breaker 10 kV, PT COMPACT 2L1P (ZPUE), 2.25 kg SF_6	0	0	0	7	9	14	16
Circuit breaker 10 kV, PT COMPACT 2L1P, 2.46 kg SF_6	15	22	22	22	22	22	22
Circuit breaker 10 kV, PT COMPACT 3L1P (ZPUE), 2.9 kg SF_6	0	0	0	0	2	2	2
Circuit breaker 10 kV, PT COMPACT 2L2P (ZPUE), 3.2 kg SF_6	0	0	0	0	0	2	2
Circuit breaker 35 kV, THO 36/0.98 kg SF_6	0	2	2	2	2	2	2
Circuit breaker 35 kV, GL-107X (2012)/2.4 kg SF_6	1	1	1	1	1	1	1
Circuit breaker 35 kV, GL-107X (2005) / 2.6 kg SF_6	4	4	4	4	4	4	4
Circuit breaker 35 kV, VOX 36/2.9 kg SF_6	12	16	16	18	18	18	18
Total circuit breakers installed	**122**	**143**	**148**	**188**	**199**	**218**	**221**

Table 4-168: Total high-tension electrical circuit breakers available in bulk at the end of calendar year for the period 2003-2019, units

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Circuit breaker 110 kV, LTB 145D/1B/6 kg SF_6	0	0	0	2	2	2	2	2	4
Circuit breaker 110 kV, GL-311 F1/12 kg SF_6	0	0	0	4	10	18	24	29	33
Circuit breaker 110 kV, PASS MO 145 kV / 15 kg SF_6	0	0	0	0	0	0	0	0	0
Circuit breaker 110 kV, HYpact/45 kg SF_6	0	0	0	0	0	0	0	0	0
Circuit breaker 110 kV, GL-311 F1/12 kg SF_6	1	1	6	21	29	29	29	29	29
Circuit breaker 110 kV, GL-311 F1 P/9.9 kg SF_6	0	0	0	0	0	0	0	3	4
Circuit breaker 110 kV, GL-312F1/4031 P / VR / 7.8 kg SF_6	0	0	0	0	0	0	0	1	1
Circuit breaker 110 kV, 120-SFM-32B / 6.8 kg SF_6	0	0	0	0	0	0	0	0	0
Circuit breaker 330 kV, GL-315 F3 / 26 kg SF_6 and 15 kg CF_4	0	0	0	8	8	10	10	14	14
Circuit breaker 400 kV, LTB 420 E2/ 30 kg SF_6	0	0	0	0	0	0	0	0	0
Total circuit breakers installed	**1**	**1**	**6**	**35**	**49**	**59**	**65**	**78**	**85**
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Circuit breaker 110 kV, LTB 145D / 1B / 6 kg SF_6	6	6	8	8	9	11	11	11	NA
Circuit breaker 110 kV, GL-311 F1 / 12 kg SF_6	35	41	41	41	44	47	48	51	NA
Circuit breaker 110 kV, PASS MO 145 kV / 15 kg SF_6	0	0	0	0	0	0	3	3	NA
Circuit breaker 110 kV, HYpact / 45 kg SF_6	0	5	8	8	8	8	8	8	NA
Circuit breaker 110 kV, GL-311 F1 / 12 kg SF_6	29	29	29	29	29	29	29	29	NA
Circuit breaker 110 kV, GL-311 F1 P / 9.9 kg SF_6	4	4	4	4	4	4	4	4	NA
Circuit breaker 110 kV, GL-312F1/4031 P / VR / 7.8 kg SF_6	1	6	6	6	6	6	6	6	NA
Circuit breaker 110 kV, 120-SFM-32B / 6.8 kg SF_6	0	0	0	0	0	0	45	65	NA
Circuit breaker 330 kV, GL-315 F3 / 26 kg SF_6 and 15 kg CF_4	14	14	14	14	14	14	14	14	NA
Circuit breaker 400 kV, LTB 420 E2/ 30 kg SF_6	2	2	2	2	2	2	2	2	NA
Total circuit breakers installed	**91**	**107**	**112**	**112**	**116**	**121**	**170**	**193**	**NA**

The amount of insulating gas (SF_6) in bulk charged into medium-tension electrical circuit breakers in the Republic of Moldova is shown in Table 4-169.

Table 4-169: Total amount of insulating gas – SF_6 available in bulk, charged into medium-tension electrical circuit breakers for the period 2006-2019, kg

	2006	2007	2008	2009	2010	2011	2012
Circuit breaker 10 kV, PT COMPACT 3L1P, 0.605 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 10 kV, THO 24/SO5/E/THO-T1, 0.98 kg SF_6	0.0	0.0	0.0	0.0	0.0	27.4	51.0
Circuit breaker 10 kV, PT COMPACT 1P, 1.25 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 10 kV, AUGUSTE 2012 / 1.5 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 10 kV, PT COMPACT 1P (ZPUE), 1.6 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 10 kV, GMA-24 / 2.2 kg SF_6	0.0	0.0	52.8	52.8	52.8	52.8	79.2
Circuit breaker 10 kV, PT COMPACT 2L1P (ZPUE), 2.25 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 10 kV, PT COMPACT 2L1P, 2.46 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	7.4
Circuit breaker 10 kV, PT COMPACT 3L1P (ZPUE), 2.9 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 10 kV, PT COMPACT 2L2P (ZPUE), 3.2 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 35 kV, THO 36 / 0.98 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	2006	2007	2008	2009	2010	2011	2012
Circuit breaker 35 kV, GL-107X (2012) / 2.4 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	2.4
Circuit breaker 35 kV, GL-107X (2005) / 2.6 kg SF_6	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Circuit breaker 35 kV, VOX 36 / 2.9 kg SF_6	0.0	0.0	5.8	20.3	20.3	20.3	34.8
Total circuit breakers installed	**13.0**	**13.0**	**71.6**	**86.1**	**86.1**	**113.5**	**187.7**
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Circuit breaker 10 kV, PT COMPACT 3L1P, 0.605 kg SF_6	0.6	1.2	1.2	1.2	1.2	1.2	1.2
Circuit breaker 10 kV, THO 24/SO5/E/THO-T1, 0.98 kg SF_6	51.0	57.8	62.7	63.7	63.7	65.7	65.7
Circuit breaker 10 kV, PT COMPACT 1P, 1.25 kg SF_6	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Circuit breaker 10 kV, AUGUSTE 2012 / 1.5 kg SF_6	0.0	0.0	0.0	43.5	54.0	66.0	67.5
Circuit breaker 10 kV, PT COMPACT 1P (ZPUE), 1.6 kg SF_6	0.0	0.0	0.0	1.6	1.6	4.8	4.8
Circuit breaker 10 kV, GMA-24 / 2.2 kg SF_6	79.2	79.2	79.2	79.2	79.2	79.2	79.2
Circuit breaker 10 kV, PT COMPACT 2L1P (ZPUE), 2.25 kg SF_6	0.0	0.0	0.0	15.8	20.3	31.5	36.0
Circuit breaker 10 kV, PT COMPACT 2L1P, 2.46 kg SF_6	36.9	54.1	54.1	54.1	54.1	54.1	54.1
Circuit breaker 10 kV, PT COMPACT 3L1P (ZPUE), 2.9 kg SF_6	0.0	0.0	0.0	0.0	5.8	5.8	5.8
Circuit breaker 10 kV, PT COMPACT 2L2P (ZPUE), 3.2 kg SF_6	0.0	0.0	0.0	0.0	0.0	6.4	6.4
Circuit breaker 35 kV, THO 36 / 0.98 kg SF_6	0.0	2.0	2.0	2.0	2.0	2.0	2.0
Circuit breaker 35 kV, GL-107X (2012) / 2.4 kg SF_6	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Circuit breaker 35 kV, GL-107X (2005) / 2.6 kg SF_6	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Circuit breaker 35 kV, VOX 36 / 2.9 kg SF_6	34.8	46.4	46.4	52.2	52.2	52.2	52.2
Total circuit breakers installed	**216.5**	**254.8**	**259.7**	**327.3**	**348.1**	**382.9**	**388.9**

The amount of insulating gas (SF_6 and CF_4) in bulk charged into high-tension electrical circuit breakers in the Republic of Moldova is shown in Tables 4-170 and 4-171.

Table 4-170: Total amount of insulating gas – SF_6 available in bulk, charged into high-tension electrical circuit breakers for the period 2003-2019, kg

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Circuit breaker 110 kV, LTB 145D / 1B / 6 kg SF_6	0.0	0.0	0.0	12.0	12.0	12.0	12.0	12.0	24.0
Circuit breaker 110 kV, GL-311 F1 / 12 kg SF_6	0.0	0.0	0.0	48.0	120.0	216.0	288.0	348.0	396.0
Circuit breaker 110 kV, PASS MO 145 kV / 15 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 110 kV, HYpact / 45 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 110 kV, GL-311 F1 / 12 kg SF6	12.0	12.0	72.0	252.0	348.0	348.0	348.0	348.0	348.0
Circuit breaker 110 kV, GL-311 F1 P / 9.9 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.7	39.6
Circuit breaker 110 kV, GL-312F1/4031 P / VR / 7.8 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8
Circuit breaker 110 kV, 120-SFM-32B / 6.8 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circuit breaker 330 kV, GL-315 F3 / 26 kg SF6 and 15 kg CF_4	0.0	0.0	0.0	208.0	208.0	260.0	260.0	364.0	364.0
Circuit breaker 400 kV, LTB 420 E2/ 30 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total circuit breakers installed	**12.0**	**12.0**	**72.0**	**520.0**	**688.0**	**836.0**	**908.0**	**1109.5**	**1179.4**
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Circuit breaker 110 kV, LTB 145D / 1B / 6 kg SF_6	36.0	36.0	48.0	48.0	54.0	66.0	66.0	66.0	NA
Circuit breaker 110 kV, GL-311 F1 / 12 kg SF_6	420.0	492.0	492.0	492.0	528.0	564.0	576.0	612.0	NA
Circuit breaker 110 kV, PASS MO 145 kV / 15 kg SF_6	0.0	0.0	0.0	0.0	0.0	0.0	45.0	45.0	NA
Circuit breaker 110 kV, HYpact / 45 kg SF_6	0.0	225.0	360.0	360.0	360.0	360.0	360.0	360.0	NA
Circuit breaker 110 kV, GL-311 F1 / 12 kg SF_6	348.0	348.0	348.0	348.0	348.0	348.0	348.0	348.0	NA
Circuit breaker 110 kV, GL-311 F1 P / 9.9 kg SF_6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	NA
Circuit breaker 110 kV, GL-312F1/4031 P / VR / 7.8 kg SF_6	7.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	NA
Circuit breaker 110 kV, 120-SFM-32B / 6.8 kg SF6	0.0	0.0	0.0	0.0	0.0	0.0	306.0	442.0	NA
Circuit breaker 330 kV, GL-315 F3 / 26 kg SF_6 si 15 kg CF_4	364.0	364.0	364.0	364.0	364.0	364.0	364.0	364.0	NA
Circuit breaker 400 kV, LTB 420 E2/ 30 kg SF_6	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	NA
Total circuit breakers installed	**1275.4**	**1611.4**	**1758.4**	**1758.4**	**1800.4**	**1848.4**	**2211.4**	**2383.4**	**NA**

Table 4-171: Total amount of insulating gas – CF_4 available in bulk, charged into medium and high-tension electrical circuit breakers for the period 2006-2019, kg

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Circuit breaker 330 kV, GL-315 F3/26 kg SF_6 and 15 kg CF_4	120.0	120.0	150.0	150.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0

2G3 ‘N_2O from Product Uses’

The methodology used to estimate N_2O emissions from source category 2G3 ‘N_2O from Product Uses’ (in anaesthesia) is represented by the following formula:

$$E_{pollutant} = (AR_{product} \bullet_{pollutant\ technology}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from N_2O use in anaesthesia, t/yr;

$AR_{product}$ – activity rate for N_2O consumption in anaesthesia, t/yr;

EF $_{pollutant\ technology}$ – the emission factor for this pollutant technology, t/t (by default, 100 per cent of the whole amount of N_2O used in anaesthesia is deemed to be emitted into the atmosphere).

AD for estimating nitrous oxide emissions from use of N_2O in anaesthesia was based on activity data provided by the former Ministry of Health, as a response to the Official Letters of the former Ministry of Ecology and Natural Resources (Table 4-172). In accordance with the response to the last Letter dated March 1st, 2011, since 2007 in the Republic of Moldova, N_2O has not been used in anaesthesia anymore.

Table 4-172: Amount of nitrous oxide used in anaesthesia for the period 1990-2006, kg

	1990	1991	1992	1993	1994	1995	1996	1997	1998
N_2O consumption in anaesthesia, kg	66	55	50	60	50	1	2	3	5
	1999	2000	2001	2002	2003	2004	2005	2006	2007-2019
N_2O consumption in anaesthesia, kg	43	44	44	44	44	50	61	59	NO

Source: Ministry of Health of the RM, through Letter No. 01-9/2513 dated 9.11.2007, as a response to Official request No. 01-07/1608 dated 15.10.2007 from the Ministry of Ecology and Natural Resources of the RM and through Letter No. 01-9/550 dated 01.03.2011, as a response to Official request No. 03-07/175 dated 02.02.2011 from the Ministry of Environment of the RM.

2G4 'Other'

Tobacco Combustion

The methodology used to estimate NO_x, CO and NMVOC emissions from tobacco combustion (SNAP 060602), available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) is the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant\ technology}) / 10^3$$

Where:

E $_{pollutant}$ – the emission of the specified pollutant from tobacco combustion, t/yr;

AR $_{product}$ – activity rate for burnt tobacco products, t/yr;

EF $_{pollutant\ technology}$ – default emission factor, kg/t.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default emission factors (Table 4-173) for the Tier 2 approach.

Table 4-173: Tier 2 default EF for category 2G4 'Other' (Tobacco Combustion)

Source	GHG	Emission Factor	Unit
2G4 'Other' (Tobacco Combustion)	NO_x CO NMVOC	1.80 55.10 4.84	kg/t of tobacco

Source: EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), Category 2D3i, SNAP 060602, Table 3-15, page 22-23.

Statistical data regarding cigar and cigarette production is available in the Statistical Yearbooks of the RM, the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019', as well as in the statistical database which can be accessed on-line on the NBS website[80]; At the same time, statistical data associated with the import and export of cigars and cigarettes was provided by the Customs Service of the Republic of Moldova, from the Automated System for Customs Data ASYCUDA World, which ensures the management and processing of customs forms and documents used in customs procedures, but offered only for the period 2013-2019; other available sources of information were consulted[81].

Table 4-174: AD on cigar and cigarette consumption for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cigars and Cigarettes Imported, billion units	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cigars and Cigarettes Produced, billion units	9.100	9.200	8.600	8.800	8.000	7.100	9.700	9.500	7.512	8.731
Cigars and Cigarettes Exported, billion units	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cigars and Cigarettes Consumed, billion units	9.100	9.200	8.600	8.800	8.000	7.100	9.700	9.500	7.512	8.731
Amount of Tobacco in Cigars and Cigarettes Consumed, kt	10.920	11.040	10.320	10.560	9.600	8.520	11.640	11.400	9.014	10.477

[80] National Bureau of Statistics of the RM, Statistical database: <http://statbank.statistica.md/pxweb/Dialog/varval.asp?ma=IND0301&ti=Productia+ principalelor+produse+industriale%2C+1997-2009&-path= ../ Database/RO/14%20IND/IND03/&lang=1>.
[81] <https://www.mold-street.com/?go=news&n=6123>, <https://www.mold-street.com/?go=news&n=9744>.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cigars and Cigarettes Imported, billion units	NA	NA	0.600	1.300	1.700	2.500	3.400	4.300	4.200	4.800
Cigars and Cigarettes Produced, billion units	9.262	9.421	6.310	7.126	7.050	6.195	5.031	4.975	3.990	4.878
Cigars and Cigarettes Exported, billion units	NA	NA	0.100	0.040	0.040	0.100	0.100	0.100	0.300	0.200
Cigars and Cigarettes Consumed, billion units	9.262	9.421	6.810	8.386	8.710	8.595	8.331	9.175	7.890	9.478
Amount of Tobacco in Cigars and Cigarettes Consumed, kt	11.114	11.305	8.172	10.063	10.452	10.314	9.997	11.010	9.468	11.373
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cigars and Cigarettes Imported, billion units	4.900	4.800	4.400	3.284	3.567	4.395	4.530	4.999	3.641	3.230
Cigars and Cigarettes Produced, billion units	6.261	6.462	4.656	3.472	2.322	1.776	1.839	1.411	0.660	0.650
Cigars and Cigarettes Exported, billion units	0.200	0.300	1.000	0.624	0.524	0.793	1.544	2.798	4.127	3.409
Cigars and Cigarettes Consumed, billion units	10.961	10.962	8.056	6.132	5.365	5.377	4.825	3.612	0.175	0.471
Amount of Tobacco in Cigars and Cigarettes Consumed, kt	13.153	13.154	9.667	7.359	6.438	6.453	5.790	4.334	0.210	0.565

Source: National Bureau of Statistics of the RM through Statistical Yearbooks for 1994 (page 290), 1999 (page 305), 2003 (page 395), 2006 (page 311), 2007 (page 310), 2008 (page 306), 2009 (page 303), 2010 (page 303), 2011 (page 304), 2012 (page 307), 2013 (page 305), 2014 (page 301); Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; Customs of the Republic of Moldova, through Letter No. 28/07-3025 dated 28.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; <https://www.mold-street.com/?go=news&n=6123>, <https://www.mold-street.com/?go=news&n=9744>.

According to the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), (source category 2D3i 'Other Solvent and Product Use' Snap 060602, page 21), a cigar contains 5 g of tobacco, whereas a cigarette – only 1 g of tobacco. In order to estimate the amount of tobacco burnt (Table 4-174), it was considered that the market share of cigarettes is 95 per cent, whereas cigars – 5 per cent.

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (IPCC 2006 Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in the atmosphere.

In order to estimate indirect CO_2 emissions from use of tobacco, the following equation was used:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from use of tobacco, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr n;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent; 2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17);

44/12 – mass ratio of CO_2/C.

Use of Shoes

The methodology used to estimate NMVOC emissions from use of shoes (SNAP 060603), is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) and uses the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant\ technology}) / 10^3$$

Where:

$E_{pollutant}$ – emission of the specified pollutant from use of shoes, t/yr;

$AR_{product}$ – activity rate for use of shoes, million pairs/yr;

$EF_{pollutant\ technology}$ – default emission factor, kg/t.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default emission factors (Table 4-175) for the Tier 2 approach.

Table 4-175: Tier 2 default EF for 2G4 'Other' (Use of Shoes)

Source	GHG	Emission Factor	Unit
2G4 'Other' (Use of Shoes)	NMVOC	60	g/pairs of shoes

Source: EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), Category 2D3i, SNAP 060603, Tab. 3-16, p. 24.

Statistical data regarding shoe production (Table 4-176) is available in the Statistical Yearbooks of the ATULBD and the RM, as well as in the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; at the same time, statistical data associated with the import and export of shoes was provided by the Customs Service of the Republic of Moldova.

Table 4-176: AD on shoe consumption in the Republic of Moldova for the period 1990-2019, million pairs

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Shoe Production, million pairs	23.200	20.800	16.268	13.197	9.467	7.606	6.929	6.193	4.591	3.747
Shoe Export, million pairs	13.041	11.692	9.144	7.418	5.321	4.275	3.895	3.481	2.581	2.106
Shoe Import, million pairs	14.725	13.202	10.325	8.376	6.009	4.828	4.398	3.931	2.914	2.378
Shoe Consumption, million pairs	24.884	22.310	17.449	14.155	10.154	8.158	7.432	6.643	4.924	4.019
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Shoe Production, million pairs	5.912	4.944	4.925	6.038	6.633	7.450	6.774	6.696	7.083	4.829
Shoe Export, million pairs	3.323	2.779	2.768	3.394	3.728	4.188	3.808	3.764	3.981	2.715
Shoe Import, million pairs	3.752	3.138	3.126	3.832	4.210	4.729	4.299	4.250	4.495	3.065
Shoe Consumption, million pairs	6.341	5.303	5.283	6.476	7.114	7.991	7.266	7.182	7.597	5.180
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Shoe Production, million pairs	6.247	7.692	7.448	8.329	7.607	5.547	5.156	4.647	4.352	3.910
Shoe Export, million pairs	3.511	4.324	4.187	3.435	5.158	3.226	2.871	2.603	2.514	2.559
Shoe Import, million pairs	3.965	4.882	4.728	2.819	6.169	4.278	5.316	6.513	5.807	6.991
Shoe Consumption, million pairs	6.701	8.250	7.989	7.713	8.618	6.599	7.601	8.557	7.645	8.342

Source: Statistical Yearbooks of the ATULBD for 1998-2020; Statistical Yearbooks of the RM for 1991-2020; Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020; Letter No. 28/07-612 dated 12.01.2018, as a response to the request from the Climate Change Office of the MARDE No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-8785 dated 26.05.2016, as a response to the request from the Climate Change Office of the Ministry of Environment No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-2231 dated 26.02.2015, as a response to the request from the Climate Change Office of the Ministry of Environment No. 407/2015-01-09 dated 29.01.2015; Letter No. 15-03-05 dated 24.01.2014, as a response to the request from the Climate Change Office of the Ministry of Environment No. 320/2014-01-01 dated 03.01.2014; Letter No. 28/07-1893 dated 23.02.2011, as a response to the request from the Ministry of Environment No. 03-07/175 dated 02.02.2011.

Indirect CO_2 emissions were estimated taking into consideration the carbon content in NMVOC emissions. The default value used is 60 per cent (2006 IPCC Guidelines, Volume 3, Chapter 5.5, page 5.17). By oxidation, this carbon is converted into CO_2 in the atmosphere.

In order to estimate indirect CO_2 emissions from use of shoes, the following equation was used:

$$CO_2\ Emission = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 Emissions – CO_2 emissions from use of shoes, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC, fraction (the default value used represents 60 per cent, with a margin of 50-70 per cent;

44/12 – mass ratio of CO_2/C.

Use of Fireworks

The methodology used to estimate NMVOC emissions from use of fireworks (SNAP 060601), is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) and uses the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant\ technology}) / 10^3$$

Where:

$E_{pollutant}$ – emission of the specified pollutant from use of fireworks, t/yr;

$AR_{product}$ – activity rate for use of fireworks, t/yr;

$EF_{pollutant\ technology}$ – default emission factor, kg/t.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) provides default emission factors (Table 4-177) for the Tier 2 approach.

Table 4-177: Tier 2 default EF for 2G4 'Other' (Use of Fireworks)

Source	GHGs	Emission Factor	Unit
2G4 'Other' (Use of Fireworks)	NO_x CO SO_2	0.260 7.150 3.020	kg/t of product

Source: EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), Category 2D3i, SNAP 060601, Tab. 3-14, p. 22.

Statistical data associated with the import and export of fireworks (code: 3604 10 000 – signalling flares, rain rockets, and other pyrotechnic articles, as well as 3604 90 000 – other fireworks) was provided by the Customs Service, from the Automated System for Customs Data ASYCUDA World, which ensures the management and processing of customs forms and documents used in customs procedures, but offered only for the period 2013-2019 (Table 4-178).

Table 4-178: AD on import of fireworks for the period 1990-2019

	2013	2014	2015	2016	2017	2018	2019
Fireworks, t	107.519	214.500	72.316	98.578	80.781	195.019	234.751
Signalling flares, rain rockets, t	2.848	29.042	11.193	15.080	31.833	30.005	43.502
Total fireworks and pyrotechnic articles, t	**110.367**	**243.542**	**83.509**	**113.658**	**112.613**	**225.024**	**278.253**

Source: Customs Service of the RM, through Letter No. 28/07-3025 dated 28.02.2020, as a response to the request from the Environment Agency No. 08-310/1 dated 11.02.2020.

4.7.3. Uncertainties Assessment and Time-Series Consistency

2G1 'Electrical Equipment'

Uncertainties associated with emission factors used to estimate SF_6 and PFC emissions from source category 2G1 'Electrical Equipment' reach up to circa 20 per cent (2006 IPCC Guidelines). Uncertainties associated with activity data on the use of SF_6 and PFC are considered low (circa 5 per cent). Thus, combined uncertainties for this source category represent circa 20.62 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in accordance with the recommendations included in the 2006 IPCC Guidelines.

2G3 'N_2O from Product Uses'

Uncertainties associated with emission factors used to estimate N_2O emissions from source category 2G3 'N_2O from Product Uses' represent circa 3 per cent. Uncertainties associated with activity data on the use of N_2O in medical applications in the RM are considered low (circa 5 per cent). Thus, combined uncertainties for this source category represent circa 5.83 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in accordance with the recommendations included in the 2006 IPCC Guidelines.

2G4 'Other'

Uncertainties associated with emission factors used to estimate GHG emissions from source category 2G4 'Other' (Tobacco Combustion and Use of Shoes) reach to circa 50 per cent. Uncertainties associated with activity data on use of tobacco and use of shoes in the RM are considered moderate (circa 15 per cent). Thus, combined uncertainties for this source category represent circa 52.20 per cent (Annex 5-3.2). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in accordance with the recommendations included in the 2006 IPCC Guidelines.

4.7.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category following a Tier 1 approach. Verification was focused on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines; on correct use of AD obtained from different reference sources, including official sources (i.e., National Bureau of Statistics, Ministry of Health, Labour and Social Protection, 'Moldelectrica' SOE, Premier Energy Ltd.). It should be noted that the AD and methods used for estimating GHG emissions from category 2G 'Other Product Manufacture and Use' were documented and archived both in hard copies and electronically.

4.7.5. Recalculations

2G1 'Electrical Equipment'

For the period 2005-2016, recalculations were made for SF_6 and CF_4 emissions under the category 2G1 'Electrical Equipment' due to updating the total number of medium-tension electrical circuit breakers. In comparison with the results obtained in the BUR2 of the RM to the UNFCCC (2019), the recalculations resulted in downward trend in GHG emissions from category 2G1 'Electrical Equipment', varying from a minimum of 1.1 per cent in 2014, to a maximum of 25.4 per cent in 2005 (Table 4-179). For the years 2017-2019, GHG emissions from the respective category were estimated for the first time. The obtained results show that between 2003 and 2019, SF_6 and CF_4 emissions had increased by circa 192 times.

Table 4-179: Comparative results of SF_6 and CF_4 emissions from source category 2G1 'Electrical Equipment' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2	0.0071	0.0071	0.0572	0.3538	0.4536	0.5474	0.5904	0.7222	0.7578
BUR3	0.0071	0.0071	0.0427	0.3319	0.4315	0.5277	0.5710	0.7020	0.7447
Difference, %	0.0	0.0	-25.4	-6.2	-4.9	-3.6	-3.3	-2.8	-1.7
	2012	2013	2014	2015	2016	2017	2018	2019	%
BUR2	0.8161	1.0173	1.1070	1.1598	1.1655				
BUR3	0.8050	1.0055	1.0943	1.0946	1.1226	1.1520	1.3687	1.4710	19,141.0
Difference, %	-1.4	-1.2	-1.1	-5.6	-3.7				

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

The table below shows SF_6 and CF_4 emissions by substances in metric tonnes and expressed in CO_2 equivalent (Table 4-180).

Table 4-180: SF_6 and CF_4 emissions from source category 2G1 'Electrical Equipment' for the period 2003-2019

	2003	2004	2005	2006	2007	2008	2009	2010	2011
	2G1 'Electrical Equipment'								
SF_6, t	0.0003	0.0003	0.0019	0.0135	0.0179	0.0219	0.0238	0.0290	0.0309
SF_6, kt CO_2 eq.	**0.0071**	**0.0071**	**0.0427**	**0.3088**	**0.4084**	**0.4988**	**0.5422**	**0.6616**	**0.7043**
CF_4, t	NO	NO	NO	0.0031	0.0031	0.0039	0.0039	0.0055	0.0055
CF_4, kt CO_2 eq.	NO	NO	NO	**0.0231**	**0.0231**	**0.0288**	**0.0288**	**0.0403**	**0.0403**
	2012	2013	2014	2015	2016	2017	2018	2019	%
	2G1 ,Electrical Equipment'								
SF_6, t	0.0335	0.0423	0.0462	0.0462	0.0475	0.0488	0.0583	0.0627	18,573.8
SF_6, kt CO_2 eq.	**0.7646**	**0.9651**	**1.0540**	**1.0542**	**1.0822**	**1.1116**	**1.3284**	**1.4306**	**18,573.8**
CF_4, t	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	75.0
CF_4, kt CO_2 eq.	**0.0403**	**0.0403**	**0.0403**	**0.0403**	**0.0403**	**0.0403**	**0.0403**	**0.0403**	**75.0**

2G3 'N_2O from Product Uses'

No recalculations were made for N_2O emissions from source category 2G3 'N_2O from Product Uses' recorded between 1990 and 2006 (Table 4-181). From 2007 through 2015, there were no records of N_2O emissions from the respective category.

Table 4-181: N_2O emissions from source category 2G3 'N_2O from Product Uses' for the period 1990-2006

	1990	1991	1992	1993	1994	1995	1996	1997	1998
N_2O Emissions, t	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
N_2O Emissions, kt CO_2 equivalent	0.0197	0.0164	0.0149	0.0179	0.0149	0.0003	0.0006	0.0009	0.0015
	1999	2000	2001	2002	2003	2004	2005	2006	%
N_2O Emissions, t	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	-10.6
N_2O Emissions, kt CO_2 equivalent	0.0128	0.0131	0.0131	0.0131	0.0131	0.0149	0.0182	0.0176	-10.6

2G4 'Other'

Indirect CO_2 emissions from category 2G4 'Other' were recalculated for the period 1990-2016 due to updating AD regarding the use of cigars and cigarettes, and shoes in the Republic of Moldova, available in the official sources of references (Statistical Yearbooks of the RM and the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type', Statistical Yearbooks of the ATULBD), and the Automated System for Customs Data ASYCUDA World, which ensures the management and processing of customs forms and documents used in customs procedures. In comparison with the results obtained in the BUR2 of the RM to the UNFCCC (2018), the recalculations resulted in an increase trend in indirect CO_2 emissions from source category 2G4 'Other' in the years 1990-2012 and 2014-2016 (Table 4-182). For the period 2017-2019, indirect CO_2 emissions from the respective category were estimated for the first time. The obtained results show that between 1990 and 2019, the respective emissions decreased in the country by circa 67.4 per cent.

Table 4-182: Comparative results of indirect CO_2 emissions from source category 2G4 'Other' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	3.1787	2.8632	2.2573	1.8544	1.3519	1.0947	1.0386	0.9389	0.7020	0.6062
BUR3	3.4010	3.0625	2.4132	1.9809	1.4426	1.1676	1.1050	0.9982	0.7460	0.6421
Difference, %	7.0	7.0	6.9	6.8	6.7	6.7	6.4	6.3	6.3	5.9
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.8987	0.7730	0.7307	0.8881	0.9656	1.0626	0.9584	0.9474	0.9859	0.6998
BUR3	0.9554	0.8204	0.7843	0.9620	1.0504	1.1646	1.0655	1.0652	1.1036	0.8048
Difference, %	6.3	6.1	7.3	8.3	8.8	9.6	11.2	12.4	11.9	15.0

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.9046	1.0979	1.0427	1.1438	1.0338	0.7549	0.7041			
BUR3	1.0245	1.2291	1.1575	1.0965	1.2062	0.9397	1.0649	1.1757	1.0114	1.1072
Difference, %	13.3	12.0	11.0	-4.1	16.7	24.5	51.3			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

The table below shows non-CO_2 emissions from source category 2G4 'Other' for the period 1990-2019 (Table 4-183). During the period under review, the respective emissions recorded similar trends as for indirect CO_2 emissions.

Table 4-183: Non-CO_2 emissions from source category 2G4 'Other' for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	0.0197	0.0199	0.0186	0.0190	0.0173	0.0153	0.0210	0.0205	0.0162	0.0189
CO	0.6017	0.6083	0.5686	0.5819	0.5290	0.4695	0.6414	0.6281	0.4967	0.5773
NMVOC	1.5459	1.3920	1.0969	0.9004	0.6557	0.5307	0.5023	0.4537	0.3391	0.2919
SO_2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NO_x	0.0200	0.0203	0.0147	0.0181	0.0188	0.0186	0.0180	0.0198	0.0170	0.0205
CO	0.6124	0.6229	0.4503	0.5545	0.5759	0.5683	0.5508	0.6066	0.5217	0.6267
NMVOC	0.4343	0.3729	0.3565	0.4373	0.4774	0.5294	0.4843	0.4842	0.5016	0.3658
SO_2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	0.0237	0.0237	0.0174	0.0133	0.0117	0.0116	0.0105	0.0078	0.0004	0.0011
CO	0.7247	0.7248	0.5326	0.4062	0.3565	0.3561	0.3198	0.2396	0.0132	0.0331
NMVOC	0.4657	0.5587	0.5261	0.4984	0.5483	0.4271	0.4841	0.5344	0.4597	0.5033
SO_2	NE	NE	NE	0.0003	0.0007	0.0003	0.0003	0.0003	0.0007	0.0008

4.7.6. Planned Improvements

Potential improvements under category 2G 'Other Product Manufacture and Use' could include updating the activity data used to estimate GHG emissions from this category for the period 1990-2019. Also, in respect of collecting AD on the use of fireworks (code 3604 10 000 – signalling flares, rain rockets, and other pyrotechnic articles, as well as other fireworks – code 3604 90 000), and for the period 1990-2012 (in the current inventory cycle, it was possible to collect data only for the period 2013-2019), in order to estimate indirect GHG emissions from the respective source (SNAP 060601) within category 2G 'Other Product Manufacture and Use'.

4.8. Other (Category 2H)

4.8.1. Source Category Description

Category 2H 'Other', covers GHG emissions generated from the following emission sources: 2H1 'Pulp and Paper Industry' and 2H2 'Food and Beverages Industry'. In the Republic of Moldova, no pulp and paper is produced, and there are no recorded emissions from 2H1 category, respectively; and these are reported as Not Occurring (NO).

NMVOC emissions have been reported from source category 2H2 „Food and Beverages Industry'. Between 1990 and 2019, the respective emissions had decreased by circa 60.4 per cent, from circa 12.08 kt in 1990 to 4.78 kt in 2019 (Table 4-184).

Table 4-184: NMVOC emissions from source category 2H2 'Food and Beverages Industry' for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2H2a 'Bread Making and Other Food'	11.0434	9.0948	7.2053	7.8286	5.0893	5.8083	5.7982	5.5868	4.7372	3.0748
2H2b 'Alcoholic Beverages'	1.0326	1.0178	0.8417	1.3868	2.3330	3.5273	2.7783	2.1109	1.5650	0.8733
2H2 'Food and Beverages Industry'	12.0760	10.1126	8.0471	9.2154	7.4223	9.3357	8.5764	7.6977	6.3022	3.9481
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2H2a 'Bread Making and Other Food'	2.9202	3.1034	3.4932	2.6133	2.9743	3.1437	3.1424	1.9021	3.4029	2.0758
2H2b 'Alcoholic Beverages'	0.6928	0.8859	1.0539	1.6616	2.3217	2.6349	1.8890	1.6852	1.4513	1.1784
2H2 'Food and Beverages Industry'	3.6129	3.9893	4.5471	4.2749	5.2960	5.7786	5.0313	3.5873	4.8542	3.2541
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2H2a 'Bread Making and Other Food'	2.8726	2.7945	2.2399	3.4545	3.8966	2.6528	3.1529	3.6075	3.1113	3.2495
2H2b 'Alcoholic Beverages'	1.3261	1.4815	1.7515	2.0150	1.8188	1.5802	1.5099	1.6013	1.5791	1.5315
2H2 'Food and Beverages Industry'	4.1987	4.2760	3.9915	5.4694	5.7153	4.2329	4.6628	5.2088	4.6903	4.7810

It should be noted that in the reference year (1990), circa 91.4 per cent of the total NMVOC emissions were generated from source category 2H2a 'Bread Making and Other Food'. By 2019, the share of this category in the total NMVOC emissions had decreased to circa 68.0 per cent (Figure 4-4).

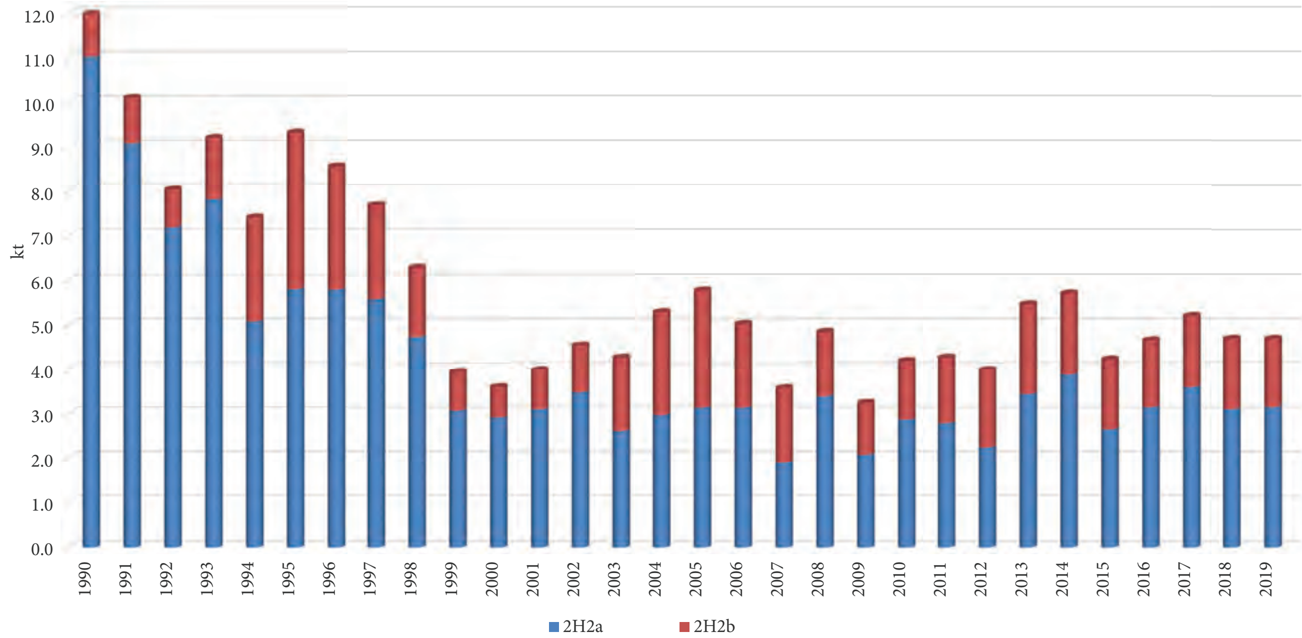

Figure 4-4: NMVOC emissions from 2H2 'Food and Beverages Industry' for the period 1990-2019.

4.8.2. Methodological Issues, Emission Factors and Data Sources

a) Bread Making and Other Food

Methodological issues pertaining to the calculation of the NMVOC emissions from bread making and other food are addressed in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019). The estimation method used implies multiplication of default EF values (Table 4-185) by activity data on bread making and other food available in the national statistics of the RM and of the ATULBD (Table 4-186).

Table 4-185: Default EFs used to estimate NMVOC emissions from Bread Making and Other Food

Source	Bread Making and Other Food	NMVOC, kg/t
Bread Making and Other Food	Meat processing	0.33
	Fish processing	1.0
	Grain drying in elevators	1.3
	Sugar; Margarine and solid cooking fats	10
	Cakes, biscuits and breakfast cereals; Animal Feed	1
	Bread	4.5

Source: EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), 2H2 Food and Beverages Industry, SNAP 040605 – Bread Making and Other Food, Tables 3-2, 3-3, 3-4, 3-11, 3-18, 3-19, 3-20, 3-21, 3-22. Pages 10-20

Table 4-186: AD on Bread Making and Other Food for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Meat	257.900	218.500	136.000	114.200	85.900	58.400	52.600	50.800	27.300	25.717
Fish	9.500	5.200	6.500	9.500	2.100	0.000	0.000	0.900	0.800	1.000
Dried grains in elevators	2169.760	2539.600	1725.894	2374.223	1241.296	1581.116	1264.628	1692.411	1339.292	985.796
Sugar	435.800	236.900	192.200	230.200	166.700	218.700	264.500	213.300	194.500	100.500
Confectionery Products	24.300	23.500	12.100	10.080	5.000	5.170	5.150	5.550	9.200	8.423
Bread	601.900	528.300	468.600	431.700	325.200	268.400	252.500	221.900	180.200	147.045
Animal Feed	1037.292	946.192	867.504	440.210	309.794	333.628	350.394	231.890	221.176	108.604
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Meat	13.351	7.301	11.262	14.855	10.180	6.651	10.228	16.122	12.809	16.260
Fish	1.900	2.300	2.700	2.700	2.700	3.000	2.500	2.300	4.600	3.700
Dried grains in elevators	899.624	860.243	876.056	618.920	849.187	814.747	678.433	282.590	920.742	658.146
Sugar	105.400	132.600	167.600	107.100	110.900	133.472	149.046	73.964	133.966	38.373
Margarine	0.024	1.034	2.616	3.301	3.515	3.390	2.624	2.225	1.940	1.657
Confectionery Products	8.745	12.834	15.852	18.036	17.876	20.726	21.692	22.284	22.910	23.629
Bread	138.126	133.280	130.779	144.650	145.830	142.026	144.848	154.774	169.806	161.564
Animal Feed	59.791	31.441	41.381	28.095	46.062	50.840	64.340	46.422	51.043	60.143

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meat	24.699	28.509	31.597	35.495	44.072	45.958	45.941	55.931	62.233	62.645
Fish	1.300	7.578	7.732	8.490	8.774	9.966	8.086	7.788	10.739	10.113
Dried grains in elevators	764.898	803.125	405.366	882.522	955.221	724.699	987.553	1115.457	1161.476	1171.525
Sugar	103.209	88.436	83.440	140.297	177.695	84.519	99.999	128.980	73.906	86.925
Margarine	1.274	1.119	0.484	0.706	C	C	C	C	C	C
Confectionery Products	27.718	29.383	31.332	34.633	34.875	34.255	35.143	36.485	37.880	40.232
Bread	160.406	162.916	161.765	165.450	160.259	161.328	157.550	157.973	156.327	158.113
Animal Feed	74.405	75.405	96.284	97.787	98.472	80.118	101.729	94.033	89.650	74.789

Source: Statistical Yearbooks of the RM for 1994 (page 289-290), 1999 (page 304-305), 2003 (page 393-394), 2006 (page 309-310), 2010 (page 301-303), 2014 (page 299-301); Statistical Reports PROD-MOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; Statistical Yearbooks of the ATULBD for 1998 (page 177), 2000 (page 100), 2002 (page 104), 2005 (page 94), 2007 (page 93), 2009 (page 93), 2011 (page 95), 2014 (page 89), 2017 (page 102), 2020 (page 103).

AD on the amount of dried grains in elevators was deduced from the information available in the national statistics of the RM and ATULBD (Table 4-187).

Table 4-187: Selective AD on agricultural crops for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Wheat, kt	1129.0	1056.5	925.8	1392.6	658.8	1154.3	673.7	1152.6	951.9	797.8
Barley, kt	417.9	427.0	405.0	481.0	324.9	311.2	136.7	256.9	242.2	203.1
Oat, kt	3.8	5.0	6.8	10.7	7.1	9.8	4.2	10.3	9.5	5.9
Grain maize, kt	885.5	1501.2	635.6	1324.5	629.3	948.6	1006.6	1788.0	1272.7	1151.3
Sunflower, kt	252.2	151.4	176.2	173.7	149.2	208.1	284.0	174.3	196.4	291.6
Soy, kt	23.8	33.4	7.9	9.3	4.0	3.3	2.5	2.7	6.0	13.7
Oilseed rape, kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.2
Total cereals, kt	2712.2	3174.5	2157.4	3391.7	1773.3	2635.2	2107.7	3384.8	2678.6	2464.5
Share of cereals dried in elevators, % of total	80	80	80	70	70	60	60	50	50	40
Cereals dried in elevators, kt	2169.8	2539.6	1725.9	2374.2	1241.3	1581.1	1264.6	1692.4	1339.3	985.8
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Wheat, kt	725.0	1180.8	1113.1	102.4	861.2	1048.6	682.3	406.5	1286.5	738.9
Barley, kt	152.3	248.4	241.7	74.4	284.1	240.9	214.6	125.7	362.3	290.5
Oat, kt	3.5	6.4	4.7	4.0	10.3	7.6	6.1	1.4	3.9	1.6
Grain maize, kt	1050.4	1141.9	1206.3	1440.2	1845.1	1523.4	1327.6	363.2	1484.1	1159.6
Sunflower, kt	305.1	278.3	340.9	421.4	354.8	368.7	396.1	158.7	387.2	310.2
Soy, kt	11.6	10.5	12.6	19.4	40.2	66.4	80.2	40.0	58.8	50.1
Oilseed rape, kt	1.1	1.0	1.0	1.2	1.1	3.4	6.9	34.9	100.1	81.6
Total cereals, kt	2249.1	2867.5	2920.2	2063.1	3396.7	3259.0	2713.7	1130.4	3683.0	2632.6
Share of cereals dried in elevators, % of total	40	30	30	30	25	25	25	25	25	25
Cereals dried in elevators, kt	899.6	860.2	876.1	618.9	849.2	814.7	678.4	282.6	920.7	658.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Wheat, kt	749.5	797.1	496.9	1009.6	1102.6	927.4	1302.4	1258.6	1169.1	1152.3
Barley, kt	240.7	218.9	139.3	241.6	244.7	199.1	273.9	265.0	188.2	178.2
Oat, kt	3.1	3.6	2.0	3.8	2.9	1.6	2.8	3.6	1.5	1.6
Grain maize, kt	1462.1	1547.2	587.2	1546.5	1642.1	1133.6	1485.5	1871.0	2208.0	2263.7
Sunflower, kt	440.2	497.4	339.1	602.2	627.1	562.3	789.4	925.1	898.7	915.3
Soy, kt	113.0	80.6	48.9	67.6	111.4	49.2	43.8	48.5	59.7	64.8
Oilseed rape, kt	51.0	67.7	8.1	58.8	90.2	25.6	52.4	89.9	120.8	110.2
Total cereals, kt	3059.6	3212.5	1621.5	3530.1	3820.9	2898.8	3950.2	4461.8	4645.9	4686.1
Share of cereals dried in elevators, % of total	25	25	25	25	25	25	25	25	25	25
Cereals dried in elevators, kt	764.9	803.1	405.4	882.5	955.2	724.7	987.6	1115.5	1161.5	1171.5

Source: National Bureau of Statistics, Statistical database, 'Sown area, average yield on agricultural crops': <http://statbank.statistica.md/pxweb/pxweb/ro/40%20Statistica%20economica/40% 20Statistica%20economica__16%20AGR__AGR020/AGR020100.px/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774>; Statistical Yearbooks of the ATULBD for 1998 (page 218), 2002 (page 113), 2005 (page 101), 2009 (page 98), 2014 (page 95), 2017 (page 112), 2020 (page 113).

Only agricultural crops the production of which is dried in elevators were considered. The share of cereal production dried in elevators was determined by opinion of experts, based on national practices during the period under review.

b) Alcoholic Beverages

Methodological issues related to calculation of NMVOC emissions from the production of alcoholic beverages are addressed in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019).

The estimation method is based on multiplying default values of emission factors (Table 4-188) by activity data on production of alcoholic beverages available in national statistics of the RM and of the ATULBD (Table 4-189).

Table 4-188: Default EFs used to calculate NMVOC emissions from alcoholic beverages

Source	Alcoholic Beverages	NMVOC, kg / hl
Alcoholic Beverages	Red Wine	0.080
	White Wine, Beer	0.035
	Spirits (unspecified)	15.0
	Whisky / Grain Whisky / Vodka	7.5
	Divin (Cognac) / Brandy	3.5

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook, (2019), 2H2 Food and Beverages Industry SNAP 040606 – Alcoholic Beverages, Tables 3-24, 3-25, 3-26, 3-27, 3-28, 3-30, 3-31. pages 21-24.

Table 4-189: AD on the production of alcoholic beverages for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Wine, thousand hl	1630.0	1430.0	920.0	1130.0	977.8	996.9	1458.0	1941.5	1239.6	690.1
White wine, thousand hl	764.5	670.7	431.5	530.0	458.6	467.5	683.8	910.6	581.4	323.7
Red wine, thousand hl	865.5	759.3	488.5	600.0	519.2	529.4	774.2	1030.9	658.2	366.4
Wines of Porto, Madeira, Sherry, Tokay and other, thousand hl	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.3	0.2	0.1
Sparkling wine, thousand hl	80.4	78.3	85.4	88.8	74.2	94.8	141.9	134.5	51.9	67.5
Brandy, thousand hl	139.4	140.2	75.0	74.0	79.3	102.7	45.7	58.6	49.7	48.6
Grain Whisky and Liqueurs, thousand hl	55.9	55.6	67.6	139.4	264.7	412.7	335.8	237.0	174.1	87.0
Beer, thousand hl	760.0	660.0	430.0	360.0	285.0	302.9	256.0	262.7	300.1	220.9
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Wine, thousand hl	1092.2	1564.2	1494.0	1921.8	3351.4	3643.5	1886.8	1258.1	1553.0	1263.1
White wine, thousand hl	512.3	733.6	700.7	901.3	1571.8	1710.2	983.0	717.9	814.4	600.4
Red wine, thousand hl	580.0	830.6	793.3	1020.5	1779.6	1933.3	903.8	540.2	738.6	662.7
Wines of Porto, Madeira, Sherry, Tokay and other, thousand hl	0.2	0.2	0.2	0.3	0.3	0.3	0.1	0.1	0.1	0.1
Sparkling wine, thousand hl	41.6	58.4	61.3	73.9	93.8	105.1	40.2	54.1	57.3	50.0
Brandy, thousand hl	71.8	95.6	103.8	136.1	142.8	171.1	79.1	82.4	103.7	69.8
Grain Whisky and Liqueurs, thousand hl	48.9	59.4	77.9	139.8	212.9	238.8	196.3	172.2	129.1	110.8
Beer, thousand hl	257.9	336.2	462.4	599.1	695.7	777.8	913.3	1014.6	866.6	781.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Wine, thousand hl	1285.5	1260.6	1422.0	1551.7	1409.5	1356.5	1345.8	1652.3	1717.3	1787.2
White wine, thousand hl	591.7	664.3	679.2	694.3	765.1	622.5	576.2	775.7	774.9	781.5
Red wine, thousand hl	693.8	596.3	742.8	857.4	644.3	734.0	768.4	880.8	932.5	979.2
Wines of Porto, Madeira, Sherry, Tokay and other, thousand hl	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Sparkling wine, thousand hl	55.6	68.6	65.4	60.0	52.2	50.2	63.3	65.2	67.4	67.9
Brandy, thousand hl	74.6	91.2	109.4	118.0	93.9	70.2	50.1	84.0	87.7	91.9
Grain Whisky and Liqueurs, thousand hl	127.1	140.2	165.9	196.1	183.4	162.3	162.8	156.9	151.9	143.0
Beer, thousand hl	952.6	1068.1	1118.4	1029.3	984.8	994.5	847.8	866.5	819.5	839.3

Source: Statistical Yearbooks of the RM for 1994 (pages 289-290), 1999 (pages 304-305), 2003 (pages 393-394), 2006 (pages 309-310), 2010 (pages 301-303), 2014 (pages 299-301);); Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2019'; Statistical Yearbooks of the ATULBD for 1998 (page 177), 2000 (page 100), 2002 (page 104), 2005 (page 94), 2007 (page 93), 2009 (page 93), 2011 (page 95), 2014 (page 89), 2017 (page 102), 2020 (page 103).

4.8.3. Uncertainty Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, EFs used to estimate GHG emissions covered by source category 2H2 'Food and Beverages Industry', and the quality of activity data available. Uncertainties related to the default EFs used to estimate the NMVOC emissions may be a factor of 2. Uncertainties related to activity data on bread making and other food and alcoholic beverage production in the Republic of Moldova are low, estimated to be circa 5 per cent. In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

4.8.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category, following a Tier 1 approach. Verification was focused on comparing and correct use of emission factors including the default EFs used as reference source according to the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019); correct use of AD obtained from different reference sources, including official sources (Statistical Yearbooks of the Republic of Moldova and the ATULBD), etc. It should be noted that the AD and methods used to estimate GHG emissions from source category 2H2 'Food and Beverages Industry' were documented and archived both in hard copies and electronically.

4.8.5. Recalculations

NMVOC emissions from source category 2H2 'Food and Beverages Industry' were recalculated for the period 1990-2016, due to updated AD. In comparison with the results obtained in the BUR2 of the

RM to the UNFCCC (2019), the recalculations in the current inventory cycle resulted in a decrease in NMVOC emissions from source category 2H2 'Food and Beverages Industry', varying from a minimum of 1.5 per cent in 1990 to a maximum of 14.1 per cent in 2005. Between 2017 and 2019, NMVOC emissions from source category 2H2 'Food and Beverages Industry' were estimated for the first time. The obtained results show that the respective emissions had decreased by 61.2 per cent over the period 1990-2019 (Table 4-190).

Table 4-190: Comparative results of NMVOC emissions from source category 2H2 'Food and Beverages Industry' source category included in the BUR2 and BUR3 of the RM to the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	12.2544	10.2883	8.2577	9.6360	8.1775	10.4463	9.3728	8.3398	6.8761	4.2144
BUR3	12.0760	10.1126	8.0471	9.2154	7.4223	9.3357	8.5764	7.6977	6.3022	3.9481
Difference, %	-1.5	-1.7	-2.6	-4.4	-9.2	-10.6	-8.5	-7.7	-8.3	-6.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	3.7608	4.1911	4.8266	4.8202	6.1437	6.7243	5.5342	3.9720	5.1274	3.4583
BUR3	3.6129	3.9893	4.5471	4.2749	5.2960	5.7786	5.0313	3.5873	4.8542	3.2541
Difference, %	-3.9	-4.8	-5.8	-11.3	-13.8	-14.1	-9.1	-9.7	-5.3	-5.9
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	4.4489	4.6537	4.4834	6.1085	6.3301	4.7483	5.1565			
BUR3	4.1987	4.2760	3.9915	5.4694	5.7153	4.2329	4.6628	5.2088	4.6903	4.6880
Difference, %	-5.6	-8.1	-11.0	-10.5	-9.7	-10.9	-9.6			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

a) *Bread Making and Other Food*

NMVOC emissions from source category 2H2a 'Bread Making and Other Food' were recalculated for the years 2015-2016 as a result of updated AD regarding the amount of dried grains in elevators in the respective years. In comparison with the results obtained in the BUR2 of the RM to the UNFCCC (2019), the recalculations in the current inventory cycle resulted in an insignificant increase in NMVOC emissions from source category 2H2a 'Bread Making and Other Food' in 2015-2016. For the years 2017-2019, NMVOC emissions from the respective category in the RM were estimated for the first time. The obtained results show that the respective emissions had decreased by 71.4 per cent over the period 1990-2019 (Table 4-191).

Table 4-191: Comparative results of NMVOC emissions from source category 2H2a 'Bread Making and Other Food' included in the BUR2 and BUR3 of the RM to the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	11.0434	9.0948	7.2053	7.8286	5.0893	5.8083	5.7982	5.5868	4.7372	3.0748
BUR3	11.0434	9.0948	7.2053	7.8286	5.0893	5.8083	5.7982	5.5868	4.7372	3.0748
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	2.9202	3.1034	3.4932	2.6133	2.9743	3.1437	3.1424	1.9021	3.4029	2.0758
BUR3	2.9202	3.1034	3.4932	2.6133	2.9743	3.1437	3.1424	1.9021	3.4029	2.0758
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	2.8726	2.7945	2.2399	3.4545	3.8966	2.6521	3.1494			
BUR3	2.8726	2.7945	2.2399	3.4545	3.8966	2.6528	3.1529	3.6075	3.1113	3.1565
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.1			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

b) *Alcoholic Beverages*

NMVOC emissions from source category 2H2b 'Alcoholic Beverages' were recalculated for the period 1990-2016 as a result of excluding the quantity of grain whisky produced during that period from the calculations in order to avoid double counting (in the previous inventory cycle, quantities of grain whisky produced were accounted for under a separate production category, whereas these quantities are under category 'Grain Whisky and Liqueurs'). In comparison with the results obtained in the BUR2 of the RM to the UNFCCC (2019), the recalculations in the current inventory cycle resulted in downward trend in NMVOC emissions from source category 2H2b 'Alcoholic Beverages' over the period 1990-2016, varying from a minimum decrease of 14.7 per cent in the years 1990-1991, to a maximum increase of 26.8 per cent in 1998. For the period 2017-2019, NMVOC emissions resulting from alcoholic beverage production were estimated for the first time. The obtained show that the respective emissions increased by 48.3 per cent over the period 1990-2019 (Table 4-192).

Table 4-192: Comparative results of NMVOC emissions from source category 2H2b 'Alcoholic Beverages' included in the BUR2 and BUR3 of the RM to the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1.2109	1.1934	1.0524	1.8074	3.0881	4.6380	3.5746	2.7530	2.1389	1.1396
BUR3	1.0326	1.0178	0.8417	1.3868	2.3330	3.5273	2.7783	2.1109	1.5650	0.8733
Difference, %	-14.7	-14.7	-20.0	-23.3	-24.5	-23.9	-22.3	-23.3	-26.8	-23.4
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
BUR2	0.8406	1.0877	1.3334	2.2069	3.1694	3.5807	2.3918	2.0699	1.7245	1.3825
BUR3	0.6928	0.8859	1.0539	1.6616	2.3217	2.6349	1.8890	1.6852	1.4513	1.1784
Difference, %	-17.6	-18.6	-21.0	-24.7	-26.7	-26.4	-21.0	-18.6	-15.8	-14.8
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
BUR2	1.5763	1.8592	2.2435	2.6539	2.4336	2.0963	2.0072			
BUR3	1.3261	1.4815	1.7515	2.0150	1.8188	1.5802	1.5099	1.6013	1.5791	1.5315
Difference, %	-15.9	-20.3	-21.9	-24.1	-25.3	-24.6	-24.8			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

This increase can be explained by the substantial growth of the production of grain whisky and liqueurs (by 155.8 per cent), beer (by 10.4 per cent), wines (by 9.6 per cent) albeit there had been a decrease over this period in brandy production (by 34.1 per cent); sparkling wine production (by 15.5 per cent); Porto, Madeira, Sherry, Tokay and other (by 90.2 per cent).

4.8.6. Planned Improvements

Possible improvements under category 2H2 'Food and Beverages Industry' aim at updating the activity data used to estimate NMVOC emissions from this category for the reporting period included within the previous inventory cycles.

5. AGRICULTURE SECTOR

Agriculture sector plays a significant role in the national economy of the Republic of Moldova, contributing with circa 10.1 per cent to its GDP (NBS, 2019). In terms of the branches of agricultural production, plant production accounted for a relatively larger share – 70.1 per cent, animal breeding – 28.2 per cent, whereas services – circa 1.7 per cent (NBS, 2019). More than 36.1 per cent of the active population is employed in this sector (NBS, 2019). The overwhelming majority of agricultural workers represent small and medium agricultural production enterprises.

On January 1, 2019, the total area of the country represented 3,384.7 thousand ha, including 2,496.4 thousand ha (73.7 per cent) – agricultural lands; 1,838.5 thousand ha (54.3 per cent) – arable lands; 286.6 thousand ha (8.5 per cent) – perennial plantations; 341.1 thousand ha (10.1 per cent) – hayfields and pastures; 30.2 thousand ha (0.9 per cent) – fallow lands; 467.2 thousand ha (13.8 per cent) – forests and lands covered with forest vegetation; 96.5 thousand ha (2.9 per cent) – rivers, lakes, water basins and bogs, and 324.7 thousand ha (9.6 per cent) – other lands (NBS, 2019).

According to the Land Cadastre of the Republic of Moldova, by January 1, 2020, the use of agricultural land (in total 1,308 million landowners with a total area of 2,091.9 thousand ha) was as it follows: 73 state agribusiness enterprises with a total area of 179.1 thousand ha (8.6 per cent); 78 scientific research and education institutions with a total area of 20.9 thousand ha (1.0 per cent); 56 monasteries and religious institutions with a total area of 0.7 thousand ha (0.03 per cent); 134 other enterprises and auxiliary households in state ownership with a total area 72.4 thousand ha (3.5 per cent); 48.0 thousand plots in the public property of the administrative-territorial units with a total area of 112.6 thousand ha (5.4 per cent); 1781 production cooperatives with a total area of 77.9 thousand ha (3.7 per cent); 1,034 joint stock companies with a total area of 28.9 thousand ha (1.4 per cent); 36.2 thousand limited liability companies with a total area 791.2 thousand ha (37.8 per cent); 290.0 thousand peasant farms with a total area 480.6 thousand ha (23.0 per cent); 800.5 thousand plots used individually by private owners with a total area of 259.5 thousand ha (12.4 per cent); 35.3 thousand orchard farms with a total area 2.8 thousand ha (0.1 per cent); and 94.3 thousand other lands with a total area of 64.8 thousand ha (3.1 per cent).

5.1. Overview

The main sources covered by Sector 3 'Agriculture' include methane emissions from animal breeding, in particular from categories 3A 'Enteric Fermentation' and 3B 'Manure Management', nitrous oxide emissions from 3B 'Manure Management', and 3D 'Agricultural Soils', as well as carbon dioxide emissions in agricultural land from category 3H 'Urea Application'. As in the RM rice is not cultivated and there are no savannas, no GHG emission were reported from categories 3C 'Rice Cultivation' and 3E 'Prescribed Burning of Savannas'. Likewise, GHG emissions from category 3F 'Field Burning of Agricultural Residues' were reported under Sector 4 'Land Use, Land-Use Change and Forestry', source category 4B1 'Cropland Remaining Cropland'. A brief overview, methodological issues and data sources, key categories, uncertainties and times-series consistency, QA and QC procedures, recalculations made and planned improvements are described for each source category in this sector.

5.1.1. Summary of Emission Trends

In 2019, Sector 3 'Agriculture' accounted for circa 14.1 per cent of the total national direct GHG emissions in the Republic of Moldova (without LULUCF), being the second major source of GHG emissions after Sector 1 'Energy'. It should be noted that Sector 3 'Agriculture' was a major source of CH_4 and N_2O emissions, accounting for circa 19.4 per cent and 88.9 per cent, respectively, of the total emissions reported at national level.

Between 1990 and 2019, the total GHG emissions originating from Sector 3 'Agriculture' recorded a downward trend, decreasing by circa 63.6 per cent, from 5.33 Mt recorded in 1990 to 1.94 Mt in 2019 (Table 5-1), particularly due to decreasing values of such indicators as: the number of domestic livestock and poultry, the amount of synthetic and organic nitrogen fertilisers applied to soils, the quantities of agricultural crop residues returned to soil and carbon losses from land use change and soil management practices.

Table 5-1: Direct GHG emissions from Sector 3 'Agriculture' for the period 1990-2019, kt CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	0.5820	0.5226	0.3905	0.1276	0.0537	0.0607	0.0911	1.0992	0.2721	0.0034
CH_4	2 684.5230	2 443.9487	2 369.9032	2 147.8512	2 088.0629	1 824.3626	1 679.2333	1 434.7631	1 372.9086	1 264.1202
N_2O	2 650.3850	2 518.8921	2 175.7763	1 858.7494	1 643.1284	1 585.8914	1 584.7691	1 389.9530	1 343.9319	1 228.5490
Total	**5 335.4900**	**4 963.3633**	**4 546.0699**	**4 006.7282**	**3 731.2450**	**3 410.3147**	**3 264.0934**	**2 825.8154**	**2 717.1126**	**2 492.6726**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
CO_2	0.4397	0.1496	0.0470	0.2381	0.3669	0.1739	0.1460	0.2631	0.8505	0.5864
CH_4	1 170.7947	1 189.1882	1 215.5580	1 112.2119	1 042.7191	1 009.1750	981.6300	784.6471	751.6286	783.8786
N_2O	1 140.8793	1 218.6278	1 262.2421	1 122.2738	1 190.9262	1 230.9898	1 200.1445	986.4551	1 090.3227	1 099.9468
Total	**2 312.1138**	**2 407.9656**	**2 477.8471**	**2 234.7239**	**2 234.0121**	**2 240.3387**	**2 181.9206**	**1 771.3653**	**1 842.8018**	**1 884.4118**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
CO_2	1.7443	3.6752	5.5908	4.1840	10.2058	11.2402	12.2747	26.2081	43.3624	39.6306
CH_4	785.0631	739.5373	699.4024	702.7643	723.0006	698.0678	692.9104	647.6104	586.2345	508.2390
N_2O	1 179.9272	1 148.2647	1 085.6068	1 207.8645	1 390.7607	1 139.1383	1 282.3315	1 364.0727	1 363.3633	1 395.6062
Total	**1 966.7346**	**1 891.4772**	**1 790.6000**	**1 914.8127**	**2 123.9671**	**1 848.4464**	**1 987.5167**	**2 037.8912**	**1 992.9602**	**1 943.4759**

It should be noted that in 1990, CO_2, CH_4 and N_2O emissions accounted for 0.01 per cent, 50.3 per cent and 49.7 per cent, respectively, of the total direct GHG emissions originating from Sector 3 'Agriculture'. By 2019, the share of CO_2 emissions increased up to 2.0 per cent, N_2O emissions increased up to 71.8 per cent, whereas CH_4 emissions decreased to 26.1 per cent.

During the period under review, total direct GHG emissions from Sector 3 'Agriculture' decreased by circa 63.6 per cent, whereas CH_4 and N_2O emissions decreased by 81.1 per cent and 47.3 per cent, respectively (Figure 5-1, Table 5-2).

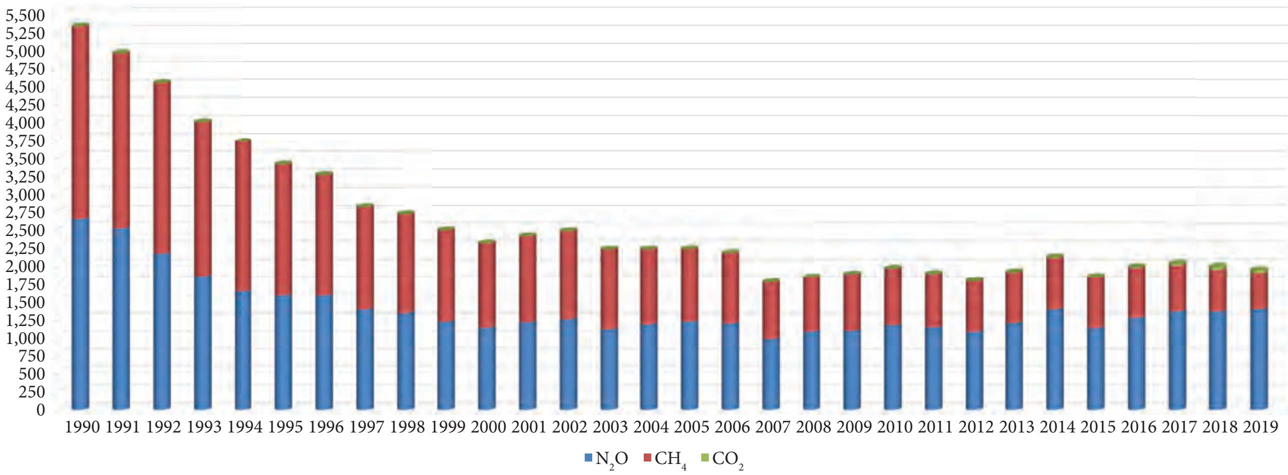

Figure 5-1: Direct GHG emissions from Sector 3 'Agriculture' in the Republic of Moldova for the period 1990-2019, kt CO_2 equivalent.

At the same time, between 1990 and 2019, CO_2 emissions from urea application increased by circa 68.1 times.

Table 5-2: Total direct GHG emissions from Sector 3 'Agriculture' by category for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3H Urea Application	0.5820	0.5226	0.3905	0.1276	0.0537	0.0607	0.0911	1.0992	0.2721	0.0034
Total CO_2 emissions from Sector 3 'Agriculture'	**0.5820**	**0.5226**	**0.3905**	**0.1276**	**0.0537**	**0.0607**	**0.0911**	**1.0992**	**0.2721**	**0.0034**
3A Enteric Fermentation	87.5771	81.1547	79.8715	74.9162	72.9133	64.7235	59.6750	51.3040	49.8079	46.0727
3B Manure Management	19.8038	16.6032	14.9247	10.9978	10.6093	8.2510	7.4943	6.0866	5.1085	4.4921
Total CH_4 emissions from Sector 3 'Agriculture'	**107.3809**	**97.7579**	**94.7961**	**85.9140**	**83.5225**	**72.9745**	**67.1693**	**57.3905**	**54.9163**	**50.5648**
3B Manure Management	3.7470	3.4991	3.1392	2.7360	2.6585	2.4596	2.5974	2.0035	1.9398	1.7608
3D Agricultural Soils	5.1469	4.9535	4.1621	3.5014	2.8554	2.8621	2.7206	2.6607	2.5700	2.3619
Total N_2O emissions from Sector 3 'Agriculture'	**8.8939**	**8.4527**	**7.3013**	**6.2374**	**5.5139**	**5.3218**	**5.3180**	**4.6643**	**4.5098**	**4.1226**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
3H Urea Application	0.4397	0.1496	0.0470	0.2381	0.3669	0.1739	0.1460	0.2631	0.8505	0.5864
Total CO_2 emissions from Sector 3 'Agriculture'	**0.4397**	**0.1496**	**0.0470**	**0.2381**	**0.3669**	**0.1739**	**0.1460**	**0.2631**	**0.8505**	**0.5864**
3A Enteric Fermentation	43.4313	44.1309	45.0244	41.1415	38.4568	36.9611	35.7523	28.8838	27.5714	28.5438
3B Manure Management	3.4005	3.4366	3.5979	3.3469	3.2519	3.4059	3.5129	2.5021	2.4937	2.8113
Total CH_4 emissions from Sector 3 'Agriculture'	**46.8318**	**47.5675**	**48.6223**	**44.4885**	**41.7088**	**40.3670**	**39.2652**	**31.3859**	**30.0651**	**31.3551**
3B Manure Management	1.5712	1.5998	1.6116	1.5302	1.4804	1.5820	1.6257	1.2423	1.2244	1.3794
3D Agricultural Soils	2.2573	2.4896	2.6241	2.2358	2.5160	2.5488	2.4016	2.0680	2.4344	2.3117
Total N_2O emissions from Sector 3 'Agriculture'	**3.8285**	**4.0894**	**4.2357**	**3.7660**	**3.9964**	**4.1308**	**4.0273**	**3.3103**	**3.6588**	**3.6911**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
3H Urea Application	1.7443	3.6752	5.5908	4.1840	10.2058	11.2402	12.2747	26.2081	43.3624	39.6306
Total CO_2 emissions from Sector 3 'Agriculture'	**1.7443**	**3.6752**	**5.5908**	**4.1840**	**10.2058**	**11.2402**	**12.2747**	**26.2081**	**43.3624**	**39.6306**
3A Enteric Fermentation	28.3270	26.6765	25.2109	25.3945	26.1032	25.1684	24.8801	23.1182	20.6560	17.6658
3B Manure Management	3.0755	2.9050	2.7652	2.7160	2.8169	2.7544	2.8363	2.7862	2.7933	2.6637
Total CH_4 emissions from Sector 3 'Agriculture'	**31.4025**	**29.5815**	**27.9761**	**28.1106**	**28.9200**	**27.9227**	**27.7164**	**25.9044**	**23.4494**	**20.3296**
3B Manure Management	1.4304	1.3045	1.1973	1.1202	1.2335	1.1952	1.2328	1.1730	1.0372	0.9345
3D Agricultural Soils	2.5291	2.5488	2.4457	2.9330	3.4335	2.6274	3.0703	3.4045	3.5378	3.7488
Total N_2O emissions from Sector 3 'Agriculture'	**3.9595**	**3.8532**	**3.6430**	**4.0532**	**4.6670**	**3.8226**	**4.3031**	**4.5774**	**4.5750**	**4.6832**

Table 5-3 shows that category 3D 'Agricultural Soils' is the largest source of total direct GHG emissions from Sector 3 'Agriculture' (with a share varying from a minimum of 22.8 per cent in 1994 to a maximum of 57.5 per cent in 2019), followed by category 3A 'Enteric Fermentation' (with a share varying between a minimum of 22.7 per cent in 2019 to a maximum of 48.8 per cent in 1994), and category 3B 'Manure Management' (with a share varying between a minimum of 17.7 per cent in 2019 to a maximum of 30.2 per cent in 1990), respectively. The share of category 3H 'Urea Application' in managed soils was initially insignificant; however, there had been a constant upward trend, reaching 2.0 per cent of the total emissions from the respective sector in 2019.

Table 5-3: Breakdown of total direct GHG emissions from Sector 3 'Agriculture' for the period 1990-2019, % of total

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3A Enteric Fermentation	41.04	40.88	43.92	46.74	48.85	47.45	45.71	45.39	45.83	46.21
3B Manure Management	30.21	29.37	28.79	27.21	28.34	27.54	29.45	26.51	25.98	25.56
3D Agricultural Soils	28.75	29.74	27.28	26.04	22.80	25.01	24.84	28.06	28.19	28.24
3H Urea Application	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.04	0.01	0.00
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
3A Enteric Fermentation	46.96	45.82	45.43	46.03	43.04	41.24	40.96	40.76	37.40	37.87
3B Manure Management	23.93	23.37	23.01	24.15	23.39	24.84	26.23	24.43	23.18	25.54
3D Agricultural Soils	29.09	30.81	31.56	29.81	33.56	33.90	32.80	34.79	39.37	36.56
3H Urea Application	0.02	0.01	0.00	0.01	0.02	0.01	0.01	0.01	0.05	0.03
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
3A Enteric Fermentation	36.01	35.26	35.20	33.16	30.72	34.04	31.30	28.36	25.91	22.72
3B Manure Management	25.58	24.39	23.79	20.98	20.62	22.99	22.05	20.57	19.01	17.75
3D Agricultural Soils	38.32	40.16	40.70	45.65	48.17	42.36	46.04	49.78	52.90	57.48
3H Urea Application	0.09	0.19	0.31	0.22	0.48	0.61	0.62	1.29	2.18	2.04

5.1.2. Key Categories

The results of key category analysis (including LULUCF) carried out following a Tier 1 approach are provided in Chapter 1.5 of the present Report, as well as in Annex 1. Table 5-4 provides information on identified key categories under Sector 3 'Agriculture'.

Table 5-4: Key categories identified under Sector 3 'Agriculture'

IPCC Category	GHG	Source Category	Key Categories
3A	CH_4	CH_4 emissions from enteric fermentation	Yes (L, T)
3B	CH_4	CH_4 emissions from manure management	Yes (L, T)
3B1	N_2O	Direct N_2O emissions from manure management	Yes (L, T)
3B5	N_2O	Indirect N_2O emissions from manure management	Yes (L, T)
3Da	N_2O	Direct N_2O emissions from agricultural soils	Yes (L, T)
3Db	N_2O	Indirect N_2O emissions from agricultural soils	Yes (L, T)
3H	CO_2	CO_2 emissions from urea application	No

Abbreviations: L – Level Assessment; T – Trend Assessment.

5.1.3. Methodological Issues

Emissions covered by categories 3A 'Enteric Fermentation', 3B 'Manure Management', 3D 'Agricultural Soils' and 3H 'Urea Application' were estimated using both the Tier 1 methodological approach and default EF values, as well as the Tier 2 methodological approach and country-specific emission factors, particularly for the key categories. A summary description of the methods used to estimate emissions by category is provided in Table 5-5, whereas a more detailed description is available in sub-chapters 5.2-5.5 of the present Report.

Table 5-5: Summary of methods used to estimate GHG emissions from Sector 3 'Agriculture'

IPCC Category	Source Category	CO_2		CH_4		N_2O	
		Method	EF	Method	EF	Method	EF
3A	Enteric Fermentation	NA	NA	T2, T1	CS, D	NA	NA
3B	Manure Management	NA	NA	T2, T1	CS, D	T2, T1	CS, D
3D	Agricultural Soils	NA	NA	NA	NA	T2, T1	CS, D
3H	Urea Application	T1	D	NA	NA	NA	NA

Abbreviations: T1 – Tier 1 Method; T2 – Tier 2 Method; T3 – Tier 3 Method; CS – Country-Specific; D – Default; EF – Emission Factor.

5.1.4. Uncertainties Assessment and Time-Series Consistency

Results of uncertainty analysis of GHG emissions from Sector 3 'Agriculture' (by category) are closely described in sub-chapters 5.2-5.5 as well as in the Annex 5-3.4 of the present Report. Combined uncertainties as a percentage of the total direct GHG emissions from Sector 3 'Agriculture' were estimated at 22.66 per cent. Uncertainties in the trend of total direct GHG emissions from this sector were estimated at circa 6.04 per cent. In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review.

5.1.5. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for Sector 3 'Agriculture', following a Tier 1 methodological approach. It should be noted that the AD and methods used to estimate GHG emissions under this sector were documented and archived both in hard copies and electronically. In order to identify the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the 2006 IPCC Guidelines, GHG emissions were estimated using AD and national factors and parameters from official sources of reference.

5.1.6. Recalculations

GHG emission recalculations performed under Sector 3 'Agriculture' are due to the availability of an updated set of activity data (the Statistical Yearbooks of the RM and those of the ATULBD, and other relevant publications in the field), updated country-specific EFs, and as a result of the alteration of calculation methodologies. In comparison with the results recorded within the previous inventory cycle (reported in the BUR2 of the RM to the UNFCCC), the performed recalculations resulted in an upward trend in direct GHG emissions for the years 1990-1992, 2007, and 2012, varying from a minimum of 1.7 per cent in 2012, to a maximum of 3.3 per cent in 1992, and a downward trend in direct GHG emissions for the years 1993-2006, 2008-2011 and 2013-2016, respectively, varying from a minimum decrease of 0.4 per cent in 1994, to a maximum decrease of 18.2 per cent in 2016 (Table 5-6). The results of recalculations performed at category level are shown in sub-chapters 5.2-5.5 of this Report.

Table 5-6: Recalculated GHG emissions under Sector 3 'Agriculture' for the period 1990-2016, included in the BUR2 of the RM under the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	5 220.5740	4 862.8405	4 399.9514	4 229.6703	3 745.9701	3 602.9153	3 384.6136	3 185.1794	2 952.5257	2 696.2176
BUR3	5 335.4900	4 963.3633	4 546.0699	4 006.7282	3 731.2450	3 410.3147	3 264.0934	2 825.8154	2 717.1126	2 492.6726
Difference, %	2.2	2.1	3.3	-5.3	-0.4	-5.3	-3.6	-11.3	-8.0	-7.5
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	2 480.8483	2 676.0581	2 744.8721	2 399.8528	2 592.6098	2 578.3718	2 466.4190	1 676.7796	2 243.3912	2 075.1686
BUR3	2 312.1138	2 407.9656	2 477.8471	2 234.7239	2 234.0121	2 240.3387	2 181.9206	1 771.3653	1 842.8018	1 884.4118
Difference, %	-6.8	-10.0	-9.7	-6.9	-13.8	-13.1	-11.5	5.6	-17.9	-9.2
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	2 255.0151	2 207.9339	1 760.0998	2 252.5504	2 492.3149	2 091.1781	2 428.4639			
BUR3	1 966.7346	1 891.4772	1 790.6000	1 914.8127	2 123.9671	1 848.4464	1 987.5167	2 037.8912	1 992.9602	1 943.4759
Difference, %	-12.8	-14.3	1.7	-15.0	-14.8	-11.6	-18.2			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

5.1.7. Assessment of Completeness

The current inventory covers GHG emissions from 4 source categories: 3A 'Enteric Fermentation', 3B 'Manure Management', 3D 'Agricultural Soils', and 3H 'Urea Application' (Table 5-7).

Table 5-7: Assessment of completeness of GHG emissions under Sector 3 'Agriculture'

IPCC Category	Source Category	CO_2	CH_4	N_2O
3A	Enteric Fermentation	NA	X	NO
3B	Manure Management	NA	X	X
3C	Rice Cultivation	NA	NO	NA
3D	Agricultural Soils	NA	NA	X
3E	Prescribed Burning of Savannas	NA	NO	NO
3F	Field Burning of Agricultural Residues	NA	IE	IE
3G	Liming	NO	NA	NA
3H	Urea Application	X	NA	NA
3I	Other Carbon-Containing Fertilizers	NO	NA	NA
3J	Other	NO	NO	NO

Abbreviations: X – source categories included in the inventory; NA – Not Applicable; NO – Not Occurring; NE – Not Estimated; IE – Included Elsewhere.

Since rice is not cultivated in the RM and there are no savannas, no GHG emissions have been registered from categories 3C 'Rice Cultivation' and 3E 'Prescribed Burning of Savannas', respectively. GHG emissions from source category 3F 'Field Burning of Agricultural Residues' were reported under Sector 4 'LULUCF', specifically source category 4B 'Cropland'. CO_2 emissions from categories 3G 'Liming' and 3I 'Other Carbon-Containing Fertilizers' were not estimated due to lack of such activities in the RM.

5.1.8. Planned Improvements

Planned improvements at source categories level within Sector 3 'Agriculture' are closely described in the respective sub-chapters (5.2-5.5) of this Report.

5.2. Enteric Fermentation (Category 3A)

5.2.1. Source Category Description

Ruminant livestock, due to the symbiosis between macro-and microorganisms that inhabit the stomach consisting of four chambers (rumen, reticulum, omasum, abomasum) can be regarded as a complex biological factory, which converts feedstock into high quality food products, creating daily a protein mass of up to 2.5 kg. Also, in the process, due to the fermentation of nutrients, significant quantities of gases are generated, containing up to 30-40 per cent of CH_4 and 60-70 per cent of CO_2[82]. About 5 per cent of ingested feed gross energy is lost through gaseous emissions. The problem of reducing gas emissions within feed fermentation process is thereby important not only in terms of environmental protection, but also from an economic point of view. It should be noted that both ruminant (cattle, sheep and goats) and non-ruminant livestock (pigs, horses, asses and mules) are major sources of CH_4 emissions. However, ruminant livestock account for a larger share of total CH_4 emissions from category 3A 'Enteric fermentation'. The amount of methane that is released depends on a number of factors, such as species, age, weight of the animal, quantity and quality of feed intake, etc.

5.2.2. Activity Data, Methodological Issues and Emission Factors

In order to estimate methane emissions from category 3A 'Enteric Fermentation', three basic steps were undertaken:

(1) Divide the livestock population into subgroups and characterise each subgroup (see basic information on domestic breeds of animals bred in the RM in Annex 3-3);

(2) Estimate emission factors for each subgroup, as well as the average situation for the entire population, by age, kilograms of CH_4/animal/year;

(3) Estimate CH_4 emissions by multiplying the specific emission factors with AD on the number of animals (then summing the emissions from each category of animals, obtaining the total methane emissions from category 3A 'Enteric Fermentation').

It was possible to carry out these steps for different levels of details and complexity, following two methodological approaches: Tier 1 and Tier 2. While following the Tier 1 methodology, CH_4 emissions from category 3A 'Enteric Fermentation' were estimated based on equations 10.19 and 10.20 in the 2006 IPCC Guidelines:

[82] 'Technical Guideline for Milk Production', Babcock International Institute for Dairy Research and Development, USA, 1996 (<www.animals-feed.info>).

$$Total\ CH_{4\ enteric} = \Sigma_i\ E_i\ [EF_{(T)} \bullet (N_{(T)} / 10^6)]$$

Where:

- $Total\ CH_{4\ enteric}$ – total CH_4 emissions from enteric fermentation, kt CH_4/yr;
- E_i – emissions for the *i* livestock categories and subcategories;
- $EF_{(T)}$ – emission factor for the defined livestock population, kg CH_4/head/yr;
- $N_{(T)}$ – number of head of livestock species/category T;
- T – species/category of livestock.

The Tier 1 methodology is a simplified approach based on use of default EFs (Table 5-8) multiplied by national AD on the animal population data (Table 5-9).

The Tier 2 methodology is a more complex approach requiring country-specific data on the animal population (including distribution by species and sub-categories), maintenance requirements and feeding conditions for typical livestock under each species and sub-categories (particularly for cattle and sheep, which have a larger share in the total CH_4 emissions from 3A 'Enteric Fermentation').

Table 5-8: Default EFs for Western Europe (WE) and Eastern Europe (EE) used to estimate CH_4 emissions from category 3A 'Enteric Fermentation'

Animal by category	EF, kg CH_4/head/yr		Comments
	Western Europe	Eastern Europe	
Dairy cows	117	99	Average Milk Production: WE – 6000 kg/head/year, EE – 2550 kg/head/year WE: Average live weight – 600 kg. EE: Average live weight – 550 kg.
Other cattle	57	58	Beef cows, including young cattle. WE: Average live weight of other cattle –420 kg, including: males – 600 kg, females – 500 kg, young cattle – 230 kg. EE: Average live weight of other cattle – 391 kg, including: males – 600 kg, females – 500 kg, young cattle – 230 kg.
Sheep	8	5	Average live weight: WE – 48.5 kg, EE – 28 kg
Goats	5	5	Average live weight: WE – 38.5 kg, EE – 30 kg
Horses	18	18	Average live weight: WE – 377 kg, EE – 238 kg
Asses and mules	10	10	Average live weight: WE – 130 kg, EE – 130 kg
Swine	1.5	1	Average live weight: WE – 50 kg, breeding – 198 kg. Average live weight: EE – 50 kg, breeding – 180 kg.

Distribution of livestock population into subgroups. Following 2006 IPCC Guidelines, it is *good practice* to divide the livestock population into sub-categories (Table 5-9).

Table 5-9: Livestock and poultry population for the period 1990-2019, thousand heads

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cattle total, including:	1060.7	1000.5	970.1	882.6	832.0	729.5	646.3	549.7	532.4	482.4
...Dairy Cows	395.2	397.1	403.2	401.8	402.6	380.8	355.4	323.7	318.4	306.9
...Other Cattle	665.5	603.4	566.9	480.7	429.4	348.7	290.9	226.0	214.0	175.5
Sheep and Goats total, including:	1281.9	1288.8	1357.2	1437.3	1501.9	1423.0	1372.4	1235.3	1147.2	1055.5
...Sheep	1244.8	1239.3	1294.3	1362.4	1409.8	1326.6	1271.1	1136.3	1046.4	948.9
...Goats	37.1	49.5	62.9	74.9	92.2	96.4	101.3	99.0	100.8	106.6
Horses	47.2	48.4	51.4	54.5	58.2	61.6	63.3	65.4	68.5	72.0
Asses and Mules	1.7	1.8	2.1	2.2	2.9	3.2	3.1	3.0	3.2	3.4
Swine	1850.1	1753.0	1487.4	1082.3	1046.8	1016.4	950.1	797.5	928.0	751.3
Poultry total, including:	24625.0	23715.0	17128.0	12809.2	13448.3	13746.4	12364.9	12363.9	13046.0	13730.1
... Chickens	20234.4	19607.1	13271.0	9516.6	9957.4	10200.6	9137.4	9112.0	9557.0	9992.5
...Geese	1335.5	1321.8	1300.4	1378.9	1457.0	1487.4	1357.9	1372.3	1470.0	1581.6
...Ducks	2165.7	1914.7	1736.5	1198.9	1284.8	1293.3	1166.6	1169.5	1264.8	1349.4
...Turkeys	889.3	871.3	820.2	714.8	749.0	765.2	703.0	710.1	754.2	806.6
Rabbits	283.0	250.8	298.5	262.4	237.2	209.3	189.8	176.8	185.9	182.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cattle total, including:	445.4	453.8	454.7	409.1	359.5	339.8	326.9	253.7	238.4	243.0
...Dairy Cows	298.5	300.1	304.8	277.7	249.0	233.1	222.0	181.1	171.9	173.2
...Other Cattle	146.9	153.7	149.9	131.5	110.5	106.7	104.9	72.6	66.5	69.8
Sheep and Goats total, including:	962.1	971.8	978.4	958.4	959.8	954.3	962.5	866.4	879.6	929.7
...Sheep	846.3	851.7	843.7	829.2	832.6	827.0	842.6	759.9	767.7	809.4
...Goats	115.8	120.2	134.6	129.2	127.2	127.3	119.9	106.5	111.9	120.3
Horses	76.0	81.6	82.6	81.4	75.8	72.0	69.3	60.5	57.4	56.1
Asses and Mules	3.8	4.3	4.0	4.3	4.0	3.7	3.6	3.1	3.2	2.9
Swine	492.7	490.8	550.1	476.4	422.3	493.0	568.3	320.8	302.9	403.6
Poultry total, including:	13624.9	14737.4	15535.3	16195.5	17883.9	22773.6	23017.2	17544.2	18830.6	22986.6
... Chickens	9952.9	10952.8	11484.5	12184.2	13559.0	17195.3	17320.6	14162.0	15464.0	18836.1
...Geese	1550.6	1589.9	1777.4	1780.2	1828.0	2120.3	2111.5	1342.2	1277.2	1497.4
...Ducks	1325.3	1368.2	1423.3	1461.9	1592.6	2394.1	2551.0	1435.5	1501.7	1981.8
...Turkeys	796.2	826.6	850.1	769.3	904.4	1063.9	1034.0	604.5	587.8	671.4
Rabbits	161.3	191.4	190.7	205.4	239.1	278.9	326.0	263.4	248.5	274.5

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cattle total, including:	236.4	224.4	210.6	208.0	210.7	204.5	199.9	185.6	162.7	141.2
...Dairy Cows	165.8	155.8	145.1	141.3	140.6	137.7	132.3	122.1	106.4	90.2
...Other Cattle	70.5	68.6	65.5	66.7	70.1	66.9	67.7	63.5	56.3	51.0
Sheep and Goats total, including:	920.6	846.2	836.9	862.0	887.0	880.8	882.0	853.8	781.2	688.8
...Sheep	793.1	714.2	699.0	717.4	733.5	722.2	714.9	683.6	618.3	536.1
...Goats	127.5	132.0	137.8	144.6	153.4	158.6	167.0	170.3	162.9	152.7
Horses	53.6	50.9	47.5	46.0	42.8	40.2	37.4	34.1	30.4	26.5
Asses and Mules	2.8	2.5	2.4	2.1	2.2	2.0	3.1	5.0	3.8	1.4
Swine	511.7	471.7	438.4	444.8	504.7	484.5	469.8	439.8	431.6	428.4
Poultry total, including:	23782.5	19766.7	15897.8	11947.9	12520.0	12590.6	13172.6	13616.4	11456.5	11115.7
... Chickens	19456.4	16194.1	13252.8	10096.2	10438.5	10633.3	11155.0	11542.6	9666.9	9494.4
...Geese	1597.3	1351.6	1028.5	718.7	768.0	746.1	770.6	790.7	683.8	621.3
...Ducks	2010.8	1622.1	1166.9	822.4	986.1	904.1	929.1	956.9	823.6	742.8
...Turkeys	718.1	599.0	449.6	310.6	327.4	307.1	317.8	326.1	282.2	257.1
Rabbits	277.0	277.4	267.0	296.2	326.1	350.2	366.7	376.5	351.5	329.7

Source: Statistical Annual Report No. 24-agr „Animal Breeding Sector". Number of livestock and poultry in all households categories as of January 1 (annual reports for 1990-2019); Statistical Yearbooks of the ATULBD for 1998 (page 224), 2002 (page 118), 2006 (page 109), 2010 (page 110), 2014 (page 104), 2017 (page 117), 2019 (page 115), 2020 (page 118).

Average daily feed intake per day. In addition to activity data on livestock, information on average daily feed intake is required. Because data on average daily feed intake is not available in statistical sources, it was necessary to calculate this information indirectly. The following general data was collected for each representative animal category: weight of a typical animal in the respective category (kg), average weight gain per day (g), feeding situation (either confined or grazing), average daily milk production (kg), milk fat content (%), percentage of females that give birth in a year (%) average annual wool production per animal (kg), number of offspring produced per year (heads), and feed digestibility (%).

Weight (W) and Mature Weight (MW) in livestock and poultry. Information on the weight of the most prevalent breeds of livestock and poultry is provided by statistical sources (Table 5-10), as well as by the scientific literature.

Table 5-10: Livestock and poultry weight, by species and sub-categories, for 1990-2019, kg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Average weight per head at the end of the year, kg:										
Cattle, including	325	320	316	310	295	279	264	307	308	303
Dairy cows	476	443	430	415	413	412	411	452	443	439
Breeding males	580	562	550	545	540	539	537	551	542	539
Swine, including	145	143	132	140	118	109	100	55	51	46
Female sows	189	186	181	185	176	169	162	144	141	137
Sheep and goats	43	44	43	43	44	39	39	35	35	35
Horses, including	376	326	341	344	369	356	340	276	282	279
Female horses older than 3 years and stallions	433	381	396	399	414	401	382	308	314	311
Poultry of all species and ages	1.74	1.69	1.54	1.49	1.50	1.43	1.28	1.38	1.62	1.65
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Average weight per head at the end of the year, kg:										
Cattle, including	294	297	294	290	300	293	297	284	286	289
Dairy cows	435	434	434	431	435	429	427	425	405	409
Breeding males	533	535	534	532	535	531	529	475	480	478
Swine, including	56	49	47	54	51	50	51	51	56	56
Female sows	145	139	137	145	141	138	140	137	141	137
Sheep and goats	35	33	33	33	33	33	34	33	33	35
Horses, including	285	283	277	277	282	275	297	297	308	302
Female horses older than 3 years and stallions	317	315	309	309	314	307	322	339	342	346
Poultry of all species and ages	1.62	1.57	1.60	1.29	1.35	1.39	1.50	1.36	1.26	1.28
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Average weight per head at the end of the year, kg:										
Cattle, including	291	322	318	310	344	348	344	391	400	425
Dairy cows	420	421	427	430	450	463	457	461	451	438
Breeding males	480	467	474	431	591	595	505	456	540	495
Swine, including	55	57	59	54	57	54	75	60	102	55
Female sows	141	155	167	176	170	172	164	176	170	173
Sheep and goats	35	35	36	38	43	41	42	41	41	41
Horses, including	307	304	320	326	318	316	315	365	331	347
Female horses older than 3 years and stallions	345	343	342	343	338	375	293	360	361	354
Poultry of all species and ages	1.28	1.28	1.23	1.31	1.16	2.00	1.80	1.40	1.30	1.20

Source: NBS, Statistical Annual Report No. 24-agr 'Animal Breeding Sector'. Basic indicators of livestock development sector in all household categories in the Republic of Moldova (annual reports for 1990-2019).

As for cattle[83], the information on the weight of the most prevalent breeds of cattle in the RM (Steppe Red and Spotted Black), in dynamics (by age), is presented in Table 5-11. It should be noted that currently, most animals in the RM are not purebred, but crossbred (Bucataru, Radionov, 1999). Productivity indicators for crossbreeds thereby have average values. Information on the typical body weight of sheep and goats at different stages of ontogeny (birth, weaning, one year of age and slaughter) is available in the scientific literature (Bucataru, Radionov, Varban, 2003).

Table 5-11: Weight of most widespread breeds of cattle in the RM

Breed	Sex	Weight in dynamics by months, kg														
		At birth	6	7	8	9	10	12	15	18	24	30	36	48	60	72
Steppe Red	♀	30	150	170	190	205	220	250	295	340	400	425	450	490	520	520
	♂	30	170	195	220	240	260	300	375	445	525	590	650	750	800	800
Spotted Black	♀	35	165	180	200	220	240	270	320	375	430	455	480	520	550	550
	♂	35	180	205	250	255	280	330	405	480	575	640	750	820	880	880

According to the information collected, the weight of sheep and goats at birth is circa 2-4 kg, lambs are weaned at the age of 3-4 months, when they reach the mass of 18-23 kg; whereas kids at the age of 2-3, months when they reach the weight of 13-15 kg; young sheep that are not left for breeding are fed intensely until the age of 6-7 months, when they reach the weight of 30-35 kg, after which they are slaughtered. Other relevant information on the weight of sheep and goats in the RM is provided in Annex 3-3.

Average daily weight gain per day (WG)[84]*, g/day.* The information on daily actual weight gain reported in the RM over the period 1990-2019 for cattle and swine is shown in Table 5-12.

Table 5-12: Average daily weight gain for cattle and swine for the period 1990-2019

Index	Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Daily weight gain, g	cattle	515.0	421.0	425.0	376.0	363.0	223.0	203.0	181.0	230.0	192.0
	swine	304.0	117.0	110.0	89.0	94.0	148.0	171.0	189.0	222.0	117.0
Index	**Category**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Daily weight gain, g	cattle	217.0	260.0	287.0	262.0	275.0	321.0	323.0	297.0	325.0	378.0
	swine	107.0	134.0	147.0	136.0	166.0	187.0	200.0	218.0	268.0	311.0
Index	**Category**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Daily weight gain, g	cattle	345.0	366.0	379.0	355.0	383.0	342.0	437.0	398.0	456.0	415.0
	swine	317.0	339.0	398.0	402.0	451.0	448.0	487.0	507.0	622.0	541.0

Source: NBS, Statistical Annual Report No. 24-agr 'Animal Breeding Sector'. Basic Indicators of Animal Breeding Sector Development in all Households Categories in the Republic of Moldova (annual reports for 1990-2019).

Average Annual Milk Production per One Cow. In the past 20 years, the average productivity of dairy cows in the Republic of Moldova varied between a maximum of 3735 kg of milk per year in 1990 and a minimum of 1957 kg of milk per year in 1997 (Table 5-13) albeit the potential is much higher (Annex 3-3). Table 5-13 shows that the average milk productivity featured over the period since 1993-2003 is inferior to the one reported at the beginning of the 1990s, comparable with milk productivity reported in the 1960-1970s when the cattle stock in the RM was mainly represented by the Red Estonian (circa 8 per cent), Simmental (35-37 per cent) and Steppe Red (48-53 per cent) (Bucataru, Cosman, Holban, 2006).

Table 5-13: Average annual milk production per one cow for the period 1990-2019, kg/head/yr

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total national average annual milk production per one cow	3 735	3 248	2 841	2 398	2 189	2 043	2 021	1 957	2 040	2 030
Average annual milk production per one cow at agricultural enterprises and farm households	3 975	3 394	3 026	2 413	2 245	2 207	2 051	1 687	2 001	2 036
Average annual milk production per one cow at individual farms	2 940	2 815	2 421	2 100	2 097	2 125	2 029	2 038	2 048	2 038
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Total national average annual milk production per one cow	2 039	2 072	2 111	2 126	2 480	2 800	2 807	2 871	3 011	3 316
Average annual milk production per one cow at agricultural enterprises and farm households	2 179	2 447	2 710	2 493	2 561	3 018	2 913	2 710	2 743	3 098
Average annual milk production per one cow at individual farms	2 028	2 052	2 081	2 110	2 477	2 792	2 803	2 877	3 020	3 323
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Total national average annual milk production per one cow	3 435	3 438	3 425	3 607	3 672	3 666	3 607	3 758	3 815	3 698
Average annual milk production per one cow at agricultural enterprises and farm households	2 993	3 224	3 380	3 225	3 742	3 468	3 939	4 363	3 626	3 573
Average annual milk production per one cow at individual farms	3 449	3 444	3 426	3 621	3 669	3 676	3 590	3 728	3 828	3 198

Source: NBS, Statistical Annual Report No. 24-agr „Animal Breeding Sector". Basic Indicators of Animal Breeding Sector Development in all Households Categories in the Republic of Moldova (annual reports for 1990-2019).

[83] Default values used for Eastern European countries: 550 kg for dairy cows, 600 kg for males and 230 kg for young cattle (IPCC 2006 Guidelines, Volume 4, Chapter 10, Table 10A-2, Page 10.73).
[84] The default values are: WG – 0 kg per day for dairy cows and adult males (>5 years), and WG – 0.4 kg per day for young cattle (2006, IPCC Guidelines, Vol. 4, Chap.10, Tab. 10A.2).

Since 1970, there has been a massive import of Spotted Black cattle in the country. A programme was developed to crossbreed all stock with this breed, considered to be one of the most productive in the world. As a consequence, over the following 30 years, absorption crossbreeding was carried out for Simmental, Estonian Red and Steppe Red breeds with Spotted Black breed. The Holstein breed was also intensely used to improve the breed, particularly in the 1980–1990s. Developing an immense stock of half-breeds of different generations and a good organization of foddering had thereby led to a national average daily milk yield of 10-11 kg per head by 1990 (Table 5-14).

Table 5-14: Average daily milk production per one cow for the period 1990-2019, kg/head/day

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total national average daily milk production per one cow	10.2	8.9	7.8	6.6	6.0	5.6	5.5	5.4	5.6	5.6
Average daily milk production per one cow at agricultural enterprises and farm households	10.9	9.3	8.3	6.6	6.2	6.0	5.6	4.6	5.5	5.6
Average daily milk production per one cow at individual farms	8.1	7.7	6.6	5.8	5.7	5.8	5.5	5.6	5.6	5.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total national average daily milk production per one cow	5.6	5.7	5.8	5.8	6.8	7.7	7.7	7.9	8.2	9.1
Average daily milk production per one cow at agricultural enterprises and farm households	6.0	6.7	7.4	6.8	7.0	8.3	8.0	7.4	7.5	8.5
Average daily milk production per one cow at individual farms	5.5	5.6	5.7	5.8	6.8	7.6	7.7	7.9	8.3	9.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total national average daily milk production per one cow	9.4	9.4	9.4	9.9	10.1	10.0	9.9	10.3	10.5	10.1
Average daily milk production per one cow at agricultural enterprises and farm households	8.2	8.8	9.2	8.8	10.3	9.5	10.8	12.0	9.9	9.8
Average daily milk production per one cow at individual farms	9.4	9.4	9.4	9.9	10.1	10.1	9.8	10.2	10.5	8.8

Source: NBS, Statistical Annual Report No. 24-agr 'Animal Breeding Sector'. Basic Indicators of Animal Breeding Sector Development in all Households Categories in the Republic of Moldova (annual reports for 1990-2019).

Subsequently, once the big collective farms collapsed and livestock was concentrated in the private sector (currently, according to the NBS, circa 85 per cent of the total cattle of the Republic of Moldova is in the private sector[85]), the average productivity of dairy cows decreased decidedly, particularly as a consequence of poor organization of foddering and inappropriate animal feeding and maintenance conditions in the private sector.

It should be noted that milk yield greatly depends on the content of protein in the animal diet. The optimal level of protein is circa 14-18 per cent of the dry matter in the feed intake. At a 20 per cent deficit of protein in the feed intake the milk yield decreases by 30 per cent, and at a 30 per cent deficit of protein, milk productivity drops by up to 50 per cent. For a long time, the protein deficit in the cattle diet exceeded 20 per cent (Bucataru, Cosman, Holban, 2006), being the main reason for poor productivity indicators, particularly over the period 1993-2003. Between 2003 and 2019, the average productivity of dairy cows tended to grow.

Average annual milk production per one sheep and goat. Milk yield from sheep and goats in the RM varies in different breeds (Bucataru, Radionov, Urzica, 2002; Bucataru, Radionov, Varban, 2003). For example, the potential average milk yield of a Karakul breed sheep is 60-80 kg of milk per year with a fat content of 7-8 per cent, and Tsigae breed reaches a productivity of 75-120 kg of milk per year with a fat content of 6.5-7.0 per cent, while in local goats the milking potential is 224-324 kg of milk per year with an average fat content of 4.7 per cent (see Annex 3-3). Table 5-15 provides statistical data on the average milk production per sheep and goats at individual farms in the Republic of Moldova, for the period 1990-2019.

Table 5-15: Average milk production per sheep and goats at individual farms for the period 1990-2019, kg/head/year

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total national average annual milk production per one goat	102.0	105.0	108.0	121.0	134.0	117.0	121.0	125.0	110.0	106.0
Total national average annual milk production per one sheep	15.9	16.0	16.1	16.2	16.3	16.1	16.3	16.2	18.9	20.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total national average annual milk production per one goat	97.0	97.0	99.0	98.0	105.0	112.0	137.0	143.0	139.0	147.0
Total national average annual milk production per one sheep	20.0	20.0	24.0	26.0	21.0	32.0	30.0	33.0	35.0	36.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total national average annual milk production per one goat	149.0	136.9	168.8	201.3	167.0	178.0	179.0	188.0	191.0	156.0
Total national average annual milk production per one sheep	36.0	34.6	32.7	37.1	39.0	37.0	40.0	40.0	41.0	38.0

Source: NBS, Statistical Annual Report No. 24-agr 'Animal Breeding Sector'. Basic Indicators of Animal Breeding Sector Development in all Households Categories in the Republic of Moldova (annual reports for 1990-2019).

[85] NBS, on-line database: < http://statbank.statistica.md/pxweb/Database/RO/16%20AGR/AGR03/AGR03.asp>.

Average Wool Production per Sheep. The default value used is 4 kg/year/head (2006 IPCC Guidelines). According to statistical data, the value of this indicator varied in the RM over the period 1990-2019 between 1.2 and 2.3 kg of wool collected per year from one sheep (Table 5-16).

Table 5-16: Average wool production from sheep at individual farms for the period 1990-2019, kg/head/year

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Average annual amount of wool sheared per sheep	2.30	2.30	2.10	1.90	2.00	2.00	1.90	2.00	2.00	1.90
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Average annual amount of wool sheared per sheep	1.80	2.30	2.20	2.00	2.10	2.20	2.00	1.80	1.70	1.80
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Average annual amount of wool sheared per sheep	1.76	1.66	1.25	1.64	1.93	1.51	1.53	1.41	1.74	2.00

Source: NBS, Statistical Annual Report No. 24-agr 'Animal Breeding Sector'. Basic Indicators of Animal Breeding Sector Development in all Households Categories in the Republic of Moldova (annual reports for 1990-2019).

Climate Conditions. Feeding conditions for animals are greatly dependent on climate conditions, particularly on average the annual temperature in areas where livestock is bred. In accordance with the 2006 IPCC Guidelines, data on the average annual temperature in areas with animal population have to be used as follows: areas with average annual temperatures lower than 15°C are defined as cold climate areas; areas with average annual temperatures between 15°C and 25°C are defined as temperate climate areas; and areas with average annual temperatures higher than 25°C are defined as warm climate areas. In accordance with data on the average annual temperature in the Celsius scale available in the Statistical Yearbooks, the Republic of Moldova refers to Eastern European countries with cold climate (Table 5-17).

Table 5-17: Average annual temperature in the RM for the period 1990-2019, °C

Geographic Areas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
North	9.5	8.0	8.5	7.8	9.5	8.4	7.1	7.7	8.2	9.2
Centre	11.3	9.4	10.1	9.4	11.3	10.0	9.1	9.4	10.3	11.0
South	11.4	9.3	10.2	9.3	11.3	10.0	9.1	9.1	10.1	10.9
Geographic Areas	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
North	9.7	8.8	9.5	8.6	9.0	8.7	9.7	9.6	8.9	9.1
Centre	11.2	10.3	10.8	9.8	10.3	10.5	11.3	11.4	10.6	10.5
South	11.2	10.4	11.0	10.3	10.9	10.8	11.8	11.8	11.2	10.6
Geographic Areas	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
North	9.3	9.4	9.7	9.4	9.3	10.5	9.9	9.8	9.8	10.6
Centre	11.2	11.1	11.3	11.1	10.9	12.0	11.2	11.2	11.2	12.2
South	11.7	11.5	11.8	11.5	11.3	12.1	11.8	11.5	11.7	12.6

Source: NBS, Statistical Yearbooks of the RM for 1991 (page 207), 1994 (page 31), 1999 (page 13), 2006 (page 15), 2011 (page 15), 2013 (page 15), 2014 (page 15), 2016 (page 18), 2017 (page 16).

Percentage of females that give birth in a year (%)[86]. Table 5-18 provides statistical data on live products from 100 females at publicly owned agricultural enterprises over 1990-2019 periods.

Table 5-18: Live products from 100 females at publicly owned agricultural enterprises for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Calves from cows	86	80	79	75	72	66	65	58	61	55
Pigs from sows	1466	1317	1569	1223	989	983	1019	892	1187	772
Lambs from sheep giving birth	91	84	80	79	78	76	75	73	75	68
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Calves from cows	58	65	69	63	60	72	66	63	62	67
Pigs from sows	434	869	967	558	689	997	949	782	1015	1222
Lambs from sheep giving birth	71	79	81	75	79	84	80	73	81	83
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Calves from cows	63	71	63	56	93	71	71	67	66	73
Pigs from sows	1040	1136	1106	1173	1646	2378	2403	1877	2539	2828
Lambs from sheep giving birth	73	82	89	89	126	85	64	65	59	70

Source: NBS, Statistical Annual Report No. 24-agr 'Animal Breeding Sector'. Basic Indicators of Animal Breeding Sector Development in all Households Categories in the Republic of Moldova (annual reports for 1990-2019).

It should be noted, that the birth rate of some local breeds of sheep and goats is much higher than the one officially reported: circa 115 lambs per 100 Karakul breed female sheep giving birth; circa 120 lambs per 100 Tsigae breed female sheep giving birth; and circa 165 kids per 100 local female goats giving birth (see Annex 3-3).

[86] Default values used for Eastern European countries: 80 per cent for dairy cows and 67 for other cattle, see 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10A.1-2, page 10.73.

Digestible energy (DE)[87]. The situation regarding the quality of animal feed and digestibility of the food consumed, which represents the percentage of energy from food which is not eliminated in the form of feces (50-60 per cent for crop by-products and range lands, 60-75 per cent for high quality pastures, good preserved forages, and grain supplemented forage-based diets, and 75-85 per cent for grain-based diets fed in feedlots).

In the Republic of Moldova, DE values varied over the years. In the reference year, when the livestock maintenance conditions, foddering and feeding situation were optimal, the value was admitted DE – 69 per cent; for 1991-1992, DE – 68 per cent; for 1993, DE – 66 per cent; for 1994-1996, DE – 65 per cent; for 1997-2004, DE – 66 per cent; for 2005-2008, DE – 67 per cent; for 2009-2013, DE – 68 per cent; and for 2014-2019, DE – 68 per cent, respectively.

Gross Energy (GE). Animal performance and diet data were collected from Statistical Yearbooks and other relevant specialty publications to estimate feed intake, which is the amount of energy (MJ/day) an animal needs for maintenance and for activities such as growth, lactation, and pregnancy. The 2006 IPCC Guidelines provides a series of equations (Table 5-19) that were used to calculate the average amount of gross energy required for animal maintenance and other relevant vital activities.

Table 5-19: Equations used to estimate daily gross energy intake for cattle, sheep and goats for maintenance and other relevant vital activities

Metabolic Function	Equation in 2006 IPCC Guidelines	
	Cattle	Sheep and Goats
Maintenance (*NE_m*)	10.3	10.3
Activity (*NE_a*)	10.4	10.5
Growth (*NE_g*)	10.6	10.7
Lactation (*NE_l*)	10.8	10.9 and 10.10
Work (*NE_w*)	10.11	NA
Wool Production (NE_{wool})	NA	10.12
Pregnancy (*NE_p*)	10.13	10.13
REM {NE_{ma}/DE}	10.14	10.14
REG {NE_{ga}/DE}	10.15	10.15
Gross Energy *(GE)*	10.16	10.16

Net energy for maintenance (NE_m). Net energy required for maintenance represents the amount of energy needed to keep the animal in equilibrium where body energy is neither gained nor lost. NE_m was calculated based on Equation 10.3 in 2006 IPCC Guidelines.

$$NE_m = Cf_i \bullet (Weight)^{0.75}$$

Where:

NE_m – net energy required by the animal for maintenance, MJ/day;

Cf_i – a coefficient which varies for each animal category[88], default values being used as follows: Cf_i – 0.386 for dairy cows in the dry period (60 days), Cf_i – 0.451 for dairy cows during the lactation period (305 days), Cf_i – 0.370 for work oxen, Cf_i – 0.426 for breeding bulls, Cf_i – 0.322 for other cattle, Cf_i – 0.236 for sheep and goats up to 1 year, Cf_i – 0.247 for breeding males and Cf_i – 0.217 for animals older than 1 year, MJ/kg day;

Weight – live-weight of animal, kg.

Net energy for animal activity (NE_a). NE_a is the net energy for activity, or the energy needed for animals to obtain their food, water and shelter. NE_a for cattle was calculated in accordance with Equation 10.4, while for sheep and goats in accordance with Equation 10.5 in the 2006 IPCC Guidelines.

$$NE_a = C_a \bullet NE_m$$

Where:

NE_a – net energy for animal (cattle) activity, MJ/day;

C_a – coefficient corresponding to animal's feeding situation[89], default values used are as follows: cattle is confined to a small area with the result that they expend very little or no energy to acquire feed; Ca – 0.17, cattle is confined in areas with sufficient forage requiring modest energy

[87] Default values used, available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.2, Page 10.14.
[88] Default values available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.4, Page 10.16.
[89] Default values available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.5, Page 10.17.

expense to acquire feed; Ca – 0.36, cattle graze in open range land or hilly terrain and expend significant energy to acquire feed; taking into account that the grazing period for cattle in the RM is generally circa 210 days (April-November), and the confinement period is respectively circa 155 days (December-March) (Andries, Rusu, Donos, Constantinov, 2005), the average weighted values for Ca coefficient for conditions of the Republic of Moldova were estimated as: Ca – 0.098 for 1990-1991 period and Ca – 0.207 for 1992-2019;

NE_m – net energy required by the animal for maintenance, MJ/day.

$$NE_a = C_a \bullet Weight$$

Where:

NE_a – net energy for animal (sheep and goats) activity, MJ/day;

C_a – coefficient corresponding to animal's feeding situation[90]), default values used are as follows: C_a – 0.0090, when animals are confined due to pregnancy in final trimester (50 days), C_a – 0.0107, when animals walk up to 1000 meters per day and expend very little energy to acquire feed, C_a – 0.024, when animals walk up to 5 km per day and expend significant energy to acquire feed and C_a – 0.0067, when animals are housed for fattening, MJ/kg day; taking into account that the grazing period for sheep and goats in the RM is generally circa 210 days (April-November) and the confinement period is respectively circa 155 days (December-March) (Andries, Rusu, Donos, Constantinov, 2005), the weighted average values for C_a coefficient for conditions of the RM is C_a – 0.0167 for mature rams and respectively C_a – 0.0202 for growing lambs and kids up to 1 year;

Weight – live-weight of animal, kg.

Net energy for growth: (*NE_g*) is the net energy needed for growth (i.e., weight gain). NE_a for cattle was calculated based on Equation 10.6, and for sheep and goats – Equation 10.7 in the 2006 IPCC Guidelines.

$$NE_g = 22.02 \bullet (BW / C \bullet MW)^{0.75} \bullet WG^{1.097}$$

Where:

NE_g – net energy needed for cattle growth, MJ/day;

BW – the average live body weight (BW) of cattle in the population, kg;

C – coefficient with a value of 0.8 for females, 1.0 for castrates and 1.2 for breeding bulls[91];

MW – the mature live body weight of an adult female in moderate body condition, kg;

WG – average daily weight gain of the animals in the population, kg/day.

$$NE_g = \{WG_{lamb} \bullet [a + 0.5b (BW_i + BW_f)]\} / (365\ days/yr)$$

Where:

NE_g – net energy needed for growth (sheep and goats), MJ/day;

WG_{lamb} – average weight gain (BW_f-BW_i), kg/year;

BW_i – average live body weight at weaning, kg;

BW_f – average live bodyweight at one year old or at slaughter (live-weight) if slaughtered prior to 1 year of age, kg;

a, b – constants, a – 2.5 and b – 0.35 for breeding males; a – 4.4 and b – 0.32 for castrates; a – 2.1 and b – 0.45 for females[92].

Net energy for lactation: (*NE_l*) is the net energy for lactation. For cattle, the net energy for lactation was calculated in conformity with Equation 10.8, based on information on the amount of milk produced and its fat content, and for sheep it was calculated in accordance with Equation 10.9 in the 2006 IPCC Guidelines.

$$NE_l = Milk \bullet (1.47+0.40 \bullet Fat)$$

[90] Default values available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.5, Page 10.17.
[91] Default values available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Equation 10.6, Page 10.17.
[92] Default values available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Equation 10.6, Page 10.18.

Where:

NE_l – net energy for lactation (cattle), MJ/day;

Milk – amount of milk produced by a dairy cow, kg of milk/day;

Fat – fat content of milk (cattle), per cent by weight.

For sheep and goats NE_l may be calculated using two possible methods. The first method, used in the current inventory cycle, is used when the amount of milk produced is known (Equation 10.9 in the 2006 IPCC Guidelines), and the second method is used when the amount of milk produced is not known (Equation 10.10 in the 2006 IPCC Guidelines).

$$NE_l = Milk \bullet EV_{milk}$$

Where:

NE_l – net energy for lactation (sheep and goats), MJ/day;

Milk – amount of milk produced, kg of milk/day;

EV_{milk} – the net energy required producing 1 kg of milk; a default value of 4.6 MJ/kg can be used, which corresponds to a milk fat content of 7 per cent by weight.

Net energy for work: (*NE_{work}*) is the net energy for work. It is believed that one hour of typical work of draft animals (cattle) requires circa 10 per cent of the net daily energy for maintenance (NE_m). NE_{work} is calculated in conformity with Equation 10.11 in the 2006 IPCC Guidelines.

$$NE_{work} = 0.10 \bullet NE_m \bullet Hours$$

Where:

NE_{work} – net energy for work (cattle), MJ/days;

NE_m – net energy required by the animal for maintenance (from Equation 10.3), MJ/day;

Hours – number of hours of work per day[93]; this inventory cycle used 2 hours of work per day regarding the 1990-1991 time period and 3 hours of work per day for 1992-2019.

Net energy for wool production: (NE_{wool}) is the average daily net energy required for wool production. NE_{wool} was calculated in accordance with Equation 10.12 in the 2006 IPCC Guidelines.

$$NE_{wool} = (EV_{wool} \bullet Production_{wool}) / 365$$

Where:

NE_{wool} – net energy required to produce wool, (sheep and goats), MJ /day;

EV_{wool} – the energy value of each kg of wool produced, MJ/kg, the default value used is 24 MJ/kg;

$Production_{wool}$ – annual wool production per sheep, kg.

Net energy for pregnancy: (NE_p) is the energy required for pregnancy[94] and shall be calculated in accordance with Equation 10.13 in the 2006 IPCC Guidelines. For cattle, the total energy requirement for pregnancy for a 281-day gestation period averaged over an entire year is calculated as 10 per cent of NE_m. For sheep and goats, the NE_p requirement is similarly estimated for the 144-154-days gestation period although the percentage varies with the number of lambs born[95].

$$NE_p = C_{pregnancy} \bullet NE_m$$

Where:

NE_p – net energy required for pregnancy, MJ/day;

$C_{pregnancy}$ – pregnancy coefficient;

NE_m – net energy required by the animal for maintenance (Equation 10.3), MJ/day.

Ratio of net energy available in diet for maintenance to digestible energy consumed (REM). REM was calculated in accordance with Equation 10.14 in the 2006 IPCC Guidelines.

$$REM = [1.123 - (4.092 \bullet 10^{-3} \bullet DE\%) + [1.126 \bullet 10^{-5} \bullet (DE\%)^2] - (25.4/DE\%)]$$

Where:

[93] Default value available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10A-2, Page 10.73

[94] Default value available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.7, Page 10.20.

[95] Cpregnancy default values were estimated regarding average prolificacy of the local breeds in the RM: Cpregnancy – 0.087 for sheep and goats.

REM – ratio of net energy available in diet for maintenance to digestible energy consumed;

DE – digestible energy expressed as a percentage of gross energy.

Ratio of net energy available for growth in a diet to digestible energy consumed (REG). REG was calculated in accordance with Equation 10.15 in the 2006 IPCC Guidelines.

$$REG = [1.164 - (5.160 \bullet 10^{-3} \bullet DE\%) + (1.308 \bullet 10^{-5} \bullet (DE\%)^2) - (37.4/DE\%)]$$

Where:

REG – ratio of net energy available for growth in a diet to digestible energy consumed;

DE – digestible energy expressed as a percentage of gross energy.

Gross Energy (GE). Gross energy (GE) was calculated in accordance with Equation 10.16 in the 2006 IPCC Guidelines.

$$GE = \{[(NE_m + NE_a + NE_l + NE_{work} + NE_p) / REM] + [(NE_g) + NE_{wool} / REG]\} / (DE\%/100)$$

Where:

GE – gross energy, MJ/day;

NE_m – net energy required by the animal for maintenance (Equation 10.3), MJ/day;

NE_a – net energy for animal activity (Equations 10.4 and 10.5), MJ/day;

NE_l – net energy for lactation (Equations 10.8, 10.9 and 10.10), MJ/day;

NE_{work} – net energy for work (Equation 10.11), MJ/day;

NE_p – net energy required for pregnancy (Equation 10.13), MJ/day;

REM – ratio of net energy available in diet for maintenance to digestible energy consumed (Equation 10.14);

NE_g – net energy needed for growth (Equations 10.6 and 10.7), MJ/day;

NE_{wool} – net energy required to produce wool (Equation 10.12), MJ/day;

REG – ratio of net energy available for growth in a diet to digestible energy consumed (Equation 10.15);

DE – digestible energy expressed as a percentage of gross energy.

GE values calculated for animal categories relevant in the RM are provided in Table 5-20.

Table 5-20: Gross Energy (GE) values calculated for animal categories following a Tier 2 methodology, MJ/head/day

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy cows	245.8	229.0	227.3	219.8	217.8	213.2	211.8	211.4	212.1	212.5
Other cattle (average)	118.4	116.1	116.8	122.5	125.9	123.4	129.5	124.7	123.3	123.6
…Calves and heifers up to 1 year	100.2	94.6	95.0	95.4	96.7	78.5	75.4	69.9	77.4	71.6
…Heifers between 12 and 18 months	131.0	131.0	126.7	127.2	127.4	127.4	125.7	120.8	114.8	114.8
…Heifers between 18 and 24 months	156.8	152.3	147.2	142.7	146.4	146.4	146.4	142.7	136.1	136.1
…Heifers between 24 months and more	167.2	165.0	158.8	158.8	160.2	160.2	164.4	158.7	152.0	152.0
…Breeding males	207.9	204.9	191.9	194.2	190.4	188.3	184.2	178.2	178.2	178.2
…Work bullocks	182.5	181.8	170.7	185.5	187.0	187.0	187.0	183.0	180.5	177.9
Sheep and goats (average)	16.9	16.9	16.3	16.2	16.3	15.6	15.6	15.2	15.1	15.2
…Mature females ≥ 1 year	17.4	17.3	16.7	16.7	17.0	16.0	15.9	15.6	15.6	15.6
…Breeding males	24.9	24.3	23.9	23.8	23.9	23.1	23.1	22.9	22.4	22.3
…Growing lambs and kids up to 1 year	13.2	12.9	12.4	12.4	12.7	12.4	12.3	11.4	10.6	11.4
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Dairy cows	213.5	216.2	218.9	219.4	227.1	229.8	228.7	230.1	230.8	232.2
Other cattle (average)	128.9	124.6	127.4	126.3	131.7	129.4	130.2	127.7	121.7	120.7
…Calves and heifers up to 1 year	75.5	81.5	85.0	81.7	83.5	86.7	87.0	83.9	87.2	90.5
…Heifers between 12 and 18 months	114.8	120.8	129.4	129.4	128.3	130.1	132.5	130.1	119.4	114.9
…Heifers between 18 and 24 months	136.1	142.7	147.9	147.9	151.5	149.2	154.1	152.1	142.1	143.3
…Heifers between 24 months and more	152.0	160.1	161.5	161.5	166.8	166.3	170.3	166.3	151.9	150.3
…Breeding males	178.2	178.2	180.3	180.3	182.3	178.5	180.4	180.4	182.4	180.6
…Work bullocks	175.3	177.9	180.5	183.0	185.5	184.1	184.1	184.1	186.6	185.2
Sheep and goats (average)	15.1	15.2	15.3	14.9	15.3	15.7	15.5	15.6	15.5	16.2
…Mature females ≥ 1 year	15.6	15.6	15.8	15.5	15.7	16.4	16.3	16.3	16.2	16.9
…Breeding males	22.3	21.9	21.9	21.3	22.4	21.4	21.6	21.5	20.7	21.3
…Growing lambs and kids up to 1 year	10.6	11.1	11.5	10.5	11.8	10.9	10.5	11.1	10.2	10.9

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Dairy cows	237.6	238.8	239.0	242.3	245.9	245.8	243.5	246.9	247.1	241.8
Other cattle (average)	121.8	123.7	124.3	122.0	118.5	114.8	122.9	115.6	117.7	115.9
…Calves and heifers up to 1 year	87.1	89.3	90.7	88.1	86.5	82.6	91.4	88.1	92.7	91.4
…Heifers between 12 and 18 months	120.5	122.9	123.7	121.3	118.0	113.9	122.5	118.0	124.0	122.5
…Heifers between 18 and 24 months	144.6	146.6	147.6	145.1	140.9	138.0	140.9	140.9	142.7	140.9
…Heifers between 24 months and more	153.6	154.6	155.1	154.1	149.4	146.6	149.4	149.4	151.3	149.4
…Breeding males	180.6	180.6	180.6	180.6	177.4	173.6	172.7	177.4	176.5	175.6
…Work bullocks	185.2	185.2	185.2	185.2	186.9	178.0	176.9	186.9	181.0	179.8
Sheep and goats (average)	16.2	16.0	15.7	16.7	17.7	17.0	17.4	17.0	17.3	17.1
…Mature females ≥ 1 year	16.8	16.7	16.6	17.8	19.0	18.2	18.6	18.3	18.5	18.3
…Breeding males	21.3	21.2	21.1	21.2	20.4	20.7	20.7	20.7	20.8	20.9
…Growing lambs and kids up to 1 year	11.6	10.5	10.7	10.8	11.9	11.7	12.0	11.7	11.8	11.9

For animal categories 'other cattle'[96] 'sheep' and 'goats'[97], GE values are weighted averages, taking into account the specific GE values for each subcategory of animals, the percentage distribution of their population, respectively (Table 5-21).

Table 5-21: Distribution of animal population by sub-categories between 1990-2019, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Other cattle, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
…Calves and heifers up to 1 year	62.3	58.2	53.3	40.9	37.4	31.9	22.3	27.0	27.1	24.2
…Heifers between 12 and 18 months	17.3	19.8	21.0	25.5	27.0	26.8	31.1	18.0	14.2	13.2
…Heifers between 18 and 24 months	8.7	10.2	12.4	17.3	16.2	18.5	20.1	24.2	26.4	32.3
…Heifers between 24 months and more	11.4	11.4	12.9	14.8	17.5	20.7	23.5	27.5	28.6	26.0
…Breeding males	0.2	0.3	0.4	1.1	1.4	1.4	1.9	2.3	2.6	3.1
…Work bullocks	0.0	0.0	0.1	0.4	0.5	0.7	1.0	0.9	1.1	1.3
Sheep and goats, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
…Mature females ≥ 1 an	79.2	83.0	82.4	80.0	74.0	81.5	82.2	82.5	82.5	81.8
…Breeding Males	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
…Growing lambs and kids up to 1 year	17.8	14.0	14.6	17.0	23.0	15.5	14.8	14.5	14.5	15.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Other cattle, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
…Calves and heifers up to 1 year	16.8	32.2	34.7	33.7	29.5	34.2	34.2	34.8	37.0	35.9
…Heifers between 12 and 18 months	13.4	15.9	14.7	16.3	17.9	15.0	20.4	18.3	17.2	19.6
…Heifers between 18 and 24 months	40.0	26.6	25.8	27.0	27.4	27.0	25.7	26.2	25.9	25.5
…Heifers between 24 months and more	25.4	21.4	21.0	19.4	21.9	20.7	17.3	18.3	17.6	17.0
…Breeding males	3.0	2.8	2.7	2.6	2.4	2.2	1.8	1.7	1.6	1.4
…Work bullocks	1.3	1.1	1.0	0.9	0.8	0.9	0.5	0.7	0.7	0.4
Sheep and goats, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
…Mature females ≥ 1 an	82.0	82.9	81.7	81.5	81.5	81.9	79.6	80.7	82.5	82.1
…Breeding Males	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
…Growing lambs and kids up to 1 year	15.0	14.1	15.3	15.5	15.5	15.1	17.4	16.3	14.5	14.9
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Other cattle, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
…Calves and heifers up to 1 year	35.5	34.6	36.2	35.7	36.9	36.8	32.6	44.0	46.8	47.0
…Heifers between 12 and 18 months	19.1	21.2	20.2	22.0	21.0	20.6	22.2	18.4	17.6	18.6
…Heifers between 18 and 24 months	26.9	26.4	25.4	24.5	24.2	25.1	26.0	20.9	20.6	19.6
…Heifers between 24 months and more	16.7	16.3	15.7	15.2	15.4	15.4	16.9	14.5	13.5	13.3
…Breeding males	1.4	0.4	0.4	0.5	0.4	0.3	0.4	0.4	0.3	0.2
…Work bullocks	0.3	1.2	2.1	2.2	2.1	1.9	1.9	1.8	1.3	1.3
Sheep and goats, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
…Mature females ≥ 1 an	82.7	83.0	79.7	79.2	78.0	77.2	77.8	76.3	77.9	77.5
…Breeding Males	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
…Growing lambs and kids up to 1 year	14.3	14.0	17.3	17.8	19.0	19.8	19.2	20.7	19.1	19.5

Source: NBS, Statistical Annual Report No. 24-agr 'Animal Breeding Sector'. Basic Indicators of Animal Breeding Sector Development in all Households Categories in the Republic of Moldova (annual reports for 1990-2019).

Methane Conversion Factor (Y_m). The extent to which feed energy is converted to CH_4 depends on several interacting feed and animal factors. As CH_4 conversion factors are unavailable from country-specific research, default values provided in the 2006 IPCC Guidelines were used for cattle[98]: Y_m – 0.03 for feedlot fed cattle (young animals) and Y_m – 0.065 for dairy cows and other cattle; for sheep and goats[99]: Y_m – 0.045 for lambs and kids and Y_m – 0.065 for mature rams, ewes and goats.

Methane emission factors (EF). Based on the information above, country-specific national factors were developed for source category 3A 'Enteric Fermentation' (for cattle, sheep and goats). The emission factor for each animal category was developed following Equation 10.21 in the 2006 IPCC Guidelines.

[96] Default values used for „other cattle" category are: 30% of total – mature females, 22% – mature males, and 48% – young cattle (2006 IPCC Guidelines, Vol. 3, Ch. 10, Table 10A-2, Page 10.73).
[97] According to the literature in the field (Bucataru et al., 2003), the reproduction structure at local sheep and goats is: breeding males – circa 3%, mature females – circa 75%, breeding youngsters – circa 22%.
[98] Default values used for cattle available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.12, Tables 10A-1 and 10A-2, Pages 10.30, 10.72-10.73.
[99] Default values used for sheep and goats available in 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.13, Page 10.31.

$$EF = [GE \bullet (Y_m/100) \bullet 365 / 55.65]$$

Where:

EF – emission factor, kg CH_4/head/yr;

GE – gross energy intake, MJ/head/day;

Y_m – methane conversion factor, % of gross energy in feed converted to methane;

55.65 MJ/kg CH_4 – the energy content of methane.

Table 5-22 shows country-specific emission factors for cattle bred in the RM, developed by using a Tier 2 simplified methodology.

Table 5-22: Country-Specific EFs for enteric fermentation, calculated for cattle population following a Tier 2 methodology, kg CH_4/head/year

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy cows	**104.8**	**97.6**	**97.2**	**93.7**	**92.8**	**90.9**	**90.5**	**90.1**	**90.4**	**90.6**
Other cattle (average)	**50.5**	**49.5**	**49.9**	**52.2**	**53.7**	**52.6**	**55.3**	**53.2**	**52.6**	**52.7**
…Calves and heifers up to 1 year	42.7	40.3	40.6	40.7	41.2	33.5	32.2	29.8	33.0	30.5
…Heifers between 12 and 18 months	55.9	55.8	54.2	54.2	54.3	54.3	53.7	51.5	49.0	49.0
…Heifers between 18 and 24 months	66.8	64.9	62.9	60.8	62.4	62.4	62.6	60.8	58.0	58.0
…Heifers between 24 months and more	71.3	70.4	67.9	67.7	68.3	68.3	70.3	67.7	64.8	64.8
…Breeding males	88.6	87.3	82.0	82.8	81.2	80.3	78.8	76.0	76.0	76.0
…Work bullocks	77.8	77.5	73.0	79.1	79.7	79.7	79.9	78.0	76.9	75.8
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Dairy cows	**91.3**	**92.2**	**93.3**	**93.5**	**97.1**	**98.0**	**97.5**	**98.1**	**98.7**	**99.0**
Other cattle (average)	**55.1**	**53.1**	**54.3**	**53.9**	**56.3**	**55.2**	**55.5**	**54.4**	**52.0**	**51.4**
…Calves and heifers up to 1 year	32.3	34.8	36.3	34.8	35.7	37.0	37.1	35.8	37.3	38.6
…Heifers between 12 and 18 months	49.1	51.5	55.1	55.1	54.9	55.5	56.5	55.5	51.1	49.0
…Heifers between 18 and 24 months	58.2	60.8	63.0	63.0	64.8	63.6	65.7	64.9	60.8	61.1
…Heifers between 24 months and more	65.0	68.3	68.8	68.8	71.3	70.9	72.6	70.9	64.9	64.1
…Breeding males	76.2	76.0	76.9	76.9	77.9	76.1	76.9	76.9	78.0	77.0
…Work bullocks	75.0	75.8	76.9	78.0	79.3	78.5	78.5	78.5	79.8	79.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Dairy cows	**101.3**	**101.8**	**102.2**	**103.3**	**104.8**	**104.8**	**104.1**	**105.3**	**105.3**	**103.1**
Other cattle (average)	**51.9**	**52.7**	**53.1**	**52.0**	**50.5**	**49.0**	**52.5**	**49.3**	**50.2**	**49.5**
…Calves and heifers up to 1 year	37.1	38.1	38.8	37.6	36.9	35.2	39.1	37.5	39.5	39.0
…Heifers between 12 and 18 months	51.4	52.4	52.9	51.7	50.3	48.6	52.4	50.3	52.9	52.2
…Heifers between 18 and 24 months	61.7	62.5	63.1	61.9	60.1	58.9	60.2	60.1	60.8	60.1
…Heifers between 24 months and more	65.5	65.9	66.3	65.7	63.7	62.5	63.9	63.7	64.5	63.7
…Breeding males	77.0	77.0	77.2	77.0	75.6	74.0	73.8	75.6	75.2	74.8
…Work bullocks	79.0	79.0	79.2	79.0	79.7	75.9	75.6	79.7	77.2	76.7

Table 5-23 shows country-specific emission factors calculated for sheep and goats. The obtained results are intermediary to default values characteristic to developing countries – with 5 kg CH_4/head/year for sheep and goats, and developed countries – with 8 kg CH_4/head/year, respectively (2006 IPCC Guidelines).

Table 5-23: Country-Specific EFs from Enteric Fermentation, calculated for sheep population following a Tier 2 methodology, kg CH_4/head/year

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sheep (average), including:	**6.9**	**6.9**	**6.7**	**6.6**	**6.5**	**6.4**	**6.4**	**6.3**	**6.2**	**6.2**
…Mature ewes and Ewe lambs ≥ 1 year	7.4	7.4	7.1	7.1	7.3	6.8	6.8	6.6	6.6	6.7
…Breeding rams	10.6	10.4	10.2	10.2	10.2	9.9	9.9	9.8	9.5	9.5
…Growing lambs up to 1 year	3.9	3.8	3.7	3.7	3.7	3.6	3.6	3.4	3.1	3.4
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sheep (average), including:	**6.2**	**6.3**	**6.3**	**6.1**	**6.3**	**6.5**	**6.4**	**6.4**	**6.4**	**6.7**
…Mature ewes and Ewe lambs ≥ 1 year	6.7	6.7	6.7	6.6	6.7	7.0	7.0	6.9	6.9	7.2
…Breeding rams	9.5	9.3	9.3	9.1	9.6	9.1	9.2	9.2	8.9	9.1
…Growing lambs up to 1 year	3.1	3.3	3.4	3.1	3.5	3.2	3.1	3.3	3.0	3.2
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sheep (average), including:	**6.7**	**6.6**	**6.5**	**6.8**	**7.2**	**6.9**	**7.1**	**6.9**	**7.1**	**7.0**
…Mature ewes and Ewe lambs ≥ 1 year	7.2	7.1	7.1	7.6	8.1	7.7	7.9	7.8	7.9	7.8
…Breeding rams	9.1	9.1	9.0	9.1	8.7	8.8	8.9	8.8	8.9	8.9
…Growing lambs up to 1 year	3.4	3.1	3.2	3.2	3.5	3.4	3.5	3.4	3.5	3.5

5.2.3. Uncertainties Assessment and Time-Series Consistency

Uncertainties related to estimation of methane emissions from enteric fermentation, particularly those related to livestock estimation, and also on the emission factors used. The uncertainties associated with the domestic animal population in the RM are moderate (circa 10 per cent). The accuracy of default EFs estimated by using a Tier 1 method is circa 30 per cent (2006 IPCC Guidelines). Because this methodology does not rely on country-specific values and does not take into account the country's livestock characteristics, general uncertainty of results obtained by using this approach could reach up to circa 50 per cent (2006 IPCC Guidelines).

In case of a Tier 2 approach, uncertainties will depend mostly on how accurately the characteristics of the main animal categories are used and on the extent to which estimation methods and coefficients applied in various equations used to calculate net energy comply with the national circumstances (2006 IPCC Guidelines). The accuracy of EFs estimated by using a Tier 2 methodology are likely to be in the order of circa 20 per cent (2006 IPCC Guidelines). Thus, the combined uncertainties for source category 3A 'Enteric Fermentation' represent circa 22.36 per cent (Annex 5-3.3).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

5.2.4. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for category 3A 'Enteric Fermentation', following a Tier 1 approach.

It should be noted that the AD and methods used to estimate GHG emissions under this category were documented and archived both in hard copies and electronically. In order to identify the data entry and the CH_4 emissions estimation process related errors there were applied verifications and quality control procedures.

Following the recommendations included in the 2006 IPCC Guidelines, CH_4 emissions were estimated using AD from official reference sources.

5.2.5. Recalculations

CH_4 emissions from source category 3A 'Enteric fermentation' were recalculated as a result of using default emission factors for goats for the entire period 1990-2016 (this decision is supported by the fact that methane emissions generated by the population of goats are not a key emission source, and the fact that the series of complete statistical data on goat population productivity in the RM during the reporting period is missing, respectively), and as a result of the updated DE values for the period 2013-2016 expressed as a percentage of gross energy, GE values and country-specific emission factors for cattle, and sheep and goats, calculated using a Tier 2 methodology. Additionally, in the case of leap years (1992, 1996, 2000, 2004, 2008, 2012 and 2016), in the equations used to calculate the gross energy required for cattle, sheep and goats categories for maintenance and other activities relevant to life (Table 5-19), the number of days in the calendar year was corrected, from 365 to 366. In comparison with results recorded in the BUR2, the changes performed in the current inventory cycle resulted in an insignificant downward trend in CH_4 emissions for the period 1990-2016 (Table 5-24).

Table 5-24: Comparative results of CH_4 emissions from category 3A 'Enteric Fermentation' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	87.6278	81.2260	79.7785	75.0132	73.0168	64.8293	59.6463	51.4030	49.9008	46.1673
BUR3	87.5771	81.1547	79.8715	74.9162	72.9133	64.7235	59.6750	51.3040	49.8079	46.0727
Difference, %	-0.1	-0.1	0.1	-0.1	-0.1	-0.2	0.0	-0.2	-0.2	-0.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	43.4256	44.2270	45.1436	41.2430	38.4891	37.0587	35.8683	28.9954	27.6273	28.7000
BUR3	43.4313	44.1309	45.0244	41.1415	38.4568	36.9611	35.7523	28.8838	27.5714	28.5438
Difference, %	0.0	-0.2	-0.3	-0.2	-0.1	-0.3	-0.3	-0.4	-0.2	-0.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	28.5028	26.8403	25.3134	25.7324	27.2385	26.1360	25.9708			
BUR3	28.3270	26.6765	25.2109	25.3945	26.1032	25.1684	24.8801	23.1182	20.6560	17.6658
Difference, %	-0.6	-0.6	-0.4	-1.3	-4.2	-3.7	-4.2			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

The table below presents the comparative results of the inventory of methane emissions from source category 3A 'Enteric Fermentation' included in the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 (GWP_{100} = 25) (Table 5-25).

Table 5-25: Comparative results of CH_4 emissions from category 3A 'Enteric Fermentation' included into the BUR2 and BUR3 and of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	2190.6944	2030.6501	1994.4621	1875.3295	1825.4206	1620.7325	1491.1578	1285.0760	1247.5198	1154.1817
BUR3	2189.4276	2028.8687	1996.7865	1872.9050	1822.8316	1618.0865	1491.8749	1282.5988	1245.1973	1151.8178
Difference, %	-0.1	-0.1	0.1	-0.1	-0.1	-0.2	0.0	-0.2	-0.2	-0.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1085.6403	1105.6742	1128.5903	1031.0757	962.2286	926.4666	896.7070	724.8851	690.6823	717.4997
BUR3	1085.7826	1103.2722	1125.6099	1028.5383	961.4211	924.0273	893.8074	722.0955	689.2854	713.5953
Difference, %	0.0	-0.2	-0.3	-0.2	-0.1	-0.3	-0.3	-0.4	-0.2	-0.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	712.5704	671.0063	632.8347	643.3105	680.9618	653.4004	649.2698			
BUR3	708.1752	666.9120	630.2714	634.8631	652.5791	629.2090	622.0031	577.9552	516.4012	441.6456
Difference, %	-0.6	-0.6	-0.4	-1.3	-4.2	-3.7	-4.2			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the period 2017-2019, CH_4 emissions resulting from category 3A 'Enteric Fermentation' were estimated for the first time. The obtained results allow us to assert that between 1990 and 2019, methane emissions from the respective category had decreased by 79.8 per cent, particularly due to reduced animal population.

Between 1990-2019, the share of different livestock categories in the overall methane emissions from source category 3A 'Enteric Fermentation' had changed significantly. By 2019, the percentage of categories such as 'other cattle' had decreased considerably compared to the level in 1990, whereas the percentage of other categories such as 'dairy cows', 'sheep', 'goats', 'horses', 'asses and mules', and 'rabbits' recorded an upward trend (Table 5-26).

Table 5-26: Breakdown of CH_4 emissions from source category 3A 'Enteric Fermentation' by livestock category for the period 1990-2019, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy cows	47.3	47.8	49.1	50.3	51.3	53.5	53.9	56.9	57.8	60.3
Other cattle	38.3	36.8	35.4	33.5	31.6	28.3	27.0	23.4	22.6	20.1
Sheep	9.8	10.6	10.9	12.0	12.7	13.1	13.7	13.9	13.1	12.9
Goats	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.0	1.2
Horses	1.0	1.1	1.2	1.3	1.4	1.7	1.9	2.3	2.5	2.8
Asses and mules	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
Swine	3.2	3.2	2.8	2.2	2.2	2.4	2.4	2.3	2.8	2.4
Rabbits	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Dairy cows	62.7	62.7	63.2	63.1	62.9	61.8	60.5	61.5	61.5	60.1
Other cattle	18.6	18.5	18.1	17.2	16.2	15.9	16.3	13.7	12.6	12.6
Sheep	12.1	12.1	11.8	12.4	13.6	14.5	15.0	16.9	17.9	18.9
Goats	1.3	1.4	1.5	1.6	1.7	1.7	1.7	1.8	2.0	2.1
Horses	3.2	3.3	3.3	3.6	3.5	3.5	3.5	3.8	3.7	3.5
Asses and mules	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Swine	1.7	1.7	1.8	1.7	1.6	2.0	2.4	1.7	1.6	2.1
Rabbits	0.2	0.3	0.2	0.3	0.4	0.4	0.5	0.5	0.5	0.6
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Dairy cows	59.3	59.5	58.8	57.5	56.5	57.3	55.3	55.6	54.3	52.6
Other cattle	12.9	13.6	13.8	13.7	13.6	13.0	14.3	13.5	13.7	14.3
Sheep	18.7	17.7	17.9	19.3	20.4	19.9	20.5	20.5	21.1	21.2
Goats	2.2	2.5	2.7	2.8	2.9	3.2	3.4	3.7	3.9	4.3
Horses	3.4	3.4	3.4	3.3	2.9	2.9	2.7	2.7	2.7	2.7
Asses and mules	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1
Swine	2.7	2.7	2.6	2.6	2.9	2.9	2.8	2.9	3.1	3.6
Rabbits	0.6	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.0	1.1

It should also be noted the impact of using a Tier 2 assessment methodology at the expense of the Tier 1 methodology, which generally gave lower values of methane emissions from category 3A 'Enteric Fermentation', this reduction varying from a minimum of 9.4 per cent in 2014 and a maximum of 18.6 per cent in 1999 (Table 5-27).

Table 5-27: Comparative results of CH_4 emissions from 3A 'Enteric Fermentation', estimated using Tier 1 and Tier 2 Methodologies

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Tier 1, kt	98.1242	94.6819	93.5080	88.4700	86.1070	78.3118	71.5496	62.8516	61.0890	56.6017
Tier 2, kt	87.5771	81.1547	79.8715	74.9162	72.9133	64.7235	59.6750	51.3040	49.8079	46.0727
Difference, %	-10.7	-14.3	-14.6	-15.3	-15.3	-17.4	-16.6	-18.4	-18.5	-18.6
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Tier 1, kt	52.8901	53.6474	54.0904	49.6052	44.9070	42.8450	41.6227	33.6952	32.2693	33.1232
Tier 2, kt	43.4313	44.1309	45.0244	41.1415	38.4568	36.9611	35.7523	28.8838	27.5714	28.5438
Difference, %	-17.9	-17.7	-16.8	-17.1	-14.4	-13.7	-14.1	-14.3	-14.6	-13.8
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Tier 1, kt	32.3301	30.3247	28.6838	28.4903	28.8193	28.1627	27.5135	25.7706	22.8584	19.8389
Tier 2, kt	28.3270	26.6765	25.2109	25.3945	26.1032	25.1684	24.8801	23.1182	20.6560	17.6658
Difference, %	-12.4	-12.0	-12.1	-10.9	-9.4	-10.6	-9.6	-10.3	-9.6	-11.0

5.2.6. Planned Improvements

Planned improvements could include updating AD and productivity indicators used to estimate GHG emissions within this source category following a Tier 2 methodology, particularly for cattle and sheep, the animal categories that account for the largest share in the structure of total methane emissions originating from category 3A 'Enteric Fermentation'.

5.3. Manure Management (Category 3B)

Category 3B 'Manure Management' includes both methane and nitrous oxide emissions. The emissions level depends on the amount of manure treated and handled within manure management systems, properties of manure and type of manure management systems. Usually, poorly aerated manure management systems generate larger amounts of CH_4 and smaller amounts of N_2O; while well aerated systems generate less CH_4 emissions and more N_2O emissions.

5.3.1. Methane Emissions

5.3.1.1. Source Category Description

When manure decomposes anaerobically (in the absence of oxygen), methanogenic bacteria produce methane. The main factors affecting the production of CH_4 emissions from manure are the amount of manure produced and the share (or percentage) of manure decomposed anaerobically. The first category of these factors depends on the production rate of animal manure during a calendar year, as well as on livestock; and the second group of factors – the way in which animal manure is collected, stored and, used. The share of manure that decomposes anaerobically depends on how the manure is managed. When manure is stored or treated as a liquid (e.g., in lagoons, ponds, etc.), it decomposes anaerobically and can produce a significant quantity of CH_4, and when manure is stored or handled as a solid (e.g., in stacks or piles) or when it is excreted in the grazing process or applied on agricultural soils as organic fertilizer, it tends to decompose under more aerobic conditions and produce insignificant amounts of methane.

In order to estimate methane emissions from manure management, the total animal population was divided into subgroups to better reflect the average amount of waste produced per animal or poultry per year, as well as the way manure is managed. Average emissions rates were calculated for existent animal and poultry categories based on typical manure management systems and country-specific emission factors for cattle and swine, as well as based on default emission factors for other livestock and poultry categories.

5.3.1.2. Activity Data, Assessment Methodologies and Emission Factors

When using the Tier 1 methodology, emissions may be calculated by multiplying the activity data on livestock (identical to those used to estimate CH_4 emissions from 3A 'Enteric Fermentation') by default emission factors in countries with cold climate (average annual temperature being less than 15°C) (see Equation 10.22, 2006 IPCC Guidelines)

$$CH_4 Emissions= \Sigma_{(T)} [(EF_{(T)} \bullet N_{(T)})/10^6]$$

Where:

CH_4 Emissions – CH4 from manure management, for a defined population, kt CH4/yr;

$EF_{(T)}$ – emission factor for the defined livestock population, kg CH_4/head/yr;

$N_{(T)}$ – number of head of livestock species/category *T* in the country;

T – species/category of livestock.

Since source category 3B 'Manure Management' has a significant share in the country's emissions and default values used do not correspond to the specific conditions of animal growth and manure management practices used in the Republic of Moldova, following the 2006 IPCC Guidelines, in order to estimate CH_4 emissions, a Tier 2 methodology was used (for cattle and swine).

Methane Emission Factors (EFs). In the Republic of Moldova, country-specific EFs (for cattle and swine) were calculated based on information collected from statistical publications and various scientific research publications. To calculate these coefficients, it was necessary to determine the range in manure volatile solids content per animal (VS, in kg) and the maximum methane producing capacity typical to certain type of manure (B_0 in m^3 per kg of VS). Additionally, methane conversion factors (MCF) which also account for the influence of climate conditions on methane formation process were identified for each type of manure management system. CH_4 emission factors under category 3B 'Manure Management' were calculated by using Equation 10.23 in the 2006 IPCC Guidelines.

$$EF_{(T)}= (VS_{(T)} \bullet 365) \bullet [B_{0(T)} \bullet 0.67\ kg/m^3 \bullet \Sigma_{(S,\ k)} (MCF_{(S,\ k)}/100) \bullet MS_{(T,S,\ k)}]$$

Where:

$EF_{(T)}$ – annual CH_4 emission factor for livestock category *T*, kg CH_4/animal/yr;

$VS_{(T)}$ – daily volatile solid excreted for livestock category *T*, kg dm/animal/day (Table 5-28);

$B_{0(T)}$ – maximum methane producing capacity for manure produced by livestock category *T*, m^3 CH_4/kg of VS excreted;

0.67 – conversion factor (CF) of m^3 CH_4 to kilograms CH_4;

$MCF_{(S,k)}$ – methane conversion factors for each manure management system *S* by climate region *k*, %;

$MS_{(T,S,k)}$ – fraction of livestock category *T*'s manure handled using management system *S* in climate region *k*, dimensionless.

Table 5-28: Daily volatile solid excreted (VS) calculated for the period 1990-2019, kg dry matter/day

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy cows	4.15	3.98	3.95	4.03	4.10	4.01	3.98	3.87	3.89	3.89
Other cattle	1.99	2.00	2.02	2.23	2.36	2.31	2.42	2.27	2.25	2.25
Market swine	0.54	0.54	0.52	0.53	0.51	0.49	0.47	0.42	0.41	0.40
Fattening swine	0.34	0.34	0.33	0.34	0.32	0.31	0.29	0.26	0.26	0.25
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Dairy cows	3.91	3.96	4.01	4.02	4.16	4.10	4.08	4.11	4.12	4.03
Other cattle	2.35	2.27	2.32	2.30	2.40	2.30	2.31	2.27	2.16	2.08
Market swine	0.42	0.40	0.40	0.42	0.41	0.40	0.40	0.40	0.41	0.40
Fattening swine	0.26	0.25	0.25	0.26	0.26	0.25	0.25	0.25	0.26	0.25
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Dairy cows	4.13	4.15	4.15	4.21	4.03	4.03	3.99	4.05	4.05	3.97
Other cattle	2.10	2.14	2.15	2.11	1.93	1.87	2.00	1.89	1.92	1.89
Market swine	0.41	0.45	0.48	0.51	0.49	0.50	0.47	0.51	0.49	0.50
Fattening swine	0.26	0.28	0.30	0.32	0.31	0.31	0.30	0.32	0.31	0.31

Volatile Solids Excretion Rate (VS) was calculated following Equation 10.24 in the 2006 IPCC Guidelines.

$$VS = [GE \bullet (1 - DE\%/100)+(UE \bullet GE)] \bullet [(1 - ASH/18.45)]$$

Where:

VS – volatile solid excretion per day on a dry-organic matter basis, kg VS/day[100] (see country-specific values in Table 5-28);

[100] Default values used as follows: for dairy cows – 4.5 kg VS/day, other cattle – 2.7 kg VS/day (2006 IPCC Guidelines , Volume 4, Chapter 10, Table 10A-4, Page 10.77, and Table 10A-5, Page 10.78); for swine: market swine – 0.5 kg VS/day, fattening swine – 0.3 kg VS/day (2006 IPCC Guidelines , Volume 4, Chapter 10, Table 10A-8, Page 10.81 and Table 10A-7, Page 10.80).

GE – gross energy intake, MJ/day; the same values as those used for Enteric Fermentation;

DE – digestibility of the feed in per cent; for cattle the same values were used as under the 3A 'Enteric Fermentation'; for fattening swine, *DE*– 85 per cent, while for market swine DE – 75 per cent;

(UE • GE) – urinary energy expressed as fraction of gross energy (GE); typically, this value is 0.04GE for cattle and 0.02GE for swine;

ASH – the ash content of manure calculated as a fraction of the dry matter feed intake; values used by Austria into its NIR for 1990-2018 were used, 11 per cent for dairy cows, 11.5 per cent for other cattle, the default value of 2 per cent was used for swine (2006 IPCC Guidelines);

18.45 – conversion factor (CF) for dietary GE in MJ per kg of dry matter; this value is relatively constant across a wide range of forage and grain-based feeds commonly consumed by livestock.

The maximum *methane-producing capacity of the manure* (B_0) varies by species and diet. As it was not possible to identify country-specific values of B_0 expressed in m^3 per kg of VS in specialty literature, default values characteristic of EE countries were used (Tables 5-29 and 5-30).

Table 5-29: Coefficients and default EFs used for 3B 'Manure Management' for cattle and swine

Categories	Weight, kg	Digestibility, %	Energy, MJ/day	Daily feed intake, kg	Manure, kg/ dry (dry basis)	VS, kg/day	B_0, m^3 CH_4 / kg VS	EF, kg CH_4/ year
Dairy cows	550	60	207.2	11.2	4.49	4.5	0.24	11
Other cattle	391	60	134.4	7.3	2.91	2.7	0.17	6
Fattening swine	50	75	38.0	2.1	0.51	0.3	0.45	3
Market swine	180	60	38.0	2.1	0.51	0.5	0.45	4

Source: 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.14, page 10.38; Table 10A-4, page 10.77; Table 10A-5, page 10.78; Table 10A-7, page 10.80 and Table 10A-8, page 10.81.

Table 5-30: Coefficients and default emission factors used in category 3B 'Manure Management' (Developed Countries)

Categories	Weight, kg	Digestibility, %	Daily feed intake, kg	% Ash, dry basis.	VS per day, kg VS	B_0, m^3/kg VS	CF CH_4, %	EF, kg CH_4/ year
Sheep	48.5	60	1.08	8	0.40	0.19	1	0.19
Goats	38.5	60	0.76	8	0.30	0.18	1	0.13
Horses	377	70	5.96	4	2.13	0.30	1	1.56
Asses and Mules	130	70	3.25	4	0.94	0.33	1	0.76
Rabbits	1.6	-	-	-	0.10	0.32	1	0.08
Chickens	1.8	63	-	5	0.02	0.39	1	0.03
Turkeys	6.8	68	-	3	0.07	0.36	1	0.09
Broilers	0.9	68	-	2	0.01	0.36	1	0.02
Ducks	2.7	66	-	2	0.02	0.36	1	0.02

Source: 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.15, page 10.41; Table 10A-9, pages 10.82-10.83.

Methane Conversion Factors (MCF) values vary by different manure management systems and by annual average temperatures. Because of the unavailability of country-specific methane conversion factors (MCF), default values provided in the 2006 IPCC Guidelines were used (Table 5-31). MCF represents the extent to which maximum methane producing capacity (B_0) is attained. Thus, measurement of MCF values should include the following factors: timing of storage/application; length of storage; manure characteristics; determination of the amount of manure left in the storage facility; time and temperature distribution between indoor and outdoor storage; daily temperature fluctuation; seasonal temperature variation, etc.

Table 5-31: Default values of MCF for Manure Management Systems, %

Manure Management System		MCF, %
Pasture/Range/Paddock: the manure from pasture and range grazing animals is allowed to lie as deposited, and is not managed		1
Daily Spread: animal manure is collected in solid form, being then immediately applied to cropland or pastures with a certain regularity. Manure is not stored or treated, so emissions are considered zero		0.1
Solid storage: manure is collected and stored in solid form for a long time (by default – a few months) before use.		2
Dry lot: in countries with dry climates, animals can be kept in confinement areas, the manure formed is allowed to dry, being periodically evacuated in a dry state and used accordingly.		1
Liquid/Slurry: manure is stored as excreted or with minimal addition of water in either tanks or earthen ponds for six months or more, later applied to land; in order to facilitate manure management, water is added to it.	with natural crust cover	10
	without natural crust cover	17
Uncovered anaerobic lagoon: systems that use water to transport animal manure to lagoons/ponds, where they are kept for 30 to 200 days; the water can be recycled or then used to irrigate and fertilize agricultural land.		66

Manure Management System		MCF, %
Pit Storage below animal confinements: solid and liquid animal manure is excreted on the floor, under which there are deep pits, from where manure is discharged after a certain period, which also varies for this analysis, was divided into two categories.	< 30 days	3
	> 30 days	17
Anaerobic Digester: manure, usually in liquid form, is subjected to anaerobic digestion in fermenters in order to produce methane or energy. Emissions, in this case, come from leaks and vary depending on the type of fermenter.		0-100
Burned for Fuel: manure is collected, dried and burned for fuel. Methane emissions associated with burned manure are not included in the Agriculture Sector but were considered in the Energy Sector , category 'Biomass Burning'.		10
Composting – Intensive windrow: solid and liquid manure is collected and stored in tanks or pits, with forced aeration of manure.		0.5
Composting – Passive windrow: solid and liquid animal manure is collected and stored in piles, with regular turning for aeration.		0.5
Poultry manure with litter: poultry manure is excreted on the floor with bedding; birds do tread on the manure.		1.5
Poultry manure without litter: poultry manure is excreted on the floor without bedding; birds do not tread on the manure.		1.5
Aerobic treatment: animal manure (dung and urine) is collected in a liquid state, subjected to forced aeration, or treated in aerobic lagoons or ponds or in moist soil systems to ensure the nitrification or denitrification process.		0

Source: 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.17, pages 10.44-10.47.

The default values of methane conversion factor for cattle and swine are presented in Table 5-32, while the percentage of using different manure management systems in Eastern European countries, in Table 5-33 below.

Table 5-32: MCFs for Different Animal Categories and Manure Management Systems

Manure Management Systems	MCF, %	
	Cattle	Swine
Anaerobic Lagoon	66	66
Liquid/Slurry	17	17
Solid Storage	2	2
Dry lot	1	1
Pasture/Range/Paddock	1	0
Pit Storage below animal confinements < 1 month	0	3
Pit Storage below animal confinements > 1 month	0	17
Daily Spread	0.1	0.1
Anaerobic Digester	10	10
Burning for fuel	10	0
Other Systems	1	1

Source: 2006 IPCC GUIDELINES, Volume 4, Chapter 10, Table 10A-4 page 10.77, Table 10A-5 page 10.78, Table 10A-7 page 10.80 and Table 10A-8 page 10.88.

Table 5-33: Default Manure Management Systems used in Eastern European countries (MS%)

	Anaerobic Lagoon	Liquid / Slurry	Solid Storage	Pasture	Daily Spread	Other
Dairy cows	0	17.5	60	18	2.5	2
Other cattle	0	22.5	44	20	0	13.5
	Anaerobic Lagoon	Liquid / Slurry	Solid Storage	Pit storage <1 month	Pit storage>1 month	Other
Fattening swine	3	0	42	24.7	24.7	5.7
Market swine	3	0	42	24.7	24.7	5.7

Source: 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10A-4 page 10.77, Table 10A-5 page 10.78, Table 10A-7 page 10.80 and Table 10A-8 page 10.88.

Based on country-specific information (identical to that used for enteric fermentation), as well as on default EFs and coefficients, country-specific CH_4 EFs for 3B 'Manure Management' were developed (for animal categories 'cattle' and 'swine'). Following *good practices*, the same estimation methodology was used for the entire period under review.

As significant changes occurred in the livestock breeding sector of the RM in terms of manure management practices (large scale feedlots for cattle and swine were closed down, most animal population being concentrated currently in the private sector; the share of liquid manure management contributing to a greater extent to the generation of CH_4 emissions had decreased; while the share of solid manure management systems, less responsible for the generation of CH_4 emissions, increased), as well as a consequence of non-compliance to actual manure management systems in the RM with the ones described in the 2006 IPCC Guidelines (for Eastern European countries), it was not deemed necessary to use default values in terms of share of different manure management systems characteristic of Eastern European countries.

Thus, in order to estimate CH_4 emissions from category 3B 'Manure Management' (for cattle and swine), country-specific values (Table 5-34) were used, available in a study developed in May-June 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine as well as from the National Agency for Food Security.

Table 5-34: Share of Manure Management Systems (MS%) for the period 1989-2019

Animal Categories (T) and Manure Management Systems (MS)	1989 / 1990	1991 / 1992	1993 / 1994	1995 / 1997	1998 / 1999	2000 / 2001	2002 / 2003	2004 / 2005	2006 / 2007	2008 / 2009	2010 / 2011	2012 / 2015	2016 / 2017	2018 / 2019
	MS $_{(T,S)}$ values													
Dairy cows	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Pasture/Range/Paddock	6.0	10.0	16.0	20.0	23.0	24.0	24.0	24.5	24.5	24.5	24.5	25.0	25.0	25.0
Liquid/Slurry	24.0	20.0	12.0	7.0	3.0	1.0	1.0	1.5	1.5	1.5	1.5	1.5	1.7	2.1
Solid Storage	70.0	70.0	72.0	73.0	74.0	75.0	75.0	74.0	74.0	74.0	74.0	73.5	73.3	72.9
Other cattle	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Pasture/Range/Paddock	4.0	8.0	12.0	16.0	20.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Liquid/Slurry	34.0	26.0	18.0	10.0	4.0	4.0	4.0	6.0	6.0	6.0	6.0	6.1	10.6	13.5
Solid Storage	62.0	66.0	70.0	74.0	76.0	74.0	74.0	72.0	72.0	72.0	72.0	71.9	67.4	64.5
Swine	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Liquid/Slurry	73.0	65.0	60.0	55.0	40.0	30.0	30.0	32.0	32.0	35.0	35.0	37.0	42.5	52.4
Solid Storage	27.0	35.0	40.0	45.0	60.0	70.0	70.0	68.0	68.0	65.0	65.0	63.0	57.5	47.6
Sheep and Goats	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Pasture/Range/Paddock	18.0	18.0	20.0	20.0	22.0	22.0	24.0	24.0	24.0	26.0	26.0	26.0	27.0	27.0
Solid Storage	82.0	82.0	80.0	80.0	78.0	78.0	76.0	76.0	76.0	74.0	74.0	74.0	73.0	73.0
Horses, Asses and Mules	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Pasture/Range/Paddock	18.0	18.0	20.0	20.0	22.0	22.0	24.0	24.0	24.0	26.0	26.0	26.0	27.0	27.0
Solid Storage	82.0	82.0	80.0	80.0	78.0	78.0	76.0	76.0	76.0	74.0	74.0	74.0	73.0	73.0
Rabbits	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Solid Storage	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Poultry	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Pasture/Range/Paddock	7.0	7.0	7.0	8.0	8.0	8.0	9.0	9.0	9.0	10.0	10.0	10.0	10.0	10.0
Solid Storage	93.0	93.0	93.0	92.0	92.0	92.0	91.0	91.0	91.0	90.0	90.0	90.0	90.0	90.0

The goal of the study was to determine the share of manure management systems in the RM in order to enhance the accuracy of GHG inventory results from category 3B 'Manure Management'. In the process of carrying out this study, dairy cows and other cattle farms with a livestock of more than 5 heads were inspected, as well as pig farms with more than 30 heads and the largest poultry farms in the country. The study comprised 36 districts of the country. In total, manure management systems from 179 farms were inspected, of which 96 cattle farms, 66 pig farms and 17 poultry farms (Table 5-35).

Table 5-35: Share of Different Manure Management Systems in agricultural enterprises and individual farms in 2015

Animal Categories (T) and Manure Management Systems (MS)	Farms, units	Share, % of total	Livestock, heads	Share, % of total
Dairy cows	**94**	**100.0**	**7 149**	**100.0**
Solid storage, including:	81	86.2	4 879	68.2
On concrete platforms	12	12.8	714	10.0
Directly on the ground	69	73.4	4 165	58.3
Liquid/slurry, including:	13	13.8	2 270	31.8
Special tanks	4	4.3	591	8.3
Ponds and lakes	9	9.6	1 679	23.5
Other cattle	**96**	**100.0**	**9 179**	**100.0**
Solid storage, including:	83	86.5	5 578	60.8
On concrete platforms	10	10.4	593	6.5
Directly on the ground	73	76.0	4 985	54.3
Liquid/slurry, including:	13	13.5	3 601	39.2
Special tanks	6	6.3	1 981	21.6
Ponds and lakes	7	7.3	1 620	17.6
Swine	**66**	**100.0**	**177 186**	**100.0**
Solid storage, including:	36	54.5	17 310	9.8
On concrete platforms	2	3.0	115	0.1
Directly on the ground	34	51.5	17 195	9.7
Liquid/slurry, including:	30	45.5	159 876	90.2
Special tanks	8	12.1	54 598	30.8
Ponds and lakes	22	33.3	105 278	59.4
Poultry	**17**	**100.0**	**1 784 655**	**100.0**
Solid storage, including:	17	100.0	1 784 655	100.0
On concrete platforms	7	41.2	760 812	42.6
Directly on the ground	10	58.8	1 023 843	57.4

In order to estimate the share of manure management systems (MS%) (Table 5-34) for the period 1990-2019, the information on livestock and poultry population was considered (Table 5-9), and their share in agricultural enterprises and individual farms, respectively (Table 5-36).

Table 5-36: Livestock and poultry population for the period 1990-2019, % of total

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Agricultural enterprises									
Cattle	81.8	77.2	71.3	59.0	50.7	43.8	37.0	26.8	20.9	13.0
Cows	74.9	69.5	62.0	49.9	40.0	33.1	26.7	18.6	14.3	8.4
Other Cattle	86.0	82.2	78.0	66.8	61.0	55.8	50.1	39.0	31.2	21.6
Swine	81.0	77.4	71.1	60.3	54.0	55.1	52.0	40.2	36.9	19.6
Sheep and Goats	35.9	31.3	27.3	20.3	16.5	14.6	11.7	9.4	8.1	5.9
Sheep	37.0	32.6	28.7	21.5	17.6	15.6	12.6	10.2	8.9	6.6
Goats	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Horses	84.7	76.4	66.2	53.6	46.3	41.9	35.8	28.0	21.9	11.9
Poultry	53.5	51.9	36.4	21.9	20.5	19.4	16.9	14.9	12.9	9.8
	Individual farms									
Cattle	18.1	22.9	28.8	41.1	49.3	56.3	63.0	73.3	79.1	87.0
Cows	25.0	30.5	37.9	50.2	59.9	66.7	73.5	81.5	85.6	91.7
Other Cattle	14.0	17.9	22.2	33.3	39.1	44.6	49.7	61.1	68.9	78.4
Swine	19.0	22.5	29.0	40.0	46.1	44.9	47.9	59.8	63.2	80.4
Sheep and Goats	64.1	68.7	72.6	79.6	83.5	85.4	88.3	90.5	91.9	94.1
Sheep	63.1	67.5	71.3	78.5	82.4	84.4	87.4	89.7	91.1	93.4
Goats	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.1	100.0	100.0
Horses	14.8	24.8	35.0	45.9	53.4	57.7	64.8	70.8	78.2	87.8
Poultry	46.5	48.1	63.6	78.1	79.5	80.6	83.1	85.1	87.1	90.2

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Agricultural enterprises									
Cattle	9.4	7.9	7.8	6.7	6.0	6.4	6.4	6.6	6.1	6.0
Cows	5.6	4.8	4.3	3.9	3.5	3.7	3.4	3.6	3.2	3.0
Other Cattle	17.6	14.3	15.3	12.9	12.0	12.9	13.0	14.8	14.1	13.7
Swine	9.2	11.1	14.6	9.2	8.5	10.0	12.6	20.6	23.3	25.1
Sheep and Goats	5.0	4.9	5.0	4.5	4.0	3.9	3.8	3.7	3.0	2.6
Sheep	5.7	5.5	5.7	5.1	4.6	4.5	4.3	4.1	3.3	2.9
Goats	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.3	0.4	0.4
Horses	8.4	6.5	6.4	5.2	4.1	4.3	3.0	2.9	2.7	2.2
Poultry	9.6	12.6	10.9	9.5	11.3	11.7	11.3	13.0	17.4	14.9
	Individual farms									
Cattle	90.6	92.1	92.3	93.3	94.1	93.4	93.6	93.4	93.9	94.0
Cows	94.4	94.9	95.6	96.4	96.6	96.3	96.8	96.5	96.8	97.0
Other Cattle	82.5	86.4	85.1	86.6	88.2	86.7	86.5	85.2	85.8	86.2
Swine	90.8	88.9	85.4	90.8	91.5	90.1	87.4	79.4	76.7	74.9
Sheep and Goats	95.0	95.2	94.7	95.5	96.0	96.0	96.2	96.3	97.0	97.4
Sheep	94.4	94.5	94.2	94.8	95.4	95.4	95.7	95.9	96.7	97.1
Goats	100.0	100.0	97.6	100.0	100.0	100.0	100.0	99.7	99.6	99.6
Horses	91.4	94.0	94.6	95.6	95.2	96.9	97.4	97.2	97.3	97.8
Poultry	90.4	87.4	89.1	90.5	88.7	88.3	88.7	87.0	82.6	85.1

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	Agricultural enterprises									
Cattle	5.4	5.9	6.1	6.5	7.2	8.1	10.0	11.4	12.6	14.9
Cows	2.9	3.0	3.5	3.9	4.5	4.6	4.7	4.8	5.2	6.3
Other Cattle	11.5	12.9	12.2	12.4	13.0	15.7	20.9	25.1	27.6	31.3
Swine	29.1	27.5	34.6	37.8	41.6	41.0	43.6	45.4	51.9	57.8
Sheep and Goats	2.2	2.5	2.1	2.3	2.7	3.2	2.9	3.0	2.7	2.8
Sheep	2.5	2.9	2.5	2.6	3.1	3.7	3.3	3.5	3.1	3.3
Goats	0.3	0.4	0.4	0.7	0.8	0.7	0.8	0.9	0.8	1.0
Horses	2.1	1.8	1.7	1.3	1.2	1.0	1.0	0.8	0.8	0.6
Poultry	13.8	14.7	22.4	30.3	29.6	33.4	34.4	34.4	32.8	38.1
	Individual farms									
Cattle	94.7	94.1	93.9	93.5	92.8	91.9	90.0	88.6	87.4	85.1
Cows	97.1	96.9	96.5	96.1	95.6	95.4	95.3	95.2	94.8	93.7
Other Cattle	88.5	87.2	87.9	87.6	87.0	84.2	79.1	74.9	72.4	68.7
Swine	70.9	72.5	65.4	62.2	58.4	59.0	56.4	54.6	48.1	42.2
Sheep and Goats	97.8	97.5	97.9	97.7	97.3	96.8	97.1	97.0	97.3	97.2
Sheep	97.5	97.1	97.5	97.4	96.9	96.3	96.6	96.5	96.9	96.7
Goats	99.7	99.6	99.6	99.3	99.2	99.3	99.2	99.1	99.2	99.0
Horses	98.0	98.1	98.3	98.6	98.7	98.9	99.0	99.2	99.4	83.6
Poultry	86.2	85.3	77.6	69.7	70.4	66.6	65.6	65.6	67.2	61.9

Country-specific EFs, calculated following a simplified Tier 2 approach (Equation 10.23 in the 2006 IPCC Guidelines) are shown in Table 5-37.

Table 5-37: Country-specific CH_4 emission factors for source category 3B 'Manure Management', calculated following a Tier 2 Methodology for Cattle and Swine Population

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy cows	13.5	11.4	11.4	8.6	8.8	6.7	6.7	6.5	5.1	5.1
Other cattle (average)	5.8	4.9	4.9	4.3	4.5	3.2	3.4	3.2	2.2	2.2
Swine (average)	5.1	4.6	4.5	4.4	4.2	3.7	3.6	3.2	2.4	2.4
Market swine	7.8	6.9	6.7	6.5	6.1	5.5	5.3	4.7	3.6	3.5
Fattening piglets	4.9	4.4	4.2	4.1	3.9	3.5	3.3	2.9	2.3	2.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Dairy cows	4.4	4.4	4.5	4.5	4.8	4.8	4.7	4.8	4.8	4.7
Other cattle (average)	2.3	2.2	2.3	2.3	2.7	2.6	2.6	2.5	2.4	2.3
Swine (average)	2.1	2.0	1.9	2.0	2.1	2.0	2.1	2.0	2.2	2.1
Market swine	3.0	2.9	2.8	3.0	3.0	3.0	3.0	3.0	3.2	3.2
Fattening piglets	1.9	1.8	1.8	1.9	1.9	1.9	1.9	1.9	2.0	2.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Dairy cows	4.8	4.8	4.8	4.9	4.7	4.7	4.7	4.8	4.9	4.8
Other cattle (average)	2.3	2.4	2.4	2.4	2.2	2.1	2.8	2.6	3.0	3.0
Swine (average)	2.2	2.4	2.7	2.8	2.7	2.8	2.9	3.2	3.6	3.6
Market swine	3.2	3.6	4.0	4.2	4.1	4.1	4.4	4.7	5.3	5.4
Fattening piglets	2.0	2.2	2.5	2.7	2.6	2.6	2.7	2.9	3.3	3.4

Regarding other cattle and swine population, the share of animal population by sub-categories was taken into account to estimate average national EFs (see Table 5-21 for 'Other Cattle' and Table 5-38 for 'Swine').

Table 5-38: Swine population distribution by sub-categories for the period 1990-2019, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Swine, total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
…Market swine	8.4	9.1	9.9	12.3	12.5	12.1	12.8	13.6	14.6	14.5
…Piglets over 4 months	7.4	8.7	9.4	11.5	12.4	12.7	12.9	12.7	16.0	28.6
...Other swine	84.2	82.2	80.7	76.3	75.1	75.1	74.4	73.7	69.4	56.9
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Swine, total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
…Market swine	15.3	16.6	16.3	14.7	14.9	15.5	14.2	13.2	13.0	12.9
…Piglets over 4 months	37.8	56.3	56.5	65.0	66.4	64.4	65.2	66.3	60.7	65.8
...Other swine	46.9	27.1	27.1	20.3	18.8	20.1	20.6	20.5	26.2	21.3
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Swine, total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
…Market swine	12.1	12.2	11.0	10.6	10.8	11.4	12.0	12.3	11.0	10.7
…Piglets over 4 months	64.9	64.5	65.0	57.6	62.1	54.1	54.0	58.5	57.3	59.0
...Other swine	23.0	23.2	23.9	31.8	27.1	34.5	34.0	29.1	31.7	30.3

Source: NBS, Statistical Annual Report No. 24-agr 'Animal Breeding Sector', the Number of Livestock and Poultry in all Households Categories as of January 1 (annually for 1990-2019).

5.3.1.3. Uncertainties Assessment and Time-Series Consistency

Uncertainties related to the estimation of methane emissions from category 3B 'Manure Management', result from uncertainties related to the estimation of livestock, and also on the default emission factors used. The uncertainties associated with the total animal population in the Republic of Moldova are average (circa 10 per cent).

It should be noted that the uncertainty range for the default emission factors calculated using a Tier 1 method is estimated to be circa 30 per cent (2006 IPCC Guidelines). Since this approach is not based on the country-specific data and the characteristics of livestock from the particular country are not taken into account, the general uncertainty related to the use of this methodology can reach circa 50 per cent (2006 IPCC Guidelines). Should a Tier 2 methodology be used, uncertainties related to manure management systems depend on the characteristic features of the livestock breeding sector and how information on manure management systems is collected in the RM. Because the RM lately uses mainly three manure management systems (pasture/range/paddock, solid storage and, to a lesser extent, liquid/slurry), uncertainties related to manure management systems can be considered relatively low; however, due to the fact that a wide spectrum of manure management systems was used, the uncertainties associated with these are considered may reach circa 30 per cent. Thus, combined uncertainties of AD and EFs for source category 3B 'Manure Management' account for circa 31.62 per cent (Annex 5-3.3).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

5.3.1.4. Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for the respective category, following a Tier 1 approach. It should be noted that the AD and methods used to estimate CH_4 emissions under this category were documented and archived both in hard copies and electronically. In order to identify the data entry and GHG emissions estimation process related errors, AD and EFs verifications and quality control procedures were applied.

5.3.1.5. Recalculations

CH_4 emissions from category 3B 'Manure Management' were recalculated as a result of updating values regarding digestible energy (DE) as a percentage of daily gross energy – GE (MJ/day) for dairy cows and cattle, and as a result of updating the shares of manure management systems (MS%) in the RM, based on a study developed in 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine as well as from the National Agency for Food Security.

In comparison with the results recorded in the BUR2 of the RM to the UNFCCC, the changes made in the current inventory cycle resulted in an insignificant resulted in an insignificant variation in CH_4 emissions during the period under review, except for the years 2014-2016, when variations reached more consistent values (Table 5-39). The increase by 6.3 per cent in methane emissions from the respective source category in 2016 is due to the increase in liquid-based manure management systems (MS%): for swine (from 37 per cent in 2012-2015 to circa 52.4 per cent in 2018-2019), for other cattle (from 6.1 per cent in 2012-2015, to circa 13.5 per cent in 2018-2019) and for dairy cows (from 1.5 per cent in 2012-2015, to circa 2.1 per cent in 2018-2019). The recorded increases in liquid-based manure management systems for the respective animal categories (MS%) (see Table 5-34) occurred at the expense of the corresponding decrease in the share of the management system 'solid storage of animal manure'. Confirmation of this trend can also be found in Table 5-36, from which we can observe that over the period 2018-2019, within agricultural enterprises and individual farms, the average share per period of the number of dairy cows, other cattle and swine, had increased somewhat significantly compared with the average recorded for the period 2012-2015: for dairy cows, from 4.1 per cent to 5.8 per cent of the total number of animals in households of all categories; other cattle: from 13.3 per cent to 29.5 per cent; and for swine, from 38.8 per cent to 54.9 per cent, respectively. As it is shown in the results of the study conducted in 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine as well as from the National Agency for Food Security, liquid-based manure management systems (MS%) are used more consistently on animal farms within agricultural enterprises and individual farms, but are practically not applied in households.

Table 5-39: Comparative results of CH_4 emissions inventory from source category 3B 'Manure Management' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	19.8038	16.6032	14.9283	10.9978	10.6093	8.2510	7.4958	6.0866	5.1085	4.4921
BUR3	19.8038	16.6032	14.9247	10.9978	10.6093	8.2510	7.4943	6.0866	5.1085	4.4921
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	3.4013	3.4366	3.5979	3.3469	3.2528	3.4433	3.5129	2.5021	2.4678	2.8113
BUR3	3.4005	3.4366	3.5979	3.3469	3.2519	3.4059	3.5129	2.5021	2.4937	2.8113
Difference, %	0.0	0.0	0.0	0.0	0.0	-1.1	0.0	0.0	1.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	3.0755	2.9050	2.7630	2.7162	2.9011	2.8336	2.7337			
BUR3	3.0755	2.9050	2.7652	2.7160	2.8169	2.7544	2.8363	2.7862	2.7933	2.6637
Difference, %	0.0	0.0	0.1	0.0	-2.9	-2.8	3.8			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

The table below presents comparative results of methane emissions from source category 3B 'Manure Management' included into the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 (GWP_{100} = 25) (Table 5-40).

Table 5-40: Comparative results of CH_4 emissions inventory from source category 3B 'Manure Management' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	495.0955	415.0799	373.2078	274.9462	265.2313	206.2761	187.3957	152.1643	127.7113	112.3024
BUR3	495.0955	415.0799	373.1167	274.9462	265.2313	206.2761	187.3584	152.1643	127.7113	112.3024
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	85.0324	85.9160	89.9480	83.6736	81.3197	86.0829	87.8226	62.5516	61.6958	70.2833
BUR3	85.0121	85.9160	89.9480	83.6736	81.2980	85.1477	87.8226	62.5516	62.3432	70.2833
Difference, %	0.0	0.0	0.0	0.0	0.0	-1.1	0.0	0.0	1.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	76.8879	72.6254	69.0754	67.9055	72.5269	70.8399	68.3414			
BUR3	76.8879	72.6254	69.1310	67.9012	70.4215	68.8589	70.9073	69.6553	69.8333	66.5935
Difference, %	0.0	0.0	0.1	0.0	-2.9	-2.8	3.8			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the period 2017-2019, CH_4 emissions resulting from category 3B 'Manure Management' were estimated for the first time. The obtained results allow us to assert that over the period 1990-2019, methane emissions from the respective category decreased by 86.5 per cent, due as a result of the decrease in livestock population, and changes in the share of manure management systems (overall, there had been a significant downward trend in the share of liquid-based systems and a concomitant increase in the share of solid storage of animal manure).

Over the period under review, the share of different livestock categories in the overall methane emissions from category 3B 'Manure Management' had changed significantly. By 2019, the percentage of categories such as 'Cattle' had decreased considerably compared to the 1990 level whereas the share of categories such as 'Sheep', 'Goats', 'Horses', 'Asses and Mules', 'Rabbits', and 'Poultry' tended to increase (Table 5-41).

Table 5-41: Share of different animal categories in the structure of CH_4 emissions from source category 3B 'Manure Management' for the period 1990-2019, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cattle	46.5	45.0	49.2	50.0	51.4	44.5	44.7	46.2	41.0	43.5
Sheep	1.2	1.4	1.6	2.4	2.5	3.1	3.2	3.5	3.9	4.0
Goats	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3
Horses	0.4	0.5	0.5	0.8	0.9	1.2	1.3	1.7	2.1	2.5
Asses and Mules	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Swine	47.9	48.6	44.8	42.9	41.0	45.7	45.2	41.7	44.5	39.7
Poultry	3.8	4.4	3.6	3.6	4.0	5.2	5.2	6.4	8.0	9.6
Rabbits	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cattle	48.6	48.9	47.7	46.4	46.1	40.6	37.7	41.9	39.4	34.6
Sheep	4.7	4.7	4.5	4.7	4.9	4.6	4.6	5.8	5.8	5.5
Goats	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.6	0.6	0.6
Horses	3.5	3.7	3.6	3.8	3.6	3.3	3.1	3.8	3.6	3.1
Asses and Mules	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Swine	29.7	28.3	29.8	29.1	27.1	29.6	33.3	25.7	26.7	30.6
Poultry	12.6	13.4	13.5	14.9	17.1	20.6	20.1	21.4	23.0	24.7
Rabbits	0.4	0.4	0.4	0.5	0.6	0.7	0.7	0.8	0.8	0.8
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cattle	31.2	31.5	31.0	31.2	28.7	28.4	28.6	26.9	24.8	22.0
Sheep	4.9	4.7	4.8	5.0	4.9	5.0	4.8	4.7	4.2	3.8
Goats	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.7
Horses	2.7	2.7	2.7	2.6	2.4	2.3	2.1	1.9	1.7	1.6
Asses and Mules	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Swine	36.4	39.1	42.6	46.2	48.9	48.7	48.7	49.8	55.0	58.3
Poultry	23.4	20.6	17.4	13.3	13.4	13.8	14.0	14.7	12.4	12.6
Rabbits	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.0	1.0

It should be mentioned that for animal categories 'dairy cows', 'other cattle' and 'swine', the Tier 2 methodology impact is much greater compared to the Tier 1 methodology. The use of a Tier 2 method, an approach that reflects country-specific conditions, particularly related to manure management systems (MS%), has contributed to much lower values of CH_4 emissions for the period 1993-2019, varying between a minimum of 2.9 per cent in 1993 to a maximum of 47.0 per cent in 2001; except for the years 1990-1992 when the results after using a Tier 2 method show increased values compared to those obtained after using a Tier 1 method (Table 5-42); this is explained by the fact that the productivity of livestock and poultry during the soviet period and in the following few years immediately after independence, manure management system usage was close to similar indicators characteristic of Western European countries, respectively; also, during that period, the overwhelming majority of livestock and poultry was under collective management, and large agricultural enterprises, respectively, whereas today the situation is the opposite (Table 5-36), the majority of the livestock and poultry being owned by individual farmers with much more limited opportunities, including financial ones, for the use of modern manure management systems.

Table 5-42: Comparative results of CH_4 emissions from source category 3B 'Manure Management', estimated using Tier 1 and Tier 2 methodologies, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Tier 1	14.9864	14.3176	13.1911	11.3291	10.9584	10.1404	9.2643	8.0449	8.3155	7.4377
Tier 2	19.8038	16.6032	14.9247	10.9978	10.6093	8.2510	7.4943	6.0866	5.1085	4.4921
Difference, %	32.1	16.0	13.1	-2.9	-3.2	-18.6	-19.1	-24.3	-38.6	-39.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Tier 1	6.3811	6.4811	6.7124	6.0931	5.5407	5.6963	5.7948	4.2009	4.0433	4.5108
Tier 2	3.4005	3.4366	3.5979	3.3469	3.2519	3.4059	3.5129	2.5021	2.4937	2.8113
Difference, %	-46.7	-47.0	-46.4	-45.1	-41.3	-40.2	-39.4	-40.4	-38.3	-37.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Tier 1	4.7781	4.3961	4.0340	3.9031	4.1125	3.9983	3.9153	3.6933	3.3656	3.1090
Tier 2	3.0755	2.9050	2.7652	2.7160	2.8169	2.7544	2.8363	2.7862	2.7933	2.6637
Difference, %	-35.6	-33.9	-31.5	-30.4	-31.5	-31.1	-27.6	-24.6	-17.0	-14.3

5.3.1.6. Planned Improvements

Planned improvements may include activities focused on obtaining more precise AD and productivity indices used to estimate CH_4 emissions from category 3B 'Manure Management', particularly for 'cattle' and 'swine' livestock categories accounting for the largest share in the structure of total CH_4 emissions originating from this source; as well as updating the values for the main parameters used to develop CS EFs for the respective animal categories following a Tier 2 methodology; also, there are planned activities focused on regular updating (every 3 years) AD regarding the share of manure management systems in the livestock breeding sector.

5.3.2. Nitrous Oxide Emissions

5.3.2.1. Source Category Description

During the storage and treatment of manure (dung and urine) before it is applied to land, direct N_2O emissions occur via combined nitrification and denitrification of nitrogen contained in the manure. It should be noted that nitrification is the aerobic oxidation of ammonia nitrogen (NH_4^+) into nitrate (NO_3^-), whereas denitrification consists in the reduction under anaerobic conditions of nitrates into nitrogen oxides or molecular nitrogen: $NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$. The direct emission of N_2O vary depending on the nitrogen and carbon content of manure, as well as on the duration of the storage and type of treatment within the animal waste management systems. It is considered that the aeration increase in animal waste contributes to direct N_2O emissions.

There is general agreement in the scientific literature that the ratio of N_2O/N_2 increases with increasing acidity, nitrate concentration, and reduced moisture. Generally, the production and emission of N_2O from managed manures requires the presence of either nitrites or nitrates in an anaerobic environment preceded by aerobic conditions necessary for the formation of these oxidized forms of nitrogen. In addition, conditions preventing reduction of nitrogen oxide (N_2O) to dinitrogen (N_2), such as a low pH or limited moisture, must be present.

Indirect emissions result from volatile nitrogen losses that occur primarily in the forms of ammonia (NH_3) and (NO_x). The fraction of excreted organic nitrogen that is mineralized to ammonia nitrogen during manure collection and storage depends primarily on time, and to a lesser degree temperature. Simple forms of organic nitrogen such as urea (mammals) and uric acid (poultry) are rapidly mineralized to ammonia nitrogen, which is highly volatile and easily diffused into the surrounding air. Nitrogen losses begin at the point of excretion in houses and other animal production areas and continue through on-site management in storage and treatment systems. Nitrogen is also lost through runoff and leaching[101] processes.

Due to significant direct and indirect losses of manure nitrogen in management systems it is important to estimate the remaining amount of animal manure nitrogen available for application to soils or for other purposes.

5.3.2.2. Activity Data, Assessment Methodologies and Emission Factors

N_2O emissions from category 3B 'Manure Management' were estimated based on a Tier 2 methodology (2006 IPCC Guidelines). In order to estimate direct N_2O emissions from manure management, it was necessary to collect information on the total livestock population (identical to the one used for 3A 'Enteric Fermentation'), information on the amount of produced manure per head in a year, as well as information on manure management systems usage in the Republic of Moldova.

The following five steps were used to estimate direct N_2O emissions from category 3B 'Manure Management':

(i) collect livestock population data from the livestock population characterization;

(ii) develop the annual average nitrogen excretion rate per head ($N_{ex(T)}$) for each defined livestock species/category *T*;

(iii) determine the fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in each manure management system *S* ($MS_{(T, S)}$);

(iv) develop N_2O EFs for each manure management system *S* ($FE_{3\ (S)}$);

(v) calculate N_2O emissions for each manure management system type S, multiplying the emission factor ($FE_{3(S)}$) by the total amount of nitrogen managed (from all livestock species/categories) in that system.

The obtained results for each manure management system were summed, resulting in the total N2O emissions from the respective source category.

The calculation of direct N_2O emissions is based on 10.25 in the 2006 IPCC Guidelines.

$$N_2O_{D(mm)} = [\ \Sigma_{(S)}\ [\Sigma_{(T)}\ (N_{(T)} \bullet N_{ex(T)} \bullet MS_{(T,\ S)})] \bullet FE_{3(S)}] \bullet 44/28$$

Where:

$N_2O_{D\ (mm)}$ – direct N_2O emissions from Manure Management in the country (kg N_2O/yr);

$N_{(T)}$ – number of head of livestock species/category T in the country;

$N_{ex\ (T)}$ – annual average N excretion per head of species/category T in the country (kg N/animal/yr);

$MS_{(T,\ S)}$ – fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless;

$FE_{3\ (S)}$ – emission factor for direct N_2O emissions from manure management system S in the country, (kg N_2O-N/kg N in manure management system S);

S – manure management system;

T – species/category of livestock;

44/28 – conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions.

The calculation of the average N excretion rates $N_{ex(T)}$ is based on Equation 10.30 available in the 2006 IPCC Guidelines.

$$N_{ex(T)} = N_{rate(T)} \bullet (TAM/1000) \bullet 365$$

Where:

$N_{ex\ (T)}$ – annual N excretion for livestock category T, (kg N/animal/yr);

$N_{rate\ (T)}$ – default N excretion rate, kg N (1000 kg animal mass)/day;

$TAM_{(T)}$ – typical animal mass for livestock category T, kg animal.

[101] Leaching – the loss of mineral and organic solutes due to water or other liquids percolation from soil.

The annual amount of N excreted by each livestock species/category depends on the total annual N intake and total annual N retention of the animal. Therefore, N excretion rates can be derived from N intake and N retention data.

Annual N intake (the amount of N consumed by the animal annually) depends on the annual amount of feed digested by the animal, and the protein content of that feed.

Total feed intake depends on the production level of the animal (growth rate, milk production, wool production, egg production, etc.).

Annual N retention (the fraction of N intake that is retained by the animal for the production of meat, milk, wool, eggs, etc.) is a measure of the animal's efficiency to produce animal protein from feed protein.

Default N retention values are provided in Table 10.20 (2006 IPCC Guidelines, Volume 4, Chapter 10, Page 10.60).

Rates of annual N excretion for each livestock species/category $N_{ex\ (T)}$ were estimated using Equation 10.31 available in the 2006 IPCC Guidelines.

$$N_{ex(T)} = N_{intake\ (T)} \bullet (1 - N_{retention\ (T)})$$

Where:

$N_{intake\ (T)}$ – the annual N intake per head of animal of species/category T, (kg N/animal/yr);

$N_{retention\ (T)}$ – fraction of annual N intake that is retained by animal of species/category T, dimensionless.

Based on information on the average weight of livestock and poultry in Eastern European countries and default values of nitrogen excretion rate (kg N/1000 kg of animal mass/yr) characteristic of the same region, country-specific $N_{ex(T)}$ values were calculated (Table 5-43).

It was taken into consideration the amount of N fed to animals stored in straw bedding together with manure ($N_{bedding\ MS}$). It is known from the literature in the field that this amount can reach circa 7 kg N/head/yr for dairy cows; circa 4 kg N/head/yr for other cattle; circa 0.8 kg N/head/yr for market swine; and circa 5.5 kg N/head/yr for fattening swine; at the same time, should a large straw bedding be applied, as practiced in the RM, these quantities can be doubled (Webb, 2001; Döhler et al., 2002; quoted in the 2006 IPCC Guidelines).

Table 5-43: Average annual N excretion by main livestock and poultry categories in Eastern European countries

Livestock Category	$N_{rate\ (T)}$, kg N/1000 kg/day	TAM, average weight in kg	$N_{ex\ (T)\ ANIMAL}$, kg N/head/yr	$N_{ex(T)\ ANIMAL}$	$N_{retention\ (T)}$, kg N retained / animal / yr	$N_{ex(T)\ ANIMAL\ ADJUSTED}$	$N_{bedding\ MS}$	$N_{ex(T)\ ANIMAL\ FINAL}$
Dairy cows	0.35	550	0.5500	70.3	0.20	56.2	14.0	70.2
Other cattle	0.35	391	0.3910	50.0	0.07	46.5	8.0	54.5
Sheep	0.90	28	0.0280	9.2	0.10	8.3	1.0	9.3
Goats	1.28	30	0.0300	14.0	0.10	12.6	1.0	13.6
Horses	0.30	238	0.2380	26.1	0.07	24.2	14.0	38.2
Asses and mules	0.30	130	0.1300	14.2	0.07	13.2	6.0	19.2
Swine	0.74	70	0.0695	18.8	0.30	13.1	2.0	15.1
Fattening swine	0.55	50	0.0500	10.0	0.30	7.0	2.0	9.0
Market swine	0.46	180	0.1800	30.2	0.30	21.2	2.0	23.2
Rabbits	8.10	1.6	0.0016	4.7	0.10	4.3	2.0	6.3
Chicken	0.82	1.8	0.0018	0.5	0.30	0.4	0.1	0.5
Geese	0.83	3.8	0.0038	1.2	0.30	0.8	0.1	0.9
Ducks	0.83	2.7	0.0027	0.8	0.30	0.6	0.1	0.7
Turkeys	0.74	6.8	0.0068	1.8	0.30	1.3	0.1	1.4

Source: 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.19, page 10.59, Table 10A-9, pages 10.82-10.83.

Applying the above methodological approach, the default values used for the N excretion rate characteristic to Eastern Europe, as well as country-specific data on the typical animal mass (TAM) in the RM during the period under review (see Table 5-10), country-specific values for $N_{ex(T)}$ were also estimated (Table 5-44).

Table 5-44: Average annual $N_{ex(t)}$ excretion by main livestock and poultry categories for the period 1990-2019, kg N/head/year

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy cows	62.6	59.3	58.1	56.4	56.2	56.1	56.1	60.2	59.3	58.9
Other cattle	54.4	51.5	48.6	47.0	45.5	45.8	47.1	45.8	44.6	44.0
Sheep	13.7	14.0	13.7	13.7	14.0	12.5	12.6	11.3	11.3	11.3
Goats	17.0	17.4	17.0	17.0	17.4	15.3	15.3	13.6	13.6	13.6
Horses	53.8	46.2	48.8	49.0	51.6	50.3	48.7	45.2	45.0	42.6
Asses and mules	19.3	18.8	18.7	18.8	18.6	18.1	17.6	17.5	17.4	16.6
Swine	20.5	19.1	17.7	16.9	16.2	17.7	20.2	18.1	13.7	12.8
Rabbits	6.3	6.2	6.2	6.1	6.2	6.2	42.7	6.2	6.2	6.1
Chicken	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Geese	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8
Ducks	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Turkeys	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Dairy cows	58.6	58.4	58.4	58.0	58.6	57.8	57.6	57.4	55.5	55.8
Other cattle	43.0	43.3	42.9	42.5	43.7	42.8	43.3	41.7	42.1	42.3
Sheep	11.4	10.8	10.8	10.8	10.8	10.8	11.1	10.8	10.8	11.3
Goats	13.6	12.8	12.8	12.8	12.8	12.8	13.2	12.8	12.8	13.6
Horses	43.1	42.8	43.0	43.5	42.8	44.1	47.8	44.2	45.5	44.8
Asses and mules	16.8	16.7	16.7	16.9	16.7	17.1	17.3	17.3	17.6	17.3
Swine	11.9	11.4	10.9	11.3	11.7	11.5	11.6	11.6	12.6	12.6
Rabbits	6.1	6.2	6.2	6.0	6.2	6.2	6.2	6.0	6.2	6.2
Chicken	0.4	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5
Geese	0.8	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9
Ducks	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7
Turkeys	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Dairy cows	56.9	57.0	57.8	57.9	60.0	61.3	60.7	61.1	60.1	58.8
Other cattle	42.6	46.3	45.9	44.8	48.9	49.3	48.9	54.5	55.5	58.5
Sheep	11.3	11.3	11.7	12.2	13.7	13.1	13.4	13.1	13.1	13.1
Goats	13.6	13.6	14.1	14.9	17.0	16.1	16.6	16.1	16.1	16.1
Horses	45.3	45.0	46.7	47.2	46.4	46.2	46.1	51.2	47.7	49.3
Asses and mules	17.5	17.7	17.9	18.1	17.7	17.5	17.4	19.2	18.0	18.2
Swine	12.4	12.8	13.2	12.2	12.8	12.2	16.2	13.3	13.7	12.4
Rabbits	6.3	6.2	6.0	6.0	6.2	6.2	6.2	6.3	6.2	6.2
Chicken	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Geese	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Ducks	0.7	0.7	0.6	0.6	0.7	0.7	0.6	0.6	0.6	0.6
Turkeys	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4

Based on information from scientific literature, CS values on average annual N excretion ($N_{ex(T)}$) from manure were calculated following an alternative methodological approach (Table 5-45), which does not consider the amount of N retained annually by livestock and poultry. Although the average annual N excretion values $N_{ex(T)}$ were calculated by different methods, the obtain results are still comparable.

As values featured in Table 5-45 are not available for all animal categories, country-specific values related to N retained were not identified, respectively (the fraction of N intake retained for the production of meat, milk, wool, eggs, etc.); $N_{ex(T)}$ values set forth in Table 5-44 were used to calculate the direct N_2O emissions from manure management in the RM.

Table 5-45: Average annual nitrogen excretion for a typical animal $N_{ex(T)}$ calculated based on country-specific information

Livestock Category	Solid Manure, kg/head/day	Liquid Manure, kg/ head/day	Straw Bedding, kg/head/day	Total Manure with/ without bedding, kg/ head/day	N content with/ without bedding, kg/t	$N_{ex(T)}$ with/ without bedding kg N/ head/day
Cattle	25.0	12.0	5.0	42.0 / 37.0	5.6 / 4.6	85.8 / 62.1
Sheep	2.5	1.0	0.8	4.3 / 3.5	9.5 / 9.2	14.9 / 11.8
Horses	18.0	5.0	4.0	27.0 / 23.0	6.0 / 5.0	59.1 / 42.0
swine	2.0	3.5	1.5	7.0 / 5.5	8.2 / 5.7	21.0 / 11.4
Poultry	0.1	0.0	0.1	0.2 / 0.1	16.3 / 22.3	1.2 / 0.8

Source: Ungureanu, Cerbari et al., 2006; Bucataru, Cosman, Holban, 2006; Raileanu, Jolondcovschi et al., 2006; Andries, Rusu et al., 2005; Bucataru, Maciuc, 2005; Toncea, 2004.

Activity data on manure management systems usage is identical to that previously used in sub-chapter 5.3.1. It should be noted that the actual distribution of manure management systems in the RM does not comply with the default values for Eastern European countries (MS%) available in the 2006 IPCC Guidelines, so their use was deemed to be inappropriate. In order to estimate direct N_2O emissions, country-specific information on manure management systems usage in the Republic of Moldova were used (Table 5-34). It is considered a *good practice* to estimate emissions from manure management systems keeping account of storage duration and treatment type. In order to determine the types of treatment of animal manure, temperature and aeration conditions are taken into account. Should the use of country-specific EFs not be possible, default values provided in the 2006 IPCC Guidelines are used (Table 5-46).

Table 5-46: Default EFs for N_2O emissions from Manure Management Systems

Manure Management System		EF_3, kg N_2O-N / kg N excreted	Uncertainty ranges of EF_3	Reference
Pasture/Range/Paddock: The manure from pasture and range grazing animals is allowed to lie as is, and is not managed. Direct and indirect N_2O emissions associated with the manure deposited on agricultural soils and pasture, range, paddock systems are monitored in category 3D 'Agricultural soils'	cattle, swine, poultry	0.020	0.007-0.06	2006 IPCC Guidelines, Table 11.1
	sheep, goats, horses, asses and mules	0.010	0.003-0.03	
Solid Storage: animal manure is collected and stored in solid form for a long time (by default – a few months), before being used.		0.005	Factor of 2	2006 IPCC Guidelines, Table 10.21
Dry lot: A paved or unpaved open confinement area without any significant vegetative cover where accumulating manure may be removed periodically. Dry lots are most typically found in dry climates but also are used in humid climates.		0.020	Factor of 2	2006 IPCC Guidelines, Table 10.21
Liquid/Slurry: Manure is stored as excreted. Liquid may be stored for a long time (months) with some minimal addition of water to facilitate handling and is stored in either tanks or earthen ponds for six months or more. Emissions are considered to be insignificant due to absence of oxidized forms of N, combined with the low nitrification and denitrification potential in this manure management system.	With natural crust cover	0.005	Factor of 2	2006 IPCC Guidelines, Table 10.21
	Without natural crust cover	0.000	Not Applicable	
Pit storage below animal confinements: Collection and storage of manure usually with little or no added water typically below a slatted floor in an enclosed animal confinement facility.		0.002	Factor of 2	2006 IPCC Guidelines, Table 10.21
Cattle and swine deep bedding: As manure accumulates, bedding is continually added to absorb moisture over a production cycle and possibly for as long as 6 to 12 months. This manure management system also is known as a bedded pack manure management system and may be combined with a dry lot or pasture.	No mixing	0.010	Factor of 2	2006 IPCC Guidelines, Table 10.21
	Active mixing	0.070	Factor of 2	
Composting - In-Vessel: Composting, typically in an enclosed channel, with forced aeration and continuous mixing.		0.006	Factor of 2	2006 IPCC Guidelines, Table 10.21
Composting - Static Pile: Composting in piles with forced aeration but no mixing.		0.006	Factor of 2	2006 IPCC Guidelines, Table 10.21
Composting – Intensive Windrow: Composting in windrows with regular turning for mixing and aeration		0.100	Factor of 2	2006 IPCC Guidelines, Table 10.21
Composting – Passive Windrow: Composting in windrows with infrequent turning for mixing and aeration.		0.010	Factor of 2	2006 IPCC Guidelines, Table 10.21
Poultry manure with litter: g Manure is excreted on floor with bedding, birds walk on manure.		0.001	Factor of 2	2006 IPCC Guidelines, Table 10.21
Poultry manure without bedding: Manure is excreted on floor without bedding, birds do not walk on manure.		0.001	Factor of 2	2006 IPCC Guidelines, Table 10.21
Aerobic treatment: The biological oxidation of manure collected as a liquid with either forced or natural aeration. Natural aeration is limited to aerobic and facultative ponds and wetland systems and is due primarily to photosynthesis. Hence, these systems typically become anoxic during periods without sunlight. Nitrification-denitrification is used widely for the removal of nitrogen in the biological treatment of municipal and industrial wastewaters with negligible N_2O emissions. Limited oxidation may increase emissions compared to forced aeration systems.	Natural aeration systems	0.010	Factor of 2	2006 IPCC Guidelines, Table 10.21
	Forced aeration systems	0.005	Factor of 2	

A significant share of the total amount of nitrogen excreted by livestock in different manure management systems (except pasture, range and paddock), is lost before being applied to lands. Therefore, in order to estimate the amount of nitrogen in manure which is applied to managed soils, it is necessary to omit the total nitrogen amount excreted by animals in different management systems, nitrogen losses occurring through volatilization (NH_3, NO_x), as well as runoffs and leaching.

Indirect N_2O emissions from source category 3B 'Manure Management' were estimated using a Tier 1 methodology (2006 IPCC Guidelines). Indirect N_2O emissions from volatilization of N in forms of NH_3 and NO_x were estimated by using Equations 10.26 and 10.27 in the 2006 IPCC Guidelines.

$$N_2O_{\ G(mm)} = \Sigma_{(S)} [\Sigma_{(T)} (N_{(T)} \bullet N_{ex(T)} \bullet MS_{(T,S)}) \bullet (Frac_{\ GasMS}/100)_{\ (T,S)}\ ] \bullet FE_4 \bullet 44/28$$

Where:

$N_2O_{\ G(mm)}$ – indirect N_2O emissions due to volatilization of N from Manure Management in the country (kg N_2O/yr);

$N_{(T)}$ – number of head of livestock species/category T in the country;

$N_{ex\,(T)}$ – annual average N excretion per head of species/category T in the country (kg N/animal/yr);

$MS_{(T,\,S)}$ – fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless;

$Frac_{GasMS}$ – per cent of managed manure nitrogen for livestock category T that volatilizes as NH3 and NO_x in the manure management system S, per cent (see in Table 5-47);

FE_4 – emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, the default value is 0.01 kg N_2O-N/kg NH_3-N+NO_x-N volatilized;

S – manure management system;

T – species/category of livestock;

44/28 – conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions.

Table 5-47: Default values for total nitrogen loss, that volatilize in NH_3 and NO_x from Manure Management *S*, %

Livestock Category	Manure Management System (MMS)	Total N loss from MMS due to volatilization of N-NH_3 and N-NO_x (%), $Frac_{Gas\,MS}$ (Range)
Dairy cows	Anaerobic lagoon	35% (20-80)
	Liquid/slurry	40% (15-45)
	Pit storage	28% (10-40)
	Dry lot	20% (10-35)
	Solid storage	30% (10-40)
	Daily spread	7% (5-60)
Other cattle	Dry lot	30% (20-50)
	Solid storage	45% (10-65)
	Deep bedding	30% (20-40)
Swine	Anaerobic lagoon	40% (25-75)
	Pit storage	25% (15-30)
	Deep bedding	40% (10-60)
	Liquid/slurry	48% (15-60)
	Solid storage	45% (10-65)
Sheep, Goats, Horses, Asses and Mules	Solid storage	25% (10-30)
	Deep bedding	12% (5-20)
Poultry	Poultry without litter	55% (40-70)
	Anaerobic lagoon	40% (25-75)
	Poultry with litter	40% (10-60)

Source: 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.22.

Indirect N_2O emissions from leaching and runoff were estimated using Equations 10.28 and 10.29 from the 2006 IPCC Guidelines:

$$N_2O_{L(mm)} = \Sigma_{(S)}\,[\Sigma_{(T)}\,(N_{(T)} \bullet N_{ex(T)} \bullet MS_{(T,\,S)}) \bullet (Frac_{leach\,MS}/100)_{(T,\,S)}\,] \bullet FE_5 \bullet 44/28$$

Where:

$N_2O_{L(mm)}$ – indirect N_2O emissions due to N leaching and runoff (kg N_2O/yr);

$N_{(T)}$ – number of head of livestock species/category T in the country;

$N_{ex\,(T)}$ – annual average N excretion per head of species/category T in the country (kg N/animal/yr);

$Frac_{leach\,MS}$ – per cent of managed manure nitrogen losses for livestock category T due to runoff and leaching during solid and liquid storage of manure (typical range 1-20 per cent);

FE_5 – emission factor for N_2O emissions from nitrogen leaching and runoff, kg N_2O-N/kg N leaching/runoff (default: 0.0075 kg N_2O-N/kg N leaching/runoff);

S – manure management system;

T – species/category of livestock;

44/28 – conversion of (N_2O-N)(mm) emissions to N_2L(mm) emissions.

The scientific literature show that in drier climates, runoff losses are smaller (circa 3-6 per cent of N excreted) than in areas with high humidity (5-19 per cent, respectively). Leaching losses of nitrogen depend on weather conditions, varying between 5 and 16 per cent (2006 IPCC Guidelines).

Table 5-48 shows default values for total nitrogen losses from manure management systems. These default values include losses that occur from the point of excretion, including manure storage losses, and losses from leaching and runoff at the manure storage system where applicable. It should be noted that there is a high level of variability in the range of total nitrogen losses from manure management systems. The majority of these are due to volatilization losses, primarily ammonia losses that occur rapidly following the excretion of the manure. Losses also occur in the form of NO_3, N_2O, and N_2, particularly from leaching and runoff which occur where manure is stored in piles. The values included in the table reflect average values for typical housing/storage combinations for each animal category.

Table 5-48: Default values for total nitrogen loss in different manure management systems *S*, %

Livestock Category	Manure Management System (MMS)	Total N loss from MMS (%), $Frac_{Loss\ MS}$ (Range)
Dairy cows	Anaerobic lagoon	77% (55-99)
	Liquid/slurry	40% (15-45)
	Pit storage	28% (10-40)
	Dry lot	30% (10-35)
	Solid storage	40% (10-65)
	Daily spread	22% (15-60)
Other cattle	Dry lot	40% (20-50)
	Solid storage	50% (20-70)
	Deep bedding	40% (10-50)
Swine	Anaerobic lagoon	78% (55-99)
	Pit storage	25% (15-30)
	Deep bedding	50% (10-60)
	Liquid/slurry	48% (15-60)
	Solid storage	50% (20-70)
Sheep, Goats, Horses, Asses and Mules	Solid storage	35% (15-40)
	Deep bedding	15% (5-20)
Poultry	Poultry without litter	55% (40-70)
	Anaerobic lagoon	77% (50-99)
	Poultry with litter	50% (20-80)

Source: 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.23.

Following storage in any system of manure management, nearly all the manure is applied to land. The N_2O emissions that subsequently arise from manure application to soil shall not be reported under category 3B 'Manure Management', but under 3D 'Agricultural Soils'. The estimate of managed manure N available for application to managed soils was based on Equation 10.34 in the 2006 IPCC Guidelines:

$$N_{MMS\_Avb} = \Sigma_{(S)} \{\Sigma_{(T)} [(N_{(T)} \bullet N_{ex(T)} \bullet MS_{(T,S)}) \bullet (1 - Frac_{Loss\ MS}/100)] + [N_{(T)} \bullet N_{ex(T)} \bullet N_{bending\ MS}]\}$$

Where:

N_{MMS_Avb} – amount of managed manure nitrogen available for application to managed soils or for feed, fuel, or construction purposes, kg N/yr;

$N_{(T)}$ – number of head of livestock species/category T in the country;

$N_{ex\ (T)}$ – annual average N excretion per animal of species/category T in the country, kg N/animal/yr;

$MS_{(T,S)}$ – fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless;

$Frac_{Loss\ MS}$ – amount of managed manure nitrogen for livestock category T that is lost in the manure management system S, per cent;

$N_{bedding\ MS}$ – amount of nitrogen from bedding (to be applied for solid storage and deep bedding MMS if known organic bedding usage), kg N/animal/year;

S – manure management system;

T – species/category of livestock.

5.3.2.3. Uncertainties Assessment and Time-Series Consistency

Uncertainties related to estimation of N_2O emissions from source category 3B 'Manure Management' result, particularly, from uncertainties regarding livestock estimation (±10 per cent), and also the default emission factors used. Uncertainty ranges for the default N excretion rates ($N_{ex(T)}$) are estimated at circa 50 per cent and they can be reduced to circa 30 per cent should country-specific values be used. It should be noted that the uncertainties associated with FE_3 emission factors are usually very high, from -50 per cent to +100 per cent. Uncertainties associated with the default emission factors for indirect N_2O, uncertainties related to default values for nitrogen loss due to volatilization of NH_3 and NO_x and total nitrogen loss from manure management are also somewhat high. Uncertainties associated with default emission factors for nitrogen volatilization and re-deposition (EF_4), as well as for leaching and runoff (EF_5), are also somewhat high, from -100 per cent, to +200 per cent. Thus, the combined uncertainties associated with AD and EFs for 3B 'Manure Management' represent circa 104.40 per cent for direct N_2O missions, and circa 152.97 per cent for indirect N_2O emissions, respectively (Annex 5-3.3). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

5.3.2.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under Sector 4 'Agriculture', following a Tier 1 approach. It should be mentioned that the AD and methods used to estimate direct and indirect N_2O emissions from category 3B 'Manure Management' were documented and archived both in hard copies and electronically. In order to identify the data entry and N_2O emission estimation process related errors, verifications and quality control procedures were carried out periodically, including for emission factors applied and the emission calculation process.

5.3.2.5. Recalculations

N_2O emissions from category 3B 'Manure Management' for the period 2012-2016 were estimated as a result of updating the values of shares of manure management systems (MS%) applied in the RM based on results of the study conducted in 2015 by the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine and the National Agency for Food Security. In comparison with the results recorded in the BUR2, the changes made in the current inventory cycle resulted in an insignificant increase in total N_2O emissions from category 3B 'Manure Management' (Table 5-49).

Table 5-49: Comparative results of $N_2O_{TOTAL(mm)}$ emissions from 3B 'Manure Management' included in the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	3.7470	3.4991	3.1392	2.7360	2.6585	2.4596	2.5974	2.0035	1.9398	1.7608
BUR3	3.7470	3.4991	3.1392	2.7360	2.6585	2.4596	2.5974	2.0035	1.9398	1.7608
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1.5712	1.5998	1.6116	1.5302	1.4804	1.5820	1.6257	1.2423	1.2244	1.3794
BUR3	1.5712	1.5998	1.6116	1.5302	1.4804	1.5820	1.6257	1.2423	1.2244	1.3794
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	1.4304	1.3045	1.1973	1.1203	1.2336	1.1950	1.2507			
BUR3	1.4304	1.3045	1.1973	1.1202	1.2335	1.1952	1.2328	1.1730	1.0372	0.9345
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	-1.4			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

The table below shows comparative results of the inventory NO_2 emissions from 3B 'Manure Management' included into the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 (GWP_{100} = 298) (Table 5-50).

Table 5-50: Comparative results of $N_2O_{TOTAL(mm)}$ emissions from source category 3B 'Manure Management' included in the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1,116.6179	1,042.7426	935.4783	815.3185	792.2223	732.9723	774.0215	597.0533	578.0598	524.7140
BUR3	1,116.6179	1,042.7426	935.4783	815.3185	792.2223	732.9723	774.0215	597.0533	578.0598	524.7140
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	468.2084	476.7359	480.2456	456.0074	441.1540	471.4376	484.4637	370.1945	364.8654	411.0664
BUR3	468.2084	476.7359	480.2456	456.0074	441.1540	471.4376	484.4637	370.1945	364.8654	411.0664
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	426.2558	388.7320	356.8055	333.8503	367.6124	356.1224	372.7198			
BUR3	426.2558	388.7320	356.7848	333.8296	367.5888	356.1825	367.3776	349.5395	309.0862	278.4665
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	-1.4			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the years 2017-2019, total N_2O emissions resulting from 3B 'Manure Management' were estimated for the first time. The results allow us to assert that over the period 1990-2019, nitrous oxide emissions from the respective category decreased by 75.1 per cent, due to the decrease in animal population, and in the productivity and changes in the share of manure management systems (the share of liquid/slurry systems decreased significantly whereas the share of pasture and solid storage increased).

Direct $N_2O_{D(mm)}$ (Table 5-51) and indirect $N_2O_{IND(mm)}$ (Table 5-52) emissions from category 3B 'Manure Management' were recalculated for the period 2012-2016.

Table 5-51: Comparative results of direct $N_2O_{D(mm)}$ emissions from 3B 'Manure Management' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	2.9259	2.7696	2.5012	2.2182	2.1606	2.0047	2.1230	1.6333	1.5979	1.4543
BUR3	2.9259	2.7696	2.5012	2.2182	2.1606	2.0047	2.1230	1.6333	1.5979	1.4543
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1.3081	1.3317	1.3406	1.2731	1.2299	1.3103	1.3452	1.0317	1.0152	1.1408
BUR3	1.3081	1.3317	1.3406	1.2731	1.2299	1.3103	1.3452	1.0317	1.0152	1.1408
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	1.1800	1.0769	0.9895	0.9290	1.0222	0.9909	1.0338			
BUR3	1.1800	1.0769	0.9894	0.9289	1.0222	0.9911	1.0160	0.9695	0.8530	0.7680
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	-1.7			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Table 5-52: Comparative results of indirect $N_2O_{IND(mm)}$ emissions from 3B 'Manure Management' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	0.8212	0.7295	0.6380	0.5178	0.4978	0.4550	0.4744	0.3702	0.3419	0.3065
BUR3	0.8212	0.7295	0.6380	0.5178	0.4978	0.4550	0.4744	0.3702	0.3419	0.3065
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.2631	0.2680	0.2710	0.2572	0.2505	0.2717	0.2806	0.2106	0.2092	0.2386
BUR3	0.2631	0.2680	0.2710	0.2572	0.2505	0.2717	0.2806	0.2106	0.2092	0.2386
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.2504	0.2275	0.2079	0.1913	0.2114	0.2041	0.2170			
BUR3	0.2504	0.2275	0.2079	0.1914	0.2114	0.2042	0.2168	0.2035	0.1842	0.1664
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	-0.1			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the years 2017-2019, direct $N_2O_{D(mm)}$ and indirect $N_2O_{IND(mm)}$ emissions resulting from 3B 'Manure Management' were estimated for the first time. The results allow us to assert that over the period 1990-2019, direct $N_2O_{D(mm)}$ emissions from the respective category decreased by 73.8 per cent, whereas indirect $N_2O_{IND(mm)}$ emissions decreased by circa 79.7 per cent.

It should be noted that indirect $N_2O_{G(mm)}$ emissions from volatilization of ammonia (NH_3) and nitrogen oxides (NO_x) decreased by 80.8 per cent, whereas $N_2O_{L(mm)}$ emissions from leaching and runoff of nitrogen decreased by 70.8 per cent, respectively (Table 5-53).

Table 5-53: Indirect $N_2O_{IND(mm)}$ emissions from volatilization of ammonia (NH_3) and nitrogen oxides (NO_x), as well as from leaching and runoff of nitrogen, under 3B 'Manure Management' for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Indirect $N_2O_{(G)}$	0.7311	0.6427	0.5581	0.4442	0.4256	0.3884	0.4038	0.3158	0.2883	0.2567
Indirect $N_2O_{(L)}$	0.0901	0.0868	0.0798	0.0736	0.0722	0.0666	0.0706	0.0544	0.0536	0.0498
$N_2O_{IND(mm)}$	0.8212	0.7295	0.6380	0.5178	0.4978	0.4550	0.4744	0.3702	0.3419	0.3065
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Indirect $N_2O_{(G)}$	0.2171	0.2210	0.2238	0.2122	0.2070	0.2255	0.2335	0.1738	0.1730	0.1984
Indirect $N_2O_{(L)}$	0.0460	0.0470	0.0471	0.0449	0.0435	0.0462	0.0470	0.0367	0.0361	0.0402
$N_2O_{IND(mm)}$	0.2631	0.2680	0.2710	0.2572	0.2505	0.2717	0.2806	0.2106	0.2092	0.2386
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Indirect $N_2O_{(G)}$	0.2093	0.1902	0.1736	0.1592	0.1762	0.1699	0.1824	0.1700	0.1550	0.1401
Indirect $N_2O_{(L)}$	0.0411	0.0374	0.0342	0.0321	0.0351	0.0342	0.0344	0.0335	0.0292	0.0263
$N_2O_{IND(mm)}$	0.2504	0.2275	0.2079	0.1914	0.2114	0.2042	0.2168	0.2035	0.1842	0.1664

This evolution was possible due to the drastic decrease in animal population, as well as a significant change in livestock and poultry farming practices and in the share of manure management systems.

Table 5-54 shows the total amounts of nitrogen generated by all manure management systems, as well as the amounts of nitrogen from animal waste available for application to managed soils, estimated in accordance with the methodology in the IPCC 2006 Guidelines.

Table 5-54: Total amount of nitrogen excreted ($N_{ex(T)}$) in all manure management systems and amount of nitrogen available (N_{MMS_Avb}) to be introduced into agricultural soils, for the period 1990-2019, kt N

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
$N_{ex\ (T)}$	135.1713	123.4886	110.3797	95.2995	92.4152	85.1856	88.3974	69.2488	65.7947	59.4772
N_{MMS_Avb}	85.3474	77.5640	70.2188	59.9481	58.2225	52.9686	54.7989	43.1256	40.8138	37.1658
Share, % from $N_{ex\ (T)}$	63.1	62.8	63.6	62.9	63.0	62.2	62.0	62.3	62.0	62.5
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
$N_{ex\ (T)}$	52.6415	53.4215	54.2313	51.2960	49.5581	52.1850	53.4875	41.0368	40.7807	45.6589
N_{MMS_Avb}	33.0652	33.7274	34.0138	32.2238	31.0014	32.6440	33.4153	25.7531	25.2695	28.1907
Share, % from $N_{ex\ (T)}$	62.8	63.1	62.7	62.8	62.6	62.6	62.5	62.8	62.0	61.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$N_{ex\ (T)}$	47.2092	43.2692	40.1876	38.0622	41.9332	40.5566	42.3696	40.1166	36.1017	32.4096
N_{MMS_Avb}	29.0441	26.6200	24.5900	23.3495	25.4226	24.7271	25.4846	24.2338	21.7356	19.5832
Share, % from $N_{ex\ (T)}$	61.5	61.5	61.2	61.3	60.6	61.0	60.1	60.4	60.2	60.4

5.3.2.6. Planned Improvements

Regarding N_2O emissions from source category 3B 'Manure Management', possible improvements could include activities on periodical collection of updated information on the share of manure management systems at national level during the reference period, as well as for the more recent period (once every 3-5 years), as well as information associated with specifying country-specific values of $N_{ex(T)}$ nitrogen excretion rates for different categories (kg N/head/year).

5.4. Agricultural Soils (Category 3D)

Direct and indirect N_2O emissions are monitored under category 3D 'Agricultural Soils'. The following nitrogen sources are included in the methodology for estimating direct N_2O emissions from managed soils: synthetic N fertilizers; organic N applied as fertilizer; urine and dung N deposited on pasture, range and paddock by grazing animals; N in crop residues (above-ground and below-ground), including from N-fixing crops and from forages during pasture renewal; N mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils; and drainage/management of organic soils.

Direct N_2O emissions were estimated following the 2006 IPCC Guidelines.

$$N_2O_{DIRECT} = N_2O_{SN} + N_2O_{ON} + N_2O_{PRP} + N_2O_{CR} + N_2O_{SOM}$$

Where:

N_2O_{SN} – N_2O emissions from the amount of synthetic fertilizer N applied to soils; kt/yr;

N_2O_{ON} – N_2O emissions from the amount of animal manure, compost, sewage sludge and other organic N additions applied to soils, kt/yr;

N_2O_{PRP} – N_2O emissions from urine and dung inputs to grazed soils, kt/yr;

N_2O_{CR} – N_2O emissions from the amount of N in crop residues (above-ground and below-ground), including N-fixing crops and from forages during pasture renewal, returned to soils, kt/yr;

N_2O_{SOM} – N_2O emissions from the amount of N in mineral soils that is mineralized, in association with loss of soil organic matter resulting from change of land use or management of mineral soils (dehumification), kt/yr.

It should be noted, that during the reference period (1990-201), direct N_2O emissions from category 3D 'Agricultural Soils' decreased by circa 25.7 per cent, from 3.9353 kt in 1990 to 2.9229 kt in 2019 (Figure 5-2). The contribution of different emission sources in the structure of total direct N_2O emissions had changed significantly. The share of N_2O_{ON} and N_2O_{PRP} had decreased by 69.5 per cent, and 5.4 per cent, respectively; whereas the share of N_2O_{SN}, N_2O_{CR}, and N_2O_{SOM}, had increased by circa 12.9 per cent, 20.6 per cent, and 33.9 per cent, respectively (Table 5-55).

Table 5-55: Breakdown of direct N_2O emissions from 3D 'Agricultural Soils' category by source for the period 1990-2019, % of total

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O_{SN}	36.8	34.1	30.4	15.2	10.0	7.4	9.9	8.6	8.0	5.0
N_2O_{ON}	21.8	19.9	21.7	21.8	26.1	23.5	25.7	20.5	20.1	19.8
N_2O_{PRP}	4.6	6.3	7.0	10.6	12.7	13.4	13.1	11.8	13.5	13.6
N_2O_{CR}	13.9	16.2	12.9	18.2	10.7	15.3	8.8	15.8	14.0	14.8
N_2O_{SOM}	23.0	23.5	27.9	34.1	40.5	40.4	42.5	43.2	44.5	46.8
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
N_2O_{SN}	9.1	10.2	13.7	13.1	12.8	12.6	11.5	18.3	18.0	14.7
N_2O_{ON}	18.5	17.1	16.4	18.3	15.5	16.2	17.6	15.8	13.1	15.4
N_2O_{PRP}	13.8	12.7	12.5	13.7	11.4	11.2	11.8	10.9	9.3	10.5
N_2O_{CR}	8.5	13.8	13.4	7.4	15.9	15.7	16.3	5.0	17.3	13.6
N_2O_{SOM}	50.1	46.2	44.0	47.5	44.4	44.2	42.9	50.1	42.3	45.8
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
N_2O_{SN}	16.3	19.7	28.1	28.8	35.9	29.7	28.4	32.9	36.6	41.5
N_2O_{ON}	14.5	13.2	12.8	10.1	9.4	12.0	10.5	9.0	7.8	6.6
N_2O_{PRP}	9.6	8.8	8.7	6.9	6.4	8.2	7.0	6.1	5.2	4.3
N_2O_{CR}	16.9	16.7	5.2	15.9	15.3	7.0	16.8	17.9	17.4	16.8
N_2O_{SOM}	42.8	41.7	45.2	38.3	33.0	43.1	37.2	34.0	33.0	30.7

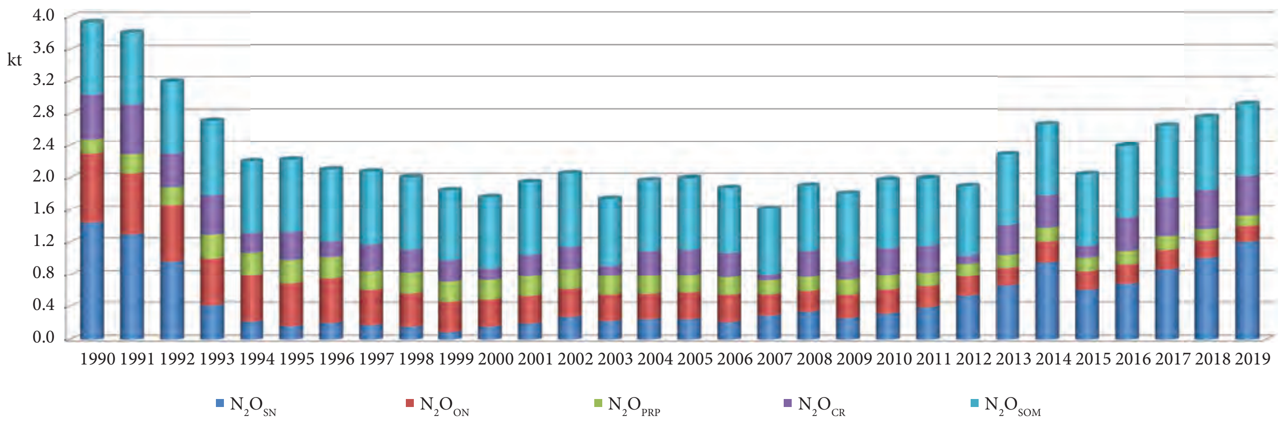

Figure 5-2: Direct N_2O emissions from 3D 'Agricultural Soils' category for the period 1990-2019 periods, kt.

N_2O emission can also take place indirectly through several pathways: the volatilization of N as NH_3 and oxides of nitrogen (NO_x), and the deposition of these gases and their products NH_4^+ and NO_3^- onto soils and the surface of lakes and other waters; while the second pathway is leaching and runoff from land of N from synthetic and organic fertilizer additions, crop residue, mineralization of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition from grazing animals.

Indirect N_2O emissions from managed soils were estimated by using the following equation from the 2006 IPCC Guidelines.

$$N_2O_{INDIRECT} = N_2O_{ATD} + N_2O_L$$

Where:

N_2O_{ATD} – indirect N2O emissions, produced from atmospheric deposition of nitrogen as ammonia (NH3), oxides of N (NOx), and their products NH4+ and NH3- onto soils and the surface of lakes and other waters; deposition of agriculturally derived NH3 and NOx, following the application of synthetic and organic N fertilizers and/or urine and dung deposition from grazing animals;

N_2O_L – from leaching and runoff from land of N from synthetic and organic fertilizer additions, crop residues returned to soils, mineralization of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices and urine and dung deposition from grazing animals.

Between 1990 and 2019, indirect N_2O emissions from source category 3D 'Agricultural Soils' had decreased by circa 31.8 per cent, from 1.2115 kt in 1990 to 0.8259 kt in 2019 (Figure 5-3).

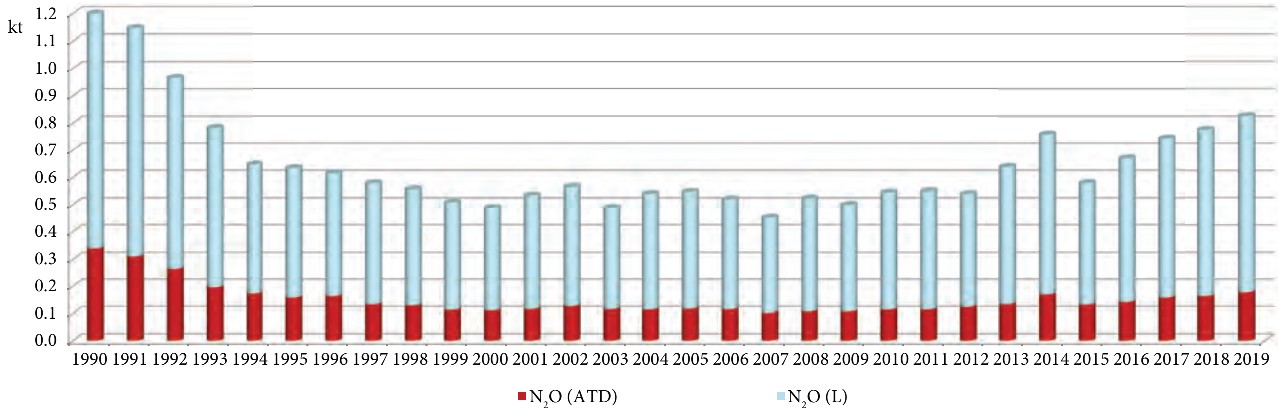

Figure 5-3: Evolution of indirect N_2O emissions from 3D 'Agricultural Soils' category for the period 1990-2019.

The contribution of emission sources in the structure of total indirect N_2O emissions had also changed within the reference period. Thus, the share of N_2O_{ATD} from atmospheric deposition of nitrogen decreased by 23.5 per cent, whereas the share of N_2O_L emissions from leaching and runoff of nitrogen from land had increased by 9.1 per cent, respectively (Table 5-56).

Table 5-56: Breakdown of indirect N_2O emissions from 3D 'Agricultural Soils' category for the period 1990-2019, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O_{ATD}	28.1	27.1	27.4	25.0	26.8	25.0	26.6	23.0	23.2	22.3
N_2O_L	71.9	72.9	72.6	75.0	73.2	75.0	73.4	77.0	76.8	77.7
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
N_2O_{ATD}	22.8	21.8	22.4	23.8	21.2	21.4	22.2	22.7	20.5	21.4
N_2O_L	77.2	78.2	77.6	76.2	78.8	78.6	77.8	77.3	79.5	78.6
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
N_2O_{ATD}	20.9	20.8	22.9	20.9	22.3	22.8	21.1	21.2	21.1	21.5
N_2O_L	79.1	79.2	77.1	79.1	77.7	77.2	78.9	78.8	78.9	78.5

5.4.1. Direct N_2O Emissions from Managed Soils

5.4.1.1. Inorganic Nitrogen Fertilizers

Source Category Description

Considerable amounts of nitrogen are applied to soils with inorganic nitrogen fertilizers. Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification. The amount of emissions from fertilizer consumption depends on a number of factors, such as: the amount and type of N fertilizers applied, crop type, soil type, climate and other environment related conditions. N_2O emissions from synthetic N fertilizers vary a lot over the year.

Methodological Issues, Emission Factors and Data Sources

Direct N_2O_{SN} emissions from applied inorganic nitrogen fertilizers were estimated by using a Tier 1 methodology, and Equation 11.2 in the 2006 IPCC Guidelines.

$$N_2O_{SN} = F_{SN} \bullet EF_1 \bullet 44/28$$

Where:

N_2O_{SN} – N_2O emissions from applied inorganic nitrogen fertilizers (kt/yr);

F_{SN} – annual amount of inorganic nitrogen fertilizers applied to soils (kg N/yr);

EF_1 – emission factor for N_2O emissions from N inputs; default: 0.01 kg N_2O-N/kg N applied; range: 0.003-0.03 kg N_2O-N/kg N;

[44/28] – mass ratio of nitrogen content in N_2O-N and N_2O.

Table 5-57 provides a short overview of inorganic N fertilizers, including complex fertilizers most commonly used in the Republic of Moldova.

Table 5-57: Overview of inorganic nitrogen fertilizers most commonly used in the RM

Type of Fertilizer	Chemical Formula	Active substance, %	Form	Features
Ammonium nitrate	NH_4NO_3	34.5	White macro crystals or pellets	Physiologically it is faintly acid, may be applied to all crops and all soils. Highly hygroscopic.
Urea (carbamide)	$CO(NH_2)_2$	46	White crystals or pellets	Has a physiologically faintly acid/neutral, low hygroscopic. Highly volatile. Applied to soils, may be used in solutions for foliar fertilization.
Ammophos	$NH_4H_2PO_4$	N: 11-12, P_2O_5: 42-50	Grey pellets	Efficient on chernozems, brown soils, and phosphor deficient soils.
Diammophos	$(NH_4)_2HPO_4$	N: 21, P_2O_5: 53	Grey pellets	Efficient on chernozems, and phosphor deficient soils.
Nitroammophos	Complex formula	N: P: K 13-19 each	Pellets of different colors	Efficient on all soils and used for all crops.
Diammophos	Complex formula	N: P: K 10:26:26	Pellets of different colors	Efficient on all soils and used for all crops.

Information on the amounts of applied inorganic N fertilizers (active substance – a.s.) on managed soils is available in the Statistical Yearbooks of the RM (for the period until 1992 – for the whole territory of the country, and for the period after 1993 – only for the right bank of the Dniester river), and in the Statistical Yearbooks of the ATULBD (for the period 1993-2019).

Table 5-58 indicates that between 1990 and 2019, there was a significant decrease by 51.3 per cent of the amounts of inorganic N fertilizers used in the agriculture sector of the RM, including a decrease by circa 16.2 per cent of inorganic N fertilizers; a decrease by circa 70.1 per cent of inorganic P fertilizers; and a decrease by circa 81.1 per cent of inorganic K fertilizers. The amounts of inorganic fertilizers used per one hectare decreased by circa 51.1 per cent, from 134.1 kg a.s./ha in 1990, to 65.6 kg a.s./ha in 2019.

Table 5-58: Applied inorganic fertilizers over the period 1990-2019, kt of active substance

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Applied inorganic fertilizer – total, kt a.s.	232.4	191.4	127.6	44.9	20.0	12.5	14.3	12.1	10.3	6.1
N fertilizer	92.1	82.7	61.8	26.4	14.1	10.5	13.2	11.4	10.2	5.9
P fertilizer	85.7	75.2	43.4	12.7	8.0	1.4	0.7	0.5	0.1	0.1
K fertilizer	54.6	33.5	22.4	5.8	1.6	0.6	0.3	0.2	0.0	0.0
kg applied for 1 sown ha	134.1	111.5	74.6	25.2	11.7	7.2	8.3	7.0	6.0	3.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Applied inorganic fertilizer – total, kt a.s.	10.3	12.8	18.4	15.4	17.5	18.0	16.6	22.4	24.7	19.9
N fertilizer	10.2	12.7	18.0	14.6	16.1	16.1	13.8	18.8	21.9	17.0
P fertilizer	0.1	0.1	0.3	0.6	1.0	1.5	2.0	2.4	1.7	2.0
K fertilizer	0.0	0.0	0.1	0.2	0.4	0.5	0.8	1.1	1.1	0.9
kg applied for 1 sown ha	6.1	7.4	10.6	9.7	10.4	10.6	10.7	14.4	15.9	12.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Applied inorganic fertilizer – total, kt a.s.	25.5	30.9	44.0	54.8	84.5	52.4	58.8	81.4	94.2	113.1
N fertilizer	20.6	25.0	34.1	42.1	61.1	38.7	43.4	55.7	64.3	77.2
P fertilizer	3.3	4.1	7.1	9.6	19.4	10.8	11.6	19.2	22.2	25.6
K fertilizer	1.6	1.8	2.8	3.1	4.0	2.9	3.8	6.4	7.8	10.3
kg applied for 1 sown ha	15.6	19.3	26.6	32.5	49.9	30.9	34.3	46.9	53.9	65.6

Source: Statistical Yearbooks of the RM for 1988 (page 280), 1994 (page 239), 1999 (page 330), 2003 (page 442), 2006 (page 352), 2011 (page 345), 2014 (page 345) and 2019 (page 296). Statistical Yearbooks of the ATULBD for 1998 (page 230), 2000 (page 107), 2002 (page 111), 2006 (page 108), 2009 (page 107), 2012 (page 114), 2017 (page 110), 2019 (page 108), 2020 (page 111).

It should be noted that the average consumption of nutrients, in kg of nitrogen per 1 ton of basic yield in most crops is 30-35 kg, and the yield capacity of crops grown in the RM, according to the National Complex Soil Fertility Enhancing Program for 2001-2020, vary between 3.5-4.8 t/ha for winter wheat, 4.5-6.4 t/ha for grain maize, 2.1-3.5 t/ha for sunflower, 26.8-37.0 t/ha for sugar beets, etc. The sharp reduction in fertilizer consumption occurred due to a number of reasons, such as: a drop in the import of synthetic fertilizer into the country, the farmers' lack of financial resources in certain periods of the year, particularly in the context of the breakdown of agriculture during the transition to market economy. It should also be noted that in accordance with the National Complex Soil Fertility Enhancing Program for 2001-2020, the annual amount of synthetic N fertilizer in the RM is planned to increase to 120-130 thousand tonnes of nitrogen by 2020.

Uncertainties Assessment and Time-Series Consistency

Uncertainties related to activity data on applied inorganic N fertilizers in the RM are considered to be low (circa 5 per cent). Uncertainties associated with the default emission factor (EF_1 for F_{SN}) may reach up to circa 6 per cent. The combined uncertainties associated with the direct N_2O emissions from applied synthetic N fertilizers are thereby considered to be low (circa 7.81 per cent) (Annex 5-3.3).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in accordance with the recommendations included in the 2006 IPCC Guidelines.

Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for category 3D 'Agricultural Soils', following a Tier 1 approach. The AD and methods used to estimate N_2O emissions originating from this source category were documented and archived both in hard copies and electronically. In order to identify the data entry and the N_2O emission estimation process related errors AD and EFs verifications and quality control procedures were applied. Following the recommendations included into the 2006 IPCC Guidelines, N_2O emissions from applied inorganic N fertilizers were estimated using AD from official reference sources.

Recalculations

No recalculations were made to estimate direct N_2O_{SN} emissions from applied inorganic N fertilizers in the country over the period 1990-2016 (Table 5-59). Between 2017 and 2019, direct N_2O_{SN} emissions from applied inorganic N fertilizers to agricultural soils were estimated for the first time. The obtained results show that over the period 1990-2019, the respective emissions had decreased by circa 16.2 per cent.

Table 5-59: Direct N_2O_{SN} emissions from applied inorganic N fertilizers included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1.4473	1.2996	0.9711	0.4145	0.2217	0.1652	0.2077	0.1795	0.1600	0.0929
BUR3	1.4473	1.2996	0.9711	0.4145	0.2217	0.1652	0.2077	0.1795	0.1600	0.0929
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.1609	0.1994	0.2823	0.2298	0.2524	0.2530	0.2170	0.2959	0.3446	0.2670
BUR3	0.1609	0.1994	0.2823	0.2298	0.2524	0.2530	0.2170	0.2959	0.3446	0.2670
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.3234	0.3928	0.5355	0.6617	0.9603	0.6078	0.6821			
BUR3	0.3234	0.3928	0.5355	0.6617	0.9603	0.6078	0.6821	0.8754	1.0105	1.2134
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Table 5-60 shows comparative results of nitrous oxide emissions from applied inorganic N fertilizers on managed lands for the period 1990-2019 included into the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 (GWP_{100} = 298).

Table 5-60: Comparative results of direct N_2O_{SN} emissions from applied inorganic N fertilizers included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	431.2911	387.2723	289.4006	123.5197	66.0704	49.2215	61.8980	53.4876	47.6855	27.6851
BUR3	431.2911	387.2723	289.4006	123.5197	66.0704	49.2215	61.8980	53.4876	47.6855	27.6851
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	47.9571	59.4114	84.1182	68.4681	75.2161	75.4034	64.6623	88.1735	102.6997	79.5613
BUR3	47.9571	59.4114	84.1182	68.4681	75.2161	75.4034	64.6623	88.1735	102.6997	79.5613
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	96.3774	117.0677	159.5721	197.1895	286.1680	181.1301	203.2777			
BUR3	96.3774	117.0677	159.5721	197.1895	286.1680	181.1301	203.2777	260.8773	301.1419	361.6060
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Planned Improvements

No activities to improve the estimation process regarding direct N_2O emissions from applied inorganic N fertilizers are planned for the next inventory cycle.

5.4.1.2. Organic Nitrogen Fertilizers

Source Category Description

Applied organic nitrogen fertilizers may enhance the processes of nitrification and denitrification, thus contributing to the increase in N_2O emissions from managed soils. While calculating emissions covered by this source category, activity data on the generation of various organic waste obtained in the national economy should be taken into account. In the Republic of Moldova, the largest share of such organic matter comes from the livestock breeding sector and the food processing industry. However, the animal breeding sector is still the major provider of organic fertilizer: animal manure; composts based on manure and crop residue, diluvial soil, sludge from water basins, manure slurry, household sludge, poultry manure, etc.; sludge from livestock complexes, poultry litter, urine and manure. Another important source is the sludge from the treatment of domestic wastewater and waste from sugar beet processing plants (sludge), as well as from wineries (vinasse, solid wine yeasts, etc.).

Methodological Issues, Emission Factors and Data Sources

N_2O emissions from applied organic N fertilizers were estimated using a Tier 1 methodology and Equation 11.2 from the 2006 IPCC Guidelines.

$$N_2O_{ON} = F_{ON} \bullet EF_1 \bullet 44/28$$

Where:

N_2O_{ON} – N_2O emissions from applied organic N fertilizers (kt/yr);

$F_{ON} = (F_{AM} + F_{SEW} + F_{COMP} + F_{OOA})$, total annual amount of organic N fertilizers applied to soils other than by grazing animals (kg N/yr);

F_{AM} – annual amount of animal manure N applied to soils (kg N/yr);

F_{SEW} – annual amount of total sewage N that is applied to soils (kg N/yr);

F_{COMP} – annual amount of total compost N applied to soils (kg N/yr);

F_{OOA} – annual amount of other organic amendments used as fertilizer (kg N/yr);

EF_1 – default EF: 0.01 kg N_2O-N/kg N applied (range: 0.003-0.03 kg N_2O-N/kg N);

[44/28] – mass ratio of nitrogen content in N_2O-N and N_2O.

Data on total amount of organic fertilizers (preponderantly, manure with bedding[102]) applied on managed lands are available in the Statistical Yearbooks of the RM and the ATULBD (Table 5-61).

[102] In the early 1990s, the share of animal bedding manure (4-6 kg bedding/animal/day) in Moldova was circa 37.6 per cent of the total amount of animal manure generated in the livestock breeding sector; the share of manure with semi-bedding (1-3 kg bedding/animal/day) constituted circa 26.7 per cent; and the share of manure without bedding – circa 35.4 per cent, respectively (Turcan et al., 1984; Balteanskyi, 1986).

Table 5-61: Applied organic fertilizers over the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Applied organic N fertilizers total, kt	9740.0	8600.0	5300.0	4200.0	1620.0	1779.2	905.7	352.9	227.3	122.1
tonnes applied to 1 ha of sown field	5.60	5.10	3.40	2.40	1.10	1.20	0.60	0.20	0.10	0.10
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Applied organic N fertilizers total, kt	83.3	98.2	54.2	47.3	42.2	44.2	10.5	7.9	8.0	6.9
tonnes applied to 1 ha of sown field	0.03	0.10	0.02	0.06	0.04	0.04	0.01	0.00	0.00	0.01
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Applied organic N fertilizers total, kt	17.7	31.5	22.9	42.6	33.8	61.2	74.6	45.5	103.4	84.0
tonnes applied to 1 ha of sown field	0.02	0.04	0.03	0.05	0.03	0.07	0.08	0.05	0.11	0.08

Source: Statistical Yearbooks of the RM for 1988 (page 280), 1994 (page 239), 1999 (page 330), 2003 (page 442), 2006 (page 352), 2011 (page 345), 2014 (page 345) and 2019 (page 296). Statistical Yearbooks of the ATULBD for 1998 (page 230), 2000 (page 107), 2002 (page 111), 2006 (page 108), 2009 (page 107), 2012 (page 114), 2017 (page 110), 2019 (page 108), 2020 (page 111).

As the table indicates, from 1990 through 2019, according to the NBS and the State Statistical Service of the ATULBD, there was a significant reduction, by circa 70 times, of the amounts of organic N fertilizers applied per hectare of sown fields, from circa 5.6 tonnes per sown hectare in 1990, to circa 84 kg per sown hectare in 2019.

It should be mentioned that the statistical data on the amount of organic N fertilizers applied to soils is collected through Questionnaire no. 9-agr 'The use of phytosanitary products and the introduction of synthetic and organic fertilizers into the crop yield of year…'. This questionnaire is submitted annually to the territorial statistical institution, by December 5, by agricultural enterprises and organizations irrespective of the organizational-legal and property forms (including individual farms with a total area of 50 or more ha) depending on the location of the land. As it can be seen, individual farms with an area less than 50 ha are not required to report data related to the type of fertilizers applied to soil. Considering that most of the livestock and poultry population is included in individual farms (Table 5-36), which also do not report to the territorial statistical institution, it is obvious that the statistical data presented above, in Table 5-61, is much underestimated.

Within the past two inventory cycles, the amount of organic N fertilizers applied to soils was estimated based on the information on the total amount of excreted nitrogen ($N_{ex(T)}$) in all manure management systems and the amount of nitrogen available (N_{MMS_Avb}) for application to managed soils (Table 5-54). As it can be seen in Table 5-62, the current statistical system fails to monitor the amounts of organic N fertilizers actually applied to soils in the RM, as it does not statistically include all producers and individual farmers.

Table 5-62: Amount of organic fertilizers generated and available to be applied to soils in the Republic of Moldova over the period 1990-2019, in comparison to the official statistical data within the same period, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Organic fertilizers available to be applied to soils (estimated AD), kt	15240.6	13850.7	12539.1	10705.0	10396.9	9458.7	9785.5	7701.0	7288.2	6636.7
Applied organic fertilizers (statistical data), kt	9740.0	8600.0	5300.0	4200.0	1620.0	1779.2	905.7	352.9	227.3	122.1
Applied organic fertilizers (statistical data), % of the amount available to be applied to soils	63.9	62.1	42.3	39.2	15.6	18.8	9.3	4.6	3.1	1.8
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Organic fertilizers available to be applied to soils (estimated AD), kt	5904.5	6022.8	6073.9	5754.3	5536.0	5829.3	5967.0	4598.8	4512.4	5034.1
Applied organic fertilizers (statistical data), kt	83.3	98.2	54.2	47.3	42.2	44.2	10.5	7.9	8.0	6.9
Applied organic fertilizers (statistical data), % of the amount available to be applied to soils	1.4	1.6	0.9	0.8	0.8	0.8	0.2	0.2	0.2	0.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Organic fertilizers available to be applied to soils (estimated AD), kt	5186.4	4753.6	4391.1	4169.5	4539.8	4415.5	4550.8	4327.5	3881.4	3497.0
Applied organic fertilizers (statistical data), kt	17.7	31.5	22.9	42.6	33.8	61.2	74.6	45.5	103.4	84.0
Applied organic fertilizers (statistical data), % of the amount available to be applied to soils	0.3	0.7	0.5	1.0	0.7	1.4	1.6	1.1	2.7	2.4

The scientific literature [103] shows that 1 ton of cattle manure with bedding contains circa 5.6 kg of nitrogen. In order to estimate the F_{ON} values (Table 5-63), the applied amount of organic fertilizer (the values for the period 1990-1991 were taken from official statistics; and for the period 1992-2019 it is agreed that 63 per cent of the available amount is actually applied to soil, this value represents an arithmetic mean between the value 63.9 per cent, characteristic of the year 1990, and the value 62.1 per cent, characteristic of the year 1991) was multiplied by the conversion factor from bedding manure to nitrogen.

[103] Ungureanu, Cerbari et al., 2006; Bucataru et al., 2006; Raileanu, Jolondcovschi et al., 2006; Andries, Rusu, et al., 2005; Bucataru, Maciuc, 2005; Toncea, 2004; Banaru, 2003.

Table 5-63: Amount of nitrogen applied to soils with organic fertilizers for 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Organic fertilizers available to be applied to soils, kt	15240.6	13850.7	12539.1	10705.0	10396.9	9458.7	9785.5	7701.0	7288.2	6636.7
Applied organic fertilizers (63 per cent of the available amounts), kt	9740.0	8600.0	7899.6	6744.2	6550.0	5959.0	6164.9	4851.6	4591.6	4181.1
Applied organic fertilizers (F_{ON}), kt of a.s. (N)	54.5440	48.1600	44.2378	37.7673	36.6802	33.3702	34.5233	27.1691	25.7127	23.4144
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Organic fertilizers available to be applied to soils, kt	5904.5	6022.8	6073.9	5754.3	5536.0	5829.3	5967.0	4598.8	4512.4	5034.1
Applied organic fertilizers (63 per cent of the available amounts), kt	3719.8	3794.3	3826.5	3625.2	3487.7	3672.5	3759.2	2897.2	2842.8	3171.5
Applied organic fertilizers (F_{ON}), kt of a.s. (N)	20.8311	21.2483	21.4287	20.3010	19.5309	20.5657	21.0517	16.2245	15.9198	17.7602
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Organic fertilizers available to be applied to soils, kt	5186.4	4753.6	4391.1	4169.5	4539.8	4415.5	4550.8	4327.5	3881.4	3497.0
Applied organic fertilizers (63 per cent of the available amounts), kt	3267.5	2994.7	2766.4	2626.8	2860.0	2781.8	2867.0	2726.3	2445.3	2203.1
Applied organic fertilizers (F_{ON}), kt of a.s. (N)	18.2978	16.7706	15.4917	14.7102	16.0163	15.5781	16.0553	15.2673	13.6934	12.3374

It should be noted that in accordance with crop rotation structure, the need for organic fertilizer is circa 10-15 t/ha for a neutral humus balance, and circa 20-30 t/ha for a positive balance (to fully compensate for the humus losses, an average amount of organic fertilizer of 10 t/ha is needed). Based on the relevant agriculture expert opinions, the stabilization of humus content in soil on arable lands and horticultural plantations requires the annual application of circa 20-22 million tonnes of organic fertilizers, whereas current resources of organic matter can ensure application of as much as 3.5-4.5 million tonnes of organic fertilizer.

It is considered that the only way to eliminate the deficit of organic fertilizer is to radically change the structure of crops by changing the land use categories, improving crop rotations, and a more comprehensive use of all local sources of organic matter.

In this context, specialists recommend that the green mass of the leguminous crops with highly developed semi-fascicular root system be used as an organic fertilizer applied to soil. The best suited for this use as green sidereal are the vetch, winter and spring peas, respectively.

The use of these crops as a green fertilizer can be achieved in two ways:

(i) the vetch or the winter peas sown in September as an intermediate crop and incorporated into the soil by early spring in the following year, at the end of April, before sowing the main crop; the crop rotation would be: winter cereals → vetch or winter peas as an intermediate crop → maize or sunflower etc.; or

(ii) in a five field crop rotation, in which the first field is used during the first year for vetch or winter and spring peas, two crop yields incorporated into the soil as green fertilizers; the crop rotation for the field used in the first year for vetch would be: winter cereals → maize → sunflower → winter cereals.

It should be noted that a vetch yield (mixed with a cereal crop of circa 20 per cent) or a peas yield, annually could return to soil circa 8 t/ha dry matter of organic mass, aerial and roots, with an average N content of circa 3.4 per cent; which provides for synthesis about 2.0 t/ha/year of humus or circa 1.2 t/ha/year of carbon. The systemic use of vetch or peas as a green fertilizer, intermediate crop, or in a five field crop rotation, where a field is occupied with vetch or peas, provides a balance of organic matter and nitrogen in the soil (Wiesmeier et. al, 2015[104]; Leah, Cerbari, 2015[105]; Cerbari, Leah, 2016[106]; Leah, 2018[107]; Leah, Cerbari, 2019[108], 2020[109]).

Uncertainties Assessment and Time-series Consistency

Uncertainties related to activity data on applied organic N fertilizers to agricultural soils in the RM reach circa 30 per cent. Uncertainties associated with the default emission factor used (EF_1 for F_{ON}) may reach circa 6 per cent. Thus, the combined uncertainties source category 3D.a.2 'Organic N Fer-

[104] Wiesmeier M., Lungu M., Hübner R. & Cerbari V. (2015), Remediation of Degraded Arable Steppe Soils in Moldova using Vetch as Green Manure. Solid Earth, 6: pages 609–620.
[105] Leah, T. & Cerbari V. (2015), Cover crops – Key to Storing Organic Matter and Remediation of Degraded Properties of Soils in Moldova. Series Agronomy. USAMV, Bucharest, pages 73-76.
[106] Cerbari V. & Leah C. (2016), Green Manure – the only Possibility to save Moldova's Arable Soils from Degradation. USAMV 'Ion Ionescu de la Brad', Iasi. Romania. Scientific papers. Agronomy. Vol. 59(2), pages 155-158.
[107] Leah T. (2018), The Importance of Crop Rotation and the Role of Legumes in the Agriculture of Moldova. Researches on the Field Crops in the Republic of Moldova. Balti, Indigou Color, pages 66-71 (Rom).
[108] Leah T.& Cerbari V. (2019), Effects of Green Fertilizers on the Quality Status and Production Capacity of the Cambic Chernozem from Moldova. International Journal AGROFOR, Volume 5 (3), 2020, pages 28-38.
[109] Leah T. & Cerbari V. (2020), Evaluation of the Conservative Agriculture Benefits on Soil Properties and Harvests in Crop Rotation with Legumes. Scientific paper. Series Agronomy. Volume 63, No. 2. UASVM 'Ion I. de la Brad', Iasi. 2020, pages 9-14.

tilizers' are considered average (circa 30.59 per cent) (Annex 5-3.3). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for Sector 3 'Agriculture', following a Tier 1 approach. Activity Data and methods used to estimate N_2O emissions originating from applied organic fertilizers were documented and archived both in hard copies and electronically. In order to identify the data entry and GHG emissions estimation process related errors, AD and EFs verifications and quality control procedures were applied.

Recalculations

Direct N_2O_{ON} emissions from source category 3D.a.2 'Organic N Fertilizers' were recalculated for the period 1990-2016, particularly due to using a new set of AD, generated based on the information regarding the amount of organic N fertilizers available to be applied to soil estimated within source category 3B 'Manure Management'. In the current inventory cycle, the amounts of organic fertilizers applied to soil for the years 1990-1991 were taken from official statistics, whereas for the period 1992-2019, it was agreed that circa 63 per cent of the available quantity is actually applied to soil (this value represents an arithmetic mean between the value of 63.9 per cent, characteristic of 1990; and the value of 62.1 per cent, characteristic of 1991), as opposed to the previous inventory cycle, when it was agreed that 65 per cent of the available amount is actually applied to the soil. In comparison with results recorded in the BUR2 of the RM to the UNFCCC, the changes made resulted in a downward trend in direct N_2O_{ON} emissions from applied organic fertilizers for the period 1990-2016 (Table 5-64).

Table 5-64: Comparative results of direct N_2O_{ON} emissions from applied organic N fertilizers included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	0.8718	0.7923	0.7172	0.6123	0.5947	0.5410	0.5597	0.4405	0.4169	0.3796
BUR3	0.8571	0.7568	0.6952	0.5935	0.5764	0.5244	0.5425	0.4269	0.4041	0.3679
Difference, %	-1.7	-4.5	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.3377	0.3445	0.3474	0.3291	0.3167	0.3334	0.3413	0.2631	0.2581	0.2879
BUR3	0.3273	0.3339	0.3367	0.3190	0.3069	0.3232	0.3308	0.2550	0.2502	0.2791
Difference, %	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.2967	0.2719	0.2510	0.2383	0.2595	0.2523	0.2605			
BUR3	0.2875	0.2635	0.2434	0.2312	0.2517	0.2448	0.2523	0.2399	0.2152	0.1939
Difference, %	-3.1	-3.1	-3.0	-3.0	-3.0	-3.0	-3.2			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the years 2017-2019, direct N_2O_{ON} emissions resulting from category 3D.a.2 'Organic N Fertilizers' were estimated for the first time. The obtained results allow us to assert that over the period 1990-2019, the respective emissions decreased by circa 74.9 per cent, particularly due to the decrease in animal population.

Table 5-65 below shows comparative results of nitrous oxide emissions from applied organic N fertilizers on managed lands in the Republic of Moldova for the period 1990-2019 included into the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 (GWP_{100} = 298).

Table 5-65: Comparative results of direct N_2O_{ON} emissions from category 3D.a.2 'Organic N Fertilizers' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	259.7852	236.0938	213.7359	182.4733	177.2211	161.2289	166.8000	131.2681	124.2314	113.1273
BUR3	255.4218	225.5264	207.1594	176.8587	171.7681	156.2680	161.6677	127.2290	120.4089	109.6464
Difference, %	-1.7	-4.5	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	100.6457	102.6614	103.5330	98.0847	94.3637	99.3638	101.7115	78.3889	76.9168	85.8086
BUR3	97.5490	99.5026	100.3474	95.0667	91.4602	96.3065	98.5819	75.9769	74.5502	83.1683
Difference, %	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	88.4060	81.0274	74.7839	71.0095	77.3187	75.1923	77.6302			
BUR3	85.6858	78.5343	72.5454	68.8856	75.0019	72.9498	75.1846	71.4945	64.1245	57.7742
Difference, %	-3.1	-3.1	-3.0	-3.0	-3.0	-3.0	-3.2			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Planned Improvements

No activities to improve the estimation process regarding direct N_2O emissions from applied organic fertilizers in the RM are planned for the future inventory cycle.

5.4.1.3. Urine and Dung Deposited by Grazing Animals

Source Category Description

By 2019, hayfields and pastures occupied circa 341.1 thousand ha (10.21 per cent of the country's area). Worldwide, permanent grasslands, hayfields and pastures generally occupy a surface twice as big as arable lands. However, this surface is 5 times smaller in the RM (Table 5-66).

Table 5-66: Land Fund by Land Use in the RM for the period 1992-2019, thousand ha

	1992	1995	2000	2005	2010	2015	2016	2017	2018	2019
Total lands, including:	**3376.0**	**3385.1**	**3384.4**	**3384.6**	**3384.4**	**3384.6**	**3384.6**	**3384.6**	**3384.6**	**3384.7**
Agricultural lands	2565.9	2556.7	2550.3	2521.6	2501.1	2499.7	2499.6	2499.8	2496.6	2496.4
including:										
Arable lands	1736.3	1758.7	1813.8	1840.2	1816.7	1817.4	1822.9	1827.3	1832.3	1838.5
Perennial plantations	474.8	430.7	352.3	297.8	301.0	291.7	288.9	288.8	290.1	286.6
including:										
Orchards	224.5	208.3	170.8	131.9	132.5	134.5	132.5	133.5	132.5	131.2
Vineyards	215.8	202.6	168.9	155.5	153.5	137.5	136.2	135.3	135.8	133.1
Pastures	350.5	365.2	373.9	370.8	352.1	346.4	345.0	342.8	340.2	339.1
Hayfields	4.3	2.1	2.5	2.7	2.2	2.2	2.1	2.1	2.1	2.0
Fallow lands	0.0	0.0	7.8	10.1	29.1	42.0	40.6	38.8	31.9	30.2
Forests and forest land	421.7	425.3	422.7	439.5	462.8	464.5	465.2	465.3	466.3	467.2
Rivers, lakes, and bogs	88.7	92.6	95.5	96.8	96.4	96.8	96.7	96.1	96.1	96.5
Other lands	299.7	310.5	315.9	326.7	324.3	323.6	323.1	323.4	325.7	324.7

Generally, the surface of land occupied by pastures varies between 0.3 and 300 ha, these being the pastures on steep slopes, where agricultural machinery cannot be used, as well as lowlands with excessive amount of water due to flooding or superficial level of surface waters. In the RM, grazing takes place from March through November, involving a big number of cattle, regardless of weather. Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification of N inputs from urine and dung N deposited on pasture by grazing animals.

Methodological Issues, Emission Factors and Data Sources

Direct N_2O emissions from urine and dung deposited by grazing animals were estimated by using a Tier 1 methodology applying Equations 11.1 and 11.2 from the 2006 IPCC Guidelines:

$$N_2O_{PRP} = F_{PRP} \bullet EF_{3\,PRP} \bullet 44/28$$

Where:

N_2O_{PRP} – N_2O emissions from urine and dung deposited by grazing animals;

F_{PRP} – annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/yr):

$$F_{PRP} = \Sigma_{(s)} [(N_{(T)} \bullet N_{ex\,(T)}) \bullet MS_{(T,\,PRP)}]$$

Where:

$N_{(T)}$ – number of head of livestock species/category T in the country (see source category 3A);

$N_{ex\,(T)}$ – annual average N excretion per animal of species/category T in the country (kg N/animal/yr) (see source category 3B);

$MS_{(T,\,PRP)}$ – fraction of annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock/number of head of livestock species/category T (see source category 3B);

$EF_{3\ PRP}$ – default emission factor values are: 0.02 kg N_2O-N/kg N for cattle, swine and poultry; 0.01 kg N_2O-N/kg N for other animal categories;

[44/28] – mass ratio of nitrogen content in N_2O-N and N_2O.

In order to estimate the amount of nitrogen from urine and dung deposited by grazing animals (Table 5-67), were used activity data on the total population of livestock and poultry from the Statistical Annual Report No. 24-agr 'Animal Breeding Sector': 'The Number of Livestock and Poultry in all Households Categories as of 1st of January' (annually for the period 1990-2019), Statistical Yearbooks of the ATULBD (identical AD to those used under categories 3A 'Enteric Fermentation' and 3B 'Manure Management'), country-specific data on nitrogen excretion rate $N_{ex(T)}$ (in kg N/head/yr), and country-specific values of the different manure management systems used (identical to those used under 3B 'Manure Management').

Table 5-67: Annual amount of urine and dung nitrogen deposited by grazing animals on pasture, range and paddock for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
F_{PRP}	7.5735	9.4632	9.0904	11.3944	11.3683	11.6633	10.8571	9.5347	10.4221	9.6861
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
F_{PRP}	9.3852	9.4625	9.9027	9.2932	8.8609	8.7819	8.7505	7.0606	7.2414	7.7838
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
F_{PRP}	7.7559	7.1786	6.8705	6.7707	7.3687	7.1345	7.2535	7.0285	6.2174	5.4995

Uncertainties Assessment and Time-Series Consistency

There is a high degree of uncertainty related to N_2O emission estimations from this source category due to high uncertainties associated with direct N_2O emissions from N urine and dung deposited by grazing animals (circa 30 per cent), and uncertainties associated with the default emission factor (EF_3) specific to this process (circa 50 per cent). The combined uncertainties associated with direct N_2O emissions from N urine and dung deposited by grazing animals are considered to be average (circa 58.31 per cent) (Annex 5-3.3).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

Quality Assurance and Quality Control

Standard verification and quality control forms and check-list were filled in for this source category within Sector 3 'Agriculture', following a Tier 1 approach. The AD and methods used to estimate N_2O emissions from N urine and dung deposited by grazing animals under this category were documented and archived both in hard copies and electronically. In order to identify the data entry and GHG emissions estimation process related errors, AD and EFs verifications and quality control procedures were applied.

Following the recommendations included into the 2006 IPCC Guidelines, N_2O emissions from urine and dung deposited by grazing animals were estimated using AD from official reference

Recalculations

Direct N_2O_{PRP} emissions from source category 3D.a.3 'Urine and Dung Deposited by Grazing Animals' were recalculated for the period 2012-2016, particularly due to the use of the updated shares of manure management systems (MS%) applied based on a study developed in 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine as well as from the National Agency for Food Security. In comparison with the results included into the BUR2 of the RM to the UNFCCC, the changes made in the current inventory cycle resulted in an insignificant upward trend in direct N_2O_{PRP} emissions from urine and dung deposited by grazing animals over the period 2012-2016 (Table 5-68).

Table 5-68: Comparative results of direct N_2O_{PRP} emissions from 3D.a.3 'Urine and Dung Deposited by Grazing Animals' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	0.1807	0.2395	0.2251	0.2869	0.2806	0.2998	0.2763	0.2455	0.2709	0.2514
BUR3	0.1807	0.2395	0.2251	0.2869	0.2806	0.2998	0.2763	0.2455	0.2709	0.2514
Difference, %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.2447	0.2481	0.2569	0.2386	0.2260	0.2241	0.2212	0.1756	0.1770	0.1900
BUR3	0.2447	0.2481	0.2569	0.2386	0.2260	0.2241	0.2212	0.1756	0.1770	0.1900
Difference, %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.1898	0.1756	0.1641	0.1578	0.1703	0.1660	0.1643			
BUR3	0.1898	0.1756	0.1654	0.1591	0.1716	0.1673	0.1680	0.1634	0.1434	0.1269
Difference, %	0.00	0.00	0.80	0.82	0.78	0.82	2.26			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the years 2017-2019, direct N_2O_{PRP} emissions resulting from urine and dung deposited by grazing animals were estimated for the first time. The results allow us to assert that over the period 1990-2019, the respective emissions decreased by circa 29.8 per cent, particularly due to a reduction in the total population of livestock over the period under review and changes in the share of manure management systems (the share of liquid/slurry systems had significantly decreased whereas the share of pasture and solid storage had increased).

Table 5-69 below shows the comparative results of direct N_2O_{PRP} emissions resulting from urine and dung deposited by grazing animals for the period 1990-2019 included into the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 (GWP_{100} = 298).

Table 5-69: Comparative results of direct N_2O_{PRP} emissions from source category 3D.a.3 'Urine and Dung Deposited by Grazing Animals' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	53.8411	71.3567	67.0890	85.4882	83.6134	89.3328	82.3343	73.1452	80.7339	74.9079
BUR3	53.8411	71.3567	67.0890	85.4882	83.6134	89.3328	82.3343	73.1452	80.7339	74.9079
Difference, %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	72.9094	73.9328	76.5423	71.0935	67.3462	66.7788	65.9181	52.3419	52.7535	56.6075
BUR3	72.9094	73.9328	76.5423	71.0935	67.3462	66.7788	65.9181	52.3419	52.7535	56.6075
Difference, %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	56.5567	52.3378	48.9082	47.0343	50.7368	49.4613	48.9589			
BUR3	56.5567	52.3378	49.3006	47.4177	51.1317	49.8657	50.0634	48.6822	42.7271	37.8123
Difference, %	0.00	0.00	0.80	0.82	0.78	0.82	2.26			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Planned Improvements

No activities to improve the estimation process regarding the direct N_2O emissions from urine and dung deposited by grazing animals are planned for the future inventory cycle.

5.4.1.4. Crop Residues

Source Categories Description

During crop harvesting, a part of the crop, as agricultural residues (above-ground and below-ground), is left in the field to decompose. The nitrogen in crop residues is a relevant source for nitrification and denitrification, contributing to N_2O emissions.

Emission estimation requires taking into account both the amount of crop residues burnt in fields to clean the stubble fields for the next agricultural cycle, as well as the amount of crop residues to be removed annually for purposes such as feed, bedding, burnt for heating and cooking, etc.

Methodological Issues, Emission Factors and Data Sources

N_2O emissions from this source category were estimated using the *'Methodology of determining the carbon balance in agricultural soils to assess GHG emissions'* (see Annex A3-4.2)[110].

[110] Banaru, Anatol (2000), Methodology to Calculate CO2 Emissions from Agricultural Soils, In the collection of papers 'Climate Change: Research, Studies, Solutions', Ministry of Environment / UNDP Moldova. 'Bons Offices' Ltd. Chişinău, 2000, pages 115-123

Equation 11.2 from the 2006 IPCC Guidelines was applied:

$$N_2O_{CR} = F_{CR} \bullet EF_1 \bullet 44/28$$

Where:

F_{CR} – annual amount of N in crop residues returned to soils annually, t N/yr;

EF_1 – default value of emission factor is 0.01 kg N_2O-N/kg N;

[44/28] – mass ratio of nitrogen content in N_2O-N and N_2O.

The total amount of N in crop residues returned to soils was estimated using the following equation:

$$F_{CR} = (Crop_{(T)} \bullet R_{AG(T)} \bullet (1-Frac_{Remove(T)}) + Crop_{(T)} \bullet R_{BG(T)}) \bullet (P_{CR}/10^2) \bullet (k_6/10^2)$$

Where:

$Crop_{(T)}$ – harvested annual dry matter yield for crop T t.d.m./ha;

$$Crop_{(T)} = Yield\ Fresh_{(T)} \bullet DRY$$

$Yield\ Fresh_{(T)}$ – harvested fresh yield for crop T, t/ha;

DRY – dry matter fraction of harvested crop T, kg dm/t of yield [111] (see Table 6-62);

$R_{AG(T)}$ – ratio of above-ground residues dry matter to harvested yield for crop T (Crop(T)), $t.d.m_{AG}/t.d.m$[112] (see Table 5-70);

$R_{BG(T)}$ – ratio of below-ground residues to harvested yield for crop T, $t.d.m_{BG}/t$ dm [113] (see Table 5-70);

$Frac_{Remove(T)}$ – fraction of above-ground residues of crop T removed and used for other purposes[114] (see Table 5-70) (it should be noted that in dry years, the fraction of crop residues reaches up to 90 per cent);

P_{CR} – amount of nitrogen in crop residues (% a.s.) (Table 5-71);

k_6 – coefficient reflecting the N in crop residues (Banaru, 2002)[115] (Table 5-71).

Indices used to estimate N_2O emissions from crop residues returned to soils come from different official sources of reference, including the 2006 IPCC Guidelines.

Table 5-70: Indices used to estimate the amount of carbon in crop residues returned to soils

Crop	DRY	$R_{AG(T)}$	$R_{BG(T)}$	$Frac_{Remove(T)}$
Winter wheat	0.89	1.40	0.23	0.75
Winter rye	0.88	1.30	0.22	0.75
Barley	0.89	1.17	0.22	0.75
Oat	0.89	1.17	0.25	0.75
Buckwheat	0.88	1.17	0.25	0.75
Millet	0.88	1.17	0.22	0.40
Grain maize	0.87	1.17	0.22	0.70
Sorghum	0.89	1.17	0.22	0.50
Pea, bean, vetch	0.90	1.30	0.19	0.40
Soybeans	0.91	1.30	0.19	0.00
Sugar beet	0.22	0.29	0.20	0.00
Sunflower	0.90	3.80	0.22	0.40
Tobacco	0.90	5.77	0.19	0.00
Rapeseed	0.88	1.17	0.22	0.00
Potatoes	0.22	0.17	0.20	0.00
Vegetables	0.22	0.17	0.20	0.00
Melons and gourds	0.22	0.17	0.20	0.00
Fodder beet	0.22	0.14	0.20	0.00
Maize for silo and green fodder	0.23	0.25	0.22	0.77
Perennial grasses for green fodder, silage and fodder	0.26	0.25	0.40	0.74
Annual grasses (oat and vetch) for green fodder	0.22	0.25	0.40	0.78

[111] 2006 IPCC Guidelines, Volume 4, Chapter 11, Table 11.2, Page 11.17.
[112] Nicolaev N., Boincean B., Sidorov M., Vanicovici Gh., Coltun V. (2006), Agrotechnics. Ministry of Education and Youth of the RM – Balti: Balti University Press, 2006, page 298.
[113] 2006 IPCC Guidelines, Volume 4, Chapter 11, Table 11.2, Page 11.17.
[114] Expert opinion, Prof. Valerian Cerbari, Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo'.
[115] Banaru A. (2002), Methodological Guidelines to Determine Humus Balance in Arable Soils, Ministry of Agriculture and Food Industry of the RM, Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo' and TACIS FDMOL 9901 Project 'Support to Developing Education, Research and Extension Services in Agriculture', Chisinau, 2002, 23 pages.

Table 5-71: Amount of N in crop residues (average values from the literature in the field)

Crop	P_{CR}, % (a.s.)	k_6
Winter wheat	0.50	Use of N from vegetal residues represents 25 per cent from the total contents
Winter rye	1.05	
Winter barley	0.80	
Oat	0.60	
Millet	1.25	
Buckwheat	0.60	
Leguminous crops	2.08	
Grain maize	1.08	
Grain sorghum	1.00	
Other cereal crops	0.60	
Sugar beet	1.65	
Sunflower	0.95	
Soybeans	2.08	
Tobacco	1.30	
Grain Rapeseed	1.05	
Potatoes	0.40	
Vegetables	2.09	
Melons and gourds	1.19	
Root crops for fodder	1.65	
Maize for silo and green fodder	1.08	
Perennial grasses for green fodder, silage and fodder	2.48	
Annual grasses for green fodder	1.60	

Activity data on areas sown with crops and average yield per ha for the main crops is available in the Statistical Yearbooks of the RM and those of the ATULBD (Tables 5-72, 5-73 and 5-74).

Table 5-72: Areas sown with crops over the period 1990-2019, thousand hectares

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sown Areas – total	**1 733.1**	**1 717.0**	**1 711.1**	**1 779.5**	**1 715.5**	**1 725.4**	**1 717.4**	**1 726.3**	**1 717.6**	**1 663.8**
Cereals and leguminous crops – total	**745.7**	**837.0**	**746.6**	**910.7**	**830.1**	**920.5**	**902.4**	**1 055.5**	**1 039.0**	**1 024.7**
…Wheat (Winter and Spring)	286.7	303.0	281.7	345.9	300.4	393.9	380.9	410.3	405.8	392.1
…Winter Rye	0.9	0.8	0.7	1.1	1.7	2.7	4.7	3.9	3.7	3.9
…Barley (Winter and Spring)	120.4	134.0	123.0	139.0	147.0	135.0	108.7	129.5	134.0	128.5
…Oat	2.1	3.0	3.0	4.0	5.0	5.8	3.7	6.5	6.1	4.9
…Millet	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.2
…Buckwheat	3.6	6.0	7.0	7.0	8.0	5.5	7.4	7.3	11.1	16.8
…Leguminous Crops	72.6	77.0	71.2	70.7	65.5	54.0	44.6	46.2	58.8	64.7
…Grain maize	258.0	310.0	259.4	342.6	283.4	321.3	350.0	450.7	416.7	411.7
…Grain sorghum	1.2	3.1	0.5	0.3	1.2	1.1	0.3	0.3	0.2	0.1
…Other cereal crops	0.1	0.0	0.0	0.0	17.8	1.0	1.8	0.5	2.2	1.7
Industrial crops – total	**295.3**	**277.0**	**275.3**	**262.7**	**263.5**	**284.0**	**333.7**	**300.0**	**344.7**	**355.1**
…Sugar beet	81.5	79.9	82.6	83.0	83.0	90.3	83.9	76.3	76.4	65.5
…Sunflower	134.1	126.9	130.9	125.5	139.5	163.2	225.1	199.0	234.5	246.0
…Soybeans	26.5	24.1	16.6	9.3	5.6	3.6	2.3	2.3	6.3	17.0
…Tobacco	32.1	32.5	28.1	31.2	28.4	20.1	16.4	17.3	22.0	18.8
…Grain rapeseed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
…Other industrial crops	21.1	13.6	17.1	13.7	7.0	6.6	6.0	5.1	5.2	5.9
Potatoes, vegetables and melons & gourds – total	**131.8**	**141.0**	**143.1**	**156.9**	**140.4**	**142.0**	**130.3**	**135.4**	**127.9**	**131.0**
…Potatoes	41.2	46.9	55.3	71.1	62.8	57.1	59.6	62.3	62.0	66.6
…Vegetables	71.1	78.0	73.7	73.2	68.1	74.0	61.4	63.5	58.6	56.3
…Melons gourds	9.2	8.0	7.0	6.0	5.0	7.6	6.7	7.9	5.2	6.0
…Other	10.3	8.1	7.1	6.6	4.5	3.3	2.6	1.7	2.1	2.1
Forage crops – total	**560.3**	**462.0**	**546.1**	**449.2**	**481.5**	**379.0**	**351.0**	**235.4**	**206.0**	**153.0**
…Forage roots	26.4	30.0	29.0	28.0	24.0	24.5	17.6	16.3	15.5	14.3
… Maize for silo and green fodder	292.3	200.0	299.3	215.8	265.5	179.0	181.0	98.7	97.1	62.8
…Perennial grasses for green fodder, silage and fodder	206.3	205.2	182.9	174.9	157.3	144.7	124.0	102.6	75.2	58.3
…Annual grasses for green fodder	31.4	26.8	35.0	30.5	34.7	29.3	27.0	16.8	17.3	16.9
…Other	3.9	0.0	0.0	0.0	0.0	1.3	1.4	1.0	0.9	0.7
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Sown Areas – total	**1 701.4**	**1 733.4**	**1 736.2**	**1 593.1**	**1 682.5**	**1 698.1**	**1 546.9**	**1 552.4**	**1 552.0**	**1 593.0**
Cereals and leguminous crops – total	**1 077.4**	**1 172.1**	**1 165.7**	**940.6**	**1 144.6**	**1 131.7**	**953.9**	**989.2**	**1 034.8**	**1 033.8**
…Wheat (Winter and Spring)	423.8	490.0	502.8	213.2	342.4	456.1	316.1	333.6	429.6	395.8
…Winter Rye	3.8	5.5	3.6	1.3	2.6	3.2	0.7	0.8	1.0	1.9
…Barley (Winter and Spring)	125.0	115.4	133.7	96.1	140.8	147.8	123.2	138.1	139.4	184.7
…Oat	4.2	4.8	4.3	4.6	5.9	6.4	4.5	4.4	2.8	2.4
…Millet	0.4	0.0	0.1	0.2	0.5	0.2	0.1	0.4	0.3	0.3
…Buckwheat	12.1	13.7	5.1	4.9	4.1	3.1	3.8	1.3	0.8	1.0
…Leguminous Crops	53.6	52.2	59.9	48.3	37.9	43.3	42.2	40.1	28.3	36.1

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
…Grain maize	454.1	488.7	454.7	567.9	604.1	469.1	461.4	469.2	429.5	407.3
…Grain sorghum	0.4	1.0	0.5	3.1	3.8	0.7	0.4	0.2	0.2	0.2
…Other cereal crops	0.0	0.8	0.7	0.8	2.5	1.8	1.4	1.3	2.8	3.8
Industrial crops – total	**364.9**	**336.6**	**358.6**	**447.9**	**367.2**	**392.6**	**413.3**	**376.7**	**355.9**	**401.0**
…Sugar beet	66.6	63.3	52.0	39.7	34.9	34.4	42.4	34.3	24.7	23.4
…Sunflower	256.9	237.8	280.7	381.3	293.0	309.2	299.7	241.1	239.1	249.5
…Soybeans	11.6	11.5	10.2	18.3	28.5	36.9	55.9	50.9	31.0	51.0
…Tobacco	23.7	17.2	9.3	5.6	5.8	4.8	3.5	3.1	2.7	2.5
…Grain rapeseed	1.0	1.0	1.0	1.0	0.9	2.4	7.1	41.3	53.5	67.4
…Other industrial crops	3.9	5.8	4.2	2.0	4.1	4.9	4.7	6.0	4.9	7.2
Potatoes, vegetables and melons & gourds – total	**132.3**	**122.5**	**112.6**	**92.5**	**81.4**	**84.0**	**90.1**	**84.0**	**83.2**	**78.7**
…Potatoes	65.4	43.0	45.1	38.6	34.8	36.7	34.8	35.8	31.3	28.5
…Vegetables	56.8	69.6	58.7	43.7	38.2	39.8	44.4	39.7	41.7	37.0
…Melons gourds	7.9	7.5	6.5	8.7	7.3	5.2	9.1	7.1	8.8	11.9
…Other	2.2	2.4	2.3	1.5	1.1	2.2	1.8	1.4	1.4	1.3
Forage crops – total	**126.8**	**102.3**	**99.3**	**112.1**	**89.3**	**89.9**	**89.6**	**102.4**	**78.1**	**79.5**
…Forage roots	11.5	4.5	4.1	4.5	3.7	2.5	3.0	1.9	1.9	1.5
… Maize for silo and green fodder	49.7	40.3	35.1	44.5	24.6	18.2	16.1	24.9	10.3	11.3
…Perennial grasses for green fodder, silage and fodder	53.1	48.4	49.8	50.9	53.6	60.2	63.5	68.4	60.2	61.5
…Annual grasses for green fodder	11.3	8.1	8.9	11.3	6.1	8.1	5.8	5.6	4.6	3.5
…Other	1.1	0.6	1.1	0.9	1.2	0.9	1.1	1.6	1.1	1.7
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Sown Areas – total	**1 628.2**	**1 597.3**	**1 653.5**	**1 686.3**	**1 694.3**	**1 693.8**	**1 715.1**	**1 735.8**	**1 749.2**	**1 724.0**
Cereals and leguminous crops – total	**1 020.3**	**991.6**	**1 037.3**	**1 080.0**	**1 055.1**	**1 065.3**	**1 074.2**	**1 050.7**	**1 095.4**	**1 074.7**
…Wheat (Winter and Spring)	380.8	353.2	374.2	432.7	415.0	416.9	454.8	410.5	455.2	438.4
…Winter Rye	1.6	0.6	1.3	2.0	0.5	0.4	0.6	0.6	0.5	0.6
…Barley (Winter and Spring)	164.9	128.4	114.1	126.9	120.9	104.8	101.4	96.9	77.9	63.3
…Oat	3.0	2.2	2.3	2.6	2.1	1.7	1.4	1.7	1.3	1.0
…Millet	0.5	0.2	0.2	0.1	0.1	0.1	0.9	0.1	0.1	0.1
…Buckwheat	0.2	0.6	0.9	0.3	0.3	0.3	0.5	0.4	0.3	0.3
…Leguminous Crops	39.5	30.2	25.2	23.5	22.5	24.9	26.3	37.1	46.1	42.9
…Grain maize	425.7	473.8	516.9	488.9	490.3	515.1	485.6	500.9	512.0	519.9
…Grain sorghum	0.2	0.1	0.1	0.1	0.1	0.2	1.4	1.3	1.1	7.3
…Other cereal crops	3.5	2.3	1.6	2.0	2.8	0.8	1.3	0.9	0.7	0.7
Industrial crops – total	**440.5**	**477.2**	**462.7**	**463.3**	**501.9**	**499.0**	**510.6**	**558.4**	**538.9**	**530.5**
…Sugar beet	26.5	25.4	31.2	28.7	28.0	21.9	20.9	23.6	19.8	15.3
…Sunflower	288.1	320.9	348.4	348.3	371.0	380.6	416.2	451.0	419.3	410.0
…Soybeans	61.5	61.0	62.5	42.8	56.5	69.7	41.4	35.5	29.4	38.1
…Tobacco	4.4	3.8	2.4	1.5	0.9	0.8	0.6	0.5	0.4	0.3
…Grain rapeseed	48.9	53.8	8.2	36.0	38.2	13.3	22.4	36.1	58.2	53.6
…Other industrial crops	10.4	12.2	10.0	5.9	7.2	12.5	9.0	11.8	11.8	12.9
Potatoes, vegetables and melons & gourds – total	**80.5**	**76.4**	**68.4**	**69.9**	**67.1**	**59.6**	**61.5**	**59.9**	**55.6**	**66.2**
…Potatoes	28.0	29.7	25.1	24.1	23.1	22.5	20.9	19.9	19.2	18.7
…Vegetables	40.6	37.4	34.9	37.0	35.5	29.4	30.5	31.0	30.4	39.4
…Melons gourds	10.6	8.2	7.3	7.8	7.3	6.7	7.9	7.8	5.5	7.4
…Other	1.4	1.1	1.1	1.0	1.2	1.1	2.2	1.1	0.5	0.7
Forage crops – total	**86.8**	**79.7**	**85.1**	**73.2**	**70.0**	**69.9**	**68.6**	**66.7**	**59.3**	**52.5**
…Forage roots	1.7	1.2	1.4	1.2	1.3	1.3	1.5	1.2	1.0	0.6
… Maize for silo and green fodder	10.1	10.4	22.4	8.8	9.3	11.2	8.0	6.8	6.3	5.7
…Perennial grasses for green fodder, silage and fodder	66.9	61.8	56.7	57.7	54.6	51.6	55.0	54.4	47.9	42.5
…Annual grasses for green fodder	6.5	4.8	3.9	4.4	3.9	4.4	2.2	2.6	2.6	2.1
…Other	1.6	1.4	0.7	1.1	0.9	1.4	1.8	1.7	1.6	1.6

Source: NBS on-line database, Section 'Sown Area, crops average yield and harvest within 1980-2019: <http://statbank.statistica.md/pxweb/Database/RO/16%20AGR/AGR02/AGR02.asp>; Statistical Yearbooks of the ATULBD for: 1998 (page 218), 2002 (page 113), 2005 (page 101), 2009 (page 97), 2011 (page 100), 2014 (page 94), 2019 (page 109), 2020 (page 112).

Table 5-73: Gross yield for main agricultural crops for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cereals and leguminous crops – total	**2538.6**	**3105.9**	**2099.8**	**3340.2**	**1753.8**	**2638.6**	**1981.2**	**3512.3**	**2751.9**	**2375.0**
…Wheat (Winter and Spring)	1129.0	1056.5	925.8	1392.6	658.8	1154.3	673.7	1152.6	951.9	797.8
…Winter Rye	1.9	1.6	1.4	2.8	2.7	5.9	9.9	10.9	7.0	6.3
…Barley (Winter and Spring)	417.9	427.0	405.0	481.0	324.9	311.2	136.7	256.9	242.2	203.1
…Oat	3.8	5.0	6.8	10.7	7.1	9.8	4.2	10.3	9.5	5.9
…Millet	0.1	0.1	0.0	0.1	0.1	0.3	0.2	0.5	0.1	0.0
…Buckwheat	1.8	5.0	2.3	5.5	3.5	2.2	3.0	4.8	4.3	6.1
…Leguminous Crops	97.1	105.7	121.8	121.6	70.2	55.4	31.6	63.2	76.9	61.6
…Grain maize	885.5	1501.2	635.6	1324.5	629.3	948.6	1006.6	1788.0	1272.7	1151.3
…Grain sorghum	1.2	3.1	1.1	1.4	1.1	0.8	0.1	0.5	0.2	0.3
…Other cereal crops	0.3	0.7	0.0	0.0	56.1	0.3	0.2	0.0	4.7	6.0
Industrial crops										

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
…Sugar beet	2374.5	1988.6	1783.4	2048.3	1526.7	1877.9	1682.1	1674.8	1356.8	956.4
…Sunflower	252.2	151.4	176.2	173.7	149.2	208.1	284.0	174.3	196.4	291.6
…Soybeans	23.8	33.4	7.9	9.3	4.0	3.3	2.5	2.7	6.0	13.7
…Tobacco	66.2	62.8	42.4	50.2	41.5	27.1	19.8	23.9	24.6	22.6
…Grain rapeseed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Potatoes, vegetables and melons & gourds										
…Potatoes	295.3	290.6	310.8	726.0	474.7	385.3	344.3	392.6	372.5	330.6
…Vegetables	1177.3	989.2	787.5	777.2	598.5	568.8	362.4	393.6	570.8	535.8
…Melons gourds	34.4	35.6	9.3	18.6	12.6	23.3	23.3	30.4	25.9	33.9
Forage crops										
…Forage roots	1171.8	1416.4	922.5	988.6	547.0	597.0	336.5	310.2	286.4	170.1
… Maize for silo and green fodder	4509.0	4979.1	3025.9	3358.7	2285.7	2136.2	1212.0	1065.0	856.5	428.6
…Perennial grasses for green fodder, silage and fodder	4456.1	6053.5	3401.4	3514.6	2013.8	1704.7	1027.2	855.6	498.5	506.8
…Annual grasses for green fodder	288.9	420.7	339.0	339.1	190.7	222.3	143.4	96.7	106.6	53.7
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Cereals and leguminous crops – total	**2070.2**	**2847.5**	**2791.2**	**1654.4**	**3178.0**	**3059.9**	**2371.2**	**932.5**	**3261.6**	**2375.5**
…Wheat (Winter and Spring)	725.0	1180.8	1113.1	102.4	861.2	1048.6	682.3	406.5	1286.5	738.9
…Winter Rye	5.0	9.3	5.9	0.8	5.1	6.1	1.1	0.8	2.0	3.4
…Barley (Winter and Spring)	152.3	248.4	241.7	74.4	284.1	240.9	214.6	125.7	362.3	290.5
…Oat	3.5	6.4	4.7	4.0	10.3	7.6	6.1	1.4	3.9	1.6
…Millet	0.1	0.0	0.1	0.1	0.3	0.2	0.0	0.1	0.5	0.7
…Buckwheat	8.0	6.4	1.4	1.6	1.2	1.1	0.5	0.4	0.5	0.6
…Leguminous Crops	30.8	79.1	50.2	30.2	51.0	67.1	68.4	14.4	38.0	32.0
…Grain maize	1050.4	1141.9	1206.3	1440.2	1845.1	1523.4	1327.6	363.2	1484.1	1159.6
…Grain sorghum	0.5	1.1	0.5	4.4	3.4	0.3	0.5	0.1	0.1	0.2
…Other cereal crops	3.2	5.7	4.2	0.7	3.7	12.3	15.2	1.1	8.1	5.3
Industrial crops										
…Sugar beet	982.5	1120.6	1157.4	660.3	911.3	996.2	1177.3	612.3	960.7	337.4
…Sunflower	305.1	278.3	340.9	421.4	354.8	368.7	396.1	158.7	387.2	310.2
…Soybeans	11.6	10.5	12.6	19.4	40.2	66.4	80.2	40.0	58.8	50.1
…Tobacco	26.3	16.3	12.4	7.2	7.9	6.7	4.9	3.6	3.9	4.4
…Grain rapeseed	1.1	1.0	1.0	1.2	1.1	3.4	6.9	34.9	100.1	81.6
Potatoes, vegetables and melons & gourds										
…Potatoes	330.4	388.6	326.0	303.2	321.8	391.1	384.1	200.9	273.7	264.8
…Vegetables	396.1	487.4	408.4	371.7	328.7	410.3	490.6	226.6	389.4	322.8
…Melons gourds	31.7	39.3	29.0	72.7	57.3	49.3	92.6	41.2	69.9	102.4
Forage crops										
…Forage roots	125.0	63.5	67.9	55.7	52.7	41.6	34.9	13.8	26.4	20.0
… Maize for silo and green fodder	350.7	316.4	322.8	327.9	219.4	199.6	153.3	104.6	113.0	106.4
…Perennial grasses for green fodder, silage and fodder	317.4	201.5	173.4	145.4	206.7	183.8	194.9	177.0	364.2	213.4
…Annual grasses for green fodder	28.8	19.3	16.0	12.6	12.6	16.3	13.6	7.4	15.3	7.9
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Cereals and leguminous crops – total	**2674.3**	**2794.6**	**1359.0**	**3130.0**	**3341.0**	**2587.0**	**3531.7**	**3813.4**	**3946.8**	**4020.6**
…Wheat (Winter and Spring)	749.5	797.1	496.9	1009.6	1102.6	927.4	1302.4	1258.6	1169.1	1152.3
…Winter Rye	2.4	1.0	2.6	5.7	1.4	1.0	1.8	2.3	1.7	1.9
…Barley (Winter and Spring)	240.7	218.9	139.3	241.6	244.7	199.1	273.9	265.0	188.2	178.2
…Oat	3.1	3.6	2.0	3.8	2.9	1.6	2.8	3.6	1.5	1.6
…Millet	0.3	0.1	0.1	0.1	0.2	0.2	1.1	0.1	0.1	0.2
…Buckwheat	0.5	0.5	0.3	0.4	0.4	0.2	0.9	0.7	0.3	0.4
…Leguminous Crops	40.1	33.1	17.3	24.1	32.9	25.1	45.1	75.2	51.5	56.6
…Grain maize	1462.1	1547.2	587.2	1546.5	1642.1	1133.6	1485.5	1871.0	2208.0	2263.7
…Grain sorghum	0.2	0.1	0.1	0.4	0.3	0.2	5.1	4.5	4.6	48.9
…Other cereal crops	7.7	4.8	2.1	5.4	8.3	2.8	4.4	4.5	2.2	1.5
Industrial crops										
…Sugar beet	837.6	588.6	587.0	1009.0	1356.2	537.5	664.8	876.3	707.2	607.0
…Sunflower	440.2	497.4	339.1	602.2	627.1	562.3	789.4	925.1	898.7	915.3
…Soybeans	113.0	80.6	48.9	67.6	111.4	49.2	43.8	48.5	59.7	64.8
…Tobacco	7.6	5.4	2.9	2.2	1.4	1.2	0.9	1.0	0.7	0.5
…Grain rapeseed	51.0	67.7	8.1	58.8	90.2	25.6	52.4	89.9	120.8	110.2
Potatoes, vegetables and melons & gourds										
…Potatoes	286.7	362.9	191.5	244.0	275.7	163.8	220.3	201.7	177.7	181.8
…Vegetables	365.8	396.0	251.9	319.1	352.3	266.9	320.6	340.9	301.2	339.4
…Melons gourds	104.9	85.2	52.6	56.6	48.3	56.7	69.3	59.6	49.1	47.0
Forage crops										
…Forage roots	31.7	23.2	10.6	22.2	26.1	14.6	21.0	21.4	19.8	18.2
… Maize for silo and green fodder	143.8	125.2	110.8	166.6	135.7	91.7	139.6	111.7	133.8	116.2
…Perennial grasses for green fodder, silage and fodder	323.9	238.5	97.6	198.6	275.0	118.5	178.8	172.4	177.9	156.3
…Annual grasses for green fodder	10.9	11.3	6.3	9.6	13.4	8.8	9.0	11.3	8.7	6.9

Source: NBS on-line database, Section 'Sown Area, crop average yield and harvest within 1980-2019', <http://statbank.statistica.md/pxweb/Database/RO/16%20AGR/AGR02/AGR02.asp>; Statistical Yearbooks of the ATULBD for 1998 (page 218), 2002 (page 113), 2005 (page 101), 2009 (page 98), 2011 (page 101), 2014 (page 95), 2019 (page 110), 2020 (page 113).

Table 5-74: Average yield per hectare for agricultural crops over the period 1990-2019, t/ha

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cereals and leguminous crops – total	**3.4**	**3.7**	**2.8**	**3.7**	**2.1**	**2.9**	**2.2**	**3.3**	**2.6**	**2.3**
…Wheat (Winter and Spring)	3.9	3.5	3.3	4.0	2.2	2.9	1.8	2.8	2.3	2.0
…Winter Rye	2.1	2.0	2.0	2.6	1.6	2.2	2.1	2.8	1.9	1.6
…Barley (Winter and Spring)	3.5	3.2	3.3	3.5	2.2	2.3	1.3	2.0	1.8	1.6
…Oat	1.8	1.7	2.3	2.7	1.4	1.7	1.1	1.6	1.6	1.2
…Millet	1.0	1.0	0.4	1.0	0.6	1.4	0.7	1.6	0.4	0.1
…Buckwheat	0.5	0.8	0.3	0.8	0.4	0.4	0.4	0.7	0.4	0.4
…Leguminous Crops	1.3	1.4	1.7	1.7	1.1	1.0	0.7	1.4	1.3	1.0
…Grain maize	3.4	4.8	2.5	3.9	2.2	3.0	2.9	4.0	3.1	2.8
…Grain sorghum	1.9	2.6	0.9	1.1	0.9	0.7	0.4	1.2	0.8	2.6
…Other cereal crops	1.7	1.6	1.3	1.8	2.8	1.7	1.3	2.0	1.7	1.9
Industrial crops										
…Sugar beet	29.1	24.9	21.6	24.7	18.4	20.8	20.0	22.0	17.8	14.6
…Sunflower	1.9	1.2	1.3	1.4	1.1	1.3	1.3	0.9	0.8	1.2
…Soybeans	0.9	1.4	0.5	1.0	0.7	1.0	1.0	1.1	0.9	0.8
…Tobacco	2.1	1.9	1.5	1.6	1.5	1.3	1.2	1.4	1.1	1.2
…Grain rapeseed	2.0	2.0	1.6	1.2	1.0	0.8	0.7	1.0	0.9	1.2
Potatoes, vegetables and melons & gourds										
…Potatoes	7.2	6.2	5.6	10.2	7.6	6.8	5.8	6.3	6.0	5.0
…Vegetables	16.6	12.7	10.7	10.6	8.8	7.7	5.9	6.2	9.7	9.5
…Melons gourds	3.7	4.5	1.3	3.1	2.5	3.1	3.5	3.8	5.0	5.7
Forage crops										
…Forage roots	44.4	47.2	31.8	35.3	22.8	24.4	19.1	19.0	18.5	11.9
… Maize for silo and green fodder	15.4	24.9	10.1	15.6	8.6	11.9	6.7	10.8	8.8	6.8
…Perennial grasses for green fodder, silage and fodder	21.6	29.5	18.6	20.1	12.8	11.8	8.3	8.3	6.6	8.7
…Annual grasses for green fodder	9.2	15.7	9.7	11.1	5.5	7.6	5.3	5.8	6.2	3.2

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cereals and leguminous crops – total	**1.9**	**2.4**	**2.4**	**1.8**	**2.8**	**2.7**	**2.5**	**0.9**	**3.2**	**2.3**
…Wheat (Winter and Spring)	1.7	2.4	2.2	0.5	2.5	2.3	2.2	1.2	3.0	1.9
…Winter Rye	1.3	1.7	1.6	0.6	2.0	1.9	1.6	1.1	1.9	1.8
…Barley (Winter and Spring)	1.2	2.2	1.8	0.8	2.0	1.6	1.7	0.9	2.6	1.6
…Oat	0.8	1.3	1.1	0.9	1.7	1.2	1.3	0.3	1.4	0.7
…Millet	0.2	0.8	0.5	0.5	0.7	0.9	0.5	0.1	1.7	2.4
…Buckwheat	0.7	0.5	0.3	0.3	0.3	0.4	0.1	0.3	0.6	0.6
…Leguminous Crops	0.6	1.5	0.8	0.6	1.3	1.6	1.6	0.4	1.3	0.9
…Grain maize	2.3	2.3	2.7	2.5	3.1	3.2	2.9	0.8	3.5	2.8
…Grain sorghum	1.2	1.1	1.0	1.4	0.9	0.4	1.3	0.4	0.5	0.9
…Other cereal crops	1.2	1.6	1.5	1.3	1.3	1.4	1.3	0.7	2.5	1.5
Industrial crops										
…Sugar beet	14.8	17.7	22.3	16.6	26.1	29.0	27.8	17.9	38.9	14.4
…Sunflower	1.2	1.2	1.2	1.1	1.2	1.2	1.3	0.7	1.6	1.2
…Soybeans	1.0	1.1	1.2	1.1	1.4	1.8	1.4	0.8	1.9	1.0
…Tobacco	1.1	0.9	1.3	1.3	1.4	1.4	1.4	1.2	1.4	1.8
…Grain rapeseed	1.0	1.0	1.0	1.0	1.2	1.4	1.0	0.8	1.9	1.2
Potatoes, vegetables and melons & gourds										
…Potatoes	5.1	9.0	7.2	7.9	9.2	10.6	11.0	5.6	8.7	9.3
…Vegetables	7.0	7.0	7.0	8.5	8.6	10.3	11.0	5.7	9.3	8.7
…Melons gourds	4.0	5.2	4.5	8.4	7.8	9.4	10.2	5.8	7.9	8.6
Forage crops										
…Forage roots	10.9	14.0	16.6	12.3	14.2	16.4	11.6	7.4	14.1	13.7
… Maize for silo and green fodder	7.1	7.8	9.2	7.4	8.9	11.0	9.6	4.2	11.0	9.4
…Perennial grasses for green fodder, silage and fodder	6.0	4.2	3.5	2.9	3.9	3.1	3.1	2.6	6.0	3.5
…Annual grasses for green fodder	2.6	2.4	1.8	1.1	2.1	2.0	2.3	1.3	3.3	2.2

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cereals and leguminous crops – total	**2.6**	**2.8**	**1.3**	**2.9**	**3.2**	**2.4**	**3.3**	**3.6**	**3.6**	**3.7**
…Wheat (Winter and Spring)	2.0	2.3	1.3	2.3	2.7	2.2	2.9	3.1	2.6	2.6
…Winter Rye	1.5	1.8	2.0	2.8	2.8	2.3	2.9	3.6	3.3	3.1
…Barley (Winter and Spring)	1.5	1.7	1.2	1.9	2.0	1.9	2.7	2.7	2.4	2.8
…Oat	1.0	1.6	0.9	1.5	1.4	0.9	2.0	2.1	1.2	1.6
…Millet	0.5	0.7	0.6	1.8	2.4	1.3	1.2	1.0	1.5	2.0
…Buckwheat	3.2	0.8	0.3	1.3	1.5	0.9	1.9	1.6	1.0	1.3
…Leguminous Crops	1.0	1.1	0.7	1.0	1.5	1.0	1.7	2.0	1.1	1.3
…Grain maize	3.4	3.3	1.1	3.2	3.3	2.2	3.1	3.7	4.3	4.4
…Grain sorghum	0.9	0.7	0.5	3.0	2.8	0.9	3.7	3.8	4.0	4.0
…Other cereal crops	1.6	1.9	1.3	2.1	1.1	1.5	2.0	2.7	3.3	3.3
Industrial crops										
…Sugar beet	31.6	23.2	18.8	35.2	48.4	24.5	31.8	37.1	35.7	39.7
…Sunflower	1.5	1.6	1.0	1.7	1.7	1.5	1.9	2.1	2.1	2.2
…Soybeans	1.9	1.4	0.8	1.6	2.0	0.7	1.1	1.4	2.0	1.7
…Tobacco	1.7	1.4	1.2	1.5	1.6	1.5	1.5	2.0	1.8	1.7

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
…Grain rapeseed	1.0	1.3	1.0	1.6	2.4	1.9	2.3	2.5	2.1	2.1
Potatoes, vegetables and melons & gourds										
…Potatoes	10.2	12.2	7.6	10.1	11.9	7.3	10.5	10.1	9.3	9.7
…Vegetables	9.0	10.6	7.2	8.6	9.9	9.1	10.5	11.0	9.9	8.6
…Melons gourds	9.9	10.4	7.2	7.3	6.6	8.5	8.8	7.6	8.9	6.3
Forage crops										
…Forage roots	18.5	19.0	7.4	18.5	20.1	11.2	14.0	17.8	19.8	30.1
… Maize for silo and green fodder	14.2	12.0	5.0	19.0	14.5	8.2	17.4	16.4	21.3	20.3
…Perennial grasses for green fodder, silage and fodder	4.8	3.9	1.7	3.4	5.0	2.3	3.2	3.2	3.7	3.7
…Annual grasses for green fodder	1.7	2.3	1.6	2.2	3.4	2.0	4.0	4.3	3.4	3.4

Source: NBS on-line database, Section 'Sown Area, crop average yield and harvest, 1980-2019': <http://statbank.statistica.md/pxweb/Database/RO/16%20AGR/AGR02/AGR02.asp>; Statistical Yearbooks of the ATULBD for 1998 (page 218), 2002 (page 113), 2005 (page 101), 2009 (page 99), 2011 (page 102), 2014 (page 96), 2019 (page 112), 2020 (page 115).

Based on information provided in Tables 5-70 and 5-71, and activity data included into Tables 5-72, 5-73 and 5-74, respectively, the total amount of nitrogen in crop residues returned to soils was estimated. The results allow us to assert that over the period 1990-2019, the total amount of nitrogen in crop residues returned to soils in the Republic of Moldova decreased by 10.4 per cent (Table 5-75).

Table 5-75: Amount of nitrogen in crop residues returned to soils for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
$F_{(CR)}$	34.7994	39.1741	26.2975	31.5452	14.9767	21.6408	11.7862	20.9379	17.9185	17.4528
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
$F_{(CR)}$	9.5485	17.2165	17.5917	8.2521	19.9839	20.0496	19.4949	5.1190	21.0310	15.6403
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
$F_{(CR)}$	21.2771	21.2544	6.3433	23.1532	25.9603	9.1734	25.7331	30.3356	30.6694	31.1818

It should be noted that implementation of activities aimed at reasonable distribution of soil resources depending on the volume and features of agricultural production, the recommended crop structure (Figure 5-4) shall permit the production of the necessary amount of cereal required to ensure food security for the population, fodder for the animal breeding sector, industrial and leguminous crops to meet the needs of the population and processing industry. At the same time, this structure shall permit the use of soil protective crop rotation, contributing to stabilizing the humus balance in soil and soil fertility conservation.

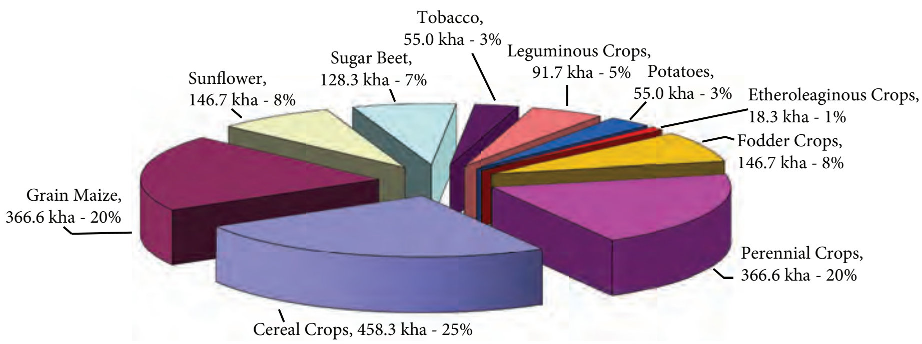

Figure 5-4: Recommended crops structure on agricultural lands[116].

Uncertainties Assessment and Time-Series Consistency

Uncertainties related to activity data on areas sown with crops and average yield per hectare for the main crops in the Republic of Moldova are considered to have decreased to circa 5 per cent. Uncertainties related to coefficients used to calculate the amount of nitrogen in agricultural crop residues returned to soils are moderate and were estimated at circa 25 per cent. Uncertainties related to the default emission factor (EF_1 for F_{CR}) may reach circa 6 per cent. The combined uncertainties associated with N_2O emissions from crop residues may reach circa 25.50 per cent. In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for Sector 3 'Agriculture' following a Tier 1 approach. It should be noted that the AD and methods used to estimate N_2O emis-

[116] Buza, Vasile et al. (2007), Disaster Risks Management in the Republic of Moldova, National Agency for Rural Development in the RM, FAO, Chisinau, 2007, page 104.

sions from crop residues returned to soil under this category were documented and archived both in hard copies and electronically. In order to identify the data entry and GHG emissions estimation process related errors, AD and EFs verifications and quality control procedures were applied. Following the recommendations included into the 2006 IPCC Guidelines, N_2O emissions from crop residues returned to soil were estimated using AD from official sources of reference.

Recalculations

Direct N_2O_{CR} emissions from crop residues returned to soil were recalculated for the year 2016 as a result of updating statistical activity data. In comparison with the results recorded in the previous inventory cycle, the changes made resulted in an insignificant increase in direct N_2O_{CR} emissions from source category 3D.a.3 'Crop Residues Returned to Soils' in 2016 (Table 5-76).

Table 5-76: Comparative results of direct N_2O_{CR} emissions from source category 3D.a.3 'Crop Residues Returned to Soils', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	0.5470	0.6157	0.4134	0.4958	0.2354	0.3401	0.1852	0.3291	0.2816	0.2743
BUR3	0.5468	0.6156	0.4132	0.4957	0.2353	0.3401	0.1852	0.3290	0.2816	0.2743
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.1500	0.2705	0.2764	0.1297	0.3140	0.3151	0.3063	0.0804	0.3305	0.2458
BUR3	0.1500	0.2705	0.2764	0.1297	0.3140	0.3151	0.3063	0.0804	0.3305	0.2458
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.3344	0.3340	0.0997	0.3639	0.4079	0.1442	0.4030			
BUR3	0.3344	0.3340	0.0997	0.3638	0.4079	0.1442	0.4044	0.4767	0.4819	0.4900
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.3			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Table 5-77 below shows the comparative results of direct N_2O emissions from crop residues returned to soil for the period 1990-2019 included into the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 ($GWP_{100} = 298$).

Table 5-77: Comparative results of N_2O_{CR} emissions from source category 3D.a.4 'Crop Residues Returned to Soils', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	162.9914	183.4866	123.1798	147.7503	70.1492	101.3530	55.2041	98.0646	83.9239	81.7291
BUR3	162.9604	183.4465	123.1477	147.7215	70.1338	101.3406	55.1933	98.0491	83.9100	81.7291
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	44.7142	80.6222	82.3792	38.6432	93.5817	93.8892	91.2919	23.9715	98.4850	73.2411
BUR3	44.7142	80.6222	82.3792	38.6432	93.5817	93.8892	91.2919	23.9715	98.4850	73.2411
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	99.6376	99.5312	29.7048	108.4328	121.5659	42.9569	120.0962			
BUR3	99.6376	99.5312	29.7048	108.4229	121.5686	42.9576	120.5046	142.0573	143.6204	146.0197
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.3			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the years 2017-2019, direct N_2O_{CR} emissions from source category 3D.a.4 'Crop Residues Returned to Soils' were estimated for the first time. The obtained results show that over the period 1990-2019, direct N_2O_{CR} emissions from crop residues returned to soils in the Republic of Moldova had decreased by circa 10.4 per cent.

The decrease in emissions over the period 1990-2019 is due to decrease in the area being sown (for example, areas sown with tobacco had decreased by 99.1 per cent, fodder plants – by 90.6 per cent, sugar beets – by 81.2 per cent, potatoes – by 54.5 per cent, oat – by 53.7 per cent, winter and spring barley – by 47.4 per cent, vegetables – by 44.6 per cent, leguminous crops – 40.9 per cent, melons gourds – by19.2 per cent, etc.), and lower average yield per hectare (for example, perennial grasses for green fodder, silage and fodder had decreased in the reference period by 83.0 per cent, annual grasses for green fodder – 63.5 per cent, sugar beets – by 74.4 per cent, vegetables – by 47.9 per cent, winter and spring wheat – by 33.2 per cent, forage roots – by 32.1 per cent, tobacco – by 19.2 per cent, winter and spring barley – by 18.9 per cent, oat – by 10.6 per cent, leguminous crops – by 1.4 per cent). Albeit some areas sown with crops increased, for instance: sunflower – by 205.7 per cent, grain maize – by 101.5 per cent, winter and spring wheat – by 52.9 per cent and soybeans – by 43.7 per cent; and an increase in yield per hectare in other crops was also recorded was also recorded was also recorded, such as soybeans – by 89.4 per cent, melons and gourds – by 69.1 per cent, winter rye – by 47.5 per cent, sugar beets – by 36.2 per cent, potatoes – by 35.4 per cent, maize for silo and green fodder – by 31.3 per cent, grain maize – by 26.9 per cent, sunflower – by 18.7 per cent and rapeseeds – by 2.9 per cent, the impact of these increases did not influence the declining trend in N_2O emissions from crop residues returned to soils.

Planned Improvements

Planned improvements could include activities focused on obtaining more precise activity data and country-specific coefficients and parameters used to estimate direct N_2O emissions from crop residues returned to soils in the RM.

5.4.1.5. Nitrogen Mineralization Associated with Loss of Soil Organic Matter

Source Category Description

Land-use change and a variety of management practices may have a significant impact on soil organic carbon storage. Organic carbon and nitrogen are closely linked in soil organic matter (humus). Where soil carbon is lost through oxidation as a result of land-use or management practice change, this loss will be accompanied by a simultaneous mineralization of nitrogen. Where a loss of soil carbon occurs, this mineralized nitrogen is regarded as an additional source of nitrogen available for conversion of N_2O emissions.

Methodological Issues, Emission Factors and Data Sources

The N_2O emissions from nitrogen mineralization associated with loss of soil organic matter as a result of land-use or management change were estimated by using a Tier 1 methodology and a simplified version of Equation 11.2 available in the 2006 IPCC Guidelines:

$$N_2O_{SOM} = F_{SOM} \bullet EF_1 \bullet 44/28$$

Where:

EF_1 – default 0.01 kg N_2O-N/kg N applied (range: 0.003-0.03 kg N_2O-N/kg N);

[44/28] – mass ratio between the content of nitrogen in N_2O-N and N_2O;

F_{SOM} – the net annual amount of N mineralized in mineral soils as a result of loss of soil carbon through change in land use or management (t N/yr).

$F_{(SOM)}$ values were estimated using Equation 11.8 in the 2006 IPCC Guidelines:

$$F_{SOM} = \Sigma\ [(\Delta C_{mineral} \bullet 1/R)]$$

Where:

R – carbon and nitrogen ratio in the soil organic matter (C : N); the 2006 IPCC Guidelines default value of 10 (range from 8 to 15) is used for arable soils; according the national scientific sources (Krupenikov, Ganenko, 1984), the C : N ratio in the soil organic matter in the Republic of Moldova is around 10.7 (range from 10.1 to 11.3);

$\Delta C_{Mineral}$ – annual change in carbon stocks in mineral soils, (t C/yr) (see Table 5-78) was estimated using a Tier 2 methodology available in the 2006 IPCC Guidelines.

In order to calculate the annual changes in carbon stocks in mineral soils, equation 2.25 in the 2006 IPCC Guidelines was used (Volume 4, Chapter 2, page 2.30):

$$\Delta C_{Mineral} = (SOC_0 - SOC_{(0-T)}) / D$$

Where:

$\Delta C_{Mineral}$ – annual change in carbon stocks in mineral soils, tonnes C yr;

SOC_0 – soil organic carbon stock in the last year of an inventory time period, tonnes C;

$SOC_{(0-T)}$ – soil organic carbon stock at the beginning of the inventory time period, tonnes C;

D – Time dependence of stock change factors which is the default time period for transition between equilibrium SOC values, yr. Commonly 20 years, but depends on assumptions made in computing the factors F_{LU}, F_{MG} and F_1. If T exceeds D, use the value for T to obtain an annual rate of change over the inventory time period.

The following aspects were taken into consideration in the process of assessing annual change in organic carbon stocks in mineral soils in the RM:

- the agricultural practices applied on arable land of the RM and the pedo-climatic conditions allow to highlight a single agricultural area of land-use (mineral soils are quite homogeneous in the country, represented mainly by chernozems); significant changes in tillage technologies over the period 1990-2019 had not occurred: the entire arable area of the country is dominated by autumn ploughing; since 1990, the amounts of carbon sequestered in arable soils decreased significantly, particularly due to the gradual reduction in both the amounts of organic fertilizers applied to soil and the amounts of crop residues returned to soil (including as a result of the significant decrease in main crop yields);
- information on the evolution of organic carbon stocks in arable land has been identified in the national scientific literature; according to the reference sources consulted, soils in the RM, mostly used for about 150 years, have meanwhile lost circa 45-50 per cent of the accumulated carbon: the content of humus in arable land in 1877 (layer – 0-30 cm, apparent density – 1.17 g/cm^3) in the northern part of the country (Napadova commune, Floresti district) constituted 5.72 per cent (200.7 tonnes of humus/ha or 116.4 tonnes of C/ha); in 1960, the content of humus in the same soil constituted 3.68 per cent (129.0 tonnes of humus/ha or 74.8 tonnes of C/ha); whereas by 2003 – 3.36 per cent (117.9 tonnes of humus/ha or 68.4 tonnes of C/ha), and in 2010 – 3.11 per cent (109.2 tonnes of humus/ha or 63.3 tonnes C/ha);
- in the same context, according to other publications in the scientific literature, by direct measurements performed on leached chernozem located in the northern part of the country, it was established that in circa 60 years of exploitation, the soil lost circa 37 per cent of accumulated carbon, and the average annual rates constituted 300 kg C/ha/year (Moldavian Soils, Volume 1, 1989); according to the Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo', in their long-term experiences (circa 40 years) in the main pedo-climatic areas of the country, located on subtypes of chernozems that dominate in the soil cover, it was established that the annual rates of carbon loss are very close to the area and subtype of chernozem, constituting circa 325 kg C/ha/year (Bulletin of Ecopedological Monitoring, 7th Edition, 2000); rates with very close values were established in the oldest long-term experiences in the RM on carbonated chernozem organised by the State Agrarian University of Moldova in Chetrosu commune, Anenii Noi district (Zagorcha, 1990); values between 300-330 kg C/ha/year regarding carbon losses from soils in agricultural soils have been established by other researchers (Ungureanu et al., 1997; Andries, 1999; Banaru, 2001);
- organic carbon stocks in soil in the first year of inventory ($SOC_{(0-T)}$) were identified in the 'Soil Quality Monitoring of the Republic of Moldova (database, conclusions, forecasts, recommendations)' (2010); according to this publication, the humus content in arable soils in 1990 (layer 0-30 cm, apparent density – 1.17 g/cm^3) in the northern part of the country constituted circa 3.46 per cent (121.3 tonnes of humus/ha or 70.3 tonnes of C/ha); at the same time, in the southern part of the RM (Lebedenco commune, Cahul district), the humus content in arable soils (layer – 0-30 cm, apparent density – 1.30 g/cm^3) constituted circa 3.27 per cent (127.3 tonnes of humus/ha or 73.9 tonnes of C/ha); in these circumstances, the national average ($SOC/_{(0-T)}$) constituted 124.3 tonnes of humus/ha or circa 72.1 tonnes C/ha;
- organic carbon stocks in soils in the last year of the inventory cycle (SOC_0) were identified in the scientific literature; according to specialists from the Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo', the humus content in arable soils in 2015 (layer – 0-30 cm, apparent density – 1.17 g/cm^3) in the northern part of the country (Napadova commune, Flo-

resti district) constituted circa 3.0 per cent (105.3 tonnes of humus/ha or 61.1 tonnes of C/ha); at the same time, in the southern part of the country (Lebedenco commune, Cahul district), the humus content in arable soils (layer – 0-30 cm, apparent density – 1.30 g/cm^3) constituted in that year circa 2.89 per cent (112.7 tonnes of humus/ha or 65.4 tonnes of C/ha), the national average (SOC_0) being circa 109.0 tonnes of humus/ha or circa 63.2 tonnes of C/ha, which corresponds to average annual losses per country of circa 354.9 kg C/ha/year over the period 1990-2019.

The annual changes in the carbon stocks in mineral soils were calculated based on the respective activity data (Table 5-78). The obtained results show changes of carbon stocks in mineral soils over the period 1990-2019 equal to circa 354.9 kg C/ha/year. This value is close to the results previously obtained by different authors from the Republic of Moldova in long-term experiences (Zagorcha, 1990; Ungureanu et al., 1997; Andries, 1999; Banaru, 2001; Cerbari, 2010, 2012).

Table 5-78: Annual loss of soil carbon in the RM for the period 1990-2019, kt C

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
$\Delta C_{Mineral}$, kt C	-615.1399	-609.4254	-607.3313	-631.6090	-608.8930	-612.4193	-609.5674	-612.7264	-609.6384	-590.5428
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
$\Delta C_{Mineral}$, kt C	-603.8884	-615.2581	-616.2402	-565.4489	-597.1801	-602.7274	-549.0508	-551.0026	-550.8762	-565.4084
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$\Delta C_{Mineral}$, kt C	-577.8919	-566.9538	-586.8987	-598.5319	-601.3621	-601.2013	-608.7341	-616.0928	-620.8494	-611.8981

The obtained results on the calculation of the total amount of mineralized nitrogen (F_{SOM}) as a result of the loss of carbon stocks in mineral soils are provided in Table 5-79.

Table 5-79: Amount of mineralized nitrogen in mineral soils as a result of loss of soil carbon in the Republic of Moldova for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
F_{SOM}	57.4897	56.9556	56.7599	59.0289	56.9059	57.2355	56.9689	57.2641	56.9756	55.1909
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
F_{SOM}	56.4382	57.5008	57.5925	52.8457	55.8112	56.3297	51.3132	51.4956	51.4838	52.8419
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
F_{SOM}	54.0086	52.9863	54.8503	55.9376	56.2021	56.1870	56.8910	57.5788	58.0233	57.1867

Uncertainties Assessment and Time-Series Consistency

Uncertainties related to activity data on areas of arable lands in the Republic of Moldova are considered to be low, up to circa 5 per cent. Uncertainties related to coefficients used to estimate N_2O from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change were estimated at circa 25 per cent, whereas uncertainties related to the default emission factor (EF_1 for F_{SOM}) may reach circa 6 per cent. Combined uncertainties associated with direct N_2O emissions from this emission source are considered to be average (circa 25.50 per cent). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective source category in Sector 3 'Agriculture' following a Tier 1 approach. It should be noted that the AD and methods used to estimate N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change in the Republic of Moldova were documented and archived both in hard copies and electronically. In order to identify the data entry and GHG emissions estimation process related errors, AD and EFs verifications and quality control procedures were applied. Following the recommendations included into the GPG, N_2O emissions originating from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change in the Republic of Moldova were estimated based on AD from official sources of reference.

Recalculations

Direct N_2O_{SOM} emissions from source category 3D.a.5 'Nitrogen Mineralization Associated with Loss of Soil Organic Matter' as a result of land-use or management change in the RM were recalculated for the period 1990-2016, as a result of the change in the methodology for calculating the annual carbon losses from mineral soils ($\Delta C_{Mineral}$).

In comparison with the previous inventory cycle, when the '*Methodology for determining the carbon balance in agricultural soils for the evaluation of GHG emissions*' was used for annual carbon loss in mineral soils (see Annex A3-4.2)[117], in the current inventory cycle, annual carbon losses were estimated using a Tier 2 methodology from the 2006 IPCC Guidelines (Equation 2.25, Volume 4, Chapter 2, page 2.30). The methodology change was made so as to ensure consistency between the calculation methodology applied to the estimation of direct N_2O_{SOM} emissions from category 3D.a.5 'Nitrogen Mineralization Associated with Loss of Soil Organic Matter', and 4B1.2 'Annual Change in Organic Carbon Stocks in Mineral Soils', respectively. Since the '*Methodology for determining the carbon balance in agricultural soils for the evaluation of GHG emissions*' is yet to be validated internationally, it shall be further used only in verification activities, but not for international inventory reporting to the UNFCCC.

In comparison with the results recorded in the previous inventory cycle, the changes made resulted in an upward trend in direct N_2O_{SOM} emissions from category 3D.a.5 'Nitrogen Mineralization Associated with Loss of Soil Organic Matter' in mineral soils for the period 1990-1992, and a decrease trend in the respective emissions for the period 1993-2016 (Table 5-80).

Table 5-80: Comparative results of direct N_2O_{SOM} emissions from category 3D.a.5 'Nitrogen Mineralization Associated with Loss of Soil Organic Matter', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	0.5680	0.5734	0.4720	1.5097	0.9061	1.4004	1.2072	1.8617	1.5189	1.4048
BUR3	0.9034	0.8950	0.8919	0.9276	0.8942	0.8994	0.8952	0.8999	0.8953	0.8673
Difference, %	59.0	56.1	89.0	-38.6	-1.3	-35.8	-25.8	-51.7	-41.1	-38.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1.3374	1.6191	1.6159	1.2640	1.8458	1.7900	1.5655	0.5331	1.8951	1.3319
BUR3	0.8869	0.9036	0.9050	0.8304	0.8770	0.8852	0.8063	0.8092	0.8090	0.8304
Difference, %	-33.7	-44.2	-44.0	-34.3	-52.5	-50.5	-48.5	51.8	-57.3	-37.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	1.6157	1.6786	0.7638	1.7737	1.8006	1.4687	2.0137			
BUR3	0.8487	0.8326	0.8619	0.8790	0.8832	0.8829	0.8940	0.9048	0.9118	0.8986
Difference, %	-47.5	-50.4	12.9	-50.4	-51.0	-39.9	-55.6			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the years 2017-2019, direct N_2O_{SOM} emissions were estimated for the first time. The obtained results show that over the period 1990-2019, direct N_2O_{SOM} emissions from nitrogen mineralization associated with loss of soil organic matter had decreased by 0.5 per cent.

Table 5-81 shows comparative results of direct N_2O_{SOM} emissions from nitrogen mineralization associated with loss of soil organic matter for the period 1990-2019 included into the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 (GWP_{100} = 298)

Table 5-81: Comparative results of direct N_2O_{SOM} emissions from source category 3D.a.5 'Nitrogen Mineralization Associated with Loss of Soil Organic Matter', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	169.2662	170.8688	140.6590	449.8780	270.0305	417.3072	359.7350	554.7821	452.6258	418.6315
BUR3	269.2161	266.7152	265.7987	276.4238	266.4822	268.0254	266.7773	268.1598	266.8084	258.4512
Difference, %	59.0	56.1	89.0	-38.6	-1.3	-35.8	-25.8	-51.7	-41.1	-38.3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	398.5316	482.4835	481.5386	376.6859	550.0344	533.4180	466.5282	158.8507	564.7379	396.9123
BUR3	264.2919	269.2678	269.6977	247.4688	261.3560	263.7838	240.2922	241.1464	241.0911	247.4511
Difference, %	-33.7	-44.2	-44.0	-34.3	-52.5	-50.5	-48.5	51.8	-57.3	-37.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	481.4933	500.2169	227.6017	528.5595	536.5925	437.6668	600.0808			
BUR3	252.9145	248.1274	256.8563	261.9476	263.1862	263.1159	266.4126	269.6331	271.7149	267.7973
Difference, %	-47.5	-50.4	12.9	-50.4	-51.0	-39.9	-55.6			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

[117] Banaru, Anatol (2000), Methodology to Calculate CO2 Emissions from Agricultural Soils, In the collection of papers 'Climate Change: Research, Studies, Solutions', Ministry of Environment / UNDP Moldova. 'Bons Offices' Ltd. Chisinau, 2000, pages 115-123

Planned Improvements

Planned improvements could include activities focused on updating country-specific coefficients used to estimate direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change in the RM. It is thereby necessary to establish the values of humus content in arable soils at least once every three years (layer – 0-30 cm) in the northern part of the country (Napadova commune, Floresti district), and in the southern part of the country, respectively (Lebedenco commune, Cahul district), in order to identify the national average (SOC_0) and the average annual losses in the Republic of Moldova during the reporting period to the UNFCCC.

5.4.2. Indirect N_2O Emissions from Managed Soils

In addition to the direct emissions of N_2O from managed soils which occur through a direct pathway (i.e., directly from the soils to which nitrogen is applied), emissions of N_2O also take place through two indirect pathways.

The first of these pathways is the volatilization of nitrogen as NH_3 and nitrogen oxides (NO_x), and the deposition of these gases and their products NH_4^+ and NO_3^- onto soils and the surface of lakes, rivers and other waters. Sources of nitrogen in the form of ammonia (NH_3) and nitrogen oxides (NO_x) come not only from the application of organic and synthetic fertilizers to soil, but also from other activities of anthropogenic origin, such as: fossil fuel combustion, biomass burning, and some industrial processes. These processes thereby cause N_2O emissions in an exactly analogous way to those resulting from deposition of agriculturally derived NH_3 and NO_x, following the application of synthetic and organic nitrogen fertilizers and/or urine and dung deposition from grazing animals.

The second pathway is the leaching and runoff from land of nitrogen from synthetic and organic fertilizer application, crop residues, mineralization of nitrogen associated with loss of soil carbon in mineral and drained/managed organic soils through land-use change or management practices. Some of the inorganic nitrogen in or on the soil, mainly in the form of NO_3^-, may bypass biological retention mechanisms in the soil/vegetation system by transport in overland water flow (runoff) and/or flow through soil macropores or pipe drains. Where NO_3^- is present in the soil in excess of biological demand, e.g., under cattle urine patches, the excess leaches through the soil profile. The nitrification and denitrification microbial processes transform some of the NH_4^+ and NO_3^- into N_2O. This may take place in the groundwater below the land to which the N was applied, or in riverside areas receiving drain or runoff water, or in ditches, streams, rivers and estuaries (and their sediments) into which the land drainage water eventually flows.

5.4.2.1. Atmospheric Deposition of Nitrogen Volatilized from Managed Soils (NO_x and NH_4)

Source Category Description

Atmospheric deposition of nitrogen oxides (NO_x^-) and ammonia (NH_4^+) induce soil and surface waters fertilization, entailing biogenic formation of N_2O.

When synthetic or organic (manure) nitrogen fertilizers are applied on managed soils, a portion of nitrogen is lost through volatilization as ammonia and nitrogen oxides. The volatilized nitrogen is then re-deposited in soils and waters may incur further changes through nitrification and denitrification entailing N_2O emissions. The amount of volatilized nitrogen depend on a series of factors, such as type of fertilizer, technology and time of application, type of soils, atmospheric precipitations, temperature, soil pH, etc.

Methodological Issues, Emission Factors and Data Sources

N_2O emissions were estimated using a Tier 1 methodology (Equation 11.9 in the 2006 IPCC Guidelines).

$$N_2O_{ATD} = \{(F_{SN} \bullet Frac_{GASF}) + ((F_{ON} + F_{PRP}) \bullet Frac_{GASM})\} \bullet EF_4 \bullet 44/28$$

Where:

F_{SN} – annual amount of inorganic N fertilizers applied to soils (t N/yr);

$Frac_{GASF}$ – fraction of inorganic fertilizers N that volatilizes as NH_3 and NO_x, t N volatilized (the default value is 0.1 t NH_3-N + NO_x-N/t N in inorganic N fertilizers applied to soils) (range from 0.03-0.3 t NH_3-N + NO_x-N/t N in inorganic N fertilizers applied to soils)

F_{ON} – annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils (t N/yr);

F_{PRP} – annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (t N/yr);

$Frac_{GASM}$ – fraction of applied organic N fertilizers materials (F_{ON}) and of urine and dung N deposited by grazing animals (F_{PRP}) that volatilizes as NH_3 and NO_x, (the default value is 0.2 t NH_3-N + NO_x-N/t N in manure) (range from 0.05 to 0.5 t NH_3-N + NO_x-N/t N in manure);

EF_4 – emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces (the default value is 0.01 t N_2O-N/t per t NH_4-N and NO_x-N emitted) (range from 0.002 to 0.05 t N_2O-N/t per t NH_4-N and NO_x-N emitted);

[44/28] – mass ratio of nitrogen content in N_2O-N and N_2O.

Activity data on the amount of nitrogen in synthetic and organic fertilizers, urine and dung of grazing animals applied to soils is available in Tables 5-58, 5-63 and in Table 5-67, respectively.

Uncertainties Assessment and Time-Series Consistency

Uncertainties related to the estimation of indirect N_2O emissions from this source are very high. Uncertainties mostly pertain to estimating the amount of volatilized fertilizer, amount of nitrogen in manure and emission factors, for which it is extremely difficult to verify to what extent they reflect the specific conditions of Republic of Moldova. Also, uncertainties associated with the estimation of the amount of nitrogen lost through volatilization of NO_x and NH_4 are somewhat high. Nitrogen volatilization fraction varies significantly, from negligible to very high, depending on environment conditions, soil features, climate conditions, etc. According to the 2006 IPCC Guidelines, uncertainties related to the estimation of indirect N_2O emissions from this source may vary up to the factor of 2. In the Republic of Moldova, combined uncertainties related to indirect N_2O emissions from this source category are considered to be very high (circa 165.53 per cent). In view of ensuring time-series consistency of the obtained results, the same approach to estimate indirect N_2O emissions from the atmospheric deposition of nitrogen oxides (NO_x) and ammonia (NH_4) was used for the entire period under review.

Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective source category, following a Tier 1 approach. The AD and methods used were documented and archived both in hard copies and electronically. In order to identify the data entry and GHG emissions estimation process related errors, AD and EFs verifications and quality control procedures were applied.

Recalculations

Indirect N_2O_{ATD} emissions from source category 3D.b.1 'Atmospheric Deposition of Nitrogen Oxides (NO_x) and Ammonia (NH_4)' were recalculated for the period 1990-2016 series, particularly due to the use of a new set of AD generated based on the information regarding the amount of organic nitrogen fertilizers available to apply to soil estimated within category 3B 'Manure Management' (in the current inventory cycle, for the years 1990 and 1991, the amounts of synthetic fertilizers applied to soil were taken from official statistics; whereas for the period 1992-2019, it was accepted that circa 63 per cent of the available amount is actually applied to soil, this value being an arithmetic mean between the value of 63.9 per cent, characteristic of the year 1990, and the value of 62.1 per cent, characteristic of the year 1991), compared to the previous inventory cycle, when it was accepted that 65 per cent of the available amount was actually applied to soil); and as a result of updating the shares of manure management systems (MS%) in the RM, based on a study developed in 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine as well as from the National Agency for Food Security.

In comparison with the results recorded in previous inventory cycle, the changes made in the current inventory cycle resulted in a downward trend in indirect N_2O_{ATD} emissions from source category 3D.b.1 'Atmospheric Deposition of Nitrogen Oxides (NO_x) and Ammonia (NH_4)' for the period 1990-2016 (Table 5-82).

Table 5-82: Comparative results of indirect N_2O_{ATD} emissions from source category 3D.b.1 'Atmospheric Deposition of Nitrogen Oxides (NO_x) and Ammonia (NH_4)', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	0.3429	0.3182	0.2691	0.1997	0.1768	0.1614	0.1668	0.1360	0.1321	0.1157
BUR3	0.3400	0.3111	0.2647	0.1960	0.1732	0.1581	0.1634	0.1333	0.1296	0.1133
Difference, %	-0.9	-2.2	-1.6	-1.9	-2.1	-2.1	-2.1	-2.0	-1.9	-2.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.1131	0.1186	0.1288	0.1180	0.1164	0.1196	0.1175	0.1044	0.1088	0.1088
BUR3	0.1111	0.1165	0.1267	0.1160	0.1145	0.1175	0.1154	0.1028	0.1073	0.1070
Difference, %	-1.8	-1.8	-1.7	-1.7	-1.7	-1.7	-1.8	-1.6	-1.5	-1.6
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.1161	0.1162	0.1252	0.1350	0.1710	0.1336	0.1428			
BUR3	0.1142	0.1146	0.1238	0.1337	0.1695	0.1322	0.1415	0.1576	0.1636	0.1774
Difference, %	-1.6	-1.4	-1.1	-1.0	-0.9	-1.1	-1.0			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Table 5-83 below shows the comparative results of indirect N_2O_{ATD} emissions from source category 3D.b.1 'Atmospheric Deposition of Nitrogen Oxides (NO_x) and Ammonia (NH_4)' for the period 1990-2019 included into the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 ($GWP_{100} = 298$).

Table 5-83: Comparative results of indirect N_2O_{ATD} emissions from source category 3D.b.1 'Atmospheric Deposition of Nitrogen Oxides (NO_x) and Ammonia (NH_4)', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	102.1793	94.8090	80.2010	59.5183	52.6985	48.0915	49.7183	40.5323	39.3759	34.4657
BUR3	101.3066	92.6955	78.8857	58.3954	51.6079	47.0993	48.6918	39.7245	38.6114	33.7695
Difference, %	-0.9	-2.2	-1.6	-1.9	-2.1	-2.1	-2.1	-2.0	-1.9	-2.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	33.7147	35.3358	38.3930	35.1675	34.6932	35.6380	35.0040	31.1079	32.4354	32.4079
BUR3	33.0954	34.7040	37.7559	34.5639	34.1125	35.0265	34.3781	30.6255	31.9621	31.8799
Difference, %	-1.8	-1.8	-1.7	-1.7	-1.7	-1.7	-1.8	-1.6	-1.5	-1.6
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	34.5829	34.6356	37.3227	40.2367	50.9555	39.8057	42.5624			
BUR3	34.0389	34.1369	36.9010	39.8373	50.5185	39.3850	42.1581	46.9693	48.7621	52.8662
Difference, %	-1.6	-1.4	-1.1	-1.0	-0.9	-1.1	-1.0			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Over the period 2017-2019, indirect N_2O_{ATD} emissions from source category 3D.b.1 'Atmospheric Deposition of Nitrogen Oxides (NO_x) and Ammonia (NH_4)' were estimated for the first time. The obtained results show that over the period 1990-2019, indirect N_2O_{ATD} emissions from source category 3D.b.1 had decreased by 47.8 per cent. This significant decrease in indirect N_2O_{ATD} emissions from atmospheric deposition of nitrogen oxides (NO_x) and ammonia (NH_4) is due to the significant decrease in the amounts of organic and inorganic fertilizer applied to soils over this period, and the significant reduction of the total livestock population and changes in the share of manure management systems in the RM.

Planned Improvements

No activities to improve the estimation process regarding indirect N_2O_{ATD} emissions from atmospheric deposition of nitrogen oxides (NO_x) and ammonia (NH_4) in the RM are planned for the future inventory cycle.

5.4.2.2. Nitrogen Leaching and Run-off

Source Category Description

A big part of nitrogen applied to soil through application of synthetic and organic fertilizer addition, through urine and dung deposition from grazing animals, crop residues and mineralization of nitrogen associated with loss of soil carbon in mineral soils through land-use change or management practices is lost through leaching and run-off. Some of the inorganic nitrogen in or on the soil, mainly in the form of NO_3^-, may bypass biological retention mechanisms in the soil/vegetation system by transport in overland water flow (run-off) and/or flow through soil macropores or pipe drains. Therefore, if NO_3^- is present in the soil in excess of biological demand, the excess leaches through the soil profile. This nitrogen may reach groundwater, riverside areas, lakes, rivers and eventually seas and oceans, where it intensifies the biogenic production of N_2O emissions

Methodological Issues, Emission Factors and Data Sources

Indirect N_2O emissions from leaching and run-off were estimated using a Tier 1 methodology (Equation 11.10 in the 2006 IPCC Guidelines).

$$N_2O_L = \{(F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) \bullet Frac_{LEACH-(H)})\} \bullet EF_5 \bullet 44/28$$

Where:

F_{SN} – annual amount of inorganic nitrogen fertilizers applied to soils (t N/yr);

F_{ON} – annual amount of managed animal manure, compost, sewage sludge and other organic nitrogen applied to soils (t N/yr);

F_{PRP} – annual amount of urine and dung nitrogen deposited by grazing animals on pasture, range and paddock (t N/yr);

F_{CR} – nitrogen in crop residues (above- and below-ground), including N-fixing crops and forage/pasture renewal returned to soils (t N/yr);

F_{SOM} – annual amount of nitrogen mineralized in mineral soils associated with loss of soil carbon from soil organic matter as a result of changes to land use or management (t N/yr);

$Frac_{LEACH}$ – fraction of all nitrogen added to/mineralized in managed soils that is lost through leaching and run-off, kg N: the default value is 0.3 kg N/kg N applied (range: 0.1-0.8 t N/t N applied with synthetic nitrogen and organic fertilizer);

EF_5 – emission factor for N_2O emissions from nitrogen leaching and run-off (the default value is 0.0075 t N_2O-N/t N), (range: 0.0005-0.025 t N_2O-N/t N leached and run-off).

[44/28] – mass ratio of nitrogen content in N_2O-N and N_2O.

Activity data on the amount of nitrogen in synthetic and organic fertilizers, urine and dung of grazing animals applied to soils, crop residues, mineralization of nitrogen associated with loss of soil carbon in mineral soils through land-use change is available in Tables 5-58, 5-63, 5-67, 5-75 and 5-79.

Uncertainties Assessment and Time-Series Consistency

Uncertainties associated with the estimation of indirect N_2O emissions from leaching and run-off are very high, being caused by estimating the amount of nitrogen applied to soil lost through leaching and run-off as well as by the emission factors, for which is extremely difficult to verify whether they reflect the specific conditions in the Republic of Moldova. It should be noted that according to the 2006 IPCC Guidelines, uncertainties associated with estimation of indirect N_2O emissions from leaching and run-off may vary up to a factor of 2. In the RM, combined uncertainties associated with indirect N_2O emissions from leaching and run-off are considered to be very high (circa 167.71 per cent). In view of ensuring time-series consistency of the obtained results, the same approach and emission factors were used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

Quality Assurance and Quality Control

Standard verification and QC forms and checklists were filled in for Sector 3 'Agriculture', following a Tier 1 approach. It should be noted that the AD and methods used were documented and archived both in hard copies and electronically. In order to identify the data entry and GHG emissions estimation process related errors, AD and EFs verifications and QC procedures were applied.

Recalculations

Indirect N_2O_L emissions from source category 3D.b.2 'Nitrogen Leaching and Run-off' were recalculated for the period 1990-2016, particularly due to the use of a new set of AD generated based on the information regarding the amount of organic N fertilizers available to apply to soil estimated within source category 3B 'Manure Management' (in the current inventory cycle, organic fertilizers applied to soil were taken from official statistics for the years 1990 and 1991, whereas for the for the period 1992-2019, it was accepted that circa 63 per cent of the available amount is actually applied to soil, this value being an arithmetic mean between the value of 63.9 per cent, characteristic of the year 1990, and the value of 62.1 per cent, characteristic of the year 1991), compared to the previous inventory cycle, when it was accepted that 65 per cent of the available amount was actually applied to soil); and as a result of updating the shares of manure management systems (MS%) in the RM, based on a study developed in 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine as well as from the National Agency for Food Security; and changing the calculation methodology for the annual carbon losses in mineral soils ($\Delta C_{Mineral}$), by applying a Tier 2 methodology from the 2006 IPCC Guidelines, using Equation 2.25 in the 2006 IPCC Guidelines, Volume 4, Chapter 2, page 2.30

In comparison with the results recorded in previous inventory cycle, the changes made in the current inventory cycle resulted in an upward trend in indirect N_2O_L emissions from source category 3D.b.2 'Nitrogen Leaching and Run-off' for the years 1990-1992, 2007 and 2012, and a downward trend in indirect N_2O_L emissions for the years 1993-2006, 2008-2011 and 2013-2016 (Table 5-84).

Table 5-84: Comparative results of indirect $N_2O_{(L)}$ emissions from source category 3D.b.2 'Nitrogen Leaching and Run-off', included into the BUR and BUR3 of the Republic of Moldova to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	0.7994	0.7717	0.6112	0.7226	0.4807	0.5917	0.5244	0.6661	0.5718	0.5184
BUR3	0.8716	0.8360	0.7007	0.5873	0.4739	0.4753	0.4503	0.4467	0.4286	0.3948
Difference, %	9.0	8.3	14.6	-18.7	-1.4	-19.7	-14.1	-32.9	-25.0	-23.8
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	0.4800	0.5810	0.6025	0.4722	0.6453	0.6366	0.5777	0.2888	0.6620	0.5074
BUR3	0.3764	0.4176	0.4401	0.3724	0.4252	0.4308	0.4046	0.3491	0.4158	0.3925
Difference, %	-21.6	-28.1	-26.9	-21.1	-34.1	-32.3	-30.0	20.9	-37.2	-22.6
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	0.6057	0.6278	0.3954	0.7073	0.7973	0.5815	0.7812			
BUR3	0.4311	0.4356	0.4159	0.5045	0.5893	0.4482	0.5280	0.5866	0.6114	0.6485
Difference, %	-28.8	-30.6	5.2	-28.7	-26.1	-22.9	-32.4			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

Table 5-85 below shows the comparative results of indirect N_2O_L emissions source category 3D.b.2 'Nitrogen Leaching and Run-off' for the period 1990-2019 included into the BUR2 and BUR3 of the RM to the UNFCCC, expressed in kt CO_2 equivalent using the GWP_{100} values available in the IPCC AR4 ($GWP_{100} = 298$).

Table 5-85: Comparative results of indirect $N_2O_{(L)}$ emissions from source category 3D.b.2 'Nitrogen Leaching and Run-off', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	238.2299	229.9582	182.1474	215.3204	143.2592	176.3389	156.2579	198.5067	170.3862	154.4696
BUR3	259.7299	249.1370	208.8169	175.0235	141.2304	141.6315	134.1852	133.1044	127.7140	117.6458
Difference, %	9.0	8.3	14.6	-18.7	-1.4	-19.7	-14.1	-32.9	-25.0	-23.8
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	143.0546	173.1353	179.5369	140.7151	192.3053	189.7197	172.1635	86.0509	197.2687	151.1941
BUR3	112.1539	124.4510	131.1560	110.9622	126.6994	128.3641	120.5563	104.0247	123.9157	116.9713
Difference, %	-21.6	-28.1	-26.9	-21.1	-34.1	-32.3	-30.0	20.9	-37.2	-22.6
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	180.5027	187.0784	117.8339	210.7733	237.6045	173.2988	232.7913			
BUR3	128.4604	129.7974	123.9418	150.3342	175.5970	133.5518	157.3529	174.8195	182.1863	193.2639
Difference, %	-28.8	-30.6	5.2	-28.7	-26.1	-22.9	-32.4			

Abbreviations: BUR2 – Second Biennial Update Report; BUR3 – Third Biennial Update Report.

For the years 2017-2019, indirect N_2O_L emissions source category 3D.b.2 'Nitrogen Leaching and Run-off' were estimated for the first time. The obtained results show that over the period 1990-2019, indirect N_2O_L emissions source category 3D.b.2 'Nitrogen Leaching and Run-off' had decreased by circa 25.6 per cent.

This decrease in indirect emissions is due to the reduction of the amounts of organic and inorganic fertilizer applied to soils, the reduction of the total livestock population and changes in the share of manure management systems in the RM; also, due to the decrease in the amount of crop residues returned to soil (including due to the irrational distribution of soil resources and non-compliance with the recommended crop structure, with a profoundly negative impact on stabilizing humus balance in the soil) and increase in carbon loss in soil, as a result of inefficient agricultural land management practices.

Planned Improvements

No activities to improve the estimation process regarding the indirect $N_2O_{(L)}$ emissions soil nitrogen leaching and runoff in the RM are planned for the future inventory cycle.

5.5. Urea Application (Category 3H)

5.5.1. Source Category Description

Adding urea ($CO(NH_2)_2$) to agricultural soils during fertilization leads to a loss of CO_2 that was fixed in the industrial production process. Urea is converted into ammonium (NH_4^+), hydroxyl ion (OH^-) and bicarbonate (HCO_3^-) in the presence of water and urease enzymes. Bicarbonate that is formed evolves into CO_2 and water.

5.5.2. Methodological Issues, Emission Factors and Data Sources

CO_2 emissions from urea application were estimated using a Tier 1 methodology and Equation 11.13 from the 2006 IPCC Guidelines:

$$CO_2 = M \bullet EF \bullet 44/12$$

Where:

CO_2 – annual CO_2 emissions from urea application (kt/yr);

M – annual amount of urea fertilization (kt urea/yr);

EF – emission factor, tonnes C/tonnes urea (default value: 0.2 t C/t urea);

[44/12] – mass ratio of carbon content in CO_2-C and CO_2.

No urea is produced in the RM. Activity data on urea application to soils as a fertilizer were generated indirectly based on the information provided by the Customs Service of the RM on urea imports and exports (Table 5-86).

It was considered that the annual consumption of urea is equal to the total urea imports minus exports. As the database of the Customs Service does not cover the period 1990-1994, information regarding urea consumption during the respective period was generated based on the trend of using inorganic fertilizers between 1990 and 1995. As it can be seen in Table 5-86, an obvious upward trend in urea consumption was recorded in the Republic of Moldova in the last decade, albeit the annual consumption varies significantly from year to year.

Table 5-86: Urea consumption as a fertilizer in the RM for the period 1990-2019, tonnes

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Urea import into the RM, t	793.6	712.6	532.5	174.1	73.2	82.7	124.3	1 499.0	371.1	4.6
Urea export in the RM, t	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Annual urea consumption in the RM, t	793.6	712.6	532.5	174.1	73.2	82.7	124.3	1 499.0	371.1	4.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Urea import into the RM, t	599.7	204.0	64.2	324.8	500.7	237.2	199.1	358.7	1 159.8	799.6
Urea export in the RM, t	0.0	0.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0
Annual urea consumption in the RM, t	599.7	204.0	64.1	324.7	500.3	237.2	199.1	358.7	1 159.8	799.6
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Urea import into the RM, t	2 385.5	5 022.2	7 634.2	5 705.4	13 917.0	15 327.6	16 738.2	35 738.3	59 130.6	54 041.7
Urea export in the RM, t	6.9	10.6	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Annual urea consumption in the RM, t	2 378.6	5 011.6	7 623.8	5 705.4	13 917.0	15 327.6	16 738.2	35 738.3	59 130.6	54 041.7

Source: Customs Service of the RM, Letter No. 28/07-8785 dated 26.05.2016, as a response to Letter No. 512/2016-05-01 dated 10.05.2016; Letter No. 28/07-612 dated 12.01.2018, as a response to Letter No. 601/2017-12-03 dated 14.12.2017; Letter No. 28/07-3025 dated 28.02.2020, as a response to Letter No. 08-310/1 dated 11.02.2020.

5.5.3. Uncertainties Assessment and Time-Series Consistency

Uncertainties related to activity data on urea application in the RM reach to circa 30 per cent. According to the 2006 IPCC Guidelines, uncertainties associated with default EFs represent circa 50 per cent. Combined uncertainties from source category 3H 'Urea Application' are thereby considered moderate (circa 58.31 per cent) (Annex 5-3.3). In view of ensuring time-series consistency of the obtained results, the same approach and emission factors were used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidance.

5.5.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective source category, following a Tier 1 approach. The AD and methods used were documented and archived both in hard copies and electronically. In order to identify the data entry and GHG emissions estimation process related errors, AD and EFs verifications and quality control procedures were applied.

5.5.5. Recalculations

CO_2 emissions from category 3H 'Urea Application' were not recalculated. For the period 2017-2019, the respective emissions were calculated for the first time. The obtained results show that over the period 1990-2019, the CO_2 emissions from category 3H 'Urea Application' increased by circa 68 times (Table 5-87).

Table 5-87: CO_2 emissions from urea application in agricultural soils in the RM for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3H 'Urea Application', kt	0.5820	0.5226	0.3905	0.1276	0.0537	0.0607	0.0911	1.0992	0.2721	0.0034
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
3H 'Urea Application', kt	0.4397	0.1496	0.0470	0.2381	0.3669	0.1739	0.1460	0.2631	0.8505	0.5864
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
3H 'Urea Application', kt	1.7443	3.6752	5.5908	4.1840	10.2058	11.2402	12.2747	26.2081	43.3624	39.6306

5.5.6. Planned Improvements

No activities to improve the process of estimating CO_2 emissions from urea application as a fertilizer in agricultural soils in the RM are planned for the future inventory cycle.

6. LAND USE, LAND-USE CHANGE AND FORESTRY SECTOR

6.1. Overview

This chapter envisages the estimation of GHG removals/emissions from Sector 4 'Land Use, Land-Use Change and Forestry'. GHG removals/emissions within this sector were estimated following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories methodologies.

The evolution of removals/emissions reported for the period 1990-2019 was greatly affected, in addition to the state of forests and other vegetation types, by the social-political and economic changes that occurred over the respective period in the RM (transition to market economy, land parceling as result of land reform, a sharp decrease in agricultural production, etc.).

Following the implementation of land reforms in the 1990s, land use in the Republic of Moldova was relatively stable in the past 10-15 years. The forest area is growing steadily. According to data provided by the General Land Cadaster, by 01.01.2020, forest lands constituted 373.2 thousand ha or 11.3 per cent of the country's territory or +14.7 per cent compared to the base year 1990.

6.1.1. Evolution of CO_2 Removal Trends

Over the period 1990-2019, especially since 2009, the evolution of CO_2 removals from Sector 4 'LULUCF' tended to decrease significantly (Figure 6-1); however, in 2019, this sector had already become an emission source.

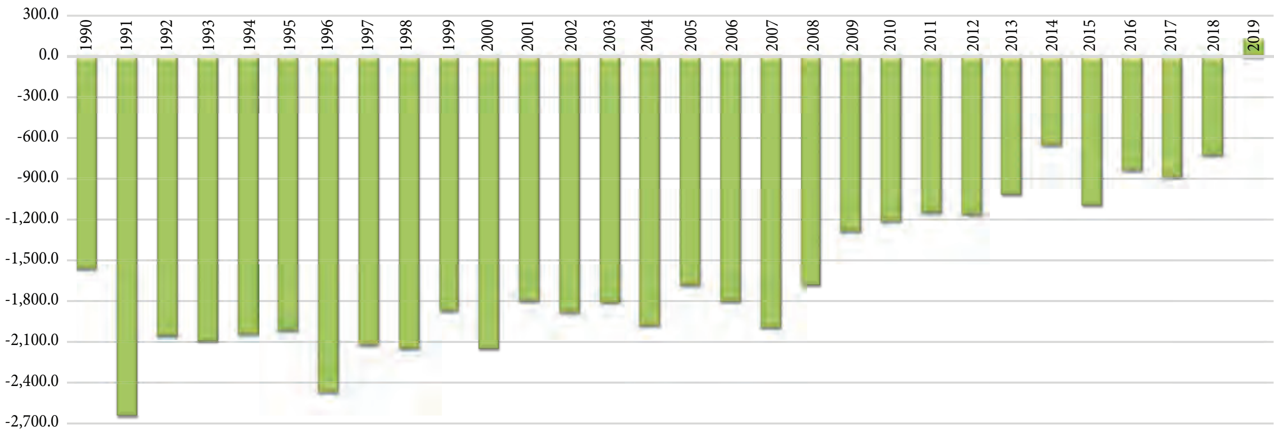

Figure 6-1: CO_2 removals/emissions from Sector 4 'LULUCF' for the period 1990-2019, kt.

The main sources of emission reduction in Sector 4 'LULUCF' are forest lands, grasslands and lands with wood vegetation from croplands, particularly subcategories: 4A1 'Forest Land Remaining Forest Land', 4A2 'Land Converted to Forest Land', 4C2 'Land Converted to Grassland', and 4B2 'Land Converted to Cropland' (Table 6-1; Figure 6-2). Subcategories 4B1 'Cropland Remaining Cropland', 4E2 'Land Converted to Settlements' and 4F2 'Land Converted to Other Land' remain a constant source of CO_2 emissions due to a profoundly negative balance as a result of the conversion of land with different vegetation types, and a significant decrease in areas with perennial plantations (circa -39.4 per cent).

Table 6-1: CO_2 Emissions/Removals within Sector 4 'LULUCF' in the RM, by categories for the period 1990-2019, kt

Year	Forest Land		Cropland		Grassland		Wetlands		Settlements		Other Land		HWP	LULUCF total	Compared to 1990, %
	4A1	4A2	4B1	4B2	4C1	4C2	4D1	4D2	4E1	4E2	4F1	4F2	4G		
1990	-1579.04	-984.39	2602.98	45.75	NO	-1205.69	NO	-555.38	NO	84.75	NO	152.36	-122.18	-1560.84	100.0
1991	-1352.65	-990.66	1489.86	27.39	NO	-1414.32	NO	-526.46	NO	88.71	NO	152.36	-113.61	-2639.38	169.1
1992	-1290.42	-893.82	1571.41	-127.44	NO	-1428.48	NO	-595.55	NO	386.62	NO	418.78	-94.30	-2053.20	131.5
1993	-1367.44	-826.08	1707.84	5.19	NO	-1303.52	NO	-525.84	NO	114.62	NO	164.02	-63.45	-2094.66	134.2
1994	-1355.18	-752.83	1479.70	-3.40	NO	-1577.33	NO	-497.64	NO	130.49	NO	549.46	-14.65	-2041.38	130.8
1995	-1350.20	-694.87	1652.62	-66.35	NO	-1601.10	NO	-469.44	NO	106.92	NO	401.13	5.97	-2015.32	129.1
1996	-1559.05	-631.39	1489.36	-101.15	NO	-1548.08	NO	-441.24	NO	101.59	NO	217.33	1.78	-2470.84	158.3
1997	-1639.49	-592.79	1802.84	-146.02	NO	-1400.86	NO	-413.03	NO	100.80	NO	188.24	-19.24	-2119.57	135.8
1998	-1732.32	-556.17	1838.57	-154.62	NO	-1436.27	NO	-384.83	NO	99.04	NO	185.01	-9.13	-2150.72	137.8
1999	-1840.91	-495.94	1814.62	-112.44	NO	-1433.29	NO	-356.63	NO	111.83	NO	425.16	18.54	-1869.06	119.7

Year	Forest Land		Cropland		Grassland		Wetlands		Settlements		Other Land		HWP	LULUCF total	Compared to 1990, %
	4A1	4A2	4B1	4B2	4C1	4C2	4D1	4D2	4E1	4E2	4F1	4F2	4G		
2000	-1881.45	-425.98	1618.81	-126.64	NO	-1291.95	NO	-328.42	NO	100.18	NO	178.52	5.81	-2151.14	137.8
2001	-1873.56	-400.15	1999.82	-171.25	NO	-1290.65	NO	-300.22	NO	67.09	NO	178.52	-6.26	-1796.66	115.1
2002	-1913.58	-354.04	1568.81	-144.11	NO	-1235.14	NO	-272.02	NO	67.09	NO	456.24	-56.69	-1883.43	120.7
2003	-1863.87	-406.25	1645.16	-139.40	NO	-1007.18	NO	-243.82	NO	67.86	NO	201.66	-65.11	-1810.95	116.0
2004	-1904.34	-430.44	1589.75	-123.40	NO	-1120.48	NO	-215.61	NO	53.67	NO	223.82	-53.47	-1980.50	126.9
2005	-1966.00	-443.52	1630.93	-87.69	NO	-1058.12	NO	-187.41	NO	53.67	NO	416.50	-41.11	-1682.75	107.8
2006	-1882.93	-483.58	1666.31	-88.69	NO	-1056.37	NO	-159.21	NO	53.67	NO	189.50	-40.59	-1801.89	115.4
2007	-1985.96	-474.43	1621.17	-80.78	NO	-1031.24	NO	-131.00	NO	49.27	NO	83.11	-44.59	-1994.44	127.8
2008	-1985.38	-477.41	1603.36	-92.51	NO	-932.15	NO	-102.80	NO	49.27	NO	291.00	-35.61	-1682.23	107.8
2009	-2008.95	-517.12	1744.06	-79.07	NO	-447.69	NO	-74.60	NO	45.57	NO	79.94	-28.47	-1286.34	82.4
2010	-1964.09	-520.08	1618.99	-72.97	NO	-691.99	NO	-46.40	NO	45.57	NO	441.48	-22.80	-1212.28	77.7
2011	-1871.43	-519.14	1610.58	-106.00	NO	-638.17	NO	-75.31	NO	62.04	NO	393.73	-4.38	-1148.09	73.6
2012	-1702.27	-592.56	1593.58	-84.81	NO	-562.75	NO	-15.47	NO	11.89	NO	114.14	76.84	-1161.40	74.4
2013	-1531.88	-609.99	1689.48	-276.10	NO	-360.17	NO	-106.10	NO	13.75	NO	103.45	61.88	-1015.68	65.1
2014	-1484.67	-650.06	1696.17	-245.69	NO	-341.11	NO	-139.75	NO	18.98	NO	436.65	58.02	-651.47	41.7
2015	-1496.39	-663.05	1700.40	-309.33	NO	-418.46	NO	-82.79	NO	39.16	NO	86.82	49.24	-1094.41	70.1
2016	-1433.25	-682.52	1775.41	-383.49	NO	-402.37	NO	-82.79	NO	19.31	NO	351.63	0.88	-837.18	53.6
2017	-1324.56	-691.87	1781.71	-412.63	NO	-384.04	NO	-82.82	NO	77.31	NO	218.21	-67.45	-886.15	56.8
2018	-1281.36	-687.99	1786.37	-299.01	NO	-440.15	NO	-82.83	NO	21.62	NO	321.21	-63.50	-725.65	46.5
2019	-1231.10	-719.55	1799.17	-9.28	NO	-293.29	NO	-82.81	NO	116.50	NO	611.79	-57.56	133.87	-8.6

This trend is due, first of all, to changes in land-use and land management practices (Category 4B), which contributed to the significant decrease in organic carbon stocks in cropland[118], thereby changing the humus balance, from a positive one into a negative and/or profoundly negative one. The respective process was also influenced by some changes in forest management and forest use (Category 4A), such the increase in authorized harvesting of wood, significant increase in illegal logging, increased conversion of cropland to forest land, etc.

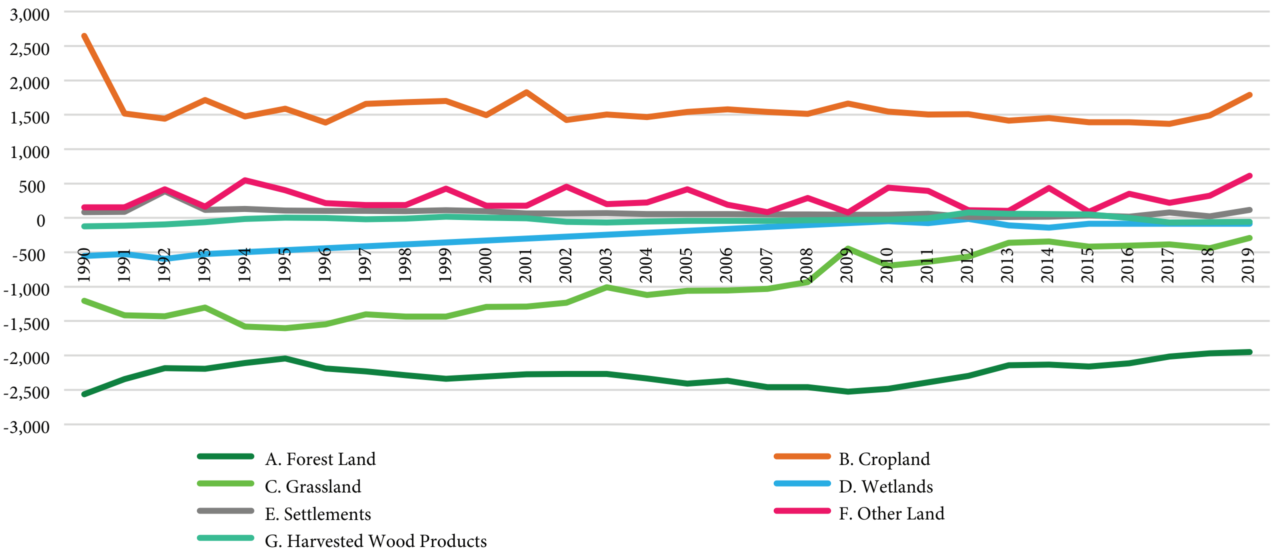

Figure 6-2: CO_2 Emissions/Removals within the Sector 4 'LULUCF' in the RM, kt.

Table 6-2 shows net CO_2 emissions/removals within Sector 4 'LULUCF' for the period 1990-2019

Table 6-2: Net direct GHG emissions/removals within Sector 4 'LULUCF' in the RM for the period 1990-2019, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	-1 560.844	-2 639.379	-2 053.202	-2 094.662	-2 041.383	-2 015.324	-2 470.840	-2 119.566	-2 150.718	-1 869.063
CH_4	2.653	2.400	2.197	2.947	1.655	2.240	1.541	2.688	2.472	2.389
N_2O	170.374	183.882	204.652	222.570	236.541	251.515	262.258	272.182	284.357	293.860
Net total	**-1387.817**	**-2453.097**	**-1846.353**	**-1869.145**	**-1803.186**	**-1761.569**	**-2207.042**	**-1844.696**	**-1863.889**	**-1572.813**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
CO_2	-2 151.136	-1 796.658	-1 883.427	-1 810.950	-1 980.502	-1 682.749	-1 801.889	-1 994.439	-1 682.226	-1 286.337
CH_4	0.912	1.270	0.266	0.061	0.201	0.248	0.251	1.518	0.770	0.314
N_2O	296.324	296.545	296.950	294.338	290.121	286.541	282.602	278.020	272.028	265.331
Net total	**-1853.899**	**-1498.842**	**-1586.211**	**-1516.550**	**-1690.180**	**-1395.959**	**-1519.036**	**-1714.901**	**-1409.428**	**-1020.691**

[118] Organic carbon and nitrogen in soil are closely related to the humus content in soil; carbon loss through oxidation due to changes in soil management and cropland use are accompanied by the simultaneous nitrogen mineralization (biochemical decomposition).

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CO_2	-1 212.282	-1 148.086	-1 161.402	-1 015.684	-651.469	-1 094.410	-837.182	-886.146	-725.646	133.865
CH_4	0.139	0.160	1.168	0.872	0.117	0.653	0.357	0.498	0.170	0.394
N_2O	258.214	251.958	233.423	217.251	202.468	190.264	179.267	171.848	165.387	161.528
Net total	**-953.928**	**-895.968**	**-926.811**	**-797.561**	**-448.884**	**-903.492**	**-657.558**	**-713.799**	**-560.088**	**295.787**

6.1.2. Key Categories

The results of key category analysis carried out following a Tier 1 approach, by level and trend, are provided in Table 6-3 under Sector 4 'LULUCF'.

Table 6-3: Key Categories in Sector 4 'LULUCF'

IPCC Category	GHG	Source and Sink Categories	Key Categories
4A1	CO_2	Forest Land Remaining Forest Land	Yes (L, T)
4A1	non-CO_2	Forest Land Remaining Forest Land	No
4A2	CO_2	Land Converted to Forest Land	Yes (L, T)
4A2	non-CO_2	Land Converted to Forest Land	No
4B1	CO_2	Cropland Remaining Cropland	Yes (L, T)
4B1	non-CO_2	Cropland Remaining Cropland	No
4B2	CO_2	Land Converted to Cropland	No
4B2	non-CO_2	Land Converted to Cropland	No
4C1	CO_2	Grassland Remaining Grassland	No
4C2	CO_2	Land Converted to Grassland	Yes (L, T)
4D1	CO_2	Wetlands Remaining Wetlands	No
4D2	CO_2	Land Converted to Wetlands	Yes (L, T)
4E1	CO_2	Settlements Remaining Settlements	No
4E2	CO_2	Land Converted to Settlements	Yes (L, T)
4E2	non-CO_2	Land Converted to Settlements	No
4F1	CO_2	Other Land Remaining Other Land	No
4F2	CO_2	Land Converted to Other Land	Yes (L, T)
4G	CO_2	Harvested Wood Products	Yes (T)

6.1.3. Methodological Issues and Data Sources

Tier 1 and Tier 2 methodologies (2006 IPCC Guidelines), as well as default and country-specific emissions/removals factors (e.g.: current biomass growth factors, basic wood density; carbon fraction of dry matter, biomass decrease/increase and/or soil carbon due to conversion etc.) were employed to estimate emissions/removals under Sector 4 'LULUCF'. At the same time, in order to estimate the emission reduction achieved in the implementation of afforestation projects through the CDM of the Kyoto Protocol: 'Moldova Soil Conservation Project' (MSCP) and 'Moldova Community Forestry Development Project' (MCFDP) a Tier 3 methodology AR-AM0002 'Restoration of degraded land through afforestation/reforestation" (Version 01 and 03) was used.

The summary of estimation methods used to calculate emissions by source and sink categories are presented in Table 6-4, and a more detailed description is provided in sub-chapters 6.2-6.8 of the NIR).

Table 6-4: CO_2 Emissions/Removals Methodological Approach applied within Sector 4 'LULUCF'

IPCC Category	Subcategories	Methodology Used	EF	Notes
4A Forest Land	A1 Forest Land Remaining Forest Land	T2	D, CS	Above-ground biomass (biomass increment in forests; losses due to authorized commercial felling and illegal logging)
	A2 Land Converted to Forest Land	T1, T2, T3	D, CS	Above-ground and below-ground biomass (biomass increment in new forests; losses / gains of biomass due to conversion; forest fires, CH_4, N_2O, NOx, CO emissions); carbon losses (carbon losses / gains due to conversion)
4B Cropland	B1. Cropland Remaining Cropland, including:	T1, T2	D, CS	
	B1.1 Cropland Covered with Woody Vegetation	T1, T2	CS	Above-ground and below-ground biomass (forest strips, other types of forest vegetation, orchards, vineyards, trees in individual gardens.)
	B1.2 Annual Change in Carbon Stocks in Mineral Soils	T2	D, CS	Annual change in carbon stocks in mineral soils (losses / gains of biomass and/or carbon in soil due to agricultural activities)
	B.1.3. Burning of Crop Residue	T1, T2	D, CS	CH_4, N_2O, NOx, CO emissions
	B2. Land Converted to Cropland	T1, T2	D, CS	Above-ground and below-ground biomass (losses / gains of biomass due to conversion), carbon stocks in mineral soils (carbon losses / gains due to conversion); N_2O emissions due to conversion to Cropland
4C Grassland	C1. Grassland Remaining Grassland	T2	CS	Neutral balance
	C2. Land Converted to Grassland	T2	CS	Above-ground and below-ground biomass (forest strips, other types of forest vegetation and degraded arable lands converted to grassland; losses / gains of biomass due to conversion), carbon stocks in mineral soils (carbon losses / gains due to conversion)

IPCC Category	Subcategories	Methodology Used	EF	Notes
4D Wetlands	D1. Wetlands Remaining Wetlands	T1	D	Neutral balance
	D2. Land Converted to Wetlands	T1, T2	D, CS	Above-ground and below-ground biomass (losses / gains of biomass due to conversion), carbon stocks in mineral soils (carbon losses / gains due to conversion)
4E Settlements	E1. Settlements Remaining Settlements	T1	D	Neutral balance
	E2. Land Converted to Settlements	T1, T2	D, CS	Above-ground and below-ground biomass (losses / gains of biomass due to conversion), carbon stocks in mineral soils (carbon losses / gains due to conversion), N_2O emissions due to conversion to Settlements
4F Other Land	F1. Other Land Remaining Other Land	T1	D	Neutral balance
	F2. Land Converted to Other Land	T1, T2	D, CS	Above-ground and below-ground biomass (losses / gains of biomass due to conversion), carbon stocks in mineral soils (carbon losses / gains due to conversion)
4G HWP	Harvested Wood Products	T1	D	Harvested wood products / processed, imported or exported (raw round wood; timber, wooden panels, etc.)

Abbreviations: T1, T2, T3 – Tier 1, 2 and 3; CS – country specific emission/removal factors; D – default emission/removal factors.

The main sources of reference for the activity data used under Sector 4 'LULUCF' were: data pertaining to State Records on Forestry Resources: areas occupied by forests, distribution by species, volume of standing wood, etc.; forest planning materials: areas occupied and dendrometrical features of forests and other types of forest vegetation; General Land Cadaster of the RM – forest areas, areas occupied by forest vegetation not included in forestry resources, grassland, perennial plantations, cropland, settlements, other land, etc.; Statistical Reports of Agency 'Moldsilva': the volume of wood harvested during forest clearings (by categories and species); illegal felling detected in forest fund managed by the Agency, as well as in the forests and forest vegetation managed by other owners; Reports of the Inspectorate for Environmental Protection: illegal felling revealed by its territorial sub-divisions; the volumes of wood mass subjected to authorized harvesting (1990-2019) in forests and forest vegetation managed by local and central public authorities: areas on which crop residue was burnt; Reports of the Environment Agency: volumes of wood mass subjected to authorized harvesting in forests and forest vegetation managed by local and central public authorities, etc. (2019); Statistical Yearbooks of the Republic of Moldova and those of the ATULBD: harvesting of wood products, forestlands that suffered from fires, cropping, the total production and the production per hectare on main crops, etc.

6.1.4. Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of the CO_2 emissions/removals from Sector 4 'LULUCF' (by source and sink categories) is described in detail in sub-chapters 6.2-6.8 of this Report, as well as in Annex 5-3.4. Combined uncertainties as a percentage of net total GHG emissions/removals from this sector were estimated at circa ±121.5 per cent. The uncertainties introduced in the trend in total direct GHG emissions from this sector were estimated at circa ±35.7 per cent. In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

6.1.5. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists by individual source and sink categories were filled in for each category under Sector 4 'LULUCF', following a Tier 1 approach. It should be noted that AD and methods used to estimate CO_2 emissions/removals from this sector were documented and archived both in hard copies and electronically. In order to identify the data entry, as well as GHG emissions estimation related errors, AD and EFs verifications and quality control procedures were applied. Following the sustainable practices, GHG emissions/removals were estimated based on AD and EFs from official reference sources. Also, an important factor that positively influenced the quality of the GHG inventory was the development of a Land Use Matrix for the period 1970-2019. Quality control (QC) measures consisted of self-monitoring own protocols and data processing procedures. QC is based on using a specific checklist by each compiler, e.g.: re-checking AD or EFs entered in the tables, verifying whether the sum of the land category matches the total area of the country for the entire time series, checking the formulas implemented in the spreadsheets or calculating some parameters (i.e. at disaggregated level or through the IEF values implemented in the spreadsheets), the re-verification of measurement units for all the parameters involved in the inventory estimation. Quality assurance activities included verifications by a person not involved in the data collection or processing operation, based on the same checklist as for QC, including to detect inconsistencies between the spreadsheets and those set out in NIR.

6.1.6. Recalculations

Net GHG emissions/removals from Sector 4 'LULUCF' were recalculated in the current inventory cycle as a result of updating activity data and country-specific emission factors utilized in most source categories. Details and arguments regarding the need to recalculate are presented in subchapters 6.2-6.8 of this Report. These may include a partial change in activity data. Since some of the assumptions for non-forest land conversions were changed, i.e. instead of using the actual annual conversion rates reported in the national statistics for 1970-1994 and their 1995 average, so far, as in previous presentations, the 1970-1994 average was implemented for the entire time series: 1970-2019. Thus, compared to the results recorded in the BUR2 of the RM to the UNFCCC, the changes made in the current inventory cycle resulted in an upward trend in net CO_2 removals between 1990 and 2016 (except for the year 2016, which recorded a decrease: -9.0 per cent), varying from a minimum of +1.9 per cent in 1991 to a maximum of +43.6 per cent in 2014 (Table 6-5). The results of recalculations performed at category level are presented in sub-chapters 6.2-6.8 of the present Report.

Table 6-5: Recalculated net CO_2 emissions/removals within Sector 4 'LULUCF' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	-1 527.5846	-2 589.8802	-1 971.5330	-2 001.0251	-1 900.9711	-1 868.9465	-2 283.1395	-1 873.4640	-1 890.6775	-1 597.3208
BUR3	-1 560.8442	-2 639.3787	-2 053.2024	-2 094.6617	-2 041.3832	-2 015.3244	-2 470.8404	-2 119.5658	-2 150.7175	-1 869.0627
Difference, %	+2.2	+1.9	+4.1	+4.7	+7.4	+7.8	+8.2	+13.1	+13.8	+17.0
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
BUR2	-1 880.6877	-1 516.1798	-1 603.2957	-1 533.2054	-1 702.3382	-1 410.9177	-1 530.7620	-1 727.1616	-1 420.4825	-1 033.2028
BUR3	-2 151.1356	-1 796.6576	-1 883.4274	-1 810.9497	-1 980.5023	-1 682.7486	-1 801.8890	-1 994.4386	-1 682.2257	-1 286.3366
Difference, %	+14.4	+18.5	+17.5	+18.1	+16.3	+19.3	+17.7	+15.5	+18.4	+24.5
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
BUR2	-961.9499	-908.0213	-939.5632	-802.7330	-453.6371	-902.1691	-920.0225			
BUR3	-1 212.2817	-1 148.0863	-1 161.4016	-1 015.6837	-651.4692	-1 094.4097	-837.1816	-886.1457	-725.6453	133.8653
Difference, %	+26.0	+26.4	+23.6	+26.5	+43.6	+21.3	-9.0			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR3 – Third Biennial Update Report of the RM under the UNFCCC.

6.1.7. Assessment of Completeness

The current inventory covers CO_2 emissions/removals from 13 source and sink categories under Sector 4 'LULUCF' (Table 6-6).

Table 6-6: Assessment of completeness under Sector 4 'LULUCF'

IPCC Category	Source Category	CO_2	CH_4	N_2O	NO_x	CO
4A1	Forest Land Remaining Forest Land	X	NE	NE	NE	NE
4A2	Land Converted to Forest Land	X	X	X	X	X
4B1	Cropland Remaining Cropland	X	X	X	X	X
4B2	Land Converted to Cropland	X	NE	X	NE	NE
4C1	Grassland Remaining Grassland	X	NE	NE	NE	NE
4C2	Land Converted to Grasslands	X	NE	NE	NE	NE
4D1	Wetlands Remaining Wetlands	X	NE	NE	NE	NE
4D2	Land Converted to Wetlands	X	NE	NE	NE	NE
4E1	Settlements Remaining Settlements	X	NE	NE	NE	NE
4E2	Land Converted to Settlements	X	NE	X	NE	NE
4F1	Other Land Remaining Other Land	X	NE	NE	NE	NE
4F2	Land Converted to Other Land	X	NE	NE	NE	NE
4G	Harvested Wood Products	X	NE	NE	NE	NE

Abbreviations: X – source and sink categories included in the inventory; NE – Not Estimated.

Non-CO_2 emissions from forest fires and burning of crop residues (CH_4; N_2O) were estimated under subcategories 4A2 'Land Converted to Forest Land' and 4B1 'Cropland Remaining Cropland', these emissions, however, being quite insignificant from a quantitative point of view. At the same time, non-CO_2 emissions were estimated partially (N_2O) for 4B2 'Land Converted to Cropland' and 4E2 'Land Converted to Settlements'.

6.1.8. Definitions regarding land-use, classification systems used and their correspondence to land-use categories, land-use change and forestry

In the context of information presented in Table 6-6, there are also defined the ways to represent land-use within the cadaster evidence system in the estimation process of sectoral emission reduction within Sector 4 'LULUCF'. Data on land areas and use categories are provided by land cadastral reports issued by the Agency of Land Relations and Cadaster, subsequently approved by Government decisions. Additionally, information on forest land is available at 'Moldsilva' Agency, the institution responsible to present sectoral statistical reports to the NBS.

The time series begin with 1970 and include circa 25 national categories of aggregate use within 11 major categories which are highlighted in Table 6-7, including correspondence with IPCC categories. According to the table, there were considered national circumstances, including the national statistical system and land cadastral records in force, regarding land-use categories applied in the RM, as well as their correspondence with the 2006 IPCC Guidelines categories.

Table 6-7: Correspondence of land categories in the National Classification and in the 2006 IPCC Guidelines

IPCC Category	National classification according to land cadaster (aggregated in 11 categories)
(1) Forest Land (4A)	**(1) forests** (land covered with forests, forest land in a regeneration process (parks, grooves, forest stands affected by fires, degraded stands, forest crops planted in the Forest Fund and not achieved the canopy closure stage etc.) and **(2) afforestation**
(2) Cropland (4B)	**3) vineyards**, **(4) orchards** (including fruit orchards, woody vegetation in individual gardens etc.), **(5) other forest vegetation** (including forest protection strips, green areas etc.), **(6) arable land**
(3) Grassland (4C)	**(7) pastures and meadows** (including landslides, land undergoing improvement and fertility restoration)
(4) Wetlands (4D)	**(8) water basins (9) standing waters, flowing waters**
(5) Settlements (4E)	**(10) constructions**, streets, yards, markets, roads
(6) Other Land (4F)	**(11) ravines,** other land categories not included in previous categories

The current inventory covers the entire area of the Republic of Moldova (3,384.63 thousand ha). Data in Table 6-8 confirms that the inventory includes all the land for the period 1990-2019.

Table 6-8: Evolution of land area included into the National Inventory System according to the 2006 IPCC Guidelines Use Categories

IPCC Category	Area, thousand ha						
	1990	1995	2000	2005	2010	2015	2019
I. Forest Land (4A), total	371.40	369.80	372.30	392.82	411.07	414.10	416.64
1.1. Forests	368.57	369.24	371.95	388.45	410.63	413.48	415.86
1.2. Afforested Land (conversions)	2.83	0.56	0.35	4.38	0.44	0.62	0.79
II. Cropland (4B), total	2258.40	2241.80	2212.50	2198.52	2197.76	2203.59	2203.08
2.1. Forest Vegetation	47.00	55.20	50.50	50.47	52.03	51.15	50.90
2.2. Vineyards	218.80	195.90	162.20	157.34	149.58	136.17	130.63
2.3. Orchards	251.80	216.70	172.70	141.68	149.21	152.73	152.86
2.4. Cropland	1740.80	1774.00	1827.10	1849.03	1846.95	1863.53	1868.68
III. Grassland (4C), total	390.70	400.60	412.80	399.14	380.92	373.87	365.88
IV. Wetlands (4D), total	89.40	92.40	96.60	96.08	99.64	96.66	96.41
V. Settlements (4E), total	218.43	234.10	236.10	235.78	233.64	236.48	244.82
VI. Other Land (4F), total	56.30	45.93	54.33	62.28	61.60	59.93	57.80
Total	**3384.63**	**3384.63**	**3384.63**	**3384.63**	**3384.63**	**3384.63**	**3384.63**

Source: Land Cadaster of the Republic of Moldova for the period 1990-2019. Land Use and Land-Use Change Matrix in the RM for the period 1970-2019.

According to current research and pedological records, no organic soils are registered in the Republic of Moldova.

6.1.9. Information on approaches used to represent lands and on land-use databases used for the inventory preparation

In accordance with the provisions of the 2006 IPCC Guidelines, Chapter 3 'Consistent Representation of Lands', Approach 3 is used for Forest Land and Conversions of Forest Land with respect to the cadastral database (the time series starts in 1970). Approach 1 is used for Forest Land Conversion, to the extent that there are no explicit statistics and tracking of land that was converted from Forest Land (thereby resulting in the difference from the net area of the national forest reported at the end of the year and taking into account the conversions to Forest Land). Also, Approach 1 is applied to all other categories of Non-Forest Land (due to a combination of cadastral and non-cadastral data).

The Representation of Lands Approach may be assessed cumulatively: Approach 3 of the IPCC (considering the cadastral basis of land-use representation and information for net area at the end of the year, as well as conversions to Forest Land through artificial plantations) and Approach 1 (considering that conversion from Forest Land to non-Forest Land and among other classifications of land are estimated based on assumptions). Conversion parts are generated based on records prior to 1994 regarding explicit conversion between Non-Forest Land categories. Conversion from Forest Land is derived from the net change in the total forest area and the annual afforestation rate.

The Republic of Moldova has developed the Land-Use Matrix since 1970 based on the annual data reported by the General Land Cadaster. The Land-Use Matrix has 11 entries which are then grouped into the six major IPCC categories (the national classification is highlighted in bold in Table 6-7). The matrix implements the 20-year transition period for conversions for mineral soils in all types of conversions, as well as litter and dead wood for conversions to Forest Land. Also, a one-year transition period is implemented in the matrix for the loss of biomass, litter and dead wood in conversions from a large stock to a low one or to land-uses where C in biomass, litter, or dead wood is missing.

6.1.10. Planned Improvements

Planned improvements at the source and sink category level within the Sector 4 'LULUCF' are described in detail in sub-chapters 6.2-6.8 of the NIR. UNFCCC independent reviews and technical reviews are sources of inspiration on which the inventory can be developed.

6.2. Forest Land (Category 4A)

6.2.1. Source Category Description

Category 4A 'Forest Land' covers estimations of CO_2 emissions/removals from the Republic of Moldova's forests, including above-ground and below-ground biomass (biomass increments in forests, losses from authorized and illegal harvesting etc.), carbon losses (carbon losses/gains due to conversion). The respective estimations were made separately for two categories: 4A1 'Forest Land Remaining Forest Land' and 4A2 'Land Converted to Forest Land'.

According to the national definition, '*forest'* is an element of geographical landscape, a functional unit of the biosphere, composed of the totality of forest vegetation (dominated by trees and shrubbery), live layers, animals and microorganisms which are interdependent in their biological development and affect their habitat. Lands covered with forest vegetation occupying areas over 0.25 ha are regarded as forests. The minimal consistency of trees and shrubbery for the lands with forest vegetation to be considered forests should reach an operational level of 30 per cent. The consistency requirement should apply only to trees and shrubbery with a natural potential to reach a minimum height of 5 meters at maturity, which is in accordance with the definition in the national legislation (Forestry Code, art. 3), and the CDM projects of the Republic of Moldova.

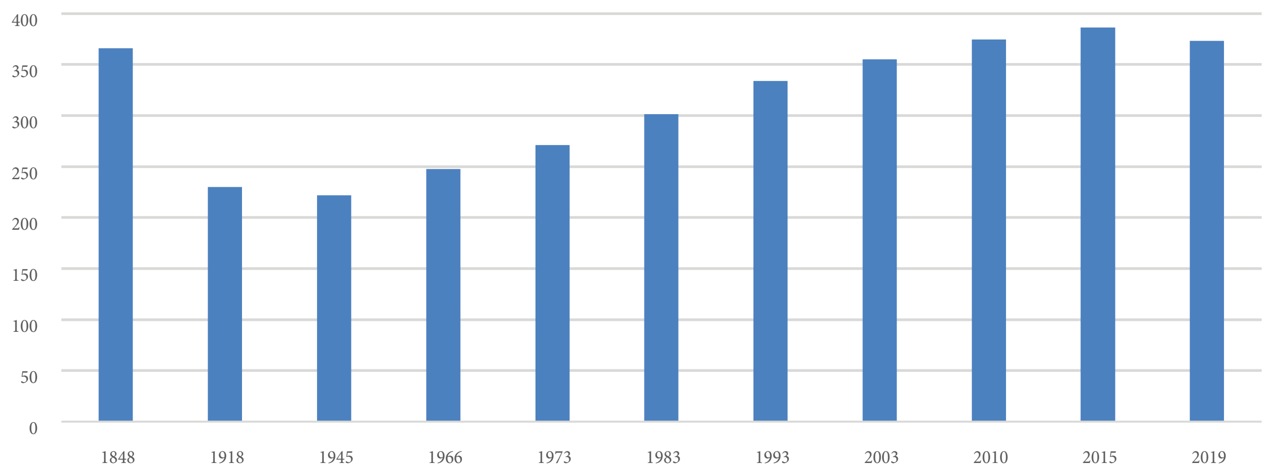

Figure 6-3: Evolution of areas covered with forests in the RM over the period 1848-2019, kha.

In the Republic of Moldova, the areas covered with forests varied considerably over time, from 366.2 thousand ha in 1848 to 222.0 thousand ha in 1945[119], recovering to 373.2 thousand ha in 2019 or circa 11.3 per cent of the country's territory (Figure 6-3).

The total volume of standing wood mass in the forests of the Republic of Moldova is circa 45.4 million m^3, on average 118 m^3 per hectare. The average forest increment is 3.8 m^3/year/ha, and the total average increment is circa 1,418.2 thousand m^3/year. The average production class is 3.9 (Annex 3-4.1). The structure by age in all forest species is misbalanced, particularly in those of low productivity.

6.2.2. Methodological Issues, Emission Factors and Data Sources

Living Biomass

To estimate CO_2 emissions/removals from the sink category 4A1 'Forest Land Remaining Forest Land', current biomass increments in forests values were used (in accordance with production tables and forest planning materials on annual growth of species from the forests of the Republic of Moldova) as well as from losses from authorized and illegal harvesting of wood. This approach allows the implementation of the Tier 1 (Gain-Loss) method and Tier 2 method for all data used. The calculation process took place in two stages using equation 2.9 in Vol. 4, Chapter 2 of the 2006 IPCC Guidelines:

1. Annual changes in carbon stocks due to biomass increment in forest land remaining forest land (in stem, branches, leaves, roots), using the following equation:

$$\Delta C_G = \Sigma\, (A \bullet G_{total} \bullet CF)$$

Where:

ΔC_G – annual increase in biomass carbon stocks due to biomass growth in land remaining forest land, tonnes C/yr;

A – area of forest land remaining forest land, ha;

CF – carbon fraction;

G_{total} – average annual biomass growth above and below-ground (t d.m.[120]/yr/ha), calculated using the following equation:

$$G_{total} = \Sigma\, \{Iv \bullet BCEF_I \bullet (1 + R)\}$$

Where:

Iv – average annual biomass growth, m^3/yr/ha;

R – root-shoot ratio;

$BCEF_I$ – biomass conversion and expansion factor for conversion of net annual increment in volume (including bark) to above-ground biomass growth for specific vegetation type, tonnes above-ground biomass growth (m^3 net annual increment), which can be calculated following the following formula:

$$BCEF_I = BEF_I \bullet D$$

Where:

BEF_I – biomass expansion factor for annual net tree biomass increase;

D – basic wood density, t d.m./m^3 volume for standing wood.

2. Annual decrease in carbon mass through biomass removals (from authorized felling and illegal logging, natural and technogenic disturbances), estimated by the following formula:

$$\Delta C_L = L_{fellings} + L_{fuelwood} + L_{perturbations}$$

Where:

ΔC_L – annual decrease in carbon stocks due to biomass loss (felling and other losses), t C/yr;

$L_{fellings}$ – annual carbon loss due to commercial felling, t C/yr;

$L_{fuelwood}$ – annual carbon loss due to fuelwood removals, t C/yr;

[119] Vdovii, Gh., Galupa, D. et al. (1997), National Report on the State of the Forest Fund of the Republic of Moldova; Galupa D., Talmaci I., Spitoc L. (2006), Forestry Sector of the Republic of Moldova – Issues, Accomplishments, Perspectives; Galupa, D., Platon, I. et al. (2011), Report on the Conditions of the Forest Resources in the Republic of Moldova: 2006-2010. Agency 'Moldsilva'; Ch., 48 p.; Government Decisio No. 357 dated 10.06.2020 on approving the Land Cadastre as of January 1, 2020.

[120] Dry Matter.

$L_{perturbations}$ – annual carbon loss due to loss of biomass affected by disturbances (diseases and pests, natural calamities, mass droughts etc.), t C/yr.

The respective indicators were estimated by the following formula:

$$L_{fellings} = \{H \bullet BCEF_R \bullet (1+R)\} \bullet CF$$

Where:

H – annual wood removals, m^3;

$BCEF_R$ – biomass conversion and expansion factors for extracted round wood conversion (including tree bark), (t of biomass extracted /m^3 extractions), which can be estimated by the following formula:

$$BCEF_R = D \bullet BEF_R$$

Where:

D – basic wood density (t d.m./m^3 volume for standing wood);

BEF_R – biomass expansion factor for extracted round wood.

$$L_{fuelwood} = [\{FG_{trees} \bullet BCEF_R \bullet (1+R)\} + FG_{parts\ of\ trees} \bullet D] \bullet CF$$

Where:

FG_{trees} – annual volume of fuelwood removal of whole trees, m^3;

$FG_{parts\ of\ trees}$ – annual volume of fuelwood removal as parts of trees, m^3 (= 0 to the extent that this method is not used in forestry practice in the Republic of Moldova);

$BCEF_R$ – biomass conversion and expansion factors for extracted fuelwood conversion (including tree bark), (t of biomass extracted/m^3 extractions), which can be estimated by the following formula:

$$BCEF_R = D \bullet BEF_R$$

Where:

D – basic wood density (t d.m/m^3 volume for standing wood);

BEF_R – biomass expansion factor for fuel wood removals.

The volumes from $L_{perturbations}$ were included in $L_{felling}$ and $L_{fuelwood}$, as forests in the Republic of Moldova are intensively managed, being regularly drawn in cleaning cuttings (including selective sanitation treatments), final harvesting (including sanitation cuttings) and various cuttings (including cleaning from fallen trees, etc.).

In principle, for both stages, the methodologies described in the 2006 IPCC Guidelines are applicable under the conditions of the Republic of Moldova for both estimation stages previously described.

At the same time, country-specific emission/removals factors were used, regarding annual biomass increment, carbon fraction etc., as well as sectoral activity data (forest land areas by species/categories of species, afforestation, wood harvesting, etc.). Eleven groups of species were formed for the inventory process so as to reflect all diversity of forest species growing in the forests of the RM (Table 6-9).

Table 6-9: Groups of forest species and their structure in the RM

No.	Groups of species by name		Species included in categories	Abbreviations
	Scientific	Common		
	Quercus spp.	Oak tree	Ilex, durmast, downy oak, red oak	QU
	Carpinus ssp.	Hornbeam	Hornbeam (*Carpinus betulus*)	CA
	Fraxinus spp.	Ash tree	Ash tree	FR
	Acer spp.	Sycamore maple	Field maple, Common maple, Mountain maple, Silver maple	AC
	Ulmus spp.	Elm	Field elm, Elm tree, Turkestan elm, etc.	UL
	Tilia spp.	Linden tree	Foul lime, Silver lime, big leaf linden tree, etc.	TI
	Salix spp.	Willow	Willow, Osier, etc.	SA
	Pinus spp.	Pine	Sylvester pine, Black pine, Spruce fir, Fir tree, etc.	PI
	Populus spp.	Poplar	White poplar, Black poplar, Aspen tree	PO
	Robinia spp.	Acacia	Acacia, Honey locust, Sophora	RB
	Other species	Other species	Apple tree, peer tree, cherry tree, mahaleb cherry tree, appricot tree, Tatar maple tree, silver berry tree, ash-leaved maple, etc.	OS

In order to estimate biomass increments in forests and implicitly, resulting in CO_2 removals, data on the areas of forest land in the Republic of Moldova were used, in the time series from 1990-2019, available into a series of national/sectoral reports on forestry resources (Table 6-10). At the same time, beginning with 2013, information on the distribution of predominant forest species were taken from Forestry Research and Management Institute database.

Table 6-10: Areas of forest land in the RM for the period 1990-2019, kha

Year	Total	Forest Land Areas by Species										
		QU	CA	FR	AC	UL	TI	SA	PI	PO	RB	OS
1990	325.4	140.6	9.4	16.6	2.9	3.1	2.9	1.9	6.9	5.7	124.0	11.4
1991	328.2	141.3	9.4	16.7	2.9	3.1	2.9	2.0	6.9	5.9	125.7	11.4
1992	331.0	142.0	9.4	16.8	3.0	3.1	2.9	2.1	6.9	6.0	127.4	11.4
1993	333.9	142.7	9.5	16.9	3.0	3.1	2.9	2.2	6.9	6.1	129.1	11.5
1994	335.4	143.1	9.9	17.2	3.0	3.1	2.9	2.2	6.9	6.2	130.0	10.9
1995	336.9	143.5	10.2	17.6	3.0	3.1	2.9	2.3	6.9	6.2	130.9	10.4
1996	338.4	143.8	10.6	17.9	3.0	3.1	2.9	2.3	6.9	6.3	131.7	9.8
1997	339.9	144.2	11.0	18.2	3.0	3.1	2.9	2.4	6.9	6.3	132.6	9.3
1998	341.4	144.6	11.3	18.6	3.0	3.1	2.9	2.4	6.9	6.4	133.5	8.7
1999	342.9	145.0	11.7	18.9	3.0	3.1	2.9	2.5	6.9	6.5	134.4	8.1
2000	344.4	145.3	12.1	19.2	3.0	3.1	2.9	2.5	6.9	6.5	135.3	7.6
2001	345.9	145.7	12.4	19.6	3.0	3.1	2.9	2.6	6.9	6.6	136.1	7.0
2002	347.3	146.0	12.8	19.9	3.0	3.1	2.9	2.6	6.9	6.6	137.0	6.4
2003	352.4	148.4	12.6	20.1	3.2	3.2	3.1	2.5	6.9	6.7	137.9	7.8
2004	357.6	151.7	12.4	20.2	3.4	3.4	3.2	2.4	6.9	6.8	138.8	8.4
2005	362.7	153.6	12.1	20.3	3.7	3.8	3.4	2.4	7.0	6.9	139.7	9.8
2006	366.0	153.9	12.1	20.5	4.0	3.8	3.4	2.4	7.0	7.0	141.9	10.0
2007	369.0	154.2	11.8	20.7	4.1	3.9	3.5	2.4	7.0	7.0	144.4	10.0
2008	372.0	154.7	11.9	20.8	4.1	3.9	3.5	2.4	6.9	7.1	146.7	10.0
2009	372.9	155.1	12.1	20.9	4.1	3.9	3.5	2.4	6.9	7.1	146.9	10.0
2010	374.5	155.4	12.1	21.0	4.1	3.9	3.5	2.4	6.9	7.1	148.0	10.1
2011	374.8	155.6	12.1	21.0	4.1	3.9	3.5	2.4	6.9	7.1	148.1	10.1
2012	375.3	155.8	12.1	21.0	4.1	3.9	3.5	2.4	6.9	7.1	148.3	10.1
2013	372.8	154.7	12.0	20.9	4.1	3.9	3.5	2.4	6.8	7.1	147.3	10.1
2014	379.3	167.1	16.4	21.8	5.7	4.1	5.7	3.9	6.3	7.5	125.6	15.1
2015	386.4	170.3	16.7	22.2	5.8	4.2	5.8	4.0	6.4	7.7	128.0	15.4
2016	386.5	170.3	16.7	22.2	5.8	4.2	5.8	4.0	6.4	7.7	128.1	15.4
2017	374.3	164.9	16.1	21.5	5.6	4.1	5.6	3.9	6.2	7.4	124.1	14.9
2018	378.7	166.8	16.3	21.7	5.7	4.1	5.7	3.9	6.3	7.5	125.5	15.1
2019	373.2	164.4	16.1	21.4	5.6	4.1	5.6	3.8	6.2	7.4	123.7	14.9

Source: Galupa, D., Platon, I. et al. (2011), National Report on Forestry Resources of the RM (2011), Land Cadaster for 1990-2019; OSC Report on updating basic indicators for forest and other types of forest vegetation in the RM (2016), Land Cadaster of the RM for 1990-2019; Land Use and Land-Use Change Matrix for 1970-2019.

Forest Land Remaining Forest Land. Final data on species distribution over the period of time under review was obtained by modelling using the primary data set obtained from the Statistical Records and Reports of Agency 'Moldsilva', which featured the following distribution of forest species planted over the reference period: *Robinia species* – accounted for circa 80 per cent, *Juglans spp.* (*Regia and Nigra*) – for 8 per cent, *Quercus species* – for 3 per cent, *Populus* and *Salix species* – for 3 per cent, *other species* – for 6 per cent. The respective species distribution (Table 6-10) was applied for the area included in the sink category 4A1 'Forest Land Remaining Forest Land" according to the Land Use and Land-Use Change Matrix of the RM between 1970 and 2019. As a result, relevant data were gathered for the GHG inventory in category 4A1 'Forest Land Remaining Forest Land' (Table 6-11).

Table 6-11: Forest land areas remaining forest land in the RM for the period 1990-2019, kha

Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Quercus spp.	97.76	99.33	103.72	107.53	110.63	113.35	116.52	118.55	120.54	123.36
Carpinus spp.	6.54	6.61	6.87	7.16	7.63	8.08	8.59	9.01	9.45	9.95
Fraxinus spp.	11.54	11.74	12.27	12.74	13.33	13.88	14.50	14.99	15.48	16.08
Acer spp.	2.02	2.04	2.19	2.26	2.32	2.37	2.43	2.47	2.50	2.55
Ulmus spp.	2.16	2.20	2.26	2.34	2.40	2.45	2.51	2.55	2.58	2.64
Tilia spp.	2.02	2.04	2.12	2.19	2.24	2.29	2.35	2.38	2.42	2.47
Salix spp.	1.32	1.41	1.53	1.66	1.74	1.81	1.89	1.96	2.02	2.10
Pinus spp.	4.80	4.85	5.04	5.20	5.34	5.45	5.59	5.67	5.75	5.87
Populus spp.	3.96	4.15	4.38	4.60	4.76	4.91	5.09	5.21	5.34	5.50
Robinia spp.	86.22	88.37	93.06	97.28	100.51	103.40	106.73	109.03	111.31	114.36
Other Species	7.93	8.01	8.33	8.67	8.43	8.22	7.94	7.65	7.25	6.89
Grooves[1]	31.99	32.11	30.53	29.99	27.64	25.98	25.54	25.87	26.77	24.63
Total	**258.25**	**262.85**	**272.30**	**281.60**	**286.95**	**292.20**	**299.67**	**305.34**	**311.41**	**316.42**

[121] It includes forest lands with consistency below the average index of 0.3, which are part of the forest management (regenerating patches, forest crops up to the state of massif, forest nurseries, different types of forest plantations, etc.).

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Quercus spp.	126.75	128.28	128.06	128.32	130.51	131.76	130.54	131.44	131.78	131.96
Carpinus spp.	10.52	10.94	11.23	10.90	10.67	10.38	10.26	10.06	10.14	10.29
Fraxinus spp.	16.77	17.23	17.45	17.38	17.38	17.41	17.39	17.64	17.72	17.78
Acer spp.	2.62	2.64	2.63	2.77	2.93	3.17	3.39	3.49	3.49	3.49
Ulmus spp.	2.70	2.73	2.72	2.77	2.93	3.26	3.22	3.32	3.32	3.32
Tilia spp.	2.53	2.55	2.54	2.68	2.75	2.92	2.88	2.98	2.98	2.98
Salix spp.	2.19	2.25	2.28	2.16	2.06	2.06	2.04	2.05	2.04	2.04
Pinus spp.	6.02	6.08	6.05	5.97	5.94	6.00	5.94	5.97	5.88	5.87
Populus spp.	5.69	5.79	5.82	5.79	5.85	5.92	5.94	5.97	6.05	6.04
Robinia spp.	117.97	119.87	120.18	119.24	119.39	119.81	120.37	123.09	124.96	124.98
Other Species	6.63	6.16	5.61	6.74	7.23	8.41	8.48	8.52	8.52	8.51
Grooves	24.32	24.48	24.97	27.76	27.79	25.84	28.69	30.43	30.42	34.73
Total	**324.71**	**329.01**	**329.57**	**332.48**	**335.43**	**336.94**	**339.15**	**344.96**	**347.30**	**352.00**
Species	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Quercus spp.	132.60	131.93	127.64	122.80	129.17	128.69	125.80	118.55	117.16	111.24
Carpinus spp.	10.32	10.27	9.93	9.55	12.64	12.59	12.31	11.60	11.46	10.88
Fraxinus spp.	17.92	17.82	17.24	16.59	16.81	16.75	16.37	15.43	15.25	14.48
Acer spp.	3.50	3.48	3.37	3.24	4.42	4.41	4.31	4.06	4.01	3.81
Ulmus spp.	3.33	3.31	3.20	3.09	3.20	3.19	3.12	2.94	2.90	2.76
Tilia spp.	2.99	2.97	2.88	2.76	4.41	4.39	4.29	4.04	4.00	3.79
Salix spp.	2.05	2.04	1.97	1.90	3.02	3.01	2.94	2.77	2.74	2.60
Pinus spp.	5.89	5.85	5.66	5.40	4.88	4.86	4.75	4.48	4.42	4.20
Populus spp.	6.06	6.02	5.83	5.64	5.81	5.79	5.66	5.33	5.27	5.01
Robinia spp.	126.29	125.60	121.51	116.89	97.10	96.73	94.65	89.19	88.15	83.69
Other Species	8.62	8.57	8.29	7.98	11.82	11.65	11.39	10.73	10.61	10.07
Grooves	33.39	30.49	30.27	33.54	26.26	20.94	20.03	29.08	26.44	29.42
Total	**352.95**	**348.34**	**337.79**	**329.39**	**319.53**	**312.99**	**305.62**	**298.19**	**292.40**	**281.95**

Source: Land Cadastre of the RM for 1990-2019; Land Use and Land-Use Change Matrix for 1970-2019.

Harvested Wood Products. The volume of harvested timber includes commercial timber (without bark), as well as the quantity of fuel wood gathered in the RM (round fuel wood, branches and tips, bark, illegally harvested wood). In national statistical reports commercial timber is identified as "working timber". BEF_R (Table 6-15) is applied only to the volume of commercial timber and it only comprises bark.

Data is provided by Agency 'Moldsilva', and the Inspectorate for Environmental Protection on authorized felling and illegal logging in forests and other woody vegetation areas managed by local public authorities, as well as data available in the Statistical Yearbooks of the ATULBD on wood harvests in forests on the left bank of Dniester river (Table 6-12).

Table 6-12: Trends in wood harvests in the RM for the period 1990-2019, thousand m^3

Sort categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Commercial timber	39.42	27.00	27.39	31.50	39.80	68.49	51.69	52.70	38.00	38.79
Fuel wood	184.80	376.50	490.29	489.18	538.70	531.42	450.43	423.85	398.55	368.62
Total	**224.22**	**403.50**	**517.68**	**520.68**	**578.50**	**599.91**	**502.12**	**476.55**	**436.55**	**407.41**
Sort categories	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Commercial timber	39.68	37.28	50.41	46.99	43.47	39.01	46.51	44.44	42.79	37.34
Fuel wood	393.34	432.47	381.98	420.20	415.37	394.79	430.10	390.92	401.84	396.82
Total	**433.02**	**469.75**	**432.39**	**467.19**	**458.84**	**433.80**	**476.61**	**435.36**	**444.63**	**434.16**
Sort categories	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Commercial timber	40.63	33.91	31.69	29.92	25.60	28.00	50.16	46.20	47.30	44.40
Fuel wood	429.89	485.45	541.47	587.20	624.33	607.32	567.42	589.71	596.71	561.29
Total	**470.52**	**519.36**	**573.16**	**617.12**	**649.93**	**635.32**	**617.57**	**635.91**	**644.01**	**605.69**

Source: Statistical Records, Reports of Agency 'Moldsilva', the Inspectorate for Environmental Protection and the Environment Agency for the period 1990-2019; Study for the Republic of Moldova 'Ensuring Sustainability of Forests and Livelihoods through Improving Governance and Control of Illegal Logging'. Chisinau, Editorial Centre of UASM, 2005, 116 pages; Statistical Yearbooks of the ATULBD (2000-2020); Galupa Dumitru, Ciobanu Anatol, Scobioala Marian et al. (2011), Illegal Logging of Forest Vegetation in the Republic of Moldova. Analytical Study, Chisinau, Agency 'Moldsilva', 38 pages.

Agency 'Moldsilva' keeps records of harvested wood by species (except for some species suitable for industrial processing), such as: (1) hardwood – oak, durmast oak, hornbeam, ash tree, sycamore maple, elm, acacia, honey locust, etc.; (2) softwood - poplar, willow, linden tree, etc. The ratio of the estimated volume by species to total volume harvested per year provided data of acceptable quality (the difference between the estimated volume and harvested volume is on average 5-10 per cent).

Distribution by species of wood suitable for industrial processing and fuel wood is presented in Tables 6-13 and 6-14 and refers to the period 1990-2019.

Table 6-13: Trends in commercial timber harvest in the RM for the period 1990-2019, thousand m^3

Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Quercus spp.	7.16	4.32	4.09	4.41	6.88	9.59	10.05	10.26	7.40	7.51
Carpinus spp.	1.05	0.71	0.72	0.83	1.04	1.79	1.35	1.39	1.00	0.99
Fraxinus spp.	3.65	2.99	3.24	3.94	4.03	8.56	4.47	4.47	3.23	3.49
Acer spp.	0.31	0.23	0.23	0.27	0.34	0.58	0.45	0.44	0.32	0.37
Ulmus spp.	0.17	0.1	0.1	0.12	0.15	0.26	0.19	0.21	0.15	0.13
Tilia spp.	3.78	2.48	2.52	2.9	3.66	6.31	4.70	4.91	3.54	3.34
Salix spp.	0.26	0.19	0.19	0.22	0.28	0.48	0.37	0.36	0.26	0.30
Pinus spp.	0.28	0.17	0.18	0.2	0.26	0.44	0.32	0.35	0.25	0.22
Populus spp.	4.87	3.2	3.26	3.74	4.73	8.14	6.07	6.33	4.56	4.32
Robinia spp.	16.74	12.02	12.26	14.18	17.54	30.83	22.66	22.70	16.37	17.67
Other species	1.15	0.59	0.6	0.69	0.89	1.51	1.06	1.28	0.92	0.45
Total	**39.42**	**27.00**	**27.39**	**31.50**	**39.80**	**68.49**	**51.69**	**52.70**	**38.00**	**38.79**
Species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Quercus spp.	7.77	5.18	10.12	10.31	9.34	7.63	9.26	7.49	7.17	5.84
Carpinus spp.	1.07	1.09	1.85	1.00	0.92	1.05	1.28	0.92	1.13	0.77
Fraxinus spp.	3.17	2.96	4.45	3.41	3.03	3.12	5.57	5.94	6.02	5.70
Acer spp.	0.28	0.30	0.42	0.26	0.19	0.28	0.28	0.28	0.25	0.15
Ulmus spp.	0.18	0.19	0.24	0.22	0.22	0.18	0.27	0.31	0.20	0.17
Tilia spp.	3.97	4.86	4.82	4.22	4.47	3.90	4.06	3.45	3.84	3.24
Salix spp.	0.24	0.32	0.29	0.20	0.21	0.24	0.31	0.42	0.38	0.38
Pinus spp.	0.30	0.33	0.00	0.00	1.10	0.30	0.79	1.60	0.60	0.89
Populus spp.	5.11	2.89	5.82	8.28	6.62	5.02	7.81	6.44	6.09	4.87
Robinia spp.	16.13	18.19	19.94	16.43	15.93	15.85	15.68	16.58	16.01	14.34
Other species	1.46	0.97	2.46	2.66	1.44	1.44	1.22	1.01	1.10	0.98
Total	**39.68**	**37.28**	**50.41**	**46.99**	**43.47**	**39.01**	**46.51**	**44.44**	**42.79**	**37.34**
Species	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Quercus spp.	7.16	5.68	4.77	6.28	6.05	6.62	12.15	8.56	8.76	8.22
Carpinus spp.	0.87	0.74	0.49	0.52	0.33	0.36	0.40	1.10	1.12	1.05
Fraxinus spp.	5.83	4.03	4.52	4.76	4.26	4.66	7.49	5.16	5.29	4.96
Acer spp.	0.20	0.14	0.11	0.15	0.06	0.06	0.14	0.30	0.31	0.29
Ulmus spp.	0.19	0.24	0.12	0.17	0.06	0.06	0.07	0.20	0.20	0.19
Tilia spp.	3.42	3.17	2.67	2.21	2.00	2.19	5.46	4.27	4.37	4.10
Salix spp.	0.14	0.19	0.24	0.25	0.07	0.08	0.37	0.31	0.32	0.30
Pinus spp.	1.19	1.95	1.35	0.73	0.62	0.68	0.49	0.67	0.68	0.64
Populus spp.	6.32	5.61	5.26	5.06	4.69	5.13	9.52	6.39	6.54	6.14
Robinia spp.	14.41	11.47	11.69	9.43	7.09	7.76	13.50	18.07	18.50	17.37
Other species	0.89	0.69	0.47	0.36	0.37	0.40	0.56	1.18	1.21	1.13
Total	**40.63**	**33.91**	**31.69**	**29.92**	**25.60**	**28.00**	**50.16**	**46.20**	**47.30**	**44.40**

Source: Statistical Records, Reports of Agency 'Moldsilva', the Inspectorate for Environmental Protection and the Environment Agency for the period 1990-2019.

Data on the volume of fuel wood gathered also include the volume of twigs, boughs, branches, etc., which are used as fuel as well. Considering that most illegal loggings occur in forests managed by local public authorities, situated near settlements and composed preponderantly of acacia, the respective volumes were attributed to *Robinia* group of species.

Table 6-14: Trends in fuel wood harvest (by group of species) in the RM for the period 1990-2019, thousand m^3

Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Quercus spp.	30.10	50.35	49.29	51.15	39.07	63.60	58.99	49.12	64.60	55.32
Carpinus spp.	12.50	17.96	13.24	13.15	10.05	11.30	15.45	20.41	26.84	24.10
Fraxinus spp.	15.80	38.99	56.52	73.07	55.81	71.97	73.74	25.80	33.93	30.09
Acer spp.	8.70	11.39	6.65	6.19	4.73	5.30	5.00	14.12	18.57	16.64
Ulmus spp.	3.50	6.19	6.54	10.23	7.81	8.76	2.26	5.72	7.52	6.38
Tilia spp.	10.60	18.97	20.40	29.23	22.32	20.10	19.50	17.29	22.73	19.59
Salix spp.	3.40	6.68	7.95	12.42	9.49	10.64	4.14	5.57	7.33	6.32
Pinus spp.	0.40	2.10	4.09	6.58	5.02	5.63	3.80	0.70	0.92	0.74
Populus spp.	11.80	34.34	55.04	73.07	55.81	74.35	70.09	19.21	25.26	20.32
Robinia spp.	76.80	172.62	256.75	198.01	316.31	246.00	184.48	247.59	166.76	168.74
Other species	11.20	16.91	13.82	16.08	12.28	13.77	12.98	18.32	24.09	20.38
Total	**184.80**	**376.50**	**490.29**	**489.18**	**538.70**	**531.42**	**450.43**	**423.85**	**398.55**	**368.62**
Species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Quercus spp.	53.71	48.34	56.93	65.45	64.16	56.64	71.56	57.00	59.84	59.35
Carpinus spp.	23.40	22.46	23.41	23.07	25.30	24.68	27.49	23.70	27.73	26.27
Fraxinus spp.	29.22	28.35	28.91	32.38	30.63	30.81	48.42	47.74	49.05	52.75
Acer spp.	16.16	14.17	17.49	16.50	17.13	17.04	23.05	21.44	23.48	23.33
Ulmus spp.	6.19	5.78	6.36	8.32	7.07	6.53	10.45	10.47	8.55	9.90
Tilia spp.	19.02	18.93	18.35	21.63	23.40	20.06	27.66	24.71	25.19	22.43
Salix spp.	6.13	5.48	6.55	6.28	8.22	6.47	9.95	8.43	7.85	4.75
Pinus spp.	0.72	1.41	0.00	0.00	2.09	0.76	3.06	2.80	2.74	3.91
Populus spp.	19.73	17.37	21.29	28.96	28.19	20.80	27.11	23.26	25.04	23.82
Robinia spp.	199.28	252.20	181.90	190.09	187.09	190.14	164.27	155.19	153.64	148.00
Other species	19.78	17.98	20.79	27.52	22.09	20.86	17.08	16.17	18.74	22.32
Total	**393.34**	**432.47**	**381.98**	**420.20**	**415.37**	**394.79**	**430.10**	**390.92**	**401.84**	**396.83**

Species	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Quercus spp.	65.69	79.64	83.02	98.39	106.84	100.82	103.58	84.55	85.56	80.48
Carpinus spp.	30.17	34.86	40.26	43.26	45.93	44.15	44.61	33.76	34.16	32.13
Fraxinus spp.	62.33	51.55	63.35	71.66	76.71	74.44	73.67	64.42	65.19	61.32
Acer spp.	23.79	22.06	12.98	21.90	17.27	31.63	30.81	21.72	21.97	20.67
Ulmus spp.	12.74	20.56	21.48	20.25	19.15	15.12	17.29	13.15	13.31	12.52
Tilia spp.	22.98	22.18	28.72	29.86	30.30	31.28	38.27	30.36	30.72	28.90
Salix spp.	5.42	7.79	9.24	10.71	10.90	12.82	11.92	10.33	10.45	9.83
Pinus spp.	4.78	10.27	8.92	10.87	17.02	5.59	4.91	5.33	5.39	5.07
Populus spp.	26.00	30.91	33.72	39.37	42.69	40.88	41.78	45.14	45.67	42.96
Robinia spp.	156.80	182.12	200.93	208.77	208.91	222.77	164.35	252.34	255.34	240.18
Other species	19.20	23.51	38.85	32.16	48.61	27.82	36.23	28.61	28.95	27.23
Total	**429.89**	**485.45**	**541.47**	**587.20**	**624.33**	**607.32**	**567.42**	**589.71**	**596.71**	**561.29**

Source: Statistical Records, Reports of Agency 'Moldsilva', the Inspectorate for Environmental Protection and the Environment Agency for the period 1990-2019; Arcadie Capcelea, Aurel Lozan, Ion Lupu et al. (2011), Analytical Study on Wood Mass Consumption in the RM. Agency 'Moldsilva', Chisinau, 48 pages; Statistical Yearbooks of the ATULBD for 2000-2020.

In order to estimate annual biomass increments and losses, country-specific emission factors were calculated/developed (Tables 6-15 and 6-16). To estimate/develop these, production tables were used, as well as data on actual productivity of stands, according to the forest planning records. BEF_1 is generated from country-specific data (Table 6-15) to keep into account the increase in above-ground biomass. BEF_R (Table 6-15) is generated from country-specific data for commercial timber, as it only reflects the contribution of bark, whereas fuel wood already includes bark in the amount of firewood recorded in national statistics. Thus, BEF does not include the entire amount of biomass lost when harvesting both commercial wood and fuel wood (for instance, small branches) that are left in the forest and represent an additional 5 per cent (Agency 'Moldsilva', 1990-2019).

Table 6-15: Coefficients used to estimate CO_2 emissions/removals from sink category 4A1 'Forest Land Remaining Forest Land'

Species	Average annual net increments, m³/ha/year	Basic wood density, t.d.m./m³ fresh volume	Biomass expansion factor for current increments, BEF_1	Biomass expansion factor for Commercial Felling Harvest, BEF_R
Quercus spp.	3.9	0.835	1.20	1.20
Carpinus spp.	5.0	0.85	1.20	1.10
Fraxinus spp.	4.4	0.72	1.20	1.20
Acer spp.	2.3	0.75	1.20	1.15
Ulmus spp.	2.9	0.70	1.20	1.15
Tilia spp.	6.4	0.55	1.20	1.15
Salix spp.	6.5	0.38	1.20	1.20
Pinus spp.	4.7	0.535	1.15	1.10
Populus spp.	5.2	0.51	1.20	1.20
Robinia spp.	3.2	0.78	1.20	1.20
Other species	3.0	0.70	1.20	1.15

Source: Ukrainian Forest Management Service: Forestry Resources of the Moldavian Soviet Socialist Republic, as of 1.01.1988, Irpeni, 1988 (in Russian); Vdovii, Gh., Galupa, D. et al., National Report on Forestry Resources of the Republic of Moldova, 1997; **Osadcev** V.G., Ivankov P.T., Sergovskii P.S. et al., Guidebook on Woodworking (for forest farms consumer goods manufacturing workshops). Moscow, 1955 (in Russian);Wood Samples Trial Report, Furniture and Wooden Goods Trial and Certification Centre, 2003 (in Russian); Trial Report of Wood Samples; Giurgiu V., Decei I., Armasescu S. Biometry of Trees and Stands in Romania, 1972; Shvidenko A.Z., Savich J.N., Reference Materials for Evaluation of forests in Ukraine and Moldova. Kiev, Urozhai, 1987 (in Russian); Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D. Talmaci I. et al., The Baseline Study for the Soil Conservation Project in Moldova, 2003; Talmaci I., Prosii E., Varzari A., Mardari A., Galupa A., Report on updating basic indicators for forest and other types of forest vegetation in the Republic of Moldova, 2016.

Table 6-16: Coefficients used to estimate CO_2 removals from sink category 4A1 'Forest Land Remaining Forest Land'

Species	Root-shoot ratio appropriate to increments	Carbon fraction of dry matter	Fraction of biomass left to decay in forest,%
Quercus spp.	0.40	0.50	0.05
Carpinus ssp.	0.35	0.50	0.05
Fraxinus spp.	0.28	0.49	0.05
Acer spp.	0.28	0.49	0.05
Ulmus spp.	0.28	0.49	0.05
Tilia spp.	0.21	0.50	0.05
Salix spp.	0.21	0.49	0.05
Pinus spp.	0.46	0.51	0.05
Populus spp.	0.21	0.50	0.05
Robinia spp.	0.28	0.49	0.05
Other species	0.28	0.50	0.05

Source: Osadcev.G., Ivankov P.T., Sergovskii P.S. et al., Guidebook on Woodworking (for Forest Farms Consumer Goods Manufacturing Workshops). Moscow, 1955 (in Russian); Giurgiu V., Decei I., Armasescu S. Biometry of Trees and Stands in Romania, 1972; Shvidenko A.Z., Savich J.N. (1987), Reference Materials for Evaluation of Forests in Ukraine and Moldova. Kiev, Urozhai, 1987 (in Russian); Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D., Talmaci I. et al.: The Baseline Study for the Soil Conservation Project in Moldova, 2003; Vanin S. I., Wood Science, Moscow, 1949 (in Russian).

Carbon stock change in mineral soils, litter and dead wood

Since there have been no significant changes in forests at national level, reporting changes in soil carbon stocks is neutral. In similar circumstances, litter and dead wood pools are also considered neutral.

4A2 'Land Converted to Forest Land'

In order to estimate CO_2 removals from category 4A2 'Land Converted to Forest Land', the same principles were applied as for category 4A1 'Forest Land Remaining Forest Land' – establishing current biomass increments (according to the results from the international monitoring and certification of MSCP and MCFDP). Calculations were made following Equation 2.15 in the 2006 IPCC Guidelines (Volume 4, Chapter 2, P. 2.20):

$$\Delta C_B = \Delta C_G + \Delta C_{Conversion} - \Delta C_L$$

Where:

ΔC_B – annual change in carbon stocks in biomass on land converted to forest land, t C/yr;

ΔC_G – annual increase in carbon stocks in biomass due to growth on land converted to forest land, t C/yr;

$\Delta C_{Conversion}$ – initial change in carbon stocks in biomass resulting from the land-use conversion, t C/yr;

ΔC_L – annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to forest land, t C/yr.

Initial changes in carbon stocks in biomass on land converted to forest land ($\Delta C_{Conversion}$) were estimated using Equation 2.16 from the 2006 IPCC Guidelines (Volume 4, Chapter 2, Page 2.20):

$$\Delta C_{Conversion} = \Sigma\{(B_{After} - B_{Before}) \bullet \Delta A_{TO\ OTHERS}\} \bullet CF$$

Where:

B_{After} – biomass stocks on land immediately after the conversion, t d.m./ha;

B_{Before} – biomass stocks on land before the conversion, t d.m./ha;

$\Delta A_{TO\ OTHERS}$ – area of land-use converted to forest land in a certain year, ha/yr;

CF – carbon fraction of dry matter.

At the same time, the estimation process considered increases in dead biomass (litter) and in soil organic carbon since afforestation is primarily done on degraded land with low fertility, forest vegetation contributing substantially to carbon gain.

AD for category 4A2 'Land Converted to Forest Land' were taken from the Land Use Matrix for the period 1970-2019 (Table 6-17). The definition of 'afforestation' used in CDM projects in accordance with 'conversion to forest land'.

Table 6-17: Annual successful afforestation included in forest land in cadastral records for the period 1970-2019, ha

Land Converted to Forest Land	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Arable lands	0.0	296.8	307.8	335.3	288.0	399.9	417.2	433.1	464.3	543.2	633.9	244.3	227.2
Orchards, Vineyards	0.0	155.5	161.3	175.7	150.9	209.6	218.6	227.0	243.3	284.6	332.2	128.0	119.1
Grassland	0.0	3428.8	3555.9	3874.3	3327.9	4620.6	4820.8	5004.4	5364.2	6276.1	7324.6	2822.2	2625.1
Other land	0.0	719.0	7675.0	4915.0	4833.0	1870.0	2243.0	0.0	0.0	0.0	0.0	1106.0	0.0
Total	**0.0**	**4600.1**	**11699.9**	**9300.4**	**8599.9**	**7100.0**	**7699.7**	**5664.5**	**6071.7**	**7104.0**	**8290.7**	**4300.5**	**2971.3**
Land Converted to Forest Land	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Arable lands	222.4	225.4	227.7	168.4	197.7	298.9	280.0	216.1	80.8	87.5	43.0	49.5	42.5
Orchards, Vineyards	116.5	118.1	119.3	88.3	103.6	156.6	146.7	113.2	42.4	45.9	22.5	25.9	22.3
Grassland	2569.7	2604.7	2630.3	1945.8	2284.1	3453.4	3234.8	2496.4	933.9	1011.3	496.3	572.1	491.0
Other land	0.0	0.0	0.0	0.0	3229.6	291.0	1038.5	1174.0	1443.0	0.0	338.5	0.0	0.0
Total	**2909.0**	**2948.0**	**2977.0**	**2202.0**	**5815.0**	**4199.9**	**4700.0**	**3999.7**	**2500.1**	**1145.0**	**900.3**	**647.5**	**555.8**
Land Converted to Forest Land	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Arable lands	24.9	29.6	33.1	30.3	27.1	23.5	344.3	347.4	336.8	334.7	352.4	355.7	372.3
Orchards, Vineyards	13.0	15.5	17.3	15.9	14.2	12.3	180.4	182.0	176.5	175.4	184.7	186.4	195.1
Grassland	287.6	341.5	382.3	349.8	312.7	271.9	3978.5	4013.9	3891.4	3866.6	4071.4	4110.1	4302.0
Other land	1.2	1113.0	1667.9	0.0	146.0	1067.2	0.0	4193.4	996.0	0.8	2383.6	223.0	0.0
Total	**326.7**	**1499.5**	**2100.6**	**396.0**	**500.0**	**1375.0**	**4503.3**	**8736.7**	**5400.6**	**4377.4**	**6992.1**	**4875.2**	**4869.0**

Land Converted to Forest Land	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Arable lands	221.7	33.3	23.4	19.4	19.6	22.0	47.2	121.0	48.8	51.0	60.1	NA	NA
Orchards, Vineyards	116.2	17.5	12.3	10.1	10.3	11.5	24.7	63.4	25.6	26.7	31.5	NA	NA
Grassland	2561.9	384.8	270.3	223.7	226.3	253.7	544.9	1397.5	563.7	588.8	694.4	NA	NA
Other land	3076.3	0.0	1886.4	8916.1	2573.0	4833.0	1894.1	2417.4	405.0	1050.0	3283.0	NA	NA
Total	**5976.1**	**436.0**	**2191.4**	**9169.3**	**2829.2**	**5120.2**	**2510.9**	**3999.3**	**1043.1**	**1716.5**	**4069.0**	**NA**	**NA**

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use Matrix for the period 1970-2019.

CDM projects implemented in the Republic of Moldova

The conversion to forest land during the reference period included afforestation under the Moldova Soil Conservation Project (MSCP) and Moldova Community Forestry Development Project (MCFDP). Both projects are implemented under the CDM of the Kyoto Protocol, and have completed all national and international validation and registration procedures. The total afforested area within MSCP and MCFDP constitutes circa 28.8 thousand ha (Table 6-18).

Table 6-18: Annual afforestation under CDM Projects in the RM for the period 2002-2015, ha

Afforested Area	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
MSC Project	4894.7	4736.6	4219.6	4029.6	891.2	71.9	475.8	152.8	211.3	276.7	98.8	116.5	45.7	68.8	20289.9
MCFD Project	0.0	0.0	0.0	0.0	2009.6	2959.3	2190.4	1224.4	10.0	12.0	8.0	52.6	2.5	0.0	8468.8
Total	**4894.7**	**4736.6**	**4219.6**	**4029.6**	**2900.8**	**3031.2**	**2666.2**	**1377.2**	**221.3**	**288.7**	**106.8**	**169.1**	**48.2**	**68.8**	**28758.7**

Source: Agency 'Moldsilva' (2009), MSCP for MCFDP, available at: https://cdm.unfccc.int/Projects/DB/SGS-UKL1216031019.22/view. Agency 'Moldsilva' (2012), MSCP for MCFDP, available at: https://cdm.unfccc.int/Projects/DB/TUEV-SUED1352989843.61. Agency 'Moldsilva' (2004-2016), Annual Reports to the World Bank for the period 2004-2016 regarding emissions reductions within MSCP and MCFDP. Agency 'Moldsilva' (2012-2013 and 2017-2018) Monitoring Reports for the MSCP and MCFDP, available at: https://cdm.unfccc.int/Projects/DB/SGS-UKL1216031019.22/view and https://cdm.unfccc.int/Projects/DB/TUEV-SUED1352989843.61.

In addition to harvested wood products, the net CO_2 emissions reduction into the atmosphere will account for circa 4.8 million tonnes (MSCP – 3.6 million tonnes; MCFDP – 1.2 million tonnes). The main participants in the implementation process of these projects are Agency 'Moldsilva', the World Bank, the Forestry Research and Management Institute, territorial forestry entities, public authorities that have allocated land for afforestation (over 500). In order to establish annual biomass gains/losses in forest land, national EFs were estimated/developed based on the respective projects outputs (MSCP and MCFDP) (Table 6-19).

Table 6-19: Indicators used to estimate CO_2 emissions/removals from 4A2 'Land Converted to Forest Land' category

Indicators	Units	Value
Annual average carbon gains in biomass (trees and shrubs)	Mg C/ha/yr	1.74
Annual average carbon gains in dead biomass (litter)	Mg C/ha/yr	0.41
Annual average carbon gains in dead biomass (dead wood)	Mg C/ha/yr	0.00
Annual average organic carbon gains in mineral soils	Mg C/ha/yr	0.32
Conversion period	years	20

Source: PDD for MSCP and MCFDP; Agency 'Moldsilva' Monitoring Reports for MSCP and MCFDP (2012; 2013; 2017; 2018).

Non-CO_2 Emissions on Forest Land

According to national statistics, there are no records of wildfires and controlled burning of biomass in forests remaining forests, thereby no non-CO_2 emissions are estimated for category 4A1.

The methodology used to estimate non-CO_2 emissions from category 4A2 'Land Converted to Forest Land' is a Tier 1 method (2006 IPCC Guidelines). Calculations were made according to the equation 2.27 2006 IPCC Guidelines (Volume 4, Chapter 2, Page 2.42):

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

Where:

- L_{fire} – amount of GHG emissions (including non-CO_2) from fires, t/yr;
- A – area burnt annually, ha/yr;
- M_B – mass of fuel available for combustion, t/ha;
- C_f – combustion factor, the default value used is 0.45 (2006 IPCC Guidelines, Volume 4, Chapter 2, Table 2.6, Page 2.48);

$M_B \bullet C_f$ – the amount of fuel actually burnt, its value, according to MSCP and MCFDP estimates is 32,632.6 kg d.m./ha;

G_{ef} – default emission factor, kg/t d.m. burnt (Tab. 6-20).

Table 6-20: EFs for different forest types, kg GHG / t d.m

	CO	CH_4	N_2O	NO_x
Temperate Forests	107	4.7	0.26	3.0

Source: 2006 IPCC Guidelines, Volume 4, Chapter 2, Table 2.5, page 2.47.

Most fires are located in young forests or stands, particularly in the vicinity of croplands. Activity data on forest land affected by fires is available in the Statistical Yearbooks of the RM and those of the ATULBD (Table 6-21).

Table 6-21: Forest Land areas affected by fires in the RM for the period 1990-2019, ha

Categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Right bank of Dniester river	120.10	20.10	22.00	1.50	33.50	1.40	0.00	0.00	9.70	0.00
Left bank of Dniester river	IE	IE	IE	IE	IE	0.53	11.20	3.40	24.00	25.20
Total in the RM	**120.10**	**20.10**	**22.00**	**1.50**	**33.50**	**1.93**	**11.20**	**3.40**	**33.70**	**25.20**
Categories	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Right bank of Dniester river	0.00	41.60	12.50	10.50	42.00	5.50	32.60	683.30	31.00	126.00
Left bank of Dniester river	0.90	15.40	18.10	23.00	46.00	2.90	58.20	108.00	24.00	8.20
Total in the RM	**0.90**	**57.00**	**30.60**	**33.50**	**88.00**	**8.40**	**90.80**	**791.30**	**55.00**	**134.20**
Categories	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Right bank of Dniester river	20.00	25.90	636.60	460.00	9.50	338.20	119.00	173.00	79.00	169.68
Left bank of Dniester river	26.90	36.90	35.80	7.10	28.90	18.00	59.8	73.80	5.90	34.40
Total in the RM	**46.90**	**62.80**	**672.40**	**467.10**	**38.40**	**356.20**	**178.8**	**246.80**	**84.90**	**204.08**

Source: Statistical Yearbooks of the RM for 1994 (page 38), 1999 (page 20), 2007 (page 22), 2011 (page 22), 2014 (page 22), 2015 (page 22); National Bureau of Statistics, Statistics for Geography and Environment (Forest Fires, as of November 1 (2010-2019); Statistical Yearbooks of the ATULBD for 2000 (page 88), 2002 (page 91), 2007 (page 81), 2009 (page 80), 2011 (page 82), 2014 (page 78), 2015 (page 88), 2016 (page 88), 2017 (page 91), 2020 (page 92).

6.2.3. Uncertainties Assessment and Time-Series Consistency

4A1 'Forest Land Remaining Forest Land'

Uncertainties associated with the process of estimating CO_2 removals from sink category 4A1 'Forest Land Remaining Forest Land' at the beginning of the reference period (1990), were rather low, circa ±5 per cent. Since 1991, due to social-political developments, the level of uncertainties increased significantly. For 2019, the level of precision of activity data related to the production processes reached circa ±15 per cent. Uncertainties related to removal factors in both cases are circa ±5 per cent. Combined uncertainties within 4A1 constitute circa ±15.81 per cent. Uncertainties introduced in the trend in total GHG emissions from source category 4A1 in Sector 4 'LULUCF' account for circa ±13.46 per cent.

The above-mentioned situation is influenced by several factors because part of the data needed to estimate GHG removals by forests in the Republic of Moldova require updating. Uncertainties by sections are also determined by the volumes of wood mass actually harvested by local public authorities and other forests owners. There is no accurate statistics on the amount of wood mass harvested during authorized felling or illegal logging. General information in this field is available to the Inspectorate for Environmental Protection only, as an institution exercising state control in the field of environment (Article 22 of the Forestry Code on state control and state control data), and the Environment Agency which authorizes (based on Article 40 of the Law on Environment Protection) felling of any type of forest vegetation. According to some estimative studies, the annual volume of wood mass from unidentified sources is circa 400-800 thousand m^3.[122] At the same time, the amount of illegal logging recorded annually is only circa 3-4 thousand m^3. The current system of monitoring and control of production processes in the forestry sector is applied only for forests managed by the Agency 'Moldsilva'. The forestry resources managed by local public authorities are practically beyond these activities. A considerable part of illicit logging is not even reported.

4A2 'Land Converted to Forest Land'

[122] Galupa, D., Ciobanu, A., Scobioala, M. et al. Illegal logging of forest vegetation in the Republic of Moldova. Analytical study. 2011. Chisinau, Agency 'Moldsilva' Agency, 38 pages.

Uncertainties associated with the process of estimating the CO_2 removals/emissions from category 4A2 'Land Converted to Forest Land' represent circa ±15 per cent, whereas uncertainties associated with removal/emission factors – circa ±5 per cent. Combined uncertainties for this source category reach circa ±15.81 per cent. Uncertainties introduced in the trend in total direct GHG emissions from category 4A2 within Sector 4 'LULUCF' account for circa ±4.14 per cent.

Uncertainties related to estimation of non-CO_2 emissions from forest land affected by fires result from uncertainties related to the mass of fuel available for combustion, as well as those related to emission factors.

Uncertainties related to annual activity data on forest land affected by fires are considered to be relatively low, up to circa ±10 per cent. Uncertainties related to default emission factors for different types of burnings (dry matter burnt), are moderate for CH_4 (circa ±30 per cent) and N_2O (circa ±30 per cent). Combined uncertainties related to non-CO_2 emissions (CH_4 and N_2O) from the respective sink category are considered relatively high and constitute circa ±31.62 per cent for both CH_4 and N_2O (Annex 5-3.4).

6.2.4. Quality Assurance and Quality Control

The quality of estimations for both subcategories 4A1 'Forest Land Remaining Forest Land' and 4A2 'Land Converted to Forest Land' was assured by the fact that most of the AD used were taken from official records. Thus, total forest area, as well as areas converted to forest land were taken from the General Land Cadaster by years, annual forest lands balance drafted annually by the state forest authorities, periodical records (once in 5 years) of forests, forest planning materials, etc. At the same time, data quality is ensured through the creation, for the entire Sector 4 'LULUCF', of a Land Use and Land-Use Change Matrix for the period 1970-2019.

Annual biomass increments were taken from production tables, periodical state records (once in 5 years) of forests, forest planning materials, by-laws and technical regulations in forestry, as well as from the international monitoring and certification procedures for Moldova Soil Conservation Project (MSCP) and Moldova Community Forestry Development Project (MCFDP).

Data on the volume of wood mass was obtained from the following sectoral statistical reports: Statistical Report 3 g.s. "Statistic Report on volumes of standing wood withdrawn from forest"; Statistical Report 5 g.s. "Statistic Report on volumes of illegal logging" and Statistical Report 2 g.s. "Statistical Report on attaining production indicators in forestry" (Section "Wood mass movement"). At the same time data on illicit logging were provided by the study *"Illegal logging of forest vegetation in the Republic of Moldova"*[123], annual reports by Agency 'Moldsilva', and the Inspectorate for Environment Protection. Standard verification and quality control forms and checklists were filled in for category 4A 'Forest Land', following a Tier 1 approach. Verification was focused on various aspects such as: ensuring correct use of estimation methodologies following the 2006 IPCC Guidelines, correct use of national coefficients, their accuracy, as well as comparing them to the values used by other countries in the region.

6.2.5. Recalculations

For the period 1990-2016, no recalculations were made for subcategories 4A1 'Forest Land Remaining Forest Land' and 4A2 'Land Converted to Forest Land' as well as for non-CO_2 emissions from 4A2 'Land Converted to Forest Land'. For 2016, for subcategories 4A1 and 4A2, an error was found in the formula for calculating the areas subject to conversion in the Land Use Matrix. This has generated a cumulative decrease in values of 0.1 per cent or -2.2154 t CO_2, for category 4A 'Forest Land'.

Between 1990 and 2019, CO_2 removals from category 4A 'Forest Land' had fallen continuously (Figure 6-4). Thus, compared to the base year (1990), in 2019, a decrease by 23.9 per cent was recorded or a difference by 613 thousand tonnes (Table 6-22). This also is due to the increase in the amount of wood officially harvested from forests.

[123] Dumitru Galupa, Anatol Ciobanu, Marian Scobioala et al. (2011), Illegal logging of forest vegetation in the Republic of Moldova. Analytical study, Chisinau, Agency 'Moldsilva', 38 pages

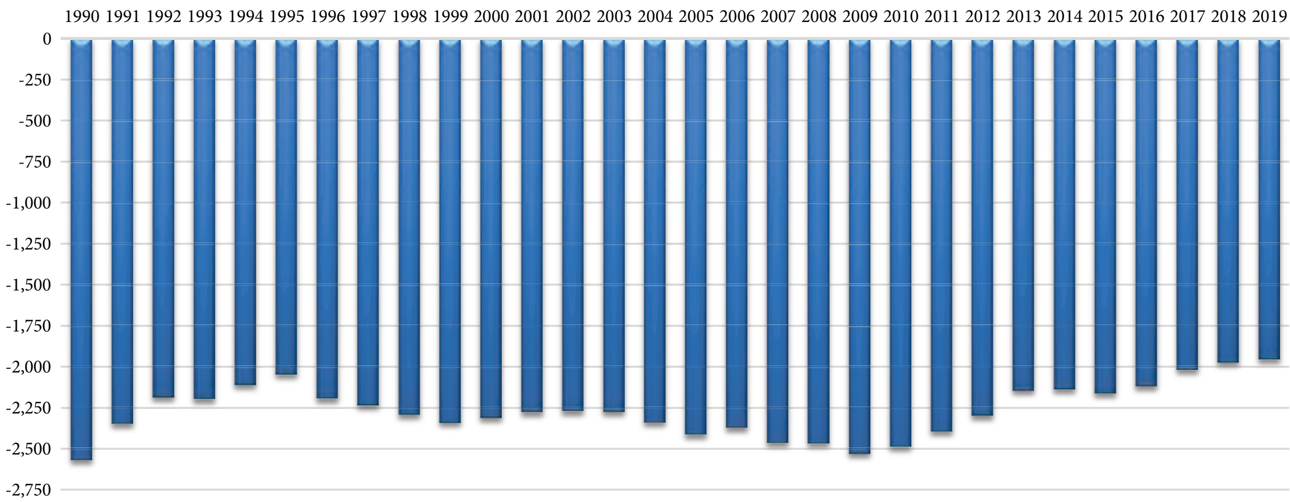

Figure 6-4: Net CO_2 removals from category 4A 'Forest Land' for the period 1990-2019, kt.

Table 6-22: Net CO_2 removals from category 4A 'Forest Land' for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4A1	-1 579.0396	-1 352.6491	-1 290.4237	-1 367.4361	-1 355.1762	-1 350.1974	-1 559.0470	-1 639.4910	-1 732.3177	-1 840.9058
4A2	-984.3932	-990.6641	-893.8167	-826.0754	-752.8259	-694.8696	-631.3866	-592.7944	-556.1680	-495.9410
4A Total	**-2 563.4328**	**-2 343.3131**	**-2 184.2404**	**-2 193.5115**	**-2 108.0022**	**-2 045.0670**	**-2 190.4337**	**-2 232.2854**	**-2 288.4857**	**-2 336.8468**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
4A1	-1 881.4545	-1 873.5555	-1 913.5787	-1 863.8705	-1 904.3372	-1 965.9956	-1 882.9327	-1 985.9585	-1 985.3822	-2 008.9453
4A2	-425.9839	-400.1473	-354.0371	-406.2471	-430.4396	-443.5229	-483.5841	-474.4270	-477.4052	-517.1206
4A Total	**-2 307.4384**	**-2 273.7027**	**-2 267.6159**	**-2 270.1176**	**-2 334.7768**	**-2 409.5185**	**-2 366.5168**	**-2 460.3855**	**-2 462.7874**	**-2 526.0659**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4A1	-1 964.0859	-1 871.4295	-1 702.2662	-1 531.8805	-1 484.6747	-1 496.3946	-1433.2460	-1324.5630	-1281.3639	-1231.1003
4A2	-520.0768	-519.1417	-592.5559	-609.9898	-650.0643	-663.0493	-682.5162	-691.8743	-687.9943	-719.5474
4A Total	**-2 484.1627**	**-2 390.5712**	**-2 294.8221**	**-2 141.8702**	**-2 134.7390**	**-2 159.4439**	**-2115.7622**	**-2016.4373**	**-1969.3582**	**-1950.6476**

As for the individual contribution of each of the categories (4A1 and 4A2), it should be noted that the share of sub-category 4A1 'Forest Land Remaining Forest Land' is dominant, accounting for circa 61.6 per cent in 1990, and circa 63.1 per cent in 2019, respectively (Figure 6-5).

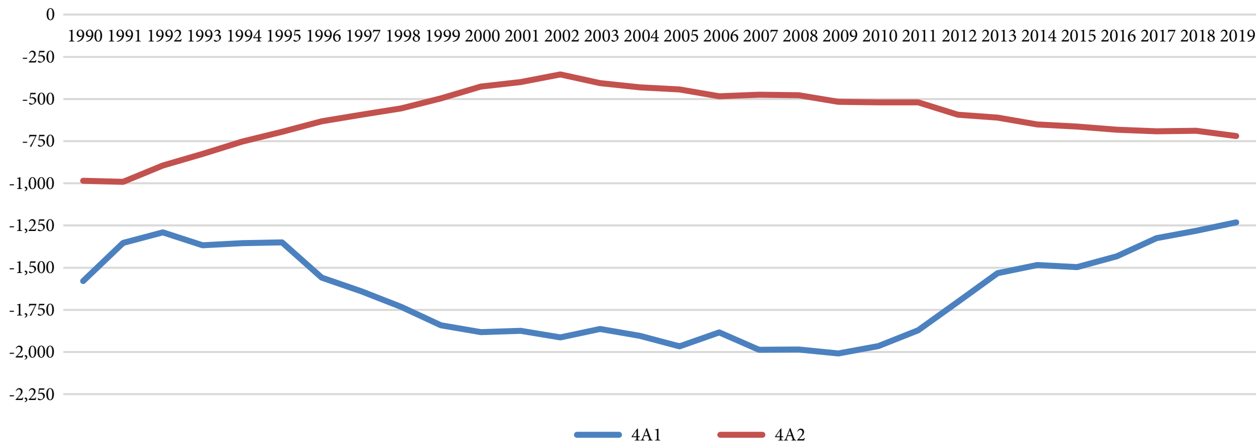

Figure 6-5: CO_2 removals by sub-category from 4A 'Forest land' category for the period 1990-2019, kt.

In the reference period, non-CO_2 emissions (CH_4 and N_2O) from 4A 'Forest Land' category were relatively constant, except for the years 2007 and 2012, when due to severe droughts, the forest areas affected by fires recorded a historical maximum of 791.0 ha and 672.4 ha or a 7 times increase compared to the reference year level. Compared to the base year, by 2019, non-CO_2 emissions from forest areas affected annually by fires within category 4A 'Forest Land' increased by circa 1.7 times (Table 6-23).

Table 6-23: Non-CO_2 emissions from forest areas annually affected by fires in 1990-2019 periods

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4 Emissions, kt	0.0083	0.0014	0.0015	0.0001	0.0023	0.0001	0.0008	0.0002	0.0023	0.0017
N_2O Emissions, kt	0.0005	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0001
Total, kt CO_2 equivalent	**0.3438**	**0.0575**	**0.0630**	**0.0043**	**0.0959**	**0.0055**	**0.0321**	**0.0097**	**0.0965**	**0.0721**
NO_x Emissions, kt	0.0053	0.0009	0.0010	0.0001	0.0015	0.0001	0.0005	0.0001	0.0015	0.0011
CO Emissions, kt	0.1887	0.0316	0.0346	0.0024	0.0526	0.0030	0.0176	0.0053	0.0529	0.0396

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CH_4 Emissions, kt	0.0001	0.0039	0.0021	0.0023	0.0061	0.0006	0.0063	0.0546	0.0038	0.0093
N_2O Emissions, kt	0.0000	0.0002	0.0001	0.0001	0.0003	0.0000	0.0003	0.0030	0.0002	0.0005
Total, kt CO_2 equivalent	**0.0026**	**0.1632**	**0.0876**	**0.0959**	**0.2519**	**0.0240**	**0.2600**	**2.2655**	**0.1575**	**0.3842**
NO_x Emissions, kt	0.0000	0.0025	0.0013	0.0015	0.0039	0.0004	0.0040	0.0349	0.0024	0.0059
CO Emissions, kt	0.0014	0.0896	0.0481	0.0526	0.1383	0.0132	0.1427	1.2432	0.0864	0.2108
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CH_4 Emissions, kt	0.0032	0.0043	0.0464	0.0322	0.0027	0.0246	0.0123	0.0170	0.0059	0.0141
N_2O Emissions, kt	0.0002	0.0002	0.0026	0.0018	0.0001	0.0014	0.0007	0.00094	0.00032	0.00078
Total, kt CO_2 equivalent	**0.1343**	**0.1798**	**1.9251**	**1.3373**	**0.1099**	**1.0198**	**0.5119**	**0.7066**	**0.2431**	**0.5843**
NO_x Emissions, kt	0.0021	0.0028	0.0296	0.0206	0.0017	0.0157	0.0079	0.0109	0.0037	0.0090
CO Emissions, kt	0.0737	0.0987	1.0564	0.7339	0.0603	0.5596	0.2809	0.3878	0.1334	0.3206

In the context of the attributed competencies, 'Moldsilva' Agency produces regular reports on CO_2 emissions reduction following the implementation of CDM Afforestation Projects (MSCP and MCFDP). These calculations are based on the AR-AM0002 Methodology 'Restoration of Degraded Lands through Afforestation/Reforestation' (Version 01 and Version 03), based on the initial modules and documentation of the MSCP and MCFDP, reports submitted by the forestry entities participating in the projects (successful forest plantation, repairs, etc.), monitoring events with measurements on sample plots and international certification, etc. Thus, according to these reports, between 2004 and 2017, a decrease in emissions by circa 2.45 Mt of CO_2 equivalent was reported, having implemented the MSCP and MCFDP (Table 6-24).

Table 6-24: CO_2 emissions reductions within the CDM Projects (MSCP and MCFDP) for the period 2004-2019, kt

Indicators	2004	2005	2006	2007	2008	2009	2010	2011
Net Removals in MSCP	-31.39	-37.36	-86.53	-93.32	-123.30	-138.40	-151.06	-190.60
Net Removals in MCFDP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**-31.39**	**-37.36**	**-86.53**	**-93.32**	**-123.30**	**-138.40**	**-151.06**	**-190.60**
Indicators	2012	2013	2014	2015	2016	2017	2018	2019
Net Removals in MSCP	-191.85	-216.49	-214.77	-221.90	-203.047	0.000	0.000	0.000
Net Removals in MCFDP	-328.81	-58.15	-39.00	-36.00	-41.000	-47.034	0.000	0.000
Total	**-520.66**	**-274.64**	**-253.78**	**-257.90**	**-244.047**	**-47.034**	**0.000**	**0.000**

Source: Agency 'Moldsilva' (2009), PDD for MSCP, Available at: https://cdm.unfccc.int/Projects/DB/SGS-UKL1216031019.22/view. Agency 'Moldsilva' (2012), PDD for MCFDP, available at: https://cdm.unfccc.int/Projects/DB/TUEV-SUED1352989843.61. Agency 'Moldsilva' (2004-2016), Annual Reports to the World Bank for the period 2004-2016 on emissions reduction within MSCP MCFDP. Agency 'Moldsilva' (2012-2013 and 2017-2018) Monitoring Reports for MSCP and MCFDP, available at: https://cdm.unfccc.int/Projects/DB/SGS-UKL1216031019.22/view and https://cdm.unfccc.int/Projects/DB/TUEV-SUED1352989843.61.

6.2.6. Planned Improvements

For the next inventory cycle, the possibility to improve records on actual wood consumption from forests will be envisaged, as well as updating national emissions/removals factors (wood density, biomass expansion factor, emission factors from forest fires, etc.).

6.3. Cropland (Category 4B)

6.3.1. Source Category Description

Category 4B 'Cropland' includes a wide range of land whose primary purpose is the cultivation of different types of agricultural crops and/or their protection against unfavorable weather conditions. Thus, category 4B 'Cropland' comprises the following lands: perennial plantations (vineyards and orchards, including fruit nurseries, woody vegetation in individual gardens, etc.); other forest vegetation, including windbreaks and green spaces; arable soils. Under the 4B category there are reported CO_2 emissions/removals estimates originated from two sub-categories: 4B1 "Cropland Remaining Cropland" and 4B2 "Land Converted to Cropland", including non-CO_2 emissions from post-harvest field burning of agricultural residues.

4B1 'Cropland Remaining Cropland'

For a clearer explanation of the calculation exercise carried out for sub-category 4B1 'Cropland Remaining Cropland', the results are presented separately for three sections: 4B1.1 'Cropland Covered with Woody Vegetation', 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils' and 4B1.3 'Non-CO_2 Emissions from Post-Harvest Field Burning of Agricultural Residues'. The basic calculations include separate categories in estimating GHGs: a) orchards, b) vineyards, c) woody vegetation and d) conversions.

4B1.1 'Cropland Covered with Woody Vegetation'

Category 4B1.1 'Cropland Covered with Woody Vegetation' comprises CO_2 removals/emissions from cropland covered with woody vegetation, including above-ground and below-ground biomass in windbreaks, tree and shrub plantations, other types of forest vegetation, as well as from perennial plantations: orchards, vineyards, trees from private gardens, etc.

Though having a smaller share in CO_2 removals in comparison with forests, the respective category is still quite important in the total balance per sector, as the quantitative share in the general land structure per country of these sources reach up to 10 per cent thus having an essential contribution to maintaining the environmental balance.

In conformity with records available in the Republic of Moldova, forest vegetation not regarded as forest resources includes the following categories:

- windbreaks by the side of agricultural fields;
- windbreaks, and tree and shrub plantations along the communication ways;
- windbreaks as protection against erosion;
- groups of trees and separately standing trees within urban and settlement areas.

According to the general definition, windbreaks represent formations of forest vegetation, located at a particular distance from each other or toward an object in order to protect it against the effects of various harmful factors and/or for climatic, economic and aesthetic-sanitary land improvement.

4B1.2 'Annual Change in Carbon Stocks in Mineral Soils'

Under category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils' there are reported CO_2 emissions from mineral soils. This source has a significant share in the total national emissions from sector 4 'LULUCF', as according the General Land Cadaster of the Republic of Moldova (standing as of 01.01.2020), this source includes arable lands with a share of over 55.2 per cent of the total, which is 1,868.68 thousand ha. It should be mentioned that over the period from 1990 through 2019, the areas of arable land remained relatively constant, increasing only by 7 per cent.

Land-use change of cropland and soil management change can considerably affect the organic carbon stocks in mineral soils[124]. Thus, for example, the conversion of natural 'Grassland' and 'Forest Land' to 'Cropland', could determine the loss of 20-40 per cent of the original soil carbon stocks (2006 IPCC Guidelines). Soil organic carbon stocks can change with management or disturbance if the net balance between carbon inputs (such as organic fertilizers, agricultural residues) and carbon losses (due to mineralization of organic substances in soil) from soil is altered. Carbon stocks also depend on the intensity of the humification process, which is directly influenced by the climatic conditions, particularly the humidity and temperature regime.

4B1.3 'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues'

'Post-Harvest Field Burning of Agricultural Residues' is a rather frequent practice. According to more recent estimations, in some developing countries, up to 40 per cent of crop residues are burnt in fields (in developed countries this percentage is much smaller, less than 10 per cent). It should be noted that in cases in which crop residues are removed from fields to be used as fuel for heating and cooking, emissions from burning are estimated under the Energy sector.

Only non-CO_2 emissions: CH_4, N_2O, NO_x and CO are monitored under this category (as CO_2 emissions are not regarded as a source of emissions, carbon emitted in atmosphere is considered to be re-absorbed in the following agricultural cycle). The amount of crop residues vary in different years, and depend on crops and management technologies. It should be noted that though burning of stubble fields is prohibited by law, this practice still persists. Crop residues are burnt in fields to clear the stubble fields from the straw left after reaping (in the RM, stubble fields are most often burnt after reaping of wheat and barley) and to prepare the fields for the next agricultural cycle.

[124] According the FAO classification: mineral soils are soils with moderate content of organic matter; unlike organic soils which contain 12-20 per cent of organic matter from total mass; it should be noted that there are no such types of soils in the Republic of Moldova.

4B2 'Land Converted to Cropland'

Sub-category 4B2 'Land Converted to Cropland' includes lands subject to conversion which previously had a certain volume of biomass (forests, grasslands, perennial plantations, windbreaks) or lacked vegetation (settlements, wetlands, etc.).

6.3.2. Methodological Issues, Emission Factors and Data Sources

4B1 'Cropland Remaining Cropland'

The calculation methods used to estimate CO_2 removals/emissions from 4B1 'Cropland Remaining Cropland' were those available in the 2006 IPCC Guidelines. At the same time, country-specific emission/removal factors were used regarding the annual biomass increments, as well as AD by sector (windbreaks, tree and shrub plantations, orchards, vineyards, wood harvesting, area of mineral soils used for agriculture).

4B1.1 'Cropland Covered with Woody Vegetation'

To estimate CO_2 removals/emissions within sub-category 4B1.1 'Cropland Covered with Woody Vegetation', current biomass increments were established in woody vegetation not included in forestry resources and perennial plantations, according to production tables, forest planning, scientific sources, data from 'Moldova Agricultural Competitiveness Project' (MACP), etc.

The calculation was done based on annual change in carbon stocks as a result of perennial woody crops growth (in stem, shoots, leaves and roots), by using Equations 2.9-2.14 from the 2006 IPCC Guidelines (pages 2.14-2.18). The estimation of these indicators was performed according to the algorithm and intermediate equations described in the paragraph dedicated to sub-category 4A1 'Forest Land Remaining Forest Land' in the current Report, the difference being in the removal/emission factors used in the calculation process.

Annual wood harvesting from orchards and vineyards occurs during cleaning technological processes. For wood harvesting from windbreaks and other types of forest vegetation, 90 per cent of which are managed by local public authorities, the volume of wood harvested was included in the total volume authorized annually by the Inspectorate for Environmental Protection for local authorities and other institutions (Article 40 of the Environmental Protection Law; Article 22 of the Forestry Code on state control and its data), since other national records for this type of vegetation are not available.

Based on data obtained from the Inspectorate for Environmental Protection and/or the Environment Agency on the amount of wood authorized for harvesting by local authorities and other public institutions (except Agency 'Moldsilva'), the annual harvested amounts were calculated (Table 6-25).

Table 6-25: Wood harvested from other types of woody vegetation for the period 1990-2019, thousand m^3

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Wood harvested volume	0	24.98	37.8	58.52	36.9	36.18	32.47	2.95	10.75	3.08
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Wood harvested volume	1.37	0.48	0.3	0.4	2.74	2.11	3.11	1.78	1.78	2.48
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Wood harvested volume	5.2	2.1	2.91	3.49	8.57	9.51	43.49	38.01	33.37	28.18

Source: Reports of the Inspectorate for Environmental Protection and/or the Environment Agency for the period 1990-2019.

In order to estimate the biomass increments in perennial woody crops on croplands, and implicitly, the resulting CO_2 removals, activity data available in the General Land Cadaster of the RM was used on areas occupied by such crops over the period 1990-2019 (Table 6-26).

Table 6-26: Areas of land covered with woody vegetation in sub-category 4B1 'Cropland Remaining Cropland' for the period 1990-2019, ha

Land Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Perennial plantations	288955.4	299617.5	290817.5	278922.5	279873.4	267483.4	278702.1	265402.1	250302.1	231902.1
Other forest vegetation	23950.0	23950.0	23950.0	22450.0	22450.0	22450.0	21850.0	18750.0	16650.0	22600.0
Total woody vegetation	**312905.4**	**323567.5**	**314767.5**	**301372.5**	**302323.4**	**289933.4**	**300552.1**	**284152.1**	**266952.1**	**254502.1**

Land Category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Perennial plantations	226234.3	197070.3	203977.4	211223.7	219946.8	219771.4	219586.8	219400.3	228261.4	226224.1
Other forest vegetation	22300.0	23084.0	23384.0	21615.0	21615.0	30615.0	34315.0	34315.0	35415.0	34115.1
Total woody vegetation	**248534.3**	**220154.3**	**227361.4**	**232838.7**	**241561.8**	**250386.4**	**253901.8**	**253715.3**	**263676.4**	**260339.3**
Land Category	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Perennial plantations	288530.4	281941.6	278612.7	272655.4	250631.5	242116.3	217331.4	217305.7	213811.6	210692.9
Other forest vegetation	34115.1	34856.0	35532.4	33705.8	39839.8	40939.8	40939.8	40880.8	40134.6	35684.6
Total woody vegetation	**322645.5**	**316797.6**	**314145.1**	**306361.2**	**290471.3**	**283056.1**	**258271.2**	**258186.5**	**253946.2**	**246377.5**

Source: Land Cadaster of the RM for the period 1970-2019; Land Use and Land-Use Change Matrix in the RM for the period 1970-2019.

According to recorded data, between 1990 and 2019 the evolution of areas of other types of woody vegetation had a positive trend, increasing by 8.3 per cent. Within the same periods, perennial plantations had constantly decreased (Table 6-8), the total area decreasing by 39.4 per cent: the area of orchards had decreased by 39.3 per cent, and vineyards – by 39.5 per cent.

At the same time, it should be mentioned that the category 4B1.1 'Cropland Covered with Woody Vegetation' also includes lands that are subject to internal conversions generating certain changes in carbon stocks (Table 6-27).

Table 6-27: Evolution of lands subject to internal conversion from category 4B1.1 'Cropland Covered with Woody Vegetation' for the period 1970-2019, ha

Land Category	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Perennial plantations to cropland	0.0	391.8	19923.5	3269.4	0.0	0.0	0.0	5178.6	5948.0	3255.2
Forest vegetation to cropland	0.0	72.4	72.0	72.4	72.0	181.0	145.0	36.0	778.0	0.0
Cropland to forest vegetation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2153.0
Cropland to perennial plantations	0.0	10511.8	0.0	5798.7	18118.8	5607.2	24273.7	0.0	0.0	0.0
Total	**0.0**	**10975.9**	**19995.5**	**9140.5**	**18190.8**	**5788.2**	**24418.7**	**5214.6**	**6726.0**	**5408.2**
Land Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Perennial plantations to cropland	0.0	1347.6	0.0	0.0	0.0	23450.9	19160.3	1076.3	0.0	1034.5
Forest vegetation to cropland	0.0	0.0	0.0	0.0	72.4	0.0	0.0	1157.9	0.0	0.0
Cropland to forest vegetation	36.0	434.0	109.0	0.0	0.0	3257.0	1338.8	0.0	398.0	615.0
Cropland to perennial plantations	11521.0	0.0	11606.3	9934.5	8757.6	0.0	0.0	0.0	8893.1	0.2
Total	**11557.0**	**1781.6**	**11715.3**	**9934.5**	**8830.0**	**26707.9**	**20499.1**	**2234.2**	**9291.2**	**1649.7**
Land Category	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Perennial plantations to cropland	0.0	0.0	8596.6	17457.5	17159.5	17752.3	13244.2	13045.4	14811.2	18053.2
Forest vegetation to cropland	470.0	0.0	0.0	542.8	0.0	0.0	217.1	1121.7	759.9	0.0
Cropland to forest vegetation	0.0	289.0	253.0	0.0	2569.1	398.0	0.0	0.0	0.0	542.8
Cropland to perennial plantations	63352.0	4166.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**63822.0**	**4455.0**	**8849.6**	**18000.3**	**19728.7**	**18150.4**	**13461.3**	**14167.1**	**15571.1**	**18596.0**
Land Category	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Perennial plantations to cropland	17072.9	28626.9	4646.4	2639.8	18.2	0.0	0.0	0.0	0.0	1886.7
Forest vegetation to cropland	144.7	150.5	0.0	640.1	0.0	0.0	0.0	0.0	0.0	1085.5
Cropland to forest vegetation	0.0	0.0	258.7	0.0	103.0	417.0	244.2	116.9	223.0	0.0
Cropland to perennial plantations	0.0	0.0	0.0	0.0	0.0	1415.4	2929.0	1107.1	453.7	0.0
Total	**17217.6**	**28777.5**	**4905.1**	**3279.9**	**121.2**	**1832.4**	**3173.2**	**1224.0**	**676.7**	**2972.2**
Land Category	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Perennial plantations to cropland	2150.1	112.4	3259.0	41.2	3497.4	2730.5	2.9	0.0	3405.0	3031.1
Forest vegetation to cropland	0.0	21.4	8.5	660.9	349.5	0.0	0.0	21.3	270.0	0.0
Cropland to forest vegetation	1066.3	0.0	0.0	0.0	0.0	724.0	178.9	0.0	0.0	20.0
Cropland to perennial plantations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1275.8	0.0	0.0
Total	**3216.4**	**133.8**	**3267.6**	**702.2**	**3846.9**	**3454.5**	**181.7**	**1297.1**	**3675.1**	**3051.1**

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use and Land-Use Change Matrix in the RM for the period 1970-2019.

In order to estimate annual biomass increments and losses in perennial woody crops, carbon stock change factors/ country-specific emission factors based on data in the National GHG Inventory Report of Hungary (2014), as well as data in the scientific literature regarding the process of perennial plantations management (Table 6-28).

Table 6-28: Emission/removal factors used in the estimation process for 4B1.1 'Cropland Covered with Woody Vegetation'

Land Category	Annual Biomass Increments, t C/yr/ha	Biomass Losses due to Conversion, t C/yr/ha
Other types of forest vegetation	1.42	-24.8
Perennial plantations	0.32	-4.43

Source: Ukrainian Forest Management Service: Forestry Resources of the Moldavian Soviet Socialist Republic, standing as of 1.01.1988, Irpeni, 1988; Gh. Vdovii, D. Galupa et al. (1997), National Report on Forestry Resources of the Republic of Moldova, Giurgiu V., Decei I., Armasescu S. Biometry of Trees and Stands in Romania, 1972; Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D. Talmaci I. et al.: The Baseline Study for the Moldova Soils Conservation Project, 2003; National GHG Inventory Report for Hungary, 2014.

For other type of forest vegetation on cropland, the estimation of carbon stock change factors was made using production tables, and activity data on windbreak productivity, according to records and forestry management practices (Table 6-28). In order to estimate carbon stock change factors in perennial plantations (orchards and vineyards), a 15-year production cycle was used, including 14 years) with a constant annual biomass growth (represented as a net annual biomass growth), while the fifteenth year being the year in which vegetation was cut, thereby assuming the total carbon emitted into the atmosphere.

Country specific emission factors were developed for lands subject to internal conversion within category 4B1.1 depending on the peculiarities of the land categories subject to the respective processes (Table 6-29).

Table 6-29: Emission/removal factors used for internal conversion under category 4B1.1 'Cropland Covered with Woody Vegetation'

Internal Conversion	Indicators	Period, years	Units	Indicator Value[125]
Perennial plantations to cropland	Annual average carbon increments in biomass	year 1	Mg C/ha/an	0.57
	Annual average carbon increments in DOM and SOC	years 1-20	Mg C/ha/an	0.00
Forest vegetation to cropland	Annual average carbon increments/losses in biomass	year 1	Mg C/ha/an	-24.80
	Annual average carbon increments/losses in dead organic matter (litter/DOM)	year 1	Mg C/ha/an	-1.15
	Annual average increments/losses in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/an	-1.1988
Cropland to forest vegetation	Annual average carbon increments/losses in biomass (trees and shrubs)	year 1	Mg C/ha/an	-3.26
	Annual average carbon increments in biomass (trees and shrubs)	years 2-20	Mg C/ha/an	1.74
	Annual average carbon increments in dead organic matter (litter/DOM)	years 1-20	Mg C/ha/an	0.41
	Annual average increments in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/an	0.32
Cropland to perennial plantations	Annual average carbon increments/losses in biomass (trees and shrubs)	year 1	Mg C/ha/an	-4.68
	Annual average carbon increments in biomass (trees and shrubs)	years 2-20	Mg C/ha/an	0.32
	Annual average carbon increments in dead organic matter (litter/DOM)	years 1-20	Mg C/ha/an	0.00
	Annual average increments in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/an	0.00

Source: Ukrainian Forest Management Service: Forestry Resources of the Moldavian Soviet Socialist Republic, standing as of 1.01.1988, Irpeni, 1988; Gh. Vdovii, D. Galupa et al. (1997), National Report on Forestry Resources of the Republic of Moldova, Giurgiu V., Decei I., Armasescu S. Biometry of Trees and Stands in Romania, 1972; Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D. Talmaci I. et al.: The Baseline Study for the Moldova Soils Conservation Project, 2003; National GHG Inventory Report for Hungary, 2014.

4B1.2 'Annual Change in Carbon Stocks in Mineral Soils'

In order to estimate emissions from sub-category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils', a Tier 2 approach was used.

For the calculation of annual changes in carbon stocks in mineral soils, Equation 2.25 from the 2006 IPCC Guidelines was used (Volume 4, Chapter 2, Page 2.30):

$$\Delta C_{mineral} = (SOC_0 - SOC_{(0-T)}) / T$$

Where:

$\Delta C_{mineral}$ – annual change in carbon stocks in mineral soils, t C/yr;

SOC_0 – soil organic carbon stock in the last year of an inventory period, t C;

$SOC_{(0-T)}$ – soil organic carbon stock at the beginning of the inventory time period, t C;

T – time dependence of stock change factors which is the default time period for transition from equilibrium SOC values, yr (T is used in this equation if T ≥ 20 years, where T represents number of years over a single inventory time period).

In order to estimate CO_2 emissions from annual change in carbon stocks in mineral soils the following equation was used:

$$CO_2 = \Delta C_{mineral} \bullet 44/12$$

Where:

CO_2 – emissions from carbon losses in mineral soils due to land-use change for cropland and soil management practices, Gg/yr;

[44/12] – mass ratio between carbon content in CO_2 and C.

[125] The 'minus' sign indicates losses.

In the process of assessing the annual change in carbon stocks in mineral soils in the RM, the following aspects were taken into consideration:

- The agricultural practices applied on the arable land of the RM and the pedo-climatic conditions allow to highlight a single agricultural land use (in the country, the mineral soils cover is quite homogeneous, mainly represented by chernozems); significant changes in soil management technologies between 1990 and 2019 did not occur: autumn plowing is dominant on the entire arable land of the country; since 1990, the amount of carbon stocks in mineral soils had decreased substantially, particularly due to the fact that the amount of organic fertilizers applied to soil have been gradually reduced, as well as the amount of crop residues returned to soil (including as a result of significant reduction of harvests for basic crops);
- Information on the evolution of organic carbon stocks in arable soils were identified in the national scientific literature; according to the reference sources consulted, the soils in the RM, used for the most part for about 150 years, in the meantime lost circa 45-50 per cent of the accumulated carbon: in 1877 the content of humus in arable soils (a layer of 0-30 cm, bulk density – 1.17 g/cm^3) in the northern area of the country (Napadova commune, Floresti district) represented 5.72 per cent (200.7 t humus/ha or 116.4 t C/ha); in 1960 the content of humus in the same area represented 3.68 per cent (129.0 t humus/ha or 74.8 t C/ha); by 2003 – 3.36 per cent (117.9 t humus/ha or 68.4 t C/ha), while in 2010 – 3.11 per cent (109.2 t humus/ha or 63.3 t C/ha);
- In the same context, according to other sources published in the field literature, through direct measurements made on leaching chernozems from the northern part of the country, it was established that over 60 years of exploitation, the soils lost about 37 per cent of the accumulated carbon, and the annual average represented 300 kg C/ha/yr (Soils of Moldova, Volume 1, 1989); within the long-term experiments (circa 40 years) of the Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo', in the main pedo-climatic areas of the country, located on the chernozems subtypes dominant in soils cover, it was established that annual rates of carbon losses are very close to zone and chernozem subtype, representing circa 325 kg C/ha/yr (Ecopedological Monitoring Bulletin, 7th Edition, 2000); very close rates were established through the oldest long-term experiments in the country organized by the Agrarian State University of Moldova in Chetrosu village, Anenii Noi district, on carbonate chernozem (Zagorcea, 1990); values between 300-330 kg C/ha/yr for carbon losses in cropland have been established by other researchers as well (Ungureanu et al., 1997; Banaru et al., 2002, Banaru, 2017);
- Organic carbon stocks in soil in the first year of inventory ($SOC_{(0-T)}$) were identified in 'Soil Quality Monitoring in the Republic of Moldova (database, conclusions, forecasts, recommendations)' (2010); according to the respective publication, in 1990, the content of humus in arable soils (a layer of 0-30 cm, apparent density – 1.17 g/cm^3) in the northern area of the country represented circa 3.46 per cent (121.3 t humus/ha or 70.3 t C/ha); at the same time, in the southern part of the country (Lebedenco commune, Cahul district), the content of humus in arable soils (a layer of 0-30 cm, apparent density – 1.30 g/cm^3) accounted for circa 3.27 per cent (127.3 t humus/ha or 73.9 t C/ha); under these circumstances, the country average ($SOC_{(0-T)}$) represented circa 124.3 t humus/ha or circa 72.1 t C/ha;
- Carbon stock change in mineral soils for the period until 1990 was estimated at -0.15 t C/ha/yr;
- Soil organic carbon stocks in the last year of the inventory cycle (SOC_0) were identified in the scientific field literature; according to the specialists from the Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo', in 2015, the content of humus in arable soils (a layer of 0-30 cm, bulk density – 1.17 g/cm^3) in the northern area of the country (Napadova commune, Floresti district) represented circa 3.0 per cent (105.3 t humus/ha or 61.1 t C/ha); at the same time, in the southern part of the country (Lebedenco commune, Cahul district), the content of humus in arable soils (a layer of 0-30 cm, apparent density – 1.30 g/cm^3) accounted for circa 2.89 per cent (112.7 t humus/ha or 65.4 t C/ha), the country average (SOC_0) represented circa 109.0 t humus/ha or circa 63.2 t C/ha, which corresponds to annual average losses of circa 354.9 kg C/ha/yr. The latest laboratory results and references in the national literature show that, currently, the average humus content in soils is 3.1 per cent, and its decrease is slower in the period 2006-2010 and 2011-2015 compared to 2001-2005.

In order to estimate CO_2 emissions from category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils', based on General Land Cadaster of the RM, there were identified areas of cropland remaining cropland in the period under review (Table 6-30).

Table 6-30: Areas of Cropland Remaining Cropland in the RM over the period 1990-2019, kha

Land Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cropland Remaining Cropland	1631.79	1624.65	1632.63	1634.17	1633.41	1631.19	1632.07	1640.22	1645.39	1642.29
Land Category	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Cropland Remaining Cropland	1630.57	1622.65	1622.53	1623.10	1620.40	1643.40	1660.27	1659.82	1659.18	1659.99
Land Category	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Cropland Remaining Cropland	1659.61	1657.53	1647.65	1654.92	1669.46	1685.03	1694.02	1691.57	1700.30	1709.54

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use Matrix for the period 1970-2019.

Based on the respective AD, annual change in carbon stocks in mineral soils were estimated (Table 6-31). The results show certain changes between 1990 and 2016 equal to circa 354.9 kg C/ha/year. This value is close to the previously results recorded by different specialists in the RM in their long-term experiments (Zagorcea, 1990; Ungureanu et al., 1997; Banaru et al., 2002; Cerbari, 2010, 2012; Andries, 2017).

Table 6-31: Annual change in carbon stocks in mineral soils in the RM for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
$\Delta C_{mineral}$, t C/yr	-579182.8	-576648.1	-579478.7	-580024.9	-579756.4	-578966.6	-579281.9	-582173.3	-584007.1	-582907.5
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
$\Delta C_{mineral}$, t C/yr	-578748.5	-575936.4	-575896.4	-576096.4	-575138.0	-583301.2	-589291.2	-589131.0	-588903.6	-589192.1
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
$\Delta C_{mineral}$, t C/yr	-589055.6	-588317.5	-584811.0	-587389.5	-592550.1	-598077.7	-601267.6	-600398.2	-603499.5	-606776.0

4B1.3 'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues (stubble fields burning)'

Non-CO_2 emissions from post-harvest field burning of crop residues (stubble fields burning) within 4B 'Cropland' were estimated using a Tier 1 methodology (2006 IPCC Guidelines, Volume 4, Chapter 2.4, pages 2.40-2.49).

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

Where:

- L_{fire} – amount of non-CO_2 greenhouse gas emissions from field burning of crop residues, t/yr;
- A – area burnt, ha/yr;
- M_B – mass of fuel available for combustion varies from year to year, based on the harvest recorded, t/ha;
- C_f – combustion factor; IPCC default value is 0.90 (2006 IPCC Guidelines), used to consider aspects regarding incomplete combustion;
- G_{ef} – default EF of non-CO_2 GHG (g/kg d.m.) (Table 6-32) according to the 2006 IPCC Guidelines: Table 2.5. EFs (g/kg d.m. burnt) for different types of combustion and Table 2.6. Combustion factor values (proportion of fuel before fire) for fires depending on the type of vegetation.

Table 6-32: EFs for field burning of crop residues, g/kg d.m.

Category	CO	CH_4	N_2O	NO_x
Field Burning of Crop Residues	92	2.7	0.07	2.5

In order to determine the amount of non-CO_2 emissions from field burning of crop residues, activity data is required on areas sown with grain crops (wheat and barley), which is available in the Statistical Yearbooks of the Republic of Moldova. Information regarding cases registered annually by environmental inspectors in connection with the phenomenon of burning stubble in the Republic of Moldova is presented in Table 6-33.

Table 6-33: Stubble fields burning in the Republic of Moldova for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Burnt stubble fields, thousand ha	12.213	13.110	12.141	14.547	13.422	15.800	18.600	20.700	21.500	24.000
Burnt stubble fields, % of total	3.00	3.00	3.00	3.00	3.00	2.99	3.80	3.83	3.98	4.61
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Burnt stubble fields, thousand ha	11.500	9.500	1.960	0.100	0.400	2.200	0.890	2.650	4.465	0.892
Burnt stubble fields, % of total	2.10	1.57	0.31	0.03	0.08	0.36	0.20	0.56	0.78	0.15

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Burnt stubble fields, thousand ha	0.627	0.475	0.106	0.575	0.400	0.346	0.321	0.395	0.150	0.237
Burnt stubble fields, % of total	0.11	0.10	0.02	0.10	0.07	0.08	0.06	0.09	0.03	0.06

Source: Ministry of Ecology, Construction and Territorial Development / National Institute of Ecology (2003), State of the Environment Report of the Republic of Moldova in 2002 (National Report). Chisinau, Mediul Ambiant, 2003, 144 p. (page 60, Figure 2.19, information covering the period 1995-2002); State Ecological Inspectorate (2014), SEI Yearbook - *2013 'Environment Protection in the Republic of Moldova'*/ State Ecological Inspectorate; editorial board: V. Curari [et al.]. – Ch.: Pontos, 2014 (Publishing house 'Europres'). – 300 p. (page 107, Figure 5, data regarding 2000-2013 time series); SEI Yearbook – *2014 'Environment Protection in the Republic of Moldova'* State Ecological Inspectorate; editorial board: V. Stangaci, red.: D. Osipov – Chisinau: 'Pontos', 2015, Publishing house 'Europres', 336 p. (page 79, Figure 4, data regarding 2000-2014 time series); SEI Yearbook - *2015 'Environment Protection in the Republic of Moldova'*/ Ministry of Environment, SEI; editorial board: Igor Talmazan [et al.]; coord.: Dumitru Osipov. Chisinau: Pontos, 2016. Publishing House 'Europres', 348 p. (page 87, Figure 4. data regarding 2000-2015 time series).

As activity data was not available for the period of time from 1990 through 1994, this data was extrapolated based on the assumption that the areas of stubble fields combusted annually make circa 3 percent of the total areas under the respective cereals (wheat and barley). For the period 2017-2019, data on fires (biomass) were presented by the Inspectorate for Environmental Protection and the General Inspectorate for Emergency Situations.

The activity data on the amount of crop residues available to be combusted on field (Table 6-34) were inferred from information on average crop yield per hectare, by multiplying it to the dry matter fraction in the basic yield of the respective crop (default value is 0.89). While estimating the amount of agricultural residues available for combustion on site, a mean arithmetic value between wheat and barley was used which is closely related to the average yield per hectare, actually reported in the Republic of Moldova over the reference period.

Table 6-34: Amount of crop residues available for combustion on field in the RM for the period 1990-2019, t d.m./ha

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Winter wheat	3.5047	3.1033	2.9248	3.5832	1.9518	2.6079	1.5741	2.5002	2.0877	1.8109
Barley	3.0891	2.836	2.9305	3.0798	1.9671	2.0518	1.1193	1.7656	1.6085	1.4064
Average	**3.2969**	**2.9696**	**2.9277**	**3.3315**	**1.9594**	**2.3298**	**1.3467**	**2.1329**	**1.8481**	**1.6086**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Winter wheat	1.5225	2.1448	1.9703	0.4274	2.2386	2.0463	1.9211	1.0847	2.6653	1.6617
Barley	1.0846	1.9163	1.6088	0.6894	1.7958	1.4511	1.5503	0.8103	2.3134	1.3993
Average	**1.3036**	**2.0305**	**1.7895**	**0.5584**	**2.0172**	**1.7487**	**1.7357**	**0.9475**	**2.4893**	**1.5305**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Winter wheat	1.7518	2.0084	1.1817	2.0765	2.3645	1.9798	2.5489	3.293	2.759	2.937
Barley	1.2991	1.518	1.0862	1.6944	1.8011	1.691	2.4043	2.759	2.403	2.848
Average	**1.5254**	**1.7632**	**1.134**	**1.8855**	**2.0828**	**1.8354**	**2.4766**	**3.026**	**2.581**	**2.8925**

4B2 'Land Converted to Cropland'

In the process of estimating CO_2 removals/emissions from category 4B2 'Land Converted to Cropland', increments and losses of biomass and carbon in soil were identified as a result of the conversion of different land categories on which there was a certain increase in biomass (forest land, grassland, perennial plantations, etc.). At the same time, estimations in this sub-category included N_2O emissions resulting from Grassland Converted to Cropland (arable land).

In the process of assessing the annual change in carbon stocks due to the conversion of different types of land to cropland, Equation 2.15 from the 2006 IPCC Guidelines (Volume 4, Chapter 2, page 2.20) was used:

$$\Delta C_B = \Delta C_G + \Delta C_{Conversion} - \Delta C_L$$

Where:

ΔC_B – annual change in carbon stocks in biomass on land converted to cropland, t C/yr;

ΔC_G – annual increase in carbon stocks in biomass due to growth on land converted to cropland, t C/yr;

$\Delta C_{Conversion}$ – initial change in carbon stocks in biomass resulting from land conversion to cropland, t C/yr;

ΔC_L – annual decrease in biomass carbon stocks due to the conversion to cropland, t C/yr.

Initial changes in carbon stocks in biomass on land converted to cropland ($\Delta C_{Conversion}$) were estimated using Equation 2.16 from the 2006 IPCC Guidelines (Volume 4, Chapter 2, page 2.20):

$$\Delta C_{Conversion} = \Sigma\{(B_{After} - B_{Before}) \bullet \Delta A_{TO\ OTHERS}\} \bullet CF$$

Where:

B_{After} – biomass stocks on land immediately after the conversion to cropland, t d.m.//ha;

B_{Before} – biomass stocks on land before the conversion to cropland, t d.m./ha;

$\Delta A_{TO\ OTHERS}$ – area of land-use converted to cropland in a certain year, ha/yr;

CF – carbon fraction of dry matter.

The estimation process considered increases in dead wood (litter) and in organic soil carbon, since the change in land-use category has a major impact on the respective stocks.

Non-CO_2 emissions (N_2O) resulting from the conversion of grassland to cropland were estimated using Equation 11.8 from the 2006 IPCC Guidelines (Volume 4, Chapter 11, page 11.16):

$$F_{SOM} = \Sigma_{LU}\ [(\Delta C_{Mineral,LU} \bullet 1/R) \bullet 1000]$$

Where:

F_{SOM} – the net annual amount of N mineralized in mineral soils as a result of loss of soil carbon through change in land-use or management, kg N;

$\Delta C_{Mineral,LU}$ – average annual loss of soil carbon for each land-use type (*LU*), tonnes C;

R – *C* : *N* ratio of the soil organic matter. A default value of 15 for the *C* : *N* ratio (R) may be used for situations involving land-use change from Forest Land or Grassland to Cropland, in the absence of more specific data for the area. A default value of 10 may be used for situations involving management changes on Cropland Remaining Cropland;

LU – land-use and/or management system type.

AD on areas subject to conversion to category 4B2 'Land Converted to Cropland' are available in the General Land Cadaster of the RM, and are included in the Land-Use Matrix for the period 1970-2019. The main types of land converted to cropland are grassland and settlements (Table 6-35).

Table 6-35: Areas of land converted to cropland in the RM for the period 1970-2019, ha

Conversion	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Grassland to Cropland	0.0	212.7	737.0	0.0	2749.0	0.0	3967.8	5699.0	238.3	0.0
Grassland to Forest Vegetation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3797.0
Grassland to Perennial Plantations	0.0	192.7	0.0	106.3	332.1	102.8	444.9	0.0	0.0	0.0
Wetlands to Cropland	0.0	600.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Settlements to Cropland	0.0	81.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Land to Cropland	0.0	0.0	0.0	0.0	0.0	0.0	1757.0	1757.0	1757.0	3583.9
Total	**0.0**	**1087.1**	**737.0**	**106.3**	**3081.1**	**102.8**	**6169.8**	**7456.0**	**1995.3**	**7380.9**
Conversion	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1999**
Grassland to Cropland	0.0	935.1	0.0	1324.5	489.5	0.0	476.6	0.0	0.0	0.0
Grassland to Forest Vegetation	64.0	766.0	191.0	0.0	0.0	5743.0	2361.2	0.0	702.0	1085.0
Grassland to Perennial Plantations	211.2	0.0	212.7	182.1	160.5	0.0	0.0	0.0	163.0	0.0
Wetlands to Cropland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Settlements to Cropland	0.0	0.0	490.1	0.0	0.0	1715.5	1470.4	0.0	408.5	0.0
Other Land to Cropland	10181.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**10457.1**	**1701.1**	**893.9**	**1506.6**	**650.1**	**7458.5**	**4308.1**	**0.0**	**1273.4**	**1085.0**
Conversion	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Grassland to Cropland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grassland to Forest Vegetation	0.0	511.0	447.0	0.0	4530.9	702.0	0.0	0.0	0.0	957.2
Grassland to Perennial Plantations	1161.2	76.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wetlands to Cropland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Settlements to Cropland	245.1	0.0	0.0	163.4	0.0	571.8	163.4	0.0	326.8	0.0
Other Land to Cropland	0.0	0.0	7460.9	0.0	618.2	0.0	0.0	0.0	0.0	0.0
Total	**1406.3**	**587.4**	**7907.9**	**163.4**	**5149.0**	**1273.8**	**163.4**	**0.0**	**326.8**	**957.2**
Conversion	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Grassland to Cropland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2110.0	5349.0	904.0
Grassland to Forest Vegetation	1880.5	0.0	0.0	0.0	0.0	1277.0	315.5	0.0	0.0	35.3
Grassland to Perennial Plantations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.4	0.0	0.0
Wetlands to Cropland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Settlements to Cropland	19.8	0.0	30.6	0.0	0.0	0.0	0.0	0.0	27.1	0.0
Other Land to Cropland	330.1	926.6	0.0	10036.4	10591.3	14595.4	17633.0	19376.0	14970.8	1768.0
Total	**2230.4**	**926.6**	**30.6**	**10036.4**	**10591.3**	**15872.4**	**17948.5**	**21509.4**	**20346.9**	**1803.3**

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use Matrix for the period 1970-2019.

Country specific EFs were calculated/developed in order to establish the annual increments/losses of biomass and carbon stocks in soil on lands subject to conversion to cropland. Calculation of such factors was based on production tables including data on productivity of grasslands according to accounting data and forest planning records, 'Moldsilva' Agency Monitoring Reports for MSCP and MCFDP (2012; 2013; 2017; 2018), as well as data in the scientific literature regarding biomass increments and the clearing process of perennial plantations (Table 6-36).

Table 6-36: Removal/Emission Factors used in the estimation process for category 4B2 'Land Converted to Cropland'

Conversion	Indicators	Period, years	Unit	Indicator Value
Grassland to Cropland	Annual average carbon increments in biomass	year 1	Mg C/ha/yr	1.22
	Annual average carbon increments in dead organic matter (litter/DOM)	year 1	Mg C/ha/ yr	0.00
	Annual average increments/losses in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/ yr	-2.2650
Grassland to Forest Vegetation	Annual average carbon increments/losses in biomass (trees and shrubs)	year 1	Mg C/ha/ yr	-2.69
	Annual average carbon increments in biomass (trees and shrubs)	years 2-20	Mg C/ha/ yr	1.74
	Annual average carbon increments in dead organic matter (litter/DOM)	years 1-20	Mg C/ha/ yr	0.41
	Annual average increments in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/ yr	0.32
Grassland to Perennial Plantations	Annual average carbon increments/losses in biomass (trees and shrubs)	year 1	Mg C/ha/ yr	-3.46
	Annual average carbon increments in biomass (trees and shrubs)	years 2-14, 16-20	Mg C/ha/ yr	0.32
	Annual average carbon increments in biomass (trees and shrubs)	year 15	Mg C/ yr	-4.43
	Annual average carbon increments in dead organic matter (litter/DOM)	years 1-20	Mg C/ha/ yr	0.00
	Annual average increments/losses in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/ yr	-2.2650
Wetlands to Cropland	Annual average carbon increments in biomass (trees and shrubs)	year 1	Mg C/ha/ yr	0,8
	Annual average carbon increments in dead organic matter (litter/DOM)	year 1	Mg C/ha/ yr	0.0
	Annual average increments/losses in soil organic carbon (SOC/SOM)	year 1	Mg C/ha/ yr	-2.2650
Settlements to Cropland	Annual average carbon increments in biomass	year 1	Mg C/ha/ yr	5.00
	Annual average carbon increments in dead organic matter (litter/DOM)	year 1	Mg C/ha/ yr	0.00
	Annual average increments in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/ yr	0.2168
Other Land to Cropland	Annual average carbon increments in biomass	year 1	Mg C/ha/ yr	5.00
	Annual average carbon increments in dead organic matter (litter/DOM)	year 1	Mg C/ha/ yr	0.00
	Annual average increments in soil organic carbon (SOC/SOM)	year 1	Mg C/ha/ yr	0.0108

Source: 'Soil Quality Monitoring in the RM (database, conclusions, forecasts, recommendations), 2010; Miron A., Vedutenco D. et al., Report on Drafting Management Plans for Grasslands in Orhei National Park, 2014; National GHG Inventory Report for Hungary, 2014; 'Moldsilva' Agency Reports on MSCP and MCFDP monitoring (2012; 2013; 2017; 2018).

6.3.3. Uncertainties Assessment and Time-Series Consistency

4B1 'Cropland Remaining Cropland'

Uncertainties related to CO_2 emissions/removals from sub-category 4.B1.1 'Cropland Remaining Cropland' may be considered relatively acceptable, falling within the values reported for other categories under Sector 4 'LULUCF'. Thus, for production processes and emission/removal factors, these uncertainties account for circa ±10 per cent. The main uncertainty pertains to the actual volume of wood mass harvested from woody vegetation managed by local public authorities and other owners since there is no accurate official statistics on the volume of wood mass harvested during forest clearings for this category. The situation was overcome after having made additional calculations based on the experience of the MACP and data from the Inspectorate for Environmental Protection (IEP). As a consequence, for sub-category 4B1.1 'Cropland Covered with Woody Vegetation', wood harvests were provided as part of the total volume authorized annually by the IEP and/or the Environment Agency for local authorities and other public institutions (except for 'Moldsilva' Agency)

Uncertainties related to activity data used to estimate CO_2 emissions/removals from category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils' are considered to be low (circa ±10 per cent). Uncertainties related to factors used to estimate CO_2 emissions from carbon loss in mineral soils due to land-use change and soil management practices are considered to be circa ±10 per cent. Thus, cumulatively for category 4B1 'Cropland Remaining Cropland', uncertainties for production processes and emission/removal factors account for circa 10 per cent, and combined uncertainties were estimated to be circa ±14.14 per cent (Annex 5-3.4). Uncertainties introduced in the trend in total direct GHG emissions from category 4B1 within Sector 4 'LULUCF' were estimated to be circa ±11.49 per cent.

In view of ensuring time-series consistency of the obtained results, the same approach and the same EFs were used for the entire period under review for estimating emissions/removals within this category.

4B1 'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues (stubble field burning)'

Uncertainties associated with the non-CO_2 emissions from post-harvest field burning of crop residues result from uncertainties related to activity data on the amounts of crop residues available to be burnt on field, as well as those related to emission factors for various types of burning.

Uncertainties related to activity data on areas occupied by cereals and average yield per hectare reported for these crops are considered relatively small, up to circa ±10 per cent. At the same time, uncertainties related to the estimation of stubble fields actually burnt are considered to be moderate, up to circa ±50 per cent. Uncertainties associated with the default emission factors for various types of burning are moderate for CH_4 (circa ±30 per cent) and N_2O (circa ±30 per cent); however, in agricultural seasons with high humidity, these uncertainties can increase to higher levels. Thus, combined uncertainties related to direct non-CO_2 (CH_4 and N_2O) emissions from this source category are regarded to be relatively high: circa ±31.62 per cent for CH_4 and N_2O, whereas uncertainties introduced in the trend in total direct GHG emissions within Sector 4 'LULUCF' were estimated to be circa ±14.73 per cent for CH_4, and circa ±0.01 per cent for N_2O (Annex 5-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach and the same EFs were used for the entire period under review for estimating emissions within this category

4B2 'Land Converted to Cropland'

Uncertainties related to CO_2 emissions/removals category 4B2 'Land Converted to Cropland' at the beginning and at the end of the reference period (1990 and 2019) are relatively low, being estimated to be circa ±10 per cent.

Uncertainties related to emission/removal factors are in both cases of circa ±10 per cent, whereas combined uncertainties in category 4B2 'Land Converted Cropland' related to emissions/removals of CO_2 constitute circa ±14.14 per cent. Uncertainties introduced in the trend in total direct GHG emissions from category 4B2 within Sector 4 'LULUCF' were estimated to be circa ±0.02 per cent (Annex 5-3.4).

As for non-CO_2 emissions from category 4B2, uncertainties related to activity data are estimated to be circa ±10 per cent, whereas uncertainties related to emission factors represent circa ±30 per cent. Combined uncertainties for non-CO_2 emissions from category 4B2 are estimated to be circa ±31.62 per cent, whereas uncertainties introduced in the trend in total direct GHG emissions within Sector 4 'LULUCF' were estimated to be circa ±0.38 per cent (Annex 5-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach and the same EFs were used for the entire period under review for estimating emissions within this category.

6.3.4. Quality Assurance and Quality Control

4B1.1 'Cropland Covered with Woody Vegetation'

The quality of assessment for category 4B1.1 'Cropland Covered with Woody Vegetation' is ensured by the fact that most of the AD used is taken from official records[126]. At the same time, the quality of estimates increased due to the development of the Land Use Matrix for the period 1970-2019. Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach. Verification was focused on various aspects such as: ensuring correct use of estimation methodologies following the 2006 IPCC Guidelines, correct use of national factors, their accuracy, as well as comparing them to the values used by other countries in the region.

4B1.2 'Annual Change in Carbon Stocks in Mineral Soils'

Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach. Verification was focused on various aspects such as: identifying data entry and CO_2 emission estimations related errors, on AD and EFs verifications and quality control procedures, etc. Activity data and methods used to estimate CO_2 emissions from annual change in carbon stocks in mineral soils due to land-use change and management practices were documented and archived both in hard copies and electronically. Following the recommendations in the 2006 IPCC Guidelines, CO_2

[126] E.g., the total area of protection forest strips and other types of forest vegetation, perennial plantations is provided annually by the General Land Cadastre, while data on annual biomass increment are provided by the Production Tables, Forest State Records – once in 5 years for forests, Forest Planning Materials, Legislative, Normative and Technical Forestry Regulations Acts.

emissions within this sector resulting from land-use change and management practices were estimated based on AD from official reference sources (General Land Cadaster of the Republic of Moldova, Statistical Yearbooks, etc.), and the results of multiannual research from scientific institutions in the country, respectively.

4B1.3 'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues (stubble field burning)'

Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach. Verification was focused on various aspects such as: identifying data entry and CO_2 emission estimations related errors, on AD and EFs verifications and quality control procedures, etc. Activity data and methods used to estimating non-CO_2 emissions from field burning of crop residues were documented and archived both in hard copies and electronically.

6.3.5. Recalculations

For the period 1990-2016, recalculations were made for both subcategories 4B1 'Cropland Remaining Cropland' and 4B2 'Land Converted to Cropland'. The recalculations for the respective categories are due to the update of activity data that emerged from the improvement of the Land Use Matrix for the period 1970-2019.

4B1 'Cropland Remaining Cropland'

4B1.1 'Cropland Covered with Woody Vegetation'

The comparative analysis of the CO_2 removals/emissions from category 4B1.1 'Cropland Covered with Woody Vegetation' for the period 1990-2016 is presented in Table 6-37. Data in the table do not show a significant decrease in values within sub-category 4B1.1. Maximum deviations represented -4.6 per cent in 2001, whereas the minimum deviations reached 0.1 per cent in 2003.

Table 6-37: Recalculation of CO_2 removals/emissions from sub-category 4B1.1 'Cropland Covered with Woody Vegetation', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	479.3100	-624.5145	-553.3445	-418.9188	-646.0762	-470.2610	-634.6691	-331.7911	-302.7888	-322.7101
BUR3	485.9001	-614.8510	-542.6873	-412.6180	-630.2934	-452.6172	-618.2578	-323.9667	-293.3590	-314.3862
Difference, %	+1.4	-1.5	-1.9	-1.5	-2.4	-3.8	-2.6	-2.4	-3.1	-2.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	-503.2714	-111.9496	-542.8150	-467.1950	-519.0901	-507.8433	-494.4273	-538.9725	-555.9583	-416.3142
BUR3	-496.2904	-106.8163	-536.6462	-466.5391	-515.1412	-511.4961	-501.0100	-540.1526	-557.6069	-428.9577
Difference, %	-1.4	-4.6	-1.1	-0.1	-0.8	+0.7	+1.3	+0.2	+0.3	+3.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	-540.8834	-546.5834	-550.7287	-464.2803	-476.5187	-492.5544	-429.2418			
BUR3	-544.0296	-550.6875	-555.4931	-472.3152	-491.6537	-505.3430	-440.5973	-426.3631	-431.9674	-431.4420
Difference, %	+0.6	+0.8	+0.9	+1.7	+3.2	+2.6	+2.6			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR3 – Third Biennial Update Report of the RM under the UNFCCC.

4B1.2 'Annual Change in Carbon Stocks in Mineral Soils'

The comparative analysis of the CO_2 removals/emissions from category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils' for the period 1990-2016 is presented in Table 6-38.

According to data in the table, we may observe an increase in emissions within the respective sub-category for the entire time series. Maximum deviations represented +22.6 per cent for 1991, and minimum deviations of +13.2 per cent for 2016.

Table 6-38: Recalculation of CO_2 removals/emissions from sub-category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1747.2754	1725.0092	1751.8566	1746.8240	1747.2071	1747.1140	1752.9849	1786.8799	1807.0429	1808.1277
BUR3	2123.6703	2114.3762	2124.7553	2126.7581	2125.7733	2122.8777	2124.0335	2134.6356	2141.3595	2137.3276
Difference, %	+21.5	+22.6	+21.3	+21.7	+21.7	+21.5	+21.2	+19.5	+18.5	+18.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1795.2647	1791.0468	1788.5129	1787.5228	1785.4564	1834.1640	1878.8552	1877.2201	1876.1181	1877.1759
BUR3	2122.0779	2111.7670	2111.6200	2112.3536	2108.8392	2138.7712	2160.7343	2160.1470	2159.3133	2160.3711
Difference, %	+18.2	+17.9	+18.1	+18.2	+18.1	+16.6	+15.0	+15.1	+15.1	+15.1

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	1877.6128	1873.4630	1838.9486	1874.1545	1899.8555	1937.1842	1958.1110			
BUR3	2159.8707	2157.1641	2144.3071	2153.7617	2172.6837	2192.9514	2204.6479	2201.4601	2212.8314	2224.8452
Difference, %	+15.0	+15.1	+16.6	+14.9	+14.4	+13.2	+12.6			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR3 – Third Biennial Update Report of the RM under the UNFCCC.

4B1.3 'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues (stubble field burning)'

No recalculations were performed for sub-category 4B1.3 'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues'.

4B2 'Land Converted to Cropland'

The comparative analysis of CO_2 removals/emissions from category 4B2 'Land Converted to Cropland' for the period 1990-2016 is presented in Table 6-39. According to data in the table, we may observe a significant decrease in values (148.7 per cent – 42.9 per cent) within category 4B2 'Land Converted to Cropland' for the period 1990-1996, and smaller deviations for the period 1997-2016. No recalculations were made for N_2O emissions from the conversion of grassland to cropland (arable land) included in sub-category 4B2 'Land Converted to Cropland' for the period 1990-2016.

Table 6-39: Recalculation of CO_2 removals/emissions from sub-category 4B2 'Land Converted to Cropland', included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	-94.02	-109.40	-252.62	-126.69	-101.19	-173.73	-177.25	-174.79	-181.41	-136.95
BUR3	45.75	27.39	-127.44	5.19	-3.40	-66.35	-101.15	-146.02	-154.62	-112.44
Difference, %	-148.7	-125.0	-49.6	-104.1	-96.6	-61.8	-42.9	-16.5	-14.8	-17.9
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	-153.43	-188.59	-161.19	-156.06	-135.56	-102.65	-100.41	-93.04	-103.57	-91.58
BUR3	-126.64	-171.25	-144.11	-139.40	-123.40	-87.69	-88.69	-80.78	-92.51	-79.07
Difference, %	-17.5	-9.2	-10.6	-10.7	-9.0	-14.6	-11.7	-13.2	-10.7	-13.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	-80.99	-118.05	-97.57	-281.28	-250.44	-308.02	-382.17			
BUR3	-72.97	-106.00	-84.81	-276.10	-245.69	-309.33	-383.49	-412.63	-299.01	-9.28
Difference, %	-9.9	-10.2	-13.1	-1.8	-1.9	+0.4	+0.3			

Abbreviations: BUR2 – Second Biennial Update Report of the RM under the UNFCCC; BUR3 – Third Biennial Update Report of the RM under the UNFCCC.

Next, CO_2 removals/emissions within category 4B 'Cropland' are shown for the period 1990-2019. Thus, during the period under review, CO_2 removals from sub-category 4B1.1 'Cropland Covered with Woody Vegetation' were relatively constant, recording significant fluctuations over the period 1990-2002 as a result of internal conversions. Towards the end of the period, an increase by circa 188.8 per cent of total CO_2 removals from sub-category 4B1.1 'Cropland Covered with Woody Vegetation' was recorded, compared to 1990. The evolution of CO_2 removals within sub-category 4B1.1 'Cropland Covered with Woody Vegetation' between 1990 and 2019 is presented in Table 6-40.

Table 6-40: CO_2 removals from sub-category 4B1.1 'Cropland Covered with Woody Vegetation' in the RM for the period 1990-2019, kt

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Perennial Plantations	621.0776	-470.8458	-412.0377	-359.7555	-532.4280	-311.5310	-488.2169	-256.3340	-213.2668	-145.0914
Woody Vegetation	-135.1775	-144.0052	-130.6496	-52.8625	-97.8655	-141.0862	-130.0409	-67.6328	-80.0922	-169.2948
Total	**485.9001**	**-614.8510**	**-542.6873**	**-412.6180**	**-630.2934**	**-452.6172**	**-618.2578**	**-323.9667**	**-293.3590**	**-314.3862**
Category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Perennial Plantations	-329.9127	61.4331	-356.7158	-349.4031	-343.8840	-316.4868	-291.7716	-326.2119	-341.7083	-318.5139
Woody Vegetation	-166.3777	-168.2494	-179.9304	-117.1359	-171.2571	-195.0093	-209.2384	-213.9407	-215.8986	-110.4438
Total	**-496.2904**	**-106.8163**	**-536.6462**	**-466.5391**	**-515.1412**	**-511.4961**	**-501.0100**	**-540.1526**	**-557.6069**	**-428.9577**
Category	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Perennial Plantations	-350.9427	-334.2057	-336.9199	-323.2828	-304.9532	-293.4707	-259.0135	-237.0690	-263.5206	-258.9820
Woody Vegetation	-193.0869	-216.4818	-218.5733	-149.0324	-186.7005	-211.8723	-181.5837	-189.2942	-168.4468	-172.4600
Total	**-544.0296**	**-550.6875**	**-555.4931**	**-472.3152**	**-491.6537**	**-505.3430**	**-440.5973**	**-426.3631**	**-431.9674**	**-431.4420**

The graphical illustration of the evolution of CO_2 removals within sub-category 4B1.1 'Cropland Covered with Woody Vegetation' is provided in Figure 6-6.

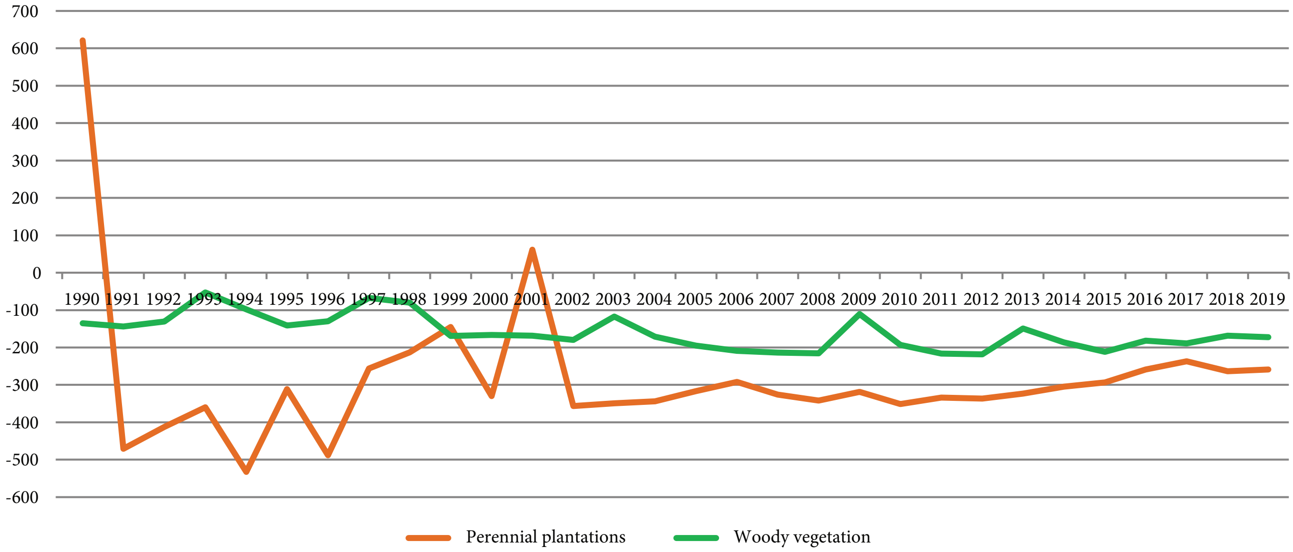

Figure 6-6: Evolution of CO_2 removals from cropland covered with woody vegetation' in sub-category 4B1 'Cropland Remaining Cropland' in the RM for the period 1990-2019, kt.

CO_2 emissions from sub-category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils' between 1990 and 2019 were relatively constant, with insignificant fluctuations in certain years (Table 6-41). At the same time, due to the above-mentioned factors, CO_2 emissions from 4B1.2 category had increased by 2016 by circa 4.6 per cent, in comparison with the base year.

Table 6-41: CO_2 removals from sub-category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils' in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Emissions from mineral soils	2123.6703	2114.3762	2124.7553	2126.7581	2125.7733	2122.8777	2124.0335	2134.6356	2141.3595	2137.3276
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Emissions from mineral soils	2122.0779	2111.7670	2111.6200	2112.3536	2108.8392	2138.7712	2160.7343	2160.1470	2159.3133	2160.3711
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Emissions from mineral soils	2159.8707	2157.1641	2144.3071	2153.7617	2172.6837	2192.9514	2204.6479	2201.4601	2212.8314	2224.8452

The graphical illustration of the evolution of CO_2 emissions within source category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils' is provided in Figure 6-7.

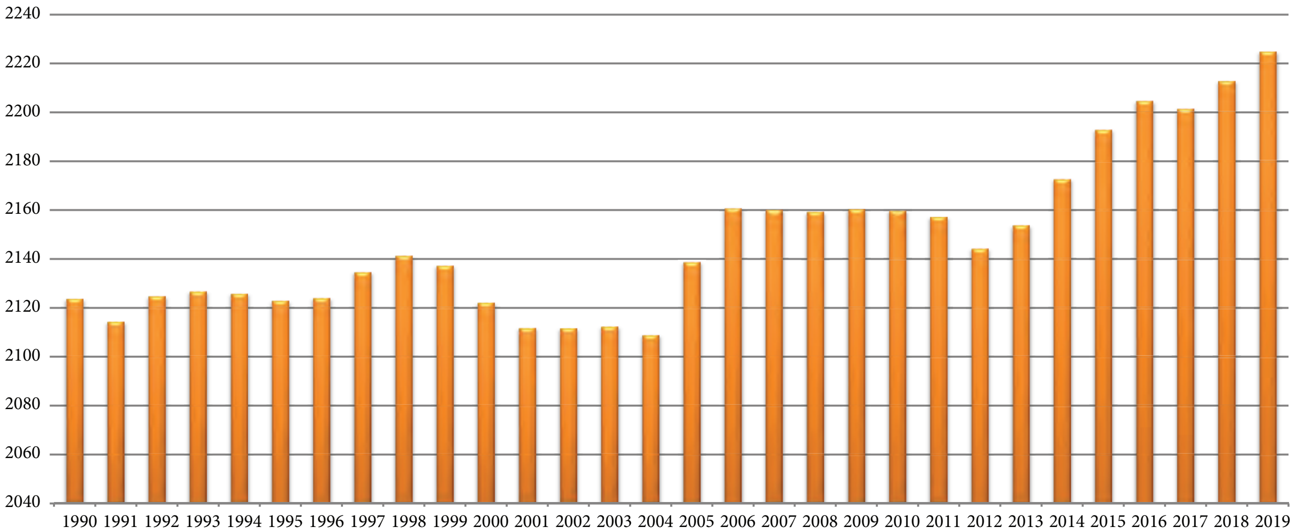

Figure 6-7: CO_2 emissions from sub-category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils' in the RM for the period 1990-2019, kt.

Non-CO_2 emissions from field burning of crop residues for the period 1990-2019 is shown in Table 6-42. By the end of the period under review, the volume had decreased significantly, representing only 1.7 per cent compared to 1990. At the same time, it should be noted that the volume fluctuates significantly from year to year due to adverse weather conditions and anthropogenic factors.

Table 6-42: Non-CO_2 emissions from stubble fields burning in the RM for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4 Emissions, kt	0.09785	0.09460	0.08637	0.11777	0.06391	0.08945	0.06087	0.10729	0.09655	0.09382
N_2O Emissions, kt	0.00254	0.00245	0.00224	0.00305	0.00166	0.00232	0.00158	0.00278	0.00250	0.00243
Total, kt CO_2 equivalent	**3.20207**	**3.09603**	**2.82667**	**3.85398**	**2.09144**	**2.92740**	**1.99197**	**3.51100**	**3.15984**	**3.07020**
NO_x Emissions, kt	0.09060	0.08760	0.07998	0.10904	0.05917	0.08283	0.05636	0.09934	0.08940	0.08687
CO Emissions, kt	3.33398	3.22358	2.94311	4.01274	2.17760	3.04799	2.07403	3.65564	3.29001	3.19668
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CH_4 Emissions, kt	0.03643	0.04687	0.00852	0.00014	0.00196	0.00935	0.00375	0.00610	0.02701	0.00332
N_2O Emissions, kt	0.00094	0.00122	0.00022	0.00000	0.00005	0.00024	0.00010	0.00016	0.00070	0.00009
Total, kt CO_2 equivalent	**1.1921**	**1.5340**	**0.2789**	**0.0044**	**0.0642**	**0.3059**	**0.1228**	**0.1997**	**0.8839**	**0.1086**
NO_x Emissions, kt	0.03373	0.04340	0.00789	0.00013	0.00182	0.00866	0.00348	0.00565	0.02501	0.00307
CO Emissions, kt	1.24126	1.59722	0.29042	0.00462	0.06681	0.31854	0.12791	0.20790	0.92031	0.11304
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CH_4 Emissions, kt	0.00232	0.00208	0.00030	0.00263	0.00202	0.00154	0.00193	0.00290	0.00094	0.00167
N_2O Emissions, kt	0.00006	0.00005	0.00001	0.00007	0.00005	0.00004	0.00005	0.00008	0.00002	0.00004
Total, kt CO_2 equivalent	**0.07606**	**0.06793**	**0.00970**	**0.08621**	**0.06625**	**0.05859**	**0.054**	**0.09505**	**0.03079**	**0.05452**
NO_x Emissions, kt	0.00215	0.00192	0.00027	0.00244	0.00187	0.00143	0.00179	0.00269	0.00087	0.00154
CO Emissions, kt	0.07919	0.07073	0.01010	0.08977	0.06898	0.05258	0.06583	0.09897	0.03206	0.05676

Between 1990 and 2019, CO_2 removals/emissions from sub-category 4B2 'Land Converted to Cropland' fluctuated (Table 6-42), this fluctuation being influenced by the process of various land conversions to the respective category, including in the period prior to 1990 (see Table 6-35).

At the start of the period, sub-category 4B2 was the source of CO_2 emissions, being a constant source of CO_2 removals since 1994, but with fluctuating values.

Table 6-42: CO_2 removals/emissions from category 4B2 'Land Converted to Cropland' in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4B2. CO_2 removals/emissions	45.75	27.39	-127.44	5.19	-3.40	-66.35	-101.15	-146.02	-154.62	-112.44
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
4B2. CO_2 removals/emissions	-126.64	-171.25	-144.11	-139.40	-123.40	-87.69	-88.69	-80.78	-92.51	-79.07
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
4B2. CO_2 removals/emissions	-72.97	-106.00	-84.81	-276.10	-245.69	-309.33	-383.49	-412.63	-299.01	-9.28

The graphical illustration of the evolution of CO_2 emissions from sub-category 4B2 'Land Converted to Cropland' is provided in Figure 6-8.

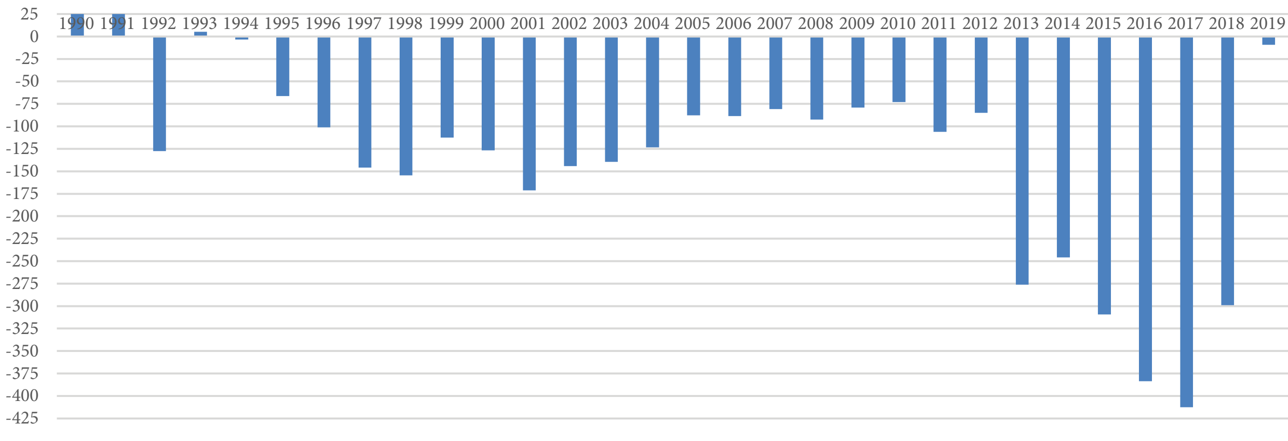

Figure 6-8: CO_2 removals/emissions from category 4B2 'Land Converted to Cropland' in the RM for the period 1990-2019, kt.

N_2O emissions resulting from the conversion of grassland to cropland included in category 4B2 'Land Converted to Cropland' fluctuated between 1990 and 2019, except for the period 1990-1995, when significant values were recorded (Table 6-43). By the end of the period under review, the volume decreased by circa 2 times compared to 1990.

Table 6-43: N_2O emissions resulting from the conversion of grassland to sub-category 4B2 'Land Converted to Cropland' for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O Emissions, kt	0.0325	0.0310	0.0299	0.0297	0.0249	0.0247	0.0178	0.0088	0.0085	0.0085
Total, kt CO_2 equivalent	**9.6848**	**9.2497**	**8.9048**	**8.8551**	**7.4135**	**7.3655**	**5.3009**	**2.6346**	**2.5231**	**2.5231**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
N_2O Emissions, kt	0.0081	0.0067	0.0063	0.0056	0.0046	0.0054	0.0047	0.0048	0.0045	0.0045
Total, kt CO_2 equivalent	**2.4243**	**1.9868**	**1.8873**	**1.6691**	**1.3645**	**1.6090**	**1.4110**	**1.4205**	**1.3481**	**1.3481**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
N_2O Emissions, kt	0.0027	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0060	0.0144	0.0158
Total, kt CO_2 equivalent	**0.8048**	**0.7691**	**0.7691**	**0.7691**	**0.7691**	**0.7691**	**0.7691**	**1.7905**	**4.2793**	**4.7060**

According to the results obtained, it can be seen that during the entire period under review, category 4B represented a source of CO_2 emissions (Table 6-44).

Table 6-44: CO_2 removals/emissions from category 4B 'Cropland' in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4B1	2602.9804	1489.8617	1571.4108	1707.8393	1479.6972	1652.6167	1489.3644	1802.8445	1838.5706	1814.6174
4B2	45.7503	27.3853	-127.4433	5.1908	-3.4030	-66.3523	-101.1521	-146.0198	-154.6249	-112.4420
4B	**2648.7307**	**1517.2470**	**1443.9675**	**1713.0301**	**1476.2941**	**1586.2644**	**1388.2124**	**1656.8247**	**1683.9458**	**1702.1754**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2007**	**2008**
4B1	1618.8065	1999.8174	1568.8050	1645.1586	1589.7492	1630.9279	1666.3069	1621.1746	1603.3550	1744.0569
4B2	-126.6383	-171.2515	-144.1054	-139.4011	-123.4019	-87.6890	-88.6864	-80.7760	-92.5128	-79.0698
4B	**1492.1681**	**1828.5659**	**1424.6996**	**1505.7575**	**1466.3473**	**1543.2389**	**1577.6205**	**1540.3986**	**1510.8422**	**1664.9870**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4B1	1618.9873	1610.5807	1593.5785	1689.4814	1696.1650	1700.3970	1775.4060	1781.7054	1786.3680	1799.1677
4B2	-72.9734	-106.0017	-84.8145	-276.1037	-245.6852	-309.3304	-383.4881	-412.6261	-299.0102	-9.2832
4B	**1546.0139**	**1504.5789**	**1508.7640**	**1413.3777**	**1450.4798**	**1391.0666**	**1391.9179**	**1369.0793**	**1487.3577**	**1789.8845**

The level of recorded emissions fluctuated relatively, except for the period 2002-2014, when it was relatively constant (Figure 6-9). By the end of the period under review, the value of emissions had marginally increased, reaching -32.4 per cent in 2019, being lower than in the base year 1990.

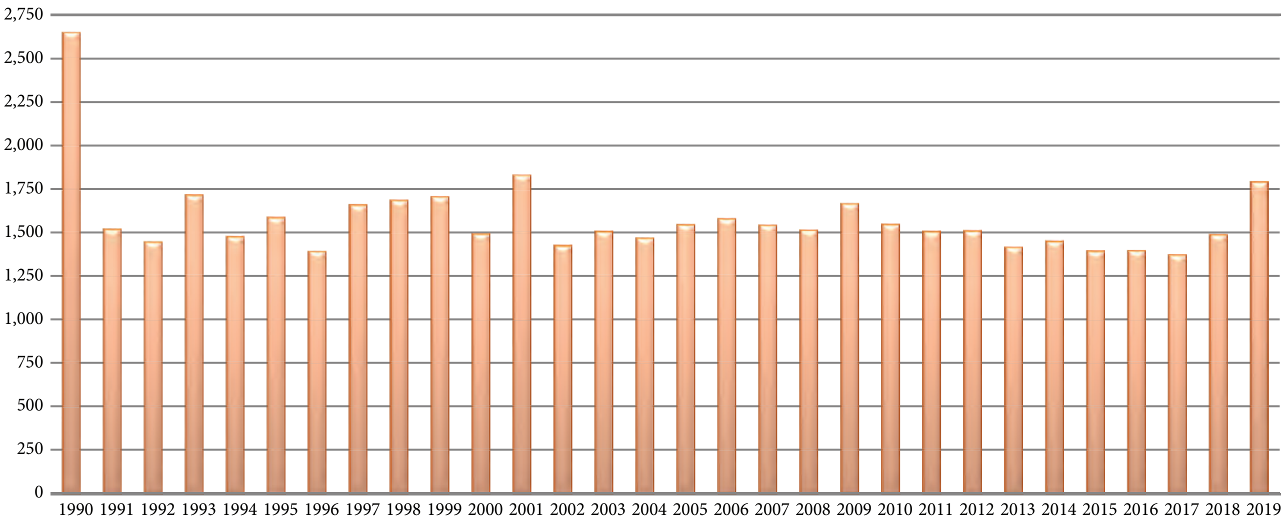

Figure 6-9: CO_2 emissions from source category 4B 'Cropland' in the RM for the period 1990-2019, kt.

Figure 6-10 shows the individual contribution of the two subcategories (4B1 and 4B2) to CO_2 removals/emissions. As it can be seen, due to the land-use change and management practices, as well as the conversion process of different types of land to cropland, 4B1 is a permanent source of CO_2 emissions, whereas 4B2 – a source of removals.

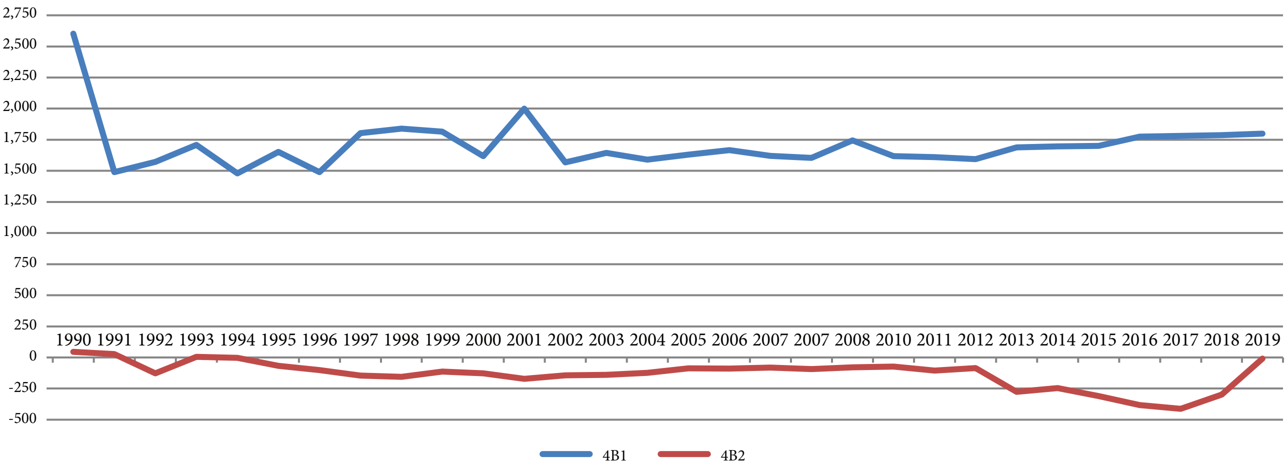

Figure 6-10: CO_2 removals/emissions from category 4B 'Cropland' in the RM for the period 1990-2019, kt.

6.3.6. Planned Improvements

For the next inventory cycle, for sub-category 4B1.1 'Cropland Covered with Woody Vegetation', the possibility to improve records pertaining to actual volume of wood mass from windbreaks management and other types of forest vegetation shall be considered, as well as activities aimed at the verification of emission/removal factors specific to perennial plantations (current biomass increments, biomass harvesting during the clearings, etc.).

For sub-category 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils', it is planned to carry out activities aimed at reducing uncertainties related to the results obtained, including by improving the country-specific methodology (Banaru, 2000) and improving the quality of activity data used to estimate CO_2 emissions/removals.

There are no planned improvements for sub-category 4B1.3. 'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues' (stubble field burning) and sub-category 4B2 'Land Converted to Cropland'.

6.4. Grassland (Category 4C)

6.4.1. Source Category Description

Category 4C 'Grassland' comprises CO_2 emissions/removals originating from two subcategories, 4C1 'Grassland Remaining Grassland' and 4C2 'Land Converted to Grassland'. Grassland is an area of land covered with perennial herbaceous vegetation used for grazing animals (pastures and hayfields).

Under Sector 4 'LULUCF', in 1990, grassland accounted for 26.6 per cent of the total CO_2 removals. In 2019, the share of grassland in this process had decreased to 11.8 per cent, remaining a significant source in total share recorded within LULUCF sector. Sub-category 4C1 'Grassland Remaining Grassland' includes: a) land which has always been covered with perennial herbaceous vegetation used as pastures or hayfields (reported together as a single input in the Land Use Matrix) and land covered with perennial herbaceous vegetation from other categories of use as b) land under improvement and fertility restoration; and c) land affected by landslides. Sub-category 4C1 also includes all land converted to grassland more than 20 years ago (taking into account that the time series commences in 1970). Within sub-category 4C2 'Land Converted to Grassland', there are estimated CO_2 emissions/ removals resulting from: a) the restoration of natural vegetation on land excluded from agricultural use and transformed into grassland; b) conversions of wetlands to grassland; c) conversions of settlements to grassland; d) conversions of land covered with forest vegetation to grassland.

The main sources of activity data utilized in the inventory for the period 1970-2019 were: the General Land Cadaster of the Republic of Moldova (all cadastral categories have been converted into IPCC Land-Use categories), reports from 'Moldsilva' Agency and the Inspectorate for Environmental Protection (Forest Land Converted to Grassland).

6.4.2. Methodological Issues, Emission Factors and Data Sources

4C1 'Grassland Remaining Grassland'

Within sub-category 4C1 'Grassland Remaining Grassland', there were estimated CO_2 emissions/ removals resulting from the following categories of national use (according to land cadastral records): 'pastures', 'hayfields', 'land under improvement and fertility restoration', 'landslides', as well as various categories of land converted to grassland more than 20 years ago. Activity data, particularly the areas included in sub-category 4C1 'Grassland Remaining Grassland' for the period 1990-2019, are provided in Table 6-45.

Table 6-45: The areas of the sub-category 4C1 'Grassland Remaining Grassland' in the Republic of Moldova for the period 1990-2019, thousand ha

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4C1 'Grassland Remaining Grassland'	243.30	241.90	237.35	244.19	237.60	236.73	236.30	235.79	236.49	242.07
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
4C1 'Grassland Remaining Grassland'	247.80	258.02	266.51	265.20	261.04	264.06	259.07	259.99	269.66	300.88

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
4C1 'Grassland Remaining Grassland'	304.84	310.26	309.63	305.92	308.06	305.45	305.92	305.34	297.16	287.02

Source: Land Use Matrix in the RM for the period 1970-2019; General Land Cadaster of the RM for the period 1970-2019.

In order to estimate the change of carbon stock in biomass for sub-category 4C1 'Grassland Remaining Grassland', the Tier 1 approach from the 2006 IPCC Guidelines is used, which assumes that grassland is at equilibrium, thereby the stock does not change in time and space on a national scale.

In order to estimate the change of carbon stock in litter, the Tier 1 approach from the 2006 IPCC Guidelines is used, which assumes that stock is at equilibrium for a long period of time.

A country-specific approach is used in order to estimate CO_2 emissions/removals from mineral soils. The humus content is available in recurrent measurements 1990 vs. 1980 in land categories converted to grassland (annual herbaceous vegetation) in national reference sources (Table 17.16 in Donos A., 2004). The estimated Emission Factor is -0.0028 tonnes C/ha/yr.

4C2 'Land Converted to Grassland'

Sub-category 4C2 'Land Converted to Grassland' includes land with forest vegetation, arable land, perennial plantations (vineyards and orchards), as well as wetlands (marshes, wetlands saturated by water), settlements converted to grasslands in the last 20 years.

GHG emissions/removals from this category result from land-use change and changes in land management, thereby eliminating the existing vegetation and its replacement with grassland vegetation. There are no conversions of forest land to grassland.

The areas currently subject to conversion are provided in Table 6-46.

Table 6-46: Area of Lands Converted to Grassland in the RM for the period 1970-2019 (annual areas initiating the conversion), ha

Category of Use	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
I. Cropland Converted to Grassland, total	0.0	134.8	493.2	8238.6	128.0	319.0	255.0	158.9	1481.0	59.7	0.0	24.7	13719.0
- arable land	0.0	0.0	0.0	8051.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13719.0
- forest vegetation	0.0	127.6	128.0	127.6	128.0	319.0	255.0	64.0	1372.0	0.0	0.0	0.0	0.0
- vineyards and orchards	0.0	7.2	365.2	59.9	0.0	0.0	0.0	94.9	109.0	59.7	0.0	24.7	0.0
II. Wetlands Converted to Grassland	0.0	0.0	0.0	0.0	800.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
III. Settlements Converted to Grassland	0.0	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	109.8
IV. Other Land Converted to Grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9027.1	16419.7	26895.7	26895.7
Total	**0.0**	**153.1**	**493.2**	**8238.6**	**928.0**	**319.0**	**255.0**	**158.9**	**1481.0**	**9086.8**	**16419.7**	**26920.4**	**40724.5**
Category of Use	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
I. Cropland Converted to Grassland, total	0.0	127.6	7211.5	351.2	7046.2	15818.4	36651.3	21077.0	3800.8	157.6	3037.1	314.5	2290.9
- arable land	0.0	0.0	6781.7	0.0	4984.4	15818.4	36632.3	20247.0	3800.8	0.0	1759.9	0.0	1965.5
- forest vegetation	0.0	127.6	0.0	0.0	2042.1	0.0	0.0	830.0	0.0	0.0	957.2	0.0	0.0
- vineyards and orchards	0.0	0.0	429.9	351.2	19.7	0.0	19.0	0.0	0.0	157.6	320.0	314.5	325.4
II. Wetlands Converted to Grassland	500.0	0.0	0.0	0.0	0.0	0.0	0.0	200.0	700.0	0.0	0.0	0.0	200.0
III. Settlements Converted to Grassland	0.0	0.0	384.5	329.5	0.0	91.5	0.0	54.9	0.0	0.0	36.6	0.0	100.0
IV. Other Land Converted to Grassland	33104.2	34252.4	43629.7	49532.5	47818.2	46326.6	43488.1	31613.8	33171.0	33154.5	34877.1	46680.4	47554.4
Total	**33604.2**	**34380.0**	**51225.7**	**50213.2**	**54864.4**	**62236.6**	**80139.4**	**52945.8**	**37671.8**	**33312.1**	**37950.8**	**46995.0**	**50145.3**
Category of Use	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
I. Cropland Converted to Grassland, total	5582.4	4873.3	3376.3	7039.4	17713.1	790.2	85.2	1177.3	0.3	0.0	0.0	407.7	0.0
- arable land	4956.8	2655.9	1764.7	6708.5	17144.9	0.0	0.0	0.0	0.0	0.0	0.0	407.7	0.0
- forest vegetation	382.9	1978.3	1340.1	0.0	255.3	265.5	0.0	1128.9	0.0	0.0	0.0	0.0	0.0
- vineyards and orchards	242.8	239.1	271.5	330.9	312.9	524.7	85.2	48.4	0.3	0.0	0.0	0.0	0.0
II. Wetlands Converted to Grassland	0.0	0.0	0.0	0.0	0.0	43.0	0.0	1121.0	0.0	731.0	0.0	0.0	0.0
III. Settlements Converted to Grassland	36.6	0.0	73.2	0.0	0.0	13.0	7.9	0.0	52.9	77.1	227.8	63.5	25.5
IV. Other Land Converted to Grassland	44423.0	42409.5	38942.2	26984.1	11947.5	6222.2	8402.9	0.0	0.0	0.0	0.0	1714.6	3921.3
Total	**50042.0**	**47282.7**	**42391.7**	**34023.5**	**29660.6**	**7068.4**	**8496.0**	**2298.3**	**53.2**	**808.1**	**227.8**	**2185.8**	**3946.8**
Category of Use	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
I. Cropland Converted to Grassland, total	1949.0	39.4	39.8	5259.4	1166.4	680.6	50.1	0.1	1818.6	538.6	55.6	NA	NA
- arable land	0.0	0.0	0.0	5184.6	0.0	0.0	0.0	0.0	1781.0	0.0	0.0	NA	NA
- forest vegetation	1914.4	0.0	37.8	15.0	1165.6	616.5	0.0	0.0	37.6	476.2	0.0	NA	NA
- vineyards and orchards	34.6	39.4	2.1	59.7	0.8	64.1	50.1	0.1	0.0	62.4	55.6	NA	NA
II. Wetlands Converted to Grassland	0.0	0.0	175.4	234.0	2405.0	79.0	131.0	526.0	86.0	322.0	60.0	NA	NA
III. Settlements Converted to Grassland	70.4	4.4	0.0	6.9	0.0	0.0	0.0	0.0	0.0	6.1	0.0	NA	NA
IV. Other Land Converted to Grassland	4039.2	19829.4	18524.4	11761.2	5166.2	0.0	2474.6	4486.8	5201.0	13044.7	3528.0	NA	NA
Total	**6058.6**	**19873.3**	**18739.7**	**17261.5**	**8737.5**	**759.6**	**2655.6**	**5012.8**	**7105.6**	**13911.4**	**3643.6**	**NA**	**NA**

Source: General Land Cadaster of the RM for the period 1990-2019, Reports of 'Moldsilva' Agency and Reports of the State Ecological Inspectorate on the area of forest land and other types of forest vegetation cleared through illegal logging for the period 1990-2019; Land Use Matrix for the period 1970-2019.

GHG inventory for land categories converted to grassland includes the assessment of changes in carbon stocks for the following carbon pools: biomass, litter, soil.

In order to estimate the annual change in carbon stock in biomass of land converted to grassland from country-specific data, and the national scientific literature, respectively, national EFs were calculated/developed. The biomass stock was thereby estimated taking into account the distribution of grassland by landscape and productivity (meadows and grassland located on slopes of high, medium, and low productivity), and by consulting national sources in the scientific literature, respectively (Table 6-47).

Table 6-47: Annual biomass growth rates used to estimate emissions/removals within category 4C2 'Land Converted to Grassland'

Categories	Productivity	Annual Biomass Stock, t d.m./ha/yr
Meadows	high	3.2
	medium	2.0
	low	1.2
Grasslands on slopes	high	2.8
	medium	1.8
	low	1.2
Landslides	low	1.2

Source: Forest Research and Management Institute Reports (2014-2016) on Grassland Inventory within the Orhei National Park.

The amount reported in Table 6-47 represents the maximum harvestable biomass resulting from the collection of hay in two successive stages (harvesting in the first stage represented 93 per cent of the total estimated biomass). To this harvestable above-ground biomass is added a percentage of 110% (to include the lower part of above-ground biomass and below-round biomass), inferred from the data provided in Table 2.3, in Donos A. (2001).

Based on the inventory surveys of the grasslands in Orhei National Park (EU/UNDP 'Clima East' Project, 2014-2016), Soroca and Stefan Voda districts ('Integration of Biodiversity Conservation Priorities into Territorial Planning Policies and Land-Use Practices in Moldova, 2015-2016' Project) it is observed that grasslands (pastures and hayfields) in these areas, like most in the RM are managed traditionally in an extensive and unsystematic way. The practiced system is characterized by minimal tending activities, or even by total lack and by the lack of correlation between the production capacity of grasslands and their loading with animals. For this reason, grasslands cannot be fully used due to under-exploitation/under-loading with animals (which is why the invasion of grassland with spontaneous shrubby vegetation occurs) or it can be overloaded, failing to provide sufficient food for the entire livestock. In order to estimate CO_2 removals in biomass on land converted to grassland, the annual increments in perennial herbaceous vegetation on newly-formed grasslands, as well as the differences of initial biomass for land previously covered with forest vegetation were established, according to the available data at national level. The calculation process is based on the annual increments in carbon pools due to current biomass growth in the new grasslands, and uses Equation 2.15 from the 2006 IPCC Guidelines (Volume 4, Chapter 2, Page 2.20). Emission factors used in the assessment process, including for litter and soil are provided in Table 6-48.

Table 6-48: EFs used to estimate emissions/removals from sub-category 4C2 'Land Converted to Grassland'

Conversion	Indicator	Period, years	Unit	Indicator Value
Cropland Converted to Grassland	Annual average carbon increments/losses in biomass	year 1	Mg C/ha/yr	-1.22
	Annual average carbon increments in dead organic matter (litter/DOM)	year 1	Mg C/ha/yr	0.00
	Annual average increments in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/yr	2.2650
Forest Vegetation (in Cropland) Converted to Grassland	Annual average carbon increments/losses in biomass	year 1	Mg C/ha/yr	-26.02
	Annual average carbon increments/losses in dead organic matter (litter/DOM)	year 1	Mg C/ha/yr	-1.15
	Annual average increments in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/yr	1.0662
Perennial Plantations (in Cropland) Converted to Grassland	Annual average carbon increments/losses in biomass	year 1	Mg C/ha/yr	-0.65
	Annual average carbon increments in dead organic matter (litter/DOM)	year 1	Mg C/ha/yr	0.00
	Annual average increments in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/yr	2.2650
Wetlands Converted to Grassland	Annual average carbon increments in biomass	year 1	Mg C/ha/yr	0.00
	Annual average carbon increments in dead organic matter (litter/DOM)	year 1	Mg C/ha/yr	0.00
	Annual average increments in soil organic carbon (SOC/SOM)	years 1-20	Mg C/ha/yr	2.4818

Conversion	Indicator	Period, years	Unit	Indicator Value
Settlements Converted to Grassland	Annual average carbon increments in biomass	year 1	Mg C/ha/yr	3.78
	Annual average carbon increments in dead organic matter (litter/DOM)	year 1	Mg C/ha/yr	0.00
	Annual average increments in soil organic carbon (SOC/SOM)	year 1	Mg C/ha/yr	0.1241

Source: Giurgiu V., Decei I., Armasescu S. Biometry of Trees and Rammels in Romania, 1972; Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D. Talmaci I. et al.: The baseline study for the 'Soils Conservation Project in Moldova', 2003; Official Monitor No. 46-49, Government Resolution No. 367 dated 13.04.2000, 'On approving the National Program to Combat Desertification 2000'; National GHG Inventory Report for Hungary, 2014; 'Soil Quality Monitoring in the Republic of Moldova (database, conclusions, forecasts, recommendations)', 2010.

6.4.3. Uncertainties Assessment and Time-Series Consistency

4C1 'Grassland Remaining Grassland'

Uncertainties associated with CO_2 emissions/removals from sub-category 4C1 'Grassland Remaining Grassland', are not estimated since there is a neutral balance in the main carbon pools (biomass, litter, soil).

4C2 'Land Converted to Grassland'

Uncertainties associated with the CO_2 emissions/removals resulting from sub-category 4C2 'Land Converted to Grassland' are within acceptable limits. Land conversion (cropland, forest vegetation, etc.) to grassland is a normal process in the Republic of Moldova, having a different magnitude between 1970 and 2019. In the base year (1990), the accuracy degree represented circa ±5 per cent for 'production processes', which is explained by the fact that state institutions ensured a rigorous control of processes and accounts.

Cadastral records thereby registered systematical changes in land-use categories, etc. By the end of the reference period (2019), the accuracy degree of activity data decreased to circa ±15 per cent, which is explained by the lack of veridical records on the evolution of land-use of forest land damaged by illegal logging (grazing, growing crops, etc.). Emission/removal factors have an uncertainty level of circa ±10 per cent.

In accordance with current practices, most of converted forest land are continuously used for grazing because most of such lands are degraded, or situated on slopes over 7°, where the cultivation of agricultural crops (including through tillage) is economically inefficient. Conversion of cropland is a contradictory process, as uncertainties associated with area of grassland were conditioned both by conversion of arable lands, and their afforestation and planting perennial vegetation (orchards, vineyards).

The General Land Cadaster of the Republic of Moldova after 1994 contains only general information in this sense, without specifying to which categories the cropland (arable lands, perennial plantations, etc.) excluded from agricultural cycle were converted. One part of them were converted to forest land, while the other (depending on condition) were transferred to other categories (grassland, ravines, landslides, etc.). Practically, only the land-use category (in many cases determined by local traditions) reflects, to some extent, the condition of such land after conversion.

Thus, combined uncertainties related to CO_2 emissions/removals from sub-category 4C2 'Land Converted to Grassland' can be regarded as moderate, and are estimated to be circa ±18.03 per cent. Uncertainties introduced in the trend in total direct GHG emissions from sub-category 4C2 within Sector 4 'LULUCF' were estimated to be circa ±0.69 per cent.

6.4.4. Quality Assurance and Quality Control

The quality of assessment for 4C 'Grassland' category is provided by the fact that most of the AD used is taken from official records. The total area of grassland is thereby provided by the General Land Cadaster of the Republic of Moldova for each year. Data regarding area of forest land converted to grassland is available in the sectoral records of the state forestry institutions (Statistical Report 5 'Statistical Report on volumes of illegal logging'), as well as in the reports of state institutions for environmental protection.

Data on annual biomass increment for forest land converted to grassland is provided by Production Tables and concrete records/measurements. For grassland, data is taken from the scientific literature in the field, from normative and technical regulation acts, as well as from the grassland inventory reports of the Forest Research and Management Institute within Orhei National Park.

Verification of the GHG inventory quality within category 4C 'Grassland' includes, in addition to complying with the recommendations included in the 2006 IPCC Guidelines, ensuring correct use of national factors, their accuracy, as well as comparing them to the values used by other Eastern and Central European countries.

At the same time, the quality of AD increased due to the development of the Land Use Matrix for the period 1970-2019.

Quality assurance and quality control measures of the GHG inventory are described in section 4A 'Forest Land'. Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach.

It should be noted that according to the recommendations included in the 2006 IPCC Guidelines, CO_2 emissions/removals from grassland use processes within this sector were estimated based on AD from official reference sources (General Land Cadaster of the Republic of Moldova and Statistical Yearbooks of the Republic of Moldova, etc.).

6.4.5. Recalculations

4C1 'Grassland Remaining Grassland'

No recalculations were performed in the current inventory cycle for category 4C1 'Grassland Remaining Grassland'.

4C2 'Land Converted to Grassland'

No recalculations were performed in the current inventory cycle for category 4C2 'Land Converted to Grassland'. Over the period 1990-2019, CO_2 removals from sub-category 4C2 'Land Converted to Grassland' had continuously decreased. Results regarding CO_2 removal rates from this sub-category are provided in Table 6-49.

Table 6-49: CO_2 removals from sub-category 4C2 'Land Converted to Grassland' in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4C2	-1205.6938	-1414.3167	-1428.4835	-1303.5202	-1577.3332	-1601.1004	-1548.0826	-1400.8607	-1436.2698	-1433.2865
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
4C2	-1291.9495	-1290.6541	-1235.1380	-1007.1842	-1120.4767	-1058.1239	-1056.3692	-1031.2350	-932.1498	-447.6932
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
4C2	-691.9874	-638.1726	-562.7510	-360.1740	-341.1085	-418.4569	-402.3693	-384.0392	-440.1513	-293.2923

At the start of the reporting period (1990), removals from sub-category 4C2 are somewhat significant at sectoral level, due to massive conversion of different lands into grasslands (Table 6-46). Towards the end of the reporting period, removals from sub-category 4C2 had decreased significantly. In 2019, the lowest rate represents only 24.3 per cent compared to the base year. Thus, compared to 1990, a decrease by 75.7 per cent, or a difference by circa 912 kt CO_2 was thereby recorded in 2019. The evolution of CO_2 removals from sub-category 4C2 'Land Converted to Grassland' is provided in Figure 6-11.

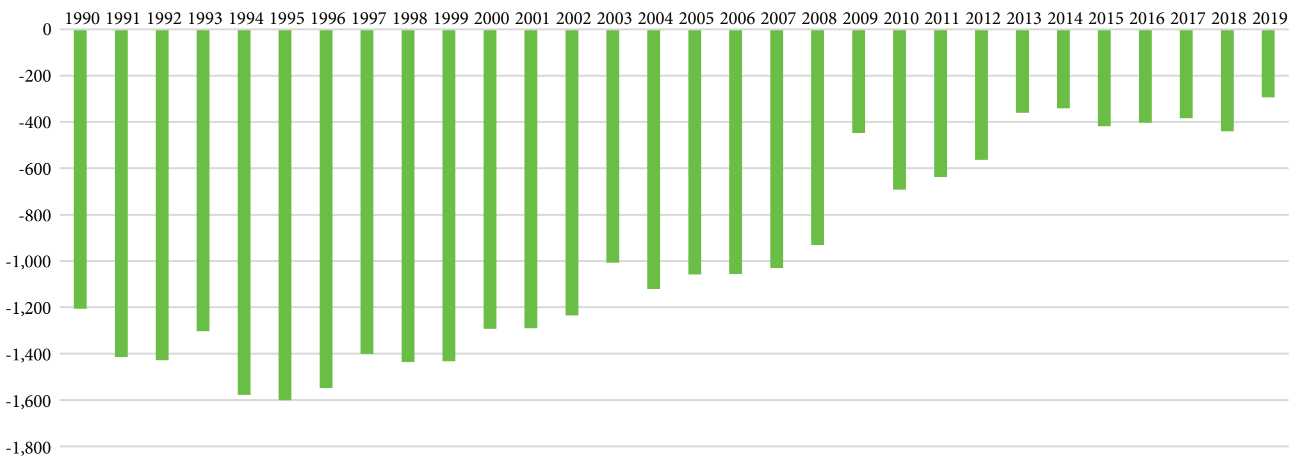

Figure 6-11: CO_2 removals from sub-category 4C2 'Land Converted to Grassland' in the RM for the period 1990-2019, kt.

6.4.6. Planned Improvements

The possibility to improve activity data on identifying the land-use categories to which lands excluded from agricultural production cycle were transferred will be considered for the next inventory cycles in the Republic of Moldova.

6.5. Wetlands (Category 4D)

6.5.1. Source Category Description

Category 4D 'Wetlands' includes any land that is covered or saturated by water for the entire or only a part of the year (for example, marshes), and does not fall into the Forest Land, Cropland, Grassland or Settlements categories. It also includes storage water reservoirs (including managed ponds), as well as unmanaged natural lakes and rivers. 4D 'Wetlands' comprises two subcategories: 4D1 'Wetlands Remaining Wetlands' and 4D2 'Land Converted to Wetlands'.

6.5.2. Methodological Issues, Emission Factors and Data Sources

4D1 'Wetlands Remaining Wetlands'

Due to the particularities of lands in the RM included in sub-category 4D1 'Wetlands Remaining Wetlands' (land without forest/herbaceous vegetation and/or no management activities contributing to essential changes in carbon pools), following the Tier 1 approach in the 2006 IPCC Guidelines, a neutral balance was established in the main carbon pools (above-ground and below-ground biomass, dead organic matter, soil). AD on areas within this category are available in the General Land Cadaster of the Republic of Moldova and are also included in the Land Use Matrix for the period 1970-2019. Sub-category 4D1 'Wetlands Remaining Wetlands' also includes lands subject to internal conversion, which do not generate essential changes in carbon pools, maintaining a steady balance (Table 6-50).

Table 6-50: Area of land included in sub-category 4D1 'Wetlands Remaining Wetlands' in the RM for the period 1990-2019, ha

Land Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Wetlands with vegetation (marshes)	9200.0	9300.0	9000.0	10000.0	10000.0	9900.0	10200.0	10200.0	10200.0	10400.0
Wetlands saturated by water	54600.0	55500.0	53800.0	56399.7	57400.0	59500.0	61100.0	62100.0	62100.0	64900.0
Wetlands with vegetation (marshes) converted to wetlands saturated by water	4100.0	4100.0	4200.0	4300.0	3300.0	2500.0	2500.0	2200.0	2200.0	2200.0
Wetlands saturated by water converted to wetlands with vegetation (marshes)	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Total	**68100.0**	**69100.0**	**67200.0**	**70899.7**	**70900.0**	**72100.0**	**74000.0**	**74700.0**	**74700.0**	**77700.0**
Land Category	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Wetlands with vegetation (marshes)	10400.0	11800.0	12400.0	10911.0	11911.0	11617.0	12017.0	11833.0	12833.0	13126.4
Wetlands saturated by water	65600.0	65425.0	67325.0	67325.0	67925.0	68488.0	68688.0	68688.0	70788.0	70888.0
Wetlands with vegetation (marshes) converted to wetlands saturated by water	1800.0	1800.0	1800.0	2168.0	2168.0	1768.0	1768.0	2152.0	2152.0	2158.6
Wetlands saturated by water converted to wetlands with vegetation (marshes)	200.0	532.0	532.0	532.0	532.0	532.0	532.0	432.0	432.0	432.0
Total	**78000.0**	**79557.0**	**82057.0**	**80936.0**	**82536.0**	**82405.0**	**83005.0**	**83105.0**	**86205.0**	**86605.0**
Land Category	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Wetlands with vegetation (marshes)	12910.4	12910.4	13262.7	12162.7	13053.7	12902.7	12510.7	12652.7	12730.7	14382.7
Wetlands saturated by water	71988.0	70112.6	71585.8	67581.6	67780.8	65580.8	63946.8	63018.8	63018.8	60305.8
Wetlands with vegetation (marshes) converted to wetlands saturated by water	1274.6	1274.6	1220.6	1120.6	2150.6	2970.6	2970.6	3270.6	3270.6	3270.6
Wetlands saturated by water converted to wetlands with vegetation (marshes)	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0
Total	**86605.0**	**84729.6**	**86501.1**	**81296.9**	**83417.1**	**81886.1**	**79860.1**	**79374.1**	**79452.1**	**78391.1**

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use and Land-Use Change Matrix for the period 1970-2019.

4D2 'Land Converted to Wetlands'

In order to estimate CO_2 removals/emissions from sub-category 4D2 'Land Converted to Wetlands', a Tier 2 approach was utilized for biomass. Losses in biomass are determined by the conversion of land-use categories which were previously covered with a certain amount of biomass (forest vegetation, grassland, perennial plantations, etc.). At the same time, biomass increments were estimated due to the conversion of land-use categories without initial vegetation (Other Land). The calculation process of CO_2 removals/emissions is based on the annual increments in carbon stocks due to current biomass growth, and uses Equation 2.15 from the 2006 IPCC Guidelines (Volume 4, Chapter 2, Page 2.20). According to Table 6-51, the main land categories converted to wetlands are grasslands and other land.

Table 6-51: Area of Land Converted to Wetlands in the RM over the period 1970-2019 (annual areas that initiate conversion), ha

Conversion	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Grassland to Wetlands	0.0	0.0	400.0	0.0	0.8	1400.0	1900.0	700.0	0.0	3000.0	300.0	1600.0	2500.0
Other Land to Wetlands	0.0	1700.0	0.0	1399.2	3099.2	3099.2	3099.2	3099.2	3099.2	3099.2	3099.2	3099.2	3099.2
Total	**0.0**	**1700.0**	**400.0**	**1399.2**	**3100.0**	**4499.2**	**4999.2**	**3799.2**	**3099.2**	**6099.2**	**3399.2**	**4699.2**	**5599.2**
Conversion	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Grassland to Wetlands	0.0	1600.0	600.0	600.0	100.0	3100.0	400.0	0.0	0.0	800.0	900.0	2200.0	0.0
Other Land to Wetlands	3099.2	3099.2	3099.2	3099.2	3099.2	3099.2	3099.2	3099.2	1399.2	3699.2	0.0	0.0	0.0
Total	**3099.2**	**4699.2**	**3699.2**	**3699.2**	**3199.2**	**6199.2**	**3499.2**	**3099.2**	**1399.2**	**4499.2**	**900.0**	**2200.0**	**0.0**
Conversion	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Grassland to Wetlands	400.0	300.0	400.0	2000.0	1100.0	0.0	905.0	0.0	472.0	0.0	178.0	80.0	40.5
Other Land to Wetlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**400.0**	**300.0**	**400.0**	**2000.0**	**1100.0**	**0.0**	**905.0**	**0.0**	**472.0**	**0.0**	**178.0**	**80.0**	**40.5**
Conversion	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Grassland to Wetlands	28.8	3231.0	63.0	47.2	32.0	0.0	3698.9	0.0	0.0	742.0	0.0	NA	NA
Other Land to Wetlands	0.0	0.0	1700.0	0.0	3699.2	3698.8	0.0	0.0	1.0	1.0	0.0	NA	NA
Total	**28.8**	**3231.0**	**1763.0**	**47.2**	**3731.2**	**3698.8**	**3698.9**	**0.0**	**1.0**	**742.0**	**0.0**	**NA**	**NA**

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use and Land-Use Change Matrix for the period 1970-2019.

Carbon stocks in mineral soils within sub-category 4D2 'Land Converted to Wetlands' is estimated based on country-specific data (Soil Quality Monitoring in the Republic of Moldova, 2010).

In order to estimate annual biomass increments/losses in land converted to wetlands, national emission factors were calculated/developed (Table 6-52).

Table 6-52: EFs used to estimate CO_2 emissions/removals from sub-category 4D2 'Land Converted to Wetlands'

Conversion	Indicators	Period, years	Unit	Indicator Value
Grassland Converted to Wetlands [3]	Annual average carbon increments in biomass (herbaceous cover)	year 1	Mg C/ha/yr	0.0
	Annual average carbon increments in dead organic matter (litter)	year 1	Mg C/ha/yr	0.0
	Annual average increments in soil organic carbon	years 1-20	Mg C/ha/yr	0.0
Other Land Converted to Wetlands	Annual average carbon increments in biomass (herbaceous cover)	year 1	Mg C/ha/yr	4.2
	Annual average carbon increments in dead organic matter (litter)	year 1	Mg C/ha/yr	0.0
	Annual average increments in soil organic carbon	years 1-20	Mg C/ha/yr	2.4818

6.5.3. Uncertainties Assessment and Time-Series Consistency

4D1 'Wetlands Remaining Wetlands'

Uncertainties for sub-category 4D1 'Wetlands Remaining Wetlands' are not estimated since a neutral balanced was established in the main carbon pools (above-ground and below-ground biomass, dead organic matter, soil).

4D2 'Land Converted to Wetlands'

Uncertainties associated with the CO_2 emissions/removals from sub-category 4D2 'Land Converted to Wetlands' at the beginning and the end of the reference period (1990 and 2019) are somewhat low, estimated at circa ±10 per cent. In both cases, emission/removal factors have an uncertainty level of circa ±10 per cent. Combined uncertainties from 4D2 'Land Converted to Wetlands' represent circa ±14.14 per cent. Uncertainties introduced in the trend in total direct GHG emissions from sub-category 4D2 within Sector 4 'LULUCF' were estimated to be circa ±0.03 per cent (see Annex 5-3.4).

6.5.4. Quality Assurance and Quality Control

The quality of assessment for category 4D 'Wetlands' is ensured by the fact that most of the AD used is taken from official records (the General Land Cadaster of the Republic of Moldova). Annual biomass increment/loss for lands converted to wetlands was estimated using country-specific EFs developed

[127] The indicator value is equal to zero, because wetlands (marshes) are associated with grasslands, thereby after conversion there are no significant changes in carbon pools.

within EU/UNDP 'Clima East' Project, and based on CDM Projects: MSCP and MCFDP. At the same time, the quality of AD increased due to the development of the Land Use Matrix for the period 1970-2019. Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach.

Within this category, verification was focused following the recommendations included in the 2006 IPCC Guidelines (Volume 4 'AFOLU'), time-series consistency for activity data, ensuring correct use of national factors, their accuracy, validation of the assumptions and calculations used in estimating the parameters inferred from other data available at national level, as well as their comparison with the values used in compiling the inventories by the countries in the region. Also, QA/QC also included monitoring the way in which data is compiled from spreadsheets and conversion between units of measurement.

6.5.5. Recalculations

4D1 'Wetlands Remaining Wetlands'

No recalculations were performed in the current inventory cycle for sub-category 4D1 'Wetlands Remaining Wetlands'.

4D2 'Land Converted to Wetlands'

No recalculations were performed in the current inventory cycle for sub-category 4D2 'Land Converted to Wetlands'. Between 1990 and 2019, CO_2 removals from the respective sub-category had continuously decreased, becoming constant in recent years (2015-2019). Results on CO_2 removal rates from this sub-category are provided in Table 6-53.

Table 6-53: CO_2 removals from category 4D 'Wetlands' in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4D2 'Land Converted to Wetlands'	-555.3798	-526.4627	-595.5455	-525.8447	-497.6418	-469.4389	-441.2360	-413.0332	-384.8303	-356.6274
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
4D2 'Land Converted to Wetlands'	-328.4245	-300.2217	-272.0188	-243.8159	-215.6130	-187.4101	-159.2073	-131.0044	-102.8015	-74.5986
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4D2 'Land Converted to Wetlands'	-46.3958	-75.3129	-15.4700	-106.0998	-139.7535	-82.7917	-82.7917	-82.8162	-82.8253	-82.8099

At the start of the reporting period (1990), removals from sub-category 4D2 'Land Converted to Wetlands' are somewhat significant at sectoral level, due to massive conversion of different lands to wetlands (see Table 6-51).

By the end of the period (2019), removals from sub-category 4D2 'Land Converted to Wetlands' had decreased significantly, constituting only 14.9 per cent compared to the base year. Thus, compared to 1990, a decrease by 85 per cent or a difference by circa 473 kt CO_2 was recorded in 2019 (Figure 6-12).

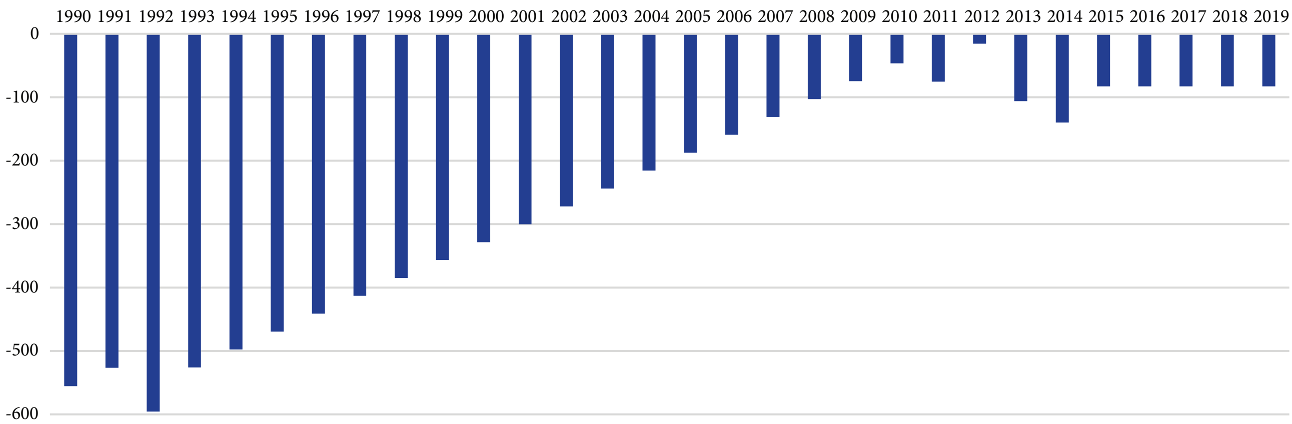

Figure 6-12: CO_2 removals from category 4D 'Wetlands' in the RM for the period 1990-2019, kt.

6.5.6. Planned Improvements

The possibility to improve the cadastral records (as the main reference sources for AD) regarding a more detailed specification in explanatory notes of initial land-use categories converted to category 4D 'Wetlands' will be considered for the next inventory cycle.

6.6. Settlements (Category 4E)

6.6.1. Source Category Description

Category 4E 'Settlements' includes all developed land (constructions, streets, yards, squares, roads, etc.), including transportation infrastructure and all size settlements if they are not accounted in another land-use category.

Depending on the type of vegetation with which they are covered, a part of land inside settlements was included in categories 4B 'Cropland' (parks, public gardens, green areas, perennial plantations, etc.), and 4C 'Grassland' (pastures and hayfields). 4E 'Settlements' comprises two subcategories: 4E1 'Settlements Remaining Settlements' and 4E2 'Land Converted to Settlements'. Activity data on land in this category are provided by the General Land Cadaster of the Republic of Moldova.

6.6.2. Methodological Issues, Emission Factors and Data Sources

4E1 'Settlements Remaining Settlements'

Category 4E1 'Settlements Remaining Settlements' includes lands without forest/herbaceous vegetation and/or no management activities contributing to essential changes in carbon pools; thus, a neutral balance was established in the main carbon pools (above-ground and below-ground biomass, dead organic matter, soil). Areas considered in sub-category 4E1 'Settlements Remaining Settlements' for the period 1970-2019 are shown in Table 6-54.

Table 6-54: Area of land included in sub-category 4E1 'Settlements Remaining Settlements' in the RM for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Settlements, ha	181826.1	181826.1	181826.1	184126.1	187326.0	187926.0	190025.9	191225.9	190825.9	194725.9
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Settlements, ha	203425.7	207055.1	207012.1	211012.1	213023.1	212602.1	211358.1	212911.1	212771.8	213987.1
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Settlements, ha	213962.9	214162.9	229325.5	226824.6	224798.7	223498.7	221199.7	220099.7	220066.1	217266.2

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use Matrix for the period 1970-2019.

4E2 'Land Converted to Settlements'

In order to estimate CO_2 removals/emissions from sub-category 4E2 'Land Converted to Settlements', a loss of carbon in biomass and in mineral soils was established due to conversion of different land types which were previously covered by a certain amount of biomass (forests, grassland, perennial plantations, etc.). At the same time, non-CO_2 (N_2O) emissions from the conversion of grassland to settlements were also estimated.

The calculation process of CO_2 removals/emissions is based on the annual increments in carbon stocks due to current biomass growth, and uses Equation 2.15 from the 2006 IPCC Guidelines (Volume 4, Chapter 2, Page 2.20).

Non-CO_2 (N_2O) emissions resulting from the conversion of grassland to settlements were estimated using Equation 11.8 from the 2006 IPCC Guidelines (Volume 4, Chapter 11, page 11.16).

The main land categories converted to settlements are croplands and grasslands (Table 6-55).

Table 6-55: Area of Lands Converted to Settlements in the RM for the period 1970-2019, ha

Conversion	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Cropland Converted to Settlements	0.0	0.0	0.0	2042.3	2614.1	1062.0	1878.9	980.3	0.0	3185.9
Grassland Converted to Settlements	0.0	0.0	0.0	457.7	585.9	238.0	421.1	219.7	0.0	714.0
Other Land Converted to Settlements	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**2500.0**	**3199.9**	**1300.0**	**2300.0**	**1200.0**	**0.0**	**3899.9**
Conversion	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Cropland Converted to Settlements	7107.0	3022.5	0.0	3267.6	1878.9	0.0	0.0	1552.1	0.0	1307.0
Grassland Converted to Settlements	1592.8	677.4	0.0	732.3	421.1	0.0	0.0	347.9	0.0	292.9
Other Land Converted to Settlements	0.0	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total	**8699.8**	**3700.5**	**0.5**	**4000.5**	**2300.6**	**0.6**	**0.6**	**1900.6**	**0.6**	**1600.6**

Conversion	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cropland Converted to Settlements	0.0	163.4	12416.9	0.0	959.0	0.0	0.0	81.7	0.0	898.6
Grassland Converted to Settlements	0.0	36.6	2782.8	0.0	214.9	0.0	0.0	18.3	0.0	201.4
Other Land Converted to Settlements	0.6	0.6	0.9	0.0	0.0	0.0	0.9	0.9	0.5	0.5
Total	**0.6**	**200.6**	**15200.6**	**0.0**	**1174.0**	**0.0**	**0.9**	**100.9**	**0.5**	**1100.5**
Conversion	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cropland Converted to Settlements	1143.7	0.0	0.0	413.4	0.0	0.0	0.0	0.0	0.0	0.0
Grassland Converted to Settlements	256.3	0.0	0.0	92.6	0.0	0.0	0.0	0.0	0.0	0.0
Other Land Converted to Settlements	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**1400.9**	**0.0**	**0.0**	**506.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Conversion	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cropland Converted to Settlements	1.0	677.2	0.0	0.0	395.4	1180.4	224.6	2597.4	0.0	4013.7
Grassland Converted to Settlements	0.0	151.8	0.0	0.0	88.6	264.6	50.3	582.1	0.0	899.5
Other Land Converted to Settlements	0.0	0.0	0.0	0.9	1.0	1.2	0.7	1.0	1.0	0.0
Total	**1.0**	**829.0**	**0.0**	**0.9**	**485.0**	**1446.1**	**275.7**	**3180.6**	**1.0**	**4913.2**

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use Matrix for the period 1970-2019.

Country-specific emission factors were developed within EU/UNDP 'Clima East' Project, and based on two other CDM Projects of the Kyoto Protocol: MSCP and MCFDP, respectively, as well as from other relevant information, in order to estimate annual biomass increments/losses on land converted to settlements (Table 6-56).

Table 6-56: EFs used to estimate CO_2 emissions/removals from sub-category 4E2 'Land Converted to Settlements'

Conversion	Indicator	Period, years	Unit	Indicator Value
Cropland Converted to Settlements	Annual average carbon increments/losses in biomass (crops)	year 1	Mg C/ha/an	-5.0
	Annual average carbon increments in dead organic matter (litter)	year 1	Mg C/ha/an	0.0
	Annual average increments/losses in soil organic carbon	years 1-20	Mg C/ha/an	-0.2168
Grassland Converted to Settlements	Annual average carbon increments/losses in biomass (herbaceous cover)	year 1	Mg C/ha/an	-3.78
	Annual average carbon increments in dead organic matter (litter)	year 1	Mg C/ha/an	0.0
	Annual average increments/losses in soil organic carbon	years 1-20	Mg C/ha/an	-2.4818
Other Land Converted to Settlements	Annual average carbon increments in biomass (herbaceous cover)	year 1	Mg C/ha/an	0.0
	Annual average carbon increments in dead organic matter (litter)	year 1	Mg C/ha/an	0.0
	Annual average increments in soil organic carbon	years 1-20	Mg C/ha/an	0.0

6.6.3. Uncertainties Assessment and Time-Series Consistency

4E1 'Settlements Remaining Settlements'

Uncertainties associated with the CO_2 emissions/removals from sub-category 4E1 'Settlements Remaining Settlements' are not estimated since a neutral balance was established in the main carbon pools (above-ground and below-ground biomass, dead organic matter, soil).

4E2 'Land Converted to Settlements'

Uncertainties associated with the CO_2 emissions/removals from sub-category 4E2 'Land Converted to Settlements' at the beginning and the end of the reference period (1990 and 2019) are somewhat low, and are estimated to be circa ±10 per cent. Uncertainties associated with emission/removals factors in both cases are also estimated to be circa ±10 per cent. Combined uncertainties from sub-category 4E2 'Land Converted to Settlements' are estimated to be circa ±14.14 per cent. Uncertainties introduced in the trend in total direct GHG emissions from sub-category 4E2 within Sector 4 'LULUCF' were estimated to be circa ±0.05 per cent.

For non-CO_2 emissions, uncertainties related to activity data represent circa ±10 per cent, whereas emission/removal factors have an uncertainty level of circa ±30 per cent. Combined uncertainties are estimated to be circa ±31.62 per cent, whereas uncertainties introduced in the trend in total direct GHG emissions within Sector 4 'LULUCF' were estimated to be circa ±0.10 per cent (see Annex 5-3.4)

6.6.4. Quality Assurance and Quality Control

The quality of assessment for category 4E 'Settlements' is ensured by the fact that most of the AD used is taken from official records (the General Land Cadaster of the Republic of Moldova). Annual biomass increment/loss for lands converted to settlements was estimated using country-specific EFs developed within EU/UNDP 'Clima East' Project, respectively based on two other CDM Projects: MSCP and MCFDP. At the same time, the quality of AD increased due to the development of the Land Use Matrix for the period 1970-2019 for the entire Sector 4 'LULUCF'.

Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach. Within this category, verification was focused, following the recommendations included in the 2006 IPCC Guidelines (Volume 4 'AFOLU'), on various aspects such as: verification of correct application of assessment methods set out in the Guidelines, ensuring correct use of national factors, their accuracy, as well as comparing them to the values used by other Eastern and Central European countries. The description of the general and specific verification process of the GHG inventory is presented in the chapter dedicated to category 4A 'Forest Land'.

6.6.5. Recalculations

No recalculations were performed to estimate CO_2 emissions/removals from sub-category 4E1 'Settlements Remaining Settlements'. No recalculations were performed to estimate CO_2 emissions/removals from sub-category 4E2 'Land Converted Settlements'. Between 1990-2019, CO_2 emissions/removals from category 4E 'Settlements' fluctuated, being influenced particularly by the impermanence of the process of conversion of different lands to this category (Table 6-55). Only emissions were recorded during the reference period, the highest being in 1992 (circa 386.6 kt CO_2), explained by large areas subject to conversion to settlements this year, and the lowest – in 2012 and 2013 (Table 6-57 and Figure 6-13).

Table 6-57: CO_2 emissions from category 4E 'Settlements' in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4E2 'Land Converted to Settlements'	84.7480	88.7139	386.6196	114.6181	130.4883	106.9167	101.5910	100.7954	99.0440	111.8259
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
4E2 'Land Converted to Settlements'	100.1768	67.0898	67.0898	67.8615	53.6737	53.6737	53.6737	49.2742	49.2742	45.5694
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4E2 'Land Converted to Settlements'	45.5694	62.0438	11.8882	13.7512	18.9848	39.1617	19.3071	77.3098	21.6217	116.5030

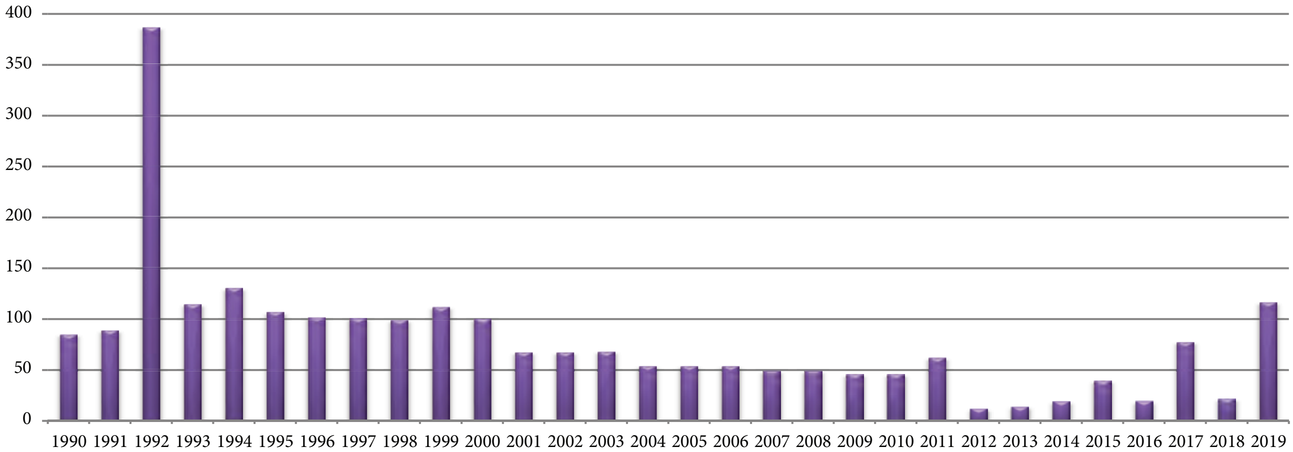

Figure 6-13: CO_2 emissions from category 4E 'Settlements' in the RM for the period 1990-2019, kt.

N_2O emissions from sub-category 4E2 'Land Converted to Settlements' are shown in Table 6-58.

Table 6-58: N_2O emissions from sub-category 4E2 'Land Converted to Settlements' in the RM for the period 1990-2019

Conversion	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4E.2.1 Cropland to Settlements, kt N_2O	0.5257	0.5729	0.6396	0.6999	0.7535	0.8037	0.8480	0.8894	0.9308	0.9636
4E.2.2 Grassland to Settlements, kt N_2O	0.0105	0.0106	0.0149	0.0142	0.0136	0.0133	0.0126	0.0123	0.0123	0.0115
4E.2 Conversions to Settlements, kt N_2O	0.5362	0.5835	0.6545	0.7141	0.7671	0.8170	0.8606	0.9017	0.9431	0.9751
4E2, Total, kt CO_2 equivalent	**159.7967**	**173.8786**	**195.0547**	**212.8037**	**228.5960**	**243.4567**	**256.4737**	**268.7144**	**281.0494**	**290.5838**
Conversion	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
4E.2.1 Cropland to Settlements, kt N_2O	0.9759	0.9787	0.9815	0.9747	0.9619	0.9492	0.9365	0.9189	0.9013	0.8796
4E.2.2 Grassland to Settlements, kt N_2O	0.0094	0.0083	0.0083	0.0073	0.0067	0.0067	0.0067	0.0061	0.0061	0.0057
4E.2 Conversions to Settlements, kt N_2O	0.9853	0.9870	0.9898	0.9820	0.9686	0.9559	0.9432	0.9250	0.9074	0.8853
4E2, Total, kt CO_2 equivalent	**293.6176**	**294.1316**	**294.9625**	**292.6299**	**288.6416**	**284.8502**	**281.0588**	**275.6524**	**270.4086**	**263.8049**
Conversion	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4E.2.1 Cropland to Settlements, kt N_2O	0.8579	0.8368	0.7767	0.7231	0.6753	0.6328	0.5965	0.5670	0.5376	0.5217
4E.2.2 Grassland to Settlements, kt N_2O	0.0057	0.0058	0.0015	0.0015	0.0013	0.0017	0.0018	0.0027	0.0027	0.0038
4E.2 Conversions to Settlements, kt N_2O	0.8636	0.8426	0.7781	0.7246	0.6766	0.6345	0.5983	0.5697	0.5403	0.5255
4E2, Total, kt CO_2 equivalent	**257.3381**	**251.1010**	**231.8871**	**215.9302**	**201.6397**	**189.0781**	**178.2795**	**169.7771**	**161.0110**	**156.5897**

6.6.6. Planned Improvements

The possibility to improve the cadastral records (as the main reference sources for AD) pertaining to specification of initial land-use categories from which they were converted to settlements, will be considered for the next inventory cycles in the Republic of Moldova.

6.7. Other Land (Category 4F)

6.7.1. Source Category Description

Category 4F 'Other Land' includes, in particular, bare soil, ravines, pits, rock, etc., as well as all land that do not fall into any of the other categories 4A-4E (for example, river banks, rocks).

This category is also used to close the sum of areas from the total official land of the country. 4F 'Other Land' comprises two categories: 4F1 'Other Land Remaining Other Land' and 4F2 'Land Converted to Other Land'.

6.7.2. Methodological Issues, Emission Factors and Data Sources

4F1 'Other Land Remaining Other Land'

Due to the particularities of lands in the Republic of Moldova included in sub-category 4F1 'Other Land Remaining Other Land' (land without forest/herbaceous vegetation and/or no management activities contributing to essential changes in carbon pools) a neutral balance was established in the main carbon pools (above-ground and belowground biomass, dead organic matter, soil).

AD on areas within this category are available in the General Land Cadaster of the Republic of Moldova and are also included in the Land Use Matrix for the period 1970-2019 (Table 6-59).

Table 6-59: Area of land included in category 4F1 'Other Land Remaining Other Land' in the RM for the period 1990-2019, ha

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Other Land	56300.0	53300.0	45855.0	51255.5	41078.0	40822.0	45444.0	48200.3	50226.0	51330.0
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Other Land	52230.0	56459.0	55383.0	54510.1	57649.4	51984.3	52532.2	61311.9	60290.5	60620.4
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Other Land	58553.4	55818.4	57268.9	60198.0	52389.0	58031.5	57836.3	55874.0	55426.4	48943.4

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use Matrix for the period 1970-2019.

4F2 'Land Converted to Other Land'

In order to estimate CO_2 removals/emissions from sub-category 4F2 'Land Converted to Other Land', a biomass loss was established due to conversion of different land categories which were previously covered by a certain amount of biomass (forests, grassland, perennial plantations, etc.). Activity data on areas subject to conversion within this category are available in the General Land Cadaster of the Republic of Moldova and are also included in the Land Use Matrix for the period 1970-2019. The main land categories subject to conversion to other land are forest lands, grasslands, and croplands – arable soils (Table 6-60).

Table 6-60: Area of Lands Converted to Other Land over the period 1970-2019, ha

Conversion	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Forest Land to Other Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	664.0	622.0	1654.0
Cropland to Other Land	0.0	0.0	6275.0	4614.4	0.0	1112.0	0.0	0.0	0.0	0.0
Grassland to Other Land	0.0	0.0	0.0	0.0	8433.0	1557.8	0.0	3436.0	3078.0	0.0
Wetlands to Other Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**6275.0**	**4614.4**	**8433.0**	**2669.8**	**0.0**	**4100.0**	**3700.0**	**1654.0**
Conversion	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Forest Land to Other Land	1691.0	0.0	1571.7	4308.3	248.5	8177.0	8802.0	1615.0	0.0	0.0
Cropland to Other Land	0.0	0.0	228.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grassland to Other Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wetlands to Other Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**1691.0**	**0.0**	**1800.4**	**4308.3**	**248.5**	**8177.0**	**8802.0**	**1615.0**	**0.0**	**0.0**

Conversion	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Forest Land to Other Land	0.0	0.0	2245.0	0.0	3248.0	1856.0	226.0	0.0	0.0	2096.0
Cropland to Other Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grassland to Other Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wetlands to Other Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**2245.0**	**0.0**	**3248.0**	**1856.0**	**226.0**	**0.0**	**0.0**	**2096.0**
Conversion	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Forest Land to Other Land	0.0	0.0	2409.0	0.0	0.0	1460.0	0.0	0.0	1860.0	0.0
Cropland to Other Land	0.0	0.0	0.0	0.0	2822.5	0.0	705.6	698.1	0.0	0.0
Grassland to Other Land	0.0	0.0	0.0	2874.9	890.1	8834.7	6836.7	0.0	0.0	0.0
Wetlands to Other Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**2409.0**	**2874.9**	**3712.6**	**10294.7**	**7542.4**	**698.1**	**1860.0**	**0.0**
Conversion	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Forest Land to Other Land	3046.6	2511.0	0.0	0.0	1900.0	0.0	2241.4	1019.0	1820.0	3740.0
Cropland to Other Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	145.0	1473.0
Grassland to Other Land	0.0	0.0	0.0	0.0	8702.9	0.0	0.0	0.0	0.0	2633.0
Wetlands to Other Land	0.0	0.0	694.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**3046.6**	**2511.0**	**694.5**	**0.0**	**10602.9**	**0.0**	**2241.4**	**1019.0**	**1965.0**	**7846.0**

Source: General Land Cadaster of the RM for the period 1970-2019; Land Use and Land-Use Change Matrix for the period 1970-2019.

The calculation process of CO_2 removals/emissions from sub-category 4F2 'Land Converted to Other Land' is based on the annual increments in carbon stocks due to current biomass growth, and uses Equation 2.15 from the 2006 IPCC Guidelines (Volume 4, Chapter 2, page 2.20). Country-specific emission factors were developed within CDM Projects: MSCP and MCFDP, as well as from other relevant information in order to estimate annual biomass increments/losses on land converted to other land (Table 6-61).

Table 6-61: EFs used to estimate CO_2 emissions/removals from sub-category 4F2 'Land Converted to Other Land'

Conversion	Indicator	Period, year	Unit	Indicator Value
Forest Land to Other Land	Annual average carbon increments/losses in biomass (trees and shrubs)	year 1	Mg C/ha/yr	-29.8
	Annual average carbon increments/losses in dead organic matter (litter)	year 1	Mg C/ha/yr	-1.15
	Annual average increments/losses in soil organic carbon	years 1-20	Mg C/ha/yr	-1.4156
Cropland to Other Land	Annual average carbon increments/losses in biomass (crops)	year 1	Mg C/ha/yr	-5.0
	Annual average carbon increments in dead organic matter (litter)	year 1	Mg C/ha/yr	0.0
	Annual average increments/losses in soil organic carbon	years 1-20	Mg C/ha/yr	-0.2168
Grassland to Other Land	Annual average carbon increments/losses in biomass (crops)	year 1	Mg C/ha/yr	-3.78
	Annual average carbon increments in dead organic matter (litter)	year 1	Mg C/ha/yr	0.0
	Annual average increments/losses in soil organic carbon	years 1-20	Mg C/ha/yr	-0.1241
Wetlands to Other Land	Annual average carbon increments/losses in biomass (crops)	year 1	Mg C/ha/yr	-4.2
	Annual average carbon increments in dead organic matter (litter)	year 1	Mg C/ha/yr	0.0
	Annual average increments/losses in soil organic carbon	years 1-20	Mg C/ha/yr	-2.4818

6.7.3. Uncertainties Assessment and Time-Series Consistency

4F1 'Other Land Remaining Other Land'

Uncertainties associated with the CO_2 emissions from 4F1 'Other Land Remaining Other Land' are not estimated, since a neutral balance was established in the main carbon pools (above-ground and below-ground biomass, dead organic matter, soils).

4F2 'Land Converted to Other Land'

Uncertainties associated with the CO_2 emissions/removals from 4F2 'Land Converted to Other Land' at the beginning and the end of the reference period (1990 and 2019) are somewhat low, and are estimated to be circa ±10 per cent. In both cases, emission/removal factors have an uncertainty level of circa ±10 per cent. Combined uncertainties from 4F2 'Land Converted to Other Land' represent circa ±14.14 per cent. Uncertainties introduced in the trend in total direct GHG emissions from sub-category 4F2 within Sector 4 'LULUCF' were estimated to be circa ±1.33 per cent (see Annex 5-3.4).

6.7.4. Quality Assurance and Quality Control

The quality of assessment for category 4F 'Other Land' is ensured by the fact that most of the AD used is taken from official records (the General Land Cadaster of the Republic of Moldova). Annual biomass increment/loss for lands converted to settlements was estimated using country-specific EFs developed within two CDM Projects: MSCP and MCFDP. At the same time, the quality of AD increased due to the development of the Land Use Matrix for the period 1970-2019.

Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach. Within this category, verification was focused, following the recommendations included in the 2006 IPCC Guidelines (Volume 4 'AFOLU'), on various aspects such as: verification of correct application of assessment methods set out in the Guidelines, ensuring correct use of national factors, their accuracy, as well as comparing them to the values used by other countries in the region.

6.7.5. Recalculations

No recalculations were performed to estimate CO_2 emissions/removals from category 4F 'Other Land'. For the year 2016, within 4F2 'Land Converted to Other Land', an error was found in the formula for calculating the areas subject to conversion in the Land Use Matrix, which generated a cumulative increase in values of 310.6 per cent or +265.99 t CO_2 for sub-category 4F 'Land Converted to Other Land'. Between 1990 and 2019, CO_2 emissions from category 4F 'Other Land' fluctuated (Table 6-62), being influenced particularly by the conversion of different lands to this category (Table 6-60).

Table 6-62: CO_2 emissions from category 4F 'Other Land' in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4F2 'Land Converted to Other Land'	152.3638	152.3638	418.7786	164.0168	549.4579	401.1281	217.3293	188.2363	185.0077	425.1554
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
4F2 'Land Converted to Other Land'	178.5246	178.5246	456.2431	201.6619	223.8177	416.5012	189.4964	83.1072	291.0044	79.9357
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
4F2 'Land Converted to Other Land'	441.4824	393.7285	114.1449	103.4500	436.6463	86.8192	351.6349	218.2055	321.2138	611.7881

The graphical illustration of the evolution of CO_2 emissions from category 4F 'Other Land' in the Republic of Moldova for the period 1990-2019 is shown in Figure 6-14.

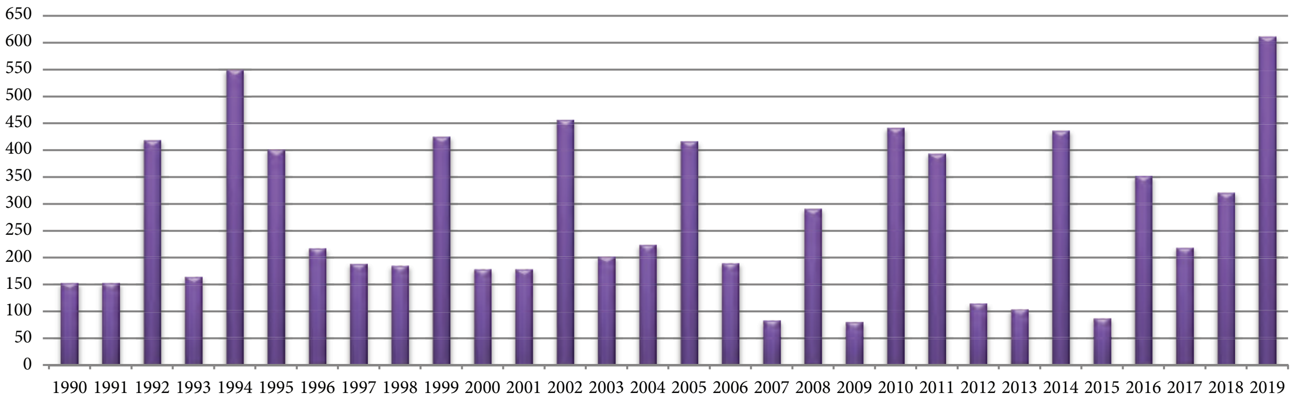

Figure 6-14: CO_2 emissions from category 4F 'Other Land' for the period 1990-2019, kt.

6.7.6. Planned Improvements

The possibility to improve the cadastral records (as the main reference sources for activity data) pertaining to specification of initial land-use categories from which they were converted to other land, will be considered for the next inventory cycle in the RM. At the same time, it is necessary to analyze the input and output process of land within category 4F 'Other Land', including in terms of establishing the average conversion period.

6.8. Harvested Wood Products (Category 4G)

6.8.1. Source Category Description

Category 4G 'Harvested Wood Products' includes CO_2 removals/emissions from wood products harvested/processed, imported or exported (rough round wood; saw logs, timber, wood panels, etc.) used in the national economy. In the Republic of Moldova, wood harvesting from forests takes place during the process of tending cutting (spacing, cleaning, thinning and hygiene cuts), final harvesting (regeneration cuts, preservation, hygiene) and ecological reconstruction. Due to the classification of the Republic of Moldova's forests in functional Group I, the harvesting in exploitable forests is made depending on their state, in order to ensure the regeneration/continuity of the stands. In this context, the low quality of the harvested wood products is observed, including the share of commercial wood in the total volume of the harvested wood. Thus, according to official records, between 1990 and 2019, the share of commercial wood in the total volume of the harvested wood was the largest in 1990 (17.6 per cent), while the lowest – in 2014 (3.9 per cent).

6.8.2. Methodological Issues, Emission Factors and Data Sources

For category 4G 'Harvested Wood Product', a Tier 1 approach was used (2006 IPCC Guidelines), and default emission/removal factors, respectively.

For the calculations, the IPCC „HWP Calculator' module was used ('Production Approach'). AD for the period 1961-2019 on wood products included in 4G 'Harvested Wood Products' are partly available in the official statistics of the Republic of Moldova, particularly for the period 1961-1993. For 1994-2019, AD from the FAOSTAT database was used. The evolution of wood products volume included in category 4G 'Harvested Wood Product' between 1961 and 2019 is presented in Table 6-63.

Table 6-63: Evolution of wood product volume considered in source category 4G 'Harvested Wood Products' for the period 1961-2019

Wood Products by Category	Source	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Rough round wood, m³	Produced	26960	26960	26960	26960	26960	24920	22880	20840	18800	16750	15100	13450
	Imported	73040	73040	73040	73040	73040	71480	69920	68360	66800	65240	63680	62120
	Exported	5620	5850	6080	6310	6540	6770	7000	7230	7460	7690	7920	8150
Other types of round wood, m³	Produced	32300	32300	32300	32300	32300	29860	27420	24980	22540	20100	18110	16120
	Imported	67700	67700	67700	67700	67700	66730	65760	64790	63820	62850	61880	60910
	Exported	0	0	0	0	0	0	0	0	0	0	0	0
Paper and cardboard, t	Produced	0	0	0	0	0	0	0	0	63150	64460	65770	67080
	Imported	37270	38760	40250	41740	43230	44720	46210	47700	49190	50680	52170	53660
	Exported	0	0	0	0	0	0	0	0	0	0	90	130
Timber, m³	Produced	42370	55720	69070	82420	95770	107700	119650	131550	142060	154070	154070	152920
	Imported	59240	60080	60920	61760	62600	62370	62140	61910	61680	61450	61220	60990
	Exported	1930	1990	2050	2110	2170	2230	2290	2350	2410	2470	2530	2590
Wood panels, m³	Produced	660	1320	1980	2640	3300	4540	5780	7020	8260	9500	18540	27580
	Imported	2580	2690	2800	2910	3020	3130	3240	3350	3460	3570	3680	3790
	Exported	2580	2690	2800	2910	3020	3130	3240	3350	3460	3570	3680	3790

Wood Products by Category	Source	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Rough round wood, m³	Produced	11800	10150	8480	8620	8760	8900	9040	9200	11750	8160	21080	26170
	Imported	60560	59000	57440	55880	54320	52760	51200	49640	48080	46520	44960	43400
	Exported	8380	8610	8840	9070	9300	9530	9760	9990	10220	10450	10680	10910
Other types of round wood, m³	Produced	14130	12140	10160	10340	10520	10700	10880	11050	14080	9780	25260	27160
	Imported	59940	58970	58000	57030	56060	55090	54120	53150	52180	51210	50240	49270
	Exported	0	0	0	0	0	0	0	0	0	0	0	0
Paper and cardboard, t	Produced	68390	69700	71010	72320	73630	74940	76250	77560	78870	80180	81490	84000
	Imported	55150	56640	58130	59620	61110	62600	64090	65580	67070	68560	70050	71560
	Exported	170	210	250	290	330	370	410	450	490	530	570	610
Timber, m³	Produced	151780	150730	149700	136260	122820	109400	95970	82530	80180	79380	86440	87610
	Imported	60760	60530	60300	60070	59840	59610	59380	59150	58920	58690	58460	58230
	Exported	2650	2710	2770	2830	2890	2950	3010	3070	3130	3190	3250	3310
Wood panels, m³	Produced	36620	45660	54700	56260	57820	59380	60940	62500	64800	67100	71600	86000
	Imported	3900	4010	4120	4230	4340	4450	4560	4670	4780	4890	5000	5110
	Exported	3900	4010	4120	4230	4340	4450	4560	4670	4780	4890	5000	5110

Wood Products by Category	Source	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Rough round wood, m³	Produced	31260	36350	41440	46530	51620	56710	61800	66890	71980	77070	82200	71800
	Imported	41840	40280	38720	37160	35600	34040	32480	30920	29360	26200	28300	28300
	Exported	11140	11370	11600	11830	12060	12290	12520	12824	6910	1000	200	200
Other types of round wood, m³	Produced	29060	30960	32860	34760	36660	38560	40460	42360	44260	46160	48100	41700
	Imported	48300	47330	46360	45390	44420	43450	42480	41510	40540	39570	38600	37630
	Exported	0	0	0	0	0	0	0	0	0	0	0	0
Paper and cardboard, t	Produced	82690	81380	80070	78760	77450	74140	68830	54470	40110	25750	11360	11010
	Imported	71560	71560	71560	71560	71560	71560	71560	5005	10114	20000	18400	18400
	Exported	650	690	730	770	810	850	890	993	993	6900	5200	5200
Timber, m³	Produced	86080	83860	81640	79320	77190	74970	72740	70520	68300	63480	59100	59300
	Imported	58000	57770	57540	57310	57080	56850	56620	55970	60000	74260	68190	65790
	Exported	3370	3430	3490	3550	3610	3670	3730	3821	2711	5600	900	600
Wood panels, m³	Produced	81670	77340	73010	68680	64350	60020	55690	51360	47000	14000	10000	10000
	Imported	5220	5330	5440	5550	5660	5770	5880	44	6400	10600	37400	37400
	Exported	5220	5330	5440	5550	5660	5770	5880	44	6400	10600	37400	37400

Wood Products by Category	Source	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Rough round wood, m³	Produced	82600	67400	74500	80800	71000	92500	94000	86600	83800	45000	43000	43000
	Imported	28300	28300	28300	28300	28300	28300	28300	28300	28300	43400	39000	39000
	Exported	200	800	900	300	300	300	300	300	300	370	2548	2548
Other types of round wood, m³	Produced	46900	37600	41300	47100	39200	49400	53800	49500	49500	17900	17000	17000
	Imported	36660	35690	34720	33750	32780	31810	30840	29870	28900	27930	26960	25990
	Exported	0	0	0	0	0	0	0	0	0	0	0	0
Paper and cardboard, t	Produced	13640	12220	5930	12220	14460	19220	31040	30530	26530	84200	97500	97500
	Imported	18400	27106	27106	27106	27106	27106	27106	27106	27106	48682	80001	80001
	Exported	5200	9970	9970	9970	9970	9970	9970	9970	9970	27880	6100	6100
Timber, m³	Produced	65300	59700	39000	39100	46800	74100	71200	68100	65300	58040	60480	60480
	Imported	56090	118190	118190	118190	118190	118190	118190	118190	118190	147020	155100	155100
	Exported	300	300	0	16	16	16	16	16	16	3900	4000	4000
Wood panels, m³	Produced	10000	10000	10000	10000	10000	10000	10000	10000	10000	18000	2800	2800
	Imported	37400	25962	25962	25962	25962	25962	25962	25962	25962	91	122	122
	Exported	37400	25962	25962	25962	25962	25962	25962	25962	25962	91	122	122

Wood Products by Category	Source	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Rough round wood, m³	Produced	43000	43000	43000	32600	29900	25600	25600	52000	46000	46000	46000	NA
	Imported	39000	39000	45448	49980	36252	29100	29100	29100	394	364	364	NA
	Exported	2548	2548	134	150	56	56	56	56	0	0	0	NA
Other types of round wood, m³	Produced	17000	17000	17000	12800	8600	8800	8800	15000	12000	12000	12000	NA
	Imported	25020	24050	23080	22110	21140	20170	18900	29652	9510	4688	4688	NA
	Exported	0	0	0	0	0	0	0	56	0	22	22	NA
Paper and cardboard, t	Produced	97500	97500	97500	4410	14100	11800	11700	26000	39800	40328	40328	NA
	Imported	80001	80001	40066	35840	34929	36066	36066	101456	97957	102837	102837	NA
	Exported	6100	6100	19898	17860	16406	14833	14833	17621	29648	31314	31314	NA
Timber, m³	Produced	60480	60480	60480	50834	37580	31700	33317	53000	51689	52735	52735	NA
	Imported	155100	155100	151113	132290	137595	150517	150517	153900	230697	232141	232141	NA
	Exported	4000	4000	1678	1980	1378	2081	2081	2081	256	224	224	NA
Wood panels, m³	Produced	2800	2800	2800	15055	15270	15000	15000	0	2487	2787	2787	NA
	Imported	122	122	161514	167030	169818	212560	212560	145001	329594	334958	334958	NA
	Exported	122	122	161514	167030	169818	212560	212560	3164	4264	4813	4813	NA

Source: Statistical Yearbooks of the RM for 1961-2019; FAOSTAT database for 1994-2019.

In order to estimate annual carbon increments/losses due to the use of wood products included in source category 4G 'Harvested Wood Products', emission/removal factors were used according to the 2006 IPCC Guidelines (Table 6-64).

Table 6-64: EFs used to estimate CO_2 emissions/removals from category 4G 'Harvested Wood Products' in the RM

Category	Indicator	Unit	Indicator Value
Period of use	Solid wood products (timber, saw logs and veneer, rough round wood, wood panels, etc.)	years	30.0
	Paper products	years	3.0
Conversion factor	Timber, other types of round wood (saw logs and veneer, etc.)	t C/m³	0.5
	Wood panels	t C/m³	0.295
	Paper and cardboards	t C/t	0.45

6.8.3. Uncertainties Assessment and Time-Series Consistency

Uncertainties associated with the CO_2 emissions/removals from category 4G 'Harvested Wood Products' at the beginning and the end of the reference period are somewhat large, and are estimated to be circa ±30 per cent. In both cases, emission/removal factors have an uncertainty level of circa ±10 per cent. Combined uncertainties from 4G 'Harvested Wood Products' represent circa ±31.62 per cent. Uncertainties introduced in the trend in total direct GHG emissions from category 4G 'Harvested Wood Products' within Sector 4 'LULUCF' were estimated to be circa ±0.12 per cent (see Annex 5-3.4)

6.8.4. Quality Assurance and Quality Control

The quality of assessment for 4G 'Harvested Wood Products' is ensured by the fact that most of the AD used is taken from official records (the Statistical Yearbooks of the RM; FAOSTAT database). At the same time, it should be noted that the export and import data for the period 1961-1993 (while the RM was part of the USSR and in the first years after independence) was calculated indirectly, considering the estimated needs in wood products of the national economy, as well as the local production capacities. Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach. Within this category, verification was focused, following the recommendations included in the 2006 IPCC Guidelines (Volume 4 'AFOLU'), on various aspects such as: verification of correct application of assessment methods set out in the Guidelines, ensuring correct use of national factors and indices, their accuracy, as well as comparing them to the values used by other countries in the region.

6.8.5. Recalculations

No recalculations were performed to estimate CO_2 emissions/removals from category 4G 'Harvested Wood Products' in the current inventory cycle for the period 1990-2016. Between 1990 and 2019, CO_2 emissions/removals from category 4G 'Harvested Wood Products' fluctuated significantly, being influenced particularly by the impermanence of the process of harvesting/production of wood with a long period of use. The largest removal volumes were recorded in 1990 (-122.2 kt), whereas the lowest – in 2011 (4.4 kt) (Table 6-65 and Figure 6-15).

Table 6-65: CO_2 removals/emissions from category 4G 'Harvested Wood Products' in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4G. CO_2 removals/emissions	-122.1804	-113.6108	-94.2986	-63.4504	-14.6464	5.9727	1.7792	-19.2429	-9.1293	18.5414
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
4G. CO_2 removals/emissions	5.8073	-6.2594	-56.6873	-65.1129	-53.4745	-41.1098	-40.5864	-44.5936	-35.6078	-28.4708
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
4G. CO_2 removals/emissions	-22.8014	-4.3808	76.8444	61.8814	58.0208	49.2353	0.8816	-67,4476	-63,5037	-57,5604

At the same time, CO_2 emissions were recorded during 9 years (1995-1996, 1999-2000, 2012-2016) – with a minimum of 0.9 kt in 2016, and a maximum of 76.8 kt in 2012.

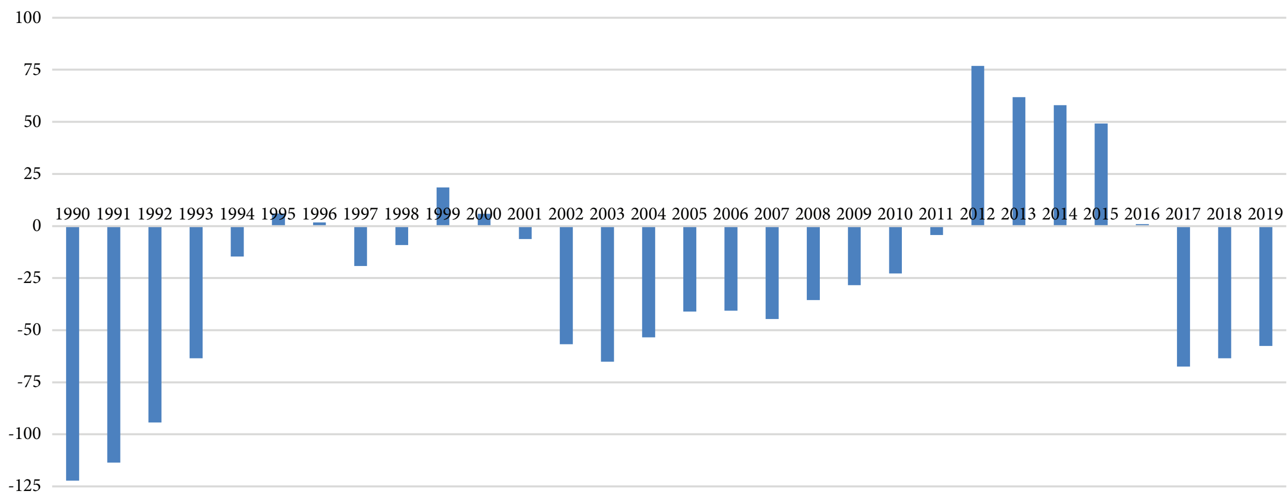

Figure 6-15: CO_2 removals/emissions from category 4G 'Harvested Wood Products' in the RM for the period 1990-2019, kt.

6.8.6. Planned Improvements

The possibility to improve the statistical records (as the main reference sources for activity data) regarding wood product production/export/import from category 4G 'Harvested Wood Products' will be considered for the next inventory cycle.

7. WASTE SECTOR

7.1. Overview

Within Sector 5 'Waste', there are monitored direct GHG emissions (CO_2, CH_4 and N_2O) from managing municipal and industrial waste, incineration and open burning of waste, as well as from wastewater treatment and discharge, estimated based on methodologies in the 2006 IPCC Guidelines. The source categories covered by this sector are: 5A 'Solid Waste Disposal', 5B 'Biological Treatment of Solid Waste', 5C 'Incineration and Open Burning of Waste' and 5D 'Wastewater Treatment and Discharge'. A brief overview, methodological issues and data sources, key categories, uncertainties assessment and times-series consistency, quality assurance and quality control verification, recalculations made and planned improvements are described for each source category within this sector.

7.1.1. Summary of Emission Trends

In 2019, Sector 5 'Waste' accounted for circa 11.2 per cent of total national direct GHG emissions (without Sector 4 'LULUCF'), being the third major source of GHG emissions in the Republic of Moldova, following Sector 1 'Energy' and Sector 3 'Agriculture'. It should be noted that Sector 5 'Waste' represents a major source of CH_4 emissions, accounting for circa 56.5 per cent of the total methane emissions reported at the national level.

Between 1990 and 2019, the total GHG emissions originating from Sector 5 'Waste' tended to slightly higher values, increasing from 1,514.23 kt CO_2 equivalent in 1990 to 1,552.64 kt CO_2 equivalent in 2019 (Table 7-1). The economic growth recorded in the last 20 years resulted in a higher level of welfare and industrial production, and increased consumption also results in a greater capacity to generate waste.

Table 7-1: Total direct GHG emissions from Sector 5 'Waste' for the period 1990-2019

Year	CO_2, kt	CH_4, kt CO_2 equivalent	N_2O, kt CO_2 equivalent	Total, kt CO_2 equivalent	CO_2, % of total	CH_4, % of total	N_2O, % of total
1990	14.9667	1,408.7400	90.5302	1,514.2369	1.0	93.0	6.0
1991	14.9994	1,449.2809	83.7658	1,548.0461	1.0	93.6	5.4
1992	15.0476	1,458.7057	77.0182	1,550.7715	1.0	94.1	5.0
1993	15.0447	1,523.1283	71.8949	1,610.0679	0.9	94.6	4.5
1994	15.0947	1,507.5656	69.8180	1,592.4783	0.9	94.7	4.4
1995	15.0979	1,504.6903	70.6313	1,590.4195	0.9	94.6	4.4
1996	15.0960	1,508.4213	69.6101	1,593.1275	0.9	94.7	4.4
1997	15.0456	1,501.7762	70.8125	1,587.6344	0.9	94.6	4.5
1998	15.0794	1,476.9649	71.8643	1,563.9087	1.0	94.4	4.6
1999	15.0071	1,474.0693	70.3233	1,559.3997	1.0	94.5	4.5
2000	14.9965	1,449.4802	71.9066	1,536.3833	1.0	94.3	4.7
2001	14.9689	1,422.8649	72.6511	1,510.4849	1.0	94.2	4.8
2002	14.9402	1,410.6925	74.5114	1,500.1442	1.0	94.0	5.0
2003	14.9100	1,380.4857	72.0468	1,467.4426	1.0	94.1	4.9
2004	14.8621	1,367.0780	68.6927	1,450.6328	1.0	94.2	4.7
2005	14.4670	1,371.6169	63.1072	1,449.1911	1.0	94.6	4.4
2006	14.1260	1,357.9231	64.9690	1,437.0182	1.0	94.5	4.5
2007	13.7672	1,351.7017	60.5129	1,425.9818	1.0	94.8	4.2
2008	13.4533	1,372.5181	55.7607	1,441.7321	0.9	95.2	3.9
2009	13.1613	1,384.7770	56.8951	1,454.8334	0.9	95.2	3.9
2010	12.8663	1,410.6943	55.0736	1,478.6343	0.9	95.4	3.7
2011	12.5793	1,420.8305	55.3120	1,488.7218	0.8	95.4	3.7
2012	12.2708	1,406.0560	55.7250	1,474.0519	0.8	95.4	3.8
2013	11.9033	1,348.4000	56.0012	1,416.3044	0.8	95.2	4.0
2014	11.5371	1,338.5668	55.4310	1,405.5348	0.8	95.2	3.9
2015	13.3135	1,336.0730	56.5261	1,405.9127	0.9	95.0	4.0
2016	13.0346	1,362.8803	57.1517	1,433.0666	0.9	95.1	4.0
2017	14.6448	1,456.4556	59.1497	1,530.2502	1.0	95.2	3.9
2018	14.2880	1,471.2802	60.7231	1,546.2913	0.9	95.1	3.9
2019	13.9120	1,477.8072	60.9234	1,552.6426	0.9	95.2	3.9
1990-2019, %	-7.0	4.9	-32.7	2.5	-9.3	2.3	-34.4

In 1990, CO_2, CH_4 and N_2O emissions accounted for circa 1.0 per cent, 93.0 per cent and 6.0 per cent, respectively, of the total GHG emissions from Sector 5 'Waste'. By 2019, the share of pollutants had not changed significantly, representing circa 0.9 per cent, 95.2 per cent, and 3.9 per cent, respectively, of the total sectoral emissions. At the same time, between 1990 and 2019, the total direct GHG emissions originating from Sector 5 'Waste' increased by circa 2.5 per cent, CH_4 emissions increased by 4.9 per cent, whereas CO_2 and N_2O emissions decreased by 7.0 per cent, and 32.7 per cent, respectively (Figure 7-1).

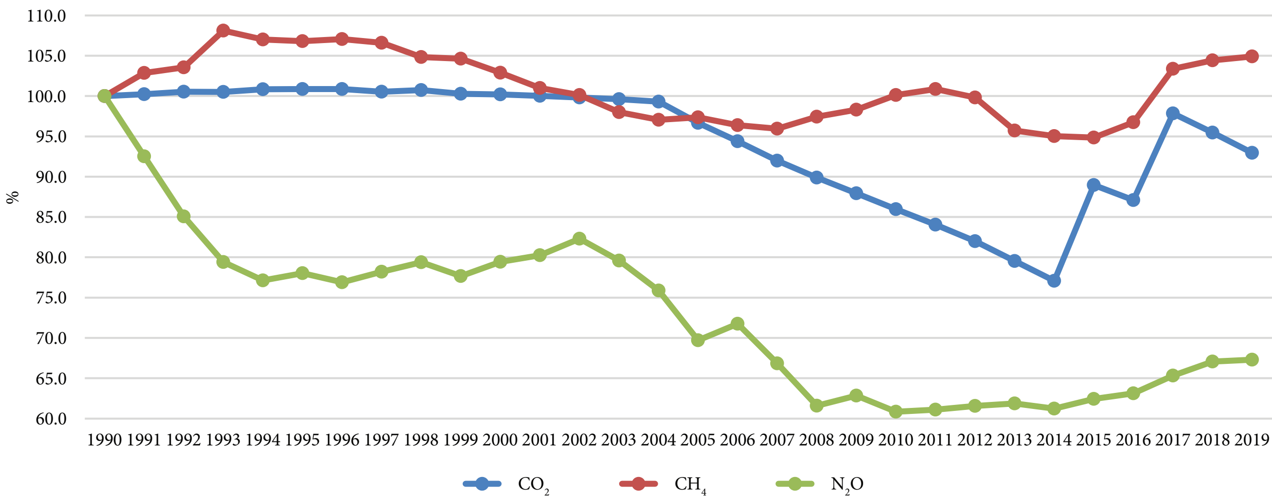

Figure 7-1: Direct GHG Emissions from Sector 5 'Waste' by Gas in the Republic of Moldova within 1990-2019 time periods, where 1990 represent 100 per cent.

Source category 5A 'Solid Waste Disposal' was the largest source of direct GHG emissions in the time period from 1990 through 2019, with a share varying between a minimum of 69.1 per cent of the total in 1990, and a maximum of 79.3 per cent of the total in 2019; followed by source category 5D 'Wastewater Treatment and Discharge', with a share varying between a minimum of 19.1 per cent of the total in 2019 and a maximum of 29.1 per cent of the total in 1990; source category 5C 'Incineration and Open Burning of Waste', with a share varying between 1.3 per cent and 1.7 per cent of the total sectoral emissions between 1990 and 2019; and source category 5B 'Biological Treatment of Solid Waste', with a share varying between 0.1 per cent and 0.2 per cent of the total sectoral emissions between 1990 and 2019.

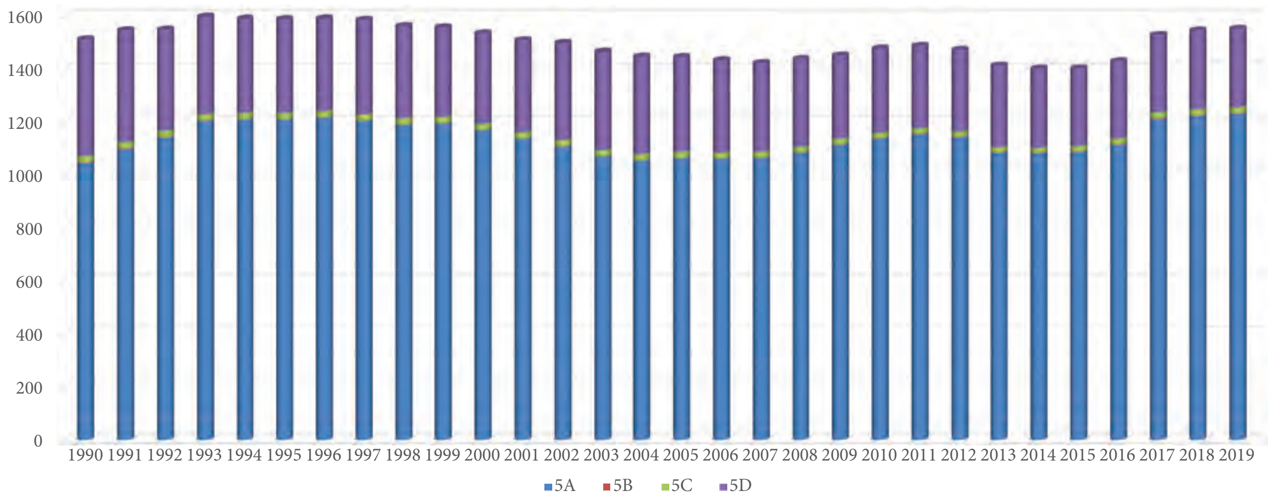

Figure 7-2: Breakdown of Direct GHG Emissions by Category under the Sector 5 'Waste' within 1990-2019 periods, kt CO_2 equivalent.

Within the reference period, direct GHG emissions from source category 5A 'Solid Waste Disposal' increased by circa 17.7 per cent; from 5B 'Biological Treatment of Solid Waste', increased by 2.7 per cent; from 5C 'Incineration and Open Burning of Waste' decreased by circa 7.0 per cent; whereas emissions from 5D 'Wastewater Treatment and Discharge' decreased by circa 32.8 per cent (Figure 7-2, Table 7-2).

Table 7-2: Breakdown of direct GHG emissions by category within Sector 5 'Waste' and their share in the total sectoral emissions in the RM for the period 1990-2019

Year	5A, kt CO_2 eq.	5B, kt CO_2 eq.	5C, kt CO_2 eq.	5D, kt CO_2 eq.	5. Waste, kt CO_2 eq.	5A, % of total	5A, % of total	5C, % of total	5D, % of total
1990	1,046.7277	2.3322	24.2621	440.9149	1,514.2369	69.1	0.2	1.6	29.1
1991	1,098.6185	2.3633	24.3113	422.7530	1,548.0461	71.0	0.2	1.6	27.3
1992	1,141.9561	2.4656	24.3859	381.9639	1,550.7715	73.6	0.2	1.6	24.6
1993	1,204.7183	1.2339	24.3780	379.7377	1,610.0679	74.8	0.1	1.5	23.6
1994	1,209.8012	1.1501	24.4557	357.0713	1,592.4783	76.0	0.1	1.5	22.4
1995	1,209.1757	1.0843	24.4574	355.7021	1,590.4195	76.0	0.1	1.5	22.4
1996	1,216.7829	1.1178	24.4511	350.7757	1,593.1275	76.4	0.1	1.5	22.0
1997	1,203.8019	1.0514	24.3673	358.4138	1,587.6344	75.8	0.1	1.5	22.6
1998	1,189.3544	1.0616	24.4200	349.0727	1,563.9087	76.1	0.1	1.6	22.3
1999	1,195.2267	0.9961	24.3095	338.8674	1,559.3997	76.6	0.1	1.6	21.7
2000	1,169.5330	0.8984	24.2867	341.6652	1,536.3833	76.1	0.1	1.6	22.2
2001	1,137.4743	0.8156	24.2427	347.9523	1,510.4849	75.3	0.1	1.6	23.0
2002	1,108.0606	0.8954	24.1900	366.9981	1,500.1442	73.9	0.1	1.6	24.5
2003	1,070.2330	0.9401	24.1339	372.1356	1,467.4426	72.9	0.1	1.6	25.4
2004	1,055.1514	0.9870	24.0505	370.4440	1,450.6328	72.7	0.1	1.7	25.5
2005	1,064.3081	1.0334	23.4100	360.4395	1,449.1911	73.4	0.1	1.6	24.9
2006	1,061.8430	1.1210	22.8582	351.1959	1,437.0182	73.9	0.1	1.6	24.4
2007	1,064.8219	1.4534	22.2776	337.4289	1,425.9818	74.7	0.1	1.6	23.7
2008	1,084.1973	1.7211	21.7640	334.0498	1,441.7321	75.2	0.1	1.5	23.2
2009	1,115.0489	1.9112	21.2853	316.5880	1,454.8334	76.6	0.1	1.5	21.8
2010	1,137.8491	1.8439	20.8019	318.1393	1,478.6343	77.0	0.1	1.4	21.5
2011	1,155.0806	1.8723	20.3296	311.4394	1,488.7218	77.6	0.1	1.4	20.9
2012	1,143.6162	1.9175	19.8260	308.6921	1,474.0519	77.6	0.1	1.3	20.9
2013	1,084.7685	2.0826	19.2357	310.2176	1,416.3044	76.6	0.1	1.4	21.9
2014	1,083.0800	2.1785	18.6487	301.6276	1,405.5348	77.1	0.2	1.3	21.5
2015	1,087.1715	2.1795	21.5422	295.0195	1,405.9127	77.3	0.2	1.5	21.0
2016	1,115.1732	2.1665	21.0986	294.6284	1,433.0666	77.8	0.2	1.5	20.6
2017	1,211.7264	2.4799	23.7193	292.3246	1,530.2502	79.2	0.2	1.6	19.1
2018	1,223.5561	2.2360	23.1496	297.3497	1,546.2913	79.1	0.1	1.5	19.2
2018	1,231.5881	2.3952	22.5520	296.1073	1,552.6426	79.3	0.2	1.5	19.1
1990-2019, %	17.7	2.7	-7.0	-32.8	2.5	14.8	0.2	-9.3	-34.5

The table below shows the evolution of direct GHG emissions from Sector 5 'Waste' in the Republic of Moldova by sources and gas (Table 7-3).

Table 7-3: Direct GHG Emissions from Sector 5 'Waste', by Source and Gas, in the Republic of Moldova within 1990-2019 periods, kt CO_2 equivalent

Year	5A	5B		5C			5D		5. Waste
	CH_4, kt CO_2 equivalent	CH_4, kt CO_2 equivalent	N_2O, kt CO_2 equivalent	CO_2, kt	CH_4, kt CO_2 equivalent	N_2O, kt CO_2 equivalent	CH_4, kt CO_2 equivalent	N_2O, kt CO_2 equivalent	Total, kt CO_2 equivalent
1990	1,046.7277	1.3597	0.9725	14.9667	7.6876	1.6078	352.9650	87.9499	1,514.2369
1991	1,098.6185	1.3779	0.9855	14.9994	7.7010	1.6109	341.5835	81.1694	1,548.0461
1992	1,141.9561	1.4375	1.0281	15.0476	7.7226	1.6157	307.5895	74.3744	1,550.7715
1993	1,204.7183	0.7194	0.5145	15.0447	7.7182	1.6150	309.9724	69.7653	1,610.0679
1994	1,209.8012	0.6705	0.4796	15.0947	7.7410	1.6200	289.3528	67.7185	1,592.4783
1995	1,209.1757	0.6322	0.4521	15.0979	7.7395	1.6200	287.1429	68.5592	1,590.4195
1996	1,216.7829	0.6517	0.4661	15.0960	7.7356	1.6194	283.2511	67.5246	1,593.1275
1997	1,203.8019	0.6130	0.4384	15.0456	7.7079	1.6138	289.6535	68.7603	1,587.6344
1998	1,189.3544	0.6189	0.4427	15.0794	7.7234	1.6172	279.2682	69.8045	1,563.9087
1999	1,195.2267	0.5807	0.4154	15.0071	7.6922	1.6101	270.5697	68.2978	1,559.3997
2000	1,169.5330	0.5238	0.3746	14.9965	7.6818	1.6084	271.7416	69.9236	1,536.3833
2001	1,137.4743	0.4755	0.3401	14.9689	7.6683	1.6055	277.2468	70.7055	1,510.4849
2002	1,108.0606	0.5221	0.3734	14.9402	7.6480	1.6017	294.4618	72.5363	1,500.1442
2003	1,070.2330	0.5481	0.3920	14.9100	7.6262	1.5977	302.0785	70.0571	1,467.4426
2004	1,055.1514	0.5754	0.4116	14.8621	7.5964	1.5919	303.7548	66.6893	1,450.6328
2005	1,064.3081	0.6025	0.4309	14.4670	7.3936	1.5495	299.3127	61.1268	1,449.1911
2006	1,061.8430	0.6536	0.4674	14.1260	7.2192	1.5130	288.2073	62.9886	1,437.0182
2007	1,064.8219	0.8474	0.6060	13.7672	7.0358	1.4745	278.9966	58.4323	1,425.9818
2008	1,084.1973	1.0034	0.7176	13.4533	6.8704	1.4403	280.4470	53.6028	1,441.7321
2009	1,115.0489	1.1143	0.7969	13.1613	6.7157	1.4083	261.8981	54.6899	1,454.8334
2010	1,137.8491	1.0751	0.7689	12.8663	6.5595	1.3761	265.2106	52.9287	1,478.6343
2011	1,155.0806	1.0916	0.7807	12.5793	6.4058	1.3445	258.2525	53.1868	1,488.7218
2012	1,143.6162	1.1179	0.7996	12.2708	6.2443	1.3109	255.0776	53.6146	1,474.0519
2013	1,084.7685	1.2142	0.8684	11.9033	6.0604	1.2720	256.3568	53.8608	1,416.3044
2014	1,083.0800	1.2701	0.9084	11.5371	5.8782	1.2334	248.3385	53.2891	1,405.5348
2015	1,087.1715	1.2707	0.9088	13.3135	6.8029	1.4258	240.8280	54.1915	1,405.9127
2016	1,115.1732	1.2631	0.9034	13.0346	6.6672	1.3968	239.7768	54.8516	1,433.0666
2017	1,211.7264	1.4458	1.0341	14.6448	7.5036	1.5709	235.7799	56.5448	1,530.2502
2018	1,223.5561	1.3036	0.9324	14.2880	7.3280	1.5335	239.0924	58.2573	1,546.2913
2019	1,231.5881	1.3965	0.9988	13.9120	7.1455	1.4945	237.6771	58.4302	1,552.6426
1990-2019, %	17.7	2.7	2.7	-7.0	-7.1	-7.0	-32.7	-33.6	2.5

Within the current inventory cycle, indirect GHG emissions, ozone and aerosol precursors (NO_x, CO, NMVOC and SO_2), from Sector 5 'Waste' were recorded (Table 7-4), in accordance with the assessment methods available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019).

Table 7-4: Indirect GHG Emissions from Sector 5 'Waste' in the RM within 1990-2019 periods, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NOx	0.1503	0.1506	0.1510	0.1508	0.1512	0.1512	0.1511	0.1505	0.1508	0.1502
CO	2.6430	2.6451	2.6506	2.6428	2.6482	2.6451	2.6417	2.6305	2.6344	2.6281
NMVOC	0.8662	0.9029	0.9417	0.9829	1.0273	1.0704	1.1226	1.1751	1.2299	1.2870
SO_2	0.0052	0.0053	0.0053	0.0053	0.0054	0.0054	0.0054	0.0054	0.0054	0.0053
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NOx	0.1500	0.1497	0.1493	0.1488	0.1481	0.1442	0.1408	0.1372	0.1339	0.1308
CO	2.6204	2.6161	2.6051	2.5930	2.5791	2.5098	2.4509	2.3898	2.3308	2.2748
NMVOC	1.3503	1.4170	1.5665	1.6449	1.7277	1.8136	1.9042	1.9996	2.1002	2.2062
SO_2	0.0054	0.0054	0.0054	0.0054	0.0054	0.0053	0.0051	0.0050	0.0049	0.0048
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NOx	0.1277	0.1246	0.1214	0.1179	0.1144	0.1326	0.1301	0.1465	0.1432	0.1397
CO	2.2175	2.1602	2.1026	2.0438	1.9861	2.3124	2.2716	2.5663	2.5112	2.4571
NMVOC	2.3162	2.4774	2.5381	2.6003	2.6641	2.7381	2.8005	2.9935	2.9680	3.0845
SO_2	0.0048	0.0047	0.0046	0.0045	0.0043	0.0049	0.0047	0.0052	0.0051	0.0049

7.1.2. Key Categories

The results of key category analysis under Sector 5 'Waste' (Table 7-5), carried out following a Tier 1 approach, are presented in Annex 1 of this Report.

Table 7-5: Key Categories identified under the Sector 5 'Waste'

IPCC Category	GHG	Source Category	Key Categories
5A	CH_4	Solid Waste Disposal	Yes (L, T)
5B	CH_4	Biological Treatment of Solid Waste	No
5B	N_2O	Biological Treatment of Solid Waste	No
5C	CO_2	Incineration and Open Burning of Waste	No
5C	CH_4	Incineration and Open Burning of Waste	No
5C	N_2O	Incineration and Open Burning of Waste	No
5D	CH_4	Wastewater Treatment and Discharge	Yes (L, T)
5D	N_2O	Wastewater Treatment and Discharge (Human Sewage)	No

Abbreviations: L – Level Assessment; T – Trend Assessment.

7.1.3. Methodological Issues

In order to estimate GHG emissions from source categories 5A 'Solid Waste Disposal', 5B 'Biological Treatment of Solid Waste', 5C 'Incineration and Open Burning of Waste', and 5D 'Wastewater Treatment and Discharge', there were used both a Tier 1 and a Tier 3 approach, default EFs values provided by the 2006 IPCC Guidebook, as well as country-specific emission factors (Table 7-6). A detailed description of methods and EFs used to estimate emissions is available in the respective sub-chapters of the NIR (7.2-7.5).

Table 7-6: Assessment methods used to estimate GHG emissions from Sector 5 'Waste'

IPCC Category	Source Category	CO_2		CH_4		N_2O	
		Method	EF	Method	EF	Method	EF
5A	Solid Waste Disposal	NA	NA	T3	D, CS	NA	NA
5B	Biological Treatment of Solid Waste	NA	NA	T1	D	T1	D
5C	Incineration and Open Burning of Waste	T1	D, CS	T1	D, CS	T1	D
5D	Wastewater Treatment and Discharge	NA	NA	T1	D, CS	T1	D

Abbreviations: T1 – Tier 1; T2 – Tier 2; CS – country-specific; D – default; NA –Not Applicable; NO – Not Occurring.

7.1.4. Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the Sector 5 'Waste' (including by source categories) is described in detail in the sub-chapters 7.2-7.5, as well as in the Annex 5-3.5 of the NIR. Combined uncertainties as a percentage of total direct sectoral emissions were estimated to be circa ±40.67 per cent. The uncertainties introduced in trend in total direct sectoral emissions were estimated to be circa ±36.11 per cent. In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

7.1.5. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists by individual source categories were filled in for each source category under the Sector 5 'Waste', following a Tier 1 approach. It should be noted that AD and methods used for estimating GHG emissions under the Sector 5 'Waste' were documented and archived both in hard copies and electronically. In order to identify the data entry, as well GHG emissions estimation related errors, AD and EFs verifications and QC procedures were applied. Following the recommendations included into the 2006 IPCC Guidelines, GHG emissions from the Sector 5 'Waste' were estimated based on AD and EFs from official sources of reference.

7.1.6. Recalculations

GHG emission from Sector 5 'Waste' were recalculated as a result of updating activity data utilised for source categories 5C 'Incineration and Open Burning of Waste', and 5D 'Wastewater Treatment and Discharge'; and as a result of including category 5B 'Biological Treatment of Solid Waste' in the inventory for the first time, respectively. In comparison with the results recorded in the previous inventory cycle, the recalculations resulted in a slight downward trend in direct GHG emissions for the years 1990-2001 and 2010-2016, and a slight upward trend in direct GHG emissions for the period 2002-2009, varying from a minimum of 0.1 per cent in 1990 and a maximum of 1.9 per cent in 2016 (Table 7-7). The results are presented in the respective sub-chapters of the NIR (7.2-7.5).

Table 7-7: Recalculation results of direct GHG emissions for the period 1990-2016, included into the BUR2 of the RM under the UNFCCC (Sector 5 'Waste'), kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1,515.3675	1,549.1274	1,551.1552	1,613.2220	1,596.2076	1,594.7260	1,598.9768	1,595.3101	1,571.3598	1,565.8223
BUR3	1,514.2369	1,548.0461	1,550.7715	1,610.0679	1,592.4783	1,590.4195	1,593.1275	1,587.6344	1,563.9087	1,559.3997
Difference, %	-0.1	-0.1	0.0	-0.2	-0.2	-0.3	-0.4	-0.5	-0.5	-0.4
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1,541.7515	1,514.6064	1,482.2734	1,447.0589	1,436.5710	1,428.7535	1,419.5998	1,419.3635	1,438.4739	1,452.6665
BUR3	1,536.3833	1,510.4849	1,500.1442	1,467.4426	1,450.6328	1,449.1911	1,437.0182	1,425.9818	1,441.7321	1,454.8334
Difference, %	-0.3	-0.3	1.2	1.4	1.0	1.4	1.2	0.5	0.2	0.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	1,483.2997	1,500.9112	1,491.1032	1,437.5505	1,436.0537	1,431.2923	1,460.2737			
BUR3	1,478.6343	1,488.7218	1,474.0519	1,416.3044	1,405.5348	1,405.9127	1,433.0666	1,530.2502	1,546.2913	1,552.6426
Difference, %	-0.3	-0.8	-1.1	-1.5	-2.1	-1.8	-1.9			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

7.1.7. Assessment of Completeness

The current inventory covers direct GHG emissions from four categories under Sector 5 'Waste' (Table 7-8). GHG emissions from source category 5B 'Biological Treatment of Solid Waste' were estimated for the first time.

Table 7-8: Assessment of Completeness under Sector 5 'Waste'

IPCC Category	Source Category	CO_2	CH_4	N_2O
5A	Solid Waste Disposal	NE	X	NE
5B	Biological Treatment of Solid Waste	NO	X	X
5C	Incineration and Open Burning of Waste	X	X	X
5D	Wastewater Treatment and Discharge	NE	X	X
5E	Other	NO, NE	NO, NE	NO, NE

Abbreviations: X – source categories included into the inventory; NO – Not Occurring; NE – Not Estimated; NA – Not Applicable.

7.1.8. Planned Improvements

Planned improvements at source category level within Sector 5 'Waste' are described in detail in sub-chapters 7.2-7.5 of the NIR.

7.2. Solid Waste Disposal (Category 5A)

7.2.1. Source Category Description

The current situation with the management of 'Municipal Solid Waste' (MSW) in the Republic of Moldova is similar to the situation in other developing countries; it is in the budding stage and includes two basic elements: municipal solid waste generating sources and the landfills.

The generating process of municipal solid waste is influenced by multiple factors, the most relevant being the income of the population, consumer behaviour, the use of new packaged products, as well as the demographic evolution.

The recent increase in the wellbeing of the population and the evolution of the urbanization process resulted in an increased waste generation rate per capita, varying, according to the World Bank's studies, between 0.3 and 0.4 kg/per capita/day in rural areas, and around 0.9 kg/per capita/per day in urban areas, respectively.

This data was taken into consideration during the development of the Republic of Moldova's Waste Management Strategy for 2013-2027[128].

Food consumption currently generates more and more waste. The introduction of new packages, particularly plastic, produces a significant negative impact on the environment. The polyethylene terephthalate (PET) packaging have replaced glass packaging in recent years; while the polyethylene (PE) sacks, bags or boxes have replaced paper packaging, thereby influencing the amount and composition of generated waste.

The increasing number of markets, shops and supermarkets, along with an increase in welfare, respectively, in the purchasing power of packaged products led to a greater capacity to generate waste, particularly in urban areas.

Waste generation indicators were revised in the Republic of Moldova during the completing process of the feasibility studies for the development of integrated waste management systems at regional level, and the following values were proposed: for rural areas: 0.5-0.7 kg/per capita/day, and 0.9 kg/per capita/day, respectively, for small urban areas and district centres, and 1.3-1.5 kg/per capita/day for Balti and Chisinau municipalities.

It should be mentioned that these calculations use AD on waste disposed provided by waste collection services.

Currently, the most used method of treating waste is waste disposal on sites, which often is a major source of soil pollution and groundwater contamination. In this context, sanitation and waste management services represent an important goal for local and governmental structures.

According to the 'State Ecological Inspectorate Yearbook for 2019 – Environment Protection in the RM', there are currently 1,137 SWDS with a total area of 1,222 ha. These sites were established in each locality by local public authorities, and are exploited according to the decision of local councils – 989 landfills with an area of 1,028 ha.

Most of the SWDS landfills, circa ¾, do not correspond to the sanitary and ecological requirements, and the volume of domestic waste, accumulated since their establishment, is unknown. Currently, in most town halls, activities regarding sanitation problems of localities, separate waste collection are organised at a satisfactory level.

Thus, specialized services in waste collection and disposal exist in municipalities, all district towns, their management being carried out in an organised way through these services, which work on a contract basis with individual generators. Thus, 168 services specialized in waste collection and disposal are organized and operate (56 services in the urban sector, and 112 – in the rural sector). 272 rural localities benefited from municipal waste-collection services.

There is no statistical evidence carried out on the volumes of previously accumulated waste in landfills, there are only visual estimates of environmental inspectors, who estimate the total volume of MSW accumulated in landfills at about 30-35 million tonnes.

In most district towns the dump sites are overfilled, the disposed waste layer being 10-15 metres deep (e.g., in Ungheni, Cahul, Ocnita, etc.); at some landfills, the layer may reach circa 10-20 metres deep (e.g., in Briceni, Balti, Ialoveni, etc.); and even 25-30 metres deep (Cretoaia and Orhei municipality). Circa 3/4 of district towns' landfills have been used for circa 30-40 years, being at over 80 per cent of their capacity.

[128] <http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=347341>.

In recent years there have been changes in waste management in Chisinau municipality. The landfill situated in Cretoaia village that serves Chisinau municipality became operational by the end of 1990 (the de facto exploitation began in 1991); this landfill has an area of about 24.95 ha, the net area being 20.89 ha.

According to the project, it was designed to store circa 44 million m^3 of MSW until the end of 2010. By 2011, when its use stopped, only 19 million m^3 of solid waste were stored, which is less than half the capacity of the landfill.

From 2011 to 2017, Chisinau municipality has stored its waste near the waste trans-shipment station, located in Bubuieci village. The new location, was treated as a temporary solution, and became a serious environmental problem since waste was disposed on an unmanaged land, lacking environmental protection measures such as sealing foundation, collecting storage gas, collecting and treating leachate, rainwater deviation, etc.

Since summer 2017, Chisinau municipality is storing again its waste at the Tintareni landfill, after negotiating the conditions for reusing the landfill with the local public authorities, including the solutions for the environmental protection problems.

Between 2018 and 2019, measures were taken to recultivate and remedy the environmental pollution caused by the landfill, located near the waste trans-shipment station in Bubuieci village.

Also, the leachate treatment station at the landfill in Tantareni village has recently been established (November 2020), together with the protection dam of the landfill.

Image 7-1: Landfill in Tantareni village and the leachate treatment facility.

The impact of waste on the environment has alarmingly increased in recent years, and its mismanagement leads to contamination of soil and groundwater, as well as CH_4, CO_2, and toxic gas emissions with direct effects on public health and the environment.

Between 1990 and 2019, methane emissions from source category 5A 'Solid Waste Disposal' increased by circa 17.7 per cent, from circa 41.87 kt in 1990, to circa 49.26 kt in 2019 (Figure 7-3).

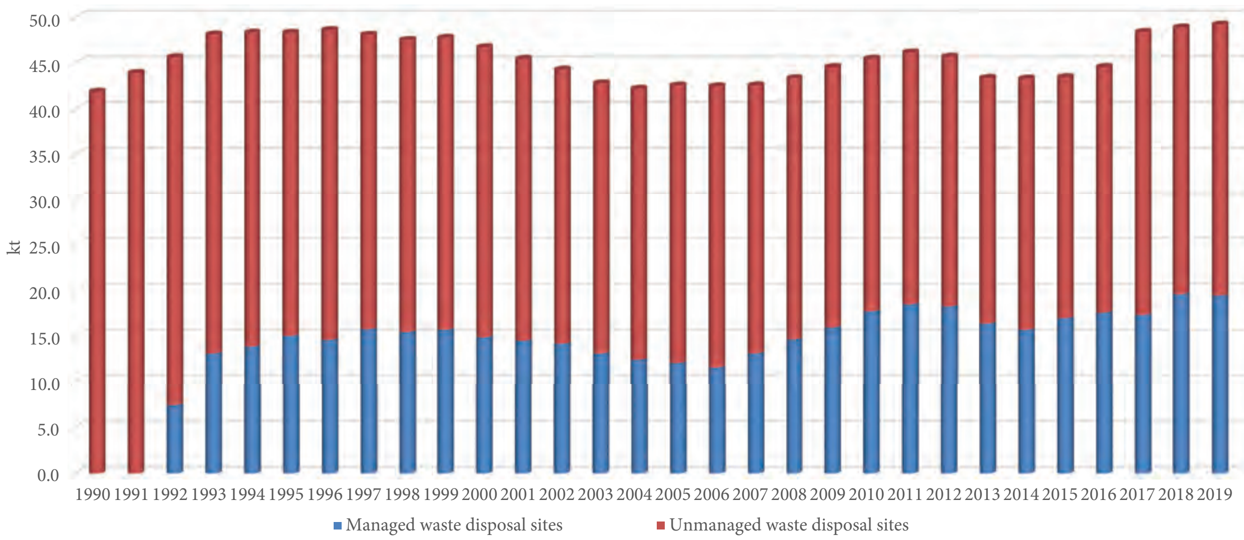

Figure 7-3: Methane emissions from 5A 'Solid Waste Disposal' for the period 1990-2019, kt.

7.2.2. Methodological Issues, Emission Factors and Data Sources

In order to estimate methane emissions from solid waste disposal, the 2006 IPCC Guidelines recommends using the First Order Decay Method, with three alternative methodological approaches – Tier 1, 2 and 3; the Tier 1 method uses mainly default activity data and default EFs; the Tier 2 method uses only default emission factors partially, requiring country-specific activity data on waste disposal at SWDS for historical periods longer than 10 years; the Tier 3 method uses national statistical data on solid waste disposal for more relevant periods (for example, longer than 25 years), with country-specific EFs and parameters resulting from measurements and research conducted periodically at national level (for example, fraction DOC or degradable organic carbon in year x; fraction DOC_f or fraction DOC dissimilated; L_o – methane generation potential, etc.).

Assessment Method

In the Republic of Moldova, methane emissions from 5A 'Solid Waste Disposal' were estimated using the First Order Decay Method (IPCC FOD), with a Tier 3 approach.

The methane emissions were estimated using Equation 3.1 from the 2006 IPCC Guidelines (Volume 5, Chapter. 3, page 3.8):

$$CH_4\ Emissions = [\Sigma_x\ CH_4\ generated_{x,T} - R_T] \bullet (1-OX_T)$$

Where:

- CH_4 Emissions – amount of methane generated in year *T*, kt;
- T – inventory year;
- x – waste category or type/material;
- R_T – recovered methane in year *T*, kt;
- OX_T – oxidation factor in year *T* (fraction).

One key input in IPCC FOD model is the amount of degradable organic matter (DOCm) in waste disposed into SWDS (Solid Waste Disposal Sites). This value is estimated using data on disposal of different waste categories (MSW – Municipal Solid Waste, sludge, industrial and other waste) and the different waste types/material (food, paper, wood, textiles, etc.) included in these categories, or alternatively as mean DOC in bulk waste disposed.

The basis for the calculation is the amount of Decomposable Degradable Organic Carbon DDOCm). DDOCm is the part of the organic carbon that will degrade under the anaerobic conditions in SWDS. The amount of DDOCm (where the index m is used for mass) can be estimated using Equation 3.2 provided by the 2006 IPCC Guidelines (Volume. 5, Chapter. 3, page 3.9):

$$DDOCm = W \bullet DOC \bullet DOCf \bullet MCF$$

Where:

- DDOCm – mass of decomposable DOC deposited, kt;
- W – mass of waste deposited, kt;
- DOC – degradable organic carbon in the year of deposition, fraction, kt C / kt waste;
- DOCf – fraction of DOC that can decompose (fraction);
- MCF – methane correction factor for aerobic decomposition in the year of deposition (fraction).

Using DDOCm, it can be estimated the methane generation potential (L_o), by applying Equation 3.3 provided by the 2006 IPCC Guidelines (Vol. 5, Chapter. 3, Page 3.9):

$$L_o = DDOCm \bullet F \bullet 12/16$$

Where:

- Lo – CH_4 generation potential, kt CH_4;
- DDOCm – mass of decomposable DOC, kt;
- F – fraction of CH_4 in generated landfill gas (volume fraction);
- 16/12 – molecular weight ratio CH_4/C (ratio).

DDOCm accumulated in the SWDS at the end of year T can be estimated using Equation 3.4 provided by the 2006 IPCC Guidelines (Vol. 5, Chapter. 3, Page 3.9), while DDOCm decomposed at the end of year T, respectively using Equation 3.5 provided by the 2006 IPCC Guidelines (Vol. 5, Chapter. 3, Page 3.9).

$$DDOCma_T = DDOCmd_T + (DDOCma_{T-1} \bullet e^{-k})$$

$$DDOCm\ decomp_T = DDOCma_{T-1} \bullet (1 - e^{-k})$$

Where,

T – inventory year;

$DDOCma_T$ – DDOCm accumulated in the SWDS at the end of year T, kt;

$DDOCma_{T-1}$ – DDOCm accumulated in the SWDS at the end of year T-1, kt;

$DDOCmd_T$ – DDOCm deposited into the SWDS in year T, kt;

$DDOCm\ decomp_T$ – DDOCm decomposed in the SWDS in year T, kt;

k – constant, $k = \ln(2)/t_{1/2}$ (y^{-1});

$t_{1/2}$ – half-life time (y).

The amount of methane formed from decomposable material is found by multiplying the CH_4 fraction in generated landfill gas and the CH_4/C molecular weight ratio and can be estimated using Equation 3.6 provided by the 2006 IPCC Guidelines (Vol. 5, Chapter. 3, Page 3.10):

$$CH_4\ generated_T = DDOCm\ decomp_T \bullet F \bullet 16/12$$

Where,

CH_4 generated in year $_T$ – amount of CH_4 generated from decomposable material;

DDOCm decomp $_T$ – DDOCm decomposed in year T, kt;

F – fraction of CH_4, by volume, in generated landfill gas (fraction);

16/12 – molecular weight ratio CH_4/C (ratio).

Emission Factors

Degradable organic carbon (DOC) is the organic carbon in waste that is accessible to biochemical decomposition and can be estimated using Equation 3.7 provided by the 2006 IPCC Guidelines (Volume 5, Chapter 3, page 3.13):

$$DOC = \sum_i (DOC_i \bullet W_i)$$

Where,

DOC – fraction of degradable organic carbon in bulk waste, kt C/kt waste;

DOC_i – fraction of degradable organic carbon in waste type *i* (e.g., the default value for paper is 0.4 (wet weight basis);

W_i – fraction of waste type *i* by waste category (e.g., the default value for paper in MSW in Eastern Europe is 0.218 (wet weight basis).

The default DOC values for these fractions for MSW can be found in Table 2.4 in the 2006 IPCC Guidelines (Vol. 5, Chapter. 2, Page 2.14), while for industrial waste by industry in Table 2.5 in the 2006 IPCC Guidelines (Vol. 5, Chapter. 2, Page 2.16). A similar approach can be used to estimate the DOC content in total waste disposed in the country annually. In the IPCC FOD model, the estimation of the DOC in MSW is needed only for the bulk waste option, and is the average DOC for the MSW disposed in the SWDS, including inert materials.

The inert part of the waste (glass, plastics, metals and other non-degradable waste (see default values in Table 2.3 in the 2006 IPCC Guidelines (Vol. 5, Chapter. 2, Pages 2.12-2.13) is important when estimating the total amount of DOC in MSW. Therefore it is advised not to use IPCC default waste composition data together with country-specific MSW disposal data, without checking that the inert part is close to the inert part in the IPCC default data. The use of country-specific values is encouraged if data are available.

Country-specific values can be obtained by performing waste generation studies, sampling at SWDS combined with analysis of the degradable carbon content within the country.

Methane Correction Factor (MCF)

The Methane Correction Factor (MCF) refers to the effect of solid waste management practices on the generation of methane emissions. Unmanaged SWDS produce less CH_4 from a given amount of waste than anaerobic managed SWDS since in the respective disposal sites, a larger fraction of waste decomposes aerobically in the top layer. Table 7-9 presents the default values of the MCF for different types of SWDS.

Table 7-9: MCF values used to estimate CH_4 emissions from Solid Waste Disposal Sites

Type of sites	MCF	MCF used in the Republic of Moldova
Managed – anaerobic[1]	1.0	Chisinau municipality, for the period 1991-2019.
Managed – semi-aerobic[2]	0.5	NA
Unmanaged – deep (> 5 m)[3]	0.8	Chisinau municipality, up to 1990. Balti municipality and district towns.
Unmanaged – shallow (< 5 m)[4]	0.4	Rural areas of the Republic of Moldova
Uncategorised SWDS[5]	0.6	NA

Notes: [1]Anaerobic managed solid waste disposal sites include the following: cover material, mechanical compacting or levelling of solid waste; [2]Semi-aerobic managed solid waste disposal sites include the following: permeable cover material, leachate drainage system, regulating pondage and gas ventilation system; [3]Unmanaged solid waste disposal sites – deep include all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 metres and/or high water table at near ground level; [4]Unmanaged solid waste disposal sites – shallow include all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 metres; [5]Uncategorised solid waste disposal sites – only if countries cannot categorise their SWDS into above four categories of managed and unmanaged SWDS, the MCF for this category can be used.

Degradable Organic Carbon (DOC)

Degradable organic carbon (*DOC*) is the organic carbon that is accessible to biochemical decomposition. It is based on the composition of waste and can be calculated from a weighted average of the carbon content of various components of the waste stream – cardboard, textiles, waste from gardens, parks and other non-food waste, food waste and wood waste.

Based on waste morphologic composition studies performed between 1986 and 2016, there were calculated the country-specific DOC values. Figure 7-4 illustrates the share of biodegradable fractions in the waste stream in the RM, indicating a decrease from circa 77.0 per cent in 1986, to circa 54.0 per cent in 2001, with a further increase to 72.4 per cent in 2005, and a subsequent decrease to circa 58.9 per cent in 2016.

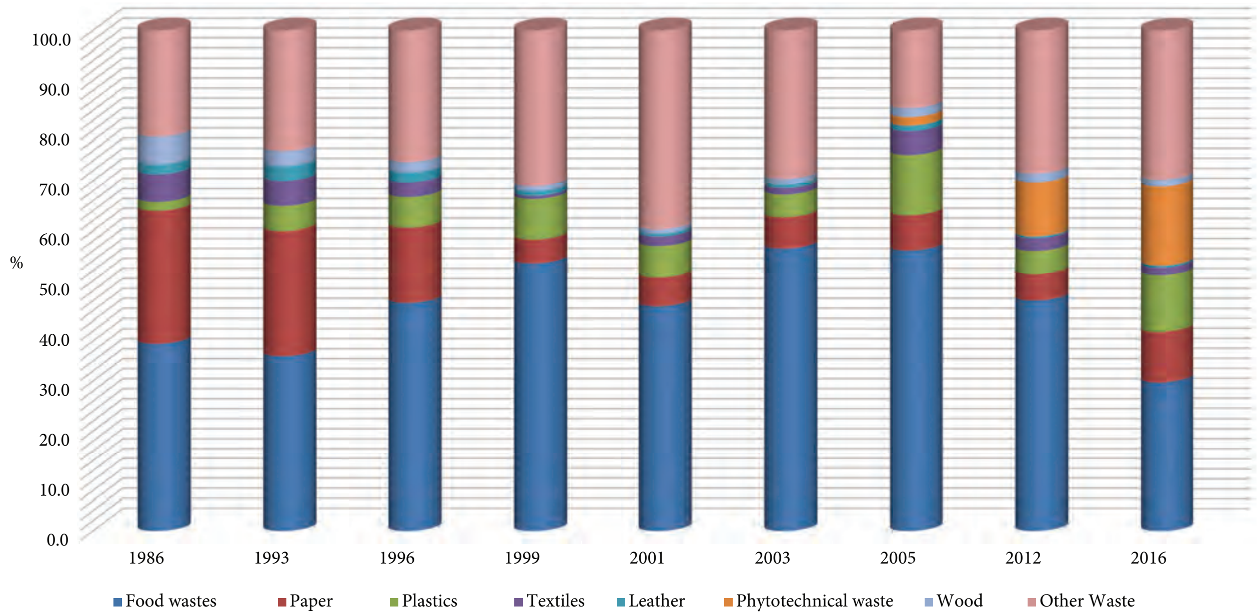

Figure 7-4: Biodegradable waste in the Major Waste Streams in the RM for the period 1986-2016.

Within the current inventory cycle, no new studies on the solid waste morphological composition were conducted. A new study is envisaged to determine the morphological composition of municipal waste in the next inventory cycle.

Fraction of Degradable Organic Carbon Which Decomposes (DOC_f)

DOC_f is the fraction of Degradable Organic Carbon, which is ulteriorly converted to biogas and reflects the fact that part of the carbon either decomposes or decomposes extremely slowly in SWDS. It is considered that DOC_f value is dependent of the temperature from the anaerobic area of the site, revealed by the following relation: 0.014T + 0.28 (Tabasaran, 1981).

The recommended default value in the 2006 IPCC Guidelines (Volume 5, Chapter 3, page 3.13) is 0.5. In the RM, the country-specific values for DOC and DOC_f fractions (Table 7-10) were calculated using the 'MSW Learning Tool' created by the University of Florida (1996) based on the laboratory experiments conducted by Dr Morton Barlaz (1987, 1997) and further investigations by Chandler, Van Soest (1980).

Table 7-10: Country-specific Values for DOC and DOC_f Fractions Used to Estimate CH_4 Emissions from SWDS within 1985-2016 periods

	1986	1993	1996	1999	2001	2003	2005	2012	2016
DOC_f	0.5178	0.5258	0.5667	0.6353	0.6207	0.6277	0.5935	0.4985	0.4204
DOC	0.2069	0.1891	0.1522	0.1091	0.1009	0.1201	0.1410	0.1405	0.1475

Fraction of CH_4 in Generated Landfill Gas (F)

The 2006 IPCC Guidelines (Volume 5, Chapter 3, page 3.15) recommends the use of a default 0.5 value for the fraction of CH_4 in landfill gas (*F*). Still, it is known that the *F* value can vary between 0.4 and 0.6, depending on several factors which can influence the process of degradation of solid household waste, including the morphological composition of MSW (Bingemer, Crutzen, 1987).

In the Republic of Moldova, the biogas composition was estimated based on the Buswell extended equation (Table 7-11 and Figure 7-5), using AD on the waste morphologic composition, which also served as the basis to estimate *DOC* and DOC_f values.

Table 7-11: Country-specific Values on Biogas Composition in Landfill Gas in the Republic of Moldova within 1986-2016 periods, Based on Extended Buswell Equation, %

	1986	1993	1996	1999	2001	2003	2005	2012	2016
C --> CH_4	53.1	54.0	54.5	55.4	55.1	54.5	55.6	54.2	55.2
C --> CO_2	46.9	46.0	45.5	44.6	44.9	45.5	44.4	45.8	44.8

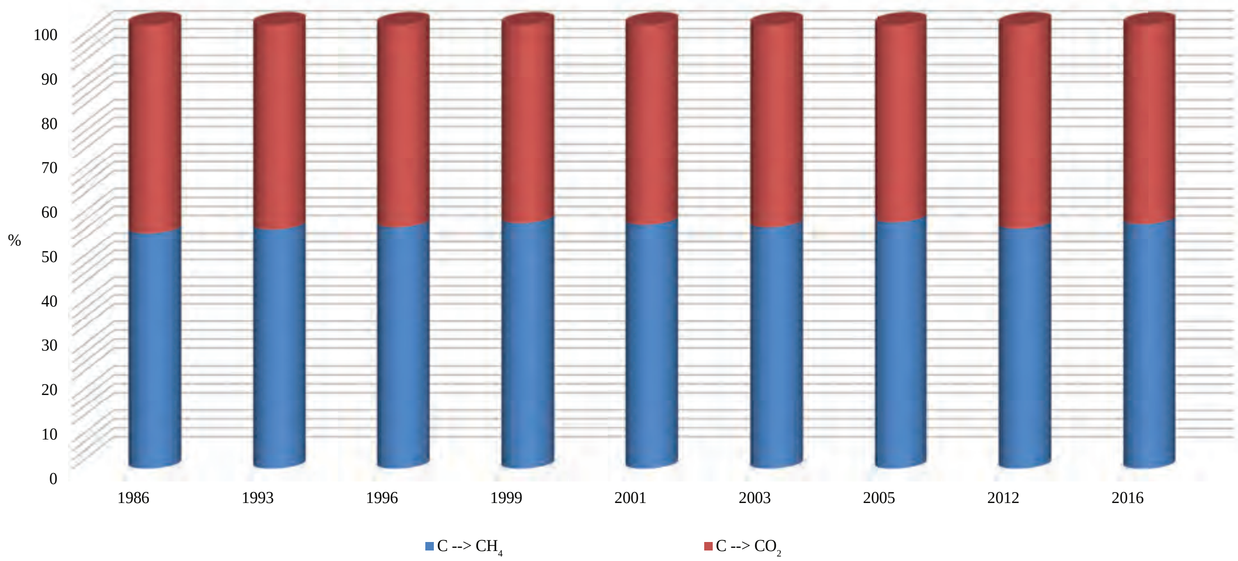

Figure 7-5: Biogas Composition in Landfill Gas in the Republic of Moldova within 1986-2016 periods, Based on Extended Buswell Equation.

At the same time, between 2000 and 2005, several studies were conducted in the RM on biogas composition from the landfills in the country, including those in Cretoaia village, Anenii Noi district. Table 7-12 presents the results of the studies.

Table 7-12: Fractions of Gases in the Landfill Gas Composition from Different SWDS in the Republic of Moldova and Other Countries

Gas	Landfill gas composition in developed countries, %	Landfill gas composition in developing countries, %	Landfill gas composition in Cretoaia, %	Landfill gas composition in Balti, %	Landfill gas composition in Straseni, %
CH_4	40-60	33-88	60-70[1]/ 63-65 [2]	75-85	23-43
CO_2	40-60	35-89	15-18[1]/ 32-34[2]	14-19	20-22
N_2	2.4-5.0	87	7-19	11-38	38-69
O_2	0.16	20.9	1-8[1]/ 0.5-1[2]	0.5-16	0.5-19

Note: [1]results obtained by national experts; [2]results obtained by DEPA (Danish Environment Protection Agency) experts.

Methane Recovery (R)

CH_4 generated at SWDS can be recovered and combusted (with or without energy recovery). The amount of methane recovered is expressed as *R* in Equation 3.1 from the 2006 IPCC Guidelines (Volume 5, Chapter 3, Page. 3.8). The default value for CH_4 recovery is zero. CH_4 recovery should be reported only when references documenting the amount of CH_4 recovery are available.

As for Republic of Moldova, AD on methane recovered and combusted at the SWDS in Tintareni (2.5199 kt of biogas in 2013, 2.9058 kt biogas in 2014, 3.1665 kt biogas in 2015 and 3.3898 kt biogas in 2016) were provided by the project document CDM 'PDD Landfill Gas Recovery and Energy Production at the Tintareni Landfill Site, Chisinau, Moldova'. Indirectly, the information can also be deduced from the Annual Reports on the activity of the National Agency for Energy Regulation[129] (which contains activity data on the amount of electricity generated annually from the biogas recovered at the SWDS in Tintareni by 'Tevas Grup' Ltd. that manages the respective site).

After the reopening of the landfill in 2017, new amounts of waste were deposited on its territory, requiring maintenance and management of the landfill. At the same time, the biogas recovery activity was interrupted, which led to the decommissioning of the biogas recovery system, previously installed on the landfill. Since 2017, the data on the amount of electricity generated annually from the biogas recovered at the MSW landfill in Tantareni by the company 'Tevas Grup' Ltd. is no longer found in the reports of the National Agency for Energy Regulation.

Oxidation Factor (OX)

The oxidation factor (OX) reflects the amount of methane from SWDS that is oxidised in the soil or other material covering the waste. If the OX is zero, methane oxidation does not occur but should the value of the oxidation factor be 1, methane oxidation represents 100 per cent. Well-managed SWDS tend to have higher oxidation rates than unmanaged dump sites, whereas unmanaged dump sites have a lower oxidation factor. The default value for the oxidation factor is zero, according to the 2006 IPCC Guidelines (Volume 5, Chapter 3, page 3.15) (Table 7-13).

Table 7-13: Oxidation Factor

Type of SDWS	Oxidation Factor (OX)
Managed[1], unmanaged and uncategorised SWDS.	0.0
Unmanaged, covered with CH_4 oxidising material[2].	0.1

Note: [1]Managed but not covered with aerated material; [2]e.g: soil or compost.

Constant k and half-life $t_{1/2}$

The half-life value $t_{1/2}$ is the time taken for the DOC_m in waste to decay to half its initial mass. The relationship between constant k and $t_{1/2}$ is the following: $k = \ln(2)/t_{1/2}$. The half-life is affected by a wide variety of factors related with the composition of the waste, climatic conditions at the site where the SWDS is located, characteristics of the SWDS, waste disposal practices and others, etc. The most rapid rates (k = 0.2 or $t_{1/2}$ = 3 years are associated with food waste in high moisture conditions, respectively the slower decay rate (k = 0.02 or $t_{1/2}$ = 35 years) for wood or paper waste slowly degradable associated with dry site conditions. There are two alternative approaches to select the half-life (or K value) for the calculations: calculate a weighted average for $t_{1/2}$ for mixed MSW or divide the waste stream into categories of waste according to their degradation speed. The default values used for constant *k* as well as the half-life value $t_{1/2}$ are available in Tables 3.3 and 3.4 in the 2006 IPCC Guidelines (Volume 5, Chapter 3, Pages 3.17 and 3.18).

NMVOC Emissions

NMVOC emissions from SWDS were estimated using the methodological approach available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019):

$$NMVOC\ Emissions = W \bullet EF \bullet 10^{-6}$$

Where:

NMVOC Emissions – NMVOC emissions in inventory year, kt / yr;

[129] <http://anre.md/ro/reports/8>.

W – amount of solid waste disposed, kt / yr;

EF – emission factor, kg NMVOC / kt of waste (default value used, 1.56 kg NMVOC/t of solid waste, available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2016), Category 5A "Biological treatment of waste – solid waste disposal on land", Table 3-1, p. 5);

10^{-6} – conversion factor, from kg to kt.

Data Sources

In the previous inventory cycle, multiple statistical sources on solid waste management records were examined, such as, Statistical Forms: F-1 'Toxic Waste' and F-2 'Waste' and Statistical Form 'Special Road Transport', whereas since 2003, also the Statistical Form No. 2–gc 'Urban Settlements Sanitation' reflecting the amounts of municipal solid waste transported to landfills and approved by the Order of the Department of Statistics and Sociology, No. 83, dated 01.08.2003, which reflects the amount of solid waste deposited.

The performed analyses revealed that only municipal solid waste is being transported to dumps by means of sanitation services, while other organic types of waste such as waste from food processing industry, from animal breeding and phytotechnical waste disposed are not included in the Statistical Form Nr.2–gc 'Urban Settlements Sanitation', because they are disposed by the beneficiary's own transport. In these conditions, data on the amount of waste from the food processing industry, from animal breeding and phytotechnical waste disposed were collected through the Statistical Form F-2 'Waste'. Considering the trends in the activity data collected through the statistical form F-2 'Waste' between 2007 and 2012, it was decided to infer a conversion coefficient from municipal waste into industrial for the period 1990-2019. The downward trend of the coefficient from 0.8 to 0.4 is justified by the economic decline that the country experienced over the period 1990-1999, as well as the increase in the amount of municipal waste. In the current inventory cycle, the same approach was used in the collection of activity data, for municipal and industrial waste, using the information on the disposal of MSW reported through the statistical form no. 2 – gc 'Sanitation of urban localities'.

Table 7-14 refers only to the urban landfills were sanitation services exist and provides activity data to the National Bureau of Statistics of the Republic of Moldova. Historical AD for the period 1959-1984 were deduced based on the population number, the social-economic development conditions as well as waste generation trends. At the same time, the average value of the MCF was estimated considering the SWDS characteristics, such as managed or unmanaged SWDS and the depth of the disposed waste layer. By the end of 1990, the landfill in Cretoaia village had become operational and serving Chisinau municipality (de facto use of this landfill started in 1991), while the GHG emissions generated by this landfill began in 1992, using the MCF = 1.

Table 7-14: Activity Data on the Amount of Solid Waste Disposed on Land and Industrial Waste Disposed on Land in the Republic of Moldova within 1959-2019

	Total	MSW			D_{ind}, kt	DDMS			Average MCF
	MSW + D_{ind}, kt	Total, kt	Inert waste, kt	Without inert waste, kt		Managed, MCF=1.0	Unmanaged, >5 m, MCF=0.8	Unmanaged, <5 m, MCF=0.4	
1959	595.26	357.16	103.56	253.60	238.11	0.0	10.0	90.0	23.4
1960	626.59	375.96	109.01	266.95	250.64	0.0	10.0	90.0	23.6
1961	659.57	395.74	114.75	280.99	263.83	0.0	15.0	85.0	23.8
1962	694.29	416.57	120.79	295.79	277.71	0.0	15.0	85.0	24.1
1963	730.83	438.50	127.17	311.33	292.33	0.0	15.0	85.0	24.3
1964	769.29	461.58	133.84	327.74	307.72	0.0	15.0	85.0	24.6
1965	809.78	485.87	140.88	344.99	323.91	0.0	15.0	85.0	24.8
1966	852.40	511.44	148.31	363.13	340.96	0.0	20.0	80.0	25.1
1967	897.26	538.36	156.11	382.25	358.91	0.0	20.0	80.0	25.4
1968	944.49	566.69	164.31	402.38	377.80	0.0	20.0	80.0	25.7
1969	994.20	596.52	172.90	423.62	397.68	0.0	20.0	80.0	26.1
1970	1046.53	627.92	182.09	445.82	418.61	0.0	20.0	80.0	26.4
1971	1162.81	697.68	202.30	495.38	465.12	0.0	25.0	75.0	27.2
1972	1224.01	734.40	212.98	521.43	489.60	0.0	25.0	75.0	27.6
1973	1288.43	773.06	224.19	548.87	515.37	0.0	25.0	75.0	28.0
1974	1356.24	813.74	235.97	577.77	542.50	0.0	25.0	75.0	28.4
1975	1427.62	856.57	248.44	608.13	571.05	0.0	25.0	75.0	28.9

	Total	MSW			D_{ind}, kt	DDMS			Average MCF
	MSW + D_{ind}, kt	Total, kt	Inert waste, kt	Without inert waste, kt		Managed, MCF=1.0	Unmanaged, >5 m, MCF=0.8	Unmanaged, <5 m, MCF=0.4	
1976	1502.76	901.66	261.46	640.19	601.10	0.0	30.0	70.0	29.4
1977	1581.85	949.11	275.24	673.87	632.74	0.0	30.0	70.0	29.9
1978	1665.11	999.06	289.73	709.34	666.04	0.0	30.0	70.0	30.4
1979	1752.74	1051.65	306.12	745.52	701.10	0.0	30.0	70.0	31.0
1980	1844.99	1014.75	294.26	720.48	830.25	0.0	35.0	65.0	31.2
1981	1892.30	1040.77	301.80	738.96	851.54	0.0	35.0	65.0	31.5
1982	1940.82	1067.45	309.55	757.91	873.37	0.0	35.0	65.0	31.9
1983	1990.59	1094.82	317.49	777.33	895.76	0.0	35.0	65.0	32.2
1984	2041.63	1122.89	325.64	797.25	918.73	0.0	35.0	65.0	32.5
1985	2093.98	1163.32	337.36	825.96	930.66	0.0	40.0	60.0	32.9
1986	2236.52	1242.51	360.33	882.18	994.01	0.0	40.0	60.0	33.8
1987	2217.94	1232.19	357.34	874.85	985.75	0.0	40.0	60.0	33.7
1988	2307.89	1282.16	371.83	910.33	1025.73	0.0	45.0	55.0	34.2
1989	2414.81	1341.56	389.04	952.53	1073.25	0.0	45.0	55.0	34.9
1990	2311.52	1359.72	394.31	965.41	951.80	0.0	45.0	55.0	34.6
1991	2204.61	1377.88	399.56	978.32	826.73	0.0	45.0	55.0	34.2
1992	2156.28	1437.52	416.88	1020.65	718.76	16.3	30.0	53.7	34.3
1993	1279.31	719.41	208.63	510.78	559.90	27.2	30.0	42.8	27.9
1994	1161.65	670.52	194.45	476.07	491.14	28.6	30.0	41.4	27.3
1995	1070.97	632.19	183.34	448.85	438.78	31.1	30.0	38.9	26.8
1996	1074.35	651.73	208.42	443.31	422.62	30.0	30.0	40.0	26.9
1997	1003.87	613.00	196.16	416.84	390.87	32.8	30.0	37.2	26.4
1998	1003.69	618.92	198.05	420.87	384.77	32.5	30.0	37.5	26.5
1999	947.81	580.75	220.67	360.08	367.06	32.9	30.0	37.1	26.1
2000	924.55	523.80	199.04	324.76	400.74	31.8	30.0	38.2	25.8
2001	867.26	475.49	213.98	261.52	391.77	31.9	30.0	38.1	25.4
2002	926.28	522.07	235.22	286.85	404.22	32.0	30.0	38.0	25.8
2003	975.80	548.08	186.35	361.73	427.72	30.6	30.0	39.4	26.1
2004	1041.40	575.44	195.64	379.80	465.96	29.4	30.0	40.6	26.5
2005	1109.58	602.50	162.68	439.83	507.08	28.3	30.0	41.7	26.9
2006	1205.78	653.59	176.47	477.12	552.18	27.2	35.0	37.8	27.5
2007	1529.12	847.37	228.77	618.60	681.74	30.8	35.0	34.2	29.6
2008	1760.41	1003.42	270.92	732.50	756.99	33.8	35.0	31.2	31.1
2009	1651.91	1114.28	300.86	813.42	537.63	35.8	35.0	29.2	31.2
2010	1531.58	1075.06	290.27	784.80	456.52	39.0	35.0	26.0	30.5
2011	1554.28	1091.58	294.73	796.84	462.70	40.1	35.0	24.9	30.7
2012	1590.83	1117.94	346.55	771.39	472.89	40.0	35.0	25.0	31.0
2013	1726.60	1214.21	376.40	837.81	512.39	37.8	35.0	27.2	31.9
2014	1824.88	1270.13	393.73	876.40	554.75	36.3	35.0	28.7	32.5
2015	1826.90	1270.69	393.92	876.78	556.21	39.1	35.0	25.9	32.5
2016	1818.37	1263.09	378.93	884.16	555.28	39.5	35.0	25.5	32.5
2017	2090.53	1445.83	433.75	1012.08	644.71	35.8	35.0	29.2	34.3
2018	1895.71	1303.63	391.09	912.54	592.08	40.1	35.0	24.9	33.0
2019	2005.93	1396.47	418.94	977.53	609.46	39.6	35.0	25.4	33.8

Since 2001, the trends in waste generation per capita are steadily growing, in Chisinau city this level even exceeded the level recorded in the early 1990s. Thus, in 1990, just 20 per cent of the waste was generated in Chisinau city; in the last four or five years, the share of Chisinau city already represents about 30 per cent of the total amount of waste disposed in landfills.

It should also be mentioned that statistical information sometimes does not reflect the real situation regarding the solid municipal waste management. Thus, for example, the amount of solid municipal waste disposed in rural areas are not subject to statistical evidence, as no sanitation services exist there. Also, although waste processing enterprises operate in the RM, information on the amount of recycled waste is not always subject to a strict statistical evidence. Given the RM's intention to align to EU standards, the waste sector will essentially be restructured. In this context, the majority of SWDS are to be recovered and their number – drastically reduced until the commissioning of the regional landfills, planned in the RM's 'Waste Management Strategy' (2013-2027).

7.2.3. Uncertainties Assessment and Time-Series Consistency

For countries with efficient statistical systems, the 2006 IPCC Guidelines recommends the use of a value of circa 10-30 per cent of uncertainties associated with AD, while for countries with poor quality data, the uncertainties can be more than a factor of two. In the Republic of Moldova, it was deemed rational to use the value of ±30 per cent for uncertainties associated with managed and unmanaged SWM. It was taken into consideration that some types of waste (ex., waste from food processing industry, accounting for approximately 10 per cent of the total amount of solid waste generated in the country), were not completely taken into account while estimating the methane emissions from category 5A 'Solid Waste Disposal'. Taking into account the results of the studies undertaken in the Republic of Moldova to identify the MSW morphologic composition, (*DOC and* DOC_f), and the study of the biogas composition (CH_4 fraction in biogas), it was considered appropriate to use the value of ± 40 per cent for the uncertainties associated with the emission factors. Therefore, combined uncertainties for category 5A 'Solid Waste Disposal' represent circa 50 per cent (Annex 5-3.5).

In view of ensuring time series consistency of results, the same approach was used for the entire period under review, in conformity with good practices applied in the GHG emissions inventory.

7.2.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the category 5A 'Solid Waste Disposal' following a Tier 1 approach. Verification was focused on various aspects such as: on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines; use of country-specific factors; correct use of AD obtained from different reference sources, etc. It should be noted that the AD and methods used for estimating GHG emissions under the category 5A 'Solid Waste Disposal' were documented and archived both in hard copies and electronically.

7.2.5. Recalculations

No recalculations were performed in the current inventory cycle regarding the amount of methane emissions from category 5A 'Solid Waste Disposal' (Table 7-15).

Table 7-15: Comparative results of CH_4 emissions from category 5A 'Solid Waste Disposal' included into the BUR2 and BUR3 of the RM to the UNFCCC, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	41.8691	43.9447	45.6782	48.1887	48.3920	48.3670	48.6713	48.1521	47.5742	47.8091
BUR3	41.8691	43.9447	45.6782	48.1887	48.3920	48.3670	48.6713	48.1521	47.5742	47.8091
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
BUR2	46.7813	45.4990	44.3224	42.8093	42.2061	42.5723	42.4737	42.5929	43.3679	44.6020
BUR3	46.7813	45.4990	44.3224	42.8093	42.2061	42.5723	42.4737	42.5929	43.3679	44.6020
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
BUR2	45.5140	46.2032	45.7446	43.3907	43.3232	43.4869	44.6069			
BUR3	45.5140	46.2032	45.7446	43.3907	43.3232	43.4869	44.6069	48.4691	48.9422	49.2635
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

7.2.6. Planned Improvements

From the sustainable development perspective as well as from the European Union integration perspective, a new approach is needed to address the environmental issues, complying with the commitments under the ratified international conventions and agreements.

Among the main priorities of the EU strategy on waste management, is the need to promote statistical evidence of the generated waste, focused on the main criterion of relevance and comparability among the member states. Thus, between 2018 and 2020, several legislative acts were adopted for the coherent application of Law No. 209/2016 on waste, and it was deemed appropriate to transpose the Resolution of the EU Commission 2000/532/EC regarding the waste list, including hazardous waste.

At the same time, the approach to records in the field of waste management was reviewed, by approving Government Decision No. 501/2018 on the Instruction on keeping records and transmitting data on waste and its management, Government Decision No. 682/2018 on the approval of the Concept of the Automated Waste Management Information System, through which the reporting system www.siamd.gov.md was developed.

It must be acknowledged, however, that 2020 was the first reporting year in the new system and the information collected does not reflect the actual situation in the field of waste management. Thus, for example, the volumes of MSW generated in rural localities are not subject to statistical records, as there are usually no sanitation services. Likewise, albeit there are waste processing companies operating in the Republic of Moldova, the information on the amounts of recycled waste is not subject to strict statistical records. Taking into account the tendency of the Republic of Moldova to align with EU standards, the sector is to be essentially restructured. In this context, most MSW sites are to be re-established, and their number – drastically reduced.

Transformation coefficient of the volume of MSW into quantity

In the next inventory cycle the activity data will be updated, particularly the transformation coefficient of the volume of MSW into quantity needs to be reviewed. In recent years, there are trends to increase the share of packaging in the total amount of waste generated per capita, and the Sanitation Service in Chisinau shows that 1 m^3 of MSW is 180-200 kg, which will cause the revision of the coefficient 0.4 kg/1 m^3 of MSW. In the next period, we shall analyse the AD reported in the Automated Information System, in the National Register of Emissions and Transfer of Pollutants, and in the Automated Waste Management Information System, by the sanitation services in the country.

Morphological Composition of MSW

It is also proposed to update the study on the morphological composition of solid waste, with the involvement of the Environmental Reference Laboratory of the Environment Agency, solid waste generated in Chisinau, respectively in the cities of Causeni and Straseni. It will also be necessary to include the weighing of waste trucks in order to infer the transformation coefficient of the volume of MSW into quantity. Another aspect that needs to be mentioned is the fact that recently, June 2020, Law No. 89 on the ratification of the Financing Agreement between the Republic of Moldova and the European Investment Bank regarding the implementation of the project 'Solid Waste in the Republic of Moldova'. Through this agreement signed on October 18, 2019 between the European Investment Bank and the Government of the Republic of Moldova, a loan of 100 million euros will be granted for the improvement of solid waste management services in the country. The loan will be offered in several instalments, the first instalment being 25 million euros. This Agreement aims to implement the Waste Management Strategy 2013-2027 in the Republic of Moldova, involving projects aimed at modernizing and developing Solid Waste Management Systems and facilities in eight regions of our country. The projects will provide localities with new collection systems, mechanical-biological waste treatment facilities and new regional sanitary landfills for the entire country. The projects will aim to reduce the negative impact on the environment and human health, by modernizing waste collection systems and separate collection of recyclable materials and bio-waste, as well as rehabilitating or closing landfills. Regional landfills will be equipped with biogas recovery systems, as it will contribute to the reduction of GHG emissions and therefore to the achievement of the updated NDC, in accordance with to the provisions of the Paris Agreement.

7.3. Biological Treatment of Solid Waste (Category 5B)

7.3.1. Source Category Description

Composting and anaerobic digestion of organic waste, such as food waste, garden and park waste, and sludge from wastewater treatment plants are common practices in both developed and developing countries. The advantages of biological treatment include: low waste, stabilization of waste, destruction of pathogens in the residual material and production of biogas for energy consumption. The final products of the biological treatment, depending on its quality, can be used as fertilizer and to improve the quality of the soil or can be disposed in SWDS.

Anaerobic treatment is usually associated with the recovery of CH_4 and its combustion for energy, and thereby greenhouse gas emissions from this process should be reported under Sector 1 'Energy'. Anaerobic treatment of sludge at wastewater treatment plants should be addressed in Chapter 5D 'Wastewater Treatment and Discharge', and emissions should be reported in that category. However, when sludge from wastewater treatment is transferred into an anaerobic plant that co-digests sludge with MSW or other waste, any related CH_4 and N_2O emissions should be reported within this category – 5B 'Biological Treatment of Solid Waste'. If these gases are used to generate energy, then the associated emissions should be reported under Sector 1 'Energy'.

Composting is an aerobic process and much of the degradable organic carbon (DOC) in the waste material is converted to CO_2. Methane is formed in the anaerobic sections of the compost, but is largely oxidized in the aerobic sections of the compost, so less than 1 per cent of the initial carbon content of the composted material is emitted into the atmosphere.

Anaerobic digestion of organic waste accelerates the natural decomposition of oxygen-free organic material by keeping the temperature, moisture content and pH close to their optimum values. The generated CH_4 can be used for the production of heat and/or electricity, so the reporting of emissions from the process is usually done under Sector 1 'Energy'. CO_2 emissions are of biogenic origin, and are reported only in Sector 1 'Energy'. CH_4 emissions from such installations are between 0 and 10 per cent of the amount of CH_4 generated, being motivated by accidental leaks during process disturbances or other unexpected events. In the absence of additional information, it is recommended to use a rate of 5 per cent as the default value for CH_4 emissions. If the technical standards for biogas plants ensure the avoidance of CH_4 emissions, they are considered to be close to zero. N_2O emissions from the process are assumed to be negligible, but data on these emissions are extremely rare.

Mechanical-biological treatment (MB) of waste is becoming more and more often practiced in Europe, being expected in the RM. In MB treatment, waste undergoes a series of mechanical and biological operations, which aim to reduce the volume of waste and stabilize it to reduce emissions from final disposal. Mechanical operations separate the residual material into fractions that will be subjected to additional treatment (composting, anaerobic decomposition, combustion, recycling). These may include separating, crushing and crushing the material. Biological operations include composting and anaerobic decomposition. Composting can take place in piles or in composting facilities with the optimization of process conditions, as well as with the filtration of the gas produced, which allows the quantitative reduction of the organic fraction to be disposed of in landfills (which is 40-60 per cent). Due to the small amount of material subjected to biological treatment, including its organic content and biological activity, waste subject to mechanical-biological treatment will produce up to 95 per cent less CH_4 than untreated waste when disposed in SWDS. CH_4 and N_2O emissions in the different phases of MB treatment depend on the specific operations and the duration of the process.

7.3.2. Methodological Issues, Emission Factors and Data Sources

The assessment of CH_4 and N_2O emissions from source category 5B 'Biological Treatment of Solid Waste' can be done using First Order Decay Model (IPCC FOD).

Methane emissions were estimated using Equation 4.1 available in the 2006 IPCC Guidelines (Volume 5, Chapter 4, page 4.5):

$$CH_4\ Emissions = \Sigma(M_i \bullet EF_i) \bullet 10^{-3} - R$$

Where:

- CH_4 Emission - total CH_4 Emissions in inventory year, Gg CH_4;
- M_i - mass of organic waste treated by biological treatment type *i*, Gg;
- EF - emission factor for treatment *i*, g CH_4/kg waste treated;
- i - composting or anaerobic digestion;
- R - total amount of CH4 recovered in inventory year, Gg CH_4;

When CH_4 emissions from anaerobic digestion are reported, the amount of recovered gas should be subtracted from the amount CH_4 generated. The recovered gas can be combusted in a flare or energy device. The amount of CH which is recovered is expressed as R in Equation 4.1.

If the recovered gas is used for energy, then also the resulting greenhouse gas emissions from the combustion of the gas should be reported under the Energy Sector. The emissions from combustion of the recovered gas are however not significant, as the CO_2 emissions are of biogenic origin, and the CH_4 and N_2O emissions are very small so good practice in the Waste Sector does not require their estimation. N_2O emissions from source category 5B 'Biological Treatment of Solid Waste' are estimated using the First Order Decay Model (IPCC FOD), according to equation 4.2 in the 2006 IPCC Guidelines (Volume 5, Chapter 4, page 4.5):

$$N_2O\ Emissions = \Sigma(M_i \bullet EF_i) \bullet 10^{-3}$$

Where:

Emisii N_2O - total N_2O emissions in inventory year, Gg N_2O;

M_i - mass of organic waste treated by biological treatment type *i*, Gg;

EF - emission factor for treatment *i*, g N_2O/kg waste treated

i - composting or anaerobic digestion;

In the current inventory cycle, a Tier 1 methodology was used with IPCC default emission factors (Table 7-16).

Table 7-16: CH_4 and N_2O default emission factors from biological treatment of waste

Type of Biological Treatment	CH_4 Emission Factor (g CH_4/kg waste treated)		N_2O Emission Factor (g N_2O/kg waste treated)		Comments
	dry weight basis	wet weight basis	dry weight basis	wet weight basis	
Composting	10 (0.08 - 20)	4 (0.03 - 8)	0.6 (0.2 – 1.6)	0.24 (0.06 – 0.6)	Assumptions on the waste treated: 25-50% DOC in dry matter, 2% N in dry matter, moisture content 60%. The emission factors for dry waste are estimated from those for wet waste assuming a moisture content of 60% in wet waste.
Anaerobic digestion at biogas facilities	2 (0 - 20)	0.8 (0 - 8)	Assumed negligible		

Emission Factors

Emissions from composting and anaerobic digestion in biogas plants will depend on factors such as the type of composting of waste, the amount and type of support material (such as wood chips and peat), temperature, moisture content and aeration during the process.

For the beginning, the activity data from the 'Purcel' Mine were requested, which would be a source of GHG emissions, from the composting of organic waste, being sent to the Chisinau City Hall, General Directorate of Housing and Communal Planning, to be presented the total amount of construction waste and vegetation waste collected from parks, including from Municipal Housing Services. Between 2000 and 2016, the Chisinau City Hall managed the land of the 'Purcel' mine (the mining perimeter for extracting clay of 'Macon' JSC), in order to store leaves, branches, construction materials waste, sand and garbage result from the city's sanitation. Upon request for activity data, the project team was informed about the lack of such data. Starting with the years 2018-2019, a new land is allocated for the storage of foliage, branches, construction material waste in the vicinity of 'Pruncul' quarry.

At the same time, recently, in 2020, on the territory of the Wastewater Treatment Plant a platform for composting vegetable waste accumulated from the green spaces of the city was launched. Thus, the vegetable remains are separated from the waste thrown at random by Green Space workers. The vegetable mass and the dehydrated sludge are then arranged in several layers, and after fermentation organic fertilizers are obtained. The technological process of obtaining organic mass consists in mixing vegetable waste with dehydrated sludge, obtained after wastewater treatment. The compost can be used to arrange flowerbeds, vases in public spaces, as well as to plant trees in parks and squares.

For the next inventory cycle, information shall be requested on the amount of biodegradable waste to be composted.

CO Emissions

The calculation of CO emissions from biological waste treatment (Table 7-17) was performed according to the methodological approach available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019):

$$CO\ Emissions = W \bullet EF \bullet 10^{-6}$$

Where:

CO Emissions - CO Emissions in inventory year, kt/year;

W - amount of solid waste composted, kt/year;

EF - emission factor, kg CO/ kt waste(the default value used, 0.56 kg CO/ tonne solid waste, is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), Source Category 5.B1; 'Biological Treatment of Solid Waste – composting', Table 3-2, page 6);

10^{-6} - conversion factor, from kg to kt.

Activity Data

Between 2000 and 2016, the Chisinau City Hall managed the land of the 'Purcel' quarry (the mining perimeter for extracting clay of 'Macon' JSC), in order to store leaves, branches, construction materials waste, sand and garbage accumulated as a result of city sanitation. Upon request for activity data, the project team was informed about the lack of such data. Starting with the years 2018-2019, a new land is allocated for the storage of foliage, branches, construction material waste in the vicinity of 'Pruncul' quarry.

In the absence of activity data for the test model, an assumption will be made that the amount of waste subject to composting has gradually increased from 1 to 3 per cent over the period 1990-2019 depending on the total amount of municipal waste stored (Table 7- 17).

Table 7-17: AD used to estimate direct and indirect GHG emissions from source category 5B 'Biological Treatment of Solid Waste'

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Amount of waste composted, kt	13.60	13.78	14.38	7.19	6.71	6.32	6,52	6.13	6.19	5.81
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Amount of waste composted, kt	5.24	4.75	5.22	5.48	5.75	6.03	6.54	8.47	10.03	11.14
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Amount of waste composted, kt	10.75	10.92	11.18	12.14	12.70	12.71	12.63	14.46	13.04	13.96

The energy potential of biodegradable waste produced annually in the agricultural and industrial sectors could play a key role in solving the energy problem, and the use of this waste as a fuel contributes to reducing GHG emissions. Thus, in 2019, there were 48 economic agents activating in the field of pellets and briquettes who used cereal straw, wood sawdust, sunflower seed husks, walnut shells and other vegetable waste in the production process. Animal manure is a dangerous source of environmental pollution. At the same time, the sources of biodegradable waste in the livestock sector represents the highest potential for the production of organic fertilizers and biogas through anaerobic fermentation, which is not used enough in domestic practice. Plants that produce biogas from waste from the animal breeding sector operate in the village of Firladeni, Hancesti district ('Garma Grup' Ltd.), Tarnova village, Donduseni district ('Rom-Cris' Ltd.) and at Zabriceni Monastery, Zabriceni village, Edinet district. The sugar factory in Drochia town, 'Sudzucher Moldova' JSC, uses waste resulting from sugar extraction process from beets to obtain biogas, producing electricity for the needs of the company.

Table 7-18 contains activity data for biogas plants, with emissions from biogas being reported under Sector 1 'Energy'.

Table 7-18: Activity Data for biogas plants

No.	Enterprise, Legal address	Est.	Raw Material Used, 2018		Plant Capacity	Energy Use
			Name	Amount, t		
1.	'Garma Grup' Ltd. Firladeni vilage, Hincesti districct	2014	Manure Vinasse from alcohol production Molasses	29000.0 6200.0 6500.0	25-30 thousand m³/day	Boiler, Electricity production
2.	'Rom-Cris' Ltd., Tirnova vilage, Donduseni district	2017	Manure Maize stalk	9125.0 3000.0	627 kW/hour	Delivery in the electrical network
3.	'Sudzucker Moldova' JSC, Drochia	2012	Vinasse from sugar production	83000	11000000 m³/year	Own consumption
4.	Zabriceni Monastery, Zabriceni village, Edinet district	2016	Animal manure	280.0	15 m³/day	Own consumption
5.	'Biogaz Inter' Ltd.	2008	Buried MSW	Circa 20.0 million	Not working	Electricity production

The Environmental Strategy for the years 2014-2023 and the Action Plan for its implementation, approved by Government Decision No. 301/2014 provides the creation of integrated waste and chemical management systems, which would contribute to a 30 per cent decrease in the amount of waste deposited and a 20 per cent increase in the recycling rate by 2023.

7.3.3. Uncertainties Assessment and Time-Series Consistency

The quality of data on the amount of waste subjected to biological decomposition by composting is considered uncertain for category 5B 'Biological Treatment of Solid Waste', being inferred by expert assumption, we thereby consider an uncertainty of circa 50 per cent. Default emission factors recommended by the 2006 IPCC Guidelines were used for the calculation, so we consider it appropriate to use the value of circa 50 per cent. Thus, uncertainties associated with the combined uncertainties of activity data and emission factors for category 5B 'Biological Treatment of Solid Waste" are considered to be circa 70 per cent (Annex 5-3.5).

In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the 2006 IPCC Guidelines.

7.3.4. Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category following a Tier 1 approach.

Verification was focused on various aspects such as: on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines; use of country specific factors; correct use of AD obtained from different sources of reference, etc. It should be noted that the AD and methods used for estimating GHG emissions under category 5A 'Solid Waste Disposal' were documented and archived both in hard copies and electronically.

For category 5B 'Biological Treatment of Solid Waste', standard verification and quality control forms and checklists were also filled in following a Tier 1 approach. The quality of this activity data will be verified and adjusted in the next inventory cycle, through additional studies

7.3.5. Recalculations

No recalculations were made in the current inventory cycle for GHG emissions from category 5B 'Biological Treatment of Solid Waste', as the respective emissions were calculated for the first time. (Table 7-19).

Table 7-19: GHG emissions from source category 5B 'Biological Treatment of Solid Waste' for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4 Emissions, kt	0.0544	0.0551	0.0575	0.0288	0.0268	0.0253	0.0261	0.0245	0.0248	0.0232
N_2O Emissions, kt	0.0033	0.0033	0.0035	0.0017	0.0016	0.0015	0.0016	0.0015	0.0015	0.0014
CO Emissions, kt	0.0076	0.0077	0.0081	0.0040	0.0038	0.0035	0.0036	0.0034	0.0035	0.0033
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CH_4 Emissions, kt	0.0210	0.0190	0.0209	0.0219	0.0230	0.0241	0.0261	0.0339	0.0401	0.0446
N_2O Emissions, kt	0.0013	0.0011	0.0013	0.0013	0.0014	0.00145	0.0016	0.0020	0.0024	0.0027
CO Emissions, kt	0.0029	0.0027	0.0029	0.0031	0.0032	0.0034	0.0037	0.0047	0.0056	0.0062
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CH_4 Emissions, kt	0.0430	0.0437	0.0447	0.0486	0.0508	0.0508	0.0505	0.0578	0.0521	0.0559
N_2O Emissions, kt	0.0026	0.0026	0.0027	0.0029	0.0030	0.0030	0.0030	0.0035	0.0031	0.0034
CO Emissions, kt	0.0060	0.0061	0.0063	0.0068	0.0071	0.0071	0.0071	0.0081	0.0073	0.0078

7.3.6. Planned Improvements

Since GHG emissions from source category 5B 'Biological Treatment of Solid Waste' were estimated for the first time in the current inventory cycle, this process may be improved in the following cycles. Thus, for example, the practices of composting organic waste at national level should be specified in order to determine the existence of these platforms in urban and rural localities, especially where there are sanitation services. Simultaneously with the implementation of a new integrated waste management system, waste composting facilities shall be developed, which would considerably reduce the impact on the environment and take control of biogas emissions from the new systems.

7.4. Incineration and Open Burning of Waste (Category 5C)

7.4.1. Source Category Description

Waste incineration is defined as the combustion of solid and liquid waste in controlled incineration facilities. Types of waste incinerated include municipal solid waste, industrial waste, hazardous waste, clinical waste and sewage sludge. The practice of MSW incineration is currently more common in developed countries, while it is common for developing countries to mostly incinerate clinical waste.

Emissions from waste incineration without energy recovery are reported within the Sector 5 'Waste', while those from waste incineration with energy recovery are included in Sector 1 'Energy'.

The methodology described in this chapter applies for both incineration with energy recovery, and without energy recovery. Co-incineration of specific waste streams as alternative fuels is reported only within the Sector 1 'Energy' (for example, emissions from the incineration of tires in the kilns from cement plants will be reported only within Sector 1 'Energy').

At the same time, emissions from agricultural residue burning are considered in Sector 3 'Agriculture' or in category 4B 'Cropland' within Sector 4 'LULUCF'.

Image 7-2: Open burning of waste at Balti and Tintareni landfills.

Open burning of waste can be defined as the unintentional combustion of combustible materials such as paper, wood, plastics, textiles, rubber, waste oils and other debris in nature (open-air) or in open dumps, where smoke and other emissions are released directly into the air without passing through a chimney or stack. Open burning can also include incineration devices that do not control the combustion air to maintain an adequate temperature and do not provide sufficient residence time for complete combustion. This waste management practice is used in many developing countries whereas in developed countries open burning of waste may either be strictly regulated, or otherwise occur more frequently in rural areas than in urban areas.

Incineration and open burning of waste are sources of direct (CO_2, CH_4 and N_2O) and indirect (NO_x, CO, NMVOC and SO_2) GHG emissions. Intentional burning of waste on solid waste disposal sites represents a waste management practice sometimes used in some developing countries. Emissions resulting from this practice and those from unintentional fires on SWDS will be estimated and reported according to the methodology and guidance provided for open burning of waste.

7.4.2. Methodological Issues, Emission Factors and Data Sources

Within category 5C 'Incineration and open Burning of Waste' were estimated CO_2, CH_4 and N_2O emissions from the open burning of MSW and clinical waste.

The amount of waste open-burned each year was estimated using Equation 5.7 from the 2006 IPCC Guidelines (Volume 5, Chapter 5.3.2, page 5.16):

$$MSW_B = P \bullet P_{frac} \bullet MSW_P \bullet B_{frac} \bullet 365 \bullet 10^{-6}$$

Where:

MSW_B – total amount of municipal solid waste open-burned, kt/yr;

P – population, capita;

P_{frac} – fraction of population burning waste (fraction);

MSW_P – per capita waste generation, kg waste/capita/day;

B_{frac} – fraction of the waste amount that is burned relative to the total amount of waste treated (fraction);

365 – number of days per year

10^{-6} – conversion factor from kg to kt.

The total population of the Republic of Moldova (as well as separately for the right and left bank of the Dniester River) is presented below in Table 7-20.

Table 7-20: Total Population of the Republic of Moldova for the period 1990-2019, million people

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Left Bank of Dniester River	0.7310	0.7307	0.7303	0.7296	0.7025	0.7017	0.6916	0.6791	0.6708	0.6657
Right Bank of Dniester River	3.6306	3.6356	3.6288	3.6182	3.6502	3.6462	3.6428	3.6409	3.6550	3.6493
Republic of Moldova - Total	4.3616	4.3663	4.3591	4.3478	4.3527	4.3479	4.3344	4.3200	4.3258	4.3150
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Left Bank of Dniester River	0.6600	0.6518	0.6425	0.6336	0.6238	0.5544	0.5475	0.5406	0.5335	0.5275
Right Bank of Dniester River	3.6435	3.6345	3.6272	3.6177	3.6068	3.5330	3.4593	3.3855	3.3118	3.2380
Republic of Moldova - Total	4.3035	4.2863	4.2697	4.2513	4.2306	4.0874	4.0068	3.9261	3.8453	3.7655
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Left Bank of Dniester River	0.5225	0.5180	0.5134	0.5094	0.5052	0.5007	0.4745	0.4706	0.4690	0.4651
Right Bank of Dniester River	3.1643	3.0905	3.0167	2.9430	2.8692	2.8447	2.8244	2.7800	2.7304	2.6817
Republic of Moldova - Total	3.6868	3.6085	3.5301	3.4524	3.3744	3.3454	3.2989	3.2506	3.1994	3.1468

According to the 2006 IPCC Guidelines, open burning includes regular burning and sporadic burning of solid household waste. Regular burning means that this is the only practice used to eliminate solid waste. Sporadic burning means that this practice is used in addition to other practices and therefore open burning is not the only practice used to eliminate waste. For countries that have well-functioning waste collection systems in place, it is good practice to investigate whether any fossil carbon is open-burned.

In developed countries, P_{frac} can be assumed to be the rural population for a rough estimate. In a region where the urban population exceeds 80 per cent of total population, it can be assumed that no open burning of waste occurs. In developing countries, mainly in urban areas, P_{frac} can be roughly estimated as being the sum of population whose waste is not collected by sanitation services and population whose waste is collected and disposed in open dumps that are open burned at solid waste landfills.

In the RM, the share of urban population varied over the period 1990-2019 between 47.4 and 45.7 per cent, whereas the rural population between 52.5 and 54.3 per cent, respectively (Table 7-21).

Table 7-21: Urban and Rural population of the RM for the period 1990-2019, million people

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Urban population	2.0693	2.0736	2.0522	2.0392	2.0366	2.033	2.0041	1.9953	2.0016	1.9907
Rural population	2.2923	2.2927	2.3069	2.3086	2.3161	2.3149	2.3303	2.3247	2.3242	2.3243
Share of urban population, %	47.4	47.5	47.1	46.9	46.8	46.8	46.2	46.2	46.3	46.1
Share of rural population, %	52.6	52.5	52.9	53.1	53.2	53.2	53.8	53.8	53.7	53.9
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Urban population	1.9834	1.9488	1.9401	1.9325	1.9192	1.7427	1.7200	1.7102	1.6778	1.6460
Rural population	2.3201	2.3375	2.3296	2.3188	2.3115	2.3447	2.2868	2.2160	2.1675	2.1196
Share of urban population, %	46.1	45.5	45.4	45.5	45.4	42.6	42.9	43.6	43.6	43.7
Share of rural population, %	53.9	54.5	54.6	54.5	54.6	57.4	57.1	56.4	56.4	56.3
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Urban population	1.6186	1.5915	1.5628	1.5389	1.5121	1.5062	1.4884	1.4722	1.4576	1.4383
Rural population	2.0682	2.0169	1.9673	1.9135	1.8623	1.8392	1.8105	1.7783	1.7417	1.7085
Share of urban population, %	43.9	44.1	44.3	44.6	44.8	45.0	45.1	45.3	45.6	45.7
Share of rural population, %	56.1	55.9	55.7	55.4	55.2	55.0	54.9	54.7	54.4	54.3

The incineration of waste practice is predominantly characteristic to rural areas, both in households and on landfills in order to reduce the volume of solid waste disposed, mainly by burning organic waste (paper, cardboard, plastics and vegetable waste). In the case of the RM, the share of population that burn waste in open-air *(P_{frac})* is equivalent to the rural population *($P_{frac\ rural}$)* plus the urban population *($P_{frac\ urban}$)* that do not benefit from sanitation services ($P_{frac} = P_{frac\ rural} + P_{frac\ urban}$).

It is worth mentioning that specialized waste collection and disposal services exist in the municipalities of the country as well as in the district centres, but this system covers only about 60-90 per cent of the total urban population generating MSW. Therefore, the share of the population that does not benefit from waste collection services is circa 10-30 per cent, or on average circa 20 per cent. Regarding the rate of waste generation per capita, for the period 1990-2015 the value of 0.5 kg/ capita/day for the rural population was used, and the value of 0.9 kg/capita/day, respectively, for the urban population, being based on data from the Waste Management Strategy in the Republic of Moldova 2013-2027. Since 2016, the NBS started to collect detailed data on the rate of the amount of municipal waste collected in the territory, as well as the number of population and households that benefit from municipal waste collection services. This data was the basis for updating the rate of waste generation per capita for the following years, being established as follows:

- for 2016-2017 – 0.6 kg/capita/day for rural population and 1.0 kg/capita/day for urban population;
- for 2018-2019 – 0.7 kg/capita/day for rural population and 1.1 kg/capita/day for urban population.

Considering the morphological composition of municipal solid waste, the fractions of organogenic waste that can be burned by the rural and urban population were identified (paper, cardboard, plastics, phytotechnical waste, textiles, furniture, wood waste). In fact, the share of combustible waste varies in large municipalities, such as Chisinau and Balti, respectively in the district centres, such as Leova and Causeni, usually ranging from the purchasing power of the population. In order to estimate emissions, the results obtained from the most recent analysis of the morphological composition of solid waste in the Republic of Moldova were used (Figure 7-4).

It was considered that circa 20 per cent of the urban population that does not benefit from waste disposal services burns the organogenic solid waste in open-air, while the fraction for solid waste burned (B_{frac}) from the total amount of treated waste in urban areas represents 0.15 (15 per cent of the total). It should be noted that the population of Chisinau was excluded from the urban population, as it is considered that open burning of waste is not practiced, as waste disposal platforms are available in the city. In rural areas, it was considered that 40 per cent of the population burns the organogenic solid waste in open-air , and the B_{frac} represents 0.2 (20 per cent of the total).

The total amount of MSW burned in open-air by the population was estimated using the following equation:

$$MSW_B = MSW_{B\ rural} + MSW_{B\ urban}$$

Where:

$$MSW_{B\ rural\ RM}\ (kt) = P_{\ rural}\ (inhabitants) \bullet MSW_{P\ rural}\ (kg/capita/day) \bullet 0.20 \bullet 365 \bullet 10^{-6}$$

$$MSW_{B\ urban\ RM}\ (kt) = P_{\ urban}\ (inhabitants) \bullet MSW_{P\ urban}\ (kg/capita/day) \bullet 0.15 \bullet 365 \bullet 10^{-6}$$

Although there are no authorized incinerators in the Republic of Moldova for the incineration of clinical waste, a certain category of plastic clinical waste generated by several medical institutions in the country is treated through the pyrolysis or autoclaving method ('UISPAC' Ltd.[130], 'Trisumg' Ltd.[131] and 'Ecostat' Ltd.[132]). Medical institutions in the RM practice the burning of clinical waste by three methods: 1) open burning; 2) closed burning in heating boilers or metal barrels; and 3) transport for pyrolysis treatment.

As a response, the Ministry of Health, Labour and Social Protection[133], mentioned that in 2018, according to data reported from 26 territories (70.3 per cent) in the structure of waste generated, non-hazardous waste prevails by 77.13 per cent, followed by hazardous waste by 21.74 per cent (986,057 kg), anatomopathological waste – 0.61 per cent (27813.9 kg), stinging-cutting waste – 0.27 per cent (11972.3 kg) and other hazardous waste – 0.25 per cent (chemical, etc.). Outsourcing of waste treatment services, including infectious and stinging, was reported in 32 territories (86.5 per cent). At the same time, the method of treating infectious waste by immersion in chlorine solutions and their incineration in open-air or improvised installations persists in medical institutions in rural areas (Chisinau municipality, Basarabeasca, Briceni, Cahul, Cimislia, Donduseni, Falesti, Floresti, Glodeni, Hancesti, Ialoveni, Nisporeni, Ocnita, Orhei, Soroca, Straseni, Soldanesti, Stefan Voda, Taraclia, Ungheni, Comrat, Ceadir-Lunga, Vulcanesti).

In order to determine AD for the estimation of direct GHG emissions (CO_2, CH_4 and N_2O) and indirect emissions (NO_x, CO, NMVOC and SO_2) from the open burning of the clinical waste, as a first step, the amount of clinical waste generated annually was estimated based on the rate of waste generation reported per hospital bed. The second step was to estimate the share of waste burned in open-air in the total clinical waste generated. In this sense, the data received from the National Centre of

[130] Authorization issued by the Environment Agency, Series 005, AM 20091601 dated 02.10.2020 on the collection, transport and processing (the pyrolysis method) of plastic waste and of waste from clinical or veterinary care activities and/or related research.
[131] Authorization issued by the Environment Agency, Series 005, AM 20090802 dated 30.09.2020 on the transport and processing of clinical waste by autoclaving.
[132] Authorization No. 071/2016 dated 27.05.2016 issued by the Ministry of Environment.
[133] Letter from the Ministry of Health, Labor and Social Protection No. 04/677 dated 04.02.2019 as an official response to the Letter from the MARDE No. 14-0//16 dated 03.01.2019.

Public Health[134] on clinical waste treated by medical institutions across the country was used, through the three above-mentioned methods for the years 2010-2014. Additionally, for the years 2015-2019, similar data was received from several medical institutions in the country, being requested through the Circular of the Ministry of Health, Labour and Social Protection[135]. Although the data received did not cover all medical institutions in all districts of the country, they allowed the deduction of a rate of clinical waste generated per hospital bed. The share of waste burned in open-air was estimated based on the data received. The historical data for the years 1990-2009 was inferred by correlating the generation rate per hospital bed with the number of beds (available in the database of the National Bureau of Statistics on www.statistica.gov.md), and the burning coefficient was estimated based on expert opinion, considering that in the 1990s the burning rate was somewhat low.

The tables below shows AD used to estimate GHG emissions from open burning of clinical waste.

Table 7-22: Amount of total clinical waste burned in open-air for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Number of hospital beds, units	57334	56992	55653	54275	53140	52986	52457	50101	48261	35089
Generation per hospital bed, kg/day	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total country, tonnes	1046.3	1040.1	1015.7	990.5	969.8	967.0	957.3	914.3	880.8	640.4
Burning rate, %	10.0	14.5	19.0	23.5	28.0	32.5	37.0	41.5	46.0	50.5
Total open burning amount, tonnes	104.63	150.82	192.98	232.77	271.55	314.27	354.22	379.45	405.15	323.39
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of hospital beds, units	32423	25044	24443	24097	23113	22961	22471	21892	21798	21938
Generation per hospital bed, kg/day	0.06	0.07	0.08	0.09	0.1	0.1	0.1	0.1	0.11	0.12
Total country, tonnes	710.1	639.9	713.7	791.6	843.6	838.1	820.2	799.1	875.2	960.9
Burning rate, %	55.0	59.5	64.0	68.5	72.5	72.5	72.5	72.5	72.5	72.5
Total open burning amount, tonnes	390.54	380.73	456.79	542.24	611.59	607.57	594.60	579.28	634.47	696.60
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of hospital beds, units	22021	22031	22162	20760	20131	18803	18805	18398	18138	18042
Generation per hospital bed, kg/day	0.13	0.14	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Total country, tonnes	1044.9	1125.8	1213.4	1136.6	1102.2	1029.5	1029.6	1007.3	993.1	987.8
Burning rate, %	72.5	74.6	72.6	71.4	66.2	55.9	45.6	35.3	25	10.3
Total open burning amount, tonnes	757.50	840.26	880.87	811.83	729.29	575.23	469.32	355.49	248.26	101.67

CO_2 emissions from open burning of waste were estimated using Equation 5.1 from the 2006 IPCC Guidelines (Volume 5, Chapter 5, page 5.7):

$$CO_2\ Emissions = \Sigma_i\ (SW_i \bullet dm_i \bullet CF_i \bullet FCF_i \bullet OF_i) \bullet 44/12$$

Where:

CO_2 Emissions - CO_2 emissions in inventory year, kt/yr;

SW_i - total amount of solid waste of type i (wet weight) incinerated or open-burned, kt/yr;

dm_i - total amount of solid waste of type i (wet weight) incinerated or open-burned, kt / yr;

dm_i – dry matter content in the waste (wet weight) incinerated or open-burned (fraction) (default values used – 76 per cent for MSW and 90 per cent for clinical waste are available in Table 2.4 from the 2006 IPCC Guidelines, Volume 5, Chapter 2, page 2.14);

CF_i - fraction of carbon in the dry matter (total carbon content) (default values used – 47 per cent for MSW and 60 per cent for clinical waste are available in Table 2.4 from the 2006 IPCC Guidelines, Volume 5, Chapter 2, page 2.14, respectively in Table 5.2 from the 2006 IPCC Guidelines, Volume 5, Chapter 5, page 5.18);

FCF_i - fraction of fossil carbon in the total carbon (default values used – 90 per cent for industrial waste, 42 per cent for MSW and 40 per cent for clinical waste are available in Table 2.4 from the 2006 IPCC Guidelines, Volume 5, Chapter 2, page 2.14, respectively in Table 5.2 from the 2006 IPCC Guidelines, Volume 5, Chapter 5, page 5.18);

OF_i - oxidation factor (default value used – 58 per cent is available in Table 5.2 from the 2006 IPCC Guidelines, Volume 5, Chapter 5, page 5.18);

44/12 - conversion factor from C to CO_2.

i - type of waste incinerated/ open-burned specified as follows: MSW – municipal solid waste (if not estimated using Equation 5.2 from the 2006 IPCC Guidelines, Volume 5, Chapter 5,

[134] Letter from the Ministry of Health No. 06t-3/2521 dated 30.10.2015 as an official response to the Letter from the Ministry of Environment No. 05-07/1425 dated 13.08.2015.

[135] Circular of the Ministry of Health, Labor and Social Protection No.06/2218 dated 23.04.2020 addressed to Health Carters/Family Medical Centers/ Territorial Medical Associations, District/ Municipal/ Republican Hospitals, prepared as a response to the interpellation of the MARDE No. 14-07/1356 dated 16.03.2020.

page 5.7); ISW: industrial solid waste; SS: sewage sludge; HW: hazardous waste; CW: clinical waste, others (to be specified).

Methane emissions from incineration and open burning of waste are a result of incomplete combustion. Important factors affecting the emissions are temperature, residence time, and air ratio (air volume in relation to the waste amount incinerated or open-burned).

In large and well-functioning incinerators, CH_4 emissions are usually very small. Methane can also be generated in the waste bunker of incinerators if there are low oxygen levels and subsequent anaerobic processes in the waste bunker, particularly where waste is wet, stored for long periods and not well agitated. Where the storage gases are fed into the air supply of the incineration chamber, they will be incinerated and emissions will be reduced to significant levels.

The calculation of methane emissions is based on Equation 5.4 from the 2006 IPCC Guidelines, Volume 5, Chapter 5, page 5.12):

$$CH_4\ Emissions = \Sigma_i\ (IW_i \bullet EF_i) \bullet 10^{-6}$$

Where:

CH_4 Emissions - CH_4 emissions in inventory year, kt/yr;

IW_i - amount of solid waste of type i incinerated or open-burned, kt/yr;

EF_i - aggregate CH_4 emission factor, kg CH_4 / kt waste type i (default value used – 6.5 kg CH_4/t MSW is available in the 2006 IPCC Guidelines, Volume. 5, Chapter 5, page 5.20);

10^{-6} - conversion factor, from kg to kt;

i - category or type of waste incinerated/open-burned, specified as follows: MSW – municipal solid waste; ISW: industrial solid waste; HW: hazardous waste; CW: clinical waste, SS: sewage sludge; others (to be specified).

Nitrous oxide is emitted in combustion processes at relatively low combustion temperatures between 500 and 950°C. Other important factors affecting the emissions are the type of air pollution control device, type and nitrogen content of the waste and the fraction of excess air.

The calculation of nitrous oxide emissions is based on Equation 5.5 from the 2006 IPCC Guidelines, Volume 5, Chapter 5, page 5.14):

$$N_2O\ Emissions = \Sigma_i\ (IW_i \bullet EF_i) \bullet 10^{-6}$$

Where:

N_2O Emissions - N_2O emissions in inventory year, kt/yr;

IW_i - amount of solid waste of type i incinerated or open-burned, kt/yr;

EF_i - N_2O emission factor, kg N_2O / kt waste type i (default value used – 0.15 kg N_2O/t of MSW, is available in the 2006 IPCC Guidelines, Volume 5, Chapter 5, Table 5.6, page 5.22);

10^{-6} - conversion factor, from kg to kt;

i - category or type of waste incinerated/open-burned, specified as follows: MSW – municipal solid waste; ISW: industrial solid waste; HW: hazardous waste; CW: clinical waste, SS: sewage sludge; others (to be specified).

The calculation of indirect GHG emissions (NO_x, CO, NMVOC and SO_2) from incineration or open burning of waste is based on the methodology available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019):

$$Indirect\ GHG\ Emissions = \Sigma_i\ (IW_i \bullet EF_i) \bullet 10^{-6}$$

Where:

Indirect GHG Emissions - indirect GHG emissions (NO_x, CO, NMVOC and SO_2) in inventory year, kt/yr;

IW_i - amount of solid waste of type i incinerated or open-burned, kt/yr;

EF_i - emission factor, kg indirect GHG / kt waste (default values are presented below, in Table 7-21);

10^{-6} - conversion factor, from kg to kt;

i - category or type of waste incinerated/open-burned, specified as follows: MSW – municipal solid waste; ISW: industrial solid waste; HW: hazardous waste; CW: clinical waste, SS: sewage sludge; others (to be specified).

Table 7-23: Default EFs used to estimate indirect GHG emissions from source category 5C 'Incineration and Open Burning of Waste' using a Tier 1 Approach

	NO_x, kg/t of waste	CO, kg/t of waste	NMVOC, kg/t of waste	SO_2, kg/t of waste
Solid Waste[1]	3.8	55.83	1.23	0.11
Clinical Waste[2]	2.3	0.19	0.7	0.54

Source: [1]EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Source Category 5.C.2 'Open Burning of Waste', Table 3-1, page 6; [2] EMEP/EEA Atmospheric Emissions Inventory Guidebook (2019), Source Category 5.C.1.b.iii 'Clinical Waste Incineration', Table 3-1, page 8.

Activity data used to estimate CO_2, CH_4 and N_2O emissions from source category 5C 'Incineration and Open Burning of Waste' are presented in Table 7-24.

Table 7-24: AD used to estimate direct and indirect GHG emissions from source category 5C 'Incineration and Open Burning of Waste'

	Urban Population, thousand inhabitants (without Chisinau)	Rural Population, thousand inhabitants	Daily ratio of generated MSW in urban areas, kg/capita/day	Daily ratio of generated MSW in rural areas, kg/capita/day	Amount of MSW burnt in urban areas, kt	Amount of MSW burnt in rural areas, kt	Total amount of MSW burnt in the RM, kt	Amount of clinical waste incinerated, kt
1990	1,393.800	2.292.3	0.9	0.5	13.7359	33.4676	47.2035	104.63
1991	1,396.900	2.292.7	0.9	0.5	13.7664	33.4734	47.2399	150.82
1992	1,385.100	2.306.9	0.9	0.5	13.6502	33.6807	47.3309	192.98
1993	1,375.800	2.308.6	0.9	0.5	13.5585	33.7056	47.2641	232.77
1994	1,375.000	2.316.1	0.9	0.5	13.5506	33.8151	47.3657	271.55
1995	1,371.500	2.314.9	0.9	0.5	13.5161	33.7975	47.3137	314.27
1996	1,342.200	2.330.3	0.9	0.5	13.2274	34.0224	47.2498	354.22
1997	1,330.600	2.324.7	0.9	0.5	13.1131	33.9406	47.0537	379.45
1998	1,338.400	2.324.2	0.9	0.5	13.1899	33.9333	47.1233	405.15
1999	1,327.100	2.324.3	0.9	0.5	13.0786	33.9348	47.0134	323.39
2000	1,320.000	2.320.1	0.9	0.5	13.0086	33.8735	46.8821	390.54
2001	1,286.800	2.337.5	0.9	0.5	12.6814	34.1275	46.8089	380.73
2002	1,278.100	2.329.6	0.9	0.5	12.5957	34.0122	46.6078	456.79
2003	1,271.800	2.318.8	0.9	0.5	12.5336	33.8545	46.3881	542.24
2004	1,257.000	2.311.5	0.9	0.5	12.3877	33.7479	46.1356	611.59
2005	1,081.537	2.344.7	0.9	0.5	10.6585	34.2327	44.8912	607.57
2006	1,059.808	2.286.8	0.9	0.5	10.4444	33.3870	43.8314	594.60
2007	1,051.759	2.216.0	0.9	0.5	10.3651	32.3531	42.7182	579.28
2008	1,014.702	2.167.5	0.9	0.5	9.9999	31.6450	41.6449	634.47
2009	982.763	2.119.6	0.9	0.5	9.6851	30.9454	40.6306	696.60
2010	955.154	2.068.2	0.9	0.5	9.4130	30.1957	39.6088	757.50
2011	926.817	2.016.9	0.9	0.5	9.1338	29.4465	38.5802	840.26
2012	895.220	1.967.3	0.9	0.5	8.8224	28.7229	37.5453	880.87
2013	867.103	1.913.5	0.9	0.5	8.5453	27.9374	36.4827	811.83
2014	837.565	1.862.3	0.9	0.5	8.2542	27.1898	35.4440	729.29
2015	827.991	1.839.2	1.0	0.6	9.0665	32.2222	41.2887	575.23
2016	807.264	1.810.5	1.0	0.6	8.8395	31.7204	40.5599	469.32
2017	786.323	1.778.3	1.1	0.7	9.4713	36.3490	45.8203	355.49
2018	767.614	1.741.7	1.1	0.7	9.2459	35.6014	44.8473	248.26
2019	742.900	1.708.5	1.1	0.7	8.9482	34.9224	43.8707	101.67

7.4.3. Uncertainties Assessment and Time-Series Consistency

The main factors affecting uncertainties assessment regard the assessment methodology, the EFs used to estimate GHG emissions from source category 5C 'Incineration and Open Burning of Waste' as well as the quality of the AD available. Thus, uncertainties associated with the default emission factors used to estimate CO_2, CH_4 and N_2O emissions from source category 5C 'Incineration and Open Burning of Waste' reach circa 25 per cent for CO_2, circa 50 per cent for CH_4, and circa 100 per cent for N_2O. Uncertainties associated with the activity data on the estimated amount of waste burnt by the rural and urban population could reach circa 40 per cent. Therefore, combined uncertainties for source category 5C 'Incineration and Open Burning of Waste' represent circa 47.17 per cent for CO_2 emissions, circa 64.03 per cent for CH_4, and circa 107.70 per cent for N_2O emissions, respectively (Annex 5-3.5).

In view of ensuring time series consistency of results, the same approach was used for the entire period under review, in conformity with good practices applied in the GHG emissions inventory.

7.4.4. Quality Assurance and Quality Control

Standard verification and quality control form and checklist was filled in for the respective category following a Tier 1 approach. Verification was focused on various aspects such as: correct use of AD obtained from different sources of reference, including the Statistical Yearbooks of the RM and the ATULBD, on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines. The AD and methods used for estimating GHG emissions under the category 5C 'Incineration and open burning of waste' were documented and archived both in hard copies and electronically etc.

7.4.5. Recalculations

Within the current inventory cycle, direct and indirect GHG emissions from category 5C 'Incineration and Open burning of Waste' were recalculated, particularly due to the need of adjusting AD with the number of population. The activity of adjusting AD was carried out by the National Bureau of Statistics which made provisional estimates[136] on the number of people with habitual residence[137] (resident population) in the Republic of Moldova. Also, activity data related to the open burning of clinical waste was also reviewed, the amount being estimated based on the rate of generating clinical waste reported per hospital bed and the rate of open burning.

In comparison with the results recorded in the BUR2 of the RM to the UNFCCC (2019), the above-mentioned changes resulted in a downward trend in direct GHG emissions from category 5C 'Incineration and Open Burning of Waste' between 1990 and 2016 (Table 7-25), varying from a minimum decrease of 8.7 per cent in 2005, to a maximum decrease by 27.1 per cent in 2014.

Table 7-25: Comparative results of direct GHG emissions from 5C 'Incineration and Open Burning of Waste' Included into the BUR2 and BUR3 of the RM to the UNFCCC, kt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	27.7249	27.7559	27.7607	27.7148	27.7652	27.7458	27.7232	27.6455	27.6826	27.6378
BUR3	24.2621	24.3113	24.3859	24.3780	24.4557	24.4574	24.4511	24.3673	24.4200	24.3095
Difference, %	-12.5	-12.4	-12.2	-12.0	-11.9	-11.9	-11.8	-11.9	-11.8	-12.0
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	27.5796	27.5456	27.4536	27.3461	27.2367	25.6447	25.6560	25.8151	25.7298	25.6744
BUR3	24.2867	24.2427	24.1900	24.1339	24.0505	23.4100	22.8582	22.2776	21.7640	21.2853
Difference, %	-11.9	-12.0	-11.9	-11.7	-11.7	-8.7	-10.9	-13.7	-15.4	-17.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	25.6241	25.7171	25.6814	25.6468	25.5716	25.3128	25.0183			
BUR3	20.8019	20.3296	19.8260	19.2357	18.6487	21.5422	21.0986	23.7193	23.1496	22.5520
Difference, %	-18.8	-20.9	-22.8	-25.0	-27.1	-14.9	-15.7			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

Direct GHG emissions from 5C 'Incineration and Open Burning of Waste' were estimated for the first time for the period 2017-2019. Over the period 1990-2019, direct GHG emissions from the respective category fluctuated due to the change of data related to the population number; whereas for clinical waste, the method to determine it was reviewed.

The table below shows the evolution of direct and indirect GHG emissions from incineration and open burning of household and clinical waste for the period 1990-2019. The obtained results allow us to assert that within the reference period, direct and indirect GHG emissions from the respective category decreased in the RM by circa 0.4 per cent (Table 7-26).

Table 7-26: Direct and indirect GHG emissions from source category 5C 'Incineration and Open Burning of Waste' in the RM for the period 1990-2019, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	14.9667	14.9994	15.0476	15.0447	15.0947	15.0979	15.0960	15.0456	15.0794	15.0071
CH_4	0.3075	0.3080	0.3089	0.3087	0.3096	0.3096	0.3094	0.3083	0.3089	0.3077
N_2O	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
NOx	0.1503	0.1506	0.1510	0.1508	0.1512	0.1512	0.1511	0.1505	0.1508	0.1502
CO	2.6354	2.6374	2.6425	2.6388	2.6445	2.6416	2.6380	2.6271	2.6310	2.6248
NMVOC	0.0581	0.0582	0.0584	0.0583	0.0584	0.0584	0.0584	0.0581	0.0582	0.0581
SO_2	0.0052	0.0053	0.0053	0.0053	0.0054	0.0054	0.0054	0.0054	0.0054	0.0053

[136] The population review at national level and estimation of domestic and international migration is carried out within the project 'Improving the Institutional Capacity of the National Bureau of Statistics', funded by the Swiss Agency for Development and Cooperation, co-financed and implemented by the UN Population Fund in Moldova.
[137] Habitual residence is defined as the place where the person has lived mainly in the last 12 months regardless of temporary absences (for recreation, vacations, visits to relatives and friends, business, medical treatment, religious pilgrimages, etc.), according to the UN Recommendations on Statistics of International Migration, 1998, and (EU) Regulation No. 1260/2013 of the European Parliament and of the Council of November 20, 2013 on European demographic statistics.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2	14.9965	14.9689	14.9402	14.9100	14.8621	14.4670	14.1260	13.7672	13.4533	13.1613
CH_4	0.3073	0.3067	0.3059	0.3050	0.3039	0.2957	0.2888	0.2814	0.2748	0.2686
N_2O	0.0054	0.0054	0.0054	0.0054	0.0053	0.0052	0.0051	0.0049	0.0048	0.0047
NOx	0.1500	0.1497	0.1493	0.1488	0.1481	0.1442	0.1408	0.1372	0.1339	0.1308
CO	2.6175	2.6134	2.6022	2.5899	2.5759	2.5064	2.4472	2.3851	2.3252	2.2685
NMVOC	0.0579	0.0578	0.0576	0.0574	0.0572	0.0556	0.0543	0.0529	0.0517	0.0505
SO_2	0.0054	0.0054	0.0054	0.0054	0.0054	0.0053	0.0051	0.0050	0.0049	0.0048
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CO_2	12.8663	12.5793	12.2708	11.9033	11.5371	13.3135	13.0346	14.6448	14.2880	13.9120
CH_4	0.2624	0.2562	0.2498	0.2424	0.2351	0.2721	0.2667	0.3001	0.2931	0.2858
N_2O	0.0046	0.0045	0.0044	0.0043	0.0041	0.0048	0.0047	0.0053	0.0051	0.0050
NOx	0.1277	0.1246	0.1214	0.1179	0.1144	0.1326	0.1301	0.1465	0.1432	0.1397
CO	2.2115	2.1541	2.0963	2.0370	1.9790	2.3053	2.2645	2.5582	2.5039	2.4493
NMVOC	0.0492	0.0480	0.0468	0.0454	0.0441	0.0512	0.0502	0.0566	0.0553	0.0540
SO_2	0.0048	0.0047	0.0046	0.0045	0.0043	0.0049	0.0047	0.0052	0.0051	0.0049

7.4.6. Planned Improvements

It should be mentioned that the Waste Management Automated Information System (SIAMD) is already developed and the economic agents have submitted the first reports for 2018-2019 years. In the coming years, when the respective system becomes fully operational and includes all economic operators, all data on waste management shall be available, including treatment by incineration or burning. At the same time, SIAMD will allow the collection of data on municipal waste or similar waste collected from the population and economic agents, as well as on the number of people benefiting from the sanitation service, this data being reported by sanitation operators. It shall thereby be possible to improve the quality of the activity data used in the assessment of emissions from source category 5C 'Incineration and Open Burning of Waste'.

7.5. Wastewater Treatment and Discharge (Category 5D)

The public sewage system represents an assembly of technological installations, functional equipment and specific facilities through which the public sewage service is operating. The system comprises the following components: public sewage networks, pumping stations, treatment plants, discharging facilities.

In the Republic of Moldova, the current sewage system is underdeveloped and has a low capacity in the context of fully securing the access of the population to quality sewage services.

In 2018, over 1.0 million people have access to centralized sewage services, which represents 29.3 per cent of the total population. In the urban area there were 979.6 thousand people with access to centralized sewage services, representing 64.1 per cent of the country's urban population, and in rural areas – 57.3 thousand people benefiting from sewage services, representing 2.8 per cent of the country's rural population .

In 2019, 1060.9 thousand people benefited from public the sewage service, out of which 1,011.5 thousand from urban areas and 49.4 thousand from rural areas. At the same time, in 2019, 40.3 per cent of the population was connected to the public sewage service, which is an increase by circa 3.0 per cent compared to 2018.

Also, in 2019, 33.1 km of public sewage systems were built and 7.5 km were rebuilt, it being 38.2 km and 8.7 km less, respectively, compared to 2018. Most new public sewage systems, 29.4 km (or 88.8 per cent of the total built length) were built in the Centre of the country: in Calarasi district – 25.0 km, Orhei and Straseni districts – 1.5 km each, and Criuleni district – 1.1 km, etc.

According to the data from 2019, 7.6 per cent of the total localities of the country, 95.0 per cent of the municipalities and towns and 4.4 per cent of the rural localities were provided with public sewage service. There is still a considerable discrepancy between villages and towns, the public sewage systems being almost absent in rural areas. The rural localities from Drochia, Falesti, Glodeni, Soroca, Rezina, Basarabeasca and Cantemir districts did not have access to centralized sewage at all.

In 2019, the activity of wastewater discharge from households and economic and social units took place in 52 municipalities and cities, but also in 64 villages. The total volume of wastewater collected in 2018 amounted to 69.5 million m^3, of which 57.2 per cent represented wastewater received from the population, which was 2.6 per cent more compared to 2017. In 2019, the total volume of wastewater discharged was 70.4 million m^3 – 0.9 million m^3 more compared to 2018. About 73 per cent of the total public sewage systems were equipped with water treatment plants. The best situation regarding the existence of water treatment plants was in the Central and North regions, which had 31 and, respectively, 21 functional stations. The lack of treatment plants was registered in Glodeni, Soroca and Rezina districts. In 2019, 68.4 million m^3 of treated wastewater (97.2 per cent) passed through the water treatment plants. Of the total volume of treated wastewater, 96.6 per cent was treated mechanically, 96.2 per cent biologically, and 2.6 per cent – not treated.

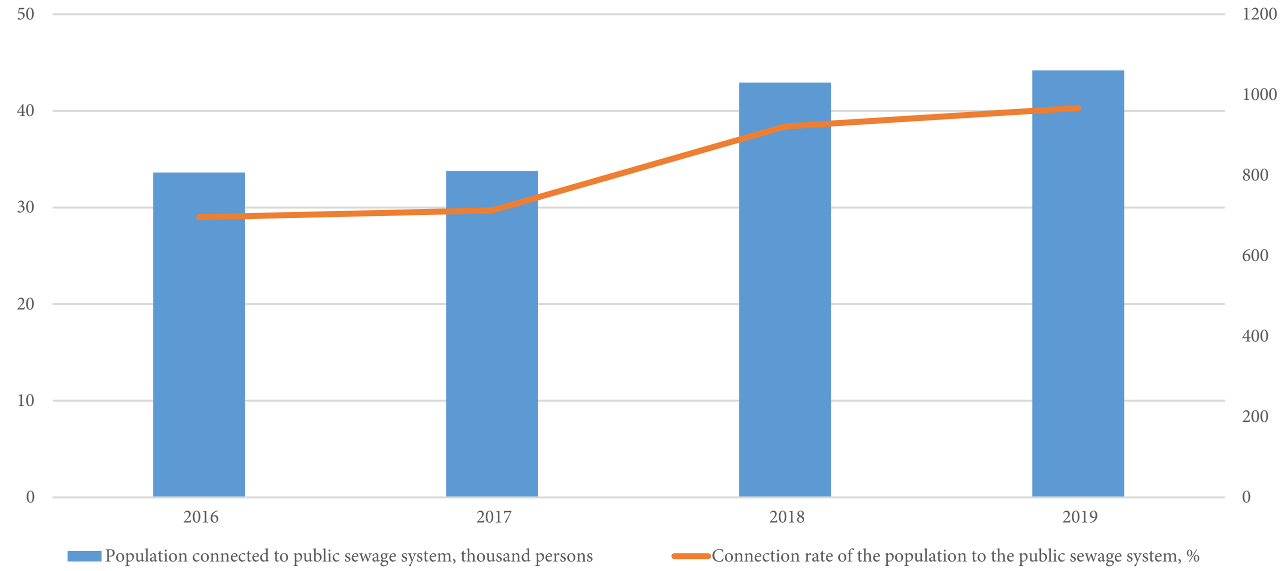

Figure 7-6: Population connected to wastewater treatment within the period 2016-2019.

Source: Activity of centralized water supply and sewage systems in the year 2018, 2019, Press Release, https://statistica.gov.md/category.php?l=ro&idc=226

We can thereby see that currently in the Republic of Moldova there is an inadequacy of the application of new technologies, as well as a lack of experience in this field. With recent investments in the water supply and sewage sector, attempts have been made to apply well-known practices in European countries. These refer to the implementation of new technologies for wastewater treatment, drinking water treatment, the use of new materials (plastics) for pipes in water and sewage systems, which have superiority over pipes made of corrosive and expensive metal materials.

Municipal wastewater in the Republic of Moldova is collected centrally, together with industrial wastewater and is directed for treatment in biological treatment plants. The wastewater treatment scheme is the classic one and has a different level of treatment in urban and rural areas, and depends on the degree of technical endowment of the installations. The main methods of wastewater treatment, according to the data presented are: mechanical, biological based on the degradation of organic substances, and chemical with the use of reagents, as well as combined methods.

The use of the new wastewater treatment technology in Soroca (constructed wetlands zones - CWZ) was not supported by the vast majority of the population and was not implemented, but experience was gained in designing these systems. Using this experience, the technology of CWZ was later multiplied in Moldova, being built and put into operation in September 2013, in Orhei town. The station uses built-up wetland technology, which has lower maintenance and operating costs compared to traditional technologies. The CWZ experience was applied in the villages Rusca, Sarata Galbena.

In small rural communities, the application of decentralized treatment solutions (septic tanks, Ecosan toilets, compact wastewater treatment plants for public/commercial buildings) have proven to be effective.

During the recent decades, a decrease in the volume of wastewater discharged into surface water basins was recorded. For example, between 1990 and 2019, the respective volume decreased by circa 75.2 per cent, from 2,731 million m^3 to 678 million m^3 (Table 7-27). Due to insufficient functioning of wastewater treatment plants, the amount of pollutants in the wastewater discharged from managed sources, as well as the maximum allowable concentration permitted by current standards, are still above the limit established by the environmental authority. During this period, the volume of insufficient treated wastewater discharged into water bodies decreased by circa 90.3 per cent, from 89 million m^3 in 1990, to 6 million m^3 in 2019.

Table 7-27: Wastewater discharged into surface water basins for the period 1990-2019, million m^3

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Discharged wastewater – total	2731	2486	2231	1993	1810	1381	1384	1239	1030	794
Conventional pure water (untreated)	2424	2173	1935	1717	1547	1120	1133	1007	802	593
Polluted wastewater	90	69	41	21	16	15	12	11	12	10
…untreated	1.0	1.0	0.0	0.0	0.4	0.4	0.5	0.3	0.4	0.4
…insufficiently treated	89	68	41	21	15	14.6	11.5	10.7	11.6	9.6
Sufficiently treated wastewater	216	244	255	255	247	245	238	222	215	191
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Discharged wastewater – total	740	708	695	685	688	689	688	680	679	678
Conventional pure water (untreated)	569	557	560	558	561	556	562	551	550	552
Polluted wastewater	9	13	19	48	42	9	7	10	14	10
…untreated	0.5	0.3	0.5	0.8	0.5	0.6	0.5	0.7	0.8	0.8
…insufficiently treated	8.2	12.6	18.9	47.5	41.4	8.3	6.7	9.2	13.3	9.5
Sufficiently treated wastewater	162	138	116	79	85	124	119	119	115	116
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Discharged wastewater – total	683	678	675	672	664	666	666	667	677	678
Conventional pure water (untreated)	556	555	553	551	545	546	544	544	545	546
Polluted wastewater	8	8	9	9	10	8	28	8	9	8
…untreated	0.9	1.0	1.5	1.0	1.4	1.0	2.0	1.4	1.6	2.0
…insufficiently treated	7.5	7.2	7.4	7.9	8.7	7.0	26.0	6.5	7.0	6.0
Sufficiently treated wastewater	119	115	113	112	109	112	94	115	123	124

Source: NBS of the RM, Statistical Yearbooks of the RM for 1994 (page 41), 1999 (page 23), 2006 (page 27), 2011 (page 24), 2014 (page 24); Statistical database: <http://statbank.statistica.md/pxweb/pxweb/ro/10%20Mediul%20inconjurator/10%20Mediul%20inconjurator__MED020/MED020200.px/table/tableViewLayout1/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774>.

The discharge of wastewater from consumers is carried out through sewage discharge systems, which currently do not fully cover the localities in the regions of the country. The quality of sewage services provided to the population is low. All urban areas in the developing regions except Soroca, Glodeni, Rezina and Criuleni, have wastewater treatment plants, but most existing facilities are damaged and inefficient. Most existing plants offer only mechanical treatment, while high-energy biological installations are decommissioned due to high operating costs. The quality of treated wastewater in all urban areas, except for some cities, does not comply to the existing discharge rules. Exceedances of maximum pollutant concentrations in treated wastewater are detected in ammonium, suspended substances and organic substances expressed in BOD_5. Only 97 per cent of urban areas in developing regions are equipped with wastewater treatment plants, and in rural areas, water sewage is performed only at 3-8 per cent of the population. Some urban areas (for example, Soroca) do not have a treatment plant and untreated municipal wastewater is discharged directly into the cross-border river Dniester (National Program for the Implementation of the Protocol on Water and Health in the Republic of Moldova 2016-2025 (Government Decision No. 1063 dated 16.09.2016).

Sewage systems, which ensure the discharge and treatment of wastewater, have a high degree of wear, are degraded and obsolete, as they have been operated for more than 25-30 years without reconstruction, and require technological modernization, respectively.

Currently, the management of sludge produced at wastewater treatment plants is inadequate and does not comply with the requirements of the regulations in force. An important problem that exists in the wastewater treatment process that significantly influences the environment is the lack of modern sludge processing facilities formed as a result of wastewater treatment. The classic method used to treat sludge is to store it on sludge platforms. Based on the fact that the design capacities of all existing installations are, as a rule, larger (circa 2-10 times, and in some localities even more) than the actual recorded volumes of water generation; at all these sites there are free surfaces to store sludge. Only in big cities, such as Chisinau, Balti and Cahul, due to the lack of modern sludge treatment technologies, its storage is carried out in layers larger than 50 cm, which causes anaerobic processes and induces the formation of methane emissions (National Program for the Implementation of the Protocol on Water and Health in the Republic of Moldova 2016-2025 (Government Decision No. 1063 dated 16.09.2016).

In 2009, in order to overcome the existing situation, for the purpose of sludge processing and odour removal, the wastewater treatment plant in Chisinau implemented the pilot-project for raw sludge dewatering using the 'Geotube' method. The annual capacity of the sludge dewatering process is 584 thousand m^3 with 95 per cent humidity, which, after dewatering has a capacity of 97.3 thousand m^3 and a 70 per cent humidity. Two open storage facilities were built to store the sludge from the 'Geotube' bags after the dewatering process.

It should be noted that in 2018 rehabilitation works of the Wastewater Treatment Plant in Chisinau were initiated. The project includes the construction of a new sludge treatment facility, the renovation of the infrastructure, the construction of several specialized facilities as well as the installation of the wastewater filtering equipment. It is planned to build a power plant using the sludge as raw material. As a result of biogas production, electricity will be produced, providing 50 per cent of the electricity used at the wastewater treatment plant. The rehabilitation works of the Chisinau Wastewater Treatment Plant have been carried out so far in proportion of 30 per cent.

7.5.1. Source Category Description

Within source category 5D 'Wastewater Treatment and Discharge' CH_4 and N2O emissions from 5D1 'Domestic Wastewater', as well as CH_4 emissions from 5D2 'Industrial Wastewater' were estimated.

5D1 'Domestic Wastewater"

Domestic wastewater is the product of using water for domestic purposes. The process of treating domestic wastewaters and sludge from treatment facilities implies CH_4 generation and, in a smaller amount – NMVOC. The wastewater treatment scheme is a classic one and has a different level of treatment in urban and rural areas, depending on the technical endowment of the installations. The main wastewater treatment methods are: mechanical, biological (based on organic matter degradation), chemical (using reagents), as well as combined methods. In some cases, wastewater is discharged directly into surface basins without special treatment, and in other cases they are treated and discharged with different levels of organic matter load.

Domestic wastewater is discharged through a network that currently does not fully cover the settlements in the country's regions. The quality of sewage services provided to the population is poor. All urban areas in the developing regions have wastewater treatment facilities, but most of them are damaged and inefficient. The majority of the existing facilities provide only a mechanical treatment, while biological facilities with a larger energy consumption are shut down due to higher operation costs. The quality of treated wastewater in all urban areas, except for certain cities, do not meet the existing discharging standards. Exceedances of maximum concentrations of pollutants in treated wastewater are detected in ammonia, suspended substances and organic substances expressed in BOD_5.

The amount of GHG emissions generated under this source category depends on domestic wastewater management practices used in the Republic of Moldova, as well as the level of coverage of the population with services of centralized sewer systems and wastewater treatment. The most widespread wastewater treatment method used in the RM is the traditional biological aerobic treatment. Another source of GHG emissions is represented by the sludge from the wastewater treatment process, subject to aerobic and anaerobic treatment, by storage on sludge fields.

Currently, domestic wastewater treatment is carried out only partially in most urban areas of the RM. It should be noted that in most rural localities the sewage systems were damaged. In urban localities, where the wastewater treatment plants operate, the sludge is treated by storing it on sludge platforms. Because the design capacities of all existing facilities are usually larger (circa 2-10 times, and in some localities even more) than the actual recorded volumes of water generation; at all these sites there are free surfaces to store sludge. Only in large cities, such as Chisinau, Balti and Cahul, due to the lack of sludge treatment technologies, its storage is carried out in layers larger than 50 cm, which causes anaerobic processes and induces the formation of methane emissions. However, compared to the total sludge storage area, these areas are insignificant to be taken into account in the emissions calculation process.

Domestic wastewater from individual households in urban and rural areas not connected to a sewage system are usually collected in latrines.

5D2 'Industrial Wastewater'

In the Republic of Moldova the industrial wastewater is released into municipal sewer lines where it combines with domestic wastewater. After generation, the industrial wastewater is discharged into the sewage systems of the domestic wastewater, being thus treated together. Industrial wastewater is redirected to sewage systems based on the technical conditions issued by the operators of 'Apa-Canal' enterprises. At the same time, based on the results of the inventory of existing wastewater treatment plants, it was found that the respective enterprises allowed the connection to urban sewage systems of several economic agents from the industrial sector due to insufficient volume of wastewater needed for the proper functioning of domestic wastewater treatment plants, which had the effect of reducing the industrial production and, respectively, the volume of industrial wastewater treated at local stations. Within the industrial sector, the processing industries contribute the most to the generation of wastewater with an increased content of organic biodegradable substances.

7.5.2. Methodological Issues, Emission Factors and Data Sources

Methane emissions from category 5D 'Wastewater Treatment and Discharge' were estimated according to a Tier 1 method available in the 2006 IPCC Guidelines, following several steps.

5D1 'Domestic Wastewater'

Step I: Estimating total organically degradable carbon in wastewater (TOW)

Estimation of total organically degradable carbon in wastewater (TOW). Available methodology in the 2006 IPCC Guidelines implies estimating total organically degradable carbon in wastewater generated by all households, connected or not to the sewage system. The value of this index is influenced, particularly, by the population number (urban and rural population), respectively by the biochemical oxygen demand (BOD) component in wastewater.

Table 7-28: AD used to estimate CH_4 emissions from source category 5D1 'Domestic Wastewater' in the RM for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TOW_{rural}, kt BOD_5/yr	50.2014	50.2101	50.6595	50.5583	50.7226	50.6963	51.1734	50.9109	50.9000	50.9022
TOW_{urban}, kt BOD_5/ yr	50.9494	51.1913	51.0182	50.7817	50.7605	51.3491	50.0804	48.5297	47.5976	46.4181
TOW_{total}, kt BOD_5/ yr	95.5190	95.6220	95.7258	95.2168	95.3241	95.2190	95.1834	94.6080	94.7350	94.4985
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
TOW_{rural}, kt BOD_5/yr	50.9494	51.1913	51.0182	50.7817	50.7605	51.3491	50.0804	48.5297	47.5976	46.4181
TOW_{urban}, kt BOD_5/ yr	43.5555	42.6787	42.4882	42.3218	42.1456	38.1659	37.6682	37.4525	36.8445	36.0466
TOW_{total}, kt BOD_5/ yr	94.5049	93.8700	93.5064	93.1035	92.9062	89.5150	87.7486	85.9822	84.4421	82.4647
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
TOW_{rural}, kt BOD_5/yr	45.2936	44.1697	43.2024	41.9061	40.7847	40.2778	39.7591	38.9454	38.1443	37.4169
TOW_{urban}, kt BOD_5/ yr	35.4463	34.8542	34.3195	33.7020	33.1142	32.9856	32.6845	32.2417	31.9218	31.4988
TOW_{total}, kt BOD_5/ yr	80.7399	79.0239	77.5219	75.6081	73.8989	73.2634	72.4436	71.1871	70.0661	68.9157

Total organically degradable carbon in wastewater was estimated following Equation 6.3 from the 2006 IPCC Guidelines (Volume 5, Chapter 6, page 6.13):

$$TOW = P \bullet BOD \bullet 0.001 \bullet I \bullet D$$

Where:

TOW – total organics in wastewater in inventory year, kg BOD/yr;

P – country population in inventory year (person);

BOD – country-specific per capita BOD in inventory year, g/person/day, the default value used for the European countries represents 60 g BOD_5/person/day (2006 IPCC Guidelines, Volume 5, Chapter 6, Table 6.4, page 6.14); in the Republic of Moldova the country-specific value is 60 BOD/person/day (SNIP G.03.02-2015 Table 7.1);

0.001 = conversion from grams BOD to kg BOD;

I – correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00);

D – number of days in a calendar year (365 days in regular years and 366 days in leap years: 1992, 1996, 2000, 2004, 2008, 2012, 2016).

Step II: Selecting wastewater treatment systems and discharge pathways

The second step consists in selecting wastewater treatment and discharge pathways according to national conditions and by taking into consideration country-specific activity data. By applying Equation

6.2 from the 2006 IPCC Guidelines (Volume 5, Chapter 6, page 6.12) it is possible to obtain the EFs for each wastewater treatment system and discharge pathway.

The emission factor depends of methane producing capacity (B_0), respectively the methane correction factor (MCF) specific to the respective wastewater treatment system and discharge pathway. B_0 represents the maximum methane producing capacity in a certain amount of organic substances (expressed in BOD) in wastewater. MCF reveals the extent to which the methane producing capacity (B_0) is achieved within each type of wastewater treatment and discharge system. This is also an index of degree that demonstrates to what extent the wastewater treatment system is anaerobic.

$$EFj = B_0 \bullet MCF_j$$

Where:

EF_j - emission factor, kg CH_4/kg BOD_5;

j - each treatment/discharge pathway or system;

B_0 - maximum methane producing capacity, kg CH_4/kg BOD_5 (according to the 2006 IPCC Guidelines, Volume 5, Chapter 6, Table 6.2, page 6.12, the default value used is 0.6);

MCF_j - methane correction factor (fraction) (Table 7-29).

Table 7-29: EFs used to estimate CH_4 emissions from source category 5D1 'Domestic Wastewater'

Type of system	Wastewater treatment systems and discharge pathways, j	B_o, kg CH_4/kg BOD_5	MCF	EF, kg CH_4/kg BOD_5
Untreated systems	Sea, river and lake discharge without the preventive wastewater treatment	0.6	0.1	0.06
	Stagnant sewer	0.6	0.5	0.30
	Flowing sewer (open or closed)	0.6	0.0	0.0
Treated systems	Centralized, aerobic treatment plant, well managed	0.6	0.1	0.6
	Centralized, aerobic treatment plant, not well managed	0.6	0.2	0.12
	Anaerobic digester for sludge	0.6	0.8	0.48
	Anaerobic shallow lagoon (<2 m)	0.6	0.2	0.12
	Anaerobic deep lagoon (>2 m)	0.6	0.8	0.48
	Septic system (half of BOD settles in anaerobic tank)	0.6	0.3	0.18
	Latrine, dry climate, ground water table lower than latrine, small family (3-5 persons)	0.6	0.1	0.06
	Latrine, dry climate, ground water table lower than latrine, communal (many users)	0.6	0.5	0.30
	Latrine, wet climate/flush water use, ground water table higher than latrine	0.6	0.7	0.42
	Latrine, regular sediment removal for fertilizer	0.6	0.1	0.06

Step III: Estimating total methane emissions from wastewater treatment and discharge

The third step consists in estimating total methane emissions from category 5D1 'Domestic Wastewater' as a sum of emissions from each wastewater treatment system and discharge pathway in the country. The assessment is according to Equation 6.1 from the 2006 IPCC Guidelines (Volume 5, Chapter 6, page 6.11):

$$CH_4\ Emissions = [\Sigma ij(Ui \bullet Tij \bullet EFj)] \bullet (TOW\text{-}S)\text{-}R$$

Where:

CH_4 Emissions - methane emissions in inventory year, kg CH_4/yr;

TOW - total organics in wastewater in inventory year, kg BOD/yr;

S - organic component removed as sludge in inventory year, kg BOD/yr;

Ui - fraction of population in income group *i,* in inventory year (fraction);

$T_{i,j}$ - degree of utilisation of treatment/discharge pathway or system, *j*, for each income group fraction *i,* in inventory year (fraction);

i - income group: rural – low income, urban – high income and urban – low income;

j - each treatment/discharge pathway or system;

EF_j - emission factor, kg CH_4 / kg BOD;

R - amount of methane recovered in inventory year, kg CH_4/yr.

According to the recommendations set out in the 2006 IPCC Guidelines (Volume 5, Chapter 6, pages 6.14-6.15), the population generating wastewater is to be divided into groups depending on the level of economic development and implicitly by the urbanization degree of the localities (Table 7-30), of which depends the access to wastewater collection and treatment systems, as well as the efficiency of these systems.

Table 7-30: Share of different groups from the total population in the RM (U_i fraction, where 100 per cent = 1.0), for the period 1990-2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
U_{rural}	0.526	0.525	0.529	0.531	0.532	0.532	0.538	0.538	0.537	0.539
$U_{urban, low income}$	0.186	0.185	0.183	0.184	0.183	0.184	0.180	0.180	0.182	0.181
$U_{urban, high income}$	0.289	0.290	0.287	0.286	0.285	0.284	0.282	0.282	0.280	0.280
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
U_{rural}	0.539	0.545	0.546	0.545	0.546	0.572	0.570	0.565	0.565	0.565
$U_{urban, low income}$	0.182	0.177	0.177	0.178	0.184	0.142	0.143	0.152	0.150	0.150
$U_{urban, high income}$	0.279	0.277	0.277	0.277	0.270	0.286	0.287	0.283	0.285	0.286
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
U_{rural}	0.564	0.562	0.562	0.560	0.558	0.556	0.555	0.553	0.551	0.550
$U_{urban, low income}$	0.151	0.151	0.151	0.152	0.154	0.155	0.153	0.152	0.151	0.149
$U_{urban, high income}$	0.286	0.286	0.287	0.288	0.289	0.289	0.292	0.295	0.298	0.301

In the Republic of Moldova the population was divided in the following groups:

- population with high urbanization rate and high incomes; within this group is included the population of Chisinau, Balti, Tiraspol, Bender, Ribnita and Cahul municipalities (Table 7-31); the respective population is connected to sewage systems and has access to centralized aerobic treatment plants for domestic and industrial wastewater collected together; their efficiency varies from well managed to not well managed; it is worth mentioning that a small part of the population of these municipalities is not connected to the centralized sewage system, the wastewater being collected in latrines and septic systems (with or without discharge);
- population with low urbanization rate and low incomes; within this group is included the population of other cities in the RM; the respective population is largely connected to sewage systems, which are rather not well managed; another part of the population within this group is not connected to sewage systems, the wastewater being collected in latrines and septic systems (with or without discharge);
- rural population; within this group is included the rural population of the RM; the income of this group is generally much lower than the level attributed to the urban population; a small part of the population of this group is connected to not well managed sewage systems; while most of the population is not connected to any sewage system, with wastewater being collected in latrines (usually without discharge).

Table 7-31: Population of the Republic of Moldova with High Urbanization Rate and High Income, for the period 1990-2019, thousand inhabitants

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Chisinau	675.5	676.7	667.1	663.4	661.6	661.5	661.9	664.7	663.2	663.6
Balti	161.7	161.8	159.0	157.5	156.1	154.8	153.5	153.4	152.4	152.0
Bender	132.2	133.0	132.7	129.3	128.6	126.8	124.7	123.4	122.4	121.2
Tiraspol	183.7	186.0	186.2	185.1	185.6	183.1	176.8	173.1	170.5	168.0
Ribnita	62.2	62.9	63.0	62.4	63.2	63.4	62.5	62.0	61.6	61.1
Cahul	44.0	44.3	44.6	43.6	43.7	43.4	43.1	43.0	42.7	42.6
Total, $P_{urban, high income}$	1259.3	1264.7	1252.6	1241.3	1238.8	1233.0	1222.5	1219.6	1212.8	1208.5
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Chisinau	663.4	662.0	662.0	660.7	662.2	661.2	660.2	658.4	663.1	663.2
Balti	151.3	146.7	146.5	145.9	144.3	144.2	143.2	142.2	143.2	143.2
Bender	119.6	117.6	116.0	114.8	96.9	85.8	95.0	94.4	94.1	93.8
Tiraspol	164.9	161.9	159.2	155.8	144.0	142.1	140.4	138.6	137.3	137.8
Ribnita	60.5	59.6	58.5	57.5	53.5	52.8	52.2	51.4	50.8	50.1
Cahul	42.4	41.2	41.2	41.1	41.0	40.8	40.7	39.2	39.0	39.4
Total, $P_{urban, high income}$	1202.1	1189.0	1183.4	1175.8	1141.9	1126.9	1131.7	1124.2	1127.5	1127.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Chisinau	663.4	664.7	667.6	671.8	674.5	678.2	681.1	685.9	690.0	695.4
Balti	143.3	144.0	144.3	144.8	144.9	145.3	145.8	146.3	146.6	146.9
Bender	93.3	93.0	92.4	91.9	91.0	84.7	83.8	83.7	83.2	83.4
Tiraspol	136.8	135.7	134.8	133.8	132.9	128.9	128.2	128.0	127.0	127.7
Ribnita	49.4	48.8	48.5	47.9	47.6	45.4	44.8	44.7	44.4	44.0
Cahul	39.4	39.7	39.8	39.8	39.6	39.6	39.6	39.5	39.5	39.4
Total, $P_{urban, high income}$	1125.6	1125.9	1127.4	1130.0	1130.5	1122.1	1123.3	1128.1	1130.7	1136.8

Source: <http://statbank.statistica.md/pxweb/pxweb/ro/20%20Populatia%20si%20procesele%20demografice/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774>; Statistical Yearbooks of the ATULBD for the period 1998-2020 http://mer.gospmr.org/gosudarstvennaya-sluzhba-statistiki/informacziya/ezhegodnik-gosudarstvennoj-sluzhby-statistiki.html

Thus, considering the level of economic development of the localities of the RM, the degree of urbanization, respectively the degree of connection to the wastewater collection and treatment systems, according to statistical data on the access to sewage systems and to expert opinion, the values of country-specific factors used to estimate CH_4 emissions from the most representative wastewater treatment and discharge systems and for each population group of the RM during the reference period were established (1990-2019) (Table 7-32).

Table 7-32: Country-specific factors used to estimate CH_4 emissions from category 5D1 'Domestic Wastewater' for the period 1990-2019

Year	Degree of use of the wastewater treatment systems and discharge pathways j, for each population group - T_{ij}															
	U = urban, high income					U = urban, low income						U = rural				
	U_i	Centralized, aerobic treatment plant, well managed	Centralized, aerobic treatment plant, not well managed	Latrine, ground water table lower than latrine, (3-5 persons)	Septic tanks	U_i	Centralized, aerobic treatment plant, well managed	Centralized, aerobic treatment plant, not well managed	Latrine, ground water table lower than latrine, (3-5 persons)	Septic tanks	Wastewater discharge in river and lakes	U_i	Centralized, aerobic treatment plant, well managed	Centralized, aerobic treatment plant, not well managed	Latrine, ground water table lower than latrine, (3-5 persons)	Septic tanks
1990	0.289	0.900	0.000	0.100	0.000	0.186	0.300	0.300	0.400	0.000	0.000	0.526	0.100	0.000	0.900	0.000
1991	0.290	0.882	0.020	0.098	0.000	0.185	0.280	0.320	0.400	0.000	0.000	0.525	0.100	0.000	0.900	0.000
1992	0.287	0.874	0.030	0.096	0.000	0.183	0.260	0.340	0.400	0.000	0.020	0.529	0.080	0.000	0.920	0.000
1993	0.286	0.866	0.040	0.094	0.000	0.184	0.240	0.360	0.360	0.000	0.040	0.531	0.060	0.000	0.940	0.000
1994	0.285	0.858	0.050	0.092	0.000	0.183	0.220	0.380	0.340	0.000	0.060	0.532	0.040	0.000	0.960	0.000
1995	0.284	0.850	0.060	0.090	0.000	0.184	0.180	0.400	0.340	0.000	0.080	0.532	0.020	0.000	0.980	0.000
1996	0.282	0.870	0.070	0.060	0.000	0.180	0.140	0.420	0.340	0.000	0.100	0.538	0.010	0.000	0.990	0.000
1997	0.282	0.900	0.080	0.020	0.000	0.180	0.090	0.440	0.350	0.000	0.120	0.538	0.000	0.015	0.985	0.000
1998	0.280	0.880	0.090	0.030	0.000	0.182	0.060	0.460	0.340	0.000	0.140	0.537	0.000	0.015	0.985	0.000
1999	0.280	0.850	0.100	0.050	0.000	0.181	0.020	0.480	0.350	0.000	0.150	0.539	0.000	0.017	0.983	0.000
2000	0.279	0.830	0.100	0.070	0.000	0.182	0.010	0.490	0.340	0.000	0.160	0.539	0.000	0.018	0.982	0.000
2001	0.277	0.800	0.100	0.100	0.000	0.177	0.010	0.490	0.320	0.000	0.180	0.545	0.001	0.019	0.980	0.000
2002	0.277	0.800	0.100	0.100	0.000	0.177	0.020	0.480	0.300	0.000	0.200	0.546	0.002	0.020	0.978	0.000
2003	0.277	0.800	0.100	0.100	0.000	0.178	0.030	0.470	0.300	0.000	0.200	0.545	0.003	0.021	0.976	0.000
2004	0.270	0.800	0.100	0.100	0.000	0.184	0.040	0.460	0.320	0.000	0.180	0.546	0.004	0.022	0.974	0.000
2005	0.286	0.801	0.090	0.109	0.000	0.142	0.040	0.460	0.330	0.000	0.170	0.572	0.005	0.023	0.972	0.000
2006	0.287	0.801	0.080	0.119	0.000	0.143	0.060	0.440	0.340	0.000	0.160	0.570	0.007	0.023	0.970	0.000
2007	0.283	0.801	0.070	0.119	0.010	0.152	0.070	0.430	0.350	0.000	0.150	0.565	0.009	0.023	0.968	0.000
2008	0.285	0.801	0.060	0.129	0.010	0.150	0.080	0.420	0.355	0.005	0.140	0.565	0.011	0.023	0.966	0.000
2009	0.286	0.802	0.060	0.128	0.010	0.150	0.090	0.410	0.335	0.015	0.150	0.565	0.013	0.023	0.959	0.005
2010	0.286	0.804	0.050	0.136	0.010	0.151	0.110	0.390	0.340	0.020	0.140	0.564	0.014	0.023	0.956	0.007
2011	0.286	0.806	0.050	0.134	0.010	0.151	0.150	0.350	0.340	0.030	0.130	0.562	0.015	0.024	0.946	0.015
2012	0.287	0.808	0.050	0.132	0.010	0.151	0.170	0.330	0.340	0.040	0.120	0.562	0.016	0.025	0.941	0.018
2013	0.288	0.810	0.050	0.125	0.015	0.152	0.200	0.300	0.340	0.050	0.110	0.560	0.017	0.026	0.937	0.020
2014	0.289	0.812	0.050	0.123	0.015	0.154	0.230	0.270	0.340	0.060	0.100	0.558	0.018	0.028	0.932	0.022
2015	0.289	0.813	0.050	0.122	0.015	0.155	0.260	0.240	0.350	0.060	0.090	0.556	0.019	0.028	0.928	0.025
2016	0.292	0.813	0.050	0.122	0.015	0.153	0.280	0.220	0.360	0.060	0.080	0.555	0.020	0.022	0.932	0.026
2017	0.295	0.816	0.040	0.126	0.018	0.152	0.300	0.220	0.348	0.062	0.070	0.553	0.022	0.020	0.931	0.027
2018	0.298	0.825	0.040	0.117	0.018	0.151	0.320	0.230	0.318	0.062	0.070	0.551	0.025	0.018	0.929	0.028
2019	0.301	0.831	0.040	0.111	0.018	0.149	0.340	0.210	0.318	0.062	0.070	0.550	0.025	0.017	0.930	0.028

5D2 'Industrial Wastewater'

Step I: Estimating total organically degradable carbon in industrial wastewater (TOW)

According to the methodology available in the 2006 IPCC Guidelines the amount of organically degradable carbon in wastewater (TOW) is a function of industrial output (product) P (tons/yr), wastewater generation W (m^3/ton of product) and degradable organics concentration in wastewater COD (kg COD/m^3).

The amount of total organically degradable carbon in wastewater (TOW) for the industrial sector was estimated using Equation 6.6 from the 2006 IPCC Guidelines (Volume 5, Chapter 6, page 6.22):

$$TOW_i = P_i \bullet W_i \bullet D_i$$

Where:

TOW $_{ind}$ - total organically degradable material in wastewater for industry i, kg COD/yr [138] (Table 7-35);

P_i - total industrial product for industrial sector i, t/yr;

W $_i$ - wastewater generated, $m^3/t_{product}$;

D $_{ind}$ - chemical oxygen demand (industrial degradable organic component in wastewater) kg CCO/m^3.

For this purpose, activity data on the generation of industrial wastewater (by industry) and its discharge into sewage networks was used.

Each industry branch was assigned a certain value of the degradable organic component expressed in kg COD/m^3 industrial wastewater, the amount of wastewater generated per industrial production output unit expressed in m^3/tonnes of product (Table 7-33), as well as the amount of annual output for each industry branch (Table 7-34).

Table 7-33: EFs used to estimate CH_4 emissions from source category 5D2 'Industrial Wastewater'

Industry Production	D $_{ind}$ – industrial degradable organic component, kg CDO/m^3	W $_{ind}$ – amount of wastewater generated per industrial production output unit, m^3/t
Canned meat	4.1	13.0
Canned vegetables and fruits	5.0	20.0
Beer	2.9	6.3
Wine and sparkling wine	1.5	23.0
Cognac and brandy	11.0	24.0
Meat and sausages	4.1	13.0
Dairy products	2.7	7.0
Sugar	3.2	11.0
Fish	2.5	13.0
Vegetable oil and fats	0.8	3.1
Soft drinks	1.0	3.8
Corrugated cardboard	9.0	162.0
Plastics and resins	3.7	0.6
Paint and varnishes	3.0	67.0
Detergents and soap	0.6	2.5
Leather	7.0	4.2
Textiles	1.0	42.6

Source: 2006 IPCC Guidelines, Volume 5, Chapter 6, Table 6.9, page 6.22; Mircea Gh. Negulescu et al., Industrial Wastewater Treatment, Technical Publishing House, Bucharest, 1968; CEC All Union Scientific Research Institute for Water Supply, Sewage, Hydraulic Engineering Works and Engineering Hydrogeology (VNII VODGEO GOSSTROI of the USSR), Consolidated Norms in Water Supply and Water Disposal for Different Industries, Moscow, 1982; Sewage System for Populated Areas and Industrial Plants. Handbook. 'Stroiizdat' Moscow, 1981.

Table 7-34: AD on industrial output used to Estimate CH_4 emissions from source category 5D2 'Industrial Wastewater', kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Canned meat	15.000	9.600	5.808	3.269	1.723	1.750	1.500	3.100	2.350	1.860
Canned vegetables and fruit	499.300	462.400	394.650	403.400	244.250	176.700	126.200	200.100	135.400	98.592
Fruit and vegetable juices	273.600	260.000	89.100	104.600	50.800	44.800	49.400	88.300	67.400	32.100
Canned vegetables	149.600	143.000	74.300	72.000	62.400	41.100	20.500	26.600	27.200	44.527
Processed and canned fruit	76.100	59.400	48.200	53.900	17.600	10.600	17.600	18.200	6.600	5.216
Beer	76.000	66.000	43.000	36.000	28.500	30.290	25.600	26.270	30.010	22.090
Grapes wine	163.000	143.000	92.000	103.000	97.780	99.690	145.800	194.150	123.960	69.010
Sparkling wine	8.040	7.830	8.540	8.880	7.420	9.480	14.190	13.450	5.190	6.752
Cognac	13.940	14.020	7.500	7.400	7.930	10.270	4.570	5.860	4.970	4.859

[138] COD – chemical oxygen demand.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Brandy and liqueurs	5.590	5.560	6.760	13.940	26.470	41.270	33.580	23.700	17.410	8.700
Meat	257.900	218.500	136.000	114.200	85.900	58.400	52.600	50.800	27.300	25.717
Sausages	50.000	52.900	27.300	14.700	9.000	8.900	8.000	9.600	8.000	9.434
Butter	27.000	21.833	18.803	11.052	9.660	6.800	4.700	2.956	2.895	2.374
Margarine	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cheese and cottage cheese	12.200	10.000	5.400	4.900	3.200	2.100	1.700	1.213	1.328	1.325
Curd, curd cream, yogurt, kefir, sour cream	138.000	115.400	70.100	65.100	48.800	21.700	11.900	20.500	26.800	20.700
Ice cream	11.520	9.600	6.400	2.900	2.500	2.400	3.000	3.251	4.389	4.264
Milk and whipped cream with a fat content <6 %	454.800	382.600	180.500	175.100	86.700	39.500	36.100	26.600	32.400	25.984
Milk and whipped cream in solid form	15.500	12.000	9.200	4.300	4.700	4.400	3.100	2.647	2.389	1.962
Crude oil, not chemically modified	125.600	117.900	57.300	60.300	50.400	50.700	39.400	35.200	28.700	24.264
Granulated sugar	435.800	236.900	208.000	230.200	166.700	218.700	264.500	213.300	194.500	100.500
Fish and fish products	9.500	5.200	6.500	9.500	2.100	0.000	0.000	0.900	0.800	1.000
Mineral and aerated water	51.924	34.616	19.774	13.749	11.382	10.003	10.120	9.772	18.578	24.585
Other non-alcoholic drinks	131.330	86.220	32.407	18.703	17.081	20.490	15.080	14.330	15.570	15.140
Paper and corrugated cardboard	5.340	4.650	1.110	1.020	0.240	0.420	0.510	0.720	0.390	0.180
Synthetic resins	17.500	14.600	5.839	4.792	1.510	1.424	0.000	0.000	0.000	0.000
Paint and Varnishes	11.700	8.800	6.000	3.100	1.200	0.800	0.700	0.509	0.370	0.674
Soap	11.700	8.000	4.800	2.700	0.700	0.600	0.500	0.608	0.301	0.231
Washing and cleaning products	15.000	10.100	9.900	4.900	1.200	1.400	1.600	0.293	0.172	0.258
Rough leather goods	0.439	0.404	0.106	0.064	0.027	0.047	0.054	0.053	0.055	0.018
Leather boxing clothes	1.174	1.173	0.897	0.611	0.182	0.143	0.177	0.214	0.095	0.040
Cotton yarn	31.600	32.600	16.668	8.561	4.252	2.655	6.524	5.364	10.552	8.131
Fabrics	33.540	16.770	11.372	7.575	5.048	3.761	7.681	7.297	13.644	11.486
Polymer film	5.200	4.400	2.600	2.300	1.200	0.712	1.896	1.285	1.268	0.701
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Canned meat	2.845	2.071	2.213	3.192	2.200	0.739	1.062	1.377	1.555	1.195
Canned vegetables and fruit	93.852	113.875	80.861	111.194	80.406	86.264	99.896	93.952	102.669	60.237
Fruit and vegetable juices	46.700	59.700	31.256	56.884	36.872	30.023	29.732	53.777	39.042	28.163
Canned vegetables	22.119	28.876	22.724	25.534	22.739	51.341	44.409	22.701	41.939	26.505
Processed and canned fruit	6.116	5.423	5.231	16.076	18.596	18.332	17.276	16.524	17.781	3.738
Beer	25.790	33.620	46.240	59.910	69.570	77.780	91.327	101.463	86.659	78.174
Grapes wine	109.224	156.423	149.398	192.183	335.140	364.350	188.677	125.812	155.297	126.305
Sparkling wine	4.162	5.843	6.130	7.385	9.383	10.513	4.016	5.407	5.720	4.997
Cognac	7.177	9.556	10.381	13.611	14.280	17.108	7.914	8.236	10.373	6.978
Brandy and liqueurs	4.890	5.940	7.790	13.980	21.291	23.876	19.625	17.216	12.911	11.080
Meat	13.351	7.301	11.262	14.855	10.180	6.651	10.228	16.122	12.809	16.260
Sausages	10.168	11.655	13.842	15.026	15.566	17.241	18.035	20.775	22.466	17.057
Butter	2.844	3.360	2.717	2.863	3.840	3.593	3.521	3.587	4.697	4.222
Margarine	0.024	1.034	2.616	3.301	3.515	3.390	2.624	2.225	1.940	1.657
Cheese and cottage cheese	1.212	1.484	1.895	1.895	1.941	2.435	2.081	2.311	2.609	1.463
Curd, curd cream, yogurt, kefir, sour cream	17.100	21.900	16.839	22.262	20.958	26.532	28.278	32.351	32.373	32.961
Ice cream	4.395	5.182	6.321	8.073	7.287	8.105	8.609	8.228	7.679	7.010
Milk and whipped cream with a fat content <6 %	26.764	35.171	43.060	16.925	16.049	20.784	50.349	55.271	66.597	61.398
Milk and whipped cream in solid form	3.114	5.000	4.186	3.709	5.059	4.565	3.806	2.676	2.693	1.821
Crude oil, not chemically modified	31.343	43.486	53.632	77.007	96.092	83.394	81.471	84.967	79.307	83.881
Granulated sugar	105.400	132.600	167.600	107.100	110.900	133.472	149.046	73.964	133.966	38.373
Fish and fish products	1.900	2.300	2.700	2.700	2.700	3.000	2.500	2.300	4.600	3.700
Mineral and aerated water	30.917	39.039	54.222	62.804	75.273	97.310	108.489	136.518	130.358	117.804
Other non-alcoholic drinks	19.180	30.910	51.370	63.450	69.743	69.438	81.344	101.594	87.526	67.617
Paper and corrugated cardboard	0.168	0.385	0.189	0.185	0.471	0.605	1.950	2.700	1.140	0.870
Synthetic resins	0.000	0.979	0.776	0.708	0.910	1.048	0.825	1.026	0.961	0.777
Paint and Varnishes	2.054	2.870	4.095	3.443	5.136	6.269	8.319	11.045	11.557	11.822
Soap	0.231	0.280	0.232	0.339	0.386	0.317	0.526	0.562	0.399	0.380
Washing and cleaning products	0.386	0.821	0.255	0.243	0.493	0.533	0.769	1.034	0.451	0.482
Rough leather goods	0.013	0.012	0.004	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Leather boxing clothes	0.043	0.060	0.135	0.042	0.000	0.000	0.000	0.000	0.000	0.000
Cotton yarn	13.030	12.400	12.501	13.300	16.200	18.537	18.728	21.319	20.635	14.867
Fabrics	17.064	16.342	16.837	19.292	20.625	23.823	23.661	26.440	26.787	18.129
Polymer film	1.734	2.141	3.324	4.211	3.300	4.464	3.985	4.048	3.384	2.973
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Canned meat	1.598	1.433	1.654	0.969	0.825	0.769	0.809	0.886	0.926	0.917
Canned vegetables and fruit	75.977	71.009	81.109	100.844	104.250	70.864	86.085	96.595	115.820	127.399
Fruit and vegetable juices	31.852	34.758	55.428	60.119	58.835	46.860	59.204	66.417	76.685	97.897
Canned vegetables	29.890	26.336	24.291	25.114	30.395	15.674	0.000	19.643	25.628	17.911
Processed and canned fruit	7.985	6.758	0.436	10.741	7.598	7.895	9.400	8.239	12.544	9.422
Beer	95.260	106.812	111.844	102.927	98.475	99.454	84.784	86.647	81.954	83.920
Grapes wine	128.550	126.057	142.202	155.166	140.946	135.653	134.575	165.232	171.726	178.710
Sparkling wine	5.561	6.864	6.539	5.955	5.140	5.023	6.292	6.524	6.744	6.744
Cognac	7.465	9.118	10.940	11.797	9.395	7.016	7.722	8.400	8.769	9.190
Brandy and liqueurs	12.711	14.021	16.586	19.614	18.338	16.234	16.278	15.694	15.192	14.299
Meat	24.699	28.509	31.597	35.495	44.072	45.735	45.900	55.931	62.233	62.645
Sausages	16.697	17.963	19.633	21.265	20.824	20.915	21.240	23.225	24.798	25.951

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Butter	4.586	4.258	4.392	5.811	5.008	5.062	6.138	5.053	4.270	4.303
Margarine	1.274	1.119	0.484	0.706	0.200	0.200	0.200	0.000	0.000	0.000
Cheese and cottage cheese	1.828	2.153	2.250	2.525	2.481	2.500	2.497	2.993	2.951	2.697
Curd, curd cream, yogurt, kefir, sour cream	32.999	35.412	39.283	41.212	40.890	41.840	43.346	43.868	44.485	45.987
Ice cream	8.490	8.313	9.436	10.173	10.477	10.706	11.076	11.394	11.810	11.367
Milk and whipped cream with a fat content <6 %	65.056	62.921	62.397	65.313	78.723	79.970	85.957	79.991	69.061	61.287
Milk and whipped cream in solid form	1.217	0.625	0.536	0.439	1.042	1.357	1.675	2.474	2.276	0.864
Crude oil, not chemically modified	80.705	89.787	96.828	65.502	113.223	109.534	79.963	86.811	106.306	124.661
Granulated sugar	103.209	88.436	83.440	140.297	177.695	84.519	99.999	128.980	73.906	86.925
Fish and fish products	1.300	7.578	7.732	8.490	8.774	9.241	7.275	7.788	7.954	7.403
Mineral and aerated water	122.668	114.370	114.375	100.470	115.695	126.312	132.573	145.461	158.805	171.473
Other non-alcoholic drinks	73.043	80.746	79.734	70.545	70.700	70.413	50.792	53.204	56.008	58.050
Paper and corrugated cardboard	1.290	2.520	1.324	2.467	2.000	2.000	2.000	0.000	0.000	0.000
Synthetic resins	1.516	1.657	1.774	1.842	1.739	0.929	1.453	1.346	2.128	2.470
Paint and Varnishes	12.864	18.011	17.907	12.345	17.685	26.858	32.746	30.069	29.838	29.524
Soap	0.538	0.523	0.570	0.637	0.786	0.993	0.995	1.243	1.261	1.540
Washing and cleaning products	0.618	0.727	0.798	1.892	1.416	1.760	2.821	2.155	2.674	3.715
Rough leather goods	0.000	0.000	0.000	0.007	0.000	0.000	13.547	0.000	0.000	0.000
Leather boxing clothes	0.000	0.000	0.000	0.035	0.000	0.000	0.000	0.000	0.000	0.000
Cotton yarn	16.155	13.078	14.290	14.886	13.193	10.445	13.547	13.345	12.934	12.456
Fabrics	21.777	17.544	19.628	24.239	18.287	13.980	17.671	17.671	17.227	16.466
Polymer film	3.498	3.708	3.175	2.528	1.671	1.640	1.635	3.351	3.673	3.354

Source: National Bureau of Statistics of the Republic of Moldova, through Letter No. 06-39/08 dated 23.02.2011 (AD for the period 1992-2010); Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic of Moldova, by product type, for the period 2005-2019'; Statistical Yearbooks of the ATULBD for 1998 (page 176-184), 2000 (page 99-100), 2002 (page 103-104), 2006 (page 93-94), 2009 (page 92-93), 2011 (page 94-96), 2014 (page 89-90), 2015 (page 89-90), 2016 (page 98-99), 2020 (page 102-104); Express Information, Key Performance Indicators for the Industry Sector in the Republic for 2019, 2018, 2017, 2016. <http://mer.gospmr.org/gosudarstvennaya-sluzhba-statistiki/informacziya/ezhegodnik-gosudarstvennoj-sluzhby-statistiki.html, http://mer.gospmr.org/gosudarstvennaya-sluzhba-statistiki/informacziya/osnovnye-pokazateli-raboty-promyshlennosti.html>

Table 7-35: Total industrial organic wastewater (TOW_i) by industry branches in the RM for the period 1990-2019, kt COD/yr

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Food industry	158.6281	138.7174	91.0192	94.2480	64.9960	58.3199	51.3862	60.9473	44.9792	31.4643
Paper and cardboard	7.7857	6.7797	1.6184	1.4872	0.3499	0.6124	0.7436	1.0498	0.5686	0.2624
Plastics in primary forms	0.0389	0.0324	0.0130	0.0106	0.0034	0.0032	0.0030	0.0028	0.0027	0.0025
Paints and Varnishes	2.3517	1.7688	1.2060	0.6231	0.2412	0.1608	0.1407	0.1023	0.0744	0.1355
Soap, detergents and beauty care products	0.0401	0.0272	0.0221	0.0114	0.0029	0.0030	0.0032	0.0014	0.0007	0.0007
Leather goods	0.0474	0.0464	0.0295	0.0198	0.0062	0.0056	0.0068	0.0078	0.0044	0.0017
Cotton yarn and fabrics	2.7750	2.1032	1.1945	0.6874	0.3962	0.2733	0.6051	0.5393	1.0308	0.8357
Plastic plates, sheets, tubes and poles	0.0115	0.0098	0.0058	0.0051	0.0027	0.0016	0.0042	0.0029	0.0028	0.0016
TOW_i, total	**171.6784**	**149.4848**	**95.1084**	**97.0926**	**65.9984**	**59.3797**	**52.8928**	**62.6536**	**46.6635**	**32.7044**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Food industry	30.9406	38.7096	34.4597	43.6393	45.7879	52.0304	44.4083	39.6450	43.5225	28.9018
Paper and cardboard	0.2449	0.5616	28.6468	31.5238	31.1821	30.9710	31.3489	29.3048	33.6731	31.2029
Plastics in primary forms	0.0023	0.0022	0.0017	0.0016	0.0020	0.0023	0.0018	0.0023	0.0021	0.0017
Paints and Varnishes	0.4129	0.5769	0.8231	0.6920	1.0323	1.2601	1.6722	2.2201	2.3230	2.3763
Soap, detergents and beauty care products	0.0009	0.0017	0.0007	0.0009	0.0013	0.0013	0.0019	0.0024	0.0013	0.0013
Leather goods	0.0016	0.0021	0.0041	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cotton yarn and fabrics	1.2820	1.2244	1.2498	1.3884	1.5687	1.8045	1.8058	2.0346	2.0202	1.4056
Plastic plates, sheets, tubes and poles	0.0038	0.0048	0.0074	0.0093	0.0094	0.0103	0.0087	0.0089	0.0081	0.0065
TOW_i, total	**32.8891**	**41.0832**	**65.1933**	**77.2567**	**79.5837**	**86.0799**	**79.2476**	**73.2180**	**81.5502**	**63.8962**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Food industry	35.3565	35.5787	39.7981	46.9033	47.9231	37.5780	40.3235	45.7435	48.2245	51.0389
Paper and cardboard	35.6302	32.1087	28.5999	31.5298	25.4503	26.8853	25.5545	27.6703	28.6396	29.0711
Plastics in primary forms	0.0034	0.0037	0.0039	0.0041	0.0039	0.0021	0.0032	0.0030	0.0047	0.0055
Paints and Varnishes	2.5857	3.6203	3.5994	2.4813	3.5554	5.3991	6.6004	6.0438	5.9974	5.9343
Soap, detergents and beauty care products	0.0017	0.0019	0.0021	0.0038	0.0033	0.0041	0.0057	0.0051	0.0059	0.0079
Leather goods	0.0000	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cotton yarn and fabrics	1.6159	1.3045	1.4449	1.6667	1.3410	1.0405	1.3299	1.3213	1.2849	1.2321
Plastic plates, sheets, tubes and poles	0.0085	0.0094	0.0083	0.0091	0.0101	0.0080	0.0078	0.0074	0.0082	0.0074
TOW_i, total	**75.2019**	**72.6271**	**73.4567**	**82.5993**	**78.2870**	**70.9171**	**73.8250**	**80.7945**	**84.1651**	**87.2972**

Step II: Selecting wastewater treatment systems and discharge pathways for industrial wastewater

The second step consists in selecting wastewater treatment and discharge pathways according to national conditions and by taking into consideration country-specific activity data. By applying Equation 6.2 from the 2006 IPCC Guidelines (Volume 5, Chapter 6, page 6.12) the EFs for each wastewater treatment system and discharge pathway one can obtained.

The emission factor depends of methane producing capacity (B_0), respectively the methane correction factor (MCF) specific to the respective wastewater treatment system and discharge pathway. B_0

represents the maximum methane producing capacity in a certain amount of organic substances (expressed in COD) within industrial wastewater. MCF reveals the extent to which the methane producing capacity (B_0) is achieved within each type of wastewater treatment and discharge system. This is also an index of degree that demonstrates to what extent the wastewater treatment system is anaerobic.

$$EFj = B_0 \bullet MCF_j$$

Where:

EF_j - emission factor, kg CH_4/kg COD;

j - each treatment/discharge pathway or system;

B_0 - maximum methane producing capacity, kg CH_4/kg COD (according to the 2006 IPCC Guidelines, Volume 5, Chapter 6, Table 6.2, page 6.12, the default value used for industrial wastewater is 0.25);

MCF_j - methane correction factor (fraction) (Table 7-36).

Table 7-36: EFs used to estimate CH_4 emissions from source category 5D2 'Industrial wastewater'

Type of system	Wastewater treatment systems and discharge pathways, j	B_o, kg CH_4/kg COD_5	MCF	EF, kg CH_4/kg COD_5
Untreated systems	River and lake discharge without the preventive wastewater treatment	0.25	0.1	0.025
Treated systems	Centralized, aerobic treatment plant, well managed	0.25	0.1	0.050
	Centralized, aerobic treatment plant, not well managed	0.25	0.2	0.025

Step III: Estimating total methane emissions from industrial wastewater treatment and discharge

The third step consists in estimating total methane emissions from category 5D2 'Industrial wastewater' as a sum of emissions from each wastewater treatment system and discharge pathway. Similar to domestic wastewater, the assessment for industrial wastewater is according to Equation 6.1 from the 2006 IPCC Guidelines (Volume 5, Chapter 6, page 6.11):

$$CH_4\ Emissions = [\Sigma ij(Ui \bullet Tij \bullet EFj)] \bullet (TOW\text{-}S)\text{-}R$$

Where:

CH_4 Emissions - methane emissions in inventory year, kg CH_4/yr;

TOW - total organics in wastewater in inventory year, kg COD/yr;

S - organic component removed as sludge in inventory year, kg BOD/yr;

Ui - fraction of population in income group *i,* in inventory year (fraction);

$T_{i,j}$ - degree of utilization of treatment/discharge pathway or system, *j*, for each income group fraction *i,* in inventory year (fraction);

i - income group: rural – low income, urban – low income

j - each treatment/discharge pathway or system;

EF_j - emission factor, kg CH_4/kg COD;

R - amount of methane recovered in inventory year, kg CH_4/yr.

It should be noted that as industrial wastewater is discharged together with domestic wastewater, and most of the economic agents connected to the sewage systems operate in urban areas, the distribution between different wastewater management practices was performed through the allocation to the urban population, subsequently divided into two sub-categories: the population with a high level of urbanization and the population with a low level of urbanization, considering only the centralized wastewater collecting systems and direct wastewater discharge into rivers and lakes (a situation present in certain cities in the country).

Thus, similar to domestic wastewater, by considering the level of economic development of the localities of the RM, the degree of urbanization, and the degree of connection to the wastewater collection and treatment systems, respectively, according to expert opinion, the values of country-specific factors used to estimate CH_4 emissions from industrial wastewater during the reference period were established (1990-2019) (Table 7-37). These values are based on the statistical data related to the number of economic agents by economic activity type in the territory.

Table 7-37: Country-specific factors used to estimate CH_4 Emissions from source category 5D2 'Industrial Wastewater' for the period 1990-2019

Year	Degree of use of the wastewater treatment systems and discharge pathways j, for each population group - T_{ij}						
	U = urban, high income			U = urban, low income			
	U_i	Centralized, aerobic treatment plant, well managed	Centralized, aerobic treatment plant, not well managed	U_i	Centralized, aerobic treatment plant, well managed	Centralized, aerobic treatment plant, not well managed	Wastewater discharge in rivers and lakes
1990	0.639	1.00	0.00	0.361	0.30	0.70	0.00
1991	0.641	0.98	0.02	0.359	0.35	0.65	0.00
1992	0.642	0.97	0.03	0.358	0.40	0.60	0.00
1993	0.644	0.96	0.04	0.356	0.42	0.58	0.00
1994	0.646	0.95	0.05	0.354	0.42	0.58	0.00
1995	0.647	0.94	0.06	0.353	0.44	0.56	0.00
1996	0.649	0.93	0.07	0.351	0.44	0.51	0.05
1997	0.651	0.92	0.08	0.349	0.44	0.51	0.05
1998	0.653	0.91	0.09	0.347	0.46	0.49	0.05
1999	0.654	0.90	0.10	0.346	0.48	0.47	0.05
2000	0.656	0.90	0.10	0.344	0.50	0.40	0.10
2001	0.658	0.90	0.10	0.342	0.52	0.38	0.10
2002	0.660	0.90	0.10	0.340	0.52	0.38	0.10
2003	0.661	0.90	0.10	0.339	0.50	0.34	0.16
2004	0.663	0.90	0.10	0.337	0.48	0.36	0.16
2005	0.662	0.91	0.09	0.338	0.49	0.35	0.16
2006	0.669	0.92	0.08	0.331	0.47	0.35	0.18
2007	0.668	0.93	0.07	0.332	0.46	0.34	0.20
2008	0.672	0.94	0.06	0.328	0.45	0.35	0.20
2009	0.236	0.95	0.05	0.326	0.44	0.37	0.19
2010	0.670	0.95	0.05	0.330	0.41	0.40	0.19
2011	0.662	0.95	0.05	0.338	0.39	0.42	0.19
2012	0.657	0.95	0.05	0.343	0.38	0.43	0.19
2013	0.651	0.95	0.05	0.349	0.36	0.43	0.21
2014	0.652	0.95	0.05	0.348	0.34	0.46	0.20
2015	0.631	0.95	0.05	0.369	0.32	0.47	0.21
2016	0.629	0.95	0.05	0.371	0.28	0.52	0.20
2017	0.628	0.96	0.04	0.372	0.372	0.27	0.55
2018	0.628	0.96	0.04	0.372	0.372	0.27	0.55
2019	0.627	0.96	0.04	0.373	0.373	0.27	0.55

N_2O Emissions from source category 5D1 'Domestic Wastewater'

Wastewater disposal into natural waterways represents an important source of nitrous oxide emissions. These could be direct emissions from treatment plants or indirect emissions from wastewater after disposal of effluent into rivers, lakes or the sea.

Nitrous oxide emissions from source category 5D1 'Domestic Wastewater' were estimated following recommendations set forth in the 2006 IPCC Guidelines, based on a Tier 1 approach.

The assessment is according to Equation 6.7 from the 2006 IPCC Guidelines (Volume 5, Chapter 6, page 6.25):

$$N_2O\ Emissions = N_{EFFLUENT} \bullet EF_{EFFLUENT} \bullet 44/28$$

Where:

N_2O Emissions – N_2O emissions in inventory year, kg N_2O/yr;

$N_{EFFLUENT}$ – total nitrogen in the effluent discharged to aquatic environments, kg N/yr;

$EF_{EFFLUENT}$ – emission factor for N_2O emissions from discharged to wastewater, kg N_2O-N/kg N; the default value used represent 0.005 kg N_2O-N/kg N (2006 IPCC Guidelines, Volume 5, Chapter 6, Table 6.11, page 6.27);

[44/28] – mass ratio of N_2O-N to N_2O.

The activity data that are needed to estimate N_2O emissions are nitrogen content in the wastewater effluent, country population and average annual per capita protein generation (kg/person/yr).

In order to estimate average annual per capita protein generation, it will additionally be considered the 'non-consumed' protein, as well as industrial and commercial protein discharged into the sewer systems.

Food and food waste that is not consumed but can be washed down the drain, as well as bath and laundry water, respectively industrial production waste and commercial food waste from grocery stores and butchers can be expected to contribute to nitrogen loadings and should be taken into consideration in the assessment process.

The total nitrogen in the effluent is estimated according to Equation 6.8 from the 2006 IPCC Guidelines (Volume 5, Chapter 6, page 6.25):

$$N_{EFFLUENT} = (P \bullet Protein \bullet F_{NPR} \bullet F_{NON-CON} \bullet F_{IND-COM}) - N_{SLUDGE}$$

Where:

$N_{EFFLUENT}$ – total annual amount of nitrogen in the wastewater effluent, kg N/yr;

P – human population;

Protein – annual per capita protein consumption, kg/person/yr;

F_{NPR} – fraction of nitrogen in protein, default = 0.16 kg N/kg protein (2006 IPCC Guidelines, Volume 5, Chapter 6, Table 6.11, page 6.27);

$F_{NON-CON}$ – factor for non-consumed protein added to the wastewater (according to the 2006 IPCC Guidelines, Volume 5, Chapter 6, Table 6.11, page 6.27, default values are 1.1 for countries with no garbage disposals, and 1.4 for countries with garbage disposals);

$F_{IND-COM}$ – factor for industrial and commercial co-discharged protein into the sewer system (according to the 2006 IPCC Guidelines, Volume 5, Chapter 6, Table 6.11, page 6.27, the default value is 1.25);

N_{SLUDGE} – nitrogen removed with sludge (according to the 2006 IPCC Guidelines, Volume 5, Chapter 6, page 6.25, the default value is 0), kg N/yr.

N_2O emissions from advanced centralised wastewater treatment plants are typically much lower than those from effluent and may only be of interest for countries that have predominantly advanced centralized wastewater treatment plants with controlled nitrification and denitrification steps.

N_2O emissions from such plants can be estimated according to Equation 6.9 from the 2006 IPCC Guidelines (Volume 5, Chapter 6, page 6.26):

$$N_2O_{PLANT} = P \bullet T_{PLANT} \bullet F_{IND\_COM} \bullet EF_{PLANT}$$

Where:

N_2O_{PLANT} – total N_2O emissions from plants in inventory year, kg N_2O/yr;

P – human population;

T_{PLANT} – degree of utilization of modern, centralized WWT plants, % (in the RM, it corresponds to $U_{urban, high income}$);

$F_{IND-COM}$ – fraction of industrial and commercial co-discharged protein (default = 1.25, according to the 2006 IPCC Guidelines, Volume 5, Chapter 6, Table 6.11, page 6.27);

EF_{PLANT} – emission factor, 3.2 g N_2O/person/year (2006 IPCC Guidelines, Volume 5, Chapter 6, page 6.26).

If we consider to include N_2O emissions from modern, centralized plants (N_2O_{PLANT}), the amount of nitrogen associated with these emissions (N_{WWT}) will be calculated and subtracted from the $N_{EFFLUENT}$. The N_{WWT} can be calculated by multiplying N_2O_{PLANTS} by 28/44 (mass ratio of N_2O to N_2O-N) using the molecular weights).

Activity data on average per capita protein consumption in the RM is provided by the FAO (Table 7-38). For the RM, AD is available on the website of the organisation only since 1992, while for 1990 and 1991 data were extrapolated taking into consideration the evolution of the respective indicator for the USSR. Also, as at the time of compiling the national GHG emissions inventory, activity data for 2014-2019 was not available on the FAO website, they were extrapolated considering the evolution of that indicator during 1992-2013.

Table 7-38: AD used to estimate N_2O emissions from domestic wastewater treatment and discharge

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
P, inhabitants	4361600	4366300	4359100	4347800	4352700	4347900	4334400	4320000	4325800	4315000
Proteins, g/per capita/day	84.27	77.69	71.11	67.06	65.02	65.90	64.93	66.52	67.44	66.15
Proteins, kg/per capita/day	30.76	28.36	26.03	24.48	23.73	24.05	23.76	24.28	24.62	24.14
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
P, inhabitants	4303500	4286300	4269700	4251300	4230600	4087443	4006785	3926128	3845270	3765513
Proteins, g/per capita/day	67.72	68.94	71.00	68.87	65.70	62.50	65.70	62.20	58.10	60.70
Proteins, kg/per capita/day	24.79	25.16	25.92	25.14	24.05	22.81	23.98	22.70	21.26	22.16
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
P, inhabitants	3686756	3608498	3530143	3452422	3374379	3345359	3298887	3250552	3199364	3146834
Proteins, g/per capita/day	60.00	61.60	63.30	65.20	66.00	67.70	69.30	72.70	76.10	77.60
Proteins, kg/per capita/day	26.23	25.99	25.79	26.06	21.90	22.48	23.17	23.80	24.09	24.71

Source: UN database on food, FAOSTAT, FAO Statistics Division 2017, 13 June 2018, <http://www.fao.org/faostat/en/#data/CL>, since 2006 protein consumption is available in the NBS database: <https://statbank.statistica.md/pxweb/pxweb/ro/30%20Statistica%20sociala/30%20Statistica%20sociala__04%20NIV__04%20NIV__NIV060/NIV060300.px/table/tableViewLayout1/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774>.

NMVOC Emissions from Source Category 5D1 'Domestic Wastewater'

NMVOC emissions from source category 5D1 'Domestic Wastewater' were estimated following recommendations set forth in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019).

$$NMVOC\ Emissions = AR \bullet EF \bullet 10^{-6}$$

Where:

NMVOC Emissions - NMVOC emissions in inventory year, kt/yr;

AR = the activity rate for total wastewater discharged in inventory year, million m^3/yr (see Table 7-28);

EF - emission factor, mg NMVOC/m^3 wastewater discharged (according to EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), source category 5D 'Wastewater Handling', Table 3-1, page 7, the default value is 15 kg NMVOC/million m^3 wastewater discharged);

10^{-6} - conversion factor, from kg to kt.

7.5.3. Uncertainties Assessment and Time-Series Consistency

The primary factors affecting uncertainties are the assessment methodology, the emission factors used to estimate CH_4 and N_2O emissions from source category 5D 'Wastewater Treatment and Discharge' and the quality of the available activity data. According to the information available in the 2006 IPCC Guidelines (Volume 5, Chapter 6, pages 6-17 and 6-23), uncertainties associated with maximum methane producing capacity (B_0) could reach circa 30 per cent; uncertainties associated with methane correction factor (fraction) (MCF) for well managed plants could reach circa 10 per cent, for not well managed plants – circa 30 per cent, while for latrines – circa 50 per cent. Uncertainties related to population (P) could reach circa 5 per cent; uncertainties related to BOD values (g/per capita/day) – circa 30 per cent; uncertainties related to the fraction of population divided depending on income level – circa 15 per cent; uncertainties related to the urbanisation level and access to wastewater treatment systems and discharge pathways could vary from 3 per cent for countries that have well developed statistical systems, up to circa 50 per cent for countries with poorly developed statistical systems. Uncertainties related to activity data regarding industrial production for countries with poorly developed statistical systems could reach circa 25 per cent; while those related to the W product (water consumption per unit of production) and COD (kg COD per cubic meter of wastewater) could reach magnitude two (-50 per cent, +100 per cent). In the Republic of Moldova, total uncertainties related to activity data used to estimate CH_4 and N_2O emissions from source category 5D 'Wastewater Treatment and Discharge' were considered to be circa 30 per cent, while total uncertainties related to emission factors – circa 40 per cent for methane emissions, and circa 50 per cent for nitrous oxide emissions, respectively. Thus, combined uncertainties of activity data and methane emissions represent circa 56.56 per cent, while for nitrous oxide emissions – circa 64.03 per cent (Annex 5-3.5).

In view of ensuring time series consistency of results, the same approach was used for the entire period under review, in conformity with good practices applied in the GHG emissions inventory.

7.5.4. Quality Assurance and Quality Control

A standard verification and quality control form was filled in for this category following a Tier 1 approach. Verification was focused on various aspects such as: comparing and ensuring correct use of the emission factors, including the default EFs available in the 2006 IPCC Guidelines; correct use of AD obtained from different sources of reference, including the Statistical Yearbooks of the Republic of Moldova and of those of the ATULBD, as well as FAO database; using the scientific literature in the field regarding planning water norms for different industries. The AD and methods used for estimating GHG emissions under category 5D 'Wastewater Treatment and Discharge' were documented and archived both in hard copies and electronically.

7.5.5. Recalculations

Recalculations were made for CH_4 emissions from category 5D 'Wastewater Treatment and Discharge' for the period 1992-2016, as a result of updating activity data, especially due to adjusting activity data associated with the population number. This activity was carried out by NBS which made the provisional estimates[139] of the population with habitual residence[140] (resident population) in the RM. At the same time, AD associated with the main industrial productions was reviewed for the period 1992-2019.

The changes made in the current inventory cycle resulted in a upward trend in CH_4 emissions from category 5D 'Wastewater Treatment and Discharge' for the period 2002-2011, varying from a maximum increase of circa 12.0 per cent in 2005, to a maximum decrease of 4.8 per cent in 2016 (Table 7-39).

Table 7-39: Comparative results of CH_4 emissions from category 5D 'Wastewater Treatment and Discharge' included into the BUR2 and BUR3 of the RM to the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2, kt, CO_2 equivalent	352.9650	341.5835	307.0640	311.0235	290.9228	289.2454	286.9461	295.1025	284.5183	274.6600
BUR3, kt, CO_2 equivalent	352.9650	341.5835	307.5895	309.9724	289.3528	287.1429	283.2511	289.6535	279.2682	270.5697
Difference, %	0.0	0.0	0.2	-0.3	-0.5	-0.7	-1.3	-1.8	-1.8	-1.5
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2, kt, CO_2 equivalent	274.7153	278.8810	274.2228	279.4227	281.0883	267.3509	261.6968	260.5483	260.1067	247.4503
BUR3, kt, CO_2 equivalent	271.7416	277.2468	294.4618	302.0785	303.7548	299.3127	288.2073	278.9966	280.4470	261.8981
Difference, %	-1.1	-0.6	7.4	8.1	8.1	12.0	10.1	7.1	7.8	5.8
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2, kt, CO_2 equivalent	252.1130	253.1427	255.4244	260.0907	259.5794	250.6923	251.8125			
BUR3, kt, CO_2 equivalent	265.2106	258.2525	255.0776	256.3568	248.3385	240.8280	239.7768	235.7799	239.0924	237.6771
Difference, %	5.2	2.0	-0.1	-1.4	-4.3	-3.9	-4.8			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

For the period 2017-2019, CH_4 emissions from category 5D 'Wastewater Treatment and Discharge' were estimated for the first time. The obtained results allow us to assert that for the period 1990-2019, CH_4 emissions from the respective category had decreased in the Republic of Moldova by circa 32.7 per cent.

N_2O emissions from category 5D 'Wastewater Treatment and Discharge' were also recalculated for the period 2001-2015, as a result of updating activity data associated with the population number in the RM.

In comparison with the results recorded in the BUR2 of the RM to the UNFCCC (2019), the changes made in this inventory cycle resulted in an insignificant increase in nitrous oxide emissions from category 5D 'Wastewater Treatment and Discharge' for the period 2004-2016, due to the decrease in population, varying from a minimum decrease of 8.8 per cent in 2004, to a maximum decrease of 21.8 per cent in 2010 (Table 7-40).

Table 7-40: Comparative results of N_2O emissions from category 5D 'Wastewater Treatment and Discharge' included into the BUR2 and BUR3 of the RM to the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2, kt, CO_2 equivalent	87.9499	81.1694	74.3744	69.7653	67.7185	68.5592	67.5246	68.7603	69.8045	68.2978
BUR3, kt, CO_2 equivalent	87.9499	81.1694	74.3744	69.7653	67.7185	68.5592	67.5246	68.7603	69.8045	68.2978
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[139] The population review at national level and estimation of domestic and international migration is carried out within the project 'Improving the Institutional Capacity of the National Bureau of Statistics', funded by the Swiss Agency for Development and Cooperation, co-financed and implemented by the UN Population Fund in Moldova.
[140] Habitual residence is defined as the place where the person has lived mainly in the last 12 months regardless of temporary absences (for recreation, vacations, visits to relatives and friends, business, medical treatment, religious pilgrimages, etc.), according to the UN Recommendations on Statistics of International Migration, 1998, and (EU) Regulation No. 1260/2013 of the European Parliament and of the Council of November 20, 2013 on European demographic statistics.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2, kt, CO_2 equivalent	69.9236	70.7055	72.5363	70.0571	73.0947	71.4498	70.4040	68.1781	68.4401	64.4928
BUR3, kt, CO_2 equivalent	69.9236	70.7055	72.5363	70.0571	66.6893	61.1268	62.9886	58.4323	53.6028	54.6899
Difference, %	0.0	0.0	0.0	0.0	-8.8	-14.4	-10.5	-14.3	-21.7	-15.2
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2, kt, CO_2 equivalent	67.7135	66.9707	66.3812	67.0444	67.8228	68.1157	68.2697			
BUR3, kt, CO_2 equivalent	52.9287	53.1868	53.6146	53.8608	53.2891	54.1915	54.8516	56.5448	58.2573	58.4302
Difference, %	-21.8	-20.6	-19.2	-19.7	-21.4	-20.4	-19.7			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

Nonetheless, the downward trend in N_2O emissions from category 5D 'Wastewater Treatment and Discharge' for the period 1990-2019 by 33.6 per cent is maintained.

In the context of the information presented above, we find that compared to the results recorded in BUR2 of the RM to the UNFCCC (2019), the changes undertaken in the current inventory cycle resulted in an insignificant downward trend in total direct GHG emissions from category 5D 'Wastewater Treatment and Discharge' for the years 1993-2001 and 2010-2016, varying from a minimum decrease of 0.3 per cent in 1993, to a maximum decrease of 8.0 per cent in 2016. At the same time, for the years 1992 and 2002-2009, there is an upward trend in emissions compared to the previous inventory cycle, with a minimum increase of 0.1 per cent in 1992, to a maximum increase of 6.5 per cent in 2003 (Table 7-41). These fluctuations in emissions are explained by variations in the production of the main industrial products from one year to the other.

Table 7-41: Comparative results of direct GHG emissions from source category 5D 'Wastewater Treatment and Discharge' included into the BUR2 and BUR3 to the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2, kt, CO_2 equivalent	440.9149	422.7530	381.4383	380.7889	358.6413	357.8046	354.4707	363.8628	354.3228	342.9578
BUR3, kt, CO_2 equivalent	440.9149	422.7530	381.9639	379.7377	357.0713	355.7021	350.7757	358.4138	349.0727	338.8674
Difference, %	0.0	0.0	0.1	-0.3	-0.4	-0.6	-1.0	-1.5	-1.5	-1.2
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2, kt, CO_2 equivalent	344.6389	349.5865	346.7591	349.4798	354.1830	338.8006	332.1009	328.7264	328.5468	311.9432
BUR3, kt, CO_2 equivalent	341.6652	347.9523	366.9981	372.1356	370.4440	360.4395	351.1959	337.4289	334.0498	316.5880
Difference, %	-0.9	-0.5	5.8	6.5	4.6	6.4	5.7	2.6	1.7	1.5
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2, kt, CO_2 equivalent	319.8265	320.1134	321.8055	327.1351	327.4022	318.8081	320.0822			
BUR3, kt, CO_2 equivalent	318.1393	311.4394	308.6921	310.2176	301.6276	295.0195	294.6284	292.3246	297.3497	296.1073
Difference, %	-0.5	-2.7	-4.1	-5.2	-7.9	-7.5	-8.0			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

The table below presents the evolution of NMVOC emissions from 5D 'Wastewater Treatment and Discharge' for the period 1990-2019. NMVOC emissions were no reviewed in the current inventory cycle. The obtained results allow us to assert that NMVOC emissions from the respective category had decreased in the RM by 57.4 per cent (Table 7-42).

Table 7-42: NMVOC emissions from category 5D 'Wastewater Treatment and Discharge' included into the BUR3 of the RM to the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NMVOC Emissions, kt	0.0410	0.0373	0.0335	0.0299	0.0272	0.0207	0.0208	0.0186	0.0155	0.0119
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NMVOC Emissions, kt	0.0111	0.0106	0.0104	0.0103	0.0103	0.0103	0.0103	0.0102	0.0102	0.0102
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NMVOC Emissions, kt	0.0102	0.0102	0.0101	0.0101	0.0100	0.0100	0.0100	0.0100	0.0102	0.0102

7.5.6. Planned Improvements

In order to improve the population's access to quality water supply and sanitation services, in the Republic of Moldova various actions of sector planning at different levels are adopted.

At the national level, it was recently approved through the Government Decision No. 199/2014 the Strategy on Water Supply and Sanitation (2014-2030)[141] (modified by Government Decision No. 442/2020[142]), which denotes the impact of climate change, combined with the lack of water in the

[141] <http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=352311>.
[142] <https://www.legis.md/cautare/getResults?doc_id=122313&lang=ro>.

country, noting that ensuring water supply in the future requires integrated urban planning, which does not include actions to reduce GHG emissions from the wastewater management sector. Thus, the general objective of the Strategy is to ensure the gradual access to safe water and adequate sanitation for all localities and population of the Republic of Moldova, thus contributing to the improvement of health, dignity and quality of life and economic development of the country.

The Regulation on Wastewater Discharge in Water Bodies, approved through the Government Decision No. 802 as of 09.10.2013 aims to regulate the conditions of discharge, the introduction of specific substances into a body of surface water, groundwater or water fields. Thus, the Regulation indicates the emission limit values applicable to the discharge of wastewater from the industrial sectors (activities) into a body of surface water.

The Regulation on the requirements for the conditions of collection, treatment and discharge of wastewater in the sewage system and/or in water outlets for urban and rural localities, approved by Government Decision No. 950/2013[143] aims to regulate the conditions of collection, treatment of wastewater in the sewage system and/or in water outlets. Thus, the Regulation provides maximum permissible limit values for the loading of wastewater with pollutants into natural discharges, which will contribute to the safe reduction of emissions from this sector.

Economic instruments will focus on the concept of 'sustainable cost recovery of services' with three main characteristics: an appropriate combination of tariffs, fees and transfers to finance recurring and capital costs and to boost other forms of financing; predictability of public subsidies to facilitate investment (planning); tariff policies that make services accessible to all, including the poorest categories, while ensuring the sustainability of service providers.

The planning perspective of the sector may significantly improve the management of wastewater and sludge from source category 5D 'Wastewater Treatment and Discharge'. Sludge treatment will reduce the risk of affecting the quality of natural water resources, which is becoming increasingly sensitive to climate change.

The above-listed actions shall contribute to the fulfilment of the obligations of the Republic of Moldova towards the implementation of the provisions of the Protocol on Water and Health and other international acts, which aim to reduce the share of the population without access to drinking water sources and sewage systems, as well as the provisions of the UNFCCC.

The planning of phased harmonization of national water legislation with that of the European Union is also a good tool to enhance the implementation of best practices on wastewater treatment technologies, sludge within the sector, which would allow the capture of and the sustainable use of methane emissions from sludge storage fields (including for the production of thermal and electrical energy).

Studying the possibility to use country-specific information on the BOD fraction removed with sludge, maximum methane formation capacity, methane correction factor and other relevant parameters used to assess emissions from source category 5D 'Wastewater Treatment and Discharge' in the process of estimating methane emissions will improve the quality of the next national GHG inventories.

[143] < https://www.legis.md/cautare/getResults?doc_id=120783&lang=ro>

8. RECALCULATIONS AND PLANNED IMPROVEMENTS

This chapter summarizes the explanations and justification for direct GHG emissions recalculations performed to the Republic of Moldova's GHG Inventory for the period 1990-2016, included in the BUR2 of the RM to the UNFCCC (2019), as well as planned improvements for the future inventory cycles. Specific information on the level of source and sink categories associated with respective recalculations and planned improvements can also be found in Chapters 3-7 of the NIR: 1990-2019.

8.1. Explanations and Justifications for Recalculations

The National Inventory Team revised and recalculated GHG emissions and removals for each calendar year covered by the inventory for the period from 1990 through 2016, a component part of the Second Biennial Update Report of the RM to the UNFCCC (2019). These activities were carried out during the on-going process of improving the quality of the National GHG Inventory (including taking into account updated activity data, methodological approaches available in the 2006 IPCC Guidelines, considering new source categories in the inventory for the first time, updating country-specific emission factor values and correcting identified errors).

Thus, under the current inventory cycle, improvements were made in all sectors (the use of higher level methodologies, revision of previously used methodological approaches, emission factors, updated activity data, addition of new source categories, etc.), entailing the need to make recalculations of national GHG emissions for the period from 1990 through 2016, reported in the BUR2 of the RM to the UNFCCC (Chapter 2 'National GHG Inventory').

In comparison with the results reported in the BUR2 of the RM to the UNFCCC (2019), the changes made during the development of the current inventory resulted in a marginal increase in total direct GHG emissions in the years 1990, 1994 and 1996, varying from a minimum of +0.2 per cent in 1996, to a maximum of +1.0 per cent in 1990, and a downward trend in total direct GHG emissions in the years 1991-1993, 1995 and 1997-2016, varying from a minimum of -0.2 per cent in 1995 to a maximum -12.1 per cent in 2009 (Table 8-1).

Table 8-1: Recalculation Results of Total Direct GHG Emissions included into the BUR2 of the RM to the UNFCCC, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	44.9188	40.7762	32.9006	24.7408	21.0382	17.8055	17.5224	16.1683	14.3515	12.5913
BUR3	45.3487	39.1255	31.2699	24.5235	21.1746	17.7666	17.5533	15.8773	14.2292	11.9511
Difference, %	1.0	-4.0	-5.0	-0.9	0.6	-0.2	0.2	-1.8	-0.9	-5.1
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	11.6256	12.4024	12.1971	12.5502	13.5394	13.8478	12.9467	12.7101	13.8693	14.4220
BUR3	11.0391	11.7365	11.6392	12.0733	12.6310	13.0252	12.2163	12.2220	12.6964	12.6698
Difference, %	-5.0	-5.4	-4.6	-3.8	-6.7	-5.9	-5.6	-3.8	-8.5	-12.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	14.5256	14.9033	14.0006	13.4784	14.3801	14.3705	14.5778			
BUR3	13.3331	13.7595	13.2349	13.0439	13.1730	13.1996	13.5035	13.2445	13.9078	13.8100
Difference, %	-8.2	-7.7	-5.5	-3.2	-8.4	-8.1	-7.4			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

With reference to the net direct GHG emissions included into the BUR2 of the RM to the UNFCCC (2019), changes made in the development of the current inventory resulted in an insignificant increase in net direct GHG emissions in the years 1990 and 1994-1995, varying from a minimum of +0.4 per cent in 1995 to a maximum of +1.3 per cent in 1990, and a downward trend in net direct GHG emissions in the years 1991-1993 and 1997-2016, varying from a minimum of -0.8 per cent in 1998 to a maximum of -13.0 per cent in 2009 (Table 8-2).

Table 8-2: Recalculation Results of Total Net Direct GHG Emissions included into the BUR2 of the RM to the UNFCCC, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	43.3912	38.1864	30.9290	22.7398	19.1372	15.9366	15.2393	14.2949	12.4608	10.9940
BUR3	43.9609	36.6725	29.4236	22.6543	19.3714	16.0050	15.3463	14.0326	12.3653	10.3782
Difference, %	1.3	-4.0	-4.9	-0.4	1.2	0.4	0.7	-1.8	-0.8	-5.6
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	9.7449	10.8863	10.5938	11.0170	11.8371	12.4369	11.4159	10.9829	12.4489	13.3888
BUR3	9.1852	10.2376	10.0530	10.5567	10.9408	11.6293	10.6973	10.5071	11.2869	11.6491
Difference, %	-5.7	-6.0	-5.1	-4.2	-7.6	-6.5	-6.3	-4.3	-9.3	-13.0
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	13.5637	13.9953	13.0611	12.6757	13.9265	13.4683	13.6578			
BUR3	12.3792	12.8635	12.3081	12.2463	12.7241	12.2961	12.8459	12.5307	13.3477	14.1058
Difference, %	-8.7	-8.1	-5.8	-3.4	-8.6	-8.7	-5.9			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

8.1.1. Sector 1 'Energy'

Recalculations of direct GHG emissions from Sector 1 'Energy' were performed based on the following considerations:

1A1 'Energy Industries'

- The transition from an average NCV for natural gas to a constant NCV for the entire period 1990-2019 (33.86 TJ/mil. m^3);
- The AD on coal and residual fuel oil consumption at the MTPP Dnestrovsk for the period 2008-2016 were updated based on the information provided in Press Releases on the official web-page of the enterprise;
- In 2015 and 2016, considering fuel consumption from sources 1A1aii 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants', only fuel consumption for 'Energy Producers for public purposes' was accounted for. Data on fuel consumption under 'Energy producers for own consumption' has been reallocated to category 1A2 'Manufacturing Industries and Construction';
- For the years 2015 and 2016, once the Energy Balances of the RM were published in MS Excel format, it became easier to monitor and allocate fuel consumption within sources 1A1b and 1A1c, thus avoiding misallocation in other categories of the sector;
- For source 1A1b 'Petroleum Refining' only 8 per cent of the total fuel consumption indicated in Chapter 'Transformation', categories 'Petroleum Installations' and 'Petrol Refineries' were taken into account;
- For source 1A1b 'Petroleum Refining', the CO_2 emission factor was updated;
- Source 1A1c 'Manufacture of Solid Fuels' (charcoal production) was excluded from the inventory as a result of the lack of information associated with energy consumption (the exclusion of which from the national inventory contributed to a decrease in GHG emissions from category 1A1 over the period 2004-2016);
- LPG were reallocated to gaseous fuels (in the previous inventory cycle, LPG was attributed to liquid fuels).

1A2 'Manufacturing Industries and Construction'

- The transition to the use of a constant NCV for natural gas for the entire time series covered by the National GHG Inventory;
- The distribution of activity data for the territory on the Left Bank of the Dniester River by industrial branches was performed by indirect methods;
- AD was reallocated from source categories 'Combined Heat and Power Generation' and 1A1aiii 'Heat Plants' (autoproducers) to source category 1A2m 'Other industrial activities';
- Primary activity data associated with the consumption of anthracite in 1994 was corrected for source category 1A2e 'Food Processing, Beverages and Tobacco';
- New fuel sources were added to several sub-categories: for 1A2d 'Pulp, Paper and Print' – wood waste, and for 1A2f 'Non-Metallic Minerals' – coal, coke oil, charcoal.

1A3a 'Civil Aviation' (1A3aii Domestic Aviation)

- Information associated with aviation gasoline consumption within source category 1A3a 'Civil Aviation' was restored based on the Energy Balances (EBs) of the RM. For the years 2001-2003, 2006, 2008-2009, 2013 and 2015-2019, data collected through official letters from the Civil Aeronautical Authority remain relevant, in the absence of the respective information in the EBs;
- Consumption of some fuels was reallocated, which was most likely used in domestic aviation (kerosene, jet fuel, motor gasoline, aviation gasoline), from source category 1A2 'Manufacturing Industries and Construction' to source category 1A3a 'Civil aviation';
- In accordance with the EBs of the RM for the years 1990, 1993 and 1998, activity data for the years 1991-1992 and 1994-1997 was restored using the interpolation method.

1A3b. 'Road Transportation'

- Diesel oil and gasoline consumption was reallocated from source category 1A2 'Manufacturing Industries and Construction' to source category 1A3b 'Road Transportation';
- Consumption of kerosene and other petroleum products was reallocated from source category 1A3b 'Road Transportation' to source category 1A3a 'Civil Aviation';
- Gasoline and diesel oil consumption for the Left Bank of the Dniester River was restored based on specific per capita consumption on the Right Bank of the Dniester River, taking into account updated data from the 2014 population census;
- Consumption of natural gas and liquefied petroleum gases for the territory on the Left Bank of the Dniester River was restored based on specific per capita consumption on the Right Bank of the Dniester River, considering the updated data of the 2014 population census.

1A3d 'Navigation'

- AD associated with the consumption of diesel oil for water-borne navigation for the RBDR was updated using two reference sources: for the years 1990 and 2005-2019 – AD available in the EBs of the RM, and for the years 1991-2004 – AD obtained through ministerial official letters was applied;
- Consumption of diesel oil in the period 1993-2019 for water-borne navigation on the LBDR was restored by indirect methods (based on the specific per capita consumption on the RBDR).

1A3e 'Other Transportation' (Pipeline Transport)

- Natural gas consumption for LBDR was restored based on the specific per capita consumption on the RBDR considering the updated data of the 2014 population census;
- The AD for the years 2010-2012 or the territory on the RBDR was specified based on the information available in the EBs of the RM for 2013 (statistical collection);
- A constant NCV (33.86 TJ / million m^3) was used for the entire time series.
- 1A4 'Other Sectors'
- AD associated with fuel consumption for the LBDR was expanded;
- A constant NCV (33.86 TJ / million m^3) was used for the entire time series;
- Updated EF values for CH_4 and N_2O were used for category 1A4cii 'Agriculture/forestry/fishing' (mobile);
- LPG consumption was reallocated from 'liquid fuel' to 'gaseous fuel'.

1A5 'Other'

- LPG was transferred from 'liquid fuel' to 'gaseous fuel';
- AD associated with fuel consumption on the LBDR for the period 2008-2019 was updated;
- Also, a switch to another source of information was made for the LBDR (Statistical Publication Socio-Economic Development of the ATULBD", section 'Use of material and energy resources') available since 2014, in which direct fuel consumption is indicated, and not fuel remaining in stock at the end of the year.

1B2 'Fugitive Emissions from Oil and Natural Gas'

- Emission factors values were updated;
- AD associated with fuel consumption and measurement units were updated;
- Likewise, the transition from an annual average NCV to the use of constant NCV for natural gas (33.86 TJ / million m^3) was made for the entire time series.

International Aviation (Memo Items)

- The total amount of kerosene was used as presented in the EBs of the RM (AD was previously provided by the CAA of the RM);
- Domestic flights were reallocated to category 1A3a 'Civil Aviation', avoiding double counting (as it had happened in the previous inventory cycle);
- AD for the years 1990-1994 were restored using the partial overlapping method (so as to obtain the complete set of values according to the Tier 2b assessment method).

CO_2 Emissions from Biomass (Memo Items)

- Fuel consumption (fuel wood, wood waste, agricultural residues, biogas, pellets and briquettes, charcoal) has been reallocated from source category 1A1 to category 1A2;
- Activity data for the years 2015 and 2016 was corrected.

In comparison with the results included into the BUR2 of the RM to the UNFCCC (2019), these changes made in the current inventory cycle resulted in an increase in direct GHG emissions from Sector 1 'Energy' for years 1990 and 1994-1998, varying from a minimum increase of 0.7 per cent in 1997 to a maximum increase of circa 1.3 per cent in 1995, and a decrease in direct GHG emissions, respectively, for the years 1991-1993 and 1999-2016, varying from a minimum decrease of 0.02 per cent in 1993 to a maximum decrease of 11.2 per cent in 2009 (Table 8-3).

Table 8-3: Recalculation Results of Total Direct GHG Emissions from Sector 1 'Energy' included into the BUR2 of the RM to the UNFCCC, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	36.6105	32.9696	26.1405	18.1730	15.1473	12.1574	12.1291	10.9364	9.4505	7.9883
BUR3	36.8953	31.2043	24.3515	18.1696	15.2946	12.3097	12.2798	11.0094	9.5700	7.5571
Difference, %	0.8	-5.4	-6.8	-0.02	1.0	1.3	1.2	0.7	1.3	-5.4
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
BUR2	7.2889	7.8927	7.5977	8.2968	9.0248	9.2488	8.3586	8.6524	9.1322	9.9117
BUR3	6.8761	7.4994	7.2925	7.9740	8.4757	8.7644	7.9199	8.0885	8.3876	8.8010
Difference, %	-5.7	-5.0	-4.0	-3.9	-6.1	-5.2	-5.2	-6.5	-8.2	-11.2
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
BUR2	10.1950	10.4985	10.0362	9.0257	9.6569	10.0638	9.9272			
BUR3	9.3278	9.7144	9.2874	8.9802	8.8830	9.1825	9.3349	8.8995	9.4093	9.3217
Difference, %	-8.5	-7.5	-7.5	-0.5	-8.0	-8.8	-6.0			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

8.1.2. Sector 2 'Industrial Processes and Product Use'

Recalculations of total direct GHG emissions from Sector 2 'Industrial Processes and Product Use' were performed for the following reasons:

2A2 'Lime Production'

- CO_2 emissions from lime production were recalculated for the period 1990-2016 as a result of updating the activity data on the amount of lime produced by auto-producers (in the current inventory cycle, information from sugar factories Sudzucker-Moldova Ltd. and Moldova-Sugar Ltd. were received, the market share of these two enterprises varied in the period 2013-2019 between 92.6 and 99.9 per cent of the total amount of sugar produced in the RM).

2A3 'Glass Production'

- CO_2 emissions from glass production were recalculated for the period 1990-2016 as a result of updating activity data regarding the amount of glass produced. In the current inventory cycle, the quantities of insulating glass with multiple layers were not included in the calculation (on the grounds that the glass used in its production is imported), nor the quantities of glass mirrors (also imported). At the same time, the conversion factor associated with the average weight of a conventional glass container was updated (as a result of the survey of glass container producers, the average weight of a conventional glass container was changed from 0.43 kg to 0.48 kg).

2A4 'Brick Production'

- CO_2 emissions from brick production were recalculated for the period 2004-2016 as a result of updating the annual values of country-specific EFs, having received updated information for that period from 'MACON' JSC.

2A4 'Other Uses of Soda Ash'

- CO_2 emissions from the other uses of soda ash were recalculated for the period 1990-2016 due to updating information on annual consumption of soda ash in glass industry (in the current inventory cycle it is considered that circa 90 per cent of the annual consumption of soda ash is recorded in glass production, while during the previous inventory cycle – 85 per cent, considering that soda ash use in glass production represented 250 kg of soda ash per ton of glass produced between 1990-1994, 200 kg of soda ash per ton of glass produced between 1995-2001, varying between 181.1 kg and 124.4 kg of soda ash per ton of glass produced between 2002-2019, the respective values being identified having enquired glass factories in the RM), and as a result of updating the information on glass production in the RM in the period 1990-2016, respectively.

2D3 'Solvent Use'

- GHG emissions from source category 2D3 'Solvent Use' were recalculated for the period 1999-2016 due to the updated activity data available in the Statistical Yearbooks of the ATULBD and of the RM, as well as in the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the Republic, by product type for 2005-2019'; particularly, updated AD on asphalt production in 1999-2002, production of paints in 2016, production of timber in 2015-2016, import of vehicles in 2011-2016 and the population number in 2005-2016 (the results of the 2004 and 2014 population censuses, conducted in parallel on both banks of the Dniester River, were re-evaluated).

2D4 'Other' (Urea-Based Catalysts)

- GHG emissions from urea-based catalysts were recalculated for the period 2005-2016 due to the updated activity data associated with diesel oil consumption on the Left Bank of the Dniester River.

2F1 'Refrigeration and Air Conditioning'

- HFC emissions from source category 2F1 'Refrigeration and Air Conditioning' were recalculated for the period 1995-2016 due to:

  a) updating and completing information on the import and consumption of HFCs in the RM for the period until 2008, as a result of using the Generalized Reports on the production, consumption, import/export of ozone-depleting substances regulated by the Montreal Protocol in the RM between 2001 and 2008 according to the Statistical Report No. 1-Ozone, provided by the NBS (since 2009, the responsibility for collecting statistical information, according to the Statistical Report No. 1-Ozone, was kept by the State Ecological Inspectorate of the RM, but due to the lack of capacities, this information was not collected), respectively, as a result of the use of information from the Automated System for Customs Data ASYCUDA World, which ensured the management and processing of customs forms and documents, used in the customs clearance procedures between 2013 and 2019;

  b) completing the list of refrigerants used mostly in the RM;

  c) updating the share of refrigerants charged into refrigeration and air conditioning equipment in the RM;

  d) updating the information on the total number of transportation units registered in the country for the period 1995-2019, as well as the share of transportation units charged with air conditioning equipment, provided by the Public Services Agency of the Republic of Moldova, based on the information included in the State Transport Register for the period 1995-2019.

2F2 'Foam Blowing Agents'

- HFCs emissions from source category 2F2 'Foam Blowing Agents' for the period 1995-2015 were recalculated as a result of updating and completing the information on the import of foam blowing products into the RM, having used information from ASYCUDA World Automated System for Customs Data, which ensured the management and processing of customs forms and documents used in customs clearance procedures for the period 2013-2019; and as a result of updating the share of blowing agents in foam blowing products imported into the RM, respectively.

2G1 'Electrical Equipment'

- for SF_6 and CF_4 emissions from category 2G1 'Electrical Equipment' were recalculated for the period 2005-2016 due to updating the total number of medium-tension, 10 kV, electrical circuit breakers.

2G4 'Other'

- Indirect CO_2 emissions from category 2G4 'Other' were recalculated for the period 1990-2016 due to updating AD regarding the use of cigars and cigarettes, and shoes in the RM, available in the official sources of references (Statistical Yearbooks of the RM and the Statistical Reports PRODMOLD-A 'Total production, as a natural expression, in the RM, by product type', Statistical Yearbooks of the ATULBD), and the Automated System for Customs Data ASYCUDA World, which ensures the management and processing of customs forms and documents used in customs procedures.

In comparison with the results included into the BUR2 of the RM to the UNFCCC (2019), the changes made in the current inventory cycle resulted in an insignificant increase in direct GHG emissions from Sector 2 'Industrial Processes and Product Use' for the period 1990-2000, varying from a minimum increase of 0.1 per cent in 2000 to a maximum increase of circa 2.0 per cent in 1990; and a decrease in direct GHG emissions, respectively, for the for the period 2001-2016, varying from a minimum decrease of 0.01 per cent in 2001 to a maximum decrease of 5.5 per cent in 2010 (Table 8-4).

Table 8-4: Recalculation Results of Direct GHG Emissions from Sector 2 'Industrial Processes and Product Use' included into the BUR2 of the RM to the UNFCCC, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1.5723	1.3947	0.8089	0.7249	0.5488	0.4505	0.4097	0.4514	0.3771	0.3410
BUR3	1.6037	1.4098	0.8216	0.7371	0.5562	0.4562	0.4163	0.4544	0.3782	0.3419
Difference, %	2.0	1.1	1.6	1.7	1.4	1.3	1.6	0.7	0.3	0.3
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
BUR2	0.3141	0.3190	0.3723	0.4065	0.4854	0.5919	0.7020	0.9616	1.0553	0.5558
BUR3	0.3144	0.3186	0.3688	0.3971	0.4707	0.5713	0.6775	0.9361	1.0242	0.5295
Difference, %	0.1	-0.1	-1.0	-2.3	-3.0	-3.5	-3.5	-2.7	-2.9	-4.7
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
BUR2	0.5923	0.6960	0.7132	0.7626	0.7949	0.7842	0.7619			
BUR3	0.5600	0.6649	0.6829	0.7326	0.7605	0.7628	0.7480	0.7768	0.9592	0.9922
Difference, %	-5.5	-4.5	-4.3	-3.9	-4.3	-2.7	-1.8			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

8.1.3. Sector 3 'Agriculture'

Recalculations of total direct GHG emissions from Sector 3 'Agriculture' were performed for the following reasons:

3A 'Enteric Fermentation'

- CH_4 emissions from source category 3A 'Enteric fermentation' were recalculated as a result of using default emission factors for goats for the entire period 1990-2016 (this decision is supported by the fact that methane emissions generated by the population of goats are not a key emission source, and the fact that the series of complete statistical data on goat population productivity in the RM during the reporting period is missing, respectively), and as a result of the updated DE values for the period 2013-2016 expressed as a percentage of gross energy, GE values and country-specific emission factors for cattle, and sheep and goats, calculated using a Tier 2 methodology. Additionally, in the case of leap years (1992, 1996, 2000, 2004, 2008, 2012 and 2016), in the equations used to calculate the gross energy required for cattle and sheep categories for maintenance and other activities relevant to life (Table 5-19), the number of days in the calendar year was corrected, from 365 to 366.

3B 'Manure Management'

- CH_4 and N_2O emissions from category 3B 'Manure Management' were recalculated as a result of updating values regarding digestible energy (DE) as a percentage of daily gross energy – GE (MJ/day) for dairy cows and cattle, and as a result of updating the shares of manure management systems (MS%) in the RM, based on a study developed in 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine, as well as from the National Agency for Food Security.

3D.a.2 'Organic N Fertilizers'

- Direct N_2O_{ON} emissions from source category 3D.a.2 'Organic N Fertilizers' were recalculated for the period 1990-2016, particularly due to using a new set of AD, generated based on the information regarding the amount of organic N fertilizers available to be applied to soil estimated within source category 3B 'Manure Management'. In the current inventory cycle, the amounts of organic fertilizers applied to soil for the years 1990-1991 were taken from official statistics, whereas for the period 1992-2019, it was agreed that circa 63 per cent of the available quantity is actually applied to soil (this value represents an arithmetic mean between the value of 63.9 per cent, characteristic of 1990; and the value of 62.1 per cent, characteristic of 1991), as opposed to the previous inventory cycle, when it was agreed that 65 per cent of the available amount is actually applied to the soil.

3D.a.3 'Urine and Dung Deposited by Grazing Animals'

- Direct N_2O_{PRP} emissions from source category 3D.a.3 'Urine and Dung Deposited by Grazing Animals' were recalculated for the period 2012-2016, particularly due to the use of the updated shares of manure management systems (MS%) applied in the RM based on a study developed in 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine, as well as from the National Agency for Food Security.

3D.a.4 'Crop Residues Returned to Soils'

- Direct N_2O_{CR} emissions from source category 3D.a.4 'Crop Residues Returned to Soils' were recalculated for the year 2016 as a result of updating statistical activity data.

3D.a.5 'Nitrogen Mineralization Associated with Loss of Soil Organic Matter'

- Direct N_2O_{SOM} emissions from source category 3D.a.5 'Nitrogen Mineralization Associated with Loss of Soil Organic Matter' as a result of land-use or management change in the RM were recalculated for the period 1990-2016, as a result of the change in the methodology for calculating the annual carbon losses from mineral soils ($\Delta C_{Mineral}$). In comparison with the previous inventory cycle, when the 'Methodology for determining the carbon balance in agricultural soils for the evaluation of GHG emissions' was used for annual carbon loss in mineral soils (see Annex A3-4.2), in the current inventory cycle, annual carbon losses were estimated using a Tier 2 methodology from the 2006 IPCC Guidelines (Equation 2.25, Volume 4, Chapter 2, page 2.30). The methodology change was made so as to ensure consistency between the calculation methodology applied to the estimation of direct N_2O_{SOM} emissions from category 3D.a.5 'Nitrogen Mineralization Associated with Loss of Soil Organic Matter', and 4B1.2 'Annual Change in Organic Carbon Stocks in Mineral Soils', respectively. Since the 'Methodology for determining the carbon balance in agricultural soils for the evaluation of GHG emissions' is yet to be validated internationally, it shall be further used only in verification activities, but not for international inventory reporting to the UNFCCC.

3D.b.1 'Atmospheric Deposition of Nitrogen Oxides (NO_x) and Ammonia (NH_4)'

- Indirect N_2O_{ATD} emissions from source category 3D.b.1 'Atmospheric Deposition of Nitrogen Oxides (NO_x) and Ammonia (NH_4)' were recalculated for the period 1990-2016 series, particularly due to the use of a new set of AD generated based on the information regarding the amount of organic nitrogen fertilizers available to apply to soil estimated within category 3B 'Manure Management' (in the current inventory cycle, for the years 1990 and 1991, the amounts of synthetic fertilizers applied to soil were taken from official statistics; whereas for the period 1992-2019, it was accepted that circa 63 per cent of the available amount is actually applied to soil, this value being an arithmetic mean between the value of 63.9 per cent, characteristic of the year 1990, and the value of 62.1 per cent, characteristic of the year 1991), compared to the previous inventory cycle, when it was accepted that 65 per cent of the available amount was actually applied to soil); and as a result of updating the shares of manure management systems (MS%) in the RM, based on a study developed in 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine as well as from the National Agency for Food Security.

3D.b.2 'Nitrogen Leaching and Run-off'

- Indirect N_2O_L emissions from source category 3D.b.2 'Nitrogen Leaching and Run-off' were recalculated for the period 1990-2016, particularly due to the use of a new set of AD generated based on the information regarding the amount of organic N fertilizers available to apply to soil estimated within source category 3B 'Manure Management' (in the current inventory cycle, organic fertilizers applied to soil were taken from official statistics for the years 1990 and 1991, whereas for the for the period 1992-2019, it was accepted that circa 63 per cent of the available amount is actually applied to soil, this value being an arithmetic mean between the value of 63.9 per cent, characteristic of the year 1990, and the value of 62.1 per cent, characteristic of the year 1991), compared to the previous inventory cycle, when it was accepted that 65 per cent of the available amount was actually applied to soil); and as a result of updating the shares of manure management systems (MS%) in the RM, based on a study developed in 2015 by specialists from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine, as well as from the National Agency for Food Security; and changing the calculation methodology for the annual carbon losses in mineral soils ($\Delta C_{Mineral}$), by applying a Tier 2 methodology from the 2006 IPCC Guidelines, using Equation 2.25 in the 2006 IPCC Guidelines, Volume 4, Chapter 2, page 2.30.

In comparison with the results included into the BUR2 of the RM to the UNFCCC (2019), the changes made in the current inventory cycle resulted in an increase in direct GHG emissions from Sector 3 'Agriculture' for the years 1990-1992, 2007 and 2012, varying from a minimum increase of 1.7 per cent in 2012 to a maximum increase of circa 5.6 per cent in 2007; and a decrease in direct GHG emissions, respectively, for the for the years 1993-2006, 2008-2011 and 2013-2016, varying from a minimum decrease of 0.4 per cent in 1994 to a maximum decrease of 24.7 per cent in 2009 (Table 8-5).

Table 8-5: Recalculation Results of Direct GHG Emissions from Sector 3 'Agriculture' included into the BUR2 of the RM to the UNFCCC, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	5.2206	4.8628	4.4000	4.2297	3.7460	3.6029	3.3846	3.1852	2.9525	2.6962
BUR3	5.3355	4.9634	4.5461	4.0067	3.7312	3.4103	3.2641	2.8258	2.7171	2.4927
Difference, %	2.2	2.1	3.3	-5.3	-0.4	-5.3	-3.6	-11.3	-8.0	-7.5
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	2.4808	2.6761	2.7449	2.3999	2.5926	2.5784	2.4664	1.6768	2.2434	2.5018
BUR3	2.3121	2.4080	2.4778	2.2347	2.2340	2.2403	2.1819	1.7714	1.8428	1.8844
Difference, %	-6.8	-10.0	-9.7	-6.9	-13.8	-13.1	-11.5	5.6	-17.9	-24.7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	2.2550	2.2079	1.7601	2.2526	2.4923	2.0912	2.4285			
BUR3	1.9667	1.8915	1.7906	1.9148	2.1240	1.8484	1.9875	2.0379	1.9930	1.9435
Difference, %	-12.8	-14.3	1.7	-15.0	-14.8	-11.6	-18.2			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

8.1.4. Sector 4 'Land Use, Land-Use Change and Forestry'

Recalculations of net direct GHG emissions from Sector 4 'LULUCF' were performed for the following reasons:

4A 'Forest Land'

- For 2016, for subcategories 4A1 'Land Remaining Forest Land' and 4A2 'Land Converted to Forest Land', an error was found in the formula for calculating the areas subject to conversion in the Land Use Matrix. This has generated a cumulative decrease in values of 0.1 per cent or -2.2154 t CO_2, for category 4A 'Forest Land'.

4B 'Cropland'

- For the period 1990-2016, recalculations were made for both sub-categories 4B1 'Cropland Remaining Cropland' and 4B2 'Land Converted to Cropland'. The recalculations for the respective categories are due to the update of activity data that emerged from the improvement of the Land Use Matrix for the period 1970-2019.

4F 'Other Land'

- For the year 2016, within 4F2 'Land Converted to Other Land', an error was found in the formula for calculating the areas subject to conversion in the Land Use Matrix, which generated a cumulative increase in values of 310.6 per cent or +265.99 t CO_2 for subcategory 4F 'Land Converted to Other Land'.

4G 'Harvested Wood Products'

- Recalculations of CO_2 removals/emissions were made for category 4G 'Harvested Wood Products' for the period 1990-2015 due to updating activity data.

In comparison with the results recorded in the BUR2 of the RM to the UNFCCC (2019), the changes made in the current inventory cycle resulted in a decrease in net CO_2 removals within Sector 4 'LULUCF' for the years 1990-2014 and 2016, varying from a minimum decrease of 0.6 per cent in 2013 to a maximum decrease of 28.5 per cent in 2016 (Table 8-6).

Table 8-6: Recalculation Results of Net CO_2 Removals from Sector 4 'Land Use, Land-Use Change and Forestry' included into the BUR2 of the RM to the UNFCCC, Mt CO_2

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	-1.5276	-2.5899	-1.9715	-2.0010	-1.9010	-1.8689	-2.2831	-1.8735	-1.8907	-1.5973
BUR3	-1.3878	-2.4531	-1.8464	-1.8691	-1.8032	-1.7616	-2.2070	-1.8447	-1.8639	-1.5728
Difference, %	-9.1	-5.3	-6.3	-6.6	-5.1	-5.7	-3.3	-1.5	-1.4	-1.5
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
BUR2	-1.8807	-1.5162	-1.6033	-1.5332	-1.7023	-1.4109	-1.5308	-1.7272	-1.4205	-1.0332
BUR3	-1.8539	-1.4988	-1.5862	-1.5166	-1.6902	-1.3960	-1.5190	-1.7149	-1.4094	-1.0207
Difference, %	-1.4	-1.1	-1.1	-1.1	-0.7	-1.1	-0.8	-0.7	-0.8	-1.2
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
BUR2	-0.9619	-0.9080	-0.9396	-0.8027	-0.4536	-0.9022	-0.9200			
BUR3	-0.9539	-0.8960	-0.9268	-0.7976	-0.4489	-0.9035	-0.6576	-0.7138	-0.5601	0.2958
Difference, %	-0.8	-1.3	-1.4	-0.6	-1.0	0.1	-28.5			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

8.1.5. Sector 5 'Waste'

Recalculations of direct GHG emissions from Sector 5 'Waste' were performed based on the following considerations:

5B 'Biological Treatment of Solid Waste'

- In the current inventory cycle, GHG emissions from category 5B 'Biological Treatment of Solid Waste' were estimated for the first time.

5C 'Incineration and Open Burning of Waste'

- Direct and indirect GHG emissions 5C 'Incineration and Open Burning of Waste' were recalculated, particularly due to the need of adjusting AD with the number of the population. This activity was performed by the NBS, which made provisional estimates of the number of the population with habitual residence (resident population) in the Republic of Moldova. Likewise, the activity data related to the open burning of clinical waste was reviewed, the amount being estimated based on the rate of generating clinical waste reported per hospital bed and the rate of open burning.

5D 'Wastewater Treatment and Discharge'

- CH_4 and N_2O emissions from category 5D 'Wastewater Treatment and Discharge' were recalculated for the period 1992-2016, as a result of updating activity data, particularly due to the need of adjusting AD with the number of the population. This activity was performed by the National Bureau of Statistics, which made provisional estimates of the number of the population with habitual residence (resident population) in the Republic of Moldova. At the same time, activity data related to the production of the main industrial products for the period 1992-2019 was reviewed.

In comparison with the results recorded in the BUR2 of the RM to the UNFCCC (2019), the changes made in the current inventory cycle resulted in a decrease in direct CO_2 emissions within Sector 5 'Waste' for the time series 1990-2001 and 2010-2016, varying from a minimum decrease of 0.03 per cent in 1992 to a maximum decrease of 2.1 per cent in 2014; and an increase in GHG emissions, respectively, for the period 2002-2009, varying from a minimum increase of 0.1 per cent in 2009 to a maximum increase of 1.4 per cent in 2003 and 2005 (Table 8-7).

Table 8-7: Recalculation Results of Direct GHG Emissions from Sector 5 'Waste' included into the BUR2 of the RM to the UNFCCC, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BUR2	1.5154	1.5491	1.5512	1.6132	1.5962	1.5947	1.5990	1.5953	1.5714	1.5658
BUR3	1.5142	1.5480	1.5508	1.6101	1.5925	1.5904	1.5931	1.5876	1.5639	1.5594
Difference, %	-0.1	-0.1	-0.03	-0.2	-0.2	-0.3	-0.4	-0.5	-0.5	-0.4
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BUR2	1.5418	1.5146	1.4823	1.4471	1.4366	1.4288	1.4196	1.4194	1.4385	1.4527
BUR3	1.5364	1.5105	1.5001	1.4674	1.4506	1.4492	1.4370	1.4260	1.4417	1.4548
Difference, %	-0.3	-0.3	1.2	1.4	1.0	1.4	1.2	0.5	0.2	0.1
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUR2	1.4833	1.5009	1.4911	1.4376	1.4361	1.4313	1.4603			
BUR3	1.4786	1.4887	1.4741	1.4163	1.4055	1.4059	1.4331	1.5303	1.5463	1.5526
Difference, %	-0.3	-0.8	-1.1	-1.5	-2.1	-1.8	-1.9			

Abbreviations: BUR2 – Second Biennial Update Report of the RM to the UNFCCC; BUR3 – Third Biennial Update Report of the RM to the UNFCCC.

8.2. Planned Improvements

A series of improvements is planned for the next inventory cycles. Below are presented the planned procedural and institutional improvements, as well as planned improvements by sectors.

8.2.1. Institutional and Procedural Improvements

The estimations process of anthropogenic GHG emissions and removals could be enhanced through the following institutional and procedural improvements:

- Enhancing the data management system used in each inventory cycle, as well as the periodical archiving of the inventory and the documentation on which inventory was drawn up, in order to comply with the principle of transparency;
- Enhancing the level of knowledge of national experts and institutions involved in developing the national GHG emission inventory by organizing a series of thematic trainings;
- Enhancing the professional skills of national experts and institutions involved in developing the inventory process, with the purpose of realizing the gradual transition from default EFs and Tier 1 methodologies to country specific EFs and Tier 2 and 3 methodologies, particularly in the case of key categories.

8.2.2. Planned Improvements

Sector 1 'Energy'

The process of monitoring GHG emissions from Sector 1 'Energy' could be improved with:

- Availability of new AD on fuel consumption for electricity and heat production (source category 1A1 'Energy Industries); for industrial production and the construction sector (source category 1A2 'Manufacturing Industries and Construction'); for energy supply of the commercial/institutional sector, residential, agriculture/forestry/fishing (source category 1A4 'Other Sectors'), respectively for other works and energy needs (source category 1A5 'Other'), for the territory on the Left Bank of the Dniester River (filling in existing gaps for some years); there could also be potential improvements in identifying additional data sources or updating activity data in official statistical publications;

- For source category 1A3a 'Civil Aviation' in the EBs of the RM, the consumption of aviation gasoline can be found expressly only for the years 1990, 1993 and 1998; there is also a series of AD associated with aviation gasoline consumption for the years 2011-2019 provided by the Civil Aeronautical Authority of the RM; however, they allowed reconstruction by the interpolation method and/or by reallocations of fuel consumption within source category 1A3a 'Civil Aviation' from other source categories. The national inventory team is aware of the inconsistency of activity data associated with aviation gasoline consumption (data being collected from two separate reference sources); however, this inconsistency would be difficult to eliminate at the moment. In the next inventory cycle, various options shall be analyzed in order to improve the quality of the national greenhouse gas inventory from the respective source category;
- Using higher-tier methodology for source categories 1A3a 'Civil Aviation' (Tier2b), and 1A3c 'Railways' (Tier 2) (for the time being, these are not key categories, thereby a switch to higher-tier methodologies is not cost-effective, not to mention the effort to be put in by the national inventory team);
- Collecting additional AD necessary for the use of the COPERT 4.9 model (1A3b 'Road Transportation') for the entire period under review (for the time being, it has been possible to collect the AD necessary for to run the respective program only for the period 1995-2016).
- Availability of additional data on fugitive leaks from oil and natural gas distribution networks (from the infrastructure needed to produce, collect, process, refine and distribute oil products and natural gases to final consumers; from equipment functioning, evaporation and flashing losses, flaring, accidental releases from pipeline dig-ins, etc.) (source category 1B2 'Fugitive Emissions from Oil and Natural Gas), i.e., in the case of adopting a higher-ranking assessment methodology, the possibility to obtain AD associated to LPG consumption on the LBDR for the entire period under review will also be estimated;
- Using a higher methodology to estimate GHG emissions from 'International Aviation' (e.g., the Tier 3 calculation methodology available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019), which considers the actual emission values for each aircraft type according to the flight distance, and the emission calculator available in the updated version of the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019) could also be used;
- extension of the data recording method on biomass consumption used in the 'Research on Energy Consumption in Households', conducted by the NBS of the RM with the support of Energy Community experts in 2015 and for the period 1990-2009, thus ensuring the consistency of the results obtained for this source category for the entire time series covered by the inventory;
- availability of new AD on biomass consumption (CO_2 Emissions from Biomass) on the Left Bank of the Dniester River and filling existing gaps for some years.

Sector 2 'Industrial Processes and Product Use'

The process of monitoring GHG emissions from Sector 2 'IPPU' could be improved with:

- Updating the activity data used to estimate GHG emissions for the period 1990-2019 under category 2A 'Mineral Industry';
- Updating activity data on raw material consumption per ton of production, as well as the specific electrode consumption per ton of steel produced by enterprises in the Republic of Moldova under category 2C1 'Iron and Steel Production';
- Updating the activity data used to estimate GHG emissions within this category for the period 1990-2019 under category 2D 'Non-Energy Products from Fuels and Solvent Use';

- Capacity building activities by setting up an on-line information system for collecting AD from companies that import, use, dispose, recover and recycle freons and refrigerant equipment. This information system will provide the MADRM, the Environment Agency, and the National Agency on Regulation of Nuclear, Radiological and Chemical activities with more accurate AD, which could potentially contribute to reducing uncertainties in the assessment of GHG emissions from category 2F 'Product Uses as Substitutes for ODS' in the Republic of Moldova;
- Updating the activity data used to estimate GHG emissions from this category for the period 1990-2019 under category 2G 'Other Product Manufacture and Use'. Also, in respect of collecting AD on the use of fireworks (code 3604 10 000 – signaling flares, rain rockets, and other pyrotechnic articles, as well as other fireworks – code 3604 90 000), and for the period 1990-2012 (in the current inventory cycle, it was possible to collect data only for the period 2013-2019), in order to estimate indirect GHG emissions from the respective source (SNAP 060601) within category 2G 'Other Product Manufacture and Use'.

Sector 3 'Agriculture'

The process of monitoring GHG emissions from Sector 3 'Agriculture' could be improved with:

- Updating AD and productivity indicators used to estimate GHG emissions from category 3A 'Enteric Fermentation' based on the Tier 2 methodology, particularly for cattle and sheep, the categories of animals with the highest share in the structure of CH4 emissions from this source category;
- Updating of AD and productivity indicators used to estimate methane emissions from category 3B 'Manure Management', particularly for cattle and swine, the categories of animals with a higher share in the structure of methane emissions from this source category; as well as activities on the specifying of coefficient values used to estimate national EFs based on the Tier 2 methodology;
- Collecting additional data used in to estimate N_2O emissions from source category 3B 'Manure Management', particularly data related to the share of manure management systems at national level during the reference period (historical data, starting with 1990, as well as for the recent period, periodically – once every 3-5 years), as well as data associated with identifying country-specific values of $N_{ex(T)}$ excretion rates (kg N/head/year) for the categories of animals in the RM;
- Updating AD and country-specific coefficients used to estimate direct N_2O emissions from crop residues returned to soils in the RM;
- Updating country-specific coefficients used to estimate direct N_2O emissions from nitrogen mineralization as a result of carbon losses resulting from changes in land-use of agricultural land and soil management practices in the Republic of Moldova; It is thereby relevant to establish the values of humus content in arable soils once every 3 years, (layer – 0-30 cm) in the northern part of the country (Napadova village, Floresti district), and in the south of the country (Lebedenco village, Cahul district), respectively, in order to identify the national average (SOC_0) and the average annual losses in the RM during the reporting period to UNFCCC.

Sector 4 'Land Use, Land-Use Change and Forestry'

The process of monitoring GHG emissions/removals from Sector 4 'LULUCF' could be improved with:

- Improving records on actual wood consumption from forests in the Republic of Moldova, as well as updating national emissions/removals factors within category 4A 'Forest Land' (e.g. wood density, biomass expansion factor, emission factors from forest fires, etc.);
- Improving records pertaining to actual volume of wood mass from windbreaks management and other types of forest vegetation for subcategory 4B1.1 'Cropland Covered with Woody Vegetation', as well as activities aimed at the verification of emission/removal factors specific to perennial plantations (current biomass increments, biomass harvesting during the clearings, etc.);

- Improving the country-specific methodology (Banaru, 2000) and improving the quality of activity data used to estimate CO_2 emissions/removals in mineral soils for subcategory 4B1.2 'Annual Change in Carbon Stocks in Mineral Soils';
- Improving cadastral records (as main sources of activity data) regarding mentioning in their explanatory notes the land-use categories to which the land excluded from the agricultural circuit is transferred (category 4C 'Grassland');
- Improving cadastral records (as main sources of activity data) regarding accurate mentioning in their explanatory notes the initial land-use categories transferred to category 4D 'Wetlands';
- Improving cadastral records (as main sources of activity data) regarding accurate mentioning in their explanatory notes the initial land-use categories transferred to category 4E 'Settlements';
- Improving cadastral records (as main sources of activity data) regarding accurate mentioning in their explanatory notes the initial land-use categories transferred to category 4F 'Other Land'; At the same time, it is necessary to analyze the input-output process of land to category 4F 'Other Land', including in terms of establishing the average conversion period;
- The possibility to improve the statistical records (as the main sources of activity data) regarding wood product production/export/import from category 4G 'Harvested Wood Products'.

Sector 5 'Waste'

The process of monitoring direct GHG emissions from Sector 5 'Waste' could be improved with:

- Imposing a new approach to dealing with environmental issues in the Republic of Moldova, in accordance with the country's commitments under ratified international conventions and agreements, respectively in terms of sustainable development, as well as from the perspective of the country's accession to the European Union; promoting statistical records on waste generated and the essential restructuring of waste management by taking into account international practices and EU standards in the field of MSW management;
- In the context of implementing Government Decision No. 501/2018 on the Instruction on keeping records and transmitting data on waste and its management, respectively in the context implementing Government Decision No. 682/2018 on the Concept of the Waste Management Automated Information System (SIAMD), through which the reporting system www.siamd.gov.md was developed, given that the years 2019 and 2020 were the first reporting years in the new system, it is recognized that the information collected does not reflect the actual situation in the field of waste management; thus, for example, the amounts of MSW generated in rural localities are not subject to statistical records, as there are usually no sanitation services; also, although there are waste processing companies operating in the RM, the information on the amounts of recycled waste is not subject to strict statistical records; taking into account the trend towards alignment of the RM with EU standards, the sector needs to be significantly restructured; in this context, most MSW deposits are to be re-established, and their number – drastically reduced;
- Updating activity data, particularly to review the transformation coefficient of the volume of MSW into quantity. In recent years, there are trends to increase the share of packaging in the total amount of waste generated per capita, and the Sanitation Service in Chisinau shows that 1 m^3 of MSW is 180-200 kg, which will cause the revision of the coefficient 0.4 kg /1 m^3 of MSW. In the next period, we shall analyze the AD reported in the Automated Information System, in the National Register of Emissions and Transfer of Pollutants, and in the Waste Management Automated Information System, by the sanitation services in the country;
- Updating the study on the morphological composition of solid waste, with the involvement of the Environmental Reference Laboratory of the Environment Agency, solid waste generated in Chisinau, respectively in the cities of Causeni and Straseni. It will also be necessary to include the weighing of waste trucks in order to infer the transformation coefficient of the volume of MSW into quantity;

- The proper implementation of the Waste Management Strategy in the Republic of Moldova for 2013-2027, which provides the development of integrated municipal waste management systems by harmonizing the legislative, institutional and regulatory framework with European Union standards, based on the regional approach (geographical location, economic development, the existence of access roads, pedological and hydrogeological conditions, population number, etc.); promotion and implementation of selective collection systems in all localities in both the residential and industrial sectors, as well as sorting, composting and recycling facilities; development of municipal waste disposal capacities through the construction of seven solid waste landfills at regional level and two stations for mechanical-biological treatment in Chisinau and Balti municipalities; it should be mentioned is the fact that recently, June 2020, Law No. 89 on the ratification of the Financing Agreement between the Republic of Moldova and the European Investment Bank regarding the implementation of the project 'Solid Waste in the Republic of Moldova'. Through this agreement signed on October 18, 2019 between the European Investment Bank and the Government of the Republic of Moldova, a loan of 100 million euros will be granted for the improvement of solid waste management services in the country. The loan will be offered in several instalments, the first instalment being 25 million euros. This Agreement aims to implement the Waste Management Strategy 2013-2027 in the Republic of Moldova, involving projects aimed at modernizing and developing Solid Waste Management Systems and facilities in eight regions of our country. The projects will provide localities with new collection systems, mechanical-biological waste treatment facilities and new regional sanitary landfills for the entire country. The projects will aim to reduce the negative impact on the environment and human health, by modernizing waste collection systems and separate collection of recyclable materials and bio-waste, as well as rehabilitating or closing landfills. Regional landfills will be equipped with biogas recovery systems, as it will contribute to the reduction of GHG emissions and therefore to the achievement of the updated NDC, in accordance with to the provisions of the Paris Agreement;
- The practices of composting organic waste at national level should be specified for source category 5B 'Biological Treatment of Solid Waste', in order to determine the existence of these platforms in urban and rural localities, especially where there are sanitation services; At the same time, with the implementation of a new integrated waste management system, waste composting facilities shall be developed, which would considerably reduce the impact on the environment and take control of biogas emissions;
- With reference to source category 5C 'Incineration and Open Burning of Waste', it is necessary to mention the fact that the Waste Management Automated Information System is already developed and the economic agents have submitted the first reports for the years 2018 and 2019. In the coming years, when the respective system becomes fully operational and includes all economic operators, all data on waste management shall be available, including treatment by incineration or burning. At the same time, SIAMD will allow the collection of data on municipal waste or similar waste collected from the population and economic agents, as well as on the number of people benefiting from the sanitation service, this data being reported by sanitation operators. It shall thereby be possible to improve the quality of the activity data used in the assessment of emissions from the respective source category;
- Improving the population's access to quality water supply and sanitation services, in the context of implementing the Government Decision No. 199 as of 20.03.2014 the Strategy on Water Supply and Sanitation (2014-2028), ensuring gradual access to quality water supply and sanitation services for all in the Republic of Moldova, contributing to the improvement of health, dignity and quality of life as well as to the economic development of the country;
- To offer access to the entire population to improved sanitation systems by 2025, including up to 50 per cent to sewage systems; to increase the performance levels of collective systems of water supply, sanitation and other types; to increase the degree of implementation of good practices recognized in the field of integrated water management as well as water and sanitation supply; to decrease by 50 per cent the amount of untreated wastewater discharged as well as reduction of

untreated rainwater discharged into natural receptors; to improve the sludge managements and the quality of treated wastewater from centralized sewage systems or other sanitation systems, in the context of fully implementing the Government Decision No. 1063 as of 16.09.2016 on approving the National Program for the Implementation of the Protocol on Water and Health in the Republic of Moldova for 2016-2025; the respective program also plans to establish several indicators to ensure the population's access to improved sanitation systems, and a level of efficiency for managing the collective sanitation systems as well as other systems; to ensure by 2025 effective collective sewage systems in 7 cities in the country, the application of good practices in the field of water supply management, water and sanitation management, to ensure sludge disposal or reuse from centralized collective sewage systems or other types of sewage systems;

- Regulate the conditions of discharge, the introduction of specific substances into a body of surface water, groundwater or water fields, in the context of implementing the Regulation on Wastewater Discharge in Water Bodies, approved through Government Decision No. 802 as of 09.10.2013; the Regulation indicates the emission limit values applicable to the discharge of wastewater from the industrial sectors (activities) into a body of surface water. It is expected that this regulation will produce a positive effect on the quality of the AD and respectively, a decrease in emissions from source category 5D 'Wastewater Treatment and Discharge';
- Regulate the conditions for wastewater collection, treatment and discharge in the sewage system and/or in water basins, in the context of implementing the Regulation on Requirements for Wastewater Collection, Treatment and Discharge in the Sewage System and/or in Water Basins for Urban and Rural Areas, approved through the Government Decision No. 950 as of 25.11.2013; the Regulation provides for the maximum allowable limit values for pollutants in discharged water into natural water basins, which will contribute to a safe decrease in emissions within source category 5D 'Wastewater Treatment and Discharge';
- Implementing *Regional Sectoral Plans for Water and Sanitation Supply* by applying clearly defined regulatory, institutional and economic instruments:
  - *Regulatory instruments* – will focus on a set of normative laws (the Water Law No. 272 as of 23.12.2011, Law No. 303 as of 13.12.2013 on *Public Service for Water and Sanitation Supply*, the Regulation on Requirements for Wastewater Collection, Treatment and Discharge in the Sewage System and/or in Water Basins for Urban and Rural Areas, Government Decision No. 950 as of 25.11.2013 on the approval of the Regulation on Requirements for Wastewater Collection, Treatment and Discharge in the Sewage System and/or in Water Basins for Urban and Rural Areas, Regional Sectoral Plans related to water and sanitation and other). These regulatory instruments through their provisions will improve the quality of water and sanitation services, of wastewater, rain water and sludge management, improving thus, the quality of services within the sector);
  - *Institutional instruments* – will focus on the regionalization of services within this sector which will encourage the providers of water supply and sanitation services to group together and create regional companies, based on inter-municipal associations/enterprises or public-private partnerships (PPP) capable of becoming strong models of economically viable enterprises. The process of strengthening water-sanitation providers will be accompanied by tariff adjustment to ensure proper operation and maintenance of systems, for expanding the services to new users. Currently, the Action Plan for 2018-2028 on the regionalization of water supply and sanitation services entered into force, created in order to implement the Strategy on water supply and sanitation for 2014-2028 and the National Program for the Implementation of the Protocol on Water and Health in the Republic of Moldova for 2016-2025. The Plan includes actions to establish regional operators and, implicitly, to delegate the water supply and sewage systems management to the Agency, which represents an essential process for ensuring compliance with the acquis communautaire on offering access to quality water supply to the entire population as a fundamental human right. One of the major objectives is to organize and strengthen the institutional capacity of the existing licensed operators by extending the area of water supply

and sewage systems services to include other administrative-territorial units. Another important goal is to optimize the number of operators, through their territorial grouping, in order to create viable regional operators by reducing the number of existing ones and establishing 5 major regional operators, according to the following administrative-territorial criteria: North-West Operator – Briceni, Ocnita, Edinet, Donduseni, Glodeni, Falesti districts; Acva-North Operator – Rascani, Drochia, Sangerei, Telenesti, Floresti, Soroca, Soldanesti, Rezina districts and Balti municipality; Centre Operator – Chisinau municipality, Ungheni, Calarasi, Straseni, Orhei, Anenii Noi, Nisporeni, Ialoveni, Hancesti municipality; South-West Operator – Leova, Cimislia, Causeni, Stefan-Voda, Cantemir and Cahul districts; ATU Gagauzia Operator;

- *Economic instruments* – will focus on the concept of 'sustainable cost recovery of services' with three main characteristics: an appropriate combination of tariffs, fees and transfers to finance recurring and capital costs and to boost other forms of financing; predictability of public subsidies to facilitate investment (planning); tariff policies that make services accessible to all, including the poorest categories, while ensuring the sustainability of service providers.

- The planning of phased harmonization of national water legislation with that of the EU is also a good tool to enhance the implementation of best practices on wastewater treatment technologies, sludge within the sector, which would allow the capture of and the sustainable use of methane emissions from sludge storage fields (including for the production of thermal and electrical energy);
- Using country-specific information on the BOD fraction removed with sludge, maximum methane formation capacity, methane correction factor and other relevant parameters used to assess emissions from source category 5D 'Wastewater Treatment and Discharge' in the process of estimating methane emissions will improve the quality of the next national GHG inventories.

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ANNEXES

Annex 1. Key Categories

Annex 1-1. Key Categories – Methodology

According to the 2006 IPCC Guidelines, it is considered good practice to identify key categories of emissions and removals so as to contribute to the inventory quality. A key category is defined as *'a priority category within the national inventory system, because its estimates influence total national direct greenhouse gas emissions, both in terms of absolute annual emissions as a trend over a period, or both'*.

This annex describes the key category analysis carried out for the Republic of Moldova's inventory, covering the period 1990-2019. The 2006 IPCC Guidelines first requires that inventories be disaggregated into categories from which key source and sink categories may be identified. Source and sink categories are defined according to the following recommendations:

- source category emissions, identified according to standard classification (2006 IPCC Guidelines), expressed in CO_2 equivalent units calculated using the Global Warming Potential for 100 years (GWP) (IPCC AR4, 2013);
- a category should be identified for each gas emitted by the source, since the methods, emission factors, and related uncertainties utilized differ for each gas;
- source categories that use the same emission factors based on common assumptions should be aggregated before analysis.

The analysis of key source and sink categories in the Republic of Moldova was carried out using the Tier 1 approach of the 2006 IPCC Guidelines (key categories were identified by quantitative methods using a predetermined cumulative emission threshold) and the Tier 2 approach (key categories were identified by considering the uncertainties of the inventory results for the respective categories).

The quantitative approach identifies key categories from two perspectives. The first analyses each category's contribution to total national emissions. The second perspective analyses the trend of emission contributions from each category to identify where the greatest absolute changes (either increases or decreases) have taken place over a given time. The percentage contributions to both levels and trends in emissions are calculated and sorted from greatest to least. A cumulative total is calculated for both approaches. The 2006 IPCC Guidelines has determined that a cumulative contribution threshold of 95 per cent for both level and trend assessments is a reasonable approximation of 90 per cent uncertainty for Tier 1 method of determining key categories. The 95 per cent cumulative contribution threshold has been used in this analysis to define a higher threshold for identifying key categories. Therefore, when source and/or sink contributions are sorted in decreasing order of importance, those that contribute to 95 per cent of the cumulative total, from a quantitative point of view, are considered key categories.

When using a Tier 1 approach, the level contribution of each source is calculated according to Equation A1-1.1 (Equation 4.1 in the 2006 IPCC Guidelines, Volume 1, Chapter 4.3.1):

Equation A1-1.1:

$$L_{x,t} = |E_{x,t}| / \Sigma |E_{y,t}|$$

Where:

$L_{x,t}$ = level assessment for source or sink x in latest inventory year (year t);

$|E_{x,t}|$ = absolute value of emission or removal estimate of source or sink category x in year t;

$\Sigma |E_{y,t}|$ = total contribution, which is the sum of the absolute values of emissions and removals in year t calculated using the aggregation level chosen by the country for key category analysis.

Because both emissions and removals are entered with positive sign, the total contribution/level can be larger than a country's total emissions less removals.

Trend contribution of each source is calculated according to Equation A1-1.2 (Equation 4.2 in the 2006 IPCC Guidelines, Volume 1, Chapter 4.3.1):

Equation A1-1.2:

$$T_{x,t} = |E_{x,0}| / \Sigma |E_{y,0}| \bullet |[(E_{x,t} - E_{x,0})/E_{x,0}] - [(\Sigma E_{y,t} - \Sigma E_{y,0}) / |\Sigma E_{y,0}|]|$$

Where:

$T_{x,t}$ = trend assessment of source or sink category *x* in year t as compared to the base year (year 0);

$|E_{x,0}|$ = absolute value of emission or removal estimate of source or sink category *x* in year 0;

$E_{x,t}$ and $E_{x,0}$ = absolute value of emission or removal estimate of source or sink category *x* in year 0 respectively;

$\Sigma E_{y,t}$ and $\Sigma E_{y,0}$ = total inventory estimates in years *t* and 0, respectively;

Should a Tier 2 approach be utilized, the level contribution of each category is calculated following Equation A1-1.3 (Equation 4.4 in the 2006 IPCC Guidelines, Volume 1, Chapter 4.3.2):

Equation A1-1.3:

$$LU_{x,t} = (L_{x,t} \bullet U_{x,t}) / \Sigma [(L_{y,t} \bullet U_{y,t})]$$

Where:

$LU_{x,t}$ = level assessment for category *x* in latest inventory year (year *t*) with uncertainty;

$L_{x,t}$ = level assessment for source or sink *x* in latest inventory year t (year *t*);

$U_{x,t}$ = category percentage uncertainty in year t calculated as described in Chapter 3 and reported in Column G in Table 3.3. If the uncertainty reported in Table 3.3 is asymmetrical, the larger uncertainty should be used. The relative uncertainty will always have a positive sign.

When using a Tier 2 approach (considering GHG emissions uncertainty), a cumulative contribution threshold of 90 per cent of the sum of all $LU_{x,t}$ was used in this analysis in order to define the limits in identifying the key categories. Thus, when $LU_{x,t}$ contributions are sorted in decreasing order of importance, those that contribute to 90 per cent of the cumulative total, from a quantitative point of view, are considered key categories.

Trend contribution of each source is calculated following Equation A1-1.4 (Equation 4.5 in the 2006 IPCC Guidelines, Volume 1, Chapter 4.3.2):

Equation A1-1.4:

$$TU_{x,t} = (T_{x,t} \bullet U_{x,t})$$

Where:

$TU_{x,t}$ = trend assessment for category x in latest inventory year (year t) with uncertainty;

$T_{x,t}$ = trend assessment of source or sink category x in year t in the latest inventory year (year 0) computed as in Equation 4.2 in the 2006 IPCC Guidelines, Volume 1, Chapter 4.3.1;

$U_{x,t}$ = category percentage uncertainty in year t calculated as described in Chapter 3. Note that this is the same uncertainty as in the total of Column G of Table 3.3 in Chapter 3, not the uncertainty assessment for trend. The relative uncertainty will always have a positive sign.

When using a Tier 2 approach (considering GHG emissions uncertainty), a cumulative contribution threshold of 90 per cent of the sum of all $TU_{x,t}$ was used in this analysis in order to define the limits in identifying the key categories. Thus, when $TU_{x,t}$ contributions are sorted in decreasing order of importance, those that contribute to 90 per cent of the cumulative total, from a quantitative point of view, are considered key categories.

The key category analysis was performed using the Key Category Estimation Tool developed by the United States Environment Protection Agency (US EPA) (US EPA's Key Category Calculation Tool v2.5)[1].

Annex 1-2. The Results of Key Category Analysis, following the Tier 1 and Tier 2 methodologic approach, without LULUCF

Tier 1 – 1990 Year Level Assessment

Key Categories from Tier 1 Base Year Level Assessment	GHG Emissions in 1990 (kt CO_2 eq.)	Level Assessment	Cumulative Sum (%)
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2	7,447.11	0.16	16.4%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	7,414.29	0.16	32.8%
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2	6,438.89	0.14	47.0%
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2	4,410.07	0.10	56.7%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	4,112.35	0.09	65.8%
3A – Enteric Fermentation – CH_4	2,189.43	0.05	70.6%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	1,916.83	0.04	74.8%
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2	1,548.35	0.03	78.2%
1A4a – Fuel Combustion – Other Sectors – Commercial/Institutional – CO_2	1,413.84	0.03	81.3%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	1,172.73	0.03	83.9%
5A – Solid Waste Disposal – CH_4	1,046.73	0.02	86.2%
2A1 – Mineral Industry – Cement Production – CO_2	971.70	0.02	88.4%
3B1 – Direct N_2O Emissions from Manure Management – N_2O	871.91	0.02	90.3%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	812.24	0.02	92.1%
3B – Manure Management – CH_4	495.10	0.01	93.2%
1A3c – Fuel Combustion – Transport – Railways – CO_2	403.47	0.01	94.1%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	361.04	0.01	94.9%
5D – Wastewater Treatment and Discharge – CH_4	352.96	0.01	95.7%

Tier 1 – 2019 Year Level Assessment

Key Categories from Tier 1 Current Year Level Assessment	GHG Emissions in 2019 (kt CO_2 eq.)	Level Assessment	Cumulative Sum (%)
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	3,115.59	0.23	22.6%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	2,567.77	0.19	41.2%
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2	1,448.88	0.10	51.6%
5A – Solid Waste Disposal – CH_4	1,231.59	0.09	60.6%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	871.01	0.06	66.9%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	715.98	0.05	72.1%
2A1 – Mineral Industry – Cement Production – CO_2	523.88	0.04	75.8%
3A – Enteric Fermentation – CH_4	441.65	0.03	79.0%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	391.10	0.03	81.9%
1A4a – Fuel Combustion – Other Sectors – Commercial/Institutional – CO_2	331.26	0.02	84.3%
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2	325.35	0.02	86.6%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	246.13	0.02	88.4%
5D – Wastewater Treatment and Discharge – CH_4	237.68	0.02	90.1%
3B1 – Direct N_2O emissions from Manure Management – N_2O	228.87	0.02	91.8%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	213.83	0.02	93.3%
2D – Non-Energy Products from Fuels and Solvent Use – CO_2	143.53	0.01	94.4%
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs	138.64	0.01	95.4%

[1] <https://19january2017snapshot.epa.gov/climatechange/national-ghg-inventory-capacity-building_.html>.

Tier 1 - Trend Assessment

Key Categories from Tier 1 Trend Assessment	GHG Emissions in 2019 (kt CO_2 eq.)	Trend Assessment	Cumulative Sum (%)
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2	3.08	0.05	22.3%
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2	1.76	0.04	41.5%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	2,567.77	0.03	54.4%
5A – Solid Waste Disposal – CH_4	1,231.59	0.02	63.4%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	3,115.59	0.02	71.8%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	871.01	0.01	76.9%
2A1 – Mineral Industry – Cement Production – CO_2	523.88	0.01	79.1%
3A – Enteric Fermentation – CH_4	441.65	0.00	81.3%
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2	325.35	0.00	82.8%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	391.10	0.00	84.2%
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs	138.64	0.00	85.5%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	246.13	0.00	86.9%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	715.98	0.00	88.2%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	213.83	0.00	89.4%
5D – Wastewater Treatment and Discharge – CH_4	237.68	0.00	90.7%
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2	1,448.88	0.00	91.8%
1A4a – Fuel Combustion – Other Sectors – Commercial/Institutional – CO_2	331.26	0.00	92.7%
1A3c – Fuel Combustion – Transport – Railways – CO_2	24.53	0.00	93.7%
2F2 – Product Use as Substitutes for ODS – Foam Blowing Agents – HFCs	89.00	0.00	94.6%
3B – Manure Management – CH_4	66.59	0.00	95.4%

Tier 2 1990 Year Level Assessment

Key Categories from Tier 2 Base Year Level Assessment	GHG Emissions in 1990 (kt CO_2 eq.)	Relative Level Assessment with Uncertainty	Cumulative Sum (%)
3B1 – Direct N_2O emissions from Manure Management – N_2O	871.91	0.13	13.1%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	361.04	0.09	21.8%
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2	7,447.11	0.08	29.4%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	7,414.29	0.08	36.9%
5A – Solid Waste Disposal – CH_4	1,046.73	0.08	44.4%
3A – Enteric Fermentation – CH_4	2,189.43	0.07	51.4%
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2	6,438.89	0.07	58.0%
3B5 – Indirect N_2O Emissions from Manure Management – N_2O	244.71	0.05	63.4%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	1,172.73	0.05	67.9%
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2	4,410.07	0.04	72.4%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	4,112.35	0.04	76.6%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	812.24	0.04	80.7%
5D – Wastewater Treatment and Discharge – CH_4	352.96	0.03	83.6%
3B – Manure Management – CH_4	495.10	0.02	85.8%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	273.92	0.02	87.8%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	1,916.83	0.02	89.7%
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2	1,548.35	0.02	91.3%

Tier 2 2019 Year Level Assessment

Key Categories from Tier 2 Current Year Level Assessment	GHG Emissions in 2019 (kt CO_2 eq.)	Relative Level Assessment with Uncertainty	Cumulative Sum (%)
5A – Solid Waste Disposal – CH_4	1,231.59	0.20	20.3%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	246.13	0.14	33.9%
3B1 – Direct N_2O emissions from Manure Management – N_2O	228.87	0.08	41.8%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	871.01	0.08	49.5%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	3,115.59	0.07	56.8%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	2,567.77	0.06	62.8%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	391.10	0.05	67.4%
5D – Wastewater Treatment and Discharge – CH_4	237.68	0.04	71.8%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	213.83	0.04	75.3%
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2	1,448.88	0.03	78.7%
3A – Enteric Fermentation – CH_4	441.65	0.03	82.0%
3B5 – Indirect N_2O Emissions from Manure Management – N_2O	49.60	0.03	84.5%
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs	138.64	0.02	86.9%
2D – Non-Energy Products from Fuels and Solvent Use – CO_2	143.53	0.02	88.8%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	715.98	0.02	90.5%

Tier 2 Trend Assessment

Key Categories from Tier 2 Trend Assessment	GHG Emissions in 2019 (kt CO_2 eq.)	Relative Level Assessment with Uncertainty	Cumulative Sum (%)
5A – Solid Waste Disposal – CH_4	1,231.59	0.24	23.7%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	246.13	0.12	35.5%
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2	3.08	0.08	43.8%
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2	1.76	0.07	51.0%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	871.01	0.07	58.1%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	2,567.77	0.05	63.0%
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs	138.64	0.04	66.8%
5D – Wastewater Treatment and Discharge – CH_4	237.68	0.04	70.7%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	213.83	0.03	74.1%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	3,115.59	0.03	77.2%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	391.10	0.03	79.8%
3A – Enteric Fermentation – CH_4	441.65	0.03	82.4%
3B1 – Direct N_2O emissions from Manure Management – N_2O	228.87	0.02	84.4%
3B5 – Indirect N_2O Emissions from Manure Management – N_2O	49.60	0.02	86.4%
2F2 – Product Use as Substitutes for ODS – Foam Blowing Agents – HFCs	89.00	0.02	88.4%
2D – Non-Energy Products from Fuels and Solvent Use – CO_2	143.53	0.02	89.9%
3B – Manure Management – CH_4	66.59	0.01	91.2%

Key Category Summary Table

Key Categories Summary Table based on the Results of the Level and Trend Assessments
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2
1A3c – Fuel Combustion – Transport – Railways – CO_2
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2
1A4a – Fuel Combustion – Other Sectors – Commercial/Institutional – CO_2
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4
2A1 – Mineral Industry – Cement Production – CO_2
2D – Non-Energy Products from Fuels and Solvent Use – CO_2
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs
2F2 – Product Use as Substitutes for ODS – Foam Blowing Agents – HFCs
3A – Enteric Fermentation – CH_4
3B – Manure Management – CH_4
3B1 – Direct N_2O emissions from Manure Management – N_2O
3B5 – Indirect N_2O Emissions from Manure Management – N_2O
3Da – Direct N_2O emissions from Agricultural Soils – N_2O
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O
5A – Solid Waste Disposal – CH_4
5D – Wastewater Treatment and Discharge – CH_4

Annex 1-3. The Results of Key Category Analysis, following the Tier 1 and Tier 2 methodologic approach, with LULUCF

Tier 1 1990 Year Level Assessment

Key Categories from Tier 1 Base Year Level Assessment	GHG Emissions in 1990 (kt CO_2 eq.)	Level Assessment	Cumulative Sum (%)
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2	7,447.11	0.14	14.1%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	7,414.29	0.14	28.1%
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2	6,438.89	0.12	40.3%
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2	4,410.07	0.08	48.6%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	4,112.35	0.08	56.4%
4B1 – Cropland Remaining Cropland (Emissions) – CO_2	2,602.98	0.05	61.3%
3A – Enteric Fermentation – CH_4	2,189.43	0.04	65.5%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	1,916.83	0.04	69.1%
4A1 – Forest Land Remaining Forest Land (Removals) – CO_2	-1,579.04	0.03	72.1%
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2	1,548.35	0.03	75.0%
1A4a – Fuel Combustion – Other Sectors – Commercial/Institutional – CO_2	1,413.84	0.03	77.7%
4C2 – Land Converted to Grassland (Removals) – CO_2	-1,205.69	0.02	80.0%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	1,172.73	0.02	82.2%
5A – Solid Waste Disposal – CH_4	1,046.73	0.02	84.2%
4A2 – Land Converted to Forest Land (Removals) – CO_2	-984.39	0.02	86.1%
2A1 – Mineral Industry – Cement Production – CO_2	971.70	0.02	87.9%
3B1 – Direct N_2O emissions from Manure Management – N_2O	871.91	0.02	89.5%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	812.24	0.02	91.1%
4D2 – Land Converted to Wetlands (Removals) – CO_2	-555.38	0.01	92.1%
3B – Manure Management – CH_4	495.10	0.01	93.1%
1A3c – Fuel Combustion – Transport – Railways – CO_2	403.47	0.01	93.8%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	361.04	0.01	94.5%
5D – Wastewater Treatment and Discharge – CH_4	352.96	0.01	95.2%

Tier 1 2019 Year Level Assessment

Key Categories from Tier 1 Current Year Level Assessment	GHG Emissions in 2019 (kt CO_2 eq.)	Level Assessment	Cumulative Sum (%)
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	3,115.59	0.16	16.5%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	2,567.77	0.14	30.1%
4B1 – Cropland Remaining Cropland (Emissions) – CO_2	1,799.17	0.10	39.6%
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2	1,448.88	0.08	47.3%
5A – Solid Waste Disposal – CH_4	1,231.59	0.07	53.8%
4A1 – Forest Land Remaining Forest Land (Removals) – CO_2	-1,231.10	0.07	60.3%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	871.01	0.05	64.9%
4A2 – Land Converted to Forest Land (Removals) – CO_2	-719.55	0.04	68.7%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	715.98	0.04	72.5%
4F2 – Land Converted to Other Land (Emissions) – CO_2	611.79	0.03	75.8%
2A1 – Mineral Industry – Cement Production – CO_2	523.88	0.03	78.5%
3A – Enteric Fermentation – CH_4	441.65	0.02	80.9%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	391.10	0.02	82.9%
1A4a – Fuel Combustion – Other Sectors – Commercial/Institutional – CO_2	331.26	0.02	84.7%
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2	325.35	0.02	86.4%
4C2 – Land Converted to Grassland (Removals) – CO_2	-293.29	0.02	88.0%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	246.13	0.01	89.3%
5D – Wastewater Treatment and Discharge – CH_4	237.68	0.01	90.5%
3B1 – Direct N_2O emissions from Manure Management – N_2O	228.87	0.01	91.7%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	213.83	0.01	92.9%
4E2 – Land Converted to Settlements (Emissions) – N_2O	161.28	0.01	93.7%
2D – Non-Energy Products from Fuels and Solvent Use – CO_2	143.53	0.01	94.5%
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs	138.64	0.01	95.2%

Tier 1 Trend Assessment

Key Categories from Tier 1 Trend Assessment	GHG Emissions in 2019 (kt CO_2 eq.)	Trend Assessment	Cumulative Sum (%)
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2	3.08	0.05	14.1%
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2	1.76	0.04	26.2%
4C2 – Land Converted to Grassland (Removals) – CO_2	-293.29	0.03	36.4%
4A1 – Forest Land Remaining Forest Land (Removals) – CO_2	-1,231.10	0.03	44.8%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	2,567.77	0.02	52.1%
4B1 – Cropland Remaining Cropland (Emissions) – CO_2	1,799.17	0.02	57.8%
4A2 – Land Converted to Forest Land (Removals) – CO_2	-719.55	0.02	63.3%
5A – Solid Waste Disposal – CH_4	1,231.59	0.02	68.6%
4D2 – Land Converted to Wetlands (Removals) – CO_2	-82.81	0.02	73.6%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	3,115.59	0.01	77.9%
4F2 – Land Converted to Other Land (Emissions) – CO_2	611.79	0.01	81.2%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	871.01	0.01	84.1%
3A – Enteric Fermentation – CH_4	441.65	0.00	85.7%
2A1 – Mineral Industry – Cement Production – CO_2	523.88	0.00	86.9%
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2	325.35	0.00	87.9%
4G – Harvested Wood Products – CO_2	-57.56	0.00	88.8%
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs	138.64	0.00	89.6%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	391.10	0.00	90.4%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	246.13	0.00	91.1%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	213.83	0.00	91.9%
5D – Wastewater Treatment and Discharge – CH_4	237.68	0.00	92.6%
1A4a – Fuel Combustion – Other Sectors – Commercial/Institutional – CO_2	331.26	0.00	93.3%
4E2 – Land Converted to Settlements (Emissions) – N_2O	161.28	0.00	94.0%
1A3c – Fuel Combustion – Transport – Railways – CO_2	24.53	0.00	94.6%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	715.98	0.00	95.2%

Tier 2 1990 Year Level Assessment

Key Categories from Tier 2 Base Year Level Assessment	GHG Emissions in 1990 (kt CO_2 eq.)	Relative Level Assessment with Uncertainty	Cumulative Sum (%)
3B1 – Direct N_2O emissions from Manure Management –– N_2O	871.91	0.11	11.2%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	361.04	0.07	18.6%
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2	7,447.11	0.06	25.0%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	7,414.29	0.06	31.4%
5A – Solid Waste Disposal – CH_4	1,046.73	0.06	37.9%
3A – Enteric Fermentation – CH_4	2,189.43	0.06	43.9%
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2	6,438.89	0.06	49.4%
3B5 – Indirect N_2O Emissions from Manure Management – N_2O	244.71	0.05	54.0%
4B1 – Cropland Remaining Cropland (Emissions) – CO_2	2,602.98	0.05	58.5%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	1,172.73	0.04	62.4%
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2	4,410.07	0.04	66.2%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	4,112.35	0.04	69.8%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	812.24	0.04	73.3%
4A1 – Forest Land Remaining Forest Land (Removals) – CO_2	-1,579.04	0.03	76.4%
4C2 – Land Converted to Grassland (Removals) – CO_2	-1,205.69	0.03	79.0%
5D – Wastewater Treatment and Discharge – CH_4	352.96	0.02	81.5%
3B – Manure Management – CH_4	495.10	0.02	83.4%
4A2 – Land Converted to Forest Land (Removals) – CO_2	-984.39	0.02	85.3%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	273.92	0.02	87.0%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	1,916.83	0.02	88.7%
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2	1,548.35	0.01	90.0%
1A4a – Fuel Combustion – Other Sectors – Commercial/Institutional – CO_2	1,413.84	0.01	91.2%

Tier 2 2019 Year Level Assessment

Key Categories from Tier 2 Current Year Level Assessment	GHG Emissions in 2019 (kt CO_2 eq.)	Relative Level Assessment with Uncertainty	Cumulative Sum (%)
5A – Solid Waste Disposal – CH_4	1,231.59	0.16	16.1%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	246.13	0.11	26.8%
4B1 – Cropland Remaining Cropland (Emissions) – CO_2	1,799.17	0.07	33.5%
3B1 – Direct N_2O emissions from Manure Management – N_2O	228.87	0.06	39.7%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	871.01	0.06	45.8%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	3,115.59	0.06	51.6%
4A1 – Forest Land Remaining Forest Land (Removals) – CO_2	-1,231.10	0.05	56.6%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	2,567.77	0.05	61.4%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	391.10	0.04	65.0%
5D – Wastewater Treatment and Discharge – CH_4	237.68	0.04	68.5%
4A2 – Land Converted to Forest Land (Removals) – CO_2	-719.55	0.03	71.5%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	213.83	0.03	74.3%
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2	1,448.88	0.03	76.9%
3A – Enteric Fermentation – CH_4	441.65	0.03	79.5%
4F2 – Land Converted to Other Land (Emissions) – CO_2	611.79	0.02	81.8%
3B5 – Indirect N_2O Emissions from Manure Management – N_2O	49.60	0.02	83.8%
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs	138.64	0.02	85.7%
2D – Non-Energy Products from Fuels and Solvent Use – CO_2	143.53	0.02	87.2%
4C2 – Land Converted to Grassland (Removals) – CO_2	-293.29	0.01	88.6%
4E2 – Land Converted to Settlements (Emissions) – N_2O	161.28	0.01	89.9%
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2	715.98	0.01	91.2%

Tier 2 Trend Assessment

Key Categories from Tier 2 Trend Assessment	GHG Emissions in 2019 (kt CO_2 eq.)	Relative Level Assessment with Uncertainty	Cumulative Sum (%)
5A – Solid Waste Disposal – CH_4	1,231.59	0.15	14.7%
4C2 – Land Converted to Grassland (Removals) – CO_2	-293.29	0.10	25.0%
4A1 – Forest Land Remaining Forest Land (Removals) – CO_2	-1,231.10	0.07	32.4%
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O	246.13	0.07	39.5%
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2	3.08	0.06	45.1%
4A2 – Land Converted to Forest Land (Removals) – CO_2	-719.55	0.05	49.9%
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2	1.76	0.05	54.7%
4B1 – Cropland Remaining Cropland (Emissions) – CO_2	1,799.17	0.04	59.2%
3Da – Direct N_2O emissions from Agricultural Soils – N_2O	871.01	0.04	63.6%
4D2 – Land Converted to Wetlands (Removals) – CO_2	-82.81	0.04	67.6%
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2	2,567.77	0.03	70.5%
4F2 – Land Converted to Other Land (Emissions) – CO_2	611.79	0.03	73.1%
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs	138.64	0.02	75.5%
5D – Wastewater Treatment and Discharge – CH_4	237.68	0.02	77.8%
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4	213.83	0.02	79.9%
3A – Enteric Fermentation – CH_4	441.65	0.02	81.8%
3B1 – Direct N_2O emissions from Manure Management – N_2O	228.87	0.02	83.6%
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2	3,115.59	0.02	85.3%
4G – Harvested Wood Products – CO_2	-57.56	0.02	86.8%
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4	391.10	0.02	88.3%
3B5 – Indirect N_2O Emissions from Manure Management – N_2O	49.60	0.01	89.8%
2F2 – Product Use as Substitutes for ODS – Foam Blowing Agents – HFCs	89.00	0.01	91.0%

Key Category Summary Table

Key Categories Summary Table based on the Results of the Level and Trend Assessments
1A1 – Fuel Combustion – Energy Industries (Gaseous Fuels) – CO_2
1A1 – Fuel Combustion – Energy Industries (Liquid Fuels) – CO_2
1A1 – Fuel Combustion – Energy Industries (Solid Fuels) – CO_2
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2
1A3b – Fuel Combustion – Transport – Road Transportation – CO_2
1A3c – Fuel Combustion – Transport – Railways – CO_2
1A2 – Fuel Combustion – Manufacturing Industries and Construction – CO_2
1A4a – Fuel Combustion – Other Sectors – Commercial/Institutional – CO_2
1A4b – Fuel Combustion – Other Sectors – Residential – CO_2
1A4b – Fuel Combustion – Other Sectors – Residential – CH_4
1A4c – Fuel Combustion – Other Sectors – Agriculture/Forestry/Fishing – CO_2
1B2 – Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas – CH_4
2A1 – Mineral Industry – Cement Production – CO_2
2D – Non-Energy Products from Fuels and Solvent Use – CO_2
2F1 – Product Use as Substitutes for ODS – Refrigeration and Air Conditioning – HFCs
2F2 – Product Use as Substitutes for ODS – Foam Blowing Agents – HFCs
3A – Enteric Fermentation – CH_4
3B – Manure Management – CH_4
3B1 – Direct N_2O emissions from Manure Management – N_2O
3B5 – Indirect N_2O Emissions from Manure Management – N_2O
3Da – Direct N_2O emissions from Agricultural Soils – N_2O
3Db – Indirect N_2O Emissions from Agricultural Soils – N_2O
4A1 – Forest Land Remaining Forest Land (Removals) – CO_2
4A2 – Land Converted to Forest Land (Removals) – CO_2
4B1 – Cropland Remaining Cropland (Emissions) – CO_2
4C2 – Land Converted to Grassland (Removals) – CO_2
4D2 – Land Converted to Wetlands (Removals) – CO_2
4E2 – Land Converted to Settlements – N_2O
4F2 – Land Converted to Other Land (Emissions) – CO_2
4G – Harvested Wood Products – CO_2
5A – Solid Waste Disposal – CH_4
5D – Wastewater Treatment and Discharge – CH_4

Annex 2. Energy Balances of the Republic of Moldova for 2019 (in natural units) (without ATULBD)

SUPPLY AND CONSUMPTION	Coal, including														Peat and Peat Products, kt	Shale, kt	Natural Gas, million m^3 stand.**
	Anthracite, kt	Coke Coal, kt	Other Bituminous Coal, kt	Semibituminous Coal, kt	Lignite, kt	Coke, kt	Coke Gas, kt	Coke Dust, kt	Semicoke, kt	Solid Fuel Briquettes, kt	Brown Coal Briquettes, kt	Coal Tar, kt	Coal gas, water gas, generator gas and similar gases, except gas from wells gas, and other gaseous hydrocarbons, million m^3	Other Coal Products, kt			
	110	**121**	**129**	**210**	**220**	**311**	**312**	**313**	**314**	**320**	**330**	**340**	**350**	**390**	**1110**	**2000**	**3000**
A	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Primary Production																	
Inputs from Other Sources																	
Import	109	1	37														**1058**
Export																	
Stock Variation	-13		-3														**-1**
Stock at the start of the year	67		17														**18**
Stock at the end of the year	54		14														**17**
GROSS DOMESTIC CONSUMPTION CALCULATED	**122**	**1**	**40**														**1059**
REAL GROSS DOMESTIC CONSUMPTION	**122**	**1**	**40**														**1059**
TRANSFORMATION, INPUTS																	432
Power Plants																	
Combined Heat Plants – Public energy producers																	321
Combined Heat Plants – Autoproducers																	19
Heat Plants – Public energy producers																	41
Heat Plants – Autoproducers																	51
Oil Refineries																	
Petrochemical plants																	
Liquefaction plants																	
Charcoal production plants																	
Other transformation installations																	
TRANSFORMATION, OUTPUTS																	
Power Plants																	
Combined Heat Plants – Public energy producers																	
Combined Heat Plants – Autoproducers																	
Heat Plants – Public energy producers																	
Heat Plants – Autoproducers																	
Oil Refineries																	
Petrochemical plants																	
Liquefaction plants																	
Charcoal production plants																	
Other transformation installations																	
Energy used in the Energy Sector																	
Oil Refineries																	
Petrochemical Plants																	
Power, Heat and Electrical Plants																	

SUPPLY AND CONSUMPTION	Coal, including														Peat and Peat Products, kt	Shale, kt	Natural Gas, million m^3 stand.**
	Anthracite, kt	Coke Coal, kt	Other Bituminous Coal, kt	Semibituminous Coal, kt	Lignite, kt	Coke, kt	Coke Gas, kt	Coke Dust, kt	Semicoke, kt	Solid Fuel Briquettes, kt	Brown Coal Briquettes, kt	Coal Tar, kt	Coal gas, water gas, generator gas and similar gases, except gas from wells gas, and other gaseous hydrocarbons, million m^3	Other Coal Products, kt			
	110	121	129	210	220	311	312	313	314	320	330	340	350	390	1110	2000	3000
A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Pumping Storage Plants																	
Unspecified elsewhere																	
Losses																	**36**
FINAL CONSUMPTION	**122**	**1**	**40**														**591**
FINAL ENERGY CONSUMPTION	**122**	**1**	**40**														**591**
INDUSTRY	**2**	**1**	**38**														**81**
Mining																	
Food Processing, Beverages and Tobacco	2																29
Textiles and Leather Industry																	2
Wood Processing, manufacture of wood and cork products, except furniture; manufacture of straw products and from other vegetable plaiting materials																	
Printing and Reproduction of Recorded Media																	1
Chemical and Petrochemical Industry (including the Pharmaceutical Industry)																	1
Non-metallic Minerals		1	38														45
Metal Industry																	
Car Engineering Industry																	1
Production of Trailers, Semitrailers and other Transport Means																	
Other Industries n.c.e.																	1
For Construction																	1
TRANSPORT																	**25**
Railways																	
Terrestrial passenger and cargo transport by autovehicles																	17
Pipeline Transportation																	8
Navigation																	
Aviation																	
Other supplementary activities for transport																	
OTHER	**120**		**2**														**485**
Agriculture/Forestry/Fishing	2																4
Commercial/Institutional	1																10
For communal Services	25		1														108
Residential	92		1														363
Not specified elsewhere																	
CONSUMED FOR NON-ENERGY PURPOSES																	
Statistical differences																	

SUPPLY AND CONSUMPTION	Oil Products, including																					
	Oil, kt	Other Gaseous Hydrocarbons (ethylene, propylene, butylene, butadiene and other), million m³ stand.**	Raw materials for refineries, kt	Additives and oxygenated compounds, kt	Other hydrocarbons, kt	Gas from wells, million m³	Ethane, million m³	Liquefied (petroleum) gases, kt	Naphtha, kt	Aviation gasoline, kt	Gasoline, kt	Gasoline for jet engines, kt	Kerosene for jet engines, kt	Other kerosene gases, kt	Diesel oil, kt	Residual fuel oil, kt	White-spirit Petroleum, kt	Oils and greases (lubricants), kt	Paraffins, kt	Petroleum coke, kt	Petroleum bitumen, kt	Other petroleum products, kt
	4100	**4200**	**4300**	**4400**	**4500**	**4610**	**4620**	**4630**	**4640**	**4651**	**4652**	**4653**	**4661**	**4669**	**4671**	**4680**	**4691**	**4692**	**4693**	**4694**	**4695**	**4699**
A	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
Primary Production	5																					
Inputs from Other Sources																						
Import								66			178		49		622	6		9		33	53	
Export															9							
Stock Variation											2		1		-2	5				-2	3	
Stock at the start of the year	1							7		1	16		3		56	42		4		3	2	
Stock at the end of the year	1							7		1	18		4		54	47		4		1	5	
GROSS DOMESTIC CONSUMPTION CALCULATED	**5**							**66**			**176**		**48**		**615**	**1**		**9**		**35**	**50**	
REAL GROSS DOMESTIC CONSUMPTION	**5**							**66**			**176**		**48**		**615**	**1**		**9**		**35**	**50**	
TRANSFORMATION, INPUTS	5														1	4						
Power Plants																						
Combined Heat Plants – Public energy producers																						
Combined Heat Plants – Autoproducers																2						
Heat Plants – Public energy producers																						
Heat Plants – Autoproducers																1						
Oil Refineries																						
Petrochemical plants	5														1	1						
Liquefaction plants																						
Charcoal production plants																						
Other transformation installations																						
TRANSFORMATION, OUTPUTs																**4**						**1**
Power Plants																						
Combined Heat Plants – Public energy producers																						
Combined Heat Plants – Autoproducers																						
Heat Plants – Public energy producers																						
Heat Plants – Autoproducers																						
Oil Refineries																						
Petrochemical plants																4						1
Liquefaction plants																						
Charcoal production plants																						
Other transformation installations																						
Energy used in the Energy Sector																						
Oil Refineries																						
Petrochemical Plants																						
Power, Heat and Electrical Plants																						
Pumping Storage Plants																						

SUPPLY AND CONSUMPTION	Oil Products, including																					
	Oil, kt	**Other Gaseous Hydrocarbons (ethylene, propylene, butylene, butadiene and other), million m³ stand.****	**Raw materials for refineries, kt**	**Additives and oxygenated compounds, kt**	**Other hydrocarbons, kt**	**Gas from wells, million m³**	**Ethane, million m³**	**Liquefied (petroleum) gases, kt**	**Naphtha, kt**	**Aviation gasoline, kt**	**Gasoline, kt**	**Gasoline for jet engines, kt**	**Kerosene for jet engines, kt**	**Other kerosene gases, kt**	**Diesel oil, kt**	**Residual fuel oil, kt**	**White-spirit Petroleum, kt**	**Oils and greases (lubricants), kt**	**Paraffins, kt**	**Petroleum coke, kt**	**Petroleum bitumen, kt**	**Other petroleum products, kt**
	4100	**4200**	**4300**	**4400**	**4500**	**4610**	**4620**	**4630**	**4640**	**4651**	**4652**	**4653**	**4661**	**4669**	**4671**	**4680**	**4691**	**4692**	**4693**	**4694**	**4695**	**4699**
A	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
Unspecified elsewhere																						
Losses								**1**			**1**				**1**							
FINAL CONSUMPTION								**65**			**175**		**48**		**613**	**1**		**9**		**35**	**50**	**1**
FINAL ENERGY CONSUMPTION								**65**			**175**		**48**		**613**	**1**		**1**		**35**		
INDUSTRY								**1**							**9**	**1**				**35**		
Mining															4							
Food Processing, Beverages and Tobacco								1														
Textiles and Leather Industry																						
Wood Processing, manufacture of wood and cork products, except furniture; manufacture of straw products and from other vegetable plaiting materials																						
Printing and Reproduction of Recorded Media																						
Chemical and Petrochemical Industry (including the Pharmaceutical Industry)																						
Non-metallic Minerals																				35		
Metal Industry																						
Car Engineering Industry																						
Production of Trailers, Semitrailers and other Transport Means																						
Other Industries n.c.e.																						
For Construction								0							5	1						
TRANSPORT								**12**			**175**		**48**		**493**							
Railways															7							
Terrestrial Passenger and Cargo Transport by Autovehicles								12			175				485							
Pipeline Transportation																						
Navigation																						
Aviation													48									
Other supplementary activities for transport															1							
OTHER								**52**							**111**							
Agriculture/Forestry/Fishing								0							110							
Commercial/Institutional								0														
For communal Services															1							
Residential								52														
Not specified elsewhere																						
CONSUMED FOR NON-ENERGY PURPOSES																		**9**			**50**	**1**
Statistical differences																						

SUPPLY AND CONSUMPTION	Biofuels and Waste, including															Waste, including		Electricity, million kWh	Heat, thousand Gcal.	Other types of fuel, kt
	Briquettes and wood pellets and other vegetable waste, kt	Fuel Wood, thousand m^3 comp.***	Wood Waste, kt	Animal Waste, kt	Black Lye, kt	Agricultural fuel residues, kt	Charcoal, kt	Biogasoline, kt	Biodiesel oil, kt	Biodiesel oil for jet engines, kt	Other types of liquid fuels, kt CC	Gas from organic waste, million m^3	Gas from sewage sludge, million m^3	Other types of biogases from anaerobic fermentation, million m^3	Biogas from heating processes million m3	Industrial waste, kt	Urban waste, kt			
	5111	**5112**	**5119**	**5130**	**5140**	**5150**	**5160**	**5210**	**5220**	**5230**	**5290**	**5311**	**5312**	**5319**	**5320**	**6100**	**6200**	**7000**	**8000**	**9900**
A	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**63**	**64**	**65**
Primary Production	24	3023	277	7		85						17						111		
Inputs from Other Sources																		2857		
Import	1						1											644		
Export	0																			
Stock Variation		18	7			1														
Stock at the start of the year	6	63	1			3														
Stock at the end of the year	6	81	8			4														
GROSS DOMESTIC CONSUMPTION CALCULATED	**25**	**3005**	**270**	**7**		**84**	**1**					**17**						**3612**		
REAL GROSS DOMESTIC CONSUMPTION	**25**	**3005**	**270**	**7**		**84**	**1**					**17**						**3612**		
TRANSFORMATION, INPUTS	8	10				29						17						111		
Power Plants												7						111		
Combined Heat Plants – Public energy producers																				
Combined Heat Plants – Autoproducers												10								
Heat Plants – Public energy producers																				
Heat Plants – Autoproducers	8					29														
Oil Refineries																				
Petrochemical plants																				
Liquefaction plants																				
Charcoal production plants		10																		
Other transformation installations																				
TRANSFORMATION, OUTPUTs							**1**											**941**	**2308**	
Power Plants																		123		
Combined Heat Plants – Public energy producers																		777	1375	
Combined Heat Plants – Autoproducers																		41	133	
Heat Plants – Public energy producers																			363	
Heat Plants – Autoproducers																			437	
Oil Refineries																				
Petrochemical plants																				
Liquefaction plants																				
Charcoal production plants							1													
Other transformation installations																				
Energy used in the Energy Sector																		**204**	**11**	
Oil Refineries																				
Petrochemical Plants																			2	
Power, Heat and Electrical Plants																		159	3	
Pumping Storage Plants																				
Unspecified elsewhere																		45	6	

SUPPLY AND CONSUMPTION	Biofuels and Waste, including															Waste, including		Electricity, million kWh	Heat, thousand Gcal.	Other types of fuel, kt
	Briquettes and wood pellets and other vegetable waste, kt	Fuel Wood, thousand m³ comp.***	Wood Waste, kt	Animal Waste, kt	Black Lye, kt	Agricultural fuel residues, kt	Charcoal, kt	Biogasoline, kt	Biodiesel oil, kt	Biodiesel oil for jet engines, kt	Other types of liquid fuels, kt CC	Gas from organic waste, million m³	Gas from sewage sludge, million m³	Other types of biogases from anaerobic fermentation, million m³	Biogas from heating processes million m3	Industrial waste, kt	Urban waste, kt			
	5111	5112	5119	5130	5140	5150	5160	5210	5220	5230	5290	5311	5312	5319	5320	6100	6200	7000	8000	9900
A	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	63	64	65
Losses																		425	346	
FINAL CONSUMPTION	17	2995	270	7		55	2											3813	1951	
FINAL ENERGY CONSUMPTION	17	2994	263			39	2											3813	1951	
INDUSTRY		1																740	485	
Mining																		15		
Food Processing, Beverages and Tobacco		1																352	419	
Textiles and Leather Industry																		51	14	
Wood Processing, manufacture of wood and cork products, except furniture; manufacture of straw products and from other vegetable plaiting materials																		6		
Printing and Reproduction of Recorded Media																		13	5	
Chemical and Petrochemical Industry (including the Pharmaceutical Industry)																		35	44	
Non-metallic Minerals																		154		
Metal Industry																		3		
Car Engineering Industry																		34	3	
Production of Trailers, Semitrailers and other Transport Means																		10		
Other Industries n.c.e.																		51		
For Construction																		16		
TRANSPORT																		45		
Railways																				
Terrestrial Passenger and Cargo Transport by Autovehicles																		43		
Pipeline Transportation																		2		
Navigation																				
Aviation																				
Other supplementary activities for transport																				
OTHER	17	2993	263			39	2											3028	1466	
Agriculture/Forestry/Fishing		5																72		
Commercial/Institutional		3					1											427	10	
For communal Services	7	25	1			5												858	369	
Residential	10	2960	262			34	1											1671	1087	
Not specified elsewhere																				
CONSUMED FOR NON-ENERGY PURPOSES		1	7	7		16														
Statistical differences																				

Annex 3. Additional Information Associated to Activity Data, Country Specific Coefficients/Parameters and Methodologies Used to Estimate Sectoral GHG Emissions

Annex 3-1. Additional Methodologies and Data Sources for Sector 1 'Energy'

Annex 3-1.1. Additional Data Sources Used to Estimate GHG Emissions within the Sector 1 'Energy' for the ATULBD

Table A3-1.1.1: Fuel Consumption for Heat and Power Generation (1A1 'Energy Industries') in the ATULBD for the period 1994-2019

	1994	1995	1996	1997	1998	1999	2000	2001	2002
Natural Gas, million m^3, including:	1297.95	1098.40	1281.50	1261.40	1081.33	1028.50	1030.80	1187.80	862.50
MTPP Dnestrovsk	1030.00	1098.40	1231.80	1113.30	856.60	841.30	768.40	937.40	719.30
Residual Fuel Oil, kt	228.000	26.100	23.600	6.055	26.919	NA	NA	NA	NA
Other bituminous coal, kt	1686.600	882.900	806.338	281.873	182.417	NA	NA	NA	NA
	2003	2004	2005	2006	2007	2008	2009	2010	2011
Natural Gas million m^3, including:	931.50	970.50	972.10	611.10	885.70	995.20	1448.30	1549.90	1428.80
MTPP Dnestrovsk	756.20	838.70	805.40	429.40	719.00	766.20	1267.20	1339.40	1220.00
Residual Fuel Oil, kt	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other bituminous coal, kt	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2012	2013	2014	2015	2016	2017	2018	2019	2020
Natural Gas, million m^3, including	1458.80	958.40	1350.70	1539.00	1504.00	1296,20	1419,80	1494,00	N/A
MTPP Dnestrovsk	1255.80	754.30	1162.60	1348.00	1312.00	999.30	1111.50	1095.50	N/A
Residual Fuel Oil, kt	2.56	1.84	1.47	1.37	2.00	0.67	0.84	0.37	N/A
Other bituminous coal, kt	13.17	312.19	2.64	1.98	7.38	0.00	0.44	0.73	N/A

Table A3-1.1.2: Fuel Consumption within source category 1A2 'Manufacturing Industries and Construction' for the ATULBD for the period 1994-2019

	1994	1995	1996	1997	1998	1999	2000	2001	2002
Natural Gas, million m^3	275.10	71.72	52.11	151.50	146.50	136.10	143.90	174.50	73.20
	2003	2004	2005	2006	2007	2008	2009	2010	2011
Natural Gas, million m^3	79.00	71.90	102.50	133.90	232.60	250.50	121.90	113.50	123.00
Residual Fuel Oil, kt						0.8715	0.5705	0.3208	0.3098
Other bituminous coal, kt						0.0737	0.1473	0.1108	0.1102
LPG, kt									0.057
	2012	2013	2014	2015	2016	2017	2018	2019	2020
Natural Gas, million m^3	134.90	110.80	129.70	108.00	120.00	100.00	108.00	112.00	N/A
Residual Fuel Oil, kt	0.2581	0.3713	0.3713	0.3713	0.3713	0.3606	0.289	0.1269	N/A
Other bituminous coal, kt	0.0840	0.0324	0.0722	0.0641	0.0622	0.335	0.0206	0.0151	N/A
LPG, kt	0.0346	0.0291	0.0249	0.0204	0.0204	0.0133	0.011	0.0121	N/A

Source: 'Moldovagaz' JSC through Letters No. 604 dated 01.04.1999, as a response to Letter No. 02-541 dated 28.05.2001; Letter No. 02-156 dated 06.02.2004, as a response to Letter No. 257-01-07 dated 26.01.2004; Letter No. 06-1253 dated 27.09.2006, as a response to Letter No.01-07/1400 dated 25.08.2006; Letter No. 07-730 dated 6.6.2007, as a response to Letter No. 47/21-103 dated 31.05.2007; Letter No. 02/1-476 dated 23.02.2011, as a response to Letter No. 03-07/175 dated 02.02.2011; Letter No. 02/1-288 dated 22.01.2014, as a response to Letter No. 320/2014-01-01 dated 03.01.2014; Letter No. 02/1-507 dated 10.02.2015, as a response to Letter No. 407/2015-01-09 dated 29.01.2015; Letter No. 02/1-2183 dated 03.06.2016, as a response to Letter No. 512/2016-05-01 dated 10.05.2016; Letter No. 03/2-74 dated 12.01.2018, as a response to Letter No. 601/2017-12-03 dated 14.12.2017; Letter No. Nr. 03/4 -676 dated 03.03.2020, as a response to Letter No. 08-310/1 dated 11.02.2020 State Statistical Service of the Transnistrian Moldovan Republic (2020), Socio-economic development of the TMR for 2019. Tiraspol, 2020, 84 p.; State Statistical Service of the Transnistrian Moldovan Republic (2019), Socio-economic development of the TMR for 2018.Tiraspol, 2019, 84 p.; State Statistical Service of the Transnistrian Moldovan Republic (2018), Socio-economic development of the TMR for 2017. Tiraspol, 2018, 80 p.; State Statistical Service of the Transnistrian Moldovan Republic (2017), Socio-economic development of the TMR for 2016. Tiraspol, 2017, 81p.; State Statistical Service of the Transnistrian Moldovan Republic (2016), Socio-economic development of the TMR for 2015. Tiraspol, 2016, 81 p.; State Statistical Service of the Transnistrian Moldovan Republic (2015), Socio-economic development of the TMR for 2014. Tiraspol, 2015. 81 p.; State Statistical Service of the Transnistrian Moldovan Republic (2013), Socio-economic development of the TMR for 2012. Tiraspol, 2013. 85 p.; State Statistical Service of the Transnistrian Moldovan Republic (2012), Socio-economic development of the TMR for 2011, Chapter 4«Energy Resources», page 23. Tiraspol, 2012. 85 p.; State Statistical Service of the Transnistrian Moldovan Republic (2011), Socio-economic development of the TMR for 2010 , Chapter 4 «Material Resources», page 21. Tiraspol, 2011. 79 p.; State Statistical Service of the Transnistrian Moldovan Republic (2010), Socio-economic development of the TMR for 2009, Chapter 4 «Material Resources», page 20. Tiraspol, 2010. 75 p.

Table A3-1.1.3: Fuel Consumption within source category 1A3b 'Road Transportation' for the ATULBD for the period 1995-2019

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Compressed Natural Gas, million m^3	4.1	6.9	1.8	2.2	5.2	4.8	5.0	5.0	NO	NO	NO

Source: 'Moldovagaz' JSC through Letter No. 02/1-476 dated 23.02.2011, as a response to Letter No. 03-07/175 dated 02.02.2011; Letter No. 02/1-288 dated 22.01.2014, as a response to Letter No. 320/2014-01-01 dated 03.01.2014; Letter No. 02/1-507 dated 10.02.2015, as a response to Letter No. 407/2015-01-09 dated 29.01.2015; Letter No. 02/1-2183 dated 03.06.2016, as a response to Letter No. 512/2016-05-01 dated 10.05.2016; Letter No. 03/2-74 dated 12.01.2018, as a response to Letter No. 601/2017-12-03 dated 14.12.2017.

Table A3-1.1.4: Fuel Consumption within source category 1A4a 'Commercial/Institutional' for the ATULBD for the period 1999-2019

	1999	2000	2001	2002	2003	2004	2005
Natural Gas, million m^3	6.80000	9.3000	13.6000	81.8000	87.4000	229.0000	181.60000
	2006	2007	2008	2009	2010	2011	2012
Natural Gas, million m^3	151.9000	14.4000	19.8000	16.1000	37.7000	209.2000	202.3000
Other bituminous coal, kt	NO	NO	0.0620	0.0626	0.0127	0.0412	0.0087
Residual Fuel Oil, kt	NO	NO	0.0868	0.1369	0.1063	0.0399	0.0400
LPG, kt	NO	NO	NO	NO		0.0026	0.00109

	2013	2014	2015	2016	2017	2018	2019
Natural Gas, million m³	99.9000	105.1000	27.0000	19.0000	19.0000	22.0000	18,8000
Other bituminous coal, kt	0.0356	0.0127	0.0050	0.0027	0.0021	0.0302	0.0214
Residual Fuel Oil, kt	0.0430	0.0820	0.0283	0.0776	0.0181	NO	3.0000
LPG, kt	0.0012	0.0011	0.0012	0.0050	0.0016	0.0014	0.0013

Table A3-1.1.5: Fuel Consumption within source category 1A4b 'Residential' for the ATULBD for the period 1995-2019

	1995	1996	1997	1998	1999	2000	2001	2002	2003
LPG, kt *	2.5	2.3	1.4	1.3	0.8	0.4	0.3	0.4	0.5
Natural Gas, million m³ *	216.6	163.4	354.8	321.6	293.2	NO	196.4	175.4	176.6
Natural Gas, million m³ **	NO	NO	NO	NO	294.2	217.9	196.4	163.5	176.6
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
LPG, kt *	0.5	0.5	0.5	0.4486	0.4962	0.3869	0.5798	0.606	0.477
Natural Gas, million m³*	162.8	164.8	161.2	150.8	150.0	156.0	174.3	184.5	184.1
Natural Gas, million m³**	132.0	144.2	157.0	149.2	148.7	154.7	173.0	184.5	184.1
Fuel Wood, thousand m³ comp.*	NO	NO	NO	NO	NO	10.2	10.8	10.0	5.4
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
LPG, kt *	0.3836	0.3525	0.2753	0.231	0.1439	0.1466	0.1176	N/A	N/A
Natural Gas, million m³ *	180.6	180.1	175.00	185.7	190.7	199.1	183.6	N/A	N/A
Fuel Wood, thousand m³ comp.*	4.7	7.7	10.9	6.9	5.4	4.6	8.2	N/A	N/A

Source: * Statistical Yearbooks of the ATULBD for 2000 (page 22), 2006 (page 22), 2009 -2013 (page 23); Press-Release The State of Housing and Communal Services of the Republic for 2011-2019 ; ** 'Moldovagaz' JSC Letter No. 06-1253 dated 27.09.2006 and Letter No. 02/1476 dated 23.02.2011; Letter No. 02/1-288 dated 22.012.2014; Letter No. 02/1-507 dated 10.02.2015; Letter No. 02/1-2183 dated 03.06.2016; Letter No. 03/2-74 dated 12.01.2018; Letter No. 03/4-676 dated 03.03.2020.

Table A3-1.1.6: Fuel Consumption within source category1A4c 'Agriculture/Forestry/Fishing' for the ATULBD for the period 1995-2019

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Diesel Oil, kt *1)	26.7732	21.4371	28.5957	22.0698	20.4030	14.5584	14.3541	11.1636	7.7409
Gasoline, kt *	9.6830	6.1160	8.8580	5.7920	3.0730	1.7550	1.6930	1.2220	1.2580
Natural Gas, mln.m³ **	NO	0	NO	NO	NO	NO	NO	NO	0.9
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Diesel Oil, kt *1)	6.9372	4.8546	4.0239	2.9331	2.6505	3.5037	7.4195	8.3934	9.2448
Gasoline, kt *	0.7810	0.6120	0.5740	0.3980	0.3340	0.4230	0.6460	0.582	0.613
Natural Gas, mln.m³ **	0.7	0.4	NO	NO	0.1	NO	0.1	0.1	0.2
Residual Fuel Oil, kt ***	NO	NO	NO	NO	0.0032	0.0032	0.0032	0.193	0.0032
Coal, kt ***	NO	NO	NO	NO	0.0153	0.0115	0.0090	0.031	0.024
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Diesel Oil, kt *1)	10.5	10.2465	9.717	NO	NO	NO	NO	N/A	N/A
Gasoline, kt *	0.849	0.721	0.6431	NO	NO	NO	NO	N/A	N/A
Natural Gas, mln.m³ **	NO	NO	NO	NO	NO	NO	NO	N/A	N/A
Residual Fuel Oil, kt ***	0.0032	NO	NO	NO	NO	NO	NO	N/A	N/A
Coal, kt ***	0.024	0.024	0.022	0.0373	0.014	0.014	0.006	N/A	N/A

Source: * Statistical Yearbooks of the ATULBD for 2000 ((page 106), 2006 (page 107), 2009 (page 106), 2010 (page 108), 2011 (page 109), 2012 (page 113), 2013 (page 102); 2014 (page. 102); 2015 (page 95); ** Official Letter from 'Moldovagaz' No. 06-1253 dated 27.09.2006 and No. 02/1476 dated 23.02.2011; Letter No. 02/1-288 dated 22.012.2014; Letter No. 02/1-507 dated 10.02.2015; Letter No. 02/1-2183 dated 03.06.2016; Letter No. 03/2-74 dated 12.01.2018; Letter No. 03/4-676 dated 03.03.2020. *** State Statistical Service of the Transnistrian Moldovan Republic (2020), *Socio-economic development of the TMR for* 2019. Tiraspol, 2020, p.22; State Statistical Service of the Transnistrian Moldovan Republic (2019), *Socio-economic development of the TMR for 2018.*Tiraspol, 2019, p. 81; State Statistical Service of the Transnistrian Moldovan Republic (2018), Socio-economic development of the TMR for 2017. Tiraspol, 2018, p. 80; State Statistical Service of the Transnistrian Moldovan Republic (2017), Socio-economic development of the TMR for 2016. Tiraspol, 2017 p. 81; State Statistical Service of the Transnistrian Moldovan Republic (2016) (final data), Socio-economic development of the TMR for 2015. Tiraspol, 2016, p. 81; State Statistical Service of the Transnistrian Moldovan Republic (2015) (final data) / Socio-economic development of the TMR for 2014. Tiraspol, 2015, p. 81; Socio-economic development of the TMR for 2014 (final data)/ State Statistical Service of the Transnistrian Moldovan Republic - Tiraspol, 2015 - 81, p. 81; State Statistical Service of the Transnistrian Moldovan Republic (2013), State Statistical Service of the Transnistrian Moldovan Republic 2012, *Chapter 4 «Energy Resources», page 23. Tiraspol, 2012. 85 p.;* State Statistical Service of the Transnistrian Moldovan Republic (2012), Socio-economic development of the TMR for 2011, *Chapter 4 «Material Resources» Chapter 4 «Energy Resources», page 23. Tiraspol, 2012. 85 p* State Statistical Service of the Transnistrian Moldovan Republic (2011), *Socio-economic development of the TMR for 2010 , Chapter 4*«Material Resources», page 21. Tiraspol, 2011. 79 p. State Statistical Service of the Transnistrian Moldovan Republic (2010), *Socio-economic development of the TMR for 2009, Chapter 4* «Material Resources», page 20. Tiraspol, 2010. *75 p.*

Table A3-1.1.7: Fuel Consumption within Source Category 1A5 'Other' for the ATULBD for the period 2014-2019

	2014	2015	2016	2017	2018	2019
Other bituminous coal, kt	9.400	8.700	9.000	9.400	9.700	9.500

Source: State Statistical Service of the Transnistrian Moldovan Republic: Use of Fuel and Energy Resources of the TMR for 2014-2019

Annex 3-2. Additional Data Sources for Sector 2 'Industrial Processes and Product Use'

Table A3-2.1: Raw Materials and Energy Balance for Cement Production at Cement Plant "LAFARGE CIMENT (Moldova)" J.S.C. in Rezina

No.	Name	Measure Units	Consumption Norm	No.	Name	Measure Units	Consumption Norm
Input				**Output**			
Materials							
1	Clinker	kg/t cement	786.9	1	Cement	kg	1000
2	Gypsum	- „ – „ -	57.7	2	Technological Loss	kg/t cement	30
3	Mineral Supplements	- „ – „ -	185.4				
Fuel							
1	Fuel, total	kg c.e./t cement	126.4	1	Clinker Drying	kg c.e./t cement	121.7
				2	Supplements Drying	kg c.e./t cement	4.7

Table A3-2.2: Average Concentration of CaO and MgO in Clay Used for Bricks Production at State Enterprises "Macon" J.S.C. in Chisinau within 1990-2019 periods

Year	Average Concentration of CaO in Clay Used, %				Average Concentration of MgO in Clay Used, %			
	From Malo-Haruza Quarry	From Micauti Quarry	From Micauti Quarry	From Purcel Quarry	From Malo-Haruza Quarry	From Micauti Quarry	From Micauti Quarry	From Purcel Quarry
1990-1996	6.915	4.08	8.22	8.44	2.67	3.21	3.57	3.03
1997-2004	6.915	4.08	8.22	8.44	2.67	3.21	3.57	3.21
2005-2010	5.87-7.96	4.08	8.22	8.44	2.16-3.18	3.21	3.57	3.03
2011-2019	6.66	4.08	6.70	8.44	2.60	3.21	2.93	3.03

Annex 3-3. Features of Races of Livestock and Poultry Bred in the Republic of Moldova, used to estimate GHG emissions from Sector 3 'Agriculture'

Cattle

In early 1990', *Steppe Red* and *Estonian Red* (in the South and partially in the Centre), *Simmental* (in the North and partially in the Centre), and *Spotted Black* (most often used in cross-breeding with local races, but also bred as pure blood) were the most widely bred races in the RM; *Holstein, Ayrshire* and *Jersey* were not bred as pure blood, but used for cross-breeding (Bucataru, Radionov, 1997; Bucataru, Radionov, Urzica, 2002; Bivol, Ciubotaru, 2005) (Table A3-3.1). At present most cattle bred in the RM are not pure blood, but represent half-breeds from crossbreeding. It should be mentioned that lately, a new kind of cattle *Moldovan Spotted Black*[2] was crossbred as a result of crossbreeding of *Steppe Red* and *Simmental* with the improved races *Spotted Black* and *Holstein*.

Table A3-3.1: Features of Cattle Races Bred in the Republic of Moldova

Cattle Race	Production	Live Weight,, kg		Milk Yield, kg	Content of:		Weight of Calf at Birth, kg
		♀	♂		Fat in milk, %	Protein in milk, %	
Spotted Black	milk	650-750	900-1100	5000-7000	3.4-3.7	3.2-3.3	35-39
Simmental	mixed	600-800	1100-1300	3000-5500	3.9-4.2	3.4-3.5	40-43
Steppe Red	milk	450-550	800-900	3000-5000	3.7-3.9	3.3-3.5	28-35
Estonian Red	milk	500-550	850-950	3500-5000	3.8-4.3	3.2-3.5	34-38
Holstein	milk	650-750	900-1150	6000-10000	3.3-3.6	3.0-3.1	40-45
Ayrshire	milk	400-500	600-700	4000-5000	3.9-4.5	3.5-3.6	30-33
Jersey	milk	300-350	400-450	3000-4000	5.0-6.5	3.7-4.5	20-25

Swine

The following races and types of swine are bred in the country: *Big White* (as pure blood and as maternal form in industrial crosses and in crossbreeding), *Bacon Estonian* (used for industrial crosses with *Big White*, *Steppe White Ukrainian* and other for crossbreeding), *Steppe White Ukrainian* (boars are used for industrial crosses with other races), *Southern Moldavian type for meat 'Sudic'* (Southern) (used in crossbreeding as paternal form) (Bucataru, Radionov, Urzica, 2002; Bivol, Ciubotaru, 2005) (Table A3-3.2). Races more often used for crossbreeding in the RM are *Landrace* (used in crossbreeding with other races to obtain half breed gilts F_1), *Duroc* (used as a paternal race in three-racial and tetra-racial crossbreeding), and *Hampshire* (used as paternal form in various crossbreeding schemes).

Table A3-3.2: Features of Swine Races and Types Bred in the Republic of Moldova

Races and Types of Swine	Production	Live Weight, kg		Proliferation, piglets in one birth	Average daily weight gain, g	Nutrition units per 1 kg of weight gain
		♀	♂			
The Big White	meat	300-350	220-260	11-12	600-650	4.0-4.1
Bacon Estonian	bacon	280-310	230-250	10-11	600-700	3.8-4.0
Steppe White Ukrainian	meat and fat	300-350	230-250	10-12	600-650	3.9-4.2
Moldavian type for meat 'Sudic'	meat	330-350	240-250	10-11	700-800	3.3-3.7
Ladrace	bacon	300-320	230-250	10-12	600-700	3.8-3.9
Duroc	meat	270-300	230-250	8-9	700-750	3.5-3.9
Hampshire	meat	230-280	200-230	9-10	650-700	3.7-4.0

Sheep

The sheep bred in the Republic of Moldova are represented by races *Karakul, Tsigaie, Turcana* and *Frisian* (Table A3-3.3).

[2] The features of the type Moldovan Spotted Black are cows yield big amounts of milk (6000 kg) after the first birth, the milking intensity is 1.8-2.5 kg/minute, production maturity is 25-27 months, effective production term is 4-6 births, weight of calf at birth is 30-35 kg; breeding heifers at 6 months of age weight 165 kg, at 12 months - circa 270 kg. And at 18 months - circa 375 kg and young cattle left for fattening has a daily weight gain of 1200 g, slaughtering efficiency being of 55%.

Table A3-3.3: Features of Sheep Races Bred in the Republic of Moldova

Sheep Races	Production	Live Weight, kg		Fertility, lambs per 100 sheep	Wool sheared, kg	Milk Yield, kg	Content in Milk, %:	
		♀	♂				fats	proteins
Karakul	skins-milk	70-80	45-50	110-120	2.0-3.5	60-80	7.0-8.0	5.5-6.5
Tsigaie	wool-milk, wool-meet	85-95	45-50	110-130	3.5-7.5	75-120	6.5-7.0	5.0-6.0
Frisian	milk	80-90	65-70	190-210	3.5-5.0	500-600	5.9-6.5	5.0-5.5

The most typical colors of *Karakul* race are black and frosty. This race was regionalized in the northern and central part of the country; it is well adaptable and is not demanding in terms of feed and maintenance conditions. *Tsigaie* sheep are well adaptable to warm climate, are bred in the South of the country and are a race of sheep with semi-fine wool and has considerable fattening abilities. In comparison with other races, *Frisian* race has high milk yield indicators and high fertility performance at crossbreeding and improves these features in crossbreeds on condition special feeding and maintenance conditions are provided (Bucataru, Radionov, Urzica, 2002; Bucataru, Radionov, Varban, 2003; Bivol, Ciubotaru, 2005).

Goats

Most native goats (90 per cent) have thick and short hairy caver, consisting of thick and long fibbers (over 70 per cent) and down (less than 30 per cent) of white (21.2 per cent), red (20.9 per cent), black (25.2 per cent), colour and spotted (32.7 per cent), with horns (73.0 per cent) and with no 'ear rings' (73.3 per cent). The research made revealed that the goats gene pool to a large extent is represented by less productive crossbreeds, however, well adapted to the climate conditions of the country. Among the improved races, recommended for improving goats productivity in the Republic of Moldova are *Saanen* (a race with remarkable milking abilities high fertility performance and longevity, which is used for crossbreeding aimed to improve the milking abilities of local goats), *French Alpine* (is well adapted for grasslands and not demanding in terms of feeding and maintenance conditions, is used to improve native breeds) and *Angora* (is the most valuable race of wool goats, may be used for crossbreeding with other races in view of improving the quality of the hairy caver) (Bucataru, Radionov, Urzica, 2002; Bucataru, Radionov, Varban, 2003; Bivol, Ciubotaru, 2005) (Table A3-3.4).

Table A3-3.4: Features of Goat Races in the Republic of Moldova

Goat Races	Production	Live Weight, kg		Fertility, lambs per 100 goats	Wool sheared, kg	Milk Yield, kg	Content in Milk, %:	
		♀	♂				fats	proteins
Saanen	milk	75-85	45-55	150-170	2.0-3.5	700-800	3.7	3.0
French Alpine	milk	80-95	50-65	125-135	2.5-3.5	550-650	3.7	3.0
Angora	wool, down	50-60	30-40	120-130	3.0-4.0	150-200	4.2	3.8
Local Goats	milk	42-49	35-41	164-169	2.0-3.0	224-323	4.7	3.4

Horses and mules

The following races of horses and interspecies hybrids are bred in the RM: *Orlov* (resistant, easily adaptable, hound-gutted, with light traction and riding abilities, live weight: 500-550 kg), *of Don* (resistant, can be used for different kinds of work in the most diverse environmental conditions, with light traction and riding abilities, live weight: 500-550 kg) and *Vladimir Heavy Harness* has harmonious features and energetic temper, with heavy traction and rapid motion abilities, live weight: 700-750 kg), and also assess and mules[3] in the Central and Southern part of the country (Bucataru, Radionov, Urzica, 2002).

Rabbits

Races of rabbits bred in the RM (Table 3-3.5) can be classified by the following criteria: main production – meat, fur, mix, wool; live weight – big (over 5 kg), medium (3-5 kg), small (2-3 kg) and dwarf (less than 2 kg); length of hair – normal, short, long (Bucataru, Maciuc, 2005).

Table A3-3.5: Features of Rabbit Races Bred in the Republic of Moldova

Rabbit races	Production	Live weight, kg	Fertility, rabbits per one birth
Big White	Meat and fur	5.5-9.0	6-8
Big Grey	Meat and fur	5.5-6.5	6-8
Butterfly	Meat and fur	5.0-6.0	6-8
Big Chinchilla	Meat and fur	3.5-5.5	6-8
Vienna Blue	Meat and fur	4.0-5.0	6-12

[3] A mule is an interspecies hybrid, obtained by crossbreeding of a mare and an ass, with a live weight of 370-390 kg, of 130-150 cm height in withers and a span of life of 30-40 years, is pest resistant, and is well adaptable to the environment, not demanding in terms of feeding and maintenance conditions, has a greater working power than a horse, but is sterile.

Rabbit races	Production	Live weight, kg	Fertility, rabbits per one birth
Silver	Meat and fur	4.0-5.0	6-12
Black-red	Meat and fur	4.5-5.5	8-12
White New Zeeland	Meat and fur	3.5-5.5	8-12
California	Meat and fur	3.6-4.8	6-8
Himalaya (Russian)	Meat and fur	2.4	6-8
Angora	Meat and wool	2.5-5.0	6-9

Chicken

The most widely spread races of chicken bred in the Republic of Moldova are: *Leghorn, Moldovan Bare Neck, Silver Adler, Kucino, Rhode Island, Plymouth-rock, New-Hampshire* and *Cornish* (Bucataru, Radionov, Urzica, 2002; Bivol, Ciubotaru, 2005) (Table A3-3.6).

Table A3-3.6: Features of Chicken Races Bred in the Republic of Moldova

Chicken Races	Production	Live Weight, kg		Annual number of laid eggs, pieces	Egg weight, g
		♀	♂		
Leghorn	eggs	2.6-3.0	1.8-2.0	220-240	57-61
Moldovan Bare Neck	meat-eggs	2.7-3.3	2.0-2.5	160-190	58-62
Silver Adler	meat-eggs	3.3-3.7	2.5-3.0	170-180	58-61
Kucino	meat-eggs	3.7-4.1	2.5-3.0	170-190	58-61
Rhode Island	meat-eggs	3.5-4.0	2.5-3.0	170-180	55-63
Plymouth-rock	meat-eggs	3.5-4.0	2.5-3.0	160-180	58-60
New-Hampshire	meat-eggs	3.8-4.1	2.5-3.0	170-200	56-62
Cornish	meat	4.5-5.0	3.4-4.0	100-130	60-65

Turkeys

Turkeys of preponderantly three races are bred in the Republic of Moldova: *Suntanned with Large Chest, White with Large Chest* and *North-Caucasian Suntanned* (Bucataru, Radionov, Urzica, 2002) (Table A3-3.7).

Table A3-3.7: Features of Turkey Races Bred in the Republic of Moldova

Turkey Races	Live Weight, kg		Annual number of laid eggs, pieces	Egg weight, g
	♀	♂		
Suntanned with Large Chest	14-17	8-11	70-90	80-90
White with Large Chest	9-20	6-10	70-110	78-82
North-Caucasian Suntanned	13-14	6.5-7.0	75-80	80-85

Geese

The most widely spread races of geese bred in the Republic of Moldova are: *Holmogor, White Italian, Kuban* and *Chinese* (Bucataru, Radionov, Urzica, 2002) (Table A3-3.8).

Table A3-3.8: Features of Geese Races Bred in the Republic of Moldova

Geese Races	Category	Live Weight, kg		Annual number of laid eggs, pieces	Egg weight, g
		♀	♂		
Holmogor	Heavy race	9.0-10.0	7.0-8.0	30-40	180-200
White Italian	Semi-heavy race	7.5-8.5	6.5-7.5	30-40	160-170
Kuban	Light race	5.0-5.5	4.0-4.5	70-75	140-160
Chinese	Light race	5.0-5.5	4.0-4.5	60-70	140-160

Ducks

Preponderantly four races of ducks are bred in the Republic of Moldova: *Beijing, Mirror, Grey Ukrainian* and *Polish* (Bucataru, Radionov, Urzica, 2002) (Table A3-3.9).

Table A3-3.9: Features of Ducks Races Bred in the Republic of Moldova

Ducks Races	Production	Live Weight, kg		Annual number of laid eggs, pieces	Egg weight, g
		♀	♂		
Beijing	meat	3.5-4.5	3.0-3.5	90-120	80-90
Mirror	meet-eggs	3.2-3.8	2.8-3.2	150-180	80-90
Grey Ukrainian	meat	3.3-3.7	2.8-3.2	110-130	80-90
Polish	meat	5.0-6.0	2.0-3.0	80-100	70-80

Annex 3-4. Additional Methodologies and Data Sources for Sector 4 'LULUCF'

Annex 3-4.1. Additional Information Associated with 4A 'Forest Land'

Table A3-4.1.1. The General Structure of the Forestry Fund in the Republic of Moldova

Structure Elements	Total / average	Species							
		QU	GO	STP	PLA	SA	PA	FR	TE
Area, ha	386 395.4	57 152.1	46 289.2	7 240.8	5 071.2	4 707.1	6 859.1	30 290.6	13 666.8
Proportions of above-ground species, %	100.0	14.8	12.0	1.9	1.3	1.2	1.8	7.8	3.5
Average production class	3.9	3.6	2.8	3.0	3.1	4.0	3.7	3.4	3.1
Average consistency	0.76	0.75	0.76	0.73	0.75	0.66	0.76	0.77	0.78
Average age, year	45	68	79	79	38	35	35	60	67
Current growth, m^3/ yr /ha	3.8	4.2	3.9	0.9	5.6	6.5	2.3	4.4	6.4
Annual growth, m^3	1 457 791	241 111	178 467	6 875	28 262	30 540	16 046	134 292	87 863
Average volume per standing wood, m^3/ha	118	184	234	119	174	106	90	195	238
Forest fund per standing wood, m^3	45 407 785	10 536 945	10 843 035	863 755	881 432	498 840	615 719	5 909 773	3 256 044
Proportion of species per volume, %	100.0	23.2	23.9	1.9	1.9	1.1	1.3	13.0	7.2
Structure Elements	**Total / average**	**Species**							
		CA	**ULC**	**NU**	**SC**	**DR**	**DM**	**DT**	**EX**
Area, ha	386 395.4	20 576.9	6 261.9	11 762.7	127 902.7	6 033.0	3 886.9	38 257.4	437.0
Proportions of above-ground species, %	100.0	5.3	1.6	3.1	33.1	1.6	1.0	9.9	0.1
Average production class	3.9	3.6	4.4	4.8	4.6	3.9	3.7	4.1	4.5
Average consistency	0.76	0.79	0.68	0.63	0.77	0.69	0.67	0.72	0.74
Average age, year	45	60	28	34	17	34	33	37	28
Current growth, m^3/ yr /ha	3.8	5.0	2.9	2.7	3.2	4.7	4.6	3.1	2.6
Annual growth, m^3	1 457 791	102 138	17 927	32 332	414 757	28 455	18 012	119 572	1142
Average volume per standing wood, m^3/ha	118	152	62	34	30	89	116	84	70
Forest fund per standing wood, m^3	45 407 785	3 131 245	386 897	403 949	3 841 412	534 891	450 882	3 222 509	30 457
Proportion of species per volume, %	100.0	6.9	0.8	0.9	8.5	1.2	1.0	7.1	0.1

Table A3-4.1.2. Abbreviations used in category 4A 'Forest Land'

Full name of species	Abbreviation
Ilex	QU
Durmast	QU
Downy oak	QU
White poplar	PO
White willow	SA
Field maple	AC
Common maple	AC
Lime	TI
Hornbeam	CA
Field elm	UL
Common walnut	JR
Acacia	SC
Various resinous species	RS
Various softwood species	SS
Various hardwood species	HS
Various exotic species	EX

Note: * includes 3 species (silver lime, big leaf linden tree, foul lime).

Table A3-4.1.3. Abbreviations used in the process of forest management in the Republic of Moldova

Full name of species	Abbreviation	Full name of species	Abbreviation	Full name of species	Abbreviation
Turkish hazel	TH	Wilmott	FR	Sycamore	PT
Grey alder	AG	Italian oak	QF	White Willow	SA
Black alder	AG	Honey locust	GT	Goat willow	SA
Tatar maple	AC	Durmast	QU	Brittle willow	SA
American maple	AC	Field maple	AC	Sorb	SO
Fir tree	PI	Larch	PI	Acacia	RB
Hornbeam	CA	Apple tree	MD	Russian olive	EA
Horse chestnut	AH	Birch	BE	Rowan	SA
Sweet chestnut	CS	Flowering ash	FR	Ilex	QU
Cherry plum	PC	Spruce	PI	Pedunculate oak	QU
Turkey oak	QU	Common walnut	JR	Downy oak	QU
Cherry tree	PA	American walnut	JR	Red oak	QU
Oriental hornbeam	CA	Sumac	RC	Taxodium	TA
Tree of heaven	AA	Field maple	AC	Silver lime	LI

Full name of species	Abbreviation	Full name of species	Abbreviation	Full name of species	Abbreviation
Mulberry	BR	Mountain maple	AC	big leaf linden tree	LI
Various softwood	SS	Sylvester pine	PI	Foul lime	LI
Various resinous	RS	Black pine	PI	Yew	TB
Various hardwood	DT	White poplar	PO	White cedar	TO
Douglas fir	PI	Grey poplar	PO	Field elm	UK
Various exotic	EX	Black poplar	PO	Mountain elm	UL
Beech	FA	Trembling poplar	PO	European white elm	UL
Common ash tree	FR	Pear tree	PR	Turkish cherry	TC
American ash tree	FR	Plum tree	PD		

Annex 3-4.2. Methodology for determining the carbon balance in agricultural soils for the evaluation of GHG emissions

The methodology for determining the carbon balance in agricultural soils for the evaluation of GHG emissions (Banaru, 2000)[4] was used by the Republic of Moldova to compile its GHG emissions inventories within the Second National Communications (2010), Third National Communications (2014) and the First Biennial Update Report (2016).

In 2010, the methodology was updated[5], due to the availability of new scientific data, as well as considering available data within the 2006 IPCC Guidelines.

Principles laid at the basis of the method are, as follows:

- Carbon balance represent the difference between the carbon entering the soil (humification of vegetal residues and organic fertilizers) and the carbon coming out of the soil due to organic matter mineralization process;
- The amount of organic matter in soil can be estimated considering the Nitrogen export accumulated in crop yield (main and additional) removed from the cropland;
- The amount of Carbon entered and stored in soil can be estimated according to the mass of crop residues and the amount of organic fertilizers applied considering the carbon content and the humification coefficients;
- A positive and neutral carbon balance indicates the absence of GHG emissions;
- A negative balance occurs when the carbon coming out of the soil exceeds the amount of organic matter stored through humification processes and indicates the existence of GHG emissions to the extent of the assessed deficit;
- Carbon balance estimation by the proposed method can be used for a field, crop rotation, agricultural farm, administrative-territorial unit, as well as for the total area of agricultural lands in the country, for a period of one year or longer.

Arguments supporting the principles used to develop the methodology

The possibility to use the nitrogen export by crops from soil for estimating the humus consumption was argued by I.V. Tiurin (1965), the idea being further developed by A.M. Likov (1979). It was considered the close link between carbon emissions and the amount of N released from soils due to the biochemical decomposition of organic matter. The content of carbon and nitrogen in humus is stable with minor variations within the pedogeographic zones' limits. The soils humus in the RM present a carbon – nitrogen ratio of circa 10.7, varying closely from 10.1 to 11.3 (Krupenikov, 1967; Krupenikov, Ganenco, 1984). This is the typical ratio of the surface layer of soils, decreasing slightly in deeper layers.

Considering the stable carbon – nitrogen ratio of the soil organic matter and knowing the nitrogen export stored in crop yield (main and additional) removed from the cropland, it is possible to estimate the amount of carbon released from soil at the same time with the nitrogen, in other words, the carbon released through carbon dioxide emissions.

[4] Banaru, Anatol (2000), Methodology to Calculate CO2 Emissions from Arable Soils, In the collection of papers 'Climate Change. Research, Studies, Solutions'. Ministry of Environment / UNDP Moldova. 'Bons Offices' Ltd. Chisinau, 2000. P. 115-123.
[5] Cerbari, V., Scorpan, V., Taranu, M. (2010), The potential for reducing the CO2 emissions from arable soils of the Republic of Moldova. Mediul Ambiant (Environment), Scientific Journal of Information and Ecological Culture, No. 1 (49), February 2010, ISSN: 1810-9551. P. 6-13.

While performing calculations, it should be considered that part of the nitrogen used by plants may have a different source than the humus. Therefore, the atmospheric Nitrogen fixed by leguminous crops, the N from synthetic and organic fertilizers, as well as the N from crop residues should be subtracted from the total nitrogen export. A small amount of N enters the soil with atmospheric precipitations (circa 7 kg/ha), and through non-symbiotic fixation (circa 5 kg/ha). The N from these sources corresponds to denitrification and leaching losses and should not be considered.

In order to estimate the carbon balance and the GHG emissions from soil, it should be determined the amount of CO_2 entered and fixed in the soil with the crop yield that was not removed and with the organic fertilizers used. Other carbon sources entering the soil such as the carbon from seeds and the atmospheric carbon fixed by the blue algae are considered to be insignificant.

The amount of carbon entering the soil is determined by considering the humification coefficients of crop residues and organic fertilizers, as well as by the carbon content in humus.

The difference between the carbon coming out and the carbon entering the soil (the balance) should consider CO_2 emissions if the mineralization processes prevail over the humification processes.

The exposed principles were used by several authors to determine the humus balance in agricultural soils and to develop measures for fertility conservation and enhancement (Likov, 1979; Diakonova, 1984, 1990; Lozanovskaya et al., 1987; Popov et al., 1987; Turcan, Banaru, 1994). Obtaining satisfactory results is conditioned by specifying the indicators used at local and regional level, related to their variation according to pedologic and climatic factors.

The developed methodology aims to estimating CO_2 emissions from croplands. During this exercise, data from international and national scientific literature were used, including information published in the last 15 years: Ungurean et al., 1997; Boincean, 1999; Rusu et al., 2005; Nicolaev, Boincean et al., 2006.

Following all above mentioned, the carbon balance can be estimated using the following equation:

$$B_C \pm = (V_I - C_O) \bullet Area_{(T)}$$

Where:

B_C – carbon balance, tonnes;

V_I – carbon entered into the soil through crop yield and organic matter humification, tonnes/yr;

C_O – carbon coming out from the soil through CO_2 emissions as a result of humus mineralization, tonnes/yr;

$Area_{(T)}$ – area covered with T crop, ha.

The amount of carbon entered in soil (V) can be estimated using the following equation:

$$V = V_1 + V_2$$

Where:

V_1 – carbon returned to soils with crop residues, tonnes/yr;

V_2 – carbon returned to soils with organic fertilizers, tonnes/yr.

The amount of carbon in crop residues returned to soils (V_1) can be estimated using the following equation:

$$V_1 = [\,(Crop_{(T)} \bullet R_{AG\,(T)} \bullet (1\text{-}Frac_{Remove\,(T)}) + Crop_{(T)} \bullet R_{BG\,(T)}) \bullet k_1\,] / 1.724$$ [6]

Where:

$Crop_{(T)}$ – harvested annual dry matter yield for crop T t.d.m./ha;

Where:

$$Crop_{(T)} = Yield_{Fresh\,(T)} \bullet DRY$$

$Yield_{Fresh(T)}$ – harvested fresh yield for crop T, t/ha;

[6] Arinushkina E.V. Guidelines for Chemical Analysis of Soils (in Russian). Moscow, Moscow State University Press, 1961. p.136.

DRY – dry matter fraction of harvested crop T, kg d.m./t of yield[7];

$R_{AG\ (T)}$ – ratio of above-ground residues dry matter to harvested yield for crop T (Crop(T)), $t.d.m_{AG}/t.d.m$[8];

$R_{BG\ (T)}$ – ratio of below-ground residues to harvested yield for crop T, $t.d.m_{BG}/t\ dm$[9];

$Frac_{Remove\ (T)}$ – fraction of above-ground residues of crop T removed and used for other purposes[10];

k_1 – coefficient reflecting the humification of crop residues[11];

1.724 – coefficient reflecting the conversion from humus to carbon[12].

The coefficients used to estimate the amount of carbon from crop residues returned to soils come from different sources of reference, including the 2006 IPCC Guidelines (Table A3-4.2.1).

Table A3-4.2.1: Coefficients Used to Estimate the Amount of C in Crop Residues Returned to Soils

Crop	DRY	$R_{AG\ (T)}$	$R_{BG\ (T)}$	$Frac_{Remove\ (T)}$	k_1
Winter wheat (crop residues returned to soils without N inputs during stubble-turning)	0.89	1.40	0.23	0.75	0.11
Winter wheat (crop residues returned to soils with N inputs during stubble-turning)	0.89	1.40	0.23	0.75	0.19
Winter rye (crop residues returned to soils without N inputs during stubble-turning)	0.88	1.30	0.22	0.75	0.11
Winter rye (crop residues returned to soils with N inputs during stubble-turning)	0.88	1.30	0.22	0.75	0.19
Barley (crop residues returned to soils without N inputs during stubble-turning)	0.89	1.17	0.22	0.75	0.11
Barley (crop residues returned to soils with N inputs during stubble-turning)	0.89	1.17	0.22	0.75	0.20
Oat (crop residues returned to soils without N inputs during stubble-turning)	0.89	1.17	0.25	0.75	0.11
Oat (crop residues returned to soils with N inputs during stubble-turning)	0.89	1.17	0.25	0.75	0.20
Buckwheat (crop residues returned to soils without N inputs during stubble-turning)	0.88	1.17	0.25	0.75	0.11
Buckwheat (crop residues returned to soils with N inputs during stubble-turning)	0.88	1.17	0.25	0.75	0.20
Millet (crop residues returned to soils without N inputs during stubble-turning)	0.88	1.17	0.22	0.40	0.11
Millet (crop residues returned to soils with N inputs during stubble-turning)	0.88	1.17	0.22	0.40	0.20
Grain maize (crop residues returned to soils without N inputs during stubble-turning)	0.87	1.17	0.22	0.70	0.11
Grain maize (crop residues returned to soils with N inputs during stubble-turning)	0.87	1.17	0.22	0.70	0.20
Sorghum (crop residues returned to soils without N inputs during stubble-turning)	0.89	1.17	0.22	0.50	0.11
Sorghum (crop residues returned to soils with N inputs during stubble-turning)	0.89	1.17	0.22	0.50	0.20
Pea, bean, vetch	0.90	1.30	0.19	0.40	0.25
Soybeans	0.91	1.30	0.19	0.00	0.25
Sugar beet	0.22	0.29	0.20	0.00	0.10
Sun flower (crop residues returned to soils without N inputs during stubble-turning)	0.90	3.80	0.22	0.40	0.08
Sun flower (crop residues returned to soils with N inputs during stubble-turning)	0.90	3.80	0.22	0.40	0.15
Tobacco	0.90	5.77	0.19	0.00	0.10
Rapeseed	0.88	1.17	0.22	0.00	0.11
Potatoes	0.22	0.17	0.20	0.00	0.13
Vegetables	0.22	0.17	0.20	0.00	0.13
Melons and gourds	0.22	0.17	0.20	0.00	0.13
Fodder beet	0.22	0.14	0.20	0.00	0.10
Maize for silo and green fodder	0.23	0.25	0.22	0.77	0.17
Perennial grasses for green fodder, silage and fodder	0.26	0.25	0.40	0.74	0.25
Annual grasses (oat and vetch) for green fodder	0.22	0.25	0.40	0.78	0.22
Annual grasses (oat and peas) for green fodder	0.22	0.25	0.40	0.78	0.22

The amount of carbon in organic fertilizers returned to soils (V_2) can be estimated using the following equation:

$$V_2 = (F_{ON} \bullet k_2) / 1.724$$

Where:

F_{ON} – Total annual amount of organic N applied to soils other than by grazing animals, (t/yr);

$$F_{ON} = F_{AM} + F_{SEW} + F_{COMP} + F_{OOA}$$

Where:

F_{AM} – annual amount of animal manure N applied to soils, t/yr;

F_{SEW} – annual amount of total sewage N that is applied to soils, t/yr;

[7] 2006 IPCC Guidelines, Volume 4, Chapter 11, Table 11.2, Page 11.17.
[8] Nicolaev N., Boincean B., Sidorov M., Vanicovici Gh., Coltun V. (2006), Agrotechnics. Ministry of Education and Youth of the Republic of Moldova – Balti: Balti University Press, 2006, P. 298.
[9] 2006 IPCC Guidelines, Volume 4, Chapter 11, Table 11.2, Page 11.17.
[10] Expert opinion, Prof. Valerian Cerbari, Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo'.
[11] Rusu M., Marghitas M., Oroian I., Mihăilescu T., Dumitras A. (2005), Agrochemistry Treaty (in Romanian). Bucuresti, Publishing House Ceres, 2005. 672 p.
[12] Arinushkina E.V. Guidelines for Chemical Analysis of Soils (in Russian). Moscow, Moscow State University Press, 1961. p 136.

F_{COMP} – annual amount of total compost N applied to soils, t/yr;

F_{OOA} – annual amount of other organic amendments used as fertilizer t/yr;

k_2 – coefficient reflecting the humification of organic fertilizers (Table A3-4.2.2)[13];

1.724 – coefficient reflecting the transition from humus to carbon [14].

Table A3-4.2.2: Normative of humus accumulation in the country's soils on the account of applied organic fertilizers and their humification

Organic Fertilizers	Applied dose, t/ha	Humus Accumulation		k_2
		from the applied dose, t/ha	from 1t of fertilizer, kg/t	
Animal manure with bedding (moisture 52%)	40	5.2	130	0.13
Semiliquid manure (moisture 82%)	50	1.6	29	0.03
Solid fraction of manure without bedding (moisture 65%)	40	3.1	78	0.08
Compost of manure solid fraction and soil (moisture 50%)	40	3.2	81	0.08
Poultry manure (moisture 48%)	10	1.8	180	0.18
Sludge from wastewater treatment (moisture 56%)	40	4.1	102	0.10
Defecate from sugar factories (moisture 44%)	40	1.0	25	0.03
Lignin from bio-chemical factories (moisture 66%)	80	13.3	165	0.17
Sludge from bio-chemical factories (moisture 80%)	80	3.5	45	0.05
Compost from manure and sludge from wastewater treatment (moisture 54%)	80	9.8	121	0.12
Compost from manure and defecate (moisture 48%)	80	9.5	119	0.12
Compost of sludge from wastewater treatment and defecate (moisture 50%)	80	5.4	67	0.07
Compost of sludge from wastewater treatment, defecate and manure (moisture 51%)	120	10.8	90	0.09
Average	44	4.1	93	0.10

The amount of carbon coming out of the soils can be estimated using the following equation:

$$C = [E_R - (E_M + E_O + E_V + E_S)] \bullet r_1 \bullet r_2 \bullet R$$

Where:

E_R – the amount of N exported from the main and additional crop yield, t/yr; can be estimated using the following equation:

$$E_{r\,(T)} = (Yield\ Fresh_{(T)} \bullet k_{3\,(T)}) / 10^3$$

Where:

$Yield\ Fresh_{(T)}$ – harvested fresh yield for crop T, t/ha;

$k_{3(T)}$ – coefficient reflecting the N export with the crop yield for crop T, kg/t (see Table A3-4.2.3)[15].

Table A3-4.2.3: Export of nitrogen with the crop yield, kg per 1 ton of the main crop, taking into account the secondary crop (average data for the RM)

Crop	Export of Nitrogen, kg/t
Winter wheat	33
Winter barley	30
Spring barley	30
Oats	30
Grain maize	28
Peas	44
Beans	40
Vetch, vetch mixtures	50
Sorghum	30
Sugar beat	6
Sunflower	49
Soy	65
Tobacco	36
Potatoes	7
Vegetables	3
Fodder roots	3
Silo maize	4
Annual herbs for hay	21
Annual herbs for green mass	5
Perennial herbs for hay	30

[13] Banaru A. (2003), Guidebook for Organic Fertilisers Use (in Romanian). ACSA/ Agricultural Extension and Education Agency, the World Bank Project RISP - Rural Investments and Services and TACIS FDMOL 9901 Support to Developing Education, Research and Extension Services in Agriculture Project. Chisinau, 2003, 52 p.

[14] Arinushkina E.V. Guidelines for Chemical Analysis of Soils (in Russian). Moscow, Moscow State University Press, 1961. p 136

[15] Banaru A. (2002), Methodological Guidelines to Determine Humus Balance in Agricultural Soils (in Romanian). Ministry of Agriculture and Food Industry. Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo' and TACIS FDMOL 9901 Support to Developing Education, Research and Extension Services in Agriculture Project, Chisinau, 2002. 23 p.

Crop	Export of Nitrogen, kg/t
Perennial herbs for green mass	9
Vineyards	7
Orchards	2
Pastures and hay fields	18

E_M – the amount of N export from inorganic fertilizers can be estimated using the following equation:

$$E_M = F_{SN} \cdot k_4$$

Where:

F_{SN} – total amount of inorganic N fertilizers applied to soils, tons of active substance per year; can be estimated using the following equation:

$$F_{SN} = F_T \cdot (P_{SN}/10^2)$$

Where:

F_T – total amount of inorganic fertilizers applied to soils, t/yr;

P_{SN} – percentage share of N in inorganic fertilizers, % of active substance (Table A3-4.2.4);

k_4 – coefficient reflecting the N use from inorganic fertilizers; constitutes circa 50 per cent of the applied quantity (Banaru, 2002).

Table A3-4.2.4: Nitrogen content in inorganic fertilizers applied more frequently in the country

Chemical Fertilizers	Chemical formula	Active substance, %
Anhydrous ammonia	NH_3	82.0
Sulphate of ammonia	$(NH_4)_2SO_4$	20.5
Ammonium chloride	NH_4Cl	26.0
Potassium nitrate	KNO_3	13.5
Calcium nitrate	$Ca(NO_3)_2$	15.0
Sodium nitrate	$NaNO_3$	16.0
Nitrate of ammonia	NH_4NO_3	34.4
Calcium ammonium nitrate	$NH_4NO_3 \cdot CaCO_3$	20.0
Ammonium sulphate	$NH_4NO_3 \cdot (NH_4)_2SO_4$	26.0
Urea	$CO(NH_2)_2$	46.0
Calcium cyanide	$CaCN_2$	21.0
Ammonium phosphate	$NH_4H_2PO_4$	11.0
Diammonium phosphate	$(NH_4)_2HPO_4$	16.0
Superfphosphate	Complex formula	4.0
Ammonium polyphosphate	Complex formula	18.0
Nitrophosphate	Complex formula	22.0
Nitro-ammonium phosphate	Complex formula	23.0
Nitroammophos	Complex formula	16.0
Mixed liquid fertilizers	Complex formula	10.0

E_O – the amount of N exported from organic fertilizers; can be estimated using the following equation:

$$E_O = F_{ON} \cdot k_5$$

Where:

F_{ON} – total N content in organic fertilizers applied to soils, t/yr; can be estimated using the following equation:

$$F_{ON} = F_T \cdot (P_{ON}/10^2)$$

Where:

F_T – total amount of organic fertilizers applied to soils, t/yr;

P_{ON} – percentage share of N in organic fertilizers, % active substance (Table A3-4.2.5);

k_5 – average coefficient reflecting the N content in organic fertilizers (Banaru, 2002) (Table A3-4.2.5).

Table A3-4.2.5: Nitrogen content in organic fertilizers applied in the country

Organic Fertilizers	Nitrogen Content, %	Average Coefficients for Nitrogen Use from Organic Fertilizers, %
Animal manure with bedding	0.71	13
Semiliquid manure	0.30	14

Organic Fertilizers	Nitrogen Content, %	Average Coefficients for Nitrogen Use from Organic Fertilizers, %
Solid fraction of manure	0.57	13
Poultry manure	1.53	33
Sludge from wastewater treatment	0.86	12
Defecate from sugar factories	0.13	12
Lignin of hydrolysis	0.14	1
Sludge of hydrolysis	0.33	9
Solid fraction of manure + soil	0.71	16
Manure + sludge from wastewater treatment	0.79	16
Manure + defecate	0.45	16
Manure + defecate + sludge	0.58	16

The use of recalculation coefficients available in Table A3-4.2.6, enables the AD conversion related to the use of various organic fertilizers in stable waste with bed.

Table A3-4.2.6: Coefficients for re-calculation of different forms and types of organic fertilizers in stable waste with bed

Type and Form of Organic Fertilizers	Recalculation Coefficients
Animal manure with bedding (moisture up to 77%), solid fraction	1.00
Manure without bed and semiliquid manure (90-93%)	0.50
Liquid manure (moisture 93-97%)	0.25
Residual wastewater from zoo-technical complexes (moisture over 97%)	0.10
Compost of peat and manure (1:1)	1.20
Compost of peat and poultry manure	1.30
Poultry manure	1.20
Straw (with added nitrogen 10 kg per 1t)	3.40
Sapropel	0.25
Defecate from sugar factories	0.25
Green fertilizers (natural moisture)	0.25
Sludge produced from wastewater treatment	0.80
Composts from municipal solid waste	0.90

E_V – the amount of N from crop residues returned to soils; can be estimated using the following equation:

$$E_V = F_{CR} \bullet k_6$$

Where:

F_{CR} – annual amount of N in crop residues returned to soils annually, t N/yr; can be estimated using the following equation:

$$F_{CR} = (Crop_{(T)} \bullet R_{AG\,(T)} \bullet (1\text{-}Frac_{Remove\,(T)}) + Crop_{(T)} \bullet R_{BG\,(T)}) \bullet (P_{CR}/10^2) \bullet (k_6/10^2)$$

Where:

$Crop_{(T)}$ – harvested annual dry matter yield for crop T t.d.m./ha;

$R_{AG\,(T)}$ – ratio of above-ground residues dry matter to harvested yield for crop T (Crop(T)), $t.d.m_{AG}$/t.d.m.[16];

$R_{BG\,(T)}$ – ratio of below-ground residues to harvested yield for crop T, $t.d.m_{BG}$/t d.m.[17];

$Frac_{Remove(T)}$ – fraction of above-ground residues of crop T removed and used for other purposes[18];

P_{CR} – amount of Nitrogen in crop residues, % active substance (see Table A3-4.2.7);

k_6 – coefficient reflecting the N in crop residues (Banaru, 2002) (see Table A3-4.2.7).

[16] Nicolaev N., Boincean B., Sidorov M., Vanicovici Gh., Coltun V. (2006), Agrotechnics. Ministry of Education and Youth of the Republic of Moldova. – Balti: Balti University Press, 2006, p. 298.
[17] 2006 IPCC Guidelines, Volume 4, Chapter 11, Table 11.2, Page 11.17.
[18] Expert opinion, Prof. Valerian Cerbari, Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo'

Table A3-4.2.7: Amount of N in Crop Residues (country-specific average values)

Crop	k_6, content of nitrogen, %	Amount of used N from Crop Residues, % of total
Winter wheat	0.50	Amount of used N from crop residues represents 25 per cent from the total
Winter rye	1.05	
Winter barley	0.80	
Oat	0.60	
Millet	1.25	
Buckwheat	0.60	
Leguminous crops	2.08	
Grain maize	1.08	
Grain sorghum	1.00	
Other cereal crops	0.60	
Sugar beet	1.65	
Sun flower	0.95	
Soybeans	2.08	
Tobacco	1.30	
Grain Rapeseed	1.05	
Potatoes	0.40	
Legumes	2.09	
Melons and gourds	1.19	
Root crops for fodder	1.65	
Maize for silo and green fodder	1.08	
Perennial grasses for green fodder, silage and fodder	2.48	
Annual grasses for green fodder	1.60	
Vetch green manure, above-ground dry mass	4.20	
Vetch green manure, below-ground dry mass	1.40	

E_S – the amount of N fixed and exported from soils by vegetables and perennial herbs; the quality of symbiotic nitrogen can be estimated using the following equation:

$$E_{S(T)} = Yield_{Fresh\ (T)} \bullet (k_{7\ (T)} / 10^3) \bullet (k_{8\ (T)} / 10^2)$$

Where:

$Yield_{Fresh(T)}$ – harvested fresh yield for crop T, t/ha;

$k_{7(T)}$ – coefficients reflecting symbiotic nitrogen fixation for crop T (Banaru, 2002) (Table A3-4.2.8);

$k_{8(T)}$ – coefficients reflecting symbiotic nitrogen export for crop T (Banaru, 2002) (Table A3-4.2.8).

Table A3-4.2.8: Fixation and Export of Nitrogen by Vegetables and Perennial Herbs (average values from the scientific literature in the field)

Crops	Nitrogen fixation, kg/t production	Nitrogen export, % from the total export
Peas	44	60
Beans	37	60
Soy	70	60
Vetch	50	60
Vetch in mixtures	5	37
Perennial herbs	30	70

r_1 – coefficient reflecting the humus mineralization dependence by the soils granulometry[19] (see Table A3-4.2.9).

Table A3-4.2.9: Coefficient of humus mineralization correction based on soil granulometry (according to Likov, 1979)

Soil Granulometry	Correction coefficient (r_1)
Argillaceous clay	0.8
Clay	1.0
Sandy clay	1.2
Clayey sand	1.4
Sand	1.8

r_2 – coefficient reflecting the humus mineralization dependence by the crops technology[20] (see Table A3-4.2.10).

[19] Likov A.M. On the Methods of Estimating the Humus Balance in Soils Used in Intensive Agriculture (in Russian). Timiryazev Agricultural Academy Bulletin, 1979. Nr. 6, pp. 14-20.
[20] Idem.

Table A3-4.2.10: Coefficient of humus mineralization correction based on crops' technology (according to Likov, 1979)

Crops	Correction coefficient (r_2)
Perennial herbs	1.0
One year cereal crops	1.2
Perishable crops	1.6

R – carbon-nitrogen ratio of the soil organic matter (humus) (R = C : N), according to the 2006 IPCC Guidelines, the default value for Cropland Remaining Cropland is 10 (range from 8 to 15); according to national sources (Krupenikov, 1967; Krupenikov, Ganenco, 1984; Banaru, 2002) the carbon – nitrogen ratio of humus in the Republic of Moldova is 10.7 (range from 10.1 to 11.3).

CO_2 emissions from soils engaged in agricultural circuit can be estimated using the following equation:

$$CO_2 = \pm B \bullet 44/12$$

Where:

B – carbon balance, tonnes;

[44/12] – mass ratio between C and CO_2.

As for the results obtained using this methodology, it is necessary to mention that over the last two decades, agriculture in the RM is mainly based on the exploitation of soils natural fertility (and/or the existing humus content in the soils). As a result, any increase in harvest (as happened for example in 1997, 2004, 2008, 2013, 2014 or 2016), caused particularly by favorable climatic factors, not followed by the compensation of carbon losses with the yield crop, leads to increased CO_2 emissions. Thus, the intensification of the dehumidification processes (mineralization of organic matter in soil) within the current subsistence agriculture leads to decreased carbon stocks in humus, respectively to increased CO_2 emissions as well as to the decrease of soil quality and fertility

The significant decrease between 1990 and 2019 of carbon returned to soil with manure (by 30.7 per cent), respectively with below-ground and above-ground crop residues (by 77.4 per cent), led to a shift from a positive carbon balance (+0.31 t/ha in 1990, +0.30 t/ha in 1991 and +0.24 t/ha in 1992: the period before the agrarian reform in the country) to a deep negative balance (-0.66 t/ha in 2017 and 2018; and -0.65 t/ha in 2019) (Table A3-4.2.11).

Table A3-4.2.11: Carbon Balance in Cropland in the RM for the period 1990-2019

Indicators	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Carbon introduced in soil with organic fertilizers, kt	364.4	409.2	281.2	363.0	119.6	182.2	92.6	177.4	150.0	142.3
Carbon introduced in soil with above- and below-ground residues, kt	556.5	491.4	451.3	385.3	374.2	340.5	352.2	277.2	262.3	238.9
Carbon losses from soil due to humus mineralization, kt	-388.0	-393.5	-323.2	-1,029.4	-618.8	-955.1	-823.7	-1,268.9	-1,035.4	-957.8
Carbon balance in cropland, kt	532.9	507.0	409.4	-281.0	-124.9	-432.5	-378.8	-814.3	-623.1	-576.6
Carbon balance in cropland, t/ha	0.31	0.30	0.24	-0.16	-0.07	-0.25	-0.22	-0.47	-0.36	-0.35
Indicators	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Carbon introduced in soil with organic fertilizers, kt	76.9	148.5	148.3	62.1	165.3	169.4	157.3	44.4	184.2	134.9
Carbon introduced in soil with above- and below-ground residues, kt	212.5	216.8	218.6	207.1	199.3	209.8	214.8	165.5	162.4	181.2
Carbon losses from soil due to humus mineralization, kt	-911.7	-1,045.8	-1,101.4	-861.8	-1,257.8	-1,219.9	-1,067.1	-363.8	-1,291.2	-907.9
Carbon balance in cropland, kt	-622.3	-680.6	-734.4	-592.6	-893.2	-840.6	-695.0	-153.9	-944.6	-591.7
Carbon balance in cropland, t/ha	-0.37	-0.39	-0.43	-0.37	-0.53	-0.50	-0.45	-0.10	-0.61	-0.37
Indicators	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Carbon introduced in soil with organic fertilizers, kt	174.8	175.0	53.6	189.2	213.5	80.7	211.8	245.2	247.9	252.5
Carbon introduced in soil with above- and below-ground residues, kt	186.7	171.1	158.1	150.1	163.4	158.9	163.8	155.8	139.7	125.9
Carbon losses from soil due to humus mineralization, kt	-1,101.1	-1,143.8	-520.9	-1,208.3	-1,226.9	-1,000.9	-1,369.1	-1,536.3	-1,537.2	-1,496.0
Carbon balance in cropland, kt	-739.6	-797.7	-309.2	-869.1	-850.0	-761.2	-993.4	-1,135.4	-1,149.6	-1,117.7
Carbon balance in cropland, t/ha	-0.46	-0.50	-0.19	-0.53	-0.50	-0.45	-0.58	-0.66	-0.66	-0.65

It should be noted that if the carbon balance in the arable land represented in average -0.21 t/ha per year between 1990 and 2004, for the 2005-2019 time series it already reached an average of circa -0.48 t/ha per year (Table A3-4.2.12).

Table 3-4.2.12 presents other relevant information in the calculation process, including total area of cropland, as well as data on crop yields recorded for the period 1990-2019.

Regarding the '*Methodology to Calculate CO_2 Emissions from Agricultural Soils*' (Banaru, 2000), the following should also be mentioned:

- The balance (difference) between the carbon entered and coming out of the soil, related to one unit of area (ha), is multiplied to the crop total area ($Area_{(T)}$);
- In the described order, the carbon balance is estimated for each crop (T);
- The estimation of the carbon balance for the total area of croplands is performed by adding the data for each crop (T);
- The positive and negative values are summed;
- In the case where the sum has a positive value, the carbon balance should be considered positive, and proves that the croplands represent a source of CO_2 removals;
- In the case where the sum has a negative value, the carbon balance should be considered negative and proves that the croplands represent a source of CO_2 emissions.

Table A3-4.2.12: Carbon Balance and CO_2 emissions from all arable lands in the Republic of Moldova for the period 1990-2019

Years	Area of cropland, ha	Crop yields, t	Crop yields, t d.m.	Carbon					CO_2 Emissions balance	
				Carbon introduced in soil with organic fertilizers, t	Carbon introduced in soil with above- and below-ground residues, t	Carbon losses from soil due to humus mineralization, kt	Carbon balance			
							t	t/ha	t	t/ha
1990	1,697,840	17,188,730	5,922,312	364,400	556,491	-387,994	532,896	0.31	-1,953,954	-1.15
1991	1,695,380	19,527,955	6,809,184	409,193	491,357	-393,501	507,049	0.30	-1,859,181	-1.10
1992	1,686,980	12,907,263	4,556,155	281,237	451,341	-323,214	409,365	0.24	-1,501,003	-0.89
1993	1,759,280	15,345,591	5,922,214	363,033	385,324	-1,029,396	-281,038	-0.16	1,030,474	0.59
1994	1,704,040	9,598,540	3,510,318	119,589	374,233	-618,759	-124,937	-0.07	458,103	0.27
1995	1,713,799	10,244,424	4,155,627	182,191	340,463	-955,137	-432,483	-0.25	1,585,770	0.93
1996	1,707,440	7,306,163	3,100,899	92,624	352,228	-823,666	-378,815	-0.22	1,388,988	0.81
1997	1,718,540	8,317,933	4,185,792	177,412	277,196	-1,268,896	-814,288	-0.47	2,985,723	1.74
1998	1,709,040	6,870,799	3,391,396	149,951	262,337	-1,035,417	-623,129	-0.36	2,284,806	1.34
1999	1,654,100	5,583,312	2,953,880	142,264	238,888	-957,777	-576,625	-0.35	2,114,293	1.28
2000	1,692,900	4,885,494	2,630,067	76,860	212,531	-911,714	-622,323	-0.37	2,281,852	1.35
2001	1,724,235	5,621,814	3,229,053	148,467	216,788	-1,045,845	-680,590	-0.39	2,495,497	1.45
2002	1,726,800	5,495,606	3,205,702	148,343	218,628	-1,101,411	-734,439	-0.43	2,692,943	1.56
2003	1,588,474	4,057,652	2,290,355	62,085	207,123	-861,770	-592,562	-0.37	2,172,726	1.37
2004	1,676,000	5,579,823	3,530,408	165,334	199,266	-1,257,819	-893,220	-0.53	3,275,138	1.95
2005	1,690,054	5,640,911	3,471,787	169,437	209,824	-1,219,906	-840,645	-0.50	3,082,365	1.82
2006	1,539,051	5,345,640	3,043,778	157,349	214,782	-1,067,093	-694,963	-0.45	2,548,197	1.66
2007	1,543,304	2,534,568	1,331,746	44,403	165,532	-363,817	-153,882	-0.10	564,235	0.37
2008	1,544,512	5,948,617	3,802,219	184,168	162,423	-1,291,225	-944,634	-0.61	3,463,657	2.24
2009	1,582,620	4,054,261	2,676,943	134,921	181,200	-907,852	-591,731	-0.37	2,169,682	1.37
2010	1,613,660	5,223,762	3,230,241	174,835	186,685	-1,101,142	-739,622	-0.46	2,711,948	1.68
2011	1,609,878	5,088,336	3,287,993	174,994	171,104	-1,143,844	-797,746	-0.50	2,925,068	1.82
2012	1,641,372	2,955,044	1,751,176	53,633	158,056	-520,871	-309,182	-0.19	1,133,667	0.69
2013	1,652,276	5,594,170	3,607,186	189,159	150,082	-1,208,302	-869,061	-0.53	3,186,556	1.93
2014	1,684,385	6,348,492	3,974,070	213,507	163,408	-1,226,940	-850,026	-0.50	3,116,763	1.85
2015	1,678,526	4,187,875	2,873,611	80,738	158,937	-1,000,878	-761,203	-0.45	2,791,079	1.66
2016	1,701,597	5,632,847	3,913,021	211,818	163,806	-1,369,058	-993,435	-0.58	3,642,594	2.14
2017	1,720,985	6,345,429	4,425,174	245,160	155,766	-1,536,296	-1,135,370	-0.66	4,163,022	2.42
2018	1,735,120	6,282,442	4,509,583	247,925	139,709	-1,537,223	-1,149,589	-0.66	4,215,160	2.43
2019	1,708,205	6,268,999	4,564,649	252,468	125,874	-1,496,012	-1,117,671	-0.65	4,098,127	2.40
1990-2019	**1,670,013**	**7,199,416**	**3,661,885**	**180,583**	**243,046**	**-998,759**	**-575,130**	**-0.35**	**2,108,810**	**1.27**
1990-2004	1,696,990	9,235,407	3,959,557	192,199	318,946	-864,821	-353,676	-0.21	1,155,503	0.77
2005-2019	**1,643,036**	**5,163,426**	**3,364,212**	**168,968**	**167,146**	**-1,132,697**	**-796,584**	**-0.48**	**2,920,808**	**1.77**

Annex 4. Quality Assurance and Quality Control

Annex 4.1. Quality Assurance and Quality Control Form for the National GHG Inventory of the Republic of Moldova (National Inventory Report: 1990-2019. Greenhouse Gas Sources and Sinks in the Republic of Moldova)

Document: National Inventory Report: 1990-2019. Greenhouse Gas Sources and Sinks in the Republic of Moldova

Stage of Report Preparation: final draft report

Highlight all categories subject to verification: tables and figures, equations, references, general editing, content editing

Surname and first name of the expert: ____

Organization in which he/she operates and his/her function: ______________________________

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is to be completed for each chapter and provides a record of the checks performed and any corrective actions taken

The form should be completed electronically. Once completed, the form should be sent to the National Inventory Team Leader on the electronic address: <marius.taranu@uipm.gov.md>, together with copies on paper, signed and personally presented at the following address: 51A Alexandru cel Bun St, MD 2012, Chisinau, Republic of Moldova.

The first page of this form summarizes the results of the checks (once completed) and highlights any significant findings or actions to be undertaken on quality assurance of the National GHG Inventory. The expert takes personal responsibility for the process of inventory quality assurance and control at the sectoral level (separate chapter of the National Inventory Report for 1990-2019). Checks/rows that are not relevant or not available should indicate 'n/r' or 'n/a' (not be left blank or deleted).

All sources of information associated with the inventory compilation process for each sector require clear references in the respective column of the form (support documentation).

Document Verification Summary: National Inventory Report: 1990-2019. Greenhouse Gas Sources and Sinks in the Republic of Moldova	
Summary of results of checks and corrective actions taken:	
Suggested checks to be performed in the future:	Any residual problems after corrective actions are taken:

Quality Assurance and Quality Control Form: National Inventory Report: 1990-2019. Greenhouse Gas Sources and Sinks in the Republic of Moldova.
Chapter: ____

Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first name, last name)	Errors (Y/N)	Date	Individual (first name, last name)	
TABLES AND FIGURES							
1	Check that numbers in tables in the respective chapter match numbers in reported tables (the reporting format provided by the 2006 IPCC Guidelines and/or the decisions of the COP)						
2	Check that numbers in tables specific to source categories (see the respective sub chapters of the Report) match numbers in tables from „Overview" of the sector						
3	Check that numbers in the text are consistent with numbers in tables						
4	Check that table formatting is consistent						
5	Check that the information presented in figures is consistent with tables and the content						
6	Check that table titles and the numbers included are consistent with the content						
EQUATIONS – ALL EQUATIONS WILL CONTAIN THE FOLLOWING FEATURES							
7	Equation should be written in the text according to the following example: z = x + y						
8	For the multiplied sign use the • symbol, and not the letter x or * symbol						
9	Equation is to be centered						
10	After an equation, use: Where, and define the variables						
11	Defining variables is paragraphed with the following style 'Table No.: Text' (the first word with bold)						
REFERENCES							

Quality Assurance and Quality Control Form: National Inventory Report: 1990-2019. Greenhouse Gas Sources and Sinks in the Republic of Moldova. Chapter: ______							
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first name, last name)	Errors (Y/N)	Date	Individual (first name, last name)	
12	Check consistency of references used in multiple sections (ex.: the 2006 IPCC Guidelines and not the IPCC Guidelines)						
13	Check consistency of text citations and references with final references						
14	Check that the style of references is consistent						
15	Web - addresses should not include hyperlinks, but need to be included in brackets < >						
GENERAL FORMAT							
16	All acronyms are spelled out first time and not subsequent times throughout each chapter						
17	Check that all lines are similar, use the symbol 'insert' to insert a line (–)						
18	Check that all fonts in text, headings, titles, and subheadings are consistent						
19	Check that notes and comments are removed from document						
20	Check that all references to annexes in the text match the appropriate number of annexes						
21	Check that the name of all gases, such as CO_2 and N_2O uses letter 'O' and not number '0'						
22	All numbers in the GHG formulas are to be subscribed (ex.: CO_2, SF_6, CH_4, N_2O etc.)						
23	Notes under tables need to be written with a smaller font than the text						
24	Check that the number of decimal points used in text and tables are consistent						
25	Check that the size, style and indenting of the chapters and subchapters numbers are consistent						
26	Check that spell check is complete						
27	Check that the numbering of tables, figures, annexes and references in the text is correct						
OTHER ASPECTS							
28	Other (to specify):						

Annex 4.2. Category-Specific Tier 1 Quality Control Procedures

National Inventory Report: 1990-2019

Source Category: ______

Surname and first name of the expert: ______

Organization in which he/she operates and his/her function: ______

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is to be completed for each individual source category (according to the Tier 1 methodological approach), ensuring the control / verifications performed, as well as the corrective actions taken. The form should be completed electronically. Once completed, the form should be sent to the National Inventory Team Leader on the electronic address: <marius.taranu@uipm.gov.md>, together with copies on paper, signed and personally presented at the following address: 51A Alexandru cel Bun St, MD 2012, Chisinau, Republic of Moldova.

The first page of this form summarizes the results of the checks (once completed) and highlights any significant findings or actions to be undertaken on ensuring the high quality of the National GHG Inventory. The expert takes personal responsibility for the process of inventory quality assurance and control at individual source category level. Not all checks included in the forms will be applicable at source category level; checks/rows that are not relevant or not available should indicate 'n/r' or 'n/a' (not be left blank or deleted). All sources of information associated with the inventory compilation process for each source category require clear references in the respective column of the form (support documentation).

Summary of Verifications, Quality Control and Corrective Actions	
Summary of results of checks and corrective actions taken:	
Suggested checks to be performed in the future:	Any residual problems after corrective actions are taken:

Verification and Quality Control Form for Individual Source Categories Source Category: ___								
Quality Control Activities/ Verifications and Quality Control Procedures		**Check Completed**			**Corrective Action**		**Supporting documents (provide reference)**
		Date	**Individual (first name, last name)**	**Errors (Y/N)**	**Individual (first name, last name)**	**Date**	
Data Gathering, Input, and Handling Checks							
1	Check that assumptions and criteria for the selection of activity data and EFs are documented: • Cross-check descriptions of activity data and emission factors with information on categories and ensure that these are properly recorded and archived						
2	Check for transcription errors in data input and reference: • Confirm that bibliographical data references are properly cited in the internal documentation • Cross-check a sample of input data from each category (parameters used in calculations) for transcription errors • Use electronic data where possible to minimize transcription errors • Check that spreadsheet features are used to minimize user/entry error: Avoid hardwiring factors into formulas - Create automatic look-up tables for common values used throughout calculations - Use cell protection so fixed data cannot accidentally be changed - Use cross-checks for calculations performed						
3	Check that emissions/removals are calculated correctly: • Reproduce a representative sample of GHG emissions/removals calculations • If models are used, selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy						
4	Check that parameter and emission/removal units are correctly recorded and that appropriate conversion factors are used: • Check that units are properly labelled in calculation sheets and MDD template report • Check that units are correctly carried through from beginning to end of calculations • Check that conversion factors are correct • Check that temporal and spatial adjustment factors are used correctly						
5	Check the integrity of database files and archive: • Confirm that the appropriate data processing steps are correctly represented in the database • Confirm that data relationships are correctly represented in the database • Ensure that data fields are properly labelled and have the correct design specifications • Ensure that adequate documentation of database and model structure and operation are archived						
6	Check for consistency in data between categories: • Identify parameters (e.g., activity data, constants) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emissions/removals calculations						
7	Check that the movement of inventory data among processing steps is correct: • Check that emissions/removals data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries at category and sectoral levels • Check that emissions/removals data are correctly transcribed between different intermediate products						
DATA DOCUMENTATION							
8	Review of internal documentation and archiving: • Check that there is detailed internal documentation to support the estimates and enable duplication of calculations • Check that every primary data element has a reference for the source of the data (via cell comments or another system of notation) • Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review • Check that the archive is closed and retained in secure place following completion of the inventory • Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation						
CALCULATION CHECKS							

Verification and Quality Control Form for Individual Source Categories Source Category: ___								
Quality Control Activities/ Verifications and Quality Control Procedures		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first name, last name)	Errors (Y/N)	Individual (first name, last name)	Date	
9	Check methodological and data changes resulting in recalculations of emissions/removals: • Check for temporal consistency in time series input data for each category • Check for consistency in the algorithm/method used for calculations throughout the time series • Reproduce a representative sample of emission calculations to ensure mathematical correctness						
10	Check time series consistency: • Check for temporal consistency in time series input data for each category • Check for consistency in the algorithm/method used for calculations throughout the time series • Check methodological and data changes resulting in recalculations of emissions/removals • Check that the effects of mitigation activities have been appropriately reflected in time series calculations						
11	Check completeness: • Confirm that estimates are reported for all categories and for all years from the appropriate base year over the period of the current inventory • For subcategories, confirm that the entire category is being covered • Provide clear definition of 'Other' type categories • Check that known data gaps that result in incomplete category emissions/removals estimates are properly documented, including qualitative evaluation of the importance of the estimate in relation to total net emissions (e.g. subcategories classified as 'not estimated')						
12	Trend checks: • For each category, compare current inventory estimates to previous estimates, if available. If there are significant changes or departures from expected trends, re-check estimates and explain any difference. Significant changes in emissions or removals from previous years may indicate possible input or calculation errors. • Check value of implied emission factors (aggregate emissions/removals divided by activity data) across time series. Are changes in emissions or removals being captured? • Check if there are any unusual or inexplicable trends noticed for activity data or other parameters used to estimate GHG emissions/removals						

Annex 4.3. Category-Specific Tier 2 Quality Control Procedures

National Inventory Report: 1990-2019

Source Category: ___

Surname and first name of the expert: ___

Organization in which he/she operates and his/her function: ___

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is to be completed for each individual source category (according to the Tier 2 methodological approach), ensuring the control / verifications performed, as well as the corrective actions taken. The form should be completed electronically. Once completed, the form should be sent to the National Inventory Team Leader on the electronic address: <marius.taranu@uipm.gov.md>, together with copies on paper, signed and personally presented at the following address: 51A Alexandru cel Bun St, MD 2012, Chisinau, Republic of Moldova.

The first page of this form summarizes the results of the checks and highlights any significant findings or actions to be undertaken on ensuring the high quality of the National GHG Inventory. The expert takes personal responsibility for the process of inventory quality assurance and control at individual source category level. Not all checks included in the forms will be applicable at source category level; checks/rows that are not relevant or not available should indicate 'n/r' or 'n/a' (not be left blank or deleted). All sources of information associated with the inventory compilation process for each source category require clear references in the respective column of the form (support documentation).

Summary of Verifications, Quality Control and Corrective Actions	
Summary of results of checks and corrective actions taken:	
Suggested checks to be performed in the future:	Suggested checks to be performed in the future:

Verification and Quality Control Form for Individual Source Categories

Source Category: ______________________________

	Quality Control Activities/ Verifications and Quality Control Procedures	Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first name, last name)	Errors (Y/N)	Individual (first name, last name)	Date	
1	Assess the applicability of IPCC default factors: • Evaluate whether national conditions are similar to those used to develop the IPCC default factors • Compare default factors to site or plant-level factors • Consider options for obtaining country-specific factors • Document results of this assessment						
2	Review country-specific factors: • QC the data used to develop the country-specific factor • Assess whether secondary studies used to develop country-specific factors used Tier 1 QC activities i • Compare country-specific factors to IPCC defaults; document any significant discrepancies • Compare country-specific factors to site or plant-level factors • Compare to factors from other countries (using IPCC Emission Factor Database) • Document results of this assessment						
3	Review measurements at site, enterprise, or location of the emission source: • Determine if national or international (e.g., ISO) standards were used in measurements • Ensure measurement equipment is calibrated and maintained properly • Compare direct measurements with estimates using a default factor; document any significant discrepancies						
4	Evaluate time series consistency: • Review significant (> 10%) changes in year-over-year estimates for categories and sub-categories • Compare top-down and bottom-up estimates for similar orders of magnitude • Conduct reference calculations that use stoichiometric ratios and conservation of mass and land						
5	Review national level activity data: • Determine the level of QC performed by the data collection agency. If inadequate, consider alternative data sources such as IPCC defaults and international data sets. Adjust the relevant uncertainty accordingly • Evaluate time series consistency • Compare activity data from multiple references if possible						
6	Review site-specific activity data: • Determine if national or international (e.g., ISO) standards were used in estimates • Compare aggregated site-specific data (e.g. production) to national statistics/data • Compare data across similar sites (national or international) • Compare top-down and bottom-up estimates for similar orders of magnitude						
7	QC uncertainty estimates: • Apply QC techniques to uncertainty estimates • Review uncertainty calculations • Document uncertainty assumptions and qualifications of any experts consulted						
8	Verify emission/removal estimates: • Compare GHG emission/removal estimates to other national or international results at the national, gas, sector, or sub-sector level as available						

Annex 5. Uncertainty of Greenhouse Gas Emissions

Annex 5-1. Overall Inventory Uncertainty in the Republic of Moldova for 2019

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$		$\left\|\frac{D}{\sum C}\right\|$	I*F	J*E*sqrt(2)	K^2 + L^2
1A1. Energy Industries	CO_2	21,300.2929	3,120.4282	5	5	7.0711	2.4468	0.0841	0.0710	0.4204	0.5019	0.4287
1A1. Energy Industries	CH_4	12.2813	1.4026	5	50	50.2494	0.0000	0.0001	0.0000	0.0029	0.0002	0.0000
1A1. Energy Industries	N_2O	51.6671	1.6863	3	50	50.0899	0.0000	0.0003	0.0000	0.0169	0.0002	0.0003
1A2. Manufacturing Industries and Construction	CO_2	1,916.8273	715.9769	5	5	7.0711	0.1288	0.0023	0.0163	0.0115	0.1152	0.0134
1A2. Manufacturing Industries and Construction	CH_4	2.1639	0.9489	5	50	50.2494	0.0000	0.0000	0.0000	0.0003	0.0002	0.0000
1A2. Manufacturing Industries and Construction	N_2O	4.3867	1.5501	3	50	50.0899	0.0000	0.0000	0.0000	0.0002	0.0001	0.0000
1A3. Transport	CO_2	4,697.5183	2,611.5823	5	5	7.0711	1.7139	0.0251	0.0594	0.1255	0.4201	0.1922
1A3. Transport	CH_4	33.6681	12.4582	5	40	40.3113	0.0013	0.0000	0.0003	0.0015	0.0020	0.0000
1A3. Transport	N_2O	106.7291	41.4206	5	50	50.2494	0.0218	0.0002	0.0009	0.0082	0.0067	0.0001
1A4. Other Sectors	CO_2	7,372.2624	2,105.4914	5	5	7.0711	1.1140	0.0059	0.0479	0.0295	0.3387	0.1156
1A4. Other Sectors	CH_4	287.5113	219.0565	5	50	50.2494	0.6089	0.0029	0.0050	0.1442	0.0352	0.0220
1A4. Other Sectors	N_2O	181.5317	69.2351	3	50	50.0899	0.0604	0.0002	0.0016	0.0125	0.0067	0.0002
1A5. Other	CO_2	113.9722	22.8629	5	5	7.0711	0.0001	0.0003	0.0005	0.0016	0.0037	0.0000
1A5. Other	CH_4	0.2726	0.0060	5	50	50.2494	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
1A5. Other	N_2O	1.3253	0.1080	3	50	50.0899	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000
1B2. Oil and Natural Gas and Other Emissions from Energy Production	CO_2	0.6377	1.6090	25	25	35.3553	0.0000	0.0000	0.0000	0.0008	0.0013	0.0000
1B2. Oil and Natural Gas and Other Emissions from Energy Production	CH_4	812.2415	395.8421	25	25	35.3553	0.9844	0.0031	0.0090	0.0769	0.3184	0.1073
1B2. Oil and Natural Gas and Other Emissions from Energy Production	N_2O	0.0002	0.0027	25	25	35.3553	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2A1. Cement Production	CO_2	971.6967	523.8755	2	3	3.6056	0.0179	0.0048	0.0119	0.0145	0.0337	0.0013
2A2. Lime Production	CO_2	264.3143	27.5851	10	2	10.1980	0.0004	0.0013	0.0006	0.0026	0.0089	0.0001
2A3. Glass Production	CO_2	26.0951	32.5310	15	10	18.0278	0.0017	0.0005	0.0007	0.0055	0.0157	0.0003
2A4. Other Processes Uses of Carbonates	CO_2	75.3080	16.3521	20	5	20.6155	0.0006	0.0002	0.0004	0.0009	0.0105	0.0001
2C1. Iron and steel production	CO_2	28.5023	15.7926	5	10	11.1803	0.0002	0.0002	0.0004	0.0015	0.0025	0.0000
2D1. Lubricant Use	CO_2	24.7987	5.0561	5	50	50.2494	0.0003	0.0001	0.0001	0.0033	0.0008	0.0000
2D2. Paraffin Wax Use	CO_2	0.1138	0.1348	20	100	101.9804	0.0000	0.0000	0.0000	0.0002	0.0001	0.0000
2D3. Solvent Use	CO_2	204.1460	135.0194	20	35	40.3113	0.1489	0.0016	0.0031	0.0553	0.0869	0.0106
2D4. Other (Urea-Based Catalysts)	CO_2	5.3005	3.3189	20	2	20.0998	0.0000	0.0000	0.0001	0.0001	0.0021	0.0000
2F1. Refrigeration and Air Conditioning	HFCs		138.6362	20	50	53.8516	0.2801	0.0032	0.0032	0.1577	0.0892	0.0328
2F2. Foam Blowing Agents	HFCs		89.0005	30	30	42.4264	0.0717	0.0020	0.0020	0.0607	0.0859	0.0111
2F3. Fire Protection	HFCs		2.3026	5	20	20.6155	0.0000	0.0001	0.0001	0.0010	0.0004	0.0000
2F4. Aerosols	HFCs		0.0075	5	5	7.0711	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2G1. Electrical Equipment	SF_6		1.4306	5	20	20.6155	0.0000	0.0000	0.0000	0.0007	0.0002	0.0000
2G1. Electrical Equipment	PFC		0.0403	5	20	20.6155	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2G3. N_2O from Product Uses	N_2O	0.0197		5	3	5.8310	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2G4. Other Product Use	CO_2	3.4010	1.1072	5	50	50.2494	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
3A. Enteric Fermentation	CH_4	2,189.4276	441.6456	10	20	22.3607	0.4901	0.0059	0.0100	0.1186	0.1421	0.0343
3B. Manure Management	CH_4	495.0955	66.5935	10	30	31.6228	0.0223	0.0021	0.0015	0.0630	0.0214	0.0044
3Ba. Direct N_2O Emissions from Manure Management	N_2O	871.9076	228.8695	30	100	104.4031	2.8695	0.0012	0.0052	0.1158	0.2209	0.0622
3Bb. Indirect N_2O Emissions from Manure Management	N_2O	244.7103	49.5970	30	150	152.9706	0.2893	0.0007	0.0011	0.0987	0.0479	0.0120
3D.a.1. Synthetic N Fertilizers Application	N_2O	431.2911	361.6060	5	6	7.8102	0.0401	0.0051	0.0082	0.0305	0.0582	0.0043
3D.a.2. Organic N Applied as Fertilizer	N_2O	255.4218	57.7742	30	6	30.5941	0.0157	0.0006	0.0013	0.0033	0.0558	0.0031
3D.1.3. Urine and Dung N Deposited on Pasture	N_2O	53.8411	37.8123	30	50	58.3095	0.0244	0.0005	0.0009	0.0234	0.0365	0.0019
3D.a.4. N in Crop Residue	N_2O	162.9604	146.0197	5	25	25.4951	0.0697	0.0021	0.0033	0.0533	0.0235	0.0034
3D.a.5. N Mineralization	N_2O	269.2161	267.7973	5	25	25.4951	0.2343	0.0041	0.0061	0.1032	0.0431	0.0125
3D.b.1. Atmospheric Deposition of N volatilized	N_2O	101.3066	52.8662	70	150	165.5295	0.3849	0.0005	0.0012	0.0695	0.1190	0.0190
3D.b.2. N Leaching/Runoff from Managed Soils	N_2O	259.7299	193.2639	75	150	167.7051	5.2796	0.0025	0.0044	0.3751	0.4663	0.3581
3H. Urea application	CO_2	0.5820	39.6306	30	50	58.3095	0.0268	0.0009	0.0009	0.0449	0.0382	0.0035
4A.1. Forest Land Remaining Forest Land	CO_2	-1,579.0396	-1,231.1003	15	5	15.8114	1.9043	0.0165	0.0280	0.0824	0.5941	0.3597
4A.2. Land Converted to Forest Land	CO_2	-984.3932	-719.5474	15	5	15.8114	0.6505	0.0092	0.0164	0.0459	0.3472	0.1227
4A.2. Land Converted to Forest Land. Non-CO_2 Emissions from Vegetation Fires	CH_4	0.2072	0.3521	10	30	31.6228	0.0000	0.0000	0.0000	0.0002	0.0001	0.0000
4A.2. Land Converted to Forest Land. Non-CO_2 Emissions from Vegetation Fires	N_2O	0.1366	0.2322	10	30	31.6228	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000
4B.1.Cropland Remaining Cropland	CO_2	2,602.9804	1,799.1677	10	10	14.1421	3.2537	0.0219	0.0409	0.2191	0.5788	0.3830
4B.1.Cropland Remaining Cropland. Non-CO_2 Emissions from Vegetation Fires	CH_4	2.4461	0.0416	10	30	31.6228	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000
4B.1.Cropland Remaining Cropland. Non-CO_2 Emissions from Vegetation Fires	N_2O	0.7559	0.0129	10	30	31.6228	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000
4B.2. Land Converted to Cropland	CO_2	45.7503	-9.2832	10	10	14.1421	0.0001	0.0005	0.0002	0.0055	0.0030	0.0000
4C.2. Land Converted to Grassland	CO_2	-1,205.6938	-293.2923	15	10	18.0278	0.1405	0.0021	0.0067	0.0213	0.1415	0.0205
4D.2. Land Converted to Wetlands	CO_2	-555.3798	-82.8099	10	10	14.1421	0.0069	0.0022	0.0019	0.0217	0.0266	0.0012
4E.2. Land Converted to Settlements	CO_2	84.7480	116.5030	10	10	14.1421	0.0136	0.0020	0.0027	0.0203	0.0375	0.0018
4E.2 Land Converted to Settlements	N_2O	169.4814	161.2828	10	30	31.6228	0.1307	0.0024	0.0037	0.0729	0.0519	0.0080
4F.2. Land Converted to Other Land	CO_2	152.3638	611.7881	10	10	14.1421	0.3762	0.0128	0.0139	0.1280	0.1968	0.0551
4H. HWP	CO_2	-122.1804	-57.5604	30	10	31.6228	0.0167	0.0004	0.0013	0.0042	0.0556	0.0031
5A. Solid Waste Disposal	CH_4	1,046.7277	1,231.5881	30	40	50.0000	19.0580	0.0204	0.0280	0.8148	1.1886	2.0767
5B. Biological Treatment of Solid Waste	CH_4	1.3597	1.3965	50	50	70.7107	0.0000	0.0000	0.0000	0.0011	0.0022	0.0000
5B. Biological Treatment of Solid Waste	N_2O	0.9725	0.9988	50	50	70.7107	0.0000	0.0000	0.0000	0.0008	0.0016	0.0000
5C. Incineration and Open Burning of Waste	CO_2	14.9667	13.9120	40	25	47.1699	0.0022	0.0002	0.0003	0.0052	0.0179	0.0003
5C. Incineration and Open Burning of Waste	CH_4	7.6876	7.1455	40	50	64.0312	0.0011	0.0001	0.0002	0.0053	0.0092	0.0001
5C. Incineration and Open Burning of Waste	N_2O	1.6078	1.4945	40	100	107.7033	0.0001	0.0000	0.0000	0.0022	0.0019	0.0000
5D. Wastewater Treatment and Discharge	CH_4	352.9650	237.6771	40	40	56.5685	0.9085	0.0028	0.0054	0.1132	0.3058	0.1064
5D. Wastewater Treatment and Discharge	N_2O	87.9499	58.4302	40	50	64.0312	0.0704	0.0007	0.0013	0.0344	0.0752	0.0068
END												
Total		**43,960.8959**	**14,105.7639**				**43.88**					**4.60**
Total Uncertainties						**Uncertainty in total inventory %:**	**6.62**				**Trend uncertainty %:**	**2.14**

Annex 5-2. Summary of Direct Greenhouse Gas Uncertainties

Annex 5-2.1. Carbon Dioxide Uncertainties

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$		$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F	J*E*sqrt(2)	K^2 + L^2
1A1. Energy Industries	CO_2	21,300.2929	3,120.4282	5	5	7.0711	5.3649	0.0729	0.0880	0.3647	0.6222	0.5202
1A2. Manufacturing Industries and Construction	CO_2	1,916.8273	715.9769	5	5	7.0711	0.2824	0.0057	0.0202	0.0283	0.1428	0.0212
1A3. Transport	CO_2	4,697.5183	2,611.5823	5	5	7.0711	3.7579	0.0380	0.0736	0.1901	0.5208	0.3073
1A4. Other Sectors	CO_2	7,372.2624	2,105.4914	5	5	7.0711	2.4426	0.0035	0.0594	0.0176	0.4199	0.1766
1A5. Other	CO_2	113.9722	22.8629	5	5	7.0711	0.0003	0.0002	0.0006	0.0011	0.0046	0.0000
1B2. Oil and Natural Gas and Other Emissions from Energy Production	CO_2	0.6377	1.6090	25	25	35.3553	0.0000	0.0000	0.0000	0.0010	0.0016	0.0000
2A1. Cement Production	CO_2	971.6967	523.8755	2	3	3.6056	0.0393	0.0074	0.0148	0.0222	0.0418	0.0022
2A2. Lime Production	CO_2	264.3143	27.5851	10	2	10.1980	0.0009	0.0012	0.0008	0.0024	0.0110	0.0001
2A3. Glass Production	CO_2	26.0951	32.5310	15	10	18.0278	0.0038	0.0007	0.0009	0.0072	0.0195	0.0004
2A4. Other Processes Uses of Carbonates	CO_2	75.3080	16.3521	20	5	20.6155	0.0013	0.0001	0.0005	0.0005	0.0130	0.0002
2C1. Iron and Steel Production	CO_2	28.5023	15.7926	5	10	11.1803	0.0003	0.0002	0.0004	0.0023	0.0031	0.0000
2D1. Lubricant Use	CO_2	24.7987	5.0561	5	50	50.2494	0.0007	0.0000	0.0001	0.0023	0.0010	0.0000
2D2. Paraffin Wax Use	CO_2	0.1138	0.1348	20	100	101.9804	0.0000	0.0000	0.0000	0.0003	0.0001	0.0000
2D3. Solvent Use	CO_2	204.1460	135.0194	20	35	40.3113	0.3264	0.0023	0.0038	0.0791	0.1077	0.0179
2D4. Other (Urea-Based Catalysts)	CO_2	5.3005	3.3189	20	2	20.0998	0.0000	0.0001	0.0001	0.0001	0.0026	0.0000
2G4. Other Product Use	CO_2	3.4010	1.1072	5	50	50.2494	0.0000	0.0000	0.0000	0.0003	0.0002	0.0000
3H. Urea Application	CO_2	0.5820	39.6306	30	50	58.3095	0.0588	0.0011	0.0011	0.0557	0.0474	0.0053
4A.1. Forest Land Remaining Forest Land	CO_2	-1,579.0396	-1,231.1003	15	5	15.8114	4.1754	0.0228	0.0347	0.1138	0.7365	0.5554
4A.2. Land Converted to Forest Land	CO_2	-984.3932	-719.5474	15	5	15.8114	1.4263	0.0128	0.0203	0.0642	0.4305	0.1894
4B.1.Cropland Remaining Cropland	CO_2	2,602.9804	1,799.1677	10	10	14.1421	7.1341	0.0310	0.0507	0.3100	0.7175	0.6109
4B.2. Land Converted to Cropland	CO_2	45.7503	-9.2832	10	10	14.1421	0.0002	0.0006	0.0003	0.0061	0.0037	0.0001
4C.2. Land Converted to Grassland	CO_2	-1,205.6938	-293.2923	15	10	18.0278	0.3081	0.0009	0.0083	0.0086	0.1755	0.0309
4D.2. Land Converted to Wetlands	CO_2	-555.3798	-82.8099	10	10	14.1421	0.0151	0.0019	0.0023	0.0187	0.0330	0.0014
4E.2. Land Converted to Settlements	CO_2	84.7480	116.5030	10	10	14.1421	0.0299	0.0026	0.0033	0.0264	0.0465	0.0029
4F.2. Land Converted to Other Land	CO_2	152.3638	611.7881	10	10	14.1421	0.8249	0.0161	0.0173	0.1610	0.2440	0.0854
4H. HWP	CO_2	-122.1804	-57.5604	30	10	31.6228	0.0365	0.0007	0.0016	0.0070	0.0689	0.0048
5C. Incineration and Open Burning of Waste	CO_2	14.9667	13.9120	40	25	47.1699	0.0047	0.0003	0.0004	0.0070	0.0222	0.0005
END												
Total		**35,459.8920**	**9,526.1314**				**26.24**					**2.53**
Total Uncertainties						**Uncertainty in total inventory %:**	**5.12**				**Trend uncertainty %:**	**1.59**

Annex 5-2.2. Methane Uncertainties

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$		$\left\|\frac{D}{\sum C}\right\|$	I*F	J*E*sqrt(2)	K^2 + L^2
1A1. Energy Industries	CH_4	12.2813	1.4026	5	50	50.2494	0.0007	0.0009	0.0003	0.0450	0.0019	0.0020
1A2. Manufacturing Industries and Construction	CH_4	2.1639	0.9489	5	50	50.2494	0.0003	0.0000	0.0002	0.0012	0.0013	0.0000
1A3. Transport	CH_4	33.6681	12.4582	5	40	40.3113	0.0369	0.0008	0.0024	0.0331	0.0168	0.0014
1A4. Other sectors	CH_4	287.5113	219.0565	5	50	50.2494	17.7030	0.0144	0.0418	0.7206	0.2954	0.6066
1A5. Other	CH_4	0.2726	0.0060	5	50	50.2494	0.0000	0.0000	0.0000	0.0012	0.0000	0.0000
1B2. Oil and Natural Gas and Other Emissions from Energy Production	CH_4	812.2415	395.8421	25	25	35.3553	28.6172	0.0018	0.0755	0.0446	2.6688	7.1243
3A. Enteric Fermentation	CH_4	2,189.4276	441.6456	10	20	22.3607	14.2492	0.1236	0.0842	2.4710	1.1910	7.5245
3B. Manure Management	CH_4	495.0955	66.5935	10	30	31.6228	0.6479	0.0344	0.0127	1.0311	0.1796	1.0953
4A2. Land Converted to Forest Land	CH_4	0.2072	0.3521	10	30	31.6228	0.0000	0.0000	0.0001	0.0014	0.0009	0.0000
4B1. Cropland Remaining Cropland	CH_4	2.4461	0.0416	10	30	31.6228	0.0000	0.0002	0.0000	0.0067	0.0001	0.0000
5A. Solid Waste Disposal	CH_4	1,046.7277	1,231.5881	30	40	50.0000	554.0440	0.1350	0.2349	5.4003	9.9640	128.4446
5B. Biological Treatment of Solid Waste	CH_4	1.3597	1.3965	50	50	70.7107	0.0014	0.0001	0.0003	0.0068	0.0188	0.0004
5C. Incineration and Open Burning of Waste	CH_4	7.6876	7.1455	40	50	64.0312	0.0306	0.0006	0.0014	0.0316	0.0771	0.0069
5D. Wastewater Treatment and Discharge	CH_4	352.9650	237.6771	40	40	56.5685	26.4118	0.0117	0.0453	0.4695	2.5639	6.7938
END												
Total		**5,244.0550**	**2,616.1543**				**641.74**					**151.60**
Total Uncertainties						**Uncertainty in total inventory %:**	**25.33**				**Trend uncertainty %:**	**12.31**

Annex 5-2.3. Nitrous Oxide Uncertainties

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$		$\left\|\frac{D}{\sum C}\right\|$	I*F	J*E*sqrt(2)	K^2 + L^2
1A1. Energy Industries	N_2O	51.6671	1.6863	3	50	50.0899	0.0024	0.0079	0.0005	0.3959	0.0022	0.1567
1A2. Manufacturing Industries and Construction	N_2O	4.3867	1.5501	3	50	50.0899	0.0020	0.0002	0.0005	0.0120	0.0020	0.0001
1A3. Transport	N_2O	106.7291	41.4206	5	50	50.2494	1.4440	0.0047	0.0127	0.2354	0.0899	0.0635
1A4. Other Sectors	N_2O	181.5317	69.2351	3	50	50.0899	4.0089	0.0084	0.0213	0.4189	0.0902	0.1836
1A5. Other	N_2O	1.3253	0.1080	3	50	50.0899	0.0000	0.0002	0.0000	0.0092	0.0001	0.0001
1B2. Oil and Natural Gas and Other Emissions from energy Production	N_2O	0.0002	0.0027	25	25	35.3553	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2G3. N_2O from Product Uses (Medical Applications)	N_2O	0.0197		5	3	5.8310	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3Ba. Direct N_2O Emissions from Manure Management	N_2O	871.9076	228.8695	30	100	104.4031	190.3164	0.0719	0.0703	7.1904	2.9814	60.5905
3Bb. Indirect N_2O Emissions From Manure Management	N_2O	244.7103	49.5970	30	150	152.9706	19.1867	0.0247	0.0152	3.7066	0.6461	14.1560

3Da1. Inorganic N-Fertilizers	N_2O	431.2911	361.6060	5	6	7.8102	2.6587	0.0405	0.1110	0.2433	0.7851	0.6755
3Da2. Organic N Fertilizers	N_2O	255.4218	57.7742	30	6	30.5941	1.0414	0.0239	0.0177	0.1437	0.7526	0.5870
3D1.3. Urine and Dung N Deposited on Pasture	N_2O	53.8411	37.8123	30	50	58.3095	1.6204	0.0028	0.0116	0.1409	0.4926	0.2625
3Da4. N in Crop Residue	N_2O	162.9604	146.0197	5	25	25.4951	4.6197	0.0182	0.0448	0.4554	0.3170	0.3079
3Da5. N Mineralization	N_2O	269.2161	267.7973	5	25	25.4951	15.5382	0.0382	0.0822	0.9558	0.5814	1.2517
3Db1. Atmospheric Deposition of N volatilized	N_2O	101.3066	52.8662	70	150	165.5295	25.5258	0.0003	0.0162	0.0465	1.6069	2.5842
3Db2. N Leaching/Runoff from Managed Soils	N_2O	259.7299	193.2639	75	150	167.7051	350.1613	0.0169	0.0593	2.5374	6.2938	46.0509
4A2. Land Converted to Forest Land	N_2O	0.1366	0.2322	10	30	31.6228	0.0000	0.0000	0.0001	0.0015	0.0010	0.0000
4B1. Cropland Remaining Cropland	N_2O	0.7559	0.0129	10	30	31.6228	0.0000	0.0001	0.0000	0.0036	0.0001	0.0000
4E2. Land Converted to Settlements	N_2O	169.4814	161.2828	10	30	31.6228	8.6706	0.0218	0.0495	0.6550	0.7003	0.9195
5B. Biological Treatment of Solid Waste	N_2O	0.9725	0.9988	50	50	70.7107	0.0017	0.0001	0.0003	0.0074	0.0217	0.0005
5C. Incineration and Open Burning of Waste	N_2O	1.6078	1.4945	40	100	107.7033	0.0086	0.0002	0.0005	0.0196	0.0260	0.0011
5D. Wastewater Treatment and Discharge	N_2O	87.9499	58.4302	40	50	64.0312	4.6659	0.0036	0.0179	0.1789	1.0148	1.0619
END												
Total		**3,256.9490**	**1,732.0603**				**629.47**					**128.85**
Total Uncertainties						**Uncertainty in total inventory %:**	**25.09**				**Trend uncertainty %:**	**11.35**

Annex 5-3. Overall Inventory Uncertainty

Annex 5-3.1. Overall Inventory Uncertainty for Sector 1 'Energy'

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$		$\left\|\frac{D}{\sum C}\right\|$	I*F	J*E*sqrt(2)	K^2 + L^2
1.A.1. Energy Industries	CO_2	21,300.2929	3,120.4282	5	5	7.0711	5.6029	0.0609	0.0846	0.3047	0.5980	0.4505
1.A.1. Energy Industries	CH_4	12.2813	1.4026	5	50	50.2494	0.0001	0.0000	0.0000	0.0023	0.0003	0.0000
1.A.1. Energy Industries	N_2O	51.6671	1.6863	3	50	50.0899	0.0001	0.0003	0.0000	0.0154	0.0002	0.0002
1.A.2. Manufacturing Industries and Construction	CO_2	1,916.8273	715.9769	5	5	7.0711	0.2950	0.0063	0.0194	0.0314	0.1372	0.0198
1.A.2. Manufacturing Industries and Construction	CH_4	2.1639	0.9489	5	50	50.2494	0.0000	0.0000	0.0000	0.0005	0.0002	0.0000
1.A.2. Manufacturing Industries and Construction	N_2O	4.3867	1.5501	3	50	50.0899	0.0001	0.0000	0.0000	0.0006	0.0002	0.0000
1.A.3. Transport	CO_2	4,697.5183	2,611.5823	5	5	7.0711	3.9246	0.0386	0.0708	0.1928	0.5005	0.2877
1.A.3. Transport	CH_4	33.6681	12.4582	5	40	40.3113	0.0029	0.0001	0.0003	0.0043	0.0024	0.0000
1.A.3. Transport	N_2O	106.7291	41.4206	5	50	50.2494	0.0499	0.0004	0.0011	0.0196	0.0079	0.0004
1.A.4. Other sectors	CO_2	7,372.2624	2,105.4914	5	5	7.0711	2.5509	0.0066	0.0571	0.0328	0.4035	0.1639
1.A.4. Other sectors	CH_4	287.5113	219.0565	5	50	50.2494	1.3944	0.0040	0.0059	0.1984	0.0420	0.0411
1.A.4. Other sectors	N_2O	181.5317	69.2351	3	50	50.0899	0.1384	0.0006	0.0019	0.0317	0.0080	0.0011
1.A.5. Other	CO_2	113.9722	22.8629	5	5	7.0711	0.0003	0.0002	0.0006	0.0008	0.0044	0.0000
1.A.5. Other	CH_4	0.2726	0.0060	5	50	50.2494	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
1.A.5. Other	N_2O	1.3253	0.1080	3	50	50.0899	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000
1.B.2. Oil and Natural Gas and Other Emissions from Energy Production	CO_2	0.6377	1.6090	25	25	35.3553	0.0000	0.0000	0.0000	0.0010	0.0015	0.0000

1.B.2. Oil and Natural Gas and Other Emissions from Energy Production	CH_4	812.2415	395.8421	25	25	35.3553	2.2541	0.0052	0.0107	0.1291	0.3793	0.1606
1.B.2. Oil and Natural Gas and Other Emissions from Energy Production	N_2O	0.0002	0.0027	25	25	35.3553	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
END												
Total		**36,895.2895**	**9,321.6679**				**16.21**					**1.13**
Total Uncertainties						**Uncertainty in total inventory %:**	**4.03**				**Trend uncertainty %:**	**1.06**

Annex 5-3.2. Overall Inventory Uncertainty for Sector 2 'Industrial Processes and Product Use'

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$		$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F	J*E*sqrt(2)	K^2 + L^2
2.A.1. Cement Production	CO_2	971.6967	523.8755	2	3	3.6056	3.6242	0.0479	0.3267	0.1437	0.9240	0.8744
2.A.2. Lime Production	CO_2	264.3143	27.5851	10	2	10.1980	0.0804	0.0846	0.0172	0.1693	0.2433	0.0878
2.A.3. Glass Production	CO_2	26.0951	32.5310	15	10	18.0278	0.3494	0.0102	0.0203	0.1022	0.4303	0.1956
2.A.4. Other Processes Uses of Carbonates	CO_2	75.3080	16.3521	20	5	20.6155	0.1154	0.0188	0.0102	0.0942	0.2884	0.0921
2.C.1. Iron and Steel Production	CO_2	28.5023	15.7926	5	10	11.1803	0.0317	0.0011	0.0098	0.0115	0.0696	0.0050
2.D.1. Lubricant Use	CO_2	24.7987	5.0561	5	50	50.2494	0.0656	0.0064	0.0032	0.3207	0.0223	0.1033
2.D.2. Paraffin Wax Use	CO_2	0.1138	0.1348	20	100	101.9804	0.0002	0.0000	0.0001	0.0040	0.0024	0.0000
2.D.3. Solvent Use	CO_2	204.1460	135.0194	20	35	40.3113	30.0923	0.0054	0.0842	0.1900	2.3813	5.7068
2.D.4. Other (Urea-Based Catalysts)	CO_2	5.3005	3.3189	20	2	20.0998	0.0045	0.0000	0.0021	0.0000	0.0585	0.0034
2.F.1. Refrigeration and Air Conditioning	HFCs		138.6362	20	50	53.8516	56.6189	0.0864	0.0864	4.3224	2.4451	24.6617
2.F.2. Foam Blowing Agents	HFCs		89.0005	30	30	42.4264	14.4833	0.0555	0.0555	1.6649	2.3545	8.3158
2.F.3. Fire Protection	HFCs		2.3026	5	20	20.6155	0.0023	0.0014	0.0014	0.0287	0.0102	0.0009
2.F.4. Aerosols	HFCs		0.0075	5	5	7.0711	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2.G.1. Electrical Equipment	SF_6		1.4306	5	20	20.6155	0.0009	0.0009	0.0009	0.0178	0.0063	0.0004
2.G.1. Electrical Equipment	PFC		0.0403	5	20	20.6155	0.0000	0.0000	0.0000	0.0005	0.0002	0.0000
2.G.3. N_2O from Product Uses	N_2O	0.0197		5	3	5.8310	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2.G.4. Other Product Use	CO_2	3.4010	1.1072	5	50	50.2494	0.0031	0.0006	0.0007	0.0311	0.0049	0.0010
END												
Total		**1,603.6964**	**992.1906**				**105.47**					**40.05**
Total Uncertainties						**Uncertainty in total inventory %:**	**10.27**				**Trend uncertainty %:**	**6.33**

Annex 5-3.3. Overall Inventory Uncertainty for Sector 3 'Agriculture'

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$		$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F	J*E*sqrt(2)	K^2 + L^2

3.A. Enteric Fermentation	CH_4	2,189.4276	441.6456	10	20	22.3607	25.8202	0.0664	0.0828	1.3285	1.1706	3.1352
3.B. Manure Management	CH_4	495.0955	66.5935	10	30	31.6228	1.1741	0.0213	0.0125	0.6390	0.1765	0.4394
3.B.a. Direct N_2O Emissions from Manure Management	N_2O	871.9076	228.8695	30	100	104.4031	151.1624	0.0166	0.0429	1.6602	1.8199	6.0685
3.B.b. Indirect N_2O Emissions from Manure Management	N_2O	244.7103	49.5970	30	150	152.9706	15.2394	0.0074	0.0093	1.1111	0.3944	1.3901
3.D.a.1. Inorganic N-Fertilizers	N_2O	431.2911	361.6060	5	6	7.8102	2.1118	0.0383	0.0678	0.2298	0.4792	0.2825
3.D.a.2. Organic N-Fertilizers	N_2O	255.4218	57.7742	30	6	30.5941	0.8272	0.0066	0.0108	0.0396	0.4594	0.2126
3.D.1.3. Urine and Dung N Deposited on Pasture	N_2O	53.8411	37.8123	30	50	58.3095	1.2870	0.0034	0.0071	0.1705	0.3007	0.1195
3.D.a.4. N in Crop Residue	N_2O	162.9604	146.0197	5	25	25.4951	3.6693	0.0162	0.0274	0.4059	0.1935	0.2022
3.D.a.5. N Mineralization	N_2O	269.2161	267.7973	5	25	25.4951	12.3415	0.0318	0.0502	0.7949	0.3549	0.7578
3.D.b.1. Atmospheric Deposition of N Volatilized	N_2O	101.3066	52.8662	70	150	165.5295	20.2744	0.0030	0.0099	0.4487	0.9809	1.1635
3.D.b.2. N Leaching/Runoff from Managed Soils	N_2O	259.7299	193.2639	75	150	167.7051	278.1223	0.0185	0.0362	2.7722	3.8420	22.4459
3.H. Urea Application	CO_2	0.5820	39.6306	30	50	58.3095	1.4138	0.0074	0.0074	0.3694	0.3151	0.2358
END												
Total		**5,335.4900**	**1,943.4759**				**513.44**					**36.45**
Total Uncertainties						**Uncertainty in total inventory %:**	**22.66**				**Trend uncertainty %:**	**6.04**

Annex 5-3.4. Overall Inventory Uncertainty for Sector 4 'LULUCF'

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{(G\bullet D)^2}{(\sum D)^2}$		$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F	J*E*sqrt(2)	K^2 + L^2
4.A.1. Forest Land Remaining Forest Land	CO_2	-1,579.0396	-1,231.1003	15	5	15.8114	4330.8081	1.1169	0.8871	5.5843	18.8177	385.2922
4.A.2. Land Converted to Forest Land	CO_2	-984.3932	-719.5474	15	5	15.8114	1479.4519	0.6649	0.5185	3.3247	10.9985	132.0204
4.A.2. Land Converted to Forest Land	CH_4	0.2072	0.3521	10	30	31.6228	0.0014	0.0003	0.0003	0.0086	0.0036	0.0001
4.A.2. Land Converted to Forest Land	N_2O	0.1366	0.2322	10	30	31.6228	0.0006	0.0002	0.0002	0.0056	0.0024	0.0000
4.B.1. Cropland Remaining Cropland	CO_2	2,602.9804	1,799.1677	10	10	14.1421	7399.7217	1.7286	1.2964	17.2857	18.3339	634.9266
4.B.1. Cropland Remaining Cropland	CH_4	2.4461	0.0416	10	30	31.6228	0.0000	0.0004	0.0000	0.0122	0.0004	0.0001
4.B.1. Cropland Remaining Cropland	N_2O	0.7559	0.0129	10	30	31.6228	0.0000	0.0001	0.0000	0.0038	0.0001	0.0000
4.B.2. Land Converted to Cropland	CO_2	45.7503	-9.2832	10	10	14.1421	0.1970	0.0003	0.0067	0.0034	0.0946	0.0090
4.C.2. Land Converted to Grassland	CO_2	-1,205.6938	-293.2923	15	10	18.0278	319.5412	0.3931	0.2113	3.9308	4.4831	35.5491
4.D.2. Land Converted to Wetlands	CO_2	-555.3798	-82.8099	10	10	14.1421	15.6760	0.1444	0.0597	1.4438	0.8438	2.7967
4.E.2. Land Converted to Settlements	CO_2	84.7480	116.5030	10	10	14.1421	31.0274	0.0970	0.0839	0.9702	1.1872	2.3507
4.E.2. Land Converted to Settlements	N_2O	169.4814	161.2828	10	30	31.6228	297.3158	0.1424	0.1162	4.2724	1.6435	20.9549
4.F.2. Land Converted to Other Land	CO_2	152.3638	611.7881	10	10	14.1421	855.6067	0.4647	0.4408	4.6474	6.2342	60.4638
4.H. HWP	CO_2	-122.1804	-57.5604	30	10	31.6228	37.8695	0.0602	0.0415	0.6019	1.7597	3.4586
END												
Total		**-1,387.8169**	**295.7869**				**14767.22**					**1277.82**
Total Uncertainties						**Uncertainty in total inventory %:**	**121.52**				**Trend uncertainty %:**	**35.75**

Annex 5-3.5. Overall Inventory Uncertainty for Sector 5 'Waste'

IPCC Category	Gas	Emissions / Removals in 1990	Emissions / Removals in 2019	Activity Data Uncertainty (1)	Emission Factor Uncertainty (1)	Combined Uncertainty	Contribution to Variance by Category in 2019	Type A Sensitivity	Type B Sensitivity	Uncertainty in the Trend in GHG Emissions Introduced by Emission Factor (2)	Uncertainty in the Trend in GHG emissions Introduced by AD (3)	Uncertainty Introduced into the Trend in Total National Emissions
		kt CO_2 equivalent	kt CO_2 equivalent	%	%	%		%	%	%	%	%
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$		$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F	J*E*sqrt(2)	K^2 + L^2
5.A. Solid Waste Disposal	CH_4	1,046.7277	1,231.5881	30	40	50.0000	1572.9974	0.1038	0.8133	4.1533	34.5071	1207.9865
5.B. Biological Treatment of Solid Waste	CH_4	1.3597	1.3965	50	50	70.7107	0.0040	0.0000	0.0009	0.0001	0.0652	0.0043
5.B. Biological Treatment of Solid Waste	N_2O	0.9725	0.9988	50	50	70.7107	0.0021	0.0000	0.0007	0.0001	0.0466	0.0022
5.C. Incineration and Open Burning of Waste	CO_2	14.9667	13.9120	40	25	47.1699	0.1786	0.0009	0.0092	0.0237	0.5197	0.2707
5.C. Incineration and Open Burning of Waste	CH_4	7.6876	7.1455	40	50	64.0312	0.0868	0.0005	0.0047	0.0243	0.2669	0.0718
5.C. Incineration and Open Burning of Waste	N_2O	1.6078	1.4945	40	100	107.7033	0.0107	0.0001	0.0010	0.0102	0.0558	0.0032
5.D. Wastewater Treatment and Discharge	CH_4	352.9650	237.6771	40	40	56.5685	74.9862	0.0819	0.1570	3.2743	8.8791	89.5592
5.D. Wastewater Treatment and Discharge	N_2O	87.9499	58.4302	40	50	64.0312	5.8065	0.0210	0.0386	1.0478	2.1828	5.8626
END												
Total		**1,514.2369**	**1,552.6426**				**1,654.07**					**1,303.76**
Total Uncertainties						**Total Uncertainties**	**40.67**				**Trend uncertainty %:**	**36.11**

Annex 6. Sectoral and Summary Reports on GHG Emissions in the Republic of Moldova within 1990-2019

Annex 6-1. Sectoral Report for Sector 1 'Energy' within 1990-2019

1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**35,401.5108**	**45.9255**	**1.1599**	**85.7741**	**268.1988**	**31.3695**	**148.7358**
A. Fuel combustion activities (sectoral approach)	**35,400.8731**	**13.4359**	**1.1599**	**85.7741**	**268.1988**	**30.7878**	**148.7358**
1. Energy industries	**21,300.2929**	**0.4913**	**0.1734**	**39.4664**	**7.2099**	**0.6297**	**102.3606**
a. Public electricity and heat production	21,300.2929	0.4913	0.1734	39.4664	7.2099	0.6297	102.3606
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**1,916.8273**	**0.0866**	**0.0147**	**9.0489**	**3.4763**	**0.8788**	**2.6881**
a. Iron and steel	140.4257	0.0038	0.0005	0.1903	0.2114	0.0647	0.1441
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	19.5198	0.0005	0.0001	0.0588	0.0122	0.0075	0.0039
d. Pulp, paper and print	NO	NO	NO	NO	NO	NO	NO
e. Food processing, beverages and tobacco	213.3694	0.0164	0.0027	1.0661	0.8576	0.1479	0.7288
f. Non-metallic minerals	1,415.5799	0.0554	0.0100	7.4152	1.9054	0.5437	1.4602
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	80.2053	0.0031	0.0004	0.1458	0.1876	0.0422	0.1473
i. Mining and quarrying	8.6233	0.0005	0.0001	0.0501	0.0307	0.0046	0.0282
j. Wood and wood production	8.8101	0.0046	0.0006	0.0415	0.0892	0.0474	0.0036
k. Construction	10.0221	0.0003	0.0001	0.0463	0.0073	0.0036	0.0038
l. Textile and leather	20.2718	0.0019	0.0003	0.0348	0.1750	0.0174	0.1682
m. Other industries	NO	NO	NO	NO	NO	NO	NO
3. Transport	**4,697.5183**	**1.3467**	**0.3582**	**14.9012**	**68.3923**	**8.6079**	**0.7843**
a. Domestic aviation	71.6091	0.0005	0.0021	0.0001	0.0284	0.0004	0.0000
b. Road transportation	4,112.3462	1.3202	0.1997	8.0733	66.9472	7.9749	0.6806
c. Railways	403.4745	0.0226	0.1557	6.7071	1.3696	0.5952	0.1024
d. Domestic navigation	18.9103	0.0018	0.0005	0.0005	0.0000	0.0000	0.0001
e. Other transportation	91.1782	0.0016	0.0002	0.1203	0.0471	0.0374	0.0011
4. Other sectors	**7,372.2624**	**11.5005**	**0.6092**	**21.5980**	**188.2917**	**20.5488**	**42.5973**
a. Commercial/institutional	1,413.8434	0.2471	0.0204	2.8346	11.4100	1.2276	10.1050
b. Residential	4,410.0721	10.9567	0.0600	4.7280	166.3414	17.7118	31.5785
c. Agriculture/forestry/fishing	1,548.3469	0.2967	0.5288	14.0354	10.5404	1.6094	0.9137
ci. Stationary	160.5842	0.1930	0.0018	0.5222	0.6712	0.0894	0.5995
cii. Mobile	1,387.7627	0.1037	0.5269	13.5132	9.8692	1.5200	0.3142
5. Other	**113.9722**	**0.0109**	**0.0044**	**0.7597**	**0.8286**	**0.1226**	**0.3055**
a. Stationary	41.9609	0.0020	0.0007	0.0908	0.3458	0.0459	0.2890
b. Mobile	72.0113	0.0089	0.0037	0.6690	0.4828	0.0767	0.0165
B. Fugitive emissions from fuels	**0.6377**	**32.4897**	**0.0000**	**NO**	**NO**	**0.5817**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.6377**	**32.4897**	**0.0000**	**NO**	**NO**	**0.5817**	**NO**
a. Oil	0.1075	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.5302	32.4897				0.5817	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**193.4599**	**0.0153**	**0.0063**	**0.7651**	**0.5859**	**0.2298**	**0.0613**
Aviation	193.4599	0.0153	0.0063	0.7651	0.5859	0.2298	0.0613
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**232.8093**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**29,939.0721**	**40.3057**	**0.8645**	**70.2758**	**196.5828**	**23.0138**	**123.5938**
A. Fuel combustion activities (sectoral approach)	**29,938.4581**	**9.8131**	**0.8645**	**70.2758**	**196.5828**	**22.4700**	**123.5938**

1. Energy industries	**18,927.0336**	**0.4230**	**0.1562**	**35.0660**	**6.4107**	**0.5515**	**90.5225**
a. Public electricity and heat production	18,927.0336	0.4230	0.1562	35.0660	6.4107	0.5515	90.5225
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**1,277.9476**	**0.0546**	**0.0096**	**6.5424**	**1.7479**	**0.5482**	**1.2265**
a. Iron and steel	NO	NO	NO	NO	NO	NO	NO
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	NO	NO	NO	NO	NO	NO	NO
d. Pulp, paper and print	NO	NO	NO	NO	NO	NO	NO
e. Food processing, beverages and tobacco	173.2316	0.0135	0.0022	0.8444	0.7182	0.1221	0.6121
f. Non-metallic minerals	1,022.1104	0.0345	0.0065	5.4552	0.8022	0.3525	0.4871
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	65.7107	0.0024	0.0004	0.1556	0.1470	0.0315	0.1198
i. Mining and quarrying	NO	NO	NO	NO	NO	0.0000	NO
j. Wood and wood production	7.4013	0.0038	0.0005	0.0377	0.0734	0.0388	0.0033
k. Construction	9.4936	0.0003	0.0001	0.0495	0.0072	0.0033	0.0043
l. Textile and leather	NO	NO	NO	NO	NO	NO	NO
m. Other industries	NO	NO	NO	NO	NO	NO	NO
3. Transport	**3,655.5565**	**1.0343**	**0.2931**	**11.9958**	**52.0755**	**6.5987**	**0.6152**
a. Domestic aviation	54.2011	0.0004	0.0016	0.0001	0.0215	0.0003	0.0000
b. Road transportation	3,168.4585	1.0125	0.1538	6.1603	50.8436	6.0583	0.5267
c. Railways	356.6274	0.0200	0.1376	5.7352	1.1711	0.5089	0.0876
d. Domestic navigation	0.2877	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	75.9818	0.0014	0.0001	0.1002	0.0393	0.0312	0.0009
4. Other sectors	**5,971.5518**	**8.2940**	**0.4021**	**16.0136**	**135.7317**	**14.6862**	**30.9518**
a. Commercial/institutional	1,001.8165	0.1805	0.0145	1.9330	8.1628	0.8850	7.2071
b. Residential	3,918.0402	7.8968	0.0482	3.9336	118.9213	12.6219	23.0351
c. Agriculture/forestry/fishing	1,051.6950	0.2167	0.3395	10.1470	8.6476	1.1793	0.7096
ci. Stationary	158.5106	0.1454	0.0016	0.5499	0.5381	0.0765	0.4858
cii. Mobile	893.1844	0.0713	0.3378	9.5970	8.1096	1.1028	0.2239
5. Other	**106.3685**	**0.0072**	**0.0034**	**0.6579**	**0.6170**	**0.0855**	**0.2778**
a. Stationary	51.5108	0.0011	0.0006	0.1355	0.2916	0.0316	0.2649
b. Mobile	54.8577	0.0061	0.0028	0.5224	0.3255	0.0539	0.0128
B. Fugitive emissions from fuels	**0.6140**	**30.4926**	**0.0000**	**NO**	**NO**	**0.5438**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.6140**	**30.4926**	**0.0000**	**NO**	**NO**	**0.5438**	**NO**
a. Oil	0.0942	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.5197	30.4926				0.5438	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**147.3846**	**0.0117**	**0.0048**	**0.5829**	**0.4464**	**0.1751**	**0.0467**
Aviation	147.3846	0.0117	0.0048	0.5829	0.4464	0.1751	0.0467
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**201.2009**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

1992

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**23,328.3149**	**33.7339**	**0.6034**	**53.1383**	**124.2406**	**14.8719**	**91.3906**
A. Fuel combustion activities (sectoral approach)	**23,327.7974**	**6.1296**	**0.6034**	**53.1383**	**124.2406**	**14.3788**	**91.3906**
1. Energy industries	**15,660.9863**	**0.3579**	**0.1219**	**28.7536**	**5.5760**	**0.4762**	**71.2477**
a. Public electricity and heat production	15,660.9863	0.3579	0.1219	28.7536	5.5760	0.4762	71.2477
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**926.7893**	**0.0399**	**0.0069**	**4.5977**	**1.3236**	**0.4070**	**0.9321**
a. Iron and steel	NO	NO	NO	NO	NO	NO	NO
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	NO	NO	NO	NO	NO	NO	NO
d. Pulp, paper and print	NO	NO	NO	NO	NO	NO	NO
e. Food processing, beverages and tobacco	133.0938	0.0106	0.0017	0.6226	0.5788	0.0962	0.4953
f. Non-metallic minerals	727.5218	0.0240	0.0044	3.7221	0.5686	0.2540	0.3366

g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	51.2162	0.0020	0.0003	0.1662	0.1115	0.0235	0.0924
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	5.9925	0.0030	0.0004	0.0340	0.0575	0.0302	0.0031
k. Construction	8.9651	0.0003	0.0001	0.0527	0.0072	0.0030	0.0047
l. Textile and leather	NO	NO	NO	NO	NO	NO	NO
m. Other industries	NO	NO	NO	NO	NO	NO	NO
3. Transport	**2,614.8520**	**0.7228**	**0.2234**	**9.0885**	**35.7574**	**4.5881**	**0.4462**
a. Domestic aviation	36.7932	0.0003	0.0011	0.0000	0.0146	0.0002	0.0000
b. Road transportation	2,224.5569	0.7049	0.1079	4.2499	34.7407	4.1418	0.3728
c. Railways	296.2694	0.0166	0.1143	4.7633	0.9727	0.4227	0.0727
d. Domestic navigation	0.2461	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	56.9864	0.0010	0.0001	0.0752	0.0295	0.0234	0.0007
4. Other sectors	**4,047.4223**	**5.0044**	**0.2490**	**10.2209**	**81.2407**	**8.8561**	**18.6039**
a. Commercial/institutional	663.3266	0.1233	0.0093	1.2969	5.1389	0.5724	4.5184
b. Residential	2,725.3457	4.7460	0.0313	2.6457	70.8755	7.5582	13.6337
c. Agriculture/forestry/fishing	658.7500	0.1350	0.2084	6.2784	5.2263	0.7256	0.4518
ci. Stationary	111.0452	0.0917	0.0011	0.3902	0.3480	0.0514	0.3144
cii. Mobile	547.7048	0.0433	0.2073	5.8882	4.8783	0.6743	0.1373
5. Other	**77.7474**	**0.0046**	**0.0023**	**0.4776**	**0.3429**	**0.0514**	**0.1606**
a. Stationary	42.5895	0.0012	0.0004	0.1334	0.1655	0.0202	0.1522
b. Mobile	35.1579	0.0034	0.0018	0.3442	0.1774	0.0313	0.0084
B. Fugitive emissions from fuels	**0.5175**	**27.6043**	**0.0000**	**NO**	**NO**	**0.4931**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.5175**	**27.6043**	**0.0000**	**NO**	**NO**	**0.4931**	**NO**
a. Oil	0.0555	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.4620	27.6043				0.4931	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**108.5369**	**0.0086**	**0.0036**	**0.4293**	**0.3287**	**0.1289**	**0.0344**
Aviation	108.5369	0.0086	0.0036	0.4293	0.3287	0.1289	0.0344
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**169.5924**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

1993

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**17,335.5539**	**27.4021**	**0.5000**	**74.1648**	**59.6995**	**7.9444**	**71.7045**
A. Fuel combustion activities (sectoral approach)	**17,335.1157**	**2.5995**	**0.5000**	**74.1648**	**59.6995**	**7.5007**	**71.7045**
1. Energy industries	**12,640.6006**	**0.2823**	**0.1058**	**23.6435**	**4.2355**	**0.3687**	**62.2743**
a. Public electricity and heat production	12,640.6006	0.2823	0.1058	23.6435	4.2355	0.3687	62.2743
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**612.1245**	**0.0268**	**0.0045**	**34.8853**	**0.9478**	**0.2790**	**0.6765**
a. Iron and steel	0.9630	0.0001	0.0000	0.0016	0.0084	0.0008	0.0081
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	NO	NO	NO	NO	NO	NO	NO
d. Pulp, paper and print	NO	NO	NO	NO	NO	NO	NO
e. Food processing, beverages and tobacco	93.6442	0.0077	0.0012	0.4045	0.4425	0.0709	0.3816
f. Non-metallic minerals	432.9331	0.0135	0.0024	1.9891	0.3351	0.1554	0.1862
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	37.1299	0.0016	0.0003	0.1799	0.0764	0.0157	0.0652
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	4.5837	0.0022	0.0003	0.0302	0.0417	0.0217	0.0028
k. Construction	10.0674	0.0004	0.0001	0.0657	0.0112	0.0034	0.0087
l. Textile and leather	0.5898	0.0001	0.0000	0.0010	0.0056	0.0005	0.0054
m. Other industries	32.2134	0.0012	0.0002	32.2134	0.0269	0.0106	0.0185
3. Transport	**1,855.0176**	**0.4932**	**0.1808**	**7.3893**	**23.2766**	**3.0794**	**0.3241**
a. Domestic aviation	19.3853	0.0001	0.0006	0.0000	0.0077	0.0001	0.0000
b. Road transportation	1,538.8959	0.4773	0.0745	2.8038	22.3270	2.6658	0.2543
c. Railways	274.0715	0.0153	0.1058	4.5560	0.9303	0.4043	0.0696

d. Domestic navigation	0.2841	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	22.3809	0.0004	0.0000	0.0295	0.0116	0.0092	0.0003
4. Other sectors	**2,133.9212**	**1.7913**	**0.2065**	**7.7876**	**30.6143**	**3.6883**	**8.0858**
a. Commercial/institutional	589.8426	0.0968	0.0081	1.2145	4.4553	0.4890	3.9426
b. Residential	979.3320	1.5728	0.0109	1.0172	23.0558	2.5808	3.7608
c. Agriculture/forestry/fishing	564.7466	0.1217	0.1875	5.5560	3.1032	0.6185	0.3824
ci. Stationary	76.7498	0.0890	0.0009	0.2572	0.3046	0.0481	0.2594
cii. Mobile	487.9968	0.0327	0.1865	5.2988	2.7986	0.5704	0.1230
5. Other	**93.4518**	**0.0058**	**0.0024**	**0.4591**	**0.6253**	**0.0853**	**0.3437**
a. Stationary	62.1343	0.0021	0.0008	0.1586	0.3875	0.0485	0.3369
b. Mobile	31.3175	0.0038	0.0016	0.3005	0.2378	0.0369	0.0068
B. Fugitive emissions from fuels	**0.4382**	**24.8026**	**0.0000**	**NO**	**NO**	**0.4437**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.4382**	**24.8026**	**0.0000**	**NO**	**NO**	**0.4437**	**NO**
a. Oil	0.0294	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.4088	24.8026				0.4437	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**55.2342**	**0.0044**	**0.0018**	**0.2184**	**0.1673**	**0.0656**	**0.0175**
Aviation	55.2342	0.0044	0.0018	0.2184	0.1673	0.0656	0.0175
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**143.2360**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

1994

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**14,485.6701**	**26.9625**	**0.4526**	**33.5131**	**67.5876**	**8.6559**	**56.8209**
A. Fuel combustion activities (sectoral approach)	**14,485.2616**	**3.0910**	**0.4526**	**33.5131**	**67.5876**	**8.2290**	**56.8209**
1. Energy industries	**9,961.8515**	**0.1888**	**0.0872**	**18.8108**	**3.5570**	**0.2847**	**47.1207**
a. Public electricity and heat production	9,961.8515	0.1888	0.0872	18.8108	3.5570	0.2847	47.1207
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**731.5285**	**0.0178**	**0.0013**	**1.2443**	**0.7197**	**0.3201**	**0.3552**
a. Iron and steel	NO	NO	NO	NO	NO	NO	NO
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	NO	NO	NO	NO	NO	NO	NO
d. Pulp, paper and print	NO	NO	NO	NO	NO	NO	NO
e. Food processing, beverages and tobacco	60.8339	0.0042	0.0007	0.2237	0.3229	0.0374	0.3059
f. Non-metallic minerals	138.3445	0.0030	0.0004	0.2560	0.1016	0.0569	0.0358
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	10.1211	0.0003	0.0001	0.0495	0.0075	0.0036	0.0042
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	NO	NO	NO	NO	NO	NO	NO
k. Construction	6.1935	0.0002	0.0000	0.0324	0.0047	0.0021	0.0028
l. Textile and leather	NO	NO	NO	NO	NO	NO	NO
m. Other industries	516.0355	0.0092	0.0000	0.6800	0.2665	0.0087	0.0062
3. Transport	**1,612.7695**	**0.4373**	**0.1096**	**4.5224**	**21.4510**	**2.7103**	**0.2180**
a. Domestic aviation	19.5692	0.0001	0.0006	0.0000	0.0078	0.0001	0.0000
b. Road transportation	1,380.0934	0.4292	0.0668	2.5755	21.0200	2.5069	0.1891
c. Railways	108.8607	0.0061	0.0420	1.8096	0.3695	0.1606	0.0276
d. Domestic navigation	0.2218	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	104.0244	0.0019	0.0002	0.1372	0.0538	0.0426	0.0012
4. Other sectors	**2,090.7472**	**2.4402**	**0.2529**	**8.6031**	**41.2528**	**4.8276**	**8.8679**
a. Commercial/institutional	386.9544	0.0757	0.0058	0.7644	3.2117	0.3524	2.8277
b. Residential	1,062.6784	2.2578	0.0145	1.1542	33.6023	3.7128	5.7460
c. Agriculture/forestry/fishing	641.1144	0.1067	0.2326	6.6845	4.4387	0.7624	0.2942
ci. Stationary	32.3295	0.0637	0.0006	0.0911	0.1888	0.0360	0.1407
cii. Mobile	608.7849	0.0430	0.2321	6.5934	4.2499	0.7264	0.1535
5. Other	**88.3648**	**0.0069**	**0.0016**	**0.3325**	**0.6071**	**0.0863**	**0.2592**
a. Stationary	71.3256	0.0026	0.0008	0.1867	0.3052	0.0469	0.2561
b. Mobile	17.0392	0.0042	0.0008	0.1458	0.3020	0.0394	0.0031

B. Fugitive emissions from fuels	**0.4085**	**23.8714**	**0.0000**	**NO**	**NO**	**0.4269**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.4085**	**23.8714**	**0.0000**	**NO**	**NO**	**0.4269**	**NO**
a. Oil	0.0140	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.3945	23.8714				0.4269	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**30.8414**	**0.0024**	**0.0010**	**0.1220**	**0.0934**	**0.0366**	**0.0098**
Aviation	30.8414	0.0024	0.0010	0.1220	0.0934	0.0366	0.0098
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**157.4600**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

1995

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**11,471.5441**	**28.3934**	**0.4304**	**27.7416**	**57.4485**	**7.1117**	**31.2910**
A. Fuel combustion activities (sectoral approach)	**11,471.1247**	**1.9379**	**0.4304**	**27.7416**	**57.4485**	**6.6356**	**31.2910**
1. Energy industries	**7,174.0286**	**0.1370**	**0.0502**	**12.9854**	**3.1484**	**0.2369**	**25.5949**
a. Public electricity and heat production	7,174.0286	0.1370	0.0502	12.9854	3.1484	0.2369	25.5949
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**381.5061**	**0.0114**	**0.0015**	**0.6870**	**0.5581**	**0.1795**	**0.3662**
a. Iron and steel	37.3285	0.0007	0.0001	0.0492	0.0193	0.0153	0.0004
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	0.1362	0.0000	0.0000	0.0002	0.0001	0.0001	0.0000
d. Pulp, paper and print	3.6784	0.0001	0.0000	0.0049	0.0019	0.0015	0.0000
e. Food processing, beverages and tobacco	93.6486	0.0059	0.0009	0.2579	0.3808	0.0610	0.3313
f. Non-metallic minerals	159.9009	0.0032	0.0004	0.2361	0.1096	0.0665	0.0307
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	31.1666	0.0006	0.0001	0.0411	0.0161	0.0128	0.0004
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	1.9073	0.0000	0.0000	0.0025	0.0010	0.0008	0.0000
k. Construction	13.9589	0.0003	0.0001	0.0427	0.0087	0.0053	0.0029
l. Textile and leather	20.1628	0.0004	0.0000	0.0266	0.0104	0.0083	0.0002
m. Other industries	19.6179	0.0003	0.0000	0.0259	0.0101	0.0080	0.0002
3. Transport	**1,617.7816**	**0.4448**	**0.1058**	**4.4098**	**22.5934**	**2.8292**	**0.2340**
a. Domestic aviation	19.7163	0.0001	0.0006	0.0000	0.0078	0.0001	0.0000
b. Road transportation	1,401.8149	0.4375	0.0680	2.6826	22.2081	2.6465	0.2084
c. Railways	95.9593	0.0054	0.0370	1.5952	0.3257	0.1416	0.0244
d. Domestic navigation	0.2143	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	100.0768	0.0018	0.0002	0.1320	0.0517	0.0410	0.0012
4. Other sectors	**2,172.1646**	**1.3343**	**0.2708**	**9.1456**	**30.5187**	**3.2884**	**4.8320**
a. Commercial/institutional	395.4161	0.0766	0.0059	0.7759	3.3189	0.3623	2.9241
b. Residential	1,068.7561	1.1441	0.0112	1.0930	15.7025	1.9490	1.6609
c. Agriculture/forestry/fishing	707.9924	0.1136	0.2536	7.2766	11.4973	0.9770	0.2471
ci. Stationary	18.7639	0.0361	0.0003	0.0376	0.1054	0.0205	0.0771
cii. Mobile	689.2285	0.0775	0.2534	7.2390	11.3919	0.9565	0.1700
5. Other	**125.6438**	**0.0104**	**0.0022**	**0.5138**	**0.6299**	**0.1015**	**0.2639**
a. Stationary	104.4054	0.0050	0.0011	0.3366	0.3173	0.0599	0.2593
b. Mobile	21.2384	0.0054	0.0011	0.1771	0.3125	0.0416	0.0046
B. Fugitive emissions from fuels	**0.4194**	**26.4555**	**0.0000**	**NO**	**NO**	**0.4761**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.4194**	**26.4555**	**0.0000**	**NO**	**NO**	**0.4761**	**NO**
a. Oil	0.0140	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.4054	26.4555				0.4761	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						

1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**41.9508**	**0.0066**	**0.0014**	**0.1676**	**0.1539**	**0.0809**	**0.0133**
Aviation	41.9508	0.0066	0.0014	0.1676	0.1539	0.0809	0.0133
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**230.0480**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

1996

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**11,375.0177**	**31.7295**	**0.3744**	**26.0139**	**70.5633**	**8.5666**	**31.5407**
A. Fuel combustion activities (sectoral approach)	**11,374.5451**	**2.9740**	**0.3744**	**26.0139**	**70.5633**	**8.0506**	**31.5407**
1. Energy industries	**7,107.0544**	**0.1353**	**0.0469**	**12.7474**	**3.2595**	**0.2422**	**23.4411**
a. Public electricity and heat production	7,107.0544	0.1353	0.0469	12.7474	3.2595	0.2422	23.4411
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**321.2863**	**0.0115**	**0.0016**	**0.6490**	**0.6323**	**0.1600**	**0.4747**
a. Iron and steel	27.9139	0.0005	0.0000	0.0368	0.0144	0.0114	0.0003
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	0.0990	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000
d. Pulp, paper and print	1.9797	0.0000	0.0000	0.0026	0.0010	0.0008	0.0000
e. Food processing, beverages and tobacco	97.2375	0.0063	0.0010	0.2881	0.4097	0.0634	0.3601
f. Non-metallic minerals	126.9882	0.0033	0.0004	0.1968	0.1701	0.0573	0.1094
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	17.5511	0.0003	0.0000	0.0232	0.0091	0.0072	0.0002
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	0.8909	0.0000	0.0000	0.0012	0.0005	0.0004	0.0000
k. Construction	13.3874	0.0004	0.0001	0.0538	0.0092	0.0049	0.0042
l. Textile and leather	19.7971	0.0004	0.0000	0.0261	0.0102	0.0081	0.0002
m. Other industries	15.4417	0.0003	0.0000	0.0204	0.0080	0.0063	0.0002
3. Transport	**1,578.6670**	**0.4313**	**0.1009**	**4.2800**	**21.5297**	**2.7137**	**0.2207**
a. Domestic aviation	19.8341	0.0001	0.0006	0.0000	0.0079	0.0001	0.0000
b. Road transportation	1,324.5171	0.4234	0.0641	2.5463	21.1329	2.5185	0.1954
c. Railways	93.1056	0.0052	0.0359	1.5477	0.3160	0.1373	0.0236
d. Domestic navigation	0.2325	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	140.9777	0.0025	0.0003	0.1860	0.0729	0.0578	0.0017
4. Other sectors	**2,285.6997**	**2.3850**	**0.2228**	**7.8951**	**44.6759**	**4.8360**	**7.2025**
a. Commercial/institutional	362.4420	0.0905	0.0056	0.7011	2.9937	0.3484	2.5956
b. Residential	1,349.8119	2.1821	0.0175	1.4404	31.3610	3.6754	4.3875
c. Agriculture/forestry/fishing	573.4458	0.1124	0.1997	5.7537	10.3212	0.8122	0.2194
ci. Stationary	26.9754	0.0459	0.0005	0.0693	0.1310	0.0316	0.0857
cii. Mobile	546.4704	0.0666	0.1992	5.6843	10.1902	0.7806	0.1338
5. Other	**81.8376**	**0.0109**	**0.0023**	**0.4423**	**0.4659**	**0.0987**	**0.2016**
a. Stationary	58.7906	0.0062	0.0012	0.2011	0.2969	0.0717	0.1964
b. Mobile	23.0470	0.0047	0.0012	0.2412	0.1689	0.0271	0.0051
B. Fugitive emissions from fuels	**0.4726**	**28.7555**	**0.0000**	**NO**	**NO**	**0.5160**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.4726**	**28.7555**	**0.0000**	**NO**	**NO**	**0.5160**	**NO**
a. Oil	0.0162	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.4564	28.7555				0.5160	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**56.7300**	**0.0048**	**0.0018**	**0.2197**	**0.1539**	**0.0822**	**0.0180**
Aviation	56.7300	0.0048	0.0018	0.2197	0.1539	0.0822	0.0180
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**294.0280**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

1997

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**10,258.1517**	**25.9642**	**0.3429**	**22.8510**	**63.9617**	**7.7630**	**16.2324**
A. Fuel combustion activities (sectoral approach)	**10,257.6867**	**2.3214**	**0.3429**	**22.8510**	**63.9617**	**7.3454**	**16.2324**
1. Energy industries	**5,615.6123**	**0.1108**	**0.0244**	**9.5174**	**3.1362**	**0.2233**	**10.5370**
a. Public electricity and heat production	5,615.6123	0.1108	0.0244	9.5174	3.1362	0.2233	10.5370
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**546.9038**	**0.0181**	**0.0023**	**0.9180**	**0.7370**	**0.2841**	**0.3965**
a. Iron and steel	101.5868	0.0018	0.0002	0.1340	0.0525	0.0416	0.0012
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	0.2878	0.0000	0.0000	0.0004	0.0001	0.0001	0.0000
d. Pulp, paper and print	5.1801	0.0001	0.0000	0.0068	0.0027	0.0021	0.0001
e. Food processing, beverages and tobacco	117.6227	0.0095	0.0013	0.2877	0.4339	0.1049	0.3055
f. Non-metallic minerals	173.1187	0.0039	0.0005	0.2562	0.1684	0.0748	0.0839
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	41.3852	0.0007	0.0001	0.0546	0.0214	0.0170	0.0005
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	1.4389	0.0000	0.0000	0.0019	0.0007	0.0006	0.0000
k. Construction	22.5394	0.0005	0.0001	0.0659	0.0139	0.0086	0.0043
l. Textile and leather	45.7572	0.0008	0.0001	0.0604	0.0237	0.0188	0.0005
m. Other industries	37.9871	0.0007	0.0001	0.0501	0.0196	0.0156	0.0005
3. Transport	**1,515.9813**	**0.4010**	**0.0976**	**4.2427**	**23.8049**	**2.9428**	**0.2299**
a. Domestic aviation	19.9282	0.0001	0.0006	0.0000	0.0079	0.0001	0.0000
b. Road transportation	1,357.2181	0.3953	0.0661	2.8354	23.4951	2.8006	0.2089
c. Railways	80.0082	0.0045	0.0309	1.3300	0.2716	0.1180	0.0203
d. Domestic navigation	0.2506	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	58.5761	0.0010	0.0001	0.0773	0.0303	0.0240	0.0007
4. Other sectors	**2,502.5306**	**1.7835**	**0.2165**	**7.8855**	**35.7839**	**3.8166**	**4.8638**
a. Commercial/institutional	307.2393	0.0668	0.0046	0.5690	2.5613	0.2901	2.2341
b. Residential	1,621.9510	1.5902	0.0153	1.6364	21.8422	2.6721	2.4605
c. Agriculture/forestry/fishing	573.3403	0.1265	0.1967	5.6801	11.3804	0.8544	0.1692
ci. Stationary	31.3633	0.0554	0.0007	0.0802	0.1313	0.0568	0.0372
cii. Mobile	541.9770	0.0710	0.1960	5.5999	11.2491	0.7976	0.1320
5. Other	**76.6587**	**0.0081**	**0.0020**	**0.2875**	**0.4997**	**0.0785**	**0.2051**
a. Stationary	51.7920	0.0031	0.0007	0.1428	0.2585	0.0462	0.2014
b. Mobile	24.8668	0.0050	0.0013	0.1447	0.2412	0.0324	0.0038
B. Fugitive emissions from fuels	**0.4651**	**23.6428**	**0.0000**	**NO**	**NO**	**0.4176**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.4651**	**23.6428**	**0.0000**	**NO**	**NO**	**0.4176**	**NO**
a. Oil	0.0191	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.4459	23.6428				0.4176	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**66.1918**	**0.0054**	**0.0021**	**0.2640**	**0.1777**	**0.0937**	**0.0210**
Aviation	66.1918	0.0054	0.0021	0.2640	0.1777	0.0937	0.0210
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**291.1280**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

1998

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,894.2769**	**23.8409**	**0.2674**	**19.1724**	**48.6044**	**6.2399**	**12.0244**
A. Fuel combustion activities (sectoral approach)	**8,893.8495**	**1.7160**	**0.2674**	**19.1724**	**48.6044**	**5.8483**	**12.0244**
1. Energy industries	**4,836.6106**	**0.0962**	**0.0190**	**8.1103**	**2.7791**	**0.1972**	**7.9288**
a. Public electricity and heat production	4,836.6106	0.0962	0.0190	8.1103	2.7791	0.1972	7.9288
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**542.6603**	**0.0186**	**0.0024**	**1.0266**	**0.7118**	**0.3020**	**0.3295**
a. Iron and steel	91.5553	0.0016	0.0002	0.1208	0.0473	0.0375	0.0011

b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	5.5657	0.0001	0.0000	0.0073	0.0029	0.0023	0.0001
d. Pulp, paper and print	4.1743	0.0001	0.0000	0.0055	0.0022	0.0017	0.0000
e. Food processing, beverages and tobacco	129.4657	0.0099	0.0014	0.4266	0.4366	0.1146	0.2924
f. Non-metallic minerals	161.3491	0.0041	0.0005	0.2436	0.1435	0.0846	0.0313
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	28.0343	0.0005	0.0000	0.0370	0.0145	0.0115	0.0003
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	1.3914	0.0000	0.0000	0.0018	0.0007	0.0006	0.0000
k. Construction	19.2728	0.0004	0.0001	0.0497	0.0115	0.0075	0.0029
l. Textile and leather	63.1704	0.0011	0.0001	0.0833	0.0327	0.0259	0.0008
m. Other industries	38.6814	0.0007	0.0001	0.0510	0.0200	0.0159	0.0005
3. Transport	**1,363.0743**	**0.4035**	**0.0827**	**3.4803**	**20.7338**	**2.5523**	**0.1945**
a. Domestic aviation	20.3049	0.0001	0.0006	0.0000	0.0081	0.0001	0.0000
b. Road transportation	1,226.9125	0.3990	0.0591	2.4217	20.4956	2.4417	0.1788
c. Railways	59.1972	0.0033	0.0228	0.9840	0.2009	0.0873	0.0150
d. Domestic navigation	0.1567	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	56.5030	0.0010	0.0001	0.0745	0.0292	0.0232	0.0007
4. Other sectors	**2,078.6760**	**1.1889**	**0.1612**	**6.1632**	**23.7935**	**2.6926**	**3.3628**
a. Commercial/institutional	305.5365	0.0669	0.0047	0.5770	2.6137	0.2925	2.2854
b. Residential	1,339.7948	1.0523	0.0123	1.3409	13.7327	1.8101	0.9304
c. Agriculture/forestry/fishing	433.3447	0.0696	0.1442	4.2453	7.4470	0.5901	0.1470
ci. Stationary	38.7431	0.0215	0.0003	0.1101	0.0766	0.0233	0.0497
cii. Mobile	394.6016	0.0481	0.1439	4.1351	7.3705	0.5668	0.0973
5. Other	**72.8283**	**0.0088**	**0.0021**	**0.3919**	**0.5862**	**0.1041**	**0.2088**
a. Stationary	50.4380	0.0048	0.0010	0.1495	0.2909	0.0624	0.2034
b. Mobile	22.3903	0.0041	0.0011	0.2424	0.2953	0.0417	0.0054
B. Fugitive emissions from fuels	**0.4274**	**22.1250**	**0.0000**	**NO**	**NO**	**0.3916**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.4274**	**22.1250**	**0.0000**	**NO**	**NO**	**0.3916**	**NO**
a. Oil	0.0184	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.4090	22.1250				0.3916	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**53.5923**	**0.0041**	**0.0017**	**0.2144**	**0.1439**	**0.0721**	**0.0170**
Aviation	53.5923	0.0041	0.0017	0.2144	0.1439	0.0721	0.0170
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**269.0120**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

1999

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**6,903.7219**	**23.9591**	**0.1824**	**13.5355**	**36.4419**	**4.8899**	**5.4709**
A. Fuel combustion activities (sectoral approach)	**6,903.3288**	**1.5546**	**0.1824**	**13.5355**	**36.4419**	**4.4892**	**5.4709**
1. Energy industries	**3,660.2540**	**0.0727**	**0.0088**	**5.8881**	**2.3787**	**0.1638**	**2.1288**
a. Public electricity and heat production	3,660.2540	0.0727	0.0088	5.8881	2.3787	0.1638	2.1288
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**473.8274**	**0.0129**	**0.0015**	**0.7360**	**0.4969**	**0.2249**	**0.2275**
a. Iron and steel	94.6213	0.0017	0.0002	0.1248	0.0489	0.0388	0.0011
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	4.9120	0.0001	0.0000	0.0065	0.0025	0.0020	0.0001
d. Pulp, paper and print	3.1023	0.0001	0.0000	0.0041	0.0016	0.0013	0.0000
e. Food processing, beverages and tobacco	85.9107	0.0057	0.0008	0.2111	0.2701	0.0646	0.1955
f. Non-metallic minerals	153.1548	0.0030	0.0003	0.2033	0.1047	0.0642	0.0279
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	21.7411	0.0004	0.0000	0.0287	0.0112	0.0089	0.0003
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	1.0341	0.0000	0.0000	0.0014	0.0005	0.0004	0.0000
k. Construction	16.2809	0.0003	0.0000	0.0334	0.0092	0.0065	0.0015
l. Textile and leather	57.6518	0.0010	0.0001	0.0760	0.0298	0.0236	0.0007

m. Other industries	35.4184	0.0006	0.0001	0.0467	0.0183	0.0145	0.0004
3. Transport	**910.6886**	**0.2475**	**0.0514**	**2.0599**	**11.9843**	**1.4854**	**0.1366**
a. Domestic aviation	2.0097	0.0000	0.0001	0.0000	0.0008	0.0000	0.0000
b. Road transportation	815.2894	0.2447	0.0394	1.4651	11.8466	1.4144	0.1281
c. Railways	30.8413	0.0017	0.0119	0.5127	0.1047	0.0455	0.0078
d. Domestic navigation	0.2609	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	62.2873	0.0011	0.0001	0.0822	0.0322	0.0255	0.0007
4. Other sectors	**1,809.4024**	**1.2151**	**0.1190**	**4.7057**	**21.2190**	**2.5511**	**2.8154**
a. Commercial/institutional	228.3903	0.0500	0.0033	0.4263	1.8054	0.2102	1.5675
b. Residential	1,283.2132	1.1327	0.0126	1.2942	15.0238	1.9524	1.1679
c. Agriculture/forestry/fishing	297.7989	0.0324	0.1031	2.9851	4.3898	0.3885	0.0800
ci. Stationary	18.5433	0.0021	0.0001	0.0488	0.0160	0.0064	0.0111
cii. Mobile	279.2556	0.0304	0.1030	2.9363	4.3738	0.3822	0.0689
5. Other	**49.1563**	**0.0065**	**0.0016**	**0.1458**	**0.3630**	**0.0640**	**0.1625**
a. Stationary	30.9893	0.0033	0.0007	0.0812	0.2285	0.0465	0.1608
b. Mobile	18.1670	0.0032	0.0009	0.0645	0.1345	0.0175	0.0017
B. Fugitive emissions from fuels	**0.3931**	**22.4045**	**0.0000**	**NO**	**NO**	**0.4007**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.3931**	**22.4045**	**0.0000**	**NO**	**NO**	**0.4007**	**NO**
a. Oil	0.0228	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.3703	22.4045				0.4007	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**63.0390**	**0.0040**	**0.0020**	**0.2517**	**0.1574**	**0.0796**	**0.0200**
Aviation	63.0390	0.0040	0.0020	0.2517	0.1574	0.0796	0.0200
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**266.1120**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**6,188.5808**	**25.5633**	**0.1627**	**11.9074**	**34.0667**	**4.7767**	**3.9685**
A. Fuel combustion activities (sectoral approach)	**6,188.2049**	**1.5379**	**0.1627**	**11.9074**	**34.0667**	**4.3426**	**3.9685**
1. Energy industries	**3,155.7517**	**0.0610**	**0.0069**	**5.0439**	**2.1204**	**0.1437**	**0.9753**
a. Public electricity and heat production	3,155.7517	0.0610	0.0069	5.0439	2.1204	0.1437	0.9753
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**519.5881**	**0.0119**	**0.0014**	**0.7914**	**0.4871**	**0.2261**	**0.2274**
a. Iron and steel	97.5840	0.0017	0.0002	0.1287	0.0504	0.0400	0.0012
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	5.1935	0.0001	0.0000	0.0069	0.0027	0.0021	0.0001
d. Pulp, paper and print	4.9202	0.0001	0.0000	0.0065	0.0025	0.0020	0.0001
e. Food processing, beverages and tobacco	80.4316	0.0038	0.0006	0.1988	0.2338	0.0448	0.1948
f. Non-metallic minerals	184.8715	0.0035	0.0004	0.2453	0.1211	0.0772	0.0283
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	25.7242	0.0005	0.0000	0.0339	0.0133	0.0105	0.0003
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	1.6401	0.0000	0.0000	0.0022	0.0008	0.0007	0.0000
k. Construction	9.6117	0.0002	0.0000	0.0246	0.0057	0.0037	0.0015
l. Textile and leather	80.6367	0.0014	0.0001	0.1064	0.0417	0.0331	0.0010
m. Other industries	28.9745	0.0005	0.0001	0.0382	0.0150	0.0119	0.0003
3. Transport	**982.3588**	**0.2520**	**0.0574**	**2.1165**	**11.8853**	**1.4687**	**0.1582**
a. Domestic aviation	2.0097	0.0000	0.0001	0.0000	0.0008	0.0000	0.0000
b. Road transportation	911.9010	0.2495	0.0444	1.5160	11.7532	1.4052	0.1514
c. Railways	33.3462	0.0019	0.0129	0.5543	0.1132	0.0492	0.0063
d. Domestic navigation	0.1154	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	34.9864	0.0006	0.0001	0.0461	0.0181	0.0143	0.0004
4. Other sectors	**1,494.1182**	**1.2084**	**0.0960**	**3.8246**	**19.3419**	**2.4620**	**2.4553**
a. Commercial/institutional	205.2273	0.0475	0.0027	0.3932	1.4361	0.1789	1.2316
b. Residential	1,052.5201	1.1385	0.0126	1.0868	15.2688	1.9972	1.1697
c. Agriculture/forestry/fishing	236.3708	0.0225	0.0807	2.3445	2.6371	0.2859	0.0541

ci. Stationary	20.7663	0.0024	0.0001	0.0580	0.0188	0.0070	0.0139
cii. Mobile	215.6045	0.0201	0.0806	2.2865	2.6183	0.2790	0.0401
5. Other	**36.3881**	**0.0046**	**0.0010**	**0.1311**	**0.2320**	**0.0421**	**0.1523**
a. Stationary	26.5856	0.0021	0.0005	0.0540	0.2033	0.0364	0.1515
b. Mobile	9.8025	0.0025	0.0005	0.0770	0.0287	0.0057	0.0008
B. Fugitive emissions from fuels	**0.3759**	**24.0254**	**0.0000**	**NO**	**NO**	**0.4341**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.3759**	**24.0254**	**0.0000**	**NO**	**NO**	**0.4341**	**NO**
a. Oil	0.0258	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.3502	24.0254				0.4341	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**63.0779**	**0.0043**	**0.0020**	**0.2591**	**0.1688**	**0.0773**	**0.0200**
Aviation	63.0779	0.0043	0.0020	0.2591	0.1688	0.0773	0.0200
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**272.3720**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**6,818.6569**	**25.2353**	**0.1673**	**13.1876**	**32.9406**	**4.6812**	**3.5081**
A. Fuel combustion activities (sectoral approach)	**6,818.2477**	**1.4145**	**0.1673**	**13.1876**	**32.9406**	**4.2534**	**3.5081**
1. Energy industries	**3,677.7189**	**0.0726**	**0.0080**	**5.8773**	**2.5004**	**0.1689**	**0.8801**
a. Public electricity and heat production	3,677.7189	0.0726	0.0080	5.8773	2.5004	0.1689	0.8801
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**601.1675**	**0.0147**	**0.0019**	**1.1500**	**0.5744**	**0.2598**	**0.2825**
a. Iron and steel	117.6721	0.0021	0.0002	0.1552	0.0608	0.0482	0.0014
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	4.3091	0.0001	0.0000	0.0057	0.0022	0.0018	0.0001
d. Pulp, paper and print	7.9553	0.0001	0.0000	0.0105	0.0041	0.0033	0.0001
e. Food processing, beverages and tobacco	85.6929	0.0044	0.0007	0.2196	0.2889	0.0494	0.2492
f. Non-metallic minerals	201.6827	0.0046	0.0006	0.5046	0.1225	0.0820	0.0282
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	29.8276	0.0005	0.0001	0.0393	0.0154	0.0122	0.0004
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	3.6462	0.0001	0.0000	0.0048	0.0019	0.0015	0.0000
k. Construction	11.1639	0.0002	0.0000	0.0266	0.0065	0.0044	0.0015
l. Textile and leather	98.4468	0.0018	0.0002	0.1299	0.0509	0.0404	0.0012
m. Other industries	40.7709	0.0007	0.0001	0.0538	0.0211	0.0167	0.0005
3. Transport	**1,061.8643**	**0.2668**	**0.0634**	**2.2613**	**12.7722**	**1.5702**	**0.1332**
a. Domestic aviation	0.0972	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
b. Road transportation	1,008.2654	0.2644	0.0495	1.6424	12.6415	1.5102	0.1262
c. Railways	35.8469	0.0020	0.0138	0.5959	0.1217	0.0529	0.0068
d. Domestic navigation	0.2082	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	17.4466	0.0003	0.0000	0.0230	0.0090	0.0072	0.0002
4. Other sectors	**1,434.1009**	**1.0554**	**0.0928**	**3.7425**	**16.7367**	**2.1939**	**2.1063**
a. Commercial/institutional	236.4333	0.0681	0.0032	0.4574	1.5666	0.2133	1.3118
b. Residential	967.0035	0.9564	0.0113	0.9940	12.5835	1.6945	0.7359
c. Agriculture/forestry/fishing	230.6641	0.0309	0.0783	2.2910	2.5866	0.2862	0.0586
ci. Stationary	21.7542	0.0113	0.0003	0.0740	0.0390	0.0155	0.0197
cii. Mobile	208.9099	0.0195	0.0781	2.2170	2.5476	0.2707	0.0389
5. Other	**43.3961**	**0.0050**	**0.0012**	**0.1565**	**0.3569**	**0.0605**	**0.1061**
a. Stationary	28.7767	0.0023	0.0005	0.0593	0.1541	0.0341	0.1047
b. Mobile	14.6194	0.0027	0.0007	0.0973	0.2027	0.0264	0.0014
B. Fugitive emissions from fuels	**0.4092**	**23.8208**	**0.0000**	**NO**	**NO**	**0.4278**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.4092**	**23.8208**	**0.0000**	**NO**	**NO**	**0.4278**	**NO**

a. Oil	0.0346	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.3746	23.8208				0.4278	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**50.4863**	**0.0039**	**0.0016**	**0.1936**	**0.1468**	**0.0630**	**0.0160**
Aviation	50.4863	0.0039	0.0016	0.1936	0.1468	0.0630	0.0160
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**282.2280**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**6,537.0389**	**27.6591**	**0.2146**	**13.4336**	**40.0559**	**5.7445**	**4.2675**
A. Fuel combustion activities (sectoral approach)	**6,536.6488**	**1.7766**	**0.2146**	**13.4336**	**40.0559**	**5.2748**	**4.2675**
1. Energy industries	**2,933.2101**	**0.0614**	**0.0069**	**4.6959**	**2.0055**	**0.1356**	**0.6884**
a. Public electricity and heat production	2,933.2101	0.0614	0.0069	4.6959	2.0055	0.1356	0.6884
b. Petroleum refining	NO	NO	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NO	NO	NO	NO
2. Manufacturing industries and construction	**410.3969**	**0.0096**	**0.0011**	**0.6019**	**0.4089**	**0.1809**	**0.2019**
a. Iron and steel	27.2532	0.0005	0.0000	0.0359	0.0141	0.0112	0.0003
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	1.6686	0.0000	0.0000	0.0022	0.0009	0.0007	0.0000
d. Pulp, paper and print	0.5562	0.0000	0.0000	0.0007	0.0003	0.0002	0.0000
e. Food processing, beverages and tobacco	60.3136	0.0033	0.0005	0.1236	0.2269	0.0376	0.1959
f. Non-metallic minerals	219.0040	0.0039	0.0004	0.2889	0.1132	0.0898	0.0026
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	11.2157	0.0002	0.0000	0.0148	0.0058	0.0046	0.0001
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	1.8076	0.0000	0.0000	0.0024	0.0009	0.0007	0.0000
k. Construction	8.4872	0.0002	0.0000	0.0277	0.0054	0.0032	0.0020
l. Textile and leather	41.4359	0.0007	0.0001	0.0547	0.0214	0.0170	0.0005
m. Other industries	38.6550	0.0007	0.0001	0.0510	0.0200	0.0158	0.0005
3. Transport	**1,405.7644**	**0.3418**	**0.0947**	**3.5165**	**16.6121**	**2.0849**	**0.1735**
a. Domestic aviation	0.0841	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
b. Road transportation	1,285.5278	0.3365	0.0631	2.1094	16.3153	1.9489	0.1575
c. Railways	81.6327	0.0046	0.0315	1.3570	0.2771	0.1204	0.0155
d. Domestic navigation	0.4824	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	38.0374	0.0007	0.0001	0.0502	0.0197	0.0156	0.0005
4. Other sectors	**1,747.8245**	**1.3555**	**0.1103**	**4.4782**	**20.7434**	**2.8052**	**3.0494**
a. Commercial/institutional	426.8063	0.0852	0.0039	0.6876	1.9660	0.3107	1.5930
b. Residential	1,065.7157	1.2513	0.0134	1.1067	16.9457	2.1953	1.4044
c. Agriculture/forestry/fishing	255.3025	0.0189	0.0930	2.6839	1.8318	0.2992	0.0521
ci. Stationary	10.9356	0.0012	0.0000	0.0267	0.0089	0.0039	0.0056
cii. Mobile	244.3669	0.0178	0.0930	2.6572	1.8229	0.2953	0.0464
5. Other	**39.4529**	**0.0083**	**0.0016**	**0.1411**	**0.2860**	**0.0683**	**0.1543**
a. Stationary	25.3685	0.0047	0.0009	0.0632	0.2530	0.0620	0.1534
b. Mobile	14.0844	0.0036	0.0007	0.0779	0.0330	0.0063	0.0008
B. Fugitive emissions from fuels	**0.3901**	**25.8825**	**0.0000**	**NO**	**NO**	**0.4697**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**0.3901**	**25.8825**	**0.0000**	**NO**	**NO**	**0.4697**	**NO**
a. Oil	0.0353	NO	0.0000	NO	NO	NO	NO
b. Natural gas	0.3548	25.8825				0.4697	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**59.9541**	**0.0036**	**0.0020**	**0.2413**	**0.1619**	**0.0653**	**0.0190**
Aviation	59.9541	0.0036	0.0020	0.2413	0.1619	0.0653	0.0190

Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**322.0800**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**7,178.5944**	**29.3273**	**0.2087**	**13.6324**	**48.5365**	**6.7927**	**5.7410**
A. Fuel combustion activities (sectoral approach)	7,177.5353	2.2688	0.2087	13.6324	48.5365	6.2607	5.7410
1. Energy industries	**3,036.7494**	**0.0626**	**0.0069**	**4.8529**	**2.0895**	**0.1407**	**0.5251**
a. Public electricity and heat production	3,036.7432	0.0626	0.0069	4.8529	2.0895	0.1407	0.5251
b. Petroleum refining	0.0062	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**438.8946**	**0.0096**	**0.0011**	**0.6697**	**0.3867**	**0.1868**	**0.1729**
a. Iron and steel	46.9701	0.0008	0.0001	0.0620	0.0243	0.0193	0.0006
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	1.8008	0.0000	0.0000	0.0024	0.0009	0.0007	0.0000
d. Pulp, paper and print	2.2833	0.0000	0.0000	0.0030	0.0012	0.0009	0.0000
e. Food processing, beverages and tobacco	87.1890	0.0033	0.0005	0.1935	0.2041	0.0428	0.1673
f. Non-metallic minerals	216.6633	0.0039	0.0004	0.2981	0.1128	0.0886	0.0040
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	13.6320	0.0002	0.0000	0.0180	0.0070	0.0056	0.0002
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	1.8008	0.0000	0.0000	0.0024	0.0009	0.0007	0.0000
k. Construction	5.8287	0.0001	0.0000	0.0077	0.0030	0.0024	0.0001
l. Textile and leather	26.4113	0.0005	0.0000	0.0348	0.0137	0.0108	0.0003
m. Other industries	36.3155	0.0006	0.0001	0.0479	0.0188	0.0149	0.0004
3. Transport	**1,588.8147**	**0.4004**	**0.0912**	**3.2350**	**19.3977**	**2.3730**	**0.2110**
a. Domestic aviation	0.6492	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000
b. Road transportation	1,517.3343	0.3974	0.0744	2.4785	19.2363	2.2979	0.2024
c. Railways	43.3647	0.0024	0.0167	0.7209	0.1472	0.0640	0.0083
d. Domestic navigation	0.4371	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	27.0294	0.0005	0.0000	0.0357	0.0140	0.0111	0.0003
4. Other sectors	**2,084.6537**	**1.7920**	**0.1085**	**4.7321**	**26.3815**	**3.5078**	**4.7236**
a. Commercial/institutional	580.5169	0.2144	0.0072	0.9785	3.2421	0.5411	2.5345
b. Residential	1,266.4167	1.5509	0.0154	1.3135	21.3449	2.6822	2.1437
c. Agriculture/forestry/fishing	237.7201	0.0267	0.0859	2.4401	1.7945	0.2845	0.0454
ci. Stationary	12.1050	0.0099	0.0002	0.0246	0.0244	0.0134	0.0032
cii. Mobile	225.6151	0.0168	0.0857	2.4155	1.7701	0.2711	0.0422
5. Other	**28.4228**	**0.0043**	**0.0009**	**0.1427**	**0.2811**	**0.0524**	**0.1085**
a. Stationary	20.4111	0.0027	0.0005	0.0565	0.1610	0.0359	0.1069
b. Mobile	8.0117	0.0016	0.0004	0.0862	0.1201	0.0166	0.0017
B. Fugitive emissions from fuels	**1.0592**	**27.0585**	**0.0000**	**NO**	**NO**	**0.5320**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.0592**	**27.0585**	**0.0000**	**NO**	**NO**	**0.5320**	**NO**
a. Oil	0.6825	0.0436	0.0000	NO	NO	0.0423	NO
b. Natural gas	0.3767	27.0149				0.4897	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**34.7676**	**0.0035**	**0.0012**	**0.1317**	**0.1223**	**0.0403**	**0.0110**
Aviation	34.7676	0.0035	0.0012	0.1317	0.1223	0.0403	0.0110
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**373.5760**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2004

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**7,629.0126**	**31.3493**	**0.2113**	**14.5781**	**45.4715**	**6.8425**	**4.8407**

A. Fuel combustion activities (sectoral approach)	7,627.9081	1.9794	0.2113	14.5781	45.4715	5.9870	4.8407
1. Energy industries	**3,109.0519**	**0.0640**	**0.0071**	**4.9687**	**2.1439**	**0.1442**	**0.4936**
a. Public electricity and heat production	3,107.0816	0.0639	0.0071	4.9649	2.1435	0.1442	0.4804
b. Petroleum refining	1.9703	0.0001	0.0000	0.0038	0.0004	0.0001	0.0132
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**443.9172**	**0.0115**	**0.0014**	**0.9313**	**0.4457**	**0.2047**	**0.2038**
a. Iron and steel	45.9378	0.0008	0.0001	0.0607	0.0264	0.0190	0.0032
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	2.4700	0.0000	0.0000	0.0037	0.0013	0.0010	0.0001
d. Pulp, paper and print	2.5342	0.0000	0.0000	0.0033	0.0013	0.0010	0.0000
e. Food processing, beverages and tobacco	68.1883	0.0042	0.0006	0.1748	0.2245	0.0476	0.1749
f. Non-metallic minerals	241.5433	0.0045	0.0005	0.3300	0.1379	0.0996	0.0167
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	13.6301	0.0003	0.0000	0.0190	0.0106	0.0058	0.0039
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	1.5422	0.0002	0.0000	0.0031	0.0048	0.0027	0.0001
k. Construction	9.3591	0.0003	0.0000	0.0311	0.0075	0.0039	0.0031
l. Textile and leather	25.7064	0.0005	0.0000	0.0351	0.0134	0.0105	0.0004
m. Other industries	33.0059	0.0006	0.0001	0.2705	0.0180	0.0136	0.0013
3. Transport	**1,787.2739**	**0.4316**	**0.1062**	**3.7615**	**21.1158**	**2.6011**	**0.2464**
a. Domestic aviation	0.3465	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	1,682.8848	0.4274	0.0829	2.7070	20.8895	2.4947	0.2344
c. Railways	59.9718	0.0034	0.0231	0.9969	0.2036	0.0885	0.0114
d. Domestic navigation	0.4437	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	43.6271	0.0008	0.0001	0.0575	0.0226	0.0179	0.0005
4. Other sectors	**2,260.0278**	**1.4692**	**0.0957**	**4.7005**	**21.4786**	**2.9899**	**3.8578**
a. Commercial/institutional	822.7869	0.1775	0.0062	1.2643	2.8567	0.5596	2.1550
b. Residential	1,220.2545	1.2703	0.0130	1.2394	17.2761	2.1827	1.6543
c. Agriculture/forestry/fishing	216.9864	0.0214	0.0764	2.1967	1.3459	0.2475	0.0485
ci. Stationary	17.0312	0.0075	0.0001	0.0282	0.0245	0.0103	0.0107
cii. Mobile	199.9552	0.0139	0.0763	2.1685	1.3214	0.2373	0.0378
5. Other	**27.6373**	**0.0031**	**0.0010**	**0.2161**	**0.2875**	**0.0472**	**0.0392**
a. Stationary	11.3982	0.0010	0.0002	0.0210	0.0596	0.0148	0.0372
b. Mobile	16.2391	0.0021	0.0008	0.1951	0.2280	0.0324	0.0019
B. Fugitive emissions from fuels	**1.1045**	**29.3699**	**0.0000**	**NO**	**NO**	**0.8554**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.1045**	**29.3699**	**0.0000**	**NO**	**NO**	**0.8554**	**NO**
a. Oil	0.7008	0.2735	0.0000	NO	NO	0.3269	NO
b. Natural gas	0.4037	29.0964				0.5285	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**34.7903**	**0.0035**	**0.0012**	**0.1283**	**0.1296**	**0.0344**	**0.0110**
Aviation	34.7903	0.0035	0.0012	0.1283	0.1296	0.0344	0.0110
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**307.6800**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**7,874.0484**	**33.0942**	**0.2113**	**15.3208**	**47.1427**	**6.9429**	**4.4388**
A. Fuel combustion activities (sectoral approach)	7,872.9265	2.0769	0.2113	15.3208	47.1427	6.1778	4.4388
1. Energy industries	**3,231.6708**	**0.0661**	**0.0073**	**5.1612**	**2.2323**	**0.1500**	**0.4532**
a. Public electricity and heat production	3,229.4503	0.0660	0.0072	5.1572	2.2318	0.1500	0.4400
b. Petroleum refining	2.2205	0.0001	0.0000	0.0040	0.0005	0.0001	0.0132
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**574.4257**	**0.0133**	**0.0015**	**1.4886**	**0.4932**	**0.2545**	**0.1904**
a. Iron and steel	67.1236	0.0012	0.0001	0.0887	0.0391	0.0277	0.0053
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	3.3632	0.0001	0.0000	0.0082	0.0020	0.0013	0.0005
d. Pulp, paper and print	3.1614	0.0001	0.0000	0.0042	0.0016	0.0013	0.0000
e. Food processing, beverages and tobacco	76.0554	0.0039	0.0006	0.1739	0.2093	0.0474	0.1602

f. Non-metallic minerals	311.1749	0.0057	0.0006	0.4239	0.1740	0.1281	0.0177
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	18.8073	0.0004	0.0000	0.0254	0.0130	0.0081	0.0030
i. Mining and quarrying	0.2244	0.0000	0.0000	0.0003	0.0001	0.0001	0.0000
j. Wood and wood production	2.1000	0.0002	0.0000	0.0046	0.0046	0.0027	0.0002
k. Construction	7.9570	0.0002	0.0000	0.0184	0.0055	0.0032	0.0019
l. Textile and leather	38.6593	0.0007	0.0001	0.0535	0.0202	0.0158	0.0007
m. Other industries	45.7991	0.0008	0.0001	0.6875	0.0238	0.0188	0.0008
3. Transport	**1,821.8133**	**0.4397**	**0.1150**	**4.1042**	**21.5603**	**2.6742**	**0.0452**
a. Domestic aviation	1.6632	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000
b. Road transportation	1,698.1860	0.4344	0.0836	2.7038	21.2636	2.5380	0.0427
c. Railways	81.0126	0.0045	0.0313	1.3467	0.2750	0.1195	0.0021
d. Domestic navigation	0.2572	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	40.6943	0.0007	0.0001	0.0537	0.0210	0.0167	0.0005
4. Other sectors	**2,219.0765**	**1.5553**	**0.0866**	**4.3367**	**22.7299**	**3.0691**	**3.7081**
a. Commercial/institutional	702.3918	0.1394	0.0050	1.0584	2.3491	0.4633	1.7723
b. Residential	1,331.6290	1.3938	0.0140	1.3513	19.0413	2.3831	1.9247
c. Agriculture/forestry/fishing	185.0557	0.0221	0.0675	1.9270	1.3395	0.2227	0.0112
ci. Stationary	7.8184	0.0091	0.0001	0.0155	0.0226	0.0100	0.0067
cii. Mobile	177.2373	0.0130	0.0674	1.9115	1.3168	0.2128	0.0045
5. Other	**25.9403**	**0.0024**	**0.0010**	**0.2301**	**0.1272**	**0.0300**	**0.0418**
a. Stationary	11.6992	0.0011	0.0002	0.0215	0.0654	0.0163	0.0405
b. Mobile	14.2411	0.0013	0.0007	0.2086	0.0618	0.0137	0.0013
B. Fugitive emissions from fuels	**1.1219**	**31.0174**	**0.0000**	**NO**	**NO**	**0.7651**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.1219**	**31.0174**	**0.0000**	**NO**	**NO**	**0.7651**	**NO**
a. Oil	0.6943	0.1750	0.0000	NO	NO	0.2050	NO
b. Natural gas	0.4275	30.8424				0.5602	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**37.9260**	**0.0035**	**0.0013**	**0.1433**	**0.1362**	**0.0373**	**0.0120**
Aviation	37.9260	0.0035	0.0013	0.1433	0.1362	0.0373	0.0120
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**307.3920**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2006

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**7,115.3279**	**29.6025**	**0.2164**	**14.0428**	**48.1466**	**7.0634**	**4.5650**
A. Fuel combustion activities (sectoral approach)	**7,114.1019**	**2.2722**	**0.2164**	**14.0428**	**48.1466**	**6.4042**	**4.5650**
1. Energy industries	**2,494.5441**	**0.0518**	**0.0057**	**3.9870**	**1.7266**	**0.1161**	**0.3443**
a. Public electricity and heat production	2,492.9310	0.0517	0.0057	3.9840	1.7263	0.1160	0.3339
b. Petroleum refining	1.6131	0.0001	0.0000	0.0030	0.0003	0.0000	0.0103
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**634.7036**	**0.0134**	**0.0015**	**1.2181**	**0.4873**	**0.2692**	**0.1704**
a. Iron and steel	76.1837	0.0014	0.0001	0.1007	0.0446	0.0315	0.0063
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	4.7471	0.0001	0.0000	0.0113	0.0028	0.0019	0.0006
d. Pulp, paper and print	3.9945	0.0001	0.0000	0.0053	0.0021	0.0016	0.0000
e. Food processing, beverages and tobacco	90.4278	0.0033	0.0005	0.1877	0.1909	0.0453	0.1482
f. Non-metallic minerals	308.9913	0.0056	0.0006	0.4204	0.1614	0.1265	0.0060
g. Transport equipment	0.5049	0.0000	0.0000	0.0007	0.0003	0.0002	0.0000
h. Machinery	25.8939	0.0005	0.0001	0.0351	0.0170	0.0108	0.0040
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	1.9401	0.0001	0.0000	0.0032	0.0022	0.0014	0.0001
k. Construction	16.6913	0.0004	0.0001	0.0444	0.0115	0.0069	0.0036
l. Textile and leather	59.7847	0.0011	0.0001	0.0797	0.0310	0.0245	0.0008
m. Other industries	45.5442	0.0008	0.0001	0.3297	0.0237	0.0187	0.0007
3. Transport	**1,742.1498**	**0.4060**	**0.1198**	**4.2102**	**19.7807**	**2.4731**	**0.0436**
a. Domestic aviation	0.1952	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	1,632.5602	0.4002	0.0807	2.5166	19.4329	2.3206	0.0409

c. Railways	101.2768	0.0057	0.0391	1.6835	0.3438	0.1494	0.0026
d. Domestic navigation	0.5150	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	7.6025	0.0001	0.0000	0.0100	0.0039	0.0031	0.0001
4. Other sectors	**2,203.6648**	**1.7981**	**0.0881**	**4.2950**	**25.7482**	**3.4823**	**3.8856**
a. Commercial/institutional	644.5057	0.1450	0.0050	0.9774	2.2544	0.4462	1.6893
b. Residential	1,380.1564	1.6302	0.0164	1.4268	22.3504	2.8199	2.1869
c. Agriculture/forestry/fishing	179.0027	0.0229	0.0668	1.8908	1.1435	0.2162	0.0094
ci. Stationary	4.4555	0.0109	0.0001	0.0097	0.0240	0.0110	0.0049
cii. Mobile	174.5472	0.0120	0.0666	1.8811	1.1194	0.2052	0.0044
5. Other	**39.0397**	**0.0029**	**0.0013**	**0.3325**	**0.4037**	**0.0635**	**0.1212**
a. Stationary	21.4826	0.0013	0.0004	0.0397	0.1547	0.0256	0.1197
b. Mobile	17.5571	0.0016	0.0009	0.2928	0.2491	0.0379	0.0015
B. Fugitive emissions from fuels	**1.2260**	**27.3303**	**0.0000**	**NO**	**NO**	**0.6592**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.2260**	**27.3303**	**0.0000**	**NO**	**NO**	**0.6592**	**NO**
a. Oil	0.8506	0.1484	0.0000	NO	NO	0.1653	NO
b. Natural gas	0.3754	27.1820				0.4939	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**37.9241**	**0.0039**	**0.0013**	**0.1428**	**0.1424**	**0.0397**	**0.0120**
Aviation	37.9241	0.0039	0.0013	0.1428	0.1424	0.0397	0.0120
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**361.4360**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2007

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**7,254.6164**	**30.8615**	**0.2092**	**14.5286**	**41.5390**	**6.4325**	**3.1267**
A. Fuel combustion activities (sectoral approach)	**7,253.3587**	**1.8076**	**0.2092**	**14.5286**	**41.5390**	**5.5816**	**3.1267**
1. Energy industries	**2,894.4441**	**0.0593**	**0.0064**	**4.6191**	**2.0159**	**0.1351**	**0.2335**
a. Public electricity and heat production	2,890.4481	0.0592	0.0063	4.6122	2.0151	0.1350	0.2113
b. Petroleum refining	3.9960	0.0002	0.0000	0.0069	0.0008	0.0001	0.0222
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**800.8383**	**0.0156**	**0.0017**	**1.8040**	**0.5048**	**0.3350**	**0.0992**
a. Iron and steel	205.9880	0.0037	0.0004	0.2719	0.1109	0.0847	0.0070
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	4.8752	0.0001	0.0000	0.0069	0.0026	0.0020	0.0001
d. Pulp, paper and print	3.7308	0.0001	0.0000	0.0049	0.0019	0.0015	0.0000
e. Food processing, beverages and tobacco	86.0581	0.0025	0.0003	0.1434	0.1174	0.0404	0.0732
f. Non-metallic minerals	304.0586	0.0055	0.0006	0.4151	0.1598	0.1245	0.0070
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	32.7994	0.0006	0.0001	0.0456	0.0215	0.0137	0.0051
i. Mining and quarrying	0.1122	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000
j. Wood and wood production	1.2629	0.0002	0.0000	0.0029	0.0036	0.0020	0.0002
k. Construction	46.3088	0.0009	0.0001	0.0855	0.0255	0.0186	0.0033
l. Textile and leather	60.1808	0.0011	0.0001	0.0795	0.0329	0.0248	0.0025
m. Other industries	55.4634	0.0010	0.0001	0.7482	0.0288	0.0227	0.0008
3. Transport	**1,846.8209**	**0.4275**	**0.1253**	**4.3251**	**20.3245**	**2.5389**	**0.0462**
a. Domestic aviation	1.0395	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000
b. Road transportation	1,740.0088	0.4217	0.0860	2.6263	19.9763	2.3871	0.0436
c. Railways	101.9157	0.0057	0.0393	1.6942	0.3459	0.1503	0.0026
d. Domestic navigation	0.3437	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	3.5131	0.0001	0.0000	0.0046	0.0018	0.0014	0.0000
4. Other sectors	**1,666.7458**	**1.3012**	**0.0741**	**3.3949**	**18.3862**	**2.5173**	**2.6494**
a. Commercial/institutional	361.9216	0.1193	0.0039	0.5932	1.7515	0.3099	1.3479
b. Residential	1,152.4286	1.1664	0.0126	1.1728	15.6716	2.0252	1.2959
c. Agriculture/forestry/fishing	152.3956	0.0155	0.0576	1.6289	0.9631	0.1822	0.0057
ci. Stationary	1.8161	0.0052	0.0001	0.0039	0.0113	0.0053	0.0019
cii. Mobile	150.5795	0.0103	0.0575	1.6250	0.9519	0.1768	0.0038
5. Other	**44.5097**	**0.0039**	**0.0017**	**0.3855**	**0.3075**	**0.0552**	**0.0983**
a. Stationary	17.7980	0.0014	0.0003	0.0335	0.1302	0.0238	0.0962

b. Mobile	26.7117	0.0025	0.0014	0.3520	0.1773	0.0315	0.0020
B. Fugitive emissions from fuels	**1.2577**	**29.0539**	**0.0000**	**NO**	**NO**	**0.8509**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.2577**	**29.0539**	**0.0000**	**NO**	**NO**	**0.8509**	**NO**
a. Oil	0.8624	0.2797	0.0000	NO	NO	0.3279	NO
b. Natural gas	0.3952	28.7741				0.5230	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**44.2052**	**0.0027**	**0.0015**	**0.1782**	**0.1296**	**0.0393**	**0.0140**
Aviation	44.2052	0.0027	0.0015	0.1782	0.1296	0.0393	0.0140
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**304.6560**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2008

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**7,554.7011**	**30.7785**	**0.2128**	**21.7647**	**43.8150**	**6.9585**	**4.7111**
A. Fuel combustion activities (sectoral approach)	**7,553.4263**	**1.8799**	**0.2128**	**21.7647**	**43.8150**	**5.8303**	**4.7111**
1. Energy industries	**2,997.3662**	**0.0655**	**0.0072**	**4.7979**	**2.0911**	**0.1406**	**0.3428**
a. Public electricity and heat production	2,990.8419	0.0652	0.0072	4.7865	2.0898	0.1404	0.3057
b. Petroleum refining	6.5242	0.0003	0.0001	0.0114	0.0013	0.0002	0.0371
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**885.0132**	**0.0337**	**0.0045**	**8.9704**	**2.2677**	**0.4690**	**1.8481**
a. Iron and steel	215.0768	0.0039	0.0004	0.2907	0.1150	0.0882	0.0068
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	5.5350	0.0001	0.0000	0.0074	0.0029	0.0023	0.0001
d. Pulp, paper and print	4.2395	0.0001	0.0000	0.0056	0.0022	0.0017	0.0001
e. Food processing, beverages and tobacco	98.0144	0.0027	0.0004	0.1801	0.1271	0.0448	0.0785
f. Non-metallic minerals	337.2822	0.0223	0.0032	0.5476	1.8897	0.2357	1.7516
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	31.7603	0.0006	0.0001	0.0476	0.0204	0.0132	0.0047
i. Mining and quarrying	0.0561	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
j. Wood and wood production	0.7587	0.0004	0.0001	0.0022	0.0078	0.0042	0.0002
k. Construction	58.0267	0.0011	0.0001	0.0969	0.0321	0.0238	0.0031
l. Textile and leather	59.2250	0.0011	0.0001	0.0825	0.0311	0.0243	0.0014
m. Other industries	75.0387	0.0014	0.0001	7.7098	0.0393	0.0307	0.0016
3. Transport	**1,950.0498**	**0.4512**	**0.1272**	**4.3022**	**20.8778**	**2.5997**	**0.0485**
a. Domestic aviation	0.1500	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	1,851.1715	0.4458	0.0910	2.7385	20.5573	2.4596	0.0461
c. Railways	93.6942	0.0052	0.0362	1.5575	0.3180	0.1382	0.0024
d. Domestic navigation	0.3441	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	4.6899	0.0001	0.0000	0.0062	0.0024	0.0019	0.0001
4. Other sectors	**1,677.3708**	**1.3260**	**0.0723**	**3.3719**	**18.2724**	**2.5708**	**2.3550**
a. Commercial/institutional	370.7184	0.1296	0.0040	0.6218	1.6815	0.3165	1.2642
b. Residential	1,156.8420	1.1821	0.0135	1.1865	15.7179	2.0802	1.0848
c. Agriculture/forestry/fishing	149.8105	0.0143	0.0549	1.5636	0.8729	0.1741	0.0060
ci. Stationary	6.1945	0.0046	0.0001	0.0097	0.0117	0.0059	0.0024
cii. Mobile	143.6160	0.0097	0.0549	1.5539	0.8613	0.1681	0.0036
5. Other	**43.6263**	**0.0036**	**0.0015**	**0.3223**	**0.3060**	**0.0503**	**0.1167**
a. Stationary	20.3604	0.0011	0.0003	0.0393	0.1450	0.0228	0.1147
b. Mobile	23.2659	0.0025	0.0012	0.2830	0.1610	0.0274	0.0020
B. Fugitive emissions from fuels	**1.2748**	**28.8986**	**0.0000**	**NO**	**NO**	**1.1281**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.2748**	**28.8986**	**0.0000**	**NO**	**NO**	**1.1281**	**NO**
a. Oil	0.8808	0.5096	0.0000	NO	NO	0.6125	NO
b. Natural gas	0.3940	28.3890				0.5156	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO

C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**44.1680**	**0.0016**	**0.0014**	**0.1855**	**0.1080**	**0.0365**	**0.0140**
Aviation	44.1680	0.0016	0.0014	0.1855	0.1080	0.0365	0.0140
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**352.4520**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2009

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,095.5552**	**25.9141**	**0.1933**	**14.1829**	**44.1050**	**6.8238**	**4.6784**
A. Fuel combustion activities (sectoral approach)	**8,094.2820**	**1.9968**	**0.1933**	**14.1829**	**44.1050**	**5.7115**	**4.6784**
1. Energy industries	**3,844.8870**	**0.0835**	**0.0093**	**6.1595**	**2.6604**	**0.1794**	**0.6695**
a. Public electricity and heat production	3,835.5110	0.0831	0.0092	6.1430	2.6585	0.1791	0.6150
b. Petroleum refining	9.3760	0.0004	0.0001	0.0165	0.0019	0.0003	0.0545
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**494.2397**	**0.0215**	**0.0029**	**0.7591**	**1.5897**	**0.2773**	**1.3676**
a. Iron and steel	74.7795	0.0014	0.0001	0.1017	0.0399	0.0307	0.0023
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	3.7690	0.0001	0.0000	0.0050	0.0020	0.0015	0.0001
d. Pulp, paper and print	2.8343	0.0001	0.0000	0.0038	0.0015	0.0012	0.0001
e. Food processing, beverages and tobacco	54.5104	0.0014	0.0002	0.0751	0.0756	0.0249	0.0491
f. Non-metallic minerals	219.2269	0.0160	0.0023	0.3748	1.3959	0.1620	1.3108
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	13.5838	0.0002	0.0000	0.0184	0.0072	0.0056	0.0004
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	0.2337	0.0000	0.0000	0.0003	0.0001	0.0001	0.0000
k. Construction	9.3637	0.0002	0.0000	0.0223	0.0056	0.0037	0.0013
l. Textile and leather	38.8219	0.0007	0.0001	0.0527	0.0207	0.0159	0.0012
m. Other industries	77.1164	0.0014	0.0001	0.1049	0.0412	0.0316	0.0024
3. Transport	**1,919.7221**	**0.4576**	**0.1112**	**3.6631**	**20.7880**	**2.5446**	**0.0046**
a. Domestic aviation	0.0752	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
b. Road transportation	1,856.3041	0.4544	0.0914	2.7946	20.6078	2.4641	0.0043
c. Railways	51.3203	0.0029	0.0198	0.8531	0.1742	0.0757	0.0001
d. Domestic navigation	0.3447	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	11.6778	0.0002	0.0000	0.0154	0.0060	0.0048	0.0001
4. Other sectors	**1,824.9424**	**1.4331**	**0.0696**	**3.4994**	**18.9129**	**2.6852**	**2.6186**
a. Commercial/institutional	476.5648	0.2179	0.0053	0.7996	1.9153	0.4377	1.3016
b. Residential	1,209.2046	1.1981	0.0130	1.2291	16.0649	2.0783	1.3140
c. Agriculture/forestry/fishing	139.1730	0.0171	0.0513	1.4707	0.9328	0.1692	0.0029
ci. Stationary	4.6102	0.0074	0.0001	0.0087	0.0165	0.0083	0.0025
cii. Mobile	134.5628	0.0098	0.0512	1.4619	0.9163	0.1609	0.0004
5. Other	**10.4909**	**0.0011**	**0.0003**	**0.1018**	**0.1540**	**0.0251**	**0.0182**
a. Stationary	7.4748	0.0006	0.0001	0.0162	0.0299	0.0081	0.0181
b. Mobile	3.0161	0.0006	0.0002	0.0856	0.1241	0.0170	0.0000
B. Fugitive emissions from fuels	**1.2732**	**23.9173**	**0.0000**	**NO**	**NO**	**1.1123**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.2732**	**23.9173**	**0.0000**	**NO**	**NO**	**1.1123**	**NO**
a. Oil	0.8893	0.5753	0.0000	NO	NO	0.6938	NO
b. Natural gas	0.3839	23.3420				0.4185	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**44.1719**	**0.0017**	**0.0014**	**0.1878**	**0.1094**	**0.0380**	**0.0140**
Aviation	44.1719	0.0017	0.0014	0.1878	0.1094	0.0380	0.0140
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**362.1000**						
CO_2 captured	NO						

For domestic storage	NO						
For storage in other countries	NO						

2010

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,632.1613**	**25.3328**	**0.2091**	**15.1357**	**45.4312**	**6.6774**	**3.9590**
A. Fuel combustion activities (sectoral approach)	**8,630.8866**	**2.1399**	**0.2091**	**15.1357**	**45.4312**	**5.8205**	**3.9590**
1. Energy industries	**4,054.4452**	**0.0894**	**0.0099**	**6.4930**	**2.8209**	**0.1900**	**0.5660**
a. Public electricity and heat production	4,047.8107	0.0891	0.0098	6.4814	2.8196	0.1898	0.5281
b. Petroleum refining	6.6345	0.0003	0.0001	0.0115	0.0013	0.0002	0.0379
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**422.5661**	**0.0120**	**0.0015**	**0.9779**	**0.5900**	**0.1993**	**0.3732**
a. Iron and steel	40.8744	0.0008	0.0001	0.0550	0.0243	0.0169	0.0038
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	3.9111	0.0001	0.0000	0.0053	0.0021	0.0016	0.0001
d. Pulp, paper and print	3.0075	0.0001	0.0000	0.0044	0.0016	0.0012	0.0001
e. Food processing, beverages and tobacco	69.0254	0.0020	0.0003	0.1206	0.1018	0.0328	0.0669
f. Non-metallic minerals	147.3193	0.0053	0.0007	0.2241	0.3584	0.0752	0.2913
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	17.7529	0.0004	0.0000	0.0283	0.0126	0.0080	0.0027
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	0.6096	0.0006	0.0001	0.0027	0.0123	0.0065	0.0002
k. Construction	17.0147	0.0005	0.0001	0.0626	0.0117	0.0066	0.0047
l. Textile and leather	48.7909	0.0009	0.0001	0.0655	0.0258	0.0200	0.0013
m. Other industries	74.2603	0.0013	0.0001	0.4093	0.0394	0.0305	0.0020
3. Transport	**2,140.5856**	**0.4708**	**0.1225**	**3.7759**	**19.9436**	**2.4515**	**0.0052**
a. Domestic aviation	0.3465	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	2,070.0334	0.4676	0.1023	2.8843	19.7570	2.3672	0.0048
c. Railways	52.2332	0.0029	0.0202	0.8683	0.1773	0.0771	0.0001
d. Domestic navigation	0.2590	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	17.7135	0.0003	0.0000	0.0234	0.0092	0.0073	0.0002
4. Other sectors	**1,985.9921**	**1.5654**	**0.0746**	**3.7644**	**21.8247**	**2.9363**	**2.9155**
a. Commercial/institutional	477.2015	0.1304	0.0035	0.7498	1.3667	0.3305	0.9312
b. Residential	1,353.0451	1.4132	0.0141	1.3733	19.3270	2.4123	1.9815
c. Agriculture/forestry/fishing	155.7455	0.0218	0.0570	1.6413	1.1309	0.1935	0.0028
ci. Stationary	5.8039	0.0105	0.0001	0.0106	0.0226	0.0118	0.0023
cii. Mobile	149.9416	0.0114	0.0569	1.6307	1.1083	0.1818	0.0005
5. Other	**27.2976**	**0.0023**	**0.0006**	**0.1245**	**0.2519**	**0.0434**	**0.0991**
a. Stationary	23.7958	0.0017	0.0004	0.0438	0.1389	0.0278	0.0991
b. Mobile	3.5018	0.0007	0.0002	0.0806	0.1130	0.0156	0.0000
B. Fugitive emissions from fuels	**1.2747**	**23.1928**	**0.0000**	**NO**	**NO**	**0.8568**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.2747**	**23.1928**	**0.0000**	**NO**	**NO**	**0.8568**	**NO**
a. Oil	0.8778	0.3783	0.0000	NO	NO	0.4499	NO
b. Natural gas	0.3969	22.8146				0.4070	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**41.0593**	**0.0026**	**0.0014**	**0.1667**	**0.1218**	**0.0377**	**0.0130**
Aviation	41.0593	0.0026	0.0014	0.1667	0.1218	0.0377	0.0130
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**341.0480**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2011

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,932.6787**	**28.6871**	**0.2165**	**15.2503**	**48.9451**	**7.3977**	**4.8498**
A. Fuel combustion activities (sectoral approach)	**8,931.3646**	**2.2709**	**0.2164**	**15.2503**	**48.9451**	**6.4011**	**4.8498**
1. Energy industries	**3,752.5675**	**0.0801**	**0.0087**	**5.9997**	**2.6109**	**0.1755**	**0.4345**
a. Public electricity and heat production	3,746.1444	0.0799	0.0087	5.9885	2.6096	0.1753	0.3978
b. Petroleum refining	6.4231	0.0003	0.0001	0.0112	0.0013	0.0002	0.0367

c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**575.5238**	**0.0263**	**0.0036**	**1.1461**	**1.8629**	**0.3338**	**1.5813**
a. Iron and steel	53.4830	0.0010	0.0001	0.0726	0.0327	0.0222	0.0059
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	5.8483	0.0001	0.0000	0.0152	0.0035	0.0023	0.0010
d. Pulp, paper and print	5.6177	0.0001	0.0000	0.0074	0.0029	0.0023	0.0001
e. Food processing, beverages and tobacco	73.3569	0.0022	0.0003	0.1077	0.1108	0.0356	0.0721
f. Non-metallic minerals	276.1642	0.0186	0.0027	0.4479	1.6002	0.1933	1.4922
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	19.4960	0.0005	0.0001	0.0279	0.0144	0.0093	0.0024
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	0.5716	0.0011	0.0001	0.0039	0.0202	0.0107	0.0004
k. Construction	16.2007	0.0004	0.0001	0.0551	0.0109	0.0064	0.0040
l. Textile and leather	48.3919	0.0009	0.0001	0.0652	0.0267	0.0205	0.0012
m. Other industries	76.3933	0.0014	0.0001	0.3431	0.0405	0.0313	0.0020
3. Transport	**2,272.7076**	**0.4687**	**0.1281**	**3.8091**	**20.7693**	**2.5479**	**0.0056**
a. Domestic aviation	0.0693	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
b. Road transportation	2,197.5929	0.4655	0.1094	2.9729	20.5920	2.4659	0.0052
c. Railways	48.1916	0.0027	0.0186	0.8011	0.1636	0.0711	0.0001
d. Domestic navigation	0.2596	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	26.5942	0.0005	0.0000	0.0351	0.0137	0.0109	0.0003
4. Other sectors	**2,310.7777**	**1.6944**	**0.0756**	**4.1423**	**23.3551**	**3.2990**	**2.7405**
a. Commercial/institutional	806.0042	0.1538	0.0040	1.1678	1.5327	0.4616	0.9375
b. Residential	1,352.5610	1.5224	0.0161	1.3930	20.6430	2.6529	1.7971
c. Agriculture/forestry/fishing	152.2126	0.0182	0.0555	1.5815	1.1793	0.1845	0.0058
ci. Stationary	5.8163	0.0067	0.0001	0.0099	0.0168	0.0071	0.0054
cii. Mobile	146.3963	0.0114	0.0554	1.5716	1.1625	0.1773	0.0005
5. Other	**19.7881**	**0.0013**	**0.0004**	**0.1531**	**0.3469**	**0.0449**	**0.0879**
a. Stationary	15.9259	0.0007	0.0002	0.0276	0.1091	0.0164	0.0878
b. Mobile	3.8622	0.0006	0.0002	0.1255	0.2378	0.0285	0.0001
B. Fugitive emissions from fuels	**1.3141**	**26.4162**	**0.0000**	**NO**	**NO**	**0.9966**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.3141**	**26.4162**	**0.0000**	**NO**	**NO**	**0.9966**	**NO**
a. Oil	0.8859	0.4439	0.0000	NO	NO	0.5312	NO
b. Natural gas	0.4282	25.9723				0.4654	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**41.0082**	**0.0028**	**0.0013**	**0.1611**	**0.1246**	**0.0496**	**0.0130**
Aviation	41.0082	0.0028	0.0013	0.1611	0.1246	0.0496	0.0130
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**384.6400**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2012

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,516.3274**	**28.4550**	**0.2003**	**14.7349**	**46.5729**	**7.0769**	**4.0166**
A. Fuel combustion activities (sectoral approach)	**8,515.0170**	**2.4185**	**0.2003**	**14.7349**	**46.5729**	**6.1673**	**4.0166**
1. Energy industries	**3,810.0873**	**0.0758**	**0.0086**	**6.0970**	**2.6166**	**0.1758**	**0.7051**
a. Public electricity and heat production	3,803.4077	0.0755	0.0086	6.0853	2.6153	0.1756	0.6665
b. Petroleum refining	6.6796	0.0003	0.0001	0.0117	0.0014	0.0002	0.0386
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**433.9361**	**0.0111**	**0.0013**	**1.1466**	**0.4237**	**0.2029**	**0.1794**
a. Iron and steel	65.1111	0.0012	0.0001	0.0872	0.0342	0.0267	0.0014
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	5.8764	0.0001	0.0000	0.0079	0.0031	0.0024	0.0001
d. Pulp, paper and print	3.5210	0.0001	0.0000	0.0047	0.0018	0.0014	0.0000
e. Food processing, beverages and tobacco	80.7580	0.0025	0.0003	0.1199	0.1299	0.0400	0.0867
f. Non-metallic minerals	112.3394	0.0027	0.0003	0.1554	0.1357	0.0502	0.0809
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	18.8443	0.0004	0.0000	0.0257	0.0117	0.0078	0.0022
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO

j. Wood and wood production	1.1744	0.0014	0.0002	0.0065	0.0263	0.0140	0.0006
k. Construction	18.8991	0.0005	0.0001	0.0564	0.0121	0.0075	0.0038
l. Textile and leather	46.8614	0.0009	0.0001	0.0629	0.0266	0.0199	0.0019
m. Other industries	80.5508	0.0014	0.0001	0.6201	0.0424	0.0330	0.0018
3. Transport	**1,992.5907**	**0.4049**	**0.1152**	**3.4048**	**17.0098**	**2.1022**	**0.0048**
a. Domestic aviation	0.1386	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	1,916.4223	0.4016	0.0951	2.5099	16.8211	2.0158	0.0044
c. Railways	51.9397	0.0029	0.0200	0.8634	0.1763	0.0766	0.0001
d. Domestic navigation	0.2601	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	23.8300	0.0004	0.0000	0.0314	0.0123	0.0098	0.0003
4. Other sectors	**2,271.4679**	**1.9260**	**0.0750**	**4.0329**	**26.3885**	**3.6707**	**3.1225**
a. Commercial/institutional	777.0093	0.1756	0.0041	1.1061	1.4891	0.4719	0.8608
b. Residential	1,345.5955	1.7270	0.0175	1.4064	23.7408	3.0150	2.2553
c. Agriculture/forestry/fishing	148.8631	0.0235	0.0534	1.5204	1.1586	0.1838	0.0065
ci. Stationary	8.4205	0.0126	0.0002	0.0145	0.0290	0.0137	0.0060
cii. Mobile	140.4426	0.0109	0.0532	1.5059	1.1296	0.1701	0.0004
5. Other	**6.9350**	**0.0006**	**0.0002**	**0.0536**	**0.1342**	**0.0157**	**0.0047**
a. Stationary	3.5864	0.0001	0.0000	0.0057	0.0070	0.0019	0.0046
b. Mobile	3.3486	0.0005	0.0002	0.0479	0.1273	0.0138	0.0000
B. Fugitive emissions from fuels	**1.3104**	**26.0365**	**0.0000**	**NO**	**NO**	**0.9095**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.3104**	**26.0365**	**0.0000**	**NO**	**NO**	**0.9095**	**NO**
a. Oil	0.8861	0.3783	0.0000	NO	NO	0.4499	NO
b. Natural gas	0.4243	25.6583				0.4597	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**47.3142**	**0.0028**	**0.0015**	**0.1806**	**0.1322**	**0.0558**	**0.0150**
Aviation	47.3142	0.0028	0.0015	0.1806	0.1322	0.0558	0.0150
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**403.3840**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2013

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,232.5336**	**27.2893**	**0.2194**	**14.0791**	**48.5108**	**7.1035**	**12.4901**
A. Fuel combustion activities (sectoral approach)	**8,230.8896**	**2.4910**	**0.2194**	**14.0791**	**48.5108**	**6.2507**	**12.4901**
1. Energy industries	**3,603.6566**	**0.0679**	**0.0189**	**6.2373**	**2.0266**	**0.1399**	**7.1687**
a. Public electricity and heat production	3,596.7176	0.0677	0.0188	6.2249	2.0253	0.1397	7.1268
b. Petroleum refining	6.9390	0.0003	0.0001	0.0124	0.0014	0.0002	0.0419
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**575.6355**	**0.0299**	**0.0042**	**0.8821**	**2.2984**	**0.3553**	**2.0310**
a. Iron and steel	31.7706	0.0006	0.0001	0.0430	0.0183	0.0131	0.0024
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	7.4355	0.0004	0.0000	0.0180	0.0083	0.0050	0.0010
d. Pulp, paper and print	3.6648	0.0001	0.0000	0.0049	0.0019	0.0015	0.0000
e. Food processing, beverages and tobacco	82.3397	0.0026	0.0003	0.1167	0.1201	0.0420	0.0717
f. Non-metallic minerals	302.2747	0.0233	0.0034	0.4927	2.0645	0.2291	1.9523
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	17.7355	0.0003	0.0000	0.0239	0.0093	0.0073	0.0003
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	4.6059	0.0005	0.0001	0.0073	0.0098	0.0058	0.0002
k. Construction	14.8863	0.0003	0.0000	0.0260	0.0082	0.0061	0.0009
l. Textile and leather	51.6217	0.0009	0.0001	0.0697	0.0270	0.0211	0.0010
m. Other industries	59.3009	0.0011	0.0001	0.0801	0.0310	0.0243	0.0011
3. Transport	**2,101.3096**	**0.4086**	**0.1153**	**3.1411**	**16.4003**	**2.0085**	**0.0049**
a. Domestic aviation	0.1945	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	2,052.7538	0.4065	0.1024	2.5682	16.2795	1.9533	0.0046
c. Railways	33.2930	0.0019	0.0128	0.5534	0.1130	0.0491	0.0001
d. Domestic navigation	0.2608	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	14.8075	0.0003	0.0000	0.0195	0.0077	0.0061	0.0002
4. Other sectors	**1,947.9381**	**1.9842**	**0.0809**	**3.7783**	**27.7557**	**3.7434**	**3.2852**

a. Commercial/institutional	471.0134	0.1303	0.0035	0.6965	1.3776	0.3334	0.9323
b. Residential	1,311.5084	1.8255	0.0186	1.3894	25.1279	3.2071	2.3343
c. Agriculture/forestry/fishing	165.4163	0.0284	0.0589	1.6923	1.2502	0.2029	0.0185
ci. Stationary	10.5355	0.0166	0.0002	0.0184	0.0420	0.0149	0.0181
cii. Mobile	154.8808	0.0118	0.0587	1.6739	1.2082	0.1880	0.0005
5. Other	**2.3497**	**0.0003**	**0.0001**	**0.0403**	**0.0297**	**0.0037**	**0.0003**
a. Stationary	0.2064	0.0000	0.0000	0.0008	0.0002	0.0001	0.0003
b. Mobile	2.1433	0.0003	0.0001	0.0395	0.0295	0.0036	0.0000
B. Fugitive emissions from fuels	**1.6441**	**24.7983**	**0.0000**	**NO**	**NO**	**0.8528**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.6441**	**24.7983**	**0.0000**	**NO**	**NO**	**0.8528**	**NO**
a. Oil	1.2856	0.3539	0.0000	NO	NO	0.4105	NO
b. Natural gas	0.3585	24.4443				0.4423	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**41.0717**	**0.0046**	**0.0013**	**0.1592**	**0.1584**	**0.0571**	**0.0130**
Aviation	41.0717	0.0046	0.0013	0.1592	0.1584	0.0571	0.0130
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**429.2796**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2014

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,100.9817**	**28.3950**	**0.2423**	**13.6328**	**74.2343**	**11.1095**	**3.5942**
A. Fuel combustion activities (sectoral approach)	**8,099.3097**	**4.5821**	**0.2422**	**13.6328**	**74.2343**	**10.3588**	**3.5942**
1. Energy industries	**3,562.1775**	**0.0752**	**0.0083**	**5.7085**	**2.4794**	**0.1666**	**0.4461**
a. Public electricity and heat production	3,555.9756	0.0750	0.0082	5.6971	2.4781	0.1664	0.4068
b. Petroleum refining	6.2019	0.0002	0.0000	0.0114	0.0012	0.0002	0.0394
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**443.8148**	**0.0139**	**0.0018**	**0.6822**	**0.7672**	**0.2183**	**0.5408**
a. Iron and steel	67.3977	0.0012	0.0001	0.0907	0.0354	0.0276	0.0015
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	6.5826	0.0001	0.0000	0.0088	0.0034	0.0027	0.0001
d. Pulp, paper and print	3.8055	0.0001	0.0000	0.0050	0.0020	0.0016	0.0001
e. Food processing, beverages and tobacco	92.2655	0.0032	0.0004	0.1736	0.1611	0.0468	0.1116
f. Non-metallic minerals	121.9674	0.0060	0.0008	0.1806	0.4747	0.0725	0.4221
g. Transport equipment	NO	NO	NO	NO	NO	NO	NO
h. Machinery	10.9026	0.0002	0.0000	0.0147	0.0057	0.0045	0.0002
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	2.3703	0.0005	0.0001	0.0046	0.0104	0.0058	0.0002
k. Construction	23.9061	0.0005	0.0001	0.0499	0.0143	0.0099	0.0024
l. Textile and leather	34.8302	0.0006	0.0001	0.0468	0.0183	0.0143	0.0008
m. Other industries	79.7870	0.0014	0.0001	0.1074	0.0419	0.0327	0.0018
3. Transport	**2,140.5749**	**0.4056**	**0.1070**	**2.6984**	**16.1489**	**1.9476**	**0.0049**
a. Domestic aviation	0.1386	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	2,115.9635	0.4049	0.1058	2.6265	16.1294	1.9356	0.0047
c. Railways	2.7887	0.0002	0.0011	0.0464	0.0095	0.0041	0.0000
d. Domestic navigation	2.3529	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000
e. Other transportation	19.3312	0.0003	0.0000	0.0255	0.0100	0.0079	0.0002
4. Other sectors	**1,927.7357**	**4.0868**	**0.1247**	**4.4921**	**54.5828**	**8.0026**	**2.4012**
a. Commercial/institutional	482.9781	0.1892	0.0038	0.7164	1.2199	0.3830	0.6697
b. Residential	1,246.5418	3.8638	0.0477	1.6926	51.8127	7.3703	1.7147
c. Agriculture/forestry/fishing	198.2158	0.0339	0.0732	2.0830	1.5501	0.2492	0.0168
ci. Stationary	5.7310	0.0191	0.0002	0.0124	0.0444	0.0165	0.0162
cii. Mobile	192.4849	0.0147	0.0730	2.0706	1.5057	0.2327	0.0006
5. Other	**25.0067**	**0.0006**	**0.0005**	**0.0516**	**0.2560**	**0.0237**	**0.2011**
a. Stationary	22.8029	0.0002	0.0004	0.0421	0.2229	0.0213	0.2011
b. Mobile	2.2039	0.0003	0.0001	0.0095	0.0331	0.0025	0.0000
B. Fugitive emissions from fuels	**1.6721**	**23.8129**	**0.0000**	**NO**	**NO**	**0.7507**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	

b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.6721**	**23.8129**	**0.0000**	**NO**	**NO**	**0.7507**	**NO**
a. Oil	1.2829	0.2883	0.0000	NO	NO	0.3292	NO
b. Natural gas	0.3892	23.5247				0.4215	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**53.6855**	**0.0034**	**0.0018**	**0.2110**	**0.1599**	**0.0553**	**0.0170**
Aviation	53.6855	0.0034	0.0018	0.2110	0.1599	0.0553	0.0170
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**1,314.4896**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,414.0596**	**27.5422**	**0.2680**	**14.3835**	**79.7012**	**11.9147**	**4.3217**
A. Fuel combustion activities (sectoral approach)	**8,412.4014**	**4.8782**	**0.2680**	**14.3835**	**79.7012**	**11.2253**	**4.3217**
1. Energy industries	**3,686.3133**	**0.0659**	**0.0067**	**5.8546**	**2.5551**	**0.1705**	**0.1241**
a. Public electricity and heat production	3,680.5003	0.0657	0.0067	5.8439	2.5540	0.1704	0.0871
b. Petroleum refining	5.8130	0.0002	0.0000	0.0108	0.0012	0.0002	0.0370
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**651.5441**	**0.0405**	**0.0055**	**0.8128**	**2.1701**	**0.4888**	**1.6259**
a. Iron and steel	49.7715	0.0009	0.0001	0.0672	0.0262	0.0204	0.0011
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	4.5092	0.0002	0.0000	0.0089	0.0048	0.0030	0.0004
d. Pulp, paper and print	4.1181	0.0001	0.0000	0.0055	0.0021	0.0017	0.0001
e. Food processing, beverages and tobacco	81.4230	0.0032	0.0004	0.1245	0.1168	0.0489	0.0532
f. Non-metallic minerals	239.3253	0.0180	0.0026	0.4005	1.5777	0.1805	1.4848
g. Transport equipment	0.1000	0.0000	0.0000	0.0001	0.0006	0.0003	0.0000
h. Machinery	9.3882	0.0002	0.0000	0.0131	0.0058	0.0039	0.0012
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	0.2065	0.0004	0.0001	0.0015	0.0075	0.0040	0.0001
k. Construction	13.5991	0.0003	0.0000	0.0274	0.0077	0.0055	0.0013
l. Textile and leather	26.9907	0.0005	0.0001	0.0365	0.0147	0.0114	0.0006
m. Other industries	222.2125	0.0167	0.0022	0.1276	0.4060	0.2094	0.0832
3. Transport	**2,261.5959**	**0.4285**	**0.1197**	**3.1090**	**16.5574**	**2.0183**	**0.0051**
a. Domestic aviation	0.3082	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	2,216.7708	0.4267	0.1109	2.7094	16.4708	1.9771	0.0048
c. Railways	22.4827	0.0013	0.0087	0.3737	0.0763	0.0332	0.0000
d. Domestic navigation	2.4400	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000
e. Other transportation	19.5943	0.0003	0.0000	0.0258	0.0101	0.0080	0.0002
4. Other sectors	**1,790.2120**	**4.3428**	**0.1357**	**4.5595**	**58.1877**	**8.5261**	**2.3805**
a. Commercial/institutional	340.0285	0.1451	0.0032	0.5495	1.0622	0.2889	0.6518
b. Residential	1,231.3854	4.1654	0.0518	1.7302	55.8313	7.9789	1.7027
c. Agriculture/forestry/fishing	218.7982	0.0323	0.0807	2.2799	1.2941	0.2583	0.0260
ci. Stationary	7.9737	0.0180	0.0002	0.0147	0.0468	0.0134	0.0253
cii. Mobile	210.8245	0.0142	0.0806	2.2652	1.2474	0.2449	0.0007
5. Other	**22.7360**	**0.0005**	**0.0004**	**0.0475**	**0.2309**	**0.0216**	**0.1861**
a. Stationary	21.0924	0.0002	0.0003	0.0389	0.2062	0.0197	0.1861
b. Mobile	1.6436	0.0003	0.0001	0.0086	0.0247	0.0019	0.0000
B. Fugitive emissions from fuels	**1.6581**	**22.6641**	**0.0000**	**NO**	**NO**	**0.6894**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.6581**	**22.6641**	**0.0000**	**NO**	**NO**	**0.6894**	**NO**
a. Oil	1.2797	0.2554	0.0000	NO	NO	0.2886	NO
b. Natural gas	0.3785	22.4087				0.4008	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						

Memo items:							
International bunkers	**56.8077**	**0.0056**	**0.0018**	**0.2255**	**0.1841**	**0.0817**	**0.0180**
Aviation	56.8077	0.0056	0.0018	0.2255	0.1841	0.0817	0.0180
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**1,428.4386**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2016

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,506.6885**	**29.7033**	**0.2875**	**14.6974**	**83.3929**	**12.6250**	**3.5714**
A. Fuel combustion activities (sectoral approach)	**8,505.0181**	**5.2597**	**0.2875**	**14.6974**	**83.3929**	**11.9423**	**3.5714**
1. Energy industries	**3,644.9312**	**0.0657**	**0.0069**	**5.7964**	**2.5196**	**0.1682**	**0.2330**
a. Public electricity and heat production	3,640.9061	0.0656	0.0069	5.7905	2.5188	0.1681	0.2166
b. Petroleum refining	4.0252	0.0002	0.0000	0.0059	0.0008	0.0001	0.0164
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**641.3590**	**0.0345**	**0.0047**	**0.7558**	**1.6752**	**0.4441**	**1.1555**
a. Iron and steel	41.7346	0.0008	0.0001	0.0563	0.0219	0.0171	0.0009
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	6.1742	0.0001	0.0000	0.0087	0.0033	0.0025	0.0002
d. Pulp, paper and print	3.4368	0.0001	0.0000	0.0046	0.0018	0.0014	0.0000
e. Food processing, beverages and tobacco	93.8442	0.0032	0.0004	0.1609	0.1222	0.0495	0.0618
f. Non-metallic minerals	179.8937	0.0120	0.0017	0.2892	1.0247	0.1258	0.9526
g. Transport equipment	0.6339	0.0000	0.0000	0.0047	0.0006	0.0002	0.0004
h. Machinery	11.3216	0.0003	0.0000	0.0158	0.0083	0.0050	0.0021
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	0.2293	0.0002	0.0000	0.0008	0.0030	0.0016	0.0001
k. Construction	15.6972	0.0004	0.0000	0.0262	0.0097	0.0070	0.0009
l. Textile and leather	33.6231	0.0006	0.0001	0.0454	0.0182	0.0141	0.0007
m. Other industries	254.7704	0.0170	0.0023	0.1433	0.4616	0.2198	0.1358
3. Transport	**2,428.3819**	**0.4966**	**0.1370**	**3.5658**	**16.9243**	**2.0880**	**0.0054**
a. Domestic aviation	0.2278	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	2,362.5871	0.4935	0.1188	2.7637	16.7562	2.0119	0.0051
c. Railways	46.9095	0.0026	0.0181	0.7798	0.1592	0.0692	0.0001
d. Domestic navigation	1.8175	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	16.8399	0.0003	0.0000	0.0222	0.0087	0.0069	0.0002
4. Other sectors	**1,767.4874**	**4.6624**	**0.1384**	**4.5317**	**62.0479**	**9.2199**	**1.9853**
a. Commercial/institutional	338.3570	0.1263	0.0029	0.5233	1.0317	0.2712	0.6526
b. Residential	1,218.4931	4.5000	0.0574	1.7856	59.9968	8.6972	1.3069
c. Agriculture/forestry/fishing	210.6373	0.0361	0.0781	2.2228	1.0193	0.2515	0.0257
ci. Stationary	7.8135	0.0235	0.0002	0.0164	0.0570	0.0190	0.0251
cii. Mobile	202.8239	0.0126	0.0779	2.2064	0.9624	0.2325	0.0006
5. Other	**22.8586**	**0.0005**	**0.0004**	**0.0476**	**0.2260**	**0.0221**	**0.1923**
a. Stationary	21.6596	0.0002	0.0003	0.0396	0.2132	0.0203	0.1923
b. Mobile	1.1989	0.0002	0.0001	0.0080	0.0128	0.0017	0.0000
B. Fugitive emissions from fuels	**1.6704**	**24.4436**	**0.0000**	**NO**	**NO**	**0.6827**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.6704**	**24.4436**	**0.0000**	**NO**	**NO**	**0.6827**	**NO**
a. Oil	1.2788	0.2226	0.0000	NO	NO	0.2479	NO
b. Natural gas	0.3916	24.2211				0.4348	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**100.9698**	**0.0062**	**0.0033**	**0.4139**	**0.2665**	**0.1113**	**0.0320**
Aviation	100.9698	0.0062	0.0033	0.4139	0.2665	0.1113	0.0320
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	**1,600.9890**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2017

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**7,978.8973**	**32.8547**	**0.3331**	**14.6688**	**105.3838**	**15.8287**	**4.4594**
A. Fuel combustion activities (sectoral approach)	**7,977.2397**	**6.9497**	**0.3331**	**14.6688**	**105.3838**	**15.1571**	**4.4594**
1. Energy industries	**2,883.9360**	**0.0523**	**0.0053**	**4.5840**	**2.0066**	**0.1339**	**0.0467**
a. Public electricity and heat production	2,880.0130	0.0522	0.0053	4.5786	2.0058	0.1338	0.0327
b. Petroleum refining	3.9230	0.0002	0.0000	0.0055	0.0008	0.0001	0.0140
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**658.7329**	**0.0361**	**0.0051**	**0.9406**	**1.7853**	**0.4514**	**1.2695**
a. Iron and steel	60.4498	0.0011	0.0001	0.0817	0.0339	0.0249	0.0035
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	4.8893	0.0001	0.0000	0.0067	0.0038	0.0026	0.0002
d. Pulp, paper and print	1.0009	0.0000	0.0000	0.0013	0.0005	0.0004	0.0000
e. Food processing, beverages and tobacco	91.6554	0.0031	0.0004	0.1418	0.1115	0.0497	0.0484
f. Non-metallic minerals	230.4297	0.0146	0.0022	0.5447	1.1514	0.1457	1.0684
g. Transport equipment	0.1122	0.0000	0.0000	0.0002	0.0006	0.0003	0.0000
h. Machinery	10.1061	0.0002	0.0000	0.0146	0.0075	0.0043	0.0024
i. Mining and quarrying	NO	NO	NO	NO	NO	NO	NO
j. Wood and wood production	0.2561	0.0001	0.0000	0.0010	0.0019	0.0010	0.0001
k. Construction	14.3249	0.0003	0.0000	0.0343	0.0089	0.0057	0.0023
l. Textile and leather	25.0214	0.0005	0.0001	0.0358	0.0146	0.0106	0.0014
m. Other industries	220.4871	0.0160	0.0022	0.0785	0.4508	0.2061	0.1426
3. Transport	**2,451.2514**	**0.4838**	**0.1350**	**3.3935**	**16.3018**	**2.0056**	**0.0054**
a. Domestic aviation	0.5809	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000
b. Road transportation	2,390.4768	0.4811	0.1203	2.7369	16.1624	1.9413	0.0051
c. Railways	37.8634	0.0021	0.0146	0.6294	0.1285	0.0559	0.0001
d. Domestic navigation	1.7329	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	20.5974	0.0004	0.0000	0.0272	0.0106	0.0084	0.0002
4. Other sectors	**1,960.6971**	**6.3772**	**0.1874**	**5.7093**	**85.0674**	**12.5450**	**2.9370**
a. Commercial/institutional	335.0924	0.1784	0.0036	0.5315	1.1387	0.3228	0.6628
b. Residential	1,338.5229	6.1521	0.0770	2.1429	82.5867	11.8845	2.2317
c. Agriculture/forestry/fishing	287.0818	0.0467	0.1067	3.0348	1.3421	0.3377	0.0425
ci. Stationary	9.9673	0.0297	0.0003	0.0206	0.0759	0.0211	0.0416
cii. Mobile	277.1146	0.0170	0.1064	3.0143	1.2662	0.3166	0.0009
5. Other	**22.6223**	**0.0002**	**0.0004**	**0.0414**	**0.2226**	**0.0212**	**0.2009**
a. Stationary	22.6223	0.0002	0.0004	0.0414	0.2226	0.0212	0.2009
b. Mobile	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	**1.6576**	**25.9050**	**0.0000**	**NO**	**NO**	**0.6716**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.6576**	**25.9050**	**0.0000**	**NO**	**NO**	**0.6716**	**NO**
a. Oil	1.2717	0.1897	0.0000	NO	NO	0.2072	NO
b. Natural gas	0.3859	25.7152				0.4644	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**148.2788**	**0.0058**	**0.0048**	**0.5821**	**0.3478**	**0.1423**	**0.0470**
Aviation	148.2788	0.0058	0.0048	0.5821	0.3478	0.1423	0.0470
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	**2,122.7228**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2018

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,426.8382**	**34.7321**	**0.3830**	**15.9767**	**154.4533**	**23.3603**	**3.7006**
A. Fuel combustion activities (sectoral approach)	**8,425.1725**	**10.6318**	**0.3830**	**15.9767**	**154.4533**	**22.7246**	**3.7006**
1. Energy industries	**3,177.3538**	**0.0579**	**0.0059**	**5.0572**	**2.2137**	**0.1477**	**0.0567**
a. Public electricity and heat production	3,174.2616	0.0578	0.0058	5.0528	2.2130	0.1476	0.0452
b. Petroleum refining	3.0922	0.0001	0.0000	0.0044	0.0007	0.0001	0.0115
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**748.6264**	**0.0412**	**0.0058**	**1.2726**	**1.7293**	**0.5219**	**1.0791**
a. Iron and steel	65.6959	0.0012	0.0001	0.0869	0.0360	0.0270	0.0029
b. Non-ferrous metals	NO	NO	NO	NO	NO	NO	NO
c. Chemicals	6.2779	0.0002	0.0000	0.0085	0.0051	0.0035	0.0003
d. Pulp, paper and print	3.0670	0.0002	0.0000	0.0044	0.0039	0.0025	0.0001
e. Food processing, beverages and tobacco	103.4659	0.0039	0.0005	0.1579	0.1361	0.0599	0.0582

f. Non-metallic minerals	292.0067	0.0145	0.0022	0.8417	0.9877	0.1504	0.8876
g. Transport equipment	0.3927	0.0000	0.0000	0.0006	0.0008	0.0005	0.0000
h. Machinery	11.3814	0.0002	0.0000	0.0164	0.0072	0.0047	0.0015
i. Mining and quarrying	0.0642	0.0000	0.0000	0.0005	0.0001	0.0000	0.0000
j. Wood and wood production	0.2701	0.0002	0.0000	0.0012	0.0030	0.0016	0.0001
k. Construction	16.0621	0.0003	0.0000	0.0358	0.0096	0.0064	0.0022
l. Textile and leather	27.3122	0.0005	0.0001	0.0358	0.0155	0.0115	0.0011
m. Other industries	222.6302	0.0200	0.0028	0.0827	0.5244	0.2537	0.1250
3. Transport	**2,529.5979**	**0.5024**	**0.1334**	**3.2503**	**17.1884**	**2.0927**	**0.0056**
a. Domestic aviation	0.1520	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	2,489.2483	0.5008	0.1254	2.8857	17.1094	2.0550	0.0053
c. Railways	20.4915	0.0011	0.0079	0.3406	0.0696	0.0302	0.0000
d. Domestic navigation	1.5629	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	18.1432	0.0003	0.0000	0.0239	0.0094	0.0074	0.0002
4. Other sectors	**1,946.2502**	**10.0301**	**0.2376**	**6.3540**	**133.0922**	**19.9404**	**2.3520**
a. Commercial/institutional	343.4576	0.1814	0.0036	0.5367	1.1329	0.3301	0.6440
b. Residential	1,316.6041	9.8051	0.1277	2.7543	130.7890	19.2736	1.6723
c. Agriculture/forestry/fishing	286.1884	0.0436	0.1063	3.0630	1.1703	0.3367	0.0356
ci. Stationary	10.9565	0.0276	0.0003	0.0213	0.0704	0.0217	0.0347
cii. Mobile	275.2319	0.0160	0.1060	3.0418	1.1000	0.3150	0.0009
5. Other	**23.3443**	**0.0002**	**0.0004**	**0.0427**	**0.2297**	**0.0219**	**0.2073**
a. Stationary	23.3443	0.0002	0.0004	0.0427	0.2297	0.0219	0.2073
b. Mobile	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	**1.6657**	**24.1003**	**0.0000**	**NO**	**NO**	**0.6357**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.6657**	**24.1003**	**0.0000**	**NO**	**NO**	**0.6357**	**NO**
a. Oil	1.2710	0.1897	0.0000	NO	NO	0.2072	NO
b. Natural gas	0.3947	23.9106				0.4285	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**170.4060**	**0.0071**	**0.0058**	**0.6507**	**0.5113**	**0.1537**	**0.0540**
Aviation	170.4060	0.0071	0.0058	0.6507	0.5113	0.1537	0.0540
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	**3,567.9567**						
CO_2 captured	NO						
For domestic storage	NO						
For storage in other countries	NO						

2019

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(kt)						
1. Total Energy	**8,577.9507**	**25.1886**	**0.3826**	**16.3122**	**138.9236**	**20.6159**	**4.4574**
A. Fuel combustion activities (sectoral approach)	**8,576.3417**	**9.3549**	**0.3826**	**16.3122**	**138.9236**	**20.1359**	**4.4574**
1. Energy industries	**3,120.4282**	**0.0561**	**0.0057**	**4.9637**	**2.1725**	**0.1449**	**0.0468**
a. Public electricity and heat production	3,119.0875	0.0560	0.0056	4.9613	2.1722	0.1449	0.0387
b. Petroleum refining	1.3407	0.0001	0.0000	0.0024	0.0003	0.0000	0.0081
c. Manufacture of solid fuels and other energy industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
2. Manufacturing industries and construction	**715.9769**	**0.0380**	**0.0052**	**1.2738**	**1.5227**	**0.4795**	**0.9228**
a. Iron and steel	56.1180	0.0010	0.0001	0.0755	0.0291	0.0230	0.0008
b. Non-ferrous metals	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
c. Chemicals	7.4154	0.0002	0.0000	0.0100	0.0050	0.0036	0.0001
d. Pulp, paper and print	3.1594	0.0001	0.0000	0.0042	0.0025	0.0013	0.0009
e. Food processing, beverages and tobacco	91.8051	0.0024	0.0003	0.1338	0.0902	0.0439	0.0365
f. Non-metallic minerals	281.4803	0.0139	0.0022	0.8540	0.9517	0.1433	0.8585
g. Transport equipment	0.7854	0.0001	0.0000	0.0012	0.0015	0.0009	0.0000
h. Machinery	14.1818	0.0003	0.0000	0.0206	0.0075	0.0058	0.0004
i. Mining and quarrying	0.2805	0.0000	0.0000	0.0004	0.0000	0.0001	0.0000
j. Wood and wood production	0.1944	0.0000	0.0000	0.0008	0.0007	0.0004	0.0001
k. Construction	16.1140	0.0004	0.0000	0.0396	0.0095	0.0063	0.0023
l. Textile and leather	28.0485	0.0005	0.0001	0.0372	0.0146	0.0115	0.0004
m. Other industries	216.3941	0.0191	0.0025	0.0966	0.4103	0.2392	0.0228
3. Transport	**2,611.5823**	**0.4983**	**0.1390**	**3.4499**	**17.8412**	**2.1766**	**0.0058**
a. Domestic aviation	0.2806	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
b. Road transportation	2,567.7670	0.4965	0.1294	3.0002	17.7450	2.1317	0.0055
c. Railways	24.5271	0.0014	0.0095	0.4270	0.0872	0.0379	0.0000
d. Domestic navigation	1.8260	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
e. Other transportation	17.1815	0.0003	0.0000	0.0227	0.0089	0.0070	0.0002

4. Other sectors	**2,105.4914**	**8.7623**	**0.2323**	**6.5829**	**117.1622**	**17.3134**	**3.2791**
a. Commercial/institutional	331.2579	0.1634	0.0032	0.5136	1.0310	0.3058	0.5807
b. Residential	1,448.8793	8.5531	0.1081	2.6327	114.7834	16.6329	2.6586
c. Agriculture/forestry/fishing	325.3542	0.0458	0.1210	3.4366	1.3478	0.3748	0.0398
ci. Stationary	11.8344	0.0274	0.0003	0.0222	0.0711	0.0202	0.0388
cii. Mobile	313.5198	0.0183	0.1207	3.4144	1.2767	0.3546	0.0010
5. Other	**22.8629**	**0.0002**	**0.0004**	**0.0418**	**0.2250**	**0.0215**	**0.2030**
a. Stationary	22.8629	0.0002	0.0004	0.0418	0.2250	0.0215	0.2030
b. Mobile	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	**1.6090**	**15.8337**	**0.0000**	**NO**	**NO**	**0.4800**	**NO**
1. Solid fuels	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
a. Coal mining and handling	NO	NO	NO	NO	NO	NO	
b. Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
c. Other	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	**1.6090**	**15.8337**	**0.0000**	**NO**	**NO**	**0.4800**	**NO**
a. Oil	1.2673	0.1897	0.0000	NO	NO	0.2072	NO
b. Natural gas	0.3417	15.6440				0.2728	NO
c. Venting and flaring	NO	NO	NO	NO	NO	NO	NO
d. Other	NO	NO	NO	NO	NO	NO	NO
C. CO_2 Transport and storage	**NO**						
1. Transport of CO_2	NO						
2. Injection and storage	NO						
3. Other	NO						
Memo items:							
International bunkers	**151.5015**	**0.0055**	**0.0051**	**0.6236**	**0.4162**	**0.1199**	**0.0480**
Aviation	151.5015	0.0055	0.0051	0.6236	0.4162	0.1199	0.0480
Navigation	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	**2,963.2154**						
CO_2 captured	**NO**						
For domestic storage	NO						
For storage in other countries	NO						

Annex 6-2. Sectoral Report for Sector 2 'Industrial Processes and Product Use', 1990-2019

1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**1,603.6767**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**3.7209**	**5.4932**	**106.5515**	**1.3586**
A. Mineral industry	**1,337.4142**								**3.5653**	**3.4372**	**0.0339**	**1.2943**
1. Cement production	971.6967								2.2355	2.6210	0.0324	0.6737
2. Lime production	264.3143								0.4875	0.6909		0.1125
3. Glass production	26.0951								0.7202		0.0015	0.4818
4. Other process uses of carbonates	75.3080								0.1221	0.1254		0.0263
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0650**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0650	NO
C. Metal industry	**28.5023**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0925**	**1.2102**	**0.0370**	**0.0427**
1. Iron and steel production	28.5023	NO							0.0925	1.2102	0.0370	0.0427
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**234.3591**	**NO**	**NO**						**0.0434**	**0.2441**	**92.7937**	**0.0216**
1. Lubricant use	24.7987	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.1138	NO	NO						NO	NO	NO	NO
3. Solvent use	204.1460	NO	NO						0.0434	0.2441	92.7937	0.0216
4. Other	5.3005	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				

F. Product uses as substitutes for ODS				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				NO	NO	NO	NO	NO				
2. Foam blowing agents				NO	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**3.4010**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0197**	**0.6017**	**1.5459**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0001									
4. Other	3.4010	NO	NO	NO	NO	NO	NO	NO	0.0197	0.6017	1.5459	NO
H. Other									**NO**	**NO**	**12.0760**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	12.0760	NO
3. Other									NO	NO	NO	NO

1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**1,409.7794**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**3.4025**	**4.9046**	**87.8864**	**1.2732**
A. Mineral industry	**1,188.6687**								**3.2662**	**3.0431**	**0.0315**	**1.2182**
1. Cement production	900.7877								2.0682	2.4249	0.0300	0.6233
2. Lime production	192.2260								0.3546	0.5024		0.0818
3. Glass production	25.8454								0.7307		0.0015	0.4888
4. Other process uses of carbonates	69.8096								0.1127	0.1158		0.0243
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0544**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0544	NO
C. Metal industry	**24.7297**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0803**	**1.0502**	**0.0323**	**0.0371**
1. Iron and steel production	24.7297	NO							0.0803	1.0502	0.0323	0.0371
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**193.3185**	**NO**	**NO**						**0.0361**	**0.2030**	**76.2635**	**0.0180**
1. Lubricant use	20.7617	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0953	NO	NO						NO	NO	NO	NO
3. Solvent use	167.7797	NO	NO						0.0361	0.2030	76.2635	0.0180
4. Other	4.6818	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				NO	NO	NO	NO	NO				
2. Foam blowing agents				NO	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**3.0625**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0199**	**0.6083**	**1.3920**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0001									
4. Other	3.0625	NO	NO	NO	NO	NO	NO	NO	0.0199	0.6083	1.3920	NO
H. Other									**NO**	**NO**	**10.1126**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	10.1126	NO
3. Other									NO	NO	NO	NO

1992

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**821.5621**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**1.8308**	**3.4045**	**72.1808**	**0.6681**
A. Mineral industry	**640.8940**								**1.7039**	**1.6459**	**0.0165**	**0.6171**
1. Cement production	474.3138								1.0912	1.2794	0.0158	0.3289
2. Lime production	116.1612								0.2143	0.3036		0.0495
3. Glass production	12.7167								0.3372		0.0007	0.2256
4. Other process uses of carbonates	37.7023								0.0613	0.0629		0.0132
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0238**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0238	NO
C. Metal industry	**23.9922**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0780**	**1.0194**	**0.0314**	**0.0360**
1. Iron and steel production	23.9922	NO							0.0780	1.0194	0.0314	0.0360
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**154.2628**	**NO**	**NO**						**0.0304**	**0.1706**	**62.9651**	**0.0151**
1. Lubricant use	12.1110	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0556	NO	NO						NO	NO	NO	NO
3. Solvent use	138.5232	NO	NO						0.0304	0.1706	62.9651	0.0151
4. Other	3.5730	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				NO	NO	NO	NO	NO				
2. Foam blowing agents				NO	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**2.4132**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0186**	**0.5686**	**1.0969**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0001									
4. Other	2.4132	NO	NO	NO	NO	NO	NO	NO	0.0186	0.5686	1.0969	NO
H. Other									**NO**	**NO**	**8.0471**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	8.0471	NO
3. Other									NO	NO	NO	NO

1993

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**737.0521**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**1.7342**	**3.2411**	**60.2823**	**0.6501**
A. Mineral industry	**586.7703**								**1.6117**	**1.4853**	**0.0143**	**0.6015**
1. Cement production	405.7165								0.9338	1.0949	0.0135	0.2814
2. Lime production	112.7887								0.2080	0.2948		0.0480
3. Glass production	11.4809								0.3767		0.0008	0.2520
4. Other process uses of carbonates	56.7842								0.0931	0.0957		0.0200
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0199**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				

10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0199	NO
C. Metal industry	**24.4250**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0794**	**1.0383**	**0.0315**	**0.0366**
1. Iron and steel production	24.4250	NO							0.0794	1.0383	0.0315	0.0366
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**123.8759**	**NO**	**NO**						**0.0241**	**0.1356**	**50.1008**	**0.0120**
1. Lubricant use	10.9576	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0503	NO	NO						NO	NO	NO	NO
3. Solvent use	110.2218	NO	NO						0.0241	0.1356	50.1008	0.0120
4. Other	2.6463	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				NO	NO	NO	NO	NO				
2. Foam blowing agents				NO	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.9809**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0190**	**0.5819**	**0.9004**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0001									
4. Other	1.9809	NO	NO	NO	NO	NO	NO	NO	0.0190	0.5819	0.9004	NO
H. Other									**NO**	**NO**	**9.2154**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	9.2154	NO
3. Other									NO	NO	NO	NO

1994

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**556.2338**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**1.3699**	**2.8404**	**40.9264**	**0.5189**
A. Mineral industry	**444.9885**								**1.2556**	**1.1521**	**0.0116**	**0.4736**
1. Cement production	328.4361								0.7552	0.8854	0.0110	0.2276
2. Lime production	83.8378								0.1546	0.2191		0.0357
3. Glass production	4.0547								0.2995		0.0006	0.2003
4. Other process uses of carbonates	28.6600								0.0463	0.0475		0.0100
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0074**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0074	NO
C. Metal industry	**25.3289**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0824**	**1.0774**	**0.0322**	**0.0380**
1. Iron and steel production	25.3289	NO							0.0824	1.0774	0.0322	0.0380
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**84.4738**	**NO**	**NO**						**0.0146**	**0.0820**	**32.7972**	**0.0073**
1. Lubricant use	10.1022	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0464	NO	NO						NO	NO	NO	NO
3. Solvent use	72.1539	NO	NO						0.0146	0.0820	32.7972	0.0073
4. Other	2.1713	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				

F. Product uses as substitutes for ODS				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				NO	NO	NO	NO	NO				
2. Foam blowing agents				NO	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.4426**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0173**	**0.5290**	**0.6557**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0001									
4. Other	1.4426	NO	NO	NO	NO	NO	NO	NO	0.0173	0.5290	0.6557	NO
H. Other									**NO**	**NO**	**7.4223**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	7.4223	NO
3. Other									NO	NO	NO	NO

1995

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)			(kt)					
2. Total Industrial Processes	**455.1468**	**NO**	**0.0000**	**1.0298**	**NO**	**NO**	**NO**	**NO**	**1.1818**	**2.5644**	**39.1320**	**0.4737**
A. Mineral industry	**351.1816**								**1.0679**	**0.9044**	**0.0090**	**0.4277**
1. Cement production	248.5258								0.5705	0.6689	0.0083	0.1719
2. Lime production	78.0227								0.1439	0.2039		0.0332
3. Glass production	5.1447								0.3228		0.0007	0.2159
4. Other process uses of carbonates	19.4885								0.0307	0.0315		0.0066
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0060**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0060	NO
C. Metal industry	**26.2369**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0854**	**1.1166**	**0.0327**	**0.0394**
1. Iron and steel production	26.2369	NO							0.0854	1.1166	0.0327	0.0394
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**76.5607**	**NO**	**NO**						**0.0132**	**0.0740**	**29.2180**	**0.0065**
1. Lubricant use	10.1316	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0465	NO	NO						NO	NO	NO	NO
3. Solvent use	64.2795	NO	NO						0.0132	0.0740	29.2180	0.0065
4. Other	2.1031	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**1.0298**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				0.7535	NO	NO	NO	NO				
2. Foam blowing agents				0.2763	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.1676**	**NO**	**0.0000**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0153**	**0.4695**	**0.5307**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0000									
4. Other	1.1676	NO	NO	NO	NO	NO	NO	NO	0.0153	0.4695	0.5307	NO
H. Other									**NO**	**NO**	**9.3357**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	9.3357	NO
3. Other									NO	NO	NO	NO

1996

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**414.5996**	**NO**	**0.0000**	**1.6593**	**NO**	**NO**	**NO**	**NO**	**1.0325**	**2.6496**	**36.1550**	**0.4021**
A. Mineral industry	**315.6974**								**0.9126**	**0.8037**	**0.0070**	**0.3560**
1. Cement production	193.1220								0.4434	0.5198	0.0064	0.1336
2. Lime production	97.7677								0.1803	0.2555		0.0416
3. Glass production	7.6130								0.2613		0.0005	0.1748
4. Other process uses of carbonates	17.1947								0.0276	0.0283		0.0059
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0085**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0085	NO
C. Metal industry	**26.7261**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0870**	**1.1375**	**0.0332**	**0.0401**
1. Iron and steel production	26.7261	NO							0.0870	1.1375	0.0332	0.0401
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**71.0712**	**NO**	**NO**						**0.0119**	**0.0671**	**27.0276**	**0.0059**
1. Lubricant use	9.7676	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0448	NO	NO						NO	NO	NO	NO
3. Solvent use	59.4608	NO	NO						0.0119	0.0671	27.0276	0.0059
4. Other	1.7979	NO	NO						NO	NO	NO	NO
E. Electronics industry				NO	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**1.6593**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				1.2463	NO	NO	NO	NO				
2. Foam blowing agents				0.4130	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.1050**	**NO**	**0.0000**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0210**	**0.6414**	**0.5023**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0000									
4. Other	1.1050	NO	NO	NO	NO	NO	NO	NO	0.0210	0.6414	0.5023	NO
H. Other									**NO**	**NO**	**8.5764**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	8.5764	NO
3. Other									NO	NO	NO	NO

1997

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**452.0432**	**NO**	**0.0000**	**2.3137**	**NO**	**NO**	**NO**	**NO**	**1.2371**	**3.0011**	**22.3411**	**0.4833**
A. Mineral industry	**376.6116**								**1.1071**	**0.9721**	**0.0096**	**0.4327**
1. Cement production	270.1273								0.6207	0.7278	0.0090	0.1871
2. Lime production	81.2988								0.1500	0.2125		0.0346
3. Glass production	5.0803								0.3055		0.0006	0.2043
4. Other process uses of carbonates	20.1052								0.0309	0.0318		0.0067
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0068**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				

10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0068	NO
C. Metal industry	**32.3806**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1054**	**1.3781**	**0.0401**	**0.0486**
1. Iron and steel production	32.3806	NO							0.1054	1.3781	0.0401	0.0486
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**42.0528**	**NO**	**NO**						**0.0040**	**0.0227**	**14.1331**	**0.0020**
1. Lubricant use	9.2153	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0423	NO	NO						NO	NO	NO	NO
3. Solvent use	31.0929	NO	NO						0.0040	0.0227	14.1331	0.0020
4. Other	1.7024	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**2.3137**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				1.7920	NO	NO	NO	NO				
2. Foam blowing agents				0.5216	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**0.9982**	**NO**	**0.0000**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0205**	**0.6281**	**0.4537**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0000									
4. Other	0.9982	NO	NO	NO	NO	NO	NO	NO	0.0205	0.6281	0.4537	NO
H. Other									**NO**	**NO**	**7.6977**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	7.6977	NO
3. Other									NO	NO	NO	NO

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**375.0296**	**NO**	**0.0000**	**3.1372**	**NO**	**NO**	**NO**	**NO**	**1.0896**	**2.5238**	**19.9607**	**0.4481**
A. Mineral industry	**307.9930**								**0.9767**	**0.7878**	**0.0078**	**0.4034**
1. Cement production	215.0572								0.4937	0.5788	0.0072	0.1488
2. Lime production	68.5945								0.1265	0.1793		0.0292
3. Glass production	5.4490								0.3276		0.0007	0.2192
4. Other process uses of carbonates	18.8923								0.0289	0.0297		0.0062
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0066**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0066	NO
C. Metal industry	**28.6822**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0934**	**1.2208**	**0.0371**	**0.0431**
1. Iron and steel production	28.6822	NO							0.0934	1.2208	0.0371	0.0431
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**37.6084**	**NO**	**NO**						**0.0033**	**0.0185**	**13.2678**	**0.0016**
1. Lubricant use	7.0105	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0322	NO	NO						NO	NO	NO	NO
3. Solvent use	29.1892	NO	NO						0.0033	0.0185	13.2678	0.0016
4. Other	1.3765	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				

F. Product uses as substitutes for ODS				**3.1372**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				2.4126	NO	NO	NO	NO				
2. Foam blowing agents				0.7246	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**0.7460**	**NO**	**0.0000**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0162**	**0.4967**	**0.3391**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0000									
4. Other	0.7460	NO	NO	NO	NO	NO	NO	NO	0.0162	0.4967	0.3391	NO
H. Other									**NO**	**NO**	**6.3022**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	6.3022	NO
3. Other									NO	NO	NO	NO

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**337.9160**	**NO**	**0.0000**	**4.0002**	**NO**	**NO**	**NO**	**NO**	**0.9619**	**2.6451**	**17.0520**	**0.3868**
A. Mineral industry	**271.3959**								**0.8365**	**0.6973**	**0.0076**	**0.3375**
1. Cement production	210.8122								0.4844	0.5680	0.0070	0.1460
2. Lime production	37.8903								0.0699	0.0990		0.0161
3. Glass production	3.6841								0.2527		0.0005	0.1690
4. Other process uses of carbonates	19.0092								0.0294	0.0302		0.0063
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0050**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0050	NO
C. Metal industry	**31.7942**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1035**	**1.3533**	**0.0408**	**0.0478**
1. Iron and steel production	31.7942	NO							0.1035	1.3533	0.0408	0.0478
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**34.0839**	**NO**	**NO**						**0.0031**	**0.0172**	**12.7587**	**0.0015**
1. Lubricant use	4.9998	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0230	NO	NO						NO	NO	NO	NO
3. Solvent use	28.0692	NO	NO						0.0031	0.0172	12.7587	0.0015
4. Other	0.9920	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**4.0002**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				3.0811	NO	NO	NO	NO				
2. Foam blowing agents				0.9191	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**0.6421**	**NO**	**0.0000**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0189**	**0.5773**	**0.2919**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0000									
4. Other	0.6421	NO	NO	NO	NO	NO	NO	NO	0.0189	0.5773	0.2919	NO
H. Other									**NO**	**NO**	**3.9481**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	3.9481	NO
3. Other									NO	NO	NO	NO

2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**309.3065**	**NO**	**0.0000**	**5.1199**	**NO**	**NO**	**NO**	**NO**	**1.1041**	**2.7463**	**16.6713**	**0.5164**
A. Mineral industry	**239.4427**								**0.9636**	**0.5762**	**0.0068**	**0.4607**
1. Cement production	172.7600								0.3975	0.4660	0.0058	0.1198
2. Lime production	31.4020								0.0579	0.0821		0.0134
3. Glass production	16.8043								0.4808		0.0010	0.3216
4. Other process uses of carbonates	18.4764								0.0274	0.0282		0.0059
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0073**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0073	NO
C. Metal industry	**36.2689**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1181**	**1.5438**	**0.0462**	**0.0545**
1. Iron and steel production	36.2689	NO							0.1181	1.5438	0.0462	0.0545
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**32.6395**	**NO**	**NO**						**0.0025**	**0.0139**	**12.5638**	**0.0012**
1. Lubricant use	3.9115	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0180	NO	NO						NO	NO	NO	NO
3. Solvent use	27.6403	NO	NO						0.0025	0.0139	12.5638	0.0012
4. Other	1.0697	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**5.1199**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				3.8190	NO	NO	NO	NO				
2. Foam blowing agents				1.3010	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**0.9554**	**NO**	**0.0000**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0200**	**0.6124**	**0.4343**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0000									
4. Other	0.9554	NO	NO	NO	NO	NO	NO	NO	0.0200	0.6124	0.4343	NO
H. Other									**NO**	**NO**	**3.6129**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	3.6129	NO
3. Other									NO	NO	NO	NO

2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**311.7431**	**NO**	**0.0000**	**6.8681**	**NO**	**NO**	**NO**	**NO**	**1.0590**	**2.8557**	**18.4464**	**0.4857**
A. Mineral industry	**235.8758**								**0.9098**	**0.5713**	**0.0067**	**0.4262**
1. Cement production	173.8847								0.3995	0.4684	0.0058	0.1204
2. Lime production	28.4519								0.0525	0.0744		0.0121
3. Glass production	15.2214								0.4301		0.0009	0.2877
4. Other process uses of carbonates	18.3178								0.0278	0.0285		0.0060
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0080**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				

10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0080	NO
C. Metal industry	**38.6274**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1257**	**1.6441**	**0.0500**	**0.0580**
1. Iron and steel production	38.6274	NO							0.1257	1.6441	0.0500	0.0580
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**36.4195**	**NO**	**NO**						**0.0031**	**0.0174**	**14.0195**	**0.0015**
1. Lubricant use	4.3872	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0201	NO	NO						NO	NO	NO	NO
3. Solvent use	30.8429	NO	NO						0.0031	0.0174	14.0195	0.0015
4. Other	1.1693	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**6.8681**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				5.0012	NO	NO	NO	NO				
2. Foam blowing agents				1.8669	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**0.8204**	**NO**	**0.0000**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0203**	**0.6229**	**0.3729**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0000									
4. Other	0.8204	NO	NO	NO	NO	NO	NO	NO	0.0203	0.6229	0.3729	NO
H. Other									**NO**	**NO**	**3.9893**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	3.9893	NO
3. Other									NO	NO	NO	NO

2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)			(kt)					
2. Total Industrial Processes	**359.6162**	**NO**	**0.0000**	**9.1227**	**NO**	**NO**	**NO**	**NO**	**1.2104**	**2.0646**	**19.7693**	**0.5537**
A. Mineral industry	**299.9546**								**1.1263**	**0.7266**	**0.0084**	**0.5216**
1. Cement production	219.1917								0.5048	0.5919	0.0073	0.1521
2. Lime production	38.2546								0.0706	0.1000		0.0163
3. Glass production	20.4783								0.5171		0.0011	0.3459
4. Other process uses of carbonates	22.0299								0.0338	0.0347		0.0073
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0104**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0104	NO
C. Metal industry	**20.5030**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0667**	**0.8725**	**0.0263**	**0.0308**
1. Iron and steel production	20.5030	NO							0.0667	0.8725	0.0263	0.0308
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**38.3743**	**NO**	**NO**						**0.0027**	**0.0153**	**14.8206**	**0.0013**
1. Lubricant use	4.3239	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0198	NO	NO						NO	NO	NO	NO
3. Solvent use	32.6053	NO	NO						0.0027	0.0153	14.8206	0.0013
4. Other	1.4252	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**9.1227**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				6.1655	NO	NO	NO	NO				
2. Foam blowing agents				2.9571	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				NO	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**0.7843**	**NO**	**0.0000**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0147**	**0.4503**	**0.3565**	**NO**
1. Electrical equipment				NO	NO	NO	NO	NO				
2. SF_6 and PFCs from other product use					NO	NO	NO					
3. N_2O from product uses			0.0000									
4. Other	0.7843	NO	NO	NO	NO	NO	NO	NO	0.0147	0.4503	0.3565	NO
H. Other									**NO**	**NO**	**4.5471**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	4.5471	NO
3. Other									NO	NO	NO	NO

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**384.9507**	**NO**	**0.0000**	**12.1632**	**NO**	**NO**	**0.0000**	**NO**	**1.2463**	**2.8260**	**19.6527**	**0.5577**
A. Mineral industry	**307.6352**								**1.1103**	**0.7495**	**0.0091**	**0.5032**
1. Cement production	245.6276								0.5618	0.6586	0.0081	0.1693
2. Lime production	20.5213								0.0379	0.0536		0.0087
3. Glass production	18.8812								0.4744		0.0010	0.3174
4. Other process uses of carbonates	22.6051								0.0363	0.0372		0.0078
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0123**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0123	NO
C. Metal industry	**35.4283**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1153**	**1.5074**	**0.0456**	**0.0532**
1. Iron and steel production	35.4283	NO							0.1153	1.5074	0.0456	0.0532
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO						NO		NO	NO	NO	NO
4. Magnesium production	NO			NO			NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**40.9252**	**NO**	**NO**						**0.0026**	**0.0145**	**14.8735**	**0.0013**
1. Lubricant use	6.5825	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0302	NO	NO						NO	NO	NO	NO
3. Solvent use	32.7216	NO	NO						0.0026	0.0145	14.8735	0.0013
4. Other	1.5908	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**12.1632**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				7.3862	NO	NO	NO	NO				
2. Foam blowing agents				4.7770	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0001	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**0.9620**	**NO**	**0.0000**	**NO**	**NO**	**NO**	**0.0000**	**NO**	**0.0181**	**0.5545**	**0.4373**	**NO**
1. Electrical equipment				NO	NO	NO	0.0000	NO				
2. SF_6 and PFCs from other product use							NO					
3. N_2O from product uses			0.0000									
4. Other	0.9620	NO	NO	NO	NO	NO	NO	NO	0.0181	0.5545	0.4373	NO
H. Other									**NO**	**NO**	**4.2749**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	4.2749	NO
3. Other									NO	NO	NO	NO

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**454.6376**	**NO**	**0.0001**	**16.0027**	**NO**	**NO**	**0.0000**	**NO**	**1.3978**	**3.2083**	**31.1818**	**0.6178**
A. Mineral industry	**348.9485**								**1.2390**	**0.8629**	**0.0105**	**0.5529**
1. Cement production	282.5765								0.6524	0.7649	0.0095	0.1966
2. Lime production	20.5790								0.0380	0.0538		0.0088
3. Glass production	19.5625								0.5056		0.0011	0.3382
4. Other process uses of carbonates	26.2305								0.0431	0.0443		0.0093
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0129**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0129	NO
C. Metal industry	**40.5084**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1318**	**1.7236**	**0.0522**	**0.0608**
1. Iron and steel production	40.5084	NO							0.1318	1.7236	0.0522	0.0608
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO						NO		NO	NO	NO	NO
4. Magnesium production	NO			NO			NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**64.1303**	**NO**	**NO**						**0.0082**	**0.0459**	**25.3328**	**0.0041**
1. Lubricant use	6.5622	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0301	NO	NO						NO	NO	NO	NO
3. Solvent use	55.7321	NO	NO						0.0082	0.0459	25.3328	0.0041
4. Other	1.8059	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**16.0027**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				8.5552	NO	NO	NO	NO				
2. Foam blowing agents				7.4473	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0002	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.0504**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**0.0000**	**NO**	**0.0188**	**0.5759**	**0.4774**	**NO**
1. Electrical equipment				NO	NO	NO	0.0000	NO				
2. SF_6 and PFCs from other product use							NO					
3. N_2O from product uses			0.0001									
4. Other	1.0504	NO	NO	NO	NO	NO	NO	NO	0.0188	0.5759	0.4774	NO
H. Other									**NO**	**NO**	**5.2960**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	5.2960	NO
3. Other									NO	NO	NO	NO

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**548.7488**	**NO**	**0.0001**	**22.5106**	**NO**	**NO**	**0.0000**	**NO**	**1.6740**	**3.4998**	**33.6172**	**0.7262**
A. Mineral industry	**437.4573**								**1.5114**	**1.1045**	**0.0134**	**0.6594**
1. Cement production	365.0817								0.8422	0.9874	0.0122	0.2538
2. Lime production	27.8408								0.0514	0.0728		0.0119
3. Glass production	22.4939								0.5747		0.0012	0.3844
4. Other process uses of carbonates	22.0409								0.0431	0.0443		0.0093
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0149**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											

7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0149	NO
C. Metal industry	**41.9358**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1364**	**1.7839**	**0.0545**	**0.0630**
1. Iron and steel production	41.9358	NO							0.1364	1.7839	0.0545	0.0630
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO						NO		NO	NO	NO	NO
4. Magnesium production	NO			NO			NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**68.1910**	**NO**	**NO**						**0.0077**	**0.0431**	**27.2264**	**0.0038**
1. Lubricant use	6.4692	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0149	NO	NO						NO	NO	NO	NO
3. Solvent use	59.8981	NO	NO						0.0077	0.0431	27.2264	0.0038
4. Other	1.8088	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**22.5106**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				10.2213	NO	NO	NO	NO				
2. Foam blowing agents				12.2889	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0004	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.1646**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**0.0000**	**NO**	**0.0186**	**0.5683**	**0.5294**	**NO**
1. Electrical equipment				NO	NO	NO	0.0000	NO				
2. SF_6 and PFCs from other product use							NO					
3. N_2O from product uses			0.0001									
4. Other	1.1646	NO	NO	NO	NO	NO	NO	NO	0.0186	0.5683	0.5294	NO
H. Other									**NO**	**NO**	**5.7786**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	5.7786	NO
3. Other									NO	NO	NO	NO

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**643.8927**	**NO**	**0.0001**	**33.2493**	**0.0231**	**NO**	**0.0000**	**NO**	**1.8134**	**3.1294**	**38.8065**	**0.7492**
A. Mineral industry	**533.8283**								**1.6951**	**1.3597**	**0.0164**	**0.7025**
1. Cement production	457.0753								1.0555	1.2376	0.0153	0.3181
2. Lime production	30.1048								0.0555	0.0787		0.0128
3. Glass production	23.3604								0.5418		0.0011	0.3624
4. Other process uses of carbonates	23.2878								0.0423	0.0434		0.0091
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0130**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0130	NO
C. Metal industry	**27.0182**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0879**	**1.1492**	**0.0355**	**0.0406**
1. Iron and steel production	27.0182	NO							0.0879	1.1492	0.0355	0.0406
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**81.9807**	**NO**	**NO**						**0.0124**	**0.0697**	**33.2258**	**0.0062**
1. Lubricant use	6.9861	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0594	NO	NO						NO	NO	NO	NO
3. Solvent use	73.0967	NO	NO						0.0124	0.0697	33.2258	0.0062
4. Other	1.8385	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				

1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**33.2493**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				14.7472	NO	NO	NO	NO				
2. Foam blowing agents				18.5004	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0018	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.0655**	**NO**	**0.0001**	**NO**	**0.0231**	**NO**	**0.0000**	**NO**	**0.0180**	**0.5508**	**0.4843**	**NO**
1. Electrical equipment				NO	0.0231	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			0.0001									
4. Other	1.0655	NO	NO	NO	NO	NO	NO	NO	0.0180	0.5508	0.4843	NO
H. Other									**NO**	**NO**	**5.0313**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	5.0313	NO
3. Other									NO	NO	NO	NO

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**890.8914**	**NO**	**NO**	**44.7889**	**0.0231**	**NO**	**0.0000**	**NO**	**2.3583**	**4.3206**	**39.1521**	**0.9039**
A. Mineral industry	**766.4702**								**2.1999**	**1.9983**	**0.0245**	**0.8394**
1. Cement production	702.6656								1.6161	1.8948	0.0234	0.4870
2. Lime production	21.9382								0.0405	0.0573		0.0093
3. Glass production	20.3570								0.4984		0.0010	0.3334
4. Other process uses of carbonates	21.5093								0.0449	0.0462		0.0097
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0139**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0139	NO
C. Metal industry	**38.6127**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1256**	**1.6426**	**0.0508**	**0.0580**
1. Iron and steel production	38.6127	NO							0.1256	1.6426	0.0508	0.0580
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**84.7433**	**NO**	**NO**						**0.0130**	**0.0732**	**34.9915**	**0.0065**
1. Lubricant use	5.7679	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0595	NO	NO						NO	NO	NO	NO
3. Solvent use	76.9812	NO	NO						0.0130	0.0732	34.9915	0.0065
4. Other	1.9347	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**44.7889**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				17.2579	NO	NO	NO	NO				
2. Foam blowing agents				27.5284	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0026	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.0652**	**NO**	**NO**	**NO**	**0.0231**	**NO**	**0.0000**	**NO**	**0.0198**	**0.6066**	**0.4842**	**NO**
1. Electrical equipment				NO	0.0231	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.0652	NO	NO	NO	NO	NO	NO	NO	0.0198	0.6066	0.4842	NO
H. Other									**NO**	**NO**	**3.5873**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	3.5873	NO
3. Other									NO	NO	NO	NO

2008

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**966.3539**	**NO**	**NO**	**57.3627**	**0.0288**	**NO**	**0.0000**	**NO**	**2.5411**	**4.3540**	**32.0314**	**0.9421**
A. Mineral industry	**863.1338**								**2.4014**	**2.2832**	**0.0277**	**0.8853**
1. Cement production	789.9160								1.8448	2.1630	0.0268	0.5560
2. Lime production	29.1378								0.0537	0.0762		0.0124
3. Glass production	22.8439								0.4599		0.0010	0.3076
4. Other process uses of carbonates	21.2360								0.0429	0.0441		0.0092
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0122**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0122	NO
C. Metal industry	**35.4118**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.1152**	**1.5064**	**0.0465**	**0.0532**
1. Iron and steel production	35.4118	NO							0.1152	1.5064	0.0465	0.0532
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**66.7047**	**NO**	**NO**						**0.0075**	**0.0427**	**26.5891**	**0.0037**
1. Lubricant use	6.1481	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0295	NO	NO						NO	NO	NO	NO
3. Solvent use	58.4959	NO	NO						0.0075	0.0427	26.5891	0.0037
4. Other	2.0312	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**57.3627**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				19.6858	NO	NO	NO	NO				
2. Foam blowing agents				37.6745	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0023	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.1036**	**NO**	**NO**	**NO**	**0.0288**	**NO**	**0.0000**	**NO**	**0.0170**	**0.5217**	**0.5016**	**NO**
1. Electrical equipment				NO	0.0288	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.1036	NO	NO	NO	NO	NO	NO	NO	0.0170	0.5217	0.5016	NO
H. Other									**NO**	**NO**	**4.8542**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	4.8542	NO
3. Other									NO	NO	NO	NO

2009

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**461.4652**	**NO**	**NO**	**67.4807**	**0.0288**	**NO**	**0.0000**	**NO**	**1.2752**	**2.3712**	**26.6433**	**0.5133**
A. Mineral industry	**386.0179**								**1.1937**	**0.9874**	**0.0123**	**0.4849**
1. Cement production	340.5679								0.7959	0.9331	0.0115	0.2398
2. Lime production	8.4641								0.0156	0.0221		0.0036
3. Glass production	17.2425								0.3509		0.0007	0.2347
4. Other process uses of carbonates	19.7434								0.0314	0.0322		0.0068
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0100**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				

10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0100	NO
C. Metal industry	**17.0619**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0555**	**0.7255**	**0.0227**	**0.0256**
1. Iron and steel production	17.0619	NO							0.0555	0.7255	0.0227	0.0256
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**57.5805**	**NO**	**NO**						**0.0056**	**0.0316**	**22.9783**	**0.0028**
1. Lubricant use	5.0916	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0742	NO	NO						NO	NO	NO	NO
3. Solvent use	50.5522	NO	NO						0.0056	0.0316	22.9783	0.0028
4. Other	1.8625	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**67.4807**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				21.3675	NO	NO	NO	NO				
2. Foam blowing agents				46.1098	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0033	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**0.8048**	**NO**	**NO**	**NO**	**0.0288**	**NO**	**0.0000**	**NO**	**0.0205**	**0.6267**	**0.3658**	**NO**
1. Electrical equipment				NO	0.0288	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	0.8048	NO	NO	NO	NO	NO	NO	NO	0.0205	0.6267	0.3658	NO
H. Other									**NO**	**NO**	**3.2541**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	3.2541	NO
3. Other									NO	NO	NO	NO

2010

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**481.3565**	**NO**	**NO**	**77.8936**	**0.0403**	**NO**	**0.0000**	**NO**	**1.3529**	**2.2003**	**31.1949**	**0.5567**
A. Mineral industry	**404.3936**								**1.2908**	**1.0242**	**0.0127**	**0.5387**
1. Cement production	349.8333								0.8135	0.9538	0.0118	0.2452
2. Lime production	15.3644								0.0283	0.0402		0.0065
3. Glass production	20.2715								0.4195		0.0009	0.2806
4. Other process uses of carbonates	18.9244								0.0294	0.0302		0.0063
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0143**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0143	NO
C. Metal industry	**9.6985**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0315**	**0.4121**	**0.0128**	**0.0145**
1. Iron and steel production	9.6985	NO							0.0315	0.4121	0.0128	0.0145
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**66.2398**	**NO**	**NO**						**0.0069**	**0.0392**	**26.4907**	**0.0034**
1. Lubricant use	5.4648	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.1795	NO	NO						NO	NO	NO	NO
3. Solvent use	58.2796	NO	NO						0.0069	0.0392	26.4907	0.0034
4. Other	2.3159	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				

5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**77.8936**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				23.2625	NO	NO	NO	NO				
2. Foam blowing agents				54.6272	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0040	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.0245**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0000**	**NO**	**0.0237**	**0.7247**	**0.4657**	**NO**
1. Electrical equipment				NO	0.0403	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.0245	NO	NO	NO	NO	NO	NO	NO	0.0237	0.7247	0.4657	NO
H. Other									**NO**	**NO**	**4.1987**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	4.1987	NO
3. Other									NO	NO	NO	NO

2011

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**574.0527**	**NO**	**NO**	**90.1296**	**0.0403**	**NO**	**0.0000**	**NO**	**1.6703**	**2.5605**	**33.5228**	**0.6974**
A. Mineral industry	**488.6436**								**1.5970**	**1.2450**	**0.0156**	**0.6742**
1. Cement production	427.2624								0.9986	1.1709	0.0145	0.3010
2. Lime production	16.6236								0.0307	0.0435		0.0071
3. Glass production	26.3926								0.5378		0.0011	0.3597
4. Other process uses of carbonates	18.3651								0.0299	0.0307		0.0064
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0157**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0157	NO
C. Metal industry	**12.8556**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0418**	**0.5465**	**0.0169**	**0.0193**
1. Iron and steel production	12.8556	NO							0.0418	0.5465	0.0169	0.0193
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**71.3244**	**NO**	**NO**						**0.0078**	**0.0443**	**28.6400**	**0.0039**
1. Lubricant use	5.7762	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0747	NO	NO						NO	NO	NO	NO
3. Solvent use	63.0079	NO	NO						0.0078	0.0443	28.6400	0.0039
4. Other	2.4656	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**90.1296**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				27.0796	NO	NO	NO	NO				
2. Foam blowing agents				63.0458	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0042	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.2291**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0000**	**NO**	**0.0237**	**0.7248**	**0.5587**	**NO**
1. Electrical equipment				NO	0.0403	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.2291	NO	NO	NO	NO	NO	NO	NO	0.0237	0.7248	0.5587	NO
H. Other									**NO**	**NO**	**4.2760**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	4.2760	NO
3. Other									NO	NO	NO	NO

2012

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**582.0682**	**NO**	**NO**	**100.0227**	**0.0403**	**NO**	**0.0000**	**NO**	**1.5763**	**2.4006**	**35.1868**	**0.6289**
A. Mineral industry	**493.5610**								**1.5088**	**1.2782**	**0.0159**	**0.6054**
1. Cement production	442.1615								1.0335	1.2118	0.0150	0.3115
2. Lime production	15.5304								0.0286	0.0406		0.0066
3. Glass production	21.2592								0.4215		0.0009	0.2819
4. Other process uses of carbonates	14.6099								0.0251	0.0258		0.0054
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0150**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0150	NO
C. Metal industry	**12.6973**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0413**	**0.5398**	**0.0171**	**0.0191**
1. Iron and steel production	12.6973	NO							0.0413	0.5398	0.0171	0.0191
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**74.6523**	**NO**	**NO**						**0.0088**	**0.0500**	**30.6212**	**0.0044**
1. Lubricant use	4.9418	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.1351	NO	NO						NO	NO	NO	NO
3. Solvent use	67.3666	NO	NO						0.0088	0.0500	30.6212	0.0044
4. Other	2.2088	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**100.0227**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				30.2879	NO	NO	NO	NO				
2. Foam blowing agents				69.7304	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0043	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.1575**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0000**	**NO**	**0.0174**	**0.5326**	**0.5261**	**NO**
1. Electrical equipment				NO	0.0403	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.1575	NO	NO	NO	NO	NO	NO	NO	0.0174	0.5326	0.5261	NO
H. Other									**NO**	**NO**	**3.9915**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	3.9915	NO
3. Other									NO	NO	NO	NO

2013

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**623.2187**	**NO**	**NO**	**108.3873**	**0.0403**	**NO**	**0.0000**	**NO**	**1.7417**	**2.1714**	**34.2507**	**0.7105**
A. Mineral industry	**544.9842**								**1.6947**	**1.3902**	**0.0172**	**0.6943**
1. Cement production	476.9104								1.1139	1.3060	0.0162	0.3357
2. Lime production	20.7696								0.0383	0.0543		0.0088
3. Glass production	27.8304								0.5135		0.0011	0.3435
4. Other process uses of carbonates	19.4739								0.0290	0.0298		0.0063
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0159**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO

9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0159	NO
C. Metal industry	**7.6569**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0249**	**0.3250**	**0.0100**	**0.0115**
1. Iron and steel production	7.6569	NO							0.0249	0.3250	0.0100	0.0115
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**69.4810**	**NO**	**NO**						**0.0088**	**0.0501**	**28.2397**	**0.0044**
1. Lubricant use	4.8461	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0751	NO	NO						NO	NO	NO	NO
3. Solvent use	62.1274	NO	NO						0.0088	0.0501	28.2397	0.0044
4. Other	2.4324	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**108.3873**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				33.8193	NO	NO	NO	NO				
2. Foam blowing agents				74.5640	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0041	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.0965**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0000**	**NO**	**0.0133**	**0.4062**	**0.4984**	**0.0003**
1. Electrical equipment				NO	0.0403	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.0965	NO	NO	NO	NO	NO	NO	NO	0.0133	0.4062	0.4984	0.0003
H. Other									**NO**	**NO**	**5.4694**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	5.4694	NO
3. Other									NO	NO	NO	NO

2014

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**637.7956**	**NO**	**NO**	**121.5640**	**0.0403**	**NO**	**0.0000**	**NO**	**1.7285**	**2.3772**	**42.6162**	**0.7077**
A. Mineral industry	**535.5064**								**1.6590**	**1.3602**	**0.0167**	**0.6799**
1. Cement production	464.6082								1.0820	1.2686	0.0157	0.3261
2. Lime production	23.8218								0.0439	0.0623		0.0101
3. Glass production	27.8833								0.5045		0.0011	0.3375
4. Other process uses of carbonates	19.1931								0.0286	0.0294		0.0062
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0166**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0166	NO
C. Metal industry	**13.8464**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0450**	**0.5882**	**0.0186**	**0.0208**
1. Iron and steel production	13.8464	NO							0.0450	0.5882	0.0186	0.0208
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**87.2367**	**NO**	**NO**						**0.0128**	**0.0723**	**36.3007**	**0.0064**
1. Lubricant use	4.7832	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0301	NO	NO						NO	NO	NO	NO
3. Solvent use	79.8615	NO	NO						0.0128	0.0723	36.3007	0.0064
4. Other	2.5619	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				

3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**121.5640**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				43.5320	NO	NO	NO	NO				
2. Foam blowing agents				78.0278	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0043	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.2062**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0000**	**NO**	**0.0117**	**0.3565**	**0.5483**	**0.0007**
1. Electrical equipment				NO	0.0403	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.2062	NO	NO	NO	NO	NO	NO	NO	0.0117	0.3565	0.5483	0.0007
H. Other									**NO**	**NO**	**5.7153**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	5.7153	NO
3. Other									NO	NO	NO	NO

2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**607.8444**	**NO**	**NO**	**153.8517**	**0.0403**	**NO**	**0.0000**	**NO**	**1.6501**	**2.4169**	**39.6803**	**0.6796**
A. Mineral industry	**505.0564**								**1.5734**	**1.2767**	**0.0160**	**0.6490**
1. Cement production	443.2441								1.0311	1.2089	0.0150	0.3107
2. Lime production	15.7407								0.0290	0.0411		0.0067
3. Glass production	28.3000								0.4873		0.0010	0.3260
4. Other process uses of carbonates	17.7716								0.0260	0.0267		0.0056
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0119**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0119	NO
C. Metal industry	**17.2792**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0561**	**0.7340**	**0.0221**	**0.0259**
1. Iron and steel production	17.2792	NO							0.0561	0.7340	0.0221	0.0259
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**84.5691**	**NO**	**NO**						**0.0089**	**0.0501**	**34.9703**	**0.0044**
1. Lubricant use	4.8165	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0600	NO	NO						NO	NO	NO	NO
3. Solvent use	76.9346	NO	NO						0.0089	0.0501	34.9703	0.0044
4. Other	2.7580	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**153.8517**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				71.1976	NO	NO	NO	NO				
2. Foam blowing agents				82.6488	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0053	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**0.9397**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0000**	**NO**	**0.0116**	**0.3561**	**0.4271**	**0.0003**
1. Electrical equipment				NO	0.0403	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	0.9397	NO	NO	NO	NO	NO	NO	NO	0.0116	0.3561	0.4271	0.0003
H. Other									**NO**	**NO**	**4.2329**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	4.2329	NO
3. Other									NO	NO	NO	NO

2016

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**583.6350**	**NO**	**NO**	**163.2067**	**0.0403**	**NO**	**0.0000**	**NO**	**1.5759**	**1.8206**	**40.1158**	**0.6517**
A. Mineral industry	**492.5454**								**1.5410**	**1.2375**	**0.0156**	**0.6398**
1. Cement production	433.9022								1.0040	1.1771	0.0146	0.3026
2. Lime production	13.6470								0.0252	0.0357		0.0058
3. Glass production	28.3761								0.4877		0.0010	0.3263
4. Other process uses of carbonates	16.6202								0.0241	0.0248		0.0052
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0131**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0131	NO
C. Metal industry	**5.2203**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0169**	**0.2204**	**0.0075**	**0.0078**
1. Iron and steel production	5.2203	NO							0.0169	0.2204	0.0075	0.0078
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**84.8044**	**NO**	**NO**						**0.0076**	**0.0429**	**34.9327**	**0.0038**
1. Lubricant use	4.9177	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0449	NO	NO						NO	NO	NO	NO
3. Solvent use	76.8520	NO	NO						0.0076	0.0429	34.9327	0.0038
4. Other	2.9897	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**163.2067**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				79.1826	NO	NO	NO	NO				
2. Foam blowing agents				84.0180	NO	NO	NO	NO				
3. Fire protection				NO	NO	NO	NO	NO				
4. Aerosols				0.0061	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.0649**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0000**	**NO**	**0.0105**	**0.3198**	**0.4841**	**0.0003**
1. Electrical equipment				NO	0.0403	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.0649	NO	NO	NO	NO	NO	NO	NO	0.0105	0.3198	0.4841	0.0003
H. Other									**NO**	**NO**	**4.6628**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	4.6628	NO
3. Other									NO	NO	NO	NO

2017

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**593.1469**	**NO**	**NO**	**182.4923**	**0.0403**	**NO**	**0.0000**	**NO**	**1.5388**	**2.2988**	**46.2368**	**0.6304**
A. Mineral industry	**476.0597**								**1.4599**	**1.2025**	**0.0146**	**0.5970**
1. Cement production	404.9290								0.9420	1.1045	0.0137	0.2839
2. Lime production	28.8043								0.0531	0.0753		0.0123
3. Glass production	27.1229								0.4425		0.0009	0.2960
4. Other process uses of carbonates	15.2034								0.0222	0.0228		0.0048
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0123**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO

9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0123	NO
C. Metal industry	**18.8842**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0613**	**0.8019**	**0.0249**	**0.0283**
1. Iron and steel production	18.8842	NO							0.0613	0.8019	0.0249	0.0283
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**97.0273**	**NO**	**NO**						**0.0097**	**0.0547**	**40.4418**	**0.0048**
1. Lubricant use	4.8128	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.0600	NO	NO						NO	NO	NO	NO
3. Solvent use	88.9719	NO	NO						0.0097	0.0547	40.4418	0.0048
4. Other	3.1825	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**182.4923**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				96.6091	NO	NO	NO	NO				
2. Foam blowing agents				85.6195	NO	NO	NO	NO				
3. Fire protection				0.2576	NO	NO	NO	NO				
4. Aerosols				0.0061	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.1757**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0000**	**NO**	**0.0078**	**0.2396**	**0.5344**	**0.0003**
1. Electrical equipment				NO	0.0403	NO	0.0000	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.1757	NO	NO	NO	NO	NO	NO	NO	0.0078	0.2396	0.5344	0.0003
H. Other									**NO**	**NO**	**5.2088**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	5.2088	NO
3. Other									NO	NO	NO	NO

2018

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)			(kt)					
2. Total Industrial Processes	**763.3854**	**NO**	**NO**	**194.4750**	**0.0403**	**NO**	**0.0001**	**NO**	**1.9325**	**2.5146**	**70.1179**	**0.8052**
A. Mineral industry	**590.9800**								**1.8391**	**1.4895**	**0.0185**	**0.7607**
1. Cement production	511.1209								1.1891	1.3941	0.0172	0.3584
2. Lime production	27.7944								0.0513	0.0726		0.0118
3. Glass production	36.2388								0.5766		0.0012	0.3857
4. Other process uses of carbonates	15.8259								0.0221	0.0227		0.0048
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0155**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0155	NO
C. Metal industry	**20.2133**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0657**	**0.8586**	**0.0267**	**0.0303**
1. Iron and steel production	20.2133	NO							0.0657	0.8586	0.0267	0.0303
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**151.1808**	**NO**	**NO**						**0.0273**	**0.1534**	**64.9072**	**0.0136**
1. Lubricant use	5.0145	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.1198	NO	NO						NO	NO	NO	NO
3. Solvent use	142.7958	NO	NO						0.0273	0.1534	64.9072	0.0136
4. Other	3.2507	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				

5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**194.4750**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				106.2543	NO	NO	NO	NO				
2. Foam blowing agents				87.2640	NO	NO	NO	NO				
3. Fire protection				0.9500	NO	NO	NO	NO				
4. Aerosols				0.0066	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.0114**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0001**	**NO**	**0.0004**	**0.0132**	**0.4597**	**0.0007**
1. Electrical equipment				NO	0.0403	NO	0.0001	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.0114	NO	NO	NO	NO	NO	NO	NO	0.0004	0.0132	0.4597	0.0007
H. Other									**NO**	**NO**	**4.6903**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	4.6903	NO
3. Other									NO	NO	NO	NO

2019

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			CO_2 equivalent (kt)					(kt)			
2. Total Industrial Processes	**760.7727**	**NO**	**NO**	**229.9469**	**0.0403**	**NO**	**0.0001**	**NO**	**1.9016**	**2.3347**	**66.6202**	**0.7768**
A. Mineral industry	**600.3437**								**1.8306**	**1.5265**	**0.0188**	**0.7430**
1. Cement production	523.8755								1.2187	1.4289	0.0177	0.3673
2. Lime production	27.5851								0.0509	0.0721		0.0117
3. Glass production	32.5310								0.5362		0.0011	0.3587
4. Other process uses of carbonates	16.3521								0.0248	0.0255		0.0053
B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**0.0168**	**NO**
1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2. Nitric acid production			NO						NO			
3. Adipic acid production	NO		NO						NO	NO	NO	
4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO
5. Carbide production	NO	NO							NO	NO	NO	NO
6. Titanium dioxide production	NO											
7. Soda ash production	NO											
8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO
9. Fluorochemical production				NO	NO	NO	NO	NO				
10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0168	NO
C. Metal industry	**15.7926**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.0513**	**0.6704**	**0.0209**	**0.0237**
1. Iron and steel production	15.7926	NO							0.0513	0.6704	0.0209	0.0237
2. Ferroalloys production	NO	NO							NO	NO	NO	NO
3. Aluminium production	NO				NO		NO		NO	NO	NO	NO
4. Magnesium production	NO			NO	NO		NO		NO	NO	NO	NO
5. Lead production	NO								NO	NO	NO	NO
6. Zinc production	NO								NO	NO	NO	NO
7. Other	NO	NO	NO						NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	**143.5292**	**NO**	**NO**						**0.0186**	**0.1047**	**61.3724**	**0.0093**
1. Lubricant use	5.0561	NO	NO						NO	NO	NO	NO
2. Paraffin wax use	0.1348	NO	NO						NO	NO	NO	NO
3. Solvent use	135.0194	NO	NO						0.0186	0.1047	61.3724	0.0093
4. Other	3.3189	NO	NO						NO	NO	NO	NO
E. Electronics industry				**NO**	**NO**	**NO**	**NO**	**NO**				
1. Integrated circuit or semiconductor				NO	NO	NO	NO	NO				
2. TFT flat panel display				NO	NO	NO	NO	NO				
3. Photovoltaics				NO	NO	NO	NO	NO				
4. Heat transfer fluid				NO	NO	NO	NO	NO				
5. Other				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				**229.9469**	**NO**	**NO**	**NO**	**NO**				
1. Refrigeration and air conditioning				138.6362	NO	NO	NO	NO				
2. Foam blowing agents				89.0005	NO	NO	NO	NO				
3. Fire protection				2.3026	NO	NO	NO	NO				
4. Aerosols				0.0075	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO				
6. Other applications				NO	NO	NO	NO	NO				
G. Other product manufacture and use	**1.1072**	**NO**	**NO**	**NO**	**0.0403**	**NO**	**0.0001**	**NO**	**0.0011**	**0.0331**	**0.5033**	**0.0008**
1. Electrical equipment				NO	0.0403	NO	0.0001	NO				
2. SF_6 and PFCs from other product use					NO		NO					
3. N_2O from product uses			NO									
4. Other	1.1072	NO	NO	NO	NO	NO	NO	NO	0.0011	0.0331	0.5033	0.0008
H. Other									**NO**	**NO**	**4.6880**	**NO**
1. Pulp and Paper Industry									NO	NO	NO	NO
2. Food and Beverages Industry									NO	NO	4.6880	NO
3. Other									NO	NO	NO	NO

Annex 6-3. Sectoral Report for Sector 3 'Agriculture', 1990-2019

1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.5820**	**107.3809**	**8.8939**	**NO**	**NO**	**NE, NO**
I. Livestock		**107.3809**	**3.7470**			**NE**
A. Enteric fermentation		**87.5771**				
1. Cattle		74.9935				
Dairy cattle		41.4105				
Non-dairy cattle		33.5830				
2. Sheep		8.5887				
3. Swine		2.7751				
4. Other livestock		1.2198				
Goats		0.1855				
Horses		0.8505				
Mules and asses		0.0169				
Other (rabbits)		0.1670				
B. Manure management		**19.8038**	**3.7470**			**NE**
1. Cattle		9.2140	1.3936			NE
Dairy cattle		5.3324	0.5914			NE
Non-dairy cattle		3.8816	0.8022			NE
2. Sheep		0.2365	0.4399			NE
3. Swine		9.4938	0.5406			NE
4. Other livestock		0.8595	0.5517			NE
Goats		0.0048	0.0162			NE
Horses		0.0737	0.0655			NE
Mules and asses		0.0013	0.0008			NE
Poultry		0.7571	0.4135			NE
Other (rabbits)		0.0226	0.0557			NE
5. Indirect N_2O emissions			0.8212			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**5.1469**			
a. Direct N_2O emissions from managed soils			3.9353			
1. Inorganic N fertilizers			1.4473			
2. Organic N fertilizers			0.8571			
a. Animal manure applied to soils			0.8571			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1807			
4. Crop residues			0.5468			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.9034			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			1.2115			
1. Atmospheric deposition			0.3400			
2. Nitrogen leaching and run-off			0.8716			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.5820**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.5226**	**97.7579**	**8.4527**	**NO**	**NO**	**NE, NO**
I. Livestock		**97.7579**	**3.4991**			**NE**
A. Enteric fermentation		**81.1547**				
1. Cattle		68.6275				
Dairy cattle		38.7594				
Non-dairy cattle		29.8681				
2. Sheep		8.6126				
3. Swine		2.6295				
4. Other livestock		1.2852				
Goats		0.2474				
Horses		0.8719				
Mules and asses		0.0179				
Other (rabbits)		0.1479				
B. Manure management		**16.6032**	**3.4991**			**NE**
1. Cattle		7.4678	1.2622			NE
Dairy cattle		4.5405	0.5548			NE

Non-dairy cattle		2.9272	0.7074			NE
2. Sheep		0.2355	0.4474			NE
3. Swine		8.0652	0.5391			NE
4. Other livestock		0.8348	0.5209			NE
Goats		0.0064	0.0222			NE
Horses		0.0756	0.0576			NE
Mules and asses		0.0014	0.0009			NE
Poultry		0.7314	0.3913			NE
Other (rabbits)		0.0201	0.0489			NE
5. Indirect N_2O emissions			0.7295			
C. Rice cultivation		NO				NO
D. Agricultural soils			**4.9535**			
a. Direct N_2O emissions from managed soils			3.8064			
1. Inorganic N fertilizers			1.2996			
2. Organic N fertilizers			0.7568			
a. Animal manure applied to soils			0.7568			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2395			
4. Crop residues			0.6156			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8950			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			1.1471			
1. Atmospheric deposition			0.3111			
2. Nitrogen leaching and run-off			0.8360			
E. Prescribed burning of savannas		NO	NO			
F. Field burning of agricultural residues		IE	IE			
G. Liming	NO					
H. Urea application	**0.5226**					
I. Other carbon-containing fertilizers	NO, NE					
J. Other	NO	NO	NO	NO	NO	NO

1992

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.3905**	**94.7961**	**7.3013**	**NO**	**NO**	**NE, NO**
I. Livestock		**94.7961**	**3.1392**			**NE**
A. Enteric fermentation		**79.8715**				
1. Cattle		67.4852				
Dairy cattle		39.1801				
Non-dairy cattle		28.3051				
2. Sheep		8.7186				
3. Swine		2.2311				
4. Other livestock		1.4366				
Goats		0.3146				
Horses		0.9248				
Mules and asses		0.0211				
Other (rabbits)		0.1761				
B. Manure management		**14.9247**	**3.1392**			**NE**
1. Cattle		7.3437	1.1797			NE
Dairy cattle		4.5773	0.5518			NE
Non-dairy cattle		2.7665	0.6279			NE
2. Sheep		0.2459	0.4586			NE
3. Swine		6.6885	0.4236			NE
4. Other livestock		0.6465	0.4394			NE
Goats		0.0082	0.0276			NE
Horses		0.0802	0.0646			NE
Mules and asses		0.0016	0.0010			NE
Poultry		0.5327	0.2883			NE
Other (rabbits)		0.0239	0.0578			NE
5. Indirect N_2O emissions			0.6380			
C. Rice cultivation		NO				NO
D. Agricultural soils			**4.1621**			
a. Direct N_2O emissions from managed soils			3.1966			
1. Inorganic N fertilizers			0.9711			
2. Organic N fertilizers			0.6952			
a. Animal manure applied to soils			0.6952			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2251			
4. Crop residues			0.4132			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8919			

6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.9654			
1. Atmospheric deposition			0.2647			
2. Nitrogen leaching and run-off			0.7007			
E. Prescribed burning of savannas		NO	NO			
F. Field burning of agricultural residues		IE	IE			
G. Liming	NO					
H. Urea application	0.3905					
I. Other carbon-containing fertilizers	NO, NE					
J. Other	NO	NO	NO	NO	NO	NO

1993

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.1276**	**85.9140**	**6.2374**	NO	NO	NE, NO
I. Livestock		**85.9140**	**2.7360**			NE
A. Enteric fermentation		**74.9162**				
1. Cattle		62.7512				
Dairy cattle		37.6503				
Non-dairy cattle		25.1009				
2. Sheep		9.0097				
3. Swine		1.6235				
4. Other livestock		1.5318				
Goats		0.3744				
Horses		0.9802				
Mules and asses		0.0225				
Other (rabbits)		0.1548				
B. Manure management		**10.9978**	**2.7360**			NE
1. Cattle		5.5019	1.0636			NE
Dairy cattle		3.4585	0.5343			NE
Non-dairy cattle		2.0434	0.5293			NE
2. Sheep		0.2589	0.4697			NE
3. Swine		4.7183	0.3163			NE
4. Other livestock		0.5188	0.3685			NE
Goats		0.0097	0.0320			NE
Horses		0.0849	0.0671			NE
Mules and asses		0.0017	0.0011			NE
Poultry		0.4014	0.2179			NE
Other (rabbits)		0.0210	0.0505			NE
5. Indirect N_2O emissions			0.5178			
C. Rice cultivation		NO				NO
D. Agricultural soils			**3.5014**			
a. Direct N_2O emissions from managed soils			2.7182			
1. Inorganic N fertilizers			0.4145			
2. Organic N fertilizers			0.5935			
a. Animal manure applied to soils			0.5935			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2869			
4. Crop residues			0.4957			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.9276			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.7833			
1. Atmospheric deposition			0.1960			
2. Nitrogen leaching and run-off			0.5873			
E. Prescribed burning of savannas		NO	NO			
F. Field burning of agricultural residues		IE	IE			
G. Liming	NO					
H. Urea application	0.1276					
I. Other carbon-containing fertilizers	NO, NE					
J. Other	NO	NO	NO	NO	NO	NO

1994

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.0537**	**83.5225**	**5.5139**	NO	NO	NE, NO
I. Livestock		**83.5225**	**2.6585**			NE
A. Enteric fermentation		**72.9133**				
1. Cattle		60.4337				
Dairy cattle		37.3768				
Non-dairy cattle		23.0570				

2. Sheep		9.2321				
3. Swine		1.5702				
4. Other livestock		1.6772				
Goats		0.4608				
Horses		1.0473				
Mules and asses		0.0292				
Other (rabbits)		0.1399				
B. Manure management		**10.6093**	**2.6585**			**NE**
1. Cattle		5.4501	0.9913			NE
Dairy cattle		3.5237	0.5334			NE
Non-dairy cattle		1.9264	0.4579			NE
2. Sheep		0.2679	0.4965			NE
3. Swine		4.3463	0.2928			NE
4. Other livestock		0.5449	0.3800			NE
Goats		0.0120	0.0403			NE
Horses		0.0908	0.0755			NE
Mules and asses		0.0022	0.0014			NE
Poultry		0.4210	0.2168			NE
Other (rabbits)		0.0190	0.0460			NE
5. Indirect N_2O emissions			0.4978			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.8554**			
a. Direct N_2O emissions from managed soils			2.2083			
1. Inorganic N fertilizers			0.2217			
2. Organic N fertilizers			0.5764			
a. Animal manure applied to soils			0.5764			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2806			
4. Crop residues			0.2353			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8942			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.6471			
1. Atmospheric deposition			0.1732			
2. Nitrogen leaching and run-off			0.4739			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.0537**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

1995

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.0607**	**72.9745**	**5.3218**	**NO**	**NO**	**NE, NO**
I. Livestock		**72.9745**	**2.4596**			**NE**
A. Enteric fermentation		**64.7235**				
1. Cattle		52.9539				
Dairy cattle		34.6078				
Non-dairy cattle		18.3461				
2. Sheep		8.4987				
3. Swine		1.5246				
4. Other livestock		1.7463				
Goats		0.4820				
Horses		1.1086				
Mules and asses		0.0323				
Other (rabbits)		0.1235				
B. Manure management		**8.2510**	**2.4596**			**NE**
1. Cattle		3.6724	0.8857			NE
Dairy cattle		2.5546	0.5019			NE
Non-dairy cattle		1.1178	0.3838			NE
2. Sheep		0.2520	0.4179			NE
3. Swine		3.7683	0.3320			NE
4. Other livestock		0.5583	0.3690			NE
Goats		0.0125	0.0371			NE
Horses		0.0961	0.0778			NE
Mules and asses		0.0025	0.0015			NE
Poultry		0.4305	0.2118			NE
Other (rabbits)		0.0167	0.0408			NE
5. Indirect N_2O emissions			0.4550			
C. Rice cultivation		**NO**				**NO**

D. Agricultural soils			**2.8621**			
a. Direct N_2O emissions from managed soils			2.2288			
1. Inorganic N fertilizers			0.1652			
2. Organic N fertilizers			0.5244			
a. Animal manure applied to soils			0.5244			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2998			
4. Crop residues			0.3401			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8994			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.6333			
1. Atmospheric deposition			0.1581			
2. Nitrogen leaching and run-off			0.4753			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.0607**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

1996

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.0911**	**67.1693**	**5.3180**	**NO**	**NO**	**NE, NO**
I. Livestock		**67.1693**	**2.5974**			**NE**
A. Enteric fermentation		**59.6750**				
1. Cattle		48.2754				
Dairy cattle		32.1785				
Non-dairy cattle		16.0969				
2. Sheep		8.1851				
3. Swine		1.4251				
4. Other livestock		1.7894				
Goats		0.5063				
Horses		1.1403				
Mules and asses		0.0308				
Other (rabbits)		0.1120				
B. Manure management		**7.4943**	**2.5974**			**NE**
1. Cattle		3.3469	0.7978			NE
Dairy cattle		2.3687	0.4686			NE
Non-dairy cattle		0.9781	0.3292			NE
2. Sheep		0.2415	0.4015			NE
3. Swine		3.3886	0.3544			NE
4. Other livestock		0.5174	0.5693			NE
Goats		0.0132	0.0390			NE
Horses		0.0988	0.0776			NE
Mules and asses		0.0023	0.0014			NE
Poultry		0.3879	0.1968			NE
Other (rabbits)		0.0152	0.2544			NE
5. Indirect N_2O emissions			0.4744			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.7206**			
a. Direct N_2O emissions from managed soils			2.1069			
1. Inorganic N fertilizers			0.2077			
2. Organic N fertilizers			0.5425			
a. Animal manure applied to soils			0.5425			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2763			
4. Crop residues			0.1852			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8952			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.6137			
1. Atmospheric deposition			0.1634			
2. Nitrogen leaching and run-off			0.4503			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.0911**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

1997

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**1.0992**	**57.3905**	**4.6643**	**NO**	**NO**	**NE, NO**
I. Livestock		**57.3905**	**2.0035**			**NE**
A. Enteric fermentation		**51.3040**				
1. Cattle		41.1875				
Dairy cattle		29.1741				
Non-dairy cattle		12.0134				
2. Sheep		7.1139				
3. Swine		1.1963				
4. Other livestock		1.8063				
Goats		0.4949				
Horses		1.1773				
Mules and asses		0.0297				
Other (rabbits)		0.1043				
B. Manure management		**6.0866**	**2.0035**			**NE**
1. Cattle		2.8115	0.7066			NE
Dairy cattle		2.0983	0.4578			NE
Non-dairy cattle		0.7132	0.2488			NE
2. Sheep		0.2159	0.3242			NE
3. Swine		2.5398	0.2661			NE
4. Other livestock		0.5194	0.3365			NE
Goats		0.0129	0.0339			NE
Horses		0.1020	0.0743			NE
Mules and asses		0.0023	0.0013			NE
Poultry		0.3881	0.1924			NE
Other (rabbits)		0.0141	0.0346			NE
5. Indirect N_2O emissions			0.3702			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.6607**			
a. Direct N_2O emissions from managed soils			2.0808			
1. Inorganic N fertilizers			0.1795			
2. Organic N fertilizers			0.4269			
a. Animal manure applied to soils			0.4269			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2455			
4. Crop residues			0.3290			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8999			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5800			
1. Atmospheric deposition			0.1333			
2. Nitrogen leaching and run-off			0.4467			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**1.0992**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

1998

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.2721**	**54.9163**	**4.5098**	**NO**	**NO**	**NE, NO**
I. Livestock		**54.9163**	**1.9398**			**NE**
A. Enteric fermentation		**49.8079**				
1. Cattle		40.0305				
Dairy cattle		28.7829				
Non-dairy cattle		11.2475				
2. Sheep		6.5068				
3. Swine		1.3921				
4. Other livestock		1.8785				
Goats		0.5038				
Horses		1.2330				
Mules and asses		0.0320				
Other (rabbits)		0.1097				
B. Manure management		**5.1085**	**1.9398**			**NE**
1. Cattle		2.0923	0.6743			NE
Dairy cattle		1.6125	0.4433			NE
Non-dairy cattle		0.4798	0.2309			NE
2. Sheep		0.1988	0.2911			NE
3. Swine		2.2708	0.2802			NE
4. Other livestock		0.5466	0.3523			NE
Goats		0.0131	0.0336			NE
Horses		0.1069	0.0755			NE

Mules and asses		0.0024	0.0014			NE
Poultry		0.4093	0.2058			NE
Other (rabbits)		0.0149	0.0361			NE
5. Indirect N_2O emissions			0.3419			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.5700**			
a. Direct N_2O emissions from managed soils			2.0119			
1. Inorganic N fertilizers			0.1600			
2. Organic N fertilizers			0.4041			
a. Animal manure applied to soils			0.4041			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2709			
4. Crop residues			0.2816			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8953			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5581			
1. Atmospheric deposition			0.1296			
2. Nitrogen leaching and run-off			0.4286			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.2721**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

1999

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.0034**	**50.5648**	**4.1226**	**NO**	**NO**	**NE, NO**
I. Livestock		**50.5648**	**1.7608**			**NE**
A. Enteric fermentation		**46.0727**				
1. Cattle		37.0494				
Dairy cattle		27.7978				
Non-dairy cattle		9.2516				
2. Sheep		5.9250				
3. Swine		1.1270				
4. Other livestock		1.9714				
Goats		0.5331				
Horses		1.2964				
Mules and asses		0.0341				
Other (rabbits)		0.1077				
B. Manure management		**4.4921**	**1.7608**			**NE**
1. Cattle		1.9520	0.6113			NE
Dairy cattle		1.5573	0.4244			NE
Non-dairy cattle		0.3947	0.1869			NE
2. Sheep		0.1803	0.2640			NE
3. Swine		1.7854	0.2112			NE
4. Other livestock		0.5744	0.3678			NE
Goats		0.0139	0.0356			NE
Horses		0.1124	0.0752			NE
Mules and asses		0.0026	0.0014			NE
Poultry		0.4310	0.2206			NE
Other (rabbits)		0.0146	0.0350			NE
5. Indirect N_2O emissions			0.3065			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.3619**			
a. Direct N_2O emissions from managed soils			1.8538			
1. Inorganic N fertilizers			0.0929			
2. Organic N fertilizers			0.3679			
a. Animal manure applied to soils			0.3679			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2514			
4. Crop residues			0.2743			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8673			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5081			
1. Atmospheric deposition			0.1133			
2. Nitrogen leaching and run-off			0.3948			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.0034**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.4397**	**46.8318**	**3.8285**	**NO**	**NO**	**NE, NO**
I. Livestock		**46.8318**	**1.5712**			**NE**
A. Enteric fermentation		**43.4313**				
1. Cattle		35.3438				
Dairy cattle		27.2476				
Non-dairy cattle		8.0962				
2. Sheep		5.2675				
3. Swine		0.7390				
4. Other livestock		2.0810				
Goats		0.5788				
Horses		1.3687				
Mules and asses		0.0384				
Other (rabbits)		0.0951				
B. Manure management		**3.4005**	**1.5712**			**NE**
1. Cattle		1.6513	0.5625			NE
Dairy cattle		1.3098	0.4135			NE
Non-dairy cattle		0.3416	0.1490			NE
2. Sheep		0.1608	0.2360			NE
3. Swine		1.0111	0.1423			NE
4. Other livestock		0.5772	0.3672			NE
Goats		0.0150	0.0387			NE
Horses		0.1186	0.0803			NE
Mules and asses		0.0029	0.0016			NE
Poultry		0.4278	0.2157			NE
Other (rabbits)		0.0129	0.0308			NE
5. Indirect N_2O emissions			0.2631			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.2573**			
a. Direct N_2O emissions from managed soils			1.7699			
1. Inorganic N fertilizers			0.1609			
2. Organic N fertilizers			0.3273			
a. Animal manure applied to soils			0.3273			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2447			
4. Crop residues			0.1500			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8869			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.4874			
1. Atmospheric deposition			0.1111			
2. Nitrogen leaching and run-off			0.3764			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.4397**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.1496**	**47.5675**	**4.0894**	**NO**	**NO**	**NE, NO**
I. Livestock		**47.5675**	**1.5998**			**NE**
A. Enteric fermentation		**44.1309**				
1. Cattle		35.8303				
Dairy cattle		27.6639				
Non-dairy cattle		8.1664				
2. Sheep		5.3399				
3. Swine		0.7362				
4. Other livestock		2.2245				
Goats		0.6008				
Horses		1.4680				
Mules and asses		0.0427				
Other (rabbits)		0.1129				
B. Manure management		**3.4366**	**1.5998**			**NE**
1. Cattle		1.6789	0.5710			NE
Dairy cattle		1.3334	0.4142			NE
Non-dairy cattle		0.3455	0.1569			NE
2. Sheep		0.1618	0.2246			NE
3. Swine		0.9724	0.1358			NE
4. Other livestock		0.6235	0.4004			NE
Goats		0.0156	0.0376			NE
Horses		0.1272	0.0856			NE

Mules and asses		0.0032	0.0017			NE
Poultry		0.4621	0.2381			NE
Other (rabbits)		0.0153	0.0373			NE
5. Indirect N_2O emissions			0.2680			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.4896**			
a. Direct N_2O emissions from managed soils			1.9555			
1. Inorganic N fertilizers			0.1994			
2. Organic N fertilizers			0.3339			
a. Animal manure applied to soils			0.3339			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2481			
4. Crop residues			0.2705			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.9036			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5341			
1. Atmospheric deposition			0.1165			
2. Nitrogen leaching and run-off			0.4176			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.1496**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.0470**	**48.6223**	**4.2357**	**NO**	**NO**	**NE, NO**
I. Livestock		**48.6223**	**1.6116**			**NE**
A. Enteric fermentation		**45.0244**				
1. Cattle		36.5787				
Dairy cattle		28.4383				
Non-dairy cattle		8.1404				
2. Sheep		5.3074				
3. Swine		0.8252				
4. Other livestock		2.3130				
Goats		0.6732				
Horses		1.4875				
Mules and asses		0.0397				
Other (rabbits)		0.1125				
B. Manure management		**3.5979**	**1.6116**			**NE**
1. Cattle		1.7151	0.5723			NE
Dairy cattle		1.3707	0.4206			NE
Non-dairy cattle		0.3444	0.1517			NE
2. Sheep		0.1603	0.2168			NE
3. Swine		1.0728	0.1459			NE
4. Other livestock		0.6498	0.4056			NE
Goats		0.0175	0.0411			NE
Horses		0.1289	0.0849			NE
Mules and asses		0.0030	0.0016			NE
Poultry		0.4851	0.2410			NE
Other (rabbits)		0.0153	0.0370			NE
5. Indirect N_2O emissions			0.2710			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.6241**			
a. Direct N_2O emissions from managed soils			2.0573			
1. Inorganic N fertilizers			0.2823			
2. Organic N fertilizers			0.3367			
a. Animal manure applied to soils			0.3367			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2569			
4. Crop residues			0.2764			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.9050			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5668			
1. Atmospheric deposition			0.1267			
2. Nitrogen leaching and run-off			0.4401			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.0470**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Ariculture	**0.2381**	**44.4885**	**3.7660**	**NO**	**NO**	**NE, NO**
I. Livestock		**44.4885**	**1.5302**			**NE**
A. Enteric fermentation		**41.1415**				
1. Cattle		33.0553				
Dairy cattle		25.9741				
Non-dairy cattle		7.0812				
2. Sheep		5.0960				
3. Swine		0.7146				
4. Other livestock		2.2756				
Goats		0.6461				
Horses		1.4656				
Mules and asses		0.0428				
Other (rabbits)		0.1212				
B. Manure management		**3.3469**	**1.5302**			**NE**
1. Cattle		1.5515	0.5128			NE
Dairy cattle		1.2520	0.3812			NE
Non-dairy cattle		0.2996	0.1316			NE
2. Sheep		0.1575	0.2130			NE
3. Swine		0.9748	0.1307			NE
4. Other livestock		0.6631	0.4166			NE
Goats		0.0168	0.0394			NE
Horses		0.1270	0.0847			NE
Mules and asses		0.0033	0.0017			NE
Poultry		0.4996	0.2517			NE
Other (rabbits)		0.0164	0.0390			NE
5. Indirect N_2O emissions			0.2572			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.2358**			
a. Direct N_2O emissions from managed soils			1.7475			
1. Inorganic N fertilizers			0.2298			
2. Organic N fertilizers			0.3190			
a. Animal manure applied to soils			0.3190			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2386			
4. Crop residues			0.1297			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8304			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.4883			
1. Atmospheric deposition			0.1160			
2. Nitrogen leaching and run-off			0.3724			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.2381**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2004

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.3669**	**41.7088**	**3.9964**	**NO**	**NO**	**NE, NO**
I. Livestock		**41.7088**	**1.4804**			**NE**
A. Enteric fermentation		**38.4568**				
1. Cattle		30.3973				
Dairy cattle		24.1796				
Non-dairy cattle		6.2177				
2. Sheep		5.2446				
3. Swine		0.6335				
4. Other livestock		2.1815				
Goats		0.6358				
Horses		1.3646				
Mules and asses		0.0400				
Other (rabbits)		0.1410				
B. Manure management		**3.2519**	**1.4804**			**NE**
1. Cattle		1.5003	0.4526			NE
Dairy cattle		1.2049	0.3410			NE
Non-dairy cattle		0.2954	0.1116			NE
2. Sheep		0.1582	0.2145			NE
3. Swine		0.8799	0.1177			NE
4. Other livestock		0.7135	0.4451			NE
Goats		0.0165	0.0389			NE
Horses		0.1183	0.0775			NE

Mules and asses		0.0030	0.0016			NE
Poultry		0.5566	0.2809			NE
Other (rabbits)		0.0191	0.0463			NE
5. Indirect N_2O emissions			0.2505			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.5160**			
a. Direct N_2O emissions from managed soils			1.9764			
1. Inorganic N fertilizers			0.2524			
2. Organic N fertilizers			0.3069			
a. Animal manure applied to soils			0.3069			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2260			
4. Crop residues			0.3140			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8770			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5396			
1. Atmospheric deposition			0.1145			
2. Nitrogen leaching and run-off			0.4252			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.3669**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.1739**	**40.3670**	**4.1308**	**NO**	**NO**	**NE, NO**
I. Livestock		**40.3670**	**1.5820**			**NE**
A. Enteric fermentation		**36.9611**				
1. Cattle		28.7238				
Dairy cattle		22.8364				
Non-dairy cattle		5.8874				
2. Sheep		5.3632				
3. Swine		0.7395				
4. Other livestock		2.1346				
Goats		0.6366				
Horses		1.2961				
Mules and asses		0.0374				
Other (rabbits)		0.1645				
B. Manure management		**3.4059**	**1.5820**			**NE**
1. Cattle		1.3841	0.4207			NE
Dairy cattle		1.1110	0.3152			NE
Non-dairy cattle		0.2731	0.1055			NE
2. Sheep		0.1571	0.2125			NE
3. Swine		1.0087	0.1349			NE
4. Other livestock		0.8559	0.5422			NE
Goats		0.0166	0.0388			NE
Horses		0.1123	0.0759			NE
Mules and asses		0.0028	0.0015			NE
Poultry		0.7019	0.3718			NE
Other (rabbits)		0.0223	0.0541			NE
5. Indirect N_2O emissions			0.2717			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.5488**			
a. Direct N_2O emissions from managed soils			2.0005			
1. Inorganic N fertilizers			0.2530			
2. Organic N fertilizers			0.3232			
a. Animal manure applied to soils			0.3232			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2241			
4. Crop residues			0.3151			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8852			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5483			
1. Atmospheric deposition			0.1175			
2. Nitrogen leaching and run-off			0.4308			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.1739**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2006

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Aiculture	**0.1460**	**39.2652**	**4.0273**	**NO**	**NO**	**NE, NO**
I. Livestock		**39.2652**	**1.6257**			**NE**
A. Enteric fermentation		**35.7523**				
1. Cattle		27.4654				
Dairy cattle		21.6435				
Non-dairy cattle		5.8220				
2. Sheep		5.3596				
3. Swine		0.8524				
4. Other livestock		2.0749				
Goats		0.5994				
Horses		1.2468				
Mules and asses		0.0364				
Other (rabbits)		0.1923				
B. Manure management		**3.5129**	**1.6257**			**NE**
1. Cattle		1.3230	0.4040			NE
Dairy cattle		1.0530	0.2991			NE
Non-dairy cattle		0.2700	0.1049			NE
2. Sheep		0.1601	0.2224			NE
3. Swine		1.1714	0.1580			NE
4. Other livestock		0.8584	0.5607			NE
Goats		0.0156	0.0378			NE
Horses		0.1081	0.0791			NE
Mules and asses		0.0028	0.0015			NE
Poultry		0.7059	0.3787			NE
Other (rabbits)		0.0261	0.0636			NE
5. Indirect N_2O emissions			0.2806			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.4016**			
a. Direct N_2O emissions from managed soils			1.8817			
1. Inorganic N fertilizers			0.2170			
2. Organic N fertilizers			0.3308			
a. Animal manure applied to soils			0.3308			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.2212			
4. Crop residues			0.3063			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8063			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5199			
1. Atmospheric deposition			0.1154			
2. Nitrogen leaching and run-off			0.4046			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.1460**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2007

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.2631**	**31.3859**	**3.3103**	**NO**	**NO**	**NE, NO**
I. Livestock		**31.3859**	**1.2423**			**NE**
A. Enteric fermentation		**28.8838**				
1. Cattle		21.7190				
Dairy cattle		17.7675				
Non-dairy cattle		3.9515				
2. Sheep		4.8749				
3. Swine		0.4812				
4. Other livestock		1.8088				
Goats		0.5325				
Horses		1.0897				
Mules and asses		0.0312				
Other (rabbits)		0.1554				
B. Manure management		**2.5021**	**1.2423**			**NE**
1. Cattle		1.0477	0.3131			NE
Dairy cattle		0.8644	0.2431			NE
Non-dairy cattle		0.1833	0.0700			NE
2. Sheep		0.1444	0.1952			NE
3. Swine		0.6434	0.0892			NE
4. Other livestock		0.6665	0.4341			NE
Goats		0.0138	0.0325			NE
Horses		0.0944	0.0640			NE

Mules and asses		0.0024	0.0013			NE
Poultry		0.5348	0.2866			NE
Other (rabbits)		0.0211	0.0498			NE
5. Indirect N_2O emissions			0.2106			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.0680**			
a. Direct N_2O emissions from managed soils			1.6161			
1. Inorganic N fertilizers			0.2959			
2. Organic N fertilizers			0.2550			
a. Animal manure applied to soils			0.2550			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1756			
4. Crop residues			0.0804			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8092			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.4518			
1. Atmospheric deposition			0.1028			
2. Nitrogen leaching and run-off			0.3491			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.2631**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2008

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.8505**	**30.0651**	**3.6588**	**NO**	**NO**	**NE, NO**
I. Livestock		**30.0651**	**1.2244**			**NE**
A. Enteric fermentation		**27.5714**				
1. Cattle		20.4224				
Dairy cattle		16.9616				
Non-dairy cattle		3.4609				
2. Sheep		4.9237				
3. Swine		0.4544				
4. Other livestock		1.7709				
Goats		0.5596				
Horses		1.0329				
Mules and asses		0.0319				
Other (rabbits)		0.1466				
B. Manure management		**2.4937**	**1.2244**			**NE**
1. Cattle		0.9830	0.2877			NE
Dairy cattle		0.8230	0.2230			NE
Non-dairy cattle		0.1601	0.0647			NE
2. Sheep		0.1459	0.1925			NE
3. Swine		0.6661	0.0886			NE
4. Other livestock		0.6988	0.4465			NE
Goats		0.0145	0.0333			NE
Horses		0.0895	0.0607			NE
Mules and asses		0.0024	0.0013			NE
Poultry		0.5724	0.3028			NE
Other (rabbits)		0.0199	0.0483			NE
5. Indirect N_2O emissions			0.2092			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.4344**			
a. Direct N_2O emissions from managed soils			1.9113			
1. Inorganic N fertilizers			0.3446			
2. Organic N fertilizers			0.2502			
a. Animal manure applied to soils			0.2502			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1770			
4. Crop residues			0.3305			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8090			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5231			
1. Atmospheric deposition			0.1073			
2. Nitrogen leaching and run-off			0.4158			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.8505**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2009

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**0.5864**	**31.3551**	**3.6911**	**NO**	**NO**	**NE, NO**
I. Livestock		**31.3551**	**1.3794**			**NE**
A. Enteric fermentation		**28.5438**				
1. Cattle		20.7338				
Dairy cattle		17.1419				
Non-dairy cattle		3.5919				
2. Sheep		5.4028				
3. Swine		0.6054				
4. Other livestock		1.8018				
Goats		0.6014				
Horses		1.0092				
Mules and asses		0.0294				
Other (rabbits)		0.1619				
B. Manure management		**2.8113**	**1.3794**			**NE**
1. Cattle		0.9735	0.2942			NE
Dairy cattle		0.8114	0.2259			NE
Non-dairy cattle		0.1621	0.0683			NE
2. Sheep		0.1538	0.2136			NE
3. Swine		0.8616	0.1178			NE
4. Other livestock		0.8224	0.5153			NE
Goats		0.0156	0.0381			NE
Horses		0.0875	0.0584			NE
Mules and asses		0.0022	0.0012			NE
Poultry		0.6951	0.3639			NE
Other (rabbits)		0.0220	0.0537			NE
5. Indirect N_2O emissions			0.2386			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.3117**			
a. Direct N_2O emissions from managed soils			1.8122			
1. Inorganic N fertilizers			0.2670			
2. Organic N fertilizers			0.2791			
a. Animal manure applied to soils			0.2791			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1900			
4. Crop residues			0.2458			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8304			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.4995			
1. Atmospheric deposition			0.1070			
2. Nitrogen leaching and run-off			0.3925			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**0.5864**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2010

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**1.7443**	**31.4025**	**3.9595**	**NO**	**NO**	**NE, NO**
I. Livestock		**31.4025**	**1.4304**			**NE**
A. Enteric fermentation		**28.3270**				
1. Cattle		20.4583				
Dairy cattle		16.7968				
Non-dairy cattle		3.6615				
2. Sheep		5.3083				
3. Swine		0.7675				
4. Other livestock		1.7929				
Goats		0.6373				
Horses		0.9646				
Mules and asses		0.0275				
Other (rabbits)		0.1635				
B. Manure management		**3.0755**	**1.4304**			**NE**
1. Cattle		0.9603	0.2900			NE
Dairy cattle		0.7951	0.2207			NE
Non-dairy cattle		0.1652	0.0694			NE
2. Sheep		0.1507	0.2093			NE
3. Swine		1.1196	0.1470			NE
4. Other livestock		0.8449	0.5336			NE
Goats		0.0166	0.0404			NE
Horses		0.0836	0.0564			NE

Mules and asses		0.0021	0.0011			NE
Poultry		0.7205	0.3813			NE
Other (rabbits)		0.0222	0.0545			NE
5. Indirect N_2O emissions			0.2504			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.5291**			
a. Direct N_2O emissions from managed soils			1.9838			
1. Inorganic N fertilizers			0.3234			
2. Organic N fertilizers			0.2875			
a. Animal manure applied to soils			0.2875			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1898			
4. Crop residues			0.3344			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8487			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5453			
1. Atmospheric deposition			0.1142			
2. Nitrogen leaching and run-off			0.4311			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**1.7443**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2011

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**3.6752**	**29.5815**	**3.8532**	**NO**	**NO**	**NE, NO**
I. Livestock		**29.5815**	**1.3045**			**NE**
A. Enteric fermentation		**26.6765**				
1. Cattle		19.4806				
Dairy cattle		15.8625				
Non-dairy cattle		3.6181				
2. Sheep		4.7236				
3. Swine		0.7076				
4. Other livestock		1.7648				
Goats		0.6601				
Horses		0.9160				
Mules and asses		0.0251				
Other (rabbits)		0.1636				
B. Manure management		**2.9050**	**1.3045**			**NE**
1. Cattle		0.9142	0.2810			NE
Dairy cattle		0.7509	0.2077			NE
Non-dairy cattle		0.1633	0.0733			NE
2. Sheep		0.1357	0.1885			NE
3. Swine		1.1353	0.1397			NE
4. Other livestock		0.7198	0.4677			NE
Goats		0.0172	0.0418			NE
Horses		0.0794	0.0532			NE
Mules and asses		0.0019	0.0010			NE
Poultry		0.5992	0.3176			NE
Other (rabbits)		0.0222	0.0541			NE
5. Indirect N_2O emissions			0.2275			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.5488**			
a. Direct N_2O emissions from managed soils			1.9987			
1. Inorganic N fertilizers			0.3928			
2. Organic N fertilizers			0.2635			
a. Animal manure applied to soils			0.2635			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1756			
4. Crop residues			0.3340			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8326			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5501			
1. Atmospheric deposition			0.1146			
2. Nitrogen leaching and run-off			0.4356			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**3.6752**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2012

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**5.5908**	**27.9761**	**3.6430**	**NO**	**NO**	**NE, NO**
I. Livestock		**27.9761**	**1.1973**			**NE**
A. Enteric fermentation		**25.2109**				
1. Cattle		18.3057				
Dairy cattle		14.8262				
Non-dairy cattle		3.4795				
2. Sheep		4.5222				
3. Swine		0.6576				
4. Other livestock		1.7254				
Goats		0.6892				
Horses		0.8546				
Mules and asses		0.0242				
Other (rabbits)		0.1575				
B. Manure management		**2.7652**	**1.1973**			**NE**
1. Cattle		0.8563	0.2652			NE
Dairy cattle		0.6988	0.1959			NE
Non-dairy cattle		0.1575	0.0693			NE
2. Sheep		0.1328	0.1898			NE
3. Swine		1.1790	0.1313			NE
4. Other livestock		0.5971	0.4032			NE
Goats		0.0179	0.0451			NE
Horses		0.0741	0.0515			NE
Mules and asses		0.0018	0.0010			NE
Poultry		0.4820	0.2549			NE
Other (rabbits)		0.0214	0.0506			NE
5. Indirect N_2O emissions			0.2079			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.4457**			
a. Direct N_2O emissions from managed soils			1.9060			
1. Inorganic N fertilizers			0.5355			
2. Organic N fertilizers			0.2434			
a. Animal manure applied to soils			0.2434			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1654			
4. Crop residues			0.0997			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8619			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5397			
1. Atmospheric deposition			0.1238			
2. Nitrogen leaching and run-off			0.4159			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**5.5908**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Altele	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2013

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**4.1840**	**28.1106**	**4.0532**	**NO**	**NO**	**NE, NO**
I. Livestock		**28.1106**	**1.1202**			**NE**
A. Enteric fermentation		**25.3945**				
1. Cattle		18.0684				
Dairy cattle		14.5984				
Non-dairy cattle		3.4700				
2. Sheep		4.9122				
3. Swine		0.6672				
4. Other livestock		1.7466				
Goats		0.7230				
Horses		0.8275				
Mules and asses		0.0214				
Other (rabbits)		0.1748				
B. Manure management		**2.7160**	**1.1202**			**NE**
1. Cattle		0.8475	0.2604			NE
Dairy cattle		0.6900	0.1914			NE
Non-dairy cattle		0.1575	0.0690			NE
2. Sheep		0.1363	0.2041			NE
3. Swine		1.2548	0.1233			NE
4. Other livestock		0.4775	0.3410			NE
Goats		0.0188	0.0500			NE
Horses		0.0717	0.0505			NE

Mules and asses		0.0016	0.0009			NE
Poultry		0.3617	0.1838			NE
Other (rabbits)		0.0237	0.0558			NE
5. Indirect N_2O emissions			0.1914			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.9330**			
a. Direct N_2O emissions from managed soils			2.2948			
1. Inorganic N fertilizers			0.6617			
2. Organic N fertilizers			0.2312			
a. Animal manure applied to soils			0.2312			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1591			
4. Crop residues			0.3638			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8790			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.6382			
1. Atmospheric deposition			0.1337			
2. Nitrogen leaching and run-off			0.5045			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**4.1840**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2014

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**10.2058**	**28.9200**	**4.6670**	**NO**	**NO**	**NE, NO**
I. Livestock		**28.9200**	**1.2335**			**NE**
A. Enteric fermentation		**26.1032**				
1. Cattle		18.2780				
Dairy cattle		14.7376				
Non-dairy cattle		3.5404				
2. Sheep		5.3168				
3. Swine		0.7571				
4. Other livestock		1.7513				
Goats		0.7671				
Horses		0.7699				
Mules and asses		0.0220				
Other (rabbits)		0.1924				
B. Manure management		**2.8169**	**1.2335**			**NE**
1. Cattle		0.8090	0.2762			NE
Dairy cattle		0.6572	0.1971			NE
Non-dairy cattle		0.1517	0.0791			NE
2. Sheep		0.1394	0.2339			NE
3. Swine		1.3764	0.1464			NE
4. Other livestock		0.4921	0.3656			NE
Goats		0.0199	0.0606			NE
Horses		0.0667	0.0461			NE
Mules and asses		0.0017	0.0009			NE
Poultry		0.3777	0.1947			NE
Other (rabbits)		0.0261	0.0633			NE
5. Indirect N_2O emissions			0.2114			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**3.4335**			
a. Direct N_2O emissions from managed soils			2.6747			
1. Inorganic N fertilizers			0.9603			
2. Organic N fertilizers			0.2517			
a. Animal manure applied to soils			0.2517			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1716			
4. Crop residues			0.4079			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8832			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.7588			
1. Atmospheric deposition			0.1695			
2. Nitrogen leaching and run-off			0.5893			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**10.2058**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**11.2402**	**27.9227**	**3.8226**	**NO**	**NO**	**NE, NO**
I. Livestock		**27.9227**	**1.1952**			**NE**
A. Enteric fermentation		**25.1684**				
1. Cattle		17.6976				
Dairy cattle		14.4250				
Non-dairy cattle		3.2727				
2. Sheep		5.0019				
3. Swine		0.7267				
4. Other livestock		1.7422				
Goats		0.7932				
Horses		0.7227				
Mules and asses		0.0196				
Other (rabbits)		0.2066				
B. Manure management		**2.7544**	**1.1952**			**NE**
1. Cattle		0.7835	0.2734			NE
Dairy cattle		0.6433	0.1973			NE
Non-dairy cattle		0.1403	0.0761			NE
2. Sheep		0.1372	0.2204			NE
3. Swine		1.3412	0.1343			NE
4. Other livestock		0.4924	0.3629			NE
Goats		0.0206	0.0595			NE
Horses		0.0626	0.0431			NE
Mules and asses		0.0015	0.0008			NE
Poultry		0.3796	0.1918			NE
Other (rabbits)		0.0280	0.0677			NE
5. Indirect N_2O emissions			0.2042			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**2.6274**			
a. Direct N_2O emissions from managed soils			2.0470			
1. Inorganic N fertilizers			0.6078			
2. Organic N fertilizers			0.2448			
a. Animal manure applied to soils			0.2448			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1673			
4. Crop residues			0.1442			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8829			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.5803			
1. Atmospheric deposition			0.1322			
2. Nitrogen leaching and run-off			0.4482			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**11.2402**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2016

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**12.2747**	**27.7164**	**4.3031**	**NO**	**NO**	**NE, NO**
I. Livestock		**27.7164**	**1.2328**			**NE**
A. Enteric fermentation		**24.8801**				
1. Cattle		17.3237				
Dairy cattle		13.7699				
Non-dairy cattle		3.5538				
2. Sheep		5.0967				
3. Swine		0.7047				
4. Other livestock		1.7551				
Goats		0.8352				
Horses		0.6728				
Mules and asses		0.0308				
Other (rabbits)		0.2163				
B. Manure management		**2.8363**	**1.2328**			**NE**
1. Cattle		0.8116	0.2589			NE
Dairy cattle		0.6217	0.1861			NE
Non-dairy cattle		0.1899	0.0728			NE
2. Sheep		0.1358	0.2201			NE
3. Swine		1.3799	0.1627			NE
4. Other livestock		0.5089	0.3743			NE
Goats		0.0217	0.0635			NE
Horses		0.0583	0.0395			NE

Mules and asses		0.0023	0.0012			NE
Poultry		0.3973	0.1986			NE
Other (rabbits)		0.0293	0.0715			NE
5. Indirect N_2O emissions			0.2168			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**3.0703**			
a. Direct N_2O emissions from managed soils			2.4008			
1. Inorganic N fertilizers			0.6821			
2. Organic N fertilizers			0.2523			
a. Animal manure applied to soils			0.2523			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1680			
4. Crop residues			0.4044			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8940			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.6695			
1. Atmospheric deposition			0.1415			
2. Nitrogen leaching and run-off			0.5280			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**12.2747**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2017

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**26.2081**	**25.9044**	**4.5774**	**NO**	**NO**	**NE, NO**
I. Livestock		**25.9044**	**1.1730**			**NE**
A. Enteric fermentation		**23.1182**				
1. Cattle		15.9817				
Dairy cattle		12.8523				
Non-dairy cattle		3.1294				
2. Sheep		4.7390				
3. Swine		0.6597				
4. Other livestock		1.7378				
Goats		0.8514				
Horses		0.6143				
Mules and asses		0.0500				
Other (rabbits)		0.2221				
B. Manure management		**2.7862**	**1.1730**			**NE**
1. Cattle		0.7496	0.2490			NE
Dairy cattle		0.5818	0.1729			NE
Non-dairy cattle		0.1677	0.0761			NE
2. Sheep		0.1299	0.2058			NE
3. Swine		1.3869	0.1257			NE
4. Other livestock		0.5199	0.3890			NE
Goats		0.0221	0.0630			NE
Horses		0.0532	0.0401			NE
Mules and asses		0.0038	0.0022			NE
Poultry		0.4106	0.2097			NE
Other (rabbits)		0.0301	0.0740			NE
5. Indirect N_2O emissions			0.2035			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**3.4045**			
a. Direct N_2O emissions from managed soils			2.6602			
1. Inorganic N fertilizers			0.8754			
2. Organic N fertilizers			0.2399			
a. Animal manure applied to soils			0.2399			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1634			
4. Crop residues			0.4767			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.9048			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.7443			
1. Atmospheric deposition			0.1576			
2. Nitrogen leaching and run-off			0.5866			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**26.2081**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2018

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Agriculture	**43.3624**	**23.4494**	**4.5750**	**NO**	**NO**	**NE, NO**
I. Livestock		**23.4494**	**1.0372**			**NE**
A. Enteric fermentation		**20.6560**				
1. Cattle		14.0331				
Dairy cattle		11.2095				
Non-dairy cattle		2.8237				
2. Sheep		4.3682				
3. Swine		0.6474				
4. Other livestock		1.6073				
Goats		0.8143				
Horses		0.5480				
Mules and asses		0.0377				
Other (rabbits)		0.2074				
B. Manure management		**2.7933**	**1.0372**			**NE**
1. Cattle		0.6935	0.2142			NE
Dairy cattle		0.5227	0.1476			NE
Non-dairy cattle		0.1709	0.0666			NE
2. Sheep		0.1175	0.1861			NE
3. Swine		1.5371	0.1130			NE
4. Other livestock		0.4452	0.3396			NE
Goats		0.0212	0.0603			NE
Horses		0.0475	0.0333			NE
Mules and asses		0.0029	0.0016			NE
Poultry		0.3456	0.1756			NE
Other (rabbits)		0.0281	0.0688			NE
5. Indirect N_2O emissions			0.1842			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**3.5378**			
a. Direct N_2O emissions from managed soils			2.7628			
1. Inorganic N fertilizers			1.0105			
2. Organic N fertilizers			0.2152			
a. Animal manure applied to soils			0.2152			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1434			
4. Crop residues			0.4819			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.9118			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.7750			
1. Atmospheric deposition			0.1636			
2. Nitrogen leaching and run-off			0.6114			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**43.3624**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2019

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
3. Total Aiculture	**39.6306**	**20.3296**	**4.6832**	**NO**	**NO**	**NE, NO**
I. Livestock		**20.3296**	**0.9345**			**NE**
A. Enteric fermentation		**17.6658**				
1. Cattle		11.8242				
Dairy cattle		9.2961				
Non-dairy cattle		2.5281				
2. Sheep		3.7500				
3. Swine		0.6426				
4. Other livestock		1.4490				
Goats		0.7636				
Horses		0.4768				
Mules and asses		0.0142				
Other (rabbits)		0.1945				
B. Manure management		**2.6637**	**0.9345**			**NE**
1. Cattle		0.5860	0.1859			NE
Dairy cattle		0.4334	0.1223			NE
Non-dairy cattle		0.1526	0.0637			NE
2. Sheep		0.1019	0.1614			NE
3. Swine		1.5520	0.1013			NE
4. Other livestock		0.4239	0.3194			NE
Goats		0.0199	0.0565			NE

Horses		0.0413	0.0300			NE
Mules and asses		0.0011	0.0006			NE
Poultry		0.3353	0.1680			NE
Other (rabbits)		0.0264	0.0643			NE
5. Indirect N_2O emissions			0.1664			
C. Rice cultivation		**NO**				**NO**
D. Agricultural soils			**3.7488**			
a. Direct N_2O emissions from managed soils			2.9229			
1. Inorganic N fertilizers			1.2134			
2. Organic N fertilizers			0.1939			
a. Animal manure applied to soils			0.1939			
b. Sewage sludge applied to soils			NO, NE			
c. Other organic fertilizers applied to soils			NO, NE			
3. Urine and dung deposited by grazing animals			0.1269			
4. Crop residues			0.4900			
5. Mineralization/immobilization associated with loss/gain of soil organic matter			0.8986			
6. Cultivation of organic soils (i.e. histosols)			NO			
7. Other			NO			
b. Indirect N_2O Emissions from managed soils			0.8259			
1. Atmospheric deposition			0.1774			
2. Nitrogen leaching and run-off			0.6485			
E. Prescribed burning of savannas		**NO**	**NO**			
F. Field burning of agricultural residues		**IE**	**IE**			
G. Liming	**NO**					
H. Urea application	**39.6306**					
I. Other carbon-containing fertilizers	**NO, NE**					
J. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Annex 6-4. Sectoral Reports for Sector 4 'LULUCF', 1990-2019

1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,560.8442**	**0.1061**	**0.5717**	**0.0959**	**3.5227**	**NO, NE**
A. Forest land	**-2,563.4328**	**0.0083**	**0.0005**	**0.0053**	**0.1887**	**NO, NE**
1. Forest land remaining forest land	-1,579.0396	NE	NE	NE	NE	NE
2. Land converted to forest land	-984.3932	0.0083	0.0005	0.0053	0.1887	NO
B. Cropland	**2,648.7307**	**0.0978**	**0.0025**	**0.0906**	**3.3340**	**NO**
1. Cropland remaining cropland	2,602.9804	0.0978	0.0025	0.0906	3.3340	NO
2. Land converted to cropland	45.7503	NE	NE	NE	NE	NE
C. Grassland	**-1,205.6938**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,205.6938	NE	NE	NE	NE	NE
D. Wetlands	**-555.3798**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-555.3798	NE	NE	NE	NE	NE
E. Settlements	**84.7480**	**NO, NE**	**0.5687**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	84.7480	NO	0.5687	NO	NO	NO
F. Other land	**152.3638**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	152.3638	NE	NE	NE	NE	NE
G. Harvested wood products	**-122.1804**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-2,639.3787**	**0.0960**	**0.6171**	**0.0885**	**3.2552**	**NO, NE**
A. Forest land	**-2,343.3131**	**0.0014**	**0.0001**	**0.0009**	**0.0316**	**NO, NE**
1. Forest land remaining forest land	-1,352.6491	NE	NE	NE	NE	NE
2. Land converted to forest land	-990.6641	0.0014	0.0001	0.0009	0.0316	NO
B. Cropland	**1,517.2470**	**0.0946**	**0.0025**	**0.0876**	**3.2236**	**NO**
1. Cropland remaining cropland	1,489.8617	0.0946	0.0025	0.0876	3.2236	NO
2. Land converted to cropland	27.3853	NE	NE	NE	NE	NE
C. Grassland	**-1,414.3167**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,414.3167	NE	NE	NE	NE	NE
D. Wetlands	**-526.4627**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-526.4627	NE	NE	NE	NE	NE
E. Settlements	**88.7139**	**NO, NE**	**0.6145**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE

2. Land converted to settlements	88.7139	NO	0.6145	NO	NO	NO
F. Other land	**152.3638**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	152.3638	NE	NE	NE	NE	NE
G. Harvested wood products	**-113.6108**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

1992

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-2,053.2024**	**0.0879**	**0.6868**	**0.0809**	**2.9777**	**NO, NE**
A. Forest land	**-2,184.2404**	**0.0015**	**0.0001**	**0.0010**	**0.0346**	**NO, NE**
1. Forest land remaining forest land	-1,290.4237	NE	NE	NE	NE	NE
2. Land converted to forest land	-893.8167	0.0015	0.0001	0.0010	0.0346	NO
B. Cropland	**1,443.9675**	**0.0864**	**0.0022**	**0.0800**	**2.9431**	**NO**
1. Cropland remaining cropland	1,571.4108	0.0864	0.0022	0.0800	2.9431	NO
2. Land converted to cropland	-127.4433	NE	NE	NE	NE	NE
C. Grassland	**-1,428.4835**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,428.4835	NE	NE	NE	NE	NE
D. Wetlands	**-595.5455**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-595.5455	NE	NE	NE	NE	NE
E. Settlements	**386.6196**	**NO, NE**	**0.6844**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	386.6196	NO	0.6844	NO	NO	NO
F. Other land	**418.7786**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	418.7786	NE	NE	NE	NE	NE
G. Harvested wood products	**-94.2986**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

1993

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-2,094.6617**	**0.1179**	**0.7469**	**0.1091**	**4.0151**	**NO, NE**
A. Forest land	**-2,193.5115**	**0.0001**	**0.0000**	**0.0001**	**0.0024**	**NO, NE**
1. Forest land remaining forest land	-1,367.4361	NE	NE	NE	NE	NE
2. Land converted to forest land	-826.0754	0.0001	0.0000	0.0001	0.0024	NO
B. Cropland	**1,713.0301**	**0.1178**	**0.0031**	**0.1090**	**4.0127**	**NO**
1. Cropland remaining cropland	1,707.8393	0.1178	0.0031	0.1090	4.0127	NO
2. Land converted to cropland	5.1908	NE	NE	NE	NE	NE
C. Grassland	**-1,303.5202**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,303.5202	NE	NE	NE	NE	NE
D. Wetlands	**-525.8447**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-525.8447	NE	NE	NE	NE	NE
E. Settlements	**114.6181**	**NO, NE**	**0.7438**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	114.6181	NO	0.7438	NO	NO	NO
F. Other land	**164.0168**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	164.0168	NE	NE	NE	NE	NE
G. Harvested wood products	**-63.4504**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

1994

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-2,041.3832**	**0.0662**	**0.7938**	**0.0606**	**2.2302**	**NO, NE**
A. Forest land	**-2,108.0022**	**0.0023**	**0.0001**	**0.0015**	**0.0526**	**NO, NE**
1. Forest land remaining forest land	-1,355.1762	NE	NE	NE	NE	NE
2. Land converted to forest land	-752.8259	0.0023	0.0001	0.0015	0.0526	NO
B. Cropland	**1,476.2941**	**0.0639**	**0.0017**	**0.0592**	**2.1776**	**NO**
1. Cropland remaining cropland	1,479.6972	0.0639	0.0017	0.0592	2.1776	NO
2. Land converted to cropland	-3.4030	NE	NE	NE	NE	NE
C. Grassland	**-1,577.3332**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,577.3332	NE	NE	NE	NE	NE
D. Wetlands	**-497.6418**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-497.6418	NE	NE	NE	NE	NE

E. Settlements	**130.4883**	**NO, NE**	**0.7920**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	130.4883	NO	0.7920	NO	NO	NO
F. Other land	**549.4579**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	549.4579	NE	NE	NE	NE	NE
G. Harvested wood products	**-14.6464**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

1995

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-2,015.3244**	**0.0896**	**0.8440**	**0.0829**	**3.0510**	**NO, NE**
A. Forest land	**-2,045.0670**	**0.0001**	**0.0000**	**0.0001**	**0.0030**	**NO, NE**
1. Forest land remaining forest land	-1,350.1974	NE	NE	NE	NE	NE
2. Land converted to forest land	-694.8696	0.0001	0.0000	0.0001	0.0030	NO
B. Cropland	**1,586.2644**	**0.0895**	**0.0023**	**0.0828**	**3.0480**	**NO**
1. Cropland remaining cropland	1,652.6167	0.0895	0.0023	0.0828	3.0480	NO
2. Land converted to cropland	-66.3523	NE	NE	NE	NE	NE
C. Grassland	**-1,601.1004**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,601.1004	NE	NE	NE	NE	NE
D. Wetlands	**-469.4389**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-469.4389	NE	NE	NE	NE	NE
E. Settlements	**106.9167**	**NO, NE**	**0.8417**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	106.9167	NO	0.8417	NO	NO	NO
F. Other land	**401.1281**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	401.1281	NE	NE	NE	NE	NE
G. Harvested wood products	**5.9727**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

1996

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-2,470.8404**	**0.0616**	**0.8801**	**0.0569**	**2.0916**	**NO, NE**
A. Forest land	**-2,190.4337**	**0.0008**	**0.0000**	**0.0005**	**0.0176**	**NO, NE**
1. Forest land remaining forest land	-1,559.0470	NE	NE	NE	NE	NE
2. Land converted to forest land	-631.3866	0.0008	0.0000	0.0005	0.0176	NO
B. Cropland	**1,388.2124**	**0.0609**	**0.0016**	**0.0564**	**2.0740**	**NO**
1. Cropland remaining cropland	1,489.3644	0.0609	0.0016	0.0564	2.0740	NO
2. Land converted to cropland	-101.1521	NE	NE	NE	NE	NE
C. Grassland	**-1,548.0826**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,548.0826	NE	NE	NE	NE	NE
D. Wetlands	**-441.2360**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-441.2360	NE	NE	NE	NE	NE
E. Settlements	**101.5910**	**NO, NE**	**0.8784**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	101.5910	NO	0.8784	NO	NO	NO
F. Other land	**217.3293**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	217.3293	NE	NE	NE	NE	NE
G. Harvested wood products	**1.7792**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

1997

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-2,119.5658**	**0.1075**	**0.9134**	**0.0995**	**3.6610**	**NO, NE**
A. Forest land	**-2,232.2854**	**0.0002**	**0.0000**	**0.0001**	**0.0053**	**NO, NE**
1. Forest land remaining forest land	-1,639.4910	NE	NE	NE	NE	NE
2. Land converted to forest land	-592.7944	0.0002	0.0000	0.0001	0.0053	NO
B. Cropland	**1,656.8247**	**0.1073**	**0.0028**	**0.0993**	**3.6556**	**NO**
1. Cropland remaining cropland	1,802.8445	0.1073	0.0028	0.0993	3.6556	NO
2. Land converted to cropland	-146.0198	NE	NE	NE	NE	NE
C. Grassland	**-1,400.8607**	**NE**	**NE**	**NE**	**NE**	**NE**

1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,400.8607	NE	NE	NE	NE	NE
D. Wetlands	**-413.0332**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-413.0332	NE	NE	NE	NE	NE
E. Settlements	**100.7954**	**NO, NE**	**0.9106**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	100.7954	NO	0.9106	NO	NO	NO
F. Other land	**188.2363**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	188.2363	NE	NE	NE	NE	NE
G. Harvested wood products	**-19.2429**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

1998

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-2,150.7175**	**0.0989**	**0.9542**	**0.0909**	**3.3430**	**NO, NE**
A. Forest land	**-2,288.4857**	**0.0023**	**0.0001**	**0.0015**	**0.0529**	**NO, NE**
1. Forest land remaining forest land	-1,732.3177	NE	NE	NE	NE	NE
2. Land converted to forest land	-556.1680	0.0023	0.0001	0.0015	0.0529	NO
B. Cropland	**1,683.9458**	**0.0966**	**0.0025**	**0.0894**	**3.2900**	**NO**
1. Cropland remaining cropland	1,838.5706	0.0966	0.0025	0.0894	3.2900	NO
2. Land converted to cropland	-154.6249	NE	NE	NE	NE	NE
C. Grassland	**-1,436.2698**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,436.2698	NE	NE	NE	NE	NE
D. Wetlands	**-384.8303**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-384.8303	NE	NE	NE	NE	NE
E. Settlements	**99.0440**	**NO, NE**	**0.9516**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	99.0440	NO	0.9516	NO	NO	NO
F. Other land	**185.0077**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	185.0077	NE	NE	NE	NE	NE
G. Harvested wood products	**-9.1293**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

1999

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,869.0627**	**0.0956**	**0.9861**	**0.0880**	**0.1265**	**NO, NE**
A. Forest land	**-2,336.8468**	**0.0017**	**0.0001**	**0.0011**	**0.0396**	**NO, NE**
1. Forest land remaining forest land	-1,840.9058	NE	NE	NE	NE	NE
2. Land converted to forest land	-495.9410	0.0017	0.0001	0.0011	0.0396	NO
B. Cropland	**1,702.1754**	**0.0938**	**0.0024**	**0.0869**	**0.0869**	**NO**
1. Cropland remaining cropland	1,814.6174	0.0938	0.0024	0.0869	0.0869	NO
2. Land converted to cropland	-112.4420	NE	NE	NE	NE	NE
C. Grassland	**-1,433.2865**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,433.2865	NE	NE	NE	NE	NE
D. Wetlands	**-356.6274**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-356.6274	NE	NE	NE	NE	NE
E. Settlements	**111.8259**	**NO, NE**	**0.9836**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	111.8259	NO	0.9836	NO	NO	NO
F. Other land	**425.1554**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	425.1554	NE	NE	NE	NE	NE
G. Harvested wood products	**18.5414**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-2,151.1356**	**0.0365**	**0.9944**	**0.0338**	**1.2427**	**NO, NE**
A. Forest land	**-2,307.4384**	**0.0001**	**0.0000**	**0.0000**	**0.0014**	**NO, NE**
1. Forest land remaining forest land	-1,881.4545	NE	NE	NE	NE	NE
2. Land converted to forest land	-425.9839	0.0001	0.0000	0.0000	0.0014	NO
B. Cropland	**1,492.1681**	**0.0364**	**0.0009**	**0.0337**	**1.2413**	**NO**
1. Cropland remaining cropland	1,618.8065	0.0364	0.0009	0.0337	1.2413	NO
2. Land converted to cropland	-126.6383	NE	NE	NE	NE	NE

C. Grassland	**-1,291.9495**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,291.9495	NE	NE	NE	NE	NE
D. Wetlands	**-328.4245**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-328.4245	NE	NE	NE	NE	NE
E. Settlements	**100.1768**	**NO, NE**	**0.9934**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	100.1768	NO	0.9934	NO	NO	NO
F. Other land	**178.5246**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	178.5246	NE	NE	NE	NE	NE
G. Harvested wood products	**5.8073**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,796.6576**	**0.0508**	**0.9951**	**0.0459**	**1.6868**	**NO, NE**
A. Forest land	**-2,273.7027**	**0.0039**	**0.0002**	**0.0025**	**0.0896**	**NO, NE**
1. Forest land remaining forest land	-1,873.5555	NE	NE	NE	NE	NE
2. Land converted to forest land	-400.1473	0.0039	0.0002	0.0025	0.0896	NO
B. Cropland	**1,828.5659**	**0.0469**	**0.0012**	**0.0434**	**1.5972**	**NO**
1. Cropland remaining cropland	1,999.8174	0.0469	0.0012	0.0434	1.5972	NO
2. Land converted to cropland	-171.2515	NE	NE	NE	NE	NE
C. Grassland	**-1,290.6541**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,290.6541	NE	NE	NE	NE	NE
D. Wetlands	**-300.2217**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-300.2217	NE	NE	NE	NE	NE
E. Settlements	**67.0898**	**NO, NE**	**0.9937**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	67.0898	NO	0.9937	NO	NO	NO
F. Other land	**178.5246**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	178.5246	NE	NE	NE	NE	NE
G. Harvested wood products	**-6.2594**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,883.4274**	**0.0106**	**0.9965**	**0.0092**	**0.3385**	**NO, NE**
A. Forest land	**-2,267.6159**	**0.0021**	**0.0001**	**0.0013**	**0.0481**	**NO, NE**
1. Forest land remaining forest land	-1,913.5787	NE	NE	NE	NE	NE
2. Land converted to forest land	-354.0371	0.0021	0.0001	0.0013	0.0481	NO
B. Cropland	**1,424.6996**	**0.0085**	**0.0002**	**0.0079**	**0.2904**	**NO**
1. Cropland remaining cropland	1,568.8050	0.0085	0.0002	0.0079	0.2904	NO
2. Land converted to cropland	-144.1054	NE	NE	NE	NE	NE
C. Grassland	**-1,235.1380**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,235.1380	NE	NE	NE	NE	NE
D. Wetlands	**-272.0188**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-272.0188	NE	NE	NE	NE	NE
E. Settlements	**67.0898**	**NO, NE**	**0.9961**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	67.0898	NO	0.9961	NO	NO	NO
F. Other land	**456.2431**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	456.2431	NE	NE	NE	NE	NE
G. Harvested wood products	**-56.6873**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,810.9497**	**0.0024**	**0.9877**	**0.0016**	**0.0573**	**NO, NE**
A. Forest land	**-2,270.1176**	**0.0023**	**0.0001**	**0.0015**	**0.0526**	**NO, NE**
1. Forest land remaining forest land	-1,863.8705	NE	NE	NE	NE	NE
2. Land converted to forest land	-406.2471	0.0023	0.0001	0.0015	0.0526	NO
B. Cropland	**1,505.7575**	**0.0001**	**0.0000**	**0.0001**	**0.0046**	**NO**
1. Cropland remaining cropland	1,645.1586	0.0001	0.0000	0.0001	0.0046	NO
2. Land converted to cropland	-139.4011	NE	NE	NE	NE	NE
C. Grassland	**-1,007.1842**	**NE**	**NE**	**NE**	**NE**	**NE**

1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,007.1842	NE	NE	NE	NE	NE
D. Wetlands	**-243.8159**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-243.8159	NE	NE	NE	NE	NE
E. Settlements	**67.8615**	**NO, NE**	**0.9876**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	67.8615	NO	0.9876	NO	NO	NO
F. Other land	**201.6619**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	201.6619	NE	NE	NE	NE	NE
G. Harvested wood products	**-65.1129**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2004

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,980.5023**	**0.0080**	**0.9736**	**0.0057**	**0.1401**	**NO, NE**
A. Forest land	**-2,334.7768**	**0.0061**	**0.0003**	**0.0039**	**0.1383**	**NO, NE**
1. Forest land remaining forest land	-1,904.3372	NE	NE	NE	NE	NE
2. Land converted to forest land	-430.4396	0.0061	0.0003	0.0039	0.1383	NO
B. Cropland	**1,466.3473**	**0.0020**	**0.0001**	**0.0018**	**0.0018**	**NO**
1. Cropland remaining cropland	1,589.7492	0.0020	0.0001	0.0018	0.0018	NO
2. Land converted to cropland	-123.4019	NE	NE	NE	NE	NE
C. Grassland	**-1,120.4767**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,120.4767	NE	NE	NE	NE	NE
D. Wetlands	**-215.6130**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-215.6130	NE	NE	NE	NE	NE
E. Settlements	**53.6737**	**NO, NE**	**0.9732**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	53.6737	NO	0.9732	NO	NO	NO
F. Other land	**223.8177**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	223.8177	NE	NE	NE	NE	NE
G. Harvested wood products	**-53.4745**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,682.7486**	**0.0099**	**0.9615**	**0.0090**	**0.3317**	**NO, NE**
A. Forest land	**-2,409.5185**	**0.0006**	**0.0000**	**0.0004**	**0.0132**	**NO, NE**
1. Forest land remaining forest land	-1,965.9956	NE	NE	NE	NE	NE
2. Land converted to forest land	-443.5229	0.0006	0.0000	0.0004	0.0132	NO
B. Cropland	**1,543.2389**	**0.0093**	**0.0002**	**0.0087**	**0.3185**	**NO**
1. Cropland remaining cropland	1,630.9279	0.0093	0.0002	0.0087	0.3185	NO
2. Land converted to cropland	-87.6890	NE	NE	NE	NE	NE
C. Grassland	**-1,058.1239**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,058.1239	NE	NE	NE	NE	NE
D. Wetlands	**-187.4101**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-187.4101	NE	NE	NE	NE	NE
E. Settlements	**53.6737**	**NO, NE**	**0.9613**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	53.6737	NO	0.9613	NO	NO	NO
F. Other land	**416.5012**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	416.5012	NE	NE	NE	NE	NE
G. Harvested wood products	**-41.1098**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2006

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,801.8890**	**0.0100**	**0.9483**	**0.0075**	**0.2706**	**NO, NE**
A. Forest land	**-2,366.5168**	**0.0063**	**0.0003**	**0.0040**	**0.1427**	**NO, NE**
1. Forest land remaining forest land	-1,882.9327	NE	NE	NE	NE	NE
2. Land converted to forest land	-483.5841	0.0063	0.0003	0.0040	0.1427	NO
B. Cropland	**1,577.6205**	**0.0038**	**0.0001**	**0.0035**	**0.1279**	**NO**
1. Cropland remaining cropland	1,666.3069	0.0038	0.0001	0.0035	0.1279	NO
2. Land converted to cropland	-88.6864	NE	NE	NE	NE	NE

C. Grassland	**-1,056.3692**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,056.3692	NE	NE	NE	NE	NE
D. Wetlands	**-159.2073**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-159.2073	NE	NE	NE	NE	NE
E. Settlements	**53.6737**	**NO, NE**	**0.9479**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	53.6737	NO	0.9479	NO	NO	NO
F. Other land	**189.4964**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	189.4964	NE	NE	NE	NE	NE
G. Harvested wood products	**-40.5864**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2007

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,994.4386**	**0.0607**	**0.9330**	**0.0405**	**1.4511**	**NO, NE**
A. Forest land	**-2,460.3855**	**0.0546**	**0.0030**	**0.0349**	**1.2432**	**NO, NE**
1. Forest land remaining forest land	-1,985.9585	NE	NE	NE	NE	NE
2. Land converted to forest land	-474.4270	0.0546	0.0030	0.0349	1.2432	NO
B. Cropland	**1,540.3986**	**0.0061**	**0.0002**	**0.0056**	**0.2079**	**NO**
1. Cropland remaining cropland	1,621.1746	0.0061	0.0002	0.0056	0.2079	NO
2. Land converted to cropland	-80.7760	NE	NE	NE	NE	NE
C. Grassland	**-1,031.2350**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-1,031.2350	NE	NE	NE	NE	NE
D. Wetlands	**-131.0044**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-131.0044	NE	NE	NE	NE	NE
E. Settlements	**49.2742**	**NO, NE**	**0.9298**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	49.2742	NO	0.9298	NO	NO	NO
F. Other land	**83.1072**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	83.1072	NE	NE	NE	NE	NE
G. Harvested wood products	**-44.5936**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2008

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,682.2257**	**0.0308**	**0.9128**	**0.0274**	**1.0067**	**NO, NE**
A. Forest land	**-2,462.7874**	**0.0038**	**0.0002**	**0.0024**	**0.0864**	**NO, NE**
1. Forest land remaining forest land	-1,985.3822	NE	NE	NE	NE	NE
2. Land converted to forest land	-477.4052	0.0038	0.0002	0.0024	0.0864	NO
B. Cropland	**1,510.8422**	**0.0270**	**0.0007**	**0.0250**	**0.9203**	**NO**
1. Cropland remaining cropland	1,603.3550	0.0270	0.0007	0.0250	0.9203	NO
2. Land converted to cropland	-92.5128	NE	NE	NE	NE	NE
C. Grassland	**-932.1498**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-932.1498	NE	NE	NE	NE	NE
D. Wetlands	**-102.8015**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-102.8015	NE	NE	NE	NE	NE
E. Settlements	**49.2742**	**NO, NE**	**0.9119**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	49.2742	NO	0.9119	NO	NO	NO
F. Other land	**291.0044**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	291.0044	NE	NE	NE	NE	NE
G. Harvested wood products	**-35.6078**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2009

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,286.3366**	**0.0126**	**0.8904**	**0.0090**	**0.3239**	**NO, NE**
A. Forest land	**-2,526.0659**	**0.0093**	**0.0005**	**0.0059**	**0.2108**	**NO, NE**

1. Forest land remaining forest land	-2,008.9453	NE	NE	NE	NE	NE
2. Land converted to forest land	-517.1206	0.0093	0.0005	0.0059	0.2108	NO
B. Cropland	**1,664.9870**	**0.0033**	**0.0001**	**0.0031**	**0.1130**	**NO**
1. Cropland remaining cropland	1,744.0569	0.0033	0.0001	0.0031	0.1130	NO
2. Land converted to cropland	-79.0698	NE	NE	NE	NE	NE
C. Grassland	**-447.6932**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-447.6932	NE	NE	NE	NE	NE
D. Wetlands	**-74.5986**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-74.5986	NE	NE	NE	NE	NE
E. Settlements	**45.5694**	**NO, NE**	**0.8898**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	45.5694	NO	0.8898	NO	NO	NO
F. Other land	**79.9357**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	79.9357	NE	NE	NE	NE	NE
G. Harvested wood products	**-28.4708**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2010

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,212.2817**	**0.0056**	**0.8665**	**0.0042**	**0.1529**	**NO, NE**
A. Forest land	**-2,484.1627**	**0.0032**	**0.0002**	**0.0021**	**0.0737**	**NO, NE**
1. Forest land remaining forest land	-1,964.0859	NE	NE	NE	NE	NE
2. Land converted to forest land	-520.0768	0.0032	0.0002	0.0021	0.0737	NO
B. Cropland	**1,546.0139**	**0.0023**	**0.0001**	**0.0022**	**0.0792**	**NO**
1. Cropland remaining cropland	1,618.9873	0.0023	0.0001	0.0022	0.0792	NO
2. Land converted to cropland	-72.9734	NE	NE	NE	NE	NE
C. Grassland	**-691.9874**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-691.9874	NE	NE	NE	NE	NE
D. Wetlands	**-46.3958**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-46.3958	NE	NE	NE	NE	NE
E. Settlements	**45.5694**	**NO, NE**	**0.8663**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	45.5694	NO	0.8663	NO	NO	NO
F. Other land	**441.4824**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	441.4824	NE	NE	NE	NE	NE
G. Harvested wood products	**-22.8014**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2011

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,148.0863**	**0.0064**	**0.8455**	**0.0047**	**0.1694**	**NO, NE**
A. Forest land	**-2,390.5712**	**0.0043**	**0.0002**	**0.0028**	**0.0987**	**NO, NE**
1. Forest land remaining forest land	-1,871.4295	NE	NE	NE	NE	NE
2. Land converted to forest land	-519.1417	0.0043	0.0002	0.0028	0.0987	NO
B. Cropland	**1,504.5789**	**0.0021**	**0.0001**	**0.0019**	**0.0707**	**NO**
1. Cropland remaining cropland	1,610.5807	0.0021	0.0001	0.0019	0.0707	NO
2. Land converted to cropland	-106.0017	NE	NE	NE	NE	NE
C. Grassland	**-638.1726**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-638.1726	NE	NE	NE	NE	NE
D. Wetlands	**-75.3129**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-75.3129	NE	NE	NE	NE	NE
E. Settlements	**62.0438**	**NO, NE**	**0.8452**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	62.0438	NO	0.8452	NO	NO	NO
F. Other land	**393.7285**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	393.7285	NE	NE	NE	NE	NE
G. Harvested wood products	**-4.3808**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2012

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,161.4016**	**0.0467**	**0.7833**	**0.0299**	**1.0665**	**NO, NE**
A. Forest land	**-2,294.8221**	**0.0464**	**0.0026**	**0.0296**	**1.0564**	**NO, NE**
1. Forest land remaining forest land	-1,702.2662	NE	NE	NE	NE	NE
2. Land converted to forest land	-592.5559	0.0464	0.0026	0.0296	1.0564	NO
B. Cropland	**1,508.7640**	**0.0003**	**0.0000**	**0.0003**	**0.0101**	**NO**
1. Cropland remaining cropland	1,593.5785	0.0003	0.0000	0.0003	0.0101	NO
2. Land converted to cropland	-84.8145	NE	NE	NE	NE	NE
C. Grassland	**-562.7510**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-562.7510	NE	NE	NE	NE	NE
D. Wetlands	**-15.4700**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-15.4700	NE	NE	NE	NE	NE
E. Settlements	**11.8882**	**NO, NE**	**0.7807**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	11.8882	NO	0.7807	NO	NO	NO
F. Other land	**114.1449**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	114.1449	NE	NE	NE	NE	NE
G. Harvested wood products	**76.8444**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2013

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,015.6837**	**0.0349**	**0.7290**	**0.0230**	**0.8236**	**NO, NE**
A. Forest land	**-2,141.8702**	**0.0322**	**0.0018**	**0.0206**	**0.7339**	**NO, NE**
1. Forest land remaining forest land	-1,531.8805	NE	NE	NE	NE	NE
2. Land converted to forest land	-609.9898	0.0322	0.0018	0.0206	0.7339	NO
B. Cropland	**1,413.3777**	**0.0026**	**0.0001**	**0.0024**	**0.0898**	**NO**
1. Cropland remaining cropland	1,689.4814	0.0026	0.0001	0.0024	0.0898	NO
2. Land converted to cropland	-276.1037	NE	NE	NE	NE	NE
C. Grassland	**-360.1740**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-360.1740	NE	NE	NE	NE	NE
D. Wetlands	**-106.0998**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-106.0998	NE	NE	NE	NE	NE
E. Settlements	**13.7512**	**NO, NE**	**0.7272**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	13.7512	NO	0.7272	NO	NO	NO
F. Other land	**103.4500**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	103.4500	NE	NE	NE	NE	NE
G. Harvested wood products	**61.8814**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2014

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-651.4692**	**0.0047**	**0.6794**	**0.0036**	**0.1293**	**NO, NE**
A. Forest land	**-2,134.7390**	**0.0027**	**0.0001**	**0.0017**	**0.0603**	**NO, NE**
1. Forest land remaining forest land	-1,484.6747	NE	NE	NE	NE	NE
2. Land converted to forest land	-650.0643	0.0027	0.0001	0.0017	0.0603	NO
B. Cropland	**1,450.4798**	**0.0020**	**0.0001**	**0.0019**	**0.0690**	**NO**
1. Cropland remaining cropland	1,696.1650	0.0020	0.0001	0.0019	0.0690	NO
2. Land converted to cropland	-245.6852	NE	NE	NE	NE	NE
C. Grassland	**-341.1085**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-341.1085	NE	NE	NE	NE	NE
D. Wetlands	**-139.7535**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-139.7535	NE	NE	NE	NE	NE
E. Settlements	**18.9848**	**NO, NE**	**0.6792**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	18.9848	NO	0.6792	NO	NO	NO
F. Other land	**436.6463**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	436.6463	NE	NE	NE	NE	NE
G. Harvested wood products	**58.0208**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-1,094.4097**	**0.0261**	**0.6385**	**0.0171**	**0.6122**	**NO, NE**
A. Forest land	**-2,159.4439**	**0.0246**	**0.0014**	**0.0157**	**0.5596**	**NO, NE**
1. Forest land remaining forest land	-1,496.3946	NE	NE	NE	NE	NE
2. Land converted to forest land	-663.0493	0.0246	0.0014	0.0157	0.5596	NO
B. Cropland	**1,391.0666**	**0.0015**	**0.0000**	**0.0014**	**0.0526**	**NO**
1. Cropland remaining cropland	1,700.3970	0.0015	0.0000	0.0014	0.0526	NO
2. Land converted to cropland	-309.3304	NE	NE	NE	NE	NE
C. Grassland	**-418.4569**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-418.4569	NE	NE	NE	NE	NE
D. Wetlands	**-82.7917**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-82.7917	NE	NE	NE	NE	NE
E. Settlements	**39.1617**	**NO, NE**	**0.6371**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	39.1617	NO	0.6371	NO	NO	NO
F. Other land	**86.8192**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	86.8192	NE	NE	NE	NE	NE
G. Harvested wood products	**49.2353**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2016

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-837.1816**	**0.0143**	**0.6016**	**0.0097**	**0.3467**	**NO, NE**
A. Forest land	**-2,115.7622**	**0.0123**	**0.0007**	**0.0079**	**0.2809**	**NO, NE**
1. Forest land remaining forest land	-1,433.2460	NE	NE	NE	NE	NE
2. Land converted to forest land	-682.5162	0.0123	0.0007	0.0079	0.2809	NO
B. Cropland	**1,391.9179**	**0.0019**	**0.0001**	**0.0018**	**0.0658**	**NO**
1. Cropland remaining cropland	1,775.4060	0.0019	0.0001	0.0018	0.0658	NO
2. Land converted to cropland	-383.4881	NE	NE	NE	NE	NE
C. Grassland	**-402.3693**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-402.3693	NE	NE	NE	NE	NE
D. Wetlands	**-82.7917**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-82.7917	NE	NE	NE	NE	NE
E. Settlements	**19.3071**	**NO, NE**	**0.6008**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	19.3071	NO	0.6008	NO	NO	NO
F. Other land	**351.6349**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	351.6349	NE	NE	NE	NE	NE
G. Harvested wood products	**0.8816**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2017

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-886.1457**	**0.0199**	**0.5767**	**0.0136**	**0.4867**	**NO, NE**
A. Forest land	**-2,016.4373**	**0.0170**	**0.0009**	**0.0109**	**0.3878**	**NO, NE**
1. Forest land remaining forest land	-1,324.5630	NE	NE	NE	NE	NE
2. Land converted to forest land	-691.8743	0.0170	0.0009	0.0109	0.3878	NO
B. Cropland	**1,369.0793**	**0.0029**	**0.0001**	**0.0027**	**0.0990**	**NO**
1. Cropland remaining cropland	1,781.7054	0.0029	0.0001	0.0027	0.0990	NO
2. Land converted to cropland	-412.6261	NE	NE	NE	NE	NE
C. Grassland	**-384.0392**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-384.0392	NE	NE	NE	NE	NE
D. Wetlands	**-82.8162**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-82.8162	NE	NE	NE	NE	NE
E. Settlements	**77.3098**	**NO, NE**	**0.5757**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	77.3098	NO	0.5757	NO	NO	NO
F. Other land	**218.2055**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	218.2055	NE	NE	NE	NE	NE
G. Harvested wood products	**-67.4476**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2018

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**-725.6453**	**0.0068**	**0.5550**	**0.0046**	**0.1654**	**NO, NE**
A. Forest land	**-1,969.3582**	**0.0059**	**0.0003**	**0.0037**	**0.1334**	**NO, NE**
1. Forest land remaining forest land	-1,281.3639	NE	NE	NE	NE	NE
2. Land converted to forest land	-687.9943	0.0059	0.0003	0.0037	0.1334	NO
B. Cropland	**1,487.3577**	**0.0009**	**0.0000**	**0.0009**	**0.0321**	**NO**
1. Cropland remaining cropland	1,786.3680	0.0009	0.0000	0.0009	0.0321	NO
2. Land converted to cropland	-299.0102	NE	NE	NE	NE	NE
C. Grassland	**-440.1513**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-440.1513	NE	NE	NE	NE	NE
D. Wetlands	**-82.8253**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-82.8253	NE	NE	NE	NE	NE
E. Settlements	**21.6217**	**NO, NE**	**0.5546**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	21.6217	NO	0.5546	NO	NO	NO
F. Other land	**321.2138**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	321.2138	NE	NE	NE	NE	NE
G. Harvested wood products	**-63.5037**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

2019

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	NO_x	CO	NMVOC
	(kt)					
4. Total LULUCF	**133.8653**	**0.0157**	**0.5420**	**0.0105**	**0.3774**	**NO, NE**
A. Forest land	**-1,950.6476**	**0.0141**	**0.0008**	**0.0090**	**0.3206**	**NO, NE**
1. Forest land remaining forest land	-1,231.1003	NE	NE	NE	NE	NE
2. Land converted to forest land	-719.5474	0.0141	0.0008	0.0090	0.3206	NO
B. Cropland	**1,789.8845**	**0.0017**	**0.0000**	**0.0015**	**0.0568**	**NO**
1. Cropland remaining cropland	1,799.1677	0.0017	0.0000	0.0015	0.0568	NO
2. Land converted to cropland	-9.2832	NE	NE	NE	NE	NE
C. Grassland	**-293.2923**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Grassland remaining grassland	NO	NE	NE	NE	NE	NE
2. Land converted to grassland	-293.2923	NE	NE	NE	NE	NE
D. Wetlands	**-82.8099**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Wetlands remaining wetlands	NO	NE	NE	NE	NE	NE
2. Land converted to wetlands	-82.8099	NE	NE	NE	NE	NE
E. Settlements	**116.5030**	**NO, NE**	**0.5412**	**NO, NE**	**NO, NE**	**NO, NE**
1. Settlements remaining settlements	NO	NE	NE	NE	NE	NE
2. Land converted to settlements	116.5030	NO	0.5412	NO	NO	NO
F. Other land	**611.7881**	**NE**	**NE**	**NE**	**NE**	**NE**
1. Other land remaining other land						
2. Land converted to other land	611.7881	NE	NE	NE	NE	NE
G. Harvested wood products	**-57.5604**					
H. Other	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

Annex 6-5. Sectoral Report for Sector 5 'Waste' 1990-2019

1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.9667**	**56.3496**	**0.3038**	**0.1503**	**2.6430**	**0.8662**	**0.0052**
A. Solid waste disposal	**NA, NO**	**41.8691**		**NA, NO**	**NA, NO**	**0.7671**	
1. Managed waste disposal sites	NA, NO	NO		NA, NO	NA	NO	
2. Unmanaged waste disposal sites	NA, NO	41.8691		NA, NO	NA	0.7671	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0544**	**0.0033**	**NO, NE**	**0.0076**	**NO, NE**	
1. Composting		0.0544	0.0033	NO	0.0076	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.9667**	**0.3075**	**0.0054**	**0.1503**	**2.6354**	**0.0581**	**0.0052**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.9667	0.3075	0.0054	0.1503	2.6354	0.0581	0.0052
D. Wastewater treatment and discharge		**14.1186**	**0.2951**	**NA, IE**	**NA, IE**	**0.0410**	
1. Domestic wastewater		14.1186	0.2951	NA	NA	0.0410	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.9994**	**57.9712**	**0.2811**	**0.1506**	**2.6451**	**0.9029**	**0.0053**
A. Solid waste disposal	**NA, NO**	**43.9447**		**NA, NO**	**NA, NO**	**0.8074**	
1. Managed waste disposal sites	NA, NO	NO		NA, NO	NA	NO	
2. Unmanaged waste disposal sites	NA, NO	43.9447		NA, NO	NA	0.8074	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0551**	**0.0033**	**NO, NE**	**0.0077**	**NO, NE**	
1. Composting		0.0551	0.0033	NO	0.0077	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.9994**	**0.3080**	**0.0054**	**0.1506**	**2.6374**	**0.0582**	**0.0053**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.9994	0.3080	0.0054	0.1506	2.6374	0.0582	0.0053
D. Wastewater treatment and discharge		**13.6633**	**0.2724**	**NA, IE**	**NA, IE**	**0.0373**	
1. Domestic wastewater		13.6633	0.2724	NA	NA	0.0373	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

1992

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**15.0476**	**58.3482**	**0.2585**	**0.1510**	**2.6506**	**0.9417**	**0.0053**
A. Solid waste disposal	**NA, NE**	**45.6782**		**NA, NO**	**NA, NO**	**0.8499**	
1. Managed waste disposal sites	NA, NO	7.4456		NA, NO	NA	0.1385	
2. Unmanaged waste disposal sites	NA, NO	38.2327		NA, NO	NA	0.7114	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0575**	**0.0035**	**NO, NE**	**0.0081**	**NO, NE**	
1. Composting		0.0575	0.0035	NO	0.0081	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**15.0476**	**0.3089**	**0.0054**	**0.1510**	**2.6425**	**0.0584**	**0.0053**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	15.0476	0.3089	0.0054	0.1510	2.6425	0.0584	0.0053
D. Wastewater treatment and discharge		**12.3036**	**0.2496**	**NA, IE**	**NA, IE**	**0.0335**	
1. Domestic wastewater		12.3036	0.2496	NA	NA	0.0335	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

1993

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**15.0447**	**60.9251**	**0.2413**	**0.1508**	**2.6428**	**0.9829**	**0.0053**
A. Solid waste disposal	**NA, NO**	**48.1887**		**NA, NO**	**NA, NO**	**0.8947**	
1. Managed waste disposal sites	NA, NO	13.1073		NA, NO	NA	0.2433	
2. Unmanaged waste disposal sites	NA, NO	35.0814		NA, NO	NA	0.6513	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0288**	**0.0017**	**NO, NE**	**0.0040**	**NO, NE**	
1. Composting		0.0288	0.0017	NO	0.0040	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**15.0447**	**0.3087**	**0.0054**	**0.1508**	**2.6388**	**0.0583**	**0.0053**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	15.0447	0.3087	0.0054	0.1508	2.6388	0.0583	0.0053
D. Wastewater treatment and discharge		**12.3989**	**0.2341**	**NA, IE**	**NA, IE**	**0.0299**	
1. Domestic wastewater		12.3989	0.2341	NA	NA	0.0299	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

1994

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**15.0947**	**60.3026**	**0.2343**	**0.1512**	**2.6482**	**1.0273**	**0.0054**
A. Solid waste disposal	**NA, NO**	**48.3920**		**NA, NO**	**NA, NO**	**0.9417**	
1. Managed waste disposal sites	NA, NO	13.8401		NA, NO	NA	0.2693	
2. Unmanaged waste disposal sites	NA, NO	34.5519		NA, NO	NA	0.6724	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0268**	**0.0016**	**NO, NE**	**0.0038**	**NO, NE**	
1. Composting		0.0268	0.0016	NO	0.0038	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**15.0947**	**0.3096**	**0.0054**	**0.1512**	**2.6445**	**0.0584**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	15.0947	0.3096	0.0054	0.1512	2.6445	0.0584	0.0054
D. Wastewater treatment and discharge		**11.5741**	**0.2272**	**NA, IE**	**NA, IE**	**0.0272**	
1. Domestic wastewater		11.5741	0.2272	NA	NA	0.0272	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

1995

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**15.0979**	**60.1876**	**0.2370**	**0.1512**	**2.6451**	**1.0704**	**0.0054**
A. Solid waste disposal	**NA, NO**	**48.3670**		**NA, NO**	**NA, NO**	**0.9913**	
1. Managed waste disposal sites	NA, NO	15.0421		NA, NO	NA	0.3083	
2. Unmanaged waste disposal sites	NA, NO	33.3249		NA, NO	NA	0.6830	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0253**	**0.0015**	**NO, NE**	**0.0035**	**NO, NE**	
1. Composting		0.0253	0.0015	NO	0.0035	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**15.0979**	**0.3096**	**0.0054**	**0.1512**	**2.6416**	**0.0584**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	15.0979	0.3096	0.0054	0.1512	2.6416	0.0584	0.0054
D. Wastewater treatment and discharge		**11.4857**	**0.2301**	**NA, IE**	**NA, IE**	**0.0207**	
1. Domestic wastewater		11.4857	0.2301	NA	NA	0.0207	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

1996

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**15.0960**	**60.3369**	**0.2336**	**0.1511**	**2.6417**	**1.1226**	**0.0054**
A. Solid waste disposal	**NA, NO**	**48.6713**		**NA, NO**	**NA, NO**	**1.0435**	
1. Managed waste disposal sites	NA, NO	14.6014		NA, NO	NA	0.3130	
2. Unmanaged waste disposal sites	NA, NO	34.0699		NA, NO	NA	0.7304	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0261**	**0.0016**	**NO, NE**	**0.0036**	**NO, NE**	
1. Composting		0.0261	0.0016	NO	0.0036	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**15.0960**	**0.3094**	**0.0054**	**0.1511**	**2.6380**	**0.0584**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	15.0960	0.3094	0.0054	0.1511	2.6380	0.0584	0.0054
D. Wastewater treatment and discharge		**11.3300**	**0.2266**	**NA, IE**	**NA, IE**	**0.0208**	
1. Domestic wastewater		11.3300	0.2266	NA	NA	0.0208	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

1997

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**15.0456**	**60.0710**	**0.2376**	**0.1505**	**2.6305**	**1.1751**	**0.0054**
A. Solid waste disposal	**NA, NO**	**48.1521**		**NA, NO**	**NA, NO**	**1.0984**	
1. Managed waste disposal sites	NA, NO	15.7939		NA, NO	NA	0.3603	
2. Unmanaged waste disposal sites	NA, NO	32.3582		NA, NO	NA	0.7381	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0245**	**0.0015**	**NO, NE**	**0.0034**	**NO, NE**	
1. Composting		0.0245	0.0015	NO	0.0034	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**15.0456**	**0.3083**	**0.0054**	**0.1505**	**2.6271**	**0.0581**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	15.0456	0.3083	0.0054	0.1505	2.6271	0.0581	0.0054
D. Wastewater treatment and discharge		**11.5861**	**0.2307**	**NA, IE**	**NA, IE**	**0.0186**	
1. Domestic wastewater		11.5861	0.2307	NA	NA	0.0186	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

1998

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**15.0794**	**59.0786**	**0.2412**	**0.1508**	**2.6344**	**1.2299**	**0.0054**
A. Solid waste disposal	**NA, NO**	**47.5742**		**NA, NO**	**NA, NO**	**1.1562**	
1. Managed waste disposal sites	NA, NO	15.4616		NA, NO	NA	0.3758	
2. Unmanaged waste disposal sites	NA, NO	32.1126		NA, NO	NA	0.7804	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0248**	**0.0015**	**NO, NE**	**0.0035**	**NO, NE**	
1. Composting		0.0248	0.0015	NO	0.0035	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**15.0794**	**0.3089**	**0.0054**	**0.1508**	**2.6310**	**0.0582**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	15.0794	0.3089	0.0054	0.1508	2.6310	0.0582	0.0054
D. Wastewater treatment and discharge		**11.1707**	**0.2342**	**NA, IE**	**NA, IE**	**0.0155**	
1. Domestic wastewater		11.1707	0.2342	NA	NA	0.0155	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

1999

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**15.0071**	**58.9628**	**0.2360**	**0.1502**	**2.6281**	**1.2870**	**0.0053**
A. Solid waste disposal	**NA, NO**	**47.8091**		**NA, NO**	**NA, NO**	**1.2171**	
1. Managed waste disposal sites	NA, NO	15.7292		NA, NO	NA	0.4004	
2. Unmanaged waste disposal sites	NA, NO	32.0799		NA, NO	NA	0.8167	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0232**	**0.0014**	**NO, NE**	**0.0033**	**NO, NE**	
1. Composting		0.0232	0.0014	NO	0.0033	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**15.0071**	**0.3077**	**0.0054**	**0.1502**	**2.6248**	**0.0581**	**0.0053**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	15.0071	0.3077	0.0054	0.1502	2.6248	0.0581	0.0053
D. Wastewater treatment and discharge		**10.8228**	**0.2292**	**NA, IE**	**NA, IE**	**0.0119**	
1. Domestic wastewater		10.8228	0.2292	NA	NA	0.0119	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.9965**	**57.9792**	**0.2413**	**0.1500**	**2.6204**	**1.3503**	**0.0054**
A. Solid waste disposal	**NA, NO**	**46.7813**		**NA, NO**	**NA, NO**	**1.2812**	
1. Managed waste disposal sites	NA, NO	14.8765		NA, NO	NA	0.4074	
2. Unmanaged waste disposal sites	NA, NO	31.9049		NA, NO	NA	0.8738	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0210**	**0.0013**	**NO, NE**	**0.0029**	**NO, NE**	
1. Composting		0.0210	0.0013	NO	0.0029	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.9965**	**0.3073**	**0.0054**	**0.1500**	**2.6175**	**0.0579**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.9965	0.3073	0.0054	0.1500	2.6175	0.0579	0.0054
D. Wastewater treatment and discharge		**10.8697**	**0.2346**	**NA, IE**	**NA, IE**	**0.0111**	
1. Domestic wastewater		10.8697	0.2346	NA	NA	0.0111	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.9689**	**56.9146**	**0.2438**	**0.1497**	**2.6161**	**1.4170**	**0.0054**
A. Solid waste disposal	**NA, NO**	**45.4990**		**NA, NO**	**NA, NO**	**1.3485**	
1. Managed waste disposal sites	NA, NO	14.5142		NA, NO	NA	0.4302	
2. Unmanaged waste disposal sites	NA, NO	30.9848		NA, NO	NA	0.9183	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0190**	**0.0011**	**NO, NE**	**0.0027**	**NO, NE**	
1. Composting		0.0190	0.0011	NO	0.0027	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.9689**	**0.3067**	**0.0054**	**0.1497**	**2.6134**	**0.0578**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.9689	0.3067	0.0054	0.1497	2.6134	0.0578	0.0054
D. Wastewater treatment and discharge		**11.0899**	**0.2373**	**NA, IE**	**NA, IE**	**0.0106**	
1. Domestic wastewater		11.0899	0.2373	NA	NA	0.0106	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.9402**	**56.4277**	**0.2500**	**0.1493**	**2.6051**	**1.5665**	**0.0054**
A. Solid waste disposal	**NA, NO**	**44.3224**		**NA, NO**	**NA, NO**	**1.4984**	
1. Managed waste disposal sites	NA, NO	14.1832		NA, NO	NA	0.4795	
2. Unmanaged waste disposal sites	NA, NO	30.1392		NA, NO	NA	1.0189	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0209**	**0.0013**	**NO, NE**	**0.0029**	**NO, NE**	
1. Composting		0.0209	0.0013	NO	0.0029	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.9402**	**0.3059**	**0.0054**	**0.1493**	**2.6022**	**0.0576**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.9402	0.3059	0.0054	0.1493	2.6022	0.0576	0.0054
D. Wastewater treatment and discharge		**11.7785**	**0.2434**	**NA, IE**	**NA, IE**	**0.0104**	
1. Domestic wastewater		11.7785	0.2434	NA	NA	0.0104	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.9100**	**55.2194**	**0.2418**	**0.1488**	**2.5930**	**1.6449**	**0.0054**
A. Solid waste disposal	**NA, NO**	**42.8093**		**NA, NO**	**NA, NO**	**1.5772**	
1. Managed waste disposal sites	NA, NO	13.0997		NA, NO	NA	0.4826	
2. Unmanaged waste disposal sites	NA, NO	29.7097		NA, NO	NA	1.0946	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0219**	**0.0013**	**NO, NE**	**0.0031**	**NO, NE**	
1. Composting		0.0219	0.0013	NO	0.0031	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.9100**	**0.3050**	**0.0054**	**0.1488**	**2.5899**	**0.0574**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.9100	0.3050	0.0054	0.1488	2.5899	0.0574	0.0054
D. Wastewater treatment and discharge		**12.0831**	**0.2351**	**NA, IE**	**NA, IE**	**0.0103**	
1. Domestic wastewater		12.0831	0.2351	NA	NA	0.0103	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2004

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.8621**	**54.6831**	**0.2305**	**0.1481**	**2.5791**	**1.7277**	**0.0054**
A. Solid waste disposal	**NA, NO**	**42.2061**		**NA, NO**	**NA, NO**	**1.6602**	
1. Managed waste disposal sites	NA, NO	12.4086		NA, NO	NA	0.4881	
2. Unmanaged waste disposal sites	NA, NO	29.7975		NA, NO	NA	1.1721	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0230**	**0.0014**	**NO, NE**	**0.0032**	**NO, NE**	
1. Composting		0.0230	0.0014	NO	0.0032	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.8621**	**0.3039**	**0.0053**	**0.1481**	**2.5759**	**0.0572**	**0.0054**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.8621	0.3039	0.0053	0.1481	2.5759	0.0572	0.0054
D. Wastewater treatment and discharge		**12.1502**	**0.2238**	**NA, IE**	**NA, IE**	**0.0103**	
1. Domestic wastewater		12.1502	0.2238	NA	NA	0.0103	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.4670**	**54.8647**	**0.2118**	**0.1442**	**2.5098**	**1.8136**	**0.0053**
A. Solid waste disposal	**NA, NO**	**42.5723**		**NA, NO**	**NA, NO**	**1.7476**	
1. Managed waste disposal sites	NA, NO	12.0480		NA, NO	NA	0.4946	
2. Unmanaged waste disposal sites	NA, NO	30.5244		NA, NO	NA	1.2530	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0241**	**0.0014**	**NO, NE**	**0.0034**	**NO, NE**	
1. Composting		0.0241	0.0014	NO	0.0034	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.4670**	**0.2957**	**0.0052**	**0.1442**	**2.5064**	**0.0556**	**0.0053**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.4670	0.2957	0.0052	0.1442	2.5064	0.0556	0.0053
D. Wastewater treatment and discharge		**11.9725**	**0.2051**	**NA, IE**	**NA, IE**	**0.0103**	
1. Domestic wastewater		11.9725	0.2051	NA	NA	0.0103	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2006

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.1260**	**54.3169**	**0.2180**	**0.1408**	**2.4509**	**1.9042**	**0.0051**
A. Solid waste disposal	**NA, NO**	**42.4737**		**NA, NO**	**NA, NO**	**1.8395**	
1. Managed waste disposal sites	NA, NO	11.5529		NA, NO	NA	0.5003	
2. Unmanaged waste disposal sites	NA, NO	30.9209		NA, NO	NA	1.3392	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0261**	**0.0016**	**NO, NE**	**0.0037**	**NO, NE**	
1. Composting		0.0261	0.0016	NO	0.0037	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.1260**	**0.2888**	**0.0051**	**0.1408**	**2.4472**	**0.0543**	**0.0051**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.1260	0.2888	0.0051	0.1408	2.4472	0.0543	0.0051
D. Wastewater treatment and discharge		**11.5283**	**0.2114**	**NA, IE**	**NA, IE**	**0.0103**	
1. Domestic wastewater		11.5283	0.2114	NA	NA	0.0103	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2007

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**13.7672**	**54.0681**	**0.2031**	**0.1372**	**2.3898**	**1.9996**	**0.0050**
A. Solid waste disposal	**NA, NO**	**42.5929**		**NA, NO**	**NA, NO**	**1.9364**	
1. Managed waste disposal sites	NA, NO	13.1186		NA, NO	NA	0.5964	
2. Unmanaged waste disposal sites	NA, NO	29.4743		NA, NO	NA	1.3400	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0339**	**0.0020**	**NO, NE**	**0.0047**	**NO, NE**	
1. Composting		0.0339	0.0020	NO	0.0047	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**13.7672**	**0.2814**	**0.0049**	**0.1372**	**2.3851**	**0.0529**	**0.0050**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	13.7672	0.2814	0.0049	0.1372	2.3851	0.0529	0.0050
D. Wastewater treatment and discharge		**11.1599**	**0.1961**	**NA, IE**	**NA, IE**	**0.0102**	
1. Domestic wastewater		11.1599	0.1961	NA	NA	0.0102	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2008

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**13.4533**	**54.9007**	**0.1871**	**0.1339**	**2.3308**	**2.1002**	**0.0049**
A. Solid waste disposal	**NA, NO**	**43.3679**		**NA, NO**	**NA, NO**	**2.0383**	
1. Managed waste disposal sites	NA, NO	14.6583		NA, NO	NA	0.6890	
2. Unmanaged waste disposal sites	NA, NO	28.7095		NA, NO	NA	1.3494	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0401**	**0.0024**	**NO, NE**	**0.0056**	**NO, NE**	
1. Composting		0.0401	0.0024	NO	0.0056	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**13.4533**	**0.2748**	**0.0048**	**0.1339**	**2.3252**	**0.0517**	**0.0049**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	13.4533	0.2748	0.0048	0.1339	2.3252	0.0517	0.0049
D. Wastewater treatment and discharge		**11.2179**	**0.1799**	**NA, IE**	**NA, IE**	**0.0102**	
1. Domestic wastewater		11.2179	0.1799	NA	NA	0.0102	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2009

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**13.1613**	**55.3911**	**0.1909**	**0.1308**	**2.2748**	**2.2062**	**0.0048**
A. Solid waste disposal	**NA, NO**	**44.6020**		**NA, NO**	**NA, NO**	**2.1456**	
1. Managed waste disposal sites	NA, NO	15.9675		NA, NO	NA	0.7681	
2. Unmanaged waste disposal sites	NA, NO	28.6345		NA, NO	NA	1.3775	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0446**	**0.0027**	**NO, NE**	**0.0062**	**NO, NE**	
1. Composting		0.0446	0.0027	NO	0.0062	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**13.1613**	**0.2686**	**0.0047**	**0.1308**	**2.2685**	**0.0505**	**0.0048**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	13.1613	0.2686	0.0047	0.1308	2.2685	0.0505	0.0048
D. Wastewater treatment and discharge		**10.4759**	**0.1835**	**NA, IE**	**NA, IE**	**0.0102**	
1. Domestic wastewater		10.4759	0.1835	NA	NA	0.0102	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2010

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**12.8663**	**56.4278**	**0.1848**	**0.1277**	**2.2175**	**2.3162**	**0.0048**
A. Solid waste disposal	**NA, NO**	**45.5140**		**NA, NO**	**NA, NO**	**2.2567**	
1. Managed waste disposal sites	NA, NO	17.7504		NA, NO	NA	0.8801	
2. Unmanaged waste disposal sites	NA, NO	27.7635		NA, NO	NA	1.3766	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0430**	**0.0026**	**NO, NE**	**0.0060**	**NO, NE**	
1. Composting		0.0430	0.0026	NO	0.0060	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**12.8663**	**0.2624**	**0.0046**	**0.1277**	**2.2115**	**0.0492**	**0.0048**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	12.8663	0.2624	0.0046	0.1277	2.2115	0.0492	0.0048
D. Wastewater treatment and discharge		**10.6084**	**0.1776**	**NA, IE**	**NA, IE**	**0.0102**	
1. Domestic wastewater		10.6084	0.1776	NA	NA	0.0102	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2011

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**12.5793**	**56.8332**	**0.1856**	**0.1246**	**2.1602**	**2.4774**	**0.0047**
A. Solid waste disposal	**NA, NO**	**46.2032**		**NA, NO**	**NA, NO**	**2.4191**	
1. Managed waste disposal sites	NA, NO	18.5275		NA, NO	NA	0.9701	
2. Unmanaged waste disposal sites	NA, NO	27.6757		NA, NO	NA	1.4491	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0437**	**0.0026**	**NO, NE**	**0.0061**	**NO, NE**	
1. Composting		0.0437	0.0026	NO	0.0061	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**12.5793**	**0.2562**	**0.0045**	**0.1246**	**2.1541**	**0.0480**	**0.0047**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	12.5793	0.2562	0.0045	0.1246	2.1541	0.0480	0.0047
D. Wastewater treatment and discharge		**10.3301**	**0.1785**	**NA, IE**	**NA, IE**	**0.0102**	
1. Domestic wastewater		10.3301	0.1785	NA	NA	0.0102	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2012

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**12.2708**	**56.2422**	**0.1870**	**0.1214**	**2.1026**	**2.5381**	**0.0046**
A. Solid waste disposal	**NA, NO**	**45.7446**		**NA, NO**	**NA, NO**	**2.4812**	
1. Managed waste disposal sites	NA, NO	18.2979		NA, NO	NA	0.9925	
2. Unmanaged waste disposal sites	NA, NO	27.4468		NA, NO	NA	1.4887	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0447**	**0.0027**	**NO, NE**	**0.0063**	**NO, NE**	
1. Composting		0.0447	0.0027	NO	0.0063	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**12.2708**	**0.2498**	**0.0044**	**0.1214**	**2.0963**	**0.0468**	**0.0046**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	12.2708	0.2498	0.0044	0.1214	2.0963	0.0468	0.0046
D. Wastewater treatment and discharge		**10.2031**	**0.1799**	**NA, IE**	**NA, IE**	**0.0101**	
1. Domestic wastewater		10.2031	0.1799	NA	NA	0.0101	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2013

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**11.9033**	**53.9360**	**0.1879**	**0.1179**	**2.0438**	**2.6003**	**0.0045**
A. Solid waste disposal	**NA, NO**	**43.3907**		**NA, NO**	**NA, NO**	**2.5448**	
1. Managed waste disposal sites	NA, NO	16.4017		NA, NO	NA	0.9619	
2. Unmanaged waste disposal sites	NA, NO	26.9890		NA, NO	NA	1.5829	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0486**	**0.0029**	**NO, NE**	**0.0068**	**NO, NE**	
1. Composting		0.0486	0.0029	NO	0.0068	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**11.9033**	**0.2424**	**0.0043**	**0.1179**	**2.0370**	**0.0454**	**0.0045**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	11.9033	0.2424	0.0043	0.1179	2.0370	0.0454	0.0045
D. Wastewater treatment and discharge		**10.2543**	**0.1807**	**NA, IE**	**NA, IE**	**0.0101**	
1. Domestic wastewater		10.2543	0.1807	NA	NA	0.0101	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2014

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**11.5371**	**53.5427**	**0.1860**	**0.1144**	**1.9861**	**2.6641**	**0.0043**
A. Solid waste disposal	**NA, NO**	**43.3232**		**NA, NO**	**NA, NO**	**2.6100**	
1. Managed waste disposal sites	NA, NO	15.7263		NA, NO	NA	0.9474	
2. Unmanaged waste disposal sites	NA, NO	27.5969		NA, NO	NA	1.6626	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0508**	**0.0030**	**NO, NE**	**0.0071**	**NO, NE**	
1. Composting		0.0508	0.0030	NO	0.0071	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**11.5371**	**0.2351**	**0.0041**	**0.1144**	**1.9790**	**0.0441**	**0.0043**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	11.5371	0.2351	0.0041	0.1144	1.9790	0.0441	0.0043
D. Wastewater treatment and discharge		**9.9335**	**0.1788**	**NA, IE**	**NA, IE**	**0.0100**	
1. Domestic wastewater		9.9335	0.1788	NA	NA	0.0100	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**13.3135**	**53.4429**	**0.1897**	**0.1326**	**2.3124**	**2.7381**	**0.0049**
A. Solid waste disposal	**NA, NO**	**43.4869**		**NA, NO**	**NA, NO**	**2.6769**	
1. Managed waste disposal sites	NA, NO	17.0034		NA, NO	NA	1.0467	
2. Unmanaged waste disposal sites	NA, NO	26.4835		NA, NO	NA	1.6303	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0508**	**0.0030**	**NO, NE**	**0.0071**	**NO, NE**	
1. Composting		0.0508	0.0030	NO	0.0071	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**13.3135**	**0.2721**	**0.0048**	**0.1326**	**2.3053**	**0.0512**	**0.0049**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	13.3135	0.2721	0.0048	0.1326	2.3053	0.0512	0.0049
D. Wastewater treatment and discharge		**9.6331**	**0.1819**	**NA, IE**	**NA, IE**	**0.0100**	
1. Domestic wastewater		9.6331	0.1819	NA	NA	0.0100	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2016

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**13.0346**	**54.5152**	**0.1918**	**0.1301**	**2.2716**	**2.8005**	**0.0047**
A. Solid waste disposal	**NA, NO**	**44.6069**		**NA, NO**	**NA, NO**	**2.7403**	
1. Managed waste disposal sites	NA, NO	17.6134		NA, NO	NA	1.0820	
2. Unmanaged waste disposal sites	NA, NO	26.9935		NA, NO	NA	1.6583	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0505**	**0.0030**	**NO, NE**	**0.0071**	**NO, NE**	
1. Composting		0.0505	0.0030	NO	0.0071	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**13.0346**	**0.2667**	**0.0047**	**0.1301**	**2.2645**	**0.0502**	**0.0047**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	13.0346	0.2667	0.0047	0.1301	2.2645	0.0502	0.0047
D. Wastewater treatment and discharge		**9.5911**	**0.1841**	**NA, IE**	**NA, IE**	**0.0100**	
1. Domestic wastewater		9.5911	0.1841	NA	NA	0.0100	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2017

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.6448**	**58.2582**	**0.1985**	**0.1465**	**2.5663**	**2.9935**	**0.0052**
A. Solid waste disposal	**NA, NO**	**48.4691**		**NA, NO**	**NA, NO**	**2.9269**	
1. Managed waste disposal sites	NA, NO	17.3684		NA, NO	NA	1.0488	
2. Unmanaged waste disposal sites	NA, NO	31.1007		NA, NO	NA	1.8780	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0578**	**0.0035**	**NO, NE**	**0.0081**	**NO, NE**	
1. Composting		0.0578	0.0035	NO	0.0081	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.6448**	**0.3001**	**0.0053**	**0.1465**	**2.5582**	**0.0566**	**0.0052**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.6448	0.3001	0.0053	0.1465	2.5582	0.0566	0.0052
D. Wastewater treatment and discharge		**9.4312**	**0.1897**	**NA, IE**	**NA, IE**	**0.0100**	
1. Domestic wastewater		9.4312	0.1897	NA	NA	0.0100	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2018

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**14.2880**	**58.8512**	**0.2038**	**0.1432**	**2.5112**	**2.9680**	**0.0051**
A. Solid waste disposal	**NA, NO**	**48.9422**		**NA, NO**	**NA, NO**	**2.9025**	
1. Managed waste disposal sites	NA, NO	19.6449		NA, NO	NA	1.1651	
2. Unmanaged waste disposal sites	NA, NO	29.2973		NA, NO	NA	1.7375	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0521**	**0.0031**	**NO, NE**	**0.0073**	**NO, NE**	
1. Composting		0.0521	0.0031	NO	0.0073	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**14.2880**	**0.2931**	**0.0051**	**0.1432**	**2.5039**	**0.0553**	**0.0051**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	14.2880	0.2931	0.0051	0.1432	2.5039	0.0553	0.0051
D. Wastewater treatment and discharge		**9.5637**	**0.1955**	**NA, IE**	**NA, IE**	**0.0102**	
1. Domestic wastewater		9.5637	0.1955	NA	NA	0.0102	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

2019

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(kt)						
5. Total Waste	**13.9120**	**59.1123**	**0.2044**	**0.1397**	**2.4571**	**3.0845**	**0.0049**
A. Solid waste disposal	**NA, NO**	**49.2635**		**NA, NO**	**NA, NO**	**3.0203**	
1. Managed waste disposal sites	NA, NO	19.4895		NA, NO	NA	1.1949	
2. Unmanaged waste disposal sites	NA, NO	29.7741		NA, NO	NA	1.8254	
3. Uncategorized waste disposal sites	NO	NO		NO	NO	NO	
B. Biological treatment of solid waste		**0.0559**	**0.0034**	**NO, NE**	**0.0078**	**NO, NE**	
1. Composting		0.0559	0.0034	NO	0.0078	NO	
2. Anaerobic digestion at biogas facilities		NE	NE	NE	NE	NE	
C. Incineration and open burning of waste	**13.9120**	**0.2858**	**0.0050**	**0.1397**	**2.4493**	**0.0540**	**0.0049**
1. Waste incineration	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	13.9120	0.2858	0.0050	0.1397	2.4493	0.0540	0.0049
D. Wastewater treatment and discharge		**9.5071**	**0.1961**	**NA, IE**	**NA, IE**	**0.0102**	
1. Domestic wastewater		9.5071	0.1961	NA	NA	0.0102	
2. Industrial wastewater		IE	IE	IE	IE	IE	
3. Other		NA	NA	NA	NA	NA	
E. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo item:							
Long-term storage of C in waste disposal sites	NE						
Annual change in total long-term C storage	NE						
Annual change in total long-term C storage in HWP waste	NE						

Annex 6-6. Summary Reports on GHG Emissions in the Republic of Moldova within 1990-2019

1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**35459.8920**	**209.7622**	**10.9294**	**NO**	**NO**	**NO**	**NO**	**NO**	**89.7413**	**279.8576**	**138.7872**	**150.0997**
1. Energy	**35401.5108**	**45.9255**	**1.1599**						**85.7741**	**268.1988**	**31.3695**	**148.7358**
A. Fuel combustion Reference approach	35188.0913											
Sectoral approach	35400.8731	13.4359	1.1599						85.7741	268.1988	30.7878	148.7358
1. Energy industries	21300.2929	0.4913	0.1734						39.4664	7.2099	0.6297	102.3606
2. Manufacturing industries and construction	1916.8273	0.0866	0.0147						9.0489	3.4763	0.8788	2.6881
3. Transport	4697.5183	1.3467	0.3582						14.9012	68.3923	8.6079	0.7843
4. Other sectors	7372.2624	11.5005	0.6092						21.5980	188.2917	20.5488	42.5973
5. Other	113.9722	0.0109	0.0044						0.7597	0.8286	0.1226	0.3055
B. Fugitive emissions from fuels	0.6377	32.4897	0.0000						NO	NO	0.5817	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.6377	32.4897	0.0000						NO	NO	0.5817	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**1603.6767**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**3.7209**	**5.4932**	**106.5515**	**1.3586**
A. Mineral industry	1337.4142								3.5653	3.4372	0.0339	1.2943
B. Chemical industry	NO	NO	NO						NO	NO	0.0650	NO
C. Metal industry	28.5023	NO	NO	NO	NO	NO	NO	NO	0.0925	1.2102	0.0370	0.0427
D. Non-energy products from fuels and solvent use	234.3591	NO	NO						0.0434	0.2441	92.7937	0.0216
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				NO	NO	NO	NO	NO				
G. Other product manufacture and use	3.4010	NO	0.0001	NO	NO	NO	NO	NO	0.0197	0.6017	1.5459	NO
H. Other									NO	NO	12.0760	NO
3. Agriculture	**0.5820**	**107.3809**	**8.8939**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		87.5771										
B. Manure management		19.8038	3.7470								NO	
C. Rice cultivation		NO										
D. Agricultural soils			5.1469									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.5820											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1560.8442**	**0.1061**	**0.5717**						**0.0959**	**3.5227**	**NO, NE**	
A. Forest land	-2563.4328	0.0083	0.0005						0.0053	0.1887	NO, NE	
B. Cropland	2648.7307	0.0978	0.0025						0.0906	3.3340	NO	
C. Grassland	-1205.6938	NE	NE						NE	NE	NE	
D. Wetlands	-555.3798	NE	NE						NE	NE	NE	
E. Settlements	84.7480	NO, NE	0.5687						NO, NE	NO, NE	NO, NE	
F. Other land	152.3638	NE	NE						NE	NE	NE	
G. Harvested wood products	-122.1804											
H. Other	NE	NE	NE						NE	NE	NE	

5. Waste	**14.9667**	**56.3496**	**0.3038**						**0.1503**	**2.6430**	**0.8662**	**0.0052**
A. Solid waste disposal	NA, NO	41.8691							NA, NO	NA, NO	0.7671	
B. Biological treatment of solid waste		0.0544	0.0033						NO, NE	0.0076	NO, NE	
C. Incineration and open burning of waste	14.9667	0.3075	0.0054						0.1503	2.6354	0.0581	0.0052
D. Wastewater treatment and discharge		14.1186	0.2951						NA, IE	NA, IE	0.0410	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**193.4599**	**0.0153**	**0.0063**						**0.7651**	**0.5859**	**0.2298**	**0.0613**
Aviation	193.4599	0.0153	0.0063						0.7651	0.5859	0.2298	0.0613
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	232.8093											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			2.0327									
Indirect CO_2	**207.5471**											

1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**28724.9948**	**196.1309**	**10.2154**	**NO**	**NO**	**NO**	**NO**	**NO**	**73.9174**	**207.3877**	**111.8032**	**124.8723**
1. Energy	**29939.0721**	**40.3057**	**0.8645**						**70.2758**	**196.5828**	**23.0138**	**123.5938**
A. Fuel combustion Reference approach	29776.3533											
Sectoral approach	29938.4581	9.8131	0.8645						70.2758	196.5828	22.4700	123.5938
1. Energy industries	18927.0336	0.4230	0.1562						35.0660	6.4107	0.5515	90.5225
2. Manufacturing industries and construction	1277.9476	0.0546	0.0096						6.5424	1.7479	0.5482	1.2265
3. Transport	3655.5565	1.0343	0.2931						11.9958	52.0755	6.5987	0.6152
4. Other sectors	5971.5518	8.2940	0.4021						16.0136	135.7317	14.6862	30.9518
5. Other	106.3685	0.0072	0.0034						0.6579	0.6170	0.0855	0.2778
B. Fugitive emissions from fuels	0.6140	30.4926	0.0000						NO	NO	0.5438	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.6140	30.4926	0.0000						NO	NO	0.5438	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**1409.7794**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**3.4025**	**4.9046**	**87.8864**	**1.2732**
A. Mineral industry	1188.6687								3.2662	3.0431	0.0315	1.2182
B. Chemical industry	NO	NO	NO						NO	NO	0.0544	NO
C. Metal industry	24.7297	NO	NO	NO	NO	NO	NO	NO	0.0803	1.0502	0.0323	0.0371
D. Non-energy products from fuels and solvent use	193.3185	NO	NO						0.0361	0.2030	76.2635	0.0180
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				NO	NO	NO	NO	NO				
G. Other product manufacture and use	3.0625	NO	0.0001	NO	NO	NO	NO	NO	0.0199	0.6083	1.3920	NO
H. Other									NO	NO	10.1126	NO
3. Agriculture	**0.5226**	**97.7579**	**8.4527**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		81.1547										
B. Manure management		16.6032	3.4991									

C. Rice cultivation		NO										
D. Agricultural soils			4.9535									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.5226											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-2639.3787**	**0.0960**	**0.6171**						**0.0885**	**3.2552**	**NO, NE**	
A. Forest land	-2343.3131	0.0014	0.0001						0.0009	0.0316	NO, NE	
B. Cropland	1517.2470	0.0946	0.0025						0.0876	3.2236	NO	
C. Grassland	-1414.3167	NE	NE						NE	NE	NE	
D. Wetlands	-526.4627	NE	NE						NE	NE	NE	
E. Settlements	88.7139	NO, NE	0.6145						NO, NE	NO, NE	NO, NE	
F. Other land	152.3638	NE	NE						NE	NE	NE	
G. Harvested wood products	-113.6108											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**14.9994**	**57.9712**	**0.2811**						**0.1506**	**2.6451**	**0.9029**	**0.0053**
A. Solid waste disposal	NA, NO	43.9447							NA, NO	NA, NO	0.8074	
B. Biological treatment of solid waste		0.0551	0.0033						NO, NE	0.0077	NO, NE	
C. Incineration and open burning of waste	14.9994	0.3080	0.0054						0.1506	2.6374	0.0582	0.0053
D. Wastewater treatment and discharge		13.6633	0.2724						NA, IE	NA, IE	0.0373	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**147.3846**	**0.0117**	**0.0048**						**0.5829**	**0.4464**	**0.1751**	**0.0467**
Aviation	147.3846	0.0117	0.0048						0.5829	0.4464	0.1751	0.0467
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	201.2009											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**1.8766**									
Indirect CO_2	**170.8422**											

1992

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**22112.1127**	**186.9661**	**8.8500**	NO	NO	NO	NO	NO	**55.2010**	**133.2734**	**87.9944**	**92.0640**
1. Energy	**23328.3149**	**33.7339**	**0.6034**						**53.1383**	**124.2406**	**14.8719**	**91.3906**
A. Fuel combustion Reference approach	23208.4202											
Sectoral approach	23327.7974	6.1296	0.6034						53.1383	124.2406	14.3788	91.3906
1. Energy industries	15660.9863	0.3579	0.1219						28.7536	5.5760	0.4762	71.2477
2. Manufacturing industries and construction	926.7893	0.0399	0.0069						4.5977	1.3236	0.4070	0.9321
3. Transport	2614.8520	0.7228	0.2234						9.0885	35.7574	4.5881	0.4462
4. Other sectors	4047.4223	5.0044	0.2490						10.2209	81.2407	8.8561	18.6039
5. Other	77.7474	0.0046	0.0023						0.4776	0.3429	0.0514	0.1606

B. Fugitive emissions from fuels	0.5175	27.6043	0.0000						NO	NO	0.4931	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.5175	27.6043	0.0000						NO	NO	0.4931	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**821.5621**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**1.8308**	**3.4045**	**72.1808**	**0.6681**
A. Mineral industry	640.8940								1.7039	1.6459	0.0165	0.6171
B. Chemical industry	NO	NO	NO						NO	NO	0.0238	NO
C. Metal industry	23.9922	NO	NO	NO	NO	NO	NO	NO	0.0780	1.0194	0.0314	0.0360
D. Non-energy products from fuels and solvent use	154.2628	NO	NO						0.0304	0.1706	62.9651	0.0151
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				NO	NO	NO	NO	NO				
G. Other product manufacture and use	2.4132	NO	0.0001	NO	NO	NO	NO	NO	0.0186	0.5686	1.0969	NO
H. Other									NO	NO	8.0471	NO
3. Agriculture	**0.3905**	**94.7961**	**7.3013**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		79.8715										
B. Manure management		14.9247	3.1392								NO	
C. Rice cultivation		NO										
D. Agricultural soils			4.1621									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.3905											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-2053.2024**	**0.0879**	**0.6868**						**0.0809**	**2.9777**	**NO, NE**	
A. Forest land	-2184.2404	0.0015	0.0001						0.0010	0.0346	NO, NE	
B. Cropland	1443.9675	0.0864	0.0022						0.0800	2.9431	NO	
C. Grassland	-1428.4835	NE	NE						NE	NE	NE	
D. Wetlands	-595.5455	NE	NE						NE	NE	NE	
E. Settlements	386.6196	NO, NE	0.6844						NO, NE	NO, NE	NO, NE	
F. Other land	418.7786	NE	NE						NE	NE	NE	
G. Harvested wood products	-94.2986											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**15.0476**	**58.3482**	**0.2585**						**0.1510**	**2.6506**	**0.9417**	**0.0053**
A. Solid waste disposal	NA, NE	45.6782							NA, NO	NA, NO	0.8499	
B. Biological treatment of solid waste		0.0575	0.0035						NO, NE	0.0081	NO, NE	
C. Incineration and open burning of waste	15.0476	0.3089	0.0054						0.1510	2.6425	0.0584	0.0053
D. Wastewater treatment and discharge		12.3036	0.2496						NA, IE	NA, IE	0.0335	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**108.5369**	**0.0086**	**0.0036**						**0.4293**	**0.3287**	**0.1289**	**0.0344**
Aviation	108.5369	0.0086	0.0036						0.4293	0.3287	0.1289	0.0344
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	169.5924											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**1.6034**									
Indirect CO_2	**140.9363**											

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**15993.1166**	**174.3592**	**7.7257**	**NO**	**NO**	**NO**	**NO**	**NO**	**76.1590**	**69.5986**	**69.2095**	**72.3599**
1. Energy	**17335.5539**	**27.4021**	**0.5000**						**74.1648**	**59.6995**	**7.9444**	**71.7045**
A. Fuel combustion Reference approach	17274.3650											
Sectoral approach	17335.1157	2.5995	0.5000						74.1648	59.6995	7.5007	71.7045
1. Energy industries	12640.6006	0.2823	0.1058						23.6435	4.2355	0.3687	62.2743
2. Manufacturing industries and construction	612.1245	0.0268	0.0045						34.8853	0.9478	0.2790	0.6765
3. Transport	1855.0176	0.4932	0.1808						7.3893	23.2766	3.0794	0.3241
4. Other sectors	2133.9212	1.7913	0.2065						7.7876	30.6143	3.6883	8.0858
5. Other	93.4518	0.0058	0.0024						0.4591	0.6253	0.0853	0.3437
B. Fugitive emissions from fuels	0.4382	24.8026	0.0000						NO	NO	0.4437	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.4382	24.8026	0.0000						NO	NO	0.4437	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**737.0521**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**1.7342**	**3.2411**	**60.2823**	**0.6501**
A. Mineral industry	586.7703								1.6117	1.4853	0.0143	0.6015
B. Chemical industry	NO	NO	NO						NO	NO	0.0199	NO
C. Metal industry	24.4250	NO	NO	NO	NO	NO	NO	NO	0.0794	1.0383	0.0315	0.0366
D. Non-energy products from fuels and solvent use	123.8759	NO	NO						0.0241	0.1356	50.1008	0.0120
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				NO	NO	NO	NO	NO				
G. Other product manufacture and use	1.9809	NO	0.0001	NO	NO	NO	NO	NO	0.0190	0.5819	0.9004	NO
H. Other									NO	NO	9.2154	NO
3. Agriculture	**0.1276**	**85.9140**	**6.2374**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		74.9162										
B. Manure management		10.9978	2.7360								NO	
C. Rice cultivation		NO										
D. Agricultural soils			3.5014									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.1276											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-2094.6617**	**0.1179**	**0.7469**						**0.1091**	**4.0151**	**NO, NE**	
A. Forest land	-2193.5115	0.0001	0.0000						0.0001	0.0024	NO, NE	
B. Cropland	1713.0301	0.1178	0.0031						0.1090	4.0127	NO	
C. Grassland	-1303.5202	NE	NE						NE	NE	NE	
D. Wetlands	-525.8447	NE	NE						NE	NE	NE	
E. Settlements	114.6181	NO, NE	0.7438						NO, NE	NO, NE	NO, NE	
F. Other land	164.0168	NE	NE						NE	NE	NE	
G. Harvested wood products	-63.4504											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**15.0447**	**60.9251**	**0.2413**						**0.1508**	**2.6428**	**0.9829**	**0.0053**

A. Solid waste disposal	NA, NO	48.1887							NA, NO	NA, NO	0.8947	
B. Biological treatment of solid waste		0.0288	0.0017						NO, NE	0.0040	NO, NE	
C. Incineration and open burning of waste	15.0447	0.3087	0.0054						0.1508	2.6388	0.0583	0.0053
D. Wastewater treatment and discharge		12.3989	0.2341						NA, IE	NA, IE	0.0299	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**55.2342**	**0.0044**	**0.0018**						**0.2184**	**0.1673**	**0.0656**	**0.0175**
Aviation	55.2342	0.0044	0.0018						0.2184	0.1673	0.0656	0.0175
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	143.2360											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**1.3011**									
Indirect CO_2	**112.2027**											

1994

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**13015.6690**	**170.8538**	**6.9945**	**NO**	**NO**	**NO**	**NO**	**NO**	**35.0949**	**75.3065**	**50.6096**	**57.3452**
1. Energy	**14485.6701**	**26.9625**	**0.4526**						**33.5131**	**67.5876**	**8.6559**	**56.8209**
A. Fuel combustion Reference approach	14451.3398											
Sectoral approach	14485.2616	3.0910	0.4526						33.5131	67.5876	8.2290	56.8209
1. Energy industries	9961.8515	0.1888	0.0872						18.8108	3.5570	0.2847	47.1207
2. Manufacturing industries and construction	731.5285	0.0178	0.0013						1.2443	0.7197	0.3201	0.3552
3. Transport	1612.7695	0.4373	0.1096						4.5224	21.4510	2.7103	0.2180
4. Other sectors	2090.7472	2.4402	0.2529						8.6031	41.2528	4.8276	8.8679
5. Other	88.3648	0.0069	0.0016						0.3325	0.6071	0.0863	0.2592
B. Fugitive emissions from fuels	0.4085	23.8714	0.0000						NO	NO	0.4269	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.4085	23.8714	0.0000						NO	NO	0.4269	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**556.2338**	**NO**	**0.0001**	**NO**	**NO**	**NO**	**NO**	**NO**	**1.3699**	**2.8404**	**40.9264**	**0.5189**
A. Mineral industry	444.9885								1.2556	1.1521	0.0116	0.4736
B. Chemical industry	NO	NO	NO						NO	NO	0.0074	NO
C. Metal industry	25.3289	NO	NO	NO	NO	NO	NO	NO	0.0824	1.0774	0.0322	0.0380
D. Non-energy products from fuels and solvent use	84.4738	NO	NO						0.0146	0.0820	32.7972	0.0073
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				NO	NO	NO	NO	NO				
G. Other product manufacture and use	1.4426	NO	0.0001	NO	NO	NO	NO	NO	0.0173	0.5290	0.6557	NO
H. Other									NO	NO	7.4223	NO
3. Agriculture	**0.0537**	**83.5225**	**5.5139**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		72.9133										
B. Manure management		10.6093	2.6585								NO	
C. Rice cultivation		NO										

D. Agricultural soils			2.8554									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.0537											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-2041.3832**	**0.0662**	**0.7938**						**0.0606**	**2.2302**	**NO, NE**	
A. Forest land	-2108.0022	0.0023	0.0001						0.0015	0.0526	NO, NE	
B. Cropland	1476.2941	0.0639	0.0017						0.0592	2.1776	NO	
C. Grassland	-1577.3332	NE	NE						NE	NE	NE	
D. Wetlands	-497.6418	NE	NE						NE	NE	NE	
E. Settlements	130.4883	NO, NE	0.7920						NO, NE	NO, NE	NO, NE	
F. Other land	549.4579	NE	NE						NE	NE	NE	
G. Harvested wood products	-14.6464											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**15.0947**	**60.3026**	**0.2343**						**0.1512**	**2.6482**	**1.0273**	**0.0054**
A. Solid waste disposal	NA, NO	48.3920							NA, NO	NA, NO	0.9417	
B. Biological treatment of solid waste		0.0268	0.0016						NO, NE	0.0038	NO, NE	
C. Incineration and open burning of waste	15.0947	0.3096	0.0054						0.1512	2.6445	0.0584	0.0054
D. Wastewater treatment and discharge		11.5741	0.2272						NA, IE	NA, IE	0.0272	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**30.8414**	**0.0024**	**0.0010**						**0.1220**	**0.0934**	**0.0366**	**0.0098**
Aviation	30.8414	0.0024	0.0010						0.1220	0.0934	0.0366	0.0098
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	157.4600											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**1.1449**									
Indirect CO_2	**73.5965**											

1995

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**9926.5250**	**161.6451**	**6.8333**	**1.0298**	NO	NO	NO	NO	**29.1576**	**65.7090**	**47.3142**	**31.7701**
1. Energy	**11471.5441**	**28.3934**	**0.4304**						**27.7416**	**57.4485**	**7.1117**	**31.2910**
A. Fuel combustion — Reference approach	11437.2030											
Sectoral approach	11471.1247	1.9379	0.4304						27.7416	57.4485	6.6356	31.2910
1. Energy industries	7174.0286	0.1370	0.0502						12.9854	3.1484	0.2369	25.5949
2. Manufacturing industries and construction	381.5061	0.0114	0.0015						0.6870	0.5581	0.1795	0.3662
3. Transport	1617.7816	0.4448	0.1058						4.4098	22.5934	2.8292	0.2340
4. Other sectors	2172.1646	1.3343	0.2708						9.1456	30.5187	3.2884	4.8320
5. Other	125.6438	0.0104	0.0022						0.5138	0.6299	0.1015	0.2639
B. Fugitive emissions from fuels	0.4194	26.4555	0.0000						NO	NO	0.4761	NO

1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.4194	26.4555	0.0000						NO	NO	0.4761	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**455.1468**	**NO**	**0.0000**	**1.0298**	**NO**	**NO**	**NO**	**NO**	**1.1818**	**2.5644**	**39.1320**	**0.4737**
A. Mineral industry	351.1816								1.0679	0.9044	0.0090	0.4277
B. Chemical industry	NO	NO	NO						NO	NO	0.0060	NO
C. Metal industry	26.2369	NO	NO	NO	NO	NO	NO	NO	0.0854	1.1166	0.0327	0.0394
D. Non-energy products from fuels and solvent use	76.5607	NO	NO						0.0132	0.0740	29.2180	0.0065
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				1.0298	NO	NO	NO	NO				
G. Other product manufacture and use	1.1676	NO	0.0000	NO	NO	NO	NO	NO	0.0153	0.4695	0.5307	NO
H. Other									NO	NO	9.3357	NO
3. Agriculture	**0.0607**	**72.9745**	**5.3218**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		64.7235										
B. Manure management		8.2510	2.4596								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.8621									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.0607											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-2015.3244**	**0.0896**	**0.8440**						**0.0829**	**3.0510**	**NO, NE**	
A. Forest land	-2045.0670	0.0001	0.0000						0.0001	0.0030	NO, NE	
B. Cropland	1586.2644	0.0895	0.0023						0.0828	3.0480	NO	
C. Grassland	-1601.1004	NE	NE						NE	NE	NE	
D. Wetlands	-469.4389	NE	NE						NE	NE	NE	
E. Settlements	106.9167	NO, NE	0.8417						NO, NE	NO, NE	NO, NE	
F. Other land	401.1281	NE	NE						NE	NE	NE	
G. Harvested wood products	5.9727											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**15.0979**	**60.1876**	**0.2370**						**0.1512**	**2.6451**	**1.0704**	**0.0054**
A. Solid waste disposal	NA, NO	48.3670							NA, NO	NA, NO	0.9913	
B. Biological treatment of solid waste		0.0253	0.0015						NO, NE	0.0035	NO, NE	
C. Incineration and open burning of waste	15.0979	0.3096	0.0054						0.1512	2.6416	0.0584	0.0054
D. Wastewater treatment and discharge		11.4857	0.2301						NA, IE	NA, IE	0.0207	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**41.9508**	**0.0066**	**0.0014**						**0.1676**	**0.1539**	**0.0809**	**0.0133**
Aviation	41.9508	0.0066	0.0014						0.1676	0.1539	0.0809	0.0133
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	230.0480											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**1.0883**									
Indirect CO_2	**65.4471**											

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**9333.9640**	**159.2973**	**6.8061**	**1.6593**	**NO**	**NO**	**NO**	**NO**	**27.2543**	**77.9462**	**45.8441**	**31.9482**
1. Energy	**11375.0177**	**31.7295**	**0.3744**						**26.0139**	**70.5633**	**8.5666**	**31.5407**
A. Fuel combustion Reference approach	11319.0368											
Sectoral approach	11374.5451	2.9740	0.3744						26.0139	70.5633	8.0506	31.5407
1. Energy industries	7107.0544	0.1353	0.0469						12.7474	3.2595	0.2422	23.4411
2. Manufacturing industries and construction	321.2863	0.0115	0.0016						0.6490	0.6323	0.1600	0.4747
3. Transport	1578.6670	0.4313	0.1009						4.2800	21.5297	2.7137	0.2207
4. Other sectors	2285.6997	2.3850	0.2228						7.8951	44.6759	4.8360	7.2025
5. Other	81.8376	0.0109	0.0023						0.4423	0.4659	0.0987	0.2016
B. Fugitive emissions from fuels	0.4726	28.7555	0.0000						NO	NO	0.5160	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.4726	28.7555	0.0000						NO	NO	0.5160	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**414.5996**	**NO**	**0.0000**	**1.6593**	**NO**	**NO**	**NO**	**NO**	**1.0325**	**2.6496**	**36.1550**	**0.4021**
A. Mineral industry	315.6974								0.9126	0.8037	0.0070	0.3560
B. Chemical industry	NO	NO	NO						NO	NO	0.0085	NO
C. Metal industry	26.7261	NO	NO	NO	NO	NO	NO	NO	0.0870	1.1375	0.0332	0.0401
D. Non-energy products from fuels and solvent use	71.0712	NO	NO						0.0119	0.0671	27.0276	0.0059
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				1.6593	NO	NO	NO	NO				
G. Other product manufacture and use	1.1050	NO	0.0000	NO	NO	NO	NO	NO	0.0210	0.6414	0.5023	NO
H. Other									NO	NO	8.5764	NO
3. Agriculture	**0.0911**	**67.1693**	**5.3180**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		59.6750										
B. Manure management		7.4943	2.5974								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.7206									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.0911											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-2470.8404**	**0.0616**	**0.8801**						**0.0569**	**2.0916**	**NO, NE**	
A. Forest land	-2190.4337	0.0008	0.0000						0.0005	0.0176	NO, NE	
B. Cropland	1388.2124	0.0609	0.0016						0.0564	2.0740	NO	
C. Grassland	-1548.0826	NE	NE						NE	NE	NE	
D. Wetlands	-441.2360	NE	NE						NE	NE	NE	
E. Settlements	101.5910	NO, NE	0.8784						NO, NE	NO, NE	NO, NE	
F. Other land	217.3293	NE	NE						NE	NE	NE	
G. Harvested wood products	1.7792											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**15.0960**	**60.3369**	**0.2336**						**0.1511**	**2.6417**	**1.1226**	**0.0054**

A. Solid waste disposal	NA, NO	48.6713							NA, NO	NA, NO	1.0435	
B. Biological treatment of solid waste		0.0261	0.0016						NO, NE	0.0036	NO, NE	
C. Incineration and open burning of waste	15.0960	0.3094	0.0054						0.1511	2.6380	0.0584	0.0054
D. Wastewater treatment and discharge		11.3300	0.2266						NA, IE	NA, IE	0.0208	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**56.7300**	**0.0048**	**0.0018**						**0.2197**	**0.1539**	**0.0822**	**0.0180**
Aviation	56.7300	0.0048	0.0018						0.2197	0.1539	0.0822	0.0180
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	294.0280											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**1.0881**									
Indirect CO_2	**60.5658**											

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**8606.7740**	**143.5333**	**6.1582**	**2.3137**	**NO**	**NO**	**NO**	**NO**	**24.3381**	**73.2543**	**31.2793**	**16.7211**
1. Energy	**10258.1517**	**25.9642**	**0.3429**						**22.8510**	**63.9617**	**7.7630**	**16.2324**
A. Fuel combustion Reference approach	10192.9270											
Sectoral approach	10257.6867	2.3214	0.3429						22.8510	63.9617	7.3454	16.2324
1. Energy industries	5615.6123	0.1108	0.0244						9.5174	3.1362	0.2233	10.5370
2. Manufacturing industries and construction	546.9038	0.0181	0.0023						0.9180	0.7370	0.2841	0.3965
3. Transport	1515.9813	0.4010	0.0976						4.2427	23.8049	2.9428	0.2299
4. Other sectors	2502.5306	1.7835	0.2165						7.8855	35.7839	3.8166	4.8638
5. Other	76.6587	0.0081	0.0020						0.2875	0.4997	0.0785	0.2051
B. Fugitive emissions from fuels	0.4651	23.6428	0.0000						NO	NO	0.4176	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.4651	23.6428	0.0000						NO	NO	0.4176	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**452.0432**	**NO**	**0.0000**	**2.3137**	**NO**	**NO**	**NO**	**NO**	**1.2371**	**3.0011**	**22.3411**	**0.4833**
A. Mineral industry	376.6116								1.1071	0.9721	0.0096	0.4327
B. Chemical industry	NO	NO	NO						NO	NO	0.0068	NO
C. Metal industry	32.3806	NO	NO	NO	NO	NO	NO	NO	0.1054	1.3781	0.0401	0.0486
D. Non-energy products from fuels and solvent use	42.0528	NO	NO						0.0040	0.0227	14.1331	0.0020
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				2.3137	NO	NO	NO	NO				
G. Other product manufacture and use	0.9982	NO	0.0000	NO	NO	NO	NO	NO	0.0205	0.6281	0.4537	NO
H. Other									NO	NO	7.6977	NO
3. Agriculture	**1.0992**	**57.3905**	**4.6643**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		51.3040										
B. Manure management		6.0866	2.0035								NO	
C. Rice cultivation		NO										

D. Agricultural soils			2.6607									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	1.0992											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-2119.5658**	**0.1075**	**0.9134**						**0.0995**	**3.6610**	**NO, NE**	
A. Forest land	-2232.2854	0.0002	0.0000						0.0001	0.0053	NO, NE	
B. Cropland	1656.8247	0.1073	0.0028						0.0993	3.6556	NO	
C. Grassland	-1400.8607	NE	NE						NE	NE	NE	
D. Wetlands	-413.0332	NE	NE						NE	NE	NE	
E. Settlements	100.7954	NO, NE	0.9106						NO, NE	NO, NE	NO, NE	
F. Other land	188.2363	NE	NE						NE	NE	NE	
G. Harvested wood products	-19.2429											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**15.0456**	**60.0710**	**0.2376**						**0.1505**	**2.6305**	**1.1751**	**0.0054**
A. Solid waste disposal	NA, NO	48.1521							NA, NO	NA, NO	1.0984	
B. Biological treatment of solid waste		0.0245	0.0015						NO, NE	0.0034	NO, NE	
C. Incineration and open burning of waste	15.0456	0.3083	0.0054						0.1505	2.6271	0.0581	0.0054
D. Wastewater treatment and discharge		11.5861	0.2307						NA, IE	NA, IE	0.0186	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**66.1918**	**0.0054**	**0.0021**						**0.2640**	**0.1777**	**0.0937**	**0.0210**
Aviation	66.1918	0.0054	0.0021						0.2640	0.1777	0.0937	0.0210
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	291.1280											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.9502**									
Indirect CO_2	**32.0911**											

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**7133.9405**	**137.9347**	**5.9726**	**3.1372**	**NO**	**NO**	**NO**	**NO**	**20.5036**	**57.1055**	**27.4305**	**12.4779**
1. Energy	**8894.2769**	**23.8409**	**0.2674**						**19.1724**	**48.6044**	**6.2399**	**12.0244**
A. Fuel combustion Reference approach	8841.4250											
Sectoral approach	8893.8495	1.7160	0.2674						19.1724	48.6044	5.8483	12.0244
1. Energy industries	4836.6106	0.0962	0.0190						8.1103	2.7791	0.1972	7.9288
2. Manufacturing industries and construction	542.6603	0.0186	0.0024						1.0266	0.7118	0.3020	0.3295
3. Transport	1363.0743	0.4035	0.0827						3.4803	20.7338	2.5523	0.1945
4. Other sectors	2078.6760	1.1889	0.1612						6.1632	23.7935	2.6926	3.3628
5. Other	72.8283	0.0088	0.0021						0.3919	0.5862	0.1041	0.2088
B. Fugitive emissions from fuels	0.4274	22.1250	0.0000						NO	NO	0.3916	NO

1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.4274	22.1250	0.0000						NO	NO	0.3916	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**375.0296**	**NO**	**0.0000**	**3.1372**	**NO**	**NO**	**NO**	**NO**	**1.0896**	**2.5238**	**19.9607**	**0.4481**
A. Mineral industry	307.9930								0.9767	0.7878	0.0078	0.4034
B. Chemical industry	NO	NO	NO						NO	NO	0.0066	NO
C. Metal industry	28.6822	NO	NO	NO	NO	NO	NO	NO	0.0934	1.2208	0.0371	0.0431
D. Non-energy products from fuels and solvent use	37.6084	NO	NO						0.0033	0.0185	13.2678	0.0016
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				3.1372	NO	NO	NO	NO				
G. Other product manufacture and use	0.7460	NO	0.0000	NO	NO	NO	NO	NO	0.0162	0.4967	0.3391	NO
H. Other									NO	NO	6.3022	NO
3. Agriculture	**0.2721**	**54.9163**	**4.5098**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		49.8079										
B. Manure management		5.1085	1.9398								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.5700									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.2721											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-2150.7175**	**0.0989**	**0.9542**						**0.0909**	**3.3430**	**NO, NE**	
A. Forest land	-2288.4857	0.0023	0.0001						0.0015	0.0529	NO, NE	
B. Cropland	1683.9458	0.0966	0.0025						0.0894	3.2900	NO	
C. Grassland	-1436.2698	NE	NE						NE	NE	NE	
D. Wetlands	-384.8303	NE	NE						NE	NE	NE	
E. Settlements	99.0440	NO, NE	0.9516						NO, NE	NO, NE	NO, NE	
F. Other land	185.0077	NE	NE						NE	NE	NE	
G. Harvested wood products	-9.1293											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**15.0794**	**59.0786**	**0.2412**						**0.1508**	**2.6344**	**1.2299**	**0.0054**
A. Solid waste disposal	NA, NO	47.5742							NA, NO	NA, NO	1.1562	
B. Biological treatment of solid waste		0.0248	0.0015						NO, NE	0.0035	NO, NE	
C. Incineration and open burning of waste	15.0794	0.3089	0.0054						0.1508	2.6310	0.0582	0.0054
D. Wastewater treatment and discharge		11.1707	0.2342						NA, IE	NA, IE	0.0155	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**53.5923**	**0.0041**	**0.0017**						**0.2144**	**0.1439**	**0.0721**	**0.0170**
Aviation	53.5923	0.0041	0.0017						0.2144	0.1439	0.0721	0.0170
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	269.0120											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.9001**									
Indirect CO_2	**29.9352**											

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**5387.5857**	**133.5823**	**5.5272**	**4.0002**	**NO**	**NO**	**NO**	**NO**	**14.7356**	**41.8414**	**23.2289**	**5.8630**
1. Energy	**6903.7219**	**23.9591**	**0.1824**						**13.5355**	**36.4419**	**4.8899**	**5.4709**
A. Fuel combustion Reference approach	6841.6529											
Sectoral approach	6903.3288	1.5546	0.1824						13.5355	36.4419	4.4892	5.4709
1. Energy industries	3660.2540	0.0727	0.0088						5.8881	2.3787	0.1638	2.1288
2. Manufacturing industries and construction	473.8274	0.0129	0.0015						0.7360	0.4969	0.2249	0.2275
3. Transport	910.6886	0.2475	0.0514						2.0599	11.9843	1.4854	0.1366
4. Other sectors	1809.4024	1.2151	0.1190						4.7057	21.2190	2.5511	2.8154
5. Other	49.1563	0.0065	0.0016						0.1458	0.3630	0.0640	0.1625
B. Fugitive emissions from fuels	0.3931	22.4045	0.0000						NO	NO	0.4007	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.3931	22.4045	0.0000						NO	NO	0.4007	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**337.9160**	**NO**	**0.0000**	**4.0002**	**NO**	**NO**	**NO**	**NO**	**0.9619**	**2.6451**	**17.0520**	**0.3868**
A. Mineral industry	271.3959								0.8365	0.6973	0.0076	0.3375
B. Chemical industry	NO	NO	NO						NO	NO	0.0050	NO
C. Metal industry	31.7942	NO	NO	NO	NO	NO	NO	NO	0.1035	1.3533	0.0408	0.0478
D. Non-energy products from fuels and solvent use	34.0839	NO	NO						0.0031	0.0172	12.7587	0.0015
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				4.0002	NO	NO	NO	NO				
G. Other product manufacture and use	0.6421	NO	0.0000	NO	NO	NO	NO	NO	0.0189	0.5773	0.2919	NO
H. Other									NO	NO	3.9481	NO
3. Agriculture	**0.0034**	**50.5648**	**4.1226**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		46.0727										
B. Manure management		4.4921	1.7608								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.3619									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.0034											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1869.0627**	**0.0956**	**0.9861**						**0.0880**	**0.1265**	**NO, NE**	
A. Forest land	-2336.8468	0.0017	0.0001						0.0011	0.0396	NO, NE	
B. Cropland	1702.1754	0.0938	0.0024						0.0869	0.0869	NO	
C. Grassland	-1433.2865	NE	NE						NE	NE	NE	
D. Wetlands	-356.6274	NE	NE						NE	NE	NE	
E. Settlements	111.8259	NO, NE	0.9836						NO, NE	NO, NE	NO, NE	
F. Other land	425.1554	NE	NE						NE	NE	NE	
G. Harvested wood products	18.5414											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**15.0071**	**58.9628**	**0.2360**						**0.1502**	**2.6281**	**1.2870**	**0.0053**

A. Solid waste disposal	NA, NO	47.8091							NA, NO	NA, NO	1.2171	
B. Biological treatment of solid waste		0.0232	0.0014						NO, NE	0.0033	NO, NE	
C. Incineration and open burning of waste	15.0071	0.3077	0.0054						0.1502	2.6248	0.0581	0.0053
D. Wastewater treatment and discharge		10.8228	0.2292						NA, IE	NA, IE	0.0119	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**63.0390**	**0.0040**	**0.0020**						**0.2517**	**0.1574**	**0.0796**	**0.0200**
Aviation	63.0390	0.0040	0.0020						0.2517	0.1574	0.0796	0.0200
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	266.1120											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.8146**									
Indirect CO_2	**28.7113**											

2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**4362.1880**	**130.4108**	**5.2269**	**5.1199**	**NO**	**NO**	**NO**	**NO**	**13.1953**	**40.6761**	**22.7982**	**4.4903**
1. Energy	**6188.5808**	**25.5633**	**0.1627**						**11.9074**	**34.0667**	**4.7767**	**3.9685**
A. Fuel combustion Reference approach	6126.5290											
Sectoral approach	6188.2049	1.5379	0.1627						11.9074	34.0667	4.3426	3.9685
1. Energy industries	3155.7517	0.0610	0.0069						5.0439	2.1204	0.1437	0.9753
2. Manufacturing industries and construction	519.5881	0.0119	0.0014						0.7914	0.4871	0.2261	0.2274
3. Transport	982.3588	0.2520	0.0574						2.1165	11.8853	1.4687	0.1582
4. Other sectors	1494.1182	1.2084	0.0960						3.8246	19.3419	2.4620	2.4553
5. Other	36.3881	0.0046	0.0010						0.1311	0.2320	0.0421	0.1523
B. Fugitive emissions from fuels	0.3759	24.0254	0.0000						NO	NO	0.4341	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.3759	24.0254	0.0000						NO	NO	0.4341	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**309.3065**	**NO**	**0.0000**	**5.1199**	**NO**	**NO**	**NO**	**NO**	**1.1041**	**2.7463**	**16.6713**	**0.5164**
A. Mineral industry	239.4427								0.9636	0.5762	0.0068	0.4607
B. Chemical industry	NO	NO	NO						NO	NO	0.0073	NO
C. Metal industry	36.2689	NO	NO	NO	NO	NO	NO	NO	0.1181	1.5438	0.0462	0.0545
D. Non-energy products from fuels and solvent use	32.6395	NO	NO						0.0025	0.0139	12.5638	0.0012
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				5.1199	NO	NO	NO	NO				
G. Other product manufacture and use	0.9554	NO	0.0000	NO	NO	NO	NO	NO	0.0200	0.6124	0.4343	NO
H. Other									NO	NO	3.6129	NO
3. Agriculture	**0.4397**	**46.8318**	**3.8285**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		43.4313										
B. Manure management		3.4005	1.5712								NO	
C. Rice cultivation		NO										

D. Agricultural soils			2.2573									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.4397											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-2151.1356**	**0.0365**	**0.9944**						**0.0338**	**1.2427**	**NO, NE**	
A. Forest land	-2307.4384	0.0001	0.0000						0.0000	0.0014	NO, NE	
B. Cropland	1492.1681	0.0364	0.0009						0.0337	1.2413	NO	
C. Grassland	-1291.9495	NE	NE						NE	NE	NE	
D. Wetlands	-328.4245	NE	NE						NE	NE	NE	
E. Settlements	100.1768	NO, NE	0.9934						NO, NE	NO, NE	NO, NE	
F. Other land	178.5246	NE	NE						NE	NE	NE	
G. Harvested wood products	5.8073											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**14.9965**	**57.9792**	**0.2413**						**0.1500**	**2.6204**	**1.3503**	**0.0054**
A. Solid waste disposal	NA, NO	46.7813							NA, NO	NA, NO	1.2812	
B. Biological treatment of solid waste		0.0210	0.0013						NO, NE	0.0029	NO, NE	
C. Incineration and open burning of waste	14.9965	0.3073	0.0054						0.1500	2.6175	0.0579	0.0054
D. Wastewater treatment and discharge		10.8697	0.2346						NA, IE	NA, IE	0.0111	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**63.0779**	**0.0043**	**0.0020**						**0.2591**	**0.1688**	**0.0773**	**0.0200**
Aviation	63.0779	0.0043	0.0020						0.2591	0.1688	0.0773	0.0200
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	272.3720											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.7505**									
Indirect CO_2	**28.5957**											

2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**5348.8609**	**129.7683**	**5.4957**	**6.8681**	**NO**	**NO**	**NO**	**NO**	**14.4422**	**40.0992**	**24.5445**	**3.9993**
1. Energy	**6818.6569**	**25.2353**	**0.1673**						**13.1876**	**32.9406**	**4.6812**	**3.5081**
A. Fuel combustion Reference approach	6768.9070											
Sectoral approach	6818.2477	1.4145	0.1673						13.1876	32.9406	4.2534	3.5081
1. Energy industries	3677.7189	0.0726	0.0080						5.8773	2.5004	0.1689	0.8801
2. Manufacturing industries and construction	601.1675	0.0147	0.0019						1.1500	0.5744	0.2598	0.2825
3. Transport	1061.8643	0.2668	0.0634						2.2613	12.7722	1.5702	0.1332
4. Other sectors	1434.1009	1.0554	0.0928						3.7425	16.7367	2.1939	2.1063
5. Other	43.3961	0.0050	0.0012						0.1565	0.3569	0.0605	0.1061
B. Fugitive emissions from fuels	0.4092	23.8208	0.0000						NO	NO	0.4278	NO

1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.4092	23.8208	0.0000						NO	NO	0.4278	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**311.7431**	**NO**	**0.0000**	**6.8681**	**NO**	**NO**	**NO**	**NO**	**1.0590**	**2.8557**	**18.4464**	**0.4857**
A. Mineral industry	235.8758								0.9098	0.5713	0.0067	0.4262
B. Chemical industry	NO	NO	NO						NO	NO	0.0080	NO
C. Metal industry	38.6274	NO	NO	NO	NO	NO	NO	NO	0.1257	1.6441	0.0500	0.0580
D. Non-energy products from fuels and solvent use	36.4195	NO	NO						0.0031	0.0174	14.0195	0.0015
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				6.8681	NO	NO	NO	NO				
G. Other product manufacture and use	0.8204	NO	0.0000	NO	NO	NO	NO	NO	0.0203	0.6229	0.3729	NO
H. Other									NO	NO	3.9893	NO
3. Agriculture	**0.1496**	**47.5675**	**4.0894**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		44.1309										
B. Manure management		3.4366	1.5998								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.4896									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.1496											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1796.6576**	**0.0508**	**0.9951**						**0.0459**	**1.6868**	**NO, NE**	
A. Forest land	-2273.7027	0.0039	0.0002						0.0025	0.0896	NO, NE	
B. Cropland	1828.5659	0.0469	0.0012						0.0434	1.5972	NO	
C. Grassland	-1290.6541	NE	NE						NE	NE	NE	
D. Wetlands	-300.2217	NE	NE						NE	NE	NE	
E. Settlements	67.0898	NO, NE	0.9937						NO, NE	NO, NE	NO, NE	
F. Other land	178.5246	NE	NE						NE	NE	NE	
G. Harvested wood products	-6.2594											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**14.9689**	**56.9146**	**0.2438**						**0.1497**	**2.6161**	**1.4170**	**0.0054**
A. Solid waste disposal	NA, NO	45.4990							NA, NO	NA, NO	1.3485	
B. Biological treatment of solid waste		0.0190	0.0011						NO, NE	0.0027	NO, NE	
C. Incineration and open burning of waste	14.9689	0.3067	0.0054						0.1497	2.6134	0.0578	0.0054
D. Wastewater treatment and discharge		11.0899	0.2373						NA, IE	NA, IE	0.0106	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**50.4863**	**0.0039**	**0.0016**						**0.1936**	**0.1468**	**0.0630**	**0.0160**
Aviation	50.4863	0.0039	0.0016						0.1936	0.1468	0.0630	0.0160
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	282.2280											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.8021**									
Indirect CO_2	**31.6632**											

2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**5028.2150**	**132.7197**	**5.6969**	**9.1227**	**NO**	**NO**	**NO**	**NO**	**14.8025**	**45.0642**	**27.0803**	**4.8266**
1. Energy	**6537.0389**	**27.6591**	**0.2146**						**13.4336**	**40.0559**	**5.7445**	**4.2675**
A. Fuel combustion Reference approach	6478.0567											
Sectoral approach	6536.6488	1.7766	0.2146						13.4336	40.0559	5.2748	4.2675
1. Energy industries	2933.2101	0.0614	0.0069						4.6959	2.0055	0.1356	0.6884
2. Manufacturing industries and construction	410.3969	0.0096	0.0011						0.6019	0.4089	0.1809	0.2019
3. Transport	1405.7644	0.3418	0.0947						3.5165	16.6121	2.0849	0.1735
4. Other sectors	1747.8245	1.3555	0.1103						4.4782	20.7434	2.8052	3.0494
5. Other	39.4529	0.0083	0.0016						0.1411	0.2860	0.0683	0.1543
B. Fugitive emissions from fuels	0.3901	25.8825	0.0000						NO	NO	0.4697	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.3901	25.8825	0.0000						NO	NO	0.4697	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**359.6162**	**NO**	**0.0000**	**9.1227**	**NO**	**NO**	**NO**	**NO**	**1.2104**	**2.0646**	**19.7693**	**0.5537**
A. Mineral industry	299.9546								1.1263	0.7266	0.0084	0.5216
B. Chemical industry	NO	NO	NO						NO	NO	0.0104	NO
C. Metal industry	20.5030	NO	NO	NO	NO	NO	NO	NO	0.0667	0.8725	0.0263	0.0308
D. Non-energy products from fuels and solvent use	38.3743	NO	NO						0.0027	0.0153	14.8206	0.0013
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				9.1227	NO	NO	NO	NO				
G. Other product manufacture and use	0.7843	NO	0.0000	NO	NO	NO	NO	NO	0.0147	0.4503	0.3565	NO
H. Other									NO	NO	4.5471	NO
3. Agriculture	**0.0470**	**48.6223**	**4.2357**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		45.0244										
B. Manure management		3.5979	1.6116								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.6241									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.0470											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1883.4274**	**0.0106**	**0.9965**						**0.0092**	**0.3385**	**NO, NE**	
A. Forest land	-2267.6159	0.0021	0.0001						0.0013	0.0481	NO, NE	
B. Cropland	1424.6996	0.0085	0.0002						0.0079	0.2904	NO	
C. Grassland	-1235.1380	NE	NE						NE	NE	NE	
D. Wetlands	-272.0188	NE	NE						NE	NE	NE	
E. Settlements	67.0898	NO, NE	0.9961						NO, NE	NO, NE	NO, NE	
F. Other land	456.2431	NE	NE						NE	NE	NE	
G. Harvested wood products	-56.6873											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**14.9402**	**56.4277**	**0.2500**						**0.1493**	**2.6051**	**1.5665**	**0.0054**

A. Solid waste disposal	NA, NO	44.3224							NA, NO	NA, NO	1.4984	
B. Biological treatment of solid waste		0.0209	0.0013						NO, NE	0.0029	NO, NE	
C. Incineration and open burning of waste	14.9402	0.3059	0.0054						0.1493	2.6022	0.0576	0.0054
D. Wastewater treatment and discharge		11.7785	0.2434						NA, IE	NA, IE	0.0104	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**59.9541**	**0.0036**	**0.0020**						**0.2413**	**0.1619**	**0.0653**	**0.0190**
Aviation	59.9541	0.0036	0.0020						0.2413	0.1619	0.0653	0.0190
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	322.0800											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.8378**									
Indirect CO_2	**33.3896**											

2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**5767.7437**	**129.0376**	**5.2042**	**12.1632**	**NO**	**NO**	**0.0000**	**NO**	**15.0290**	**54.0127**	**28.0904**	**6.3041**
1. Energy	**7178.5944**	**29.3273**	**0.2087**						**13.6324**	**48.5365**	**6.7927**	**5.7410**
A. Fuel combustion Reference approach	7143.6135											
Sectoral approach	7177.5353	2.2688	0.2087						13.6324	48.5365	6.2607	5.7410
1. Energy industries	3036.7494	0.0626	0.0069						4.8529	2.0895	0.1407	0.5251
2. Manufacturing industries and construction	438.8946	0.0096	0.0011						0.6697	0.3867	0.1868	0.1729
3. Transport	1588.8147	0.4004	0.0912						3.2350	19.3977	2.3730	0.2110
4. Other sectors	2084.6537	1.7920	0.1085						4.7321	26.3815	3.5078	4.7236
5. Other	28.4228	0.0043	0.0009						0.1427	0.2811	0.0524	0.1085
B. Fugitive emissions from fuels	1.0592	27.0585	0.0000						NO	NO	0.5320	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.0592	27.0585	0.0000						NO	NO	0.5320	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**384.9507**	**NO**	**0.0000**	**12.1632**	**NO**	**NO**	**0.0000**	**NO**	**1.2463**	**2.8260**	**19.6527**	**0.5577**
A. Mineral industry	307.6352								1.1103	0.7495	0.0091	0.5032
B. Chemical industry	NO	NO	NO						NO	NO	0.0123	NO
C. Metal industry	35.4283	NO	NO	NO	NO	NO	NO	NO	0.1153	1.5074	0.0456	0.0532
D. Non-energy products from fuels and solvent use	40.9252	NO	NO						0.0026	0.0145	14.8735	0.0013
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				12.1632	NO	NO	NO	NO				
G. Other product manufacture and use	0.9620	NO	0.0000	NO	NO	NO	0.0000	NO	0.0181	0.5545	0.4373	NO
H. Other									NO	NO	4.2749	NO
3. Agriculture	**0.2381**	**44.4885**	**3.7660**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		41.1415										
B. Manure management		3.3469	1.5302								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.2358									

E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.2381											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1810.9497**	**0.0024**	**0.9877**						**0.0016**	**0.0573**	**NO, NE**	
A. Forest land	-2270.1176	0.0023	0.0001						0.0015	0.0526	NO, NE	
B. Cropland	1505.7575	0.0001	0.0000						0.0001	0.0046	NO	
C. Grassland	-1007.1842	NE	NE						NE	NE	NE	
D. Wetlands	-243.8159	NE	NE						NE	NE	NE	
E. Settlements	67.8615	NO, NE	0.9876						NO, NE	NO, NE	NO, NE	
F. Other land	201.6619	NE	NE						NE	NE	NE	
G. Harvested wood products	-65.1129											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**14.9100**	**55.2194**	**0.2418**						**0.1488**	**2.5930**	**1.6449**	**0.0054**
A. Solid waste disposal	NA, NO	42.8093							NA, NO	NA, NO	1.5772	
B. Biological treatment of solid waste		0.0219	0.0013						NO, NE	0.0031	NO, NE	
C. Incineration and open burning of waste	14.9100	0.3050	0.0054						0.1488	2.5899	0.0574	0.0054
D. Wastewater treatment and discharge		12.0831	0.2351						NA, IE	NA, IE	0.0103	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**34.7676**	**0.0035**	**0.0012**						**0.1317**	**0.1223**	**0.0403**	**0.0110**
Aviation	34.7676	0.0035	0.0012						0.1317	0.1223	0.0403	0.0110
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	373.5760											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.7455**									
Indirect CO_2	**33.6837**											

2004

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**6118.3768**	**127.7492**	**5.4118**	**16.0027**	**NO**	**NO**	**0.0000**	**NO**	**16.1297**	**51.3990**	**39.7519**	**5.4639**
1. Energy	**7629.0126**	**31.3493**	**0.2113**						**14.5781**	**45.4715**	**6.8425**	**4.8407**
A. Fuel combustion Reference approach	7593.9863											
Sectoral approach	7627.9081	1.9794	0.2113						14.5781	45.4715	5.9870	4.8407
1. Energy industries	3109.0519	0.0640	0.0071						4.9687	2.1439	0.1442	0.4936
2. Manufacturing industries and construction	443.9172	0.0115	0.0014						0.9313	0.4457	0.2047	0.2038
3. Transport	1787.2739	0.4316	0.1062						3.7615	21.1158	2.6011	0.2464
4. Other sectors	2260.0278	1.4692	0.0957						4.7005	21.4786	2.9899	3.8578
5. Other	27.6373	0.0031	0.0010						4.7005	21.4786	2.9899	3.8578
B. Fugitive emissions from fuels	1.1045	29.3699	0.0000						NO	NO	0.8554	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO

2. Oil and natural gas and other emissions from energy production	1.1045	29.3699	0.0000						NO	NO	0.8554	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**454.6376**	**NO**	**0.0001**	**16.0027**	**NO**	**NO**	**0.0000**	**NO**	**1.3978**	**3.2083**	**31.1818**	**0.6178**
A. Mineral industry	348.9485								1.2390	0.8629	0.0105	0.5529
B. Chemical industry	NO	NO	NO						NO	NO	0.0129	NO
C. Metal industry	40.5084	NO	NO	NO	NO	NO	NO	NO	0.1318	1.7236	0.0522	0.0608
D. Non-energy products from fuels and solvent use	64.1303	NO	NO						0.0082	0.0459	25.3328	0.0041
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				16.0027	NO	NO	NO	NO				
G. Other product manufacture and use	1.0504	NO	0.0001	NO	NO	NO	0.0000	NO	0.0188	0.5759	0.4774	NO
H. Other									NO	NO	5.2960	NO
3. Agriculture	**0.3669**	**41.7088**	**3.9964**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		38.4568										
B. Manure management		3.2519	1.4804								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.5160									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.3669											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1980.5023**	**0.0080**	**0.9736**						**0.0057**	**0.1401**	**NO, NE**	
A. Forest land	-2334.7768	0.0061	0.0003						0.0039	0.1383	NO, NE	
B. Cropland	1466.3473	0.0020	0.0001						0.0018	0.0018	NO	
C. Grassland	-1120.4767	NE	NE						NE	NE	NE	
D. Wetlands	-215.6130	NE	NE						NE	NE	NE	
E. Settlements	53.6737	NO, NE	0.9732						NO, NE	NO, NE	NO, NE	
F. Other land	223.8177	NE	NE						NE	NE	NE	
G. Harvested wood products	-53.4745											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**14.8621**	**54.6831**	**0.2305**						**0.1481**	**2.5791**	**1.7277**	**0.0054**
A. Solid waste disposal	NA, NO	42.2061							NA, NO	NA, NO	1.6602	
B. Biological treatment of solid waste		0.0230	0.0014						NO, NE	0.0032	NO, NE	
C. Incineration and open burning of waste	14.8621	0.3039	0.0053						0.1481	2.5759	0.0572	0.0054
D. Wastewater treatment and discharge		12.1502	0.2238						NA, IE	NA, IE	0.0103	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**34.7903**	**0.0035**	**0.0012**						**0.1283**	**0.1296**	**0.0344**	**0.0110**
Aviation	34.7903	0.0035	0.0012						0.1283	0.1296	0.0344	0.0110
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	307.6800											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.7901**									
Indirect CO_2	**56.7824**											

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**6754.6895**	**128.3358**	**5.5155**	**22.5106**	**NO**	**NO**	**0.0000**	**NO**	**17.1480**	**53.4840**	**42.3738**	**5.1702**
1. Energy	**7874.0484**	**33.0942**	**0.2113**						**15.3208**	**47.1427**	**6.9429**	**4.4388**
A. Fuel combustion Reference approach	7835.9210											
Sectoral approach	7872.9265	2.0769	0.2113						15.3208	47.1427	6.1778	4.4388
1. Energy industries	3231.6708	0.0661	0.0073						5.1612	2.2323	0.1500	0.4532
2. Manufacturing industries and construction	574.4257	0.0133	0.0015						1.4886	0.4932	0.2545	0.1904
3. Transport	1821.8133	0.4397	0.1150						4.1042	21.5603	2.6742	0.0452
4. Other sectors	2219.0765	1.5553	0.0866						4.3367	22.7299	3.0691	3.7081
5. Other	25.9403	0.0024	0.0010						0.2301	0.1272	0.0300	0.0418
B. Fugitive emissions from fuels	1.1219	31.0174	0.0000						NO	NO	0.7651	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.1219	31.0174	0.0000						NO	NO	0.7651	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**548.7488**	**NO**	**0.0001**	**22.5106**	**NO**	**NO**	**0.0000**	**NO**	**1.6740**	**3.4998**	**33.6172**	**0.7262**
A. Mineral industry	437.4573								1.5114	1.1045	0.0134	0.6594
B. Chemical industry	NO	NO	NO						NO	NO	0.0149	NO
C. Metal industry	41.9358	NO	NO	NO	NO	NO	NO	NO	0.1364	1.7839	0.0545	0.0630
D. Non-energy products from fuels and solvent use	68.1910	NO	NO						0.0077	0.0431	27.2264	0.0038
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				22.5106	NO	NO	NO	NO				
G. Other product manufacture and use	1.1646	NO	0.0001	NO	NO	NO	0.0000	NO	0.0186	0.5683	0.5294	NO
H. Other									NO	NO	5.7786	NO
3. Agriculture	**0.1739**	**40.3670**	**4.1308**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		36.9611										
B. Manure management		3.4059	1.5820								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.5488									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.1739											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1682.7486**	**0.0099**	**0.9615**						**0.0090**	**0.3317**	**NO, NE**	
A. Forest land	-2409.5185	0.0006	0.0000						0.0004	0.0132	NO, NE	
B. Cropland	1543.2389	0.0093	0.0002						0.0087	0.3185	NO	
C. Grassland	-1058.1239	NE	NE						NE	NE	NE	
D. Wetlands	-187.4101	NE	NE						NE	NE	NE	
E. Settlements	53.6737	NO, NE	0.9613						NO, NE	NO, NE	NO, NE	
F. Other land	416.5012	NE	NE						NE	NE	NE	
G. Harvested wood products	-41.1098											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**14.4670**	**54.8647**	**0.2118**						**0.1442**	**2.5098**	**1.8136**	**0.0053**

A. Solid waste disposal	NA, NO	42.5723							NA, NO	NA, NO	1.7476	
B. Biological treatment of solid waste		0.0241	0.0014						NO, NE	0.0034	NO, NE	
C. Incineration and open burning of waste	14.4670	0.2957	0.0052						0.1442	2.5064	0.0556	0.0053
D. Wastewater treatment and discharge		11.9725	0.2051						NA, IE	NA, IE	0.0103	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**37.9260**	**0.0035**	**0.0013**						**0.1433**	**0.1362**	**0.0373**	**0.0120**
Aviation	37.9260	0.0035	0.0013						0.1433	0.1362	0.0373	0.0120
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	307.3920											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.8200**									
Indirect CO_2	**61.0627**											

2006

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**5971.6037**	**123.1947**	**5.4102**	**33.2493**	**0.0231**	**NO**	**0.0000**	**NO**	**16.0044**	**53.9974**	**47.7740**	**5.3193**
1. Energy	**7115.3279**	**29.6025**	**0.2164**						**14.0428**	**48.1466**	**7.0634**	**4.5650**
A. Fuel combustion Reference approach	7077.0963											
Sectoral approach	7114.1019	2.2722	0.2164						14.0428	48.1466	6.4042	4.5650
1. Energy industries	2494.5441	0.0518	0.0057						3.9870	1.7266	0.1161	0.3443
2. Manufacturing industries and construction	634.7036	0.0134	0.0015						1.2181	0.4873	0.2692	0.1704
3. Transport	1742.1498	0.4060	0.1198						4.2102	19.7807	2.4731	0.0436
4. Other sectors	2203.6648	1.7981	0.0881						4.2950	25.7482	3.4823	3.8856
5. Other	39.0397	0.0029	0.0013						0.3325	0.4037	0.0635	0.1212
B. Fugitive emissions from fuels	1.2260	27.3303	0.0000						NO	NO	0.6592	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.2260	27.3303	0.0000						NO	NO	0.6592	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**643.8927**	**NO**	**0.0001**	**33.2493**	**0.0231**	**NO**	**0.0000**	**NO**	**1.8134**	**3.1294**	**38.8065**	**0.7492**
A. Mineral industry	533.8283								1.6951	1.3597	0.0164	0.7025
B. Chemical industry	NO	NO	NO						NO	NO	0.0130	NO
C. Metal industry	27.0182	NO	NO	NO	NO	NO	NO	NO	0.0879	1.1492	0.0355	0.0406
D. Non-energy products from fuels and solvent use	81.9807	NO	NO						0.0124	0.0697	33.2258	0.0062
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				33.2493	NO	NO	NO	NO				
G. Other product manufacture and use	1.0655	NO	0.0001	NO	0.0231	NO	0.0000	NO	0.0180	0.5508	0.4843	NO
H. Other									NO	NO	5.0313	NO
3. Agriculture	**0.1460**	**39.2652**	**4.0273**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		35.7523										
B. Manure management		3.5129	1.6257								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.4016									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	

F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.1460											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1801.8890**	**0.0100**	**0.9483**						**0.0075**	**0.2706**	**NO, NE**	
A. Forest land	-2366.5168	0.0063	0.0003						0.0040	0.1427	NO, NE	
B. Cropland	1577.6205	0.0038	0.0001						0.0035	0.1279	NO	
C. Grassland	-1056.3692	NE	NE						NE	NE	NE	
D. Wetlands	-159.2073	NE	NE						NE	NE	NE	
E. Settlements	53.6737	NO, NE	0.9479						NO, NE	NO, NE	NO, NE	
F. Other land	189.4964	NE	NE						NE	NE	NE	
G. Harvested wood products	-40.5864											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**14.1260**	**54.3169**	**0.2180**						**0.1408**	**2.4509**	**1.9042**	**0.0051**
A. Solid waste disposal	NA, NO	42.4737							NA, NO	NA, NO	1.8395	
B. Biological treatment of solid waste		0.0261	0.0016						NO, NE	0.0037	NO, NE	
C. Incineration and open burning of waste	14.1260	0.2888	0.0051						0.1408	2.4472	0.0543	0.0051
D. Wastewater treatment and discharge		11.5283	0.2114						NA, IE	NA, IE	0.0103	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**37.9241**	**0.0039**	**0.0013**						**0.1428**	**0.1424**	**0.0397**	**0.0120**
Aviation	37.9241	0.0039	0.0013						0.1428	0.1424	0.0397	0.0120
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	361.4360											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.8005**									
Indirect CO_2	**74.1622**											

2007

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**6165.0995**	**116.3761**	**4.6555**	**44.7889**	**0.0231**	**NO**	**0.0000**	**NO**	**17.0646**	**49.7006**	**47.5842**	**4.0356**
1. Energy	**7254.6164**	**30.8615**	**0.2092**						**14.5286**	**41.5390**	**6.4325**	**3.1267**
A. Fuel combustion Reference approach	7210.1856											
Sectoral approach	7253.3587	1.8076	0.2092						14.5286	41.5390	5.5816	3.1267
1. Energy industries	2894.4441	0.0593	0.0064						4.6191	2.0159	0.1351	0.2335
2. Manufacturing industries and construction	800.8383	0.0156	0.0017						1.8040	0.5048	0.3350	0.0992
3. Transport	1846.8209	0.4275	0.1253						4.3251	20.3245	2.5389	0.0462
4. Other sectors	1666.7458	1.3012	0.0741						3.3949	18.3862	2.5173	2.6494
5. Other	44.5097	0.0039	0.0017						0.3855	0.3075	0.0552	0.0983
B. Fugitive emissions from fuels	1.2577	29.0539	0.0000						NO	NO	0.8509	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.2577	29.0539	0.0000						NO	NO	0.8509	NO

C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**890.8914**	**NO**	**NO**	**44.7889**	**0.0231**	**NO**	**0.0000**	**NO**	**2.3583**	**4.3206**	**39.1521**	**0.9039**
A. Mineral industry	766.4702								2.1999	1.9983	0.0245	0.8394
B. Chemical industry	NO	NO	NO						NO	NO	0.0139	NO
C. Metal industry	38.6127	NO	NO	NO	NO	NO	NO	NO	0.1256	1.6426	0.0508	0.0580
D. Non-energy products from fuels and solvent use	84.7433	NO	NO						0.0130	0.0732	34.9915	0.0065
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				44.7889	NO	NO	NO	NO				
G. Other product manufacture and use	1.0652	NO	NO	NO	0.0231	NO	0.0000	NO	0.0198	0.6066	0.4842	NO
H. Other									NO	NO	3.5873	NO
3. Agriculture	**0.2631**	**31.3859**	**3.3103**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		28.8838										
B. Manure management		2.5021	1.2423								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.0680									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.2631											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1994.4386**	**0.0607**	**0.9330**						**0.0405**	**1.4511**	**NO, NE**	
A. Forest land	-2460.3855	0.0546	0.0030						0.0349	1.2432	NO, NE	
B. Cropland	1540.3986	0.0061	0.0002						0.0056	0.2079	NO	
C. Grassland	-1031.2350	NE	NE						NE	NE	NE	
D. Wetlands	-131.0044	NE	NE						NE	NE	NE	
E. Settlements	49.2742	NO, NE	0.9298						NO, NE	NO, NE	NO, NE	
F. Other land	83.1072	NE	NE						NE	NE	NE	
G. Harvested wood products	-44.5936											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**13.7672**	**54.0681**	**0.2031**						**0.1372**	**2.3898**	**1.9996**	**0.0050**
A. Solid waste disposal	NA, NO	42.5929							NA, NO	NA, NO	1.9364	
B. Biological treatment of solid waste		0.0339	0.0020						NO, NE	0.0047	NO, NE	
C. Incineration and open burning of waste	13.7672	0.2814	0.0049						0.1372	2.3851	0.0529	0.0050
D. Wastewater treatment and discharge		11.1599	0.1961						NA, IE	NA, IE	0.0102	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**44.2052**	**0.0027**	**0.0015**						**0.1782**	**0.1296**	**0.0393**	**0.0140**
Aviation	44.2052	0.0027	0.0015						0.1782	0.1296	0.0393	0.0140
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	304.6560											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.6624**									
Indirect CO_2	**78.0464**											

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**6853.1332**	**115.7752**	**4.9716**	**57.3627**	**0.0288**	**NO**	**0.0000**	**NO**	**24.4671**	**51.5065**	**41.0900**	**5.6582**
1. Energy	**7554.7011**	**30.7785**	**0.2128**						**21.7647**	**43.8150**	**6.9585**	**4.7111**
A. Fuel combustion Reference approach	7510.2532											
Sectoral approach	7553.4263	1.8799	0.2128						21.7647	43.8150	5.8303	4.7111
1. Energy industries	2997.3662	0.0655	0.0072						4.7979	2.0911	0.1406	0.3428
2. Manufacturing industries and construction	885.0132	0.0337	0.0045						8.9704	2.2677	0.4690	1.8481
3. Transport	1950.0498	0.4512	0.1272						4.3022	20.8778	2.5997	0.0485
4. Other sectors	1677.3708	1.3260	0.0723						3.3719	18.2724	2.5708	2.3550
5. Other	43.6263	0.0036	0.0015						0.3223	0.3060	0.0503	0.1167
B. Fugitive emissions from fuels	1.2748	28.8986	0.0000						NO	NO	1.1281	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.2748	28.8986	0.0000						NO	NO	1.1281	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**966.3539**	**NO**	**NO**	**57.3627**	**0.0288**	**NO**	**0.0000**	**NO**	**2.5411**	**4.3540**	**32.0314**	**0.9421**
A. Mineral industry	863.1338								2.4014	2.2832	0.0277	0.8853
B. Chemical industry	NO	NO	NO						NO	NO	0.0122	NO
C. Metal industry	35.4118	NO	NO	NO	NO	NO	NO	NO	0.1152	1.5064	0.0465	0.0532
D. Non-energy products from fuels and solvent use	66.7047	NO	NO						0.0075	0.0427	26.5891	0.0037
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				57.3627	NO	NO	NO	NO				
G. Other product manufacture and use	1.1036	NO	NO	NO	0.0288	NO	0.0000	NO	0.0170	0.5217	0.5016	NO
H. Other									NO	NO	4.8542	NO
3. Agriculture	**0.8505**	**30.0651**	**3.6588**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		27.5714										
B. Manure management		2.4937	1.2244								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.4344									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.8505											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1682.2257**	**0.0308**	**0.9128**						**0.0274**	**1.0067**	**NO, NE**	
A. Forest land	-2462.7874	0.0038	0.0002						0.0024	0.0864	NO, NE	
B. Cropland	1510.8422	0.0270	0.0007						0.0250	0.9203	NO	
C. Grassland	-932.1498	NE	NE						NE	NE	NE	
D. Wetlands	-102.8015	NE	NE						NE	NE	NE	
E. Settlements	49.2742	NO, NE	0.9119						NO, NE	NO, NE	NO, NE	
F. Other land	291.0044	NE	NE						NE	NE	NE	
G. Harvested wood products	-35.6078											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**13.4533**	**54.9007**	**0.1871**						**0.1339**	**2.3308**	**2.1002**	**0.0049**
A. Solid waste disposal	NA, NO	43.3679							NA, NO	NA, NO	2.0383	

B. Biological treatment of solid waste		0.0401	0.0024						NO, NE	0.0056	NO, NE	
C. Incineration and open burning of waste	13.4533	0.2748	0.0048						0.1339	2.3252	0.0517	0.0049
D. Wastewater treatment and discharge		11.2179	0.1799						NA, IE	NA, IE	0.0102	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**44.1680**	**0.0016**	**0.0014**						**0.1855**	**0.1080**	**0.0365**	**0.0140**
Aviation	44.1680	0.0016	0.0014						0.1855	0.1080	0.0365	0.0140
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	352.4520											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.7322**									
Indirect CO_2	**59.5995**											

2009

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**7284.4315**	**112.6729**	**4.9657**	**67.4807**	**0.0288**	**NO**	**0.0000**	**NO**	**15.5979**	**49.0749**	**35.6733**	**5.1965**
1. Energy	**8095.5552**	**25.9141**	**0.1933**						**14.1829**	**44.1050**	**6.8238**	**4.6784**
A. Fuel combustion Reference approach	8051.1089											
Sectoral approach	8094.2820	1.9968	0.1933						14.1829	44.1050	5.7115	4.6784
1. Energy industries	3844.8870	0.0835	0.0093						6.1595	2.6604	0.1794	0.6695
2. Manufacturing industries and construction	494.2397	0.0215	0.0029						0.7591	1.5897	0.2773	1.3676
3. Transport	1919.7221	0.4576	0.1112						3.6631	20.7880	2.5446	0.0046
4. Other sectors	1824.9424	1.4331	0.0696						3.4994	18.9129	2.6852	2.6186
5. Other	10.4909	0.0011	0.0003						0.1018	0.1540	0.0251	0.0182
B. Fugitive emissions from fuels	1.2732	23.9173	0.0000						NO	NO	1.1123	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.2732	23.9173	0.0000						NO	NO	1.1123	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**461.4652**	**NO**	**NO**	**67.4807**	**0.0288**	**NO**	**0.0000**	**NO**	**1.2752**	**2.3712**	**26.6433**	**0.5133**
A. Mineral industry	386.0179								1.1937	0.9874	0.0123	0.4849
B. Chemical industry	NO	NO	NO						NO	NO	0.0100	NO
C. Metal industry	17.0619	NO	NO	NO	NO	NO	NO	NO	0.0555	0.7255	0.0227	0.0256
D. Non-energy products from fuels and solvent use	57.5805	NO	NO						0.0056	0.0316	22.9783	0.0028
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				67.4807	NO	NO	NO	NO				
G. Other product manufacture and use	0.8048	NO	NO	NO	0.0288	NO	0.0000	NO	0.0205	0.6267	0.3658	NO
H. Other									NO	NO	3.2541	NO
3. Agriculture	**0.5864**	**31.3551**	**3.6911**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		28.5438										
B. Manure management		2.8113	1.3794								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.3117									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	

F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	0.5864											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1286.3366**	**0.0126**	**0.8904**						**0.0090**	**0.3239**	**NO, NE**	
A. Forest land	-2526.0659	0.0093	0.0005						0.0059	0.2108	NO, NE	
B. Cropland	1664.9870	0.0033	0.0001						0.0031	0.1130	NO	
C. Grassland	-447.6932	NE	NE						NE	NE	NE	
D. Wetlands	-74.5986	NE	NE						NE	NE	NE	
E. Settlements	45.5694	NO, NE	0.8898						NO, NE	NO, NE	NO, NE	
F. Other land	79.9357	NE	NE						NE	NE	NE	
G. Harvested wood products	-28.4708											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**13.1613**	**55.3911**	**0.1909**						**0.1308**	**2.2748**	**2.2062**	**0.0048**
A. Solid waste disposal	NA, NO	44.6020							NA, NO	NA, NO	2.1456	
B. Biological treatment of solid waste		0.0446	0.0027						NO, NE	0.0062	NO, NE	
C. Incineration and open burning of waste	13.1613	0.2686	0.0047						0.1308	2.2685	0.0505	0.0048
D. Wastewater treatment and discharge		10.4759	0.1835						NA, IE	NA, IE	0.0102	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**44.1719**	**0.0017**	**0.0014**						**0.1878**	**0.1094**	**0.0380**	**0.0140**
Aviation	44.1719	0.0017	0.0014						0.1878	0.1094	0.0380	0.0140
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	362.1000											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.7381**									
Indirect CO_2	**51.3571**											

2010

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**7915.8467**	**113.1687**	**5.2199**	**77.8936**	**0.0403**	**NO**	**0.0000**	**NO**	**16.6205**	**50.0018**	**40.1884**	**4.5204**
1. Energy	**8632.1613**	**25.3328**	**0.2091**						**15.1357**	**45.4312**	**6.6774**	**3.9590**
A. Fuel combustion Reference approach	8590.7973											
Sectoral approach	8630.8866	2.1399	0.2091						15.1357	45.4312	5.8205	3.9590
1. Energy industries	4054.4452	0.0894	0.0099						6.4930	2.8209	0.1900	0.5660
2. Manufacturing industries and construction	422.5661	0.0120	0.0015						0.9779	0.5900	0.1993	0.3732
3. Transport	2140.5856	0.4708	0.1225						3.7759	19.9436	2.4515	0.0052
4. Other sectors	1985.9921	1.5654	0.0746						3.7644	21.8247	2.9363	2.9155
5. Other	27.2976	0.0023	0.0006						0.1245	0.2519	0.0434	0.0991
B. Fugitive emissions from fuels	1.2747	23.1928	0.0000						NO	NO	0.8568	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.2747	23.1928	0.0000						NO	NO	0.8568	NO

C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**481.3565**	**NO**	**NO**	**77.8936**	**0.0403**	**NO**	**0.0000**	**NO**	**1.3529**	**2.2003**	**31.1949**	**0.5567**
A. Mineral industry	404.3936								1.2908	1.0242	0.0127	0.5387
B. Chemical industry	NO	NO	NO						NO	NO	0.0143	NO
C. Metal industry	9.6985	NO	NO	NO	NO	NO	NO	NO	0.0315	0.4121	0.0128	0.0145
D. Non-energy products from fuels and solvent use	66.2398	NO	NO						0.0069	0.0392	26.4907	0.0034
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				77.8936	NO	NO	NO	NO				
G. Other product manufacture and use	1.0245	NO	NO	NO	0.0403	NO	0.0000	NO	0.0237	0.7247	0.4657	NO
H. Other									NO	NO	4.1987	NO
3. Agriculture	**1.7443**	**31.4025**	**3.9595**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		28.3270										
B. Manure management		3.0755	1.4304								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.5291									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	1.7443											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1212.2817**	**0.0056**	**0.8665**						**0.0042**	**0.1529**	**NO, NE**	
A. Forest land	-2484.1627	0.0032	0.0002						0.0021	0.0737	NO, NE	
B. Cropland	1546.0139	0.0023	0.0001						0.0022	0.0792	NO	
C. Grassland	-691.9874	NE	NE						NE	NE	NE	
D. Wetlands	-46.3958	NE	NE						NE	NE	NE	
E. Settlements	45.5694	NO, NE	0.8663						NO, NE	NO, NE	NO, NE	
F. Other land	441.4824	NE	NE						NE	NE	NE	
G. Harvested wood products	-22.8014											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**12.8663**	**56.4278**	**0.1848**						**0.1277**	**2.2175**	**2.3162**	**0.0048**
A. Solid waste disposal	NA, NO	45.5140							NA, NO	NA, NO	2.2567	
B. Biological treatment of solid waste		0.0430	0.0026						NO, NE	0.0060	NO, NE	
C. Incineration and open burning of waste	12.8663	0.2624	0.0046						0.1277	2.2115	0.0492	0.0048
D. Wastewater treatment and discharge		10.6084	0.1776						NA, IE	NA, IE	0.0102	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**41.0593**	**0.0026**	**0.0014**						**0.1667**	**0.1218**	**0.0377**	**0.0130**
Aviation	41.0593	0.0026	0.0014						0.1667	0.1218	0.0377	0.0130
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	341.0480											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.7957**									
Indirect CO_2	**59.3041**											

2011

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**8374.8996**	**115.1082**	**5.1008**	**90.1296**	**0.0403**	**NO**	**0.0000**	**NO**	**17.0499**	**53.8352**	**43.3979**	**5.5519**
1. Energy	**8932.6787**	**28.6871**	**0.2165**						**15.2503**	**48.9451**	**7.3977**	**4.8498**
A. Fuel combustion Reference approach	8891.2753											
Sectoral approach	8931.3646	2.2709	0.2164						15.2503	48.9451	6.4011	4.8498
1. Energy industries	3752.5675	0.0801	0.0087						5.9997	2.6109	0.1755	0.4345
2. Manufacturing industries and construction	575.5238	0.0263	0.0036						1.1461	1.8629	0.3338	1.5813
3. Transport	2272.7076	0.4687	0.1281						3.8091	20.7693	2.5479	0.0056
4. Other sectors	2310.7777	1.6944	0.0756						4.1423	23.3551	3.2990	2.7405
5. Other	19.7881	0.0013	0.0004						0.1531	0.3469	0.0449	0.0879
B. Fugitive emissions from fuels	1.3141	26.4162	0.0000						NO	NO	0.9966	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.3141	26.4162	0.0000						NO	NO	0.9966	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**574.0527**	**NO**	**NO**	**90.1296**	**0.0403**	**NO**	**0.0000**	**NO**	**1.6703**	**2.5605**	**33.5228**	**0.6974**
A. Mineral industry	488.6436								1.5970	1.2450	0.0156	0.6742
B. Chemical industry	NO	NO	NO						NO	NO	0.0157	NO
C. Metal industry	12.8556	NO	NO	NO	NO	NO	NO	NO	0.0418	0.5465	0.0169	0.0193
D. Non-energy products from fuels and solvent use	71.3244	NO	NO						0.0078	0.0443	28.6400	0.0039
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				90.1296	NO	NO	NO	NO				
G. Other product manufacture and use	1.2291	NO	NO	NO	0.0403	NO	0.0000	NO	0.0237	0.7248	0.5587	NO
H. Other									NO	NO	4.2760	NO
3. Agriculture	**3.6752**	**29.5815**	**3.8532**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		26.6765										
B. Manure management		2.9050	1.3045								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.5488									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	3.6752											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1148.0863**	**0.0064**	**0.8455**						**0.0047**	**0.1694**	**NO, NE**	
A. Forest land	-2390.5712	0.0043	0.0002						0.0028	0.0987	NO, NE	
B. Cropland	1504.5789	0.0021	0.0001						0.0019	0.0707	NO	
C. Grassland	-638.1726	NE	NE						NE	NE	NE	
D. Wetlands	-75.3129	NE	NE						NE	NE	NE	
E. Settlements	62.0438	NO, NE	0.8452						NO, NE	NO, NE	NO, NE	
F. Other land	393.7285	NE	NE						NE	NE	NE	
G. Harvested wood products	-4.3808											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**12.5793**	**56.8332**	**0.1856**						**0.1246**	**2.1602**	**2.4774**	**0.0047**

A. Solid waste disposal	NA, NO	46.2032							NA, NO	NA, NO	2.4191	
B. Biological treatment of solid waste		0.0437	0.0026						NO, NE	0.0061	NO, NE	
C. Incineration and open burning of waste	12.5793	0.2562	0.0045						0.1246	2.1541	0.0480	0.0047
D. Wastewater treatment and discharge		10.3301	0.1785						NA, IE	NA, IE	0.0102	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	41.0082	0.0028	0.0013						0.1611	0.1246	0.0496	0.0130
Aviation	41.0082	0.0028	0.0013						0.1611	0.1246	0.0496	0.0130
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	384.6400											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.7777**									
Indirect CO_2	**64.2370**											

2012

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**7954.8556**	**112.7200**	**4.8135**	**100.0227**	**0.0403**	**NO**	**0.0000**	**NO**	**16.4625**	**52.1427**	**44.8018**	**4.6501**
1. Energy	**8516.3274**	**28.4550**	**0.2003**						**14.7349**	**46.5729**	**7.0769**	**4.0166**
A. Fuel combustion Reference approach	8468.7601											
Sectoral approach	8515.0170	2.4185	0.2003						14.7349	46.5729	6.1673	4.0166
1. Energy industries	3810.0873	0.0758	0.0086						6.0970	2.6166	0.1758	0.7051
2. Manufacturing industries and construction	433.9361	0.0111	0.0013						1.1466	0.4237	0.2029	0.1794
3. Transport	1992.5907	0.4049	0.1152						3.4048	17.0098	2.1022	0.0048
4. Other sectors	2271.4679	1.9260	0.0750						4.0329	26.3885	3.6707	3.1225
5. Other	6.9350	0.0006	0.0002						0.0536	0.1342	0.0157	0.0047
B. Fugitive emissions from fuels	1.3104	26.0365	0.0000						NO	NO	0.9095	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.3104	26.0365	0.0000						NO	NO	0.9095	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**582.0682**	**NO**	**NO**	**100.0227**	**0.0403**	**NO**	**0.0000**	**NO**	**1.5763**	**2.4006**	**35.1868**	**0.6289**
A. Mineral industry	493.5610								1.5088	1.2782	0.0159	0.6054
B. Chemical industry	NO	NO	NO						NO	NO	0.0150	NO
C. Metal industry	12.6973	NO	NO	NO	NO	NO	NO	NO	0.0413	0.5398	0.0171	0.0191
D. Non-energy products from fuels and solvent use	74.6523	NO	NO						0.0088	0.0500	30.6212	0.0044
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				100.0227	NO	NO	NO	NO				
G. Other product manufacture and use	1.1575	NO	NO	NO	0.0403	NO	0.0000	NO	0.0174	0.5326	0.5261	NO
H. Other									NO	NO	3.9915	NO
3. Agriculture	**5.5908**	**27.9761**	**3.6430**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		25.2109										
B. Manure management		2.7652	1.1973								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.4457									

E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	5.5908											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1161.4016**	**0.0467**	**0.7833**						**0.0299**	**1.0665**	**NO, NE**	
A. Forest land	-2294.8221	0.0464	0.0026						0.0296	1.0564	NO, NE	
B. Cropland	1508.7640	0.0003	0.0000						0.0003	0.0101	NO	
C. Grassland	-562.7510	NE	NE						NE	NE	NE	
D. Wetlands	-15.4700	NE	NE						NE	NE	NE	
E. Settlements	11.8882	NO, NE	0.7807						NO, NE	NO, NE	NO, NE	
F. Other land	114.1449	NE	NE						NE	NE	NE	
G. Harvested wood products	76.8444											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**12.2708**	**56.2422**	**0.1870**						**0.1214**	**2.1026**	**2.5381**	**0.0046**
A. Solid waste disposal	NA, NO	45.7446							NA, NO	NA, NO	2.4812	
B. Biological treatment of solid waste		0.0447	0.0027						NO, NE	0.0063	NO, NE	
C. Incineration and open burning of waste	12.2708	0.2498	0.0044						0.1214	2.0963	0.0468	0.0046
D. Wastewater treatment and discharge		10.2031	0.1799						NA, IE	NA, IE	0.0101	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**47.3142**	**0.0028**	**0.0015**						**0.1806**	**0.1322**	**0.0558**	**0.0150**
Aviation	47.3142	0.0028	0.0015						0.1806	0.1322	0.0558	0.0150
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	403.3840											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.7476**									
Indirect CO_2	**68.5241**											

2013

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**7856.1559**	**109.3707**	**5.1896**	**108.3873**	**0.0403**	**NO**	**0.0000**	**NO**	**15.9618**	**53.5496**	**43.9545**	**13.2050**
1. Energy	**8232.5336**	**27.2893**	**0.2194**						**14.0791**	**48.5108**	**7.1035**	**12.4901**
A. Fuel combustion Reference approach	8190.8002											
Sectoral approach	8230.8896	2.4910	0.2194						14.0791	48.5108	6.2507	12.4901
1. Energy industries	3603.6566	0.0679	0.0189						6.2373	2.0266	0.1399	7.1687
2. Manufacturing industries and construction	575.6355	0.0299	0.0042						0.8821	2.2984	0.3553	2.0310
3. Transport	2101.3096	0.4086	0.1153						3.1411	16.4003	2.0085	0.0049
4. Other sectors	1947.9381	1.9842	0.0809						3.7783	27.7557	3.7434	3.2852
5. Other	2.3497	0.0003	0.0001						0.0403	0.0297	0.0037	0.0003
B. Fugitive emissions from fuels	1.6441	24.7983	0.0000						NO	NO	0.8528	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO

2. Oil and natural gas and other emissions from energy production	1.6441	24.7983	0.0000						NO	NO	0.8528	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**623.2187**	**NO**	**NO**	**108.3873**	**0.0403**	**NO**	**0.0000**	**NO**	**1.7417**	**2.1714**	**34.2507**	**0.7105**
A. Mineral industry	544.9842								1.6947	1.3902	0.0172	0.6943
B. Chemical industry	NO	NO	NO						NO	NO	0.0159	NO
C. Metal industry	7.6569	NO	NO	NO	NO	NO	NO	NO	0.0249	0.3250	0.0100	0.0115
D. Non-energy products from fuels and solvent use	69.4810	NO	NO						0.0088	0.0501	28.2397	0.0044
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				108.3873	NO	NO	NO	NO				
G. Other product manufacture and use	1.0965	NO	NO	NO	0.0403	NO	0.0000	NO	0.0133	0.4062	0.4984	0.0003
H. Other									NO	NO	5.4694	NO
3. Agriculture	**4.1840**	**28.1106**	**4.0532**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		25.3945										
B. Manure management		2.7160	1.1202								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.9330									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	4.1840											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1015.6837**	**0.0349**	**0.7290**						**0.0230**	**0.8236**	**NO, NE**	
A. Forest land	-2141.8702	0.0322	0.0018						0.0206	0.7339	NO, NE	
B. Cropland	1413.3777	0.0026	0.0001						0.0024	0.0898	NO	
C. Grassland	-360.1740	NE	NE						NE	NE	NE	
D. Wetlands	-106.0998	NE	NE						NE	NE	NE	
E. Settlements	13.7512	NO, NE	0.7272						NO, NE	NO, NE	NO, NE	
F. Other land	103.4500	NE	NE						NE	NE	NE	
G. Harvested wood products	61.8814											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**11.9033**	**53.9360**	**0.1879**						**0.1179**	**2.0438**	**2.6003**	**0.0045**
A. Solid waste disposal	NA, NO	43.3907							NA, NO	NA, NO	2.5448	
B. Biological treatment of solid waste		0.0486	0.0029						NO, NE	0.0068	NO, NE	
C. Incineration and open burning of waste	11.9033	0.2424	0.0043						0.1179	2.0370	0.0454	0.0045
D. Wastewater treatment and discharge		10.2543	0.1807						NA, IE	NA, IE	0.0101	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**41.0717**	**0.0046**	**0.0013**						**0.1592**	**0.1584**	**0.0571**	**0.0130**
Aviation	41.0717	0.0046	0.0013						0.1592	0.1584	0.0571	0.0130
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	429.2796											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.8295**									
Indirect CO_2	**63.2239**											

2014

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**8109.0510**	**110.8624**	**5.7747**	**121.5640**	**0.0403**	**NO**	**0.0000**	**NO**	**15.4792**	**78.7269**	**56.3898**	**4.3062**
1. Energy	**8100.9817**	**28.3950**	**0.2423**						**13.6328**	**74.2343**	**11.1095**	**3.5942**
A. Fuel combustion Reference approach	8046.8852											
Sectoral approach	8099.3097	4.5821	0.2422						13.6328	74.2343	10.3588	3.5942
1. Energy industries	3562.1775	0.0752	0.0083						5.7085	2.4794	0.1666	0.4461
2. Manufacturing industries and construction	443.8148	0.0139	0.0018						0.6822	0.7672	0.2183	0.5408
3. Transport	2140.5749	0.4056	0.1070						2.6984	16.1489	1.9476	0.0049
4. Other sectors	1927.7357	4.0868	0.1247						4.4921	54.5828	8.0026	2.4012
5. Other	25.0067	0.0006	0.0005						0.0516	0.2560	0.0237	0.2011
B. Fugitive emissions from fuels	1.6721	23.8129	0.0000						NO	NO	0.7507	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.6721	23.8129	0.0000						NO	NO	0.7507	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**637.7956**	**NO**	**NO**	**121.5640**	**0.0403**	**NO**	**0.0000**	**NO**	**1.7285**	**2.3772**	**42.6162**	**0.7077**
A. Mineral industry	535.5064								1.6590	1.3602	0.0167	0.6799
B. Chemical industry	NO	NO	NO						NO	NO	0.0166	NO
C. Metal industry	13.8464	NO	NO	NO	NO	NO	NO	NO	0.0450	0.5882	0.0186	0.0208
D. Non-energy products from fuels and solvent use	87.2367	NO	NO						0.0128	0.0723	36.3007	0.0064
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				121.5640	NO	NO	NO	NO				
G. Other product manufacture and use	1.2062	NO	NO	NO	0.0403	NO	0.0000	NO	0.0117	0.3565	0.5483	0.0007
H. Other									NO	NO	5.7153	NO
3. Agriculture	**10.2058**	**28.9200**	**4.6670**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		26.1032										
B. Manure management		2.8169	1.2335								NO	
C. Rice cultivation		NO										
D. Agricultural soils			3.4335									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	10.2058											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-651.4692**	**0.0047**	**0.6794**						**0.0036**	**0.1293**	**NO, NE**	
A. Forest land	-2134.7390	0.0027	0.0001						0.0017	0.0603	NO, NE	
B. Cropland	1450.4798	0.0020	0.0001						0.0019	0.0690	NO	
C. Grassland	-341.1085	NE	NE						NE	NE	NE	
D. Wetlands	-139.7535	NE	NE						NE	NE	NE	
E. Settlements	18.9848	NO, NE	0.6792						NO, NE	NO, NE	NO, NE	
F. Other land	436.6463	NE	NE						NE	NE	NE	
G. Harvested wood products	58.0208											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**11.5371**	**53.5427**	**0.1860**						**0.1144**	**1.9861**	**2.6641**	**0.0043**

A. Solid waste disposal	NA, NO	43.3232							NA, NO	NA, NO	2.6100	
B. Biological treatment of solid waste		0.0508	0.0030						NO, NE	0.0071	NO, NE	
C. Incineration and open burning of waste	11.5371	0.2351	0.0041						0.1144	1.9790	0.0441	0.0043
D. Wastewater treatment and discharge		9.9335	0.1788						NA, IE	NA, IE	0.0100	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**53.6855**	**0.0034**	**0.0018**						**0.2110**	**0.1599**	**0.0553**	**0.0170**
Aviation	53.6855	0.0034	0.0018						0.2110	0.1599	0.0553	0.0170
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	1314.4896											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.9701**									
Indirect CO_2	**81.0677**											

2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**7952.0481**	**108.9340**	**4.9188**	**153.8517**	**0.0403**	**NO**	**0.0000**	**NO**	**16.1834**	**85.0427**	**54.3331**	**5.0062**
1. Energy	**8414.0596**	**27.5422**	**0.2680**						**14.3835**	**79.7012**	**11.9147**	**4.3217**
A. Fuel combustion Reference approach	8356.8931											
Sectoral approach	8412.4014	4.8782	0.2680						14.3835	79.7012	11.2253	4.3217
1. Energy industries	3686.3133	0.0659	0.0067						5.8546	2.5551	0.1705	0.1241
2. Manufacturing industries and construction	651.5441	0.0405	0.0055						0.8128	2.1701	0.4888	1.6259
3. Transport	2261.5959	0.4285	0.1197						3.1090	16.5574	2.0183	0.0051
4. Other sectors	1790.2120	4.3428	0.1357						4.5595	58.1877	8.5261	2.3805
5. Other	22.7360	0.0005	0.0004						0.0475	0.2309	0.0216	0.1861
B. Fugitive emissions from fuels	1.6581	22.6641	0.0000						NO	NO	0.6894	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.6581	22.6641	0.0000						NO	NO	0.6894	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**607.8444**	**NO**	**NO**	**153.8517**	**0.0403**	**NO**	**0.0000**	**NO**	**1.6501**	**2.4169**	**39.6803**	**0.6796**
A. Mineral industry	505.0564								1.5734	1.2767	0.0160	0.6490
B. Chemical industry	NO	NO	NO						NO	NO	0.0119	NO
C. Metal industry	17.2792	NO	NO	NO	NO	NO	NO	NO	0.0561	0.7340	0.0221	0.0259
D. Non-energy products from fuels and solvent use	84.5691	NO	NO						0.0089	0.0501	34.9703	0.0044
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				153.8517	NO	NO	NO	NO				
G. Other product manufacture and use	0.9397	NO	NO	NO	0.0403	NO	0.0000	NO	0.0116	0.3561	0.4271	0.0003
H. Other									NO	NO	4.2329	NO
3. Agriculture	**11.2402**	**27.9227**	**3.8226**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		25.1684										
B. Manure management		2.7544	1.1952								NO	
C. Rice cultivation		NO										
D. Agricultural soils			2.6274									

E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	11.2402											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-1094.4097**	**0.0261**	**0.6385**						**0.0171**	**0.6122**	**NO, NE**	
A. Forest land	-2159.4439	0.0246	0.0014						0.0157	0.5596	NO, NE	
B. Cropland	1391.0666	0.0015	0.0000						0.0014	0.0526	NO	
C. Grassland	-418.4569	NE	NE						NE	NE	NE	
D. Wetlands	-82.7917	NE	NE						NE	NE	NE	
E. Settlements	39.1617	NO, NE	0.6371						NO, NE	NO, NE	NO, NE	
F. Other land	86.8192	NE	NE						NE	NE	NE	
G. Harvested wood products	49.2353											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**13.3135**	**53.4429**	**0.1897**						**0.1326**	**2.3124**	**2.7381**	**0.0049**
A. Solid waste disposal	NA, NO	43.4869							NA, NO	NA, NO	2.6769	
B. Biological treatment of solid waste		0.0508	0.0030						NO, NE	0.0071	NO, NE	
C. Incineration and open burning of waste	13.3135	0.2721	0.0048						0.1326	2.3053	0.0512	0.0049
D. Wastewater treatment and discharge		9.6331	0.1819						NA, IE	NA, IE	0.0100	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**56.8077**	**0.0056**	**0.0018**						**0.2255**	**0.1841**	**0.0817**	**0.0180**
Aviation	56.8077	0.0056	0.0018						0.2255	0.1841	0.0817	0.0180
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	1428.4386											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.7845**									
Indirect CO_2	**77.8743**											

2016

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**8278.4511**	**111.9492**	**5.3839**	**163.2067**	**0.0403**	**NO**	**0.0000**	**NO**	**16.4130**	**87.8319**	**55.5414**	**4.2279**
1. Energy	**8506.6885**	**29.7033**	**0.2875**						**14.6974**	**83.3929**	**12.6250**	**3.5714**
A. Fuel combustion Reference approach	8406.3366											
Sectoral approach	8505.0181	5.2597	0.2875						14.6974	83.3929	11.9423	3.5714
1. Energy industries	3644.9312	0.0657	0.0069						5.7964	2.5196	0.1682	0.2330
2. Manufacturing industries and construction	641.3590	0.0345	0.0047						0.7558	1.6752	0.4441	1.1555
3. Transport	2428.3819	0.4966	0.1370						3.5658	16.9243	2.0880	0.0054
4. Other sectors	1767.4874	4.6624	0.1384						4.5317	62.0479	9.2199	1.9853
5. Other	22.8586	0.0005	0.0004						0.0476	0.2260	0.0221	0.1923
B. Fugitive emissions from fuels	1.6704	24.4436	0.0000						NO	NO	0.6827	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.6704	24.4436	0.0000						NO	NO	0.6827	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**583.6350**	**NO**	**NO**	**163.2067**	**0.0403**	**NO**	**0.0000**	**NO**	**1.5759**	**1.8206**	**40.1158**	**0.6517**
A. Mineral industry	492.5454								1.5410	1.2375	0.0156	0.6398
B. Chemical industry	NO	NO	NO						NO	NO	0.0131	NO
C. Metal industry	5.2203	NO	NO	NO	NO	NO	NO	NO	0.0169	0.2204	0.0075	0.0078
D. Non-energy products from fuels and solvent use	84.8044	NO	NO						0.0076	0.0429	34.9327	0.0038
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				163.2067	NO	NO	NO	NO				
G. Other product manufacture and use	1.0649	NO	NO	NO	0.0403	NO	0.0000	NO	0.0105	0.3198	0.4841	0.0003
H. Other									NO	NO	4.6628	NO
3. Agriculture	**12.2747**	**27.7164**	**4.3031**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		24.8801										
B. Manure management		2.8363	1.2328								NO	
C. Rice cultivation		NO										
D. Agricultural soils			3.0703									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	12.2747											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-837.1816**	**0.0143**	**0.6016**						**0.0097**	**0.3467**	**NO, NE**	
A. Forest land	-2115.7622	0.0123	0.0007						0.0079	0.2809	NO, NE	
B. Cropland	1391.9179	0.0019	0.0001						0.0018	0.0658	NO	
C. Grassland	-402.3693	NE	NE						NE	NE	NE	
D. Wetlands	-82.7917	NE	NE						NE	NE	NE	
E. Settlements	19.3071	NO, NE	0.6008						NO, NE	NO, NE	NO, NE	
F. Other land	351.6349	NE	NE						NE	NE	NE	
G. Harvested wood products	0.8816											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**13.0346**	**54.5152**	**0.1918**						**0.1301**	**2.2716**	**2.8005**	**0.0047**
A. Solid waste disposal	NA, NO	44.6069							NA, NO	NA, NO	2.7403	
B. Biological treatment of solid waste		0.0505	0.0030						NO, NE	0.0071	NO, NE	
C. Incineration and open burning of waste	13.0346	0.2667	0.0047						0.1301	2.2645	0.0502	0.0047
D. Wastewater treatment and discharge		9.5911	0.1841						NA, IE	NA, IE	0.0100	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**100.9698**	**0.0062**	**0.0033**						0.4139	0.2665	0.1113	0.0320
Aviation	100.9698	0.0062	0.0033						0.4139	0.2665	0.1113	0.0320
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	1600.9890											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.8863**									
Indirect CO_2	**77.9170**											

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**7726.7513**	**117.0372**	**5.6857**	**182.4923**	**0.0403**	**NO**	**0.0000**	**NO**	**16.3676**	**110.7356**	**65.0590**	**5.0951**
1. Energy	**7978.8973**	**32.8547**	**0.3331**						**14.6688**	**105.3838**	**15.8287**	**4.4594**
A. Fuel combustion Reference approach	7832.3013											
Sectoral approach	7977.2397	6.9497	0.3331						14.6688	105.3838	15.1571	4.4594
1. Energy industries	2883.9360	0.0523	0.0053						4.5840	2.0066	0.1339	0.0467
2. Manufacturing industries and construction	658.7329	0.0361	0.0051						0.9406	1.7853	0.4514	1.2695
3. Transport	2451.2514	0.4838	0.1350						3.3935	16.3018	2.0056	0.0054
4. Other sectors	1960.6971	6.3772	0.1874						5.7093	85.0674	12.5450	2.9370
5. Other	22.6223	0.0002	0.0004						0.0414	0.2226	0.0212	0.2009
B. Fugitive emissions from fuels	1.6576	25.9050	0.0000						NO	NO	0.6716	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.6576	25.9050	0.0000						NO	NO	0.6716	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**593.1469**	**NO**	**NO**	**182.4923**	**0.0403**	**NO**	**0.0000**	**NO**	**1.5388**	**2.2988**	**46.2368**	**0.6304**
A. Mineral industry	476.0597								1.4599	1.2025	0.0146	0.5970
B. Chemical industry	NO	NO	NO						NO	NO	0.0123	NO
C. Metal industry	18.8842	NO	NO	NO	NO	NO	NO	NO	0.0613	0.8019	0.0249	0.0283
D. Non-energy products from fuels and solvent use	97.0273	NO	NO						0.0097	0.0547	40.4418	0.0048
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				182.4923	NO	NO	NO	NO				
G. Other product manufacture and use	1.1757	NO	NO	NO	0.0403	NO	0.0000	NO	0.0078	0.2396	0.5344	0.0003
H. Other									NO	NO	5.2088	NO
3. Agriculture	**26.2081**	**25.9044**	**4.5774**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		23.1182										
B. Manure management		2.7862	1.1730								NO	
C. Rice cultivation		NO										
D. Agricultural soils			3.4045									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	26.2081											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-886.1457**	**0.0199**	**0.5767**						**0.0136**	**0.4867**	**NO, NE**	
A. Forest land	-2016.4373	0.0170	0.0009						0.0109	0.3878	NO, NE	
B. Cropland	1369.0793	0.0029	0.0001						0.0027	0.0990	NO	
C. Grassland	-384.0392	NE	NE						NE	NE	NE	
D. Wetlands	-82.8162	NE	NE						NE	NE	NE	
E. Settlements	77.3098	NO, NE	0.5757						NO, NE	NO, NE	NO, NE	
F. Other land	218.2055	NE	NE						NE	NE	NE	
G. Harvested wood products	-67.4476											
H. Other	NE											
5. Waste	**14.6448**	**58.2582**	**0.1985**						**0.1465**	**2.5663**	**2.9935**	**0.0052**
A. Solid waste disposal	NA, NO	48.4691							NA, NO	NA, NO	2.9269	
B. Biological treatment of solid waste		0.0578	0.0035						NO, NE	0.0081	NO, NE	
C. Incineration and open burning of waste	14.6448	0.3001	0.0053						0.1465	2.5582	0.0566	0.0052

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
D. Wastewater treatment and discharge		9.4312	0.1897						NA, IE	NA, IE	0.0100	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**148.2788**	**0.0058**	**0.0048**						**0.5821**	**0.3478**	**0.1423**	**0.0470**
Aviation	148.2788	0.0058	0.0048						0.5821	0.3478	0.1423	0.0470
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	2122.7228											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.9477**									
Indirect CO_2	**90.1477**											

2018

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**8522.2288**	**117.0395**	**5.7168**	**194.4750**	**0.0403**	**NO**	**0.0001**	**NO**	**18.0570**	**159.6446**	**96.4462**	**4.5109**
1. Energy	**8426.8382**	**34.7321**	**0.3830**						**15.9767**	**154.4533**	**23.3603**	**3.7006**
A. Fuel combustion Reference approach	8258.6476											
Sectoral approach	8425.1725	10.6318	0.3830						15.9767	154.4533	22.7246	3.7006
1. Energy industries	3177.3538	0.0579	0.0059						5.0572	2.2137	0.1477	0.0567
2. Manufacturing industries and construction	748.6264	0.0412	0.0058						1.2726	1.7293	0.5219	1.0791
3. Transport	2529.5979	0.5024	0.1334						3.2503	17.1884	2.0927	0.0056
4. Other sectors	1946.2502	10.0301	0.2376						6.3540	133.0922	19.9404	2.3520
5. Other	23.3443	0.0002	0.0004						0.0427	0.2297	0.0219	0.2073
B. Fugitive emissions from fuels	1.6657	24.1003	0.0000						NO	NO	0.6357	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.6657	24.1003	0.0000						NO	NO	0.6357	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**763.3854**	**NO**	**NO**	**194.4750**	**0.0403**	**NO**	**0.0001**	**NO**	**1.9325**	**2.5146**	**70.1179**	**0.8052**
A. Mineral industry	590.9800								1.8391	1.4895	0.0185	0.7607
B. Chemical industry	NO	NO	NO						NO	NO	0.0155	NO
C. Metal industry	20.2133	NO	NO	NO	NO	NO	NO	NO	0.0657	0.8586	0.0267	0.0303
D. Non-energy products from fuels and solvent use	151.1808	NO	NO						0.0273	0.1534	64.9072	0.0136
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				194.4750	NO	NO	NO	NO				
G. Other product manufacture and use	1.0114	NO	NO	NO	0.0403	NO	0.0001	NO	0.0004	0.0132	0.4597	0.0007
H. Other									NO	NO	4.6903	NO
3. Agriculture	**43.3624**	**23.4494**	**4.5750**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		20.6560										
B. Manure management		2.7933	1.0372								NO	
C. Rice cultivation		NO										
D. Agricultural soils			3.5378									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
G. Liming	NO											
H. Urea application	43.3624											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**-725.6453**	**0.0068**	**0.5550**						**0.0046**	**0.1654**	**NO, NE**	
A. Forest land	-1969.3582	0.0059	0.0003						0.0037	0.1334	NO, NE	
B. Cropland	1487.3577	0.0009	0.0000						0.0009	0.0321	NO	
C. Grassland	-440.1513	NE	NE						NE	NE	NE	
D. Wetlands	-82.8253	NE	NE						NE	NE	NE	
E. Settlements	21.6217	NO, NE	0.5546						NO, NE	NO, NE	NO, NE	
F. Other land	321.2138	NE	NE						NE	NE	NE	
G. Harvested wood products	-63.5037											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**14.2880**	**58.8512**	**0.2038**						**0.1432**	**2.5112**	**2.9680**	**0.0051**
A. Solid waste disposal	NA, NO	48.9422							NA, NO	NA, NO	2.9025	
B. Biological treatment of solid waste		0.0521	0.0031						NO, NE	0.0073	NO, NE	
C. Incineration and open burning of waste	14.2880	0.2931	0.0051						0.1432	2.5039	0.0553	0.0051
D. Wastewater treatment and discharge		9.5637	0.1955						NA, IE	NA, IE	0.0102	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**170.4060**	**0.0071**	**0.0058**						0.6507	0.5113	0.1537	0.0540
Aviation	170.4060	0.0071	0.0058						0.6507	0.5113	0.1537	0.0540
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	3567.9567											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.9592**									
Indirect CO_2	**143.8072**											

2019

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	**9526.1314**	**104.6462**	**5.8123**	**229.9469**	**0.0403**	**NO**	**0.0001**	**NO**	**18.3641**	**144.0928**	**90.3206**	**5.2391**
1. Energy	**8577.9507**	**25.1886**	**0.3826**						**16.3122**	**138.9236**	**20.6159**	**4.4574**
A. Fuel combustion Reference approach	8428.3196											
Sectoral approach	8576.3417	9.3549	0.3826						16.3122	138.9236	20.1359	4.4574
1. Energy industries	3120.4282	0.0561	0.0057						4.9637	2.1725	0.1449	0.0468
2. Manufacturing industries and construction	715.9769	0.0380	0.0052						1.2738	1.5227	0.4795	0.9228
3. Transport	2611.5823	0.4983	0.1390						3.4499	17.8412	2.1766	0.0058
4. Other sectors	2105.4914	8.7623	0.2323						6.5829	117.1622	17.3134	3.2791
5. Other	22.8629	0.0002	0.0004						0.0418	0.2250	0.0215	0.2030
B. Fugitive emissions from fuels	1.6090	15.8337	0.0000						NO	NO	0.4800	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	1.6090	15.8337	0.0000						NO	NO	0.4800	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions / removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	**760.7727**	**NO**	**NO**	**229.9469**	**0.0403**	**NO**	**0.0001**	**NO**	**1.9016**	**2.3347**	**66.6202**	**0.7768**
A. Mineral industry	600.3437								1.8306	1.5265	0.0188	0.7430
B. Chemical industry	NO	NO	NO						NO	NO	0.0168	NO
C. Metal industry	15.7926	NO	NO	NO	NO	NO	NO	NO	0.0513	0.6704	0.0209	0.0237
D. Non-energy products from fuels and solvent use	143.5292	NO	NO						0.0186	0.1047	61.3724	0.0093
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				229.9469	NO	NO	NO	NO				
G. Other product manufacture and use	1.1072	NO	NO	NO	0.0403	NO	0.0001	NO	0.0011	0.0331	0.5033	0.0008
H. Other									NO	NO	4.6880	NO
3. Agriculture	**39.6306**	**20.3296**	**4.6832**						**NO**	**NO**	**NE, NO**	
A. Enteric fermentation		17.6658										
B. Manure management		2.6637	0.9345								NO	
C. Rice cultivation		NO										
D. Agricultural soils			3.7488									
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		IE	IE						IE	IE	NO, NE	
G. Liming	NO											
H. Urea application	39.6306											
I. Other carbon-containing fertilizers	NO, NE											
J. Other	NO	NO	NO						NO	NO	NO	
4. Land use, land-use change and forestry	**133.8653**	**0.0157**	**0.5420**						**0.0105**	**0.3774**	**NO, NE**	
A. Forest land	-1950.6476	0.0141	0.0008						0.0090	0.3206	NO, NE	
B. Cropland	1789.8845	0.0017	0.0000						0.0015	0.0568	NO	
C. Grassland	-293.2923	NE	NE						NE	NE	NE	
D. Wetlands	-82.8099	NE	NE						NE	NE	NE	
E. Settlements	116.5030	NO, NE	0.5412						NO, NE	NO, NE	NO, NE	
F. Other land	611.7881	NE	NE						NE	NE	NE	
G. Harvested wood products	-57.5604											
H. Other	NE	NE	NE						NE	NE	NE	
5. Waste	**13.9120**	**59.1123**	**0.2044**						**0.1397**	**2.4571**	**3.0845**	**0.0049**
A. Solid waste disposal	NA, NO	49.2635							NA, NO	NA, NO	3.0203	
B. Biological treatment of solid waste		0.0559	0.0034						NO, NE	0.0078	NO, NE	
C. Incineration and open burning of waste	13.9120	0.2858	0.0050						0.1397	2.4493	0.0540	0.0049
D. Wastewater treatment and discharge		9.5071	0.1961						NA, IE	NA, IE	0.0102	
E. Other	NO	NO	NO						NO	NO	NO	
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items:												
International bunkers	**151.5015**	**0.0055**	**0.0051**						**0.6236**	**0.4162**	**0.1199**	**0.0480**
Aviation	151.5015	0.0055	0.0051						0.6236	0.4162	0.1199	0.0480
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
CO_2 emissions from biomass	2963.2154											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	NE											
Indirect N_2O			**0.9924**									
Indirect CO_2	**136.1265**											

Annex 6-7. Summary Reports for GHG Emissions in CO_2 equivalent in the Republic of Moldova within 1990-2019

1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**35,459.8920**	**5,244.0550**	**3,256.9490**	**NO**	**NO**	**NO**	**NO**	**NO**	**43,960.8959**
1. Energy	**35,401.5108**	**1,148.1386**	**345.6401**						**36,895.2895**
A. Fuel Combustion (Sectoral approach)	35,400.8731	335.8971	345.6399						36,082.4102
1. Energy Industries	21,300.2929	12.2813	51.6671						21,364.2413
2. Manufacturing Industries and Construction	1,916.8273	2.1639	4.3867						1,923.3779
3. Transport	4,697.5183	33.6681	106.7291						4,837.9155
4. Other Sectors	7,372.2624	287.5113	181.5317						7,841.3054
5. Other	113.9722	0.2726	1.3253						115.5701
B. Fugitive Emissions from Fuels	0.6377	812.2415	0.0002						812.8794
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.6377	812.2415	0.0002						812.8794
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**1,603.6767**	**NO**	**0.0197**	**NO**	**NO**	**NO**	**NO**	**NO**	**1,603.6964**
A. Mineral Industry	1,337.4142								1,337.4142
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	28.5023	NO	NO	NO	NO	NO	NO	NO	28.5023
D. Non-Energy Products From Fuels and Solvent Use	234.3591	NO	NO						234.3591
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				NO	NO	NO	NO	NO	NO
G. Other Product Manufacture and Use	3.4010	NO	0.0197	NO	NO	NO	NO	NO	3.4207
H. Other									
3. Agriculture	**0.5820**	**2,684.5230**	**2,650.3850**						**5,335.4900**
A. Enteric Fermentation		2,189.4276							2,189.4276
B. Manure Management		495.0955	1,116.6179						1,611.7134
C. Rice Cultivation		NO							NO
D. Agricultural Soils			1,533.7671						1,533.7671
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.5820								0.5820
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,560.8442**	**2.6533**	**170.3740**						**-1,387.8169**
A. Forest Land	-2,563.4328	0.2072	0.1366						-2,563.0889
B. Cropland	2,648.7307	2.4461	0.7559						2,651.9328
C. Grassland	-1,205.6938	NE	NE						-1,205.6938
D. Wetlands	-555.3798	NE	NE						-555.3798
E. Settlements	84.7480	NO, NE	169.4814						254.2294
F. Other Land	152.3638	NE	NE						152.3638
G. Harvested Wood Products	-122.1804								-122.1804
H. Other	NE	NE	NE						NE

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
5. Waste	**14.9667**	**1,408.7400**	**90.5302**						**1,514.2369**
A. Solid Waste Disposal	NA, NO	1,046.7277							1,046.7277
B. Biological Treatment of Solid Waste		1.3597	0.9725						2.3322
C. Incineration and Open Burning of Waste	14.9667	7.6876	1.6078						24.2621
D. Wastewater Treatment and Discharge		352.9650	87.9499						440.9149
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO

Memo Items									
International Bunkers	**193.4599**	**0.3828**	**1.8920**						**195.7347**
Aviation	193.4599	0.3828	1.8920						195.7347
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	232.8093								232.8093
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			605.7468						605.7468
Indirect CO_2	207.5471								207.5471
								Total (without LULUCF)	**45,348.7128**
								Total (with LULUCF)	**43,960.8959**

1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**28,724.9948**	**4,903.2718**	**3,044.1839**	NO	NO	NO	NO	NO	**36,672.4506**
1. Energy	**29,939.0721**	**1,007.6425**	**257.6276**						**31,204.3422**
A. Fuel Combustion (Sectoral approach)	29,938.4581	245.3280	257.6275						30,441.4136
1. Energy Industries	18,927.0336	10.5744	46.5622						18,984.1702
2. Manufacturing Industries and Construction	1,277.9476	1.3649	2.8505						1,282.1630
3. Transport	3,655.5565	25.8572	87.3527						3,768.7665
4. Other Sectors	5,971.5518	207.3507	119.8389						6,298.7414
5. Other	106.3685	0.1809	1.0231						107.5724
B. Fugitive Emissions from Fuels	0.6140	762.3145	0.0001						762.9286
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.6140	762.3145	0.0001						762.9286
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**1,409.7794**	**NO**	**0.0164**	**NO**	**NO**	**NO**	**NO**	**NO**	**1,409.7958**
A. Mineral Industry	1,188.6687								1,188.6687
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	24.7297	NO	NO	NO	NO	NO	NO	NO	24.7297
D. Non-Energy Products From Fuels and Solvent Use	193.3185	NO	NO						193.3185
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				NO	NO	NO	NO	NO	NO
G. Other Product Manufacture and Use	3.0625	NO	0.0164	NO	NO	NO	NO	NO	3.0789

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
H. Other									
3. Agriculture	**0.5226**	**2,443.9487**	**2,518.8921**						**4,963.3633**
A. Enteric Fermentation		2,028.8687							2,028.8687
B. Manure Management		415.0799	1,042.7426						1,457.8226
C. Rice Cultivation		NO							NO
D. Agricultural Soils			1,476.1495						1,476.1495
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.5226								0.5226
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-2,639.3787**	**2.3998**	**183.8820**						**-2,453.0969**
A. Forest Land	-2,343.3131	0.0347	0.0229						-2,343.2556
B. Cropland	1,517.2470	2.3651	0.7309						1,520.3430
C. Grassland	-1,414.3167	NE	NE						-1,414.3167
D. Wetlands	-526.4627	NE	NE						-526.4627
E. Settlements	88.7139	NO, NE	183.1282						271.8421
F. Other Land	152.3638	NE	NE						152.3638
G. Harvested Wood Products	-113.6108								-113.6108
H. Other	NE	NE	NE						NE
5. Waste	**14.9994**	**1,449.2809**	**83.7658**						**1,548.0461**
A. Solid Waste Disposal	NA, NO	1,098.6185							1,098.6185
B. Biological Treatment of Solid Waste		1.3779	0.9855						2.3633
C. Incineration and Open Burning of Waste	14.9994	7.7010	1.6109						24.3113
D. Wastewater Treatment and Discharge		341.5835	81.1694						422.7530
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**147.3846**	**0.2917**	**1.4414**						**149.1177**
Aviation	147.3846	0.2917	1.4414						149.1177
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	201.2009								201.2009
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			559.2225						559.2225
Indirect CO_2	170.8422								170.8422
								Total (without LULUCF)	**39,125.5475**
								Total (with LULUCF)	**36,672.4506**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**22,112.1127**	**4,674.1534**	**2,637.2882**	**NO**	**NO**	**NO**	**NO**	**NO**	**29,423.5542**
1. Energy	**23,328.3149**	**843.3472**	**179.8270**						**24,351.4890**
A. Fuel Combustion (Sectoral approach)	23,327.7974	153.2401	179.8269						23,660.8644
1. Energy Industries	15,660.9863	8.9470	36.3227						15,706.2560
2. Manufacturing Industries and Construction	926.7893	0.9986	2.0591						929.8471
3. Transport	2,614.8520	18.0694	66.5696						2,699.4911
4. Other Sectors	4,047.4223	125.1098	74.2043						4,246.7365
5. Other	77.7474	0.1152	0.6712						78.5337
B. Fugitive Emissions from Fuels	0.5175	690.1071	0.0001						690.6247
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.5175	690.1071	0.0001						690.6247
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**821.5621**	**NO**	**0.0149**	**NO**	**NO**	**NO**	**NO**	**NO**	**821.5770**
A. Mineral Industry	640.8940								640.8940
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	23.9922	NO	NO	NO	NO	NO	NO	NO	23.9922
D. Non-Energy Products From Fuels and Solvent Use	154.2628	NO	NO						154.2628
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				NO	NO	NO	NO	NO	NO
G. Other Product Manufacture and Use	2.4132	NO	0.0149	NO	NO	NO	NO	NO	2.4281
H. Other									
3. Agriculture	**0.3905**	**2,369.9032**	**2,175.7763**						**4,546.0699**
A. Enteric Fermentation		1,996.7865							1,996.7865
B. Manure Management		373.1167	935.4783						1,308.5949
C. Rice Cultivation		NO							NO
D. Agricultural Soils			1,240.2980						1,240.2980
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.3905								0.3905
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-2,053.2024**	**2.1973**	**204.6518**						**-1,846.3532**
A. Forest Land	-2,184.2404	0.0380	0.0250						-2,184.1774
B. Cropland	1,443.9675	2.1593	0.6673						1,446.7941
C. Grassland	-1,428.4835	NE	NE						-1,428.4835
D. Wetlands	-595.5455	NE	NE						-595.5455
E. Settlements	386.6196	NO, NE	203.9595						590.5790
F. Other Land	418.7786	NE	NE						418.7786
G. Harvested Wood Products	-94.2986								-94.2986
H. Other	NE	NE	NE						NE
5. Waste	**15.0476**	**1,458.7057**	**77.0182**						**1,550.7715**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
A. Solid Waste Disposal	NA, NE	1,141.9561							1,141.9561
B. Biological Treatment of Solid Waste		1.4375	1.0281						2.4656
C. Incineration and Open Burning of Waste	15.0476	7.7226	1.6157						24.3859
D. Wastewater Treatment and Discharge		307.5895	74.3744						381.9639
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**108.5369**	**0.2148**	**1.0615**						**109.8132**
Aviation	108.5369	0.2148	1.0615						109.8132
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	169.5924								169.5924
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			477.8129						477.8129
Indirect CO_2	140.9363								140.9363
								Total (without LULUCF)	**31,269.9075**
								Total (with LULUCF)	**29,423.5542**

1993

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**15,993.1166**	**4,358.9792**	**2,302.2454**	**NO**	**NO**	**NO**	**NO**	**NO**	**22,654.3413**
1. Energy	**17,335.5539**	**685.0530**	**149.0130**						**18,169.6200**
A. Fuel Combustion (Sectoral approach)	17,335.1157	64.9870	149.0129						17,549.1157
1. Energy Industries	12,640.6006	7.0580	31.5167						12,679.1754
2. Manufacturing Industries and Construction	612.1245	0.6702	1.3537						614.1484
3. Transport	1,855.0176	12.3308	53.8911						1,921.2395
4. Other Sectors	2,133.9212	44.7823	61.5223						2,240.2258
5. Other	93.4518	0.1456	0.7291						94.3265
B. Fugitive Emissions from Fuels	0.4382	620.0660	0.0000						620.5042
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.4382	620.0660	0.0000						620.5042
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**737.0521**	**NO**	**0.0179**	**NO**	**NO**	**NO**	**NO**	**NO**	**737.0699**
A. Mineral Industry	586.7703								586.7703
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	24.4250	NO	NO	NO	NO	NO	NO	NO	24.4250
D. Non-Energy Products From Fuels and Solvent Use	123.8759	NO	NO						123.8759
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				NO	NO	NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
G. Other Product Manufacture and Use	1.9809	NO	0.0179	NO	NO	NO	NO	NO	1.9988
H. Other									
3. Agriculture	**0.1276**	**2,147.8512**	**1,858.7494**						**4,006.7282**
A. Enteric Fermentation		1,872.9050							1,872.9050
B. Manure Management		274.9462	815.3185						1,090.2647
C. Rice Cultivation		NO							NO
D. Agricultural Soils			1,043.4308						1,043.4308
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.1276								0.1276
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-2,094.6617**	**2.9467**	**222.5703**						**-1,869.1447**
A. Forest Land	-2,193.5115	0.0026	0.0017						-2,193.5072
B. Cropland	1,713.0301	2.9441	0.9098						1,716.8841
C. Grassland	-1,303.5202	NE	NE						-1,303.5202
D. Wetlands	-525.8447	NE	NE						-525.8447
E. Settlements	114.6181	NO, NE	221.6588						336.2769
F. Other Land	164.0168	NE	NE						164.0168
G. Harvested Wood Products	-63.4504								-63.4504
H. Other	NE	NE	NE						NE
5. Waste	**15.0447**	**1,523.1283**	**71.8949**						**1,610.0679**
A. Solid Waste Disposal	NA, NO	1,204.7183							1,204.7183
B. Biological Treatment of Solid Waste		0.7194	0.5145						1.2339
C. Incineration and Open Burning of Waste	15.0447	7.7182	1.6150						24.3780
D. Wastewater Treatment and Discharge		309.9724	69.7653						379.7377
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**55.2342**	**0.1093**	**0.5402**						**55.8837**
Aviation	55.2342	0.1093	0.5402						55.8837
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	143.2360								143.2360
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			387.7227						387.7227
Indirect CO_2	112.2027								112.2027
								Total (without LULUCF)	**24,523.4860**
								Total (with LULUCF)	**22,654.3413**

1994

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**13,015.6690**	**4,271.3454**	**2,084.3702**	**NO**	**NO**	**NO**	**NO**	**NO**	**19,371.3847**
1. Energy	**14,485.6701**	**674.0615**	**134.8675**						**15,294.5990**
A. Fuel Combustion (Sectoral approach)	14,485.2616	77.2758	134.8675						14,697.4049
1. Energy Industries	9,961.8515	4.7207	25.9879						9,992.5601
2. Manufacturing Industries and Construction	731.5285	0.4451	0.3756						732.3493
3. Transport	1,612.7695	10.9325	32.6659						1,656.3679
4. Other Sectors	2,090.7472	61.0059	75.3551						2,227.1082
5. Other	88.3648	0.1716	0.4830						89.0194
B. Fugitive Emissions from Fuels	0.4085	596.7856	0.0000						597.1941
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.4085	596.7856	0.0000						597.1941
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**556.2338**	**NO**	**0.0149**	**NO**	**NO**	**NO**	**NO**	**NO**	**556.2487**
A. Mineral Industry	444.9885								444.9885
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	25.3289	NO	NO	NO	NO	NO	NO	NO	25.3289
D. Non-Energy Products From Fuels and Solvent Use	84.4738	NO	NO						84.4738
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				NO	NO	NO	NO	NO	NO
G. Other Product Manufacture and Use	1.4426	NO	0.0149	NO	NO	NO	NO	NO	1.4575
H. Other									
3. Agriculture	**0.0537**	**2,088.0629**	**1,643.1284**						**3,731.2450**
A. Enteric Fermentation		1,822.8316							1,822.8316
B. Manure Management		265.2313	792.2223						1,057.4535
C. Rice Cultivation		NO							NO
D. Agricultural Soils			850.9062						850.9062
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.0537								0.0537
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-2,041.3832**	**1.6555**	**236.5414**						**-1,803.1863**
A. Forest Land	-2,108.0022	0.0578	0.0381						-2,107.9063
B. Cropland	1,476.2941	1.5977	0.4937						1,478.3856
C. Grassland	-1,577.3332	NE	NE						-1,577.3332
D. Wetlands	-497.6418	NE	NE						-497.6418
E. Settlements	130.4883	NO, NE	236.0095						366.4978
F. Other Land	549.4579	NE	NE						549.4579
G. Harvested Wood Products	-14.6464								-14.6464
H. Other	NE	NE	NE						NE
5. Waste	**15.0947**	**1,507.5656**	**69.8180**						**1,592.4783**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
A. Solid Waste Disposal	NA, NO	1,209.8012							1,209.8012
B. Biological Treatment of Solid Waste		0.6705	0.4796						1.1501
C. Incineration and Open Burning of Waste	15.0947	7.7410	1.6200						24.4557
D. Wastewater Treatment and Discharge		289.3528	67.7185						357.0713
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**30.8414**	**0.0610**	**0.3016**						**31.2041**
Aviation	30.8414	0.0610	0.3016						31.2041
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	157.4600								157.4600
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			341.1879						341.1879
Indirect CO_2	73.5965								73.5965
								Total (without LULUCF)	**21,174.5710**
								Total (with LULUCF)	**19,371.3847**

1995

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**9,926.5250**	**4,041.1279**	**2,036.3114**	**1.0298**	**NO**	**NO**	**NO**	**NO**	**16,004.9941**
1. Energy	**11,471.5441**	**709.8353**	**128.2729**						**12,309.6523**
A. Fuel Combustion (Sectoral approach)	11,471.1247	48.4472	128.2729						11,647.8448
1. Energy Industries	7,174.0286	3.4249	14.9539						7,192.4074
2. Manufacturing Industries and Construction	381.5061	0.2855	0.4425						382.2342
3. Transport	1,617.7816	11.1198	31.5301						1,660.4315
4. Other Sectors	2,172.1646	33.3580	80.6996						2,286.2222
5. Other	125.6438	0.2589	0.6468						126.5495
B. Fugitive Emissions from Fuels	0.4194	661.3881	0.0000						661.8075
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.4194	661.3881	0.0000						661.8075
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**455.1468**	**NO**	**0.0003**	**1.0298**	**NO**	**NO**	**NO**	**NO**	**456.1769**
A. Mineral Industry	351.1816								351.1816
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	26.2369	NO	NO	NO	NO	NO	NO	NO	26.2369
D. Non-Energy Products From Fuels and Solvent Use	76.5607	NO	NO						76.5607
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				1.0298	NO	NO	NO	NO	1.0298

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
G. Other Product Manufacture and Use	1.1676	NO	0.0003	NO	NO	NO	NO	NO	1.1679
H. Other									
3. Agriculture	**0.0607**	**1,824.3626**	**1,585.8914**						**3,410.3147**
A. Enteric Fermentation		1,618.0865							1,618.0865
B. Manure Management		206.2761	732.9723						939.2484
C. Rice Cultivation		NO							NO
D. Agricultural Soils			852.9191						852.9191
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.0607								0.0607
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-2,015.3244**	**2.2396**	**251.5155**						**-1,761.5693**
A. Forest Land	-2,045.0670	0.0033	0.0022						-2,045.0615
B. Cropland	1,586.2644	2.2363	0.6911						1,589.1918
C. Grassland	-1,601.1004	NE	NE						-1,601.1004
D. Wetlands	-469.4389	NE	NE						-469.4389
E. Settlements	106.9167	NO, NE	250.8222						357.7389
F. Other Land	401.1281	NE	NE						401.1281
G. Harvested Wood Products	5.9727								5.9727
H. Other	NE	NE	NE						NE
5. Waste	**15.0979**	**1,504.6903**	**70.6313**						**1,590.4195**
A. Solid Waste Disposal	NA, NO	1,209.1757							1,209.1757
B. Biological Treatment of Solid Waste		0.6322	0.4521						1.0843
C. Incineration and Open Burning of Waste	15.0979	7.7395	1.6200						24.4574
D. Wastewater Treatment and Discharge		287.1429	68.5592						355.7021
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**41.9508**	**0.1638**	**0.4066**						**42.5212**
Aviation	41.9508	0.1638	0.4066						42.5212
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	230.0480								230.0480
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			324.3061						324.3061
Indirect CO_2	65.4471								65.4471
								Total (without LULUCF)	**17,766.5634**
								Total (with LULUCF)	**16,004.9941**

1996

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**9,333.9640**	**3,982.4323**	**2,028.2199**	**1.6593**	**NO**	**NO**	**NO**	**NO**	**15,346.2755**
1. Energy	**11,375.0177**	**793.2366**	**111.5825**						**12,279.8368**
A. Fuel Combustion (Sectoral approach)	11,374.5451	74.3491	111.5825						11,560.4767
1. Energy Industries	7,107.0544	3.3821	13.9743						7,124.4109
2. Manufacturing Industries and Construction	321.2863	0.2865	0.4689						322.0417
3. Transport	1,578.6670	10.7821	30.0640						1,619.5131
4. Other Sectors	2,285.6997	59.6255	66.3824						2,411.7076
5. Other	81.8376	0.2730	0.6929						82.8034
B. Fugitive Emissions from Fuels	0.4726	718.8875	0.0000						719.3601
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.4726	718.8875	0.0000						719.3601
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**414.5996**	**NO**	**0.0006**	**1.6593**	**NO**	**NO**	**NO**	**NO**	**416.2595**
A. Mineral Industry	315.6974								315.6974
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	26.7261	NO	NO	NO	NO	NO	NO	NO	26.7261
D. Non-Energy Products From Fuels and Solvent Use	71.0712	NO	NO						71.0712
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				1.6593	NO	NO	NO	NO	1.6593
G. Other Product Manufacture and Use	1.1050	NO	0.0006	NO	NO	NO	NO	NO	1.1056
H. Other									
3. Agriculture	**0.0911**	**1,679.2333**	**1,584.7691**						**3,264.0934**
A. Enteric Fermentation		1,491.8749							1,491.8749
B. Manure Management		187.3584	774.0215						961.3798
C. Rice Cultivation		NO							NO
D. Agricultural Soils			810.7476						810.7476
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.0911								0.0911
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-2,470.8404**	**1.5410**	**262.2576**						**-2,207.0418**
A. Forest Land	-2,190.4337	0.0193	0.0127						-2,190.4016
B. Cropland	1,388.2124	1.5217	0.4703						1,390.2043
C. Grassland	-1,548.0826	NE	NE						-1,548.0826
D. Wetlands	-441.2360	NE	NE						-441.2360
E. Settlements	101.5910	NO, NE	261.7746						363.3656
F. Other Land	217.3293	NE	NE						217.3293
G. Harvested Wood Products	1.7792								1.7792
H. Other	NE	NE	NE						NE
5. Waste	**15.0960**	**1,508.4213**	**69.6101**						**1,593.1275**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
A. Solid Waste Disposal	NA, NO	1,216.7829							1,216.7829
B. Biological Treatment of Solid Waste		0.6517	0.4661						1.1178
C. Incineration and Open Burning of Waste	15.0960	7.7356	1.6194						24.4511
D. Wastewater Treatment and Discharge		283.2511	67.5246						350.7757
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**56.7300**	**0.1196**	**0.5436**						**57.3932**
Aviation	56.7300	0.1196	0.5436						57.3932
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	294.0280								294.0280
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			324.2523						324.2523
Indirect CO_2	60.5658								60.5658
								Total (without LULUCF)	**17,553.3172**
								Total (with LULUCF)	**15,346.2755**

1997

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**8,606.7740**	**3,588.3326**	**1,835.1383**	**2.3137**	**NO**	**NO**	**NO**	**NO**	**14,032.5585**
1. Energy	**10,258.1517**	**649.1052**	**102.1901**						**11,009.4471**
A. Fuel Combustion (Sectoral approach)	10,257.6867	58.0360	102.1901						10,417.9128
1. Energy Industries	5,615.6123	2.7692	7.2856						5,625.6671
2. Manufacturing Industries and Construction	546.9038	0.4535	0.6820						548.0393
3. Transport	1,515.9813	10.0244	29.0960						1,555.1016
4. Other Sectors	2,502.5306	44.5872	64.5312						2,611.6491
5. Other	76.6587	0.2017	0.5953						77.4557
B. Fugitive Emissions from Fuels	0.4651	591.0693	0.0000						591.5343
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.4651	591.0693	0.0000						591.5343
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**452.0432**	**NO**	**0.0009**	**2.3137**	**NO**	**NO**	**NO**	**NO**	**454.3577**
A. Mineral Industry	376.6116								376.6116
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	32.3806	NO	NO	NO	NO	NO	NO	NO	32.3806
D. Non-Energy Products From Fuels and Solvent Use	42.0528	NO	NO						42.0528
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				2.3137	NO	NO	NO	NO	2.3137

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
G. Other Product Manufacture and Use	0.9982	NO	0.0009	NO	NO	NO	NO	NO	0.9991
H. Other									
3. Agriculture	**1.0992**	**1,434.7631**	**1,389.9530**						**2,825.8154**
A. Enteric Fermentation		1,282.5988							1,282.5988
B. Manure Management		152.1643	597.0533						749.2176
C. Rice Cultivation		NO							NO
D. Agricultural Soils			792.8997						792.8997
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	1.0992								1.0992
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-2,119.5658**	**2.6880**	**272.1818**						**-1,844.6961**
A. Forest Land	-2,232.2854	0.0059	0.0039						-2,232.2757
B. Cropland	1,656.8247	2.6821	0.8289						1,660.3357
C. Grassland	-1,400.8607	NE	NE						-1,400.8607
D. Wetlands	-413.0332	NE	NE						-413.0332
E. Settlements	100.7954	NO, NE	271.3490						372.1444
F. Other Land	188.2363	NE	NE						188.2363
G. Harvested Wood Products	-19.2429								-19.2429
H. Other	NE	NE	NE						NE
5. Waste	**15.0456**	**1,501.7762**	**70.8125**						**1,587.6344**
A. Solid Waste Disposal	NA, NO	1,203.8019							1,203.8019
B. Biological Treatment of Solid Waste		0.6130	0.4384						1.0514
C. Incineration and Open Burning of Waste	15.0456	7.7079	1.6138						24.3673
D. Wastewater Treatment and Discharge		289.6535	68.7603						358.4138
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**66.1918**	**0.1341**	**0.6341**						**66.9600**
Aviation	66.1918	0.1341	0.6341						66.9600
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	291.1280								291.1280
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			283.1453						283.1453
Indirect CO_2	32.0911								32.0911
								Total (without LULUCF)	**15,877.2546**
								Total (with LULUCF)	**14,032.5585**

1998

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**7,133.9405**	**3,448.3686**	**1,779.8253**	**3.1372**	**NO**	**NO**	**NO**	**NO**	**12,365.2716**
1. Energy	**8,894.2769**	**596.0230**	**79.6708**						**9,569.9708**
A. Fuel Combustion (Sectoral approach)	8,893.8495	42.8988	79.6708						9,016.4191
1. Energy Industries	4,836.6106	2.4047	5.6624						4,844.6778
2. Manufacturing Industries and Construction	542.6603	0.4653	0.7141						543.8396
3. Transport	1,363.0743	10.0864	24.6360						1,397.7966
4. Other Sectors	2,078.6760	29.7213	48.0295						2,156.4269
5. Other	72.8283	0.2211	0.6289						73.6783
B. Fugitive Emissions from Fuels	0.4274	553.1242	0.0000						553.5516
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.4274	553.1242	0.0000						553.5516
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**375.0296**	**NO**	**0.0015**	**3.1372**	**NO**	**NO**	**NO**	**NO**	**378.1683**
A. Mineral Industry	307.9930								307.9930
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	28.6822	NO	NO	NO	NO	NO	NO	NO	28.6822
D. Non-Energy Products From Fuels and Solvent Use	37.6084	NO	NO						37.6084
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				3.1372	NO	NO	NO	NO	3.1372
G. Other Product Manufacture and Use	0.7460	NO	0.0015	NO	NO	NO	NO	NO	0.7475
H. Other									
3. Agriculture	**0.2721**	**1,372.9086**	**1,343.9319**						**2,717.1126**
A. Enteric Fermentation		1,245.1973							1,245.1973
B. Manure Management		127.7113	578.0598						705.7711
C. Rice Cultivation		NO							NO
D. Agricultural Soils			765.8721						765.8721
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.2721								0.2721
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-2,150.7175**	**2.4720**	**284.3568**						**-1,863.8888**
A. Forest Land	-2,288.4857	0.0581	0.0383						-2,288.3892
B. Cropland	1,683.9458	2.4139	0.7460						1,687.1056
C. Grassland	-1,436.2698	NE	NE						-1,436.2698
D. Wetlands	-384.8303	NE	NE						-384.8303
E. Settlements	99.0440	NO, NE	283.5725						382.6164
F. Other Land	185.0077	NE	NE						185.0077
G. Harvested Wood Products	-9.1293								-9.1293
H. Other	NE	NE	NE						NE

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
5. Waste	**15.0794**	**1,476.9649**	**71.8643**						**1,563.9087**
A. Solid Waste Disposal	NA, NO	1,189.3544							1,189.3544
B. Biological Treatment of Solid Waste		0.6189	0.4427						1.0616
C. Incineration and Open Burning of Waste	15.0794	7.7234	1.6172						24.4200
D. Wastewater Treatment and Discharge		279.2682	69.8045						349.0727
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**53.5923**	**0.1025**	**0.5152**						**54.2100**
Aviation	53.5923	0.1025	0.5152						54.2100
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	269.0120								269.0120
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			268.2206						268.2206
Indirect CO_2	29.9352								29.9352
								Total (without LULUCF)	**14,229.1603**
								Total (with LULUCF)	**12,365.2716**

1999

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**5,387.5857**	**3,339.5567**	**1,647.0987**	**4.0002**	**NO**	**NO**	**NO**	**NO**	**10,378.2414**
1. Energy	**6,903.7219**	**598.9783**	**54.3533**						**7,557.0535**
A. Fuel Combustion (Sectoral approach)	6,903.3288	38.8658	54.3533						6,996.5479
1. Energy Industries	3,660.2540	1.8165	2.6146						3,664.6852
2. Manufacturing Industries and Construction	473.8274	0.3217	0.4606						474.6097
3. Transport	910.6886	6.1883	15.3298						932.2067
4. Other Sectors	1,809.4024	30.3769	35.4659						1,875.2453
5. Other	49.1563	0.1623	0.4823						49.8010
B. Fugitive Emissions from Fuels	0.3931	560.1125	0.0000						560.5056
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.3931	560.1125	0.0000						560.5056
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**337.9160**	**NO**	**0.0128**	**4.0002**	**NO**	**NO**	**NO**	**NO**	**341.9290**
A. Mineral Industry	271.3959								271.3959
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	31.7942	NO	NO	NO	NO	NO	NO	NO	31.7942
D. Non-Energy Products From Fuels and Solvent Use	34.0839	NO	NO						34.0839
E. Electronic Industry				NO	NO	NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
F. Product Use as Substitutes for ODS				4.0002	NO	NO	NO	NO	4.0002
G. Other Product Manufacture and Use	0.6421	NO	0.0128	NO	NO	NO	NO	NO	0.6549
H. Other									
3. Agriculture	**0.0034**	**1,264.1202**	**1,228.5490**						**2,492.6726**
A. Enteric Fermentation		1,151.8178							1,151.8178
B. Manure Management		112.3024	524.7140						637.0164
C. Rice Cultivation		NO							NO
D. Agricultural Soils			703.8350						703.8350
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.0034								0.0034
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,869.0627**	**2.3889**	**293.8604**						**-1,572.8135**
A. Forest Land	-2,336.8468	0.0435	0.0287						-2,336.7747
B. Cropland	1,702.1754	2.3454	0.7248						1,705.2456
C. Grassland	-1,433.2865	NE	NE						-1,433.2865
D. Wetlands	-356.6274	NE	NE						-356.6274
E. Settlements	111.8259	NO, NE	293.1069						404.9328
F. Other Land	425.1554	NE	NE						425.1554
G. Harvested Wood Products	18.5414								18.5414
H. Other	NE	NE	NE						NE
5. Waste	**15.0071**	**1,474.0693**	**70.3233**						**1,559.3997**
A. Solid Waste Disposal	NA, NO	1,195.2267							1,195.2267
B. Biological Treatment of Solid Waste		0.5807	0.4154						0.9961
C. Incineration and Open Burning of Waste	15.0071	7.6922	1.6101						24.3095
D. Wastewater Treatment and Discharge		270.5697	68.2978						338.8674
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**63.0390**	**0.0994**	**0.6040**						**63.7425**
Aviation	63.0390	0.0994	0.6040						63.7425
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	266.1120								266.1120
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			242.7494						242.7494
Indirect CO_2	28.7113								28.7113
								Total (without LULUCF)	**11,951.0548**
								Total (with LULUCF)	**10,378.2414**

2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**4,362.1880**	**3,260.2690**	**1,557.6079**	**5.1199**	**NO**	**NO**	**NO**	**NO**	**9,185.1849**
1. Energy	**6,188.5808**	**639.0818**	**48.4844**						**6,876.1471**
A. Fuel Combustion (Sectoral approach)	6,188.2049	38.4473	48.4844						6,275.1366
1. Energy Industries	3,155.7517	1.5249	2.0520						3,159.3286
2. Manufacturing Industries and Construction	519.5881	0.2981	0.4147						520.3009
3. Transport	982.3588	6.2992	17.0962						1,005.7542
4. Other Sectors	1,494.1182	30.2106	28.6196						1,552.9485
5. Other	36.3881	0.1145	0.3018						36.8044
B. Fugitive Emissions from Fuels	0.3759	600.6346	0.0000						601.0105
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.3759	600.6346	0.0000						601.0105
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**309.3065**	**NO**	**0.0131**	**5.1199**	**NO**	**NO**	**NO**	**NO**	**314.4396**
A. Mineral Industry	239.4427								239.4427
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	36.2689	NO	NO	NO	NO	NO	NO	NO	36.2689
D. Non-Energy Products From Fuels and Solvent Use	32.6395	NO	NO						32.6395
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				5.1199	NO	NO	NO	NO	5.1199
G. Other Product Manufacture and Use	0.9554	NO	0.0131	NO	NO	NO	NO	NO	0.9685
H. Other									
3. Agriculture	**0.4397**	**1,170.7947**	**1,140.8793**						**2,312.1138**
A. Enteric Fermentation		1,085.7826							1,085.7826
B. Manure Management		85.0121	468.2084						553.2206
C. Rice Cultivation		NO							NO
D. Agricultural Soils			672.6709						672.6709
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.4397								0.4397
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-2,151.1356**	**0.9123**	**296.3244**						**-1,853.8990**
A. Forest Land	-2,307.4384	0.0016	0.0010						-2,307.4358
B. Cropland	1,492.1681	0.9107	0.2814						1,493.3603
C. Grassland	-1,291.9495	NE	NE						-1,291.9495
D. Wetlands	-328.4245	NE	NE						-328.4245
E. Settlements	100.1768	NO, NE	296.0419						396.2187
F. Other Land	178.5246	NE	NE						178.5246
G. Harvested Wood Products	5.8073								5.8073
H. Other	NE	NE	NE						NE

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
5. Waste	**14.9965**	**1,449.4802**	**71.9066**						**1,536.3833**
A. Solid Waste Disposal	NA, NO	1,169.5330							1,169.5330
B. Biological Treatment of Solid Waste		0.5238	0.3746						0.8984
C. Incineration and Open Burning of Waste	14.9965	7.6818	1.6084						24.2867
D. Wastewater Treatment and Discharge		271.7416	69.9236						341.6652
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**63.0779**	**0.1086**	**0.6101**						**63.7967**
Aviation	63.0779	0.1086	0.6101						63.7967
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	272.3720								272.3720
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			223.6470						223.6470
Indirect CO_2	28.5957								28.5957
								Total (without LULUCF)	**11,039.0838**
								Total (with LULUCF)	**9,185.1849**

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**5,348.8609**	**3,244.2065**	**1,637.7041**	**6.8681**	**NO**	**NO**	**NO**	**NO**	**10,237.6396**
1. Energy	**6,818.6569**	**630.8832**	**49.8666**						**7,499.4067**
A. Fuel Combustion (Sectoral approach)	6,818.2477	35.3627	49.8666						6,903.4769
1. Energy Industries	3,677.7189	1.8154	2.3940						3,681.9284
2. Manufacturing Industries and Construction	601.1675	0.3673	0.5542						602.0890
3. Transport	1,061.8643	6.6689	18.8944						1,087.4276
4. Other Sectors	1,434.1009	26.3857	27.6641						1,488.1507
5. Other	43.3961	0.1253	0.3599						43.8813
B. Fugitive Emissions from Fuels	0.4092	595.5205	0.0001						595.9298
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.4092	595.5205	0.0001						595.9298
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**311.7431**	**NO**	**0.0131**	**6.8681**	**NO**	**NO**	**NO**	**NO**	**318.6243**
A. Mineral Industry	235.8758								235.8758
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	38.6274	NO	NO	NO	NO	NO	NO	NO	38.6274
D. Non-Energy Products From Fuels and Solvent Use	36.4195	NO	NO						36.4195
E. Electronic Industry				NO	NO	NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
F. Product Use as Substitutes for ODS				6.8681	NO	NO	NO	NO	6.8681
G. Other Product Manufacture and Use	0.8204	NO	0.0131	NO	NO	NO	NO	NO	0.8335
H. Other									
3. Agriculture	**0.1496**	**1,189.1882**	**1,218.6278**						**2,407.9656**
A. Enteric Fermentation		1,103.2722							1,103.2722
B. Manure Management		85.9160	476.7359						562.6519
C. Rice Cultivation		NO							NO
D. Agricultural Soils			741.8919						741.8919
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.1496								0.1496
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,796.6576**	**1.2702**	**296.5454**						**-1,498.8419**
A. Forest Land	-2,273.7027	0.0983	0.0648						-2,273.5395
B. Cropland	1,828.5659	1.1719	0.3622						1,830.0999
C. Grassland	-1,290.6541	NE	NE						-1,290.6541
D. Wetlands	-300.2217	NE	NE						-300.2217
E. Settlements	67.0898	NO, NE	296.1184						363.2082
F. Other Land	178.5246	NE	NE						178.5246
G. Harvested Wood Products	-6.2594								-6.2594
H. Other	NE	NE	NE						NE
5. Waste	**14.9689**	**1,422.8649**	**72.6511**						**1,510.4849**
A. Solid Waste Disposal	NA, NO	1,137.4743							1,137.4743
B. Biological Treatment of Solid Waste		0.4755	0.3401						0.8156
C. Incineration and Open Burning of Waste	14.9689	7.6683	1.6055						24.2427
D. Wastewater Treatment and Discharge		277.2468	70.7055						347.9523
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**50.4863**	**0.0977**	**0.4911**						**51.0751**
Aviation	50.4863	0.0977	0.4911						51.0751
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	282.2280								282.2280
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			239.0312						239.0312
Indirect CO_2	31.6632								31.6632
								Total (without LULUCF)	**11,736.4815**
								Total (with LULUCF)	**10,237.6396**

2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**5,028.2150**	**3,317.9926**	**1,697.6802**	**9.1227**	**NO**	**NO**	**NO**	**NO**	**10,053.0105**
1. Energy	**6,537.0389**	**691.4763**	**63.9631**						**7,292.4783**
A. Fuel Combustion (Sectoral approach)	6,536.6488	44.4141	63.9631						6,645.0260
1. Energy Industries	2,933.2101	1.5342	2.0510						2,936.7953
2. Manufacturing Industries and Construction	410.3969	0.2405	0.3333						410.9707
3. Transport	1,405.7644	8.5453	28.2260						1,442.5357
4. Other Sectors	1,747.8245	33.8864	32.8830						1,814.5940
5. Other	39.4529	0.2076	0.4698						40.1303
B. Fugitive Emissions from Fuels	0.3901	647.0622	0.0001						647.4523
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	0.3901	647.0622	0.0001						647.4523
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**359.6162**	**NO**	**0.0131**	**9.1227**	**NO**	**NO**	**NO**	**NO**	**368.7520**
A. Mineral Industry	299.9546								299.9546
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	20.5030	NO	NO	NO	NO	NO	NO	NO	20.5030
D. Non-Energy Products From Fuels and Solvent Use	38.3743	NO	NO						38.3743
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				9.1227	NO	NO	NO	NO	9.1227
G. Other Product Manufacture and Use	0.7843	NO	0.0131	NO	NO	NO	NO	NO	0.7974
H. Other									
3. Agriculture	**0.0470**	**1,215.5580**	**1,262.2421**						**2,477.8471**
A. Enteric Fermentation		1,125.6099							1,125.6099
B. Manure Management		89.9480	480.2456						570.1936
C. Rice Cultivation		NO							NO
D. Agricultural Soils			781.9966						781.9966
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.0470								0.0470
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,883.4274**	**0.2659**	**296.9504**						**-1,586.2111**
A. Forest Land	-2,267.6159	0.0528	0.0348						-2,267.5283
B. Cropland	1,424.6996	0.2131	0.0658						1,424.9786
C. Grassland	-1,235.1380	NE	NE						-1,235.1380
D. Wetlands	-272.0188	NE	NE						-272.0188
E. Settlements	67.0898	NO, NE	296.8498						363.9396
F. Other Land	456.2431	NE	NE						456.2431
G. Harvested Wood Products	-56.6873								-56.6873
H. Other	NE	NE	NE						NE
5. Waste	**14.9402**	**1,410.6925**	**74.5114**						**1,500.1442**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
A. Solid Waste Disposal	NA, NO	1,108.0606							1,108.0606
B. Biological Treatment of Solid Waste		0.5221	0.3734						0.8954
C. Incineration and Open Burning of Waste	14.9402	7.6480	1.6017						24.1900
D. Wastewater Treatment and Discharge		294.4618	72.5363						366.9981
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**59.9541**	**0.0909**	**0.5847**						**60.6297**
Aviation	59.9541	0.0909	0.5847						60.6297
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	322.0800								322.0800
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			249.6670						249.6670
Indirect CO_2	33.3896								33.3896
								Total (without LULUCF)	**11,639.2216**
								Total (with LULUCF)	**10,053.0105**

2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**5,767.7437**	**3,225.9410**	**1,550.8568**	**12.1632**	**NO**	**0.0071**	**NO**	**NO**	**10,556.7118**
1. Energy	**7,178.5944**	**733.1822**	**62.1848**						**7,973.9615**
A. Fuel Combustion (Sectoral approach)	7,177.5353	56.7195	62.1834						7,296.4381
1. Energy Industries	3,036.7494	1.5649	2.0677						3,040.3820
2. Manufacturing Industries and Construction	438.8946	0.2398	0.3304						439.4649
3. Transport	1,588.8147	10.0088	27.1820						1,626.0055
4. Other Sectors	2,084.6537	44.7997	32.3247						2,161.7781
5. Other	28.4228	0.1063	0.2785						28.8076
B. Fugitive Emissions from Fuels	1.0592	676.4627	0.0014						677.5233
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.0592	676.4627	0.0014						677.5233
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**384.9507**	**NO**	**0.0131**	**12.1632**	**NO**	**0.0071**	**NO**	**NO**	**397.1342**
A. Mineral Industry	307.6352								307.6352
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	35.4283	NO	NO	NO	NO	NO	NO	NO	35.4283
D. Non-Energy Products From Fuels and Solvent Use	40.9252	NO	NO						40.9252
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				12.1632	NO	NO	NO	NO	12.1632

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
G. Other Product Manufacture and Use	0.9620	NO	0.0131	NO	NO	0.0071	NO	NO	0.9823
H. Other									
3. Agriculture	**0.2381**	**1,112.2119**	**1,122.2738**						**2,234.7239**
A. Enteric Fermentation		1,028.5383							1,028.5383
B. Manure Management		83.6736	456.0074						539.6810
C. Rice Cultivation		NO							NO
D. Agricultural Soils			666.2664						666.2664
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.2381								0.2381
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,810.9497**	**0.0612**	**294.3382**						**-1,516.5503**
A. Forest Land	-2,270.1176	0.0578	0.0381						-2,270.0217
B. Cropland	1,505.7575	0.0034	0.0010						1,505.7619
C. Grassland	-1,007.1842	NE	NE						-1,007.1842
D. Wetlands	-243.8159	NE	NE						-243.8159
E. Settlements	67.8615	NO, NE	294.2991						362.1605
F. Other Land	201.6619	NE	NE						201.6619
G. Harvested Wood Products	-65.1129								-65.1129
H. Other	NE	NE	NE						NE
5. Waste	**14.9100**	**1,380.4857**	**72.0468**						**1,467.4426**
A. Solid Waste Disposal	NA, NO	1,070.2330							1,070.2330
B. Biological Treatment of Solid Waste		0.5481	0.3920						0.9401
C. Incineration and Open Burning of Waste	14.9100	7.6262	1.5977						24.1339
D. Wastewater Treatment and Discharge		302.0785	70.0571						372.1356
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**34.7676**	**0.0873**	**0.3479**						**35.2028**
Aviation	34.7676	0.0873	0.3479						35.2028
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	373.5760								373.5760
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			222.1574						222.1574
Indirect CO_2	33.6837								33.6837
								Total (without LULUCF)	**12,073.2621**
								Total (with LULUCF)	**10,556.7118**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**6,118.3768**	**3,193.7303**	**1,612.7308**	**16.0027**	**NO**	**0.0071**	**NO**	**NO**	**10,940.8476**
1. Energy	**7,629.0126**	**783.7323**	**62.9756**						**8,475.7204**
A. Fuel Combustion (Sectoral approach)	7,627.9081	49.4858	62.9741						7,740.3680
1. Energy Industries	3,109.0519	1.6004	2.1117						3,112.7641
2. Manufacturing Industries and Construction	443.9172	0.2869	0.4102						444.6143
3. Transport	1,787.2739	10.7899	31.6423						1,829.7061
4. Other Sectors	2,260.0278	36.7303	28.5047						2,325.2628
5. Other	27.6373	0.0782	0.3052						28.0207
B. Fugitive Emissions from Fuels	1.1045	734.2465	0.0015						735.3524
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.1045	734.2465	0.0015						735.3524
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**454.6376**	**NO**	**0.0149**	**16.0027**	**NO**	**0.0071**	**NO**	**NO**	**470.6623**
A. Mineral Industry	348.9485								348.9485
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	40.5084	NO	NO	NO	NO	NO	NO	NO	40.5084
D. Non-Energy Products From Fuels and Solvent Use	64.1303	NO	NO						64.1303
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				16.0027	NO	NO	NO	NO	16.0027
G. Other Product Manufacture and Use	1.0504	NO	0.0149	NO	NO	0.0071	NO	NO	1.0724
H. Other									
3. Agriculture	**0.3669**	**1,042.7191**	**1,190.9262**						**2,234.0121**
A. Enteric Fermentation		961.4211							961.4211
B. Manure Management		81.2980	441.1540						522.4520
C. Rice Cultivation		NO							NO
D. Agricultural Soils			749.7721						749.7721
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.3669								0.3669
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,980.5023**	**0.2008**	**290.1214**						**-1,690.1801**
A. Forest Land	-2,334.7768	0.1518	0.1001						-2,334.5249
B. Cropland	1,466.3473	0.0490	0.0151						1,466.4115
C. Grassland	-1,120.4767	NE	NE						-1,120.4767
D. Wetlands	-215.6130	NE	NE						-215.6130
E. Settlements	53.6737	NO, NE	290.0061						343.6798
F. Other Land	223.8177	NE	NE						223.8177
G. Harvested Wood Products	-53.4745								-53.4745
H. Other	NE	NE	NE						NE

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
5. Waste	**14.8621**	**1,367.0780**	**68.6927**						**1,450.6328**
A. Solid Waste Disposal	NA, NO	1,055.1514							1,055.1514
B. Biological Treatment of Solid Waste		0.5754	0.4116						0.9870
C. Incineration and Open Burning of Waste	14.8621	7.5964	1.5919						24.0505
D. Wastewater Treatment and Discharge		303.7548	66.6893						370.4440
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**34.7903**	**0.0863**	**0.3548**						**35.2315**
Aviation	34.7903	0.0863	0.3548						35.2315
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	307.6800								307.6800
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			235.4581						235.4581
Indirect CO_2	56.7824								56.7824
								Total (without LULUCF)	**12,631.0277**
								Total (with LULUCF)	**10,940.8476**

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**6,754.6895**	**3,208.3959**	**1,643.6329**	**22.5106**	**NO**	**0.0427**	**NO**	**NO**	**11,629.2716**
1. Energy	**7,874.0484**	**827.3559**	**62.9766**						**8,764.3809**
A. Fuel Combustion (Sectoral approach)	7,872.9265	51.9218	62.9752						7,987.8235
1. Energy Industries	3,231.6708	1.6527	2.1625						3,235.4860
2. Manufacturing Industries and Construction	574.4257	0.3327	0.4566						575.2151
3. Transport	1,821.8133	10.9934	34.2802						1,867.0868
4. Other Sectors	2,219.0765	38.8835	25.7923						2,283.7523
5. Other	25.9403	0.0595	0.2836						26.2833
B. Fugitive Emissions from Fuels	1.1219	775.4341	0.0015						776.5574
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.1219	775.4341	0.0015						776.5574
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**548.7488**	**NO**	**0.0182**	**22.5106**	**NO**	**0.0427**	**NO**	**NO**	**571.3202**
A. Mineral Industry	437.4573								437.4573
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	41.9358	NO	NO	NO	NO	NO	NO	NO	41.9358
D. Non-Energy Products From Fuels and Solvent Use	68.1910	NO	NO						68.1910
E. Electronic Industry				NO	NO	NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
F. Product Use as Substitutes for ODS				22.5106	NO	NO	NO	NO	22.5106
G. Other Product Manufacture and Use	1.1646	NO	0.0182	NO	NO	0.0427	NO	NO	1.2255
H. Other									
3. Agriculture	**0.1739**	**1,009.1750**	**1,230.9898**						**2,240.3387**
A. Enteric Fermentation		924.0273							924.0273
B. Manure Management		85.1477	471.4376						556.5852
C. Rice Cultivation		NO							NO
D. Agricultural Soils			759.5523						759.5523
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.1739								0.1739
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,682.7486**	**0.2482**	**286.5410**						**-1,395.9594**
A. Forest Land	-2,409.5185	0.0145	0.0096						-2,409.4945
B. Cropland	1,543.2389	0.2337	0.0722						1,543.5448
C. Grassland	-1,058.1239	NE	NE						-1,058.1239
D. Wetlands	-187.4101	NE	NE						-187.4101
E. Settlements	53.6737	NO, NE	286.4592						340.1329
F. Other Land	416.5012	NE	NE						416.5012
G. Harvested Wood Products	-41.1098								-41.1098
H. Other	NE	NE	NE						NE
5. Waste	**14.4670**	**1,371.6169**	**63.1072**						**1,449.1911**
A. Solid Waste Disposal	NA, NO	1,064.3081							1,064.3081
B. Biological Treatment of Solid Waste		0.6025	0.4309						1.0334
C. Incineration and Open Burning of Waste	14.4670	7.3936	1.5495						23.4100
D. Wastewater Treatment and Discharge		299.3127	61.1268						360.4395
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**37.9260**	**0.0872**	**0.3848**						**38.3980**
Aviation	37.9260	0.0872	0.3848						38.3980
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	307.3920								307.3920
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			244.3645						244.3645
Indirect CO_2	61.0627								61.0627
								Total (without LULUCF)	**13,025.2310**
								Total (with LULUCF)	**11,629.2716**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**5,971.6037**	**3,079.8668**	**1,612.2311**	**33.2493**	**0.0231**	**0.3088**	**NO**	**NO**	**10,697.2828**
1. Energy	**7,115.3279**	**740.0631**	**64.4979**						**7,919.8889**
A. Fuel Combustion (Sectoral approach)	7,114.1019	56.8046	64.4961						7,235.4026
1. Energy Industries	2,494.5441	1.2952	1.6998						2,497.5390
2. Manufacturing Industries and Construction	634.7036	0.3339	0.4482						635.4857
3. Transport	1,742.1498	10.1509	35.7004						1,788.0010
4. Other Sectors	2,203.6648	44.9525	26.2676						2,274.8849
5. Other	39.0397	0.0722	0.3801						39.4920
B. Fugitive Emissions from Fuels	1.2260	683.2585	0.0018						684.4863
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.2260	683.2585	0.0018						684.4863
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**643.8927**	**NO**	**0.0176**	**33.2493**	**0.0231**	**0.3088**	**NO**	**NO**	**677.4915**
A. Mineral Industry	533.8283								533.8283
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	27.0182	NO	NO	NO	NO	NO	NO	NO	27.0182
D. Non-Energy Products From Fuels and Solvent Use	81.9807	NO	NO						81.9807
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				33.2493	NO	NO	NO	NO	33.2493
G. Other Product Manufacture and Use	1.0655	NO	0.0176	NO	0.0231	0.3088	NO	NO	1.4150
H. Other									
3. Agriculture	**0.1460**	**981.6300**	**1,200.1445**						**2,181.9206**
A. Enteric Fermentation		893.8074							893.8074
B. Manure Management		87.8226	484.4637						572.2863
C. Rice Cultivation		NO							NO
D. Agricultural Soils			715.6808						715.6808
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.1460								0.1460
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,801.8890**	**0.2505**	**282.6021**						**-1,519.0364**
A. Forest Land	-2,366.5168	0.1567	0.1033						-2,366.2568
B. Cropland	1,577.6205	0.0938	0.0290						1,577.7434
C. Grassland	-1,056.3692	NE	NE						-1,056.3692
D. Wetlands	-159.2073	NE	NE						-159.2073
E. Settlements	53.6737	NO, NE	282.4698						336.1435
F. Other Land	189.4964	NE	NE						189.4964
G. Harvested Wood Products	-40.5864								-40.5864
H. Other	NE	NE	NE						NE

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
5. Waste	**14.1260**	**1,357.9231**	**64.9690**						**1,437.0182**
A. Solid Waste Disposal	NA, NO	1,061.8430							1,061.8430
B. Biological Treatment of Solid Waste		0.6536	0.4674						1.1210
C. Incineration and Open Burning of Waste	14.1260	7.2192	1.5130						22.8582
D. Wastewater Treatment and Discharge		288.2073	62.9886						351.1959
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**37.9241**	**0.0979**	**0.3865**						**38.4085**
Aviation	37.9241	0.0979	0.3865						38.4085
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	361.4360								361.4360
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			238.5383						238.5383
Indirect CO_2	74.1622								74.1622
								Total (without LULUCF)	**12,216.3192**
								Total (with LULUCF)	**10,697.2828**

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**6,165.0995**	**2,909.4029**	**1,387.3445**	**44.7889**	**0.0231**	**0.4084**	**NO**	**NO**	**10,507.0673**
1. Energy	**7,254.6164**	**771.5363**	**62.3563**						**8,088.5091**
A. Fuel Combustion (Sectoral approach)	7,253.3587	45.1901	62.3545						7,360.9033
1. Energy Industries	2,894.4441	1.4837	1.9002						2,897.8280
2. Manufacturing Industries and Construction	800.8383	0.3908	0.4977						801.7268
3. Transport	1,846.8209	10.6871	37.3517						1,894.8597
4. Other Sectors	1,666.7458	32.5309	22.0918						1,721.3685
5. Other	44.5097	0.0975	0.5132						45.1203
B. Fugitive Emissions from Fuels	1.2577	726.3463	0.0018						727.6057
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.2577	726.3463	0.0018						727.6057
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**890.8914**	**NO**	**NO**	**44.7889**	**0.0231**	**0.4084**	**NO**	**NO**	**936.1118**
A. Mineral Industry	766.4702								766.4702
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	38.6127	NO	NO	NO	NO	NO	NO	NO	38.6127
D. Non-Energy Products From Fuels and Solvent Use	84.7433	NO	NO						84.7433
E. Electronic Industry				NO	NO	NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
F. Product Use as Substitutes for ODS				44.7889	NO	NO	NO	NO	44.7889
G. Other Product Manufacture and Use	1.0652	NO	NO	NO	0.0231	0.4084	NO	NO	1.4967
H. Other									
3. Agriculture	**0.2631**	**784.6471**	**986.4551**						**1,771.3653**
A. Enteric Fermentation		722.0955							722.0955
B. Manure Management		62.5516	370.1945						432.7461
C. Rice Cultivation		NO							NO
D. Agricultural Soils			616.2605						616.2605
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.2631								0.2631
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,994.4386**	**1.5178**	**278.0202**						**-1,714.9006**
A. Forest Land	-2,460.3855	1.3652	0.9002						-2,458.1201
B. Cropland	1,540.3986	0.1525	0.0471						1,540.5982
C. Grassland	-1,031.2350	NE	NE						-1,031.2350
D. Wetlands	-131.0044	NE	NE						-131.0044
E. Settlements	49.2742	NO, NE	277.0728						326.3470
F. Other Land	83.1072	NE	NE						83.1072
G. Harvested Wood Products	-44.5936								-44.5936
H. Other	NE	NE	NE						NE
5. Waste	**13.7672**	**1,351.7017**	**60.5129**						**1,425.9818**
A. Solid Waste Disposal	NA, NO	1,064.8219							1,064.8219
B. Biological Treatment of Solid Waste		0.8474	0.6060						1.4534
C. Incineration and Open Burning of Waste	13.7672	7.0358	1.4745						22.2776
D. Wastewater Treatment and Discharge		278.9966	58.4323						337.4289
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**44.2052**	**0.0681**	**0.4402**						**44.7135**
Aviation	44.2052	0.0681	0.4402						44.7135
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	304.6560								304.6560
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			197.4012						197.4012
Indirect CO_2	78.0464								78.0464
								Total (without LULUCF)	**12,221.9680**
								Total (with LULUCF)	**10,507.0673**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**6,853.1332**	**2,894.3800**	**1,481.5277**	**57.3627**	**0.0288**	**0.4988**	**NO**	**NO**	**11,286.9312**
1. Energy	**7,554.7011**	**769.4632**	**63.4163**						**8,387.5806**
A. Fuel Combustion (Sectoral approach)	7,553.4263	46.9980	63.4145						7,663.8388
1. Energy Industries	2,997.3662	1.6371	2.1525						3,001.1558
2. Manufacturing Industries and Construction	885.0132	0.8419	1.3337						887.1888
3. Transport	1,950.0498	11.2799	37.9128						1,999.2424
4. Other Sectors	1,677.3708	33.1490	21.5577						1,732.0776
5. Other	43.6263	0.0901	0.4578						44.1742
B. Fugitive Emissions from Fuels	1.2748	722.4652	0.0018						723.7417
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.2748	722.4652	0.0018						723.7417
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**966.3539**	**NO**	**NO**	**57.3627**	**0.0288**	**0.4988**	**NO**	**NO**	**1,024.2442**
A. Mineral Industry	863.1338								863.1338
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	35.4118	NO	NO	NO	NO	NO	NO	NO	35.4118
D. Non-Energy Products From Fuels and Solvent Use	66.7047	NO	NO						66.7047
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				57.3627	NO	NO	NO	NO	57.3627
G. Other Product Manufacture and Use	1.1036	NO	NO	NO	0.0288	0.4988	NO	NO	1.6312
H. Other									
3. Agriculture	**0.8505**	**751.6286**	**1,090.3227**						**1,842.8018**
A. Enteric Fermentation		689.2854							689.2854
B. Manure Management		62.3432	364.8654						427.2086
C. Rice Cultivation		NO							NO
D. Agricultural Soils			725.4572						725.4572
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.8505								0.8505
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,682.2257**	**0.7701**	**272.0280**						**-1,409.4276**
A. Forest Land	-2,462.7874	0.0949	0.0626						-2,462.6300
B. Cropland	1,510.8422	0.6752	0.2087						1,511.7261
C. Grassland	-932.1498	NE	NE						-932.1498
D. Wetlands	-102.8015	NE	NE						-102.8015
E. Settlements	49.2742	NO, NE	271.7567						321.0310
F. Other Land	291.0044	NE	NE						291.0044
G. Harvested Wood Products	-35.6078								-35.6078
H. Other	NE	NE	NE						NE
5. Waste	**13.4533**	**1,372.5181**	**55.7607**						**1,441.7321**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
A. Solid Waste Disposal	NA, NO	1,084.1973							1,084.1973
B. Biological Treatment of Solid Waste		1.0034	0.7176						1.7211
C. Incineration and Open Burning of Waste	13.4533	6.8704	1.4403						21.7640
D. Wastewater Treatment and Discharge		280.4470	53.6028						334.0498
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**44.1680**	**0.0409**	**0.4319**						**44.6408**
Aviation	44.1680	0.0409	0.4319						44.6408
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	352.4520								352.4520
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			218.2046						218.2046
Indirect CO_2	59.5995								59.5995
								Total (without LULUCF)	**12,696.3587**
								Total (with LULUCF)	**11,286.9312**

2009

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**7,284.4315**	**2,816.8217**	**1,479.7749**	**67.4807**	**0.0288**	**0.5422**	**NO**	**NO**	**11,649.0797**
1. Energy	**8,095.5552**	**647.8516**	**57.6017**						**8,801.0085**
A. Fuel Combustion (Sectoral approach)	8,094.2820	49.9194	57.5999						8,201.8013
1. Energy Industries	3,844.8870	2.0870	2.7733						3,849.7472
2. Manufacturing Industries and Construction	494.2397	0.5373	0.8732						495.6502
3. Transport	1,919.7221	11.4390	33.1376						1,964.2987
4. Other Sectors	1,824.9424	35.8275	20.7387						1,881.5086
5. Other	10.4909	0.0286	0.0771						10.5966
B. Fugitive Emissions from Fuels	1.2732	597.9322	0.0018						599.2072
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.2732	597.9322	0.0018						599.2072
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**461.4652**	**NO**	**NO**	**67.4807**	**0.0288**	**0.5422**	**NO**	**NO**	**529.5169**
A. Mineral Industry	386.0179								386.0179
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	17.0619	NO	NO	NO	NO	NO	NO	NO	17.0619
D. Non-Energy Products From Fuels and Solvent Use	57.5805	NO	NO						57.5805
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				67.4807	NO	NO	NO	NO	67.4807

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
G. Other Product Manufacture and Use	0.8048	NO	NO	NO	0.0288	0.5422	NO	NO	1.3759
H. Other									
3. Agriculture	**0.5864**	**783.8786**	**1,099.9468**						**1,884.4118**
A. Enteric Fermentation		713.5953							713.5953
B. Manure Management		70.2833	411.0664						481.3497
C. Rice Cultivation		NO							NO
D. Agricultural Soils			688.8804						688.8804
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	0.5864								0.5864
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,286.3366**	**0.3145**	**265.3313**						**-1,020.6908**
A. Forest Land	-2,526.0659	0.2315	0.1527						-2,525.6817
B. Cropland	1,664.9870	0.0829	0.0256						1,665.0956
C. Grassland	-447.6932	NE	NE						-447.6932
D. Wetlands	-74.5986	NE	NE						-74.5986
E. Settlements	45.5694	NO, NE	265.1529						310.7223
F. Other Land	79.9357	NE	NE						79.9357
G. Harvested Wood Products	-28.4708								-28.4708
H. Other	NE	NE	NE						NE
5. Waste	**13.1613**	**1,384.7770**	**56.8951**						**1,454.8334**
A. Solid Waste Disposal	NA, NO	1,115.0489							1,115.0489
B. Biological Treatment of Solid Waste		1.1143	0.7969						1.9112
C. Incineration and Open Burning of Waste	13.1613	6.7157	1.4083						21.2853
D. Wastewater Treatment and Discharge		261.8981	54.6899						316.5880
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**44.1719**	**0.0429**	**0.4319**						**44.6466**
Aviation	44.1719	0.0429	0.4319						44.6466
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	362.1000								362.1000
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			219.9449						219.9449
Indirect CO_2	51.3571								51.3571
								Total (without LULUCF)	**12,669.7705**
								Total (with LULUCF)	**11,649.0797**

2010

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**7,915.8467**	**2,829.2163**	**1,555.5244**	**77.8936**	**0.0403**	**0.6616**	**NO**	**NO**	**12,379.1830**
1. Energy	**8,632.1613**	**633.3199**	**62.3093**						**9,327.7905**
A. Fuel Combustion (Sectoral approach)	8,630.8866	53.4986	62.3075						8,746.6927
1. Energy Industries	4,054.4452	2.2345	2.9480						4,059.6277
2. Manufacturing Industries and Construction	422.5661	0.2998	0.4446						423.3105
3. Transport	2,140.5856	11.7706	36.5158						2,188.8720
4. Other Sectors	1,985.9921	39.1358	22.2344						2,047.3623
5. Other	27.2976	0.0579	0.1646						27.5201
B. Fugitive Emissions from Fuels	1.2747	579.8212	0.0018						581.0977
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.2747	579.8212	0.0018						581.0977
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**481.3565**	**NO**	**NO**	**77.8936**	**0.0403**	**0.6616**	**NO**	**NO**	**559.9521**
A. Mineral Industry	404.3936								404.3936
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	9.6985	NO	NO	NO	NO	NO	NO	NO	9.6985
D. Non-Energy Products From Fuels and Solvent Use	66.2398	NO	NO						66.2398
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				77.8936	NO	NO	NO	NO	77.8936
G. Other Product Manufacture and Use	1.0245	NO	NO	NO	0.0403	0.6616	NO	NO	1.7265
H. Other									
3. Agriculture	**1.7443**	**785.0631**	**1,179.9272**						**1,966.7346**
A. Enteric Fermentation		708.1752							708.1752
B. Manure Management		76.8879	426.2558						503.1437
C. Rice Cultivation		NO							NO
D. Agricultural Soils			753.6714						753.6714
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	1.7443								1.7443
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,212.2817**	**0.1390**	**258.2142**						**-953.9285**
A. Forest Land	-2,484.1627	0.0809	0.0534						-2,484.0285
B. Cropland	1,546.0139	0.0581	0.0180						1,546.0900
C. Grassland	-691.9874	NE	NE						-691.9874
D. Wetlands	-46.3958	NE	NE						-46.3958
E. Settlements	45.5694	NO, NE	258.1429						303.7123
F. Other Land	441.4824	NE	NE						441.4824
G. Harvested Wood Products	-22.8014								-22.8014
H. Other	NE	NE	NE						NE
5. Waste	**12.8663**	**1,410.6943**	**55.0736**						**1,478.6343**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
A. Solid Waste Disposal	NA, NO	1,137.8491							1,137.8491
B. Biological Treatment of Solid Waste		1.0751	0.7689						1.8439
C. Incineration and Open Burning of Waste	12.8663	6.5595	1.3761						20.8019
D. Wastewater Treatment and Discharge		265.2106	52.9287						318.1393
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**41.0593**	**0.0648**	**0.4071**						**41.5312**
Aviation	41.0593	0.0648	0.4071						41.5312
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	341.0480								341.0480
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			237.1044						237.1044
Indirect CO_2	59.3041								59.3041
								Total (without LULUCF)	**13,333.1115**
								Total (with LULUCF)	**12,379.1830**

2011

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**8,374.8996**	**2,877.7059**	**1,520.0364**	**90.1296**	**0.0403**	**0.7043**	**NO**	**NO**	**12,863.5161**
1. Energy	**8,932.6787**	**717.1777**	**64.5021**						**9,714.3586**
A. Fuel Combustion (Sectoral approach)	8,931.3646	56.7720	64.5003						9,052.6369
1. Energy Industries	3,752.5675	2.0035	2.6063						3,757.1773
2. Manufacturing Industries and Construction	575.5238	0.6580	1.0725						577.2543
3. Transport	2,272.7076	11.7183	38.1651						2,322.5910
4. Other Sectors	2,310.7777	42.3603	22.5291						2,375.6672
5. Other	19.7881	0.0318	0.1273						19.9471
B. Fugitive Emissions from Fuels	1.3141	660.4057	0.0018						661.7217
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.3141	660.4057	0.0018						661.7217
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**574.0527**	**NO**	**NO**	**90.1296**	**0.0403**	**0.7043**	**NO**	**NO**	**664.9270**
A. Mineral Industry	488.6436								488.6436
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	12.8556	NO	NO	NO	NO	NO	NO	NO	12.8556
D. Non-Energy Products From Fuels and Solvent Use	71.3244	NO	NO						71.3244
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				90.1296	NO	NO	NO	NO	90.1296

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
G. Other Product Manufacture and Use	1.2291	NO	NO	NO	0.0403	0.7043	NO	NO	1.9738
H. Other									
3. Agriculture	**3.6752**	**739.5373**	**1,148.2647**						**1,891.4772**
A. Enteric Fermentation		666.9120							666.9120
B. Manure Management		72.6254	388.7320						461.3574
C. Rice Cultivation		NO							NO
D. Agricultural Soils			759.5327						759.5327
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	3.6752								3.6752
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,148.0863**	**0.1602**	**251.9575**						**-895.9685**
A. Forest Land	-2,390.5712	0.1083	0.0714						-2,390.3914
B. Cropland	1,504.5789	0.0519	0.0160						1,504.6468
C. Grassland	-638.1726	NE	NE						-638.1726
D. Wetlands	-75.3129	NE	NE						-75.3129
E. Settlements	62.0438	NO, NE	251.8701						313.9139
F. Other Land	393.7285	NE	NE						393.7285
G. Harvested Wood Products	-4.3808								-4.3808
H. Other	NE	NE	NE						NE
5. Waste	**12.5793**	**1,420.8305**	**55.3120**						**1,488.7218**
A. Solid Waste Disposal	NA, NO	1,155.0806							1,155.0806
B. Biological Treatment of Solid Waste		1.0916	0.7807						1.8723
C. Incineration and Open Burning of Waste	12.5793	6.4058	1.3445						20.3296
D. Wastewater Treatment and Discharge		258.2525	53.1868						311.4394
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**41.0082**	**0.0696**	**0.3921**						**41.4700**
Aviation	41.0082	0.0696	0.3921						41.4700
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	384.6400								384.6400
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			231.7437						231.7437
Indirect CO_2	64.2370								64.2370
								Total (without LULUCF)	**13,759.4846**
								Total (with LULUCF)	**12,863.5161**

2012

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**7,954.8556**	**2,818.0002**	**1,434.4343**	**100.0227**	**0.0403**	**0.7646**	**NO**	**NO**	**12,308.1177**
1. Energy	**8,516.3274**	**711.3743**	**59.6790**						**9,287.3807**
A. Fuel Combustion (Sectoral approach)	8,515.0170	60.4615	59.6772						8,635.1557
1. Energy Industries	3,810.0873	1.8944	2.5658						3,814.5475
2. Manufacturing Industries and Construction	433.9361	0.2782	0.3865						434.6008
3. Transport	1,992.5907	10.1228	34.3266						2,037.0401
4. Other Sectors	2,271.4679	48.1511	22.3422						2,341.9613
5. Other	6.9350	0.0149	0.0562						7.0060
B. Fugitive Emissions from Fuels	1.3104	650.9128	0.0018						652.2250
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.3104	650.9128	0.0018						652.2250
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**582.0682**	**NO**	**NO**	**100.0227**	**0.0403**	**0.7646**	**NO**	**NO**	**682.8958**
A. Mineral Industry	493.5610								493.5610
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	12.6973	NO	NO	NO	NO	NO	NO	NO	12.6973
D. Non-Energy Products From Fuels and Solvent Use	74.6523	NO	NO						74.6523
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				100.0227	NO	NO	NO	NO	100.0227
G. Other Product Manufacture and Use	1.1575	NO	NO	NO	0.0403	0.7646	NO	NO	1.9625
H. Other									
3. Agriculture	**5.5908**	**699.4024**	**1,085.6068**						**1,790.6000**
A. Enteric Fermentation		630.2714							630.2714
B. Manure Management		69.1310	356.7848						425.9157
C. Rice Cultivation		NO							NO
D. Agricultural Soils			728.8220						728.8220
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	5.5908								5.5908
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,161.4016**	**1.1675**	**233.4235**						**-926.8106**
A. Forest Land	-2,294.8221	1.1601	0.7650						-2,292.8970
B. Cropland	1,508.7640	0.0074	0.0023						1,508.7737
C. Grassland	-562.7510	NE	NE						-562.7510
D. Wetlands	-15.4700	NE	NE						-15.4700
E. Settlements	11.8882	NO, NE	232.6562						244.5444
F. Other Land	114.1449	NE	NE						114.1449
G. Harvested Wood Products	76.8444								76.8444
H. Other	NE	NE	NE						NE
5. Waste	**12.2708**	**1,406.0560**	**55.7250**						**1,474.0519**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
A. Solid Waste Disposal	NA, NO	1,143.6162							1,143.6162
B. Biological Treatment of Solid Waste		1.1179	0.7996						1.9175
C. Incineration and Open Burning of Waste	12.2708	6.2443	1.3109						19.8260
D. Wastewater Treatment and Discharge		255.0776	53.6146						308.6921
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**47.3142**	**0.0701**	**0.4520**						**47.8362**
Aviation	47.3142	0.0701	0.4520						47.8362
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	403.3840								403.3840
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			222.7835						222.7835
Indirect CO_2	68.5241								68.5241
								Total (without LULUCF)	**13,234.9283**
								Total (with LULUCF)	**12,308.1177**

2013

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**7,856.1559**	**2,734.2678**	**1,546.5047**	**108.3873**	**0.0403**	**0.9651**	**NO**	**NO**	**12,246.3211**
1. Energy	**8,232.5336**	**682.2318**	**65.3880**						**8,980.1535**
A. Fuel Combustion (Sectoral approach)	8,230.8896	62.2748	65.3853						8,358.5497
1. Energy Industries	3,603.6566	1.6985	5.6270						3,610.9821
2. Manufacturing Industries and Construction	575.6355	0.7487	1.2427						577.6270
3. Transport	2,101.3096	10.2152	34.3692						2,145.8940
4. Other Sectors	1,947.9381	49.6054	24.1133						2,021.6567
5. Other	2.3497	0.0071	0.0332						2.3899
B. Fugitive Emissions from Fuels	1.6441	619.9570	0.0027						621.6037
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.6441	619.9570	0.0027						621.6037
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**623.2187**	**NO**	**NO**	**108.3873**	**0.0403**	**0.9651**	**NO**	**NO**	**732.6114**
A. Mineral Industry	544.9842								544.9842
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	7.6569	NO	NO	NO	NO	NO	NO	NO	7.6569
D. Non-Energy Products From Fuels and Solvent Use	69.4810	NO	NO						69.4810
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				108.3873	NO	NO	NO	NO	108.3873

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
G. Other Product Manufacture and Use	1.0965	NO	NO	NO	0.0403	0.9651	NO	NO	2.1020
H. Other									
3. Agriculture	**4.1840**	**702.7643**	**1,207.8645**						**1,914.8127**
A. Enteric Fermentation		634.8631							634.8631
B. Manure Management		67.9012	333.8296						401.7308
C. Rice Cultivation		NO							NO
D. Agricultural Soils			874.0349						874.0349
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	4.1840								4.1840
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,015.6837**	**0.8718**	**217.2510**						**-797.5610**
A. Forest Land	-2,141.8702	0.8059	0.5314						-2,140.5329
B. Cropland	1,413.3777	0.0659	0.0204						1,413.4639
C. Grassland	-360.1740	NE	NE						-360.1740
D. Wetlands	-106.0998	NE	NE						-106.0998
E. Settlements	13.7512	NO, NE	216.6993						230.4505
F. Other Land	103.4500	NE	NE						103.4500
G. Harvested Wood Products	61.8814								61.8814
H. Other	NE	NE	NE						NE
5. Waste	**11.9033**	**1,348.4000**	**56.0012**						**1,416.3044**
A. Solid Waste Disposal	NA, NO	1,084.7685							1,084.7685
B. Biological Treatment of Solid Waste		1.2142	0.8684						2.0826
C. Incineration and Open Burning of Waste	11.9033	6.0604	1.2720						19.2357
D. Wastewater Treatment and Discharge		256.3568	53.8608						310.2176
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**41.0717**	**0.1149**	**0.3986**						**41.5852**
Aviation	41.0717	0.1149	0.3986						41.5852
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	429.2796								429.2796
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			247.1941						247.1941
Indirect CO_2	63.2239								63.2239
								Total (without LULUCF)	**13,043.8821**
								Total (with LULUCF)	**12,246.3211**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**8,109.0510**	**2,771.5588**	**1,720.8509**	**121.5640**	**0.0403**	**1.0540**	**NO**	**NO**	**12,724.1190**
1. Energy	**8,100.9817**	**709.8746**	**72.1910**						**8,883.0474**
A. Fuel Combustion (Sectoral approach)	8,099.3097	114.5519	72.1883						8,286.0499
1. Energy Industries	3,562.1775	1.8805	2.4669						3,566.5248
2. Manufacturing Industries and Construction	443.8148	0.3475	0.5251						444.6875
3. Transport	2,140.5749	10.1395	31.8915						2,182.6059
4. Other Sectors	1,927.7357	102.1699	37.1642						2,067.0698
5. Other	25.0067	0.0145	0.1406						25.1618
B. Fugitive Emissions from Fuels	1.6721	595.3227	0.0027						596.9975
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.6721	595.3227	0.0027						596.9975
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**637.7956**	**NO**	**NO**	**121.5640**	**0.0403**	**1.0540**	**NO**	**NO**	**760.4540**
A. Mineral Industry	535.5064								535.5064
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	13.8464	NO	NO	NO	NO	NO	NO	NO	13.8464
D. Non-Energy Products From Fuels and Solvent Use	87.2367	NO	NO						87.2367
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				121.5640	NO	NO	NO	NO	121.5640
G. Other Product Manufacture and Use	1.2062	NO	NO	NO	0.0403	1.0540	NO	NO	2.3005
H. Other									
3. Agriculture	**10.2058**	**723.0006**	**1,390.7607**						**2,123.9671**
A. Enteric Fermentation		652.5791							652.5791
B. Manure Management		70.4215	367.5888						438.0103
C. Rice Cultivation		NO							NO
D. Agricultural Soils			1,023.1720						1,023.1720
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	10.2058								10.2058
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-651.4692**	**0.1169**	**202.4681**						**-448.8843**
A. Forest Land	-2,134.7390	0.0663	0.0437						-2,134.6291
B. Cropland	1,450.4798	0.0506	0.0156						1,450.5461
C. Grassland	-341.1085	NE	NE						-341.1085
D. Wetlands	-139.7535	NE	NE						-139.7535
E. Settlements	18.9848	NO, NE	202.4088						221.3936
F. Other Land	436.6463	NE	NE						436.6463
G. Harvested Wood Products	58.0208								58.0208
H. Other	NE	NE	NE						NE
5. Waste	**11.5371**	**1,338.5668**	**55.4310**						**1,405.5348**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
A. Solid Waste Disposal	NA, NO	1,083.0800							1,083.0800
B. Biological Treatment of Solid Waste		1.2701	0.9084						2.1785
C. Incineration and Open Burning of Waste	11.5371	5.8782	1.2334						18.6487
D. Wastewater Treatment and Discharge		248.3385	53.2891						301.6276
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**53.6855**	**0.0852**	**0.5281**						**54.2988**
Aviation	53.6855	0.0852	0.5281						54.2988
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	1,314.4896								1,314.4896
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			289.0993						289.0993
Indirect CO_2	81.0677								81.0677
								Total (without LULUCF)	**13,173.0033**
								Total (with LULUCF)	**12,724.1190**

2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**7,952.0481**	**2,723.3498**	**1,465.7916**	**153.8517**	**0.0403**	**1.0542**	**NO**	**NO**	**12,296.1358**
1. Energy	**8,414.0596**	**688.5558**	**79.8628**						**9,182.4782**
A. Fuel Combustion (Sectoral approach)	8,412.4014	121.9541	79.8601						8,614.2156
1. Energy Industries	3,686.3133	1.6479	1.9977						3,689.9589
2. Manufacturing Industries and Construction	651.5441	1.0120	1.6369						654.1931
3. Transport	2,261.5959	10.7128	35.6677						2,307.9763
4. Other Sectors	1,790.2120	108.5694	40.4338						1,939.2152
5. Other	22.7360	0.0120	0.1241						22.8721
B. Fugitive Emissions from Fuels	1.6581	566.6018	0.0027						568.2626
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.6581	566.6018	0.0027						568.2626
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**607.8444**	**NO**	**NO**	**153.8517**	**0.0403**	**1.0542**	**NO**	**NO**	**762.7907**
A. Mineral Industry	505.0564								505.0564
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	17.2792	NO	NO	NO	NO	NO	NO	NO	17.2792
D. Non-Energy Products From Fuels and Solvent Use	84.5691	NO	NO						84.5691
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				153.8517	NO	NO	NO	NO	153.8517

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
G. Other Product Manufacture and Use	0.9397	NO	NO	NO	0.0403	1.0542	NO	NO	2.0343
H. Other									
3. Agriculture	**11.2402**	**698.0678**	**1,139.1383**						**1,848.4464**
A. Enteric Fermentation		629.2090							629.2090
B. Manure Management		68.8589	356.1825						425.0414
C. Rice Cultivation		NO							NO
D. Agricultural Soils			782.9558						782.9558
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	11.2402								11.2402
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-1,094.4097**	**0.6531**	**190.2643**						**-903.4922**
A. Forest Land	-2,159.4439	0.6146	0.4052						-2,158.4241
B. Cropland	1,391.0666	0.0386	0.0119						1,391.1171
C. Grassland	-418.4569	NE	NE						-418.4569
D. Wetlands	-82.7917	NE	NE						-82.7917
E. Settlements	39.1617	NO, NE	189.8472						229.0089
F. Other Land	86.8192	NE	NE						86.8192
G. Harvested Wood Products	49.2353								49.2353
H. Other	NE	NE	NE						NE
5. Waste	**13.3135**	**1,336.0730**	**56.5261**						**1,405.9127**
A. Solid Waste Disposal	NA, NO	1,087.1715							1,087.1715
B. Biological Treatment of Solid Waste		1.2707	0.9088						2.1795
C. Incineration and Open Burning of Waste	13.3135	6.8029	1.4258						21.5422
D. Wastewater Treatment and Discharge		240.8280	54.1915						295.0195
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
Memo Items									
International Bunkers	**56.8077**	**0.1395**	**0.5458**						**57.4930**
Aviation	56.8077	0.1395	0.5458						57.4930
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	1,428.4386								1,428.4386
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			233.7742						233.7742
Indirect CO_2	77.8743								77.8743
								Total (without LULUCF)	**13,199.6280**
								Total (with LULUCF)	**12,296.1358**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**8,278.4511**	**2,798.7309**	**1,604.4145**	**163.2067**	**0.0403**	**1.0822**	**NO**	**NO**	**12,845.9258**
1. Energy	**8,506.6885**	**742.5834**	**85.6644**						**9,334.9363**
A. Fuel Combustion (Sectoral approach)	8,505.0181	131.4923	85.6644						8,722.1748
1. Energy Industries	3,644.9312	1.6434	2.0586						3,648.6333
2. Manufacturing Industries and Construction	641.3590	0.8631	1.4070						643.6290
3. Transport	2,428.3819	12.4139	40.8280						2,481.6237
4. Other Sectors	1,767.4874	116.5604	41.2504						1,925.2983
5. Other	22.8586	0.0116	0.1204						22.9905
B. Fugitive Emissions from Fuels	1.6704	611.0910	0.0027						612.7641
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.6704	611.0910	0.0027						612.7641
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**583.6350**	**NO**	**NO**	**163.2067**	**0.0403**	**1.0822**	**NO**	**NO**	**747.9643**
A. Mineral Industry	492.5454								492.5454
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	5.2203	NO	NO	NO	NO	NO	NO	NO	5.2203
D. Non-Energy Products From Fuels and Solvent Use	84.8044	NO	NO						84.8044
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				163.2067	NO	NO	NO	NO	163.2067
G. Other Product Manufacture and Use	1.0649	NO	NO	NO	0.0403	1.0822	NO	NO	2.1875
H. Other									
3. Agriculture	**12.2747**	**692.9104**	**1,282.3315**						**1,987.5167**
A. Enteric Fermentation		622.0031							622.0031
B. Manure Management		70.9073	367.3776						438.2849
C. Rice Cultivation		NO							NO
D. Agricultural Soils			914.9539						914.9539
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	12.2747								12.2747
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-837.1816**	**0.3568**	**179.2669**						**-657.5580**
A. Forest Land	-2,115.7622	0.3085	0.2034						-2,115.2503
B. Cropland	1,391.9179	0.0483	0.0149						1,391.9811
C. Grassland	-402.3693	NE	NE						-402.3693
D. Wetlands	-82.7917	NE	NE						-82.7917
E. Settlements	19.3071	NO, NE	179.0485						198.3556
F. Other Land	351.6349	NE	NE						351.6349
G. Harvested Wood Products	0.8816								0.8816
H. Other	NE	NE	NE						NE

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
5. Waste	**13.0346**	**1,362.8803**	**57.1517**						**1,433.0666**
A. Solid Waste Disposal	NA, NO	1,115.1732							1,115.1732
B. Biological Treatment of Solid Waste		1.2631	0.9034						2.1665
C. Incineration and Open Burning of Waste	13.0346	6.6672	1.3968						21.0986
D. Wastewater Treatment and Discharge		239.7768	54.8516						294.6284
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items									
International Bunkers	**100.9698**	**0.1538**	**0.9827**						**102.1063**
Aviation	100.9698	0.1538	0.9827						102.1063
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	1,600.9890								1,600.9890
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			264.1134						264.1134
Indirect CO_2	77.9170								77.9170
								Total (without LULUCF)	**13,503.4838**
								Total (with LULUCF)	**12,845.9258**

2017

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**7,726.7513**	**2,925.9311**	**1,694.3354**	**182.4923**	**0.0403**	**1.1116**	**NO**	**NO**	**12,530.6620**
1. Energy	**7,978.8973**	**821.3666**	**99.2645**						**8,899.5284**
A. Fuel Combustion (Sectoral approach)	7,977.2397	173.7422	99.2644						8,250.2463
1. Energy Industries	2,883.9360	1.3082	1.5765						2,886.8208
2. Manufacturing Industries and Construction	658.7329	0.9030	1.5066						661.1426
3. Transport	2,451.2514	12.0951	0.1069						2,463.4534
4. Other Sectors	1,960.6971	159.4299	55.8319						2,175.9589
5. Other	22.6223	0.0060	0.1069						22.7351
B. Fugitive Emissions from Fuels	1.6576	647.6244	0.0027						649.2847
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.6576	647.6244	0.0027						649.2847
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**593.1469**	**NO**	**NO**	**182.4923**	**0.0403**	**1.1116**	**NO**	**NO**	**776.7911**
A. Mineral Industry	476.0597								476.0597
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	18.8842	NO	NO	NO	NO	NO	NO	NO	18.8842
D. Non-Energy Products From Fuels and Solvent Use	97.0273	NO	NO						97.0273
E. Electronic Industry				NO	NO	NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
F. Product Use as Substitutes for ODS				182.4923	NO	NO	NO	NO	182.4923
G. Other Product Manufacture and Use	1.1757	NO	NO	NO	0.0403	1.1116	NO	NO	2.3277
H. Other									
3. Agriculture	**26.2081**	**647.6104**	**1,364.0727**						**2,037.8912**
A. Enteric Fermentation		577.9552							577.9552
B. Manure Management		69.6553	349.5395						419.1947
C. Rice Cultivation		NO							NO
D. Agricultural Soils			1,014.5332						1,014.5332
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	26.2081								26.2081
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-886.1457**	**0.4984**	**171.8485**						**-713.7989**
A. Forest Land	-2,016.4373	0.4258	0.2808						-2,015.7307
B. Cropland	1,369.0793	0.0726	0.0224						1,369.1743
C. Grassland	-384.0392	NE	NE						-384.0392
D. Wetlands	-82.8162	NE	NE						-82.8162
E. Settlements	77.3098	NO, NE	171.5452						248.8550
F. Other Land	218.2055	NE	NE						218.2055
G. Harvested Wood Products	-67.4476								-67.4476
H. Other	NE	NE	NE						NE
5. Waste	**14.6448**	**1,456.4556**	**59.1497**						**1,530.2502**
A. Solid Waste Disposal	NA, NO	1,211.7264							1,211.7264
B. Biological Treatment of Solid Waste		1.4458	1.0341						2.4799
C. Incineration and Open Burning of Waste	14.6448	7.5036	1.5709						23.7193
D. Wastewater Treatment and Discharge		235.7799	56.5448						292.3246
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items									
International Bunkers	**148.2788**	**0.1454**	**1.4311**						**149.8553**
Aviation	148.2788	0.1454	1.4311						149.8553
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	2,122.7228								2,122.7228
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			282.4208						282.4208
Indirect CO_2	90.1477								90.1477
								Total (without LULUCF)	**13,244.4609**
								Total (with LULUCF)	**12,530.6620**

2018

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**8,522.2288**	**2,925.9877**	**1,703.6191**	**194.4750**	**0.0403**	**1.3284**	**NO**	**NO**	**13,347.6794**
1. Energy	**8,426.8382**	**868.3031**	**114.1458**						**9,409.2870**
A. Fuel Combustion (Sectoral approach)	8,425.1725	265.7950	114.1457						8,805.1132
1. Energy Industries	3,177.3538	1.4469	1.7477						3,180.5484
2. Manufacturing Industries and Construction	748.6264	1.0300	1.7288						751.3852
3. Transport	2,529.5979	12.5597	39.7569						2,581.9145
4. Other Sectors	1,946.2502	250.7521	70.8021						2,267.8044
5. Other	23.3443	0.0062	0.1103						23.4607
B. Fugitive Emissions from Fuels	1.6657	602.5081	0.0027						604.1765
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.6657	602.5081	0.0027						604.1765
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**763.3854**	**NO**	**NO**	**194.4750**	**0.0403**	**1.3284**	**NO**	**NO**	**959.2291**
A. Mineral Industry	590.9800								590.9800
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	20.2133	NO	NO	NO	NO	NO	NO	NO	20.2133
D. Non-Energy Products From Fuels and Solvent Use	151.1808	NO	NO						151.1808
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				194.4750	NO	NO	NO	NO	194.4750
G. Other Product Manufacture and Use	1.0114	NO	NO	NO	0.0403	1.3284	NO	NO	2.3801
H. Other									
3. Agriculture	**43.3624**	**586.2345**	**1,363.3633**						**1,992.9602**
A. Enteric Fermentation		516.4012							516.4012
B. Manure Management		69.8333	309.0862						378.9195
C. Rice Cultivation		NO							NO
D. Agricultural Soils			1,054.2771						1,054.2771
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	43.3624								43.3624
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**-725.6453**	**0.1700**	**165.3869**						**-560.0883**
A. Forest Land	-1,969.3582	0.1465	0.0966						-1,969.1152
B. Cropland	1,487.3577	0.0235	0.0073						1,487.3885
C. Grassland	-440.1513	NE	NE						-440.1513
D. Wetlands	-82.8253	NE	NE						-82.8253
E. Settlements	21.6217	NO, NE	165.2831						186.9048
F. Other Land	321.2138	NE	NE						321.2138
G. Harvested Wood Products	-63.5037								-63.5037
H. Other	NE	NE	NE						NE
5. Waste	**14.2880**	**1,471.2802**	**60.7231**						**1,546.2913**
A. Solid Waste Disposal	NA, NO	1,223.5561							1,223.5561

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
B. Biological Treatment of Solid Waste		1.3036	0.9324						2.2360
C. Incineration and Open Burning of Waste	14.2880	7.3280	1.5335						23.1496
D. Wastewater Treatment and Discharge		239.0924	58.2573						297.3497
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items									
International Bunkers	**170.4060**	**0.1782**	**1.7154**						**172.2996**
Aviation	170.4060	0.1782	1.7154						172.2996
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	3,567.9567								3,567.9567
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			285.8518						285.8518
Indirect CO_2	143.8072								143.8072
								Total (without LULUCF)	**13,907.7677**
								Total (with LULUCF)	**13,347.6794**

2019

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	**9,526.1314**	**2,616.1543**	**1,732.0603**	**229.9469**	**0.0403**	**1.4306**	**NO**	**NO**	**14,105.7639**
1. Energy	**8,577.9507**	**629.7143**	**114.0029**						**9,321.6679**
A. Fuel Combustion (Sectoral approach)	8,576.3417	233.8722	114.0002						8,924.2142
1. Energy Industries	3,120.4282	1.4026	1.6863						3,123.5171
2. Manufacturing Industries and Construction	715.9769	0.9489	1.5501						718.4760
3. Transport	2,611.5823	12.4582	41.4206						2,665.4611
4. Other Sectors	2,105.4914	219.0565	69.2351						2,393.7830
5. Other	22.8629	0.0060	0.1080						22.9770
B. Fugitive Emissions from Fuels	1.6090	395.8421	0.0027						397.4538
1. Solid Fuels	NO	NO	NO						NO
2. Oil and Natural Gas	1.6090	395.8421	0.0027						397.4538
C. CO_2 Transport and Storage	NO								NO
2. Industrial Processes and Product Use	**760.7727**	**NO**	**NO**	**229.9469**	**0.0403**	**1.4306**	**NO**	**NO**	**992.1906**
A. Mineral Industry	600.3437								600.3437
B. Chemical Industry	NO	NO	NO						NO
C. Metal Industry	15.7926	NO	NO	NO	NO	NO	NO	NO	15.7926
D. Non-Energy Products From Fuels and Solvent Use	143.5292	NO	NO						143.5292
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product Use as Substitutes for ODS				229.9469	NO	NO	NO	NO	229.9469
G. Other Product Manufacture and Use	1.1072	NO	NO	NO	0.0403	1.4306	NO	NO	2.5781
H. Other									
3. Agriculture	**39.6306**	**508.2390**	**1,395.6062**						**1,943.4759**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
A. Enteric Fermentation		441.6456							441.6456
B. Manure Management		66.5935	278.4665						345.0599
C. Rice Cultivation		NO							NO
D. Agricultural Soils			1,117.1398						1,117.1398
E. Prescribed Burning of Savannas		NO	NO						NO
F. Field Burning of Agricultural Residues		IE	IE						IE
G. Liming	NO								NO
H. Urea Application	39.6306								39.6306
I. Other Carbon-Containing Fertilizers	NO, NE								NO, NE
J. Other	NO	NO	NO						NO
4. LULUCF	**133.8653**	**0.3937**	**161.5278**						**295.7869**
A. Forest Land	-1,950.6476	0.3521	0.2322						-1,950.0633
B. Cropland	1,789.8845	0.0416	0.0129						1,789.9390
C. Grassland	-293.2923	NE	NE						-293.2923
D. Wetlands	-82.8099	NE	NE						-82.8099
E. Settlements	116.5030	NO, NE	161.2828						277.7857
F. Other Land	611.7881	NE	NE						611.7881
G. Harvested Wood Products	-57.5604								-57.5604
H. Other	NE	NE	NE						NE
5. Waste	**13.9120**	**1,477.8072**	**60.9234**						**1,552.6426**
A. Solid Waste Disposal	NA, NO	1,231.5881							1,231.5881
B. Biological Treatment of Solid Waste		1.3965	0.9988						2.3952
C. Incineration and Open Burning of Waste	13.9120	7.1455	1.4945						22.5520
D. Wastewater Treatment and Discharge		237.6771	58.4302						296.1073
E. Other	NO	NO	NO						NO
6. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items									
International Bunkers	**151.5015**	**0.1369**	**1.5333**						**153.1717**
Aviation	151.5015	0.1369	1.5333						153.1717
Navigation	NO	NO	NO						NO
Multilateral Operations	**NO**	**NO**	**NO**						**NO**
CO_2 Emissions from Biomass	2,963.2154								2,963.2154
CO_2 Captured and Stored	NO								NO
Long-term Storage of C in Waste Disposal Sites	NE								NE
Indirect N_2O			295.7271						295.7271
Indirect CO_2	136.1265								136.1265
								Total (without LULUCF)	**13,809.9770**
								Total (with LULUCF)	**14,105.7639**