National Inventory Report

Greenhouse Gas Sources and Sinks in the Republic of Moldova

1990-2010

Submission to the United Nations
Framework Convention on Climate Change
Chisinau, 2013

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF MOLDOVA

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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 report to the Conference of the Parties (COP) data on emissions (by types of sources) and sinks (by types of storage) of all greenhouse gases (GHG) that do not fall under the Montreal Protocol.

This Report has been developed within the „Republic of Moldova: Enabling Activities for the Preparation of the Third National Communication under the United Nations Framework Convention on Climate Change" Project, implemented by the Ministry of Environment (MoEN) and United Nations Environment Programme (UNEP), with financial support of the Global Environment Facility (GEF), from October 2010 through September 2013.

The National Inventory Report reflects the efforts made by the National Inventory Team during 2010-2013, including previous results obtained under the UNEP-GEF Project „Republic of Moldova: Enabling Activities for the preparation of the Second National Communication under the United Nations Framework Convention on Climate Change", that ended with the National Inventory Report:1990-2005, Greenhouse Gas Sources and Sinks in the Republic of Moldova (submitted to UNFCCC on January 27, 2010); also the results obtained based on UNDP-GEF Regional Project „Capacity Building for Improving the Quality of Greenhouse Gas National Inventories (Central Europe and CIS countries)", that ended with the National Inventory Report of the Republic of Moldova: 1990-2002 (unpublished); as well as the results obtained under the UNDP-GEF Project „Republic of Moldova: Enabling Activities for the Preparation of the First National Communication under the United Nations Framework Convention on Climate Change" that ended with the preparation of the national inventory for the period from 1990 through 1998, included in the First National Communication of the Republic of Moldova (submitted to UNFCCC on November 13, 2000).

Besides the inventory results, the Report contains additional relevant data, as well as the analysis of recent trends in GHG emissions and sinks in the Republic of Moldova, the analysis of key-emission sources, additional sectoral data used in emission inventory, data regarding the activities related to inventory quality control and uncertainty management.

The United Nations Framework Convention on Climate Change 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 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 the continuous improvement of the quality of national inventories. Through the series of initiatives that 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 publication of the first national inventory for the period from 1990 through 1998, an impressive number of persons in the Republic of Moldova expressed interest for the climate change phenomenon, and particularly, for greenhouse gas emissions. Though this interest generated numerous research activities, only a limited number were focused on the process of quantitative evaluation of emissions and development of national emission factors.

Despite the fact that there will always be emissions evaluation associated uncertainties, the monitoring process will continue, both in the Republic of Moldova, and internationally, in view of improving the quality of inventory and reducing the greenhouse gas associated uncertainties.

Un independent intern peer review of the quality of the national inventory of the Republic of Moldova for 1990-2010 time periods was made in June-July 2013 by relevant national experts, previously not involved in the national inventory compilation activities, representing public institutions (State Ecological Inspectorate), universities (Technical University of Moldova, State Agrarian University of Moldova), research and development institutes (Institute of Power Engineering and Institute of Pedology, Agrochemistry and Soil Protection „N. Dimo" of the Academy of Sciences of Moldova and Agribusiness and Rural Development Management Institute).

The findings of this peer review allowed to identify 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 storage) within the greenhouse gas national inventory of the Republic of Moldova.

Dr. Vasile Scorpan
30 June, 2013

Manager, Climate Change Office,
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We also want to thank PhD Mihai Tirsu, Deputy Director, Institute of Power Engineering of the Academy of Sciences of Moldova, for his contribution to GHG Inventory Quality Assessment in Energy Sector, PhD Natalia Begleț, associate professor, Chair "Heating and Gas Supply, Ventilation", Faculty of Urbanism and Architecture, the Technical University of Moldova, for her contribution to GHG Inventory Quality Assessment in Industrial Processes Sector and PhD Andrei Chiciuc, head of the Department for Management Quality, the Technical University of Moldova, associate professor, Chair "Electromechanics and Metrology", Faculty of Energetics, for his contribution to GHG Inventory Quality Assessment in Solvent and Other Product Use Sector, prof. PhD. Nicolae Bucataru, Deputy Director, the Agribusiness and Rural Development Management Institute, for his contribution to GHG Inventory Quality Assessment in Agriculture Sector, source categories 4A "Enteric fermentation" and 4B "Manure Management", Dr. Tamara Leah, Deputy Director,the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo", for her contribution to GHG Inventory Quality Assessment in Agriculture Sector, source category 4D "Agricultural Soils", and in the Land Use, Land-Use Change and Forestry Sector, category 5B "Cropland", Mr. Victor Svecla, forestry engineer, senior lecturer, Chair "Forestry and Public Gardens", Faculty of Horticulture, the State Agrarian University of Moldova, for his contribution to GHG Inventory Quality Assessment in the Land Use, Land-Use Change and Forestry Sector, the categories 5A "Forest Land" and 5C "Grassland" and Ms. Veronica Andronic, Head of Division „Soil protection, management of wastes and chemical substances", the State Ecological Inspectorate, for her contribution to GHG Inventory Quality Assessment in the Waste Sector.

This chapter would be incomplete, without thanks to Dr. Vasile Scorpan, the project manager of UNEP-GEF Project "Republic of Moldova: Enabling Activities for the Preparation of the Third National Communication under the United Nations Framework Convention on Climate Change", for his continuous involvement during project implementation, in the successful implementation of the activities stipulated in the Terms of Reference of the National Inventory Team.

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

ABS	Acrilonitril Butadien Styrene
AD	Activity Data
Al	Aluminium
Al_2O_3	Aluminium oxide
$Area_{(T)}$	Total annual area harvested of crop *T*
Area burnt $_{(T)}$	Annual area of crop *T* burnt (stubble fields burning)
ASH	Ash content of the manure in per cent
ASM	Academy of Science of Moldova
a.s.	Active substance
ATD	Atmospheric Deposition
ATULBD	Administrative-Territorial Units on the Left Bank of Dniester
B	Billion
B_0	Maximum methane producing capacity
BEF_I	Biomass expansion factor for conversion of annual net increment to aboveground tree biomass increment
BOD	Biochemical Oxygen Demand
BWTP	Biological Wastewater Treatment Plants
BOF	Basic Oxygen Furnaces
BW	Average live body weight of animal
^0C	Celsius degrees
C	Carbon
c	Flight cycle: cruise
C_a	Animal Feeding Situation Coefficient
CA	Honrbeam species (Carpinsus ssp.)
CAA	Civil Aeronautical Authority
$CaCO_3$	Limestone
$CaCO_3$•$MgCO_3$	Dolomite
CaO	Lime
CaO • MgO	Dolomite lime
CCO	Climate Change Office
C_f	Burning coefficient (used to keep account of incomplete burning related aspects)
CF	Carbon fraction in biomass
CF_4	Perfuoromethane
C_2F_6	Hexafluoroethane
C_3F_8	Perfluorpropan
C_4F_{10}	Perfluorbutan
c-C_4F_8	Perfluorociclobutan
C_5F_{12}	Perfluoropentan
C_6F_{14}	Perfluorohexan
CFC	Chlorofluorocarbons
CHP	Combined Heat and Power Plant
CH_4	Methane
$C_6H_{12}O_6$	Glucose
C_2H_5OH	Ethanol
CIS	Commonwealth of Independent States
CKD	Cement Kiln Dust)
CO	Carbon monoxide
CO_2	Carbon dioxide
$CO(NH_2)_2$	Urea (carbamide)
COP	Conference of the Parties
CORINAIR	Atmospheric Emission Inventory Guidebook, developed by European Environment Agency
cm	centimeter
cm^2	Square centimeter
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
dm	Dry matter
DOC	Degradable Organic Carbon
DOC_F	Dissimilated DOC fraction
DRY	Dry matter fraction of harvested crop
DS	Fraction of organic component removed with sludge
EAF	Electric Arc Furnace
EE	Eastern Europe
EBs	Energy Balances
eq.	Equivalent
EV_{milk}	Energy value for milk
EU	European Union
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 urine and dung N deposited by grazing animals on pasture, range and paddock
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
Fe_2O_3	Iron oxide
FE	Emission Factor
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 NH_3 and NO_x
$Frac_{GASM}$	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
g	grams
G_w	Average annual above and belowground biomass increment
GBP	Good Practice Guidance
Gcal	Gigacalory
GDP	Gross Domestic Product
g.c.e.	Grams coal equivalent
GE	Gross Energy
GEF	Global Environment Fund
GHG	Greenhouse Gas
Gg	Gigagram = 10^9 gram
GWP	Global Warming Potential
GPG	Good Practice Guidance
GSTS	Gas-Steam Turbine Systems
H	Annually extracted volume, round wood
ha	Hectare
HDP	High Density Polyethylene
HFC	Hidrofluorocarbons
hl	Hectolitre
HNO_3	Nitric acid
HP	Heat Plant
I_v	Average annual net increment in volume suitable for industrial processing
IE	Included Elsewhere
IPCC	Intergovernmental Panel for Climate Change
J.S.C.	Joint Stock Company
k	Methane generation rate constant
kg	kilogram
km	kilometer
km^2	square kilometer
kPa	kilopascal
KS	Key Sources
KSA	Key Sources Assessment
kt	kiloton
kW	kilowatt
kWh	kilowatt-hour
l	Liter
L	Level
$L_{fellings}$	Annual carbon loss due to commercial fellings
L_0	Methane Generation Potential
LBD	Left Bank of Dniester River
LDP	Low Density Polyethylene
LDLP	Low Density Linear Polyethylene
LEDS	Low Emission Development Strategy
Ltd.	Limited Liability Company
LTO	Cycle: Landing/Take Off
LULUCF	Land Use, Land-Use Change and Forest
m	meter
m^2	square meter
m^3	cubic meter

MAFI	Ministry of Agriculture and Food Industry
MCF	Methane Correction Factor
MEC	Ministry of Economy
MD	Ministry of Defense
MITC	Ministry of Information Technology and Communication
MH	Ministry of Health
MoEN	Ministry of Environment
MgO	magnesia
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*
MSW	Municipal Solid Wastes
MTPP	Moldovan Thermal Power Plant in Dnestrovsk
MTRI	Ministry of Transport and Road Infrastructure
Mt	megatone = 10^6 tone
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_2	Molecular nitrogen
$N_{AG\ (T)}$	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_2CO_3	Natron
NA	Non Applicable
Nex	Nitrogen excretion rate
NAMA	National Appropriate Mitigation Actions
NBS	National Bureau of Statistics
NaOH	Sodium Hydroxide (caustic soda)
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
NH_3	Ammonia
NH_4^+	Ammonium
NH_4NO_3	Ammonia Nitrate
$NH_4H_2PO_4$	Monoammonium phosphate
$(NH_4)_2HPO_4$	Diammonium phosphate
NIR	National Inventory Report
NMVOC	Non Methane Volatile Organic Compounds
NO	Not Occuring
NO_x	Nitrogen Oxides
NO_3^-	Nitrate
N_2O	Nitrous oxide
N_2O_{ATD}	Indirect emissions of N_2O 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 emissions of N_2O
N_2O_{IND}	Indirect emissions of N_2O
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 dung 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
ODS	Ozone-Depleting Substances
OHF	Open hearth furnace
ON	Organic nitrogen
p	*p* Value

PA	Species of sycamore maple tree (Acer spp.)
PARE	Public Association of Refrigerating Engineers in the Republic of Moldova
P_{EQ}	Population equivalent number
Pag.	Page
PFC	Perfluorocarbons
PI	Species of pine (Pinus spp.)
PJ	Petajoule = 10^{15} Joule
PL	Species of poplar (Populus spp.)
ppb	Parts per billion of volume
ppm	Parts per million of volume
PPP	Public-Private Partnership
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*
RB	Species of acacia (Robinia spp.)
RBD	Right Bank of Dniester River
$R_{BG\,(T)}$	Ratio of below-ground residues to harvested yield for crop *T*
REG	Ratio of net energy available for growth in a diet to digestible energy consumed
REM	Ratio of net energy available in diet for maintenance to digestible energy consumed
RM	Republic of Moldova
SEI	State Ecological Inspectorate
SF_6	Sulphur hexafluoride
SHS	State Hydrometeorological Service
SiO_2	Silicon oxide
SM	Emissions from sludge treatment
SN	Synthetic Nitrogen fertilizers
SNC	Second National Communication
SO_2	Sulphur dioxide
SOE	State Owned Enterprise
SS_{ix}	Fraction of anaerobically treated sludge
SSS	State Statistical Service
SW	Species of willow (Salix spp.)
SWDS	Solid Waste Disposal Sites
SY	Statistical Yearbook
σ	Standard Error
t	ton
T	Trend
T1	Tier 1 Methodological approach
T2	Tier 2 Methodological approach
TAM	Typical animal mass
t.c.e.	Tons of coal equivalent
TI	Species of linden tree (Tilia spp.)
TJ	Terajoule = 10^{12} Joule
TM	Emissions from wastewater and sludge treatment
TNC	Third National Communication
TOS	Total organic waste in sludge
TOW	Total organic waste in wastewater
UCET	Union for Coordination of Electricity Transportation
UL	Species of elm tree (Ulmus spp.)
UNDP	United Nations Development Programme
UN	United Nations
UNEP	United Nations Environment Program
USA	United States of America
US EPA	United States Environment 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
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
$\text{Yield Fresh}_{(T)}$	Harvested fresh yield for crop *T*
%	Per cent

CONTENTS

EXECUTIVE SUMMARY

The Convention, Kyoto Protocol 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. 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, during 1998 to 2000, under the *UNDP-GEF Project "Enabling Activities for the preparation of the FNC under the UNFCCC"*, Republic of Moldova developed its First National Communication to UNFCCC (including a national GHG inventory for a time series from 1990 through 1998), submitted to the COP 6 (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, during 2005-2009 time period, under the *UNEP-GEF Project "Enabling Activities for the preparation of the Second National Communication under the UNFCCC"*, Republic of Moldova developed its SNC under the UNFCCC (including a national GHG inventory for 1990-2005 time periods), followed by the Third National Communication under the UNFCCC developed within 2010-2013 period.

The COP 3 (Kyoto, 1997) adopted the Kyoto Protocol, representing an instrument setting binding targets for the Parties under Convention, by committing industrialized countries and economies in transition 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 2008-2012. The Republic of Moldova ratified the Kyoto Protocol on February 13, 2003 (the official date of accession was April 22, 2003). As a non-Annex I Party, the Republic of Moldova has 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 15th Conference of the Parties 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, inclusive through the implementation of Low Emission Development Strategies.

The 16th Conference of the Parties to the UNFCCC, 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 Republic of Moldova associated itself with the Copenhagen Accord 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 Republic of Moldova under this Agreement is "to reduce, to not less than 25% 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 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.

During 2010-2013, it was drawn the *Low Emissions Development Strategy of the Republic of Moldova until 2020*, a strategic document that will 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 supports overall objectives, providing strategic national context for the mitigation efforts, for which countries receive international support.

LEDS was developed in accordance with the Republic of Moldova's Governance Programme "European Integration: Freedom, Democracy, Welfare" (2011-2014), Chapter "Environmental Protection" and the provisions of chapter "Climate Change" of the European Union Association Agreement. The Strategy contains a set of measures that 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, include national appropriate mitigation actions, as provided for non-Annex I Parties to the United Nations Framework Convention on Climate Change. LEDS also provides information on implementation procedures and timeframes, as well as provisions on monitoring, measurement, reporting and assessment of the results. It is anticipated that LEDS will be approved by the Government by the end of 2013 year.

Inventory Process in the Republic of Moldova

The Ministry of Environment (MoEN) of the Republic of Moldova (RM) is the state authority responsible for the 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, MoEN is in charge for implementation the international environment treaties to which the Republic of Moldova is a Part (including Rio Conventions). Within the MoEN, the Climate Change Office is totally responsible for National Communications and National Inventory Reports preparation activities. The National Inventory Team is responsible for estimating emissions by categories of sources and removals by categories of sinks, key sources analysis, quality assurance and quality control activities, uncertainty assessment, documentation and archiving of the information related to GHG inventory preparation process.

In the process of preparing the national GHG inventory, the Climate Change Office employed a centralized approach. The national GHG inventory consists of the National Inventory Report (NIR) and the inventory itself in the IPCC standard reporting framework – a series of standardized Sectoral and Summary Report Tables.

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', Chapter 5 'Solvents and Other Products Use', Chapter 6 'Agriculture', Chapter 7 'Land Use, Land Use Change and Forests', Chapter 8 'Waste', Chapter 9 'Recalculations and Planned Improvements', 'References' and 'Annexes'.

Direct (CO_2, CH_4, N_2O, HFC and SF_6) and indirect (NO_x, CO, COVNM and SO_2) greenhouse gas emissions were estimated in compliance with methodologies provided for in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003), 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and EMEP/CORINAIR Emission Inventory Guidebook (CORINAIR, 2009).

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 central public authorities (ministries and subordinated institutions); central administrative authorities (agencies, services and bureaus), private sector and industrial associations.

The results of the key sources analysis carried out following a Tier 1 methodological approach, by use of the Key Source Calculation Tool developed by the US Environment Protection Agency (US EPA), revealed 18 key categories by level and 17 key categories by trend (including LULUCF sector), as well as 17 key categories by level and 15 key categories by trend (excluding LULUCF sector).

As a part of continuous efforts to develop an accurate, complete, consistent, transparent and reliable inventory, the Republic of Moldova developed a Quality Assurance and Quality Control Plan, the key attributes of which include detailed Tier 1 (general procedures) and Tier 2 (source-specific) procedures and standard verification and quality control forms and checklists, that serve to standardize the process of implementing quality assurance and quality control activities meant to ensure the quality of the national inventory; peer reviews (technical audits) carried out by experts not directly involved in the national inventory drafting and development process; activity data quality check, inclusive by comparing data obtained from different sources, as well as further documentation of the national inventory development process.

Inventory quality assurance activities were supported by experts representing: 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 Sector 3 'Solvents and Other Products Use'; the Agribusiness and Rural Development Management Institute and Institute of Pedology, Agrochemistry and Soil Protection 'N. Dimo' – for Sector 4 'Agriculture' and partially for Sector 5 'Land Use, Land-Use Change and Forestry'; the Forest Research and Management Institute – for Sector

5 'Land Use, Land-Use Change and Forestry'; the State Ecological Inspectorate – for Sector 6 'Waste'.

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 emissions.

Direct Greenhouse Gas Emission Trends

In 2010, the Republic of Moldova contributed with approximately 13.276 Mt CO_2 eq. to direct GHG emissions, which is 1.2 per cent increase over the 2009 emissions (13.124 Mt CO_2 eq.). In comparison with the base year level (43.260 Mt CO_2 eq.), by 2010, the Republic of Moldova has reduced its GHG emissions by 69.3% (Table S-1 and Figure S-1).

In comparison with the previous year, in 2010 the Republic of Moldova achieved an economic growth – the GDP increased approximately by 6.9 per cent.

This entailed an 5.4 per cent decrease in direct GHG intensity – the amount of GHG emitted per unit of economic activity, or in other words, overall quantity of national GHG emissions expressed in CO_2 equivalent divided by the real value of the GDP (in 2010, about 3.797 kg CO_2 eq. / US $ of GDP updated to the level of 2005 year, respectively in 2009 about 4.014 kg CO_2 eq. / US $ of GDP updated at the level of 2005 year).

From the table, it is evident that the 69.3 per cent decrease in GHG emissions over the last 20 years is in full consistency with a decrease in some important economic and social indicators: consumption of primary energy resources decreased by 77.9 per cent, electricity consumption – by 61.0 per cent, heat consumption – by 88.6 per cent, the GDP – by 41.3 per cent, population number – by 6.4 per cent, etc.

The significant reduction in national GHG emissions over the period since 1990 to 2010 is a consequence of the economic crisis characteristic for the transition to the market economy (1991-2000) in the Republic of Moldova after the breakup of the Soviet Union.

Table S -1: Republic of Moldova's total GHG Emissions and Accompanying Variables, 1990-2010

Indicators	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total GHG emissions, Mt CO_2 eq.	**43.260**	**17.381**	**10.911**	**12.940**	**12.118**	**11.389**	**13.122**	**13.124**	**13.276**
Compared to 1990, %	100.0	-59.8	-74.8	-70.1	-72.0	-73.7	-69.7	-69.7	-69.3
% to the previous year		-16.9	-8.7	3.1	-6.4	-6.0	15.2	0.0	1.2
GDP, billion 2005 US $ [1]	**5.961**	**2.390**	**2.123**	**2.989**	**3.132**	**3.228**	**3.478**	**3.270**	**3.497**
Compared to 1990, %	100.0	-59.9	-64.4	-49.9	-47.5	-45.9	-41.7	-45.1	-41.3
% to the previous year		-1.4	2.1	7.5	4.8	3.1	7.8	-6.0	6.9
GHG intensity, kg CO_2 eq. / 2005 US$ from GDP	**7.257**	**7.272**	**5.140**	**4.330**	**3.870**	**3.529**	**3.773**	**4.014**	**3.797**
Compared to1990, %	100.0	0.2	-29.2	-40.3	-46.7	-51.4	-48.0	-44.7	-47.7
% to the previous year		-15.7	-10.6	-4.1	-10.6	-8.8	6.9	6.4	-5.4
Population, millions inhabitants [2]	**4.362**	**4.348**	**4.282**	**4.148**	**4.131**	**4.115**	**4.100**	**4.090**	**4.082**
Compared 1990, %	100.0	-0.3	-1.8	-4.9	-5.3	-5.7	-6.0	-6.2	-6.4
% to the previous year		-0.1	-0.3	-0.3	-0.4	-0.4	-0.3	-0.2	-0.2
GHG per capita, tons CO_2 / per capita	**9.918**	**3.998**	**2.548**	**3.120**	**2.934**	**2.768**	**3.200**	**3.209**	**3.253**
Compared 1990, %	100.0	-59.7	-74.3	-68.5	-70.4	-72.1	-67.7	-67.6	-67.2
% to the previous year		-16.8	-8.5	3.4	-6.0	-5.6	15.6	0.3	1.4
Consumed energy, million t.c.e. [3]	**14.269**	**5.085**	**2.647**	**3.257**	**3.242**	**3.090**	**3.128**	**2.960**	**3.157**
Compared to 1990, %	100.0	-64.4	-81.4	-77.2	-77.3	-78.3	-78.1	-79.3	-77.9
% to the previous year		-23.2	-20.2	6.3	-0.5	-4.7	1.2	-5.4	6.7
Imported energy, million t.c.e. [3]	**16.703**	**5.109**	**2.535**	**3.123**	**3.080**	**3.025**	**3.006**	**2.820**	**2.960**
Compared to 1990, %	100.0	-69.4	-84.8	-81.3	-81.6	-81.9	-82.0	-83.1	-82.3
% to the previous year		-29.6	-18.0	4.2	-1.4	-1.8	-0.6	-6.2	5.0
Produced electricity, billion kWh [3]	**15.690**	**6.168**	**4.216**	**4.225**	**2.867**	**3.869**	**4.041**	**6.202**	**6.125**
Compared to 1990, %	100.0	-60.7	-73.1	-73.1	-81.7	-75.3	-74.2	-60.5	-61.0
% to the previous year		-25.4	2.6	1.1	-32.2	35.0	4.4	53.5	-1.2
Consumed electricity, billion kWh [3]	**11.426**	**7.022**	**4.620**	**5.838**	**5.485**	**5.684**	**5.732**	**5.302**	**5.257**
Compared to1990, %	100.0	-38.5	-59.6	-48.9	-52.0	-50.3	-49.8	-53.6	-54.0
% to the previous year		-9.9	-2.0	-3.1	-6.0	3.6	0.8	-7.5	-0.9
Consumed heat, million Gcal [3]	**20.983**	**6.126**	**2.673**	**3.084**	**2.903**	**2.554**	**2.553**	**2.223**	**2.397**
Compared to 1990, %	100.0	-70.8	-87.3	-85.3	-86.2	-87.8	-87.8	-89.4	-88.6
% to the previous year		-8.0	-31.4	14.8	-5.9	-12.0	0.0	-12.9	7.8

References: [1]Economic Research Service US Department of Agriculture (<http://www.ers.usda.gov/data-products/international-macroeconomic-data-set.aspx#.UXFRlKJTCQo>); [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 RM for 1990, 1993-2011 and Statistical Yearbooks of ATULBD.

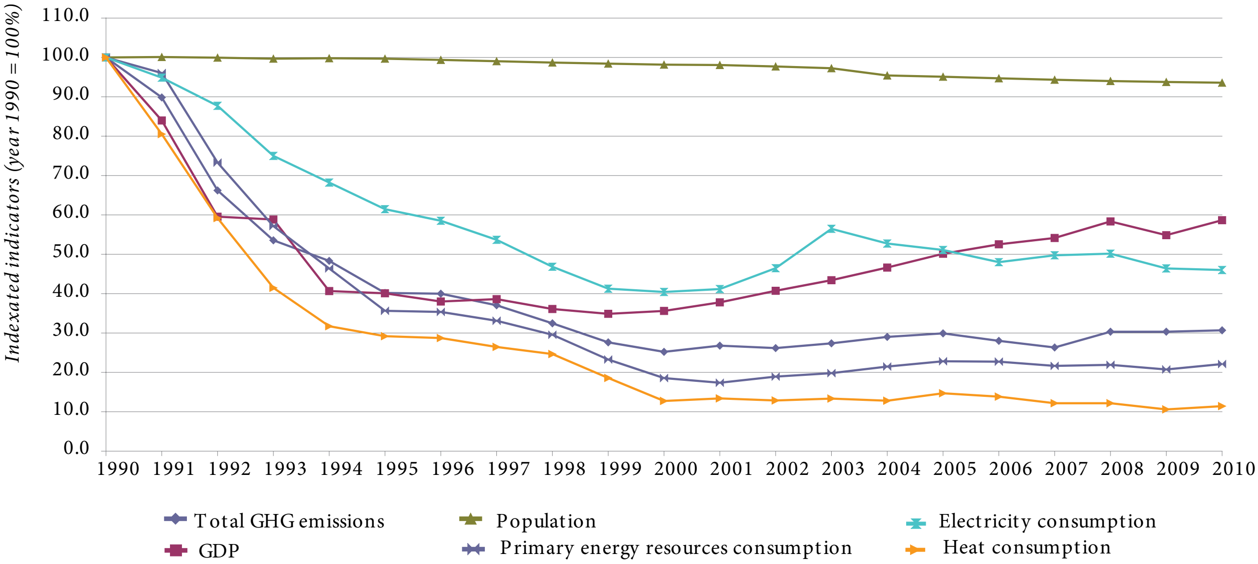


Figure S-1: Trends in Total GHG Emissions and Accompanying Variables, 1990-2010

The decrease by 67.2 per cent in GHG emissions per capita is also caused by a significant reduction of more polluting fossil fuels consumption (in particular, coal and residual fuel oil) in favour of less polluting fossil fuels (natural gases) used for generation of electricity and heat.

Table S-2 provides data on total and net GHG emissions in the Republic of Moldova in 2010. The share of CO_2 emissions in the total direct GHG emissions was 66.9 per cent, CH_4 contributed with 20.2 per cent, while N_2O emissions accounted for 12.1 per cent of the total, the share of F-gases (HFCs, PFCs, SF_6) being totally insignificant, less than 0.8 per cent of the total (Figure S-2).

In 2010, in the Republic of Moldova, approximately 67.3 per cent of the total national direct GHG emissions originated from Sector 1 „Energy". Other relevant direct GHG sources are represented by Sector 4 „Agriculture" (16.0 per cent of the total), Sector 6 „Waste" (11.9 per cent of the total) and Sector 2 „Industrial Processes" (4.2 per cent of the total). The share of two other sectors (Sector 3 „Solvents and Other Product Use" and Sector 5 „Land Use, Land-Use Change and Forestry Sector") is being insignificant, less than 1.0 per cent (Figure S-3).

The table below shows the evolution of total GHG emissions and removals in the Republic of Moldova for the time series from 1990 through 2010 (Table S-3).

As it can be noted from this table, the total national GHG emissions (excluding LULUCF) have reduced during the period under review by 69.3 per cent, from 43.260 Mt CO_2 eq. in 1990 to 13.276 Mt CO_2 eq. in 2010 (however, increasing by 1.2 per cent against the 2009 year level).

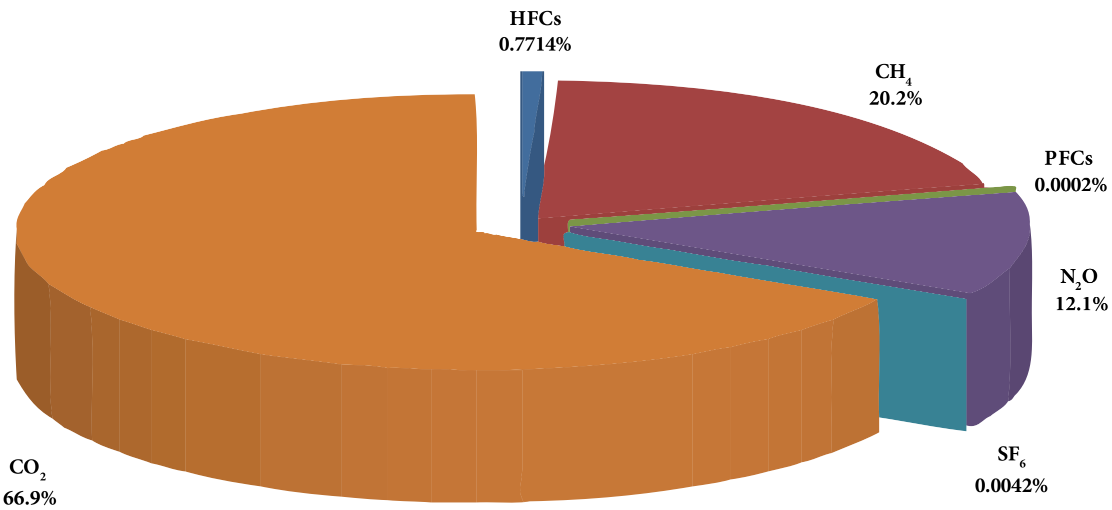


Figure S-2: Republic of Moldova's GHG Emissions by Gas, 2010

Table S-2: Republic of Moldova's Direct GHG Emissions, 2010

Categories of emissions and stocks	CO_2	CH_4		N_2O		HFC		PFC		SF_6		Total
	Gg	Gg	Gg CO_2 eq.	Gg	Gg CO_2 eq.	Gg	Gg CO_2 eq.	Gg	Gg CO_2 eq.	Gg	Gg CO_2 eq.	Gg CO_2 eq.
Total	**8885.1911**	**127.6582**	**2680.8230**	**5.1842**	**1607.0924**	**0.0748**	**102.4171**	**0.0000**	**0.0273**	**0.0000**	**0.5545**	**13276.1054**
Total net emissions	8911.3371	127.6652	2680.9697	5.1845	1607.1884	0.0748	102.4171	0.0000	0.0273	0.0000	0.5545	13302.4940
1. Energy	**8369.7595**	**25.1976**	**529.1487**	**0.1536**	**47.6150**							**8946.5232**
A. Fuel Combustion Activities	8367.8987	1.9985	41.9686	0.1536	47.6102							8457.4776
1. Energy Industries	4188.3127	0.0739	1.5513	0.0152	4.7032							4194.5671
2. Manufacturing Industries and Construction	539.2384	0.0226	0.4748	0.0031	0.9709							540.6841
3. Transport	1861.9016	0.3475	7.2973	0.1145	35.4955							1904.6945
4. Other Sectors	1653.9545	1.5470	32.4869	0.0195	6.0357							1692.4772
5. Other Works and Needs in Energy	124.4914	0.0075	0.1583	0.0013	0.4049							125.0546
B. Fugitive Emissions from Oil and Natural Gas	1.8608	23.1990	487.1800	0.0000	0.0047							489.0456
1. Solid Fuels	NO	NO	NO	NO	NO							NO
2. Oil and Natural Gas	1.8608	23.1990	487.1800	0.0000	0.0047							489.0456
2. Industrial Processes	**461.5626**	**0.0024**	**0.0507**	**0.0012**	**0.3744**	**0.0748**	**102.4171**	**0.0000**	**0.0273**	**0.0000**	**0.5545**	**564.9866**
A. Mineral Products	457.5688	NO	NO	NO	NO							457.5688
B. Chemical Industry	NO	NO	NO	NO	NO							NO
C. Metal Production	3.9938	0.0024	0.0507	0.0012	0.3744							4.4189
D. Other Production	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE							NO, NE
E. Production of Halocarbons and SF_6						NO	NO	NO	NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6						0.0748	102.4171	0.0000	0.0273	0.0000	0.5545	102.9988
3. Solvents and Other Products Use	**53.8690**			**0.0000**	**0.0000**							**53.8690**
A. Paint Application	20.7260											20.7260
B. Degreasing and Dry Cleaning	12.3930											12.3930
C. Chemical Products and Manufacture	3.0075											3.0075
D. Other	17.7426											17.7426
4. Agriculture		**31.2269**	**655.7653**	**4.7634**	**1476.6572**							**2132.4225**
A. Enteric Fermentation		28.4934	598.3605									598.3605
B. Manure Management		2.7336	57.4048	1.6095	498.9470							556.3518
C. Rice cultivation		NO	NO									0.0000
D. Agricultural Soils				3.1539	977.7103							977.7103
E. Prescribed Burning of Savannas		NO	NO	NO	NO							NO
F. Field Burning of Agricultural Residues		IE	IE	IE	IE							IE
5. LULUCF	**26.1460**	**0.0070**	**0.1467**	**0.0003**	**0.0959**							**26.3886**
A. Forest Land	-2193.2612	0.0044	0.0917	0.0002	0.0748							-2193.0947
B. Cropland	2977.0255	0.0026	0.0551	0.0001	0.0211							2977.1017
C. Grassland	-757.6184	NE	NE	NE	NE							-757.6184
D. Wetlands	NE	NE	NE	NE	NE							NE
E. Settlements	IE	NE	NE	NE	NE							IE, NE
F. Other land	NE	NE	NE	NE	NE							NE
6. Waste		**71.2313**	**1495.8583**	**0.2660**	**82.4458**							**1578.3041**
A. Solid Waste Disposal on Land		66.0980	1388.0583									1388.0583
B. Wastewater Handling		5.1333	107.8000	0.2660	82.4458							190.2458
C. Waste Incineration		NO, NE	NO, NE	NO, NE	NO, NE							NO, NE
7. Other	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**							**NO, NE**
Memo Items												
International Bunkers	82.7287	0.0028	0.0598	0.0028	0.8581							83.6467
CO_2 Emissions from Biomass	289.1029											289.1029

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

To be noted that during the period under review, the GHG emissions from Energy Sector have decreased by 74.1 per cent (by 1.3 per cent compared to 2009), emissions from Industrial Processes Sector have decreased by 70.3 per cent (an increase, by 8.6 per cent against the 2009 year level occurred in 2010), emissions from Solvents and Other Products Use Sector decreased by 40.7 per cent (increasing in 2010 by 11.0 per cent, compared to 2009 year level), emissions from Agriculture Sector decreased by 58.4 per cent (increasing in 2010 emissions by 10.8 per cent, compared to 2009 year level), net removals in LULUCF Sector decreased by 100.4 per cent (decreasing by 103.0 per cent in 2010 against the 2009 year level), respectively, emissions from Waste Sector decreased by 3.0 per cent (increasing in 2010 by 0.9 per cent, against the 2009 year level).

The most significant reduction of GHG emissions by source categories during the period under review took place in: 1A4 "Other Sectors" (-78.9 per cent), 1A1 "Energy Industries" (-78.4 per cent), 2A "Mineral Products" (-75.6 per cent), 1A2 "Manufacturing Industries and Constructions" (-75.4 per cent), 4A "Enteric Fermentation" (-67.4 per cent), 4B "Manure Management" (-66.0 per cent), 2C "Metal Production" (-65.9 per cent), 1A3 "Transport" (-53.0 per cent), 4D "Agricultural Soils" (-40.7 per cent), 6B "Wastewater Handling" (-38.1 per cent), etc.

The increase of national GHG emissions in 2009/2010 is due to the increase of emissions originated in the source categories 1A5 „Other" (+54.6 per cent), 4D „Agricultural Soils" (+23.5 per cent), 2F „Consumption of halocarbons and sulphur hexafluoride"' (+17.6 per cent), 1A3 „Transport" (+14.9 per cent), 3A-D „Solvents and Other Products Use" (+11.0 per cent), 2A „Mineral Products" (+7.7 per cent), 1A2 „Manufacturing Industries and Construction" (+6.3 per cent), 4B „Manure Management" (+4.9 per cent), 6B „Wastewater Handling" (+3.8 per cent), etc.

Indirect GHG Emission Trends / 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.

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

In 1990-2010, nitrogen oxides emissions decreased by 73.0 per cent: from 137.22 Gg in 1990 to 37.06 Gg in 2010, carbon monoxide emissions decreased by 73.9 per cent: from 428.07 Gg in 1990 to 111.93 Gg in 2010, non-methane volatile organic compounds emissions decreased by 81.4 per cent: from 512.23 Gg in 1990 to 95.23 Gg in 2010, while sulphur dioxide emissions decreased by 93.6 per cent: from 294.91 Gg in 1990 to 18.78 Gg in 2010 (Figure S-4).

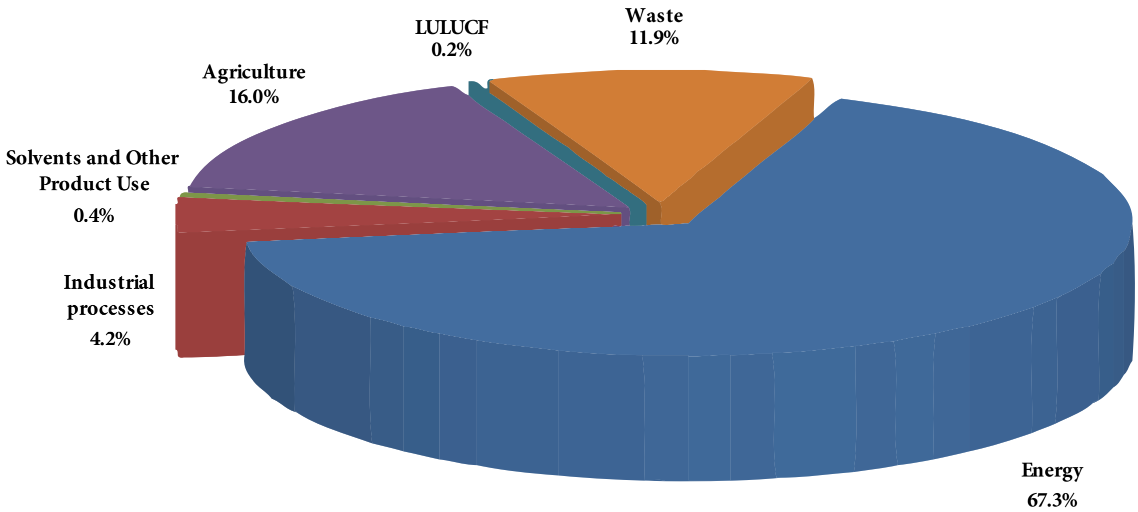


Figure S-3: Sectoral Breakdown of the Republic of Moldova's Total GHG Emissions, 2010

Table S-3: Republic of Moldova's Direct GHG Emissions, 1990-2010, Gg CO_2 equivalent

Categories of emissions and stocks	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total	**43259.8058**	**17380.9305**	**10910.7688**	**12939.9232**	**12118.0288**	**11389.4001**	**13121.6003**	**13124.3237**	**13276.1054**
Total net emission	36082.8090	16222.8497	10128.6933	12835.6758	11715.2394	8779.6214	13252.5298	12252.8250	13302.4940
1. Energy	**34520.3934**	**11710.7161**	**6662.3193**	**8518.8831**	**7703.5778**	**7408.5283**	**8427.4354**	**9065.9645**	**8946.5232**
A. Fuel Combustion Activities	33837.4613	11154.7307	6158.9008	7858.5790	7128.3457	6796.8008	7818.6288	8561.6623	8457.4776
1. Energy Industries	19393.2858	6931.7635	3152.4214	3236.0698	2494.1332	2476.0860	3295.1211	4460.5118	4194.5671
2. Manufacturing Industries and Construction	2195.8930	453.0153	531.7701	591.8781	651.7256	817.8938	913.0712	508.5564	540.6841
3. Transport	4055.6062	1338.1514	863.3531	1656.3456	1581.7184	1650.8829	1741.7494	1658.3330	1904.6945
4. Other Sectors	8037.7787	2258.4776	1550.3379	2255.7659	2250.6673	1698.2365	1706.1998	1853.3520	1692.4772
5. Other Works and Needs in Energy Sector	154.8976	173.3229	61.0183	118.5196	150.1013	153.7016	162.4874	80.9092	125.0546
B. Fugitive Emissions from Oil and Natural Gas	682.9320	555.9854	503.4185	660.3041	575.2321	611.7275	608.8065	504.3022	489.0456
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	682.9320	555.9854	503.4185	660.3041	575.2321	611.7275	608.8065	504.3022	489.0456
2. Industrial Processes	**1901.0463**	**491.4557**	**281.2098**	**568.3628**	**663.8045**	**945.7798**	**1022.1859**	**520.1068**	**564.9866**
A. Mineral Products	1888.0806	477.5446	251.2206	509.7252	604.0505	867.3911	929.2221	424.7167	457.5688
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Production	12.9657	12.0149	16.6138	19.1793	12.3922	17.6589	16.1905	7.7924	4.4189
D. Other Production	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6	NO, NE	1.8961	13.3755	39.4583	47.3617	60.7298	76.7734	87.5976	102.9988
3. Solvents and Other Products Use	**90.7765**	**38.1978**	**31.6256**	**68.1829**	**48.1948**	**52.2152**	**53.5824**	**48.5216**	**53.8690**
4. Agriculture	**5120.2069**	**3359.0696**	**2277.0491**	**2373.3748**	**2268.1718**	**1515.0860**	**2117.6508**	**1924.8512**	**2132.4225**
A. Enteric Fermentation	1834.3768	1360.8374	911.1819	778.3712	752.9796	608.8270	579.7075	602.7211	598.3605
B. Manure Management	1636.7952	976.3711	570.4557	595.7165	617.8647	465.9036	465.3276	530.5607	556.3518
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	1649.0348	1021.8610	795.4115	999.2872	897.3275	440.3554	1072.6157	791.5695	977.7103
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	IE	IE	IE	IE	IE	IE	IE	IE	IE
5. LULUCF	**-7176.9968**	**-1158.0807**	**-782.0755**	**-104.2474**	**-402.7894**	**-2609.7787**	**130.9296**	**-871.4986**	**26.3886**
A. Forest Land	-2197.1526	-1620.7880	-2140.3153	-2246.2034	-2087.5600	-2189.5482	-2222.8067	-2251.2659	-2193.0947
B. Cropland	-4193.3441	1082.2493	2183.7678	2961.4120	2491.5062	378.6159	3143.0390	2161.5725	2977.1017
C. Grassland	-786.5000	-619.5420	-825.5280	-819.4560	-806.7356	-798.8464	-789.3028	-781.8052	-757.6184
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	IE, NE	IE, NE	IE, NE	IE, NE	IE, NE	IE, NE	IE, NE	IE, NE	IE, NE
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**1627.3829**	**1781.4913**	**1658.5649**	**1411.1196**	**1434.2799**	**1467.7908**	**1500.7458**	**1564.8796**	**1578.3041**
A. Solid Waste Disposal on Land	1320.0836	1576.2543	1509.0919	1212.9287	1239.9320	1283.2945	1308.6906	1381.6433	1388.0583
B. Wastewater Handling	307.2993	205.2370	149.4730	198.1909	194.3479	184.4963	192.0552	183.2363	190.2458
C. Waste Incineration	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
7. Other	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**
Memo Items	**428.1942**	**687.4859**	**434.0549**	**362.7335**	**399.6598**	**373.1249**	**425.9714**	**403.8931**	**371.8317**
International Bunkers	217.3668	41.9185	66.1989	67.6961	75.9977	79.9382	89.3145	82.6447	82.7287
CO_2 Emissions from Biomass	210.8274	645.5674	367.8560	295.0374	323.6620	293.1867	336.6568	321.2484	289.1029

Abbreviations: IE – Included Elsewhere; NE – Not Estimates; NO – Not Occurring

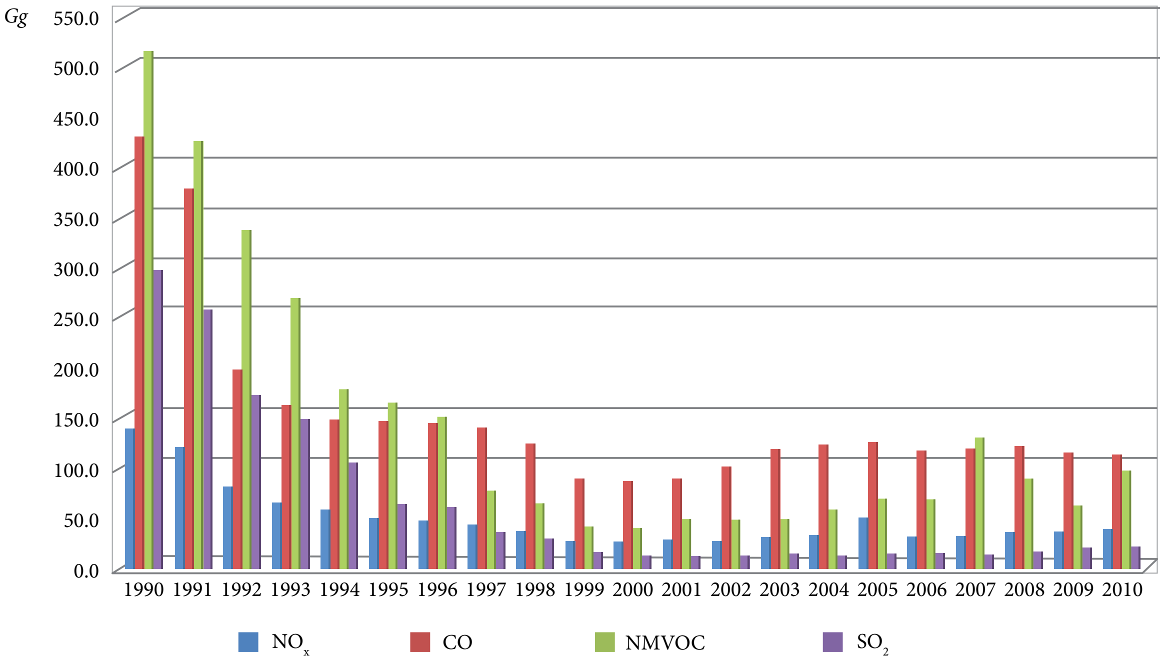


Figure S-4: National Indirect GHG Emissions in the RM, 1990-2010

1. INTRODUCTION

1.1 Climate Change Phenomena

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 that alters the composition of the global atmosphere and which is in addition 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 changing the solar radiation reflection and absorption, or emission and absorption of terrestrial radiation (IPCC, 1996).

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 surface, and warming it. Long-wave radiation (infrared rays) emitted by the surface of the Earth is captured by these gases and partially send back to the Earth surface. As a consequence, the average atmospheric temperature is by 33°C warmer than it could have been 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, has been measured via the hydro-meteorological monitoring network since 1886.

The character of observed changes to the Republic of Moldova's climate was identified through the trends and variability of individual climatic variables. The early 90's years of 20^{th} century are usually taken as a "benchmark" for global warming, therefore the seasonal and annual temperature and precipitation data at Chisinau meteorological station (for which there are available the longest series of instrumental observation) have been studied and compared for two periods: 1887-1980 (for temperature) and 1891-1980 (for precipitation), respectively for 1981-2010 (Tables 1-1 and 1-2 and Figure 1-1). A change may be considered real if the parameters of the trends are statistically significant.

As can be seen from Table 1-1 and Figure 1-1, a slight growth in annual air temperature (at a 90 per cent level) in the Republic of Moldova, observed before the 90's years of 20^{th} century (0.05 ^{0}C per decade and/or ~ 0.5^{0}C per century) is followed by a sharp increase (about 0.63^{0}C per decade and/or ~6.3^{0}C per century). Moreover, compared to the first period (1887-1980), the temperature trends in the last three decades (1981-2010) are statistically significant for summer and annual (at a 99 per cent confidence level) and for spring and autumn (at 95 per cent confidence level).

Absolutely during all season's precipitation trends for the two periods are positive, with the exception of spring of the 1891-1980 period and summer of the 1981-2010 period, where the trends was negative. However, the precipitation trends in these periods are not statistically significant with the exception of annual trend for 1891-1980 years ($p \leq 0.1$), so it can be noted just a tendency to a slight increase in the precipitations (Table 1-1; Figure 1-1).

The comparison of the mean air temperatures and standard deviations for two referred periods, both season and annual, have confirmed substantial changes in the temperature regime mentioned above (Table 1-2).

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 above-mentioned conditions are related to short periods of time. The notion of climate usually refers to the mean 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, speed of the wind and such phenomenon as fog, frost, hoarfrost, hail and other. Climate change refer to long term changes in weather patterns caused by 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), as well as phenomena of anthropogenic nature (induced by humans), such as pollution of terrestrial atmosphere (change of the global atmosphere composition by generation of GHG).

In conformity with the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007), it is expected that the climate change phenomenon will have different impact in different regions of the world. It is expected that in the next 100 years global air surface temperature will increase by circa 1.8-4.0^{0}C (in 1901- 2000 the average global air surface temperature increased by 0.6^{0}C), and the sea level will raise respectively, by circa 0.18-0.59 m (in 1961-1992 the average sea level raised at a rate of 1.8 mm/year, and starting 1993, at a rate of 3.1 mm/year); the frequency of natural disasters (floods, droughts, heat waves, hurricanes, tornados, etc.) will also grow. In some regions their impact can 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.

Table 1-1: Average air temperature (^{0}C/year) and precipitation trends (mm/year) and their statistical significance of change (*p-value*) for two time periods at Chisinau meteorological station

Season	Air temperature				Precipitation			
	1887-1980		1981-2010		1891-1980		1981-2010	
	Trend	P-Value	Trend	P-Value	Trend	P-Value	Trend	P-Value
Winter	0.010	0.214	0.039	0.300	0.472	0.108	1.234	0.258
Spring	0.005	0.352	0.061	**0.028**	- 0.059	0.823	0.187	0.873
Summer	0.002	0.578	0.097	**0.000**	0.619	0.291	- 1.406	0.392
Autumn	0.003	0.545	0.048	**0.032**	0.412	0.256	1.291	0.412
Annual	0.005	**0.097**	0.063	**0.001**	1.448	**0.073**	1.301	0.578

Note: Bold is used to mark statistically significant values.

It may be stated with high level confidence that the mean values of the seasonal (except autumn) and annual temperatures in last three decades are different from the previous time period while the variability remains practically the same (except annual temperature for which there was identified a significant increase in the inter-annual variability of mean annual temperatures for the last three decades).

The comparison of the mean values of the total amount of precipitation (Table 1-2) shows the lack of statistically significant difference, however slight increase of average annual precipitation (mainly due to the fall) cannot be regarded as statistically significant, it may be explained by inter-annual fluctuations. Also, there aren't revealed any statistically significant differences in the variability of precipitation, with the exception of spring season.

An analysis of data provided by the National Hydro-Meteorological Data Fund for the instrumental record period (1890-2012) revealed that drought affects the Republic of Moldova on a recurring basis – over the 122 year period, 23 years were marked by serious drought during the vegetation period (April-September), and 19 years were marked by close to drought conditions (mild droughts). According to National Hydro-Meteorological data, the average frequency of droughts in the Republic of Moldova in a 10-year time span is 1-2 droughts in the North; 2-3 droughts in the central part and 5-6 droughts in the South.

Furthermore, the frequency of droughts is increasing, with significant impacts on lives and livelihoods. In the 1990–2012 time span, 10 years (1990, 1992, 1994, 1996, 1999, 2000, 2001, 2003, 2007 and 2012) were marked by droughts of various intensity, which contributed to a significant reduction in crop yields.

In 1990, 1992 and 2003, the droughts continued during the entire vegetation period (April-September), while in other years the droughts occurred in summer. The disastrous droughts of 2007 and 2012 affected over 70 per cent of the territory of the country, being the most severe droughts in the entire instrumental record period.

Floods also affect the Republic of Moldova on a recurring basis. In the past 70 years, 10 major floods on the great rivers of Moldova (Dniester and Prut) were reported, and three of those occurred in this decade (2006, 2008 and 2010). Large floods on the smaller rivers in the country are also quite common. The socio-economic costs of climate related natural disasters are significant, with the greatest impacts coming from droughts and floods.

1.1.3 Greenhouse Gases

The most important greenhouse gas in atmosphere is water vapors (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. 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 sub-

Table 1-2: Comparison of the mean (x) and standard deviation (σ) of the seasonal and annual air temperatures and precipitation for the period before 1981 year (x1, σ1) and beyond (x2, σ2) at Chisinau meteorological station

Season	Air temperature						Precipitation					
	x_1	x_2	p	$σ_1$	$σ_2$	p	x_1	x_2	p	$σ_1$	$σ_2$	p
Winter	-2.2	-1.1	**0.009**	1.96	1.77	0.539	100.6	105.6	0.638	47.42	48.26	0.615
Spring	9.4	10.2	**0.006**	1.25	1.33	0.651	121.5	123.7	0.829	42.02	54.16	**0.090**
Summer	20.5	21.3	**0.001**	1.06	1.17	0.465	185.9	186.1	0.992	94.38	76.31	0.207
Autumn	10.1	10.3	0.444	1.34	1.08	0.189	113.1	132.2	0.170	58.55	55.29	0.130
Annual	9.5	10.2	**0.001**	0.71	0.97	**0.024**	521.1	547.6	0.333	130.79	108.22	0.261

Note: Bold is used to mark statistically significant values

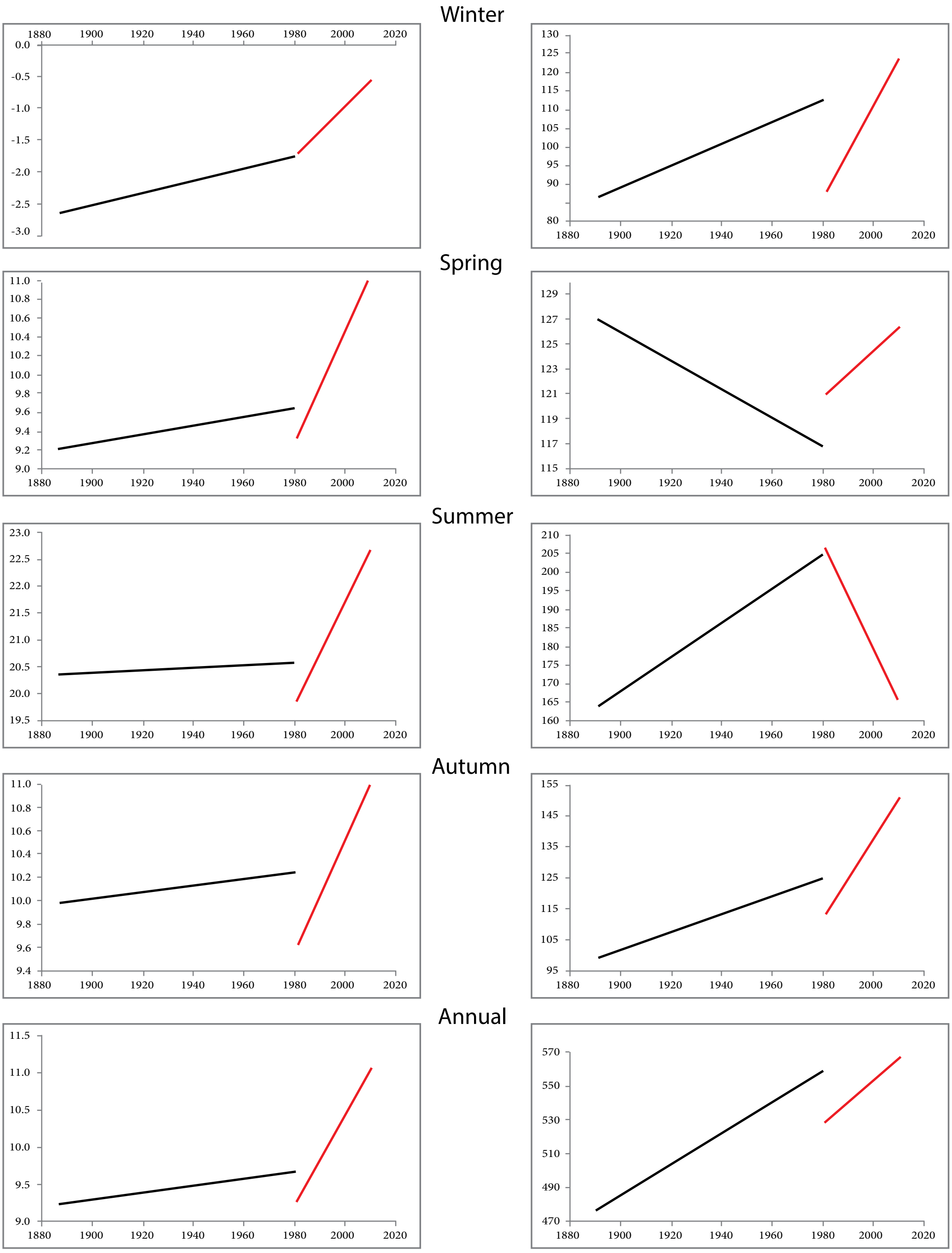


Figure 1-1: Trends in average air temperature (^{0}C/year) – left side, and precipitation (mm/year) – right side, for the period before 1981 year and beyond, at Chisinau Meteorological Station

stances 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 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[1]. Thus, from 1750 to 2012, the concentration of CO_2 increased by 40%, concentration of CH_4 - by 168%, and concentration of N_2O - by 20% (Table 1-3). To a great extent these trends can be attributed to human activities — in particular, to fossil fuels combustion and continuous deforestation of forest lands.

Globally, the amount of annual emissions of carbon dioxide is circa 31.6 Gigatones (Gt)[2], which in the past 45 years has increased more than significantly (by 4.9 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 atmosphere vary 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 per cent 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.

Concentration of methane in atmosphere is affected 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 atmosphere is circa 12 years. The annual accumulation rate of CH_4 in atmosphere is about 40 and 60 Mt, from which approximately 11.5 per cent are generated from anthropogenic activities (in 2010, the global methane emissions represented circa 7 Mt[3]).

It has been stated that circa 1/3 of the atmospheric N_2O is of anthropogenic origin[4], coming from use of synthetic nitrogen fertilizer, soil cultivation, animal breeding (manure management), wastewater handling, adipic acid and nitric acid production, fossil fuels combustion, waste incineration and biomass burning. The other 2/3 of the atmospheric N_2O comes from the soil and denitrification of water in anaerobic conditions. N_2O breaks down photochemically in atmosphere. Global annual N_2O emissions from anthropogenic activities are estimated at circa 9 Mt[5].

PFCs (perfluorocarbones), HFCs (hydrofluorocarbones) 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 characterized by a considerable infrared radiation absorption capacity, so that in the future it might have a considerable impact on the global warming.

[1] <http://cdiac.ornl.gov/pns/current_ghg.html>.
[2] <http://cleantechnica.com/2012/05/25/global-CO_2-emissions-reach-recordhigh-driven-fossil-fuel-use-rapidly-industrializing-nations/>.
[3] <http://www.globalmethane.org/documents/analysis_fs_en.pdf>.
[4] <http://globalchange.mit.edu/files/document/MITJPSPGC_Rpt206.pdf>.
[5] <http://edgar.jrc.ec.europa.eu/part_N_2O.php#1overview>.

Table 1-3: Tropospheric Concentration (in the Northern Hemisphere), Concentration Change Rate and Direct GHG Lifetime in Atmosphere

Greenhouse Gases	Pre-1750 tropospheric concentration	Recent tropospheric concentration	GWP (100-yr time horizon) (IPCC, 2007)	Atmospheric lifetime (years)	Increased radiative forcing* (W/m²)
Concentration in parts per million (ppm)					
Carbon dioxide (CO_2)	280	392.6	1	~ 100	1.85
Concentration in parts per billion (ppb)					
Methane (CH_4)	700	1874	25	12	0.51
Nitrous oxide (N_2O)	270	324	298	114	0.18
Tropospheric ozone (O_3)	25	34	n.a.	hours-days	0.35
Concentration in parts per trillion (ppt)					
CFC-11 (CCl_3F)	zero	238	4750	45	0.06
CFC-12 (CCl_2F_2)	zero	531	10900	100	0.17
CF-113 (CCl_2CClF_2)	zero	75	6130	85	0.024
HCFC-22 ($CHClF_2$)	zero	226	1810	12	0.041
HCFC-141b (CH_3CCl_2F)	zero	23	725	9.3	0.0025
HCFC-142b (CH_3CClF_2)	zero	23	2310	17.9	0.0031
Halon 1211 ($CBrClF_2$)	zero	4.2	1890	16	0.001
Halon 1301 ($CBrClF_3$)	zero	3.3	7140	65	0.001
HFC-134a (CH_2FCF_3)	zero	68	1430	14	0.0055
Carbon tetrachloride (CCl_4)	zero	86	1400	26	0.012
Sulphur hexafluoride (SF_6)	zero	7.5	22800	3200	0.0029

Note: *The „radiative forcing" term refers to the amount of any given GHG heat-trapping potential and it is measured in power units (watt) per surface units (m²).

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 radiative gas (i.e., GHG) might have on the surface of troposphere. The GWP of a GHG takes into account both the instantaneous radiative forcing due to an incremental concentration increase in the atmosphere and the lifetime of these gases in the atmosphere.

This report relate to the GWP for a period of 100 years recommended by the IPCC (IPCC Second Assessment Report, 1996) for use in GHG emissions inventory under UNFCCC and adopted at the COP 3 (Table 1-4).

1.1.5 Convention, Kyoto Protocol 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.

The overall objective of the UNFCCC is aimed at stabilizing 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), (b) and (c) of the UNFCCC stipulate that each Party has to make available to the Conference of the Parties (COP), "national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled 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, material relevant 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 by non-Annex I Parties (Decision 10/CP 2). In conformity with the Guidelines, in 1998-2000, under the UNDP-GEF Project "Republic of Moldova: Enabling Activities for the Preparation of the FNC under the UNFCCC", the Republic of Moldova developed the First National Communication to the UNFCCC (including a national greenhouse gas emissions inventory for the time series 1990 through 1998), made available at the COP 6 (Hague, 2000).

Table 1-4: GWP for a Period of 100 Years and GHG Atmospheric Lifetimes

GHG	Chemical formula	Lifetime	SAR	TAR	AR4
Carbon dioxide	CO_2	50-200	1	1	1
Methane	CH_4	12	21	23	25
Nitrous oxide	N_2O	120	310	296	298
Sulphur hexafluoride	SF_6	3200	23900	22200	22800
Hydrofluorocarbons (HFC)					
HFC-23	CHF_3	264	11700	12000	14800
HFC-32	CH_2F_3	5.6	650	550	675
HFC-43-10mee	$C_5H_2F_{10}$	17.1	1300	1500	1640
HFC-125	C_2HF_5	32.6	2800	3400	3500
HFC-134a	$C_2H_2F_2$ (CH_2FCF_3)	14.6	1300	1300	1430
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	48.3	3800	4300	4470
HFC-152a	C_2H4F_2 (CH_3CHF_2)	1.5	140	120	124
HFC-227ea	C_3HF_7	36.5	2900	3500	3220
HFC-236fa	$C_3H_2F_6$	209	6300	9400	9810
Perfluorocarbones (PFC)					
Perfluoromethane	CF_4	50000	6500	5700	7390
Perfluoroethane	C_2F_6	10000	9200	11900	12200
Perfluoropropane	C_3F_8	2600	7000	8600	8860
Perfluorohexane	C_6F_{14}	3200	7400	9000	9300

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

COP 8 (New Delhi, 2002) adopted a new Guidelines on national communications from non- Annex I Parties to the Convention (Decision 17/CP 8). In conformity with this document, in 2005-2009 the Republic of Moldova developed its Second National Communication under the UNFCCC and, within 2010-2013 time period its Third National Communication under the UNFCCC.

The COP 3 (Kyoto, 1997) adopted the so-called Kyoto Protocol[6], representing an instrument setting binding targets for the Convention Parties, by committing industrialized countries and economies in transition 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 2008-2012.

The Republic of Moldova ratified the Kyoto Protocol on February 13, 2003. It should be noted however, that as a non-Annex I Party, the Republic of Moldova had no commitments to reduce GHG emissions under the Protocol during the first commitment period (2008-2012).

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 15th Conference of the Parties 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.

The 16th Conference of the Parties to the UNFCCC, 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 that offers substantial opportunities and ensures continued economic growth and sustainable development*."

The Republic of Moldova associated itself with the Copenhagen Accord and submitted an emissions reduction target that is specified in Annex II of this Agreement "National Appropriate Mitigation Actions in Developing Countries."

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

The target of mitigation actions for Republic of Moldova under this Agreement is "*to reduce, to not less than 25% 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 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.

During 2010-2013, it was drawn the *Low Emission Development Strategy of the Republic of Moldova until 2020*, a strategic document that will 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 supports overall objectives, providing strategic national context for mitigation efforts, for which countries receive international support. LEDS was developed in accordance with the Republic of Moldova's Governmental Programme "European Integration: Freedom, Democracy, Welfare" (2011-2014), Chapter "Environmental Protection" and the provisions of chapter "Climate Change" of the Association Agreement with European Union. LEDS contains a set of mitigation measures that contribute to the decrease of GHG emissions; they also help to quantify the corresponding reduction of emissions for each mitigation measure, and the financial requirements for their implementation. The Action Plan annexed to the Strategy includes a list of prioritized national appropriate mitigation actions. The strategy envisages the implementation procedures, timeframes and provisions on monitoring, reporting and verification. LEDS has been developed by the Ministry of Environment of the Republic of Moldova, the process being guided by an Inter-ministerial working group for climate change, with support from the UNDP Country Office. The strategy development process has involved a wide consultation with stakeholders, represented by ministries, academic and research institutions, donor organizations, NGOs and civil society. It is anticipated that LEDS will be approved by the Government by end of 2013 year.

1.1.6 Republic of Moldova's Contribution to Global Warming

In 1990, Republic of Moldova contributes only about 0.3 per cent of total global GHG emissions. Within the 1990-2010, the total national GHG emissions (excluding LULUCF) decreased by 69.3 per cent, which is much more than in some industrialized countries and economies in transition included in Annex I to Convention (Figure 1-2).

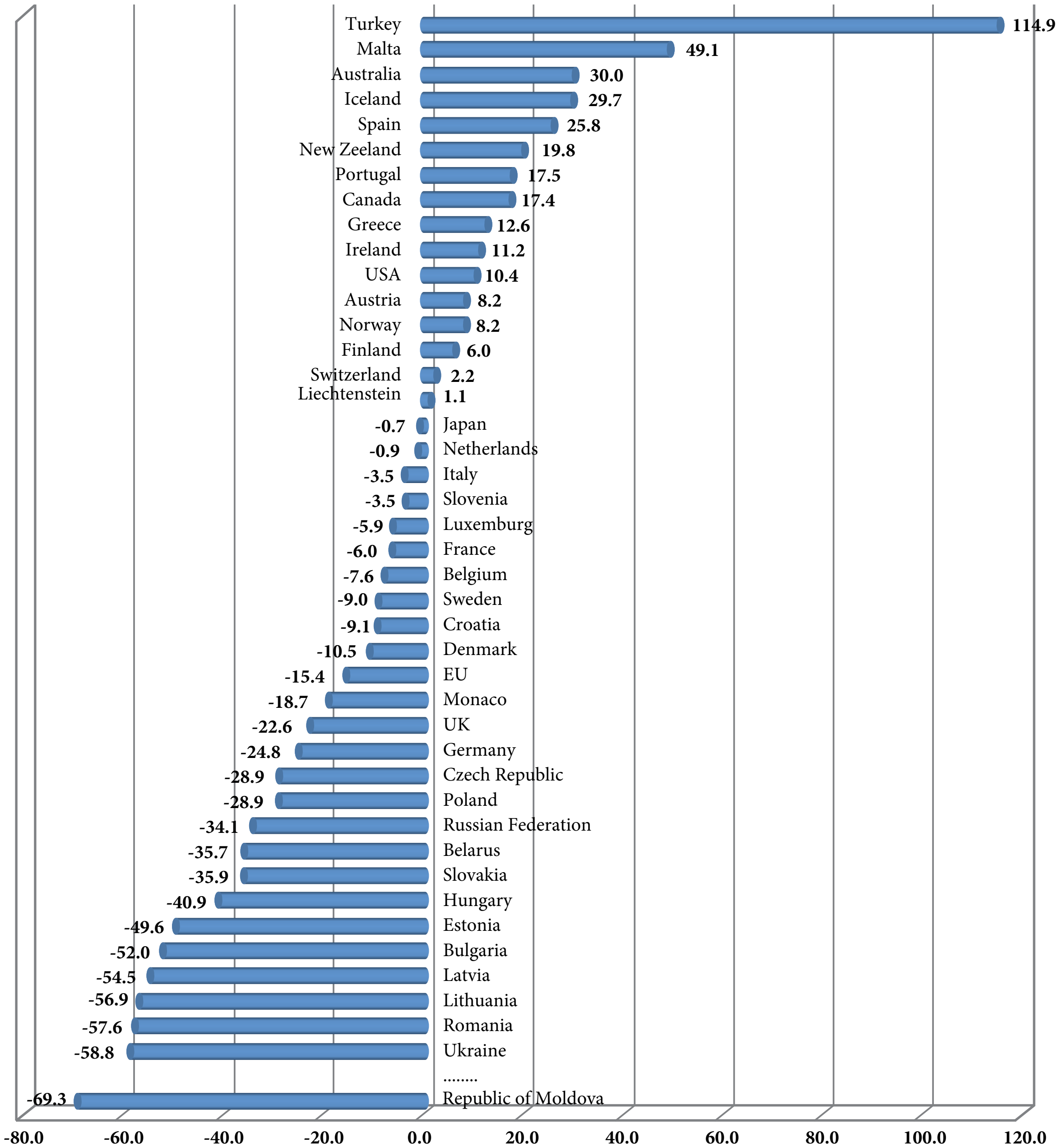


Figure 1-2: Change in Aggregate GHG Emissions for Annex I Parties and the Republic of Moldova, 1990-2010 (change relative to 1990, %)

1.2 Institutional and Legal Arrangements for Inventory Preparation

1.2.1 National Inventory System

The Ministry of Environment (MoEN)[7] of the Republic of Moldova (RM) 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 RM, MoEN is in charge for implementation of international environment treaties to which RM is a Part (including UNFCCC). Representatives of MoEN also act as GEF and UNFCCC Focal Points[8].

In view of implementing and accomplishing the UNFCCC provisions, as well as mechanisms and provisions of Kyoto Protocol based on Order No. 21 as of February 11, 2004, the Climate Change Office (CCO)[9] was established under the Ministry of Ecology, Constructions and Territory Develop-

[7] <http://mediu.gov.md/>

[8] <http://maindb.unfccc.int/public/nfp.pl>

[9] <http://www.clima.md/>

ment of the Republic of Moldova (*reorganized into Ministry of Environment and Natural Resources in April 2005, respectively into the Ministry of Environment in September 2009*).

The main tasks of the CCO are:

providing logistical support to the Government, central and local public administration authorities, non-government and academic organizations, in activities implemented and promoted by the RM under the UNFCCC and Kyoto Protocol; and

a) implementing climate change related projects and programs providing for such activities as: GHG emissions evaluations and national inventory reports preparation; development and

a) implementation of GHG emissions mitigation activities; development and implementation of measures aimed to adapt to climate change; assessment of the climate change impact on environment and socio-economic components; cooperation, promotion and implementation of activities and projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol; implementation and facilitation of activities aimed at building awareness and information among civil society, relevant experts and decision makers in climate change related issues, etc.

The National Inventory System (NIS) includes all institutional and legal arrangements associated with the national greenhouse gas inventory preparation process, as well as reporting this information on the national and international level. This process implies preliminary planning and preparation activities such as for example, defining specific responsibilities within the inventory preparation process (such responsibilities are described in section 1.2.2 'Institutional and Legal Arrangements', while Section 1.3 'Process for Inventory Preparation' provides more details about the inventory preparation process).

1.2.2 Institutional and Legal Arrangements

As explained below in Figures 1-3 and 1-4, within the MoEN, the Climate Change Office (CCO) is totally responsible for the activities related to preparation of National Communications (NCs) and National Inventory Reports (NIRs). Further there are outlined the responsibilities and arrangements for the National Inventory System (NIS) of the Republic of Moldova.

Within the CCO the National Inventory Team (NIT) is responsible for estimating emissions by categories of sources and removals by categories of sinks, Key Sources Analysis (KSA), Quality Assurance (QA) and Quality Control (QC) procedures, uncertainties assessment, documentation, reporting and archiving of data related to GHG inventory preparation process.

Below is a brief description of functional responsibilities of the participants in the process:

- The National Inventory Team Leader (NITL), a full time employee in the CCO, 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, KSA, 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.
- The task group leaders and 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 (Energy, Industrial Processes, Solvents and Other Products Use, Agriculture, LULUCF and Waste). National experts are responsible for the 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 task group leaders are responsible for development the NIR's sectoral chapters.

The activity data (AD) needed for developing the national GHG inventories are available in the Statistical Yearbooks (SY), Energy Balances (EBs) and other sectoral statistic publications of the National Bureau of Statistics (NBS) of the Republic of Moldova.

It is worth mentioned that the activity data provided by the NBS of the RM in the Statistical Yearbooks, Energy Balances[10], sectoral statistical publications and on its website, as part of the statistical database (see on <http://statbank.statistica.md/pxweb/Database/EN/databasetree.asp>) are available for the period until 1992 for the whole territory of the Republic of the Moldova, while since 1993 only for the right bank of Dniester (without Transnitria, further referred as Administrative Territorial Units on the Left Bank of Dniester) .

The statistical data for the left bank of Dniester are collected by the State Statistical Service beside the Ministry of Economy of the ATULBD[11], being published in the Statistical Yearbooks[12], and other periodic statistical publications available on the website of the Ministry of Economy of the ATULBD (see on <http://www.mepmr.org/gosudarstvennaya-statistika/informaczyya>).

Additional statistical data (unpublished) may be provided at request, in conformity with provisions of the Law nr. 412 as of 09.12.2004 on 'Official Statistics', Article 9 (2), item a) and b), according to which "*the official statistics authorities must*

[10] Energy Balances of the Republic of Moldova have been not developed only for two years, 1991 and 1992, respectively. CCO of the MoEN has copies of Energy Balances for 1990 and 1993-2011 years.
[11] State Statistical Service, Ministry of Economy of the ATULBD.
[12] CCO of the MoEN has copies of the Statistical Yearbooks of ATULBD for the years of 2000 and 2006-2012, covering the statistical data for the 1990 year and 1995-2011 periods.

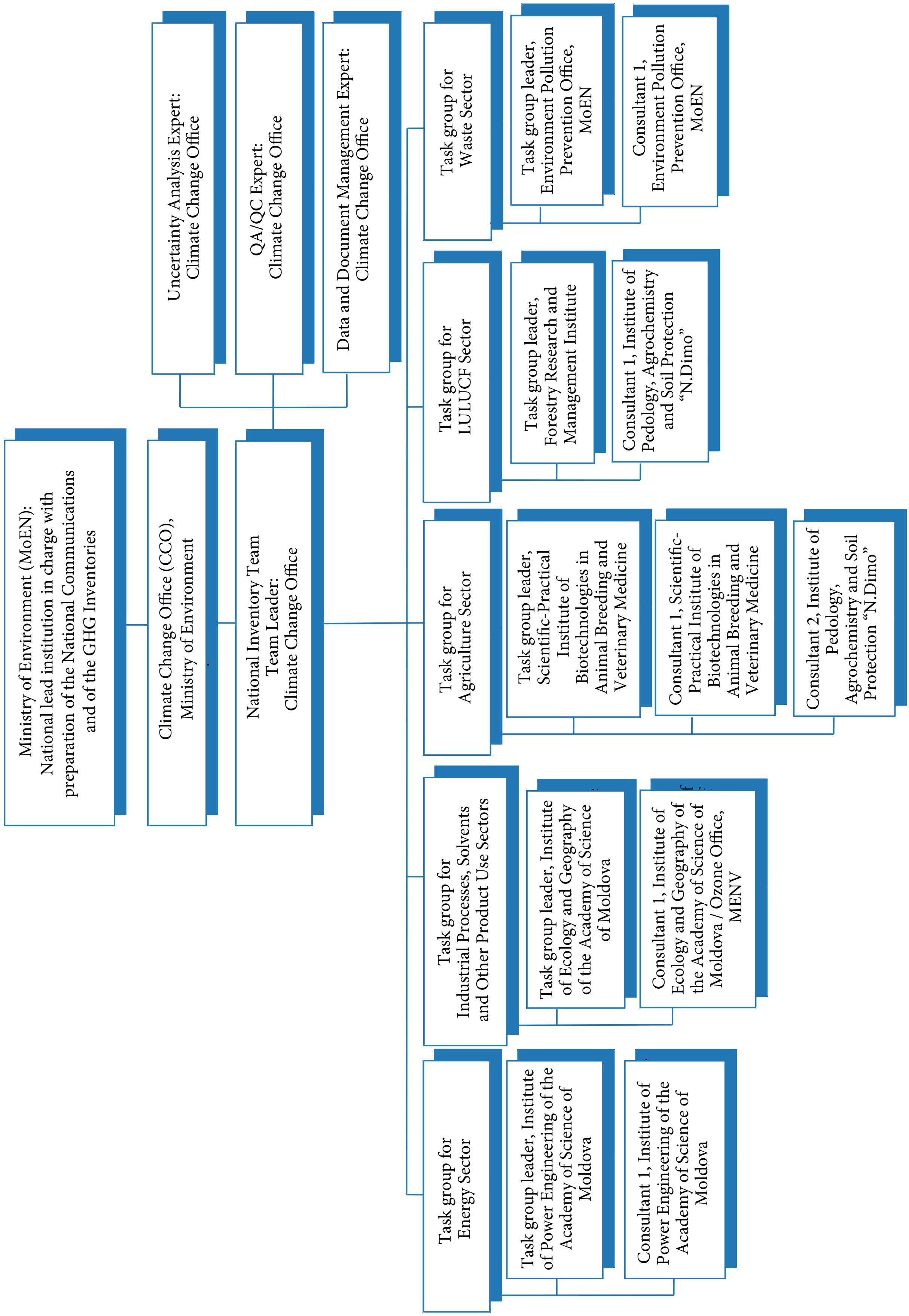


Figure 1-3: Institutional structure for developing the National GHG Inventories

disseminate statistical data to users in the amount, manner and terms specified in the statistical works programme", as well as to "*to ensure access of all users to non-confidential statistic on equal conditions in terms of amount and terms of dissemination*".

Based on the provisions of the Law on Access to Information, adopted by the Decision of the Parliament No. 982-XIV as of 11.05.2000, other relevant activity data are collected by CCO of the MoEN (through surveys and questionnaires), from various state institutions and enterprises.

The main data providers (see also Figure 1-4) are mentioned below:

- from Ministry of Transports and Roads Infrastructure is collected information on the amount of fuel used to ensure operation of road, railway, navigation, air transport and asphalt production;
- from Civil Aeronautical Authority – information on the number of flights by type of aircrafts and amount of fuels used in air transportation;
- from State Enterprise 'Moldavian Railways" – information of fuel used for rail transport;
- from Ministry of Economy – data on fuel consumption and energy production at power plants;
- from Ministry of Information Technology and Communications – information on transport units registered, ages of fleet and/or production year and other relevant characteristics;
- from the Ministry of Agriculture and Food Processing Industry – data on livestock and poultry, as well as on fuel consumption and energy production at sugar plants;
- from the Ministry of Defense – information on fuel used by the National Army;
- from the Ministry of Health – information on use of medicines which contains aerosols (specifically on HFCs), as well as on use of N_2O for anesthesia purposes;
- from Agency "Moldsilva" – information on forestry related statistics;
- from Agency for Geology and Mineral Resources – information on extraction of mineral resources, inclusive of limestone and dolomite use for cement production, glass production, iron and steel production, etc.;
- from State Ecological Inspectorate – information on illegal felling and stubble fields burning;
- from Ozone Office – information on import-export of freons in bulk and type of freons used in the imported refrigeration and air-conditioning equipment;
- from Land Relations and Cadastre Agency – information on available land by use;
- from Customs Service – statistics on import-export operations in the Republic of Moldova;
- from IPROCOM State Projections Institute – information on existing types of landfills currently operated in the Republic of Moldova, as well as their technical characteristics;
- from Municipal Enterprise "Regia Autosalubritate" in Chisinau – information on the amount of Municipal Solid Waste disposed on the Tintareni Landfill (MSW generated in the Chisinau municipality);
- from "Moldova-Gaz" J.S.C. – information on the amount of natural gas transited through the territory of the Republic of Moldova, as well as on the consumption of natural gas in the natural economy (the whole amount of natural gas used in the Republic of Moldova is imported by Moldova-Gas J.S.C. from Russian Federation),
- from Power Plants (Moldavian Thermal Power Plant, CHP-1 and CHP-2 in Chisinau and CHP-North in Balti) and Municipal Enterprise "TERMOCOM" S.A. – information on the amount of fuel used and energy production;
- from enterprises specialized in transportation and distribution of electricity (Î.S. „Moldelectrica", Î.C.S. „Red Union Fenosa", S.A. „Red-North", S.A. „Red North-West") – information on the amount of PFCs and SF_6 used in electrical equipment;
- from a range of industrial enterprises representing mainly the manufacture of non-metallic mineral products ("Lafarge-Ciment" J.S.C., "Macon" S.A., Glass Factory No. 1 in Chisinau, "Glass-Container" Company in Chisinau, "Cristal-Flor" Glass Company in Floresti, etc.) - information on industrial output, amount of mineral resources used, amount of fuel used, etc.

In the above mentioned context it is worth mentioned that the Article 1 of the Law on Access to Information regulates the relationships between information providers and individual / legal entity in the process of ensuring and implementing the constitutional right of access to information; principles, conditions, ways and manner of accomplishing access to official data owned by information providers; aspects of access to and protection of personal information within the scope of access to such data; rights of data solicitants, including petitioners of personal data; obligations of information providers in the process of ensuring access to official information; ways to protect the right to access to information.

Article 4 (1) stipulates that "anyone, under this law's conditions, has the right to look for, receive and make public official information". According to Article 6 (1), "official information are deemed to be all information owned and available to information providers, developed, selected, processed, consolidated and /or adopted by authorities or official persons or made available to them by other legal entities". This Article is a review of information bearing documents as stipulated by the provisions of this law. Article 7 refers to cases of limited access to official information. Rights of data solicitants are reflected in Article 10, while Article 11 refers to the obligations of information provider.

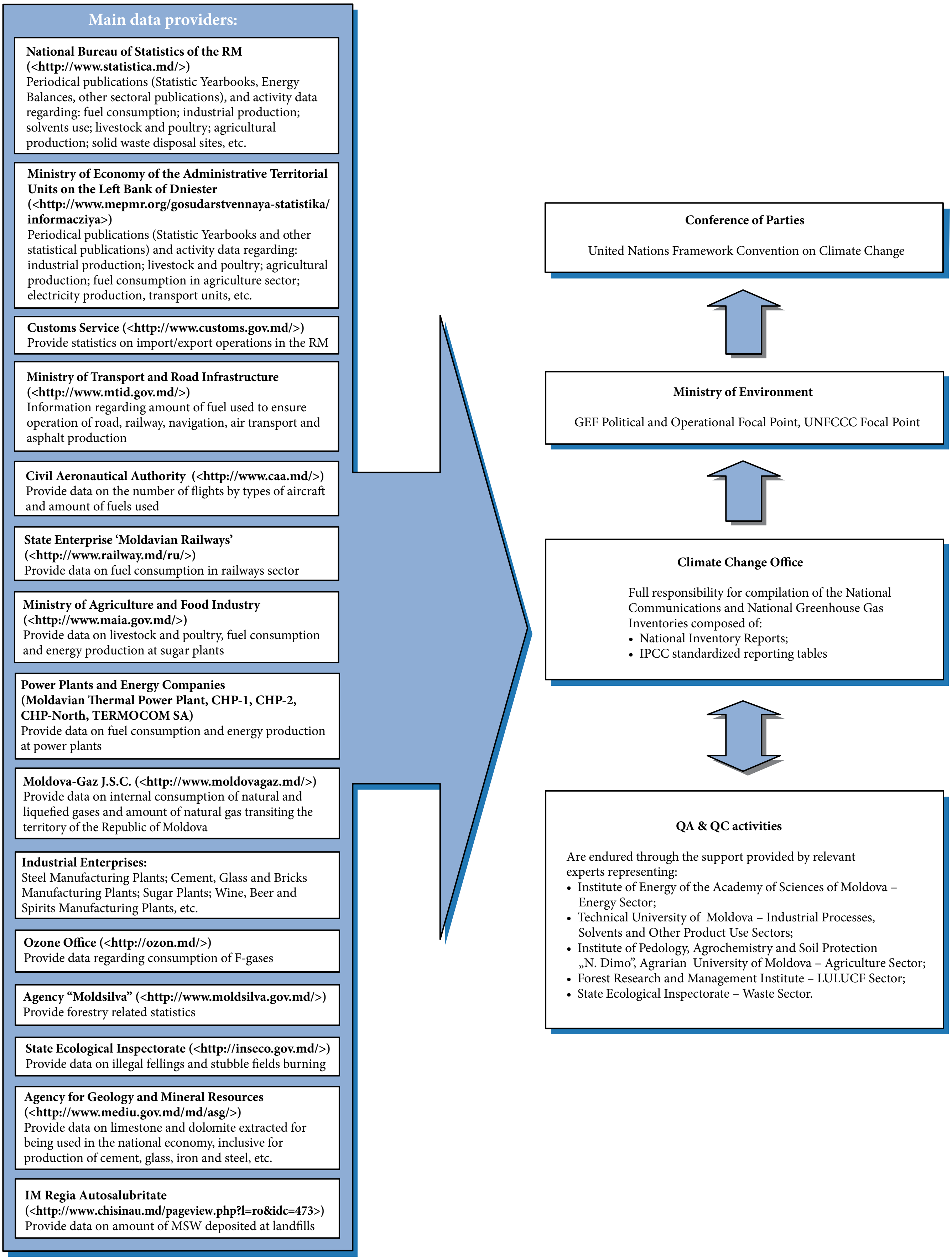


Figure 1-4: Institutional arrangements under the National Inventory System of the Republic Moldova (as of June 2013)

According to Article 13 (1), ways of access to information are the following: hearing of information which can be provided verbally; document review on the premises of the institution; issuing a copy of the requested document or information; issuing a copy of the document, information translated into a different language than the language of the original, for an additional charge; sending by mail (including e-mail) of a copy of the document, information, a copy of the translated document, information into a different language, at the solicitant's request, for a payment. Article 13(2) stipulate that extracts from registers, documents, information, as per solicitant's request, can be made available to the solicitant in a reasonable and acceptable to the solicitant form.

Article 16 of the Law refers to the requirements that have to be met to ensure access to information: the requested information or documents shall be made available to the solicitant from the moment it becomes available for issuing, but not later than 15 working days from the date the application for access to information is registered; the leadership of the public institution may extend the term of providing the information, or document by 5 working days if: (1) the request refers to a very big volume of information requiring their selection; (2) additional consultations are needed to satisfy the request. The solicitant will be informed about any extension of the information delivery term and about the reasons for such extension 5 days prior to the expiry of the initial term. The Law also refers to cases when access to information is denied, to payments for official information provision, to modalities of protecting the right for access to information and prosecution in court of information providers' actions.

Also, a series of laws contain provisions pertaining to wide public to environment protection related information. So, Article 29 (3) of the Law on Natural Resources, adopted by the Parliament Decision No. 1102-XIII as of 06.02.1997, stipulates that „*Government, local public administration authorities, state bodies assigned with natural resources management and environment protection, as well as businesses, shall make public valid and accessible information regarding natural resources use and environment protection activities*".

Article 23 of the Forestry Code, adopted by the Parliament Decision No. 887 as of 21.06.1996, stipulates that "*citizens and NGO-s are entitled to receive information from the state forestry authorities and environment protection bodies about forestry and hunting resources, planned and accomplished conservation measures and use of such resources*".

The Regulation regarding trading and regulated use of halogenated hydrocarbons that deplete the ozone layer, approved by the Law of the Republic of Moldova No. 852-XV as of 14.02.2002, stipulates the procedure of presenting by the MENR of information regarding production, import, export, trading and use (recycled and reclaimed quantities of controlled substances) of halogenated hydrocarbons that deplete the ozone layer, regulated by Montreal Protocol.

1.3 Process for Inventory Preparation

The Climate Change Office adopted a centralized approach to the process of preparing the national inventory comprising the NIR and standard estimation and reporting tables. The National Inventory preparation process is outlined in Figure 1-5.

The NITL is responsible for compiling the estimations and ensuring consistency and quality of the inventory by producing the NIR. Estimation of emissions by individual source categories and removals by individual sink categories is the responsibility of national experts who are more competent about individual features of source/sink categories.

The national experts, under direct coordination of the task group leaders and national inventory team leader, decide, by applying decision trees, on employing the best estimation methodology, collect AD needed for estimation. For most source categories methodologies used in the previous inventory cycle are applied. Under such circumstances it was 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 NITL, task group leaders and 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 educational, academic institutions, ministries and subordinated institutions, central administrative authorities and/or private sector. National experts produced 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.

NITL and task group leaders are responsible for collecting and reviewing these materials, used in drafting the NIR sectoral chapters (Chapter 3 'Energy', Chapter 4 'Industrial Processes', Chapter 5 'Solvents and Other Products Use', Chapter 6 'Agriculture', Chapter 7 'LULUCF', Chapter 8 'Waste'). The NITL is also responsible for drafting other chapters (Executive Summary, Chapter 1 'Introduction', Chapter 2 'Trends in National GHG Emissions', Chapter 9 'Recalculations', 'Bibliography' and 'Annexes'), as well as for checking the correctness of the key sources analysis, compatible with Good Practice Guidance - GPG (IPCC, 2000) and GPG for Land Use, Change in Land Use and Forestry Sector (IPCC, 2003) requirements.

The NIR was produced in compliance with UNFCCC reporting guidelines on annual inventories. In addition to NIR, IPCC standard common reporting format tables were filled-in. NITL and ask group leaders have the task to monitor the process of development of standard common reporting format tables, to ensure the consistency of results.

The national experts accomplished the uncertainties analysis, as well as verification and QA/QC activities, in close co-

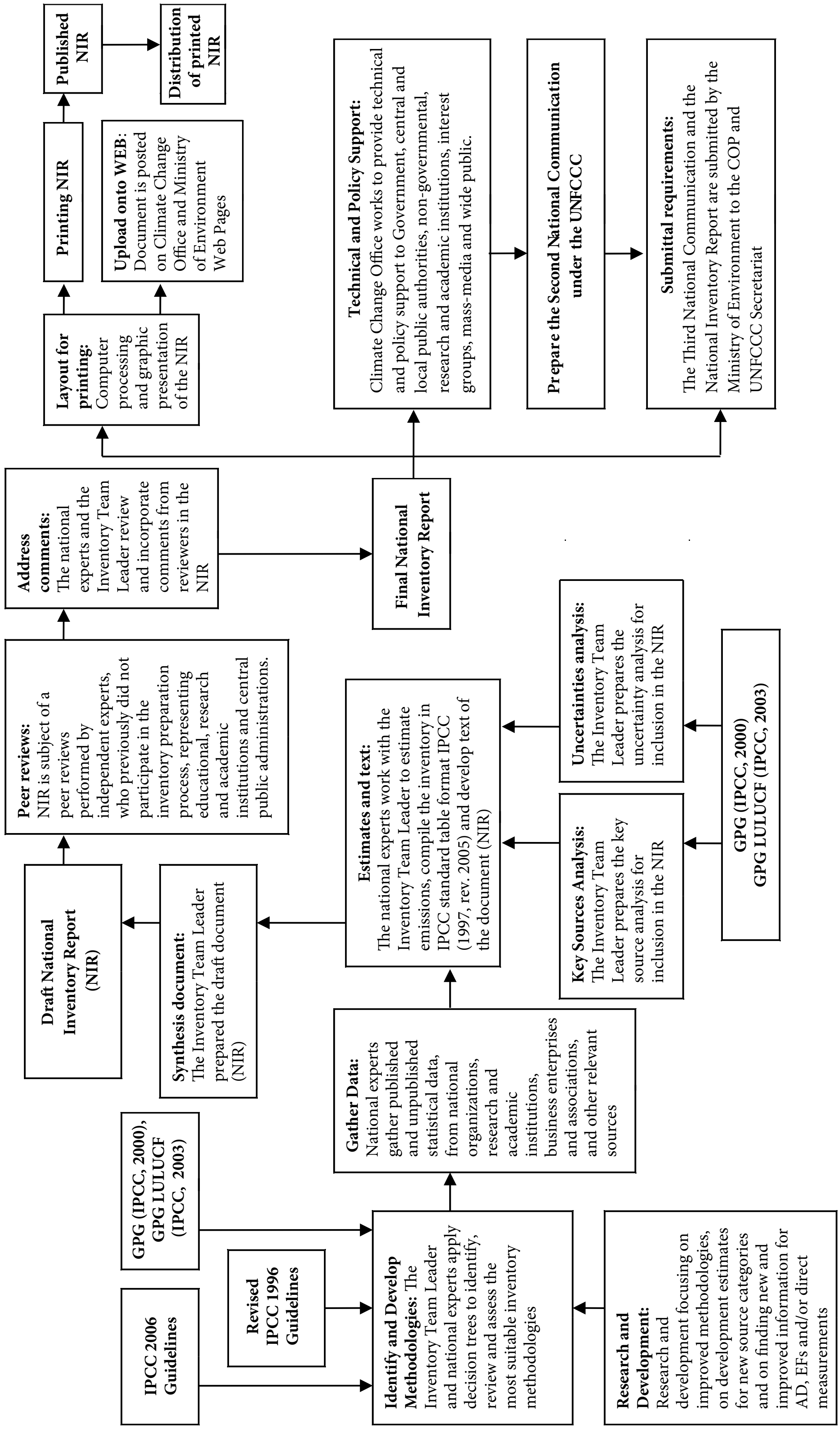


Figure 1-5: Inventory Process in the Republic of Moldova

operation with the task group leaders and NITL. The QA/QC Plan produced in 2005 within the UNDP-GEF Regional Project "Capacity Building for Improving the Quality of the National GHG Inventories (Central Europe and CIS region)" complies with the GPG (IPCC, 2000) requirements.

During the peer reviews, the draft version of the NIR was sent to a group of independent experts (who did not previously participate in the national inventory preparation). The purpose of the inventory peer reviews was 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 were reviewed and estimations and explanatory notes to them were corrected.

Following the final review, after the incorporation of comments received in the process of peer reviews, the Climate Change Office prepared the final version of the National Inventory Report, which was then electronically processed, printed and published. Once published, the National Inventory Report and the Third National Communication are submitted by the MoEN to the COP, in conformity with international commitments of the Republic of Moldova under the UNFCCC.

1.4 Methodologies and Data Sources

The national inventory is structured to match the reporting requirement of the UNFCCC and is divided into six main sectors: (1) Energy, (2) Industrial Processes, (3) Solvents and Other Products Use, (4) Agriculture, (5) Land Use, Land-Use Change and Forestry and (6) Waste. Each of these sectors is further subdivided, within the inventory, by source categories (Table 1-5).

Emissions of direct (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) and indirect (NO_x, CO, NMVOC, SO_2) greenhouse gases were estimated based on methodologies contained in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997).

Further, the National Inventory Team used methodologies available in Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GPG for Land Use, Land-Use Change and Forestry (IPCC, 2003), Atmospheric Emissions Inventory Guidebook (CORINAIR, 2009) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

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 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 at a sectoral level of segregation without attribution to individual emitters. 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 CCO 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 detailed source specific data.

To the extent possible, AD used in this report are based on officially published data: national (Statistical Yearbooks (SY) of the RM, respectively of the Administrative-Territorial Units from the Left Bank of Dniester river (ATULBD), Energy Balances (EBs), etc.) and international statistical publications (International Statistic Yearbook of Iron and Steel, UN FAO database), publications of academic, research and development institutions (Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo", Institute of Ecology and Geography, Institute of Power Engineering, Forest Research and Management Institute, etc.), AD provided by ministries and subordinated institutions (MITC, MAFI, MD, MH, MTRI, CAA, MEC, SEI, SHS, Ozone Office) and central administrative authorities (National Bureau of Statistics, Forestry Agency "Moldsilva", Agency for Land Relations and Cadaster, Customs Service), data obtained from enterprises and businesses associations (State Enterprise "Moldavian Railways", "Moldova-Gas" J.S.C., "Lafarge-Ciment" J.S.C., "Macon" J.S.C., "Glass Company Plant in Chisinau", "Glass Container Company" J.S.C., M.E. "Cristal-Flor" J.S.C., etc.), legislation acts (*National Complex Program of Enhancing Soil Fertility in 2001-2020*, approved by the Government Decree No. 591 as of 20.06.2000; *Complex Program for Reclamation of Degraded Lands and Enhancing Soils Fertility. Part I Reclamation of degraded lands*, approved by the Government Decree No. 636 as of 26.05.2003 and *Complex Program for Reclamation of Degraded Lands and Enhancing Soils Fertility, Part II Enhancing Soils Fertility*, approved by the Government Decree No. 841 as of 26.07.2004, etc.).

1.5 Key Categories

According to GPG (IPCC, 2000, 2003), it is *good practice* to identify *key categories*, as it helps prioritize efforts and improve the overall quality of the national inventory.

A "key category" is defined as a "source or sink category, that is prioritized 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 1-6 presents the key categories for the Republic of Moldova inventory based on the Tier 1 methodological approach [with LULUCF: 18 key categories by level (L) and 17 key categories by trend (T); without LULUCF: 17 key categories by

Table 1-5: Summary of Methods and Emission Factors Used for Inventory Preparation Process in the Republic of Moldova

Categories by sources and sinks	CO_2		CH_4		N_2O		HFC		PFC		SF_6	
	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
1. Energy	T1	D, CS	T1	D	T1	D						
A. Fuel Combustion Activities	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 (other works and needs in energy sector)	T1	D, CS	T1	D	T1	D						
B. Fugitive Emissions from Oil and Natural Gas	T1	D, CS	T1	D	T1	D						
1. Solid Fuels	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE						
2. Oil and Natural Gas	T1	D, CS	T1	D	T1	D						
2. Industrial Processes	T2, T1	D, CS	T1	D	T1	D	T2, T1	D	NO, NE	NO, NE	T2, T1	D
A. Mineral Products	T2, T1	D, CS	NA	NA	NA	NA						
B. Chemical Industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE						
C. Metal Production	T1	D	T1	D	T1	D						
D. Other Production	T1	D, CS	NA	NA	NA	NA						
E. Production of halocorbons and SF_6							NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
F. Consumption of halocorbons and SF_6							T2, T1	D	NO, NE	NO, NE	T2, T1	D
3. Solvents and Other Products Use	C	D	NA	NA	C	D						
A. Paint application	C	D	NA	NA	NA	NA						
B. Degreasing and dry cleaning	C	D	NA	NA	NA	NA						
C. Chemical Products, Manufacture and Processing	C	D	NA	NA	NA	NA						
D. Other	C	D	NA	NA	C	D						
4. Agriculture			T2, T1	D, CS	T2, T1	D, CS						
A. Enteric fermentation			T2, T1	D, CS	NA	NA						
B. Manure management			T2, T1	D, CS	T2, T1	D, CS						
C. Rice cultivation			NO	NO	NA	NA						
D. Agricultural soils			NA	NA	T1	D, CS						
E. Prescribed burning of savannas			NO	NO	NA	NA						
F. Field burning of agricultural residues			IE	IE	IE	IE						
5. LULUCF	T2, T1	D, CS	T1	D	T1	D						
A. Forest lands	T2, T1	D, CS	T1	D	T1	D						
B. Croplands	T2, T1	D, CS	T1	D	T1	D						
C. Grasslands	T2, T1	D, CS	NE	NE	NE	NE						
D. Wetlands	NE	NE	NE	NE	NE	NE						
E. Settlements	IE	IE	NE	NE	NE	NE						
6. Waste			T2, T1	D, CS	T1	D						
A. Solid Waste Disposal on Land			T2, T1	D, CS	NA	NA						
B. Wastewater Handling			T1	D, CS	T1	D						
C. Waste Incineration			NO, NE	NO, NE	NO, NE	NO, NE						
7. Other	T2, T1	D, CS	T1	D	T1	D						
International bunkers	T2, T1	D, CS	T1	D	T1	D						
CO_2 emissions from biomass	T1	D, CS										

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

level (L) and 15 key categories by trend (T)] using emissions data in this report for the 1990-2010 period.

Following the recommendations set in the GPG (IPCC, 2000, 2003), the inventory was first disaggregated by source and sink categories which further were used to identify key categories. Source categories were defined in conformity with the following guidelines:

(1) IPCC categories should be used with emissions specified in CO_2 equivalent units according to standard GWP;
(2) a category should be identified for each gas emitted by the sources, since the methods, emission factors, and related uncertainties differ for each gas;
(3) source categories that use the same emission factors based on common assumptions should be aggregated before analysis.

Key categories were identified from two perspectives:

- the first analysis the emission contribution that each category makes to the national total (with and without LULUCF); and
- 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 (with and without LULUCF categories).

The per cent contributions to both levels and trends in emissions are calculated and sorted from greatest to least (**Annex 1**). The 95% cumulative contribution threshold has been used in this analysis to define an upper boundary for the key category identification.

The Key Sources Analysis (KSA) was carried out using the Key Source Estimation Tool developed by the United States Environment Protection Agency (US EPA).

1.6 Quality Assurance and Quality Control

Fallowing the GPG recommendations (IPCC, 2000), national inventories have to be transparent, well documented, consistent, complete, comparable, assessed for uncertainties, subject to verification and QA/QC.

Good Practice Guidance (IPCC, 2000) 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, during 2005, under the UNDP-GEF Regional Project "Capacity Building for Improving the Quality of Greenhouse Gases National Inventories (Central Europe and CIS region)", the Republic of Moldova developed a "*Quality Assurance and Quality Control Plan*" and the "*Procedures Manual for Quality Assurance and Quality Control Plan*".

The key attributes of the "*Quality Assurance and Quality Control Plan*" include Tier 1 (general procedures) and Tier 2 (source-specific procedures) detailed specific procedures (Figure 1-6) and standard verification and quality control forms and checklists (**Annex 4**), 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 Team 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 Revised 1996 IPCC Guidelines (IPCC, 1997) and GPG (IPCC, 2000) 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 (3-8), as well as in the Chapter 9 'Recalculations and Improvements' of the NIR.

Individual source 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 categories; (6) annexes; (7) references.

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 CCO holds all documentation used for its compilation.

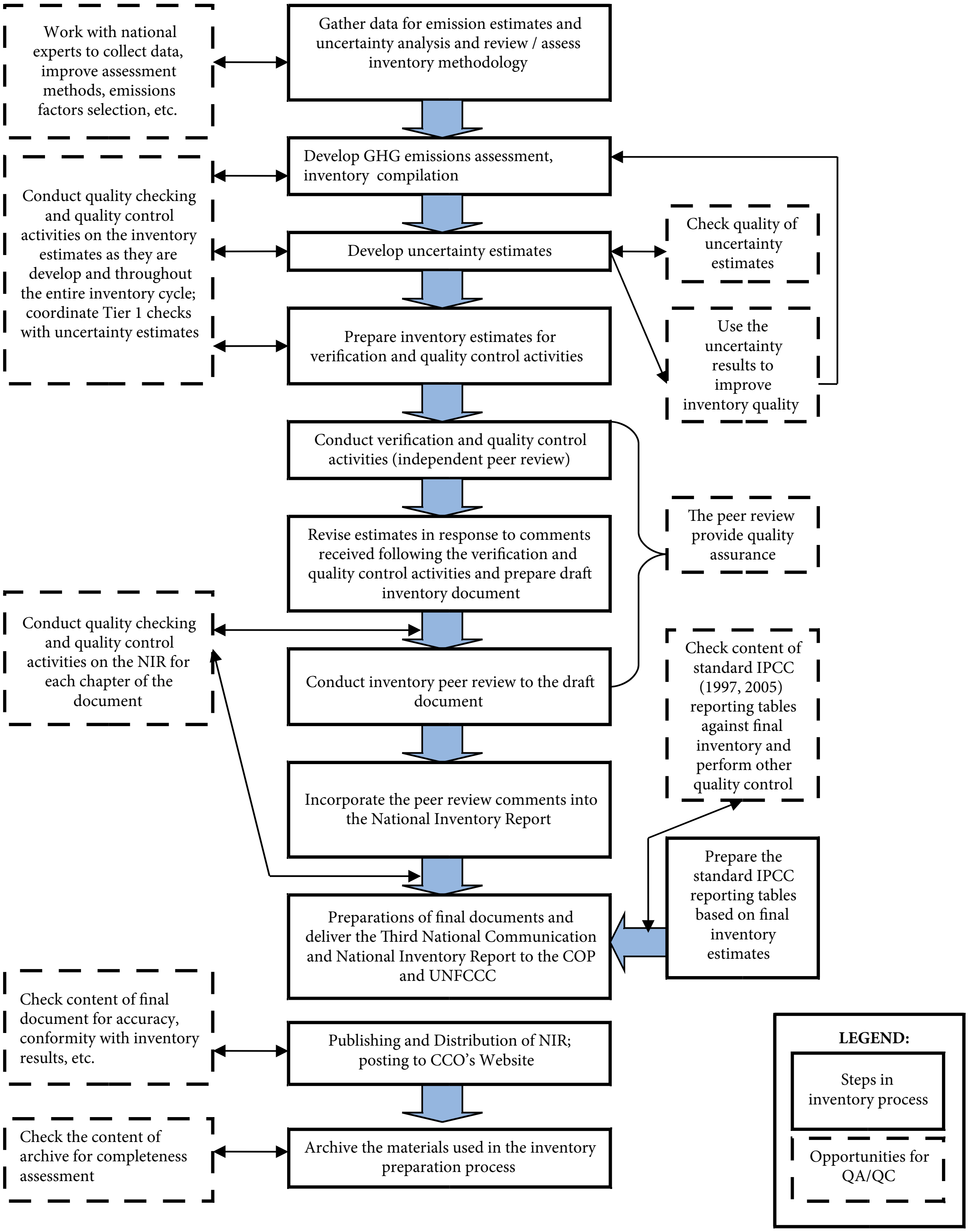


Figure 1-6: The Role of QA/QC Activities in the Inventory Preparing Process

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 categories.

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

Table 1-6: Summary Overview of the Republic of Moldova's Key Sources Categories for 1990-2010, Based on Tier 1 Approach

IPCC classification	Key Categories by Sources/Sinks	Gas	Tier 1 Approach				2010 GHG Emissions (Gg CO_2 eq.)
			With LULUCF		Without LULUCF		
			L	T	L	T	
1A1	Energy Industries - Gas	CO_2	X	X	X	X	3564.3081
5B	Cropland	CO_2	X	X			2977.0255
5A	Forest lands	CO_2	X	X			-2193.2612
1A3b	Road Transportation	CO_2	X		X	X	1792.4501
6A	Solid Waste Disposal on Land	CH_4	X	X	X	X	1388.0583
1A4b	Other: Residential	CO_2	X	X	X	X	1017.2414
4D	Direct Emissions from Agricultural Soils	N_2O	X	X	X	X	788.0248
5C	Grasslands	CO_2	X	X			-779.4600
4A	Enteric Fermentation	CH_4	X	X	X		598.3605
1A2	Manufacturing Industries and Construction	CO_2	X	X	X	X	539.2384
1A1	Energy Industries - Coal	CO_2	X	X	X	X	491.5622
1B2	Fugitive Emissions from Oil and Natural Gas	CH_4	X		X	X	487.1800
1A4a	Other: Commercial/Institutional	CO_2	X	X	X		480.8328
4B	Direct Emissions from Manure Management	N_2O	X	X	X	X	412.2018
2A1	Cement Production	CO_2	X	X	X		349.8365
4D	Indirect Emissions from Agricultural Soils	N_2O	X	X	X	X	189.6854
1A4c	Other: Agriculture/Forestry/Fishing	CO_2	X	X	X	X	155.8803
1A1	Energy Industries – Residual Fuel Oil	CO_2	X	X	X	X	132.4424
1A5	Other (Energy)	CO_2			X	X	124.4914
6B	Wastewater Handling	CH_4			X		107.8000
2A3	Limestone and Dolomite Use	CO_2				X	74.4613
1A3c	Railways	CO_2		X		X	67.1844
Sub-total without LULUCF							**12761.2401**
Total National Emissions without LULUCF							13275.9981
Per cent of Total without LULUCF							96.12%
Sub-total with LULUCF							**12765.5445**
Total National Emissions with LULUCF							13302.3867
Per cent of Total with LULUCF							95.96%

Abbreviations: L – Level Assessment; T – Trend Assessment.

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 energy-related activities and cement processing, 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 Republic of Moldova's Inventory:

- *Incorporating excluded emission sources.* Quantitative estimates for some of the sources and sinks of GHG emissions are not available at this time. In particular, emissions from a number of categories in Industrial Processes and Land Use, Land-Use Changes and Forestry sectors are not included in the inventory because data are incomplete.
- *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 use, indirect N_2O emissions from waste 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 (for example, the ability to estimate emissions of F-gases

(HFCs, PFCs and SF_6) from Industrial Processes sector is limited).

The overall inventory uncertainty was estimated using a Tier 1 methodological approach (IPCC, 2000). An estimate of the overall quantitative uncertainty, ±7.76 per cent level uncertainty and ±3.55 per cent trend uncertainty, are shown in Table 1-7, as well as in the **Annex 5** of the NIR.

Table 1-7: Estimated Overall National Inventory Quantitative Uncertainty, %

Indicator	CO_2	CH_4	N_2O	Total
Level Uncertainty	±9.70	±14.16	±28.83	±7.76
Trend Uncertainty	±4.08	±9.91	±8.36	±3.55

Emissions evaluated under the Republic of Moldova's 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 Republic of Moldova's National 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, HFCs, PFCs and SF_6, using 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:

- emissions of F-gases (HFCs, PFCs and SF_6) from 2F3 'Fire Extinguishes', 2F5 'Solvents' and 2F6 'Other Applications with ODS';
- CO_2 emissions and removals from 5D 'Wetlands'; and
- GHG emissions from 6C 'Waste Incineration' (in particular, from medical waste).

As part of the improvement plan, during the future inventory activities, the National Inventory Team will continue the efforts to identify new and relevant data for the GHG emissions/removals assessment.

2. GREENHOUSE GAS EMISSION TRENDS

2.1 Summary of Direct GHG Emission Trends

Between 1990 and 2010, the total direct greenhouse gas emissions dynamic expressed in CO_2 equivalent, revealed a decreasing trend in the Republic of Moldova, reducing by circa 69.3 per cent: from 43.2598 Mt CO_2 equivalent in 1990 to 13.2761 Mt CO_2 equivalent in 2010 (Figure 2-1).

The most significant emissions reductions have been registered under the following source categories: 1A4 'Other Sectors' (-78.9 per cent), 1A1 'Energy Industries' (-78.4 per cent), 2A 'Mineral Products' (-75.6 per cent), 1A2 'Manufacturing Industries and Constructions' (-75.4 per cent), 4A 'Enteric Fermentation' (-67.4 per cent), 4B 'Manure Management' (-66.0 per cent), 2C 'Metal Production' (-65.9 per cent), 1A3 'Transport' (-53.0 per cent), 4D 'Agricultural Soils' (-40.7 per cent), 6B 'Wastewater Handling' (-38.1 per cent), etc.

Between 2009 and 2010, total direct GHG emissions increased in the Republic of Moldova by circa 1.2 per cent, in particular due to increased emissions from the source categories 1A5 'Other' (+54.6 per cent), 4D 'Agricultural Soil' (+23.5 per cent), 2F 'Consumption of HFCs and SF_6' (+17.6 per cent), 1A3 'Transport' (+14.9 per cent), 3A-D 'Solvents and Other Products Use' (+11.0 per cent), 2A 'Mineral Products' (+7.7 per cent), 1A2 'Manufacturing Industries and Constructions' (+6.3 per cent), 4B 'Manure Management' (+4.9 per cent), 6B 'Wastewater Handling' (+3.8 per cent), etc.

2.2 Emission Trends by Gas

In the time series from 1990 through 2010, the total CO_2 emissions (without CO_2 removals in LULUCF sector) decreased by circa 74.9 per cent (from 35.3561 Mt in 1990, to 8.8852 Mt in 2010).

Emissions of CH_4 have decreased by circa 41.6 per cent (from 4.5884 Mt CO_2 eq. in 1990, to 2.6808 Mt CO_2 eq. in 2010, while emissions of N_2O decreased by circa 51.5 per cent (from 3.3153 Mt CO_2 eq. in 1990, to 1.6071 Mt CO_2 eq. in 2010) (Table 2-1).

Halocarbons emissions (HFCs, PFCs) and sulphur hexafluoride (SF_6) emissions have been registered so far in the Republic of Moldova commenced in 1995, considered as a reference year for F-gases (HFCs, PFCs and SF_6) 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 continue to contribute most to the total national direct greenhouse gas emissions in the Republic of Moldova. Figure 2-2 shows the variation of the share of direct GHG emissions by gas in the structure of total national emissions in 1990 and 2010.

In 2010, source categories of CO_2 having the biggest share in the total dioxide of carbon emissions in the Republic of Moldova were: 1A1 'Energy Industries' (4.1883 Mt or 47.0 per cent of the total), 1A3b 'Road Transport' (1.8619 Mt or

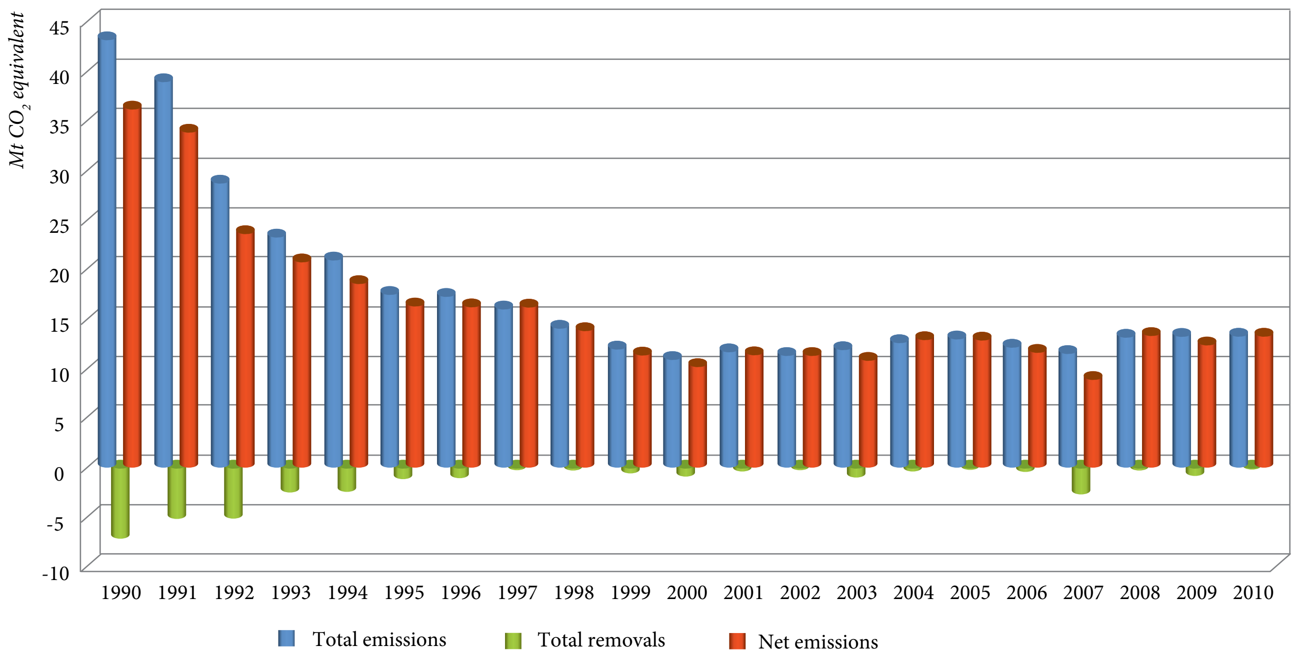


Figure 2-1: Greenhouse Gas Emission and Sink Trends in the Republic of Moldova, 1990-2010

Table 2-1: Direct GHG Emission Dynamic in the Republic of Moldova, 1990-2010, Mt CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996
CO_2 (without LULUCF)	35.3561	31.0769	21.8231	16.5959	14.9995	11.5570	11.6641
CO_2 (with LULUCF)	28.1758	25.9968	16.7116	14.1791	12.6202	10.3962	10.6555
CH_4 (without LULUCF)	4.5884	4.4620	4.3616	4.1363	4.0357	3.8149	3.7936
CH_4 (with LULUCF)	4.5907	4.4640	4.3635	4.1388	4.0371	3.8169	3.7950
N_2O (without LULUCF)	3.3153	3.3255	2.4631	2.4338	1.8684	2.0071	1.8367
N_2O (with LULUCF)	3.3163	3.3263	2.4639	2.4348	1.8690	2.0079	1.8373
HFCs	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	0.0019	0.0041
PFCs	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
SF_6	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
Total (without LULUCF)	43.2598	38.8643	28.6479	23.1660	20.9036	17.3809	17.2985
Total (with LULUCF)	36.0828	33.7870	23.5389	20.7527	18.5263	16.2228	16.2919

	1997	1998	1999	2000	2001	2002	2003
CO_2 (without LULUCF)	10.6911	9.0655	7.1684	6.3903	7.0002	6.6770	7.4889
CO_2 (with LULUCF)	10.8640	8.8753	6.6077	5.6070	6.7194	6.6052	6.4424
CH_4 (without LULUCF)	3.3948	3.2648	3.2389	3.1089	3.0090	3.0052	2.9385
CH_4 (with LULUCF)	3.3973	3.2671	3.2411	3.1097	3.0102	3.0055	2.9386
N_2O (without LULUCF)	1.9338	1.7038	1.5323	1.3983	1.5634	1.6227	1.3892
N_2O (with LULUCF)	1.9348	1.7047	1.5332	1.3986	1.5639	1.6228	1.3892
HFCs	0.0066	0.0095	0.0115	0.0134	0.0165	0.0195	0.0259
PFCs	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
SF_6	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	0.0000
Total (without LULUCF)	16.0263	14.0435	11.9511	10.9108	11.5891	11.3244	11.8425
Total (with LULUCF)	16.2026	13.8565	11.3935	10.1287	11.3099	11.2530	10.7960

	2004	2005	2006	2007	2008	2009	2010
CO_2 (without LULUCF)	7.9717	8.3678	7.6996	7.6515	8.7307	8.9607	8.8852
CO_2 (with LULUCF)	8.2813	8.2632	7.2964	5.0388	8.8607	8.0887	8.9113
CH_4 (without LULUCF)	2.8866	2.8704	2.7878	2.6925	2.6923	2.6825	2.6808
CH_4 (with LULUCF)	2.8868	2.8706	2.7881	2.6942	2.6929	2.6828	2.6810
N_2O (without LULUCF)	1.6608	1.6622	1.5833	0.9846	1.6218	1.3935	1.6071
N_2O (with LULUCF)	1.6609	1.6623	1.5835	0.9859	1.6222	1.3937	1.6072
HFCs	0.0320	0.0394	0.0471	0.0604	0.0763	0.0871	0.1024
PFCs	NE, NO	NE, NO	0.0000	0.0000	0.0000	0.0000	0.0000
SF_6	0.0000	0.0000	0.0003	0.0004	0.0004	0.0005	0.0006
Total (without LULUCF)	12.5511	12.9399	12.1180	11.3894	13.1216	13.1243	13.2761
Total (with LULUCF)	12.8611	12.8357	11.7152	8.7796	13.2525	12.2528	13.3025

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

20.9 per cent of the total), 1A4 'Other Sectors' (1.6540 Mt or 18.6 per cent of the total), 1A2 'Manufacturing Industries and Constructions' (0.5392 Mt or 6.1 per cent of the total), 2A 'Mineral Production' (0.4576 Mt or 5.1 per cent of the total) and 1A5 'Other' (0.1245 Mt or 1.4 per cent of the total) (Figure 2-3).

In 2010, the source categories of CH_4 having the biggest share in the total methane emissions in the Republic of Mol-

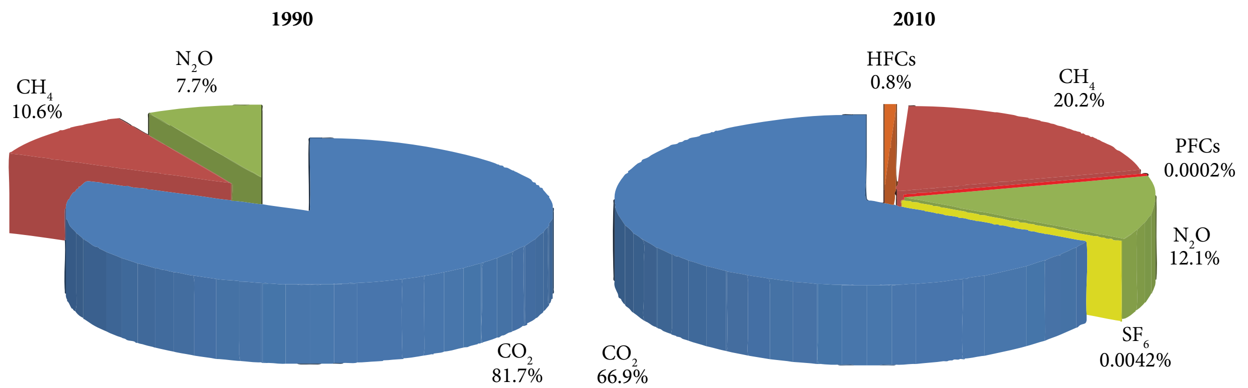


Figure 2-2: Direct GHG share in the structure of total GHG emission in the Republic of Moldova, 1990-2010

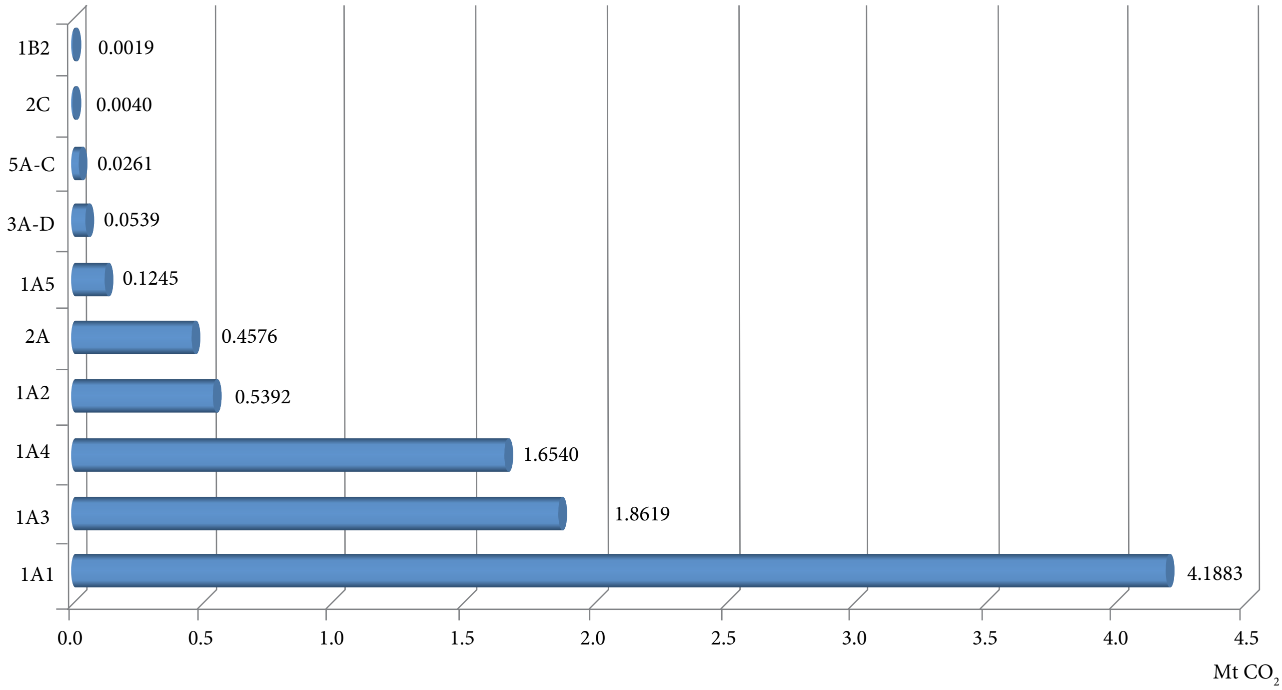


Figure 2-3: Source Categories of CO_2 in the Republic of Moldova, 2010

dova were: 6A 'Solid Waste Disposal on Land' (1.3881 Mt CO_2 eq. or 51.8 per cent of the total), 4A 'Enteric Fermentation' (0.5984 Mt CO_2 eq. or 22.3 per cent of the total), 1B2 'Fugitive Emissions From Oil and Natural Gas' (0.4872 Mt CO_2 eq. or 18.2 per cent of the total), 6B 'Wastewater Handling' (0.1078 Mt CO_2 eq. or 4.0 per cent of the total), 4B 'Manure Management' (0.0574 Mt CO_2 eq. or 2.1 per cent of the total) and 1A4 'Other sectors' (0.0325 Mt CO_2 eq. or 1.2 per cent of the total) (Figure 2-4).

In 2010, the source categories of N_2O having the largest share in the total nitrous oxide emissions in the Republic of Moldova were: 4D 'Agricultural Soils' (0.9777 Mt CO_2 eq. or 60.8 per cent of the total), 4B 'Manure Management' (0.4989 Mt CO_2 eq. or 31.0 per cent of the total), 6B 'Wastewater Handling' (0.8245 Mt CO_2 eq. or 5.1 per cent of the total) and 1A3 Transport (0.3550 Mt CO_2 eq. or 2.2 per cent of the total) (Figure 2-5).

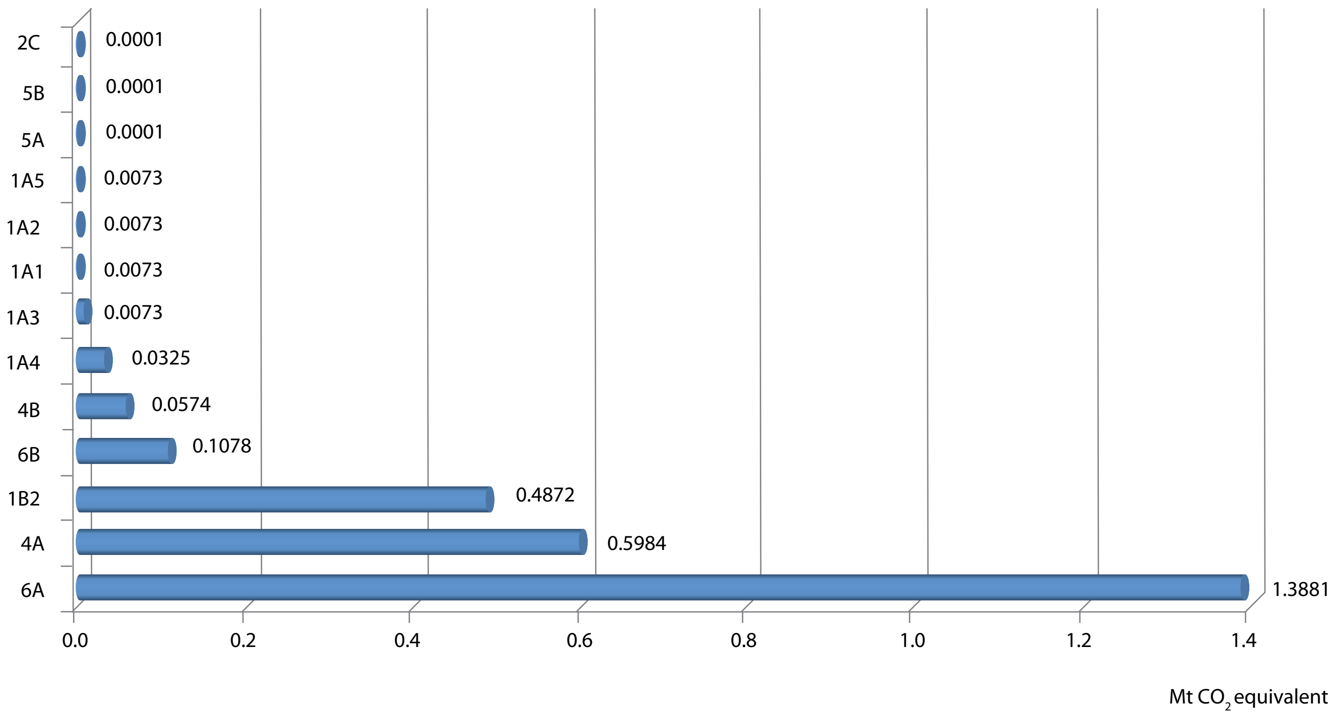


Figure 2-4: Source Categories of CH_4 in the Republic of Moldova, 2010

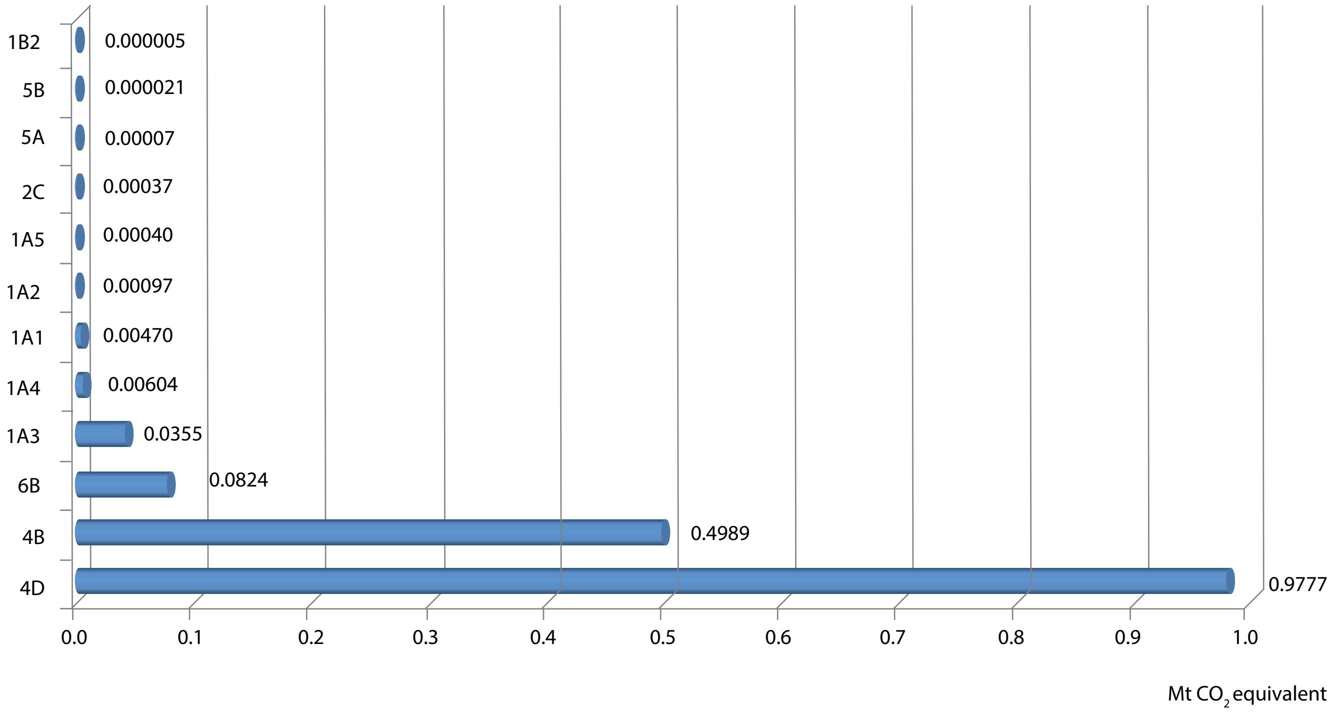


Figure 2-5: Source Categories of N_2O in the Republic of Moldova, 2010

2.3 Emission Trends by Sources

According to the UNFCCC Reporting Guidelines (IPCC, 1997), emissions estimates are grouped into six large categories: Energy Sector, Industrial Processes Sector, Solvents and Other Products Use Sector, Agriculture Sector, Land Use, Land-Use Change and Forestry Sector and Waste Sector. Interpretation of GHG emissions inventory results under Land Use, Land-Use Change and Forestry Sector is somewhat 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 source of CO_2 removals.

In the time series 1990 through 2010, total GHG emissions in the Republic of Moldova tended to decrease, so emissions under Energy Sector decreased by circa 74.1 per cent, Industrial Processes Sector – by circa 70.3 per cent, Solvents and Other Products Use Sector – by circa 40.7 per cent, Agriculture Sector – by 58.4 per cent, Land Use, Land-Use Change and Forestry Sector – by 100.4 per cent, Waste Sector – by 3.0 per cent (Table 2-2).

Table 2-2: Direct Greenhouse Gas Emission Dynamic in the Republic of Moldova by Sector, 1990-2010, Mt CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996
1. Energy	34.5204	30.2204	21.3842	16.4752	15.0077	11.7107	11.9417
2. Industrial Processes	1.9010	1.8067	1.1743	0.7701	0.6230	0.4915	0.4368
3. Solvents	0.0908	0.0782	0.0625	0.0508	0.0417	0.0382	0.0339
4. Agriculture	5.1202	5.0028	4.1542	4.0033	3.4099	3.3591	3.0718
5. LULUCF	-7.1770	-5.0773	-5.1089	-2.4133	-2.3773	-1.1581	-1.0066
6. Waste	1.6274	1.7563	1.8727	1.8665	1.8213	1.7815	1.8143
	1997	1998	1999	2000	2001	2002	2003
1. Energy	10.7761	9.2605	7.3728	6.6623	7.2653	6.9497	7.7622
2. Industrial Processes	0.4898	0.3433	0.3086	0.2812	0.2727	0.3304	0.3828
3. Solvents	0.0299	0.0238	0.0309	0.0316	0.0453	0.0385	0.0357
4. Agriculture	2.9873	2.7318	2.4885	2.2770	2.4541	2.5246	2.1969
5. LULUCF	0.1763	-0.1870	-0.5577	-0.7821	-0.2791	-0.0714	-1.0465
6. Waste	1.7432	1.6841	1.7503	1.6586	1.5517	1.4812	1.4650
	2004	2005	2006	2007	2008	2009	2010
1. Energy	8.2344	8.5189	7.7036	7.4085	8.4274	9.0660	8.9465
2. Industrial Processes	0.4288	0.5684	0.6638	0.9458	1.0222	0.5201	0.5650
3. Solvents	0.0438	0.0682	0.0482	0.0522	0.0536	0.0485	0.0539
4. Agriculture	2.4012	2.3734	2.2682	1.5151	2.1177	1.9249	2.1324
5. LULUCF	0.3099	-0.1042	-0.4028	-2.6098	0.1309	-0.8715	0.0264
6. Waste	1.4430	1.4111	1.4343	1.4678	1.5007	1.5649	1.5783

Energy Sector is the most important source of total national direct GHG emissions, its share varying from 79.8 per cent to 67.3 per cent over the time series from 1990 through 2010. Other relevant sources are represented by Agriculture Sector, Waste Sector, and Industrial Processes Sector (Figure 2-6).

2.3.1 Energy Sector

Energy-related activities are by far the largest source of GHG emissions in the Republic of Moldova. The Energy Sector includes emissions of all GHGs from fuel combustion for the primary purpose of delivering energy. Emissions in this sector are classified as either fuel combustion (94.5 per cent of total emissions per sector in 2010) or fugitive releases defined as intentional or unintentional releases of GHGs from the production, processing, transmission, storage, and delivery of fossil oil and natural gas (5.5 per cent of total emissions per sector in 2010) (Figure 2-7, Table 2-3).

Overall, these emissions accounted, in 2010, for 67.3 per cent of total Republic of Moldova's GHG emissions. Between 1990 and 2010, total GHG emissions from Energy Sector decreased by circa 74.1 per cent: from 34.5204 Mt CO_2 eq. in 1990 to 8.9465 Mt CO_2 eq. in 2010.

The 1A1 'Energy Industries' contribute more than any other category to the Republic of Moldova's emissions, accounting for circa 46.9 per cent of the total per sector in 2010 (56.2 per cent in 1990). Other relevant categories are represented by 1A3 'Transport', accounting for circa 21.3 per cent of the total (11.7 per cent in 1990) and 1A4 'Other Sectors', accounting for 18.9 per cent of the total per sector (23.3 per cent in 1990) (Figure 2-8).

2.3.2 Industrial Processes Sector

The Industrial Processes Sector represents an important GHG emission source in the Republic of Moldova that includes emissions generated by non-energy industrial activities. In 2010, this sector accounted for 4.2 per cent of the total national GHG emissions (4.4 per cent in 1990). During 1990-2010 time periods, total sectoral GHG emissions decreased by circa 70.3 per cent: from 1.9010 Mt CO_2 eq. in 1990, to 0.5650 Mt CO_2 eq. in 2010 (Figure 2-9).

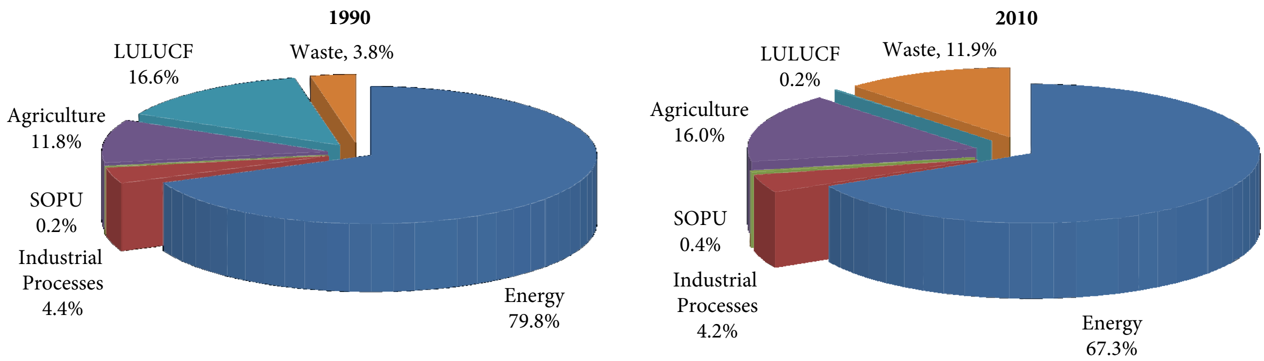


Figure 2-6: Sectoral Breakdown of the Republic of Moldova's total GHG Emissions in 1990 and 2010

Table 2-3: GHG Emissions from Energy Sector, 1990–2010, Mt CO_2 eq.

Source Categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
1. Energy	34.5204	11.7107	6.6623	8.5189	7.7036	7.4085	8.4274	9.0660	8.9465
A. Fuel Combustion	33.8375	11.1547	6.1589	7.8586	7.1283	6.7968	7.8186	8.5617	8.4575
A.1. Energy Industries	19.3933	6.9318	3.1524	3.2361	2.4941	2.4761	3.2951	4.4605	4.1946
A.2. Manufacturing industries and constructions	2.1959	0.4530	0.5318	0.5919	0.6517	0.8179	0.9131	0.5086	0.5407
A.3. Transport	4.0556	1.3382	0.8634	1.6565	1.5816	1.6509	1.7417	1.6583	1.9047
A.3a. Civil Aviation	NO, NE	NO, NE	NO, NE	0.0002	0.0001	0.0002	0.0002	0.0001	0.0001
A.3b. Road Transport	3.4383	1.0927	0.7398	1.4908	1.4090	1.5069	1.6085	1.5725	1.8271
A.3c. Railways	0.5070	0.1617	0.0931	0.1290	0.1665	0.1398	0.1289	0.0759	0.0753
A.3d. Navigation	0.0191	0.0002	0.0001	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
A.3e. Pipeline Transport	0.0912	0.0836	0.0304	0.0361	0.0057	0.0038	0.0038	0.0095	0.0019
A.4. Other sectors	8.0378	2.2585	1.5503	2.2558	2.2507	1.6982	1.7062	1.8534	1.6925
A.4a. Institutional/Commercial	1.4241	0.3950	0.2300	0.7109	0.6529	0.3663	0.3717	0.4716	0.4847
A.4b. Residential	4.6573	1.1322	1.0811	1.3614	1.4195	1.1798	1.1851	1.2428	1.0509
A.4c. Agriculture/Forestry/Fishing	1.9564	0.7313	0.2393	0.1834	0.1783	0.1521	0.1494	0.1390	0.1569
A.5. Other works and needs in energy	0.1549	0.1733	0.0610	0.1185	0.1501	0.1537	0.1625	0.0809	0.1251
B. Fugitive Emissions	0.6829	0.5560	0.5034	0.6603	0.5752	0.6117	0.6088	0.5043	0.4890
B.1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
B.2. Oil and Natural Gas	0.6829	0.5560	0.5034	0.6603	0.5752	0.6117	0.6088	0.5043	0.4890

Abbreviations: NE – Not Estimates; NO – Not Occurring

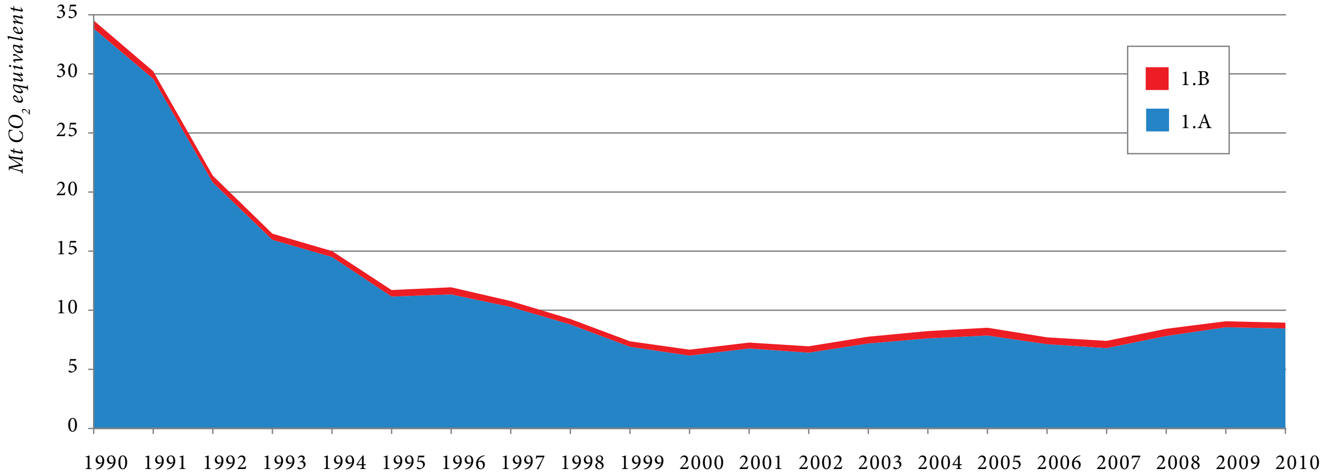


Figure 2-7: GHG Emissions from Energy Sector in the Republic of Moldova, 1990-2010

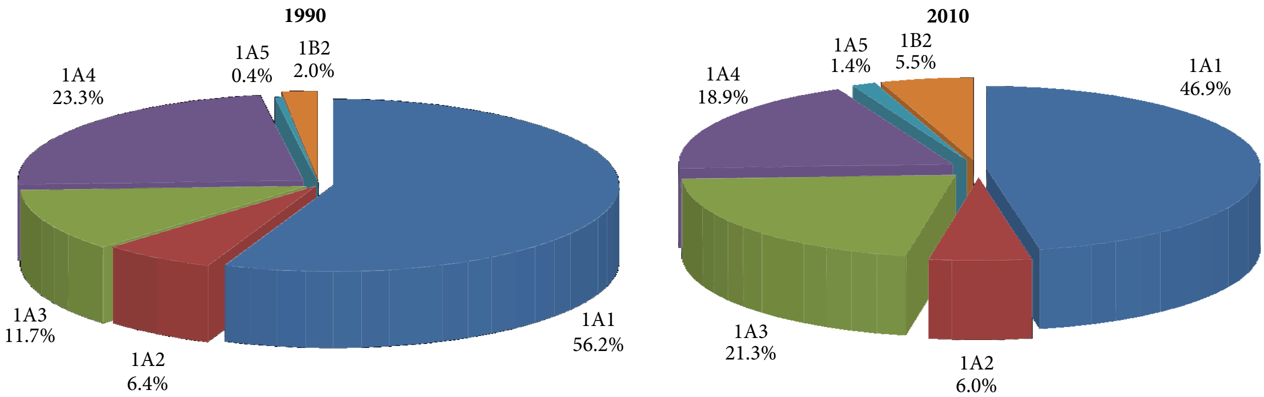


Figure 2-8: Energy Sector Greenhouse Gas Sources in the Republic of Moldova in 1990 and 2010

Between 2008-2009 respective emissions decreased by 49.1 per cent as a consequence of the global economic crises that significantly affected the industrial sector in RM. However, between 2009 and 2010, the total national GHG emissions increased by 8.6 per cent, in particular as a result of cement production growth, widespread use of limestone and dolomite, of soda ash (Na_2CO_3), as well as due to the increased use of halocarbons and SF_6 (Table 2-4).

The most important source of emission in this sector is represented by 2A1 „Cement Production", with a share of circa 61.9 per cent of the total sectoral emissions in 2010 (51.1 per cent in 1990) (Figure 2-10).

Other relevant sources in 2010 were represented by categories 2A3 'Limestone and Dolomite Use' accounting for 13.2 per cent from the total (32.6 per cent in 1990), 2F1 'Refrigeration and Air Conditioning Equipment' – circa 11.6 per

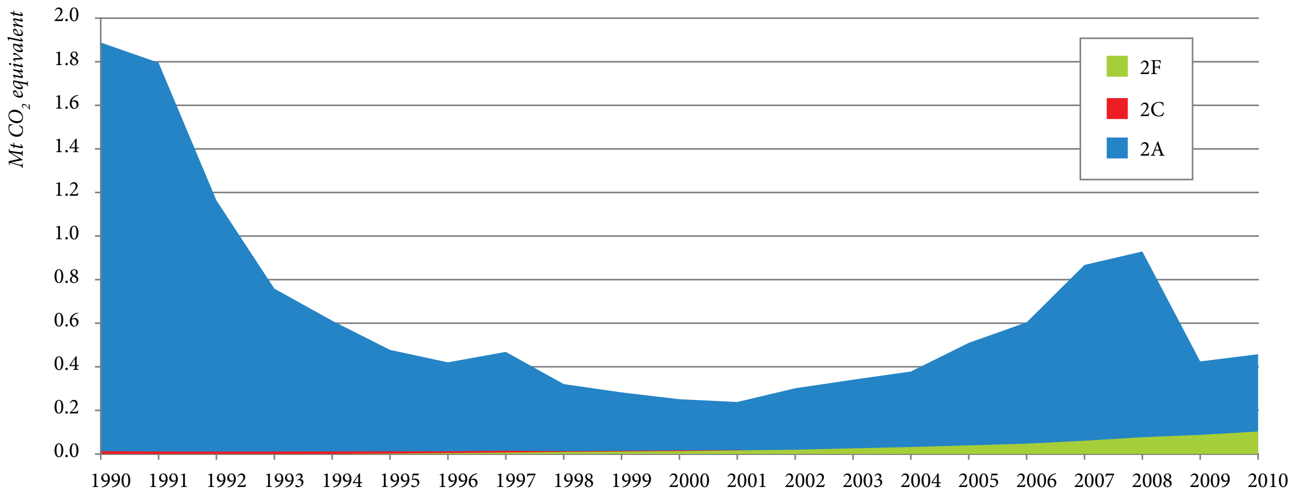


Figure 2-9: GHG Emissions from Industrial Processes, 1990–2010

Table 2-4: Direct GHG Emissions from Industrial Processes, 1990-2010, Mt CO_2 eq.

Sources by Categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
2. Industrial Processes	1.9010	0.4915	0.2812	0.5684	0.6638	0.9458	1.0222	0.5201	0.5650
A. Mineral Products	1.8881	0.4775	0.2512	0.5097	0.6041	0.8674	0.9292	0.4247	0.4576
A1. Cement Production	0.9717	0.2485	0.1728	0.3651	0.4571	0.7027	0.7899	0.3406	0.3498
A2. Lime Production	0.1487	0.0282	0.0110	0.0066	0.0074	0.0110	0.0104	0.0033	0.0023
A3. Limestone and Dolomite Use	0.6195	0.1625	0.0322	0.0988	0.1010	0.1189	0.0942	0.0514	0.0745
A4. Soda Ash Use	0.0330	0.0146	0.0140	0.0182	0.0161	0.0142	0.0140	0.0101	0.0120
A7. Other Mineral Products	0.1153	0.0237	0.0213	0.0211	0.0225	0.0207	0.0207	0.0194	0.0189
B. Chemical Industry	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
C. Metal Production	0.0130	0.0120	0.0166	0.0192	0.0124	0.0177	0.0162	0.0078	0.0044
C1. Iron and Steel Production	0.0130	0.0120	0.0166	0.0192	0.0124	0.0177	0.0162	0.0078	0.0044
D. Other	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6	NO, NE	0.0019	0.0134	0.0395	0.0474	0.0607	0.0768	0.0876	0.1030
F1. Refrigeration and Air Conditioning Equipment	NO, NE	0.0002	0.0081	0.0235	0.0270	0.0351	0.0462	0.0537	0.0654
F2. Foam Blowing	NO, NE	0.0017	0.0053	0.0159	0.0201	0.0252	0.0301	0.0334	0.0370
F4. Aerosols	NO, NE	NO, NE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
F8. Electrical Equipment	NO, NE	NO, NE	NO, NE	0.0000	0.0003	0.0004	0.0005	0.0005	0.0007

Abbreviations: NE – Not Estimates; NO – Not Occurring

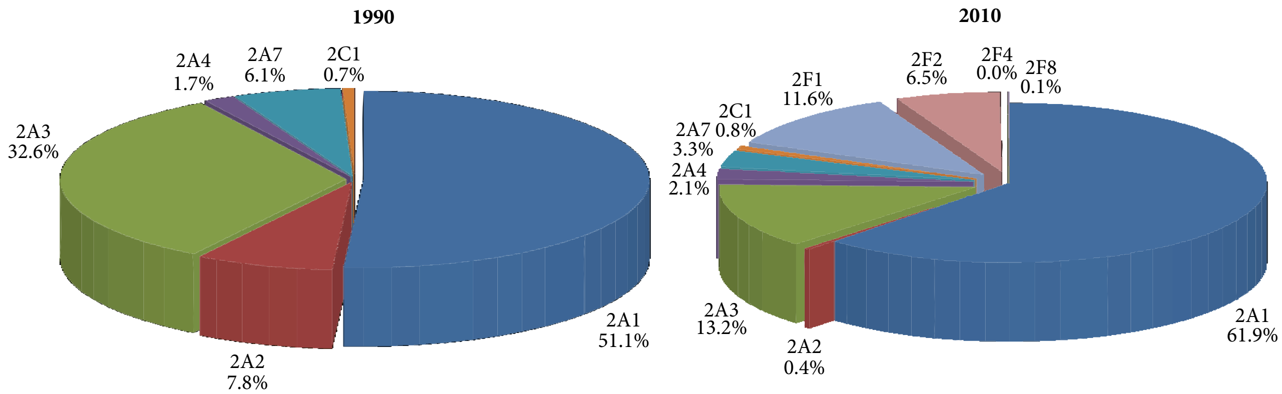


Figure 2-10: Breakdown of Industrial Processes' GHG Emissions by Category in RM in 1990 and 2010

cent from the total, 2F2 'Foam Blowing' – 6.5 per cent of the total, 2A7 'Other Mineral Products' (Mineral Wool Production, Brick Production, Expanded Clay Production) accounting 3.3 per cent from the total (6.1 per cent in 1990) and 2A4 'Soda Ash Use' accounting 2.1 per cent from the total (1.7 per cent in 1990).

2.3.3 Solvents and Other Products Use Sector

In the Republic of Moldova the Solvents and Other Products Use Sector is a modest source and includes emissions of non-methane volatile organic compounds (NMVOC), also considered as a CO_2 emissions source - as the majority of solvents are obtained from fossil fuels, as well as N_2O emissions from use of N_2O for anesthesia. In 2010, the respective sector accounted for as little as circa 0.4 per cent of the total national GHG emissions (0.2 per cent in 1990).

Between 1990 and 2010, the total GHG emissions covered by this sector decreased by 40.7 per cent: from 0.0908 Mt CO_2 eq. in 1990, to 0.0539 Mt CO_2 eq. in 2010 (Table 2-5). However, between 2009 and 2010, respective emissions increased in the RM by circa 11.0 per cent, in particular as a result of increased use of household products.

In the Solvents and Other Products Use Sector, in 2010, the largest source of emissions was represented by 3A 'Paint Application' accounting for circa 38.5 per cent of the total sectoral emissions (35.1 per cent in 1990). Other relevant source categories are represented by 3D 'Other' accounting for 32.9 per cent of the total (22.2 per cent in 1990), 3B 'Degreasing and Dry Cleaning' – 23.0 per cent of the total sectoral emissions (36.6 per cent in 1990) and 3C 'Chemical Products, Manufacture and Processing' – 5.6 per cent of the total sectoral emissions (6.2 per cent in 1990) (Figure 2-11).

2.3.4 Agriculture Sector

The Agriculture Sector represents an important source of GHG emissions in the Republic of Moldova: CH_4 emissions, in particular from 4A 'Enteric Fermentation', 4B 'Manure Management'; N_2O emissions from 4B 'Manure Management' and 4D 'Agricultural Soils'. In the Republic of Moldova there are no registered emissions from 4C 'Rice Cultivation' and 4E

Table 2-5: GHG Emissions from Solvents and Other Products Use, 1990–2010, Mt CO_2 eq.

Source Categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
3. Solvents and Other Products Use	0.0908	0.0382	0.0316	0.0682	0.0482	0.0522	0.0536	0.0485	0.0539
A. Paint Application	0.0319	0.0036	0.0060	0.0308	0.0180	0.0219	0.0206	0.0192	0.0207
B. Degreasing and Dry Cleaning	0.0332	0.0197	0.0107	0.0173	0.0089	0.0094	0.0112	0.0085	0.0124
C. Chemical Products, Manufacture and Processing	0.0056	0.0007	0.0007	0.0019	0.0023	0.0030	0.0041	0.0036	0.0030
D. Other	0.0201	0.0142	0.0142	0.0181	0.0190	0.0179	0.0176	0.0172	0.0177
D1. Printing	0.0007	0.0001	0.0001	0.0004	0.0003	0.0003	0.0004	0.0003	0.0004
D2. Domestic Solvents Use	0.0130	0.0130	0.0128	0.0124	0.0124	0.0123	0.0123	0.0122	0.0122
D3. Other Products Use	0.0063	0.0010	0.0013	0.0054	0.0064	0.0053	0.0049	0.0046	0.0051

Abbreviations: NE – Not Estimates; NO – Not Occurring

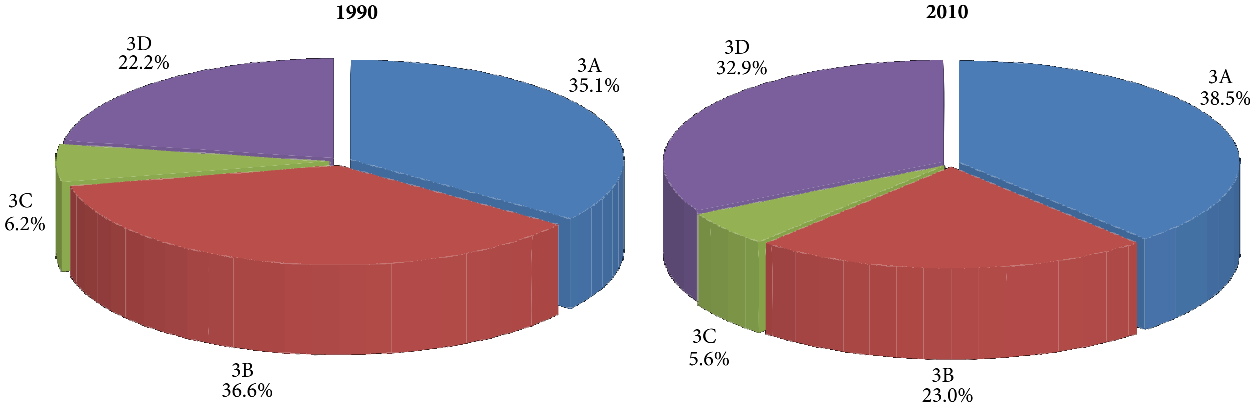


Figure 2-11: Breakdown of Solvents and Other Products Use GHG Emissions by Category in the Republic of Moldova in 1990 and 2010

'Prescribed Burning of Savannas', as for the emissions from 4F Field Burning of Agricultural Residues, these are monitored in the LULUCF Sector, under the category 5B 'Cropland'.

In 2010, Agriculture Sector accounted for circa 16.0 per cent of the total national GHG emissions (11.8 per cent in 1990). Between 1990 and 2010 total GHG emissions originated from this sector decreased by circa 58.4 per cent: from 5.1202 Mt CO_2 eq. in 1990, to 2.1324 Mt CO_2 eq. in 2010 (Table 2-6, Figure 2-12), in particular, due to a sharp drop in such indicators as: domestic livestock and poultry population, amounts of synthetic nitrogen and organic fertilizers applied to soils, amounts of agricultural crop residues returned to soils, carbon losses from mineral soils and changes of tillage practices.

Between 2009 and 2010, direct greenhouse gas emissions originated from Agriculture Sector increased by circa 10.8 per cent, in particular as a result of increase of N_2O emissions from 4D 'Agricultural Soils' and 4B 'Manure Management'. In 2010, the largest source of emission was 4D 'Agricultural Soils', accounting for 45.8 per cent of the total sectoral emissions (35.8 per cent in 1990). Other relevant sources are represented by 4A 'Enteric Fermentation', accounting for 28.1 per cent of the total (35.8 per cent in 1990) and 4B 'Manure Management', accounting for circa 26.1 per cent of the total sectoral emissions (32.0 per cent in 1990) (Figure 2-13)

2.3.5 Land Use, Land-Use Change and Forestry Sector

Generally, during 1990-2010, the LULUCF Sector represented a source of net carbon removals (the only exceptions were 1997, 2004, 2008 and 2010 years, when sector represented a source of net emissions). Between 1990 and 2010, net CO_2 emissions/removals dynamic registered a clear decreasing trend, reducing by 100.4 per cent, from -7.1770 Mt

Table 2-6: GHG Emissions from Agriculture Sector, 1990–2010, Mt CO_2 eq.

Source Categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
4. Agriculture	5.1202	3.3591	2.2770	2.3734	2.2682	1.5151	2.1177	1.9249	2.1324
A. Enteric Fermentation	1.8344	1.3608	0.9112	0.7784	0.7530	0.6088	0.5797	0.6027	0.5984
B. Manure Management	1.6368	0.9764	0.5705	0.5957	0.6179	0.4659	0.4653	0.5306	0.5564
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	1.6490	1.0219	0.7954	0.9993	0.8973	0.4404	1.0726	0.7916	0.9777
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	IE	IE	IE	IE	IE	IE	IE	IE	IE

Abbreviations: IE – Included Elsewhere; NE – Not Estimates; NO – Not Occurring

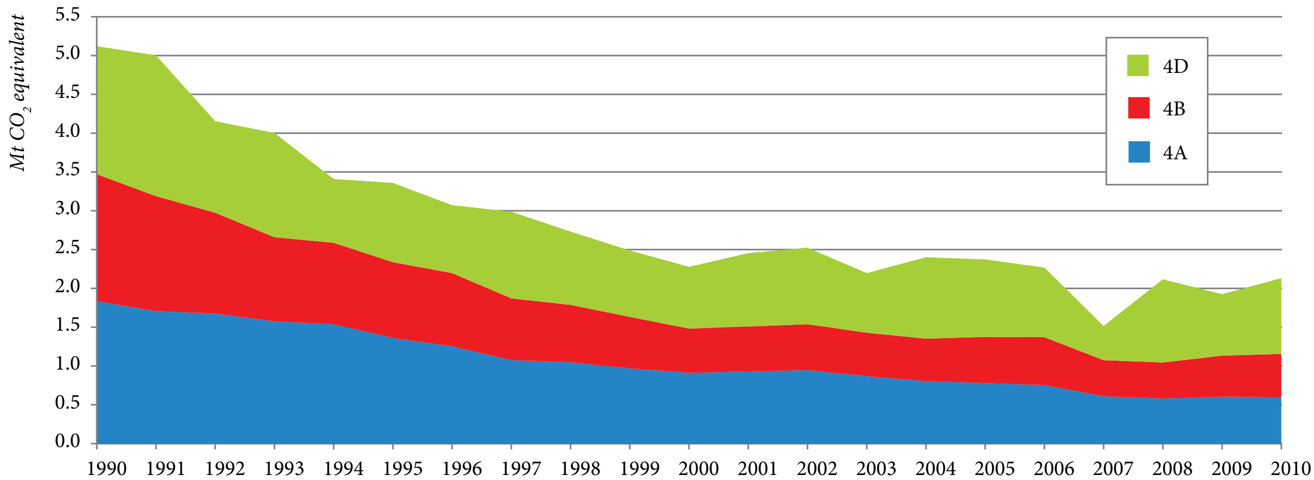


Figure 2-12: GHG Emissions from Agriculture Sector in the Republic of Moldova, 1990 – 2010

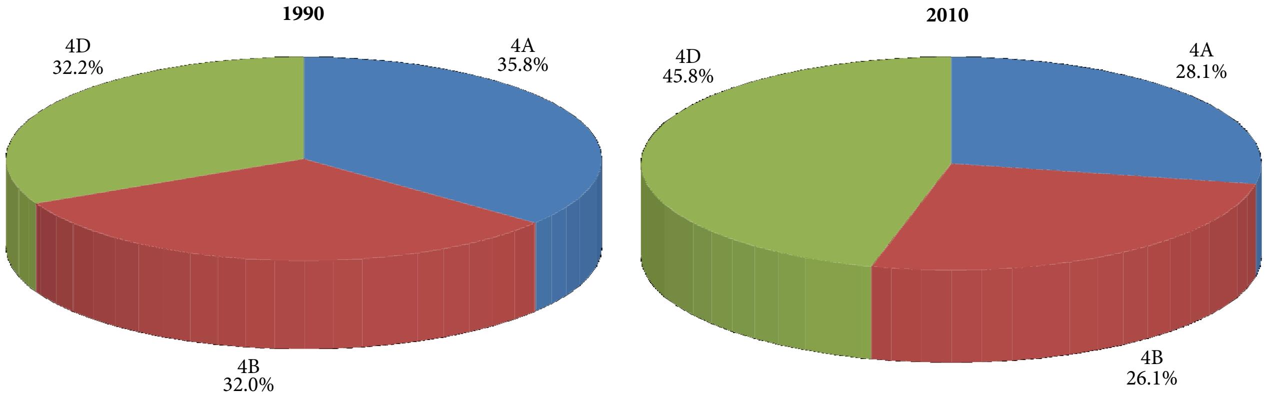


Figure 2-13: Breakdown of Agriculture GHG Emissions by Category in the Republic of Moldova in 1990 and 2010

in 1990 to +0.0264 Mt in 2010 (Figure 2-14, Table 2-7). Between 2009 and 2010, CO_2 net removals decreased by circa 103.0 per cent in the LULUCF Sector.

This situation can be explained, in particular, due to changes in the use and management of agricultural soils (5B 'Cropland'), that contributed to the substantial decrease of organic carbon from the agricultural soils, changing the humus balance from a positive one like in 1990-1992, to a relatively neutral balance, specific to 1993-1994, respectively to a profoundly negative balance, like in 1995-2010 time

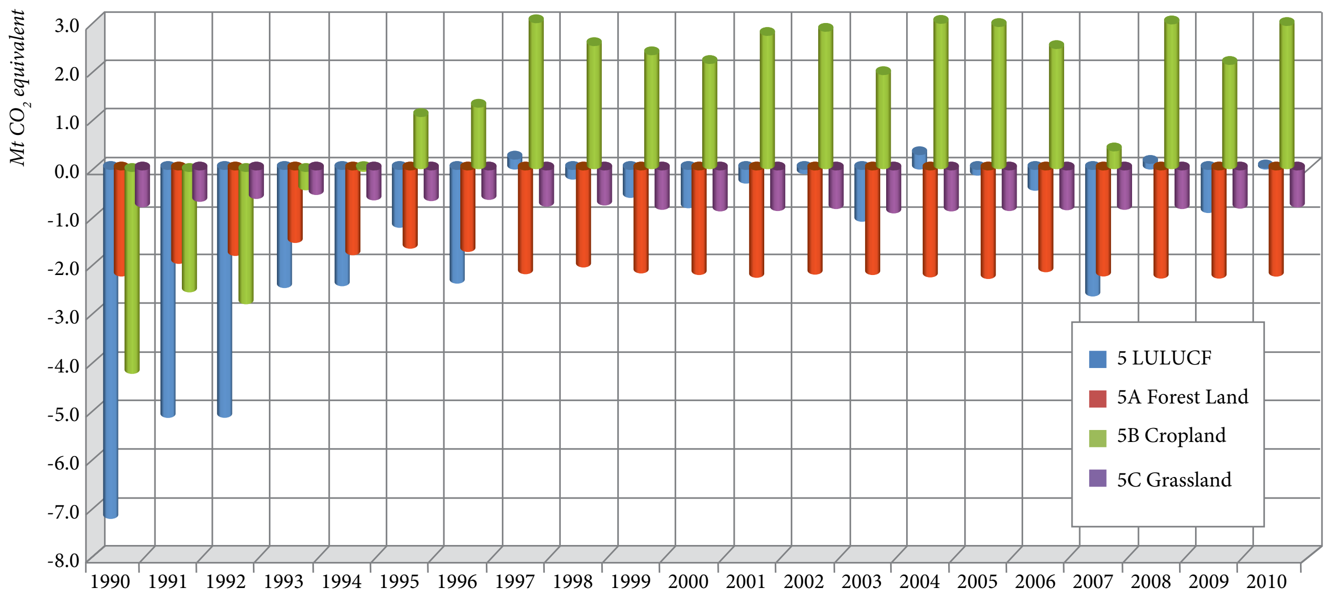


Figure 2-14: Emissions/Removals in LULUCF Sector by Source Categories, 1990-2010

Table 2-7: Emissions and Removals in LULUCF Sector, 1990-2010, Mt CO_2 eq.

Source Categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
5. LULUCF	-7.1770	-1.1581	-0.7821	-0.1042	-0.4028	-2.6098	0.1309	-0.8715	0.0264
A. Forest Land	-2.1972	-1.6208	-2.1403	-2.2462	-2.0876	-2.1895	-2.2228	-2.2513	-2.1931
B. Cropland	-4.1933	1.0822	2.1838	2.9614	2.4915	0.3786	3.1430	2.1616	2.9771
C. Grassland	-0.7865	-0.6195	-0.8255	-0.8195	-0.8067	-0.7988	-0.7893	-0.7818	-0.7576
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	NE, IE	NE, IE	NE, IE	NE, IE	NE, IE	NE, IE	NE, IE	NE, IE	NE, IE
F. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE

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

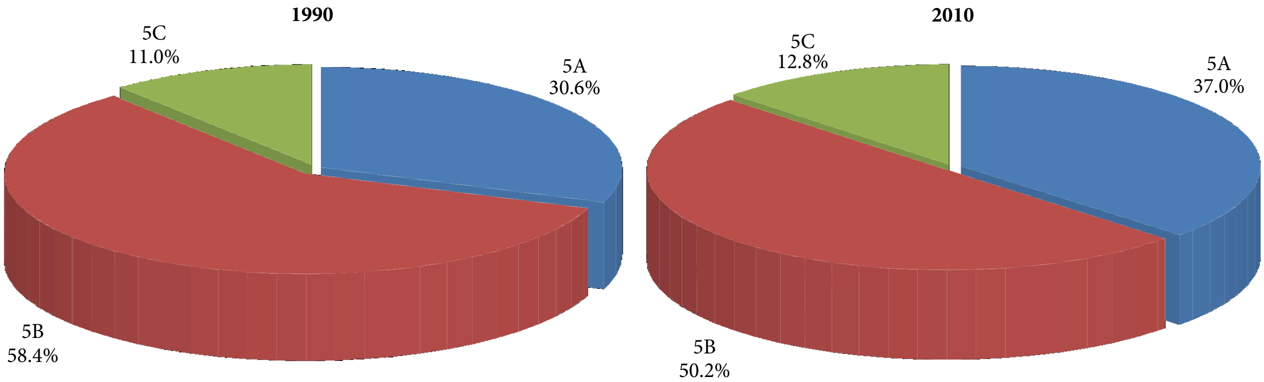


Figure 2-15: Breakdown of GHG Emissions and Removals by source and sink categories in LULUCF Sector, in 1990 and 2010

periods. This process was also influenced by some changes in the maintenance and use of forests (5A 'Forest Land'), authorized increased amounts of harvested wood, substantial increase of illegal fellings, increased conversion of forest lands into croplands, etc.

In 1990, the largest source of carbon removals under LULUCF Sector was 5B 'Cropland' (lands covered with wood vegetation – multiannual plantations as well as the agricultural soils) accounting for 58.4 per cent of the sectoral totals, followed by 5A 'Forest Land' (forests, protective forests, etc.) accounting for 30.6 per cent, respectively by 5C 'Grassland', accounting for 11.0 per cent (Figure 2-15). Starting with 1993, the 5B 'Cropland' category became a source of CO_2 emissions, as a result of profoundly negative balance from agricultural soils, as well as due to reduction of multiannual plantation areas.

As was mentioned above, emissions from 5B 'Cropland' in 1997, 2004, 2008 and 2010 took precedence over net carbon removals registered in other categories, and this despite the fact that the contribution of land areas occupied by forest ecosystems (5A 'Forest Land') in the process of carbon removals is still growing, especially due to the expansion of areas covered with forest vegetation. Subsequently, growth could be extended at the expense of increasing productivity of existing forests by applying broader reconstruction of damaged trees and with low productivity.

In the RM the emissions/removals from 5D 'Wetlands' and 5F 'Other land' were not estimated, while the emissions/removals from 5E 'Settlements' were partly taken into account in 5B 'Cropland' category, especially CO_2 removals from land covered with wood vegetation, including terrestrial and underground biomass of orchards, vineyards, and trees in individual gardens.

2.3.6 Waste Sector

Waste Sector is an important source of GHG emissions: CH_4 emissions from 'Solid Waste Disposal on Land' (Category 6A) and 'Wastewater Handling' (Category 6B), as well as N_2O emissions from 'Human Sewage' (Category 6B). At the moment, in RM there are no registered emissions from 6C 'Waste Incineration' category.

In 2010, Waste Sector accounted for circa 11.9 per cent of the total national direct GHG emissions (3.8 per cent in 1990). In the time series from 1990 through 2010, total GHG emissions from this sector decreased by circa 3.0 per cent: from 1.6274 Mt CO_2 eq. in 1990, to 1.5783 Mt CO_2 eq. in 2010 (Table 2-8). At the same time, between 2009 and 2010, GHG emissions from Waste Sector increased by 0.9 per cent.

Reduction of total GHG emissions from the Waste Sector within 1990-2005 is explained by the economic decline that occurred in the Republic of Moldova during the period under review, by a significant drop in the wellbeing of population, and respectively, capacity to generate solid and other types of wastes. At the same time, starting with 2006, there has been a clear growing trend of direct GHG emissions from the 'Waste Sector' (Figure 2-16).

In 2010 the largest source of GHG emissions within the Waste Sector was Category 6A 'Solid Waste Disposal on Land', accounting for circa 87.9 per cent of the total sectoral emissions (81.2 per cent in 1990) (Figure 2-17).

Table 2-8: GHG Emissions from Waste Sector, 1990–2010, Mt CO_2 eq.

Source Categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
6. Waste	1.6274	1.7815	1.6586	1.4111	1.4343	1.4678	1.5007	1.5649	1.5783
A. Solid Waste Disposal on Land	1.3201	1.5763	1.5091	1.2129	1.2399	1.2833	1.3087	1.3816	1.3881
B. Wastewater Handling	0.3073	0.2052	0.1495	0.1982	0.1943	0.1845	0.1921	0.1832	0.1902
C. Waste Incineration	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE

Abbreviations: NE – Not Estimates; NO – Not Occurring

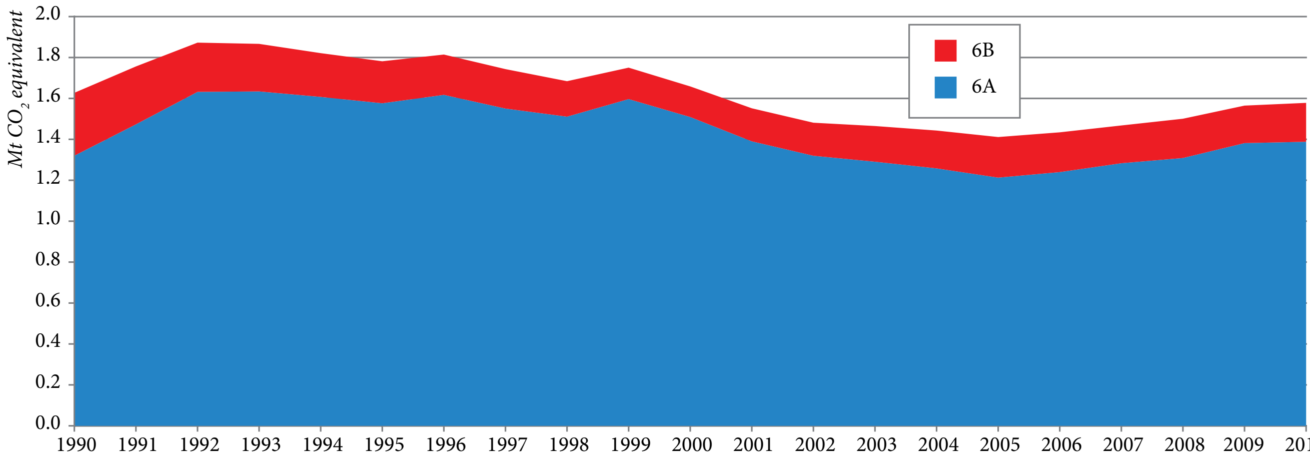


Figure 2-16: Total Waste Sector GHG Emissions Trends in the Republic of Moldova, 1990–2010

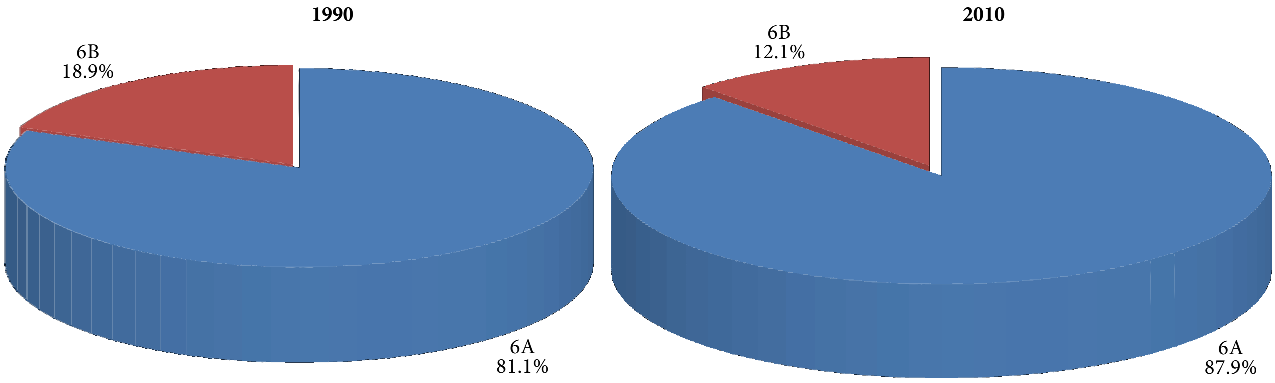


Figure 2-17: Breakdown of Waste GHG Emissions by Category in the Republic of Moldova in 1990 and 2010

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

In 1990-2010, nitrogen oxides emissions decreased by 73.0 per cent: from 137.2194 kt in 1990 to 37.0635 kt in 2010, carbon monoxide emissions decreased by 73.9 per cent: from 428.0672 kt in 1990 to 111.9294 kt in 2010, non-methane volatile organic compounds emissions decreased by 81.4 per cent: from 512.2303 kt in 1990 to 95.2324 kt in 2010, while sulphur dioxide emissions decreased by 93.6 per cent: from 294.9063 kt in 1990 to 18.7756 kt in 2010 (Table 2-9).

In 2010, the source categories of NO_x having the biggest share in the total nitrogen oxides emissions in the Republic of Moldova were: 1A3 'Transport' (18.7731 kt or 50.7 per cent of the total), 1A1 'Energy Industries' (11.4309 kt or 30.8 per cent of the total), 1A4 'Other Sectors' (4.2172 kt or 11.4 per cent of the total), 1A2 'Manufacturing Industries and Constructions' (1.5105 kt or 4.1 per cent of the total) and 2A 'Mineral Products' (0.7316 kt or 4.1 per cent of the total) (Figure 2-18).

In 2010, the source categories of CO having the biggest share in the total carbon monoxide emissions in the Republic of Moldova were: 1A3 'Transport' (85.1121 kt or 76.0 per cent

Table 2-9: Ozone and Aerosol Precursors Emission Trends in the RM in 1990-2010, kt

	1990	1991	1992	1993	1994	1995	1996
NO_x	137.2194	118.9043	79.9920	63.1479	56.7902	47.8938	45.1745
CO	428.0672	376.9457	195.6386	160.3229	146.6000	145.3208	142.8140
NMVOC	512.2303	424.0149	334.4593	266.7580	175.1392	162.6902	148.9657
SO_2	294.9063	256.1539	170.1669	146.0971	102.6067	61.0006	58.9692
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NO_x	41.9948	35.2592	25.8379	24.5483	26.7705	27.4538	30.8025
CO	138.7959	122.6704	86.9378	84.2057	87.3850	99.7837	118.1225
NMVOC	75.1749	62.6311	39.5516	37.4619	45.6717	45.6605	48.3082
SO_2	33.9676	26.9756	14.0259	9.9288	9.4514	10.5082	13.0501
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NO_x	32.3275	49.3686	31.0410	31.4840	34.8908	34.9055	37.0635
CO	121.9150	124.7128	116.0094	118.1991	120.5858	114.0031	111.9294
COVNM	56.2400	67.3736	65.8121	129.9583	87.1732	60.5991	95.2324
SO_2	11.2448	11.8426	12.3622	10.7123	14.8404	18.2960	18.7756

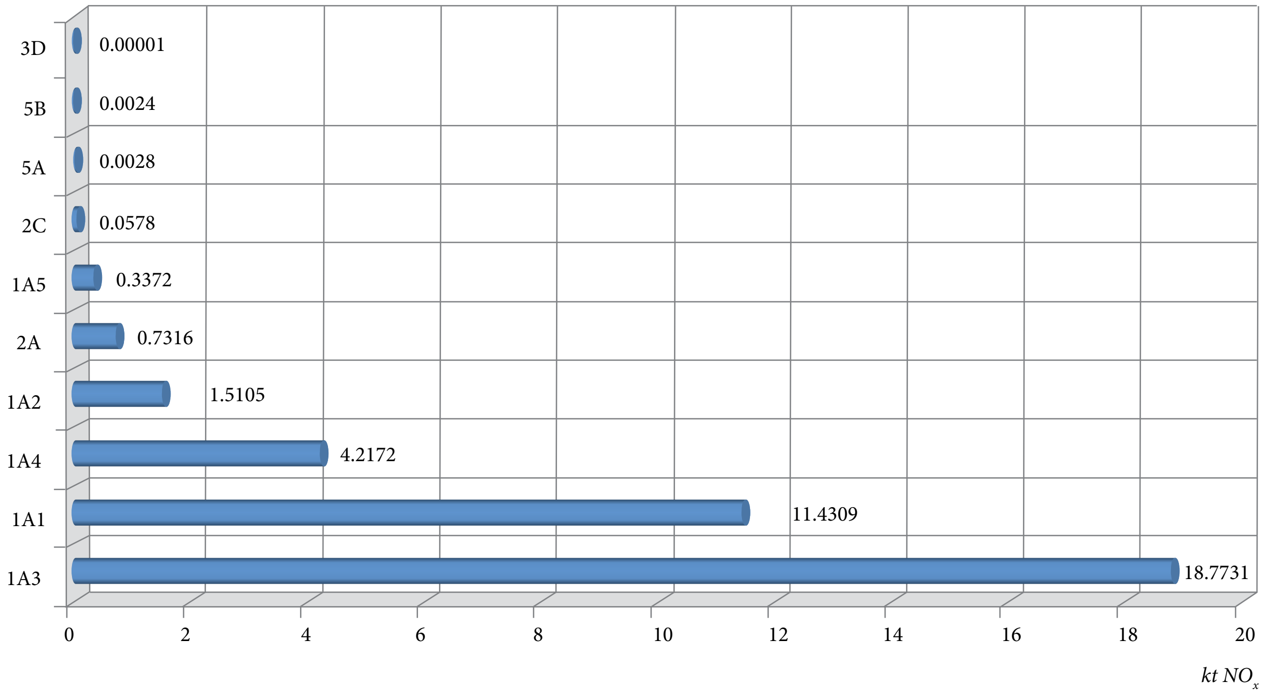


Figure 2-18: 2010 Source Categories of NO_x in the Republic of Moldova

of the total), 1A4 'Other Sectors' (22.1317 kt or 19.8 per cent of the total), 2C 'Metal Production' (12.4158 kt or 2.2 per cent of the total) and 1A1 'Energy Industries' (1.4003 kt or 1.3 per cent of the total) (Figure 2-19).

In 2010, the source categories of NMVOC having the biggest share in the total non-methane volatile organic compounds emissions in the Republic of Moldova were: 2A 'Mineral Products' (53.3495 kt or 56.0 per cent of the total), 3A-D 'Solvents and Other Products Use' (18.8146 kt or 19.8 per cent of the total), 1A3 'Transport' (16.1605 kt or 17.0 per cent of the total), 2D 'Other Production' (foods and beverages) (2.8602 kt or 3.0 per cent of the total), 1A4 'Other Sectors' (2.6764 kt or 2.8 per cent of the total), 1B2 'Fugitive Emissions From Oil and Natural Gas' (0.8833 kt or 0.9 per cent of the total) (Figure 2-20).

In 2010, the source categories of SO_2 having the biggest share in the total sulphur dioxide emissions in the Republic of Moldova were: 1A1 'Energy Industries' (8.3173 kt or 44.3 per cent of the total), 1A4 'Other Sectors' (5.0450 kt or 26.9 per cent of the total), 1A3 'Transport' (2.8017 kt or 14.9 per cent of the total), 1A5 'Other' (Other Needs and Works in Energy Sector) (1.4976 kt or 8.0 per cent of the total), 1A2 'Manufacturing Industries and Constructions' (0.5832 kt or 3,1 per cent of the total) and 2A 'Mineral Products' (0.4887 kt or 2.6 per cent of the total) (Figure 2-21).

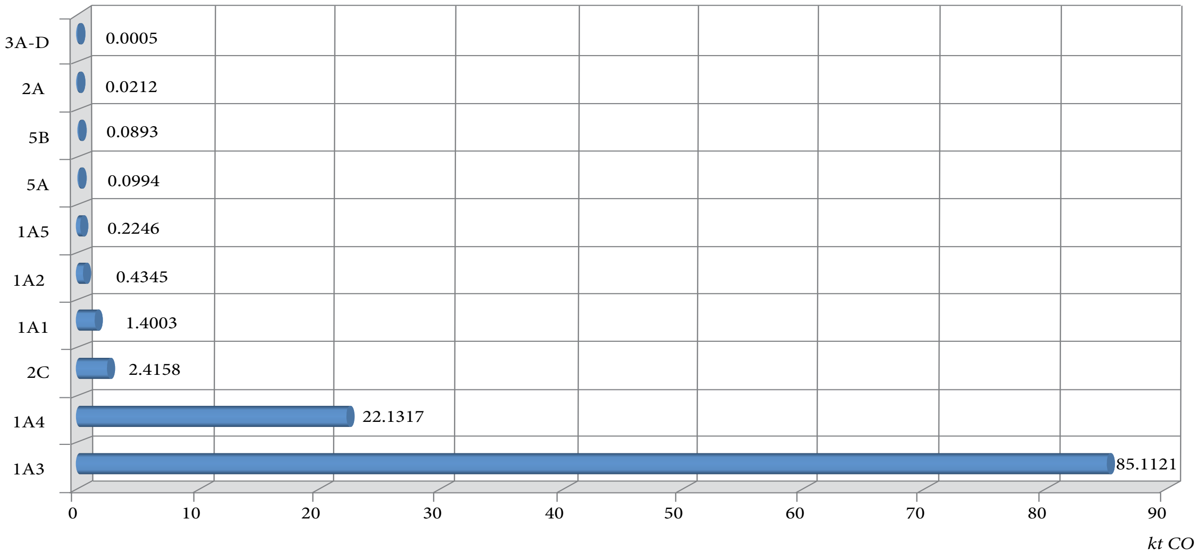


Figure 2-19: 2010 Source Categories of CO in the Republic of Moldova

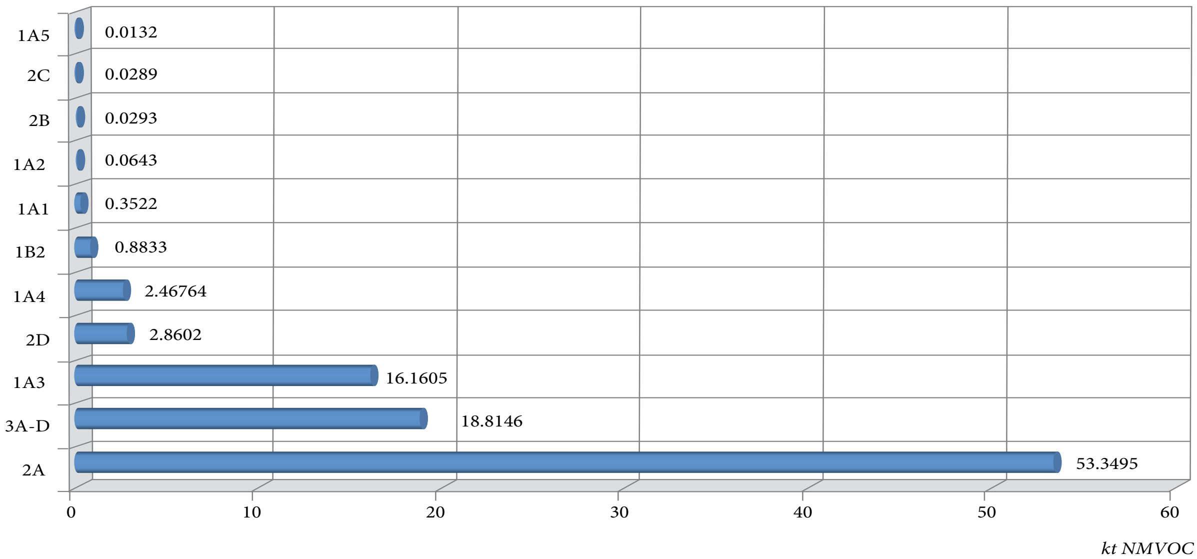


Figure 2-20: 2010 Source Categories of NMVOC in the Republic of Moldova

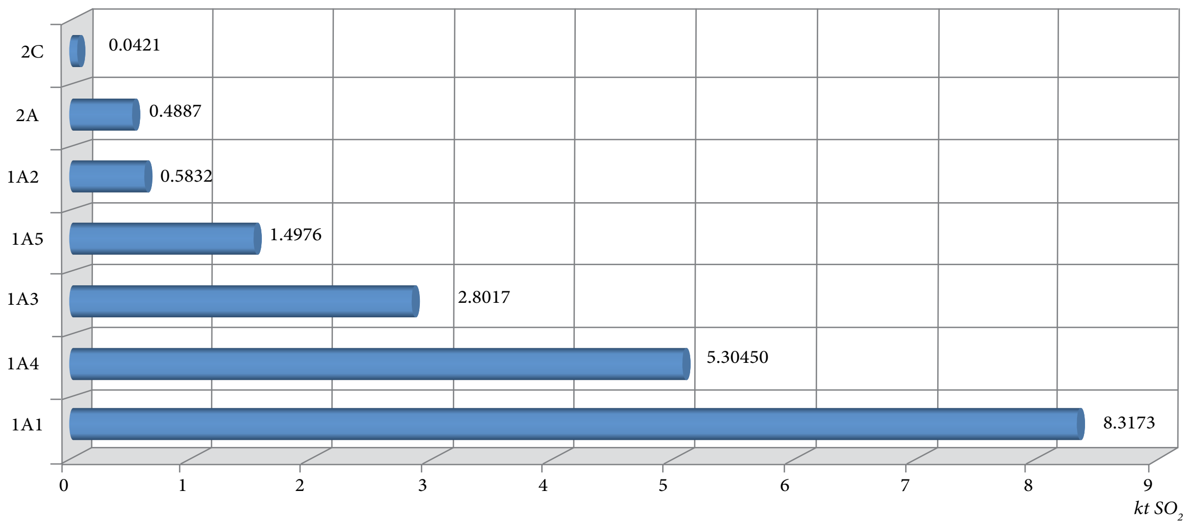


Figure 2-21: 2010 Source Categories of SO_2 Total Emissions in the Republic of Moldova

3. ENERGY SECTOR

3.1 Overview

Energy Sector includes GHG emissions resulting from electricity and heat production activities, and fuel combustion for energy generation purposes. Methodological guidance used includes the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), Good Practice Guidance (IPCC, 2000), 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and other guidelines developed under the United Nations Framework Convention on Climate Change (UNFCCC, 2005a, 2005b).

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

1. Energy Sector
   - 1A. Fuel Combustion Activities
     - *1A1. Energy Industries*
     - *1A2. Manufacturing Industries and Constructions*
     - *1A3. Transport (Civil Aviation, Road Transport, Railways, Navigation, Pipeline Transport)*
     - *1A4. Other Sectors (Commercial/Institutional, Residential, Agricultural/Forestry/Fishing)*
     - *1A5. Other*
   - 1B. Fugitive emissions
     - *1B2. Oil and Natural Gas*

Memo items

International Bunkers

CO_2 Emissions from Biomass

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

GHG emissions in the Energy Sector result from fuel combustion for power generation (electricity and heat), industrial production (in energy purposes), transportation needs, from residential, agriculture, forestry, fishing sectors, as well as for other needs and works in energy sector.

3.1.1 Summary of Emission Trends

In 2010, Energy Sector accounted for circa 67.4 per cent of total national direct GHG emissions (without LULUCF), being the most important source of GHG emissions at the national level.

Energy Sector was also a relevant source of CH_4 and N_2O emissions, accounting for circa 19.7 per cent and, respectively 3.0 per cent of total methane and nitrous oxide emissions registered at the national level.

Between 1990 and 2010, the total GHG emissions from the Energy Sector tended to lower values, decreasing by 74.1 per cent (Table 3-1, Figure 3-1), in particular, because of the economic decline in the Republic of Moldova in the respective period.

Compared to the base year (1990), by 2010 the GHG emissions have significantly reduced: CO_2 by 74.9 per cent, CH_4 by 45.1 per cent, N_2O by 75.1 per cent, NO_x by 73.1 per cent, CO by 74.2 per cent, NMVOC by 72.0 per cent and SO_2 emissions has reduced by 93.8 per cent (Tables 3-2 and 3-3).

Table 3-1: Total Direct GHG Emissions from Energy Sector in the Republic of Moldova, 1990-2010, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996
Energy Sector	34520.3934	30220.3831	21384.2436	16475.2288	15007.7005	11710.7161	11941.7032
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Energy Sector	10776.1010	9260.5249	7372.7948	6662.3193	7265.2698	6949.6719	7762.1833
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Energy Sector	8234.3880	8518.8831	7703.5778	7408.5283	8427.4354	9065.9645	8946.5232

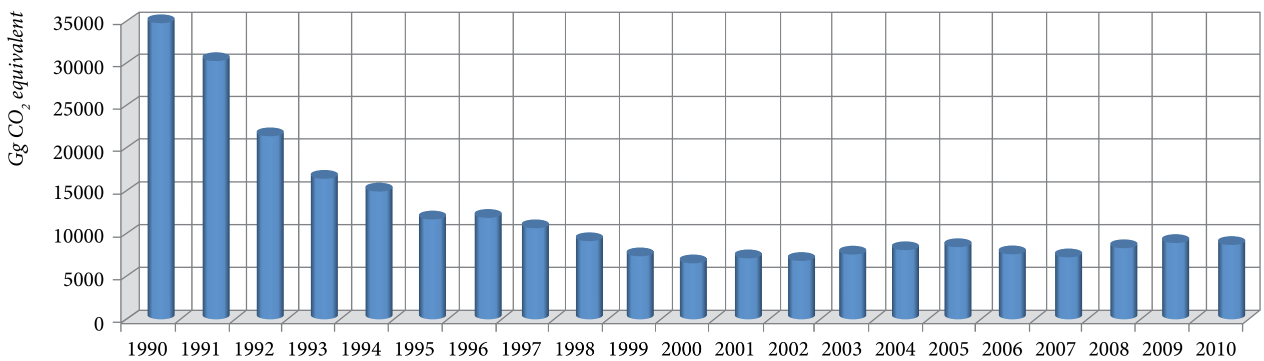


Figure 3-1: Total Direct GHG Emissions from Energy Sector in the Republic of Moldova, 1990-2010.

Table 3-2: Direct and Indirect GHG Emissions from the Energy Sector in 1990-2010, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2	33365.5535	29193.0936	20587.3862	15776.0767	14335.8965	11030.3907	11198.7301
CH_4	45.8690	40.9613	32.7354	28.9628	28.1368	29.4496	32.5523
N_2O	0.6180	0.5390	0.3529	0.2933	0.2611	0.1996	0.1915
NO_x	134.6595	116.4861	78.3833	61.6055	55.6893	46.9101	44.3305
CO	423.1362	366.4809	186.1429	149.7682	137.6924	135.3017	133.5421
NMVOC	71.9509	63.4604	32.6833	25.0331	23.0075	23.2127	22.5061
SO_2	293.0068	254.5103	169.0262	144.5701	101.8663	60.4022	58.4038
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	10179.4508	8709.0855	6841.7537	6092.4074	6700.4292	6328.5245	7097.9321
CH_4	26.0885	24.1905	23.9243	25.6880	25.3406	27.7260	29.4534
N_2O	0.1574	0.1401	0.0924	0.0983	0.1054	0.1255	0.1475
NO_x	40.9470	34.3358	25.0195	23.5733	25.8089	26.5019	29.8096
CO	126.4156	111.6272	75.3152	73.7128	75.8569	94.2123	109.1685
NMVOC	22.3271	19.5024	12.8458	12.7201	13.2617	16.4424	19.0950
SO_2	33.3351	26.4235	13.5377	9.3243	8.8672	9.9252	12.4325
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	7532.9793	7772.5759	7036.1667	6715.9617	7733.2846	8480.4656	8369.7595
CH_4	31.2551	33.3583	29.4661	30.7889	30.7089	25.7669	25.1976
N_2O	0.1453	0.1477	0.1568	0.1484	0.1589	0.1432	0.1536
NO_x	31.2550	31.7845	29.8031	29.8817	33.3096	34.0651	36.2690
CO	111.5122	113.8159	108.8576	106.5704	110.6004	109.3094	109.3032
NMVOC	20.4590	20.9926	19.4557	19.5972	20.5653	20.3062	20.1500
SO_2	10.5425	11.0710	11.5750	9.7208	13.8455	17.7339	18.2448

Table 3-3: Direct and Indirect GHG Emissions from the Energy Sector in 1990-2010, % in comparison with 1990 level

	1990	1991	1992	1993	1994	1995	1996
CO_2	100.0	87.5	61.7	47.3	43.0	33.1	33.6
CH_4	100.0	89.3	71.4	63.1	61.3	64.2	71.0
N_2O	100.0	87.2	57.1	47.5	42.2	32.3	31.0
NO_x	100.0	86.5	58.2	45.7	41.4	34.8	32.9
CO	100.0	86.6	44.0	35.4	32.5	32.0	31.6
NMVOC	100.0	88.2	45.4	34.8	32.0	32.3	31.3
SO_2	100.0	86.9	57.7	49.3	34.8	20.6	19.9
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	30.5	26.1	20.5	18.3	20.1	19.0	21.3
CH_4	56.9	52.7	52.2	56.0	55.2	60.4	64.2
N_2O	25.5	22.7	14.9	15.9	17.1	20.3	23.9
NO_x	30.4	25.5	18.6	17.5	19.2	19.7	22.1
CO	29.9	26.4	17.8	17.4	17.9	22.3	25.8
NMVOC	31.0	27.1	17.9	17.7	18.4	22.9	26.5
SO_2	11.4	9.0	4.6	3.2	3.0	3.4	4.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	22.6	23.3	21.1	20.1	23.2	25.4	25.1
CH_4	68.1	72.7	64.2	67.1	66.9	56.2	54.9
N_2O	23.5	23.9	25.4	24.0	25.7	23.2	24.9
NO_x	23.2	23.6	22.1	22.2	24.7	25.3	26.9
CO	26.4	26.9	25.7	25.2	26.1	25.8	25.8
NMVOC	28.4	29.2	27.0	27.2	28.6	28.2	28.0
SO_2	3.6	3.8	4.0	3.3	4.7	6.1	6.2

Within 1990-2010, practically all source categories under the Energy Sector revealed in the Republic of Moldova a GHG emission decreasing trend (Table 3-4, Figure 3-2):

- 1A1 'Energy Industry' – by 78.4%;
- 1A2 'Manufacturing Industry and Construction' – by 75.4%;
- 1A3 'Transport' – by 53.0%;
- 1A4 'Other Sectors' – by 79.8%;
- 1A5 'Other' – by 19.3%;
- 1B2 'Fugitive Emissions from Oil and Natural Gas' – by 28.4%.

Within the Energy Sector, the source category with the largest specific weight in the national direct GHG emissions is 1A1 'Energy Industries', with a share varying over the review period, from 69.0 per cent (1993) to 32.4 per cent (2006). Other major emissions sources within the Energy Sector are represented by 1A4 'Other Sectors', with a share varying from 14.2 per cent (1993) to 29.2 per cent (2006), 1A3 'Transport', with a share varying from 8.8 per cent (1993) to 22.3 per cent (2007), and 1B2 'Fugitive Emissions from

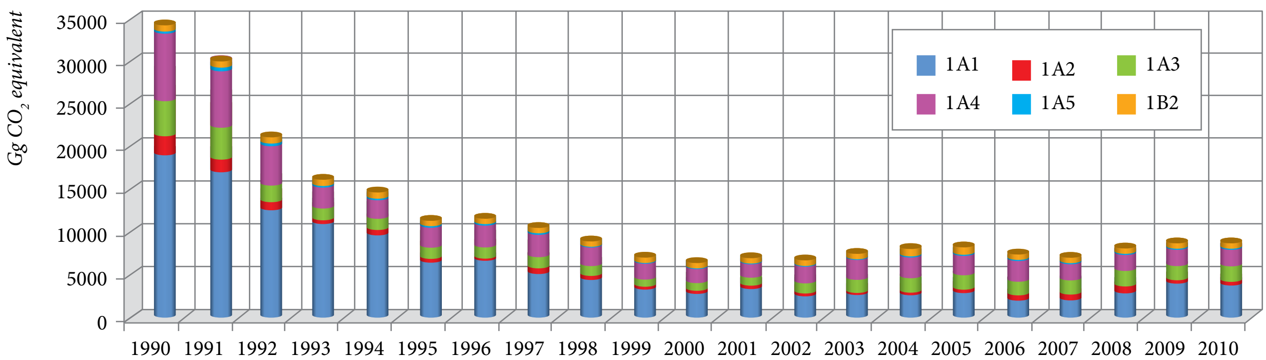


Figure 3-2: Breakdown of the Republic of Moldova's Energy Sector Direct GHG Emissions by Category within 1990-2010

Table 3-4: Breakdown of the Republic of Moldova's Energy Sector Direct GHG Emissions by Category, 1990-2010, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996
1A1	19393.2858	17414.4185	13049.3384	11373.2009	10029.8177	6931.7635	7152.4697
1A2	2195.8930	1690.8854	965.3383	541.7823	809.2528	453.0153	360.9377
1A3	4055.6062	3662.6428	2054.3256	1513.5229	1317.3265	1338.1514	1305.6741
1A4	8037.7787	6507.3984	4494.1909	2338.1399	2203.3690	2258.4776	2372.8651
1A5	154.8976	304.0835	240.8572	187.2816	146.2261	173.3229	145.4184
1B2	682.9320	640.9545	580.1931	521.3013	501.7084	555.9854	604.3381
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
1A1	5651.6191	4854.8011	3674.2878	3152.4214	3678.7653	2943.9751	3041.9389
1A2	587.4922	538.3181	496.0956	531.7701	617.8880	424.1633	451.5848
1A3	1331.4576	1161.3321	792.0086	863.3531	920.4350	1166.6483	1455.2998
1A4	2571.3352	2147.0139	1888.7497	1550.3379	1484.7254	1808.0977	2122.2620
1A5	136.0699	92.8322	56.5604	61.0183	63.2896	64.5181	117.7306
1B2	498.1270	466.2276	465.0926	503.4185	500.1666	542.2695	573.3672
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
1A1	3113.0195	3236.0698	2494.1332	2476.0860	3295.1211	4460.5118	4194.5671
1A2	456.5067	591.8781	651.7256	817.8938	913.0712	508.5564	540.6841
1A3	1624.5617	1656.3456	1581.7184	1650.8829	1741.7494	1658.3330	1904.6945
1A4	2299.7274	2255.7659	2250.6673	1698.2365	1706.1998	1853.3520	1692.4772
1A5	123.0030	118.5196	150.1013	153.7016	162.4874	80.9092	125.0546
1B2	617.5696	660.3041	575.2321	611.7275	608.8065	504.3022	489.0456

Oil and Natural Gas', with a share varying from 2.0 per cent (1990) to 8.3 per cent (2007) (Table 3-5, Figure 3-3).

Table 3-5: Breakdown of the Republic of Moldova's Energy Sector Direct GHG Emissions by Category in 1990-2010, %

	1990	1991	1992	1993	1994	1995	1996
1A1	56.2	57.6	61.0	69.0	66.8	59.2	59.9
1A2	6.4	5.6	4.5	3.3	5.4	3.9	3.0
1A3	11.7	12.1	9.6	9.2	8.8	11.4	10.9
1A4	23.3	21.5	21.0	14.2	14.7	19.3	19.9
1A5	0.4	1.0	1.1	1.1	1.0	1.5	1.2
1B2	2.0	2.1	2.7	3.2	3.3	4.7	5.1
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
1A1	52.4	52.4	49.8	47.3	50.6	42.4	39.2
1A2	5.5	5.8	6.7	8.0	8.5	6.1	5.8
1A3	12.4	12.5	10.7	13.0	12.7	16.8	18.7
1A4	23.9	23.2	25.6	23.3	20.4	26.0	27.3
1A5	1.3	1.0	0.8	0.9	0.9	0.9	1.5
1B2	4.6	5.0	6.3	7.6	6.9	7.8	7.4
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
1A1	37.8	38.0	32.4	33.4	39.1	49.2	46.9
1A2	5.5	6.9	8.5	11.0	10.8	5.6	6.0
1A3	19.7	19.4	20.5	22.3	20.7	18.3	21.3
1A4	27.9	26.5	29.2	22.9	20.2	20.4	18.9
1A5	1.5	1.4	1.9	2.1	1.9	0.9	1.4
1B2	7.5	7.8	7.5	8.3	7.2	5.6	5.5

The share of fugitive emissions (sub-sector 1B 'Fugitive Emissions', in particular from the category 1B2 'Fugitive Emissions from Oil and Natural Gas'), in the structure of the total GHG emissions originated from the Energy Sector, tended to grow from a minimum of 2.0 per cent in 1990 to maximum of 8.8 per cent in 2000. At the same time, the share of GHG emissions originated from the sub-sector 1A 'Fuel Combustion Activities' somewhat decreased: from 98.0 per cent in 1990 to 91.2 per cent in 2000 (Table 3-7, Figure 3-5).

The CO_2 has the largest share in the structure of total GHG emissions originated from the Energy Sector, varying over the reference period, from a maximum of 96.65 per cent in 1990, to a minimum of 90.65 per cent in 2007. Other direct GHG had smaller contribution: CH_4, between 2.79 per cent in 1990 and 8.73 per cent in 2007; while N_2O respectively, between the minimum of 0.39 per cent in 1999 and a maximum of 0.63 per cent in 2006 (Table 3-8).

3.1.2 Key Categories

The results of key source assessment (including LULUCF) carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5 (**Annex 1-2**). Table 3-9 provides in-

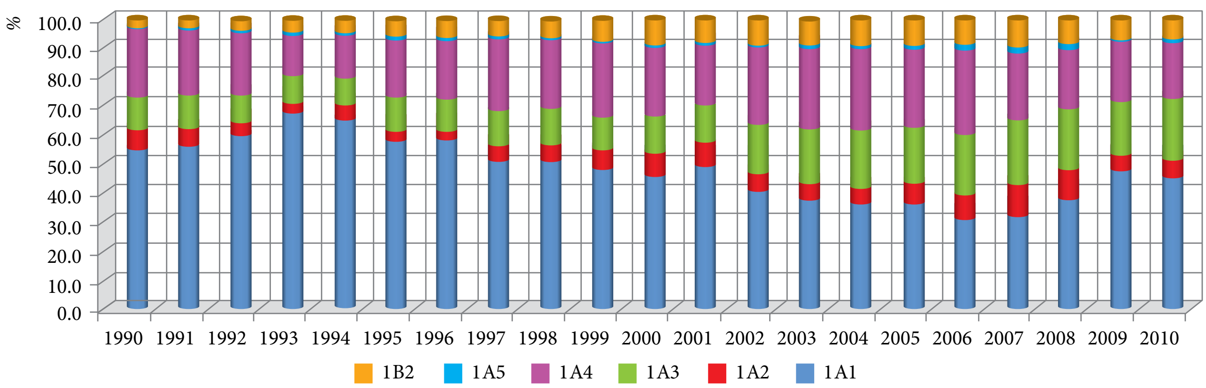


Figure 3-3: Breakdown of the Republic of Moldova's Energy Sector Direct GHG Emissions by Category, %

Table 3-6: GHG Emissions from the 'Stationary Fuel Combustion' and 'Mobile Fuel Combustion' Sub-sectors in the RM, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996
Stationary Fuel Combustion	29626.9575	25612.7023	18508.8677	14253.1231	13042.4395	9643.2564	9886.2725
% from the total	87.6	86.6	89.0	89.3	89.9	86.4	87.2
Mobile Fuel Combustion	4210.5038	3966.7262	2295.1828	1700.8045	1463.5526	1511.4743	1451.0925
% from the total	12.4	13.4	11.0	10.7	10.1	13.6	12.8
Total Sub-sector 1A	33837.4613	29579.4286	20804.0505	15953.9276	14505.9921	11154.7307	11337.3650
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Stationary Fuel Combustion	8810.4465	7540.1331	6059.1331	5234.5293	5781.3787	5176.2360	5615.7857
% from the total	85.7	85.7	87.7	85.0	85.5	80.8	78.1
Mobile Fuel Combustion	1467.5275	1254.1643	848.5690	924.3714	983.7246	1231.1664	1573.0304
% from the total	14.3	14.3	12.3	15.0	14.5	19.2	21.9
Total Sub-sector 1A	10277.9740	8794.2973	6907.7021	6158.9008	6765.1033	6407.4024	7188.8161
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Stationary Fuel Combustion	5869.2536	6083.7138	5396.5261	4992.2163	5914.3920	6822.4201	6427.7285
% from the total	77.1	77.4	75.7	73.4	75.6	79.7	76.0
Mobile Fuel Combustion	1747.5648	1774.8652	1731.8196	1804.5845	1904.2368	1739.2421	2029.7491
% from the total	22.9	22.6	24.3	26.6	24.4	20.3	24.0
Total Sub-sector 1A	7616.8184	7858.5790	7128.3457	6796.8008	7818.6288	8561.6623	8457.4776

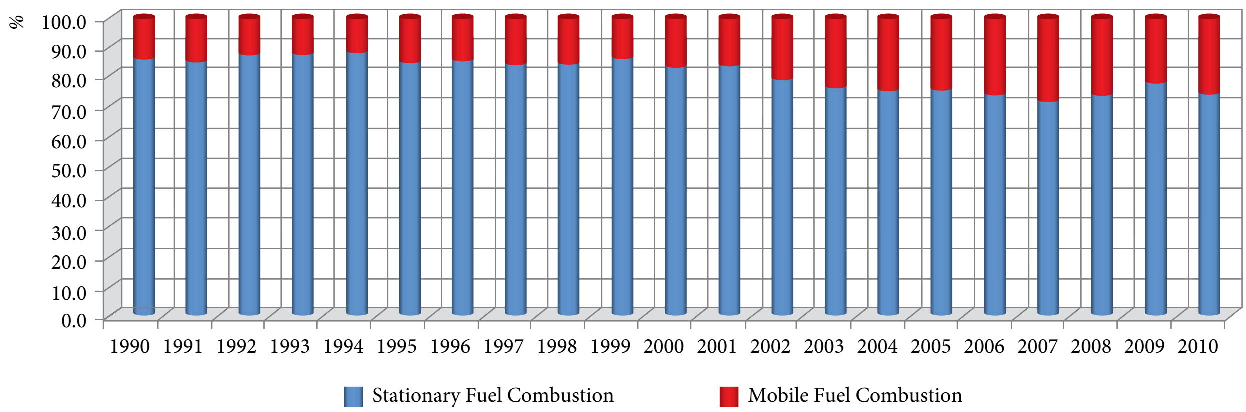


Figure 3-4: GHG Emissions from the 'Stationary Fuel Combustion' and 'Mobile Fuel Combustion' sub-sectors in the RM, % from the total sub-sector 1A.

Table 3-7: Direct GHG Emissions from 1A 'Fuel Combustion Activities' and 1B 'Fugitive Emissions' sub-sectors within 1990-2010, Gg CO_2 eq. from the Total Sectoral GHG Emissions

	1990	1991	1992	1993	1994	1995	1996
1A Fuel Combustion Activities	33837.4613	29579.4286	20804.0505	15953.9276	14505.9921	11154.7307	11337.3650
% from the total	98.0	97.9	97.3	96.8	96.7	95.3	94.9
1B Fugitive Emissions	682.9320	640.9545	580.1931	521.3013	501.7084	555.9854	604.3381
% from the total	2.0	2.1	2.7	3.2	3.3	4.7	5.1
1 Energy Sector	34520.3934	30220.3831	21384.2436	16475.2288	15007.7005	11710.7161	11941.7032
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
1A Fuel Combustion Activities	10277.9740	8794.2973	6907.7021	6158.9008	6765.1033	6407.4024	7188.8161
% from the total	95.4	95.0	93.7	92.4	93.1	92.2	92.6
1B Fugitive Emissions	498.1270	466.2276	465.0926	503.4185	500.1666	542.2695	573.3672
% from the total	4.6	5.0	6.3	7.6	6.9	7.8	7.4
1 Energy Sector	10776.1010	9260.5249	7372.7948	6662.3193	7265.2698	6949.6719	7762.1833
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
1A Fuel Combustion Activities	7616.8184	7858.5790	7128.3457	6796.8008	7818.6288	8561.6623	8457.4776
% from the total	92.5	92.2	92.5	91.7	92.8	94.4	94.5
1B Fugitive Emissions	617.5696	660.3041	575.2321	611.7275	608.8065	504.3022	489.0456
% from the total	7.5	7.8	7.5	8.3	7.2	5.6	5.5
1 Energy Sector	8234.3880	8518.8831	7703.5778	7408.5283	8427.4354	9065.9645	8946.5232

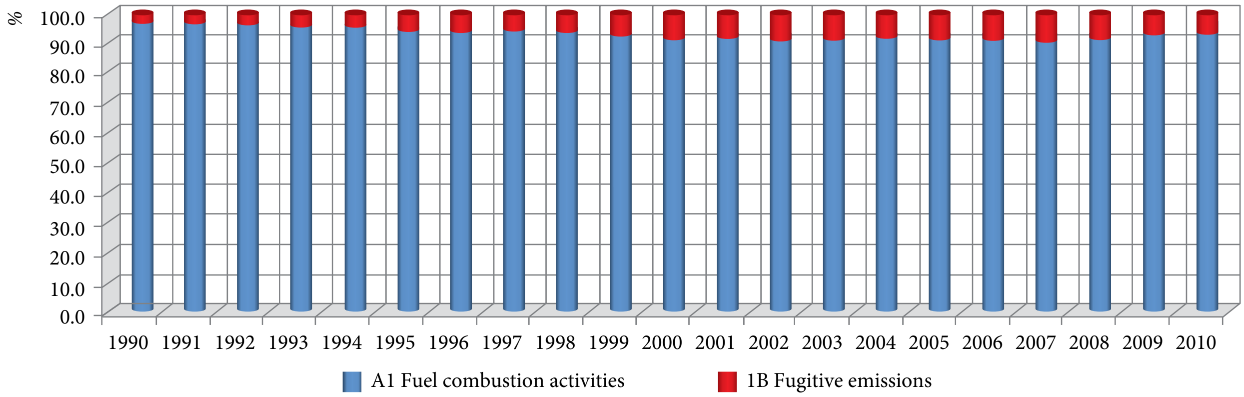


Figure 3-5: Direct GHG Emissions from the 1A 'Fuel Combustion Activities' and 1B 'Fugitive Emissions' Sub-sectors in the RM within 1990-2010, % from the Total Sectoral GHG Emissions

Table 3-8: Direct GHG Emissions from the Energy Sector by Gas (CO_2, CH_4 and N_2O) in the Republic of Moldova within 1990-2010

	GHG Emissions, Gg CO_2 equivalent				Share in the Total Sectoral Emissions, %		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	33365.5535	963.2493	191.5906	34520.3934	96.65	2.79	0.56
1991	29193.0936	860.1871	167.1023	30220.3831	96.60	2.85	0.55
1992	20587.3862	687.4440	109.4134	21384.2436	96.27	3.21	0.51
1993	15776.0767	608.2191	90.9331	16475.2288	95.76	3.69	0.55
1994	14335.8965	590.8720	80.9320	15007.7005	95.52	3.94	0.54
1995	11030.3907	618.4412	61.8842	11710.7161	94.19	5.28	0.53
1996	11198.7301	683.5992	59.3739	11941.7032	93.78	5.72	0.50
1997	10179.4508	547.8583	48.7919	10776.1010	94.46	5.08	0.45
1998	8709.0855	507.9999	43.4395	9260.5249	94.05	5.49	0.47
1999	6841.7537	502.4107	28.6304	7372.7948	92.80	6.81	0.39
2000	6092.4074	539.4480	30.4639	6662.3193	91.45	8.10	0.46
2001	6700.4292	532.1524	32.6883	7265.2698	92.23	7.32	0.45
2002	6328.5245	582.2469	38.9005	6949.6719	91.06	8.38	0.56
2003	7097.9321	618.5217	45.7295	7762.1833	91.44	7.97	0.59
2004	7532.9793	656.3568	45.0519	8234.3880	91.48	7.97	0.55
2005	7772.5759	700.5251	45.7821	8518.8831	91.24	8.22	0.54
2006	7036.1667	618.7885	48.6227	7703.5778	91.34	8.03	0.63
2007	6715.9617	646.5675	45.9990	7408.5283	90.65	8.73	0.62
2008	7733.2846	644.8871	49.2636	8427.4354	91.76	7.65	0.58
2009	8480.4656	541.1059	44.3929	9065.9645	93.54	5.97	0.49
2010	8369.7595	529.1487	47.6150	8946.5232	93.55	5.91	0.53

formation on identified key categories (by level and trend assessment) under the Energy Sector of the Republic of Moldova.

3.1.3 Methodological Issues

Under the Energy Sector there were estimated GHG emissions originated from 5 source categories under sub-sector 1A (1A1, 1A2, 1A3, 1A4 and 1A5), 1 source category under subsector 1B (1B2) and 2 source categories under Memo Items (International Bunkers: Aviation, and CO_2 Emissions from Biomass).

GHG emissions originated from the Energy Sector were estimated following a Tier 1 methodological approach, for all source categories, except 'International Bunkers: Aviation', for which was applied a Tier 2 methodology (Table 3-10).

The basic equations used to estimate GHG emissions under the Energy Sector are described below (CO_2 and SO_2 emissions estimation methodologies are described as well in the **Annex 3-1.1**):

CO_2 Emissions = Σ (Fuel Consumption $_j$ • Conversion Factor (TJ/unit) • Carbon Emission Factor $_j$ (t C/TJ) – Carbon Stored • Oxidation Fraction $_j$ • 44/12) and

Non-CO_2 Emissions= Σ (Fuel Consumption $_j$ • Emission Factor $_j$)

Where: j – type of fuel.

Table 3-9: Key Categories Identified under the Energy Sector of the Republic of Moldova

IPCC Category	GHG	Source Category	Key Source
1.A.1	CO_2	CO_2 Emissions from Energy Industry – solid fuels	Yes (L, T)
1.A.1	CO_2	CO_2 Emissions from Energy Industry – gaseous fuels	Yes (L, T)
1.A.1	CO_2	CO_2 Emissions from Energy Industry – liquid fuels	Yes (L, T)
1.A.1	CH_4	CH_4 Emissions from Energy Industry	No
1.A.1	N_2O	N_2O Emissions from Energy Industry	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 (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 Navigation	No
1.A.3d	CH_4	CH_4 Emissions from Navigation	No
1.A.3d	N_2O	N_2O Emissions from Navigation	No
1.A.3e	CO_2	CO_2 Emissions from Pipeline Transportation	No
1.A.3e	CH_4	CH_4 Emissions from Pipeline Transportation	No
1.A.3e	N_2O	N_2O Emissions from Pipeline Transportation	No
1.A.4a	CO_2	CO_2 Emissions from Institutional/Commercial Sectors	No
1.A.4a	CH_4	CH_4 Emissions from Institutional/Commercial Sectors	No
1.A.4a	N_2O	N_2O Emissions from Institutional/Commercial Sectors	No
1.A.4b	CO_2	CO_2 Emissions from Residential Sector	Yes (L, T)
1.A.4b	CH_4	CH_4 Emissions from Residential Sector	No
1.A.4b	N_2O	N_2O Emissions from 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 Works and Needs in Energy	Yes (L, T)
1.A.5	CH_4	CH_4 Emissions from Other Works and Needs in Energy	No
1.A.5	N_2O	N_2O Emissions from Other Works and Needs in Energy	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

Table 3-10: Summary of Methods Used to Estimate GHG Emissions from the Energy Sector

IPCC Categories	Source Category	Method	EF
1.A.1	Energy Industry	T1	D, CS
1.A.2	Manufacturing Industries and Construction	T1	D, CS
1.A.3	Transport (Civil Aviation, Road Transportation, Railways, Navigation, Pipeline Transportation)	T1	D, CS
1.A.4	Other Sectors (Commercial/Institutional, Residential, Agriculture/Forestry/Fishing)	T1	D, CS
1.A.5	Other (Other Works and Needs in Energy Sector)	T1	D, CS
1.B.2	Fugitive Emissions from Oil and Natural Gas	T1	D
Memo items	International Bunkers: 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 of Emission Factors; CS – Country Specific.

Practically all fuels consumed at the national level are imported (coal - from Ukraine, Russian Federation, Kazakhstan; natural gas – from Russian Federation; oil products – from Romania, Ukraine, Russian Federation, Belarus, Lithuania, etc.). Since 1997, oil and natural gas exploration works were initiated in the South of the RM, however, the extracted amounts are yet insignificant.

The main source of reference for activity data used for estimating GHG emissions under the Energy Sector is the National Bureau of Statistics (NBS), through its annual publication – Energy Balances of the Republic of Moldova for 1990, 1993-2010 years (**Annex 2**) and Statistical Yearbooks, including those of ATULBN (activity data regarding fuel consumption on the territory on the left bank of the Dniester River are available in **Annex 3-1.2**).

Additional AD were provided by central public authorities (Ministry of Transport and Road Infrastructure, Ministry of Agriculture and Food Industry, Ministry of Defense, Ministry of Information Technology and Communication), central administrative authorities (Customs Service, "Moldsilva" Agency), public institutions (Civil Aeronautical Authority), as well as by some enterprises ("Moldavian Railways" State Enterprises and "MOLDOVAGAZ" J.S.C.), as response to the requests coming from the Ministry of Environment (the national entity responsible for the development of national GHG inventory).

The Energy Balance for 1990 year ensured geographical coverage of the whole country, while the Energy Balances for the time series from 1993 through 2010 covered only the territory on the right bank of the Dniester River (in the 1991-1992 years the Energy Balances were not published).

The estimation of GHG emissions for the FNC of the RM to the UNFCCC was based on default values of "Net Calorific Values", while the SNC and the current inventory relied on country specific values for NCVs (Table 3-11).

Table 3-11: Emission Factors and Other Relevant Parameters Used to Estimate GHG Emissions from the Energy Sector of the Republic of Moldova

Fuel Type	Net Calorific Value (country specific value), TJ/kt		Net Calorific Value, TJ/kt		Emission factors, t C/TJ		Fraction of carbon oxidized	
	Ranges according to the NBS	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
Donetsk	25.70	25.70			26.8		0.98	1
Kuznetsk	25.44	25.44			26.8		0.98	1
Ukraine	6.31 - 11.68	11.68			27.6		0.98	1
Kansk-Acinsk	15.14	15.14			25.8		0.98	1
Brown 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-EB "Energy Balance", approved through Order No. 88 from 03.10.2012 of the Department of Statistics of the RM (<http://www.statistica.md/public/files/Formulare_statistice/2013/industrie_energetica/1_BE.pdf>).

In conformity with recommendations in the IPCC 2006 Guidelines, the value of oxidation fraction was assumed being 1 for all types of fuel (in the FNC, it was 0.99 for liquid fuels, 0.98 – for solid fuels and 0.995 – for gaseous fuels).

3.1.4 Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the Energy Sector (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**. Combined uncertainties as a percentage of total direct sectoral emissions were estimated at circa ±4.34 per cent. The uncertainties introduced in trend in sectoral emissions were estimated at ±1.16 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 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.1.5 Quality Assurance and Quality Control

The main procedures associated with the quality assurance and quality control process in the Energy Sector include the following:

- verification of activity data;
- verification of the units of measure and conversion factors;
- consulting alternative sources of activity data;
- comparison of alternative data sets obtained from various sources of information;
- make recalculations based on the availability of new sources of information;
- compare the results obtained using different calculation methodologies;
- identifying and removing the errors in the calculation tool recommended by the UNFCCC.

Verification of Activity Data

Preparation of the initial information for completing the database with new information is a tedious job that requires consultation of various sources of information as well as a comparative analysis of activity data available. A common problem is the frequent change of the format of reporting the statistical data in various sources of information, which induces the need for additional verification and comparison of alternative data sets. It is necessary to mention the fact that the Energy Balances for the ATULBD are missing, information on fuel consumption and energy resources is collected using various sources of information and the process is quite difficult.

Verification of units of measure and conversion factors values

To calculate GHG emissions from the source category 1A1 "Energy industry" requires available emission factors values for each greenhouse gas, as well as conversion coefficients values from natural units to energy units. In RM there are used default values of emission factors for GHGs. With reference to the conversion factors values from natural units to energy units, within each inventory cycle is carried out a laborious work on analyzing the information provided by the Customs Service of the Republic of Moldova (the amount of imported fuels, including countries of origin) and by the National Bureau of Statistics of the Republic of Moldova (for each type of fuel in the Energy Balance there are available the average net caloric values, as well as the range to be used for converting the natural units into TJ, and tons of coal and oil equivalent; the conversion coefficients varies depending on the country of origin for each type of imported fossil fuel (ex., it should be taken into consideration the coal, oil and natural gas basins from which origins the fossil fuels); thus, the average net caloric values used in the Energy Balances can vary from year to year and require a steady and continuous verification, including a comparison with the default values). To be noted, that the Energy Balance of the Republic of Moldova is available in natural units and in energy units (in TJ, as well as in tons of oil equivalent and in tons of coal equivalent).

Consulting various alternative sources of activity data

Within each inventory cycle, alternative sources of information are consulted, such as Energy Balances, Statistical Yearbooks, official letters received from different organizations and companies. Also, the websites of various organizations and companies are analyzed. The information collected is systematized and documented, inclusive the national database used for the compilation of the national inventory of GHG emissions is updated every inventory cycle.

Comparison of alternative data sets obtained from various sources

Within each inventory cycle, information collected from different sources is evaluated through a comparison verification analysis with the purpose to identify the most reliable sources of information. It is selected a set of activity data, which then serves as a basis for evaluating GHG emissions. For each source category comparative checks are carried out for available activity data sets, also there are identified and explained the discrepancies between different data sets. These exercises allow identifying the most reliable sources of information, which helps to reduce uncertainty and offer higher accuracy assessment.

Undertake recalculations based on the availability of new information

Within each inventory cycle for individual source categories, recalculations are undertaken for the periods covered by previous inventory cycles, specifically in cases where: new sources of information were identified, activity data were revised/updated, more disaggregated data are available or higher precision data were identified, errors were identified in completing the database, or if it is applied a higher level tier methodology.

Comparing the results obtained using different methodologies

Under the current inventory cycle, there were used Tier 1 methodologies for calculating the GHG emissions from the Energy Sector. For source categories 1A1 'Energy Industry' and 1A3 'Transport' it was initiated the process of assessing the opportunity to move in the next inventory cycle to a Tier 2 methodology (i.e., there were assessed the calculation methodologies, the activity data required and the data gaps; due to lack of activity data it is not possible yet the shift from a Tier 1 to a Tier 2 methodology). It should be noted that GHG emissions from "Memo Items" (International Aviation) were assessed using two alternative methodologies (Tier 1 and Tier 2b).

Identifying and removing calculation tool gaps recommended by the UNFCCC

There were identified certain gaps in the calculation and reporting tool (i.e., Non-Annex I National Greenhouse Gas Inventory Software, Version 1.3.2), below being provided just some of them:

1. Imperfect format of the Module 1 work sheets used for calculating CO_2 (Module 1 '1-2overview') and non-CO_2 emissions ('1-3s1' and '1-3s2-3'), i.e. not in all cases there is automatic links between the cells in which are introduced energy units (TJ) values for different types of fuels;
2. Also, in the Module 1 work sheet '1-2overview' there are no allocated enough columns for additional types of fuels;
3. In the Overview 'Table 1s2', in the case of source category 1A3 'Transport', the total emissions are calculated automatically incorrectly calculated (by taking into account both the value of category 1A3e "Other" as well as the disaggregated values of other sub-categories within it).
4. The Module 1 work sheets '1-4s1', '1-4s2', '1-4s3', '1-4s4', and '1-4s5' used to assess SO2 emissions from fuel combustion by source categories are imperfect, lacking the automatic link with work sheet '1-2overview', where fuel consumption data are available in energy units (TJ) by source categories, also the list of fuels is incomplete, there are no allocated enough rows for additional types of fuels (i.e., in the work sheet '1-4s3' 'Transport', it is not included such type of fuel as "Aviation gasoline");
5. As for the Module 1 work sheet 1-5s3, in the case of adding new rows for other aircrafts types, for all GHGs the summary values are calculated correctly, while in the Overview 'Table 1s3', the links with Module 1 worksheet 1-5s3 is incorrect and need to be corrected manually;
6. In the Module 1 work sheet 1-1s1-3 'CO_2 from energy sources (Reference Approach)' the list of fuels is also incomplete, i.e., "Aviation gasoline" is not included and the respective the amount was reported under the "Gasoline" type of fuel, etc.

Table 3-12: Recalculated GHG Emissions under the Energy Sector for1990-2010, TNC of the RM under UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
SNC	34520.3934	30220.3831	21384.2436	16475.2222	13975.1926	11135.7054	11430.2703
TNC	34520.3934	30220.3831	21384.2436	16475.2288	15007.7005	11710.7161	11941.7032
Difference, %	0.0	0.0	0.0	0.0	7.4	5.2	4.5
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	9526.5817	7938.3270	6184.7355	5437.8217	6639.8741	6738.3307	7328.4007
TNC	10776.1010	9260.5249	7372.7948	6662.3193	7265.2698	6949.6719	7762.1833
Difference, %	13.1	16.7	19.2	22.5	9.4	3.1	5.9
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	7490.7434	7724.8084					
TNC	8234.3880	8518.8831	7703.5778	7408.5283	8427.4354	9065.9645	8946.5232
Difference, %	9.9	10.3					

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

3.1.6 Recalculations

GHG emission recalculations under the Energy Sector are due to the availability of an updated set of activity data for ATULBD from 1995 through 2005, as well as due to some errors correction associated with activity data entry. The reasons of recalculations performed at the category level are presented in the sub-chapters (3.2-3.9) of the NIR.

In comparison with the results included into the SNC, the performed recalculation resulted in increased direct GHG emissions, varying from a minimum 3.1 per cent in 2002, up to maximum 22.5 per cent in 2000 (Table 3-12).

3.1.7 Assessment of Completeness

Under the current inventory cycle within the Energy Sector there were estimated GHG emissions originated from 8 source categories (Table 3-13). As no coal mining exist in the Republic of Moldova, there were registered no GHG emissions from the category 1B1 'Fugitive Emissions from Coal Mining'.

3.1.8 Planned Improvements

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

3.2 Energy Industry (Category 1A1)

Energy Industry (in national statistics, this economical sector is known as "Electricity, Heat, Natural Gas and Water") plays an important role in national economy, accounting for 2.2 per cent of the GDP. Circa twenty thousands of specialists or approximately 1.7 per cent of active population are involved in the Energy Sector (NBS, 2012).

In 2011, the Energy Industry of the RM included 384 enterprises and production units, of which 248 publicly owned, 124 private, 4 with mixed ownership (public and private ownership without foreign contribution), 2 - with foreign capital and 6 – joint ventures (Table 3-14).

Table 3-13: Assessment of Completeness under the Energy Sector

IPCC Category	Source Category	CO_2	CH_4	N_2O
1.A.1	Energy Industry	X	X	X
1.A.2	Manufacturing Industry and Constructions	X	X	X
1.A.3	Transport (Civil Aviation, Road Transportation, Railways, Navigation, Pipeline)	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 in Energy Sector)	X	X	X
1.B.1	Fugitive Emissions from Coal Mining	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 RM's GHG Inventory; NO – Not Occurring.

Table 3-14: Total number of industrial enterprises and production units, by ownership, in the "Electricity, Heat, Natural Gas and Water" sector within 2007-2011 time periods

	2007	2008	2009	2010	2011
Total number of industrial enterprises and production units, including :	4749	4677	4922	5277	4985
Industrial enterprises in "Electric and Thermal Energy, Gas and Water" field:	640	582	463	546	384
Public	504	456	315	376	248
Private	118	116	140	162	124
Mixed (public and private)	8	4	3	3	4
Foreign	4	2	1	2	2
Joint ventures	6	4	4	3	6

Source: Statistical Yearbooks of the RM for 2010 year (pages 274-275) and for 2012 year (pages 286-287).

Of the total of 384 industrial enterprises and production units in "Electricity, Heat, Natural Gas and Water", in 2011 year 57 were active in the production and distribution of electricity, steam and hot water, natural gas, including: 16 - in the production and distribution of electricity, 22 - in the production and distribution of gaseous fuel, 19 - in steam and hot water supply and 327 - the capture, handling and distribution of water (Table 3-15).

Brief Description of the Energy System of the Republic of Moldova

In the Republic of Moldova electricity generation capacity include: Moldovan Thermal Power Plant (MTPP) from Dnestrovsk (on the left bank of the Dniester) with an installed capacity of 2520 MW, operating on natural gas, residual fuel oil and coal, built between 1964-1982; CHP-2 Chisinau, with an installed capacity of 240 MW (available 210 MW) and 1,200 Gcal/h heat capacity, built between 1976-1980; CHP-1 Chisinau, with an installed capacity of 66 MW (available 40 MW) and 254 Gcal/h heat capacity, built between 1951-1961; CHP-North Balti, with an installed capacity of 28.5 MW (available 24 MW) and 200 Gcal/h heat capacity built in during 1956-1970; HPP Dubasari on the river Dniester with an installed capacity of 48 MW (30 MW available), 75 per cent overused degree, built between 1954-1966; HPP Costesti on the river Prut, with an installed capacity of 16 MW (10 MW available), 67 per cent overused degree, built in 1978; other power plants, including nine CHP owned by sugar plants with an installed capacity of 97.5 MW operating on natural gas and residual fuel oil, built during 1956 -1981.

Of relatively high total nominal capacity (2996.5 MW) it can be used only about 346 MW in cogeneration regime in Chisinau and Balti and in the hydro base, respectively, it is used only about half of the MTPP capacity (in particular, due to difficult trading conditions). Most (stabilized at around 76-79% during 2007-2010) of the electricity consumption of the country is covered by MTPP and imports from Ukraine.

The power transmission system operator Moldelectrica SOE manages the internal transport network on the right bank of the Dniester River, including 5977.5 km transmission lines of 400, 330, 110kV, and 25877.4 km radial lines of 35 and 6-10 kV. Interconnections include 7 lines of 330kV and 11 lines of 110kV with Ukraine, 3 lines of 110kV and just one line of 400kV with Romania and from there, to Bulgaria.

The Republic of Moldova's electricity system operates synchronously with the IPS / UPS system and in island mode only with Romania. While currently, the connection with Ukraine is entirely used, a large volume of the use is the maximum security transit, operation of the connection with Romania offers a reduced transborder exchange, as well as a low supply security

In 2000, the Republic of Moldova privatized a large part of the distribution sector (approximately 70%), that including three of the five power distribution units, which, subsequently, merged in the ICS RED "Union Fenosa" J.S.C., while the other two remained state-owned enterprises: J.S.C "RED North" and "RED North-West" J.S.C. On the left bank of the Dniester River the service is provided by "RED East" J.S.C. and "RED South-East".

3.2.1 Source Category Description

The emission sources monitored in the Republic of Moldova under the category 1A1 'Energy Industries' are as following: 1A1ai 'Public Electricity Generation'; 1A1aii 'Public Combined Heat and Power Generation'; and 1A1aiii 'Public Heat Plants'.

1A1ai Public Electricity Generation

The energy system of the Republic of Moldova owns only one thermal power plant, situated in Dnestrovsk, on the left bank of the Dniester. At the end of 2003, the Moldovan Thermal Power Plant was sold to the Russian-Belgian Company Saint Guidon Invest NV for 29.5 million USD. In March 2005, RAO Nordic Oy (Finland), a daughter-company of Inter RAO UES, bought from Saint Guidon Invest NV 51 per cent of the plant for 50 million USD, and in August 2005, the rest of the 49 per cent that remained at Saint Guidon Invest NV, at a cost of 35 million USD. In November 2005, RAO Nordic Oy sold its 49 per cent share package for 39.2 million USD to Freecom Trading Company Ltd. (Cyprus). In July 2008, Inter RAO UES acquired from the Hungarian company EMFESZ 100 per cent of the stocks owned by Freecom Trading Ltd. in a deal worth 163 million USD, thus consolidating its stake to 100 per cent of MTPP.

The Power Plant has an installed capacity of 2520 MW, it is equipped with eight energy groups on coal, with an electric power of 200 MW (in service from 1964-1971, of which

Table 3-15: Total number of industrial enterprises and production units in "Electricity, Heat, Natural Gas and Water" sector within 2005-2011 time periods

	2005	2006	2007	2008	2009	2010	2011
Electricity, Heat, Natural Gas and Water	622	619	640	582	463	546	384
Production and Distribution of Electricity, Heat, Natural Gas and Water	92	90	87	84	61	62	57
Production and Distribution of Electricity	19	18	17	13	14	13	16
Production and Distribution of Gaseous Fuels	19	22	23	24	20	23	22
Steam and Hot Water Supply	54	50	47	47	27	26	19
Capture, Handling and Distribution of Water	530	529	553	498	402	484	327

Source: Statistical Yearbooks of the RM for 2010 year (page 278) and for 2012 year (page 290).

only five are currently operational energy groups; during 1999-2007 none was working), 2 energy groups on residual fuel oil and natural gas with an electric power of 210 MW (in service since 1973-1974, both operational) 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, both operational).

The technological processes used by MTPP are based on the classical cycle of steam turbines with condensation and involve combusting fossil fuels for electricity generation, heat production representing only a secondary process. Under specific fuel consumption, MTPP's energy groups of 200-210 MW are less efficient than analogue energy groups in the world. Note that the use of combined cycle gas-steam turbine plant type (GSTI) compared with usual blocks with condensation provides a fuel economy of about 20 per cent of the group total and can be fast included during the peak hours. The gas-steam facility used by MTPP has an efficiency of 24.8 per cent, which is much lower than modern gas turbine parameters.

Electricity generation during 1990-2010 at MTPP decreased 2.9 times (Table 3-16), respectively MTPP efficiency has also decreased considerably in recent years. In 1970-1980 the average specific fuel consumption was below 340 grams of coal equivalent (g.c.e.)/kWh thereafter, especially during the period from 1990 to 1997, this index ranged between 370-470 g.c.e./kWh.

Table 3-16: Electricity Generation at MTPP within 1990-2010 time series, million kWh

	1990	1991	1992	1993	1994	1995	1996
Electricity Generation	13569.13	11222.53	9468.15	8626.28	6835.73	4746.93	4560.44
	1997	1998	1999	2000	2001	2002	2003
Electricity generation	3628.76	3296.06	2687.49	2463.34	3365.83	2942.05	2793.00
	2004	2005	2006	2007	2008	2009	2010
Electricity generation	2890.53	2700.88	1373.63	2488.57	2631.22	4862.56	4619.15

Source: S.O.E. „Moldelectrica".

Starting with the conservation of the energy units based on coal consumption and the use of those energy units using only residual fuel oil and natural gas, as well as those two energy units that operate on gas-steam combined cycle, using natural gas, a process that evolved during 1999-2007, the specific fuel consumption decreased to circa 360 g.c.e./kWh. When the Russian Federation increased the price for imported natural gas, MTPP changed its tariff policy, increasing the price of electricity supplied to the Republic of Moldova.

In this context, from November 2005 through September 2009, the Republic of Moldova has stopped buying electricity from MTPP, opting for cheaper electricity imports from Ukraine. The lack of demand during 09.11.2005-11.01.2007 forced the MTPP to use just one energy unit that operated by gas-steam combined cycle based on natural gas consumption. During 1995-2010, the annual production of electricity on the left bank of the Dniester (MTPP from Dnestrovsk and HPP Dubasari) varied between 1.7-5.2 billion kWh, of which about 40-60% was exported to Moldova and the southern regions of Ukraine (Table 3-17).

In January-March 2007, MTPP exported 211 million kWh in Belarus and Russian Federation, but as a consequence of the increased fees adopted by Ukraine for electricity transit on its territory, the export of electricity was reoriented to Romania. From July to December 2007, MTPP managed to export about 554 million kWh. In 2008, electricity supplies provided to Romania represented about 900 million kWh. The supply of electricity to Romania was doubled in 2009-2010 years and in this context, a new scheme was applied, a scheme that implies the exclusion of some MTPP energy units from the energy system of the RM and joining them to the Romanian energy system (the energy systems of Moldova and Romania are in different synchronization areas; to ensure full synchronization of MTPP to Romania's energy system, it was necessary a change of the plant generator rotation frequency).

Exports of energy takes place through interconnection power transmission lines of 110 kW and 400 kW: MTPP (ATULBD)-Vulcanesti (RM) and Vulcanesti (RM)-Isaccea

Table 3-17: Electricity Generation in ATULBD within 1995-2010 time periods

	1995	1996	1997	1998	1999	2000	2001	2002
Electricity Generation, mill. kWh, including at:	4986.6	4839.8	3923.5	3593.4	2973.1	2720.0	3649.9	3228.5
HPP Dubasari, mill. kWh	239.7	279.4	295.0	224.0	285.6	256.7	284.1	286.5
MTPP Dnestrovsk, mil. kWh	4746.9	4560.4	3628.5	3369.4	2687.5	2463.3	3365.8	2942.0
Electricity Imports in ATULBD, mill. kWh	0.0	0.0	0.0	0.0	2.8	0.0	0.0	285.4
Electricity consumption in ATULBD, mill. kWh	2878.0	2589.4	2363.6	1928.8	2098.4	2100.0	2183.1	1899.2
Electricity exports from ATULBD, mill. kWh	2108.6	2250.4	1559.9	1664.6	877.5	620.0	1466.8	1614.7
	2003	2004	2005	2006	2007	2008	2009	2010
Electricity Generation, mill. kWh, including at:	3016.1	3156.6	2995.9	1674.8	2757.0	2929.1	5164.5	5051.0
HPP Dubasari, mill. kWh	223.0	266.1	295.0	275.0	275.0	307.4	302.9	328.0
MTPP Dnestrovsk, mill. kWh	2793.1	2890.5	2700.9	1399.8	2482.0	2621.8	4861.6	4698.4
Electricity Imports in ATULBD, mill. kWh	921.3	812.0	659.2	275.8	0.0	0.0	2.1	0.0
Electricity consumption in ATULBD, mill. kWh	2111.6	2124.3	2107.9	1898.9	2133.5	2151.1	1815.4	1669.8
Electricity exports from ATULBD, mill. kWh	1825.8	1844.3	1547.2	51.7	635.7	793.1	3357.5	3390.8

Source: Statistical Yearbooks of the ATULBD 2000 (pages 99, 101, 175, 183), 2006 (pages 93, 95, 173, 179), 2009 (pages 92, 94, 169, 175), 2010 (pages 93, 96, 167, 173), 2011 (pages 94, 97, 171, 177), 2012 (pages 98, 101, 175, 181).

(Romania). Implementation of this scheme has allowed increasing the supply of electricity to Romania (part of Zone 2 of the Union for the Coordination of Transmission of Electricity (UCTE), on whose territory it was created by prior coordination with the administration UCTE a passive energy island – towards which MTPP delivers electricity through a radial connection).

The long-term strategy of the Russian company Inter RAO EES is to create operating conditions for the plant to a capacity of at least 1,500 MW, providing energy exports to the Balkans countries, over 6.0 billion kWh annually. In order to achieve modernization plans, during 2005-2011, the Russian company has invested about 100 million dollars in upgrading MTPP.

1A1aii Public Combined Heat and Power Generation

At the moment, on the right bank of the Dniester there are three Combined Heat and Power Plants (CHP): 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.

The installed capacity of cogeneration power plants on the right bank of the Dniester River is only about 14% of the total installed capacity of power plants in the Republic of Moldova. Unlike the overall territory of the country, the right bank of Dniester River is deficient in terms of installed capacity for electricity generation. Of the total nominal installed capacity on the right bank of Dniester River, the largest share has CHP-2 in Chisinau, about 55% of the total, followed by CHP-1 in Chisinau, with a share of about 14% and CHP-North in Balti, with a share of about 7%. Total nominal installed capacity in this region covers only around 30 per cent of the electricity needs.

Total production of electricity on the right bank of Dniester River decreased from approximately 1.697 billion kWh in 1990 to about 1,060 billion kWh in 2010 (Table 3-18), which indicates that the installed capacity of power generation in this region is used inefficiently. In the context of increasing trend of electricity consumption in the last period, this is a negative factor, inclusive from the energy security point of view.

More detailed information on fuel consumption, electricity and heat generation from the three combined heat and power plants in the Republic of Moldova (CHP-1 and CHP-2 in Chisinau, respectively CHP-North in Balti) is presented in Table 3-19.

Table 3-18: Electricity Generation, Import and Consumption on the Right Bank of Dniester River within 2001-2010 time periods, million kWh

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Electricity Generation	1249.1	1166.7	1039.4	1010.9	990.1	1117.9	1086.5	1067.0	1027.0	1060.0
Electricity Imports	667.5	987.1	1757.3	1835.6	1600.2	2881.1	2931.4	2961.0	2941.0	2662.0
Electricity Consumption	3412.6	3495.4	3570.0	3454.7	3686.2	3871.2	4029.7	4065.0	3979.0	4106.0

Source: S.O.E. „Moldelectrica".

Table 3-19: Fuel Consumption, Electricity and Heat Generation from the Combined Heat and Power Plants in the Republic of Moldova within 1990-2010 time periods

		1990	1991	1992	1993	1994	1995	1996
CHP-1	Residual Fuel Oil, thousands tons	13.4	26.1	14.2	14.0	6.2	4.7	8.5
	Natural Gas, millions m³	271.2	290.0	245.8	184.2	161.0	137.6	118.6
	Electricity, millions kWh	207.5	207.0	196.3	150.2	136.5	106.4	114.6
	Heat, thousands Gcal	2249.2	2618.7	2178.1	1023.7	1308.5	1035.1	1006.3
CHP-2	Residual Fuel Oil, thousands tons	76.4	135.9	164.9	120.4	53.1	57.3	67.5
	Natural Gas, millions m³	486.1	419.0	337.1	318.4	315.2	270.7	323.2
	Electricity, millions kWh	1150.0	951.4	923.4	883.4	751.2	670.9	838.8
	Heat, thousands Gcal	2544.7	2775.8	2577.6	2021.6	1631.6	1518.2	1515.0
CHP-North	Residual Fuel Oil, thousands tons	40.0	35.0	31.9	19.6	3.8	8.1	1.4
	Natural Gas, millions m³	15.7	87.6	136.3	102.0	98.5	86.9	107.2
	Electricity, millions kWh	121.0	100.0	102.0	75.0	87.0	81.0	100.0
	Heat, thousands Gcal	1360.0	1450.0	1144.0	834.0	625.0	596.0	642.0
		1997	1998	1999	2000	2001	2002	2003
CHP-1	Residual Fuel Oil, thousands tons	3.7	4.6	4.1	1.2	0.4	0.0	0.1
	Natural Gas, millions m³	113.4	135.2	73.0	65.2	82.3	85.7	81.3
	Electricity, millions kWh	93.2	138.6	115.0	100.8	138.5	142.1	138.8
	Heat, thousands Gcal	882.1	1045.9	448.3	387.4	408.8	386.3	405.9
CHP-2	Residual Fuel Oil, thousands tons	49.9	34.3	22.3	3.7	3.1	1.2	1.9
	Natural Gas, millions m³	386.5	313.5	312.2	267.4	365.1	313.0	286.0
	Electricity, millions kWh	896.2	723.3	801.0	658.1	942.2	804.7	741.9
	Heat, thousands Gcal	1524.6	1296.0	1286.5	947.0	1068.4	1069.2	1018.6
CHP-North	Residual Fuel Oil, thousands tons	1.1	6.8	10.1	0.9	0.0	0.0	0.0
	Natural Gas, millions m³	93.6	70.1	39.3	25.0	40.5	38.0	44.6
	Electricity, millions kWh	96.0	75.0	50.7	27.3	44.4	40.6	52.5
	Heat, thousands Gcal	500.0	416.0	247.0	125.7	206.1	198.5	246.0

		2004	2005	2006	2007	2008	2009	2010
CHP-1	Residual Fuel Oil, thousands tons	0.1	0.9	0.0	0.0	0.0	1.2	0.0
	Natural Gas, millions m^3	76.3	84.8	83.5	81.1	78.3	70.0	51.2
	Electricity, millions kWh	136.5	154.9	148.0	151.9	140.3	135.6	94.9
	Heat, thousands Gcal	335.6	375.6	378.8	329.1	319.6	271.9	245.4
CHP-2	Residual Fuel Oil, thousands tons	0.0	2.9	0.0	0.0	0.0	9.6	0.0
	Natural Gas, millions m^3	278.9	326.8	316.3	308.5	294.8	284.6	304.2
	Electricity, millions kWh	714.3	854.4	818.4	805.4	755.3	754.6	782.4
	Heat, thousands Gcal	885.7	1198.1	1204.2	1159.3	1153.8	1126.8	1193.4
CHP-North	Residual Fuel Oil, thousands tons	0.0	0.0	0.0	0.0	0.0	0.8	0.0
	Natural Gas, millions m^3	41.6	44.3	44.4	38.0	37.8	38.0	41.5
	Electricity, millions kWh	57.7	67.8	74.7	67.7	67.4	66.5	70.0
	Heat, thousands Gcal	229.6	232.6	222.7	193.5	199.1	205.8	227.5

Source: CHP-1 through Letter No. 01-11/6-56 from 22.02.2011, as a response to the request of the MoEN No. 03-07/175 from 02.02.2011; CHP-2 through Letter No. 43/195 from 14.02.2011, as a response to the request of the MoEN No. 03-07/175 from 02.02.2011; CHP-North through Letter No. 04/14-119 from 28.02.2011, as a response to the request from the MoEN No. 03-07/175 from 02.02.2011.

1A1aiii Public Heat Plant

There are many Heat Plants (HPs) in the Republic of Moldova, mainly operating on natural gases and residual fuel oil, less on coal and biomass. The amount of fuel consumption is accounted in the Energy Balances of the Republic of Moldova.

During 1993-2010, the number of Heat Plants decreased by approximately 1.5 times, from 4764 units in 1993 to 3351 units in 2010 (Table 3-20).

Table 3-21 below presents information on heat generation on the right bank of the Dniester River starting with 1993 (for 1990 year information is provided for the whole country, including ATULBD).

For the right bank of the Dniester River it is characteristic a decreasing tendency of heat generation – during 1993-2010, the decrease represented about 71.8 per cent (from 10.208 million Gcal in 1993 to 2.874 million Gcal in 2010), while for the left bank of the Dniester River it was revealed a reversed tendency, compared to the production level recorded in 1995 (181 thousands Gcal), in 2010 it was produced 9 times more heat (1.614 million Gcal).

Overall, the amount of heat produced in the Republic of Moldova has decreased by 79.8 per cent, from 22.212 million Gcal in 1990 to 4.488 million Gcal in 2010 (Table 3-22).

Trend of GHG Emission within the Source Category 1A1 „Energy Industry"

During 1990-2010, GHG emission within the source category 1A1 „Energy Industries" presented a decreasing trend (Table 3-23).

Table 3-20: Public Heat Plants in Operation on the right bank of Dniester River in 1993-2010, units

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2005	2006	2007	2010
Heat Plants	4764	5068	4890	4640	4608	4421	3921	3355	3260	3235	3176	3188	3146	3169	3351

Source: Energy Balances of the Republic of Moldova, 1993-2010

Table 3-21: Heat Generation on the Right Bank of Dniester River, thousand Gcal

	1990	1993	1994	1995	1996	1997	1998	1999	2000	2001
Heat, including:	22212	10208.1	7507	7097	7077	6590	6120	4647	3057	3298
From CHP	7220	4656.9	3641	3528	3659	3294	3127	2534	1847	2113
From HP	14802	5542.4	3862	3568	3417	3296	2991	2113	1207	1183
From Other Plants	190	8.7	3	1	1	0	2	0	3	2
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**%**
Heat, including:	3217	3347	3347	3591	3552	3094	3074	2638	2874	-87.1
From CHP	2128	1922	1922	2140	2165	1855	1939	1647	1874	-74.0
From HP	1087	1423	1423	1451	1358	1386	1133	990	1000	-93.2
From Other Plants	2	2	2	-	1	1	2	1	-	-100.0

Source: Energy Balances of the Republic of Moldova, 1993-2010

Table 3-22: Heat Generation in the Republic of Moldova, 1995-2010

	1995	1996	1997	1998	1999	2000	2001	2002
Republic of Moldova: total, thousands Gcal	7278	7665	7126	7371	5650	3846	4375	4417
Right Bank of Dniester River, thousands Gcal	7097	7077	6590	6120	4647	3057	3298	3217
Left Bank of Dniester River, thousands Gcal	181	588	536	1251	1003	789	1077	1200
Right Bank of Dniester River ,% of total	97.5	92.3	92.5	83.0	82.2	79.5	75.4	72.8
Left Bank of Dniester River ,% of total	2.5	7.7	7.5	17.0	17.8	20.5	24.6	27.2

	2003	2004	2005	2006	2007	2008	2009	2010
Republic of Moldova: total, thousands Gcal	4605	4547	4830	5043	4508	4683	4075	4488
Right Bank of Dniester River, thousands Gcal	3347	3347	3591	3552	3094	3074	2638	2874
Left Bank of Dniester River, thousands Gcal	1258	1200	1239	1491	1414	1609	1437	1614
Right Bank of Dniester River ,% of total	72.7	73.6	74.3	70.4	68.6	65.6	64.7	64.0
Left Bank of Dniester River ,% of total	27.3	26.4	25.7	29.6	31.4	34.4	35.3	36.0

Source: Energy Balances of the Republic of Moldova, 1995-2010; Statistical Yearbooks of the ATULBD: 2000 (page 99), 2006 (page 93), 2009 (page 92), 2010 (page 93), 2011 (page 94), 2012 (page 98).

Table 3-23: GHG Emissions from 1A1 'Energy Industries' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg

Years	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	19332.7655	0.4423	0.1653	54.2987	4.9157	1.3281	203.2514
1991	17361.2078	0.3826	0.1457	48.8473	4.4530	1.2021	172.1415
1992	13009.2232	0.2828	0.1102	36.6784	3.3396	0.8992	128.3280
1993	11336.5625	0.2533	0.1010	32.0283	2.8827	0.7709	121.2726
1994	9998.7215	0.1898	0.0875	28.6601	2.8304	0.7050	82.8434
1995	6913.6176	0.1314	0.0496	19.4831	2.0275	0.5135	46.0290
1996	7135.1010	0.1349	0.0469	19.9904	2.1475	0.5422	42.2225
1997	5641.7033	0.1107	0.0245	15.3909	1.8340	0.4618	21.4411
1998	4846.8481	0.0964	0.0191	13.1501	1.5935	0.4015	17.0883
1999	3670.0376	0.0727	0.0088	9.7970	1.2779	0.3199	6.1854
2000	3149.1129	0.0600	0.0066	8.4121	1.1286	0.2786	2.5730
2001	3674.9208	0.0705	0.0076	9.8228	1.3623	0.3280	2.3780
2002	2940.7433	0.0582	0.0065	7.8718	1.1571	0.2656	1.9609
2003	3038.6698	0.0594	0.0065	8.1377	1.1963	0.2750	1.3954
2004	3109.5867	0.0622	0.0069	8.3348	1.2814	0.2843	1.3138
2005	3232.6387	0.0627	0.0068	8.6577	1.2731	0.2928	1.1564
2006	2491.4432	0.0492	0.0053	6.6759	1.0122	0.2273	0.8759
2007	2473.4859	0.0481	0.0051	6.6266	0.9940	0.2254	0.5434
2008	3290.3984	0.0631	0.0110	8.9530	1.2979	0.2902	4.5144
2009	4453.2554	0.0848	0.0177	12.1983	1.7020	0.3838	9.4752
2010	4188.3127	0.0739	0.0152	11.4309	1.4003	0.3522	8.3173

Compared to 1990, in 2010 the level of GHG emissions from the source category 1A1 'Energy Industries' represented: CO_2 emissions - 21.7 per cent, CH_4 - 16.7 per cent, N_2O - 9.2 per cent, NO_x - 21.1 per cent, CO - 28.5 per cent, NMVOC - 26.5 per cent and SO_2 - 4.1 per cent of the emissions recorded in the base year (Table 3-24).

Table 3-24: Direct GHG Emissions from 1A1 'Energy Industries' Source Category in the Republic of Moldova within 1990-2010, where 1990 represents 100 per cent

Years	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	89.8	86.5	88.2	90.0	90.6	90.5	84.7
1992	67.3	63.9	66.7	67.5	67.9	67.7	63.1
1993	58.6	57.3	61.1	59.0	58.6	58.0	59.7
1994	51.7	42.9	52.9	52.8	57.6	53.1	40.8
1995	35.8	29.7	30.0	35.9	41.2	38.7	22.6
1996	36.9	30.5	28.4	36.8	43.7	40.8	20.8
1997	29.2	25.0	14.8	28.3	37.3	34.8	10.5
1998	25.1	21.8	11.6	24.2	32.4	30.2	8.4
1999	19.0	16.4	5.3	18.0	26.0	24.1	3.0
2000	16.3	13.6	4.0	15.5	23.0	21.0	1.3
2001	19.0	15.9	4.6	18.1	27.7	24.7	1.2
2002	15.2	13.2	3.9	14.5	23.5	20.0	1.0
2003	15.7	13.4	3.9	15.0	24.3	20.7	0.7
2004	16.1	14.1	4.2	15.3	26.1	21.4	0.6
2005	16.7	14.2	4.1	15.9	25.9	22.0	0.6
2006	12.9	11.1	3.2	12.3	20.6	17.1	0.4
2007	12.8	10.9	3.1	12.2	20.2	17.0	0.3
2008	17.0	14.3	6.6	16.5	26.4	21.9	2.2
2009	23.0	19.2	10.7	22.5	34.6	28.9	4.7
2010	21.7	16.7	9.2	21.1	28.5	26.5	4.1

In 2010, source category 1A1 'Energy Industries' accounted for circa 31.6 per cent of the total national GHG emissions (without LULUCF). Between 1990 and 2010, direct GHG emissions from source category 1A1 'Energy Industries' tended to reveal lower values, decreasing by 78.4 per cent: from 19393.29 Gg CO_2 eq. in 1990, to 4194.57 Gg CO_2 eq. in 2010 (Table 3-25, Figure 3-6).

Compared to 1990, in 2010, the source category 1A1 'Energy Industries' accounted for circa 21.6 per cent of the total sectoral GHG emissions registered during the reference year: CO_2 – 21.7 per cent, CH_4 – 16.7 per cent and N_2O – 9.2 per cent (Table 3-26).

Table 3-25: Direct GHG Emissions from 1A1 'Energy Industries' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

Years	Gg CO_2 equivalent				%		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	19332.7655	9.2887	51.2316	19393.2858	99.69	0.05	0.26
1991	17361.2078	8.0338	45.1769	17414.4185	99.69	0.05	0.26
1992	13009.2232	5.9383	34.1769	13049.3384	99.69	0.05	0.26
1993	11336.5625	5.3188	31.3196	11373.2009	99.68	0.05	0.28
1994	9998.7215	3.9864	27.1098	10029.8177	99.69	0.04	0.27
1995	6913.6176	2.7592	15.3867	6931.7635	99.74	0.04	0.22
1996	7135.1010	2.8329	14.5358	7152.4697	99.76	0.04	0.20
1997	5641.7033	2.3243	7.5915	5651.6191	99.82	0.04	0.13
1998	4846.8481	2.0244	5.9286	4854.8011	99.84	0.04	0.12
1999	3670.0376	1.5259	2.7242	3674.2878	99.88	0.04	0.07
2000	3149.1129	1.2606	2.0479	3152.4214	99.90	0.04	0.06
2001	3674.9208	1.4797	2.3648	3678.7653	99.90	0.04	0.06
2002	2940.7433	1.2229	2.0089	2943.9751	99.89	0.04	0.07
2003	3038.6698	1.2470	2.0221	3041.9389	99.89	0.04	0.07
2004	3109.5867	1.3059	2.1269	3113.0195	99.89	0.04	0.07
2005	3232.6387	1.3177	2.1133	3236.0698	99.89	0.04	0.07
2006	2491.4432	1.0322	1.6578	2494.1332	99.89	0.04	0.07
2007	2473.4859	1.0097	1.5904	2476.0860	99.89	0.04	0.06
2008	3290.3984	1.3243	3.3984	3295.1211	99.86	0.04	0.10
2009	4453.2554	1.7818	5.4747	4460.5118	99.84	0.04	0.12
2010	4188.3127	1.5513	4.7032	4194.5671	99.85	0.04	0.11

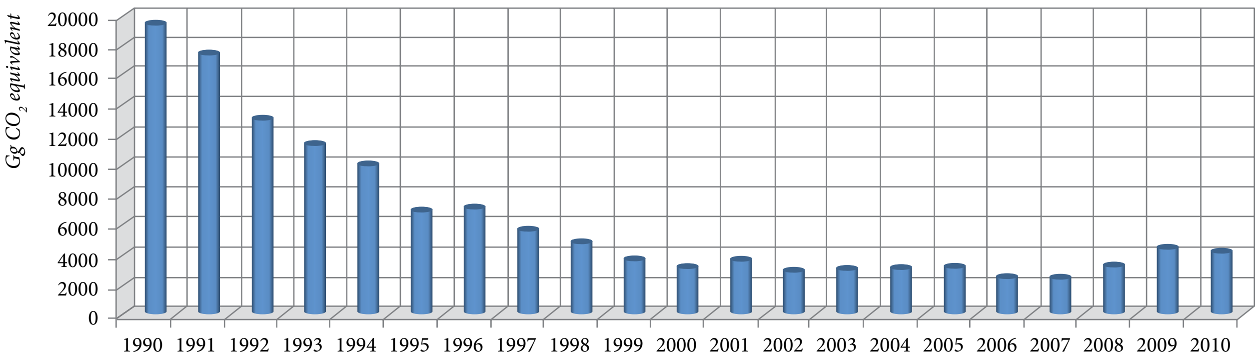


Figure 3-6: GHG Emissions from 1A1 'Energy Industries' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

Table 3-26: Direct GHG Emissions from 1A1 'Energy Industries' Source Category within 1990-2010 time periods, where 1990 represents 100 per cent

	1990	1991	1992	1993	1994	1995	1996
CO_2	100.0	89.8	67.3	58.6	51.7	35.8	36.9
CH_4	100.0	86.5	63.9	57.3	42.9	29.7	30.5
N_2O	100.0	88.2	66.7	61.1	52.9	30.0	28.4
Total	100.0	89.8	67.3	58.6	51.7	35.7	36.9
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	29.2	25.1	19.0	16.3	19.0	15.2	15.7
CH_4	25.0	21.8	16.4	13.6	15.9	13.2	13.4
N_2O	14.8	11.6	5.3	4.0	4.6	3.9	3.9
Total	29.1	25.0	18.9	16.3	19.0	15.2	15.7
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	16.1	16.7	12.9	12.8	17.0	23.0	21.7
CH_4	14.1	14.2	11.1	10.9	14.3	19.2	16.7
N_2O	4.2	4.1	3.2	3.1	6.6	10.7	9.2
Total	16.1	16.7	12.9	12.8	17.0	23.0	21.6

Table 3-27: Methods and Coefficients used for Estimating Direct GHG Emissions Originated from 1A1 'Energy Industries' Source 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
1A1a Electricity and Heat Generation	T1	CS	1	D	T1	D	T1	D

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

3.2.2 Methodological Issues, Emissions Factor and Activity Data

GHG emissions originated from 1A1 'Energy Industry' was estimated following a Tier 1 methodology using default emission factors. To assure the natural conversion from natural units to energy units, country specific NCVs were used (Table 3-11). The carbon oxidation fraction values used were those recommended by 2006 IPCC Guidelines (Table 3-27).

Default EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used for estimating non-CO_2[13] emissions (Table 3-28).

[13] The methodology used to measure SO_2 emissions is described in Annex 3-1.1 of this Report.

Table 3-28: Emission Factors Used for Estimating non-CO_2 Emissions Originated from 1A1 'Energy Industries' Source Category, kg/TJ

GHG	Coal	Natural Gas	Oil Products	Fuel Wood	Other Biomass
CH_4	1	1	3	30	30
N_2O	1.5	0.1	0.6	4	4
NO_x	300	150	200	100	100
CO	20	20	15	1 000	1 000
NMVOC	5	5	5	50	50

Source: for NO_x, CO and NMVOC: *Revised 1996 IPCC Guidelines*, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: *2006 IPCC Guidelines,* Vol. 2, Chap. 2, Tab. 2.2, Pages 2.16-2.17

Table 3-29: Fuel Consumption for Electricity and Heat Generation in the RM, 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Kerosene, kt	0.00	0.00	0.00	3.20	1.00	0.00	0.00
Diesel Oil, kt	62.00	50.00	30.00	9.10	8.00	8.00	7.00
Residual Fuel Oil, kt	2119.00	1715.00	1248.50	1204.80	559.00	335.10	308.60
Kerosene, kt	0.00	0.00	0.00	0.90	0.00	0.00	0.00
Anthracite, kt	0.00	0.00	0.00	20.10	7.00	5.00	2.00
Coking Coal, kt	0.00	0.00	0.00	0.10	0.00	0.00	0.00
Bituminous Coal, kt	2657.00	2419.00	1868.00	1683.60	1716.60	900.90	826.34
Lignite, kt	0.00	0.00	0.00	15.80	4.00	2.00	2.00
Natural Gas, millions m^3	3239.00	3184.00	2388.00	1804.00	2146.95	1928.40	2188.50
	1997	1998	1999	2000	2001	2002	2003
Kerosene, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diesel Oil, kt	5.00	3.00	3.00	4.00	3.00	2.00	3.00
Residual Fuel Oil, kt	213.06	188.92	99.00	42.00	39.00	30.00	20.00
Kerosene, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthracite, kt	1.00	1.00	0.00	0.00	0.00	2.00	2.00
Coking Coal, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bituminous Coal, kt	299.87	198.42	7.00	0.00	0.00	2.00	3.00
Lignite, kt	2.00	2.00	1.00	1.00	0.00	0.00	0.00
Natural Gas, millions m^3	2230.40	1983.33	1755.50	1581.80	1865.80	1490.50	1555.50
	2004	2005	2006	2007	2008	2009	2010
Kerosene, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diesel Oil, kt	2.00	3.00	1.00	1.00	1.00	1.00	1.00
Residual Fuel Oil, kt	18.00	16.00	12.00	7.00	17.61	44.77	41.57
Kerosene, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthracite, kt	2.00	3.00	2.00	2.00	3.00	4.00	3.00
Coking Coal, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bituminous Coal, kt	4.00	2.00	2.00	1.00	116.44	231.89	201.11
Lignite, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural Gas, millions m^3	1596.50	1664.10	1285.10	1505.70	1550.20	1970.30	2086.50

Activity Data

The AD related to fuel consumption for electricity and heat generation (Table 3-29) for the Right Bank of Dniester River were collected from the Energy Balances of the RM for 1990, 1993-2010 and other relevant sources of information including the Ministry of Economy, Customs Service and important energy enterprises (CHP-1 J.S.C., CHP-2 J.S.C., CHP-North J.S.C., SOE "Moldelectrica", "Moldova Gas" J.S.C.). For the Left Bank of Dniester River activity data were provided by "Moldova Gaz" J.S.C. and by MTPP from Dnestrovsk; also it was used the information available in the Statistical Yearbooks of ATULBD.

With reference to the activity data used to calculate GHG emissions from the source category 1A1 'Energy industries' it is necessary to specify the following:

- for 1990-2010 time series, activity data were collected for both the right and the left bank of the Dniester River, which allowed to calculate the GHG emissions for the entire territory of the RM;
- compared to the previous inventory cycle, when the lack of activity data associated with fuel consumption for electricity generation at the MTPP in the Dnestrovsk for 1999-2005 determined the use of an indirect methodology to estimate GHG emissions for respective time periods, within the current inventory cycle recalculations were made by using activity data provided by "Moldova Gas" J.S.C., and those available in the Statistical Yearbooks of ATULBD;
- for 1990-1998 time series, were used the same activity data collected previously directly from MTPP on fuel consumption for electricity generation (natural gas, coal and residual fuel oil), so there was no need for any recalculations;
- activity data on fuel consumption for heat generation are not registered separately in the current statistical system in the Republic of Moldova, so that GHG emissions from this sub-category of sources were evaluated together with those from electricity generation (Source Category 1A1 'Energy industries');
- in the official sources of information at the moment there are not available disaggregated activity data on fuel consumption for heat generation on the left bank of the Dniester River.

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 the source 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 from the 1A1 'Energy Industries' source category, were estimated at circa ±7.07 per cent, while those pertaining to EFs used to estimate CH_4 and N_2O emissions reach up to ±50.25 per cent. At the same time, combined uncertainties presented as a per cent of total direct GHG emissions within the Energy Sector were estimated at circa ±3.3103 per cent for CO_2 emissions, ±0.0087 per cent for CH_4 emissions and ±0.0264 per cent for N_2O emissions. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.8661 per cent for CO_2 emissions, ±0.0013 per cent for CH_4 emissions, and ±0.0125 per cent for N_2O emissions (**Annex 5-3.1**).

In order to ensure time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with sustainable practices used for GHG emission inventory (IPCC, 2000).

3.2.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the 1A1 'Energy Industries' source category, following a Tier 1 approach (IPCC, 2000).

The AD and methods used for estimating GHG emissions under the category 1A1 'Energy Industries' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), GHG emissions were estimated using AD and CS NCVs available in the official sources of information.

3.2.5 Recalculations

GHG emission recalculations performed under the 1A1 'Energy Industries' are due to the availability of an updated set of activity data for ATULBD covering the 1994-2005 time periods, as well as a result of some data entry errors correction (in particular, for 1996 year).

In comparison with the results included into the SNC of the RM under the UNFCCC, the performed recalculations resulted in increased values of direct GHG emissions, varying from a minimum of 1.3 per cent in 1996, up to a maximum of 18.8 per cent in 2000. At the same time, the year of 2002 presented a decrease by circa 3.4 per cent of the direct GHG emissions (Table 3-30).

The GHG emissions originated from 1A1 'Energy Industries' source category were estimated for the first time for the 2006-2010 time periods and the obtained result revealed that between 1990 and 2010, respective emissions decreased by 78.4 per cent.

3.2.6 Planned Improvements

Potential improvements within the 1A1 'Energy Industries' source category could be possible once new AD regarding the fuel consumption at MTPP during 1999-2000 are available.

Table 3-30: Comparative Results of CO_2 Emissions Originated from 1A1 'Energy Industries' Included in the SNC and TNC of the RM under the UNFCCC, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996
SNC	19393.2858	17414.4185	13049.3384	11373.2009	9520.3626	6931.7635	7057.9747
TNC	19393.2858	17414.4185	13049.3384	11373.2009	10029.8177	6931.7635	7152.4697
Difference, %	0.0	0.0	0.0	0.0	5.4	0.0	1.3
	1997	1998	1999	2000	2001	2002	2003
SNC	5370.0356	4427.5547	3318.3632	2653.7086	3416.5751	3048.9272	2927.5183
TNC	5651.6191	4854.8011	3674.2878	3152.4214	3678.7653	2943.9751	3041.9389
Difference, %	5.2	9.6	10.7	18.8	7.7	-3.4	3.9
	2004	2005	2006	2007	2008	2009	2010
SNC	2944.2215	2989.7745					
TNC	3113.0195	3236.0698	2494.1332	2476.0860	3295.1211	4460.5118	4194.5671
Difference, %	5.7	8.2					

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

3.3 Manufacturing Industries and Construction (Category 1A2)

Manufacturing Industries and Construction sectors play a significant role in the national economy, contributing to the GDP with a share of 13.8 per cent and, respectively 3.4 per cent (NBS, 2012).

According to the data of the NBS the 'Manufacturing Industries and Construction' sector provides jobs to 153, respectively 67 thousand persons, or 13.1, respectively 5.7 per cent of employed population of the country (NBS, 2012).

In 2011, 4985 enterprises and production units were active in the industrial sector, including 95 in 'Mining Industry', 4506 in 'Manufacturing Industries' and 384 in the 'Electricity and Heat, Gas and Water Supply' sector (NBS, 2012).

The 'Manufacturing Industries' of the Republic of Moldova include: Manufacture of Food Products (production, processing and preservation of meat, fruit and vegetables, milk products, grain mill products and starches, bread and bakery products, sugar, cocoa, chocolate and confectionery products) and Beverages (distilled spirits, wine, mineral water and soft drinks); Manufacture of Tobacco Products; Manufacture of Textiles; Manufacture of Wearing Apparel; Dressing and Dyeing Furs; Manufacture of Leather; Leather Products and Manufacture of Footwear; Manufacture of Wood and Wood Products; Manufacture of Paper and Paperboard; Publishing; Printing and Reproduction of Information Materials; Chemical Industry (manufacture of medicaments and pharmaceuticals products; manufacture of soaps, detergents, cleaning products, perfumes and cosmetics); Manufacture of Rubber and Plastic Products; Manufacture of Other Non-Metallic Mineral Products (glass and glassware, tiles and bricks in baked clay; articles of concrete, gypsum and cement); Metallurgical Industry; Manufacture of Fabricated Metal Products, Except Machinery and Equipment; Manufacture of Machinery and Equipment; Manufacture of Electrical Machinery and Apparatus; Manufacture of Medical Equipment, Precision and Optical Instruments; Manufacture of Furniture, etc.

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 'Industrial Processes' Sector). Between 1990 and 2010, the GHG emissions from category 1A2 'Manufacturing Industries and Construction' tended to decrease (Table 3-31).

Table 3-31: GHG Emissions from 1A2 'Manufacturing Industries and Construction' within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2	2188.7285	1684.7939	962.3355	539.8762	807.8587	452.0136	360.0648
CH_4	0.0953	0.0827	0.0403	0.0267	0.0224	0.0153	0.0131
N_2O	0.0167	0.0140	0.0070	0.0043	0.0030	0.0022	0.0019
NO_x	5.8887	4.6748	2.6619	1.4796	2.1880	1.2336	0.9864
CO	1.4012	1.3740	0.4088	0.6719	0.5786	0.3226	0.2736
NMVOC	0.1954	0.1698	0.0879	0.0576	0.0778	0.0455	0.0371
SO_2	24.1072	19.1446	10.8429	5.0323	1.5249	1.3217	1.2002
	1997	1998	1999	2000	2001	2002	2003
CO_2	586.4696	537.4686	495.3902	531.0553	616.9501	423.5694	450.9660
CH_4	0.0165	0.0141	0.0118	0.0122	0.0153	0.0101	0.0106
N_2O	0.0022	0.0018	0.0015	0.0015	0.0020	0.0012	0.0013
NO_x	1.5900	1.4532	1.3352	1.4303	1.6795	1.1434	1.2142
CO	0.3945	0.3393	0.2861	0.3089	0.3457	0.2553	0.2802
NMVOC	0.0569	0.0518	0.0461	0.0494	0.0573	0.0401	0.0422
SO_2	0.9572	0.8653	0.4769	0.4589	0.6479	0.3329	0.4528

	2004	2005	2006	2007	2008	2009	2010
CO_2	455.8446	591.0838	650.9260	817.0164	910.8888	507.1516	539.2384
CH_4	0.0112	0.0137	0.0140	0.0159	0.0348	0.0220	0.0226
N_2O	0.0014	0.0016	0.0016	0.0018	0.0047	0.0030	0.0031
NO_x	1.2277	1.5904	1.7463	2.1872	2.5335	1.4262	1.5105
CO	0.3231	0.3990	0.3660	0.4318	0.6858	0.4126	0.4345
NMVOC	0.0430	0.0554	0.0593	0.0730	0.1051	0.0622	0.0643
SO_2	0.5484	0.4599	0.5159	0.3075	0.5308	0.2667	0.5832

Compared to 1990, in 2010, the GHG emissions within the source category 1A2 'Manufacturing Industries and Construction' accounted for: CO_2 - 24.6 per cent, CH_4 – 23.7 per cent, N_2O – 18.8 per cent, NO_x – 25.7 per cent, CO – 31.0 per cent, NMVOC – 32.9 per cent, respectively SO_2 – 2.4 per cent of emissions registered during the reference year (Table 3-32).

Table 3-32: GHG Emissions from 1A2 'Manufacturing Industries and Construction' Source Category within 1990-2010 time periods, where 1990 represents 100 per cent

	1990	1991	1992	1993	1994	1995	1996
CO_2	100.0	77.0	44.0	24.7	36.9	20.7	16.5
CH_4	100.0	86.8	42.3	28.0	23.5	16.1	13.8
N_2O	100.0	84.3	41.8	26.1	17.9	13.2	11.6
NO_x	100.0	79.4	45.2	25.1	37.2	20.9	16.8
CO	100.0	98.1	29.2	48.0	41.3	23.0	19.5
NMVOC	100.0	86.9	45.0	29.5	39.8	23.3	19.0
SO_2	100.0	79.4	45.0	20.9	6.3	5.5	5.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	26.8	24.6	22.6	24.3	28.2	19.4	20.6
CH_4	17.3	14.8	12.4	12.9	16.1	10.6	11.1
N_2O	13.1	10.7	8.8	8.9	11.9	7.4	7.7
NO_x	27.0	24.7	22.7	24.3	28.5	19.4	20.6
CO	28.2	24.2	20.4	22.0	24.7	18.2	20.0
NMVOC	29.1	26.5	23.6	25.3	29.3	20.5	21.6
SO_2	4.0	3.6	2.0	1.9	2.7	1.4	1.9
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	20.8	27.0	29.7	37.3	41.6	23.2	24.6
CH_4	11.7	14.4	14.7	16.7	36.5	23.1	23.7
N_2O	8.3	9.8	9.8	10.5	28.1	18.2	18.8
NO_x	20.8	27.0	29.7	37.1	43.0	24.2	25.7
CO	23.1	28.5	26.1	30.8	48.9	29.4	31.0
NMVOC	22.0	28.4	30.4	37.3	53.8	31.8	32.9
SO_2	2.3	1.9	2.1	1.3	2.2	1.1	2.4

In 2010, the category 1A2 'Manufacturing Industries and Construction' accounted for 4.1 per cent of the total national direct GHG emissions (without LULUCF). Between 1990 and 2010, the GHG emissions from category 1A2 'Manufacturing Industries and Construction' tended to show lower values, decreasing by circa 75.4 per cent: from 2195.89 Gg CO_2 eq. in 1990 to 540.68 Gg CO_2 eq. in 2010 (Table 3-33).

Table 3-33: Direct GHG Emissions from 1A2 'Manufacturing Industries and Construction' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

Years	Gg CO_2 equivalent				%		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	2188.7285	2.0005	5.1641	2195.8930	99.67	0.09	0.24
1991	1684.7939	1.7361	4.3554	1690.8854	99.64	0.10	0.26
1992	962.3355	0.8464	2.1564	965.3383	99.69	0.09	0.22
1993	539.8762	0.5604	1.3456	541.7823	99.65	0.10	0.25
1994	807.8587	0.4709	0.9232	809.2528	99.83	0.06	0.11
1995	452.0136	0.3212	0.6805	453.0153	99.78	0.07	0.15
1996	360.0648	0.2761	0.5967	360.9377	99.76	0.08	0.17
1997	586.4696	0.3461	0.6765	587.4922	99.83	0.06	0.12
1998	537.4686	0.2954	0.5540	538.3181	99.84	0.05	0.10
1999	495.3902	0.2484	0.4569	496.0956	99.86	0.05	0.09
2000	531.0553	0.2571	0.4577	531.7701	99.87	0.05	0.09
2001	616.9501	0.3216	0.6163	617.8880	99.85	0.05	0.10
2002	423.5694	0.2128	0.3810	424.1633	99.86	0.05	0.09
2003	450.9660	0.2221	0.3966	451.5848	99.86	0.05	0.09
2004	455.8446	0.2344	0.4278	456.5067	99.85	0.05	0.09
2005	591.0838	0.2877	0.5065	591.8781	99.87	0.05	0.09
2006	650.9260	0.2934	0.5062	651.7256	99.88	0.05	0.08
2007	817.0164	0.3338	0.5436	817.8938	99.89	0.04	0.07
2008	910.8888	0.7303	1.4521	913.0712	99.76	0.08	0.16
2009	507.1516	0.4626	0.9421	508.5564	99.72	0.09	0.19
2010	539.2384	0.4748	0.9709	540.6841	99.73	0.09	0.18

During 2003-2008, the Republic of Moldova registered an increase in industrial production, reflected in increased quantities of fuels used in this sector, namely a significant increase in direct GHG emissions within this source category. The 2009 economic crisis has affected most negatively the industrial production in the RM, so by 2010 the production level was similar to that of 1993 (Figure 3-7).

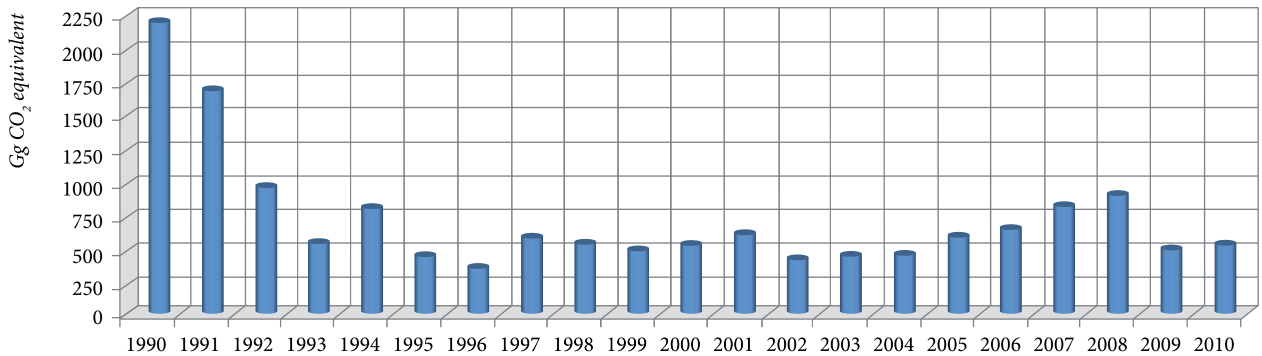


Figure 3-7: GHG Emissions from 1A2 'Manufacturing Industries and Construction' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent.

Compared to 1990, in 2010, the level of total direct GHG emissions within the source category 1A2 'Manufacturing Industries and Construction' represented only 24.62 per cent of the emission level registered in the reference year: CO_2 - 24.64 per cent, CH_4 – 23.74 per cent and N_2O – 18.80 per cent (Table 3-34).

Table 3-34: Direct GHG Emissions from 1A2 'Manufacturing Industries and Construction' Source Category within 1990-2010 time periods, where 1990 represents 100 per cent

	1990	1991	1992	1993	1994	1995	1996
CO_2	100.0	76.98	43.97	24.67	36.91	20.65	16.45
CH_4	100.0	86.79	42.31	28.01	23.54	16.06	13.80
N_2O	100.0	84.34	41.76	26.06	17.88	13.18	11.55
Total	100.0	77.00	43.96	24.67	36.85	20.63	16.44
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	26.79	24.56	22.63	24.26	28.19	19.35	20.60
CH_4	17.30	14.77	12.42	12.85	16.08	10.64	11.10
N_2O	13.10	10.73	8.85	8.86	11.93	7.38	7.68
Total	26.75	24.51	22.59	24.22	28.14	19.32	20.56
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	20.83	27.01	29.74	37.33	41.62	23.17	24.64
CH_4	11.72	14.38	14.67	16.69	36.51	23.12	23.74
N_2O	8.28	9.81	9.80	10.53	28.12	18.24	18.80
Total	20.79	26.95	29.68	37.25	41.58	23.16	24.62

3.3.2 Methodological Issues, Emissions Factor and Activity Data

GHG emissions originated from the 1A2 'Manufacturing Industries and Construction' source category was estimated following a Tier 1 methodology using default emission factors. To assure the natural conversion from measure units to energy units, country specific net calorific values were used (see Table 3-11). The value used for carbon oxidation fraction is recommended by 2006 IPCC Guidelines (Table 3-35).

Table 3-35: Methods and Coefficients Used for Assessing the Direct GHG Emissions Originated from 1A2 'Manufacturing Industries and Construction' Source 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
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 EF available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used for estimating non-CO_2[14] emissions (Table 3-36).

[14] The methodology used to estimate SO2 emissions is described in Annex 3-1.1 of this Report.

Table 3-36: Emission Factors Used for Estimating non-CO_2 Emissions Originated from 1A2 'Manufacturing Industries and Construction' Source Category, kg/TJ

GHG	Coal	Natural Gas	Oil Products	Fuel Wood	Other Biomass
CH_4	10	1	3	30	30
N_2O	1.5	0.1	0.6	4	4
NO_x	300	150	200	100	100
CO	150	30	10	2 000	4 000
NMVOC	20	5	5	50	50

Source: NO_x, CO and NMVOC – *Revised 1996 IPCC Guidelines,* Vol. 3, Tab. 1-9, 1-10 and 1-11, pages 1.37-1.42; CH_4, N_2O – *2006 IPCC Guidelines*, Vol. 2, Ch. 2, Tab. 2.3, pages 2.18 – 2.19.

Activity Data

The AD related to fuel consumption with energy purposes within the 1A2 'Manufacturing Industries and Construction' Source Category were collected from the Energy Balances of the RM for 1990, 1993-2010 as well as from statistical sectoral publications of ATULBD (Table 3-37).

From 1990 through 2010, the structure of RM industries has changed significantly. The share of energy-intensive industries has reduced and the fuel consumption in the industry fell almost twice. We should note that some types of fuel (kerosene, liquefied petroleum gas, brown coal, gaseous coke) practically are no longer used.

Table 3-37: Fuel Consumption with Energy Purposes within the 1A2 'Manufacturing Industries and Construction' Source Category within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Gasoline, kt	13.00	8.10	1.00	0.60	1.00	1.00	1.00
Diesel Oil, kt	99.00	75.00	35.00	21.00	19.00	19.00	17.00
Kerosene, kt	15.00	0.00	0.00	4.60	1.00	0.00	0.00
Residual Fuel Oil, kt	350.00	261.00	155.50	65.70	13.00	11.00	10.00
LPG, kt	0.00	0.00	0.00	0.40	0.00	0.00	0.00
Anthracite, kt	42.00	42.00	0.00	4.00	0.00	1.00	1.00
Coking Coal, kt	39.00	33.00	24.00	16.80	12.00	13.00	14.00
Bituminous Coal, kt	0.00	0.00	0.00	8.30	8.00	4.00	2.00
Brown Coal, kt	1.00	1.00	0.00	2.90	2.00	1.00	0.00
Gaseous Coke, kt	0.00	32.00	25.00	0.00	0.00	0.00	0.00
Natural Gas, millions m³	262.00	204.00	148.00	93.00	342.10	162.72	121.11
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Gasoline, kt	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Diesel Oil, kt	16.00	8.00	11.00	8.00	8.00	7.00	6.00
Kerosene, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residual Fuel Oil, kt	7.00	7.00	3.00	3.00	4.00	1.00	4.00
LPG, kt	0.00	0.00	0.00	0.00	12.00	0.00	0.00
Anthracite, kt	1.00	3.00	1.00	1.00	1.00	1.00	1.00
Coking Coal, kt	12.00	9.00	7.00	6.00	8.00	7.00	5.00
Bituminous Coal, kt	2.00	1.00	0.00	1.00	1.00	0.00	0.00
Brown Coal, kt	0.00	1.00	0.00	0.00	0.00	0.00	0.00
Gaseous Coke, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural Gas, millions m³	249.50	240.50	227.10	250.90	273.50	199.20	213.00

	2004	2005	2006	2007	2008	2009	2010
Gasoline, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diesel Oil, kt	7.00	7.00	7.00	7.00	7.00	5.00	7.00
Kerosene, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residual Fuel Oil, kt	5.00	4.00	5.00	3.00	3.87	1.57	2.33
LPG, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthracite, kt	5.00	6.00	6.00	3.00	9.00	3.00	10.00
Coking Coal, kt	2.00	0.00	0.00	0.00	0.00	2.00	4.00
Bituminous Coal, kt	0.00	2.00	0.00	0.00	75.07	54.15	42.11
Brown Coal, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gaseous Coke, kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural Gas, millions m^3	210.90	282.50	314.90	409.60	354.50	180.90	193.50

Source: EBs of the RM for 1990, 1993-2010; SSS of the ATULBD (2012), *The Socio-economic development of the ATULBD for 2011, Chapter 4 «Material and Energy Resources», Page 23*, Tiraspol, 2012. 85 p; SSS of the ATULBD (2011), *The Socio-economic development of the ATULBD for 2010, Chapter 4 «Energy Resources», Page 21*, Tiraspol, 2011. 79 p.; SSS of the ATULBD (2010), *The Socio-economic development of the ATULBD for 2009, Chapter 4 «Material Resources», Page 20*, Tiraspol, 2010.75 p.

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 source category 1A2 'Manufacturing Industries and Construction', and quality of available activity data.

Uncertainties associated with EFs used to estimate CO_2 emissions from the 1A2 'Manufacturing Industries and Construction' source category, 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. Uncertainties associated with statistical data regarding fuel consumption within the 'Manufacturing Industries and Construction Sector' in the RM can be considered relatively low (±5 per cent). Uncertainties related to GHG emissions from the 1A2 'Manufacturing Industries and Construction' source category were estimated at ±7.07 per cent for CO_2 emissions, and at ±50.25 per cent for CH_4 and N_2O emissions. At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±0.4262 per cent for CO_2 emissions, circa ±0.0027 per cent for CH_4 emissions, and ±0.0055 per cent for N_2O. Uncertainties introduced in trend in sectoral GHG emissions were estimated at ±0.1105 per cent for CO_2 emissions, at ±0.0001 per cent for CH_4 emissions, and at ±0.0006 per cent for N_2O emissions (**Annex 5-3.1**).

In view of ensuring time-series consistency of the obtained results, the same methodology was used for the entire period under review, in conformity with the recommendations included in the GPG (IPCC, 2000).

3.3.4 Quality Assurance and Quality Control

A standard verification and quality control form and checklist were filled in for the 1A2 'Manufacturing Industries and Construction' source category, following the Tier 1 approach (IPCC, 2000). The AD and methods used for estimating GHG emissions under the category 1A2 'Manufacturing Industries and Construction' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), GHG emissions were estimated using AD and CS NCVs from official sources of information.

3.3.5 Recalculations

GHG emission recalculations performed under the 1A2 'Manufacturing Industries and Construction' source category are due to the availability of an updated set of activity data for ATULBD covering the 1994-2005 time periods.

In comparison with the results included into the SNC of the RM under the UNFCCC, the performed recalculations resulted in increased values of direct GHG emissions, varying from a minimum of 37.8 per cent in 1996, up to a maximum of 182.8 per cent in 1994 (Table 3-38). The results revealed that between 1990 and 2010, GHG emissions decreased by circa 75.4 per cent.

3.3.6 Planned Improvements

Potential improvements within the 1A2 'Manufacturing Industries and Construction' source category could be possible once new AD regarding the fuel consumption with energy purposes for ATULBD are available.

Table 3-38: Comparative Results of GHG Emissions from 1A2 'Manufacturing Industries and Construction' Included into the SNC and TNC of the RM under the UNFCCC, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996
SNC	2195.8930	1690.8854	965.3383	541.7823	286.2033	316.6535	261.8606
TNC	2195.8930	1690.8854	965.3383	541.7823	809.2528	453.0153	360.9377
Difference, %	0.0	0.0	0.0	0.0	182.8	43.1	37.8
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	299.4442	259.7766	237.3277	258.1721	286.1100	284.9876	301.3815
TNC	587.4922	538.3181	496.0956	531.7701	617.8880	424.1633	451.5848
Difference, %	96.2	107.2	109.0	106.0	116.0	48.8	49.8
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	319.8028	396.9942					
TNC	456.5067	591.8781	651.7256	817.8938	913.0712	508.5564	540.6841
Difference, %	42.7	49.1					

3.4 Transport (Category 1A3)

Transport Sector plays a significant role in the national economy of the Republic of Moldova, its current contribution to the Gross Domestic Product being circa 10.7 per cent (NBS, 2012). In recent years, its share in the GDP has varied only marginally (between 10 and 12 per cent). According the NBS of the RM the Transport Sector provides jobs to 67 thousand persons, or to 5.7 per cent of the employed population of the country (NBS, 2012).

3.4.1 Source Category Description

The 1A3 'Transport' category includes greenhouse gases generated by the following emissions sources: 1A3a 'Civil Aviation', 1A3b 'Road Transportation', 1A3c 'Railways', 1A3d 'Navigation' and 1A3e 'Other' (Pipeline Transportation).

1A3a Civil Aviation

In recent years, the aircraft fleet of the Republic of Moldova significantly changed its structure. If before 2000, about 80% of flights were operated by aircrafts produced in CIS countries, by 2010 the situation was opposite. Most aircrafts used today are modern, low GHG emission, produced mainly in western countries. Table 3-39 presents information on the number of aircraft in use at the end of each year during 1996-2011.

Table 3-39: Air Transport Means Existing in the RM by the end of the year, units

	1996	1997	1998	1999	2000	2001	2002	2003
Civil aircrafts for passenger transportation	40	40	32	20	26	21	19	19
Civil aircrafts for goods transportation	9	6	6	5	6	6	7	9
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Civil aircrafts for passenger transportation	20	32	35	20	23	24	22	22
Civil aircrafts for goods transportation	8	7	16	3	3	4	3	4

Source: Statistical Yearbooks of the RM for 2004 (page 562), 2006 (page 407), 2007 (page 403), 2008 (page 399), 2009 (page 398), 2010 (page 399), 2011 (page 399), 2012 (page 399).

In the previous inventory cycle only GHG emissions from international air transport have been considered, while domestic civil air transport contribution was considered insignificant. In the current inventory cycle, activity data on aviation gasoline consumption in domestic civil aviation for 2001-2010 were collected. GHG emissions from the source category 1A3a 'Civil Aviation' (Tables 3-40 and 3-41) were calculated using a Tier 1 approach (IPCC, 2006) and default EFs.

In the Republic of Moldova road transportation is represented by a wide range of transport means: cars, buses and minibuses, trucks, special destination vehicles (ambulances, hook-and-ladder trucks, mobile cranes and other) (Table 3-42).

Table 3-40: GHG Emissions from 1A3a 'Civil Aviation' Source Category, 2001-2010, Gg

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
2001	0.0982	0.000001	0.000003	0.0004	0.0001	0.0001
2002	0.0826	0.000001	0.000002	0.0003	0.0001	0.0001
2003	0.6559	0.000005	0.000019	0.0023	0.0009	0.0005
2004	0.4134	0.000003	0.000012	0.0015	0.0006	0.0003
2005	0.1095	0.000001	0.000003	0.0004	0.0002	0.0001
2006	0.2202	0.000002	0.000006	0.0008	0.0003	0.0002
2007	0.1284	0.000001	0.000004	0.0005	0.0002	0.0001
2008	0.1715	0.000001	0.000005	0.0006	0.0002	0.0001
2009	0.1141	0.000001	0.000003	0.0004	0.0002	0.0001
2010	0.1376	0.000001	0.000004	0.0006	0.0002	0.0001

Table 3-41: GHG Emissions from 1A3a 'Civil Aviation' Source Category within 2001-2010 time periods, Gg CO_2 equivalent

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1A3a	0.0990	0.0833	0.6618	0.4171	0.1104	0.2221	0.1296	0.1731	0.1151	0.1388

1A3b Road Transportation

Table 3-42: Road Transportation Means Existent by the end of the year in the RM (RBD – Right Bank of Dniester River) within 1990-2010 time periods, units

	1990	1991	1992	1993	1994	1995	1996
Trucks	76909	77941	61595	63235	62171	59888	57138
Buses and Minibuses	11305	11226	8924	9101	9139	9181	9798
Cars	208984	218059	166259	166440	169387	165941	173618
Special Destination Vehicles	20328	19632	16155	15241	15228	14589	13668
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Trucks	56924	57404	52430	46351	45809	46277	46905
Buses and Minibuses	11169	12917	13582	12769	14703	15777	15723
Cars	205973	222769	232278	238380	256459	268882	265841
Special Destination Vehicles	12677	11860	10305	8979	8497	8061	7555
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Trucks	73774	81798	84087	94828	115967	120174	131243
Buses and Minibuses	19741	19825	21056	21095	21491	21346	21395
Cars	269551	292994	319311	338944	366351	386365	404290
Special Destination Vehicles	7521	7497	7194	6942	6699	6465	6238

Source: Statistical Yearbooks for 1994 (page 325), 1999 (page 390), 2006 (page 407), 2007 (page 403), 2008 (page 399), 2009 (page 398), 2010 (page 399), 2011 (page 399), 2012 (page 402).

To be noted that during the period under review the number of special destination vehicles decreased significantly, by 69.3 per cent, while the number of cars increased by 93.5 per cent, buses and minibuses – by89.3 per cent, and trucks – by 70.6 per cent.

The main types of fuels consumed by road transportation are Gasoline, Diesel Oil, LPG – Liquefied Petroleum Gases and LNG – Liquefied Natural Gases. The activity data used for estimating GHG emissions from road transportation were collected from the NBS as well as from MTRI.

Length of communication lines in exploitation by the end of 2010 represented, on the right bank of Dniester River approximately 9.3 thousand km with a public roads density of 306.5 km per 1000 km^2 (Table 3-43).

Table 3-43: Length and Density of Road Communication Lines by the end of the year in the Republic of Moldova (RBD – Right Bank of Dniester River) per 1000 km^2, 1997-2010

	1997	1998	1999	2000	2001	2002	2003
Public Roads – total, km	9403	9402	9401	9378	9433	9461	9462
With hard surface, km	8920	8919	8918	8780	8835	8877	8878
National Roads, km	2815	2814	2813	2812	3328	3324	3325
Local Roads, km	6587	6587	6587	6566	6105	6137	6137
Density of Public Roads, km/1000 km^2	309.9	309.9	308.4	307.7	309.5	310.4	310.4
With hard surface, km/1000 km^2	293.9	294.0	292.6	288.1	289.9	291.2	291.3
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Public Roads – total, km	9464	9467	9467	9337	9343	9344	9344
With hard surface, km	8880	8883	8887	8791	8810	8811	8811
National Roads, km	3326	3329	3329	3329	3335	3336	3336
Local Roads, km	6138	6138	6138	6008	6008	6008	6008
Density of Public Roads, km/1000 km^2	310.4	310.6	310.6	306.3	306.5	306.5	306.5
With hard surface, km/1000 km^2	291.3	291.4	291.5	288.4	289.0	289.0	289.0

Source: Statistical Yearbooks of the RM for 2003 (page 500), 2006 (page 405), 2012 (page 400).

Between 1990 and 2010, on the Left Bank of Dniester River (LBD) a clear decreasing trend was registered regarding the number of transportation units for most of the vehicles categories (trucks – 85.0 per cent, special destination vehicles – 58.0 per cent, buses – 20.6 per cent), with the exception of private cars number that increased by 11.5 per cent (Table 3-44).

Length of communication lines in exploitation by the end of 2010 represented on the Left Bank of Dniester River approximately 1.5 thousand km with a public roads density of 354.3 km per 1000 km^2 (Table 3-45).

Table 3-45: Length and Density of Road Communication Lines by the end of the year in the Republic of Moldova (LBD – Left Bank of Dniester River) per 1000 km^2, 1997-2010

	1997	1998	1999	2000	2001	2002	2003
Public Roads – total, km	1277	1277	1277	1277	1278	1278	1278
With hard surface, km	1223	1223	1223	1223	1224	1224	1224
Density of Public Roads, km/1000 km^2	307.0	307.0	307.0	307.0	307.2	307.2	307.2
With hard surface, km/1000 km^2	294.0	294.0	294.0	294.0	294.2	294.2	294.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Public Roads – total, km	1279	1279	1279	1278	1278	1473	1474
With hard surface, km	1225	1225	1225	1224	1224	1423	1428
Density of Public Roads, km/1000 km^2	307.5	307.5	307.5	307.2	307.2	354.1	354.3
With hard surface, km/1000 km^2	294.5	294.5	294.5	294.2	294.2	342.1	343.3

Source: Statistical Yearbooks of the ATULBD 2000 (page 127), 2006 (page 121), 2009 (page 119), 2010 (page 123), 2012 (page 128).

Table 3-46 presents summary information for the entire territory of the Republic of Moldova regarding the number of road transportation vehicles by the end of the year.

Table 3-46: Total Road Transportation Means in the Republic of Moldova by the end of the year within 1990-2010 time series, units

	1990	1991	1992	1993	1994	1995	1996
Trucks	79192	77941	61595	63235	62171	61433	58597
Buses and Minibuses	12033	11226	8924	9101	9139	9697	10282
Cars	261204	218059	166259	166440	169387	232866	245515
Special Destination Vehicles	23029	19632	16155	15241	15228	17255	16314
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Trucks	58206	58558	53439	47501	47099	47442	47873
Buses and Minibuses	11623	13345	14005	13176	15094	16132	16069
Cars	289105	306825	323264	329431	347574	360488	356752
Special Destination Vehicles	14981	14076	12455	11024	10437	9918	9311

Table 3-44: Road Transportation Means Existent by the end of the year in the RM (LBD – Left Bank of Dniester River) within 1990-2010 time periods, units

	1990	1995	1996	1997	1998	1999	2001	2002
Trucks	2283	1545	1459	1282	1154	1009	1290	1165
Buses	728	516	484	454	428	423	391	355
Service Cars and Taxi Cabs	1635	1261	1265	1267	1257	1374	1356	1343
Private Cars	50585	65664	70632	81865	82799	89612	89759	90263
Special Destination Vehicles	2701	2666	2646	2304	2216	2150	1940	1857
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Trucks	968	910	747	595	759	837	465	342
Buses	346	322	298	280	577	571	593	578
Service Cars and Taxi Cabs	1311	1336	1254	1270	1308	1403	1615	1617
Private Cars	89600	88361	91786	93734	101739	103172	104501	106479
Special Destination Vehicles	1756	1537	1454	1316	1244	1284	1166	1135

Source: Statistical Yearbooks of the ATULBD 2000 (page 127), 2006 (page 121), 2009 (page 119), 2010 (page 123), 2012 (page 128).

	2004	2005	2006	2007	2008	2009	2010
Trucks	74684	82545	84682	95587	116804	120639	131585
Buses and Minibuses	20063	20123	21336	21672	22062	21939	21973
Cars	359248	386034	414315	441991	470926	492481	512386
Special Desti-nation Vehicles	9058	8951	8510	8186	7983	7631	7373

This information highlights that during 1990-2010, the number of transportation units in the RM tended to increase. Compared with 1990, the total number of transportation units in 2010 increased by approximately 79.3 per cent (by 77.4 per cent on the RBD, and by 90.1 per cent on the LBD). In 2010, about 83.6 per cent of the total number of the vehicles was registered on the RBD, and 16.4% respectively, on the LBD (Table 3-47).

From 1990 to 2010, the share of trucks and special destination vehicles decreased, while the share of buses, minibuses and cars increased (Table 3-48).

Table 3-48: The Structure of Rolling Stock registered in the RM, as share of total number of road transportation means, 1990-2010, %

	1990	1991	1992	1993	1994	1995	1996
Trucks	21.1	23.8	24.4	24.9	24.3	19.1	17.7
Buses and minibuses	3.2	3.4	3.5	3.6	3.6	3.0	3.1
Cars	69.6	66.7	65.7	65.5	66.2	72.5	74.2
Special Destina-tion Vehicles	6.1	6.0	6.4	6.0	6.0	5.4	4.9
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Trucks	15.6	14.9	13.3	11.8	11.2	10.9	11.1
Buses and Minibuses	3.1	3.4	3.5	3.3	3.6	3.7	3.7
Cars	77.3	78.1	80.2	82.1	82.7	83.1	83.0
Special Destina-tion Vehicles	4.0	3.6	3.1	2.7	2.5	2.3	2.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Trucks	16.1	16.6	16.0	16.8	18.9	18.8	19.5
Buses and Minibuses	4.3	4.0	4.0	3.8	3.6	3.4	3.3
Cars	77.6	77.6	78.3	77.9	76.2	76.6	76.1
Special Destina-tion Vehicles	2.0	1.8	1.6	1.4	1.3	1.2	1.1

To be noted that GHG emissions from vehicles equipped with catalytic converters could not be estimated due to lack of information on the number of vehicles with such equipment.

1A3c Railways

The length of railways of general use in the RM by the end of 2010 represented about 1.262 thousand km (Table 3-49).

Table 3-49: Length (km) and Density (km per 1000 km^2) of Railways by the end of the year in the Republic of Moldova within 1990-2010 time periods

		1990	1991	1992	1993	1994	1995	1996
Railways, km	RBD	1150	1150	1150	1150	1150	1150	1150
	LBD	173	173	173	173	173	173	173
Railways density, km per 1000 km^2	RBD	34.1	34.1	34.2	34.2	34.2	34.2	34.1
	LBD	41.6	41.6	41.6	41.6	41.6	41.6	41.6
		1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Railways, km	RBD	1140	1137	1140	1139	1121	1120	1111
	LBD	173	173	173	140	140	140	140
Railways density, km per 1000 km^2	RBD	34.1	33.6	33.7	33.7	33.1	33.1	32.8
	LBD	41.6	41.6	41.6	33.7	33.7	33.7	33.7
		2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Railways, km	RBD	1075	1139	1154	1154	1157	1157	1157
	LBD	105	105	105	105	105	105	105
Railways density, km per 1000 km^2	RBD	31.8	33.7	34.1	34.1	34.2	34.2	34.2
	LBD	25.2	25.2	25.2	25.2	25.2	25.2	25.2

Source: Statistical Yearbooks of the RM for 1994 (page 319), 1999 (page 382), 2006 (page 405) and 2012 (page 400); Statistical Yearbooks of the ATULBD 2000 (page 127), 2006 (page 121), 2009 (page 119), 2010 (page 123), 2012 (page 128).

The railway transport in the RM is assured by Diesel Locomotives (400-4000 kW), Maneuvering Locomotives (200-2000 kW), Diesel Trains, Cargo and Passenger Trains (Table 3-50).

To be noted that during the period under review the rolling stock has decreased significantly: Diesel Locomotives (by 82.4 per cent); Maneuvering Locomotives (by 71.9 per cent); Diesel Trains (by 65.9 per cent); Cargo Wagons (by 47.6 per cent) and Passenger Coaches (by 15.0 per cent).

Table 3-47: Road Transportation Means in the Republic of Moldova by the end of the year within 1990-2010 time periods, units

	1990	1995	1996	1997	1998	1999	2001	2002
Total in the RM, units	375458	321251	330708	373915	392804	403163	420204	433980
RBD, units	317526	249599	254222	286743	304950	308595	325468	338997
LBD, units	57932	71652	76486	87172	87854	94568	94736	94983
RBD, % of total	84.6	77.7	76.9	76.7	77.6	76.5	77.5	78.1
LBD, % of total	15.4	22.3	23.1	23.3	22.4	23.5	22.5	21.9
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total in the RM, units	430005	463053	497653	528843	567436	617775	642690	673317
RBD, units	336024	370587	402114	431648	461809	510508	534350	563166
LBD, units	93981	92466	95539	97195	105627	107267	108340	110151
RBD, % of total	78.1	80.0	80.8	81.6	81.4	82.6	83.1	83.6
LBD, % of total	21.9	20.0	19.2	18.4	18.6	17.4	16.9	16.4

Table 3-50: Railway Transport Means Existent by the end of the year in the RM within the 1990-2010 time periods, units

	1990	1995	1996	1997	1998	1999
Diesel Locomotives	324	113	103	97	82	78
Maneuvering Locomotives	139	114	100	75	72	50
Diesel Trains (Sections)	44	29	28	26	26	24
Cargo Wagons	14960	14097	13316	12838	12233	11010
Passenger Coaches	486	482	480	470	458	461
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Diesel Locomotives	76	78	89	100	95	100
Maneuvering Locomotives	42	44	48	54	50	56
Diesel Trains (Sections)	22	22	22	22	18	20
Cargo Wagons	10577	10033	9303	8723	8492	8318
Passenger Coaches	460	440	460	452	452	440
	2006	**2007**	**2008**	**2009**	**2010**	**1990-2010,%**
Diesel Locomotives	100	100	90	57	57	-82.4%
Maneuvering Locomotives	56	56	53	39	39	-71.9%
Diesel Trains (Sections)	20	20	18	15	15	-65.9%
Cargo Wagons	8177	7940	7921	7919	7835	-47.6%
Passenger Coaches	436	416	398	990	413	-15.0%

Source: Official Letters from "Moldavian Railways" State Enterprise No. 94/T from 26th of March 1999; No. H-4/993 dated 17th December 2003; and No. H tex/338 from 19th of September 2006; No. 54/Nteh , answer to Letter No.03-07/175 from 02 February 2011.

The main type of fuel used in railways is Diesel Oil. Other types of fuels, such as: Coal, Residual Fuel Oil, Gasoline, Natural Gas and Lubricants are also used for auxiliary needs (GHG emissions from the use of these types of fuels are included in 1A5 'Other' Source Category, Worksheet 1-2s15-16).

The data used for estimating GHG emissions from railway transport were collected from the NBS (AD are available in the EBs and SY of the RM), as well as directly from the "Moldavian Railways" State Enterprise.

1A3d Navigation

The current length of navigable waterways of public use in the Republic of Moldova is around 624 km (which includes 558 km on the RBD and 66 km on the LBD). The number of river transport means used in the RM (both on the RBD and LBD) for both passenger and cargo transportation on Danube, Dniester and Prut, especially in the warm season, is relatively small (Table 3-51 and 3-52).

Table 3-51: River Transport Means Existent by the end of the year on the Right Bank of Dniester River, units

	1990	1991	1992	1993	1994	1995	1996
Goods Self-Propelled Ships	14	9	5	5	5	5	5
Goods Non-Self-Propelled Ships	72	67	67	67	20	20	15
Towboats, Stamps & Stamp-Towboats	49	48	47	47	12	12	11
Passenger Self-Propelled Ships	36	37	32	32	3	3	3
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Goods Self-Propelled Ships	4	4	3	-	-	-	-
Goods Non-Self-Propelled Ships	15	15	15	15	15	15	15
Towboats, Stamps & Stamp-Towboats	11	11	11	11	10	10	10
Passenger Self-Propelled Ships	4	3	3	3	3	3	3
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Goods Self-Propelled Ships	-	-	-	-	-	-	-
Goods Non-Self-Propelled Ships	15	15	13	12	9	9	9
Towboats, Stamps & Stamp-Towboats	10	10	8	8	8	8	8
Passenger Self-Propelled Ships	3	3	2	1	1	1	1

Source: Statistical Yearbooks of the RM for 1993 (page 330), 1994 (page 325), 1999 (page 390), 2006 (page 407), 2007 (page 403), 2008 (page 399), 2009 (page 398), 2010 (page 399), 2011 (page 399) and 2012 (page 402).

The main type of fuel used by river transport means in the RM is Diesel Oil. For inventory purposes (estimation of GHG emissions originated from the navigation in the Republic of Moldova) were used activity data provided by the MTRI (for 1993-2010) as well as the EB of the RM for 1990.

Table 3-52: River Transport Means Existent by the end of the year on the Left Bank of Dniester River, units

	1990	1991	1992	1993	1994	1995	1996
Goods Ships including Towboats, Stamps & Stamp-Towboats	73	71	69	67	65	63	59
Passenger Ships	33	32	31	30	29	28	25
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Goods Ships including Towboats, Stamps & Stamp-Towboats	59	58	57	54	52	52	52
Passenger Ships	25	25	25	24	23	23	23
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Goods Ships including Towboats, Stamps & Stamp-Towboats	52	50	45	42	42	42	42
Passenger Ships	23	14	8	8	8	8	8

Source: Statistical Yearbooks of the ATULBD 2000 (page 128), 2006 (page 121), 2009 (page 119), 2010 (page 124), 2012 (page 128).

1A3e Pipeline Transportation

The Republic of Moldova has a developed natural gas transportation and distribution network (Table 3-53).

In the Republic of Moldova, the natural gas distribution networks are expanded at relatively high annual rate (Table 3-54).

Only a small portion of the natural gases delivered towards the RM are consumed locally, including in the ATULBD, the largest part being transited towards the Balkans countries (Table 3-55). The main source of reference for AD used in the current inventory cycle is "MOLDOVA GAZ" J.S.C., as well as the EBs of the RM.

Table 3-53: Natural Gas Transportation and Distribution Networks in the Republic of Moldova (situation as of 01.01.2006 and 01.01.2011)

Type of Networks	Pipelines diameter (mm)	Pressure (kg f/cm²)	Year of construction	Pipelines Length (km), as of 01.01.2006	Pipelines Length (km), as of 01.01.2011	2006-2011, %
Main Gas Pipelines	530-1220	55-75	1966-1993	593.57	656.24	+10%
Connected Gas Pipelines	Up to 530	55	1966-2005	714.09	818.20	+12%
Natural Gas Distribution Networks	Up to 700	0.05-12	1966-2010	12259.05	19502.59	+37%

Source: „Moldova Gaz" J.S.C., through the Letters No. 02/1-476 dated 23.02.2011 respectively No. 06-1253 dated 27.09.2006.

Table 3-54: Implementation of Production Capacities - Natural Gas Pipes in the RM, 1995-2010

	1995	1996	1997	1998	1999	2000	2001	2002
Implementation of production capacities - gas pipes, km/year	373.15	230.97	253.04	207.16	146.47	159.60	143.90	87.63
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Implementation of production capacities - gas pipes, km/year	195.76	509.20	355.30	516.40	741.30	926.60	745.70	520.20

Source: Statistical Yearbooks of the RM for 1999 (page 367), 2003 (page 478), 2006 (page 382) and 2012 (page 378).

Table 3-55: Amount of Natural Gas Transited towards the Balkans and Sold in the Republic of Moldova over the time-series from 1990 through 2010, billion m³

	1990	1991	1992	1993	1994	1995	1996
Natural gas transited across the RM	25.000	23.000	21.000	19.000	18.265	20.909	22.396
Natural gas sold in the RM	3.8140	3.8430	3.3770	2.9600	2.8610	2.7910	3.2220
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Natural gas transited across the RM	16.934	16.021	17.142	19.365	18.625	21.332	22.132
Natural gas sold in the RM	3.4920	3.1690	2.6853	2.3202	2.6280	2.2316	2.4054
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Natural gas transited across the RM	23.873	25.313	22.339	23.693	23.290	17.891	17.034
Natural gas sold in the RM	2.5657	2.7156	2.3762	2.4899	2.5050	2.7750	2.9709

Source: „Moldova Gaz" J.S.C., through the Letters No. 02/1-476 dated 23.02.2011, respectively No. 06-1253 dated 27.09.2006.

GHG Emissions Trend within 1A3 'Transport' Source Category

In 1990-2010, the total GHG emissions from the 1A3 'Transport' source category have significantly decreased (Table 3-56)

In 2010, GHG emissions from 1A3 'Transport' source category represented: CO_2 - 47.4 per cent, CH_4 – 29.1 per cent, N_2O – 34.2 per cent, NO_x – 48.6 per cent, CO – 29.4 per cent, NMVOC – 29.6 per cent, and SO2 – 64.1 per cent of the total national GHG emissions for the reference year.

In 2010, the 'Transport' sub-sector accounted for 14.3 per cent of the total national direct GHG emissions (without LULUCF), being an important source of direct GHG emissions. The 1A3 'Transport' source category also represented a relevant source of CH_4 and N_2O emissions, accounting for 0.3 per cent and respectively, 2.2 per cent of the total national CH_4 and N_2O emissions.

Table 3-56: GHG Emissions from 1A3 'Transport' Source Category in the Republic of Moldova, 1990-2010, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2	3926.6606	3548.3245	1986.1727	1463.2667	1271.1186	1297.6775	1267.6092
CH_4	1.1921	1.0880	0.5432	0.3525	0.3262	0.3431	0.3266
N_2O	0.3352	0.2951	0.1830	0.1382	0.1270	0.1073	0.1007
NO_x	38.6268	34.4576	19.7994	15.0985	12.4665	12.3891	11.7158
CO	289.6096	264.4692	128.4896	85.9911	79.3899	83.5294	79.5586
NMVOC	54.5258	49.7832	24.2288	16.2216	14.9588	15.7355	14.9784
SO_2	4.3700	3.9274	2.4049	1.8949	1.4527	1.4669	1.3726
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	1292.0143	1126.3239	770.1737	838.3532	892.9559	1132.2307	1413.6197
CH_4	0.3711	0.3162	0.1867	0.1902	0.2055	0.2646	0.3165
N_2O	0.1021	0.0915	0.0578	0.0678	0.0747	0.0931	0.1130
NO_x	12.4630	10.8830	7.2771	8.3751	9.1449	11.4130	14.3099
CO	90.3625	77.0271	45.5918	46.5294	50.2701	64.6678	77.3685
NMVOC	17.0009	14.4903	8.5793	8.7674	9.4752	12.1906	14.6059
SO_2	1.4286	1.2511	0.8862	1.0574	1.1545	1.4349	1.8835
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	1581.1835	1612.7476	1535.8523	1606.1743	1696.5714	1619.4921	1861.9016
CH_4	0.3840	0.3573	0.3316	0.3415	0.3516	0.3469	0.3475
N_2O	0.1139	0.1164	0.1255	0.1211	0.1219	0.1018	0.1145
NO_x	15.7664	16.0982	15.9006	16.4888	17.2542	16.1041	18.7731
CO	84.7304	87.3479	80.9715	83.4406	85.9984	84.8597	85.1121
NMVOC	16.0064	16.4992	15.3324	15.8018	16.2811	16.0487	16.1605
SO_2	2.1130	2.1507	2.1698	2.2855	2.4258	2.2617	2.8017

Table 3-57: GHG Emissions from the Category 1A3 'Transport' by Source in the Republic of Moldova within 1990-2010, where 1990 represents 100 per cent

	1990	1991	1992	1993	1994	1995	1996
CO_2	100.0	90.4	50.6	37.3	32.4	33.0	32.3
CH_4	100.0	91.3	45.6	29.6	27.4	28.8	27.4
N_2O	100.0	88.0	54.6	41.2	37.9	32.0	30.0
NO_x	100.0	89.2	51.3	39.1	32.3	32.1	30.3
CO	100.0	91.3	44.4	29.7	27.4	28.8	27.5
NMVOC	100.0	91.3	44.4	29.8	27.4	28.9	27.5
SO_2	100.0	89.9	55.0	43.4	33.2	33.6	31.4
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	32.9	28.7	19.6	21.4	22.7	28.8	36.0
CH_4	31.1	26.5	15.7	16.0	17.2	22.2	26.6
N_2O	30.5	27.3	17.2	20.2	22.3	27.8	33.7
NO_x	32.3	28.2	18.8	21.7	23.7	29.5	37.0
CO	31.2	26.6	15.7	16.1	17.4	22.3	26.7
NMVOC	31.2	26.6	15.7	16.1	17.4	22.4	26.8
SO_2	32.7	28.6	20.3	24.2	26.4	32.8	43.1
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	40.3	41.1	39.1	40.9	43.2	41.2	47.4
CH_4	32.2	30.0	27.8	28.6	29.5	29.1	29.1
N_2O	34.0	34.7	37.4	36.1	36.4	30.4	34.2
NO_x	40.8	41.7	41.2	42.7	44.7	41.7	48.6
CO	29.3	30.2	28.0	28.8	29.7	29.3	29.4
NMVOC	29.4	30.3	28.1	29.0	29.9	29.4	29.6
SO_2	48.4	49.2	49.7	52.3	55.5	51.8	64.1

Table 3-58: Direct GHG Emissions from 1A3 'Transport' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

	CO_2 equivalent				%		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	3926.6606	25.0344	103.9112	4055.6062	96.82	0.62	2.56
1991	3548.3245	22.8474	91.4708	3662.6428	96.88	0.62	2.50
1992	1986.1727	11.4076	56.7452	2054.3256	96.68	0.56	2.76
1993	1463.2667	7.4019	42.8544	1513.5229	96.68	0.49	2.83
1994	1271.1186	6.8492	39.3587	1317.3265	96.49	0.52	2.99
1995	1297.6775	7.2042	33.2698	1338.1514	96.98	0.54	2.49
1996	1267.6092	6.8588	31.2062	1305.6741	97.08	0.53	2.39
1997	1292.0143	7.7931	31.6502	1331.4576	97.04	0.59	2.38
1998	1126.3239	6.6404	28.3678	1161.3321	96.99	0.57	2.44
1999	770.1737	3.9203	17.9146	792.0086	97.24	0.49	2.26
2000	838.3532	3.9947	21.0052	863.3531	97.10	0.46	2.43
2001	892.9559	4.3163	23.1627	920.4350	97.01	0.47	2.52
2002	1132.2307	5.5574	28.8602	1166.6483	97.05	0.48	2.47
2003	1413.6197	6.6475	35.0325	1455.2998	97.14	0.46	2.41
2004	1581.1835	8.0632	35.3151	1624.5617	97.33	0.50	2.17
2005	1612.7476	7.5042	36.0938	1656.3456	97.37	0.45	2.18
2006	1535.8523	6.9640	38.9020	1581.7184	97.10	0.44	2.46
2007	1606.1743	7.1718	37.5368	1650.8829	97.29	0.43	2.27
2008	1696.5714	7.3843	37.7937	1741.7494	97.41	0.42	2.17
2009	1619.4921	7.2856	31.5552	1658.3330	97.66	0.44	1.90
2010	1861.9016	7.2973	35.4955	1904.6945	97.75	0.38	1.86

In 1990-2010, the total GHG emissions from the 1A3 'Transport' Source Category have decreased by 53.0 per cent: from 4055.61 Gg CO_2 equivalent in 1990 to 1904.69 Gg CO_2 equivalent in 2010 (Table 3-58, Figure 3-8).

Comparing to 1990, in 2010 the total direct GHG emissions from 1A3 ‚Transport' source category were estimated at 47 per cent, CO_2 – 47.4 per cent, CH_4 – 29.1 per cent, respectively N_2O – 34.2 per cent of the total emissions registered for the reference year.

The decreasing trend in GHG emissions is characteristic to all emission sources covered by the category 1A3 'Transport': 1A3b – 46.9 per cent; 1A3c – 85.1 per cent; 1A3d – 98.8 per cent; 1A3e – 97.9 per cent (Table 3-59, Figure 3-9).

The emissions source having the largest share in the total direct GHG emissions under category 1A3 'Transport' is 1A3b 'Road Transportation', with a share that varied over the reference period from 75.7 per cent in 1994 to 95.9 per cent in 2010. Other major emissions sources are represented by 1A3c 'Railways', with a share varying between 3.9 per cent in 2010 and 17.9 per cent in 1994, respectively 1A3e 'Pipeline Transportation', with a share varying between 0.1 per cent in 2010 and 9.0 per cent in 1996 (Table 3-60).

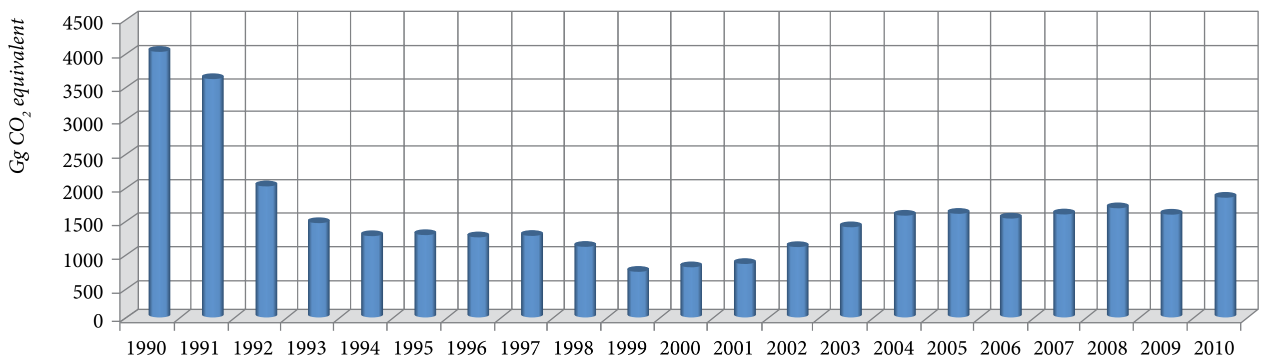


Figure 3-8: Direct GHG Emissions from 1A3 'Transport' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

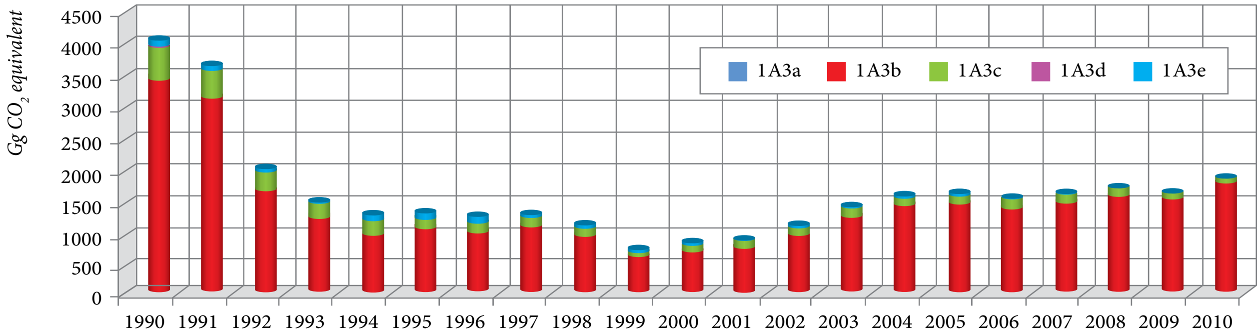


Figure 3-9: Breakdown of the Category 1A3 'Transport' GHG Emissions by Source within 1990-2010

Table 3-59: Breakdown of the Category 1A3 'Transport' GHG Emissions by Source, 1990-2010, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
1A3a	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
1A3b	3438.2866	3153.6808	1695.9873	1268.3491	997.2773	1092.7316	1037.9412
1A3c	507.0409	432.7382	301.1449	226.3196	232.4823	161.6583	149.7637
1A3d	19.1005	0.2419	0.2069	0.2388	0.1878	0.1815	0.1974
1A3e	91.1782	75.9818	56.9864	18.6156	87.3791	83.5800	117.7719
	1997	1998	1999	2000	2001	2002	2003
1A3a	NO, NE	NO, NE	NO, NE	NO, NE	0.0833	0.6618	0.4171
1A3b	1141.5255	982.3530	662.3499	739.7670	800.5442	1004.2928	1282.0785
1A3c	140.3306	131.3567	76.2486	93.0946	104.4171	129.5661	149.3893
1A3d	0.2133	0.1337	0.2228	0.0987	0.1783	0.4138	0.3756
1A3e	49.3882	47.4887	53.1873	30.3927	15.1964	32.2923	22.7946
	2004	2005	2006	2007	2008	2009	2010
1A3a	0.1104	0.2221	0.1296	0.1731	0.1731	0.1151	0.1388
1A3b	1459.6913	1490.7862	1409.0094	1506.8735	1608.5069	1572.5333	1827.1181
1A3c	126.0804	129.0328	166.5144	139.7656	128.9234	75.9131	75.3057
1A3d	0.3820	0.3247	0.2738	0.3152	0.3470	0.2738	0.2324
1A3e	37.9909	36.0914	5.6986	3.7991	3.7991	9.4977	1.8995

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

Table 3-60: Breakdown of the Category 1A3 'Transport' GHG Emissions by Source, %

	1990	1991	1992	1993	1994	1995	1996
1A3a	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
1A3b	84.78	86.10	82.56	83.80	75.70	81.66	79.49
1A3c	12.50	11.81	14.66	14.95	17.65	12.08	11.47
1A3d	0.47	0.01	0.01	0.02	0.01	0.01	0.02
1A3e	2.25	2.07	2.77	1.23	6.63	6.25	9.02
	1997	1998	1999	2000	2001	2002	2003
1A3a	NO, NE	NO, NE	NO, NE	NO, NE	0.01	0.06	0.03
1A3b	85.74	84.59	83.63	85.69	86.98	86.04	88.11
1A3c	10.54	11.31	9.63	10.78	11.34	11.10	10.27
1A3d	0.02	0.01	0.03	0.01	0.02	0.04	0.03
1A3e	3.71	4.09	6.72	3.52	1.65	2.77	1.57
	2004	2005	2006	2007	2008	2009	2010
1A3a	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1A3b	89.87	90.00	89.09	91.27	92.35	94.83	95.93
1A3c	7.76	7.79	10.53	8.47	7.40	4.58	3.95
1A3d	0.02	0.02	0.02	0.02	0.02	0.02	0.01
1A3e	2.34	2.18	0.36	0.23	0.22	0.57	0.10

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

3.4.2 Methodological Issues, Emission Factors and Activity Data

1A3a Civil Aviation

GHG emissions from 1A3a 'Civil Aviation' source category were estimated following a Tier 1 methodological approach, based on activity data on fuel consumption (Table 3-61) and default values of emission factors. To assure the natural conversion from nature units to energy units, country specific net calorific values were used (see Table 3-11). The used value of carbon oxidation fraction is that recommended in the 2006 IPCC Guidelines.

Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-62) were used for estimating non-CO_2 emissions.

Table 3-62: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A3a 'Civil Aviation', kg/TJ

	CH_4	N_2O	NO_x	CO	NMVOC
Aviation Gasoline	0.5	2	250	100	50

Source: CO and NMVOC – Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-10 and 1-11, page 1.40, 1.42; CH_4, N_2O, NO_x – 2006 IPCC Guidelines, Vol. 2, Cap. 3, Tab. 3.6.5, page 3.64.

Table 3-61: Activity Data used for GHG Emissions Assessment within 1A3a 'Civil Aviation' Source Category in the RM within 2001-2010 time periods

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Aviation Gasoline Consumption, tons	32.116	27.789	214.577	135.204	36.887	72.065	46.824	56.165	37.348	45.153
Round Trip Flights	8	3	29	41	31	169	145	175	335	249

Source: Civil Aeronautical Authority, through Letter No. 1328 dated 13.09.2011, response to Letters No. 03-07/175 dated 02.02.2011 and No. 03-07/1337 dated 08.08.2011 of the Ministry of Environment of the RM.

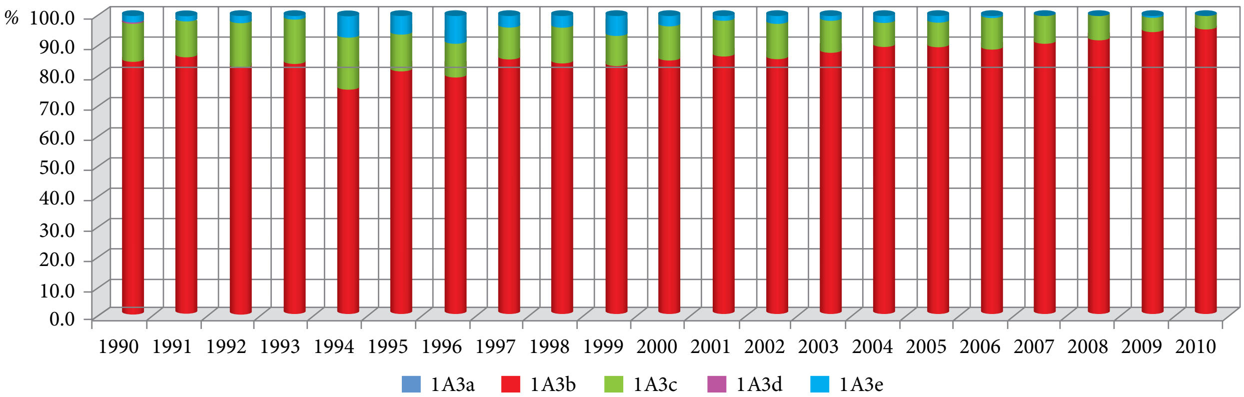


Figure 3-10: Breakdown of the Category 1A3 'Transport' GHG Emissions by Source, %

1A3b Road Transportation

GHG emissions from the 1A3b 'Road Transportation' source category were estimated following a Tier 1 methodological approach (based on AD on fuel consumption and default EFs values). It was not possible yet to use a Tier 2 or Tier 3 methods due to lack of activity data on total annual kilometers travelled per vehicle15, disaggregated for each vehicle category.

EFs used to estimate CO_2 emissions are described in Table 3-11. Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-63) were used to estimate non-CO_2 emissions.

Table 3-63: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from Road Transportation, kg/TJ

Fuel Type	CH_4	N_2O	NO_x	CO	NMVOC
Gasoline	33	3.2	600	8000	1500
Diesel Oil	3.9	3.9	800	1000	200
Natural Gas	92	3	600	400	5

Source: NO_x, CO and NMVOC – Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, pages 1.37-1.42; CH_4, N_2O – 2006 IPCC Guidelines, Vol. 2, Chap. 3, Tab. 3.2.2, page 3.21.

Activity data pertaining to fuel consumption for 1A3b 'Road Transportation' (Gasoline, Diesel Oil, LPG - Liquefied Petroleum Gases and LNG - Liquefied Natural Gases) were collected from the Energy Balances of the RM for 1990, 1993-2005 years, Statistical Yearbooks of ATULBD, as well as from other relevant sources, including central public authorities (i.e., Ministry of Transport and Roads Infrastructure, Ministry of Agriculture and Food Industry), central administration authorities (National Bureau of Statistics, Costume Service) and individual enterprises ("MOLDOVA GAZ" J.S.C.).

Activity data pertaining to Diesel Oil consumption for 1A3b 'Road Transportation' (Table 3-64) are available in the Energy Balances of the RM, see Chapter S.2.1. 'Consumed as Fuel or Energy', columns: 'for transport operation', 'for agriculture' and 'sold to population' (diesel oil consumption was added). In order to estimate the total quantity of Diesel Oil consumed by the transport means in the RM, there were summed up the amount of Diesel Oil used for 'transport operation', 'sold to population', and 10 per cent of the amount of Diesel Oil used in 'agriculture' sector (for both RBD and LBD); the remaining 90 per cent were reallocated under the 1A4c 'Agriculture / Forestry / Fishing' category.

Table 3-64: Diesel Oil Consumption under the 1A3b 'Road Transportation' in the RM within 1990-2010 time periods, kt

Type of fuel	1990	1991	1992	1993	1994	1995	1996
Diesel Oil	308.400	279.000	194.000	173.400	104.300	123.175	114.582
	1997	1998	1999	2000	2001	2002	2003
Diesel Oil	115.977	100.955	84.667	109.718	120.294	147.040	201.760
	2004	2005	2006	2007	2008	2009	2010
Diesel Oil	241.971	245.139	244.047	268.226	288.995	276.689	367.224

Source: Energy Balances of the RM for1990, 1993-2010; Statistical Yearbooks of the ATULBD 2000 (page 106), 2006 (page 107), 2009 (page 106), 2010 (page 108), 2012 (page 113).

A similar approach was used to deduce AD pertaining to the Gasoline consumption within 1A3b 'Road Transportation', for which there were summed up the total amount of Gasoline used for 'transport operation' and 'sold to population' (Table 3-65).

Table 3-65: Gasoline Consumption under the 1A3b 'Road Transportation' in the RM within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
Transport operation	655.0	600.0	275.2	209.8	159.0	143.0	135.0
Sold to population	117.0	107.0	58.0	6.7	47.0	75.0	73.0
Total consumption	772.0	707.0	333.2	216.5	206.0	218.0	208.0
	1997	1998	1999	2000	2001	2002	2003
Transport operation	112.0	93.0	56.0	50.0	55.0	80.0	99.0
Sold to population	127.0	110.0	61.0	66.0	70.0	82.0	92.0
Total consumption	239.0	203.0	117.0	116.0	125.0	162.0	191.0
	2004	2005	2006	2007	2008	2009	2010
Transport operation	71.0	69.0	73.0	80.0	77.0	64.0	69.0
Sold to population	137.0	146.0	123.0	121.0	129.0	142.0	127.0
Total consumption	208.0	215.0	196.0	201.0	206.0	206.0	196.0

Source: Energy Balances of the RM for 1990, 1993-2010.

Activity data pertaining to consumption of Liquefied Petroleum Gases and Liquefied Natural Gases under the 1A3b 'Road Transportation' in the RM were provided by "MOLDOVA GAZ" J.S.C. (Table 3-66).

[15] Track log is monitored only for certain categories of vehicles, information being available in the State Register of Transport: <http://www.registru.md/rst/>.

Table 3-66: Liquefied Petroleum Gases and Liquefied Natural Gases Consumption under the 1A3b 'Road Transportation' in the RM within 1990-2010 time periods

Fuel Type	1990	1991	1992	1993	1994	1995	1996
LPG, kt	13.00	17.29	10.38	8.40	6.00	4.00	4.00
LNG, mil. m^3	8.24	7.72	4.89	11.83	7.32	6.81	9.42
Fuel Type	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
LPG, kt	2.64	2.66	2.38	1.45	0.82	1.29	6.00
LNG, mil. m^3	10.50	10.87	10.83	12.34	12.74	13.68	13.00
Fuel Type	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
LPG, kt	5.00	5.00	5.00	6.00	10.00	10.00	13.00
LNG, mil. m^3	12.00	12.00	2.00	3.00	7.10	8.90	2.00

Source: Energy Balances of the RM for 1990, 1993-2010; Official Letters from „Moldova Gaz" J.S.C., No. 604 dated 01.04.1999 (for 1990-1998), No. 02-541, dated 28.05.2001 (for 1999-2000), No. 02-156dated 06.02.2004 (for 2001-2002); No. 06-1253 dated 27.09.2006 (for 2003-2005) and No. 02/1-476 dated 23.02.2011 (for 2006-2010).

1A3c Railways

GHG emissions from the 1A3c 'Railways' source category were estimated following a Tier 1 methodological approach (based on AD on fuel consumption and default EFs values). EFs used to estimate CO_2 emissions are mentioned in Table 3-11. Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-67) were used to estimate for non-CO_2 emissions.

Table 3-67: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A3c 'Railways', kg/TJ

Fuel Type	CH_4	N_2O	NO_x	CO	NMVOC
Diesel Oil	4.15	28.6	1200	1000	200

Source: NO_x, CO and NMVOC – Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 3, Tab. 3.4.1, Page 3.43.

Activity data pertaining to fuel consumption used to ensure railway transport operation (mainly Diesel Oil) were collected from the Energy Balances of the RM for 1990, 1993-2010, as well as directly from "Moldavian Railways" SOE (Table 3-68)

Certain discrepancies were identified between data pertaining to the fuel consumption used to ensure the railway transport operation from Energy Balance of the RM and data provided by the "Moldavian Railways" SOE. As a consequence, for estimating the GHG emissions originated from the 1A3c 'Railways' source category, there were used AD provided by the "Moldavian Railways" SOE, as being more credible.

Table 3-68: Diesel Oil Consumption under the 1A3c 'Railways' in the RM within 1990-2010 time periods, kt

Fuel Type	1990	1991	1992	1993	1994	1995	1996
Diesel Oil	143.550	122.530	85.270	64.080	65.830	45.770	42.410
Fuel Type	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Diesel Oil	39.740	37.190	21.590	26.360	29.566	36.687	42.300
Fuel Type	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Diesel Oil	35.700	36.536	47.149	39.575	36.505	21.495	21.323

Source: Official Letters from „ Moldavian Railways" SOE No. 94/T dated 26 March 1999; No. H-4/993 dated 17 December 2003; No. Nteh/338 dated 19.09.2006; No. 54/Nteh dated 28 February 2011.

"Moldavian Railways" SOE uses and other types of fossil fuels (Table 3-69), most of them with other purposes then railway transport operation (for example, for heating the administrative buildings, rolling stock maintenance, the supply of spare parts and other materials needed for the normal railway operation). These fuels are taken into account in assessing GHG emissions from 1A5 'Other' source category.

1A3d Navigation

GHG emissions from the 1A3d 'Navigation' source category were estimated following a Tier 1 methodological approach (based on AD on fuel consumption and default EFs values). EFs used to estimate CO_2 emissions are mentioned in Table 3-11.

Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used to estimate non-CO_2 emissions (Table 3-70).

Table 3-70: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A3d 'Navigation', kg/TJ

Fuel Type	CH_4	N_2O	NO_x	CO	NMVOC
Diesel Oil	7	2	1500	1000	200

Source: NO_x, CO and NMVOC – Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 3, Tab. 3.5.3, Page 3.50

To be noted that EBs of the RM does not contain data on fuel consumption used to ensure water borne transport operation (except the Energy Balance for 1990 year). The reason for that is the insignificant quantity of fuel consumed to ensure operation of this type of transport in the RM. As a consequence, for estimating the GHG emissions originated from the 1A3d 'Navigation', for the rest of the period (1991-2010) there was used information obtained from the Ministry of Transport and Roads Infrastructure of the RM (Table 3-71).

Table 3-69: The Use of Other Fossil Fuels by the "Moldavian Railways" SOE within 2000-2010 time periods

Fuel Type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Coal, kt	3.872	4.118	5.159	5.743	4.483	3.807	5.858	4.479	4.392	4.225	4.178
Residual Fuel Oil, kt	2.274	0.879	0.880	0.391	0.177	0.000	0.026	0.000	0.018	0.048	0.000
Gasoline, kt	0.624	0.665	1.081	1.514	1.418	1.337	1.213	1.298	1.253	0.561	0.231
Natural Gas, million m^3	1.572	3.846	5.202	6.650	5.630	5.778	5.624	5.213	4.756	4.158	4.289
Kerosene, kt	0.016	0.009	0.025	0.009	0.007	0.006	0.004	0.007	0.007	0.005	0.006
Diesel Oils, kt	0.650	1.162	2.110	0.888	0.888	0.863	1.158	1.091	0.945	0.648	0.623

Source: Official Letters from „Moldavian Railways" SOE No. 338/Nteh dated 19/09/2006 and No. 54/Nteh dated 28/02/2011.

Table 3-71: Diesel Oil Consumption under the 1A3d 'Navigation' in the RM within 1990-2010 time periods, kt

Fuel Type	1990	1991	1992	1993	1994	1995	1996
Diesel Oil	6.000	0.076	0.065	0.075	0.059	0.057	0.062
Fuel Type	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Diesel Oil	0.067	0.042	0.070	0.031	0.056	0.130	0.118
Fuel Type	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Diesel Oil	0.120	0.102	0.086	0.099	0.109	0.086	0.073

Source: Official Letter from the Ministry of Transport and Communications No. 03-5-2/2-32 dated 31st of March 1999; Official Letter from the Ministry of Transport and Roads Infrastructure No. 04-01-3/754 dated 2nd of October 2006 and No. 04/2-2-05 dated 12 of March 2011.

1A3e Pipeline Transportation

GHG emissions from the 1A3e 'Pipeline Transportation' source category were estimated following a Tier 1 methodological approach, based on AD on fuel consumption (Table 3-72) and default EFs values (Table 3-11). AD pertaining to fuel consumption to ensure pipeline transportation was collected from the Energy Balances of the RM (see Chapter S.2.3 'Consumed as Fuel or Energy for Transport Operations', Section 'Pipeline Transportation').

Table 3-72: Natural Gas Consumption under the 1A3e 'Pipeline Transportation' in the RM within 1990-2010 time periods, million m^3

Fuel Type	1990	1991	1992	1993	1994	1995	1996
Natural Gas	48	40	30	9.8	46	44	62
Fuel Type	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Natural Gas	26	25	28	16	8	17	12
Fuel Type	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Natural Gas	20	19	3	2	2	5	1

Source: Energy Balances of the RM for 1990 and 1993-2010; AD for 1991-1992 were interlaced due to the fact that no Energy Balances were published in that period.

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 the 1A3 'Transport' source category, and the quality of activity data available.

Uncertainties associated with EFs used to estimate CO_2 emissions from the 1A3 'Transport' source category, were estimated at about 5 per cent, for CH_4 emissions at about ±40 per cent, while those pertaining to EFs used to estimate N_2O emissions reach up to ±50 per cent. Uncertainties associated with statistical data regarding fuel consumption within the Transport Sector in the RM can be considered relatively low (±5 per cent).

The uncertainties related to GHG emissions within the 1A3 'Transport' source category were estimated, at ±7.07 per cent for CO_2 emissions, for CH_4 emissions at ±40.31 per cent, and for N_2O emissions at ±50.25 per cent. At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated for CO_2 emissions at ±1.4716 per cent, for CH_4 emissions at ±0.0329 per cent and for N_2O emissions at ±0.1994 per cent.

Uncertainties associated to the total direct GHG emissions trend within the Energy Sector were estimated at about ±0.4005 per cent for CO_2 emissions, ±0.0018 per cent for CH_4 emissions and, respectively ±0.0144 per cent for N_2O emissions (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 GPG (IPCC, 2000).

3.4.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the 1A3 'Transport' source category, following the Tier 1 approach (IPCC, 2000).

To be noted, that the AD and methods used for estimating GHG emissions under the category 1A3 'Transport' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), GHG emissions were estimated using AD and CS NCVs from official sources of information.

3.4.5 Recalculations

GHG emission recalculations performed under the 1A3 'Transport' source category are due to the availability of an updated set of activity data for the ATULBD covering the 1995-2005 time period, in the case of 1A3b 'Road Transportation' source category (Table 3-73); an updated set of activity data from the "Moldavian Railways" SOE in the case of 1A3c 'Railways' source category (Table 3-74); an updated set of activity data obtained from the Ministry of Transport and Roads Infrastructure in the case of 1A3d 'Navigation' source category (Table 3-75); as well as a result of including for the first time in the national GHG inventory the emissions originated from 1A3a 'Civil Aviation' source category (see Table 3-40 and 3-41)

Table 3-73: Comparative Results of GHG Emissions Inventory from 1A3b 'Road Transportation' Included into the SNC and TNC of the RM under the UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
SNC	3438.29	3153.68	1695.99	1268.35	997.28	1083.10	1030.40
TNC	3438.29	3153.68	1695.99	1268.35	997.28	1092.73	1037.94
Difference, %	0.0	0.0	0.0	0.0	0.0	0.9	0.7
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	1131.28	974.35	655.21	734.68	795.40	1000.29	1279.32
TNC	1141.53	982.35	662.35	739.77	800.54	1004.29	1282.08
Difference, %	0.9	0.8	1.1	0.7	0.6	0.4	0.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	1457.22	1489.06					
TNC	1459.69	1490.79	1409.01	1506.87	1608.51	1572.53	1827.12
Difference, %	0.2	0.1					

Table 3-74: Comparative Results of GHG Emissions Inventory from 1A3c 'Railways' Included into the SNC and TNC of the RM under the UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
SNC	507.04	432.74	301.14	226.32	232.48	161.66	149.76
TNC	507.04	432.74	301.14	226.32	232.48	161.66	149.76
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	140.33	131.36	76.25	82.99	115.49	125.02	149.39
TNC	140.33	131.36	76.25	93.09	104.42	129.57	149.39
Difference, %	0.0	0.0	0.0	12.2	-9.6	3.6	0.0
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	126.08	129.03					
TNC	126.08	129.03	166.51	139.77	128.92	75.91	75.31
Difference, %	0.0	0.0					

Table 3-75: Comparative Results of GHG Emissions Inventory from 1A3d 'Navigation' Included into the SNC and TNC of the RM under the UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
SNC	19.10	0.24	0.21	0.24	0.19	0.18	0.20
TNC	19.10	0.24	0.21	0.24	0.19	0.18	0.20
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	0.21	0.13	0.22	0.21	0.35	0.36	0.27
TNC	0.21	0.13	0.22	0.10	0.18	0.41	0.38
Difference, %	0.0	0.0	0.0	-52.3	-49.1	14.0	37.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	0.30	0.33					
TNC	0.38	0.32	0.27	0.32	0.35	0.27	0.23
Difference, %	29.0	-2.9					

Table 3-76: Comparative Results of GHG Emissions Inventory from 1A3 'Transport' Included in the SNC and TNC of the RM under the UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
SNC	4055.61	3662.64	2054.33	1513.52	1317.33	1328.52	1298.13
TNC	4055.61	3662.64	2054.33	1513.52	1317.33	1338.15	1305.67
Difference, %	0.0	0.0	0.0	0.0	0.0	0.7	0.6
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	1321.21	1153.33	784.87	848.27	926.43	1157.96	1451.78
TNC	1331.46	1161.33	792.01	863.35	920.44	1166.65	1455.30
Difference, %	0.8	0.7	0.9	1.8	-0.6	0.8	0.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	1621.59	1654.52					
TNC	1624.56	1656.35	1581.72	1650.88	1741.75	1658.33	1904.69
Difference, %	0.2	0.1					

In comparison with the results included into the SNC of the RM under the UNFCCC, the performed recalculations resulted in insignificant increase of direct GHG emissions within the 1A3 'Transport' source category, varying from a minimum of 0.1 per cent in 2005, up to a maximum of 1.8 per cent in 2000, excluding 2001 when a decrease of 0.6 per cent was registered (Table 3-76).

For 2006-2010 time periods, the GHG emissions originated from 1A3 'Transport' source category were estimated for the first time. The results revealed that between 1990 and 2010, the GHG emissions originated from respective source category decreased by circa 53.0 per cent.

3.4.6 Planned Improvements

Potential improvements within the 1A3 'Transport' source category could be possible once updating the AD on fuel consumption in ATULBD.

3.5 Other Sectors (Category 1A4)

3.5.1 Source Category Description

The 1A4 'Other Sectors' category includes greenhouse gases generated by the following emission sources: 1A4a 'Commercial / Institutional'; 1A4b 'Residential'; 1A4c 'Agriculture / Forestry / Fishing'.

1A4a 'Commercial / Institutional Sectors'

Commercial Sector holds a significant position in the national economy of the RM, its contribution to GDP varying within 2000-2011 time periods, from a minimum of 10.4 per cent in 2005, to a maximum of 13.3 per cent in 2011 (Table 3-77).

According to the data of the NBS (2012), over 223 thousand persons or 19 per cent of employed population of the country are involved in the Commercial Sector. As of 1st of January 2011, there were circa 12215 commercial units in the RM (Table 3-78).

Table 3-78: Number of Commercial Units in the RM within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Commercial Units	11267	11069	8781	8926	7928	7770	7802
Shops	8874	8908	7279	7379	6785	6434	6432
Booths	2393	2161	1502	1547	1143	1336	1370
Total Commercial Area, thousand m^2	840	853.1	708.6	685.7	643.4	622.7	621.2
On average per one shop, m^2	94.6	95.8	97.3	92.9	94.8	79.8	79.6
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Commercial Units	7759	7499	6501	6549	5858	6960	7158
Shops	6315	6068	5299	5316	4788	5792	5791
Booths	1444	1431	1202	1233	1070	1168	1367
Total Commercial Area, thousand m^2	578.9	546.9	469.4	438	399.2	442.7	444
On average per one shop, m^2	91.7	90.1	88.6	82.3	83.4	76.4	76.7

Table 3-77: Commercial Sector Contribution to RM's GDP within 2000-2011 time periods, %

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Wholesale and Retail	12.5	12.0	11.0	10.7	10.6	10.4	11.5	12.6	13.0	13.2	12.8	13.3

Source: NBS of the RM, <www.statbank.statistica.md>.

	2004	2005	2006	2007	2008	2009	2010
Commercial Units	7718	8350	9014	9980	11066	11082	12215
Shops	6220	6662	7159	7833	8527	8889	9556
Booths	1498	1688	1855	2147	2539	2193	2659
Total Commercial Area, thousand m²	485.7	521.1	549.8	626.6	699.0	750.6	850.9
On average per one shop, m²	78.1	78.2	76.8	80.0	82.0	84.0	89.0

Source: Statistical Yearbooks of the RM for 1994 (page 351), 1999 (page 456), 2006 (page 474) and 2012 (page 470).

The Institutional Sector includes education and research, health care, culture and sports, post and telecommunication institutions (Table 3-79).

Commercial and institutional premises are preponderantly heated with natural gas, as well as with Coal, Residual Fuel Oil, Diesel Oil, Oven Fuel, Liquefied Petroleum Gases, Fuel Wood, Wood Waste and Agricultural Residues.

1A4b 'Residential Sector'

As of 1st of January 2012, the population of the RM represented circa 4073.8 thousand inhabitants, including 3560.4 thousand inhabitants on the right bank of Dniester River, respectively 513.4 thousand people on the Left bank of Dniester River. Almost 45.1 per cent (1836.1 thousand inhabitants) of the country population live in urban areas, while 54.9 per cent (2237.7 thousand inhabitants) live in rural areas (NBS, 2012).

Table 3-79: Number of Institutional Premises in the RM within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Preschool institutions	2336	2306	1940	1877	1774	1680	1596
Non-school educational institutions	830	826	686	613	562	534	516
Primary, secondary and high schools	1635	1654	1482	1488	1504	1515	1530
Secondary, professional educational institutions	114	109	86	78	78	78	78
Colleges	50	53	44	48	47	50	51
Universities and institutes	9	13	14	17	18	20	24
R&D Institutions	95	93	91	84	81	85	89
Hospitals	334	335	342	339	334	335	325
Ambulatories and out-patient clinics	586	588	594	616	599	612	601
Sanitary-epidemiological institutions	55	55	55	55	54	53	53
Emergency stations	66	67	70	69	69	68	70
Children Homes	5	5	4	4	4	4	4
Orphanages	7	7	2	3	3	3	3
Boarding schools	6	6	2	2	2	7	7
Tuberculosis sanatoriums	8	7	6	6	6	5	5
Public libraries	2079	2037	1730	1627	1594	1602	1583
Cinemas	1791	1582	1172	960	784	671	628
Museums	79	79	66	66	66	65	65
Theatres	10	13	12	13	13	13	13
Cultural institutions	1790	1725	1487	1385	1335	1305	1268
Sports facilities	8789	9873	7254	6888	6659	6486	6007
Post and telecommunication offices	1395	1398	1395	1417	1394	1406	1406
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Preschool institutions	1497	1399	1201	1135	1128	1192	1246
Non-school educational institutions	495	481	448	427	407	409	417
Primary, secondary and high schools	1536	1556	1565	1573	1584	1587	1583
Secondary, professional educational institutions	81	80	87	81	80	82	83
Colleges	53	56	57	60	67	63	60
Universities and institutes	28	38	43	47	47	45	40
R&D Institutions	93	88	85	83	81	76	79
Hospitals	294	276	150	132	110	110	111
Ambulatories and out-patient clinics	581	625	473	571	545	562	577
Sanitary-epidemiological institutions	53	53	47	50	40	40	40
Emergency stations	71	70	89	105	107	114	122
Children Homes	4	4	4	4	3	3	3
Orphanages	3	3	3	3	3	3	3
Boarding schools	7	7	6	6	6	6	6
Tuberculosis sanatoriums	5	5	5	5	3	2	2
Public libraries	1562	1551	1439	1419	1378	1372	1380
Cinemas	666	512	353	104	115	70	71
Museums	67	68	70	70	71	73	76
Theatres	13	13	13	13	14	15	15
Cultural institutions	1284	1277	1256	1245	1244	1245	1227
Sports facilities	5468	5614	4766	4842	4926	4947	4609
Post and telecommunication offices	1373	1222	1176	1174	1176	1177	1178

	2004	2005	2006	2007	2008	2009	2010
Preschool institutions	1269	1295	1305	1334	1349	1362	1381
Non-school educational institutions	419	418	418	405	401	402	399
Primary, secondary and high schools	1577	1558	1546	1541	1526	1512	1489
Secondary, professional educational institutions	83	81	78	78	75	75	75
Colleges	56	51	49	49	47	47	48
Universities and institutes	35	35	31	31	31	33	33
R&D Institutions	86	88	67	76	70	68	69
Hospitals	116	114	84	83	82	83	84
Ambulatories and out-patient clinics	509	522	571	625	669	675	709
Sanitary-epidemiological institutions	40	40	40	40	40	40	42
Emergency stations	122	127	132	132	132	136	136
Children Homes	3	3	3	3	3	3	3
Orphanages	3	3	3	3	3	3	3
Boarding schools	6	6	6	6	6	6	6
Tuberculosis sanatoriums	2	2	2	2	2	2	2
Public libraries	1386	1389	1391	1383	1381	1385	1380
Cinemas	77	57	34	34	32	37	30
Museums	82	83	82	87	89	89	106
Theatres	15	15	14	14	14	14	14
Cultural institutions	1221	1223	1227	1225	1227	1229	1228
Sports facilities	4764	4848	4882	4907	4918	4906	4891
Post and telecommunication offices	1176	1171	1169	1170	1168	1169	1167

Source: Statistical Yearbooks of the RM for 1994 (pages 135-358), 1999 (pages 74-473), 2006 (pages 156-419) and 2012 (pages 149-411).

The dwelling stock was around 79.9 million m^2, including urban dwelling stock – 30.9 million m^2 and rural dwelling stock – 49.0 million m^2. Table 3-80 presents the situation regarding the evolution of dwelling stock in the RM, from 1990 through 2010.

To be noted that around 88.7 per cent of living space is connected to natural gas supply systems (NBS, 2012). Besides natural gas, living space is heated with Coal, Residual Fuel Oil and Biomass. Natural Gases, Liquefied Petroleum Gases and Biomass are preponderantly used also for cooking.

1A4c 'Agriculture / Forestry / Fishing Sectors'

Agriculture, forestry and fishing play an important role in the national economy of the RM, contributing around 12.2

Table 3-80: Dwelling Stock in the Republic of Moldova, 1990-2011

Years	Total			Urban			Rural		
	Total dwelling stock, mil. m^2	On average per person, m^2	Of which share of living space connected to natural gas, %	Urban dwelling stock, mil. m^2	On average per person, m^2	Of which share of living space connected to natural gas, %	Rural dwelling stock, mil. m^2	On average per person, m^2	Of which share of living space connected to natural gas, %
1990	77.9	17.8	NA	29.5	14.2	NA	48.4	21.1	NA
1991	79.1	18.2	NA	30.1	14.7	NA	49.0	21.3	NA
1992	66.9	18.2	NA	23.5	14.9	NA	43.4	20.7	NA
1993	68.7	19.0	NA	23.9	15.3	NA	44.8	21.8	NA
1994	70.2	19.5	NA	24.9	16.0	NA	45.3	22.1	NA
1995	71.8	19.9	NA	26.0	16.9	NA	45.8	22.2	NA
1996	72.2	20.1	NA	26.1	17.0	NA	46.1	22.4	NA
1997	73.2	20.0	81.3	26.6	17.3	89.0	46.6	22.0	77.3
1998	74.5	20.4	82.9	27.1	17.7	90.4	47.4	22.4	79.1
1999	75.4	20.7	81.9	27.9	18.2	90.0	47.5	22.4	77.7
2000	75.6	20.8	82.6	28.1	18.8	91.0	47.5	22.3	78.2
2001	75.9	20.9	83.2	28.4	18.9	91.2	47.5	22.3	78.9
2002	76.2	21.0	83.3	28.5	19.0	91.1	47.7	22.5	79.4
2003	76.8	21.3	84.4	28.5	19.1	91.4	48.3	22.9	80.7
2004	76.8	21.3	85.1	28.4	19.1	91.8	48.4	22.9	81.6
2005	77.1	21.4	85.4	28.6	19.2	92.1	48.5	23.0	81.8
2006	77.1	21.5	85.7	28.6	19.3	92.4	48.5	23.1	82.2
2007	77.8	21.8	86.2	29.1	19.7	93.0	48.7	23.2	82.6
2008	78.4	22.0	86.6	29.7	20.1	93.1	48.7	23.3	83.1
2009	78.9	22.1	87.3	30.1	20.4	93.4	48.8	23.4	84.0
2010	79.3	22.3	87.8	30.4	20.5	92.6	48.9	23.5	84.9
2011	79.9	22.4	88.7	30.9	20.8	93.4	49.0	23.6	85.6

Source: SY of the RM for 1994 (pages 312-314), 1999 (pages 214-216), 2006 (pages 149-152), 2011 (pages 138-141).

Table 3-81: Contribution of Agriculture / Forestry / Fishing to GDP in the RM within 2000-2011 time periods, %

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Agriculture / Forestry / Fishing	25.4	22.4	21.0	18.3	17.6	16.4	14.5	10.0	8.8	8.5	12.0	12.2

Source: NBS of the RM, <www.statbank.statistica.md>.

per cent to GDP (NBS, 2012) (Table 3-81). According to the NBS, more than 323 thousand persons or 27.5 per cent of employed population is involved in these sectors.

Diesel Oil, Natural Gases, Liquefied Petroleum Gases and Biomass are the most used fuels within the respective sectors.

Direct GHG Emissions Trend from 1A4 'Other Sectors' Source Category

Between the 1990-2010 time periods, the GHG emissions originated from the 1A4 'Other Sectors' source category decreased significantly (Table 3-82).

Table 3-82: GHG Emissions from 1A4 'Other Sectors' within 1990-2010 time periods, Gg

		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1990	1A4	**7762.4898**	**11.6427**	**0.0993**	**35.4060**	**127.0250**	**15.3004**	**60.5137**
	1A4a	1412.4933	0.2488	0.0205	1.5232	25.1126	2.5521	
	1A4b	4407.6336	10.9660	0.0626	4.7893	76.5723	7.8015	
	1A4c	1942.3629	0.4279	0.0163	29.0934	25.3400	4.9468	
1991	1A4	**6294.8303**	**8.9152**	**0.0818**	**27.7087**	**96.1384**	**11.7409**	**56.4259**
	1A4a	804.0293	0.0873	0.0098	0.8734	10.9544	1.1033	
	1A4b	3340.6505	7.3738	0.0522	3.9439	59.6958	6.3610	
	1A4c	2150.1505	1.4540	0.0197	22.8914	25.4883	4.2766	
1992	1A4	**4388.8608**	**4.2655**	**0.0508**	**18.6192**	**53.8737**	**6.9587**	**26.7322**
	1A4a	378.8167	0.0444	0.0031	0.4437	1.8106	0.1893	
	1A4b	2419.3329	2.8690	0.0330	2.9918	33.3468	3.8370	
	1A4c	1590.7112	1.3521	0.0147	15.1837	18.7163	2.9324	
1993	1A4	**2249.3719**	**3.5220**	**0.0478**	**12.4659**	**60.0628**	**7.5191**	**15.0889**
	1A4a	564.7967	0.0989	0.0080	0.6065	9.8375	0.9994	
	1A4b	981.6243	3.2568	0.0339	1.6394	41.2641	4.7795	
	1A4c	702.9509	0.1664	0.0059	10.2200	8.9612	1.7403	
1994	1A4	**2112.0567**	**3.7236**	**0.0423**	**11.9701**	**54.7840**	**6.8245**	**14.8890**
	1A4a	400.1638	0.0774	0.0060	0.4353	7.4963	0.7628	
	1A4b	1081.1592	3.5158	0.0311	1.5844	38.6676	4.3730	
	1A4c	630.7338	0.1305	0.0053	9.9505	8.6202	1.6887	
1995	1A4	**2193.9896**	**2.5000**	**0.0387**	**13.3229**	**49.2149**	**6.4240**	**9.8365**
	1A4a	391.3760	0.0844	0.0061	0.4269	7.6852	0.7840	
	1A4b	1075.9579	2.2841	0.0266	1.5601	31.8595	3.7350	
	1A4c	726.6556	0.1314	0.0060	11.3359	9.6702	1.9050	
1996	1A4	**2290.6492**	**3.3179**	**0.0405**	**11.2283**	**51.3353**	**6.4162**	**12.4324**
	1A4a	361.7405	0.1016	0.0057	0.3998	7.2692	0.7492	
	1A4b	1353.7827	3.1040	0.0299	1.8285	36.3523	4.1526	
	1A4c	575.1261	0.1122	0.0048	9.0000	7.7138	1.5144	
1997	1A4	**2522.6439**	**1.9187**	**0.0271**	**11.1212**	**33.6107**	**4.3736**	**8.5533**
	1A4a	323.0455	0.0770	0.0050	0.3524	6.3094	0.6460	
	1A4b	1626.2044	1.7448	0.0175	1.7902	19.7649	2.2393	
	1A4c	573.3940	0.0969	0.0047	8.9785	7.5365	1.4883	
1998	1A4	**2104.8957**	**1.6113**	**0.0267**	**8.5884**	**32.5657**	**4.1567**	**6.7725**
	1A4a	331.5423	0.0806	0.0053	0.3624	6.7568	0.6915	
	1A4b	1335.9716	1.4523	0.0179	1.5899	20.2208	2.3662	
	1A4c	437.3818	0.0785	0.0036	6.6361	5.5882	1.0990	
1999	1A4	**1848.8722**	**1.5520**	**0.0235**	**6.4442**	**27.8804**	**3.4965**	**5.6814**
	1A4a	260.8977	0.0545	0.0037	0.2846	4.6086	0.4708	
	1A4b	1279.2034	1.4434	0.0172	1.5279	19.3531	2.2548	
	1A4c	308.7710	0.0541	0.0025	4.6317	3.9187	0.7709	
2000	1A4	**1512.1110**	**1.4995**	**0.0217**	**5.1812**	**25.6301**	**3.1846**	**5.0113**
	1A4a	227.8605	0.0566	0.0031	0.2522	3.7238	0.3845	
	1A4b	1046.2973	1.4084	0.0167	1.3199	18.9274	2.2087	
	1A4c	237.9531	0.0345	0.0019	3.6090	2.9789	0.5915	
2001	1A4	**1451.5894**	**1.2791**	**0.0202**	**4.9727**	**23.7038**	**2.9652**	**4.4252**
	1A4a	259.6388	0.0705	0.0035	0.2881	4.0940	0.4252	
	1A4b	961.1635	1.1722	0.0149	1.2101	16.6767	1.9608	
	1A4c	230.7870	0.0364	0.0019	3.4745	2.9331	0.5791	

		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
2002	1A4	**1766.7757**	**1.6166**	**0.0238**	**5.8830**	**27.9604**	**3.4688**	**5.7914**
	1A4a	447.7479	0.0978	0.0043	0.4565	5.1180	0.5306	
	1A4b	1062.3936	1.4790	0.0174	1.3649	19.4216	2.2619	
	1A4c	256.6342	0.0397	0.0021	4.0616	3.4208	0.6763	
2003	1A4	**2076.2619**	**1.8136**	**0.0255**	**5.8270**	**30.1763**	**3.6347**	**7.6532**
	1A4a	574.2182	0.2153	0.0072	0.6105	8.8709	0.9407	
	1A4b	1265.7189	1.5614	0.0164	1.4962	18.1804	2.0770	
	1A4c	236.3248	0.0369	0.0019	3.7203	3.1251	0.6170	
2004	1A4	**2261.9540**	**1.4750**	**0.0219**	**5.5977**	**24.9627**	**3.0158**	**6.3808**
	1A4a	826.2863	0.1586	0.0061	0.8038	7.0285	0.7303	
	1A4b	1221.0034	1.2853	0.0142	1.4191	15.1733	1.7382	
	1A4c	214.6643	0.0310	0.0017	3.3748	2.7610	0.5473	
2005	1A4	**2216.1375**	**1.5670**	**0.0217**	**5.1215**	**24.6433**	**2.9563**	**6.1363**
	1A4a	706.2874	0.1435	0.0052	0.6882	6.0786	0.6339	
	1A4b	1327.4402	1.3965	0.0150	1.5220	16.1366	1.8409	
	1A4c	182.4099	0.0270	0.0015	2.9112	2.4280	0.4814	
2006	1A4	**2207.0126**	**1.7398**	**0.0230**	**5.0783**	**26.3517**	**3.1512**	**6.4084**
	1A4a	650.3973	0.0612	0.0039	0.6115	4.4931	0.4496	
	1A4b	1379.4082	1.6495	0.0176	1.6210	19.4248	2.2225	
	1A4c	177.2071	0.0292	0.0015	2.8457	2.4338	0.4792	
2007	1A4	**1664.5024**	**1.3257**	**0.0190**	**4.1738**	**21.6075**	**2.6207**	**4.6973**
	1A4a	362.3985	0.1256	0.0040	0.3790	4.9183	0.5223	
	1A4b	1150.8072	1.1797	0.0138	1.3561	14.6693	1.6945	
	1A4c	151.2968	0.0204	0.0012	2.4388	2.0199	0.4038	
2008	1A4	**1671.5326**	**1.3581**	**0.0198**	**4.1359**	**22.4985**	**2.7338**	**4.5003**
	1A4a	367.6021	0.1360	0.0040	0.3880	4.8353	0.5176	
	1A4b	1155.3499	1.1995	0.0146	1.3823	15.6854	1.8249	
	1A4c	148.5806	0.0226	0.0012	2.3656	1.9778	0.3914	
2009	1A4	**1817.8349**	**1.3972**	**0.0199**	**4.1215**	**22.2256**	**2.6797**	**4.9032**
	1A4a	466.3586	0.1777	0.0049	0.5007	5.4897	0.5946	
	1A4b	1213.3803	1.1955	0.0139	1.4085	14.8281	1.7111	
	1A4c	138.0959	0.0240	0.0012	2.2123	1.9078	0.3740	
2010	1A4	**1653.9545**	**1.5470**	**0.0195**	**4.2172**	**22.1317**	**2.6764**	**5.0450**
	1A4a	480.8328	0.1281	0.0037	0.4916	3.8768	0.4165	
	1A4b	1017.2414	1.3899	0.0145	1.2371	16.0854	1.8374	
	1A4c	155.8803	0.0290	0.0013	2.4884	2.1695	0.4226	

Within the 1A4 'Other Sectors' source category, in 2010 the level of GHG emissions, compared the level of emissions registered in the reference year, represented: for CO_2 emissions - circa 21.3 per cent, for CH_4 – 13.3 per cent, for N_2O – 19.6 per cent, for NO_x – 11.9 per cent, for CO – 17.4 per cent, for NMVOC – 17.5 per cent and for SO2 – 8.3 per cent (Table 3-83).

Table 3-83: GHG Emissions from the Category 1A4 'Other Sectors' within 1990-2010 time periods, where 1990 represents 100 per cent

	1990	1991	1992	1993	1994	1995	1996
CO_2	100.0	81.1	56.5	29.0	27.2	28.3	29.5
CH_4	100.0	76.6	36.6	30.3	32.0	21.5	28.5
N_2O	100.0	82.3	51.2	48.1	42.6	38.9	40.7
NO_x	100.0	78.3	52.6	35.2	33.8	37.6	31.7
CO	100.0	75.7	42.4	47.3	43.1	38.7	40.4
NMVOC	100.0	76.7	45.5	49.1	44.6	42.0	41.9
SO_2	100.0	93.2	44.2	24.9	24.6	16.3	20.5

	1997	1998	1999	2000	2001	2002	2003
CO_2	32.5	27.1	23.8	19.5	18.7	22.8	26.7
CH_4	16.5	13.8	13.3	12.9	11.0	13.9	15.6
N_2O	27.3	26.9	23.7	21.9	20.4	23.9	25.7
NO_x	31.4	24.3	18.2	14.6	14.0	16.6	16.5
CO	26.5	25.6	21.9	20.2	18.7	22.0	23.8
NMVOC	28.6	27.2	22.9	20.8	19.4	22.7	23.8
SO_2	14.1	11.2	9.4	8.3	7.3	9.6	12.6
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	29.1	28.5	28.4	21.4	21.5	23.4	21.3
CH_4	12.7	13.5	14.9	11.4	11.7	12.0	13.3
N_2O	22.1	21.8	23.1	19.1	20.0	20.1	19.6
NO_x	15.8	14.5	14.3	11.8	11.7	11.6	11.9
CO	19.7	19.4	20.7	17.0	17.7	17.5	17.4
NMVOC	19.7	19.3	20.6	17.1	17.9	17.5	17.5
SO_2	10.5	10.1	10.6	7.8	7.4	8.1	8.3

In 2010, the 'Other Sectors' source category accounted for 12.7 per cent of din total national direct GHG emissions (without LULUCF), being an important source of direct

GHG emissions. To be noted that this category also represented an important source of CH_4 and N_2O emissions, accounting for 1.2 per cent, respectively 0.4 per cent of total national CH_4 and N_2O emissions.

Within the 1990-2010 time periods, the total direct GHG emissions originated from the 1A4 'Other Sectors' source category tended to lower values, decreasing by 78.9 per cent: from 8037.78 Gg CO_2 equivalent in 1990 to 1692.48 Gg CO_2 equivalent in 2010 (Table 3-84, Figure 3-11).

Compared to 1990, in 2010 the direct GHG emissions originated in 1A4 'Other Sectors' source category accounted for 20.06 per cent: CO_2 – 20.31 per cent, CH_4 – 13.29 per cent, and N_2O – 19.60 per cent. From the total share of GHG emissions within the source category 1A4 "Other sectors" in 2010, 97.72 per cent represented CO2 emissions, 1.92 per cent - CH4, respectively 0.36 per cent represented N_2O emissions (Table 3-85).

The decreasing trend in GHG emissions is characteristic to all sources under the category 1A4 'Other Sectors', within 1990-2010 time period GHG emissions originated from 1A4a decreased by 66.0 per cent; from 1A4b - by 77.4 per cent; and those from 1A4c - by 92.0 per cent (Figure 3-12, Table 3-86).

Table 3-85: GHG Emissions from 1A4 'Other Sectors' Source Category within 1990-2010 time periods, where 1990 represents 100 per cent and the share of direct GHG emissions in the structure of total emissions.

Years	Compared with 1990,%				Share of total GHG emissions, %		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	100.00	100.00	100.00	100.00	96.58	3.04	0.38
1991	81.09	76.57	82.32	80.96	96.73	2.88	0.39
1992	56.54	36.64	51.16	55.91	97.66	1.99	0.35
1993	28.98	30.25	48.08	29.09	96.20	3.16	0.63
1994	27.21	31.98	42.59	27.41	95.86	3.55	0.60
1995	28.26	21.47	38.93	28.10	97.14	2.32	0.53
1996	29.51	28.50	40.73	29.52	96.54	2.94	0.53
1997	32.50	16.48	27.28	31.99	98.11	1.57	0.33
1998	27.12	13.84	26.89	26.71	98.04	1.58	0.39
1999	23.82	13.33	23.66	23.50	97.89	1.73	0.39
2000	19.48	12.88	21.88	19.29	97.53	2.03	0.43
2001	18.70	10.99	20.38	18.47	97.77	1.81	0.42
2002	22.76	13.88	23.95	22.49	97.71	1.88	0.41
2003	26.75	15.58	25.70	26.40	97.83	1.79	0.37
2004	29.14	12.67	22.08	28.61	98.36	1.35	0.30
2005	28.55	13.46	21.83	28.06	98.24	1.46	0.30
2006	28.43	14.94	23.12	28.00	98.06	1.62	0.32
2007	21.44	11.39	19.14	21.13	98.01	1.64	0.35
2008	21.53	11.66	19.97	21.23	97.97	1.67	0.36
2009	23.42	12.00	20.06	23.06	98.08	1.58	0.33
2010	21.31	13.29	19.60	21.06	97.72	1.92	0.36

Table 3-84: Direct GHG Emissions from 1A4 'Other Sectors' in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
CO_2	7762.4898	6294.8303	4388.8608	2249.3719	2112.0567	2193.9896	2290.6492
CH_4	244.4965	187.2196	89.5761	73.9626	78.1965	52.4992	69.6751
N_2O	30.7924	25.3485	15.7541	14.8054	13.1158	11.9887	12.5408
CO_2 equivalent	8037.7787	6507.3984	4494.1909	2338.1399	2203.3690	2258.4776	2372.8651
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	2522.6439	2104.8957	1848.8722	1512.1110	1451.5894	1766.7757	2076.2619
CH_4	40.2923	33.8379	32.5923	31.4895	26.8607	33.9476	38.0861
N_2O	8.3990	8.2803	7.2852	6.7374	6.2752	7.3743	7.9141
CO_2 equivalent	2571.3352	2147.0139	1888.7497	1550.3379	1484.7254	1808.0977	2122.2620
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	2261.9540	2216.1375	2207.0126	1664.5024	1671.5326	1817.8349	1653.9545
CH_4	30.9751	32.9078	36.5362	27.8389	28.5194	29.3410	32.4869
N_2O	6.7982	6.7205	7.1185	5.8951	6.1478	6.1761	6.0357
CO_2 equivalent	2299.7274	2255.7659	2250.6673	1698.2365	1706.1998	1853.3520	1692.4772

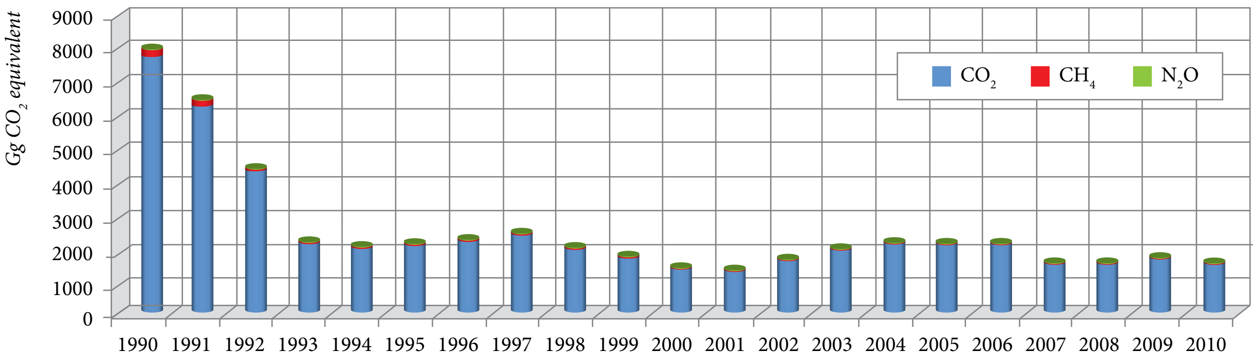


Figure 3-11: GHG Emissions from 1A4 'Other Sectors' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent.

Table 3-86: Direct GHG Emissions from the Category 1A4 'Other Sectors' by Source in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
1A4a 'Commercial / Institutional Sector'	1424.0685	808.9106	380.6989	569.3391	403.6435	395.0255	365.6557
1A4b 'Residential Sector'	4657.3239	3511.6971	2489.8212	1060.5292	1164.6211	1132.1712	1428.2501
1A4c 'Agriculture / Forestry / Fishing Sector'	1956.3862	2186.7907	1623.6708	708.2716	635.1044	731.2809	578.9593
1A4 'Other Sectors'	8037.7787	6507.3984	4494.1909	2338.1399	2203.3690	2258.4776	2372.8651
	1997	1998	1999	2000	2001	2002	2003
1A4a 'Commercial / Institutional Sector'	326.1969	334.8629	263.1959	230.0159	262.1940	451.1369	580.9628
1A4b 'Residential Sector'	1668.2665	1372.0178	1314.8603	1081.0535	990.3885	1098.8397	1303.6011
1A4c 'Agriculture / Forestry / Fishing Sector'	576.8718	440.1331	310.6935	239.2685	232.1429	258.1211	237.6981
1A4 'Other Sectors'	2571.3352	2147.0139	1888.7497	1550.3379	1484.7254	1808.0977	2122.2620
	2004	2005	2006	2007	2008	2009	2010
1A4a 'Commercial / Institutional Sector'	831.4972	710.9191	652.8965	366.2886	371.7121	471.5949	484.6585
1A4b 'Residential Sector'	1252.3923	1361.4120	1419.4916	1179.8472	1185.0593	1242.7960	1050.9161
1A4c 'Agriculture / Forestry / Fishing Sector'	215.8379	183.4348	178.2791	152.1006	149.4284	138.9611	156.9027
1A4 'Other Sectors'	2299.7274	2255.7659	2250.6673	1698.2365	1706.1998	1853.3520	1692.4772

The emissions source having the largest share in the total GHG emissions under category 1A4 'Other Sectors' is 1A4b 'Residential', with a share that varied over the reference period from the minimum of 45.4 per cent in 1993 to a maximum of 69.7 per cent in 2000. Another major emission source is represented by 1A4a 'Commercial/Institutional', with a share varying between 8.5 per cent in 1992 to 36.2 per cent in 2004. The share of 1A4c 'Agriculture/Forestry/Fishing' category varied between 7.5 per cent in 2009 and 36.1 per cent in 1993 (Table 3-87, Figure 3-13).

Table 3-87: Breakdown of the Category 1A4 'Other Sectors' Total GHG Emissions by Source, 1990-2010, %

	1990	1991	1992	1993	1994	1995	1996
1A4a 'Commercial / Institutional Sector'	17.7	12.4	8.5	24.4	18.3	17.5	15.4
1A4b 'Residential Sector'	57.9	54.0	55.4	45.4	52.9	50.1	60.2
1A4c 'Agriculture / Forestry / Fishing Sector'	24.3	33.6	36.1	30.3	28.8	32.4	24.4
	1997	1998	1999	2000	2001	2002	2003
1A4a 'Commercial / Institutional Sector'	12.7	15.6	13.9	14.8	17.7	25.0	27.4
1A4b 'Residential Sector'	64.9	63.9	69.6	69.7	66.7	60.8	61.4
1A4c 'Agriculture / Forestry / Fishing Sector'	22.4	20.5	16.4	15.4	15.6	14.3	11.2
	2004	2005	2006	2007	2008	2009	2010
1A4a 'Commercial / Institutional Sector'	36.2	31.5	29.0	21.6	21.8	25.4	28.6
1A4b 'Residential Sector'	54.5	60.4	63.1	69.5	69.5	67.1	62.1
1A4c 'Agriculture / Forestry / Fishing Sector'	9.4	8.1	7.9	9.0	8.8	7.5	9.3

3.5.2 Methodological Issues, Emission Factors and Activity Data

1A4a 'Commercial / Institutional Sector'

GHG emissions originated from the 1A4a 'Commercial/Institutional' source category were estimated following a Tier 1 methodology (based on activity data on fuel consumption and default emission factors values). EFs used for estimating CO_2 emissions are described in Table 3-11. Default values of EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used to estimate non-CO_2 emissions (Table 3-88).

Activity data related to fuel consumption in commercial and institutional sectors (Table 3-89) are available in the Energy Balances of the RM (see Chapter S.2.1 'Consumed as Fuel or Energy', in columns: "for Commerce" and "for Communal Services"). At the moment, there is available limited information on similar activity data for the territory on the left bank of Dniester River (see also Annex 3-1.1).

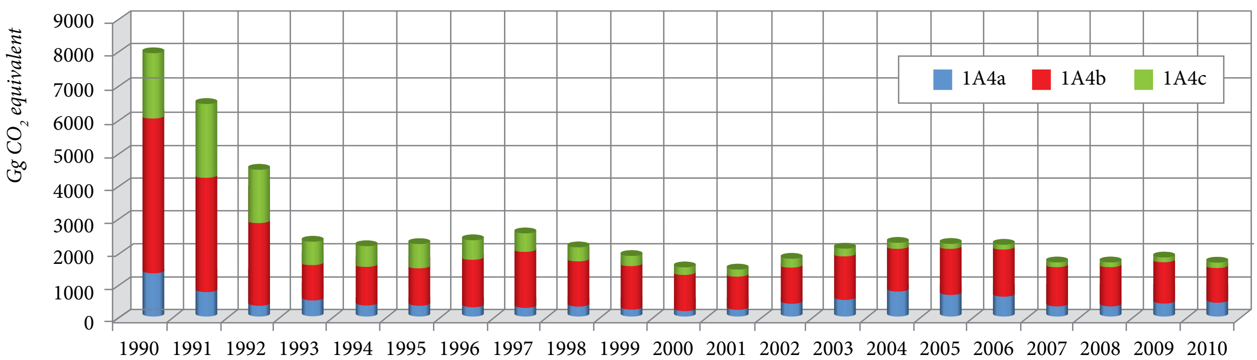


Figure 3-12: Direct GHG Emissions from the Category 1A4 'Other Sectors' by Source in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

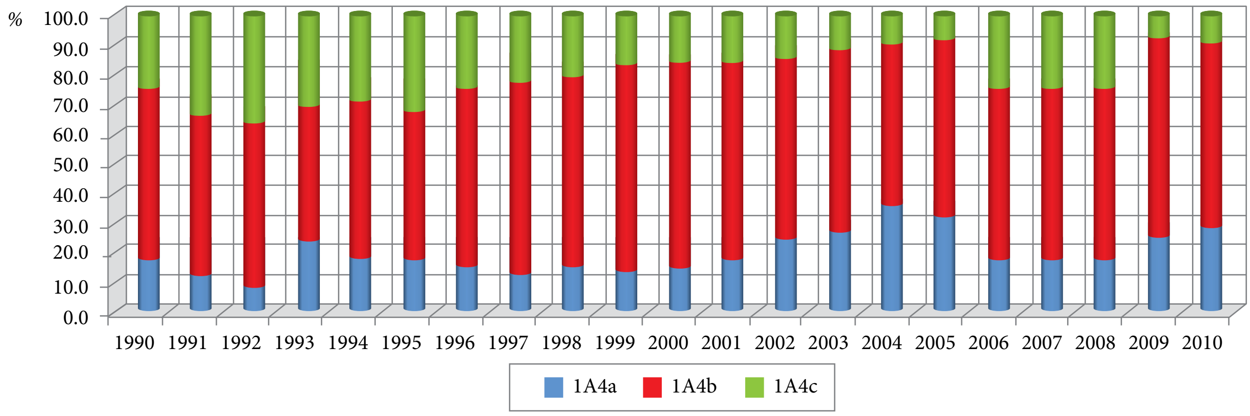


Figure 3-13: Breakdown of the Category 1A4 'Other Sectors' Direct GHG Emissions by Source, within 1990-2010 time periods, %

Table 3-88: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A4a 'Commercial/Institutional' Source Category, kg/TJ

Fuel Type	CH_4	N_2O	NO_x	CO	NMVOC
Coal	10	1.5	100	2000	200
Natural Gas	5	0.1	50	50	5
Oil Products	10	0.6	100	20	5
Fuel Wood	300	4	100	5000	600
Other Biomass	300	4	100	5000	600

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 2, Tab. 2.5, Pages 2.22 - 2.23

Table 3-89: Fuel Consumption under the 1A4a 'Commercial/ Institutional' Source Category in the RM, 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Kerosene, kt	1.0	0.0	0.0	1.1	0.0	0.0	0.0
Diesel Oil, kt	32.0	25.0	15.0	4.9	3.0	2.0	2.0
Residual Oil, kt	21.0	33.0	40.0	12.6	6.0	6.0	5.0
Kerosene, kt	6.0	4.7	10.6	1.0	2.8	1.0	1.0
Anthracite, kt	452.0	178.0	0.0	61.7	27.0	17.0	18.0
Other Bituminous Coal, kt	2.0	31.4	31.6	97.8	94.0	108.0	91.0
Lignite, kt	1.0	1.0	0.0	41.0	30.0	24.0	26.0
Natural Gas, mil. m³	42.0	42.0	51.3	33.8	18.0	17.0	22.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Kerosene, kt	2.0	2.0	4.0	4.0	6.0	2.0	1.0
Diesel Oil, kt	1.0	1.0	1.0	1.0	2.0	1.0	1.0
Residual Oil, kt	2.4	1.3	2.6	4.6	3.2	3.2	1.0
Kerosene, kt	15.0	13.0	13.0	25.0	11.0	27.0	70.0
Anthracite, kt	87.0	98.0	65.0	34.0	52.0	50.0	46.0
Other Bituminous Coal, kt	15.0	13.0	6.0	5.0	4.0	3.0	1.0
Lignite, kt	22.0	18.0	21.7	25.3	35.6	124.8	145.5
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Kerosene, kt	0.0	0.0	0.0	1.0	1.0	0.0	0.0
Diesel Oil, kt	3.0	1.0	1.0	0.0	0.0	0.0	3.0
Residual Oil, kt	1.0	0.0	0.0	0.0	2.0	4.0	1.0
Kerosene, kt	1.0	1.0	0.0	0.0	0.0	0.0	1.0
Anthracite, kt	0.0	0.0	1.0	1.0	1.0	8.0	7.0
Other Bituminous Coal, kt	69.0	55.0	44.0	39.0	31.0	46.0	32.0
Lignite, kt	32.0	30.0	36.0	24.0	27.0	13.0	0.0
Natural Gas, mil. m³	296.1	257.5	235.1	105.4	111.7	149.1	177.7

Source: EBs of the RM, Official Letter from „MOLDOVA GAZ"J.S.C., No. 06-1253 from 27.09.2006 and No. 02/1-476 dated 23.02.2011.

1A4b 'Residential Sector'

GHG emissions originated from the 1A4b 'Residential' source category were estimated following a Tier 1 methodology (based on AD on fuel consumption and default EFs values). EFs used for estimating CO_2 emissions are described in Table 3-11. Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used for estimating non-CO_2 emissions (Table 3-90).

Table 3-90: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A4b 'Residential' Source Category, kg/TJ

Fuel Type	CH_4	N_2O	NO_x	CO	NMVOC
Coal	300	1.5	100	2000	200
Natural Gas	5	0.1	50	50	50
Oil Products	10	0.6	100	20	5
Fuel Wood	300	4	100	5000	600
Other Biomass	300	4	100	5000	600

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 2, Tab. 2.5, Pages 2.22-2.23

For the territory on the right bank of Dniester, activity data related to fuel consumption in residential sector (Table 3-91) are available in the EBs of the RM (see Chapter S.2.1 'Consumed as Fuel or Energy', in column: "Sold to Population"); the amount of 'Diesel Oil' and 'Gasoline' were reallocated to 1A3b 'Road Transportation' source category.

Table 3-91: Fuel Consumption under the 1A4b 'Residential' Source Category, 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Kerosene, kt	10.0	0.0	0.0	0.6	0.0	0.0	0.0
Diesel Oil, kt	28.0	202.0	13.0	0.3	0.0	0.0	0.0
Residual Fuel Oil, kt	0.0	26.5	191.9	0.0	1.0	0.0	0.0
Liquefied Petroleum Gas, kt	125.0	0.0	18.8	28.6	12.0	14.5	17.5
Anthracite, kt	1264.0	200.0	0.0	93.6	136.0	51.0	60.0
Other Bituminous Coal, kt	30.0	384.9	155.7	61.8	118.0	21.0	132.0
Lignite, kt	164.0	441.0	0.0	16.9	3.0	2.0	2.0
Natural Gas, mil. m³	257.0	311.0	704.5	258.3	217.0	448.6	438.0

	1997	1998	1999	2000	2001	2002	2003
Diesel Oil, kt	0.0	0.0	2.0	1.0	0.0	0.0	0.0
Residual Fuel Oil, kt	0.0	0.0	0.0	1.0	0.0	0.0	0.0
Liquefied Fuel Oil, kt	21.4	21.3	25.8	28.0	27.3	42.4	42.5
Anthracite, kt	70.0	17.0	37.0	44.0	28.0	57.0	87.0
Other Bituminous Coal, kt	38.0	24.0	13.0	6.0	0.0	1.0	4.0
Lignite, kt	3.0	0.0	1.0	0.0	1.0	0.0	0.0
Natural Gas, mil. m^3	680.3	617.7	564.4	438.6	426.4	417.4	480.6
	2004	2005	2006	2007	2008	2009	2010
Diesel Oil, kt	0.0	0.0	0.0	0.0	0.0	1.0	0.0
Liquefied Fuel Oil, kt	46.5	45.5	43.4	45.5	43.4	42.6	40.6
Anthracite, kt	67.0	77.0	90.0	51.0	43.0	55.0	83.0
Other Bituminous Coal, kt	3.0	4.0	3.0	3.0	2.0	0.0	0.0
Natural Gas, mil. m^3	478.8	521.8	536.2	464.8	482.0	499.0	364.0

Source: Energy Balances of the RM for 1990, 1993-2010; Yearbooks of the ATULBD 2000 (page 22), 2006 (page 22), 2012 (page 23); Official Letters from „MOLDOVA GAZ"J.S.C., No. 06-1253 dated 27.09.2006 and No. 02/1-476 dated 23.02.2011.

For the territory on the left bank of Dniester, the main data source is the Statistical Yearbooks of the ATULBD (that contain AD regarding Liquefied Petroleum Gases and Natural Gas Consumption in Residential Sector) (see also Annex 3-1.1).

Table 3-92: Fuel Consumption under the 1A4b 'Residential' Source Category for ATULBD within 1995-2010 time periods

	1995	1996	1997	1998	1999	2000	2001	2002
Natural Gas, million m^3	216.6	163.4	354.8	321.6	293.2	217.9*	196.4	175.4
LPG, kt	2.5	2.3	1.4	1.3	0.8	0.5	0.3	0.4
	2003	2004	2005	2006	2007	2008	2009	2010
Natural Gas, million m^3	176.6	162.8	164.8	161.2	150.8	150.0	156.0	174.3
LPG, kt	0.5	0.5	0.5	0.5	0.4486	0.4962	0.3869	0.5798

Source: Statistical Yearbook of the ATULBD 2000 (page 22), 2006 (page 22), 2012 (page 23); *Official Letter from „MOLDOVA GAZ" J.S.C., No. 02/1-476 dated 23.02.2011.

1A4c 'Agriculture / Forestry / Fishing Sectors'

GHG emissions originated from the 1A4c 'Agriculture/Forestry/Fishing' source category were estimated following a Tier 1 methodology (based on the AD regarding fuel consumption and default EFs).

Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used for estimating non-CO_2 emissions (Table 3-93).

Activity data related to fuel consumption in agriculture, forestry and fishing (Table 3-94) are available in the Energy Balances of the RM for the territory on the right bank of Dniester River (see Chapter S.2.1 'Consumed as Fuel or Energy', in column: "for agriculture"; 10 per cent of the Diesel Oil share was reallocated to 1A3b 'Transport' source category, while the rest of 90 per cent – to 1A4c 'mobile combustion' sub-category).

For the territory on the left bank of Dniester River, the main activity data source are the Statistical Yearbooks of the ATULBD (contain AD on consumption of Diesel Oil, Gasoline and Lubricants for agriculture; the amount of Lubricants were reallocated to 1A5 'Other' source category).

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 the 1A4 'Other Sectors' source category, and the quality of activity data available. Uncertainties associated with EFs used to estimate CO_2 emissions from the 1A4 'Other Sectors' source 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 the category 'Other Sectors' in the RM can be considered relatively low (±5 per cent)

Within the 1A4 'Other Sectors' source category GHG emissions uncertainties estimated CO_2 emissions at circa ±7.07 per cent, while CH_4 and N_2O, at about ±50.25 per cent. At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated for CO_2 emissions at ±1.3072 per cent; for CH_4 emissions at ±0.1825 per cent; while for N_2O emissions at ±0.0339 per cent. Uncertainties related to the trend of total direct GHG emissions originated in the Energy Sector were estimated at about ±0.3427 per cent for CO_2 emissions, ±0.0452 per cent for CH_4 emissions and ±0.0031 per cent for N_2O emissions (Annex 5-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period

Table 3-93: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A4c 'Agriculture/Forestry/Fishing' Source Category, kg/TJ

Fuel Type	CH_4	N_2O	NO_x		CO		NMVOC	
			Stationary	Mobile	Stationary	Mobile	Stationary	Mobile
Coal	300	1.5	100		2000		200	
Natural Gas	5	0.1	50	1000	50	400	5	5
Petroleum Products	10	0.6	100	1200	20	1000	5	200
Fuel Wood	300	4	100		5000		600	
Other Biomass	300	4	100		5000		600	

Source: NO_x, CO and NMVOC – Revised 1996 IPCC Guidelines, Vol. 3, Tables 1-9, 1-10 and 1-11, pages 1.37-1.42; for CH_4, N_2O – IPCC 2006 Guidelines, vol. 2, chap. 2, tab. 2.5, pages 2.22-2.23

Table 3-94: Fuel Consumption under the 1A4c 'Agriculture/Forestry/Fishing' Source Category within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Gasoline, kt	7.000	6.400	3.800	1.300	2.000	11.700	11.100
Kerosene, kt	9.000	0.000	0.000	5.700	1.000	0.000	0.000
Diesel Oil (Stationary), kt	27.000	9.600	4.800	6.300	1.000	6.000	3.000
Diesel Oil (Mobile), kt	549.000	396.000	243.000	196.300	190.800	207.673	162.737
Residual Fuel Oil, kt	6.000	25.000	17.000	5.000	0.000	0.000	0.000
Kerosene, kt	1.000	79.500	56.300	0.300	0.000	0.000	0.000
Anthracite, kt	21.000	0.000	0.000	3.800	2.000	1.000	1.000
Other Bituminous Coal, kt	0.000	153.700	150.700	4.800	3.000	2.000	3.000
Lignite, kt	0.000	0.000	0.000	1.400	1.000	1.000	0.000
Natural Gas, mil. m^3	2.000	84.300	108.300	2.000	2.000	5.000	5.000
	1997	1998	1999	2000	2001	2002	2003
Gasoline, kt	11.900	7.800	4.100	2.800	2.700	1.200	1.300
Diesel Oil (Stationary), kt	2.000	6.000	3.000	4.000	5.000	1.000	1.000
Diesel Oil (Mobile), kt	160.000	118.370	84.303	65.858	63.849	76.864	69.841
Residual Fuel Oil, kt	1.000	0.003	0.003	0.003	0.003	0.003	0.003
Anthracite, kt	1.000	0.000	0.000	0.000	0.000	0.000	0.000
Other Bituminous Coal, kt	1.000	2.000	1.000	0.000	0.000	0.000	0.000
Natural Gas, mil. m^3	10.000	9.000	5.000	5.000	3.000	4.000	4.900
	2004	2005	2006	2007	2008	2009	2010
Gasoline, kt	0.800	0.600	0.574	0.398	0.334	0.423	0.660
Diesel Oil (Mobile), kt	62.737	55.255	54.424	47.033	44.951	42.204	47.020
Residual Fuel Oil, kt	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Other Bituminous Coal, kt	0.000	0.000	0.000	0.000	0.015	0.012	0.009
Natural Gas, mil. m^3	7.700	3.400	2.100	1.000	3.100	2.000	3.100

under review, in conformity with the recommendations included in the GPG (IPCC, 2000).

3.5.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective source category under the Energy Sector, following the Tier 1 approach (IPCC, 2000). Also, the AD and methods used for estimating GHG emissions under the category 1A4 'Other Sectors' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures.

Following the recommendations included into the GPG (IPCC, 2000), GHG emissions originated from the 1A4 'Other Sectors' were estimated based on AD and CS NCVs from official sources of information.

3.5.5 Recalculations

GHG emission recalculations performed under the 1A4 'Other Sectors' source category are due to the availability of an updated set of activity data for ATULBD covering the 1995-2005 time period (provided by "Moldova Gaz" J.S.C. regarding the consumption of natural gas within the 1A4a 'Commercial / Institutional' source category from 1999 to 2005; from Statistical Yearbooks of the ATULBD regarding the consumption of natural gas and LPG within 1A4b 'Residential' source category, as well as on consumption of Diesel Oil and Gasoline in agriculture sector – within 1A4c 'Agriculture / Forestry / Fishing' source category). Also, recalculations were performed due to the identification of some mechanical errors related to data entry activities, as for example, in the case of 1995 for 1A4C 'Agriculture / Forestry / Fishing' source category.

In comparison with the results included into the SNC of the RM under the UNFCCC, the performed recalculations under the 1A4 'Other Sectors' source category resulted in increased values of GHG emissions, varying from a minimum 2.6 per cent in 2001, to a maximum of 42.8 per cent in 1999 (Table 3-95).

For 2006-2010 time periods the GHG emissions from 1A4 'Other Sectors' source category were estimated for the first time. The results revealed that between 1990 and 2010, the GHG emissions originated from this sector decreased by 78.9 per cent.

3.5.6 Planned Improvements

Potential improvements within the 1A4 'Other Sectors' source category could be possible while updating the AD on fuel consumption on the territory of ATULBD.

3.6 Other (Category 1A5)

3.6.1 Source Category Description

The 1A5 'Other' source category includes GHG emissions from fuels combustion for other works and needs within the energy sector, including military transport (see the Energy

Table 3-95: Comparative Results of GHG Emissions from 1A4 'Other Sectors' Included into the SNC and TNC of the RM under the UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
SNC	8037.7787	6507.3984	4494.1910	2338.1399	2203.3690	1829.4654	2062.5488
TNC	8037.7787	6507.3984	4494.1909	2338.1399	2203.3690	2258.4776	2372.8651
Difference, %	0.0	0.0	0.0	0.0	0.0	23.5	15.0
	1997	1998	1999	2000	2001	2002	2003
SNC	1901.7010	1538.6060	1322.5374	1122.7639	1447.3310	1639.6999	1956.6592
TNC	2571.3352	2147.0139	1888.7497	1550.3379	1484.7254	1808.0977	2122.2620
Difference, %	35.2	39.5	42.8	38.1	2.6	10.3	8.5
	2004	2005	2006	2007	2008	2009	2010
SNC	1864.5957	1911.1082					
TNC	2299.7274	2255.7659	2250.6673	1698.2365	1706.1998	1853.3520	1692.4772
Difference, %	23.3	18.0					

Balances of the RM, Chapter S.2.1 'Consumed as Fuel or Energy', in column: "for other works and needs").

To be noted as well that the respective source category includes the total amount of lubricants consumed at the national level while the consumption of "oven fuel" was reported together with that of "Diesel Oil".

Between 1990 and 2010, GHG emissions originated from 1A5 'Other' source category registered a decreasing trend (excluding CH_4, CO and SO2 emissions) (Table 3-96).

Table 3-96: GHG Emissions from 1A5 'Other' Source Category within 1990-2010, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2	154.2715	303.3231	240.2766	186.5611	145.7325	172.6731	144.8332
CH_4	0.0064	0.0005	0.0000	0.0054	0.0033	0.0043	0.0043
N_2O	0.0016	0.0024	0.0019	0.0020	0.0014	0.0018	0.0016
NO_x	0.4393	0.7977	0.6244	0.5331	0.4045	0.4813	0.4095
CO	0.1847	0.0462	0.0312	0.1598	0.1096	0.2073	0.2271
NMVOC	0.0195	0.0205	0.0156	0.0203	0.0145	0.0181	0.0162
SO_2	0.7646	2.8710	0.7182	1.2813	1.1562	1.7481	1.1762
	1997	1998	1999	2000	2001	2002	2003
CO_2	135.5091	92.4763	56.2421	60.7510	62.9575	64.1625	117.3137
CH_4	0.0042	0.0023	0.0033	0.0025	0.0031	0.0039	0.0026
N_2O	0.0015	0.0010	0.0008	0.0007	0.0009	0.0009	0.0012
NO_x	0.3818	0.2611	0.1660	0.1746	0.1890	0.1907	0.3209
CO	0.2139	0.1016	0.2791	0.1158	0.1749	0.1717	0.1472
NMVOC	0.0154	0.0098	0.0090	0.0080	0.0091	0.0101	0.0117
SO_2	0.9549	0.4463	0.3077	0.2237	0.2616	0.4051	1.0477
	2004	2005	2006	2007	2008	2009	2010
CO_2	122.5701	118.0475	149.5003	153.1125	161.8454	80.5811	124.4914
CH_4	0.0026	0.0062	0.0079	0.0076	0.0084	0.0043	0.0075
N_2O	0.0012	0.0011	0.0014	0.0014	0.0015	0.0008	0.0013
NO_x	0.3285	0.3166	0.4020	0.4053	0.4329	0.2151	0.3372
CO	0.2146	0.1527	0.1562	0.0964	0.1198	0.1095	0.2246
NMVOC	0.0121	0.0108	0.0141	0.0134	0.0149	0.0073	0.0132
SO_2	0.1865	1.1677	1.6050	1.8870	1.8743	0.8271	1.4976

Compared to the level registered in the reference year, in 2010 the level of GHG emissions from 1A5 'Other' source category accounted in case of CO_2 – for circa 80.7 per cent, CH_4 – 117.2 per cent, N_2O – 82.4 per cent, NO_x – 76.8 per cent, CO – 121.6 per cent, NMVOC – 67.9 per cent, respectively SO2 – 195.9 per cent (Table 3-97).

Table 3-97: GHG Emissions from 1A5 'Other' Source Category within 1990-2010 time periods, where 1990 represents 100 per cent

	1990	1991	1992	1993	1994	1995	1996
CO_2	100.0	196.6	155.7	120.9	94.5	111.9	93.9
CH_4	100.0	7.3	0.0	83.3	51.2	67.7	67.3
N_2O	100.0	152.8	118.2	123.8	86.4	113.7	100.7
NO_x	100.0	181.6	142.1	121.3	92.1	109.5	93.2
CO	100.0	25.0	16.9	86.5	59.3	112.2	122.9
NMVOC	100.0	105.4	80.2	104.0	74.4	92.8	83.2
SO_2	100.0	375.5	93.9	167.6	151.2	228.6	153.8
	1997	1998	1999	2000	2001	2002	2003
CO_2	87.8	59.9	36.5	39.4	40.8	41.6	76.0
CH_4	64.9	36.1	52.1	39.3	47.6	60.0	40.3
N_2O	96.3	62.5	50.5	43.6	54.5	55.9	73.8
NO_x	86.9	59.4	37.8	39.7	43.0	43.4	73.0
CO	115.8	55.0	151.1	62.7	94.7	93.0	79.7
NMVOC	79.4	50.3	46.3	40.9	47.0	51.8	60.0
SO_2	124.9	58.4	40.2	29.3	34.2	53.0	137.0
	2004	2005	2006	2007	2008	2009	2010
CO_2	79.5	76.5	96.9	99.2	104.9	52.2	80.7
CH_4	40.0	95.9	122.7	118.4	130.3	66.2	117.2
N_2O	77.1	69.8	88.6	87.4	94.9	48.6	82.4
NO_x	74.8	72.1	91.5	92.3	98.5	49.0	76.8
CO	116.2	82.7	84.6	52.2	64.9	59.3	121.6
NMVOC	62.1	55.5	72.5	69.0	76.5	37.5	67.9
SO_2	24.4	152.7	209.9	246.8	245.1	108.2	195.9

In 2010, the category 1A5 'Other' accounted for 0.9 per cent of the total national GHG emissions (without LULUCF).

Between 1990 and 2010, CO2 emissions originated from 1A5 'Other' source category has decreased by 19.3 per cent: from 154.90 Gg CO_2 equivalent in 1990 to 125.05 Gg CO_2 equivalent in 2010 (Figure 3-14, Table 3-98).

Compared with reference year level, in 2010 the level of total direct GHG emissions from 1A5 ‚Other' source category accounted circa 80.7 per cent; CO_2 - 80.7 per cent, CH_4 – 117.2 per cent and N_2O – 82.4 per cent (Table 3-99).

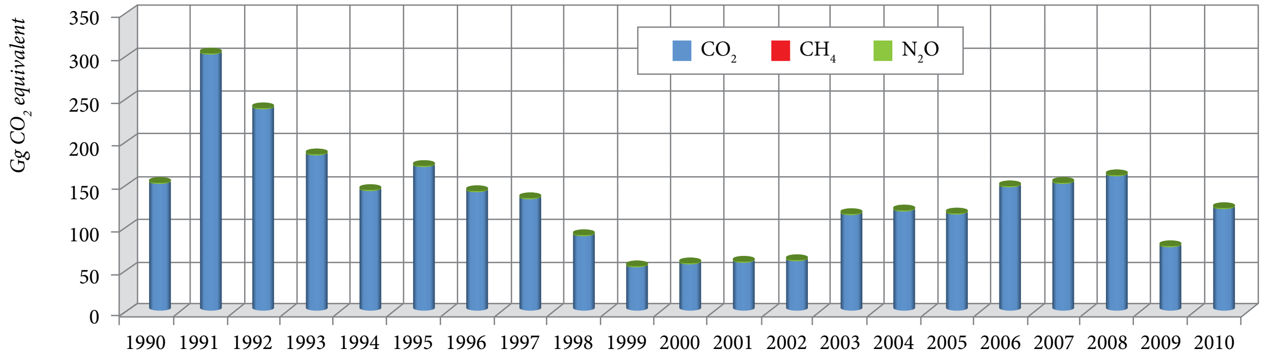


Figure 3-14: Direct GHG Emissions from 1A5 'Other' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

Table 3-98: Direct GHG Emissions from 1A5 'Other' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

Years	Gg CO_2 equivalent				%		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	154.2715	0.1350	0.4911	154.8976	99.60	0.09	0.32
1991	303.3231	0.0098	0.7506	304.0835	99.75	0.00	0.25
1992	240.2766	0.0000	0.5806	240.8572	99.76	0.00	0.24
1993	186.5611	0.1124	0.6080	187.2816	99.62	0.06	0.32
1994	145.7325	0.0691	0.4245	146.2261	99.66	0.05	0.29
1995	172.6731	0.0913	0.5585	173.3229	99.63	0.05	0.32
1996	144.8332	0.0908	0.4944	145.4184	99.60	0.06	0.34
1997	135.5091	0.0877	0.4732	136.0699	99.59	0.06	0.35
1998	92.4763	0.0487	0.3072	92.8322	99.62	0.05	0.33
1999	56.2421	0.0703	0.2480	56.5604	99.44	0.12	0.44
2000	60.7510	0.0530	0.2143	61.0183	99.56	0.09	0.35
2001	62.9575	0.0643	0.2678	63.2896	99.48	0.10	0.42
2002	64.1625	0.0810	0.2746	64.5181	99.45	0.13	0.43
2003	117.3137	0.0544	0.3626	117.7306	99.65	0.05	0.31
2004	122.5701	0.0540	0.3789	123.0030	99.65	0.04	0.31
2005	118.0475	0.1295	0.3426	118.5196	99.60	0.11	0.29
2006	149.5003	0.1657	0.4353	150.1013	99.60	0.11	0.29
2007	153.1125	0.1598	0.4292	153.7016	99.62	0.10	0.28
2008	161.8454	0.1759	0.4661	162.4874	99.60	0.11	0.29
2009	80.5811	0.0894	0.2386	80.9092	99.59	0.11	0.29
2010	124.4914	0.1583	0.4049	125.0546	99.55	0.13	0.32

3.6.2 Methodological Issues, Emission Factors and Activity Data

GHG emissions originated from the 1A5 'Other' source category was estimated following a Tier 1 methodology. EFs used for estimating CO_2 emissions are described in Table 3-11. Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used to estimate non-CO_2 emissions. Since these guidelines do not provide emission factors for 1A5 'Other' source category, coefficients recommended for 1A1 "Energy industry" source category were used (see in Table 3-36).

Activity data pertaining to the fuel consumption within 1A5 'Other' source category were collected from the EBs of the RM for 1990 and 1993-2010, as well as from the Statistical Yearbooks and sectoral statistical publications of ATULBD (Table 3-100).

Table 3-99: Direct GHG Emissions from 1A5 'Other' Source Category in the Republic of Moldova within 1990-2010 time periods, where 1990 represents 100 per cent

Years	CO_2	CH_4	N_2O	Total
1990	100.0	100.0	100.0	100.0
1991	196.6	7.3	152.8	196.3
1992	155.7	0.0	118.2	155.5
1993	120.9	83.3	123.8	120.9
1994	94.5	51.2	86.4	94.4
1995	111.9	67.7	113.7	111.9
1996	93.9	67.3	100.7	93.9
1997	87.8	64.9	96.3	87.8
1998	59.9	36.1	62.5	59.9
1999	36.5	52.1	50.5	36.5
2000	39.4	39.3	43.6	39.4
2001	40.8	47.6	54.5	40.9
2002	41.6	60.0	55.9	41.7
2003	76.0	40.3	73.8	76.0
2004	79.5	40.0	77.1	79.4
2005	76.5	95.9	69.8	76.5
2006	96.9	122.7	88.6	96.9
2007	99.2	118.4	87.4	99.2
2008	104.9	130.3	94.9	104.9
2009	52.2	66.2	48.6	52.2
2010	80.7	117.2	82.4	80.7

3.6.3 Uncertainties Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the source category 1A5 'Other', and quality of activity data available. Uncertainties associated with EFs used to estimate CO_2 emissions from the 1A5 'Other' source category are around ±5 per cent, while those pertaining 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 under other works and needs in the industrial sector of the RM could be considered relatively low (±5 per cent).

Uncertainties pertaining to GHG emissions from the 1A5 'Other' source category were estimated at ±7.07 per cent for CO_2 emissions and at ±50.25 per cent for CH_4 and N_2O emissions. At the same time, combined uncertainties, presented as a per cent of total sectoral GHG emissions were

Table 3-100: Fuel Consumption under the 1A5 'Other' Source Category within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Gasoline, kt	4.000	2.500	1.200	0.900	2.000	2.000	0.000
Kerosene, kt	1.000	0.000	0.000	26.300	1.000	0.000	0.000
Diesel Oil, kt	19.000	15.000	10.000	6.800	2.000	3.000	5.000
Residual Fuel Oil, kt	1.000	6.800	8.700	8.100	12.000	21.000	11.000
LPG, kt	1.000	0.000	0.000	2.700	1.000	3.200	3.600
Bitumen, kt	0.000	34.300	34.000	0.000	0.000	0.000	0.000
Lubricants, kt	0.000	36.000	21.000	0.000	17.000	18.065	17.119
Other Oil Products, kt	0.000	0.000	0.000	1.000	1.000	0.000	2.000
Anthracite, kt	16.000	0.000	0.000	1.900	2.000	3.000	2.000
Other Bituminous Coal, kt	0.000	0.000	0.000	13.200	5.000	5.000	5.000
Lignite, kt	4.000	4.000	0.000	5.900	4.000	4.000	5.000
Natural Gas, million m^3	14.800	0.000	0.000	0.300	6.700	1.200	0.000
Fuel Wood, kt	3.700	0.000	0.000	1.000	2.200	3.700	2.200
Other Biomass, kt	0.000	0.000	0.000	0.800	0.000	1.000	2.000
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Gasoline, kt	1.000	2.000	0.000	0.000	2.000	0.000	1.000
Kerosene, kt	0.000	0.000	1.000	0.000	0.000	0.000	1.000
Diesel Oil, kt	2.000	5.000	0.000	2.000	2.000	2.000	2.000
Residual Fuel Oil, kt	8.000	2.000	1.000	0.000	0.000	1.000	1.000
LPG, kt	1.000	1.000	1.000	1.000	4.000	1.000	1.000
Bitumen, kt	0.000	0.000	0.000	0.000	0.000	0.000	12.000
Lubricants, kt	16.574	12.188	9.133	7.605	7.756	7.615	11.403
Other Oil Products, kt	9.000	4.000	0.000	3.000	1.000	1.000	3.000
Anthracite, kt	2.000	0.000	6.000	0.000	0.000	1.000	0.000
Other Bituminous Coal, kt	4.000	3.000	4.000	3.000	5.000	8.000	5.000
Lignite, kt	5.000	4.000	2.000	2.000	0.000	0.000	0.000
Natural Gas, million m^3	0.000	0.000	2.000	5.000	0.600	1.000	2.000
Fuel Wood, kt	4.400	2.900	0.700	3.700	3.700	2.900	2.190
Other Biomass, kt	1.000	0.000	4.000	0.000	1.000	1.000	1.000
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Gasoline, kt	0.000	0.000	2.000	1.000	1.000	1.000	1.000
Kerosene, kt	1.000	1.000	0.000	0.000	0.000	0.000	1.000
Diesel Oil, kt	5.000	3.000	3.000	4.000	4.000	2.000	1.000
Residual Fuel Oil, kt	0.000	1.000	0.000	1.000	2.000	2.000	0.000
LPG, kt	0.000	2.000	1.000	1.000	1.000	0.000	2.000
Bitumen, kt	17.000	16.000	22.000	26.000	24.000	10.000	21.000
Lubricants, kt	11.316	10.220	12.148	9.153	11.790	9.107	8.194
Other Oil Products, kt	1.000	1.000	0.000	0.000	0.000	0.000	0.000
Anthracite, kt	1.000	1.000	1.000	5.000	2.000	1.000	1.000
Other Bituminous Coal, kt	1.000	0.000	5.000	1.000	5.000	0.000	4.000
Lignite, kt	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural Gas, million m^3	3.000	4.000	4.000	2.000	3.000	1.000	2.000
Fuel Wood, kt	2.920	2.920	2.190	2.190	2.920	1.460	0.000
Other Biomass, kt	2.000	1.000	1.000	0.000	0.000	1.000	0.000

estimated at ±0.0984 per cent for CO_2 emissions, ±0.0009 per cent for CH_4 emissions, and ±0.0023 per cent for N_2O. Uncertainties introduced in trend in sectoral GHG emissions were estimated at ±0.0283 per cent for CO_2 emissions, at ±0.0002 per cent for CH_4 emissions, and at ±0.0004 per cent for N_2O emissions (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 GPG (IPCC, 2000).

3.6.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for 1A5 'Other' source category, following the Tier 1 approach (IPCC, 2000). Also, the AD and methods used for estimating GHG emissions under this category were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures.

Following the recommendations included into the GPG (IPCC, 2000), GHG emissions originated from the 1A5 'Other' were estimated based on AD and EFs from official sources of reference.

3.6.5 Recalculations

GHG emission recalculations were performed under the 1A5 'Other' source category only for 2000, due to the identification of a data entry error. In comparison with the results included into the SNC of the RM under the UNFCCC, the performed changes for 2000 resulted in an increase of direct GHG emissions by 18.5 per cent (Table 3-101).

For 2006-2010 time periods the GHG emissions from 1A5 'Other' source category were estimated for the first time. The results revealed that between 1990 and 2010, the GHG emissions originated from this sector decreased by 19.3 per cent.

3.6.6 Planned Improvements

For the next inventory cycle, potential improvements in source category 1A5 'Other' are unlikely.

Table 3-101: Comparative Results of GHG Emissions from 1A5 'Other' Source Category Included in the SNC and TNC of the RM under the UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
SNC	154.8976	304.0835	240.8572	187.2816	146.2261	173.3229	145.4184
TNC	154.8976	304.0835	240.8572	187.2816	146.2261	173.3229	145.4184
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	136.0699	92.8322	56.5604	51.5118	63.2896	64.5181	117.7306
TNC	136.0699	92.8322	56.5604	61.0183	63.2896	64.5181	117.7306
Difference, %	0.0	0.0	0.0	18.5	0.0	0.0	0.0
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	123.0030	118.5196					
TNC	123.0030	118.5196	150.1013	153.7016	162.4874	80.9092	125.0546
Difference, %	0.0	0.0					

3.7 Fugitive Emissions from Oil and Natural Gas (Category1B2)

'Oil Exploration'

Between 1957-1964, in the southern part of the country, nearby Valeni village and Beleu Lake, 40 oil wells were drilled at 400 m depth. The amount of oil extracted from 27 wells was insignificant so, in 1973 the works stopped and the oil wells were preserved. More recently, the lake Beleu became part of 'Prutul de Jos' scientific reservation.

On July 6, 1995 the Government of the Republic of Moldova has signed a 20 years concession agreement with an American company Redeco LTD regarding the research and exploration of natural gas and oil resources in the Republic of Moldova. The works started in 1997. Though about 10 million US$ were invested between 1995-1998 years, there were no palpable results.

Since 2003, AS Petrol of the RM joined to the Redeco LTD business. Between 2003-2004 time periods, 5 of the old oil wells were reopened and 5 new wells were drilled (at this moment, 10 oil wells are servicing).

The oil exploration in Valeni village, Cahul district is refined at Comrat refinery (set into exploitation on July 15, 2005) which has a capacity of 30 kt per year (this refinery produces diesel oil, residual fuel oil, lubricants, as well as bitumen and bitumen for road construction).

By the end of 2006, Valiexchimp LTD Company became the main partner of Redeco LTD group. In 2007, Valiexchimp LTD founded a joint venture with the Irish 'Island Oil&Gaz plc', starting together a joint investment program in oil and natural gas exloration and refining, estimated at 12 million euro.

On October 10th, 2007 the Government accepted Redeco LTD's leasing concession to Valiexchimp LTD on all rights and obligations under the Concession Agreement for research and exploration of oil and natural gas reserves in the Republic of Moldova as of July 6th, 1995.

According to information provided by the Institute of Ecology and Geography of the ASM, the specific density of the oil extracted in Valeni is 941 kg/m3, while its retail price is approximately equal to residual fuel oil price (in 2004 it was sold at a price of 140 US$/ton).

During 2003-2011, the annual oil production in the RM has not exceeded 17 kilotons per year (Table 3-102).

Table 3-102: Oil Exploration in the RM within the 2003-2011 time periods

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Conventional Oil, kt	1	8	5	4	8	15	17	11	13

Source: Energy Balances of the RM for 2004-2011.

The estimated amount of oil reserves in Valeni is circa 2-3 million tons, of which about 1.0 million tons are available reserves.

Natural Gas Exploration

During 1945-1972, about 700 wells were drilled to depths up to 3000 meters in order to identify fossil fuel resources. Natural gas reserves have been identified nearby Victorovca village, Cantemir district.

Natural gas reserves at a depth of 400 meters are estimated at about 70-90 million m^3, at a depth of 600 meters - at about 0.7-1.2 billion m^3, while at a depth of 4 km at about 7-10 billion m^3. Natural gas extracted from respective reserves at Victorovca filed is of good quality, containing about 86-92% methane.

The Government of the RM has allocated an area of 6.3 thousand km2 to Valiexchimp LTD for geological exploration works.

During 2004-2010, from the 6 wells in service at a depth of 400 meters, up to 250,000 m^3 were extracted annually (potentially, the amount of natural gas that could be explored annually represents about 1.8-3.0 million m^3).

The natural gas explored at Victorovca field is supplied to the following settlements: Ciobaclia, Suhat, Baimaclia, Flocoasa and Victorovca (around 700 households are supplied in total) and it is planned to supply natural gas to other 3 settlements in the South of the RM. In this respect, "Moldova Gaz" J.S.C. is expected to finish the construction of 9 km of gas pipelines to connect the Victorovca field to its distribution network.

'Natural Gas Transportation and Distribution'

At the moment, the most used type of fuel in the Republic of Moldova is natural gas. This type of fuel has been used in the RM since 1966, being 100 per cent imported from Russian Federation through the gas pipeline system. The main operator on the natural gas market in the country is the Moldovan-Russian joint venture "MOLDOVAGAZ".

The infrastructure of the 'Natural Gas Supply Sector' currently includes: high and medium pressure main gas pipelines (circa 656.24 km), high and medium pressure connection gas pipelines – circa 818.20 km, medium and low pressure gas distribution pipelines – circa 19502.59 km, 5 transported gas compression and metering stations and 65 gas distribution stations

Two main gas pipelines systems cross the territory of the Republic of Moldova, in the North: the Ananiev – Cernauti –Bogorodciani gas pipeline (transit capacity: 8.7 billion m3/year); in the South: Sebelinka – Dneproppetrovsk – Krivoi Rog – Ismail and Razdelnaia – Ismail gas pipeline (total transit capacity: 15.8 billion m3/year) and Ananiev – Tiraspol – Ismail gas pipeline (transit capacity: 20.0 billion m3/year).

The total capacity of the gas transit system towards the Balkans is around 43 billion m^3/year, however it is currently used at a capacity of only circa 25 billion m^3/year. Connection gas pipelines and gas distribution stations situated on the territory of the RM allow deliver around 9 billion m^3/year to the consumers in the RM, while real consumption at present is around 2.5-3.0 billion m^3/year.

Table 3-103: LPG Imports in the RM within 2002-2012 time periods

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Liquefied Petroleum Gases, kt	47.900	56.200	52.600	53.500	50.200	50.500	60.100	60.500	66.773	78.142	70.790

Source: Activity Reports of National Energy Regulatory Agency of Moldova for 2008-2012.

'Liquefied Petroleum Gases'

LPG is used in the RM starting 1946, and is currently sold to settlements not connected to gas networks (specific density of the sold LPG is around 584 kg/m^3). LPG is refined and supplied to consumers through filling stations having a total storage capacity of 6.9 thousand m^3.

Information regarding the LPG consumption is available from two alternative sources: the Energy Balances of the RM, Official Letters from "Moldova Gaz" J.S.C., as well as from the Annual Reports of National Energy Regulatory Agency of the Republic of Moldova (Table 3-103).

In the previous inventory cycle activity data provided by "Moldova Gaz" J.S.C. were used (in 1990-1998 the share of this company in the import of liquefied gas in the RM exceeded 90% of the total), while in the current inventory cycle, there were used the activity data available in the Energy Balances of the RM (Table 3-104), since it is considered to be complete and take into consideration the quantities provided by all companies which import LPG in the RM.

Table 3-104: LPG Consumption in the RM within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Liquefied Petroleum Gases, kt	146.0	128.0	75.4	39.9	19.0	19.0	22.0
	1997	1998	1999	2000	2001	2002	2003
Liquefied Petroleum Gases, kt	26.0	25.0	31.0	35.0	47.0	48.0	50.0
	2004	2005	2006	2007	2008	2009	2010
Liquefied Petroleum Gases, kt	52.0	53.0	50.0	53.0	55.0	60.0	64.0

Source: EBs of the RM for 1990, 1993-2010; Official Letter from "Moldova Gaz" J.S.C. No. 02-156 dated 06.02.2004, for 1991-1992 years.

3.7.1 Source Category Description

The 1B2b 'Fugitive Emissions from Oil and Natural Gas' category includes the GHG emissions originated 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.).

Between 1990 and 2010, GHG emissions originated from the 1B2 'Fugitive Emissions from Oil and Natural Gas' source category tended to show lower values (other GHGs revealed an increasing trend comparing with 1990 year) (Table 3-105).

Table 3-105: GHG Emissions within 1B2 'Fugitive Emissions from Oil and Natural Gas' Source Category within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2	0.6377	0.6140	0.5175	0.4382	0.4085	0.4158	0.4680
CH_4	32.4902	30.4924	27.6036	24.8030	23.8714	26.4555	28.7555
N_2O	1.0E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NMVOC	0.5817	0.5438	0.4931	0.4437	0.4269	0.4761	0.5160
	1997	1998	1999	2000	2001	2002	2003
CO_2	1.1056	1.0691	1.0225	1.0007	1.0554	1.0428	1.1010
CH_4	23.6674	22.1502	22.0978	23.9235	23.7671	25.7726	27.2507
N_2O	5.0E-06	5.0E-06	5.0E-06	5.0E-06	5.0E-06	5.0E-06	5.0E-06
NMVOC	0.4183	0.3923	0.3950	0.4321	0.4269	0.4672	0.5255
	2004	2005	2006	2007	2008	2009	2010
CO_2	1.8405	1.9206	1.4322	1.6702	2.0480	2.1505	1.8608
CH_4	29.3202	31.3513	27.3237	29.0502	28.8930	23.9117	23.1990
N_2O	1.6E-05	1.7E-05	9.0E-06	1.3E-05	1.8E-05	2.0E-05	1.5E-05
NMVOC	1.0973	1.1781	0.6713	0.8628	1.1402	1.1245	0.8833

In 2010, the source category 1B2 'Fugitive Emissions from Oil and Natural Gas' accounted for 3.7 per cent of total national greenhouse gas emissions (excluding LULUCF).

Over the period under review, GHG emissions covered by the 1B2 'Fugitive Emissions from Oil and Natural Gas' source category tended to show lower values, decreasing by 28.4 per cent: from 682.93 Gg CO_2 eq. in 1990 up to 489.05 Gg CO_2 eq. in 2010 (Table 3-106, Figure 3-15).

Table 3-106: Direct GHG Emissions from 1B2 'Fugitive Emissions from Oil and Natural Gas' in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

Years	Gg CO_2 equivalent				%		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	0.6377	682.2942	0.0002	682.9320	0.09	99.91	0.00
1991	0.6140	640.3404	0.0001	640.9545	0.10	99.90	0.00
1992	0.5175	579.6756	0.0001	580.1931	0.09	99.91	0.00
1993	0.4382	520.8630	0.0000	521.3013	0.08	99.92	0.00
1993	0.4085	501.2999	0.0000	501.7084	0.08	99.92	0.00
1994	0.4158	555.5660	0.0000	555.9818	0.07	99.93	0.00
1995	0.4680	603.8655	0.0000	604.3335	0.08	99.92	0.00
1997	1.1056	497.0149	0.0015	498.1220	0.22	99.78	0.00
1996	1.0691	465.1532	0.0015	466.2238	0.23	99.77	0.00
1997	1.0225	464.0533	0.0015	465.0773	0.22	99.78	0.00
1998	1.0240	502.3930	0.0015	503.4185	0.20	99.80	0.00
2001	1.0554	499.1097	0.0015	500.1666	0.21	99.79	0.00
1999	1.0428	541.2252	0.0015	542.2695	0.19	99.81	0.00
2000	1.1010	572.2646	0.0017	573.3672	0.19	99.81	0.00
2001	1.8405	615.7241	0.0050	617.5696	0.30	99.70	0.00
2005	1.9206	658.3782	0.0053	660.3041	0.29	99.71	0.00
2002	1.4322	573.7970	0.0029	575.2321	0.25	99.75	0.00
2003	1.6702	610.0534	0.0039	611.7275	0.27	99.73	0.00
2004	2.0480	606.7529	0.0056	608.8065	0.34	99.66	0.00
2009	2.1505	502.1456	0.0061	504.3022	0.43	99.57	0.00
2010	1.8608	487.1800	0.0047	489.0456	0.38	99.62	0.00

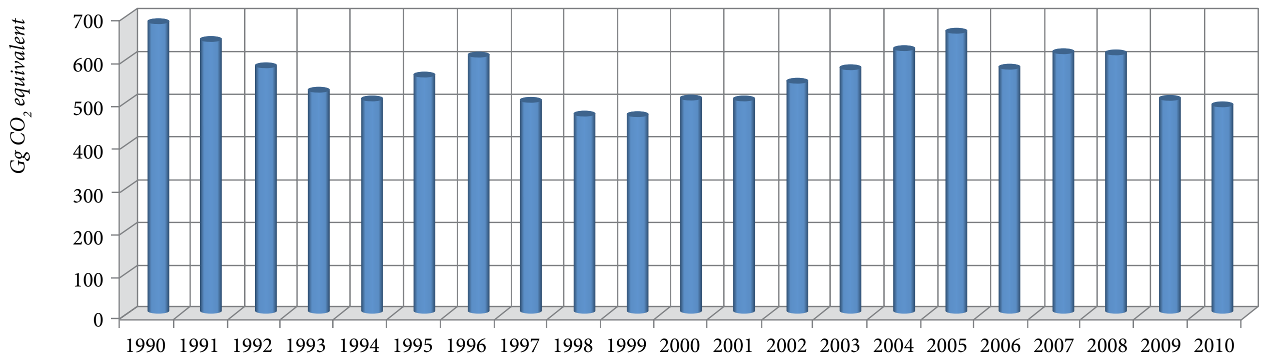


Figure 3-15: GHG Emissions from 1B2 'Fugitive Emissions from Oil and Natural Gas' Source Category in the Republic of Moldova within 1990-2010 time periods

3.7.2 Methodological Issues, Emission Factors and Data Sources

GHG emissions originated from the 1B2 'Fugitive Emissions from Oil and Natural Gas' category were estimated following a Tier 1 methodology (IPCC, 2006). Fugitive emissions of CH_4, N_2O CO_2 and NMVOC were monitored.

The basic equations used to estimate GHG emissions under this category are:

$$E_{gas,\ industry\ segment} = A_{industry\ segment} \bullet EF_{gas,\ industry\ segment}$$

$$E_{gas} = \Sigma E_{gas,\ industry\ segment}$$

Where:

$E_{gas,\ industry\ segment}$ – annual emissions (Gg);

$A_{industry\ segment}$ – activity data for the respective industry segment;

$EF_{gas,\ industry\ segment}$ – emission factor (Gg/activity unit).

Default EF values were used to estimate GHG emission according to 2006 IPCC Guidelines (Table 3-107).

Activity data related to amounts of natural gas transited across the Republic of Moldova, as well as data about amounts of natural gas sold in the Republic of Moldova were provided by the "MOLDOVA GAZ" J.S.C.

Table 3-107: Default EF Values Used to Estimate GHG emissions from 1B2 'Fugitive Emissions from Oil and Natural Gas' in the RM

Category	IPCC Code	CH_4	CO_2	COVNM	N_2O	UM	Source: 2006 IPCC Guidelines, Vol. 2, Ch. 4
		Ranges and Average for EFs Values Used					
Well drilling	1B2a	33-560 **296.5**	100-1700 **900**	0.87-15.0 **7.935**	-	kg/well/year	Page 4.55
Well testing	1B2a	51-850 **450.5**	9000-150000 **79500**	12-200 **106**	0.068-1.1 **0.584**	kg/well/year	Page 4.55
Well servicing	1B2a	110-1800 **955**	1.9-32.0 **17.0**	17-2800 **1408.5**	-	kg/well/year	Page 4.55
Fugitives from oil production	1B2a	2-60000 **30000**	0.1-4300 **2150**	1.8-75000 **37500.9**	-	kg/10^3m^3/year	
Fugitives from natural gas production	1B2b	380-24000 **12190**	14-180 **97**	91-1200 **645.5**	-	kg/10^6m^3/year	Page 4.55
Fugitives from natural gas transportation	1B2b	166-1100 **633**	0.88-2.00 **1.44**	7.0-16.0 **11.5**	-	kg/10^6m^3/year	Page 4.57
Fugitives from natural gas distribution	1B2b	1100-2500 **1800**	51-140 **95.5**	16-36 **26**	-	kg/10^6m^3/year	
Fugitives from liquefied petroleum gas transportation	1B2b	-	430	-	0.0022	kg/10^3m^3/year	Page 4.57
Flaring at natural gas production	1B2c	0.76-1.00 **0.88**	1200-1600 **1400**	0.62-0.85 **0.74**	0.021-0.029 **0.025**	kg/10^6m^3/year	Page 4.55
Ventilation at natural gas transportation	1B2c	44-740 **392**	3.1-7.3 **5.2**	4.6-11.0 **7.8**	-	kg/10^6m^3/year	page 4.57
Ventilation at oil extraction	1B2c	720-990 **855**	95-130 **112.5**	430-590 **510**	-	kg/10^3m^3/year	Page 4.58
Flaring at oil production	1B2c	25-34 **30**	41000-56000 **48500**	21-29 **25**	0.64-0.88 **0.76**	kg/10^3m^3/year	Page 4.58
Oil transportation in tanks	1B2c	25	2.3	250	-	kg/10^3m^3/year	Page 4.61

Activity data related to the exploration of oil and natural gas are available in the Energy Balances of the Republic of Moldova.

In order to be able fill in the calculation worksheets (see the Non-Annex I National Greenhouse Gas Inventory Software, Version 1.3.2), it is necessary to add in the worksheet 1-7s1-4 other measurement units (for oil and LPG in thousand m3, for natural gas in million m3) than those that are available in Energy Balances (oil and liquefied gas in kilotons and natural gas in TJ).

For converting the activity data in the units recommended by the 2006 IPCC Guidelines there were used the following conversion factors: the density of oil extracted in Valeni is 0.941 tons/m3, liquefied gas density is 0.584 tons/m3; the conversion factor of natural gas from TJ in million m3 represents 0.0295 (1/33.86).

Below are provided the activity data used to calculate the GHG emissions originated from the source category 1B2 'Fugitive Emissions from Oil and Natural Gas" in the RM in 1990-2010 time periods (Tables 3-108 and 3-109).

Table 3-108: AD used to estimate GHG Emissions originated from 1B2 'Fugitive Emissions from Oil and Natural Gas' Source Category in the RM within 1990-2010 time periods

		1990	1991	1992	1993	1994	1995	1996
LPG consumption	kt	146.000	128.000	75.400	39.900	19.000	19.000	22.000
	thousand m³	250.000	219.178	129.110	68.322	32.534	32.534	37.671
		1997	1998	1999	2000	2001	2002	2003
Oil exploration	kt	0.000	0.000	0.000	0.000	0.000	0.000	1.000
	thousand m³	0.000	0.000	0.000	0.000	0.000	0.000	1.063
LPG consumption	kt	26.000	25.000	31.000	35.000	47.000	48.000	50.000
	thousand m³	44.521	42.808	53.082	59.932	80.479	82.192	85.616
		2004	2005	2006	2007	2008	2009	2010
Oil exploration	kt	8.000	5.000	4.000	8.000	15.000	17.000	11.000
	thousand m³	8.502	5.313	4.251	8.502	15.940	18.066	11.690
Natural gas exploration	TJ	8.000	8.000	5.000	4.000	5.000	8.000	3.000
	million m³	0.236	0.236	0.148	0.118	0.148	0.236	0.089
LPG consumption	kt	52.000	53.000	50.000	53.000	55.000	60.000	64.000
	thousand m³	89.041	90.753	85.616	90.753	94.178	102.740	109.589

Table 3-109: Natural Gas Transited, Imported and Consumed in the RM within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Natural Gas Transited, billion m³	25.000	23.000	21.000	19.000	18.265	20.909	22.396
Imported Natural Gas, million m³	3844.0	3873.0	3435.0	3093.0	3012.0	3005.0	3489.0
Technological Losses, million m³, including:	30.0	30.0	58.0	133.0	151.0	214.0	267.0
in distribution networks	NA	NA	NA	NA	52.0	71.0	112.0
in main networks	NA	NA	NA	NA	98.0	143.0	155.0
Natural Gas sold in the RM, million m³	3814.0	3843.0	3377.0	2960.0	2861.0	2791.0	3222.0
On the right bank of the Dniester, million m³	NA	NA	NA	NA	1729.0	1558.0	1770.0
On the left bank of Dniester, million m³	NA	NA	NA	NA	1132.0	1233.0	1452.0
	1997	1998	1999	2000	2001	2002	2003
Natural Gas Transited, billion m³	16.934	16.021	17.142	19.365	18.625	21.332	22.132
Imported Natural Gas, million m³	3676.0	3333.0	2856.8	2477.5	2732.1	2419.8	2614.6
Technological Losses, million m³, including:	184.0	164.0	154.7	116.9	90.1	92.6	103.3
in distribution networks	68.0	107.0	102.5	79.4	72.8	65.5	66.1
in main networks	116.0	58.0	52.2	37.5	17.3	27.0	37.2
Natural Gas sold in the RM, million m³	3492.0	3169.0	2685.3	2320.2	2628.0	2231.6	2405.4
On the right bank of the Dniester, million m³	1883.0	1700.0	1219.8	918.3	1055.7	1050.6	1129.9
On the left bank of Dniester, million m³	1609.0	1469.0	1465.5	1401.9	1572.3	1181.0	1275.5
	2004	2005	2006	2007	2008	2009	2010
Natural Gas Transited, billion m³	23.873	25.313	22.339	23.693	23.290	17.891	17.034
Imported Natural Gas, million m³	2687.2	2819.2	2472.3	2714.7	2725.5	2979.4	3176.2
Technological Losses, million m³, including:	73.3	102.8	94.0	96.2	94.7	93.9	98.6
in distribution networks	52.9	54.2	55.6	54.5	55.5	55.7	57.9
in main networks	20.4	48.6	38.4	41.7	39.2	38.2	40.7
Natural Gas sold in the RM, million m³	2565.7	2715.6	2376.2	2489.9	2505.0	2775.0	2970.9
On the right bank of the Dniester, million m³	1141.5	1314.9	1322.0	1208.0	1130.8	1029.9	1089.8
On the left bank of Dniester, million m³	1424.2	1400.7	1054.2	1281.9	1374.2	1745.1	1881.1

Source: Official Letter from "Moldova Gaz" J.S.C. No. 06-1253 dated 27.09.2006 and No. 02/1476 dated 23.02.2011.

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 source category 1B2 'Fugitive Emissions from Oil and Natural Gas', and quality of available activity data.

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 industrial sector is up to ±25 per cent. The uncertainties related to GHG emissions covered by the 1B2 'Fugitive Emissions from Oil and Natural Gas' source category were estimated at ±35.36 per cent. At the same time, the combined uncertainties presented as a per cent of total sectoral emissions were estimated at ±0.0074 per cent for CO_2 emissions and ±1.9253 per cent for CH_4 emissions. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.0023 per cent for CO_2 emissions and ±0.5472 per cent for CH_4 emissions (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 GPG (IPCC, 2000).

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 (IPCC, 2000).

The AD and methods used for estimating GHG emissions under this category were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures.

Following the recommendations included into the GPG (IPCC, 2000), GHG emissions originated from the 1A4 'Other Sectors' were estimated based on AD and CS NCVs from official sources of information.

3.7.5 Recalculations

GHG emission recalculations performed under the 1B2 'Fugitive Emissions from Oil and Natural Gas' source category are due to the availability of an updated set of activity data for oil and natural gas exploration in the RM covering the 2000-2005 time periods.

In comparison with the results included into the SNC of the RM under the UNFCCC, the performed recalculations resulted in an insignificant increase of direct GHG emissions, varying from a minimum 0.005 per cent in 2000, to a maximum of 0.98 per cent in 2005 (Table 3-110).

3.7.6 Planned Improvements

Potential improvements within the 1B2 'Fugitive Emissions from Oil and Natural Gas' could be possible regarding the availability of new data related to 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 for the final consumers; from equipment functioning, evaporation and flashing losses, flaring, accidental releases from pipeline dig-ins etc.)

3.8 International Aviation (Memo Items)

3.8.1 Source Category Description

GHG emissions from 'International Bunkers: Aviation' source category (Memo Items) comes from the combustion of jet fuel used in the international air transport (in case of aircrafts which operates international flights, emissions are allocated to the country in which the aircraft was fueled). In the Republic of Moldova, international air transport includes jet propelled aircrafts using jet kerosene and aviation gasoline.

The largest share in the total GHG emissions from international aviation is covered by CO_2 (70 per cent), less than 30 per cent of the total emissions is covered by water vapors and as little as circa 1 per cent by other gases (NO_x, CO, NMVOC and SO_2). The share of methane and nitrous oxide

Table 3-110: Comparative Results of GHG Emissions from 1B2 Source Category Included in the SNC and TNC of the RM under the UNFCCC, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996
SNC	682.9320	640.9545	580.1931	521.3013	501.7084	555.9818	604.3335
TNC	682.9320	640.9545	580.1931	521.3013	501.7084	555.9818	604.3335
Difference, %	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1997	1998	1999	2000	2001	2002	2003
SNC	498.1220	466.2238	465.0773	503.3952	500.1342	542.2362	573.3318
TNC	498.1220	466.2238	465.0773	503.4185	500.1666	542.2695	573.3672
Difference, %	0.000	0.000	0.000	0.005	0.006	0.006	0.006
	2004	2005	2006	2007	2008	2009	2010
SNC	617.5333	653.8950					
TNC	617.5696	660.3041	575.2321	611.7275	608.8065	504.3022	489.0456
Difference, %	0.006	0.980					

emissions is insignificant (it is considered that modern engines emit little or no CH_4, in particular, during the cruise cycle) (IPCC, 2006).

Operation of aircrafts is divided into two phases: (i) *Landing/Take-Off (LTO)* occurring at altitudes lower than 914 meters and (ii) *Cruise* (C), occurring at altitudes higher than 914 meters. Generally, about 10 per cent of all type aircraft emissions are produced during airport ground level operations and during the LTO (landing/take-off) phase of the flight, while the bulk of aircraft emissions (90 per cent) occur at higher altitudes. For NMVOC and CO, the split is closer to 30 per cent for LTO phase of the flight and 70 per cent for cruise phase of the flight.

Between the 1990 and 2010, GHG emissions covered from the 'International Bunkers: Aviation' have a decreasing trend (Table 3-111).

Table 3-111: GHG Emissions from 'International Bunkers: Aviation' Source Category within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2	217.3668	232.8115	96.2635	62.0927	37.8235	41.9185	65.8650
CH_4	0.0430	0.0487	0.0189	0.0099	0.0058	0.0060	0.0048
N_2O	0.0070	0.0074	0.0031	0.0020	0.0012	0.0013	0.0021
NO_x	0.7949	0.8447	0.3512	0.2331	0.1433	0.1573	0.2556
CO	0.8733	0.9641	0.3847	0.2215	0.1323	0.1413	0.1687
NMVOC	0.5202	0.5792	0.2288	0.1293	0.0766	0.0820	0.0901
SO_2	0.0689	0.0738	0.0305	0.0197	0.0120	0.0133	0.0209
	1997	1998	1999	2000	2001	2002	2003
CO_2	75.6443	72.4974	72.4938	66.1989	61.9061	62.0776	73.5472
CH_4	0.0055	0.0046	0.0044	0.0041	0.0041	0.0039	0.0039
N_2O	0.0024	0.0023	0.0022	0.0021	0.0021	0.0021	0.0025
NO_x	0.2921	0.2802	0.2641	0.2528	0.2253	0.2401	0.2837
CO	0.1965	0.1828	0.1693	0.1657	0.1718	0.1719	0.1957
NMVOC	0.1020	0.0919	0.0862	0.0818	0.0727	0.0677	0.0736
SO_2	0.0240	0.0230	0.0213	0.0210	0.0188	0.0197	0.0233
	2004	2005	2006	2007	2008	2009	2010
CO_2	70.7060	67.6961	75.9977	79.9382	89.3145	82.6447	82.7287
CH_4	0.0040	0.0038	0.0045	0.0029	0.0018	0.0030	0.0028
N_2O	0.0024	0.0024	0.0026	0.0027	0.0030	0.0028	0.0028
NO_x	0.2773	0.2608	0.3029	0.3261	0.3677	0.3397	0.3427
CO	0.2022	0.2005	0.2160	0.1974	0.1904	0.1939	0.1983
NMVOC	0.0654	0.0592	0.0676	0.0664	0.0713	0.0754	0.0701
SO_2	0.0224	0.0214	0.0241	14.9301	0.0283	0.0262	0.0262

In comparison with the reference year level, in 2010 the GHG emissions from 'International Bunkers: Aviation' source category represented: for CO_2 - 38.1 per cent, for CH_4 - 6.6 per cent, for N_2O - 39.8 per cent, for NO_x - 43.1 per cent, for CO - 22.7 per cent, for NMVOC - 13.5 per cent and for SO_2 - 38.0 per cent (Table 3-112).

Between the 1990 and 2010, GHG emissions originated from the 'International Bunkers: Aviation' source category decreased by 62.1 per cent: from 220.43 Gg CO_2 eq. in 1990 to 83.65 Gg CO_2 eq. in 2010 (Figure 3-16, Table 3-113).

Table 3-112: GHG Emissions from 'International Bunkers: Aviation' source category within 1990-2010 time period, where 1990 represents 100 per cent

	1990	1991	1992	1993	1994	1995	1996
CO_2	100.0	107.1	44.3	28.6	17.4	19.3	30.3
CH_4	100.0	113.1	43.9	23.1	13.5	14.0	11.1
N_2O	100.0	107.0	44.3	28.6	17.4	19.3	30.4
NO_x	100.0	106.3	44.2	29.3	18.0	19.8	32.2
CO	100.0	110.4	44.1	25.4	15.1	16.2	19.3
NMVOC	100.0	111.4	44.0	24.9	14.7	15.8	17.3
SO_2	100.0	107.1	44.3	28.6	17.4	19.3	30.3
	1997	1998	1999	2000	2001	2002	2003
CO_2	34.8	33.4	33.4	30.5	28.5	28.6	33.8
CH_4	12.7	10.8	10.2	9.4	9.6	9.0	9.0
N_2O	35.1	33.7	31.0	30.9	29.6	29.6	35.5
NO_x	36.8	35.3	33.2	31.8	28.3	30.2	35.7
CO	22.5	20.9	19.4	19.0	19.7	19.7	22.4
NMVOC	19.6	17.7	16.6	15.7	14.0	13.0	14.2
SO_2	34.8	33.4	30.9	30.5	27.2	28.5	33.8
	2004	2005	2006	2007	2008	2009	2010
CO_2	32.5	31.1	35.0	36.8	41.1	38.0	38.1
CH_4	9.3	8.7	10.5	6.7	4.1	6.9	6.6
N_2O	34.6	33.9	37.7	38.8	42.8	39.7	39.8
NO_x	34.9	32.8	38.1	41.0	46.3	42.7	43.1
CO	23.2	23.0	24.7	22.6	21.8	22.2	22.7
NMVOC	12.6	11.4	13.0	12.8	13.7	14.5	13.5
SO_2	32.5	31.1	34.9	36.7	41.1	38.0	38.0

Table 3-113: Direct GHG Emissions from 'International Bunkers: Aviation' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

Years	Gg CO_2 equivalent				%		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
1990	217.3668	0.9036	2.1560	220.4265	98.61	0.41	0.98
1991	232.8115	1.0222	2.3076	236.1412	98.59	0.43	0.98
1992	96.2635	0.3964	0.9551	97.6150	98.62	0.41	0.98
1993	62.0927	0.2083	0.6162	62.9173	98.69	0.33	0.98
1994	37.8235	0.1218	0.3755	38.3208	98.70	0.32	0.98
1995	41.9185	0.1267	0.4161	42.4613	98.72	0.30	0.98
1996	65.8650	0.1007	0.6555	66.6212	98.86	0.15	0.98
1997	75.6443	0.1148	0.7567	76.5157	98.86	0.15	0.99
1998	72.4974	0.0976	0.7274	73.3224	98.87	0.13	0.99
1999	72.4938	0.0920	0.6694	73.2552	98.96	0.13	0.91
2000	66.1989	0.0851	0.6663	66.9503	98.88	0.13	1.00
2001	61.9061	0.0868	0.6374	62.6303	98.84	0.14	1.02
2002	62.0776	0.0816	0.6391	62.7983	98.85	0.13	1.02
2003	73.5472	0.0815	0.7648	74.3935	98.86	0.11	1.03
2004	70.7060	0.0840	0.7452	71.5352	98.84	0.12	1.04
2005	67.6961	0.0789	0.7316	68.5066	98.82	0.12	1.07
2006	75.9977	0.0946	0.8127	76.9051	98.82	0.12	1.06
2007	79.9382	0.0605	0.8372	80.8360	98.89	0.07	1.04
2008	89.3145	0.0373	0.9220	90.2738	98.94	0.04	1.02
2009	82.6447	0.0622	0.8568	83.5638	98.90	0.07	1.03
2010	82.7287	0.0598	0.8581	83.6467	98.90	0.07	1.03

Comparing with the reference year level, in 2010 the amount of total direct GHG emissions represented only

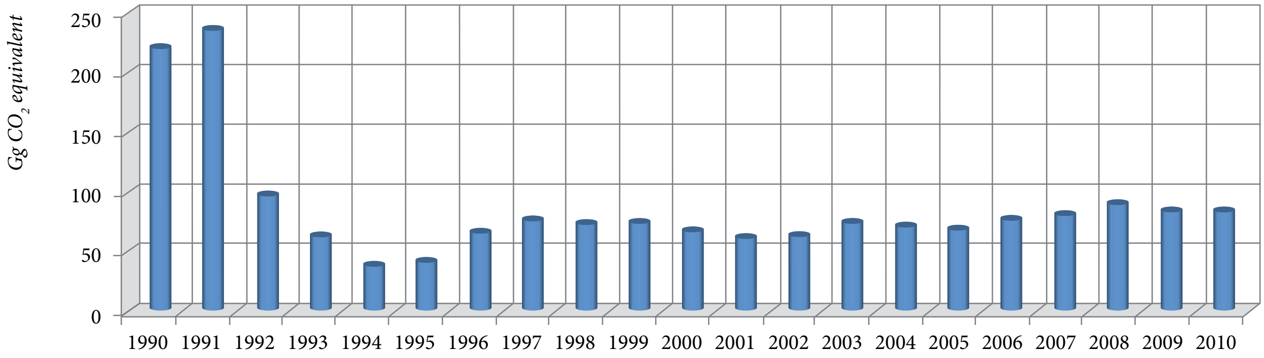


Figure 3-16: Direct GHG Emissions from 'International Bunkers: Aviation' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg CO_2 equivalent

37.9 per cent; CO_2 – 38.1 per cent; CH_4 – 6.6 per cent and N_2O – 39.8 per cent (Table 3-114).

Table 3-114: Direct GHG Emissions from 'International Bunkers: Aviation' Source Category in the Republic of Moldova within 1990-2010 time periods, where 1990 represents 100 per cent

Years	CO_2	CH_4	N_2O	Total
1990	100.0	100.0	100.0	100.0
1991	107.1	113.1	107.0	107.1
1992	44.3	43.9	44.3	44.3
1993	28.6	23.1	28.6	28.5
1994	17.4	13.5	17.4	17.4
1995	19.3	14.0	19.3	19.3
1996	30.3	11.1	30.4	30.2
1997	34.8	12.7	35.1	34.7
1998	33.4	10.8	33.7	33.3
1999	33.4	10.2	31.0	33.2
2000	30.5	9.4	30.9	30.4
2001	28.5	9.6	29.6	28.4
2002	28.6	9.0	29.6	28.5
2003	33.8	9.0	35.5	33.7
2004	32.5	9.3	34.6	32.5
2005	31.1	8.7	33.9	31.1
2006	35.0	10.5	37.7	34.9
2007	36.8	6.7	38.8	36.7
2008	41.1	4.1	42.8	41.0
2009	38.0	6.9	39.7	37.9
2010	38.1	6.6	39.8	37.9

3.8.2 Methodological Issues, Emission Factors and Data Sources

GHG emissions from the 'International Bunkers: Aviation' source category 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 • Emission Factor $_{LTO}$

LTO Fuel Consumption = Number of LTOs • Fuel Consumption per LTO

Cruise Emissions = (Total Fuel Consumption – LTO Fuel Consumption) • Emission Factor $_{Cruise}$

Emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), as well as in 2006 IPCC Guidelines were used to estimate GHG emissions originated from this source category (Table 3-115 and 3-116).

Table 3-115: Default Emission Factors Available in the Revised 1996 IPCC Guidelines, Used to Estimate GHG Emissions from International Aviation

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
New Aircraft Types: LTO, kg/LTO	7900	1.5	0.2	41	50	15	2.5
Old aircraft types: LTO (kg/LTO)	7560	7	0.2	23.6	101	66	2.4
All aircraft types: cruise phase of flight (kg/t)	3150	0	0.1	17	5	2.7	1.0

Source: Revised 1996 IPCC Guidelines, Vol. 3, Table 1-52, Page 1.98

Thus, 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, there were used EFs available in the 2006 IPCC Guidelines (Table 3-116).

To be noted, that the 2006 IPCC Guidelines does not include EFs for all types of aircraft used in the Republic of Moldova under the international air transportation. Thus, for some of them it was necessary to use EFs specific to other similar group aircrafts (turbo or jet prop aircrafts), taking into account the engine type used.

Over the period under review the aircraft park used in the Republic of Moldova for international air transport has essentially changed its structure (Table 3-117).

If before 1995, mostly aircrafts produced in the former CIS countries were used (TU-154, TU-134, IL-76, IL-18, YAK-40, YAK-42, AN-12, AN-24, AN-26, AN-32, AN-72 etc.), by

Table 3-116: Default Emission Factors Available in the 2006 IPCC Guidelines, Used to Estimate GHG Emissions from 'International Bunkers: Aviation'

Aircraft used in the RM	Consumption, t per LTO	CO_2	CH_4	N_2O	NO_x		CO	NMVOC	SO_2
					LTO	Cruise			
TU-154-B	2.23	7030	11.90	0.20	14.33	9.10	143.05	107.13	2.22
TU-134	0.93	2930	1.80	0.10	8.68	8.50	27.98	16.19	0.93
IL-76	2.31	7300	7.40	0.20	31.64	15.70	103.33	66.56	2.31
IAK-42	0.91	2880	0.25	0.10	10.66	15.60	10.22	2.27	0.91
A320	0.77	2440	0.06	0.10	9.01	12.90	6.19	0.51	0.77
B707	1.86	5890	9.75	0.20	10.96	5.90	92.37	87.81	1.86
B737-100/200	0.87	2740	0.45	0.10	6.74	8.70	16.04	4.06	0.87
B747-100	3.21	10140	4.84	0.30	49.17	15.50	114.59	43.59	3.21
B757-300	1.46	4630	0.01	0.10	17.85	9.80	11.62	0.10	1.46
L-410	2.31	7300	7.40	0.20	31.64	15.70	103.33	66.56	2.31
MD-83	1.01	3180	0.19	0.10	11.97	12.40	6.46	1.69	1.01
RJ-RJ85	0.60	1910	0.13	0.10	4.34	15.60	11.21	1.21	0.60
BAE-146	0.57	1800	0.14	0.10	4.07	8.40	11.18	1.27	0.57
CRJ-100ER	0.33	1060	0.06	0.03	2.27	8.00	6.70	0.56	0.33
ERJ-145	0.31	990	0.06	0.03	2.69	7.90	6.18	0.50	0.31
F-100/70/28	0.76	2390	0.14	0.10	5.75	8.40	13.84	1.29	0.76
BAC-561RC	0.80	2520	0.15	0.10	7.40	12.00	13.07	1.36	0.80
ATR-42	0.20	620	0.03	0.02	1.82	14.20	2.33	0.26	0.20
SF-340B	0.68	2160	0.14	0.10	5.63	8.00	8.88	1.23	0.68
Saab 2000	0.60	1890	0.03	0.10	5.58	9.50	8.42	0.28	0.60
LEAR-35	0.34	1070	0.33	0.03	0.74	7.20	34.07	3.01	0.34

2010 the share of these aircrafts in international air transport in the Republic of Moldova decreased to 32.1 per cent (Table 3-118), the rest 78.5 per cent being represented by aircrafts produced in western countries, such as: Airbus A-320, Saab 2000, Embraer EMB-120, Embraer EMB-145, Embraer EMB-190, Fokker-70, Fokker-100, Canadair Regional Jet CRJ-200, Boeing 737-300, British Aerospace BAE-146, Avions de Transport Règional ATR-42, Saab Fairchild SF-340B, etc.

Table 3-117: Number of International Flights made by aircrafts from the RM within the 1995-2010 time periods

	1995	1996	1997	1998	1999	2000	2001	2002
An 2	0	0	0	0	0	0	0	0
An 12	0	0	23	9	13	15	7	25
An 24	729	929	950	1037	755	976	749	562
An 26	3	0	0	12	7	570	182	1
An 28	0	0	0	0	1	6	6	
An 32	0	0	0	55	95	964	968	850
An 72	23	15	19	17	21	49	53	24
An 74	31	7	5	11	7	4	1	2
Il 18	15	23	23	45	71	62	18	0
Il 76	22	23		20	28	20		7
Ka-26	0	0	0	0	0	0	0	0
Ka-32	0	0	0	0	0	0	0	0
Mi-2	0	0	0	0	0	0	0	0
Mi-8	0	0	0	0	0	688	1300	3294
Mi-17	0	0	0	0	0	0	0	0
Mi-26	0	0	0	0	0	0	0	0
Tu 134	1001	1395	1261	1299	1325	1268	1329	1024
Tu 154	287	114	189	53	23	26	25	16
Yak 18	0	0	0	0	0	0	0	0
Yak 40	169	561	779	662	770	655	283	289
Yak 42	371	342	527	642	531	499	367	668
Others	158	176	366	137	104	102	91	178
Total Flights with Aircrafts from CIS	2809	3585	4142	3999	3751	5904	5379	6940
A 320	0	0	0	0	15	0	0	0
A 321	0	0	0	0	0	0	0	0
ATR-42	0	0	58	131	141	141	151	145
BAE-146	0	0	0	0	0	0	0	0
B-MD-81	0	0	0	0	0	0	0	0
B-MD-82	0	0	0	0	0	0	0	0
B-MD-83	0	0	0	0	0	0	0	0
B-707	9	7	0	0	0	0	0	0
B-737	0	27	84	128	110	16	35	102
B-747	0	0	0	0	0	0	0	2
B-757	0	0	0	7	0	0	0	2
CRG-2	0	0	0	0	0	0	96	103
CRJ	0	0	0	0	36	100	0	0
DHC-8	0	0	45	0	0	0	0	0
EMB-120	0	0	0	0	0	0	667	627
EMB-145	0	0	0	0	0	0	323	208
EMB-190	0	0	0	0	0	0	0	0
Fokker-70	0	0	0	0	23	0	0	0
Fokker-100	0	0	0	0	0	0	0	0
HS-25	0	0	9	0	0	0	0	0
L 410	11	0	0	56	45	19	0	7
Learjet-35	0	0	8	0	0	0	0	0
RJ-70	0	0	0	0		7	10	22
RJ-85	0	0	0	0	0	0	0	0
RJ-100	0	0	0	0	2	25	118	51
RomBac-561RC	0	0	0	0	0	0	0	39
SAAB-340	0	0	372	550	505	1259	1467	1024
SAAB-2000	0	0	0	0	0	0	0	0
Total Flights with Other Aircrafts	20	34	576	872	877	1567	2867	2332
Total Flights Performed	2829	3619	4718	4871	4628	7471	8246	9272

	2003	2004	2005	2006	2007	2008	2009	2010
An 2	0	0	1	144	126	145	227	202
An 12	27	197	111	194	149	1	0	0
An 24	124	3241	2811	2782	1573	5	0	0
An 26	6	243	861	3085	1690	264	1175	863
An 28	3	2	3	0	0	0	0	0
An 32	250	1131	1038	672	379	47	0	0
An 72	28	27	87	68	198	0	0	0
An 74	1	2	1	0	0	0	0	0
Il 18	0	10	98	155	12	1	31	78
Il 76	8	2	5	0	0	0	0	0
Ka-26	0	0	0	0	0	0	0	0
Ka-32	0	0	0	42	283	126	126	139
Mi-2	0	0	0	0	0	0	0	0
Mi-8	5375	3906	3375	3088	3974	5032	4321	6720
Mi-17	0	0	0	0	0	0	0	0
Mi-26	0	0	4	3	64	84	84	0
Tu 134	887	403	15	65	236	52	1	0
Tu 154	5	12	14	0	0	0	0	0
Yak 18	0	0	0	0	2	16	88	5
Yak 40	304	230	94	52	3	1	0	0
Yak 42	638	283	518	0	0	0	0	0
Others	142	255	475	0	0	0	0	0
Total Flights with Aircrafts from CIS	7798	9944	9511	10350	8689	5774	6053	8007
A 320	142	924	1256	1679	1340	1517	1935	1779
A 321	0	0	0	2	0	0	0	0
ATR-42	159	198	199	0	0	0	0	0
BAE-146	0	115	253	0	0	0	0	0
B-MD-81	0	0	0	0	9	134	0	0
B-MD-82	0	0	0	0	196	182	0	11
B-MD-83	0	16	10	0	28	54	31	0
B-707	0	0	1	0	0	0	0	0
B-737	201	341	311	0	61	1	0	0
B-747	0	0	0	0	0	0	0	0
B-757	2	5	1	0	0	0	0	0
CRG-2	218	350	356	0	0	0	0	0
CRJ	0	0	0	0	0	0	0	0
DHC-8	0	0	0	0	11	0	0	0
EMB-120	495	842	821	525	600	614	622	555
EMB-145	1	2	2	0	0	0	0	0
EMB-190	0	0	0	0	0	0	0	458
Fokker-70	0	0	7	455	85	10	12	13
Fokker-100	0	0	0	58	0	0	5	4
HS-25	0	0	0	0	0	0	0	0
L 410	7	37	3	1	2	0	0	0
Learjet-35	0	0	0	0	0	0	0	0
RJ-70	5	2	0	0	0	0	0	0
RJ-85	0	0	36	0	0	0	0	0
RJ-100	19	10	0	0	0	0	0	0
RomBac-561RC	0	0	0	0	0	0	0	0
SAAB-340	1671	369	132	21	2	0	0	0
SAAB-2000	269	970	2238	1934	1469	1442	1269	969
Total Flights with Other Aircrafts	3189	4181	5626	4675	3803	3954	3874	3789
Total Flights Performed	10987	14125	15137	15025	12492	9728	9927	11796

Source: Civil Aviation State Administration of the RM through Official Letters Nr. 3978 from 02.10.2006 and Nr. 1328 from 13.09.2011.

AD related to the consumption of fuel for international aviation was provided by the Civil Aviation State Administration (CASA)[16].

Table 3-118: Share of International Flights within the 1995-2010 time periods

	1995	1996	1997	1998	1999	2000	2001	2002
Flights with Aircrafts from CIS, %	99.3	99.1	87.8	82.1	81.1	79.0	65.2	74.8
Flights with Other Aircrafts, %	0.7	0.9	12.2	17.9	18.9	21.0	34.8	25.2
	2003	2004	2005	2006	2007	2008	2009	2010
Flights with Aircrafts from CIS, %	71.0	70.4	62.8	68.9	69.6	59.4	61.0	67.9
Flights with Other Aircrafts, %	29.0	29.6	37.2	31.1	30.4	40.6	39.0	32.1

Source: CASA through Official Letters No. 3978 dated 02.10.2006 and No. 1328 dated 13.09.2011.

To be noted that there were revealed certain discrepancies between data on aviation kerosene consumption for international aviation included in the Energy Balances of the RM for 1990 and 1993-2010 and data provided by CASA (for 2003-2010, the difference is quite significant) (Table 3-119).

Table 3-119: Aviation Kerosene Consumption for International Aviation in the Republic of Moldova within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
Data available in the EBs	69.0	NA	NA	19.7	11.0	11.0	18.0
Data provided by CASA	69.0	73.9	30.5	19.7	12.0	13.3	20.9
Difference, %	-0.1	NA	NA	0.0	9.1	20.9	16.1
	1997	1998	1999	2000	2001	2002	2003
Data available in the EBs	21.0	17.0	20.0	20.0	16.0	19.0	11.0
Data provided by CASA	24.0	23.0	23.0	21.0	19.6	19.7	23.3
Difference, %	14.3	35.3	15.0	5.0	22.6	3.5	111.9
	2004	2005	2006	2007	2008	2009	2010
Data available in the EBs	11.0	12.0	12.0	14.0	14.0	14.0	13.0
Data provided by CASA	22.4	21.4	24.1	25.3	28.3	26.2	26.2
Difference, %	103.6	78.6	100.6	80.9	102.3	87.3	101.7

Source: EBs of the RM for 1990, 1993-2010; CASA of the RM through Official Letter No. 3978 dated 02.10.2006; and through Official Letter No.1328 dated 13.09.2011.

Under such circumstances, in order to estimate GHG emissions from 'International Bunkers: Aviation' source category, it was decided to use data provided by CASA, as deemed to be more accurate and reliable.

[16] Starting with 2012 the Civil Aviation State Administration (CASA) was reorganized as Civil Aeronautical Authority (CAA) of the RM <http://www.caa.md/>.

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 the 'International Bunkers: Aviation' source category, and quality of activity data available. Uncertainties associated with the EFs used to estimate CO_2 emissions are around ±5 per cent, those pertaining to EFs used to estimate CH_4 emissions reach up to ±10 per cent, while those related to EFs used to estimate N_2O emissions reach up to ±100 per cent. Uncertainties associated with the statistical data regarding aviation kerosene consumption for international air transport is deemed to be relatively low (±5 per cent). Uncertainties pertaining to GHG emissions from the 'International Bunkers: Aviation' were estimated at ±7.07 per cent for CO_2 emissions, ±11.18 per cent for CH_4 emissions and ±100.12 per cent for N_2O. At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±0.0628 per cent for CO_2 emissions, ±0.0001 per cent for CH_4 emissions, and ±0.0092 per cent for N_2O. Uncertainties introduced in trend in the sectoral emissions were estimated at ±0.00171 per cent for CO_2 emissions, at ±0.0001 per cent for CH_4 emissions, and at ±0.0008 per cent for N_2O emissions (**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 GPG (IPCC, 2000).

3.8.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for 'International Bunkers: Aviation' source category, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating GHG emissions under this category were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), GHG emissions originated from the 'International Bunkers: Aviation' source category were estimated based on AD available in the official sources of reference.

3.8.5 Recalculations

GHG emission recalculations performed under the 'International Bunkers: Aviation' source category are due to the availability of an updated set of activity data for 2001-2010 provided by the Civil Aeronautical Authority of the Republic of Moldova.

In comparison with the results included into the SNC of the RM under the UNFCCC, the performed recalculations resulted in an increasing GHG emissions trend, varying from a minimum of 5.1 per cent increase in 2003, to a maximum of 6.5 per cent increase in 2001 (Table 3-120).

For the 2006-2010 time periods, the GHG emissions from 'International Bunkers: Aviation' source category were estimated for the first time. The results revealed that between 1990 and 2010, the GHG emissions originated from this source category decreased by 62.1 per cent.

3.8.6 Planned Improvements

Within the 'International Bunkers: Aviation' source category, potential improvements could be achieved once a higher methodology is used, as well as new disaggregated AD are collected.

3.9 CO_2 Emissions from Biomass (Memo Items)

3.9.1 Source Category Description

Under 'Memo Items' there are also monitored the CO_2 emissions from biomass. In conformity with recommendations provided in the Revised 1996 IPCC Guidelines (IPCC, 1997), GHG emissions from biomass shall be estimated under each individual source category of the Energy Sector: non-CO_2 emissions shall be reported under the respective source category, while CO_2 emissions shall be reported separately, under the 'Memo Items', being not included into the national totals.

Table 3-120: Comparative Results of GHG Emissions from 'International Bunkers: Aviation' Source Category Included into the SNC and TNC of the RM under the UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
SNC	220.4264	236.1412	97.6150	62.9173	38.3208	42.4613	66.6212
TNC	220.4265	236.1412	97.6150	62.9173	38.3208	42.4613	66.6212
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1997	1998	1999	2000	2001	2002	2003
SNC	76.5157	73.3224	73.2552	66.9503	58.8101	59.3049	70.8030
TNC	76.5157	73.3224	73.2552	66.9503	62.6303	62.7983	74.3935
Difference, %	0.0	0.0	0.0	0.0	6.5	5.9	5.1
	2004	2005	2006	2007	2008	2009	2010
SNC	67.9534	64.6384					
TNC	71.5352	68.5066	76.9051	80.8360	90.2738	83.5638	83.6467
Difference, %	5.3	6.0					

In comparison with the reference year level, by 2010 the CO_2 emissions from biomass increased by 37.1 per cent (Table 3-121, Figure 3-17)

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 Revised 1996 IPCC Guidelines (IPCC, 1997), Vol. 3, Chap. 1.4.3; as well as in the 2006 IPCC Guidelines, Vol. 2, Chap. 2.3.3.4 (IPCC, 2006).

The basic equations used to estimate CO_2 emissions from biomass are:

CO_2 emissions (fuel wood) = fuel consumption (thousand m^3) • conversion factor in natural units (t/m^3) • conversion factor in energy units (TJ/kt) • carbon emission factor (tC/TJ) – carbon stored • fraction oxidized • 44/12

CO_2 emissions (agricultural waste) = fuel consumption (thousand t.c.e.) • conversion factor in natural units (t/t.c.e.) • conversion factor in energy units (TJ/kt) • carbon emission factor (t C/TJ) –carbon stored • fraction oxidized • 44/12

Where:

1 m3 fuel wood – 0.73 t;

1 tone of bark – 0.42 t.c.e.;

1 tone of shavings – 0.05 t.c.e.;

1 tone of saw dust – 0.36 t.c.e.;

1 tone of wood processing waste – 0.12 t.c.e.;

1 tone of agricultural residues (straw, seed shells) – 0.50 t.c.e.;

1 tone of agricultural residues (maize cobs) – 0.33 t.c.e.;

1 t.c.e. – 2.00 t of agricultural residues;

1 kt of fuel wood – 12.32 TJ;

1 kt of agricultural residues – 14.67 TJ;

Fuel Wood Carbon Emission Factor – 30.5 t C/TJ;

Agricultural Residues Carbon Emission Factor – 27.3 t C/TJ

Activity data pertaining to biomass consumption (fuel wood, wood residues: barks, shavings, saw dust, wood processing waste; and agricultural crop residues: straw, seed shells, maize cobs) in such sectors as 'energy industries', 'manufacturing industry and construction', 'commercial / institutional', 'residential', 'agriculture / forestry / fishing', and 'other needs and works in energy sector' have been collected from the EBs of the RM for 1990 and for 1993-2010 (Table 3-122).

The AD available in the Energy Balances were compared with other relevant sources of reference (i.e., Galupa, Talmaci, Spitoc, 2005; Galupa, Talmaci, Spitoc, 2006; Galupa, Platon et al., 2011; Galupa, Ciobanu, Scobioala et al., 2011; Capcelea, Lozan, Lupu et al., 2011).

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 emission factors and activity data represented circa ±80 per cent. CO_2 emissions from biomass uncertainties were estimated at ±113.14 per cent. At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±3.5098 per cent, while uncertainties introduced in trend in sectoral emissions were estimated at ±1.0770 per cent (**Annex 5-3.1**).

Table 3-121: CO_2 emissions from biomass (Memo Items) in the RM within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2 emissions from biomass	210.8274	427.7268	531.1505	763.4134	599.5042	645.5674	615.3433
	1997	1998	1999	2000	2001	2002	2003
CO_2 emissions from biomass	322.4374	409.1761	373.6048	367.8560	353.0871	389.5020	359.7899
	2004	2005	2006	2007	2008	2009	2010
CO_2 emissions from biomass	296.5059	295.0374	323.6620	293.1867	336.6568	321.2484	289.1029

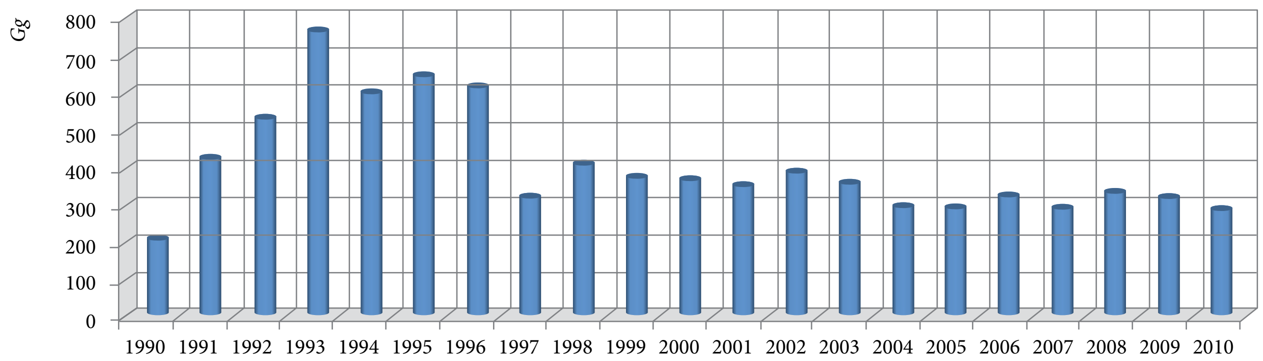


Figure 3-17: CO_2 emissions from biomass (Memo Items) in the RM within 1990-2010 time periods

Table 3-122: Biomass Consumption in the RM within 1990-2010 time periods

	Fuel Type	1A1	1A2	1A4a	1A4b	1A4c	1A5
1990	Fuel Wood, thousand m^3 comp.	1	15	37	117	4	5
	Wood and Agricultural Residues, thousand t.c.e.	2	6		8		
1993	Fuel Wood, thousand m^3 comp.	0.6	8.4	14.0	98.3	1.1	1.3
	Wood and Agricultural Residues, thousand t.c.e.	1.7	2.3	0.2	5.0	0.1	0.4
1994	Fuel Wood, thousand m^3 comp.	1	1	13	107	2	3
	Wood and Agricultural Residues, thousand t.c.e.	5	1		7		
1995	Fuel Wood, thousand m^3 comp.	1	4	16	195	3	5
	Wood and Agricultural Residues, thousand t.c.e.	3			7		1
1996	Fuel Wood, thousand m^3 comp.	1	4	19	238	2	11
	Wood and Agricultural Residues, thousand t.c.e.	3		1	11		
1997	Fuel Wood, thousand m^3 comp.	1	4	16	244	2	6
	Wood and Agricultural Residues, thousand t.c.e.	2			10		1
1998	Fuel Wood, thousand m^3 comp.	2	2	17	252	2	4
	Wood and Agricultural Residues, thousand t.c.e.	1			6		
1999	Fuel Wood, thousand m^3 comp.	1	1	10	238	2	4
	Wood and Agricultural Residues, thousand t.c.e.	1			11		1
2000	Fuel Wood, thousand m^3 comp.		1	12	220	1	5
	Wood and Agricultural Residues, thousand t.c.e.	2			17		
2001	Fuel Wood, thousand m^3 comp.		1	16	198	2	5
	Wood and Agricultural Residues, thousand t.c.e.	5			20		1
2002	Fuel Wood, thousand m^3 comp.	1	1	20	242	2	4
	Wood and Agricultural Residues, thousand t.c.e.	8			17		1
2003	Fuel Wood, thousand m^3 comp.	1	2	51	252	2	3
	Wood Residues, thousand t.c.e.	1		5	15		
	Agricultural Crop Residues, thousand t.c.e.	7			3		1
2004	Fuel Wood, thousand m^3 comp.		1	30	214	1	4
	Wood Residues, thousand t.c.e.	1	1	2	11		1
	Agricultural Crop Residues, thousand t.c.e.	11			4		1
2005	Fuel Wood, thousand m^3 comp.		1	27	218	1	4
	Wood Residues, thousand t.c.e.	1	1	1	10		
	Agricultural Crop Residues, thousand t.c.e.	8			7		1
2006	Fuel Wood, thousand m^3 comp.		1	33	272	2	3
	Wood Residues, thousand t.c.e.			1	12		
	Agricultural Crop Residues, thousand t.c.e.	7			8		1
2007	Fuel Wood, thousand m^3 comp.			32	220	2	3
	Wood Residues, thousand t.c.e.			1	9		
	Agricultural Crop Residues, thousand t.c.e.	8			7		
2008	Fuel Wood, thousand m^3 comp.			34	249	1	4
	Wood Residues, thousand t.c.e.			1	11		
	Agricultural Crop Residues, thousand t.c.e.	12		1	7		
2009	Fuel Wood, thousand m^3 comp.			31	226	2	2
	Wood Residues, thousand t.c.e.			1	13		1
	Agricultural Crop Residues, thousand t.c.e.	15		10			
2010	Fuel Wood, thousand m^3 comp.		1	27	232	3	4
	Wood Residues, thousand t.c.e.			1	8		1
	Agricultural Crop Residues, thousand t.c.e.	17		1	2		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 GPG (IPCC, 2000).

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 (IPCC, 2000). The AD and methods used for estimating GHG emissions under this category were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), GHG emissions originated from the 'CO_2 emissions from biomass' (Memo Items) were estimated based on AD and CS coefficients and parameters from official sources of reference.

3.9.5 Recalculations

No any GHG emissions recalculations were performed for 'CO_2 emissions from biomass' (Memo Items) with reference to the 1990-2005 time periods.

3.9.6 Planned Improvements

Potential improvements within the 'CO_2 emissions from biomass' (Memo Items) could be achieved by collecting more accurate AD from alternative reference sources, other than the EBs of the RM.

3.10 Comparison of Reference and Sectoral Approaches

In conformity with the recommendations provided in the GPG (IPCC, 2000), CO_2 emissions calculated by using two distinct approaches: the reference method (top-down) and the sectoral method (bottom up) were compared (Table 3-123).

For comparison purposes, below is provided the information on CO_2 emissions calculated following the reference and sectoral approaches in the frame of previous inventory cycle (Table 3-124).

Table 3-123: Comparison of CO_2 Emissions Estimated by using Reference and Sectoral Approaches in the Republic of Moldova under the current inventory cycle, Gg

	1990	1991	1992	1993	1994	1995	1996
Reference Approach	33153.73	28965.29	20493.19	15715.33	14298.90	10989.36	11134.2910
Sectoral Approach	33365.55	29193.09	20587.39	15776.08	14335.90	11030.39	11198.7301
Difference, %	-0.6	-0.8	-0.5	-0.4	-0.3	-0.4	-0.6
	1997	1998	1999	2000	2001	2002	2003
Reference Approach	10105.3956	8638.1456	6758.2232	6046.6432	6639.92	6267.25	7024.28
Sectoral Approach	10179.4508	8709.0855	6841.7537	6092.4074	6700.43	6328.52	7097.93
Difference, %	-0.7	-0.8	-1.2	-0.8	-0.9	-1.0	-1.1
	2004	2005	2006	2007	2008	2009	2010
Reference Approach	7463.88	7706.47	6966.14	6637.85	7645.95	8399.62	8288.16
Sectoral Approach	7532.98	7772.58	7036.17	6715.96	7733.28	8480.47	8369.76
Difference, %	-0.9	-0.9	-1.0	-1.2	-1.1	-1.0	-1.0

Table 3-124: Comparison of CO_2 Emissions Estimated by using Reference and Sectoral Approaches in the Republic of Moldova under the previous inventory cycle, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
Reference Method	33153.09	28964.68	20492.67	15714.89	13266.94	10415.33	10623.45	8857.12
Sectoral Method	33364.92	29192.48	20586.87	15775.64	13303.94	10456.35	10687.89	8931.13
Difference, %	-0.6	-0.8	-0.5	-0.4	-0.3	-0.4	-0.6	-0.8
	1998	1999	2000	2001	2002	2003	2004	2005
Reference Method	7317.16	5583.79	4805.08	6016.58	6059.83	6595.29	6723.10	6921.70
Sectoral Method	7388.07	5654.72	4869.83	6073.53	6117.16	6663.78	6788.91	6984.26
Difference, %	-1.0	-1.3	-1.3	-0.9	-0.9	-1.0	-1.0	-0.9

4. INDUSTRIAL PROCESSES SECTOR

According to the National Bureau of Statistics (2012), industry is an important part of the national economy, its contribution to GDP during 2000-2010 represented circa 13-18 per cent (14 per cent in 2011). The largest share among branches covered by this sector is held by the 'Manufacturing Industry' – 11.4 per cent of the total, while 'Electricity, Heat, Natural Gases and Water Supply' account for 2.2 per cent and 'Mining and Quarrying Industry' – for 0.4 per cent (NBS, 2012).

In 2011 the Industry Sector involved more than 13.1 per cent of active population (NBS, 2012). The sector includes more than 4985 enterprises and production units, of which circa 8.1 per cent are public ownership, 83.6 per cent - private ownership, 2.6 per cent - mixed (public and private) ownership (no foreign capital), 2.6 per cent - foreign capital and 4.2 per cent joint ventures (NBS, 2012).

Industry Sector structure covers 97 types of activity, grouped as follows: Group 1 – industries based on local raw materials, which maintained their traditional markets: food industry (winemaking, canned food, juices, sugar); manufacturing of other products of non-metal minerals (cement, plaster stone, lime, ceramics production); cosmetics and perfumery; manufacturing of wooden elements for construction, manufacturing of wooden packaging; waste and recyclable materials recovery; Group 2 – industries preponderantly based on imported raw materials and have a potential market which however, needs upgrading and fast restructuring: light industry (textiles, knit-wear, leather goods); machinery manufacturing (pumping machines, medical equipment, engineering-and-electrical goods, agricultural machinery and equipment; Group 3 – industries based on imported raw materials and parts having low competitiveness: furniture, chemical products, including pharmaceuticals; paper and carton; plastics; finished metal goods; Group 4 – science-intensive enterprises, requiring special restructuring programs, as well as investment attraction programs: information technologies and instrument making engineering. The largest share among all industries is held by enterprises of the first group, in particular, processing enterprises accounting for more than 50 per cent of the total industrial output.

4.1 Overview

'Industrial Processes' Sector includes greenhouse gas emissions generated directly from non-energy[17] industrial activities. Methodological guidance used includes the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), Good Practice Guidance (IPCC, 2000), European Emissions Inventory Guidebook (CORINAIR, 1996, 1999, 2009), 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), and other relevant guidelines.

[17] GHG emissions from fossil fuel combustion for production of energy used for industrial activities are estimated in the Energy Sector.

In the Republic of Moldova, the source categories covered by this sector are: 2A 'Mineral Products' (*2A1 'Cement Production', 2A2 'Lime Production', 2A3 'Limestone and Dolomite Use', 2A4 'Soda Ash Production and Use', 2A5 'Asphalt Roofing', 2A6 'Road Paving with Asphalt', 2A7 'Other' - Glass, Mineral Wood and Bricks Production),* 2B 'Chemical Industry' (*2B5 'Other' - Polyethylene, Synthetic Resins and Detergents Production*), 2C 'Metal Production' (*2C1 Iron and Steel Production*), 2D 'Other Production' *('Food Products': bread, sugar, meat, butter, confectionery, fodder; and 'Alcoholic Beverages': wine, sparkling wine, cognac, brandy, liqueur and beer*) and 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' (*2F1 'Refrigeration and Air Conditioning Equipment', 2F2 'Foam Blowing', 2F3 'Fire Extinguishers', 2F4 'Aerosols', 2F5 'Solvents', 2F8 "Electric Equipment'*).

As no halocarbons and sulphur hexafluoride are produced in the RM, respectively, there were registered no direct greenhouse gas emissions from the source category 2E 'Production of Halocarbons and Sulphur Hexafluoride'.

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 2010, 'Industrial Processes' Sector accounted for circa 4.3 per cent of total national greenhouse gas direct emissions (without LULUCF), being a relevant source of GHG emissions. To be noted that this sector represented an important source of CO_2 national emissions (5.2 per cent of national total) and the only source of F-gas emissions (HFCs, PFCs and SF_6).

Between 1990 and 2010, the total GHG emissions originated from the 'Industrial Processes' Sector tended to lower values (Figure 4-1, Table 4-1), decreasing by circa 70.3 per cent, from 1901.05 Gg in 1990 to 564.99 Gg in 2010, in particular due to reduced industrial output, such as mineral products (cement production decreased by 63.6 per cent, lime production - by 98.4 per cent, limestone use – by 87.8 per cent, dolomite use – by 99.5 per cent, soda ash use – by 63.4 per cent, bricks production – by 78.9 per cent, foam blowing – by 86.1 per cent) and metal production (steel production decreased by 65.9 per cent and laminate production – by 61.4 per cent).

To be noted that in the reference year, CO_2, CH_4 and N_2O emissions accounted for circa 99.93 per cent, 0.01 per cent and respectively 0.06 per cent of the total sectoral GHG emissions. In 2010, the share in the total GHG emissions covered by 'Industrial Processes' Sector represented: CO_2 – 81.70 per cent, CH_4 – 0.01 per cent, N_2O - 0.07 per cent, HFC – 18.13 per cent, PFC – 0.01 per cent and SF_6 - 0.10 per cent.

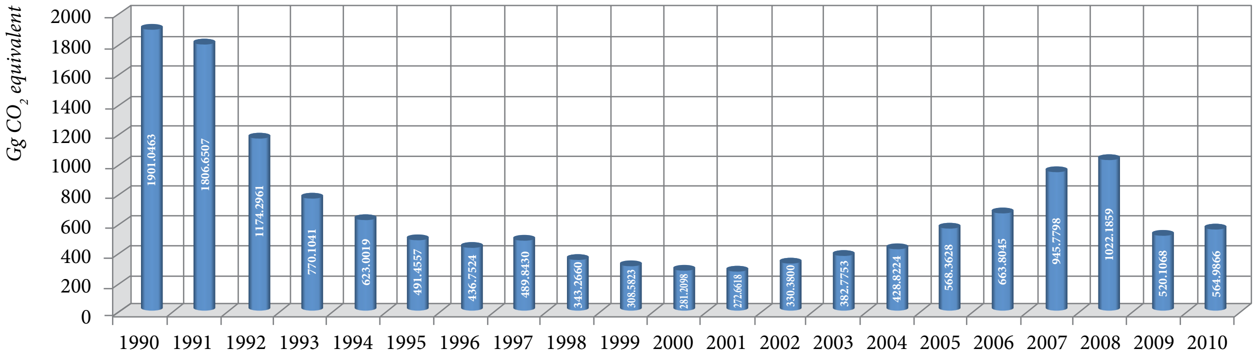


Figure 4-1: GHG Emissions from Industrial Processes Sector within 1990–2010 time periods

Table 4-1: Direct GHG Emissions from Industrial Processes Sector of the Republic of Moldova, 1990 – 2010, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
CO_2	1899.7988	1805.5679	1173.2440	769.0314	621.8877	488.4036	431.5010
CH_4	0.1488	0.1292	0.1255	0.1280	0.1330	0.1379	0.1405
N_2O	1.0986	0.9536	0.9265	0.9448	0.9813	1.0180	1.0371
HFC	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	1.8961	4.0738
PFC	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
SF_6	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
Total Direct GHG Emissions	1901.0463	1806.6507	1174.2961	770.1041	623.0019	491.4557	436.7524
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	481.8103	332.5442	295.7244	266.2359	254.4700	309.9587	355.3557
CH_4	0.1702	0.1508	0.1672	0.1907	0.2031	0.1079	0.1861
N_2O	1.2565	1.1134	1.2344	1.4077	1.4989	0.7963	1.3735
HFC	6.6059	9.4575	11.4564	13.3755	16.4898	19.5171	25.8543
PFC	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
SF_6	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	0.0057
Total Direct GHG Emissions	489.8430	343.2660	308.5823	281.2098	272.6618	330.3800	382.7753
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	395.0060	527.0592	615.2505	883.3510	943.8549	431.7594	461.5626
CH_4	0.2127	0.2202	0.1423	0.2027	0.1859	0.0895	0.0507
N_2O	1.5698	1.6251	1.0500	1.4963	1.3718	0.6603	0.3744
HFC	32.0282	39.4124	47.0741	60.3620	76.3309	87.1207	102.4171
PFC	NO, NE	NO, NE	0.0156	0.0156	0.0195	0.0195	0.0273
SF_6	0.0057	0.0459	0.2720	0.3523	0.4230	0.4574	0.5545
Total Direct GHG Emissions	428.8224	568.3628	663.8045	945.7798	1022.1859	520.1068	564.9866

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

Table 4-2: Total Direct GHG Emissions from the 'Industrial Processes' Sector by Category in the Republic of Moldova within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
2A Mineral Products	1888.0806	1795.3959	1163.3615	758.9541	611.4205	477.5446	420.4386
2C Metal Production	12.9657	11.2549	10.9346	11.1501	11.5814	12.0149	12.2400
2F Consumption of HFC, PFC and SF_6	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	1.8961	4.0738
2 Industrial Processes	1901.0463	1806.6507	1174.2961	770.1041	623.0019	491.4557	436.7524
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2A Mineral Products	468.4076	320.6681	282.5579	251.2206	238.4819	301.4648	340.7049
2C Metal Production	14.8295	13.1404	14.5681	16.6138	17.6901	9.3981	16.2103
2F Consumption of HFC, PFC and SF_6	6.6059	9.4575	11.4564	13.3755	16.4898	19.5171	25.8600
2 Industrial Processes	489.8430	343.2660	308.5823	281.2098	272.6618	330.3800	382.7753
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2A Mineral Products	378.2618	509.7252	604.0505	867.3911	929.2221	424.7167	457.5688
2C Metal Production	18.5267	19.1793	12.3922	17.6589	16.1905	7.7924	4.4189
2F Consumption of HFC, PFC and SF_6	32.0340	39.4583	47.3617	60.7298	76.7734	87.5976	102.9988
2 Industrial Processes	428.8224	568.3628	663.8045	945.7798	1022.1859	520.1068	564.9866

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

From Tables 4-2 and 4-3 one can notice that categories 2A 'Mineral Products' and 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' represent the major sources of direct GHG emissions under 'Industrial Processes' Sector, with a share varying from a maximum of 99.4 per cent (1991) to a minimum of 81.0 per cent (2010), respectively from a minimum of 0.4 per cent (1995) up to a maximum of 18.2 per cent (2010) of the total.

To be noted that the specific weight of the source category 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' in the total direct GHG emissions covered by the 'Industrial Processes' Sector, tends to increase significantly lately (Table 4-3).

Table 4-3: Breakdown of the Republic of Moldova's 'Industrial Processes' Sector GHG Emissions by Category within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
2A Mineral Products	99.3	99.4	99.1	98.6	98.1	97.2	96.3
2C Metal Production	0.7	0.6	0.9	1.4	1.9	2.4	2.8
2F Consumption of HFC, PFC and SF_6	NA	NA	NA	NA	NA	0.4	0.9
2 Industrial Processes	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	1997	1998	1999	2000	2001	2002	2003
2A Mineral Products	95.6	93.4	91.6	89.3	87.5	91.2	89.0
2C Metal Production	3.0	3.8	4.7	5.9	6.5	2.8	4.2
2F Consumption of HFC, PFC and SF_6	1.3	2.8	3.7	4.8	6.0	5.9	6.8
2 Industrial Processes	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	2004	2005	2006	2007	2008	2009	2010
2A Mineral Products	88.2	89.7	91.0	91.7	90.9	81.7	81.0
2C Metal Production	4.3	3.4	1.9	1.9	1.6	1.5	0.8
2F Consumption of HFC, PFC and SF_6	7.5	6.9	7.1	6.4	7.5	16.8	18.2
2 Industrial Processes	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Abbreviations: NA – Not Applicable.

4.1.2 Key Categories

The results of key source assessment carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the **Annex 1-2**. Table 4-4 provides information on identified key categories (by level and trend) under the 'Industrial Processes' Sector.

4.1.3 Methodological Issues

Emissions covered by source categories 2A 'Mineral Products', 2C 'Metal Production' and 2F 'Consumption of HFCs and SF_6' 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, in particular for the sources 2A1 'Cement Production', 2C1 'Iron and Steel Production' and 2F1 'Refrigeration and Air Conditioning Equipment'. 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 (4.2-4.6).

Table 4-4: Key Categories Identified under the Industrial Processes Sector

IPCC Categories	GHG	Source Category	Key Source
2A1	CO_2	Cement Production	Yes (L, T)
2A2	CO_2	Lime Production	No
2A3	CO_2	Limestone and Dolomite Use	Yes (T)
2A4	CO_2	Soda Ash Production and Use	No
2A7	CO_2	Mineral Wood Production	No
2A7	CO_2	Bricks Production	No
2C1	CO_2	Iron and Steel Production	No
2C1	CH_4	Iron and Steel Production	No
2C1	N_2O	Iron and Steel Production	No
2F1	HFC	Refrigeration and Air Conditioning Equipment	No
2F2	HFC	Foam Blowing	No
2F4	HFC	Aerosols	No
2F8	PFC	Electrical Equipment	No
2F8	SF_6	Electrical Equipment	No

Table 4-5: Summary of Methods and Emission Factors Used to Estimate GHG Emissions from the Industrial Processes Sector

IPCC Category	Source Category	CO_2		CH_4		N_2O	
		Method	EF	Method	EF	Method	EF
2A	Mineral Products	T2, T1	CS, D	NA	NA	NA	NA
2B	Chemical Industry	NO	NO	NO	NO	NO	NO
2C	Metal Production	T2	CS, D	T1	D	T1	D
2D	Other	NO	NO	NA	NA	NA	NA
2E	Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO
2F	Consumption of Halocarbons and SF_6	NA	NA	NA	NA	NA	NA
IPCC Category	Source Category	HFC		PFC		SF_6	
		Method	EF	Method	EF	Method	EF
2A	Mineral Products	NA	NA	NA	NA	NA	NA
2B	Chemical Industry	NO	NO	NO	NO	NO	NO
2C	Metal Production	NA	NA	NA	NA	NA	NA
2D	Other	NA	NA	NA	NA	NA	NA
2E	Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO
2F	Consumption of Halocarbons and SF_6	T2, T1	D	T2, T1	D	T2, T1	D

Abbreviations: T1 – Tier 1; T2 – Tier 2; CS – Country Specific; D – Default; NA – Not Applicable; NO – Not Occurring; NE – Not Estimated.

4.1.4 Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the 'Industrial Processes' Sector (by source categories) is described in detail in sub-chapters (4.2-4.6) of the NIR, as well as in **Annex 5-3.2**. To be noted, that combined uncertainties as a percentage of total sectoral emissions were estimated at circa ±7.58 per cent. The uncertainties introduced in trend in sectoral emissions were estimated at ±2.44 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 GPG (IPCC, 2000).

Table 4-6: Recalculated GHG Emissions under the 'Industrial Processes' Sector for the 1990-2005, included in the SNC of the RM under the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997
SNC, Gg CO_2 eq.	1348.7472	1103.5509	575.7686	516.8694	382.1396	380.6453	389.8105	434.9664
TNC, Gg CO_2 eq.	1901.0463	1806.6507	1174.2961	770.1041	623.0019	491.4557	436.7524	489.8430
Difference, %	40.9	63.7	104.0	49.0	63.0	29.1	12.0	12.6
	1998	1999	2000	2001	2002	2003	2004	2005
SNC, Gg CO_2 eq.	354.7176	339.2626	325.6035	331.1295	344.1033	408.0411	479.5229	581.9002
TNC, Gg CO_2 eq.	343.2660	308.5823	281.2098	272.6618	330.3800	382.7753	428.8224	568.3628
Difference, %	-3.2	-9.0	-13.6	-17.7	-4.0	-6.2	-10.6	-2.3

Abbreviations: SNC – Second National Communication; TNC – Third National Communication.

4.1.5 Quality Assurance and Quality Control

Standard verification and quality control forms and check-lists were filled in for each source category, following a Tier 1 approach (IPCC, 2000).

The AD and methods used for estimating GHG emissions originated from this sector were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), GHG emissions were estimated using AD and national coefficients and parameters from official sources of reference.

4.1.6 Recalculations

GHG emission recalculations under the 'Industrial Processes' Sector are due to:

1. The use of an updated set of AD available in the Statistical Yearbooks of the RM and of the ATULBD;
2. Replacing the Tier 1 with a Tier 2 approach (e.g. for the source category 2C1 'Iron and Steel Production');
3. The use of country specific EF (e.g. for Cement Kiln Dust fraction under the source category 2A1 'Cement Production');
4. Updated EF's values (e.g. for source category 2A2 'Lime Production');
5. The assessment for the first time of new source categories (in particular, 2A3 „Limestone and Dolomite Use", 2A4 „Soda Ash Production and Use" and 2F2 „Foam Blowing");
6. Extension of inventory period for F-gases, from 2000-2005 to 1995-2010, etc.

In comparison with the results included into the SNC, the performed recalculation resulted in a significant increase of direct GHG emission values, in particular for the 1990-1997 time periods (varying from a minimum of 12.0 per cent in 1996, up to maximum of 104.0 per cent in 1992), respectively in a decreased trend for the 1998-2005 time periods (varying from a minimum of 2.3 per cent in 2005, up to maximum of 17.7 per cent in 2001) (Table 4-6). The results of performed recalculations at the category level are presented in sub-chapters 4.2-4.6 of the NIR.

4.1.7 Assessment of Completeness

The current inventory covers greenhouse gas emissions from 5 source categories under the Republic of Moldova's Industrial Processes Sector (Table 4-7). As no HFCs and SF_6 are produced in the RM, no such emissions under the category 2E 'Production of HFCs and SF_6' were recorded.

Table 4-7: Assessment of Completeness under the Industrial Processes Sector

IPCC Categories	Source Categories	CO_2	CH_4	N_2O	HFC	PFC	SF_6
2A	Mineral Products	X	NO	NO	NO	NO	NO
2B	Chemical Industry	NO	NO	NO	NO	NO	NO
2C	Metal Production	X	X	X	NO	NO	NO
2D	Other Production	NO	NO	NO	NO	NO	NO
2E	Production of HFCs and SF_6	NO	NO	NO	NO	NO	NO
2F	Consumption of HFCs and SF_6	NO	NO	NO	X	X	X

Abbreviations: X – source categories included in the inventory; NO – Not Occurring;

4.1.8 Planned Improvements

Planned improvements at the source categories level within the Industrial Processes Sector are described in detail in respective sub-chapters (4.2-4.6) of this Report.

4.2 Mineral Products (Category 2A)

4.2.1 Source Category Description

Category 2A 'Mineral Products' includes GHG emissions from the following sources: 2A1 'Cement Production', 2A2 'Lime Production', 2A3 'Limestone and Dolomite Use', 2A4 'Soda Ash Production and Use', 2A5 'Asphalt Roofing', 2A6 'Road Paving with Asphalt' and 2A7 'Other' (Glass Production, Mineral Wool Production, Ceramics, Brick and Expanded Clay Production, etc.).

Over the period under review (1990-2010), the direct greenhouse gas emissions originated from the source category 2A 'Mineral Products' decreased by 75.8 per cent (Table 4-8).

Compared with 2008 level, the GHG emissions originated from this category decreased in 2009 sharply by 54.3 per

Table 4-8: Total Direct GHG Emissions from the Category 2A 'Mineral Products' by Source within 1990-2010 time periods, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
2A1 Cement Production	971.7056	900.7959	474.3181	405.7202	328.4391	248.5280	193.1237
2A2 Lime Production	148.6611	129.9602	63.8886	56.7575	44.3145	28.2332	39.2209
2A3 Limestone and Dolomite Use	619.4745	634.8427	547.9355	204.3052	186.8468	162.4857	158.9194
2A4 Soda Ash Use	32.9560	28.0686	23.7070	19.7592	16.3566	14.6218	8.1701
2A7 Other (Other Mineral Products)	115.2834	101.7284	53.5122	72.4120	35.4635	23.6759	21.0045
2A Mineral Products	1888.0806	1795.3959	1163.3615	758.9541	611.4205	477.5446	420.4386
	1997	1998	1999	2000	2001	2002	2003
2A1 Cement Production	270.1297	215.0591	210.8141	172.7616	173.8863	219.1937	245.6298
2A2 Lime Production	35.4371	28.1605	17.6094	10.9877	3.8566	8.2226	2.1102
2A3 Limestone and Dolomite Use	128.0979	46.4965	24.5358	32.1833	25.5001	35.9790	55.4140
2A4 Soda Ash Use	10.4874	8.4235	6.7014	14.0080	14.3793	14.2074	12.6321
2A7 Other (Other Mineral Products)	24.2555	22.5286	22.8972	21.2800	20.8596	23.8622	24.9188
2A Mineral Products	468.4076	320.6681	282.5579	251.2206	238.4819	301.4648	340.7049
	2004	2005	2006	2007	2008	2009	2010
2A1 Cement Production	282.5791	365.0851	457.0795	702.6719	789.9233	340.5710	349.8365
2A2 Lime Production	2.2557	6.6217	7.4221	10.9877	10.4055	3.3327	2.3140
2A3 Limestone and Dolomite Use	51.5384	98.7854	100.9513	118.8695	94.1925	51.3545	74.4613
2A4 Soda Ash Use	15.9454	18.1607	16.0597	14.1588	13.9856	10.0624	12.0466
2A7 Other (Other Mineral Products)	25.9431	21.0723	22.5380	20.7032	20.7152	19.3961	18.9105
2A Mineral Products	378.2618	509.7252	604.0505	867.3911	929.2221	424.7167	457.5688

cent due to the impact of the global economic crisis on the economy of the RM. At the same time, compared with the 2009 year level, the GHG emissions increased by 7.7 per cent in 2010 (Figure 4-2).

Ozone and Aerosol Precursors Emissions (NO_x, CO, NMVOC and SO_2) covered by the respective source category demonstrated the same decreasing trend (Table 4-9).

Between 1990 and 2010, NO_x emissions decreased by 68.1 per cent (from 2.2958 Gg to 0.7316 Gg); CO emissions by 98.3 per cent (from 1.2584 Gg to 0.0212 Gg); NMVOC emissions by 86.4 per cent (from 392.0868 Gg to 53.3495 Gg); while SO_2 emissions by 72.5 per cent (from 1.7797 to 0.4887 Gg).

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".

$$CaCO_3 \text{ (limestone)} + \text{heat} \rightarrow CaO \text{ (lime)} + CO_2$$

$$CaMg(CO_3)_2 \text{ (dolomite)} + \text{heat} \rightarrow CaO \bullet MgO \text{ (dolomite lime)} + 2CO_2$$

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 (grayish-black pellets about the size of 12 mm-diameter marbles). The clinker is then removed from the kiln, chilled and pulverized, and added to gypsum to obtain 'Portland Cement'. Currently, all cement produced in the Republic of Moldova is of 'Portland' type, in which, in conformity with ORTECH (1994), CaO content varies between 60-67 per cent, and MgO content is around 2 per cent.

To be noted, two cement producing plants are currently operating in the RM: Lafarge Cement J.S.C. in Rezina and Ce-

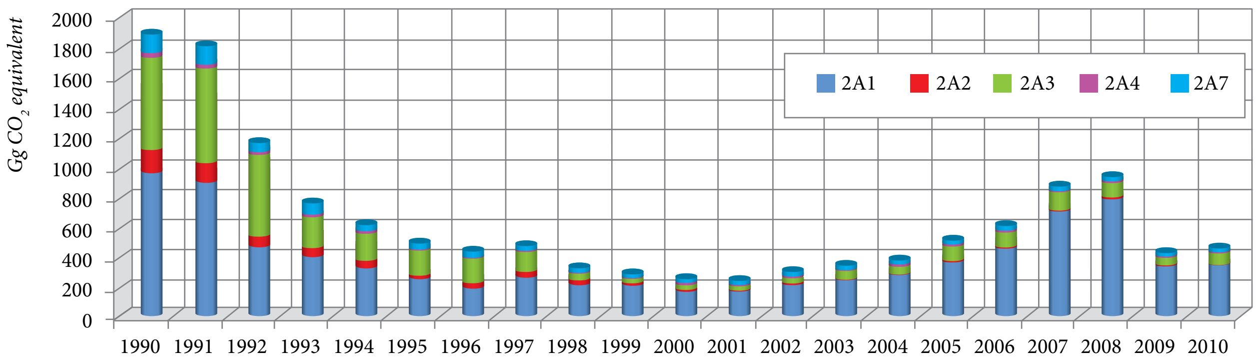


Figure 4-2: Direct GHG Emissions from the Category 2A 'Mineral Products' by Source within 1990-2010 time periods

Table 4-9: Ozone and Aerosol Precursors Emissions from the Category 2A 'Mineral Products' by Gas in the Republic of Moldova within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
NO_x	2.2958	2.1839	1.3860	1.2918	0.8955	0.7502	0.6210
CO	1.2584	1.0436	0.5263	0.4444	0.3258	0.2171	0.2816
NMVOC	392.0868	326.3613	274.2274	218.2458	131.9842	119.1409	107.9721
SO_2	1.7797	1.5383	0.9943	0.9753	0.6385	0.4970	0.4482
	1997	1998	1999	2000	2001	2002	2003
NO_x	0.7440	0.6567	0.5394	0.7317	0.6868	0.8236	0.7856
CO	0.2510	0.1987	0.1239	0.0767	0.0271	0.0565	0.0153
NMVOC	37.0856	30.2177	13.3931	11.3973	13.9627	12.4770	12.7619
SO_2	0.4906	0.4322	0.3580	0.4579	0.4229	0.4991	0.4711
	2004	2005	2006	2007	2008	2009	2010
NO_x	0.8312	0.9800	1.0679	1.3210	1.3425	0.7263	0.7316
CO	0.0166	0.0459	0.0520	0.0827	0.0740	0.0244	0.0212
NMVOC	16.1435	17.9288	25.0377	88.7208	44.1023	20.8339	53.3495
SO_2	0.5351	0.5953	0.6704	0.8263	0.8430	0.4870	0.4887

ment 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 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 chapter.

2A2. 'Lime Production'

Lime (CaO) is formed by heating the limestone to decompose the carbonates. This reaction takes place at higher 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, produce CO_2 emissions as a result of the chemical reaction described above.

2A3. 'Limestone and Dolomite Use'

Limestone ($CaCO_3$) and dolomite ($CaCO_3 \cdot MgCO_3$) represent raw materials with commercial use in a number of industries, such as: metallurgical industry, glass production, sugar production, agriculture, construction and pollution prevention. CO_2 is being generated in industrial applications involving limestone and dolomite heating at high temperatures.

2A4. 'Soda Ash Production and Use'

Soda ash or sodium carbonate (Na_2CO_3) is used as raw material in a number of industries, such as: glass, soap and detergents 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 (to be noted that in the RM, no sodium carbonate is being produced).

2A5. 'Asphalt Roofing'

Production of asphalt used in construction and roofing manufacture is accompanied by the non-methane volatile organic compounds (NMVOC) emissions. Asphalt roofing undergoes oxidation by air blowing, associated with polymerization and stabilization process to improve its characteristics to obtain a better resistance to adverse weather conditions. Blowing air is produced, as a rule, at oil refineries, asphalt plants, as well as in the asphalt manufacturing companies, and other similar products, including in rolls.

2A6. 'Road Paving with Asphalt'

Asphalt is composed of a compact aggregate and bonding material. In highly industrialized countries, typically around 80-90 per cent of the produced asphalt is used for road paving; the rest is used as roofing asphalt (US EPA, 2004). There are several types of road paving asphalt, 80 per cent of the produced asphalt is hot mix asphalt (HMA type), and the rest is liquefied asphalt (CORINAIR, 2005). Pollutant gases (NMVOC, CO) are emitted from asphalt producing plants (stationary or mobile), during road paving, as well as from the road pavement itself.

2A7. 'Other (Other Mineral Products)'

'Glass Production'

GHG emissions originated from production of different types of glass (flat window glass, glass for recipients, glassware, special glass), are covered under this source category. Glass is produced from a raw material mix containing silicon (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. Glass production process allows for a small quality of recycled glass to be used (its share can vary between 10-80 per cent of the total raw material used).

The melting process for glass of different types is similar. Glass production process implies the following phases: selection and preparation of the raw material; melting, moulding, hardening, quenching and finishing. The main polluting emissions from this process are NO_x, NMVOC, SO_2 and CO_2.

The amount of SO_2 emissions during the glass production process is mostly determined by the amount of melted dose of sulphur and its absorption capacity, by the access of air and combustion temperature. The main mechanisms of NO_x formation are related to fuel combustion and emission of NO_x, as well as emission resulting from use of nitrates in the raw material for some types of glass. CO_2 emissions result from lime calcinations and other carbonates at high temperatures (in the RM, CO_2 emissions from glass production are accounted within 2A3 'Limestone and dolomite use' and 2A4 'Soda ash production and use' source categories).

'Mineral Wool Production'

Products produced of mineral fibers are composed of inorganic fibers produced from melting of silicate and, depending on their use, contain different bonding agents and additives (a mix of minerals and coke heated until it melts and can be wriggled in fibers; the fibers are treated with resin to form a product resembling cotton wool). The main pollutants generated during the process of melting and wriggling, as well as during the finishing of mineral wool are: SO_2, CO and CO_2.

'Brick and Expanded Clay Production'

Brick and expanded clay production involves mining, extraction, processing and refining the raw material (clay) with such additives as kaolin or limestone, moulding, cutting, drying and kilning of the final product. The main pollutants resulting from calcination of carbonates at high temperatures in the process of brick production are CO_2 and SO_2.

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 (IPCC, 2000) 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.

$$EF_{clinker} = \text{Content CaO} \bullet \text{stoichiometric ratio } CO_2/CaO + \text{Content MgO} \bullet \text{stoichiometric ratio } CO_2/MgO$$

$$CO_2 \text{ emissions} = EF_{clinker} \bullet \text{Clinker Production} \bullet \text{CKD Correction Factor}$$

This approach assumes that all the CaO and MgO from the clinker is from $CaCO_3$ (limestone) and $CaMg(CO_3)_2$ (dolomite). Since no data on non-carbonate sources were available, it was no need to adjust (reduce) the emission factors. The value of CKD correction factor was also taken into account. Cement Kiln Dust (CKD) represents a mix of calcinated and uncalcinated raw materials.

Practically, all cement kilns produce CKD, its quantity depending of plant technologies. To be noted that cement kiln dust may be recovered via electrostatic precipitation or filtration from the exhaust stacks, the recovered CKD may be recycled to the kiln as a raw material. Any CKD not recycled to the kiln is lost to the cement system in terms of CO_2 emissions.

To be noted that default CKD correction factor is 1.02, and in the RM its value varied during 1990-2010 from a maximum of 1.013 to a minimum of 1.003.

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, stoichiometric 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 within 1990-2010 time periods

Coefficients	1990	1991	1992	1993	1994	1995	1996
CaO fraction	0.6576	0.6576	0.6576	0.6566	0.6566	0.6577	0.6577
CO_2/CaO stoichiometric ratio	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
CO_2/MgO stoichiometric ratio	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
$EF_{clinker}$	0.5394	0.5405	0.5394	0.5392	0.5397	0.5406	0.5406
Coefficients	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CaO fraction	0.6577	0.6577	0.6577	0.6569	0.6599	0.6602	0.6621
CO_2/CaO stoichiome tric ratio	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	0.0181
CO_2/MgO stoichiome tric ratio	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
CKD fraction	1.0120	1.0130	1.0120	1.0120	1.0090	1.0060	1.0060
$EF_{clinker}$	0.5400	0.5406	0.5400	0.5394	0.5402	0.5388	0.5426
Coefficients	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CaO fraction	0.6586	0.6591	0.6605	0.6570	0.6570	0.6510	0.6550
CO_2/CaO stoichiome tric ratio	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
MgO fraction	0.0160	0.0160	0.0140	0.0190	0.0120	0.0170	0.0160
CO_2/MgO stoichiome tric ratio	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
CKD fraction	1.0060	1.0060	1.0070	1.0060	1.0050	1.0030	1.0040
$EF_{clinker}$	0.5376	0.5380	0.5374	0.5396	0.5314	0.5311	0.5337

Below are presented the default EFs values (IPCC, 1997) used to estimate indirect GHG and SO_2 emissions from cement/clinker production (Table 4-11).

Table 4-11: Default Emission Factors used to Estimate Indirect GHG and SO_2 Emissions from 2A1 'Cement Production' Source Category

Source	Process Description	NO_x [1]	SO_2 [2]
		kg / t	
Mineral Products	Clinker Production Cement Production	0.6	0.3

Sources: [1] EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, December 2000, B3311-11and B3311-12, ic 030311; [2] Revised 1996 IPCC Guidelines (IPCC, 1997), Vol. 3, Page 2.6.

Information on cement production was received directly from the main producer in the RM, which is Lafarge Cement J.S.C. in Rezina, while activity data on cement production at Cement and Slate Combined Works in Ribnita were obtained from the Statistical Yearbooks of the ATULBD, however only for 2007-2010 years.

For other years, following the GPG recommendations (IPCC, 2000), 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:

Clinker Production = Cement Production • Clinker Fraction in Cement

In conformity with the technological documentation for Portland type cement production, in order to produce one tone of cement, cement plants in the RM use approximately 786.9 kg of clinker (**Annex 3-2**).

The information provided by Lafarge Cement J.S.C. in Rezina through the Official Letter No. 74 as of 02.03.2011 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 the source category 2A1 'Cement Production' is presented below only aggregated at the national level (Table 4-12).

Table 4-12: Activity Data on Cement and Clinker Production in the RM, 1990-2010, kt

	1990	1991	1992	1993	1994	1995	1996
Cement Production	2288.0	1800.0	1088.2	960.3	769.1	518.8	494.4
Clinker Production	1801.3	1666.6	879.3	752.5	608.6	459.7	357.3
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Cement Production	611.8	493.0	462.0	431.9	402.1	477.0	484.4
Clinker Production	500.2	397.8	390.4	320.3	321.9	406.8	452.7
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Cement Production	667.6	772.8	1051.1	1531.0	1775.9	869.4	861.4
Clinker Production	525.7	678.7	850.6	1302.2	1486.6	641.3	655.6

Source: Lafarge Cement J.S.C. in Rezina, Official Letter No. 74 dated 02.03.2011, as a response to the request of the Ministry of Environment No. 03-07/175 dated 02.02.2011; Official Letter No. 186 dated 18.04.2007, as a response to the request of 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) and 2011 (page 94).

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 on the basis of equations below.

$$EF_{quicklime} = \text{Stoichiometric Ratio } (CO_2/CaO)\ (0.785) \bullet \text{CaO Content}$$

$$EF_{dolomitic\ quicklime} = \text{Stoichiometric Ratio } (CO_2/CaO \bullet MgO)\ (0.913) \bullet (CaO \bullet MgO) \text{ Content}$$

To be noted that there are three types of lime: high-calcium lime (CaO + impurities); dolomitic lime (CaO•MgO + impurities); hydraulic lime (CaO + calcium silicates), that is a substance between lime and cement (the first two types have different stoichiometric ratios, and the third has a reduced content of CaO). Taking the types of lime into account allow improve emissions estimates.

As in the RM does not exist statistic information on lime production by type, following the good practice (IPCC, 2000), the AD on lime production was disaggregated for the breakdown of lime types according 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 from lime production are presented in Table 4-13.

Table 4-13: Basic Parameters for Estimating EFs from 2A2 'Lime Production'

Type of lime	Stoichiometric Ratio	Range of CaO Content	Range of MgO Content	Default Values for CaO/CaOMgO Content	Default EF, t CO_2/t lime
	(1)	(%)	(%)	(2)	(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	0.7762
Hydraulic lime	0.7848	65-92		0.75	0.5886

Source: GPG (IPCC, 2000), Chap. 3.1.2 'Lime Production', Table 3.4, Page 3.22.

The emission factors values for other greenhouse gases originated from 2A2 'Lime Production' are available in the EMEP CORINAIR Guidelines (1996) (Table 4-14).

Table 4-14: GHG Emission Factors from 2A2 'Lime Production'

Source	Process Description	NO_x	CO	SO_2
		kg / t		
Mineral Products	Limestone Calcination	1.4	5.0	1.0

Source: EMEP CORINAIR Guidelines, 3rd edition, February 15, 1996, B3312-5, ic030312, Lime.

Statistical Yearbooks of the RM contain aggregated AD on lime production for the period until 1992. For the time series from 1993 through 2010, activity data on lime production are available separately for the right and left bank of Dniester, the SYs of the RM and ATULBD (Table 4-15).

Table 4-15: Activity Data on Lime Production within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
RM: right bank of Dniester River	114.30	100.00	32.80	30.00	15.90	10.80	19.90
RM: left bank of Dniester River	90.00	78.60	55.00	48.00	45.00	28.00	34.00
RM: total	204.30	178.60	87.80	78.00	60.90	38.80	53.90
	1997	1998	1999	2000	2001	2002	2003
RM: right bank of Dniester River	9.70	12.70	5.20	3.10	3.30	3.30	2.90
RM: left bank of Dniester River	39.00	26.00	19.00	12.00	2.00	8.00	0.00
RM: total	48.70	38.70	24.20	15.10	5.30	11.30	2.90
	2004	2005	2006	2007	2008	2009	2010
RM: right bank of Dniester River	2.10	2.10	2.20	1.10	0.30	0.30	0.00
RM: left bank of Dniester River	1.00	7.00	8.00	14.00	14.00	4.28	3.18
RM: total	3.10	9.10	10.20	15.10	14.30	4.58	3.18

Source: SYs of the RM for 1994 (page 286), 1999 (page 302), 2003 (page 392), 2006 (page 312), 2007 (page 311); NBS of the RM through Official Letter No. 06-39/08 dated 23.02.2011, as a response to the request of the MoEN No. 03-07/175 dated 02.02.2011; SY of the ATULBD for 1998 (page 176), 2000 (page 99), 2002 (page 103), 2005 (page 94), 2007 (page 92), 2009 (page 92), 2011 (page 94).

As revealed above, during the last years, in the RM (right bank of Dniester), lime production decreased sharply. In this context, the amount of lime needed for domestic consumption is being imported. Table 4-16 provides statistical data on lime imports during 1995-2010. According to these data, lime imports increased by 76 times within this time period.

Table 4-16: Lime imports in the Republic of Moldova (Right Bank of Dniester River), 1995-2010

	1995	1996	1997	1998	1999	2000	2001	2002
Lime imports, kt	0.063	0.234	0.336	0.515	0.405	0.603	1.783	2.109
	2003	2004	2005	2006	2007	2008	2009	2010
Lime imports, kt	3.243	3.662	3.953	5.121	6.423	7.540	3.798	4.826

Source: Custom Service of the RM, Official Letter No. 28/07-1893 dated 23.02.2011, as a response to the request of the MoEN No. 03-07/175 dated 02.02.2011.

Because 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 practice (IPCC, 2000), this value was inferred from AD on total amount of lime produced in the RM, 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 4-17).

CO_2 emissions were estimated following a Tier 1 methodological approach, by multiplying the emission factors mentioned above to annual activity data on hydrated lime production, taking into account the type of lime produced.

$$Total_{l} = P_{i} \bullet EF_{lime,\, i}$$

Where:

Total $_{l}$ – CO_2 emissions from type *i* lime production (Gg/yr);

P $_{i}$ – production of lime of type *i* (kt/yr);

$EF_{lime,\, i}$ – emission factor for lime of type *i* (0.7456 t CO_2/t high-calcium lime and 0.7762 t CO_2/ t dolomitic lime)

This approach was preferred to the one available in the Revised 1996 IPCC Guidelines (IPCC, 1997), which admitted the use of emission factors that do not take into account CaO and CaO•MgO content in lime (circa 95 per cent for CaO and circa 85 per cent for CaO•MgO), what entailed excessive increase of default EF values: 0.785 t CO_2 per ton of high calcium and 0.913 t CO_2 per tonne of dolomitic lime (assuming that CaO and CaO•MgO content in lime is 100 per cent).

2A3. 'Limestone and Dolomite Use'

Methodological issues regarding estimation of CO_2 emissions from limestone and dolomite use are addressed in the Revised 1996 IPCC Guidelines (IPCC, 1997).

CO_2 emissions from limestone and dolomite use may be estimated from a consideration of consumption and purity of the raw materials, as well as the stoichiometry of the chemical processes.

Limestone emission factor (EF_{ls}) will be estimated using the following equation:

Table 4-17: Activity Data on Hydrated Lime Production within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
High calcium lime	168.4454	147.2557	72.3911	64.3110	50.2121	31.9906	44.4406
Dolomitic lime	29.7257	25.9863	12.7749	11.3490	8.8610	5.6454	7.8425
Total slaked lime produced	198.1710	173.2420	85.1660	75.6600	59.0730	37.6360	52.2830
	1997	1998	1999	2000	2001	2002	2003
High calcium lime	40.1532	31.9082	19.9529	12.4500	4.3699	9.3169	2.3911
Dolomitic lime	7.0859	5.6309	3.5211	2.1971	0.7712	1.6442	0.4220
Total slaked lime produced	47.2390	37.5390	23.4740	14.6470	5.1410	10.9610	2.8130
	2004	2005	2006	2007	2008	2009	2010
High calcium lime	2.5560	7.5030	8.4099	12.4500	11.7904	3.7762	2.6219
Dolomitic lime	0.4511	1.3241	1.4841	2.1971	2.0807	0.6664	0.4627
Total slaked lime produced	3.0070	8.8270	9.8940	14.6470	13.8710	4.4426	3.0846

$$EF_{ls} = f \bullet [44.01\ g/mole\ CO_2] / [(100.09\ g/mole\ CaCO_3)] = (440 \bullet f)\ kg\ CO_2 / t\ limestone$$

Where:

f – fractional purity of the limestone in $CaCO_3$ per tonne of total raw material weight; the default factor is 1; in the Republic of Moldova it has been considered the value of 0.9517, representing an average value for the raw material purity (the raw materials were extracted from the quarries located in: Varancau vilage, Soroca District; Beleavinti vilage, Briceni District; Caracusenii Vechi vilage, Briceni District; and Hincauti vilage, Edinet District.

Emission factor (EF_d) for dolomite use will be estimated using the following equation:

$$EF_d = f \bullet [2 \bullet 44.01\ g/mole\ CO_2] / [(184.41\ g/mole\ CaCO_3 \bullet MgCO_3)] = (477 \bullet f)\ kg\ CO_2/t\ dolomite$$

Where:

f – fractional purity of the dolomite in $CaCO_3 \bullet MgCO_3$ per ton of total raw material weight; the default factor is 1.

AD on limestone and dolomite use was provided by the Agency for Geology and Mineral Resources, institution subordinated to the Ministry of Environment of the Republic of Moldova.

To be noted that, according to the Revised 1996 IPCC Guidelines (IPCC, 1997), consumption is assumed to equal material mined plus material imported minus material exported. Data regarding the imports and exports of limestone and dolomite were provided by the Custom Service of the RM (Table 4-18).

Table 4-18: AD on Limestone and Dolomite Use in the RM, 1990-2010, kt

Year	Limestone for sugar production, kt	Limestone for glass production, kt	Limestone for the metallurgical industry, kt	Imported limestone, kt	Total consumption of limestone, kt	Total consumption of dolomite, kt
1990	1369.00	40.00	22.00	23.14	1454.14	22.14
1991	1417.00	40.00	22.00	16.25	1495.25	18.26
1992	1233.00	35.00	12.70	10.36	1291.06	15.32
1993	437.00	25.00	4.00	6.47	472.47	13.54
1994	395.00	30.00	3.00	3.59	431.59	12.83
1995	346.00	26.00	1.00	1.52	374.52	11.86
1996	307.00	30.00	1.00	23.42	361.42	15.88
1997	250.00	25.00	8.00	3.65	286.65	16.90
1998	75.00	20.00	5.00	0.00	100.00	9.69
1999	38.00	16.00	0.00	0.00	54.00	4.03
2000	37.00	13.00	0.00	0.00	50.00	23.58
2001	29.00	7.00	0.00	0.00	36.00	21.86
2002	33.00	7.00	24.00	0.00	64.00	19.24
2003	30.00	0.00	72.00	7.33	109.33	20.19
2004	63.00	0.00	60.00	0.00	123.00	0.07
2005	130.00	42.00	62.00	1.83	235.83	0.07
2006	132.00	30.00	79.00	0.00	241.00	0.07
2007	166.90	13.50	103.30	0.00	283.70	0.15
2008	88.80	38.00	98.00	0.00	224.80	0.12
2009	39.50	11.70	71.30	0.00	122.50	0.12
2010	56.10	11.70	109.90	0.00	177.70	0.10
1990-2010,%	**-95.9**	**-70.8**	**399.5**	**-100.0**	**-87.8**	**-99.5**

Source: Agency for Geology and Mineral Resources, Official Letters No. 90/05 dated 17.02.2011 and No. 516/05 dated 11.08.2011, as a response to the request of the MoEN No. 03-07/175 dated 02.02.2011; Custom Service of the RM, Official Letter No. 28/07-1893 dated 23.02.2011, as a response to the request of the MoEN No. 03-07/175 dated 02.02.2011.

Following the Revised 1996 IPCC Guidelines (IPCC, 1997) recommendations, the consumption entering this calculations excludes limestone used for producing cement, lime, agriculture, the dolomite used to produce lime, as well as the processes that are not associated with limestone and dolomite heating, respectively those processes where CO_2 is not generated.

The total CO_2 emission from limestone and dolomite use is estimated using the following equation:

$$Total_{ld} = \{(A_{ls} \bullet EF_{ls}) + (A_d \bullet EF_d)\}/10^6 = \{(440 \bullet f \bullet A_{ls}) + (477 \bullet f \bullet A_d)\}/10^6$$

Where:

$Total_{ld}$ – process CO_2 emissions from limestone and dolomite use (Gg/yr);

A_{ls} – consumption of limestone (ton/yr); consumption is assumed to equal material mined (or dredged) plus material imported minus material exported. The consumption entering this calculation excludes limestone used for producing cement and lime, agriculture and processes where CO_2 is not generated.

A_d – consumption of dolomite (ton/yr); consumption is assumed to equal material mined plus material imported minus material exported. The consumption entering this calculation excludes dolomite used for producing lime and processes where CO_2 is not generated.

2A4. Soda Ash Production and Use

Methodological issues regarding estimation of CO_2 emissions from soda ash production and use are addressed in the Revised 1996 IPCC Guidelines (IPCC, 1997).

CO_2 emissions from soda ash production and use may be estimated from a consideration of consumption, as well as the stoichiometry of the chemical processes.

The emission factor for soda ash will be estimated using the following equation:

$$EF_{sa} = 44.01\ g/mole\ CO_2 / 105.99\ g/mole\ Na_2CO_3 = 415\ kg\ CO_2 / ton\ Na_2CO_3$$

AD regarding soda ash consumption is provided in Table 4-19. To be noted that according the Revised 1996 IPCC Guidelines (IPCC, 1997), consumption is assumed to equal soda ash produced plus imports minus exports.

To be noted that no soda ash is produced in the Republic of Moldova. Data on soda ash imports and exports for 1995-2010 time series were provided by the Custom Service of the RM, while there is no information regarding 1990-1994 time series. In order to fill this gap, following the GPG (IPCC, 2000, Chapter 7, Table 7-5, Page 7.19) the trend extrapolation method was used (using regression analysis)[18].

As Table 4-19 presents, soda ash consumption in the country decreased between 1990 and 2010 by 63.4 per cent.

Table 4-19: AD on Soda Ash Production and Use in the RM within the 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
Soda ash consumption	79.4121	67.6352	57.1254	47.6125	39.4136	35.2333	19.6869
	1997	1998	1999	2000	2001	2002	2003
Soda ash consumption	25.2708	20.2975	16.1479	33.7542	34.6490	34.2346	30.4387
	2004	2005	2006	2007	2008	2009	2010
Soda ash consumption	38.4227	43.7608	38.6980	34.1175	33.7002	24.2468	29.0280

Source: Custom Service of the RM, Official Letter No. 28/07-1893 dated 23.02.2011, as a response to the request of the MoEN No. 03-07/175 dated 02.02.2011.

Total CO_2 emissions from soda ash use are estimated using the following equation:

$$Total_{sa} = A_{sa} \bullet EF_{sa} / 10^6$$

Where:

$Total_{sa}$ – CO_2 emissions from soda ash use (Gg/yr);

A_{sa} – soda ash consumption (ton/yr);

EF_{sa} – default emission factor for CO_2 emissions from soda ash use, equal to 415 kg CO_2/ton of product.

2A5. 'Asphalt Roofing Production'

Methodological issues regarding estimation of GHG emissions from asphalt roofing are addressed in the Revised 1996 Guidelines (IPCC, 1997). GHG emissions covered by this source category were estimated following a Tier 1 methodological approach. Default EFs values (no control) for NMVOC represents 2.4 kg per ton of asphalt blowing (Revised 1996 Guidelines, Volume 2, Table 2-3, Page 2.9).

AD regarding asphalt roofing production was provided by the NBS of the RM (Table 4-20). According to these data, until 2003, no domestic asphalt roofing production was recorded, the respective asphalt roofing production being imported.

Total NMVOC emissions from asphalt roofing are estimated using the following equation:

$$Total_{asr} = A_{asr} \bullet EF_{asr} / 10^6$$

Where:

Total asr – NMVOC emissions from asphalt roofing production (Gg/yr);

Aasr – annual production of asphalt roofing (ton/yr);

EFasr – default emission factor value (no control) for NMVOC emissions from asphalt blowing equal to 2.4 kg NMVOC/ton of product.

2A6. 'Road Paving with Asphalt'

Methodological issues regarding estimation of GHG emissions from road paving with asphalt are addressed in the Revised 1996 Guidelines (IPCC, 1997). GHG emissions covered by this source category were estimated following a Tier 1 methodological approach. Default EFs values for NMVOC, CO, NO_x and SO_2 are provided in Table 4-21, while the annual data related to asphalt production (provided by the Ministry of Transport and Roads Infrastructure) are available in Table 4-22.

Table 4-21: EF used to estimate GHG Emissions from Asphalt Production and Use for Road Paving with Asphalt

Source	Description	SO_2	NO_x	CO	NMVOC
		kg / t asphalt			
Mineral products	Asphalt plants	0.12	0.084	0.035	0.023
	Road surface	NAV	NAV	NAV	320

Source: Revised 1996 Guidelines, Volume 3, Table 2-4, page 2.14.

GHG emissions (NMVOC, CO, NO_x and SO_2) were estimated using the following equation:

$$Total_{rpa} = A_{rpa} \bullet EF_{rpa,\ i}$$

Where:

GHG emissions – NMVOC, CO, NO_x and SO_2 emissions;

A_{rpa} – annual production of asphalt (ton/yr);

EF_{rpa} – default emission factor for GHG emissions of type *i* (NMVOC, CO, NO_x and SO_2), kg GHG/ton of product.

[18] Regression equation used is of polynomial type: $y = 630.09x^2 - 13888x + 92911$, $R^2 = 0.9839$.

Table 4-20: AD on Asphalt Roofing Production in the RM, 2003-2010

	2003	2004	2005	2006	2007	2008	2009	2010
Production of asphalt or similar materials, in rolls exclusively, kt	8.8	6.7	6.9	10.4	11.2	90.5	15.3	18.9
Bituminous mixtures based on natural asphalt or natural bitumen, petroleum bitumen, mineral tar, mineral resin, kt	72.2	229.3	215.1	347.9	365.4	209.4	153.7	25.1

Source: NBS of the RM, Official Letter No. 06-39/08 dated 23.02.2011, as a response to the request of the MoEN No. 03-07/175 dated 02.02.2011.

Table 4-22: AD regarding Road Paving with Asphalt within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Road paving with asphalt, kt	1220.305	1014.808	853.000	678.000	410.000	370.000	335.600
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Road paving with asphalt, kt	113.727	92.328	40.275	32.589	40.800	35.700	36.300
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Road paving with asphalt, kt	45.700	51.100	72.400	271.500	133.100	61.900	164.500

Source: Ministry of Transport and Roads Infrastructure, Official Letter No. 03-5-2/2-32 dated 31.03.1999, as a response to Letter No. 01-7/172 dated 12.03.1999, regarding the period 1990-1998; Official Letter No. 04-02-3/101 dated 18.02.2004, as a response to Letter No. 257-01-07 dated 26.01.2004, regarding the period 1999-2002; Official Letter No. 04-01-3/754 dated 2.10.2006, as a response to Letter No. 01-07/1400 dated 25.08.2006, regarding the period 2001-2005;Official Letter No. 04-01-3/754 dated 2.03.2011, as a response to Letter No. 03-07/175 dated 02.02.2011, regarding the period 2003-2010.

2A7. 'Other'

'Glass Production'

Methodological issues regarding estimation of indirect GHG emissions from glass production are addressed in the Revised 1996 Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), as well as in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (2005). Default EFs used to estimate NO_x, COVNM and SO_2 emissions are provided in Table 4-23.

To be noted, CO_2 emissions from glass production are accounted in 2A3 „Limestone and Dolomite Use" and 2A4 „Soda Ash Production and Use".

Four glass plants produce glass in the RM: the S.O.E. "Glass Factory No.1" and "Glass Container Company" (since 1997) in Chisinau, "Cristal-Flor" Glass Factory in Floresti and the Glass Factory in Tiraspol (ATULBD) which ceased its activity in 2009.

Table 4-23: EF Used to Estimate Indirect GHG Emissions from Glass Production

Source	Process description	NO_x*	SO_2*	NMVOC**
		kg / t glass		
Mineral products	Flat glass production	4.6	3.0	4.5
	Production of glass for receptacles	2.4	1.2	

Source: * EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd Edition, June 2005, B3314-20-23 for flat glass production and B3314-24-27 for production of glass for receptacles, ic030314, Glass production; ** Revised 1996 Guidelines, volume 3, chapter 2.7.3 „Production of other Mineral Products", page 2.14.

Statistical Yearbooks of the Republic of Moldova provide activity data on flat glass production (Table 4-24). Since 1993, flat glass for the construction sector is no longer produced in the RM.

Table 4-24: AD on Flat Glass Production within1985-1992 time periods, thousand m^2

Category	1985	1986	1987	1988	1990	1991	1992
Flat glass for construction	94.0	124.0	118.0	265.0	226.0	287.0	184.0

Source: Statistical Yearbooks of the RM for 1988 (page 228) and 1994 (page 287).

To convert the AD in metric mass units (kt), a conversion coefficient of 0.005 t per 1 m^2 of flat glass was used.

AD related to production of glass bottles for the wine industry (expressed in conventional bottles of 0.7 liters) is available in the Statistical Yearbooks of the RM (Table 4-25).

Table 4-25: AD on Production of Glass Bottles for the Wine Industry in the RM within 1990-2010 time periods, million pieces

	1990	1991	1992	1993	1994	1995	1996
75 cl standard wine bottles	165.50	153.00	138.80	138.20	133.40	184.00	165.20
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
75 cl standard wine bottles	172.20	189.10	125.20	260.50	228.30	296.10	281.40
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
75 cl standard wine bottles	308.00	354.60	321.40	302.70	284.70	201.30	186.90

Source: Statistical Yearbooks of the Republic of Moldova for 1994 (page 287), 1999 (page 303), 2003 (page 393), 2004 (page 443), 2005 (page 321-322), 2006 (page 312), 2010 (page 305), 2011 (page 306).

Glass bottles for the wine industry are produced only on the right bank of the Dniester River. Within 1990 to 2010 the production increased by circa 12.9 per cent. To convert the activity data in metric mass units (kt), a conversion coefficient of 0.5 kg per standard 75 cl wine bottle was used. Activity data on the production of glass packaging for the canning industry (in glass jars equivalent to 0.5 liters) are available in the Statistical Yearbooks of the RM, as well as in those of the ATULBD (Table 4-26). According to information presented in the table above, during 1990-2010 this type of production decreased of approximately 84.8 per cent.

Table 4-26: AD on Production of Glass Packaging for the Canning Industry in the RM within 1990-2010 time periods, million glass jars equivalent to 0.5 liters

	1990	1991	1992	1993	1994	1995	1996
RM: right bank of Dniester River	222.60	245.70	187.40	248.90	152.70	87.40	39.60
RM: left bank of Dniester River	435.00	448.00	330.00	284.00	111.00	89.50	71.90
RM: total	657.60	693.70	517.40	532.90	263.70	176.90	111.50
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
RM: right bank of Dniester River	86.40	84.20	104.60	156.20	148.80	137.40	107.40
RM: left bank of Dniester River	81.90	52.00	19.00	56.00	69.00	77.00	69.00
RM: total	168.30	136.20	123.60	212.20	217.80	214.40	176.40

	2004	2005	2006	2007	2008	2009	2010
RM: right bank of Dniester River	98.90	103.10	121.30	98.70	80.70	92.20	99.80
RM: left bank of Dniester River	45.00	33.00	37.00	40.00	0.92	0.00	0.00
RM: total	143.90	136.10	158.30	138.70	81.62	92.20	99.80

Source: Statistical Yearbooks of the RM for 1994 (page 287), 1999 (page 303), 2003 (page 393), 2006 (page 312), 2007 (page 311), 2010 (page 305), 2011 (page 306); SY of the ATULBD for 1998 (page 180), 2000 (page 100), 2002 (page 104), 2005 (page 94), 2006 (page 93), 2007 (page 93), 2009 (page 93), 2010 (page 93), 2011 (page 94).

To convert the activity data in metric mass units (kt), a conversion coefficient of 0.4 kg per one conventional 0.5 liters jar was used.

'Mineral Wool Production'

Methodological issues regarding estimation of GHG emissions from mineral wool production are addressed in the CORINAIR Guidelines (2005) (Table 4-27).

Table 4-27: EFs Used to Estimate GHG emission from Mineral Wool Production

Source	Process Description	CO_2	CO	SO_2
		kg GES / t of product		
Mineral products	Mineral wool production	115	3.2	1.5

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, June 2005, B3318-7, ic030318, Mineral Wool.

Activity data regarding mineral wool production (expressed in thousand m^3) are available in the Statistical Yearbooks of the RM and those of the ATULBD (Table 4-28).

Table 4-28: AD on Mineral Wool Production within 1990-2002 time periods, thousand m^3

	1990	1991	1992	1993	1994	1995	1996
RM: right bank of Dniester River	124.5	110.7	66.3	55.7	14.8	29.5	21.0
RM: left bank of Dniester River	437.7	244.0	110.2	50.2	25.5	10.3	0.0
RM: total	562.2	354.7	176.5	105.9	40.3	39.8	21.0
	1997	1998	1999	2000	2001	2002	2003
RM: right bank of Dniester River	21.1	13.5	8.9	5.9	NO	NO	NO
RM: left bank of Dniester River	5.9	6.0	4.0	0.0	NO	1.0	NO
RM: total	27.0	19.5	12.9	5.9	NO	1.0	NO

Source: Statistical Yearbooks of the RM for 1988 (page 228), 1994 (page 286), 1999 (page 303) and 2003 (page 392); Statistical Yearbooks of the ATULBD for 1998 (page 177), 2000 (page 99), 2002 (page 103), 2006 (page 93).

To convert the AD in metric mass units (kt), a conversion coefficient of 0.125 t per 1 m^3 of mineral wool was used.

In conformity with the information provided by the NBS, starting 2001 no mineral wool is produced in the RM. On the left bank of Dniester River production of mineral wool stopped in 2002.

'Brick and Expanded Clay Production'

Methodological issues regarding estimation of GHG emissions from bricks and expanded clay production are addressed in 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

In the bricks and expanded clay production process, CO_2 emissions result from calcination of carbonates contained in clay, as well as in other additives used in the technological process. Similarly to cement and lime production processes, carbonates are heated in kilns at high temperatures and emit carbon dioxide.

CO_2 emissions can be estimated by multiplying annual activity data on the amount of carbonates used in production process (different types of clay) by a specific EF, taking into account the content of CaO and MgO in the carbonates used.

$$Emissions\ CO_2 = M_c \bullet EF_{c,}$$

Where:

M_c – mass of carbonate consumed in bricks production (tones of clay)

EF_c – emission factor for carbonates calcination (t CO_2 / t clay).

In carbonates calcination reaction each mole of CaO and respectively, MgO forms one mole of CO_2. This principle was used for developing countries specific values of emission factors.

$$EF = Stoichiometric\ Ratio\ (CO_2/CaO) \bullet Content\ of\ CaO\ in\ Clay + Stoichiometric\ Ratio\ (CO_2/MgO) \bullet Content\ of\ MgO\ in\ Clay$$

In the RM the content of CaO in clay varies between 8 and 9 per cent, while content of MgO, respectively between 3 and 4 per cent[19].

The values of EFs used to estimate CO_2 emissions from brick and expanded clay production (see **Annex 3-2**) was determined based on information provided by the producers (Table 4-29).

SO_2 emission factors from brick production are available in the third edition of the EMEP CORINAIR Inventory Guidebook (Table 4-30).

Statistical Yearbooks of the RM and those of the ATULBD contain activity data regarding brick production (expressed in thousand units of conventional bricks; it has been considered that 85 per cent of the total represent red bricks and 15 per cent – white bricks) (Table 4-31).

[19] In conformity with information provided by producers, the average content of CaO in clay extracted in Purcel quarry is circa 8.44%, and in Micauti and Pruncul quarries – 8.22%; the average content of MgO in clay extracted in Purcel quarry is 3.03%, and in Micauti and Pruncul quarries – 3.57%.

Table 4-29: Country Specific Emission Factors Used to Estimate CO_2 Emissions from Bricks and Expanded Clay Production, 1990-2010

Coefficients	1990	1991	1992	1993	1994	1995	1996
Content of CaO in clay used	0.0844	0.0844	0.0844	0.0844	0.0844	0.0844	0.0822
Stoichiometric Ratio CO_2/CaO	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
Content of MgO in clay used	0.0303	0.0303	0.0303	0.0303	0.0303	0.0303	0.0303
Stoichiometric Ratio CO_2/MgO	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
EF , t CO_2/t clay used	0.0993	0.0993	0.0993	0.0993	0.0993	0.0993	0.0976
Coefficients	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Content of CaO in clay used	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822
Stoichiometric Ratio CO_2/CaO	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
Content of MgO in clay used	0.0321	0.0321	0.0321	0.0321	0.0321	0.0357	0.0357
Stoichiometric Ratio CO_2/MgO	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
EF , t CO_2/t clay used	0.0996	0.0996	0.0996	0.0996	0.0996	0.1035	0.1035
Coefficients	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Content of CaO in clay used	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822
Stoichiometric Ratio CO_2/CaO	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848
Content of MgO in clay used	0.0357	0.0357	0.0357	0.0357	0.0357	0.0357	0.0357
Stoichiometric Ratio CO_2/MgO	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919	1.0919
EF , t CO_2/t clay used	0.1035	0.1035	0.1035	0.1035	0.1035	0.1035	0.1035

Table 4-30: EF Used to Estimate SO_2 Emissions from Brick Production

Source	Description	SO_2, kg / t
Mineral Products	Red Brick Production White Brick Production	0.175 0.600

Source: EMEP CORINAIR, Atmospheric Emissions Inventory Guidebook 3rd edition, February 15, 1996, B3319-5, ic030319, Bricks.

Table 4-31: AD on Brick Production within 1990-2010, million pieces

	1990	1991	1992	1993	1994	1995	1996
RM: right bank of Dniester River	190.500	177.50	83.20	149.70	64.30	39.200	37.200
RM: left bank of Dniester River	45.000	40.00	35.00	30.00	25.00	20.000	16.000
RM: total	235.500	217.50	118.20	179.70	89.30	59.200	53.200
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
RM: right bank of Dniester River	47.700	48.700	44.800	39.900	38.100	45.800	52.200
RM: left bank of Dniester River	12.000	7.000	12.000	13.000	15.000	17.000	16.000
RM: total	59.700	55.700	56.800	52.900	53.100	62.800	68.200
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
RM: right bank of Dniester River	54.900	55.700	52.800	55.900	53.000	38.100	36.600
RM: left bank of Dniester River	21.000	18.000	18.000	19.000	20.697	13.523	13.087
RM: total	75.900	73.700	70.800	74.900	73.697	51.623	49.687

Source: Statistical Yearbooks of the RM for 1988 (page 228), 1994 (page 287), 1999 (page 303), 2005 (page 322), 2010 (page 305), 2011 (page 306); Statistical Yearbooks of the ATULBD for 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).

To convert the AD in metric mass units (kt), a conversion coefficient of 4 kg per one conventional brick piece was used.

The amount of clay needed to produce one brick (on average circa 3.2 kg of clay per one brick piece) was inferred from the information provided directly from MACON J.S.C. (the largest bricks producer in the RM). This coefficient was used to estimate the amount of clay used in brick production countrywide (Table 4-32).

Table 4-32: Activity Data on the Amount of Clay Used in Brick Production in the Republic of Moldova within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Clay used, kt	506.325	467.625	254.130	386.355	191.995	127.280	114.380
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Clay used, kt	128.355	119.755	122.120	113.735	132.750	157.000	170.500
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Clay used, kt	189.750	184.250	177.000	187.250	184.243	129.058	124.218

AD regarding expanded clay production (expressed in *thousand m^3*) were provided directly by MACON J.S.C., the only expanded clay producer in the Republic of Moldova (Table 4-33).

Table 4-33: AD on the Amount of Clay Used in Expanded Clay Production in the RM, 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Expanded clay production, thousand m^3	443.148	378.759	185.666	189.455	89.789	59.463	53.570
Clay used, t/m^3 expanded clay	0.735	0.731	0.727	0.732	0.729	0.726	0.713
Specific weight, kg/m^3	399.8	397.4	397.4	396.9	396.5	395.9	395.3
Total clay used, thousand tones	325.714	276.873	134.979	138.681	65.456	43.170	38.196

	1997	1998	1999	2000	2001	2002	2003
Expanded clay production, thousand m^3	54.664	51.088	52.130	48.720	49.714	51.252	52.298
Clay used, t/m^3 expanded clay	0.724	0.719	0.723	0.729	0.715	0.711	0.717
Specific weight, kg/m^3	394.8	393.8	393.0	391.2	390.1	388.9	387.3
Total clay used, thousand tones	39.576	36.732	37.690	35.517	35.546	36.440	37.497
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Expanded clay production, thousand m^3	55.050	63.400	72.200	80.555	64.963	61.199	61.420
Clay used, t/m^3 expanded clay	0.731	0.710	0.711	0.550	0.624	0.629	0.572
Specific weight, kg/m^3	371.1	392.9	399.7	385.4	376.2	399.4	353.3
Total clay used, thousand tones	40.242	45.014	51.334	44.305	40.537	38.494	35.132

4.2.3 Uncertainties Assessment and Time-Series Consistency

2A1 'Cement Production'

The uncertainty of the CaO and MgO fractions in clinker is low (±2 per cent), the same is the uncertainty of emission factor. The activity data related uncertainties were also estimated as being moderate: in the case of AD provided by the Lafarge Cement J.S.C. uncertainties account for circa ±1 per cent, while in the case of Cement and Slake Integrated Works in Ribnita, uncertainties reach up to ±5 per cent; thus, the average AD uncertainties were accepted as being ±3 per cent.

Combined uncertainties related to GHG emissions from 2A1 'Cement Production' source category are considered low (±3.61 per cent). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±2.23 per cent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.78 per cent (see **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 GPG (IPCC, 2000).

2A2 'Lime Production'

Uncertainty of the average CaO fraction in lime was estimated at circa ±4-8 per cent. The stoichiometric ratio is an exact figure, so the uncertainties on the emission factor are about ±2 per cent. Uncertainties of activity data on lime production in the RM represent circa ±3 per cent. The correction factor used for hydrated lime adds another ±5 per cent to general uncertainties.

Combined uncertainties related to GHG emissions from 2A2 'Lime Production' source category can be considered low (±8.25 per cent). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±0.03 per cent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.05 per cent (see **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 GPG (IPCC, 2000).

2A3 'Limestone and Dolomite Use'

In theory, uncertainties related to EF for this source are quite low, as the stoichiometric ratio determines the emission factor, reflecting the amount of CO_2 emitted during the calcination of carbonates. In practice, there are uncertainties related to changes in limestone and dolomite chemical composition. For example, in addition to calcium carbonate, limestone may contain small amounts of magnesium, silicon and sulfur. Considering that AD was correctly collected and appropriate emission factors were applied, uncertainties associated with emission factors could be accepted as negligible (IPCC, 2006). However there may be some uncertainty related to the purity ratio of limestone and dolomite, so the uncertainties associated with the emission factor represent about ±5 per cent. Uncertainties of activity data on limestone and dolomite use in the country are about ±15 per cent.

The combined uncertainties related to GHG emissions from 2A3 'Limestone and Dolomite Use' source category can be considered moderate (±15.81 per cent). At the same time, the combined uncertainties presented as a percentage of total direct GHG emissions from the 'Industrial Processes' sector were estimated at about ±2.08 per cent. Uncertainties introduced in trend in total sectoral emissions were estimated at about ±0.88 per cent (see **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 GPG (IPCC, 2000).

2A4 'Soda Ash Use'

Uncertainties related to EFs for this source are insignificant (±1-2 per cent), as the stoichiometric ratio determine the emission factor, reflecting the amount of CO_2 emitted during the calcination of sodium carbonate (IPCC, 2006). Uncertainties of activity data on soda ash consumption in the country are about ±15 per cent.

The combined uncertainties related to GHG emissions from the source category 2A4 'Soda Ash Use' can be considered moderate (±15.13 per cent). At the same time, the combined uncertainties presented as a percentage of total sectoral direct GHG emissions were estimated at about ±0.32 per cent. Uncertainties introduced in trend in total sectoral emissions were estimated at about ±0.13 per cent (see **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 GPG (IPCC, 2000).

2A7 'Other: Mineral Wool Production'

Uncertainties related to default emission factors used to calculate CO_2 emissions from mineral wool production were considered low (±5 per cent). Uncertainty of activity data on mineral wool production represent about ±3 per cent. However, because activity data were converted (from cubic meters into metric mass units), additional uncertainties were added (±5 per cent).

The combined uncertainties related to GHG emissions from 2A7 'Other: Mineral Wool Production' can be considered relatively low (±9.43 per cent). Combined uncertainties, presented as a per cent of total sectoral emissions were insignificant (see **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 GPG (IPCC, 2000).

2A7 'Other: Brick and Expanded Clay Production'

The uncertainty of the average CaO and MgO fractions in carbonates used for bricks and expanded clay production represent about ±5 per cent. The stoichiometric ratio is an exact number, so the uncertainty of the emission factor is ±5 per cent. Uncertainties related to activity data on bricks production are circa ±5 per cent, while on expanded clay – circa ±15 per cent. However, because activity data were converted (from millions of manufactured bricks into ton, respectively from thousand m^3 into ton), additional uncertainties were added (±10 per cent).

The combined uncertainties related to GHG emissions from 2A7 'Other: Bricks and Expanded Clay Production' can be considered moderate (±15.81 per cent). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±0.43 per cent for bricks production and circa ±0.10 per cent for expanded clay production. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.17 per cent for bricks production and ±0.04 per cent for expanded clay production (see **Annex 5-3.2**).

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 (IPCC, 2000).

4.2.4 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 (IPCC, 2000). Also, verification was focused on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000), EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 2005), 2006 IPCC Guidelines (IPCC, 2006) and other relevant sources; 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 the category 2A 'Mineral Products' were documented and archived both in hard copies and electronically.

4.2.5 Recalculations

2A1. 'Cement Production'

CO_2 emissions from cement/clinker production were recalculated for the 1990-2005 time series, in particular due to updated AD on clinker production at the Cement Plants in Rezina and Ribnita, new data on CaO and MgO content in clinker, as well as due to use of a country specific CKD correction factor (IPCC, 2000).

In comparison with the results obtained in the previous inventory cycle for the 1990-2005 time series, the above mentioned changes resulted in a decrease of CO_2 emissions in the reference year, respectively during 1995-2005 years (Table 4-34).

The substantial decrease of CO_2 emissions from the clinker production in 1996 was due to the fact that no clinker was produced that year at the Cement Plant in Rezina, while for the cement production it was used the existing clinker available in stock.

Table 4-34: Comparative Results of CO_2 Emissions from 2A1 'Cement Production' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	988.2518	777.3313	364.2929	297.0889	229.9852	252.3529	247.7474
TNC	971.7056	900.7959	474.3181	405.7202	328.4391	248.5280	193.1237
Difference, %	-1.7	15.9	30.2	36.6	42.8	-1.5	-22.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	274.5494	218.3585	214.2372	175.5925	177.2723	224.1095	249.9639
TNC	270.1297	215.0591	210.8141	172.7616	173.8863	219.1937	245.6298
Difference, %	-1.6	-1.5	-1.6	-1.6	-1.9	-2.2	-1.7
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	288.9106	373.2628					
TNC	282.5791	365.0851	457.0795	702.6719	789.9233	340.5710	349.8365
Difference, %	-2.2	-2.2					

Under the current inventory cycle, AD were updated using information provided directly by the producers, while in the SNC there were used AD on clinker production obtained by multiplying the AD on cement production to the conversion factor of 786.9 kg of clinker per 1 ton of cement produced.

The increase of CO_2 emissions from the clinker production from 1991 to 1994 was due to updated AD on cement/clinker production at the Cement and Slake Integrated Works in Rabnita (ATULBD). This information is not available in the statistical yearbooks of the ATULBD. To fill the gap, the trend extrapolation method (using the regression analysis) was applied, according to the recommendations of GPG (IPCC, 2000, Chapter 7, Table 7-5, Page 7.19)[20].

For the 2006-2010 time periods, CO_2 emissions resulting from cement/clinker production were estimated for the first time. The results allow assert that within the 1990-2010 time series CO_2 emissions from 2A1 'Cement Production' source category decreased by circa 64.0 per cent. In the case of non-CO_2 emissions, the revision of AD on cement/clinker production had a similar trend impact as in the case of CO_2 emissions *(under the current inventory cycle, the same emission factors were used: 0.6 kg NO_x/t clinker, respectively 0.3 kg SO_2/t cement)*. Within the 1990-2010 time series, SO_2 emissions from 2A1 'Cement Production' source category decreased by circa 62.4 per cent, while NO_x emissions decreased by 63.6 per cent (Table 4-35).

Table 4-35: Non-CO_2 Emissions from the 2A1 'Cement Production' Source Category in the Republic of Moldova within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
NO_x, Gg	1.0808	1.0000	0.5276	0.4515	0.3651	0.2758	0.2144
SO_2, Gg	0.6864	0.5400	0.3265	0.2881	0.2307	0.1556	0.1483
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NO_x, Gg	0.3001	0.2387	0.2342	0.1922	0.1931	0.2441	0.2716
SO_2, Gg	0.1836	0.1479	0.1386	0.1296	0.1206	0.1431	0.1453
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NO_x, Gg	0.3154	0.4072	0.5103	0.7813	0.8919	0.3848	0.3933
SO_2, Gg	0.2003	0.2318	0.3153	0.4593	0.5328	0.2608	0.2584

2A2. 'Lime Production'

CO_2 emissions from lime production were recalculated for the 1990-2005 time series, as a result of use of more precise stoichiometric ratio, 0.7848 instead of 0.785 for the high-calcium lime (CO_2/CaO), respectively 0.9132 instead of 0.913 for the dolomitic lime (CO_2/CaO•MgO), as well as due to use of more precise values of default EFs, 0.7456 instead of 0.75 t CO_2/t of high-calcium lime, respectively 0.7762 instead of 0.77 t CO_2/t of dolomitic lime. To be noted also that the activity data on lime production in 2003 on the left bank of Dniester River have been adjusted. In comparison with the results obtained in the previous inventory cycle, the above mentioned changes resulted in an insignificant decrease of CO_2 emissions originated from lime production (Table 4-36).

[20] Polynomial regression analysis: $y = 6.0227x^2 - 174.11x + 1452.3$, $R^2 = 0.9540$.

Table 4-36: Comparative Results of CO_2 Emissions from 2A2 'Lime Production' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	149.2228	130.4512	64.1300	56.9720	44.4820	28.3399	39.3691
TNC	148.6611	129.9602	63.8886	56.7575	44.3145	28.2332	39.2209
Difference, %	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	35.5710	28.2669	17.6759	11.0292	3.8712	8.2536	2.4104
TNC	35.4371	28.1605	17.6094	10.9877	3.8566	8.2226	2.1102
Difference, %	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-12.5
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	2.2643	6.6467					
TNC	2.2557	6.6217	7.4221	10.9877	10.4055	3.3327	2.3140
Difference, %	-0.4	-0.4					

For the period 2006-2010, CO_2 emissions resulting from lime production were estimated for the first time. The results allow assert that within the 1990-2010 time series, CO_2 emissions from 2A2 'Lime Production' source category decreased by circa 98.4 per cent. The same trend was noted for the non-CO_2 emissions originated from respective category (Table 4-37).

Table 4-37: Non-CO_2 Emissions from the 2A2 'Lime Production' Source Category in the Republic of Moldova within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
NO_x, Gg	0.2774	0.2425	0.1192	0.1059	0.0827	0.0527	0.0732
CO, Gg	0.9909	0.8662	0.4258	0.3783	0.2954	0.1882	0.2614
SO_2, Gg	0.1982	0.1732	0.0852	0.0757	0.0591	0.0376	0.0523
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NO_x, Gg	0.0661	0.0526	0.0329	0.0205	0.0072	0.0153	0.0039
CO, Gg	0.2362	0.1877	0.1174	0.0732	0.0257	0.0548	0.0141
SO_2, Gg	0.0472	0.0375	0.0235	0.0146	0.0051	0.0110	0.0028
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NO_x, Gg	0.0042	0.0124	0.0139	0.0205	0.0194	0.0062	0.0043
CO, Gg	0.0150	0.0441	0.0495	0.0732	0.0694	0.0222	0.0154
SO_2, Gg	0.0030	0.0088	0.0099	0.0146	0.0139	0.0044	0.0031

2A3. 'Limestone and Dolomite Use'

CO_2 emissions resulting from limestone and dolomite use were estimated for the first time. The results allow assert that within the 1990-2010 time series, CO_2 emissions from the dolomite use decreased by circa 99.5 per cent, while those from the limestone use decreased by 87.8 per cent. Totally, CO_2 emissions from the 2A3 'Limestone and Dolomite Use' source category decreased during the period under review by 88.0 per cent (Table 4-38).

2A4. 'Soda Ash Use'

CO_2 emissions resulting from soda ash use were estimated for the first time. The results allow assert that within the 1990-2010 time series, the total CO_2 emissions from the 2A4 'Soda Ash Use' source category decreased by 63.4 per cent (Table 4-39).

Table 4-38: CO_2 Emissions from the 2A3 'Limestone and Dolomite Use' Source Category in the Republic of Moldova within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2 emissions from limestone use	608.9161	626.1313	540.6284	197.8471	180.7283	156.8303	151.3456
CO_2 emissions from dolomite use	10.5584	8.7115	7.3072	6.4581	6.1185	5.6553	7.5738
Total CO_2 emissions from limestone and dolomite use	619.4745	634.8427	547.9355	204.3052	186.8468	162.4857	158.9194
	1997	1998	1999	2000	2001	2002	2003
CO_2 emissions from limestone use	120.0350	41.8748	22.6124	20.9374	15.0749	26.7999	45.7834
CO_2 emissions from dolomite use	8.0629	4.6217	1.9234	11.2459	10.4252	9.1791	9.6306
Total CO_2 emissions from limestone and dolomite use	128.0979	46.4965	24.5358	32.1833	25.5001	35.9790	55.4140
	2004	2005	2006	2007	2008	2009	2010
CO_2 emissions from limestone use	51.5060	98.7525	100.9183	118.7988	94.1346	51.2966	74.4115
CO_2 emissions from dolomite use	0.0324	0.0329	0.0330	0.0707	0.0579	0.0579	0.0498
Total CO_2 emissions from limestone and dolomite use	51.5384	98.7854	100.9513	118.8695	94.1925	51.3545	74.4613

Table 4-39: CO_2 Emissions from the 2A4 'Soda Ash Use' Source Category in the Republic of Moldova within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
CO_2 emissions from soda ash use, Gg	32.9560	28.0686	23.7070	19.7592	16.3566	14.6218	8.1701
	1997	1998	1999	2000	2001	2002	2003
CO_2 emissions from soda ash use, Gg	10.4874	8.4235	6.7014	14.0080	14.3793	14.2074	12.6321
	2004	2005	2006	2007	2008	2009	2010
CO_2 emissions from soda ash use, Gg	15.9454	18.1607	16.0597	14.1588	13.9856	10.0624	12.0466

2A5. 'Asphalt Roofing'

NMVOC emissions from asphalt roofing were estimated for the first time. The results allow assert that within the 2003-2010 time series (no asphalt roofing was produced in the RM prior to that period), NMVOC emissions from the 2A5 'Asphalt Roofing' source category decreased by 45.7 per cent (Table 4-40).

Table 4-40: NMVOC Emissions from the 2A5 'Asphalt Roofing' Source Category, 2003-2010

	2003	2004	2005	2006	2007	2008	2009	2010
NMVOC emissions from asphalt roofing, Gg	0.1944	0.5664	0.5328	0.8599	0.9038	0.7198	0.4056	0.1056

2A6. 'Road Paving with Asphalt'

Non-CO_2 emissions from 2A6 'Road paving with asphalt' were recalculated for the 1990-2005 time series because of change of the EFs (35 g CO/ton asphalt, respectively 23 g NMVOC/ton asphalt) available in the Revised 1996 IPCC Guidelines (IPCC, 1997), different from those used in the SNC (75 g CO/ton asphalt, respectively 15 g NMVOC/ton asphalt) according to the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996). To be noted that for the 1990-2010 time series, NO_x and SO_2 emissions from this category (resulting at the asphalt plants) were estimated for the first time.

In comparison with the results obtained in the previous inventory cycle, the recalculations resulted in a 53.3 per cent decrease of CO emissions and 53.3 per cent increase of NMVOC emissions from source category 2A6 'Road Paving with Asphalt'.

Within 1990-2010 time period, the non-CO_2 emissions (NO_x, CO, NMVOC and SO_2) from 2A6 'Road Paving with Asphalt' source category decreased by 86.5 per cent (Table 4-41).

Table 4-41: Non-CO_2 Emissions from 2A6 'Road Paving with Asphalt' Source Category (Asphalt Plants) in the Republic of Moldova within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
NO_x, Gg	0.1025	0.0852	0.0717	0.0570	0.0344	0.0311	0.0282
CO , Gg	0.0427	0.0355	0.0299	0.0237	0.0144	0.0130	0.0117
NMVOC , Gg	0.0281	0.0233	0.0196	0.0156	0.0094	0.0085	0.0077
SO_2, Gg	0.1464	0.1218	0.1024	0.0814	0.0492	0.0444	0.0403
	1997	1998	1999	2000	2001	2002	2003
NO_x, Gg	0.0096	0.0078	0.0034	0.0027	0.0034	0.0030	0.0030
CO , Gg	0.0040	0.0032	0.0014	0.0011	0.0014	0.0012	0.0013
NMVOC , Gg	0.0026	0.0021	0.0009	0.0007	0.0009	0.0008	0.0008
SO_2, Gg	0.0136	0.0111	0.0048	0.0039	0.0049	0.0043	0.0044
	2004	2005	2006	2007	2008	2009	2010
NO_x, Gg	0.0038	0.0043	0.0061	0.0228	0.0112	0.0052	0.0138
CO , Gg	0.0016	0.0018	0.0025	0.0095	0.0047	0.0022	0.0058
NMVOC , Gg	0.0011	0.0012	0.0017	0.0062	0.0031	0.0014	0.0038
SO_2, Gg	0.0055	0.0061	0.0087	0.0326	0.0160	0.0074	0.0197

NMVOC emissions from asphalt production were estimated for the first time. The results allow assert that within the 1990-2010 time series NMVOC emissions from 2A6 ‚Road paving with asphalt' (emissions from asphalt used for road surfaces) decreased by 86.5 per cent (Table 4-42).

Table 4-42: NMVOC Emissions from 2A6 'Road Paving with Asphalt' Source Category (Road Surfaces) in the Republic of Moldova within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
NMVOC, Gg	390.4976	324.7386	272.9600	216.9600	131.2000	118.4000	107.3920
	1997	1998	1999	2000	2001	2002	2003
NMVOC, Gg	36.3926	29.5450	12.8880	10.4285	13.0560	11.4240	11.6160
	2004	2005	2006	2007	2008	2009	2010
NMVOC, Gg	14.6240	16.3520	23.1680	86.8800	42.5920	19.8080	52.6400

2A7. 'Other'

'Glass Production'

Non-CO_2 emissions (NO_x, NMVOC and SO_2) from glass production were recalculated for the period from 1990 through 2005, due to updated AD on glass production in the country, in particular for the left bank of Dniester River (ATULBD); also, due to some changes in activity data for 1998 and 1999 years; as well as due to misapplication of the conversion factor for glass bottles for wine industry, from conventional bottles of 0.75 cl to metric mass units (kt).

In comparison with the results obtained in the previous inventory cycle, the changes made resulted in the decrease of non-CO_2 emissions from glass production, varying from a minimum reduction of 8.4 per cent in 1999 to a maximum reduction of 43.1 per cent in 1991. The exception was 1998 year, when a small increase of 4.5 per cent was recorded.

For the 2006-2010 time periods, non-CO_2 emissions resulting from glass production were estimated for the first time. The results obtained allow assert that within the 1990-2010 time series, the non-CO_2 emissions from 2A7a 'Other' [Glass Production] source category decreased by circa 62 per cent (Table 4-43).

Table 4-43: Non-CO_2 Emissions from the 2A7 'Other' [Glass Production] Source Category in the Republic of Moldova within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
NO_x, Gg	0.8351	0.8562	0.6675	0.6774	0.4132	0.3906	0.3053
NMVOC, Gg	1.5611	1.5994	1.2478	1.2702	0.7748	0.7324	0.5724
SO_2, Gg	0.4183	0.4291	0.3344	0.3387	0.2066	0.1953	0.1526
	1997	1998	1999	2000	2001	2002	2003
NO_x, Gg	0.3682	0.3577	0.2689	0.5163	0.4830	0.5611	0.5070
NMVOC, Gg	0.6904	0.6706	0.5042	0.9681	0.9057	1.0521	0.9507
SO_2, Gg	0.1841	0.1788	0.1344	0.2582	0.2415	0.2806	0.2535
	2004	2005	2006	2007	2008	2009	2010
NO_x, Gg	0.5077	0.5562	0.5376	0.4964	0.4200	0.3301	0.3201
NMVOC, Gg	0.9520	1.0428	1.0081	0.9307	0.7875	0.6189	0.6002
SO_2, Gg	0.2539	0.2781	0.2688	0.2482	0.2100	0.1650	0.1600

'Mineral Wool Production'

The GHG emissions resulting from mineral wool production have not been recalculated. The results provided by Table 4-44 allow assert that within the 1990-2002 time series GHG emissions from 2A7b 'Other' [Mineral Wool Production] source category decreased by circa 99.8 per cent. To be noted that since 2003 no mineral wool is produced in the RM.

Table 4-44: GHG Emissions from the 2A7 'Other' [Mineral Wool Production], 1990-2002

	1990	1991	1992	1993	1994	1995	1996
CO_2, Gg	8.0816	5.0988	2.5372	1.5223	0.5793	0.5721	0.3019
CO, Gg	0.2249	0.1419	0.0706	0.0424	0.0161	0.0159	0.0084
SO_2, Gg	0.1054	0.0665	0.0331	0.0199	0.0076	0.0075	0.0039
	1997	1998	1999	2000	2001	2002	2003
CO_2, Gg	0.3881	0.2803	0.1854	0.0848	NO	0.0144	NO
CO, Gg	0.0108	0.0078	0.0052	0.0024	NO	0.0004	NO
SO_2, Gg	0.0051	0.0037	0.0024	0.0011	NO	0.0002	NO

'Brick and Expanded Clay Production'

GHG emissions from brick production were recalculated for the 1990-2005 time series due to updating the AD on brick production for 1998 and 2005 years, also due to revised activity data set on the amount of clay used for brick production: a new conversion ratio was used, 3.2 kg of clay per one brick piece, in comparison with 2.25 kg of clay per one brick piece, used in the previous inventory cycle.

In comparison with the results obtained in the previous inventory cycle, the above mentioned changes resulted in an increase of CO_2 and SO_2 emissions, varying from a minimum increase of 9.8 per cent in 2005 to a maximum increase of 47.8 per cent in 1997 and 1999-2000 years in the case of CO_2 emissions, respectively from a minimum increase of 17.3 per cent in 1998 to a maximum increase of 45.3 per cent in 2005 in the case of SO_2 emissions.

For the 2006-2010 years, CO_2 and SO_2 emissions from 2A7 'Other' (Brick Production) were estimated for the first time. The results allow assert that within 1990-2010 time series, CO_2 emissions from the respective category decreased by 79.3 per cent, while SO_2 emissions decreased by 78.9 per cent (Table 4-45).

Table 4-45: GHG Emissions from the 2A7 'Other' [Bricks Production] Source Category in the Republic of Moldova within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2 emissions	74.8506	69.1295	37.5683	57.1153	28.3828	18.8159	16.9089
SO_2 emissions	0.2249	0.2077	0.1129	0.1716	0.0853	0.0565	0.0508
	1997	1998	1999	2000	2001	2002	2003
CO_2 emissions	19.7715	18.4467	18.8110	17.5194	17.2509	20.1873	21.2651
SO_2 emissions	0.0570	0.0532	0.0542	0.0505	0.0507	0.0600	0.0651
	2004	2005	2006	2007	2008	2009	2010
CO_2 emissions	22.2557	17.6949	18.3746	17.4732	17.6768	15.7305	15.4882
SO_2 emissions	0.0725	0.0704	0.0676	0.0715	0.0704	0.0493	0.0475

At the same time, CO_2 emissions from 2A7 'Other' [Expanded Clay Production] were estimated for the first time. The results allow assert that within 1990-2010 time series CO_2 emissions from the respective category decreased by 89.4 per cent (Table 4-46), in particular due to the decrease of production.

Table 4-46: GHG Emissions from the 2A7 'Other' [Expanded Clay Production] Source Category in the Republic of Moldova within the 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
CO_2 emissions	32.3512	27.5001	13.4067	13.7744	6.5014	4.2878	3.7937
	1997	1998	1999	2000	2001	2002	2003
CO_2 emissions	4.0959	3.8015	3.9007	3.6758	3.6087	3.6605	3.6537
	2004	2005	2006	2007	2008	2009	2010
CO_2 emissions	3.6874	3.3774	4.1633	3.2300	3.0385	3.6656	3.4223

4.2.6 Planned Improvements

Possible improvements under the 2A ‚Mineral Products' source category aim at updating/précising the activity data used to estimate GHG emissions within this category.

4.3 Chemical Industry (Category 2B)

4.3.1 Source Category Description

The 2B 'Chemical Industry' category comprises the following emission sources: 2B1 'Ammonia Production', 2B2 'Nitric Acid Production', 2B3 'Adipic Acid Production', 2B4 'Carbide Production' and 2B5 'Other'. Between 1990 and 2010, no emissions were registered in the RM under the categories 2B1-2B4.

Within the 2B5 'Other', in the RM were monitored the NMVOC emissions from the following sources: 2B5a 'Polyethylene Production', 2B5b 'Acrylonitrile Butadiene Styrene Resins Production' and 2B5c 'Detergents Production'.

Between 1990 and 2010, the NMVOC emissions from category 2B 'Chemical Industry' decreased by 92.0 per cent: from 0.3657 Gg in 1990, to 0.0293 Gg in 2010 (Table 4-47).

In comparison with 2008 year level, in 2009 the NMVOC emissions decreased by 15.3 per cent, due to the global economic crisis that affected the national economy. At the same time, in comparison with 2009 year level, in 2010 the NMVOC emissions increased by 43.4 per cent (Figure 4-3), due to economic recovery.

2B5. 'Other'

'Polyethylene Production'

Three types of polyethylene are produced: 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 upon 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 0.92t/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. The major emissions to air are NMVOC - un-reacted monomer (i.e. ethylene), some partially reacted monomer (alkenes and alkane) together with small amounts of additives. NMVOCs are emitted primarily through leakages, and may be production time dependent rather than production dependent. Control techniques are primarily through replacement of leaking valves etc., and regular maintenance.

'Acrylonitrile Butadiene Styrene Resins (ABS) Production'

Acrylonitrile Butadiene Styrene (ABS) is a combination of a graft copolymer and a polymer mixture (graft copolymer

Table 4-47: NMVOC Emissions from the Category 2B 'Chemical Industry' by Source in the Republic of Moldova, 1990-2010, Gg

	1990	1991	1992	1993	1994	1995	1996
2B5a Polyethylene Production	0.1050	0.0707	0.0691	0.0346	0.0084	0.0095	0.0111
2B5b ABS Resins Production	0.2503	0.2088	0.0835	0.0685	0.0216	0.0158	0.0006
2B4c Detergents Production	0.0104	0.0088	0.0052	0.0046	0.0024	0.0015	0.0037
2B5 „Other" (in Chemical Industry)	0.3657	0.2883	0.1579	0.1077	0.0323	0.0267	0.0154
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2B5a Polyethylene Production	0.0024	0.0013	0.0019	0.0028	0.0058	0.0020	0.0019
2B5b ABS Resins Production	0.0000	0.0000	0.0000	0.0000	0.0000	0.0111	0.0101
2B4c Detergents Production	0.0025	0.0025	0.0014	0.0034	0.0042	0.0067	0.0085
2B5 „Other" (in Chemical Industry)	0.0049	0.0038	0.0033	0.0063	0.0099	0.0198	0.0205
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2B5a Polyethylene Production	0.0035	0.0035	0.0056	0.0070	0.0035	0.0035	0.0014
2B5b ABS Resins Production	0.0130	0.0150	0.0118	0.0147	0.0137	0.0111	0.0217
2B4c Detergents Production	0.0072	0.0089	0.0080	0.0081	0.0069	0.0059	0.0062
2B5 „Other" (in Chemical Industry)	0.0237	0.0274	0.0254	0.0298	0.0241	0.0204	0.0293

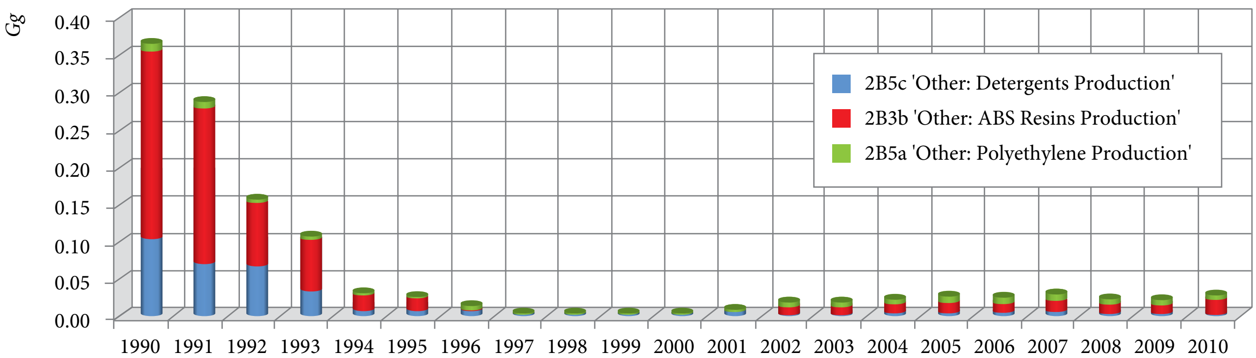


Figure 4-3: NMVOC Emissions from the Category 2B5 'Other', by Source, within 1990-2010 time periods, Gg

- 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 batch process; in the second step, which can be operated as batch and continuous, 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 destabilizing 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, being styrene and acrylonitrile; during the reaction the dissolved rubber is replaced by the Styrene Acrylonitrile Copolymer (SAN) and forms discrete rubber particles; part of the SAN is grafted on the rubber particles, while another part is occluded in the particles; the reaction mixture contains several additives, these are needed in the polymerization; the product is devolatilized to remove unreacted monomer, which are recycled to the reactor, and then pelletized; (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 is continued; unreacted monomers are stripped, then the product is centrifuged and dried.

NMVOC emissions of acrylonitrile butadiene styrene resins plants can be subdivided as follows: leakage losses from appendages, pumps, and other leakage. The losses due to leakage can be limited by use of certain types of seals and application of double seals near pumps.

'Detergent Production'

The term "synthetic detergent products" applies broadly to cleaning and laundering compounds containing surface-active compounds along with other ingredients. Until the early 1970s, almost all laundry detergents sold were heavy-duty powders. Liquid detergents that utilized sodium citrate and sodium silicate were introduced in 1980-s of the XX century. The liquids offered superior performance and solubility. Introduction of super concentrated powder detergents lead to an increase in spray drying operations at some facilities. Manufacturers are currently developing more biodegradable surfactants from natural oils. The manufacture of spray-dried detergent has 3 main processing steps: (1) slurry preparation, (2) spray drying, and (3) granule handling. The 3 major components of detergent are surfactants (to remove dirt and other unwanted materials), builders (to treat the water to improve surfactant performance), and additives to improve cleaning performance. Additives may include bleaches, bleach activators, antistatic agents, fabric softeners, optical brighteners, anti re-deposition agents, and fillers. The formulation of slurry for detergent granules requires the intimate mixing of various liquid, powdered, and granulated materials.

Detergent slurry is produced by blending liquid surfactant with powdered and liquid materials (builders and other additives) in a closed mixing tank called a soap crutcher. Premixing of various minor ingredients is performed in a variety of equipment prior to charging to the crutcher or final mixer. Liquid surfactant used in making the detergent slurry is produced by the sulfonation of either a linear alkylate or a fatty acid, which is then neutralized with a caustic solution containing sodium hydroxide (NaOH). The blended slurry is held in a surge vessel for continuous pumping to a spray dryer. The slurry is atomized by spraying through nozzles rather than by centrifugal action. The slurry is sprayed at high pressure into a vertical drying tower. The detergent granules are conveyed mechanically or by air from the tower to a mixer to incorporate additional dry or liquid ingredients, and finally to packaging and storage. The exhaust air from detergent spray drying towers contains 2 types of air contaminants: (1) fine detergent particles and (2) organics vaporized in the higher temperature zones of the tower. Dust emissions are generated at scale hoppers, mixers, and crutchers during the batching and mixing of fine dry ingredients to form slurry. Conveying, mixing, and packaging of detergent granules can also cause dust emissions. Pneumatic conveying of fine materials causes dust emissions when conveying air is separated from bulk solids. For this process, fabric filters are generally used, not only to reduce or to eliminate dust emissions, but also to recover raw materials.

The dust emissions principally consist of detergent compounds, although some of the particles are uncombined phosphates, sulfates, and other mineral compounds. Dry cyclones and cyclonic impingement scrubbers are the primary collection equipment employed to capture the detergent dust in the spray dryer exhaust for return to processing. Dry cyclones are used in parallel or in series to collect this particulate matter (PM) and recycle it back to the crutcher. The dry cyclone separators can remove 90 per cent or more by weight of the detergent product fines from the exhaust air. Cyclonic impinged scrubbers are used in parallel to collect the particulate from a scrubbing slurry and to recycle it to the crutcher. Secondary collection equipment is used to collect fine particulates that escape from primary devices. For example, cyclonic impingement scrubbers are often followed by mist eliminators. Several types of scrubbers can be used following the cyclone collectors. Venturi scrubbers have been used but are being replaced with packed bed scrubbers. Packed bed scrubbers are usually followed by wet-pipe-type electrostatic precipitators built immediately above the packed bed in the same vessel. Fabric filters have been used after cyclones but have limited applicability, especially on efficient spray dryers, due to condensing water vapour and organic aerosols binding the fabric filter.

NMVOC originate primarily from the surfactants included in the slurry. A method for controlling emissions would be to remove offending organic compounds from the slurry.

4.3.2 Methodological Issues, Emission Factors and Data Sources

2B5. 'Other'

'Polyethylene Production'

Methodological issues for calculation the NMVOC emissions from polyethylene production are addressed in the EMEP CORINAIR Inventory Guidebook (1996).

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 4-48) combined with activity data from Statistical Yearbooks of the Republic of Moldova and those of the AUTULBD (Table 4-49).

Table 4-48: EF Used to Estimate NMVOC Emissions from Polyethylene Production

Source	Description	NMVOC Emissions, kg / t
Other Chemical Products	LDPE manufacture LLDPE manufacture HDPE manufacture	2-3 2 5-6.4

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, February 15, 1996, B456-1 up to B456-3, pr040506, Polyethylene Production.

Table 4-49: Activity Data on Polyethylene Production in the Republic of Moldova within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
RM: right bank of Dniester River	3.519	3.100	1.715	1.601	0.878	0.717	1.552
RM: left bank of Dniester River	1.681	1.300	0.900	0.700	0.300	0.012	0.296
RM: total	5.200	4.400	2.615	2.301	1.178	0.729	1.848
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
RM: right bank of Dniester River	1.168	1.170	0.683	1.689	2.050	3.324	4.225
RM: left bank of Dniester River	0.085	0.068	0.001	0.034	0.041	0.024	0.011
RM: total	1.253	1.238	0.684	1.723	2.091	3.348	4.236
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
RM: right bank of Dniester River	3.595	4.100	3.600	3.700	3.200	2.800	3.100
RM: left bank of Dniester River	0.000	0.364	0.385	0.353	0.234	0.131	0.000
RM: total	3.595	4.464	3.985	4.053	3.434	2.931	3.100

Source: NBS of the RM, Official Letter No. 02-10/115 dated 06.10.2006 (comprises activity data covering the period 1992 through 2005), Official Letter No. 06-39/08 dated 23.02.2011 (comprises activity data covering the period 1992 through 2010), Statistical Yearbooks of the RM for 1994 (page 284), 1999 (page 302), 2005 (page 391), 2011 (page 305); Statistical Yearbooks of the ATULBD for 1998 (page 176), 2000 (page 99), 2002 (page 103), 2005 (page 94), 2006 (page 93), 2007 (page 92), 2010 (page 95), 2011 (page 96).

'Acrylonitrile Butadiene Styrene Resins (ABS)Production'

Methodological issues for calculating the NMVOC emissions from synthetic resins (Acrylonitrile Butadiene Styrene) production are addressed in the EMEP CORINAIR Inventory Guidebook (1996). The methodology used relied on the use of a specific emission factor (Table 4-50) combined with activity data from the national statistics (Table 4-51). To be noted that, in conformity with the information provided by the NBS, within 1997 -2001 periods, no acrylonitrile butadiene styrene (ABS) resins are produced in the Republic of Moldova.

Table 4-50: Emission Factor Used to Estimate NMVOC Emissions from Acrylonitrile Butadiene Styrene Resins (ABS) Production

Source	Description	NMVOC Emissions, kg / t
Other Chemical Products	Production of ABS Resins	1.4 – 27.2

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, February 15, 1996, B4515, pr040515, Production of ABS resins.

As it is not known what technology was used for acrylonitrile butadiene styrene resins production in the RM over the period under review, and the range for the emission factors is large (between 1.4 and 27.2 kg of NMVOC/t of product), it has been decided to use an average value, of 14.3 kg NMVOC per ton of product.

Table 4-51: Activity Data on Acrylonitrile Butadiene Styrene Resins (ABS) Production in the Republic of Moldova within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
Production of ABS Resins, kt	17.500	14.600	5.839	4.792	1.510	1.104	0.040
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Production of ABS Resins, kt	0.000	0.000	0.000	0.000	0.000	0.776	0.708
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Production of ABS Resins, kt	0.910	1.048	0.825	1.026	0.961	0.773	1.516

Source: NBS of the RM, Official Letter No. 02-10/115 dated 06.10.2006 (comprises activity data covering the period 1992-1996); Statistical Yearbooks of the RM for 1994 (page 284); Statistical Yearbooks of the ATULBD for 2007 (page 92), 2009 (page 92), 2011 (page 96).

'Detergent Production'

Methodological issues for calculating the NMVOC emissions from detergents production are addressed in the US EPA's publications. The methodology applied relied on the use of an emission factor specific for the detergents production technology used in the RM (Table 4-52), combined with activity data from the national statistics (Table 4-53). As in the RM the control devices used in detergents production are of cyclone type, the value of the NMVOC emission factor was assumed as being 7 kg per ton of detergent produced.

4.3.3 Uncertainty Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate NMVOC emissions covered by the category 2B 'Chemical Industry', and quality of activity data available. Uncertainty of the default emission

Table 4-52: EF Used to Estimate NMVOC Emissions from Detergents Production

Source	Description	Control Devices	NMVOC, kg / t
Other Chemical Products	Detergent Production	Uncontrolled	45
		Cyclone	7
		Cyclone with spray chamber	3.5
		Cyclone with packed scrubber	2.5
		Cyclone with Venturi scrubber	1.5
		Cyclone with wet scrubber	0.544
		Cyclone with wet scrubber/ electrostatic precipitation	0.023
		Cyclone with packed bed/ electrostatic precipitation	0.470
		Fabric filter	0.540

Source: EPA-450/4-90-003, EPA, USA, Research Triangle Park, NC, March 1990; Emission Test Report, Procter and Gamble, Augusta, GA Georgia Department of Natural Resources, Atlanta, GA, July 1988; A.J. Buonicore and W.T. Davis, Eds., Air Pollution Engineering Manual, Van Nostrand Reinhold, New York, NY, 1992.

Table 4-53: Activity Data on Detergents Production in the RM within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
Detergents Production	15.0000	10.1000	9.8780	4.9370	1.2000	1.3540	1.5870
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Detergents Production	0.3390	0.1820	0.2700	0.4060	0.8220	0.2830	0.2700
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Detergents Production	0.4929	0.5000	0.8000	1.0000	0.5000	0.5000	0.2000

Source: NBS of the RM, Official Letter No. 02-10/115 dated 06.10.2006 (comprises activity data covering the period 1992-2005), Official Letter No. 06-39/08 dated 23.02.2011 (comprises activity data covering the period 1992-2010); Statistical Yearbooks of the RM for 1994 (page 291), 1999 (page 306), 2003 (page 395), 2005 (page 321), 2006 (page 311), 2011 (page 305).

factors values were considered as being of ±100 per cent, while those of activity data respectively, of ±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 GPG (IPCC, 2000).

4.3.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under the 'Industrial Processes' Sector, following a Tier 1 approach (IPCC, 2000).

Verification was focused on correct use of the default emission factors available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996), US EPA publications (1990) and other relevant sources; correct use of AD obtained from different sources of reference etc. The AD and methods used for estimating GHG emissions under the category 2B 'Chemical Industry' were documented and archived both in hard copies and electronically.

4.3.5 Recalculations

NMVOC emissions from the 2B5 'Other' source category have not been recalculated. For the 2006-2010 time periods, NMVOC emissions from the respective category were estimated for the first time. The results allow assert that within 1990-2010 time series NMVOC emissions from the 2B5 'Other' source category decreased by 92.0 per cent.

4.3.6 Planned Improvements

Further improvements under the 2B 'Chemical Industry' category might be possible by considering the possibility to update the activity data set used to estimate GHG emissions from respective category.

4.4 Metal Production (Category 2C)

4.4.1 Source Category Description

The 2C 'Metal Production' category covers GHG emissions from the following sources: 2C1 'Iron and Steel Production', 2C2 'Ferroalloys Production', 2C3 'Aluminium Production', 2C4 'SF_6 used in Aluminium and Magnesium Foundries', and 2C5 'Other'. At the moment, the 2C1 'Iron and Steel Production' is the only source category relevant for the RM in terms of GHG emissions originated under the category 2C 'Metal Production'.

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.

The technology used in the RM for steel production is exclusively EAF. Electric arc furnaces are equipped with carbon electrodes (can also be made of graphite or Soderberg mix). Through carbon electrodes electricity is added to the scrap in the furnace, thus raising the temperature to 1700 ^{0}C. Lime, anthracite and pig-iron are also added. Depending on the desired quality of the steel, chromium, magnesium, molybdenum or vanadium compounds can be added as well.

CO_2 emissions from steel production in electric arc furnaces are determined by carbon losses in electrodes. When electrodes are placed above the melted metal, the electric arc oxidizes the carbon to CO or CO_2. Sometimes, electrodes are

Table 4-54: GHG Emissions from the Category 2C 'Metal Production' within 1990-2010 time periods, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
CO_2	11.7182	10.1720	9.8825	10.0773	10.4672	10.8590	11.0623
CH_4	0.1488	0.1292	0.1255	0.1280	0.1330	0.1379	0.1405
N_2O	1.0986	0.9536	0.9265	0.9448	0.9813	1.0180	1.0371
Total Direct GHG Emissions	12.9657	11.2549	10.9346	11.1501	11.5814	12.0149	12.2400
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2	13.4027	11.8761	13.1665	15.0154	15.9881	8.4939	14.6507
CH_4	0.1702	0.1508	0.1672	0.1907	0.2031	0.1079	0.1861
N_2O	1.2565	1.1134	1.2344	1.4077	1.4989	0.7963	1.3735
Total Direct GHG Emissions	14.8295	13.1404	14.5681	16.6138	17.6901	9.3981	16.2103
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2	16.7442	17.3341	11.1999	15.9599	14.6328	7.0427	3.9938
CH_4	0.2127	0.2202	0.1423	0.2027	0.1859	0.0895	0.0507
N_2O	1.5698	1.6251	1.0500	1.4963	1.3718	0.6603	0.3744
Total Direct GHG Emissions	18.5267	19.1793	12.3922	17.6589	16.1905	7.7924	4.4189

immersed in the melted metal to increase carbon concentration in steel, thus contributing to additional CO_2 emissions.

Between 1990 and 2010 time series, direct GHG emissions from the source category 2C 'Metal Production' decreased in the Republic of Moldova by 65.9 per cent (Table 4-54, Figure 4-4).

In comparison with 2008 year level, in 2009 emissions decreased sharply by 51.9 per cent due to the global economic crisis that affected the national economy. The decreasing trend continued also in 2010 year (compared with 2009 level, GHG emissions decreased by other 43.3 per cent).

The indirect greenhouse gas emissions (NO_x, CO, NMVOC) and SO_2 covered by the respective source category also tended to decrease (Table 4-55).

Between 1990 and 2010, NO_x emissions decreased by 65.2 per cent (from 0.1663 Gg to 0.0578 Gg), CO emissions - by 65.9 per cent (from 7.0883 Gg to 2.4158 Gg), NMVOC emissions - by 64.9 per cent (from 0.0822 Gg to 0.0289 Gg), and SO_2 emissions – by circa 64.8 per cent (from 0.1198 to 0.0421 Gg).

Table 4-55: Indirect GHG and SO_2 Emissions from the Category 2C 'Metal Production' within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
NO_x	0.1663	0.1455	0.1415	0.1414	0.1441	0.1456	0.1475
CO	7.0883	6.1531	5.9779	6.0957	6.3314	6.5683	6.6913
NMVOC	0.0822	0.0722	0.0702	0.0695	0.0701	0.0698	0.0704
SO_2	0.1198	0.1052	0.1023	0.1012	0.1020	0.1014	0.1023
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NO_x	0.1784	0.1672	0.1830	0.2070	0.2250	0.1180	0.2050
CO	8.1070	7.1838	7.9643	9.0826	9.6711	5.1379	8.8621
NMVOC	0.0852	0.0823	0.0894	0.1008	0.1107	0.0577	0.1006
SO_2	0.1237	0.1199	0.1302	0.1466	0.1613	0.0839	0.1465
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NO_x	0.2341	0.2453	0.1610	0.2284	0.2098	0.1027	0.0578
CO	10.1284	10.4853	6.7749	9.6541	8.8514	4.2602	2.4158
NMVOC	0.1148	0.1210	0.0801	0.1134	0.1042	0.0515	0.0289
SO_2	0.1672	0.1763	0.1168	0.1652	0.1519	0.0751	0.0421

4.4.2 Methodologies Issues, Emission Factors and Data Sources

CO_2 emissions from 2C1 'Iron and Steel Production' source category were estimated using a Tier 2 methodology (IPCC, 2000), based on carbon track through the production process.

Total CO_2 emissions from 2C1 'Iron and Steel Production' category represent the arithmetic sum of emissions from iron and steel production.

$$Total\ CO_2 = CO_{2\ pig\ iron} + CO_{2\ crude\ steel}$$

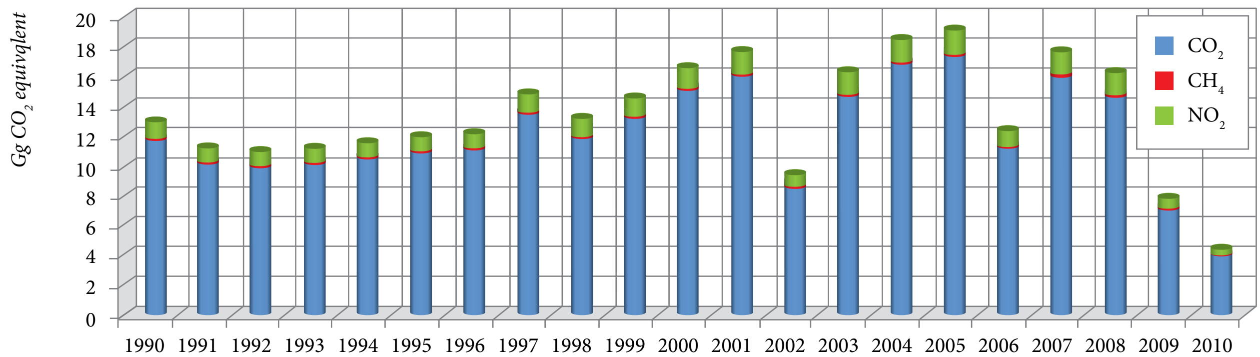


Figure 4-4: GHG Emissions from the Category 2C 'Metal Production' within 1990-2010 time periods, Gg CO_2 equivalent

GHG emissions from iron production can be estimated using the following equation:

$$CO_{2\ pig\ iron} = (EF_{reducing\ agent} \bullet Mass\ of\ Reducing\ Agent) + (Mass\ of\ Carbon\ in\ the\ Ore - Mass\ of\ Carbon\ in\ the\ Crude\ Iron) \bullet 44/12$$

Reducing agent can be coal, coke, petroleum coke and charcoal. The amount of carbon in ore is considered to be by default 'zero', while crude iron contains about four per cent (IPCC, 2000).

GHG emissions from steel production can be estimated using the following equation:

$$CO_{2\ crude\ steel} = (Mass\ of\ Carbon\ in\ the\ Crude\ Iron\ used\ for\ Crude\ Steel\ Production - Mass\ of\ Carbon\ in\ the\ Crude\ Steel) \bullet 44/12 + EF_{EAF} \bullet Mass\ of\ Steel\ Produced\ in\ EAF$$

In the Republic of Moldova, the content of carbon in crude iron represents an average of 4.3 per cent, while in crude steel – 0.25 per cent (according to the information provided by producer, the content of carbon in crude steel varies between 0.17 and 0.33%[21], in general, following the GPG (IPCC, 2000), depending of steel type and quality, the content of carbon in crude steel varies between 0.5 and 2 per cent). In addition, for steel produced in electric arc furnaces it is good practice to add carbon mass released from consumed electrodes to the emissions, roughly 1.25 kg carbon per ton of steel and/or 4.583 kg CO_2 per ton of steel (IPCC, 2000).

AD related to steel (Table 4-56) and rolling mills production (Table 4-57) is available in the statistical publications of the RM and ATULBD.

Based on respective AD, as well as on the information available in the Analysis of the Ukrainian Market of Scrap Metal, Strategic Aspects (Naziuta, 2010)[22], it was estimated the carbon balance through the production process (Table 4-58).

To be noted that Metal Integrated Works in Ribnita is one of the two mini-metallurgical works (the second is located in Jlobino, Belarus) bought by the USSR in the early 80's of the twentieth century on „dollar for oil" account. 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. By 2004 year, steel production reached 1 million tons of steel and 800 thousand tons of rolling mills.

The Metal Integrated Works in Ribnita uses scrap metal collected mainly in the RM, but also from the neighboring countries. It was not possible to get from the producer the information regarding the amount of scrap metal used for steel production (these data are not available on the company website), so that AD were generated by using the coefficient of 1078.3 kg of scrap metal per ton of steel, respec-

[21] Metal Integrated Works from Ribnita: <http://www.aommz.com/pls/webus/webus.main.show>.

22 Ukrainian Association of Metallurgists, <http://uas.su/articles/steelmaking/00002.php>.

Table 4-56: Activity Data on Steel Production within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
RM: right bank of Dniester River	0.370	0.350	0.340	0.320	0.300	0.299	0.199
RM: left bank of Dniester River	708.400	614.900	597.400	609.200	632.800	656.500	668.900
RM: total	708.770	615.250	597.740	609.520	633.100	656.799	669.099
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
RM: right bank of Dniester River	0.255	0.120	0.067	0.097	0.133	0.248	0.140
RM: left bank of Dniester River	810.400	718.200	796.300	908.100	966.900	513.500	886.000
RM: total	810.655	718.320	796.367	908.197	967.033	513.748	886.140
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
RM: right bank of Dniester River	0.164	0.140	0.122	0.125	0.097	0.031	0.059
RM: left bank of Dniester River	1012.600	1048.300	677.300	965.200	884.958	425.943	241.501
RM: total	1012.764	1048.440	677.422	965.325	885.055	425.974	241.560

Source: Statistical Yearbooks of the RM for 1994 (page 224), 1999 (page 302), 2003 (page 391), 2004 (page 441), 2010 (page 305), 2011 (page 306); Statistical Yearbooks of the ATULBD for 1998 (page 178), 2000 (page 99), 2002 (page 103), 2005 (page 94), 2006 (page 93), 2007 (page 92), 2009 (page 92), 2010 (page 93), 2011(page 94) .

Table 4-57: Activity Data on Rolling Mills Production within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
Production of Rolling Mills	614.000	561.300	547.600	487.200	438.000	357.000	341.000
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Production of Rolling Mills	407.000	589.200	592.100	635.000	790.400	381.000	695.400
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Production of Rolling Mills	789.300	889.300	639.000	883.500	818.635	437.515	237.020

Source: Statistical Yearbooks of the RM for 1994 (page 224), 1999 (page 302), 2003 (page 391), 2004 (page 441), 2010 (page 305), 2011 (page 306); Statistical Yearbooks of the ATULBD for 1998 (page 178), 2000 (page 99), 2002 (page 103), 2005 (page 94), 2006 (page 93), 2007 (page 92), 2009 (page 92), 2010 (page 93), 2011 (page 94) .

Table 4-58: AD on Steel Production within the 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
Scrap metal used in steel production, kt	764.2667	663.4241	644.5430	657.2454	682.6717	708.2264	721.4895
Content of carbon in scrap metal used, %	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mass of carbon in scrap metal used, kt	1.9107	1.6586	1.6114	1.6431	1.7067	1.7706	1.8037
Iron used in steel production, kt	9.2849	8.0598	7.8304	7.9847	8.2936	8.6041	8.7652
Content of carbon in iron used, %	4.30	4.30	4.30	4.30	4.30	4.30	4.30
Mass of carbon in iron used, kt	0.3993	0.3466	0.3367	0.3433	0.3566	0.3700	0.3769
Carbon consumption in electrodes, kg C/tonne	1.250	1.250	1.250	1.250	1.250	1.250	1.250
Mass of carbon in electrodes, burnt in the production process, kt	0.8860	0.7691	0.7472	0.7619	0.7914	0.8210	0.8364
Total carbon emissions from steel production, kt	3.1959	2.7742	2.6952	2.7484	2.8547	2.9615	3.0170
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Scrap metal used in steel production, kt	874.1293	774.5645	858.7225	979.3088	1042.7517	553.9745	955.5248
Content of carbon in scrap metal used, %	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mass of carbon in scrap metal used, kt	2.1853	1.9364	2.1468	2.4483	2.6069	1.3849	2.3888
Iron used in steel production, kt	10.6196	9.4100	10.4324	11.8974	12.6681	6.7301	11.6084
Content of carbon in iron used, %	4.30	4.30	4.30	4.30	4.30	4.30	4.30
Mass of carbon in iron used, kt	0.4566	0.4046	0.4486	0.5116	0.5447	0.2894	0.4992
Carbon consumption in electrodes, kg C/tonne	1.250	1.250	1.250	1.250	1.250	1.250	1.250
Mass of carbon in electrodes, burnt in the production process, kt	1.0133	0.8979	0.9955	1.1352	1.2088	0.6422	1.1077
Total carbon emissions from steel production, kt	3.6553	3.2389	3.5909	4.0951	4.3604	2.3165	3.9956
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Scrap metal used in steel production, kt	1092.0636	1130.5330	730.4644	1040.9095	954.3544	459.3273	260.4743
Content of carbon in scrap metal used, %	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mass of carbon in scrap metal used, kt	2.7302	2.8263	1.8262	2.6023	2.3859	1.1483	0.6512
Iron used in steel production, kt	13.2672	13.7346	8.8742	12.6458	11.5942	5.5803	3.1644
Content of carbon in iron used, %	4.30	4.30	4.30	4.30	4.30	4.30	4.30
Mass of carbon in iron used, kt	0.5705	0.5906	0.3816	0.5438	0.4986	0.2400	0.1361
Carbon consumption in electrodes, kg C/tonne	1.250	1.250	1.250	1.250	1.250	1.250	1.250
Mass of carbon in electrodes, burnt in the production process, kt	1.2660	1.3106	0.8468	1.2067	1.1063	0.5325	0.3020
Total carbon emissions from steel production, kt	4.5666	4.7275	3.0545	4.3527	3.9908	1.9207	1.0892

Table 4-59: EFs used in the RM and some Annex I Parties in compiling their national GHG inventories for 2010 year, within the source category 2C1 „Steel Production”

	Netherlands	Great Britain	Portugal	Republic of Moldova	Italy	Belgium	Romania
EF, kg CO_2/t steel	3.3	7.3	8.5	16.5	23.3	26.1	45.0
	Luxembourg	**Spain**	**Greece**	**Bulgaria**	**France**	**Slovenia**	**Sweden**
EF, kg CO_2/t steel	50.7	57.2	63.0	70.0	73.9	70.1	117.5

Source: UNFCCC database - GHG Locator (v 3.4).

tively 13.1 kg of iron per ton of steel (weighted average value of the Ukrainian plants with the same profile for 2004-2006 years)[23].

Table 4-59 shows the default emission factors used in the RM, as well as in some Annex I Parties. The results are within the EFs margin values for 2C1 'Steel Production' category used by the Annex I Parties under the UNFCCC in compiling their national GHG inventories.

The emission factors used to calculate non-CO_2 emissions from steel production in EAF rely on default values available in EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996, 1999) (Table 4-60).

Table 4-60: Default EFs Used to Estimate Non-CO_2 Emissions from Steel and Rolling Mills Production in Electric Arc Furnace (EAF)

Source	Description	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
		g / t					
EAF Steel Production	Steel Production[1]	10	5	200	10000	90	130
	Rolling Mills Production [2]	NA	NA	40	1	30	45

Source: [1] EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, September 1999, B427-1, pr040207, EAF Steel Production ; [2] EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, February 15, 1996, B428-1, pr040208, EAF Rolling Mills Production.

[23] Ukrainian Association of Metallurgists, <http://uas.su/articles/steelmaking/00002.php>.

4.4.3 Uncertainties Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the 2C1 'Iron and Steel Production' category, and quality of activity data available.

Uncertainties associated with EFs used to estimate CO_2 emissions from this source category, were estimated at ±5 per cent for CO_2 emissions, ±100 per cent for CH_4 emissions and ±150 per cent for N_2O emissions. Uncertainties associated with statistical data on steel production in the RM can be considered low (±3 per cent). Combined uncertainties pertaining to GHG emissions from the 2C1 'Iron and Steel Production' source category were considered low for CO_2 emissions (±5.8 per cent), and large for CH_4 (±100.0 per cent) and N_2O emissions (±150.0 per cent). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±0.04 per cent for CO_2 emissions, ±0.01 per cent for CH_4 emissions, and ±0.10 per cent for N_2O. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.01 per cent for CO_2 emissions, while CH_4 and N_2O emissions were rather insignificant (**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 GPG (IPCC, 2000).

4.4.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under the Industrial Processes Sector, following the Tier 1 approach (IPCC, 2000).

Verification was focused on correct use of the default EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000), EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996, 2000) and other relevant sources; correct use of AD obtained from different sources of reference, including official sources (NBS, Statistical Yearbooks of the RM and those of ATULBD, Steel Statistical Yearbooks, published by the International Institute of Iron and Steel, as well as the informationa available on the websites of different steel plants, e.g. <http://www.aommz.com/pls/webus/webus.main.show>, and other relevant sources (Naziuta, 2010), etc. The AD and methods used for estimating GHG emissions under the category 2C1 'Iron and Steel Production' were documented and archived both in hard copies and electronically.

4.4.5 Recalculations

CO_2 emissions from the 2C1 'Iron and Steel Production' source category were recalculated for the 1990 through 2005 time series as a result of move from a Tier 1 approach (IPCC, 2006) to a Tier 2 approach (IPCC, 2000), based on detailed information on carbon ratio in the production process and the use of plant specific EFs, which replaced the default EFs, available in the 2006 IPCC Guidelines (80 kg CO_2/ t steel) used within the previous inventory cycle; as well as due to use of a new set of activity data, available into the Statistical Yearbooks of the RM and those of ATULBD.

In comparison with emissions estimates included into the SNC of the RM under the UNFCCC, the changes performed resulted in a significant decrease of CO_2 emissions originated from steel production – by 79.3 per cent. For the period 2006-2010, CO_2 emissions resulting from steel production were estimated for the first time. The results allow assert that within the 1990-2010 time the respective emissions decreased by 66 per cent (Table 4-61).

Table 4-61: Comparative Results of CO_2 Emissions from 2C1 'Iron and Steel Production' included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	56.7016	49.2200	47.8192	48.7616	50.6480	52.5439	53.5279
TNC	11.7182	10.1720	9.8825	10.0773	10.4672	10.8590	11.0623
Difference, %	-79.3	-79.3	-79.3	-79.3	-79.3	-79.3	-79.3
	1997	1998	1999	2000	2001	2002	2003
SNC	64.8524	57.4656	63.7094	72.6558	77.3626	41.0998	70.8912
TNC	13.4027	11.8761	13.1665	15.0154	15.9881	8.4939	14.6507
Difference, %	-79.3	-79.3	-79.3	-79.3	-79.3	-79.3	-79.3
	2004	2005	2006	2007	2008	2009	2010
SNC	81.0211	83.8752					
TNC	16.7442	17.3341	11.1999	15.9599	14.6328	7.0427	3.9938
Difference, %	-79.3	-79.3					

The non-CO_2 emissions from the 2C1 'Iron and Steel Production' source category were recalculated as well, in particular due to change the emissions factors available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996, 1999) to the detriment of other alternative sources. For the period 2006-2010, non-CO_2 emissions resulting from steel and rolling mills production were estimated for the first time. The results allow assert that within the 1990-2010 time series non-CO_2 emissions from 2C1 'Iron and Steel Production' source category decreased by circa 66 per cent (Table 4-62).

Table 4-62: Non-CO_2 Emissions from the 2C1 'Iron and Steel Production' Source Category in the Republic of Moldova, 1990-2010, Gg

	1990	1991	1992	1993	1994	1995	1996
CH_4	0.0071	0.0062	0.0060	0.0061	0.0063	0.0066	0.0067
NO_2	0.0035	0.0031	0.0030	0.0030	0.0032	0.0033	0.0033
NO_x	0.1663	0.1455	0.1415	0.1414	0.1441	0.1456	0.1475
CO	7.0883	6.1531	5.9779	6.0957	6.3314	6.5683	6.6913
NMVOC	0.0822	0.0722	0.0702	0.0695	0.0701	0.0698	0.0704
SO_2	0.1198	0.1052	0.1023	0.1012	0.1020	0.1014	0.1023
	1997	1998	1999	2000	2001	2002	2003
CH_4	0.0081	0.0072	0.0080	0.0091	0.0097	0.0051	0.0089
NO_2	0.0041	0.0036	0.0040	0.0045	0.0048	0.0026	0.0044
NO_x	0.1784	0.1672	0.1830	0.2070	0.2250	0.1180	0.2050
CO	8.1070	7.1838	7.9643	9.0826	9.6711	5.1379	8.8621
NMVOC	0.0852	0.0823	0.0894	0.1008	0.1107	0.0577	0.1006
SO_2	0.1237	0.1199	0.1302	0.1466	0.1613	0.0839	0.1465

	2004	2005	2006	2007	2008	2009	2010
CH_4	0.0101	0.0105	0.0068	0.0097	0.0089	0.0043	0.0024
NO_2	0.0051	0.0052	0.0034	0.0048	0.0044	0.0021	0.0012
NO_x	0.2341	0.2453	0.1611	0.2285	0.2098	0.1027	0.0578
CO	10.1284	10.4853	6.7749	9.6541	8.8514	4.2602	2.4158
NMVOC	0.1148	0.1210	0.0802	0.1134	0.1043	0.0515	0.0289
SO_2	0.1672	0.1763	0.1169	0.1653	0.1520	0.0751	0.0421

4.4.6 Planned Improvements

Further improvements under the 2C 'Metal Production' category might be possible by considering the possibility to update the activity data set used to estimate GHG emissions.

4.5 Other Production (Category 2D)

4.5.1 Source Category Description

Category 2D 'Other Production' covers greenhouse gas emissions generated from the following sources: 2D1 'Pulp and Paper' and 2D2 'Food and Drink'. As no pulp and paper production is registered in the RM, respectively no GHG emissions are reported for this category as 'Not Occurring'.

The NMVOC emissions are monitored under the 2D2 'Food and Drink' source category (despite the fact that an estimating methodology for CO_2 emissions from alcoholic beverages exist, these emissions are not reported in the total national GHG emissions, as they are considered to have a biogenic origin, and according to the Revised 1996 Guidelines, only non-biogenic CO_2 emissions will be estimated.

NMVOC emissions from the 2D2 'Food and Drink' source category have decreased by 69.9 per cent over the period under review: from 9.5163 Gg in 1990 to 2.8602 Gg in 2010 (Table 4-63).

In comparison with the 2008 year level, in 2009 the NMVOC emissions decreased by 33.4 per cent, due to the global economic crisis that affected the national economy of the RM. At the same time, in comparison with 2009 year level, in 2010 the emissions increased by 15.8 per cent (Figure 4-5), due to economic recovery.

To be noted that in the reference year, around 89.1 per cent of the total NMVOC emissions from the 2D2 'Food and Drink' source category were generated by the 2D2a 'Bread Making and Other Food'. By 2010, the share of this category in the total NMVOC emissions covered by the 2D2 'Food and Drink' source category decreased to 55.7 per cent (Figure 4-6).

Table 4-63: NMVOC Emissions from 2D2 'Food and Drink' Source Category, 1990-2010

	1990	1991	1992	1993	1994	1995	1996
2D2a „Bread Making and Other Food"	8.4750	5.9996	5.1181	4.6262	3.5660	3.8191	4.1996
2D2b „Alcoholic Beverages"	1.0413	1.0254	0.8446	1.3841	2.3360	3.5282	2.7795
2D2 „Food and Drink"	9.5163	7.0250	5.9627	6.0103	5.9020	7.3473	6.9791
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2D2a „Bread Making and Other Food"	3.4138	3.0234	1.8167	1.7777	2.0169	2.3838	1.8384
2D2b „Alcoholic Beverages"	2.1125	1.5661	0.8740	0.6935	0.9235	1.0485	2.0768
2D2 „Food and Drink"	5.5263	4.5895	2.6907	2.4712	2.9404	3.4322	3.9152
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2D2a „Bread Making and Other Food"	1.9032	2.1174	2.2922	1.5651	2.2474	1.2945	1.5928
2D2b „Alcoholic Beverages"	2.3245	2.6383	1.8981	1.6912	1.4646	1.1761	1.2674
2D2 „Food and Drink"	4.2277	4.7557	4.1903	3.2564	3.7119	2.4706	2.8602

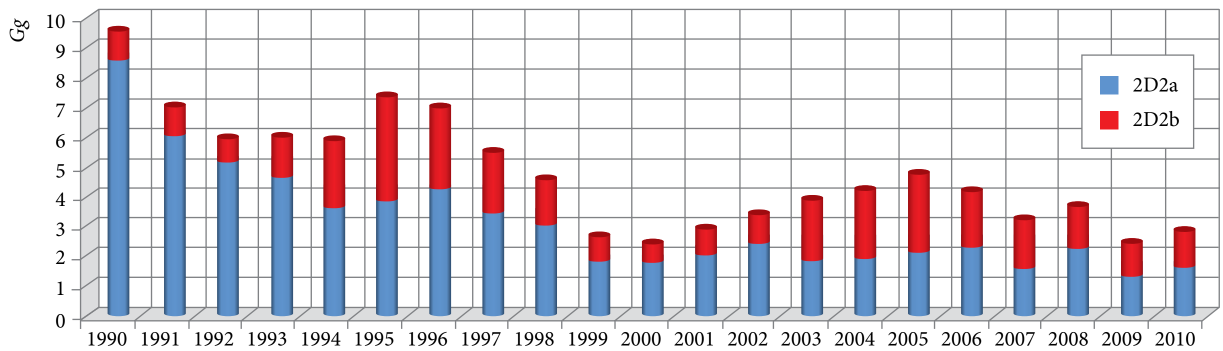


Figure 4-5: NMVOC Emissions from 2D2 'Food and Drink' Source Category within 1990-2010 time periods, Gg

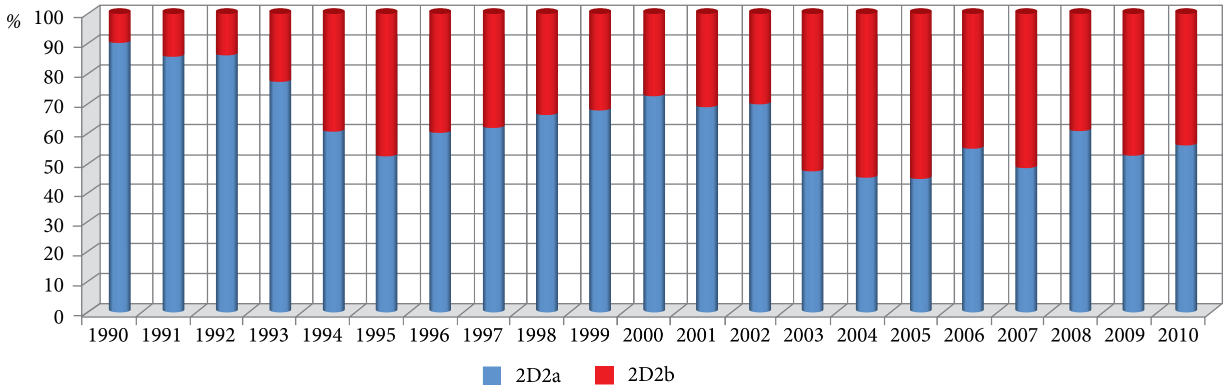


Figure 4-6: Breakdown of the NMVOC Emissions under the 2D2 'Food and Drink' Category by Source within the 1990-2010 time periods, %

4.5.2 Methodological Issues, Emission Factors and Data Sources

a) 'Bread Making and Other Food'

Methodological issues pertaining to calculation of the NMVOC emissions from bread making and other food are addressed in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996).

The estimation method used implies multiplication of default EF values (Table 4-64) by activity data on bread making and other food available in the national statistics of the RM and of the ATULBD (Table 4-65).

Table 4-64: Default Emission Factors 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, Fish and Poultry	0.3
	Sugar	10
	Margarine and Solid Cooking Fats	10
	Cakes, Biscuits and Breakfast Cereals	1
	White Bread	4.5
	Rye Bread	3
	Animal Feed	1

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, February, 15, 1996, B465-5, pr040605, Bread Making and Other Food.

Table 4-65: Activity Data on Bread Making and Other Food in the Republic of Moldova within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
Meat	257.9	218.5	136.0	114.2	85.9	58.4	52.6
Sugar	435.8	236.9	192.2	209.0	166.7	218.7	264.5
Margarine and Butter	27.0	21.8	16.7	10.9	9.5	6.8	4.7
Confectionary Products	24.3	23.5	12.1	10.1	5.0	5.2	5.2
Bread	601.9	528.3	468.6	431.7	325.2	268.4	252.5
Animal Feed	1037.3	946.2	867.5	440.2	309.8	333.6	350.4
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Meat	50.8	27.3	25.7	13.4	7.4	11.3	14.9
Sugar	213.3	194.5	100.5	105.4	132.6	167.6	107.1
Margarine and Butter	3.0	2.9	2.4	2.8	4.4	5.9	6.6
Confectionary Products	5.6	9.2	8.4	8.7	12.9	15.8	18.1
Bread	221.9	180.2	147.0	138.1	133.3	130.8	144.7
Animal Feed	231.9	221.2	110.3	61.0	32.4	41.3	28.1
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Meat	18.5	15.2	10.2	16.1	12.8	15.8	14.7
Sugar	110.9	133.5	149.0	74.0	134.0	42.4	90.8
Margarine and Butter	6.9	6.8	6.1	5.8	6.6	5.9	5.2
Confectionary Products	17.9	20.7	21.7	22.2	22.9	22.0	22.3
Bread	145.8	142.0	145.3	154.5	169.8	161.1	129.1
Animal Feed	46.1	50.8	62.6	44.8	51.0	59.9	25.4

Source: Statistical Yearbooks of the RM for 1994 (page 289-290), 1999 (page 304-305), 2003 (page 393-394), 2004 (page 443-444), 2005 (page 319-320), 2006 (page 309-310), 2010 (page 301-303), 2011 (page 302-304); Statistical Yearbooks of the ATULBD for 1998 (page 177), 2000 (page 100), 2002 (page 104), 2005 (page 94), 2006 (page 93), 2007 (page 93), 2009 (page 93), 2010 (page 94-95), 2011 (page 95).

b) 'Alcoholic Beverages'

Methodological issues related to calculation of NMVOC emissions from production of alcoholic beverages are addressed in the Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996). The estimation method is based on multiplying default values of emission factors (Table 4-66) by activity data on production of alcoholic beverages available in national statistics of the RM and ATULBD (Table 4-67).

Table 4-66: Default EFs Used to Calculate NMVOC Emissions from Alcoholic Beverages

Source	Alcoholic beverages	NMVOC, kg / hl
Alcoholic Beverages	Red Wine	0.080
	White Wine, Sparkling Wine, Beer	0.035
	Spirits (unspecified)	15.0
	Vodka/Grain Whisky	7.5
	Brandy	3.5

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, February 15, 1996, B466-5, pr040606, Alcoholic beverages

As at the time of inventory compilation there were no statistical data on the share of different types of wine in the total production reported in the RM, the breakdown percentage of different types of wines (i.e., red and white) was inferred based on a data survey covering 14 winemaking enterprises[24] from the RM.

[24] The survey results covering 14 winemaking enterprises in the RM (S.A. „Vinuri Ialoveni", Ialoveni; S.A. „Zubreşti", Zubreşti, Străşeni; „Vitis Hînceşti" S.A., Hînceşti; „Deus Vin" SRL, Ulmu, Ialoveni; C.V. „Naţional Vin", Chişinău; S.A. „Migdal-P", mun. Chişinău; S.A. "Prut" Winery, Brînza, Cahul; ÎM „Grape Valley" SRL, Borceag, Cahul; ÎM „Vinăria-Bardar" S.A. Winery; „Cricova" S.A., Cricova, mun. Chişinău; S.A. „Bravicea-Vin", Bravicea, Călăraşi; ÎS CVC „Mileştii Mici", Mileştii Mici, Ialoveni; „Nectar-S" SRL, Străşeni; "Ţiganca" Winery, Plopi, Cantemir) revealed the share of white and red wines in the total wine production.

4.5.3 Uncertainty Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, EFs used to estimate GHG emissions covered by the 2D2 'Food and Drink' source category, 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 (CORINAIR, 1996). Uncertainties related to activity data on food and drink production in the RM are quite low (±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 GPG (IPCC, 2000).

4.5.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under the 'Industrial Processes' Sector, following a Tier 1 approach (IPCC, 2000).

Table 4-67: Activity Data on Alcoholic Beverages Production within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Wine, thousand hl	1630.0	1430.0	920.0	1030.0	977.8	996.9	1458.0
White Wine, thousand hl	570.5	500.5	368.0	412.0	391.1	448.6	656.1
Red Wine, thousand hl	1059.5	929.5	552.0	618.0	586.7	548.3	801.9
Sparkling Wine, thousand hl	80.4	78.3	85.4	88.8	74.2	94.8	141.9
Brandy, thousand hl	139.4	140.2	75.0	74.0	79.3	102.7	45.7
Vodka and Liqueurs, thousand hl	55.9	55.6	67.6	139.4	264.7	412.7	335.8
Beer, thousand hl	760.0	660.0	430.0	360.0	285.0	302.9	256.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Wine, thousand hl	1941.5	1239.6	692.5	1089.0	1564.2	1494.0	1931.8
White Wine, thousand hl	873.7	557.8	311.6	490.1	782.1	821.7	1159.1
Red Wine, thousand hl	1067.8	681.8	380.9	599.0	782.1	672.3	772.7
Sparkling Wine, thousand hl	134.5	51.9	67.5	41.6	58.4	61.3	73.9
Brandy, thousand hl	58.6	49.7	48.6	71.8	95.6	103.8	136.1
Vodka and Liqueurs, thousand hl	237.0	174.1	87.0	48.9	64.7	77.9	196.6
Beer, thousand hl	262.7	300.1	219.1	259.2	336.2	462.4	599.1
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Wine, thousand hl	3353.4	3642.7	1937.9	1238.7	1552.9	1201.7	955.1
White Wine, thousand hl	1509.0	1639.2	872.1	557.4	698.8	540.8	429.8
Red Wine, thousand hl	1844.4	2003.5	1065.8	681.3	854.1	660.9	525.3
Sparkling Wine, thousand hl	93.8	105.1	40.2	54.1	57.2	50.0	53.7
Brandy, thousand hl	142.8	171.1	79.1	82.4	103.7	69.8	75.0
Vodka and Liqueurs, thousand hl	212.9	238.8	196.3	172.2	130.2	110.8	121.7
Beer, thousand hl	695.7	777.8	908.4	1011.6	866.4	778.8	948.0

Source: Statistical Yearbooks of the RM for 1994 (page 289-290), 1999 (page 304-305), 2003 (page 393-394), 2004 (page 443-444), 2005 (page 319-320), 2006 (page 309-310), 2010 (page 301-303), 2011 (page 302-304); Statistical Yearbooks of the ATULBD for 1998 (page 177), 2000 (page 100), 2002 (page 104), 2005 (page 94), 2006 (page 93), 2007 (page 93), 2009 (page 93), 2010 (page 94-95), 2011 (page 95).

Verification was focused on correct use of emission factors including the default EFs used as reference source according to the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996); correct use of AD obtained from different sources of reference, including official sources (Statistical Yearbooks of the RM and those of the ATULBD) and other relevant sources (e.g. data surveys applied to the main wine producers), etc. The AD and methods used for estimating GHG emissions under the category 2D were documented and archived both in hard copies and electronically.

4.5.5 Recalculations

NMVOC emissions from the 2D2 'Food and Drink' source category were recalculated for the period 1990-2005, in particular due to updating activity data on bread making and other food and alcoholic beverages based on new editions of the Statistical Yearbooks of the RM and ATULBD.

a) 'Bread Making and Other Food'

In comparison with values included in the SNC of the RM under the UNFCCC, the changes made resulted in an increase of NMVOC emission estimates, which varied from a minimum of 0.1 per cent in 1997 and 1998, to a maximum of 55.1 per cent in 1991 (Table 4-68).

Table 4-68: Comparative Results of NMVOC Emissions from 2D2a 'Bread Making and Other Food' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	5.9557	3.8676	3.3126	3.5892	2.9104	3.3222	3.7256
TNC	8.4750	5.9996	5.1181	4.6262	3.5660	3.8191	4.1996
Difference, %	42.3	55.1	54.5	28.9	22.5	15.0	12.7
	1997	1998	1999	2000	2001	2002	2003
SNC	3.4101	3.0198	1.8129	1.7737	2.0135	2.3751	1.8310
TNC	3.4138	3.0234	1.8167	1.7777	2.0169	2.3838	1.8384
Difference, %	0.1	0.1	0.2	0.2	0.2	0.4	0.4
	2004	2005	2006	2007	2008	2009	2010
SNC	1.9034	1.9637					
TNC	1.9032	2.1174	2.2922	1.5651	2.2474	1.2945	1.5928
Difference, %	0.0	7.8					

For the 2006-2010 time periods, the NMVOC emissions from 'bread making and other food' were estimated for the first time. The results indicate that over the period since 1990 to 2010, NMVOC emissions from bread making and other food decreased by 81.2 per cent, first of all due to a significant reduction of the manufacturing industry's outputs over the period under review (e.g. meet production decreased by 94.3 per cent, sugar – by 79.2 per cent, margarine and butter – by 80.8 per cent, confectionary products – by 8.1 per cent, bread – by 78.6 per cent, animal feed – by 97.6 per cent) (see in the Table 4-65).

a) 'Alcoholic Beverages'

In comparison with the values included in the SNC of the RM under the UNFCCC, the changes made (updating activity data for 2001 and 2003-2005 years) resulted in an increase in NMVOC emission estimates from 'alcoholic beverages', varying from a minimum of 0.2 per cent in 2004, to a maximum of 25.8 per cent in 2003 (Table 4-69).

Table 4-69: Comparative Results of NMVOC Emissions from 2D2b 'Alcoholic Beverages' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	1.0413	1.0254	0.8446	1.3841	2.3360	3.5282	2.7795
TNC	1.0413	1.0254	0.8446	1.3841	2.3360	3.5282	2.7795
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1997	1998	1999	2000	2001	2002	2003
SNC	2.1125	1.5661	0.8740	0.6935	0.8837	1.0485	1.6508
TNC	2.1125	1.5661	0.8740	0.6935	0.9235	1.0485	2.0768
Difference, %	0.0	0.0	0.0	0.0	4.5	0.0	25.8
	2004	2005	2006	2007	2008	2009	2010
SNC	2.3210	2.4979					
TNC	2.3245	2.6383	1.8981	1.6912	1.4646	1.1761	1.2674
Difference, %	0.2	5.6					

For the 2006-2010 time periods, the NMVOC emissions from alcoholic beverages were estimated for the first time. The results indicate that over the period since 1990 to 2010, NMVOC emissions from 'alcoholic beverages' increased by circa 21.7 per cent, which is explained by a substantial growth of winemaking industry's output in the Republic of Moldova over the period under review (vodka and liquor – by 117.7 per cent, beer – by 24.7 per cent) despite the fact that the production of grape wine decreased by 41.4 per cent, sparkling wine – by 33.2 per cent and brandy – by 46.2 per cent (see in the Table 4-67).

4.5.6 Planned Improvements

Further improvements under the 2D 'Other Products' category might be possible by considering the possibility to update the activity data set used to estimate NMVOC emissions.

4.6 Consumption of Halocarbons and Sulphur Hexafluoride (Category 2F)

4.6.1 Source Category Description

The group of halocarbons comprises partially fluorinated hydrocarbons (HFC-23; HFC-32; HFC-41; HFC-43-10mee; HFC-125; HFC-134; HFC-134a; HFC-143, HFC-143a; HFC-152a; HFC-227ea; HFC-236fa; HFC-245ca) and perfluorinated hydrocarbons (perfluoromethane – CF_4, perfluoroethane – C_2F_6, pefluoropropane – C_3F_8, perfluorobutane – C_4F_{10}, perfluorociclobutane – c-C_4F_8, perfluoropentane – C_5F_{12}, perfluorohexane – C_6F_{14}) (Table 4-70).

Globally, wide scale production of halocarbons started in 1991, as alternative substances to chlorofluorocarbons (CFC), ozone layer depleting substances (ODS). According the Montreal Protocol, the Parties to this treaty committed to phase out the import and consumption of chemical substances that deplete the ozone layer, with further complete elimination starting 2008 (because halocarbons do not contain atoms of chlorine, they do not have any impact on ozone layer).

The 2F 'Consumption of Halocarbons and Sulphur hexafluoride' source category includes GHG emissions from the following sources: 2F1 'Refrigeration and Air Conditioning Equipment', 2F2 'Foam Blowing', 2F3 'Fire Extinguishers', 2F4 'Aerosols', 2F5 'Solvents', 2F6 'Other Applications with ODS', 2F7 'Semiconductors Production', 2F8 'Electrical Equipment' and 2F9 'Other'.

Under the current inventory cycle the RM monitored emissions generated by the consumption of HFCs, PFCs and SF_6 from source categories 2F1, 2F2, 2F4 and 2F8. Emissions from source categories 2F5, 2F6 and 2F9 were reported as 'Not Estimated' (NE) due to lack of activity data. Emissions from source categories 2F3 and 2F7 were reported as 'Not Occurring' (NO) due to lack of such activities (as for 2F7 'Semiconductors Production') and/or due to the fact that the products used in the RM do not contain halocarbons (as for 2F3 'Fire Extinguishers' category).

Table 4-70: Global Warming Potentials and Atmospheric Lifetimes

GHG	Chemical formula	100-year GWP	Atmospheric lifetime, years
Hydrofluorocarbons (HFC)			
HFC-23	CHF_3	11700	264
HFC-32	CH_2F_3	650	5.6
HFC-41	CH_3F	150	3.7
HFC-43-10mee	$C_5H_2F_{10}$	1300	17.1
HFC-125	C_2HF_5	2800	32.6
HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1000	10.6
HFC-134a	$C_2H_2F_2$ (CH_2FCF_3)	1300	14.6
HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	300	1.5
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	3800	3.8
HFC-152a	C_2H4F_2 (CH_3CHF_2)	140	48.3
HFC-227ea	C_3HF_7	2900	36.5
HFC-236fa	$C_3H_2F_6$	6300	209
HFC-245ca	$C_3H_3F_5$	560	6.6
Perfluorocarbons (PFC)			
Perfluoromethane	CF_4	6500	50000
Perfluoroethane	C_2F_6	9200	10000
Perfluoropropane	C_3F_8	7000	2600
Perfluorobutane	C_4F_{10}	7000	2600
Perfluorociclobutan	$c\text{-}C_4F_8$	8700	3200
Perfluoropentane	C_5F_{12}	7500	4100
Perfluorohexane	C_6F_{14}	7400	3200
Sulphur Hexafluoride (SF_6)			
Sulphur Hexafluoride	SF_6	23900	3200

Source: IPCC (1995, 1996).

To be noted that the process of collecting activity data on consumption of halocarbons and sulphur hexafluoride is extremely difficult in the Republic of Moldova. The primary difficulty is due to the fact that import, export, re-export and circulation of halocarbons and equipment charged with halocarbons on the market is not regulated at the national level (like, for example, the ODS). Import of halocarbons in bulk, as well as products and equipment charged with halocarbons does not require a license and/or environmental authorization, being allowed to practically any legal entity or individual. 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 practically by any individual.

In these circumstances, GHGs under the source category 2F 'Consumption of halocarbons and sulphur hexafluoride' were estimated based on data on import and consumption of halocarbons provided by the National Bureau of Statistics, Customs Service, the Republican Association of Refrigeration Technicians and based on Annual Reports submitted by enterprises to the Ozone Office besides the Ministry of Environment: between 2004-2011, there were 3 enterprises ('Frigoinds' Ltd, 'Ecolux' Ltd and 'Frigo-Dins' Ltd) licensed to import, export, re-export, transit and placing ODS and equipment containing ODS on the market, including alternative substances (HFCs). It should be noted that the RM does not produce halocarbons and SF_6, and until 1995 these substances had a relatively narrow use, being imported in insignificant amounts.

2F1. 'Refrigeration and Air Conditioning Equipment'

Refrigeration equipment (household refrigerators, freezers, AC window units) and air conditioning equipment (stationary and mobile air conditioners) are a primary source of HFCs emissions in the RM. Since 1995, in conformity with Montreal Protocol, the developed countries are not supposed to produce CFC and equipment using CFC, the RM uses R-22 and R-600a refrigerants as transit substances, and R-134a, R-404a, R-407c, R-410a, R-507a, etc. as alternative refrigerants to chlorofluorocarbons (Table 4-71).

Table 4-71: Composition of Refrigerants Preponderantly Used in the Republic of Moldova

Commercial Name	Sector of Use	Composition
R-134a	Transport refrigerant	HFC-134a (100%)
R-404a	Commercial refrigerant	HFC-125 (44%)/HFC-143a (52%)/HFC-134a (4%)
R-407a	Commercial 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	HFC-32 (23%)/HFC-125 (25%)/HFC-134a (52%)
R-407d	Transport refrigerant	HFC-32 (15%)/HFC-125 (15%)/HFC-134a (70%)
R-408a	Commercial refrigerant	HCFC-22 (47%)/HFC-143a (46%)/HFC-125 (7%)
R-410a	Transport refrigerant	HFC-32 (50%)/HFC-125 (50%)
R-507	Transport refrigerant	HFC-125 (50%)/HFC-143a (50%)

The breakdown of refrigerants used in the Republic of Moldova in different types of refrigeration and air conditioning equipment varied in different years (Table 4-72).

2F2. 'Foam Blowing'

Since 1995 hydrofluorocarbons have been also used to replace CFCs and HCFC used in foam blowing (closed and opened cell foams), used in insulation, cushioning and packaging. The basic components for production of these foams are: HFC-245f, HFC-365mfc, HFC-134a, and HFC-152a.

There is no foam blowing production in the RM, while imported foams are preponderantly opened cell foams (emissions generated by opened cell foams have a longer time period, by default, about 20 years).

2F3. 'Fire Extinguishers'

There are two types of fire extinguishers: total fixed flooding fire extinguishing systems and portable streaming fire extinguishers. At the international level, halon based extinguishers (halon-1211 or bromoclorodifluoromethane; halon-1301 or bromotrifluoromethane and halon-2402 or dibromotetrafluoroethane) tend to be replaced by HFCs based extinguishers (HFC-227ea and HFC-236fa).

According to the information received from the Civil Protection and Emergency Situations Service of the Ministry of Intern Affaire (Official Letter No. 19/5-393 from 04.04.2008), only carbon dioxide is used in total flooding fixed fire extinguishing systems as an extinguishing agent, (halon and HFCs based stationary and portable extinguishing systems are not in use) (Table 4-73).

2F4. 'Aerosols'

In most aerosol products HFCs or CFCs are used as propellants (in insignificant quantities). Gases from aerosols are usually released shortly after production, on average 1-2 years after sale. During use of aerosols, 100 per cent of the chemical is emitted (US EPA, 1992). Most frequently, HFC-134a is used as propellant (less frequently: HFC-227ea and HFC-152a).

Table 4-72: Breakdown of Different Refrigerants Incorporated in Refrigeration and Air Conditioning Equipment Imported in the RM within 1995-2010 time period, per cent

Refrigeration equipment	Refrigerant	1995	1996	1997	1998	1999	2000	2001	2002
Refrigerators	R-134a	50	55	60	65	70	75	90	85
	R-143a	0	0	0	0	0	0	0	0
	R-600a	0	0	0	0	0	0	0	15
	R-22	50	45	40	35	30	25	10	0
Ice machines	R-134a	45	45	45	45	45	45	45	50
	R-404a	55	55	55	55	55	55	55	50
	R-507a	0	0	0	0	0	0	0	0
	R-12	0	0	0	0	0	0	0	0
AC window units	R-134a	90	90	90	90	90	90	90	85
	R-404a	0	0	0	0	0	0	0	0
	R-407c	10	10	10	10	10	10	10	15
	R-507	0	0	0	0	0	0	0	0
Air Conditioning Equipment	R-410a	5	5	5	10	10	15	30	45
	R-407c	0	5	5	5	5	5	10	15
	R-22	95	90	90	85	85	80	60	40
Refrigeration equipment	**Refrigerant**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Refrigerators	R-134a	85	85	85	80	90	40	50	5
	R-143a	0	0	0	0	0	0	15	20
	R-600a	15	15	15	20	4	0	30	75
	R-22	0	0	0	0	6	60	5	0
Ice machines	R-134a	40	35	40	45	0	0	0	0
	R-404a	60	65	60	55	100	85	55	70
	R-507a	0	0	0	0	0	0	45	30
	R-12	0	0	0	0	0	15	0	0
AC window units	R-134a	85	80	80	75	0	0	0	0
	R-404a	0	0	0	0	60	100	60	70
	R-407c	15	20	20	25	0	0	0	0
	R-507	0	0	0	0	40	0	40	30
Air Conditioning Equipment	R-410a	60	55	50	30	40	50	80	55
	R-407c	20	25	30	50	35	30	15	45
	R-22	20	20	20	20	25	20	5	0

Source: Republican Association of Refrigeration Technicians in the RM, Personal Communication of the Association Director, Mr. Ion Jicul dated 18.08.2011 to Mr. Anatol Tarata, Manager of Ozone Office by the MoEN of the RM.

Table 4-73: Import of Carbon Dioxide Based Portable Fire Extinguishers in the Republic of Moldova within 2000-2010 time periods

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Portable fire extinguishers, units	7572	4178	9247	13806	20913	18494	26666	41232	46428	154462	43347

Source: Customs Service of the RM, Official Letter No. 28/07-1893 dated February, 23, 2011 at Nr. 03-07/175 dated February, 02, 2011.

In the Republic of Moldova, aerosols containing chemical substances included in Annex A, Group I of the Montreal Protocol (including CFC-12) 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 at commission and used by the Ministry of Intern Affaire of the RM or other organizations entitled to ensure public order, and used in cases stipulated by legislation).

2F8. 'Electrical Equipment'

Sulphur Hexafluoride (SF_6) is mostly used as an insulation medium in high tension electrical equipment including gas insulated switchgear, chemical lasers and circuit breakers. To find out in what way SF_6 is used in the RM, enterprises subordinated to the Ministry of Industry and Infrastructure (including 'Moldelectrica' SOE), Ministry of Health and the Academy of Science of Moldova were surveyed.

The survey of the above mentioned organizations revealed the following:

- No activity data is available on application of SF6 in gas insulated chemical lasers at the Academy of Science of Moldova and Ministry of Health for the time period since 1990 to 2010;
- In 2010, within the Ministry of Economy (enterprises like ‚Moldelectrica' S.O.E. and Red Union Fenosa J.S.C. part of the Gas Natural Fenosa Group), SF6 was used in 85 high tension circuit breakers, varying from 2.6 kg of SF6 (GL-107 type, 35kV); 9.0 kg SF6 (GL-311 (P) type, 110 kV; 12 kg SF6 (GL-311 (VR) type, GL-311 (LTB) and GL-312, 110 kV; and respectively 41 kg each, a fusion representing 26 kg SF6 and 15 kg CF4 (GL-315 type, 330 kV).

As one can see, the use of PFCs in the RM, in particular CF_4 is being recorded currently only as an insulation medium in high tension electrical equipment including gas insulated switchgear (mostly in GL-315 type, 330 kV).

To be noted that 'potential' total direct greenhouse gas emissions covered by the source category 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' increased between 1995 and 2010 by circa 3336.2 per cent, from 41.3029 Gg CO_2 eq. in 1995 up to 1419.2684 Gg CO_2 eq. in 2010.

At the same time 'actual' total direct GHG covered by the source category 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' increased by 5332.2 per cent over the period since 1995 to 2010, from 1.8961 Gg CO_2 eq. in 1995 up to 102.9988 Gg CO_2 eq. in 2010.

Share of SF_6 emissions in the total GHG emissions generated from the source category 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' is insignificant, such emissions being reported in the RM only since 2003 (Table 4-74).

4.6.2 Methodological Issues, Emission Factors and Data Sources

2F1. 'Refrigeration and Air Conditioning Equipment'

Refrigeration equipment (refrigerators, ice machines, AC window units) and air conditioning equipment (stationary and mobile air conditioners) are a primary source of HFC emissions in the Republic of Moldova.

Greenhouse gas emissions generated from consumption of halocarbons in 2F1 'Refrigeration and Air Conditioning Equipment' source category were estimated using both Tier 1b (potential emissions), and Tier 2 estimation method (actual emissions).

Potential emissions equal to the amount of virgin chemical substances consumed in the country minus the amount of chemical substances recovered to be destroyed or exported within one calendar year.

Potential Emissions = Production + Imports (Bulk Chemicals + Chemical Contained in Products) – Exports (Bulk Chemicals + Chemical Contained in Products) – Destruction

If not destroyed, over time the entire amount of chemical substances consumed is emitted in the atmosphere, so that in the long run (for example, 50 years) potential emissions become equal to actual emissions. However, it should be noted that this approach overlooks accumulation of possible leakages of chemical substances from different products and equipment, entailing estimation uncertainties, in particular, for shorter periods of time (for example, 10-15 years). Because such an accumulation is a dominant process, potential emissions will be much more overestimated than the actual emissions.

The Tier 2 estimation method (bottom-up approach) is based on estimation of HFCs emissions from assembly, operation, and disposal of equipment.

Total Emissions = Assembly Emissions + Operation Emissions + Disposal Emissions

Where:

- Assembly Emissions include the emissions associated with product manufacturing, even if the products are eventually exported;

Table 4-74: GHG Emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' Source Category in the RM within 1995-2010 time periods, Gg CO_2 equivalent

Year	HFC		PFC		SF_6		Total	
	Potential	Actual	Potential	Actual	Potential	Actual	Potential	Actual
1995	41.3029	1.8961	NO	NO	NO	NO	41.3029	1.8961
1996	72.7763	4.0738	NO	NO	NO	NO	72.7763	4.0738
1997	101.7038	6.6059	NO	NO	NO	NO	101.7038	6.6059
1998	131.2891	9.4575	NO	NO	NO	NO	131.2891	9.4575
1999	154.9716	11.4564	NO	NO	NO	NO	154.9716	11.4564
2000	183.1792	13.3755	NO	NO	NO	NO	183.1792	13.3755
2001	221.1297	16.4898	NO	NO	NO	NO	221.1297	16.4898
2002	272.5667	19.5171	NO	NO	NO	NO	272.5667	19.5171
2003	362.2020	25.8543	NO	NO	0.2868	0.0057	362.4888	25.8600
2004	459.5423	32.0282	NO	NO	0.2868	0.0057	459.8291	32.0340
2005	570.8933	39.4124	NO	NO	2.2944	0.0459	573.1877	39.4583
2006	703.6394	47.0741	0.7800	0.0156	13.5991	0.2720	718.0185	47.3617
2007	909.1773	60.3620	0.7800	0.0156	17.6143	0.3523	927.5716	60.7298
2008	1146.3041	76.3309	0.9750	0.0195	21.1515	0.4230	1168.4306	76.7734
2009	1243.4062	87.1207	0.9750	0.0195	22.8723	0.4574	1267.2535	87.5976
2010	1390.1794	102.4171	1.3650	0.0273	27.7240	0.5545	1419.2684	102.9988
1995-2010,%	**3265.8**	**5301.5**	**75.0**	**75.0**	**9566.7**	**9566.7**	**3336.2**	**5332.2**

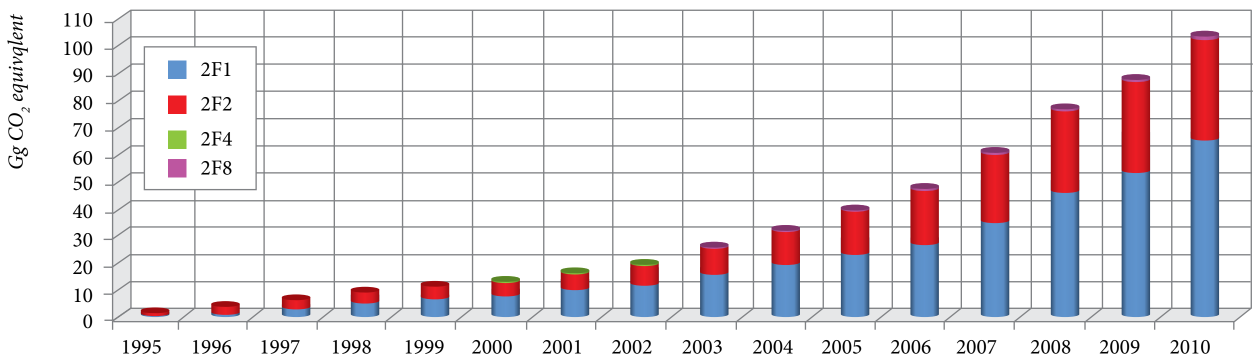


Figure 4-7: Direct GHG Emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' Source Category in the RM, by Source within 1995-2010 time periods

- Operation Emissions include annual leakage from equipment stock in use as well as servicing emissions; this calculation should include all equipment units in the country, regardless of where they were manufactured;
- Disposal Emissions include the amount of refrigerant released from scrapped systems; as with operation emissions, they should include all equipment units in the country where they were scraped, regardless of where they were manufactured;

The estimation process implies three consecutive stages using the equations below.

Assembly Emissions = (Total HFC and PFC Charged in year t) • (k /100)

Where:

k = Emission factor that represents the percentage of initial charge that is released during assembly.

Operation Emissions = (Amount of HFC and PFC Stock in year t) • (x /100)

Where:

x = Emission factor that represents the annual leak rate as a percentage of total charge; since different types of refrigeration equipment will leak at different rates, data were disaggregate into homogeneous classes in order to develop values of x specific to different types of equipment.

Disposal Emissions = (HFC and PFC Charged in year) • (y /100) • (100 – z /100) – (Amount of Intentional Destruction)

Where:

y = Percentage of the initial charge remaining in the equipment at the time of disposal;

z = Recovery efficiency at the time of disposal.

A) 'Stationary Refrigeration and Air Conditioning Equipment'

The information about the average charge for each type of equipment is based on data provided by the Customs Service of the RM, Republican Association of Refrigeration Technicians and annual reports submitted by companies to the Ozone Office by the Ministry of Environment (Table 4-75). Default values were used for other parameters and factors (IPCC, 2000).

Activity data used to estimate HFC emissions from consumption of hydrofluorocarbons charged into refrigeration and air conditioning equipment (stationary air conditioning equipment) are provided below (Table 4-76).

The information on the composition of refrigerants preponderantly used in the RM (Table 4-71), the share of refrigerants charged into the refrigeration and air conditioning equipment imported in the country over the period from 1995 through 2010 (Table 4-72), the average charge of equipment with refrigerant (Table 4-75) and statistical data on import of refrigeration and air conditioning equipment (Table 4-76) (the respective equipment is not produced in the RM) was used to estimate the total amount of HFCs imported in the country (Table 4-77), as well as the actual HFCs emissions from the freons used in the refrigeration and air conditioning equipment in the RM within the period since 1995 to 2010 (Table 4-78).

B). 'Mobile Air Conditioning Equipment'

Default values were used for average charge with freons (mainly, HFC-134a) of mobile sources of air conditioning equipment (passenger cars, trucks, buses, minibuses and refrigeration vehicles), as well as for other parameters and emission factors (IPCC, 2000) (Table 4-79).

Estimation of the amount of HFCs used in mobile air conditioning equipment was based on information on the total number of transportation means units registered in the Republic of Moldova, in conformity with data available in the Statistical Yearbooks of the RM (Table 4-80), as well as data recorded in the State Transport Register (Table 4-81 and Table 4-82) (to be noted that the share of transportation means produced after 1993, in particular Euro-1, Euro-2, Euro-3 and Euro-4 was essential for estimating the share of transportation units charged with air conditioning equipment).

Table 4-75: Estimates for Charge, Lifetime and Emission Factors for Stationary Refrigeration Equipment in the Republic of Moldova

Equipment Type	Charge, kg (Ei_{charge})[1]	Lifetime, years (n)[1]	EF, % of the initial charge/ year		% of Initial Charge Remaining at Disposal (y)[2]	End-of-Life Emissions (Recovery efficiency), (z)[1]
			Initial Emissions (k)[2]	Lifetime Emissions (x)[2]		
Domestic refrigeration	0.10	12	0.6	0.3	95	0
Chest freezers	0.20	12	0.6	5.0	90	0
Upright freezers	0.18	12	0.6	5.0	90	0
AC window units	0.40	10	0.6	10.0	60	0
Industrial AC window units	0.60	10	0.6	10.0	60	0
Air conditioning equipment	0.80	12	0.6	5.0	60	0

Source: [1] Republican Association of Refrigeration Technicians in the RM, Personal Communication of the Association Director, Mr. Ion Jicul dated 18.08.2011 to Mr. Anatol Tarata, Manager of Ozone Office by the MoEN of the RM; [2] Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), Chapter 3 „Industrial Processes", Table 3.22, page 3.106.

Table 4-76: Activity Data on Refrigeration and Air Conditioning Equipment Imported in the Republic of Moldova within 1995-2010 time periods, units

Equipment	1995	1996	1997	1998	1999	2000	2001	2002
Domestic refrigeration	18958	8376	11597	15230	8498	12092	19937	30689
Chest freezers	36	243	100	148	96	242	428	97
Upright freezers	43	337	22	320	200	393	558	995
AC window units	2696	1037	1411	2714	913	1195	1696	3153
Industrial AC window units	102	583	558	2286	622	822	977	1122
Air conditioning equipment	2245	424	1247	1177	794	1677	1213	2205
Equipment	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Domestic refrigeration	42524	52694	70412	87034	112982	78880	65306	72824
Chest freezers	442	457	1265	1713	1549	2834	2529	2492
Upright freezers	2033	1481	1965	5180	9574	3169	4323	8825
AC window units	1803	2465	2830	3621	8978	8692	4908	4296
Industrial AC window units	1605	1260	1173	1246	1436	478	422	403
Air conditioning equipment	5778	5753	7879	11308	38291	36172	8287	17607

Source: Custom Service of the RM, Official Letter No. 28/07-1893 dated February 23, 2011 at No. 03-07/175 dated February 02, 2011.

Table 4-77: Activity Data on Imported HFCs Charged into 'Refrigeration and Air Conditioning Equipment' in the RM within 1995-2010 time periods, tones

	1995	1996	1997	1998	1999	2000	2001	2002
HFC-32	0.0677	0.0277	0.0544	0.1071	0.0538	0.1355	0.1932	0.5158
HFC-125	0.0941	0.0697	0.0792	0.1782	0.0826	0.1851	0.2654	0.6228
HFC-134a	2.0262	1.2398	1.5783	3.3654	1.3315	1.9109	3.1213	4.6097
HFC-143a	0.0043	0.0312	0.0069	0.0249	0.0158	0.0341	0.0532	0.0516
Total HFCs	2.1922	1.3685	1.7187	3.6756	1.4837	2.2656	3.6331	5.7999
	2003	2004	2005	2006	2007	2008	2009	2010
HFC-32	1.6499	1.6000	2.0842	2.5071	8.5925	9.2311	2.8806	5.3314
HFC-125	1.8388	1.7951	2.3556	3.0159	11.7676	11.4860	4.5285	7.3117
HFC-134a	5.8205	6.7449	8.8411	11.7832	15.9317	7.8587	3.8638	3.7735
HFC-143a	0.1418	0.1210	0.1893	0.3647	3.3371	2.4597	2.7705	3.5367
Total HFCs	9.4510	10.2609	13.4701	17.6708	39.6289	31.0355	14.0434	19.9533

Table 4-78: Actual HFC Emissions from Freons Charged into 'Refrigeration and Air Conditioning Equipment' in the RM within 1995-2010 time periods, tones

	1995	1996	1997	1998	1999	2000	2001	2002
HFC-32	0.0049	0.0068	0.0106	0.0187	0.0219	0.0301	0.0414	0.0720
HFC-125	0.0075	0.0124	0.0182	0.0327	0.0377	0.0495	0.0658	0.1049
HFC-134a	0.1225	0.1940	0.2845	0.5325	0.5936	0.6957	0.8341	1.0389
HFC-143a	0.0002	0.0020	0.0022	0.0035	0.0042	0.0061	0.0088	0.0114
Total HFCs	0.1352	0.2153	0.3155	0.5874	0.6574	0.7813	0.9501	1.2272
	2003	2004	2005	2006	2007	2008	2009	2010
HFC-32	0.1638	0.2470	0.3715	0.5003	0.9950	1.4596	1.5593	1.8563
HFC-125	0.2092	0.3056	0.4615	0.6182	1.3958	2.0898	2.2809	2.7403
HFC-134a	1.2440	1.4529	2.3497	2.5111	3.8428	4.5077	3.7542	4.3646
HFC-143a	0.0190	0.0250	0.0348	0.0541	0.3566	0.5965	0.7256	0.9053
Total HFCs	1.6360	2.0304	3.2175	3.6838	6.5903	8.6537	8.3200	9.8665

Table 4-79: Estimates for Charge, Lifetime and Emission Factors for Mobile Air Conditioning and Transport Refrigeration Equipment in the Republic of Moldova

Equipment type	Charge with HFC-134a, kg (Ei_{charge})[1]	Lifetime, years (n)[2]	Emission factor, % of initial charge/year		% of Initial charge remaining at disposal (y)[2]	End-of-Life emissions (recovery efficiency), (z)
			Initial (k)[2]	Operational (x)[2]		
Passenger Cars	0.75	12	0.5	15	40	0
Buses	9.00	12	0.5	15	40	0
Trucks	1.50	12	0.5	15	40	0
Refrigerators	8.00	9	0.6	15	40	0

Source: [1] Environmental Protection Agency, part of the Danish Ministry of Environment (2010), <http://www2.mst.dk/udgiv/publications/2010/978-87-92617-66-8/pdf/978-87-92617-67-5.pdf>; [2] Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), Chapter 3 „Industrial Processes", Table 3.23, page 3.110 and Table 3-24, page 3.112.

Table 4-80: Number of Transportation Units Registered in the RM (standing for the end of the calendar year), units

	1995	1996	1997	1998	1999	2000	2001	2002
Passenger car	165941	173618	205973	222769	232278	238380	256459	268882
Buses and Minibuses	9181	9798	11169	12917	13582	12769	14703	15777
Trucks	59888	57138	56924	57404	52430	46351	45809	46277
	2003	2004	2005	2006	2007	2008	2009	2010
Passenger car	265841	269551	292994	319311	338944	366351	386365	404290
Buses and Minibuses	15723	19741	19825	21056	21095	21491	21346	21395
Trucks	46905	73774	81798	84087	94828	115967	120174	131243

Source: Statistical Yearbooks of the RM for 1999 (page 390), 2003 (515-516), 2005 (page 407), 2007 (page 403), 2008 (page 399), 2009 (page 398), 2010 (page 399).

Table 4-81: Transportation Units Charged with Air Conditioning Equipment in the RM (by the end of calendar year), units

	1995	1996	1997	1998	1999	2000	2001	2002
Passenger car	151	4156	9928	14402	18709	22809	28497	30705
Buses and Minibuses	4	125	436	939	1138	1137	1417	1622
Trucks	7	632	1390	2318	3126	4174	5933	6214
Refrigeration Vehicles	0	21	50	106	166	155	236	415
	2003	2004	2005	2006	2007	2008	2009	2010
Passenger car	48998	52552	59115	67856	75398	85706	93504	102384
Buses and Minibuses	1679	2168	2258	2596	2698	2894	3214	3389
Trucks	7081	11381	13252	14198	16993	22649	26122	30522
Refrigeration Vehicles	623	864	1042	1229	1412	1753	1965	2329

Table 4-82: Share of Transportation Units Charged with Air Conditioning Equipment in the RM (by the end of calendar year), % of the total

	1995	1996	1997	1998	1999	2000	2001	2002
Passenger car	0.09	2.4	4.8	6.5	8.1	9.6	11.1	11.4
Buses and Minibuses	0.04	1.3	3.9	7.3	8.4	8.9	9.6	10.3
Trucks	0.01	1.1	2.4	4.0	6.0	9.0	13.0	13.4

	2003	2004	2005	2006	2007	2008	2009	2010
Passenger car	18.4	19.5	20.2	21.3	22.2	23.4	24.2	25.3
Buses and Minibuses	10.7	11.0	11.4	12.3	12.8	13.5	15.1	15.8
Trucks	15.1	15.4	16.2	16.9	17.9	19.5	21.7	23.3

Source: Ministry of Information and Communication Technology of the RM, Official Letter No. 01/337 dated 02.03.2011, answer to the request through Official Letter No. 03-07/175 dated 02.02.2011, regarding the 1995-2010 time series.

Based on information on the average freon charge (HFC-134a) of air conditioning equipment in mobile sources (Table 4-79), information on total number of transportation units registered in the RM (Table 4-80) and information on the share of vehicles manufactured from 1993 onwards equipped with air conditioning equipment (Table 4-82), in conformity with data recorded in the State Transport Register (Table 4-81), was used to estimate the total amount of HFC-134a charged into the air conditioning equipment used in transportation units in the RM (Table 4-83), as well as actual HFC-134a emissions from freon charged into the air conditioning equipment of transportation units in the RM, within the 1995-2010 time series (Table 4-84).

C). 'Import of Hydrofluorocarbons in Bulk'

The information about import of HFCs in bulk (Table 4-85) was provided by companies licensed to import freons in bulk and equipment containing freons.

Table 4-83: Activity Data on the Amount of HFC-134a Charged into the Air Conditioning Equipment of Transportation Units in the RM within 1995-2010 time periods, tones

	1995	1996	1997	1998	1999	2000	2001	2002
HFC-134a in passenger cars	0.0105	0.9480	2.0850	3.4770	4.6890	6.2610	8.8995	9.3209
HFC-134a in buses	0.0360	1.1250	3.9240	8.4510	10.2420	10.2303	12.7530	14.5962
HFC-134a in trucks	0.1133	3.1170	7.4460	10.8015	14.0318	17.1068	21.3728	23.0286
HFC-134a in refrigeration vehicles	0.0000	0.1680	0.4000	0.8480	1.3280	1.2400	1.8880	3.3200
Total HFC-134a	0.1598	5.3580	13.8550	23.5775	30.2908	34.8381	44.9133	50.2657
	2003	2004	2005	2006	2007	2008	2009	2010
HFC-134a in passenger cars	10.6208	17.0712	19.8773	21.2973	25.4894	33.9736	39.1826	45.7830
HFC-134a in buses	15.1092	19.5098	20.3245	23.3604	24.2798	26.0433	28.9276	30.5037
HFC-134a in trucks	36.7487	39.4139	44.3364	50.8922	56.5485	64.2793	70.1283	76.7880
HFC-134a in refrigeration vehicles	4.9840	6.9120	8.3360	9.8320	11.2960	14.0240	15.7200	18.6320
Total HFC-134a	67.4626	82.9068	92.8742	105.3820	117.6136	138.3202	153.9585	171.7068

Table 4-84: Actual HFC-134a Emissions from Freon Charged into the Air Conditioning Equipment of Transportation Units in the RM within 1995-2010 time periods, tones

	1995	1996	1997	1998	1999	2000	2001	2002
HFC-134a in passenger cars	0.0016	0.1469	0.3232	0.5389	0.7268	0.9705	1.3794	1.4447
HFC-134a in buses	0.0056	0.1744	0.6082	1.3099	1.5875	1.5857	1.9767	2.2624
HFC-134a in trucks	0.0176	0.4831	1.1541	1.6742	2.1749	2.6515	3.3128	3.5694
HFC-134a in refrigeration vehicles	0.0000	0.0262	0.0624	0.1323	0.2072	0.1934	0.2945	0.5179
Total HFC-134a	0.0248	0.8307	2.1479	3.6554	4.6964	5.4011	6.9634	7.7945
	2003	2004	2005	2006	2007	2008	2009	2010
HFC-134a in passenger cars	1.6462	2.6460	3.0810	3.3011	3.9550	5.6451	6.9073	8.4872
HFC-134a in buses	2.3419	3.0240	3.1503	3.6209	3.7778	4.4867	6.0534	8.1085
HFC-134a in trucks	5.6960	6.1092	6.8721	7.8883	8.8103	11.2101	13.8483	16.2227
HFC-134a in refrigeration vehicles	0.7775	1.0783	1.3676	1.6938	2.1014	2.7189	2.9483	3.6618
Total HFC-134a	10.4617	12.8575	14.4710	16.5040	18.6445	24.0608	29.7573	36.4802

Table 4-85: Activity Data on Import of HFC in Bulk in the RM in 1995-2010, tones

	1995	1996	1997	1998	1999	2000	2001	2002
HFC-32	0.0172	0.0202	0.0238	0.0280	0.0329	0.0387	0.0455	0.0536
HFC-125	0.0864	0.1046	0.1312	0.1596	0.2029	0.2477	0.3044	0.4411
HFC-134a	0.1548	0.2229	0.3248	0.4785	0.7112	1.0647	1.6034	2.4261
HFC-143a	0.0954	0.1115	0.1565	0.1819	0.2641	0.3047	0.3565	0.4873
Total HFCs	0.3538	0.4592	0.6362	0.8479	1.2110	1.6559	2.3099	3.4080
	2003	2004	2005	2006	2007	2008	2009	2010
HFC-32	0.0630	0.0720	0.3333	0.1196	0.1040	0.5129	0.7017	0.1040
HFC-125	0.6871	2.4079	1.8678	1.6997	1.4242	6.8617	4.2243	4.5337
HFC-134a	3.6846	0.7384	3.2930	0.9386	4.7249	10.7280	5.2969	2.9771
HFC-143a	0.8115	2.5822	1.7964	1.7451	1.6805	6.9974	3.9368	5.0168
Total HFCs	5.2462	5.8005	7.2904	4.5031	7.9335	25.1000	14.1597	12.6316

Source: Republican Association of Refrigeration Technicians of the RM

At the time of inventory compilation, this information was available only for the time period from 2003 through 2010, so, in order to fill the gap regarding the period from 1995 through 2002, it was used one of the methodologies available in the GPG (IPCC, 2000, Chapter 7, Table 7-5, page 7.19) – the trend extrapolation approach based on the regression analysis.

2F2. 'Foam Blowing'

HFCs emissions from foam blowing consumption (in particular, closed-cell foam) used in insulating, cushioning and packaging, the blowing agents that may be used are HFC-245f, HFC-365mfc, HFC-134a and HFC-152a, were estimated using a Tier 2 approach.

The IPCC Guidelines (IPCC, 2000) suggest calculating HFCs emissions from open-cell foam separately from emissions from closed-cell foam.

HFCs used for open-cell foam blowing are released immediately, all of the emissions will occur in the country of manufacture. Since there is no open-cell foam blowing production in the Republic of Moldova, there are no emissions 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-cell 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 blowing are estimated in conformity with this equation:

Emissions from Closed-cell Foam = [(Total HFCs and PFCs Used in Manufacturing New Closed-cell Foam in year t) • (first-year Loss emission Factor)] + [(Original HFC or PFC Charge Blown into Closed-cell Foam Manufacturing between year t and year t-n) • (Annual Loss Emission Factor)] + [(Decommissioning losses in year n) – (HFC or PFC Destroyed)]

Where:

n – Product lifetime of closed-cell foam;

Decommissioning losses – the remaining chemical at the end of service life that occurs when the losses equipment is scrapped

This equation should be applied to each chemical and major foam application individually. Total CO_2 equivalent emissions are equal to the sum of CO_2 equivalent emissions of each combination of chemical type and foam application.

If country specific data are not available, default emission factors can be used (Table 4-86).

Table 4-86: Default EFs for 2F2 'Foam Blowing' Source Category

Emission Factor	Default Values
Product Lifetime	n = 20 years
First Year Losses	10% of the original HFC or PFC charge/year
Annual Losses	4.5% of the original HFC or PFC charge/year

Source: IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), Chapter 3 „Industrial Processes", Table 3.17, page 3.96.

AD regarding the amount of foam blowing imported in the RM, in particular on polystyrene and polyurethane, has been provided by the Custom Service of the RM (Table 4-87). To be noted that the main use of polystyrene and polyurethane consist in foam manufacturing, of different types: flexible, elastomeric, semi-rigid, rigid and structurally rigid.

According to the literature in the field, the most frequently used blowing agents in polyurethane and polystyrene foam manufacturing can be water, CO_2 resulted from the interaction of excessive isocyanate groups with water and a diversity of freons, including HFC-245f, HFC-365mfc, HFC-134a and HFC-152a.

The most frequently used blowing agent remain HFC-134a (IPCC, 2000), but since the share of HFC-134a-based foam blowing products is unknown, it has been decided to determine it considering the expert opinions (Table 4-88), taking into consideration, as well, the last years trend among the producers of foam blowing products to decrease the use of HFC as blowing agents, following the international

Table 4-87: Imported Foam Blowing products in the RM, 1995-2010, tones

	1995	1996	1997	1998	1999	2000	2001	2002
Polystyrene in primary forms, t (product code: 3903 11)	553.628	221.936	156.613	169.902	166.368	398.903	294.657	504.124
Polyurethane in primary forms, t (product code: 3909 50)	216.307	140.084	66.012	29.043	40.761	39.431	22.152	14.191
Cellular products of polystyrene, t (product code: 3921 11)	17.780	8.997	49.364	46.196	21.015	11.225	95.867	245.559
Cellular products of polyurethane, t (product code: 3921 13)	135.951	146.324	112.796	86.862	112.978	147.227	202.375	424.281
Total foam blowing products, t	923.666	517.341	384.785	332.003	341.122	596.786	615.051	1188.155
	2003	2004	2005	2006	2007	2008	2009	2010
Polystyrene in primary forms, t (product code: 3903 11)	894.583	896.594	1816.783	2475.656	2748.797	3017.817	2525.455	3097.145
Polyurethane in primary forms, t (product code: 3909 50)	67.895	181.531	364.711	306.105	540.386	769.626	598.859	684.052
Cellular products of polystyrene, t (product code: 3921 11)	395.658	491.292	605.544	612.300	597.861	712.092	627.675	638.795
Cellular products of polyurethane, t (product code: 3921 13)	528.558	573.396	681.616	1006.080	1527.649	1246.598	645.537	860.186
Total foam blowing products, t	1886.694	2142.813	3468.654	4400.141	5414.693	5746.133	4397.526	5280.178

Source: Custom Service of the RM, Official Letter No. 28/07-1893 dated February 23, 2011 at No. 03-07/175 dated February 02, 2011.

commitments to phasing out F-gas consumption, especially when there already are competitive alternative technologies on the foam blowing market[25].

Table 4-88: Share of HFC-134a-based Foam Blowing Products in Total Imports in the RM, %

	1995	1996	1997	1998	1999	2000	2001	2002
Share of HFC-134a-based Foam Blowing Products in Total Imports, %	37.5	36.0	34.5	33.0	31.5	30.0	28.5	27.0
	2003	2004	2005	2006	2007	2008	2009	2010
Share of HFC-134a-based Foam Blowing Products in Total Imports, %	25.5	24.0	22.5	21.0	19.5	18.0	16.5	15.0

[25] 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>.

Considering the AD provided in Tables 4-86, 4-87 and 4-88, as well as the assumption that the blowing agent (HFC-134a) volume in polyurethane products represents about 12 per cent, while in polystyrene products – circa 6 per cent[26], the amount of HFC-134a contained in imported foam blowing products was estimated (Table 4-89), as well as the actual HFC-134a emissions from the blowing agent charged into the foam blowing products (Table 4-90).

2F4. 'Aerosols' (Metered Dose Aerosols)

HFC emissions from consumption of aerosol (in particular – 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 (US EPA, 1992). These emissions occur within 1-2 years after sales and should be estimated using the equation below.

[26] EMEP/EEA Emission Inventory Guidebook 2009, Category 3.C, Chemical products', 3.3.2.2 'Polyurethane foam processing' and Chapter 3.3.2.3 'Polystirene processing', see on page 17.

Table 4-89: AD on Import of HFC-134a Charged into the Foam Blowing Products in the RM within 1995-2010 time periods, tones

	1995	1996	1997	1998	1999	2000	2001	2002
HFC-134a in polystyrene in primary forms	12.4566	4.7938	3.2419	3.3641	3.1444	7.1803	5.0386	8.1668
HFC-134a in polyurethane in primary forms	9.7338	6.0516	2.7329	1.1501	1.5408	1.4195	0.7576	0.4598
HFC-134a in cellular products of polystyrene	0.4001	0.1943	1.0218	0.9147	0.3972	0.2021	1.6393	3.9781
HFC-134a in cellular products of polyurethane	6.1178	6.3212	4.6698	3.4397	4.2706	5.3002	6.9212	13.7467
Total HFC-134a in foam blowing products	28.7083	17.3610	11.6664	8.8686	9.3529	14.1020	14.3568	26.3514
	2003	2004	2005	2006	2007	2008	2009	2010
HFC-134a in polystyrene in primary forms	13.6871	12.9110	24.5266	31.1933	32.1609	32.5924	25.0020	27.8743
HFC-134a in polyurethane in primary forms	2.0776	5.2281	9.8472	7.7138	12.6450	16.6239	11.8574	12.3129
HFC-134a in cellular products of polystyrene	6.0536	7.0746	8.1748	7.7150	6.9950	7.6906	6.2140	5.7492
HFC-134a in cellular products of polyurethane	16.1739	16.5138	18.4036	25.3532	35.7470	26.9265	12.7816	15.4833
Total HFC-134a in foam blowing products	37.9921	41.7275	60.9522	71.9753	87.5479	83.8335	55.8550	61.4197

Table 4-90: Actual HFC-134a Emissions from the Blowing Agent Charged into the Foam Blowing Products in the RM within 1995-2010 time periods, tones

	1995	1996	1997	1998	1999	2000	2001	2002
HFC-134a in polystyrene in primary forms	0.5605	0.7763	0.9222	1.0735	1.2150	1.5381	1.7649	2.1324
HFC-134a in polyurethane in primary forms	0.4380	0.7103	0.8333	0.8851	0.9544	1.0183	1.0524	1.0731
HFC-134a in cellular products of polystyrene	0.0180	0.0267	0.0727	0.1139	0.1318	0.1409	0.2146	0.3936
HFC-134a in cellular products of polyurethane	0.2753	0.5598	0.7699	0.9247	1.1169	1.3554	1.6668	2.2854
Total HFC-134a in foam blowing products	1.2919	2.0731	2.5981	2.9972	3.4181	4.0527	4.6987	5.8845
	2003	2004	2005	2006	2007	2008	2009	2010
HFC-134a in polystyrene in primary forms	2.7483	3.3293	4.4330	5.8367	7.2839	8.7506	9.8757	11.1300
HFC-134a in polyurethane in primary forms	1.1666	1.4018	1.8450	2.1921	2.7611	3.5092	4.0428	4.5968
HFC-134a in cellular products of polystyrene	0.6660	0.9844	1.3523	1.6994	2.0142	2.3603	2.6399	2.8986
HFC-134a in cellular products of polyurethane	3.0132	3.7564	4.5845	5.7254	7.3340	8.5457	9.1209	9.8177
Total HFC-134a in foam blowing products	7.5942	9.4719	12.2148	15.4536	19.3933	23.1658	25.6793	28.4432

Emissions of HFC = 50% of HFC Quantity Contained in Aerosol Products Sold in year t + 50% HFC Quantity Contained in Aerosol Products Sold in year t-1

The activity data on the amount of medical substances imported in the RM (metered dose inhalers used in asthma and chronicle pulmonary diseases treatment, including tuberculosis) were provided by the Ministry of Health of the RM (Table 4-91). To be noted that metered dose inhalers are not produced in the Republic of Moldova and these substances are imported preponderantly from Ukraine and more recently, from Russian Federation and China.

Based on activity data above, the amount of HFC-134a contained in metered dose aerosols was estimated (Table 4-92).

Because at the time of inventory compilation, this information was available only for the time period from 2003

Table 4-91: Import of Metered Dose Inhalers Using HFC-134a as Propellant in the RM within 2003-2010 time periods, flacons

	2003	2004	2005	2006	2007	2008	2009	2010
Salbutamol sulphate - Salbutamol pressurized inhalation suspension, 100 mcg/dose-200 doses	-	-	-	87200	60640	68960	109500	100184
Salbutamol sulphate - Ventolin Inhaler 100 mcg/dose-200 doses	-	4500	7923	12206	5448	12800	13236	19450
Fenoterol hydrobromide - Berotec N pressurized inhalation solution 100 mcg/dose-200 doses	3014	6548	4320	3524	4363	1558	5138	4164
Ipratropium bromide / Fenoterol hydrobromide - Berodual N pressurized inhalation solution 200 doses 10 ml.	-	-	-	200	500	586	1300	1726
Fluticasone propionate - Flixotide 50 Evohaler 50 µg / dose 120 doses	-	500	1630	1690	1160	1200	300	1150
Fluticasone propionate - Flixotide 125 Evohaler 125 µg /dose 60 doses	-	-	-	-	-	612	800	250
Fluticasone propionate - Flixotide 125 Evohaler 125 µg /dose 120 doses	-	282	3170	2650	1370	-	1933	1400
Fluticasone propionate - Flixotide 250 Evohaler 250 µg /dose 60 doses	-	250	950	1330	2170	-	2990	620
Fluticasone propionate - Flixotide 250 Evohaler 250 µg /dose 120 doses	-	-	-	-	-	850	480	2750
Salmeterol xinafoate / Fluticasone propionate - Seretide Inhaler 25 µg + 50 µg 120 doses	-	-	-	-	-	250	299	530
Salmeterol xinafoate - Serevente Inhaler 25 µg 120 doses	-	-	-	-	-	1200	1637	2100
Fluticasone propionate - Flixotide 250 Evohaler 250 µg /dose 60 doses	-	-	-	-	-	200	3040	620
Fluticasone propionate - Flixotide 50 Evohaler 50 µg / dose 120 doses	-	-	-	-	-	850	300	-
Fluticasone propionate - Flixotide 125 Evohaler 125 µg /dose 120 doses	-	-	-	-	-	1413	-	-
Fluticasone propionate - Flixotide 250 Evohaler 250 µg /dose 60 doses	-	-	-	-	-	100	2990	620
Totals Metered Dose Inhalers using HFC-134a as propellant	3014	12080	17993	108800	75651	90579	143943	135564

Source: Ministry of Health of the RM, Official Letter No. 019/550 from March, 1, 2011, as a response to Letter No. 03-07/175 dated 02.02.2011, regarding the period 2003-2010; respectively Official Letter No. 019/2045, dated September 14, 2011, as a response to Letter No. 05-07/1321dated 05.08.2011, regarding the period 2005-2010.

Table 4-92: Activity Data on HFC-134a Incorporated in Metered Dose Aerosols Imported in the Republic of Moldova within 2000-2010, kg

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HFC-134a, kg	0.0075	0.0151	0.0301	0.0603	0.2319	0.3164	4.1284	6.4691	7.6003	15.7534	19.8872

through 2010, the activity data for the time period from 2000 through 2002 was extrapolated based on modelling using regression type trend[27], using an exponential equation (IPCC, 2000, Chapter 7, Table 7-5, page 7.19). To be noted that according the Ministry of Health, the use of metered dose aerosols using HFC-134a as propellant, started only in 2000 in the RM.

2F8. 'Electrical Equipment'

SF_6 emissions from use of sulphur hexafluoride as insulation medium in high tension electrical circuit breakers were estimated based on Tier 2b estimation methodology using default emission factors (IPCC, 2000), based on the equation below.

Emissions of SF_6 in year t – (2% of the Total Charge of SF_6 Contained in the Existing Stock of Equipment of Operation in year t) + (95% of the Nameplate Capacity of SF_6 in Retiring Equipment)

In 2003 the Moldavian companies initiated the use of high-tension electrical circuit breakers (110 kV and 330 kV), usually of GL311 and LTB type (the SF_6 charge in each case is 12 kg).

In conformity with the manufacturer's technical log the first repairs shall take place after 25 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 4-93, respectively in Table 4-94.

The amount of insulating gas (SF_6 and CF_4) in bulk charged in the high-tension electrical circuit breakers in the Republic of Moldova is provided in Table 4-95 and 4-96, respectively.

27 The regression equation is a polynomial type: $y = 0.3532x^2 - 2.4087x + 3.1482$, $R^2 = 0.9741$.

Table 4-93: The dynamic of high-tension electrical circuit breakers installation process using SF6 and CF4 within 2003-2010 time periods, units installed per year

Enterprises	2003	2004	2005	2006	2007	2008	2009	2010
Moldelectrica S.O.E.	1	0	5	28	8	2	0	8
Red Union Fenosa J.S.C.	0	0	2	6	6	8	6	5
Total	**1**	**0**	**7**	**34**	**14**	**10**	**6**	**13**

Source: Red Union Fenosa J.S.C., Official Letter No. 0201/65392, dated August 15, 2011, answer to Letter No. 03-07/1337 dated 08.08.2011; MOLDELECTRICA S.O.E., Official Letter No. 46-47/1795 dated 23.08.2011 answer to Letter No. 03-07/1337 dated 08.08.2011.

Table 4-95: Total amount of insulating gas - SF_6 available in bulk, charged in the high-tension electrical circuit breakers in the RM, kg

	2003	2004	2005	2006	2007	2008	2009	2010
Circuit breaker GL-107, 35 kV	0	0	0	13	13	13	13	13
Circuit breaker GL-311 (VR), 110 kV	12	12	96	324	492	588	660	720
Circuit breaker GL-311 (P), 110 kV	0	0	0	0	0	0	0	27
Circuit breaker GL-311 (LTB), 110 kV	0	0	0	24	24	24	24	24
Circuit breaker GL-312, 110 kV	0	0	0	0	0	0	0	12
Circuit breaker GL-315, 330 kV	0	0	0	208	208	260	260	364
Total SF_6 in bulk	**12**	**12**	**96**	**569**	**737**	**885**	**957**	**1160**

Table 4-96: Total amount of insulating gas - CF_4 available in bulk, charged in the high-tension electrical circuit breakers in the RM, kg

	2003	2004	2005	2006	2007	2008	2009	2010
Total in circuit breakers GL-315, 330 kV	0	0	0	120	120	150	150	210

Table 4-94: Total high-tension electrical circuit breakers available in bulk at the end of calendar year within 2003-2010 time periods, units

	2003	2004	2005	2006	2007	2008	2009	2010
Circuit breaker GL-107 type, 35 kV (charged with SF_6 2.6 kg)	0	0	0	5	5	5	5	5
Circuit breaker GL-311 (VR) type, 110 kV (charged with SF_6 12 kg)	1	1	8	27	41	49	55	60
Circuit breaker GL-311 (P) type, 110 kV (charged with SF_6 9 kg)	0	0	0	0	0	0	0	3
Circuit breaker GL-311 (LTB) type, 110 kV (charged with SF_6 12 kg)	0	0	0	2	2	2	2	2
Circuit breaker GL-312 type, 110 kV (charged with SF_6 12 kg)	0	0	0	0	0	0	0	1
Circuit breaker GL-315 type, 330 kV (charged with SF_6 26 kg, with CF_4 15 kg)	0	0	0	8	8	10	10	14
Total	**1**	**1**	**8**	**42**	**56**	**66**	**72**	**85**

Source: Red Union Fenosa J.S.C., Official Letter No. 0201/65392 dated August 15, 2011, as response to Letter No. 03-07/1337 dated 08.08.2011; 'MOLDELECTRICA' S.O.E., Official Letter No. 46-47/1795 dated 23.08.2011, as response to Letter No. 03-07/1337 dated 08.08.2011.

4.6.3 Uncertainty Assessment and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions from the 2F 'Consumption of halocarbons and SF_6' source category, and quality of activity data available.

Uncertainties associated with default emission factors used to estimate halocarbons and SF_6 emissions covered by this source category reach up to ±50 per cent. Uncertainties associated with activity data on import of halocarbons (in stock and incorporated in different types of equipment) are low for 2F1 'Refrigeration and Air Conditioning Equipment' (±8 per cent), 2F4 ‚Aerosols' (±5 per cent) and 2F8 'Electrical Equipment' and medium for 2F2 'Foam Blowing' (±25 per cent). Combined uncertainties related to HFC emissions covered by the source category 2F1 'Refrigeration and Air Conditioning Equipment', 2F2 'Foam Blowing', 2F4 'Aerosols' and 2F8 'Electrical Equipment' are considered medium (±50.6 per cent, ±55.9 per cent, ±50.2 per cent and ±50.1 per cent, respectively). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±5.86 per cent for HFCs emissions from the 2F1 'Refrigeration and Air Conditioning Equipment' source category, ±3.66 per cent for HFCs emissions from the 2F2 'Foam Blowing' source category, ±0.002 per cent for HFCs emissions from the 2F4 'Aerosols' source category and only ±0.05 per cent for SF_6 emissions from the 2F8 'Electrical Equipment' source category. Uncertainties introduced in trend in sectoral emissions were estimated at ±1.76 per cent for HFCs emissions from the 2F1 'Refrigeration and Air Conditioning Equipment' source category, ±1.19 per cent for HFCs emissions from the 2F2 'Foam Blowing', ±0.0001 per cent for HFCs emissions from the 2F4 'Aerosols' and for only ±0.0013 per cent for SF_6 and CF_4 emissions from the 2F8 'Electrical Equipment' (see **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 GPG (IPCC, 2000).

4.6.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under the Industrial Processes Sector, following the Tier 1 approach (IPCC, 2000).

Verification was focused on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and GPG (IPCC, 2000); on correct use of AD obtained from different sources of reference (i.e., National Bureau of Statistics, Customs Service, Ministry of Health, Ministry of Information Technology and Communications, Republican Association of Refrigeration Technicians and Annual Reports submitted by individual companies to the Ozone Office of the Ministry of Environment), etc. The AD and methods used for estimating GHG emissions under the category 2F 'Consumption of halocarbons and SF_6' were documented and archived both in hard copies and electronically.

4.6.5 Recalculations

GHG emissions from the 2F 'Consumption of halocarbons and SF_6' were recalculated due to:

- Use of updated AD set provided by the Customs Service, Ministry of Health, Ministry of Information Technology and Communications, Republican Association of Refrigeration Technicians, Annual Reports submitted by individual companies to the Ozone Office of the Ministry of Environment, and by the electrical industry enterprises, as Moldelectrica S.O.E., Red Union Fenosa J.S.C., etc.;
- Taking into consideration for the first time the new source categories (e.g., 2F2 'Foam Blowing'); estimating for the first time F-gas emissions from 2F 'Consumption of halocarbons and SF_6' for the 1995-1999 time series.

In comparison with the results included in the SNC of the RM under the UNFCCC, the F-gas emissions estimated under the current inventory cycle increased significantly, varying from a minimum of 107.6 per cent in 2005 to a maximum of 217.9 per cent in 2000 (Table 4-97).

Potential and actual F-gas emissions from 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' source category within 1995-2010 time series are provided below. The obtained results demonstrate that over the period under review the potential F-gas emissions in the RM increased by 3362.2 per cent (Table 4-98), while the actual F-gas emissions increased by 5332.2 per cent (Table 4-99).

Table 4-97: F-gas Emissions Recalculations within the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' Source Category performed for the 1995-2005 time series, included into the SNC of the RM under the UNFCCC

	1995	1996	1997	1998	1999	2000	2001	2002
SNC, Gg CO_2 eq.	NE	NE	NE	NE	NE	4.2080	5.4113	7.5630
TNC, Gg CO_2 eq.	1.8961	4.0738	6.6059	9.4575	11.4564	13.3755	16.4898	19.5171
Difference, %	NA	NA	NA	NA	NA	217.9	204.7	158.1
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC, Gg CO_2 eq.	10.0241	13.3506	19.0028					
TNC, Gg CO_2 eq.	25.8600	32.0340	39.4583	47.3617	60.7298	76.7734	87.5976	102.9988
Difference, %	158.0	139.9	107.6					

Abbreviations: SNC – Second National Communication; TNC – Third National Communication; NE – Not Estimated; NA – Non Applicable.

Table 4-98: Potential F-gas Emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' Source Category in the RM within 1995-2010 time periods

	1995	1996	1997	1998	1999	2000	2001	2002
2F1 'Refrigeration and Air Conditioning Equipment'								
HFC-32, t	0.0849	0.1156	0.1735	0.2848	0.3436	0.4848	0.6848	1.2087
HFC-125, t	0.1805	0.2685	0.3742	0.5808	0.7067	0.9367	1.2588	2.0182
HFC-134a, t	2.3408	8.8469	19.0241	32.2656	40.5431	47.3549	61.0901	71.8749
HFC-143a, t	0.0996	0.1470	0.1988	0.2492	0.3472	0.4219	0.5269	0.7093
2F1, Gg CO_2 eq.	3.9821	12.8863	26.6475	44.7037	56.2273	66.1023	85.3891	102.5692
2F2 'Foam Blowing'								
HFC-134a, t	28.7083	46.0693	57.7356	66.6042	75.9571	90.0591	104.4159	130.7672
2F2, Gg CO_2 eq.	37.3208	59.8900	75.0563	86.5855	98.7442	117.0768	135.7406	169.9974
2F4 'Aerosols'								
HFC-134a, t	NO	NO	NO	NO	NO	0.00001	0.00002	0.00003
2F4, Gg CO_2 eq.	NO	NO	NO	NO	NO	0.00001	0.00002	0.00004
2F8 'Electrical Equipment'								
CF_4, t	NO	NO	NO	NO	NO	NO	NO	NO
SF_6, t	NO	NO	NO	NO	NO	NO	NO	NO
2F8, Gg CO_2 eq.	NO	NO	NO	NO	NO	NO	NO	NO
2F 'Consumption of Halocarbons and SF_6'								
2F, Gg CO_2 eq.	41.3029	72.7763	101.7038	131.2891	154.9716	183.1792	221.1297	272.5667
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2F1 'Refrigeration and Air Conditioning Equipment'								
HFC-32, t	2.8680	4.4769	6.8224	9.1158	17.6926	27.3327	30.4021	35.1357
HFC-125, t	4.1030	7.6189	9.4343	12.2822	23.7743	40.6978	42.5889	50.2100
HFC-134a, t	96.1509	115.3938	136.7568	158.6934	190.6430	225.2114	239.2825	258.4844
HFC-143a, t	1.1752	3.0669	2.4704	2.7838	6.0562	13.8329	13.5427	18.1594
2F1, Gg CO_2 eq.	142.8147	185.9091	218.0221	257.1953	348.9179	477.0597	501.5397	568.4619
2F2 'Foam Blowing'								
HFC-134a, t	168.7594	210.4868	271.4391	343.4144	430.9623	514.7958	570.6508	632.0705
2F2, Gg CO_2 eq.	219.3872	273.6329	352.8708	446.4387	560.2510	669.2345	741.8460	821.6917
2F4 'Aerosols'								
HFC-134a, t	0.00006	0.00023	0.00032	0.00413	0.00647	0.00760	0.01575	0.01989
2F4, Gg CO_2 eq.	0.0001	0.0003	0.0004	0.0054	0.0084	0.0099	0.0205	0.0259
2F8 'Electrical Equipment'								
CF_4, t	NO	NO	NO	0.1200	0.1200	0.1500	0.1500	0.2100
SF_6, t	0.0120	0.0120	0.0960	0.5690	0.7370	0.8850	0.9570	1.1600
2F8, Gg CO_2 eq.	0.2868	0.2868	2.2944	14.3791	18.3943	22.1265	23.8473	29.0890
2F Consumption of Halocarbons and SF_6								
2F, Gg CO_2 eq.	362.4888	459.8291	573.1877	718.0185	927.5716	1168.4306	1267.2535	1419.2684

The ratio between potential and actual F-gas emissions in the RM varied from 1995 and 2010 time series from a maximum of 21.8 per cent in 1995 to a minimum of 13.8 per cent in 2010.

Table 4-99: Actual F-gas Emissions from 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' Source Category in the RM within 1995-2010 time periods

	1995	1996	1997	1998	1999	2000	2001	2002
2F1 'Refrigeration and Air Conditioning Equipment'								
HFC-32, t	0.0049	0.0068	0.0106	0.0187	0.0219	0.0301	0.0414	0.0720
HFC-125, t	0.0075	0.0124	0.0182	0.0327	0.0377	0.0495	0.0658	0.1049
HFC-134a, t	0.1472	1.0247	2.4325	4.1878	5.2900	6.0968	7.7975	8.8334
HFC-143a, t	0.0002	0.0020	0.0022	0.0035	0.0042	0.0061	0.0088	0.0114
2F1, Gg CO_2 eq.	0.2167	1.3788	3.2284	5.5612	7.0129	8.1070	10.3814	11.8672
2F2 'Foam Blowing'								
HFC-134a, t	1.2919	2.0731	2.5981	2.9972	3.4181	4.0527	4.6987	5.8845
2F2, Gg CO_2 eq.	1.6794	2.6951	3.3775	3.8963	4.4435	5.2685	6.1083	7.6499
2F4 'Aerosols'								
HFC-134a, t	NO	NO	NO	NO	NO	0.000004	0.00001	0.00002
2F4, Gg CO_2 eq.	NO	NO	NO	NO	NO	0.000005	0.00001	0.00003
2F8 'Electrical Equipment'								
CF_4, t	NO	NO	NO	NO	NO	NO	NO	NO
SF_6, t	NO	NO	NO	NO	NO	NO	NO	NO
2F8, Gg CO_2 eq.	NO	NO	NO	NO	NO	NO	NO	NO
2F 'Consumption of Halocarbons and SF_6'								
2F, Gg CO_2 eq.	1.8961	4.0738	6.6059	9.4575	11.4564	13.3755	16.4898	19.5171

	2003	2004	2005	2006	2007	2008	2009	2010
2F1 'Refrigeration and Air Conditioning Equipment'								
HFC-32, t	0.1638	0.2470	0.3715	0.5003	0.9950	1.4596	1.5593	1.8563
HFC-125, t	0.2092	0.3056	0.4615	0.6182	1.3958	2.0898	2.2809	2.7403
HFC-134a, t	11.7056	14.3103	16.8208	19.0152	22.4873	28.5686	33.5115	40.8448
HFC-143a, t	0.0190	0.0250	0.0348	0.0541	0.3566	0.5965	0.7256	0.9053
2F1, Gg CO_2 eq.	15.9818	19.7146	23.5329	26.9815	35.1438	46.2062	53.7224	65.4178
2F2 'Foam Blowing'								
HFC-134a, t	7.5942	9.4719	12.2148	15.4536	19.3933	23.1658	25.6793	28.4432
2F2, Gg CO_2 eq.	9.8724	12.3135	15.8792	20.0897	25.2113	30.1156	33.3831	36.9761
2F4 'Aerosols'								
HFC-134a, t	0.00005	0.00015	0.00027	0.00222	0.00530	0.00703	0.01168	0.01782
2F4, Gg CO_2 eq.	0.00006	0.0002	0.0004	0.0029	0.0069	0.0091	0.0152	0.0232
2F8 'Electrical Equipment'								
CF_4, t	NO	NO	NO	0.0024	0.0024	0.0030	0.0030	0.0042
SF_6, t	0.0002	0.0002	0.0019	0.0114	0.0147	0.0177	0.0191	0.0232
2F8, Gg CO_2 eq.	0.0057	0.0057	0.0459	0.3293	0.4096	0.4947	0.5291	0.6549
2F 'Consumption of Halocarbons and SF_6'								
2F, Gg CO_2 eq.	25.8600	32.0340	39.4583	47.3617	60.7298	76.7734	87.5976	102.9988

4.6.6 Planned Improvements

Activities focused on updating data used to estimate GHG emissions from 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' source category in the Republic of Moldova, as well as on précising certain EFs values (e.g. the volume and type of blowing agents used in foam blowing products imported in the country) are planned for the next inventory cycle.

5. SOLVENTS AND OTHER PRODUCT USE SECTOR

5.1 Overview

The 'Solvents and Other Product Use' Sector includes emissions of non-methane volatile organic compounds (NMVOC) which are also regarded as CO_2 emissions source, because the majority of solvents are obtained from fossil fuels.

Most solvents are part of the final product and sooner or later will evaporate. In most countries this process is an important source of NMVOC emissions. On a European scale its contribution is approximately one quarter of the total national anthropogenic NMVOC emissions (in different countries, NMVOC emissions from this sector account for 15-40 per cent of total national NMVOC emissions).

This sector also includes nitrous oxide emissions from the use of N_2O in medicine, in particular, in anesthesia. The entire quantity of N_2O used in anesthesia is considered emitted in atmosphere.

5.1. Summary of Emission Trends

In 2010, the 'Solvents and Other Product Use' Sector accounted for 0.4 per cent of total national GHG in the RM (without LULUCF). To be noted that this sector is a major source of national NMVOC emissions, accounting for 19.8 per cent of the totals.

Since 1990 to 2010, total GHG emissions originated from 'Solvents and Other Product Use' Sector tended to decrease (Figure 5-1), reducing by 40.7 per cent: from 90.78 Gg CO_2 equivalent in 1990 to 53.87 Gg CO_2 equivalent in 2010 (Table 5-1), in particular due to reduced consumption of solvents at national level.

Categories 3A 'Paint Application' (35.1 per cent of the total in 1990, respectively 38.5 per cent in 2010), 3B 'Degreasing and Dry Cleaning' (36.6 per cent of the total in 1990, respectively 23.0 per cent in 2010) and 3D 'Other' (22.2 per cent of the total in 1990, respectively 32.9 per cent in 2010) were the major sources of direct GHG emissions originated from 'Solvents and Other Product Use Sector' in the time series since 1990 through 2010.

At the same time, between 1990 and 2010, NMVOC emissions from the 'Solvents and Other Product Use' Sector decreased significantly by 39.7 per cent, from 31.22 Gg in 1990 to 18.81 Gg in 2010 (Table 5-2).

Categories 3A 'Paint Application' (34.5 per cent of the total in 1990, respectively 37.7 per cent in 2010), 3B 'Degreasing and Dry Cleaning' (35.5 per cent of the total in 1990, respectively 22 per cent in 2010) and 3D 'Other' (24.0 per cent of the total in 1990, respectively 35.0 per cent in 2010) were the major sources of NMVOC emissions originated from 'Solvents and Other Product Use' Sector in the time series since 1990 through 2010.

5.1.2 Key Categories

The results of key source assessment carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the **Annex 1-2**. No key categories were identi-

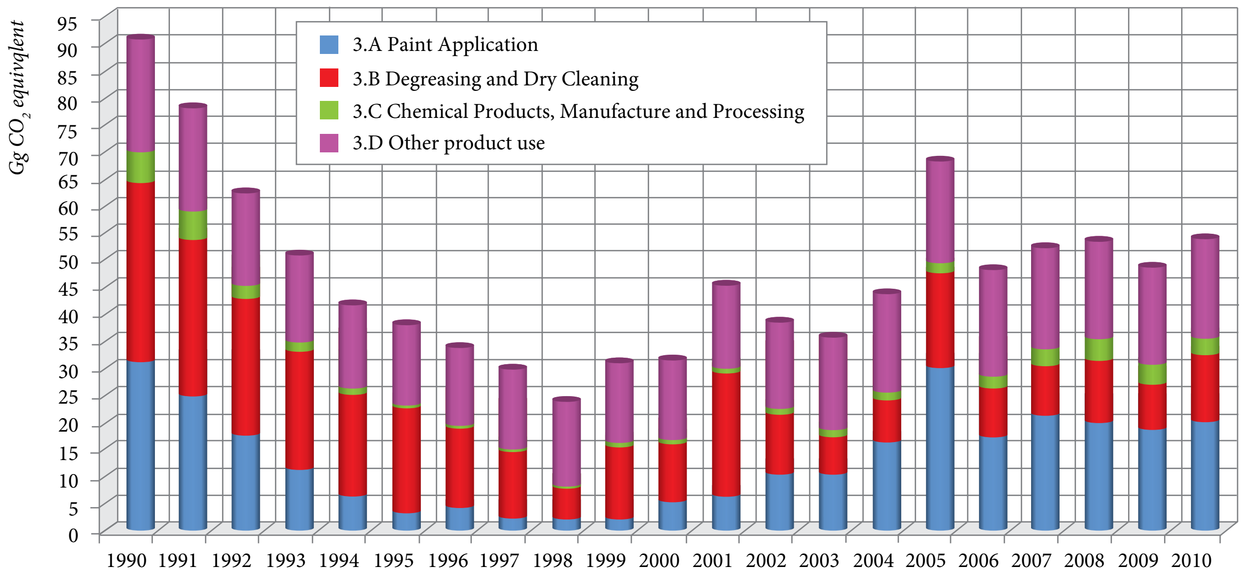


Figure 5-1: Total Direct GHG Emissions from 'Solvents and Other Product Use' Sector, by Category within 1990-2010 time periods, Gg CO_2 equivalent

Table 5-1: Direct GHG Emissions from 'Solvents and Other Product Use' Sector in the RM within 1990-2010 time periods, Gg CO_2 equivalent

Source Categories	1990	1991	1992	1993	1994	1995	1996
3.A Paint Application	31.8675	25.5359	18.2380	11.7329	6.9474	3.6168	4.7210
3.B Degreasing and Dry Cleaning	33.1963	29.0489	25.2910	22.0829	19.0422	19.7212	14.7570
3.C Chemical Products, Manufacture and Processing	5.5962	5.0043	2.2878	1.4603	0.8537	0.7051	0.5912
3.D Other	20.1165	18.6418	16.6773	15.5255	14.8754	14.1547	13.8128
3.A-D Total	90.7765	78.2310	62.4940	50.8017	41.7188	38.1978	33.8819
Source Categories	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
3.A Paint Application	2.8186	2.6482	2.6741	5.9608	6.8544	11.1043	11.1766
3.B Degreasing and Dry Cleaning	12.3617	5.7877	13.2599	10.7271	23.0020	10.9474	6.8605
3.C Chemical Products, Manufacture and Processing	0.5110	0.5273	0.7459	0.7333	0.8817	1.2371	1.3371
3.D Other	14.1655	14.8807	14.2640	14.2044	14.5568	15.2193	16.2893
3.A-D Total	29.8567	23.8439	30.9439	31.6256	45.2949	38.5080	35.6634
Source Categories	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
3.A Paint Application	16.9331	30.7948	17.9607	21.8636	20.6314	19.2190	20.7260
3.B Degreasing and Dry Cleaning	7.9314	17.3232	8.8832	9.4166	11.2457	8.4875	12.3930
3.C Chemical Products, Manufacture and Processing	1.4625	1.9181	2.3334	3.0250	4.1484	3.6242	3.0075
3.D Other	17.4244	18.1468	19.0175	17.9101	17.5569	17.1908	17.7426
3.A-D Total	43.7513	68.1829	48.1948	52.2152	53.5824	48.5216	53.8690

Table 5-2: NMVOC Emissions from the 'Solvents and Other Product Use' Sector in the Republic of Moldova within1990-2010 time periods, Gg

Source Categories	1990	1991	1992	1993	1994	1995	1996
3.A Paint Application	10.7760	8.6135	6.1516	3.9602	2.3402	1.2183	1.5886
3.B Degreasing and Dry Cleaning	11.0950	9.7089	8.4529	7.3807	6.3644	6.5913	4.9321
3.C Chemical Products, Manufacture and Processing	1.8704	1.6726	0.7646	0.4881	0.2853	0.2356	0.1976
3.D Other	7.4810	6.8129	5.9888	5.4628	5.1532	4.8474	4.6945
3.A-D Total	31.2223	26.8078	21.3579	17.2917	14.1431	12.8927	11.4128
Source Categories	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
3.A Paint Application	0.9522	0.8966	0.9077	2.0221	2.3398	3.7898	3.8244
3.B Degreasing and Dry Cleaning	4.1316	1.9344	4.4318	3.5853	7.6878	3.6589	2.2929
3.C Chemical Products, Manufacture and Processing	0.1708	0.1762	0.2493	0.2451	0.2947	0.4135	0.4469
3.D Other	4.8793	5.2282	4.9404	4.9137	5.0639	5.3694	5.8509
3.A-D Total	10.1338	8.2354	10.5293	10.7662	15.3862	13.2315	12.4151
Source Categories	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
3.A Paint Application	5.7471	10.4001	6.1169	7.4535	7.0524	6.5691	7.0886
3.B Degreasing and Dry Cleaning	2.6509	5.7899	2.9690	3.1472	3.7586	2.8367	4.1420
3.C Chemical Products, Manufacture and Processing	0.4888	0.6411	0.7799	1.0110	1.3865	1.2113	1.0052
3.D Other	6.3846	6.7170	7.1572	6.6290	6.4678	6.2994	6.5788
3.A-D Total	15.2714	23.5480	17.0229	18.2408	18.6653	16.9166	18.8146

fied under 'Solvents and Other Product Use' Sector in the Republic of Moldova (Table 5-3).

Table 5-3: Results of Key Sources Analysis for 'Solvents and Other Product Use' Sector

IPCC Category	GHG	Source Categories	Key Sources
3.A	CO_2	Paint Application	No
3.B	CO_2	Degreasing and Dry Cleaning	No
3.C	CO_2	Chemical Products, Manufacture and Processing	No
3.D	CO_2	Other	No
3.D	N_2O	Other (use of N_2O in Anesthesia)	No

5.1.3 Methodological Issues

All source categories covered by 'Solvents and Other Product Use' Sector were estimated based on the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (2009)[28], and default and/or country specific emission factors (Table 5-4).

[28] **Source:** European Environment Agency: <http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>.

Table 5-4: GHG Emissions Estimation Methodologies Used to Evaluate Emissions from 'Solvents and Other Product Use' Sector

IPCC Category	Source Categories	GHG Emissions	
		Assessment Methodology	Emission Factors
3.A	Paint Application	T3 (CORINAIR, 2009)	CS, D
3.B	Degreasing and Dry Cleaning	T3 (CORINAIR, 2009)	CS, D
3.C	Chemical Products, Manufacture and Processing	T2 (CORINAIR, 2009)	D
3.D	Other	T1 and T2 (CORINAIR, 2009)	D

Abbreviations: T1 – Tier 1; T2 – Tier 2; T3 – Tier 3; CS – Country Specific; D – Default.

To be noted that the EMEP CORINAIR/EEA Atmospheric Emissions Inventory Guidebook (2009) provides information on how to convert the SNAP nomenclature classification of source categories into the Intergovernmental Panel on Climate Change's nomenclature classification (IPCC, 1997) (Table 5-5). In general, the GHG emissions (NMVOC, CO_2 and N_2O) reported under 'Solvents and Other Product Use' Sector is emitted in the process of manufacturing, using and storage solvents. Estimating GHG emissions from 'Solvent and Other Product Use' Sector can be done following two basic ways: (1) either by estimating the amount of pure solvents consumed, or (2) by estimating the amount of solvent containing products consumed (taking account of their solvent content). The first approach implies an inventory of the most relevant categories of solvents used in the country, at least those together representing more than 90 per cent of the total GHG emissions. It is assumed that the total amount of solvents used in the country shall be equal to the total amount of national GHG emissions. In case of the second approach, the inventory covers all source categories identified under this sector (SNAP CORINAIR defines the categories 0601-0605).

Table 5-5: Converting the SNAP CORINAIR Classification into the IPCC Classification

SNAP	Solvents and Other Products Use	IPCC	Solvents and Other Products Use
0601	Paint Application	3A	Paint Application
0602	Degreasing and Dry Cleaning	3B	Degreasing and Dry Cleaning
0603	Chemical Proucts, Manufacture and Processing	3C	Chemical Products, Manufacture and Processing
0604	Other Uses of Solvents	3D	Other Uses of Solvents
0605	Use of N_2O	3D	Use of N_2O

GHG emissions covered by these source categories can be estimated based on information collected at the national level on total consumption of solvents, or by using default emission factors for the average per capita values in the European countries (Table 5-6) multiplied by the number of

Table 5-6: Default Emission Factors for Some Source Categories under the 'Solvents and Other Products Use' Sector, in kg NMVOC/per capita/year

Country	Years	Paint Application	Industrial Degreasing	Ink Use	Adhesives Use	Household Products	Total
Australia	1990	3.7	1.6	0.80		1.3	11.0
Australia	1990	5.0	1.6				9.9
Austria	1987	5.3		0.60	1.45		
Austria	1990						17.1
Canada	1985	4.8					12.7
Canada	1990	4.8					17.1
Canada	1995	6.5					22.8
Czech Republic	1988						14.6
Finland	1991	5.55					9.6
Finland	1985	3.7		1.8		0.7	12.3
France	1986	4.8	2.7	0.4	0.17	0.27	10.4
Germany	'84-'86	6.8	0.84	0.47	0.26	1.1	18.8
Italy	1983	4.5	2.0	1.5	1.1	2	12.9
Japan	1981	6.4	0.75	0.60	1.0	0.8	10.4
Netherlands	1989	6.6	0.74	1.15	0.29		15.3
Netherlands	1990	5.05	0.85	1.2	0.20	1.6	
Netherlands	1992	4.5					10.0
Netherlands	1976	4.6	0.40	0.76		1.5	11.3
Norway	1992		0.73	0.99	0.05	1.75	15.1
Norway	'88-'92	4.5					7.5
Norway	1989	2.5-5.0		0.36			10.1
Poland	1990	4.45					
Slovak Republic	1993	6.2	1.3			1.6	9.0
Slovak Republic	1988	3.6	0.64			1.6	5.8
Sweden	1990	4.7	1.4	0.82		2.6	12.1
Switzerland	1988						22.1
Great Britain	'91-'92	4.8	0.81	0.68	1.02	3.3	13.7
Great Britain	1985						11.4
USA	1989						17.5
USA	1990	8.6	2.8	1.3	1.3	1.5	21.3
USA	1990	9.5	2.7	2.5			22.9
USA	1990	7.6	2.7	1.3	2.7	3.9	21.6
Western Europe	1988						15.2
Western Europe	1990	5.3	1.0	0.86	0.84	1.1	14.4
Europe Average	**> 1990**	**4.5±0.4**	**0.85±0.30**	**0.65±0.25**	**0.6±0.45**	**1.8±0.45**	**12.0±3.4**

Source: EMEP/CORINAIR, September 1, 1999, Activity 060000, su060000, B600-5.

population in the respective country (this approach shall be applied only in cases when no AD on total consumption of solvents and other products is available on the national level). A more detailed description of estimation methodologies and emission factors used in this inventory cycle is available in sub-chapters 5.2-5.5 of the NIR.

5.1.4 Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the 'Solvents and Other Product Use' Sector (by source categories) is described in detail in sub-chapters 5.2-5.5 of the NIR, as well as in the **Annex 5-3.3**.

Combined uncertainties as a percentage of total direct sectoral emissions were estimated at circa ±15.67 per cent. The uncertainties introduced in trend in sectoral emissions were estimated at circa ±3.71 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 GPG (IPCC, 2000).

5.1.5 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 'Solvents and Other Product Use' Sector, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating GHG emissions under the 'Solvents and Other Product Use' Sector were documented and archived both in hard copies and electronically.

To identify the data entry, as well GHG emissions estimation related errors there were applied AD and EFs verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), GHG emissions under the 'Solvents and Other Product Use' Sector were estimated based on national AD and EFs from official sources of reference.

5.1.6 Recalculations

There were undertaken recalculations of the GHG emissions from the 'Solvents and Other Product Use' Sector included into the SNC of the RM under the UNFCCC. The recalculations are due to use of an updated set of activity data, also as a result of changing the methodological approach used in the SNC of the RM under the UNFCCC (EMEP CORINAIR Inventory Guidebook, 1996,1999), with those available in the EMEP CORINAIR Inventory Guidebook (2009).

The performed recalculation resulted in a significant increase of the direct GHG emissions for the 1990-1996 time series, as well as for 1999, 2001 and 2005, varying from a minimum of 3.9 per cent in 1999, up to a maximum of 38.3 per cent in 1990; and in a reduction of direct GHG emissions between 1997-1998, in 2000, as well as between 2002-2004, which varied from a minimum of 0.1 per cent in 1997, to a maximum of 21.5 per cent in 1998 (Table 5-7).

As for the NMVOC emissions, the performed recalculation resulted in a significant increase of emissions for the 1990-1997 time series, as well as for 1999-2002 and 2005, varying from a minimum of 1.2 per cent in 2002, up to a maximum of 49.8 per cent in 2005; and in a reduction of NMVOC emissions in 1998, as well as between 2003-2004, varying from a minimum of 0.4 per cent in 2004, to a maximum of 15.5 per cent in 1998 (Table 5-8). The results of recalculations performed at the category level are also presented in the sub-chapters 5.2-5.5 of the NIR.

Table 5-7: Recalculated Direct GHG Emissions under the 'Solvent and Other Product Use' Sector, for 1990-2005 time series, included into the SNC of the RM under the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997
SNC, Gg CO_2 eq.	65.6245	59.6810	46.8844	37.0661	31.2861	28.0646	28.2112	29.8819
TNC, Gg CO_2 eq.	90.7765	78.2310	62.4940	50.8017	41.7188	38.1978	33.8819	29.8567
Difference, %	38.3	31.1	33.3	37.1	33.3	36.1	20.1	-0.1
	1998	1999	2000	2001	2002	2003	2004	2005
SNC, Gg CO_2 eq.	30.3874	29.7698	33.0638	34.7125	40.7827	41.6691	47.8175	49.0021
TNC, Gg CO_2 eq.	23.8439	30.9439	31.6256	45.2949	38.5080	35.6634	43.7513	68.1829
Difference, %	-21.5	3.9	-4.3	30.5	-5.6	-14.4	-8.5	39.1

Abbreviations: SNC – Second National Communication; TNC – Third National Communication.

Table 5-8: Recalculated NMVOC Emissions under the 'Solvent and Other Product Use' Sector, for 1990-2005 time series, included into the SNC of the RM under the UNFCCC

	1990	1991	1992	1993	1994	1995	1996	1997
SNC, Gg NMVOC	21.0494	19.1435	15.0382	11.8869	10.0333	9.0046	9.0515	9.5875
TNC, Gg NMVOC	31.2223	26.8078	21.3579	17.2917	14.1431	12.8927	11.4128	10.1338
Difference, %	48.3	40.0	42.0	45.5	41.0	43.2	26.1	5.7
	1998	1999	2000	2001	2002	2003	2004	2005
SNC, Gg NMVOC	9.7495	9.5475	10.6043	11.1333	13.0810	13.3654	15.3375	15.7165
TNC, Gg NMVOC	8.2354	10.5293	10.7662	15.3862	13.2315	12.4151	15.2714	23.5480
Difference, %	-15.5	10.3	1.5	38.2	1.2	-7.1	-0.4	49.8

Abbreviations: SNC – Second National Communication; TNC – Third National Communication.

5.1.7 Assessment of Completeness

Table 5-9 includes those source categories within which GHG emissions were estimated under the 'Solvent and Other Product Use' Sector.

Table 5-9: Assessment of Completeness under the 'Solvents and Other Product Use' Sector in the Republic of Moldova

IPCC Category	Source Categories	CO_2	N_2O	NO_x	CO	NMVOC
3.A.1	Decorative Coating Application	X	NO	NO	NO	X
3.A.2	Industrial Coating Application	IE	NO	NO	NO	IE
3.A.3	Other Coating Application (Non-industrial)	IE	NO	NO	NO	IE
3.B.1	Chemical Degreasing	X	NO	NO	NO	X
3.B.2	Dry Cleaning	IE, NE	NO	NO	NO	IE, NE
3.C	Processing Polyurethane Products	X	NO	NO	NO	X
3.C	Processing Polystyrene Products	X	NO	NO	NO	X
3.C	Processing Rubber Products	X	NO	NO	NO	X
3.C	Processing Pharmaceutical Products	X	NO	NO	NO	X
3.C	Production of Paints and Varnishes	X	NO	NO	NO	X
3.C	Tanning Hides	X	NO	NO	NO	X
3.C	Tyre Manufacture and Restoration	X	NO	NO	NO	X
3.C	Shoes Manufacturing	X	NO	NO	NO	X
3.D.1	Paper Printing (printing ink use)	X	NO	NO	NO	X
3.D.2	Solvents Domestic Use	X	NO	NO	NO	X
3.D.3	Seed Oil Extraction and Seed Drying	X	NO	NO	NO	X
3.D.3	Adhesive Use	X	NO	NO	NO	X
3.D.3	Vehicles Dewaxing	X	NO	NO	NO	X
3.D.3	Tobacco Burning	X	NO	X	X	X
3.D.3	Use of N_2O in Anesthesia	NO	X	NO	NO	NO

Abbreviations: X – Source Categories included in the Inventory; IE – Included Elsewhere; NE – Not Estimated; .NO – Not Occurring.

5.1.8 Planned Improvements

Planned improvements at the source categories level within the 'Solvents and Other Product Use' Sector are described in detail in sub-chapters 5.2-5.5 of the NIR.

5.2 Paint Application (Category 3A)

5.2.1 Source Category Description

Under the 3A 'Paint Application' source category there were reported NMVOC emissions from the source categories 3A1 'Decorative Coating Application', in particular in constructions (SNAP 060103) and domestic paint application (SNAP 060104); 3A2 'Industrial Coating Application', in particular for manufacture of automobiles (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); and from 3A3 'Other Non-industrial Paint Application' (paint or varnish application to protect large metal construction from corrosion, for road marking, etc.) (SNAP 060109).

The breakdown of AD on paint and varnish consumption in the RM by sectors was not possible, so the emissions were reported only for the 3A1 'Decorative Coating Application' source category. As for 3A2 'Industrial Coating Application' and 3A3 'Other Non-industrial Paint Application', the emissions within these source categories were reported as 'Included Elsewhere' (within the 3A1 category).

Between 1990 and 2010, CO_2 emissions from the 3A1 'Decorative Coating Application' decreased by 35.0 per cent (Table 5-10).

The share of 'Conventional Solvent Paints Application' subcategory varied between 1990 and 2010 time series from a minimum of 95.0 per cent (in 2003) up to a maximum of 99.0 per cent (in 1996) of the total. To be noted, the recent years show an increasing trend for the share of 'Waterborne Paints Application' in the total CO_2 emissions originated from the 3A1 'Decorative Coating Application' source category.

In comparison with the 2005 year level of CO_2 emissions, between 2006 and 2010 the CO_2 emissions have a decreasing trend. However, compared with the 2009 year level, the CO_2 emissions increased in 2010 by 7.8 per cent (Figure 5-2).

Table 5-10: CO_2 Emissions from the 3A1 'Decorative Coating Application' Source Category, 1990-2010, Gg

Category	1990	1991	1992	1993	1994	1995	1996
CO_2 emissions from conventional solvent paints	31.1781	25.1328	17.9521	11.5301	6.8604	3.5712	4.6736
CO_2 emissions from waterborne paints	0.6894	0.4031	0.2859	0.2028	0.0870	0.0456	0.0474
Total CO_2 emissions from paints application	31.8675	25.5359	18.2380	11.7329	6.9474	3.6168	4.7210
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2 emissions from conventional solvent paints	2.7642	2.5830	2.5917	5.7867	6.5529	10.6209	10.6206
CO_2 emissions from waterborne paints	0.0543	0.0652	0.0823	0.1741	0.3016	0.4834	0.5560
Total CO_2 emissions from paints application	2.8186	2.6482	2.6741	5.9608	6.8544	11.1043	11.1766
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2 emissions from conventional solvent paints	16.4188	30.2199	17.2684	20.9693	19.6557	18.3137	19.7188
CO_2 emissions from waterborne paints	0.5143	0.5749	0.6922	0.8942	0.9757	0.9053	1.0072
Total CO_2 emissions from paints application	16.9331	30.7948	17.9607	21.8636	20.6314	19.2190	20.7260

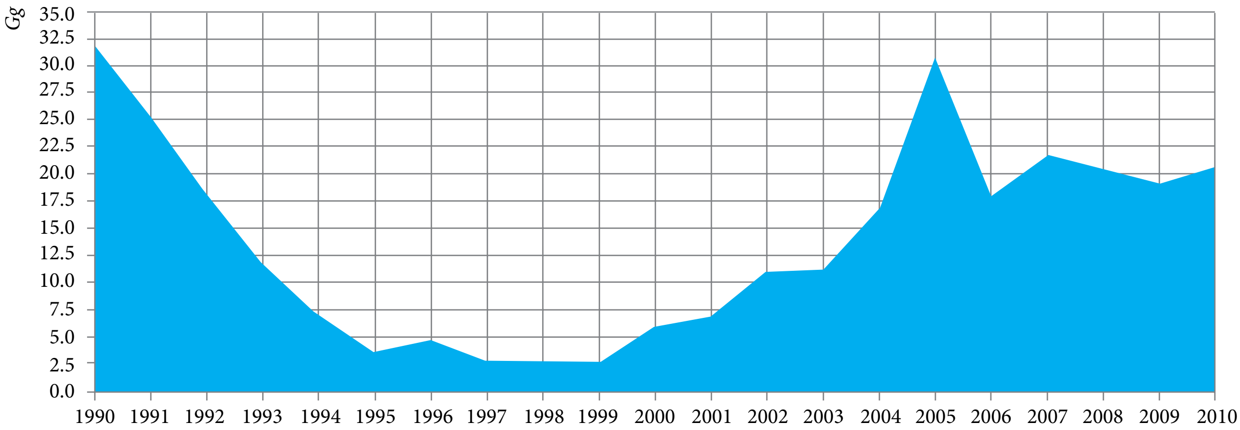


Figure 5-2: CO_2 Emissions from the 3A 'Paint Application' Source Category within 1990-2010 time periods, Gg

A similar trend was revealed for the NMVOC emissions from this category, which decreased by 34.2 per cent within 1990 - 2010 time series (Table 5-11).

The share of 'Waterborne Paints Application' sub-category varied between 1990 and 2010 time series from a minimum of 1.4 per cent (in 1996) to a maximum of 7.0 per cent (in 2003) of the total, showing since 2005 year a relatively constant increasing tendency.

In comparison with the 2005 year level, between 2006 and 2010 the NMVOC emissions have a decreasing trend. However, compared with the 2009 year level, the respective emissions increased in 2010 by 7.9 per cent (Figure 5-3).

Table 5-11: NMVOC Emissions from 'Decorative Coating Application' Source Category within 1990-2010 time periods, Gg

Category	1990	1991	1992	1993	1994	1995	1996
NMVOC emissions from conventional solvent paints	10.4461	8.4207	6.0148	3.8631	2.2985	1.1965	1.5659
NMVOC emissions from waterborne paints	0.3299	0.1928	0.1368	0.0970	0.0416	0.0218	0.0227
Total NMVOC emissions from paints application	10.7760	8.6135	6.1516	3.9602	2.3402	1.2183	1.5886
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NMVOC emissions from conventional solvent paints	0.9261	0.8654	0.8684	1.9388	2.1955	3.5585	3.5584
NMVOC emissions from waterborne paints	0.0260	0.0312	0.0394	0.0833	0.1443	0.2313	0.2660
Total NMVOC emissions from paints application	0.9522	0.8966	0.9077	2.0221	2.3398	3.7898	3.8244
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NMVOC emissions from conventional solvent paints	5.5011	10.1251	5.7857	7.0257	6.5856	6.1359	6.6067
NMVOC emissions from waterborne paints	0.2461	0.2751	0.3312	0.4279	0.4669	0.4332	0.4819
Total NMVOC emissions from paints application	5.7471	10.4001	6.1169	7.4535	7.0524	6.5691	7.0886

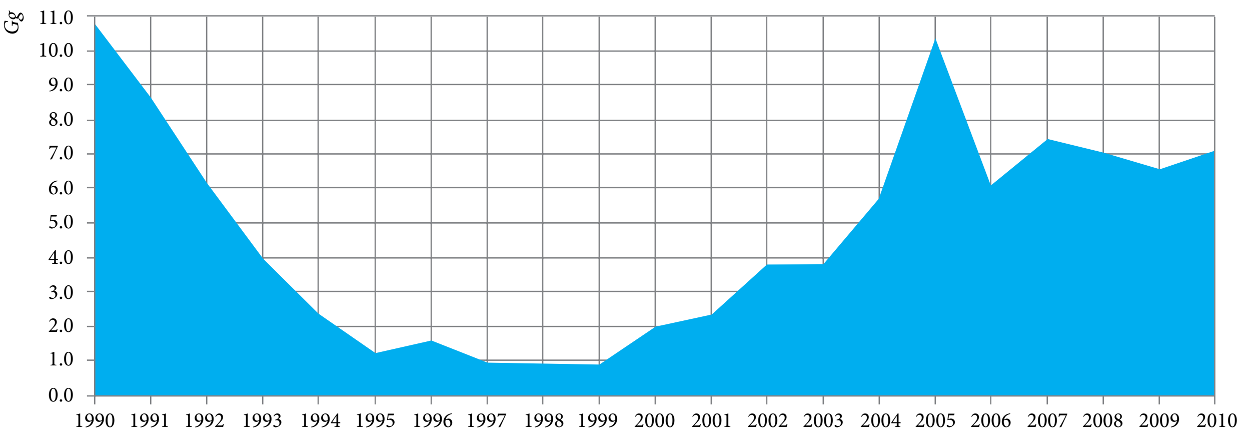


Figure 5-3: NMVOC Emissions from the 3A 'Paint Application' Source Category within 1990-2010 time periods, Gg

5.2.2 Methodological Issues, Emission Factors and Data Sources

The methodology used to estimate NMVOC emissions from paint application is available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook, (2009)[29], and is represented by the following formula:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant\ technology}) / 10^3$$

Where:

$E_{pollutant}$ – the emission of the specified pollutant, t/yr;

$AR_{product}$ – the activity rate for the paint application (consumption of paint), t/yr;

$EF_{pollutant\ technology}$ – the emission factor for this technology and this pollutant, kg/t

The EMEP/EEA Atmospheric Emissions Inventory Guidebook, (2009) provides default EFs for Tier 1 (Table 5-12) and/or Tier 2 (Table 5-13) approaches. To be noted that while determining the EFs values there were taken into consideration also typical mitigation actions for NMVOC emission.

Table 5-12: NMVOC Default Tier 1 EFs for the 3A 'Paint Application' Source Category

Source Categories	NMVOC EF	Unit
3A1 Decorative Coating Application	150	g/kg paint
3A2 Industrial Coating Application	400	g/kg paint
3A3 Other Coating Application	200	g/kg paint

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Category 3A 'Paint Application', Tables 3-1, 3-2 and 3-3, page 17.

As in the Republic of Moldova, no AD breakdown on paint and varnishes consumption within the different sectors of the national economy is available, an alternative methodology, consistent with the Tier 3 approach, was used, expressed by the following equation:

$$E_{pollutant} = AR_{product} \bullet EF_{pollutant}$$

Where:

$E_{pollutant}$ – the emission of the specified pollutant, t/yr;

$AR_{product}$ – the activity rate for the paint application (consumption of paint), t/yr;

$EF_{pollutant}$ – the emission factor for this pollutant

According to the reference literature, the content of solvents in various types of paint varies depending on the technology used to produce it (Table 5-14).

Table 5-14: Carbon and Solvents Content in Various Products

Product containing solvents	Carbon content, %[1]	Solvent content, %[1]	Solvent content, %[2]
Conventional solvent paints	81.4	50	40-70
Waterborne paints	57.0	6-8	<20
Other Paints and Varnishes	80.0	25	<30
Adhesive products	57.0	8	<10
Solvents and diluents	81.6	100	100

Source: [1] Hungarian Meteorological Service (2012), National Inventory Report for 1985-2010, Hungary, Submission under the UN Framework Convention on Climate Change and the Kyoto Protocol. Budapest. May, 2012, Annex A3.3, Table A3-2, page A39; [2] EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Source Category 3A 'Paint Application', Table 2-1, page 9.

Under the current inventory cycle, there were used data on the content of solvents in various products, including conventional solvent paint (solvent-borne), alternative paints (waterborne), as well as for other types of products containing solvents.

For most activities involving paint application, no statistics is available for activity data. Under such circumstances, the total consumption of varnishes and paints was estimated taking into account internal production and statistical data on import and export of such substances in the RM.

$$Consumption_{paint} = Production_{paints} + Import_{paints} - Export_{paints}$$

Where:

$Consumption_{paints}$ – total consumption of paints, kt/year;

[29] **Source:** European Environment Agency: <http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>.

Table 5-13: NMVOC Default Tier 2 EFs for the 3A 'Paint Application' Source Category

Source Categories	NMVOC EF	Unit
3A1 Decorative Coating Application (SNAP 060103 and 060104, in construction and domestic use)	230	g/kg paint
3A2 Industrial Coating Application (SNAP 060101, manufacture of automobiles)	8	kg/automobiles
3A2 Industrial Coating Application (SNAP 060102, car repairing)	720	g/kg paint
3A2 Industrial Coating Application (SNAP 060105, coil coating)	480	g/kg paint
3A2 Industrial Coating Application (SNAP 060107, wood coating)	960	g/kg paint
3A2 Industrial Coating Application (SNAP 060108, other industrial coating application: truck/van coating)	28	kg/automobiles
3A2 Industrial Coating Application (SNAP 060108, other industrial coating application: truck cabin application)	8	kg/automobiles
3A2 Industrial Coating Application (SNAP 060108, other industrial coating application: bus coating)	150	kg/bus
3A2 Industrial Coating Application (SNAP 060108, other industrial coating application: wire coating)	17	g/kg wire
3A2 Industrial Coating Application (SNAP 060108, other industrial coating application: leather coating)	200	g/kg leather
3A2 Industrial Coating Application (SNAP 060108, other industrial coating application: boat building)	125	g/m^2
3A3 Industrial Coating Application (SNAP 060109, other coating application)	740	g/kg paint

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Category 3A 'Paint Application', Table 3-4, 3-5, 3-6, 3-7, 3-8, 3-9, 3-10, 3-11, 3-12, 3-13, 3-14, 3-15 and 3-16, page 19-25.

$Production_{paints}$ – produced amount of paints, kt/year;

$Import_{paints}$ – imported amount of paints, kt/year;

$Export_{paints}$ – exported amount of paints, kt/an.

Statistical Yearbooks of the RM contain aggregated data on total production of varnishes and paints in the country (Table 5-15). The National Bureau of Statistics also provides disaggregated activity data on production of different types of varnishes and paints.

The Customs Service represents a primary source of information on varnishes and paints import-export operations (conventional solvent paints, code 3208; waterborne paints, code 3209; other paints and varnishes, prepared water pigments, like those used for leather coating, code 3210; prepared driers, code 3211; pigment dispersed in non-aqueous media as liquid or paste used in paint manufacture, code 3212) undertaken by economic agents on the territory of the RM (Table 5-16).

Table 5-15: Activity Data on Production of Varnishes and Paints in the RM within 1990-2010, kt

Category	1990	1991	1992	1993	1994	1995	1996
Production of conventional solvent paints	10.100	8.250	5.526	2.722	1.164	0.699	0.670
Production of waterborne paints	1.600	0.550	0.451	0.386	0.069	0.062	0.036
Total paints production	11.700	8.800	5.977	3.108	1.233	0.761	0.706
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Production of conventional solvent paints	0.451	0.350	0.674	2.025	2.713	3.399	2.428
Production of waterborne paints	0.058	0.020	0.000	0.029	0.169	0.716	1.026
Total paints production	0.509	0.370	0.674	2.054	2.882	4.115	3.454
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Production of conventional solvent paints	3.872	4.608	5.990	7.787	7.975	7.638	8.071
Production of waterborne paints	1.264	1.661	2.329	3.258	3.583	3.677	4.158
Total paints production	5.136	6.269	8.319	11.045	11.557	11.315	12.229

Source: National Bureau of Statistics of the Republic of Moldova in the Official Letter No. 06-39/08 dated 23.02.2011, as response to Letter No. 03-07/175 dated 02.02.2011 from the Ministry of Environment of the RM; Official Letter No. 06-39/38 dated 22.09.2011, as response to Letter No. 101/2011-09-01 dated 02.09.2011 from the Climate Change Office by the MoEN of the RM.

Table 5-16: Activity Data on Import of Varnishes and Paints in the RM within 1990-2010, kt

Category	1990	1991	1992	1993	1994	1995	1996
Imports of conventional solvent paints	10.792	8.591	6.504	5.004	3.433	1.694	2.462
Imports of waterborne paints	3.112	2.205	1.503	1.000	0.526	0.250	0.288
Total paints import	13.905	10.796	8.007	6.004	3.959	1.943	2.750
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Imports of conventional solvent paints	1.401	1.381	1.063	1.853	1.678	3.718	4.688
Imports of waterborne paints	0.313	0.426	0.563	1.161	1.892	2.588	2.774
Total paints import	1.715	1.807	1.625	3.014	3.571	6.306	7.463
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Imports of conventional solvent paints	7.131	15.642	5.582	6.264	5.197	4.634	5.142
Imports of waterborne paints	2.251	2.268	2.402	2.854	3.087	2.511	2.726
Total paints import	9.382	17.911	7.984	9.118	8.283	7.145	7.869

Source: Customs Service of the RM, Official Letter No. 28/07-1893 dated 23.02. 2011, as response to Letter No. 03-07/175 dated 02.02.2011 from the MoEN of the RM.

To be noted that the information on import-export operations for the 1990-1994 time series is not available in the Customs Service database. To fill this gap, following the GPG recommendations (IPCC, 2000, Chapter 7, Table 7-5, page 7.19), the trend extrapolation method was used (using the regression analysis).

AD on national consumption of varnishes and paints (Table 5-17) was inferred from information on national production (Table 5-15) and import (Table 5-16) of these products in the RM (within the period of reference no exports of these products were registered).

Table 5-17: Activity Data on Consumption of Varnishes and Paints in the RM within 1990-2010, kt

Category	1990	1991	1992	1993	1994	1995	1996
Consumption of conventional solvent paints	20.892	16.841	12.030	7.726	4.597	2.393	3.132
Consumption of waterborne paints	4.712	2.755	1.954	1.386	0.595	0.312	0.324
Total paints consumption	25.605	19.596	13.984	9.112	5.192	2.705	3.456
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Consumption of conventional solvent paints	1.852	1.731	1.737	3.878	4.391	7.117	7.117
Consumption of waterborne paints	0.371	0.446	0.563	1.190	2.061	3.304	3.800
Total paints consumption	2.224	2.177	2.299	5.068	6.452	10.421	10.917
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Consumption of conventional solvent paints	11.002	20.250	11.571	14.051	13.171	12.272	13.213
Consumption of waterborne paints	3.515	3.930	4.731	6.112	6.669	6.188	6.884
Total paints consumption	14.517	24.180	16.303	20.164	19.840	18.460	20.098

Source: NBS of the RM, Official Letter No. 06-39/08 dated 23.02.2011, as response to Letter No. 03-07/175 dated 02.02.2011 from the MoEN of the RM; Official Letter No. 06-39/38 dated 22.09.2011, as response to Letter No. 101/2011-09-01 dated 02.09.2011 from the Climate Change Office by the MoEN of the RM; Customs Service of the RM, Official Letter nr. 28/07-1893 from 23.02.2011 as response to Letter No. 03-07/175 dated 02.02.2011from the MoEN of the RM.

CO_2 emissions were estimated taking into consideration the content of carbon in NMVOC emissions (Table 5-14). Further, by oxidizing this carbon is converted in carbon dioxide in the atmosphere (it is assumed that all solvents from varnishes and paints are of fossil origin).

CO_2 emissions from paint application were estimated using the following formula:

$$CO_2\ emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 emissions – carbon dioxide emissions resulting from paint application, kt/yr;

CC – total NMVOC emissions within the respective category (see Table 5-14);

44/12 – stoichiometric ratio of carbon in CO_2 and NMVOC.

5.2.3 Uncertainties Assessment and Time-Series Consistency

Uncertainties related to the AD on production, import and export of paints in the RM are considered to be low (about ±5 per cent). At the same time, uncertainties related to content of solvents in different types of paints, as well as those related to carbon content in NMVOC are considered to be moderate. Uncertainties related to content of organic solvents in paints dissolved in conventional solvent medium are estimated to be at around ±25 per cent, while uncertainties related to content of organic solvents in alternative paints, inclusive in waterborne medium, reach to around ±50 per cent.

Combined uncertainties related to GHG emissions from the 3A 'Paint Application' source category can be considered moderate for emissions which origins from application of conventional solvent paints (±25.50 per cent), and medium for emissions from application of waterborne paints (±50.25 per cent). At the same time, combined uncertainties, presented as percentage of total sectoral emissions were estimated at ±9.33 per cent for CO_2 emissions from conventional solvent paints, and at ±0.94 per cent for CO_2 emissions from waterborne paints. Uncertainties introduced in trend in sectoral emissions were estimated at ±1.57 per cent for CO_2 emissions from conventional solvent paints and at ±0.34 per cent for CO_2 emissions from waterborne paints.

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 GPG (IPCC, 2000).

5.2.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under the 'Solvents and Other Product Use' Sector, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating GHG emissions under the category 3A 'Paint Application' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures regarding the quality of data, EFs, and estimating methodologies used.

Following the recommendations included into the GPG (IPCC, 2000), verification was focused on ensuring correct use of the default EFs available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009); on correct use of AD obtained from different sources of reference (i.e., Customs Service and National Bureau of Statistics), etc.

5.2.5 Recalculations

GHG emissions from the source category 3.A 'Paint Application' were recalculated for the period 1990 through 2005, in particular, due to employing new values for the content of solvents and carbon within the paints and varnishes used in the RM; as well as a consequence of updated AD regarding the production and imports of paint and varnishes.

In comparison with results recorded in the SNC, the changes made in the process of compiling the current inventory resulted in significantly increased NMVOC emissions over the period 1990 through 1997, respectively in 2005, varying from a minimum of 0.3 per cent in 1997, to a maximum of 131.7 per cent in 1996. At the same time, between 1998 through 2004, NMVOC emissions tended to decrease, varying from a minimum of 3.6 per cent in 1999 up to a maximum of 6.6 per cent in 1998 (Table 5-18).

Table 5-18: Comparative Results of NMVOC Emissions from 3A 'Paint Application' included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	9.6850	8.1725	5.4444	2.8407	1.2871	0.6218	0.6856
TNC	10.7760	8.6135	6.1516	3.9602	2.3402	1.2183	1.5886
Difference, %	11.3	5.4	13.0	39.4	81.8	95.9	131.7
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	0.9490	0.9596	0.9414	2.1636	2.4637	3.9893	4.0072
TNC	0.9522	0.8966	0.9077	2.0221	2.3398	3.7898	3.8244
Difference, %	0.3	-6.6	-3.6	-6.5	-5.0	-5.0	-4.6
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	6.0291	5.7694					
TNC	5.7471	10.4001	6.1169	7.4535	7.0524	6.5691	7.0886
Difference, %	-4.7	80.3					

In order to highlight the trend, the table below provides the implied emission factors (g NMVOC per one kg of paint, respectively kg of NMVOC per capita) calculated for the source category 3A 'Paint Application' in the Republic of Moldova (Table 5-19).

As it can be noted, the results are within the limits of the default emission factors (see Table 5-13), but are much lower than the European average value (4.5 kg NMVOC per capita) for this category (Table 5-6).

The decrease of the IEF values by 16.2 per cent between 1990 through 2010 (from 420.9 g NMVOC/kg paint applied in 1990, to 352.7 g NMVOC/kg in 2010), is due to the increase share of conventional solvent paint in national total consumption.

Table 5-19: IEFs calculated for the 3A 'Paint Application' Source Category in the RM, 1990-2010

Category	1990	1991	1992	1993	1994	1995	1996
IEF, g NMVOC/ kg paint	420.9	439.5	439.9	434.6	450.7	450.5	459.7
IEF, kg NMVOC/ per capita	2.5	2.0	1.4	0.9	0.5	0.3	0.4
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
IEF, g NMVOC/ kg paint	428.2	411.9	394.8	399.0	362.6	363.7	350.3
IEF, kg NMVOC/ per capita	0.2	0.2	0.2	0.5	0.5	0.9	0.9
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
IEF, g NMVOC/ kg paint	395.9	430.1	375.2	369.7	355.5	355.9	352.7
IEF, kg NMVOC/ per capita	1.4	2.5	1.5	1.8	1.7	1.6	1.7

As for the CO_2 emissions, comparing with the SNC, the recalculations resulted in increased values between 1990 and 1996, as well as during 2005, varying from a minimum of 0.3 per cent in 1991, up to a maximum of 121.0 per cent in 1996. At the same time, over the period 1997 through 2004, CO_2 emissions decreased, varying from a minimum of 4.7 per cent in 1997, to a maximum of 11.6 per cent in 2000 (Table 5-20).

Table 5-20: Comparative Results of CO_2 Emissions from 3A 'Paint Application' Source Category Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	30.1849	25.4710	16.9684	8.8535	4.0115	1.9381	2.1367
TNC	31.8675	25.5359	18.2380	11.7329	6.9474	3.6168	4.7210
Difference, %	5.6	0.3	7.5	32.5	73.2	86.6	121.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	2.9577	2.9907	2.9340	6.7433	7.6785	12.4334	12.4890
TNC	2.8186	2.6482	2.6741	5.9608	6.8544	11.1043	11.1766
Difference, %	-4.7	-11.5	-8.9	-11.6	-10.7	-10.7	-10.5
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	18.7906	17.9812					
TNC	16.9331	30.7948	17.9607	21.8636	20.6314	19.2190	20.7260
Difference, %	-9.9	71.3					

For the 2006-2010 time series, the GHG emissions resulting from the paint application were estimated for the first time. The results allow assert that over the period since 1990 through 2010, NMVOC and CO_2 emissions resulting from paint application decreased by 34.2 per cent, respectively by 35.0 per cent.

5.2.6 Planned Improvements

In the next inventory cycle there are planned activities aimed at updating AD used to estimate GHG emissions from 3A 'Paint Application' in the Republic of Moldova, inclusive through their breakdown by categories.

5.3 Degreasing and Dry Cleaning (Category 3B)

5.3.1 Source Category Description

Within the source category 3B 'Degreasing and Dry Cleaning' there are monitored the GHG emissions from 3B1 'Chemical Degreasing' category (solvent use in industry, especially for metal degreasing - SNAP 060201; electronic components manufacturing - SNAP 060203, as well as other industrial cleaning - SNAP 060204), respectively from 3B2 'Dry Cleaning' category (dry cleaning of clothes and other textiles from animal grease, oils, wax, resin, etc. - SNAP 060202).

Typically, the solvents used for degreasing are obtained by distillation of fossil fuels, representing substances such as chlorinated hydrocarbons, ketones and quinones, alcohols and phenols, etc. Thus, for example, chlorinated solvents, including trichloroethylene, tetrachloroethylene and dichloromethane are widely used in the industrial sector for cleaning metal and plastic surfaces, including for degreasing in vaporized solvents. Hydrocarbons and oxygenated solvents are used as cleaning solvents. Dry cleaning involves, for example, the use of tetrachloroethylene to clean clothes and other textiles.

In general, solvents used are recovered and recycled; in particular, if new equipment is used, however, fugitive NMVOC emissions occur especially in old, open-circuit machines when the final drying implies venting of drying air to atmosphere.

Between 1990 and 2010, GHG emissions from 3B 'Degreasing and Dry Cleaning' source category decreased by 62.7 per cent (Table 5-21). In comparison with 2008 year level, in 2009 these emissions decreased significantly by 24.5 per cent, especially due to the economic crisis that affected the economy of the RM. At the same time, compared to 2009 year level, in 2010 GHG emissions increased by 46.0 per cent, exceeding even the 2008 level (Figure 5-4).

Table 5-21: GHG Emissions from 3B 'Degreasing and Dry Cleaning' Source Category by Gas, within the 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
NMVOC	11.0950	9.7089	8.4529	7.3807	6.3644	6.5913	4.9321
CO_2	33.1963	29.0489	25.2910	22.0829	19.0422	19.7212	14.7570
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NMVOC	4.1316	1.9344	4.4318	3.5853	7.6878	3.6589	2.2929
CO_2	12.3617	5.7877	13.2599	10.7271	23.0020	10.9474	6.8605
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NMVOC	2.6509	5.7899	2.9690	3.1472	3.7586	2.8367	4.1420
CO_2	7.9314	17.3232	8.8832	9.4166	11.2457	8.4875	12.3930

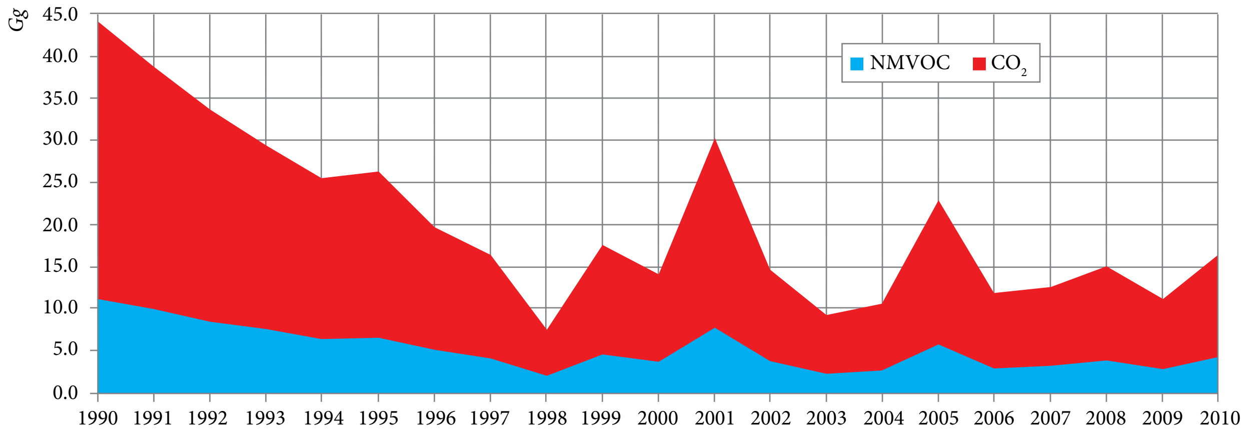


Figure 5-4: GHG Emissions from 3B 'Degreasing and Dry Cleaning' Source Category by Gas, within 1990-2010 time periods, Gg

5.3.2 Methodological Issues, Emission Factors and Activity Data

The methodology used to estimate NMVOC emissions from the use of solvents for degreasing and dry cleaning is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009)[30], and is represented by the following formula:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant\ technology}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from the use of solvents for degreasing and dry cleaning, t/yr;

$AR_{product}$ – activity rate for the use of solvents for degreasing and dry cleaning (consumption), t/yr;

$EF_{pollutant\ technology}$ – the emission factor for this pollutant technology, kg/t

EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) provides default EFs used by different estimation methodologies, such as the Tier 1 (Table 5-22) and/or the Tier 2 approaches (Table 5-23).

Table 5-22: Tier 1 Default EFs for Source Category 3B 'Degreasing and Dry Cleaning'

Source Categories	NMVOC EF	Unit
3B1 Degreasing	400	g/kg solvents
3B2 Dry Cleaning	40	g/kg treated textiles

Source: EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009), Source Category 3B „Degreasing and Dry Cleaning", Table 3-1, page 9.

To be noted that, while calculating the EFs values, there was taken into consideration also the NMVOC emissions mitigation technics within the respective sectors and/or industrial applications.

[30] European Environment Agency:< http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>.

Table 5-23: Tier 2 Default EFs for Source Category 3B 'Degreasing and Dry Cleaning'

Source Categories	NMVOC EF	Unit
3B1 Degreasing (SNAP 060201, metal degreasing)	710	g/kg solvents
3B1 Dry Cleaning (SNAP 060201, electronic components degreasing)	740	kg/t plastids
3B2 Dry Cleaning (SNAP 060202, dry cleaning)	177	g/kg treated textiles

Source: EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009), Source Category 3B „Degreasing and Dry Cleaning", Tables 3-2 and 3-3, pages 10-11.

Since no AD breakdown on solvents consumption within various sectors of national economy and/or industrial applications is available in the Republic of Moldova, it was used an alternative approach, equivalent with the Tier 3 approach, represented by the following formula:

$$E_{pollutant} = AR_{product} \bullet EF_{pollutant}$$

Where:

$E_{pollutant}$ – pollutant gas emissions from the use of solvents for degreasing and dry cleaning, t/yr;

$AR_{product}$ – activity rate for the use of solvents for degreasing and dry cleaning (consumption), t/yr;

$EF_{pollutant}$ – the emission factor for this pollutant technology (the content of organic solvents in substances used in degreasing and dry cleaning is assumed to be 100 per cent, see in EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009), Source Category 3B „Degreasing and Dry Cleaning", Table 3-5, page 12).

According to the available methodology (EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009), the content of organic solvents in substances used in degreasing and dry cleaning is assumed to be 100 per cent.

It is considered that the total amount of solvents for degreasing and dry cleaning evaporate into the atmosphere, NMVOC emissions being equal thus to the quantity of solvent 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 and degreasing (Table 5-24) is estimated following the equation:

$$Consumption_{solvents} = Production_{solvents} + Import_{solvents} - Export_{solvents}$$

Where:

Consumption $_{solvents}$ *– total consumption of solvents in the RM, kt/yr;*

Production $_{solvents}$ *– quantity of solvents produced in the country, kt/yr;*

Import $_{solvents}$ *– quantity of solvents imported in the country, kt/yr;*

Export $_{solvents}$ *– quantity of solvents exported from the country, kt/yr.*

For most activities involving use of organic solvents for dry cleaning and degreasing in the RM there are no veridical

Table 5-24: Activity Data on Consumption of Solvents Used in Dry Cleaning and Degreasing in the Republic of Moldova within 1990-2010 time periods

Category	1990	1991	1992	1993	1994	1995	1996
Benzene, toluene, xylene and other oils from coal tar distillation, kt	4.650	4.252	3.853	3.502	3.152	3.170	3.204
Cyclic and Acyclic Hydrocarbons, kt	0.725	0.600	0.483	0.383	0.296	0.285	0.059
Alcohols, kt	0.025	0.027	0.030	0.032	0.034	0.038	0.049
Phenols and Phenol-Alcohols, kt	0.220	0.182	0.147	0.117	0.088	0.017	0.126
Ethers, kt	0.730	0.559	0.440	0.341	0.255	0.198	0.074
Aldehydes, kt	2.401	2.103	1.799	1.554	1.313	1.847	0.465
Ketones and Quinones, kt	0.079	0.070	0.066	0.061	0.057	0.021	0.062
Carboxylic Acids, kt	0.473	0.417	0.389	0.374	0.352	0.579	0.285
Esters, kt	0.011	0.010	0.009	0.008	0.007	0.000	0.006
Nitrogen-function Compounds, kt	0.079	0.066	0.055	0.045	0.038	0.026	0.028
Organic Solvents and Diluents for Paint or Varnish Removal, kt	1.701	1.422	1.183	0.964	0.772	0.411	0.574
Total solvents, kt	11.095	9.709	8.453	7.381	6.364	6.591	4.932
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Benzene, toluene, xylene and other oils from coal tar distillation, kt	0.438	0.422	3.056	2.360	6.015	1.468	0.121
Cyclic and Acyclic Hydrocarbons, kt	0.111	0.124	0.028	0.154	0.060	0.170	0.120
Alcohols, kt	0.044	0.196	0.250	0.125	0.225	0.240	0.113
Phenols and Phenol-Alcohols, kt	0.004	0.006	0.020	0.008	0.000	0.021	0.029
Ethers, kt	1.668	0.110	0.060	0.003	0.374	0.003	0.069
Aldehydes, kt	0.566	0.366	0.205	0.227	0.198	0.319	0.112
Ketones and Quinones, kt	0.123	0.033	0.078	0.035	0.041	0.125	0.090
Carboxylic Acids, kt	0.577	0.378	0.505	0.398	0.515	0.961	1.275
Esters, kt	0.014	0.000	0.002	0.000	0.000	0.000	0.000
Nitrogen-function Compounds, kt	0.084	0.021	0.014	0.025	0.035	0.079	0.099
Organic Solvents and Diluents for Paint or Varnish Removal, kt	0.503	0.278	0.213	0.251	0.225	0.272	0.265
Total solvents, kt	4.132	1.934	4.432	3.585	7.688	3.659	2.293
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Benzene, toluene, xylene and other oils from coal tar distillation, kt	0.080	0.082	0.201	0.000	0.000	0.000	0.181
Cyclic and Acyclic Hydrocarbons, kt	0.191	0.109	0.126	0.127	0.111	0.116	0.175
Alcohols, kt	0.116	0.184	0.284	0.249	0.265	0.232	0.253
Phenols and Phenol-Alcohols, kt	0.034	0.001	0.001	0.022	0.001	0.024	0.327
Ethers, kt	0.073	0.004	0.015	0.004	0.009	0.003	0.014
Aldehydes, kt	0.195	0.207	0.169	0.155	0.124	0.063	0.113
Ketones and Quinones, kt	0.089	0.093	0.145	0.108	0.048	0.072	0.036
Carboxylic Acids, kt	1.281	1.521	1.552	1.659	1.669	1.130	1.312
Esters, kt	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen-function Compounds, kt	0.078	0.087	0.092	0.127	0.177	0.194	0.157
Organic Solvents and Diluents for Paint or Varnish Removal, kt	0.513	3.501	0.385	0.696	1.354	1.002	1.574
Total solvents, kt	2.651	5.790	2.969	3.147	3.759	2.837	4.142

Source: Custom Service of the RM, Official Letter No. 28/07-1893 dated 23.02. 2011, as response to Letter No. 03-07/175 dated 02.02.2011 from the MoEN of the RM.

statistic data. Under such circumstances, the total consumption of solvents used in dry cleaning and degreasing 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).

Customs Service is a primary source of information on solvents import-export operations including: (1) Oils and other products from coal tar distillation at high temperature (code 2707), including: 2707 10 900 „benzene for other use" (other than fuels); 2707 20 900 „toluene for other use" (other than fuels); 2707 30 900 „xylene for other use" (other than fuels), etc.; (2) acyclic hydrocarbons (codul 2901); (3) cyclic hydrocarbons (code 2902), including 2902 11 „ciclox-ehexanol"; 2902 20 „benzene"; 2902 30 „toluene"; 2902 40 „xylene"; 2902 50 „styrene"; 2902 60 „ethylbenzene"; 2902 70 „cumene" etc.; (4) halogenated derivatives of hydrocarbons (code 2903), including 2903 11 „chloromethane"; 2903 12 „dichloromethane"; 2903 13 „trichloromethane" (chloroform); 2903 14 „carbon tetrachloride"; 2903 15 „"ethylene chloride"; 2903 19 100 „1,1,1-trichlorethane" (methyl chloroform); 2903 21 „vinyl chloride" (chloroethylene); 2903 22 „trichloroethylene"; 2903 23 „tetrachloroethylene"; 2903 30 „fluorinated, brominated or iodinated derivatives of acyclic hydrocarbons"; 2903 40 „halogenated derivatives of acyclic hydrocarbons containing at least two different halogens" (trichlorofluoromethane, dichlorodifluoromethane, trichlorotrifluoroethane, etc.); 2903 50 „halogenated derivatives of cyclanes, cyclenic or cycloterpenes hydrocarbons"; 2903 60 „halogenated derivatives aromatic hydrocarbons"; (5) sulphonated, nitrated or nitrosated derivatives of hydrocarbons, wheather or not halogenated (code 2904); (6) acyclic alcohols and their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2905), including 2905 11 „methanol", 2905 12 „propyl and isopropyl alcohol", 2905 13 „n-butyl alcohol", 2905 14 „third butanol", 2905 16 „octyl alcohol", 2905 17 „lauryl, cetyl and stearyl alcohols" etc.; (7) cyclic alcohols and their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2906); (8) phenols and alcohols (code 2907); (9) halogenated, sulfonated, nitrated or nitrosated derivatives of phenols or phenol-alcohols (code 2908); (10) ethers, ether-alcohols, ether-phenols, ether-alcohol-phenols, alcohol peroxides, ether peroxides, ketone peroxides (whether or not chemically defined) and their halogenated sulfonated, nitrated or nitrosated derivatives (code 2909); (11) epoxides, epoxyalcohol, epoxyphenols and epoxyethers with three atoms and their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2910); (12) acetals and semiacetals, whether or not containing other oxygenated functions and their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2911); (13) aldehydes, whether or not containing other oxygenated functions; cyclic polymers of aldehydes; paraformaldehyde (code 2912); (14) halogenated, sulfonated, nitrated or nitrosated derivatives of products under heading 2912 (code 2913); (15) ketones and quinones, whether or not containing other oxygenated functions and their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2914), including 2914 11 „acetone", 2914 12 „butanone", 2914 13 „methylisobutylacetone", 2914 22 „ciclohexanone", 2914 31 „phenilacetone" etc.; (16) saturated acyclic monocarboxylic acids and their anhydrides, halides, peroxides and peroxyacids; their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2915); (17) unsaturated acyclic monocarboxylic acids and cyclic monocarboxylic acids, anhydrides, halides, peroxides and peroxyacids; their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2916); (18) polycarboxylic acids, anhydrides, halides, peroxides and peroxyacids; their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2917); (19) carboxylic acids with additional oxygenated function and their anhydrides, halides, peroxides and peroxyacids; their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2918); (20) phosphoric esters and their salts, including lactophosphates; their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2919); (21) esters of other inorganic acids of non-methals (excluding esters of hydrogen halides) and their salts, their halogenated, sulfonated, nitrated or nitrosated derivatives (code 2920); (22) amine function compounds (code 2921); (23) amino compounds with oxygenated functions (code 2922); (24) quaternary ammonium salts and hydroxides; lecithins and other phosphoaminolipids, whether or not chemically (code 2923); (25) carboxamide function compounds; carbonic acid compounds with amide function (code 2924); (26) organic solvents and diluents not included elsewhere, created for paint or varnish removal (code 3814).

To be noted that the information on import-export activities related to solvents used for degreasing and dry cleaning for 1990-1994 time series is not available in the Customs Service database. Thus, in order to fill this gap, following the GPG recommendations (IPCC, 2000, Chapter 7, Table 7-5, page 7.19), the trend extrapolation method was used (using the regression analysis).

CO_2 emissions were estimated based on the carbon content in NMVOC emissions. By oxidizing, this carbon converts into CO_2 in atmosphere (it is assumed that all solvents are of fossil origin). CO_2 emissions from degreasing and dry cleaning were estimated by the following equation:

$$CO_2\ Emissions = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 emissions – carbon dioxide emissions from degreasing and dry cleaning, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC (81.6 per cent, see in Table 5-12);

44/12 – stoichiometric ratio of carbon content in CO_2 and NMVOC.

5.3.3 Uncertainties Assessment and Time-Series Consistency

Uncertainties related to activity data on import and export of solvents in the RM are considered to be low (±5%). Uncertainties related to content of organic solvents in substances used in dry cleaning and degreasing are deemed to be low (±15 per cent), as well as the amount of organic solvents evaporated in atmosphere in the process of dry cleaning and degreasing (±20 per cent). Thus, combined uncertainties associated with GHG emissions from the 3B 'Degreasing and Dry Cleaning' source category may be considered moderate (±20.62 per cent). At the same time, combined uncertainties, presented as a percentage of total sectoral emissions were estimated at ±4.74 per cent. Uncertainties introduced in trend in sectoral emissions were estimated at ±1.87 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 GPG (IPCC, 2000).

5.3.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under the 'Solvents and Other Product Use' Sector, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating GHG emissions under the category 3B 'Degreasing and Dry Cleaning' were documented and archived both in hard copies and electronically.

For identifying the data quality, emission factors and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), verification was focused on ensuring correct use of the default EFs available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009); on correct use of AD obtained from different sources of reference (i.e., Customs Service, NBS), etc.

5.3.5 Recalculations

GHG emissions from the source category 3.B 'Degreasing and Dry Cleaning' were recalculated for the period since 1990 to 2005, in particular, due to employing new values for solvent and carbon contents in the products used for degreasing and dry cleaning; also, due to updated activity data set on import of solvents in the RM. In comparison with results recorded in the SNC of the RM under the UNFCCC, the changes made in the process of compiling the current inventory resulted in significantly increased NMVOC emissions over the period since 1990 to 2005, which varied from a minimum of 213.2 per cent in 2003, to a maximum of 9188.8 per cent in 1995 (Table 5-15).

In order to highlight the trend, Table 5-26 provide the implied emission factors (kg of NMVOC per capita) estimated for the source category 3B 'Degreasing and Dry Cleaning' in the RM. As it can be noted, the value for 1990 year is similar to the EFs values characteristic to developed countries (Table 5-6).

Table 5-25: Comparative Results of NMVOC Emissions from 3B 'Degreasing and Dry Cleaning' included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	0.6410	0.5200	0.3790	0.2280	0.1520	0.0710	0.2113
TNC	11.0950	9.7089	8.4529	7.3807	6.3644	6.5913	4.9321
Difference, %	1630.9	1767.1	2130.3	3137.1	4087.1	9188.8	2234.2
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	0.2991	0.1109	0.3059	0.1079	0.1918	0.3831	0.7321
TNC	4.1316	1.9344	4.4318	3.5853	7.6878	3.6589	2.2929
Difference, %	1281.3	1644.3	1348.8	3223.1	3908.7	855.2	213.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	0.3933	0.3979					
TNC	2.6509	5.7899	2.9690	3.1472	3.7586	2.8367	4.1420
Difference, %	574.0	1355.1					

Table 5-26: Default Emission Factors Estimated for the 3B 'Degreasing and Dry Cleaning' Source Category in the RM, 1990-2010

Category	1990	1991	1992	1993	1994	1995	1996
Default EF, kg NMVOC/ per capita	2.5	2.2	1.9	1.7	1.5	1.5	1.1
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Default EF, kg NMVOC/ per capita	1.0	0.4	1.0	0.8	1.8	0.9	0.5
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Default EF, kg NMVOC/ per capita	0.6	1.4	0.7	0.8	0.9	0.7	1.0

As for the CO_2 emissions, comparing with the results included in the SNC of the RM under the UNFCCC, the recalculations done resulted in significantly increased values, varying from a minimum of 200.7 per cent in 2003, up to a maximum of 8817.2 per cent in 1995 (Table 5-27).

Table 5-27: Comparative Results of CO_2 Emissions from 3B 'Degreasing and Dry Cleaning' Source Category Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	1.9978	1.6207	1.1812	0.7106	0.4737	0.2212	0.6586
TNC	33.1963	29.0489	25.2910	22.0829	19.0422	19.7212	14.7570
Difference, %	1561.7	1692.4	2041.1	3007.6	3919.6	8817.2	2140.8
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
SNC	0.9322	0.3456	0.9534	0.3363	0.5977	1.1938	2.2818
TNC	12.3617	5.7877	13.2599	10.7271	23.0020	10.9474	6.8605
Difference, %	1226.1	1574.5	1290.8	3090.2	3748.4	817.0	200.7
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
SNC	1.2258	1.2401					
TNC	7.9314	17.3232	8.8832	9.4166	11.2457	8.4875	12.3930
Difference, %	547.1	1296.9					

For the 2006-2010 time series, the GHG emissions resulting from solvents use for degreasing and dry cleaning were estimated for the first time. The results allow assert that over the period since 1990 to 2010, the NMVOC and CO_2 emissions resulting from 3B 'Degreasing and Dry Cleaning' category decreased by 62.7 per cent.

5.3.6 Planned Improvements

In the next inventory cycle there are planned activities focused on updating the activity data set used to estimate GHG emissions from 3B 'Degreasing and Dry Cleaning' in the RM.

5.4 Chemical Products, Manufacture and Processing (Category 3C)

5.4.1 Source Category Description

Under the 3C 'Chemical Products, Manufacture and Processing' source category there were reported GHG 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 manufacturing (SNAP 060307); inks manufacturing (SNAP 060308); glues and adhesive products manufacturing (SNAP 060309); asphalt blowing (SNAP 060310); adhesive, magnetic tapes, films and photographs (SNAP 060311); textile finishing (SNAP 060313); leather tanning (SNAP 060314), etc.

Between 1990 and 2010, CO_2 emissions from 3C 'Chemical Products, Manufacture and Processing' source category decreased by 46.3 per cent. In 1990 the emission sources with the largest share in the structure of total CO_2 emissions from this category were as following: 55.8 per cent - 'Shoes Manufacture', 20.1 per cent - 'Rubber Processing', 8.0 per cent - 'Pharmaceutical Products Manufacturing', 6.9 per cent - 'Paints Manufacturing', 4.5 per cent - 'Polyurethane Foam Processing', 3.7 per cent - 'Polystyrene Processing'. By 2010, the share of major emission sources changes as follows: 'Pharmaceutical Products Manufacturing' - 29.2 per cent, 'Polystyrene Processing' - 29.1 per cent, 'Polyurethane Foam Processing' - 18.4 per cent, 'Paints Manufacturing' - 13.4 per cent, 'Shoes Manufacture' - 9.7 per cent (Table 5-28, Figure 5-5).

In comparison with the 2008 year level, in 2009 CO_2 emissions decreased by 12.6 per cent, in particular due to the global economic crisis. The decreasing trend was characteristic also to 2010 year, when a reduction by 17.0 per cent was registered compared to 2009 year level.

A similar trend was established for the NMVOC emissions, which decreased by 46.3 per cent between 1990 and 2010 time series, from 1.87 Gg in 1990 to 1.01 Gg in 2010 (Table 5-29).

Table 5-28: CO_2 Emissions from 3C 'Chemical Products, Manufacture and Processing' by Source, 1990-2010, Gg

Category	1990	1991	1992	1993	1994	1995	1996
Polyurethane Processing	0.2544	0.2212	0.1924	0.1673	0.1454	0.1265	0.1028
Polystyrene Processing	0.2063	0.1794	0.1560	0.1357	0.1180	0.1026	0.0415
Rubber Processing	1.1226	1.0604	0.4955	0.1005	0.0215	0.0335	0.0362
Pharmaceutical Products Manufacturing	0.4454	0.3959	0.2891	0.2846	0.2178	0.2088	0.1879
Paints Manufacturing	0.3851	0.2896	0.1967	0.1023	0.0406	0.0251	0.0232
Leather Tanning	0.0237	0.0232	0.0147	0.0099	0.0031	0.0028	0.0034
Tyre Production and Reconditioning	0.0351	0.0341	0.0187	0.0007	0.0021	0.0031	0.0037
Shoes Manufacturing	3.1236	2.8005	0.9247	0.6593	0.3052	0.2028	0.1924
Total	5.5962	5.0043	2.2878	1.4603	0.8537	0.7051	0.5912
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Polyurethane Processing	0.0642	0.0416	0.0552	0.0670	0.0806	0.1574	0.2142
Polystyrene Processing	0.0370	0.0388	0.0336	0.0736	0.0701	0.1346	0.2392
Rubber Processing	0.0326	0.0295	0.0204	0.0383	0.0431	0.0735	0.0580
Pharmaceutical Products Manufacturing	0.2048	0.2931	0.4948	0.3330	0.4202	0.4728	0.3399
Paints Manufacturing	0.0168	0.0122	0.0222	0.0676	0.0948	0.1354	0.1137
Leather Tanning	0.0039	0.0022	0.0009	0.0008	0.0010	0.0020	0.0006
Tyre Production and Reconditioning	0.0046	0.0033	0.0048	0.0033	0.0043	0.0021	0.0028
Shoes Manufacturing	0.1472	0.1065	0.1140	0.1497	0.1675	0.2592	0.3686
Total	0.5110	0.5273	0.7459	0.7333	0.8817	1.2371	1.3371
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Polyurethane Processing	0.2710	0.3757	0.4711	0.7425	0.7239	0.4468	0.5544
Polystyrene Processing	0.2626	0.4795	0.6812	0.7452	0.7699	0.6779	0.8758
Rubber Processing	0.0541	0.0022	0.0076	0.0137	0.0051	0.0010	0.0012
Pharmaceutical Products Manufacturing	0.2940	0.3580	0.3999	0.6434	1.7474	1.8459	0.8788
Paints Manufacturing	0.1690	0.2063	0.2738	0.3635	0.3804	0.3724	0.4025
Leather Tanning	0.0000	0.0000	0.0001	0.0001	0.0002	0.0001	0.0000
Tyre Production and Reconditioning	0.0033	0.0050	0.0052	0.0055	0.0055	0.0041	0.0046
Shoes Manufacturing	0.4084	0.4914	0.4945	0.5111	0.5159	0.2760	0.2903
Total	1.4625	1.9181	2.3334	3.0250	4.1484	3.6242	3.0075

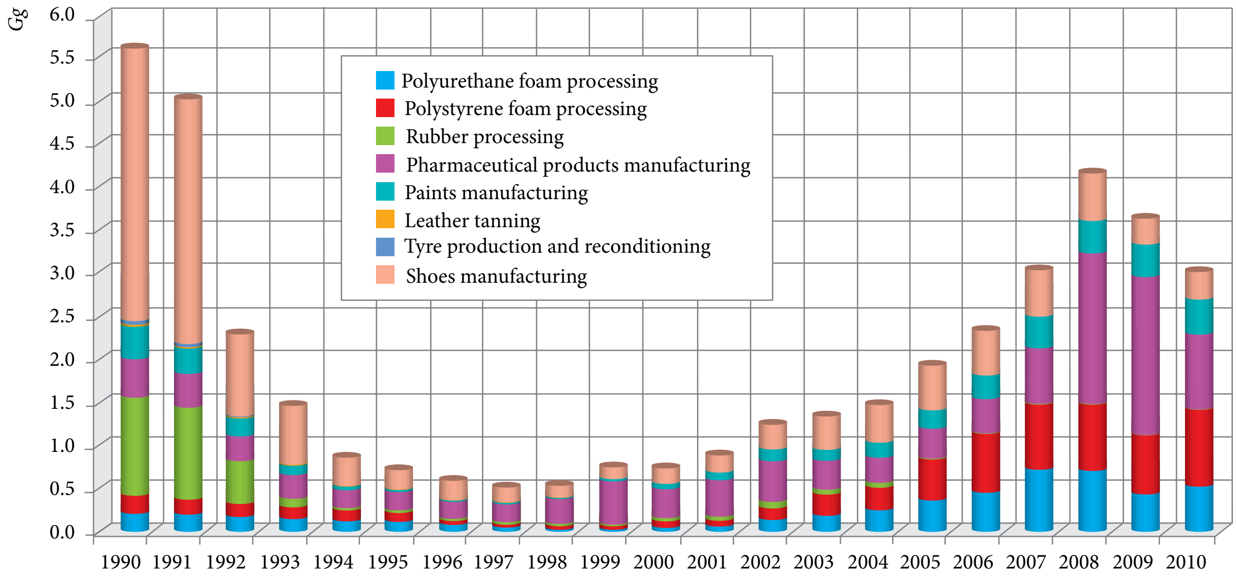


Figure 5-5: CO_2 Emissions from 3C 'Chemical Products, Manufacture and Processing' by Source, within 1990-2010 time periods, Gg

Table 5-29: NMVOC Emissions from 3C 'Chemical Products, Manufacture and Processing' by Source within 1990-2010 time periods, Gg

Category	1990	1991	1992	1993	1994	1995	1996
Polyurethane Processing	0.0850	0.0739	0.0643	0.0559	0.0486	0.0423	0.0344
Polystyrene Processing	0.0690	0.0600	0.0521	0.0453	0.0394	0.0343	0.0139
Rubber Processing	0.3752	0.3544	0.1656	0.0336	0.0072	0.0112	0.0121
Pharmaceutical Products Manufacturing	0.1489	0.1323	0.0966	0.0951	0.0728	0.0698	0.0628
Paints Manufacturing	0.1287	0.0968	0.0657	0.0342	0.0136	0.0084	0.0078
Leather Tanning	0.0079	0.0077	0.0049	0.0033	0.0010	0.0009	0.0011
Tyre Production and Refurbishing	0.0117	0.0114	0.0063	0.0002	0.0007	0.0010	0.0012
Shoes Manufacturing	1.0440	0.9360	0.3091	0.2204	0.1020	0.0678	0.0643
Total	1.8704	1.6726	0.7646	0.4881	0.2853	0.2356	0.1976
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Polyurethane Processing	0.0215	0.0139	0.0184	0.0224	0.0269	0.0526	0.0716
Polystyrene Processing	0.0124	0.0130	0.0112	0.0246	0.0234	0.0450	0.0800
Rubber Processing	0.0109	0.0099	0.0068	0.0128	0.0144	0.0246	0.0194
Pharmaceutical Products Manufacturing	0.0685	0.0980	0.1654	0.1113	0.1405	0.1580	0.1136
Paints Manufacturing	0.0056	0.0041	0.0074	0.0226	0.0317	0.0453	0.0380
Leather Tanning	0.0013	0.0007	0.0003	0.0003	0.0004	0.0007	0.0002
Tyre Production and Refurbishing	0.0015	0.0011	0.0016	0.0011	0.0014	0.0007	0.0009
Shoes Manufacturing	0.0492	0.0356	0.0381	0.0500	0.0560	0.0866	0.1232
Total	0.1708	0.1762	0.2493	0.2451	0.2947	0.4135	0.4469
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Polyurethane Processing	0.0906	0.1256	0.1575	0.2482	0.2419	0.1493	0.1853
Polystyrene Processing	0.0878	0.1602	0.2277	0.2491	0.2573	0.2266	0.2927
Rubber Processing	0.0181	0.0007	0.0025	0.0046	0.0017	0.0004	0.0004
Pharmaceutical Products Manufacturing	0.0983	0.1196	0.1337	0.2150	0.5840	0.6170	0.2937
Paints Manufacturing	0.0565	0.0690	0.0915	0.1215	0.1271	0.1245	0.1345
Leather Tanning	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
Tyre Production and Refurbishing	0.0011	0.0017	0.0017	0.0018	0.0018	0.0014	0.0015
Shoes Manufacturing	0.1365	0.1643	0.1653	0.1708	0.1724	0.0923	0.0970
Total	0.4888	0.6411	0.7799	1.0110	1.3865	1.2113	1.0052

5.4.2 Methodological Issues, Emission Factors and Data Sources

The methodology used to estimate NMVOC emissions from 'Manufacture and Processing of Chemical Products' is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009)[31], and is represented by the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{technology\ pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from solvents use for the manufacture and processing of chemical products, t/yr;

$AR_{product}$ – activity rate for manufacture and processing of chemical products, t/yr;

$EF_{pollutant\ technology}$ – the emission factor for this pollutant technology, kg/t

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) provides default EFs and alternative calculation methodologies: Tier 1 (Table 5-30) and Tier 2 approaches (Table 5-31).

Table 5-30: Tier 1 Default Emission Factors for Source Category 3C 'Chemical Products, Manufacture and Processing'

Source Category	EF_{NMVOC}	Unit
3C Chemical Products, Manufacture and Processing	10	g/kg of product

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Source Category 3C ‚Chemical Products, Manufacture and Processing', Table 3-1, page 15.

Table 5-31: Tier 2 Default Emission Factors for Source Category 3C 'Chemical Products, Manufacture and Processing'

Source Category	EF_{NMVOC}	Unit
3C Chemical Products, Manufacture and Processing (SNAP 060301, polyester processing)	50	g/kg monomer
3C Chemical Products, Manufacture and Processing (SNAP 060303, polyurethane processing)	120	g/kg foam
3C Chemical Products, Manufacture and Processing (SNAP 060304, polystyrene foam processing)	60	g/kg foam
3C Chemical Products, Manufacture and Processing (SNAP 060305, rubber processing)	8	g/kg rubber
3C Chemical Products, Manufacture and Processing (SNAP 060306,pharmaceutical products manufacturing)	300	g/kg solvent
3C Chemical Products, Manufacture and Processing (SNAP 060307, paints, inks and glues manufacturing)	11	g/kg product
3C Chemical Products, Manufacture and Processing (SNAP 060313, industrial leather tanning)	0.68	g/kg raw leather
3C Chemical Products, Manufacture and Processing (SNAP 060314, tyre production)	10	g/kg tyre
3C Chemical Products, Manufacture and Processing (glues and adhesive products manufacturing)	3	g/m^2
3C Chemical Products, Manufacture and Processing (shoes manufacture)	0.045	kg/pair of shoes

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Source Category 3C ‚Chemical Products, Manufacture and Processing', Table 3-2, 3-3, 3-4, 3-5, 3-6, 3-7, 3-8, 3-9, 3-10, 3-11, 3-12, 3-13 and 3-14, pages 17-23.

Statistical publications of the RM provide activity data on manufacturing different industrial commodities, including: leather items, shoes, as well as data on refurbished tires, other rubber products and paints manufacturing (Table 5-32).

In order to convert AD in mass metric units (tonne), the following conversion coefficient was used: (1) 15.6 tyres per tone[32] *(the value represent an weighted average, considering that a car tyre weight about 7.1 kg; a land vehicles tyre – 13.0 kg; a minibus and small tonnage truck tyre – about 11.1 kg; bus and heavy truck tyre – 46.0 kg; a tractor tyre – about 69.9 kg)* and (2) from one tone of raw leather are produced about 198 m2 of finished leather ready for use[33].

Customs Service of the Republic of Moldova is a primary source of information on import-export operations regarding primary polyurethane products (code 3909 50); polyurethane products (code 3921 13); primary polystyrene products (code 3903 11), respectively styrene polymers products (code 3921 11).

To be noted that the information on import-export activities for 1990-1994 time series is not available in the Customs Service database, thus in order to fill this gap, following the GPG recommendations (IPCC, 2000, Chapter 7, Table 7-5, page 7.19), the trend extrapolation method was used (using the regression analysis).

CO_2 emissions were estimated based on the carbon content in NMVOC emissions. By oxidizing, this carbon converts into CO_2 in atmosphere (it is assumed that all solvents from chemical products produced and processed, are of fossil origin).

CO_2 emissions were estimated by the following formula:

$$CO_2 = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 emissions – carbon dioxide emissions from solvents used for manufacturing and processing of chemical products, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC (81.6 per cent, see in Table 5-12);

44/12 – stoichiometric ratio of carbon content in CO_2 and NMVOC.

[31] European Environment Agency: < http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>.

[32] <http://www.wastexchange.co.uk/documenti/tyres/UK_Used_Tyre_Market_Report_2004_Report.pdf>.

[33] <http://preresi.ineti.pt/documentacao/guias/doc_tec/Curtumes/UNIDO/Mass%20Balance%20in%20Leather%20Processing.pdf>.

Table 5-32: Activity Data on Manufacturing Industrial Commodities in the Republic of Moldova, within 1990-2010 time periods

Category	1990	1991	1992	1993	1994	1995	1996
Polyurethane Processing, kt	0.709	0.616	0.536	0.466	0.405	0.352	0.286
Polystyrene Processing, kt	1.149	0.999	0.869	0.756	0.657	0.571	0.231
Rubber Processing, kt	46.900	44.300	20.700	4.200	0.900	1.400	1.512
Pharmaceutical Products Manufacturing, kt	0.496	0.441	0.322	0.317	0.243	0.233	0.209
Paints Manufacturing, kt	11.700	8.800	5.977	3.108	1.233	0.761	0.706
Leather Tanning, kt	11.636	11.379	7.237	4.869	1.510	1.369	1.667
Refurbished Tyres, thousand pieces	75.300	73.100	40.100	1.500	4.500	6.600	8.000
Shoes, thousand pairs	23.200	20.800	6.868	4.897	2.267	1.506	1.429
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Polyurethane Processing, kt	0.179	0.116	0.154	0.187	0.225	0.438	0.596
Polystyrene Processing, kt	0.206	0.216	0.187	0.410	0.391	0.750	1.333
Rubber Processing, kt	1.361	1.234	0.853	1.598	1.801	3.071	2.425
Pharmaceutical Products Manufacturing, kt	0.228	0.327	0.551	0.371	0.468	0.527	0.379
Paints Manufacturing, kt	0.509	0.370	0.674	2.054	2.882	4.115	3.454
Leather Tanning, kt	1.924	1.081	0.419	0.399	0.515	1.005	0.318
Refurbished Tyres, thousand pieces	9.800	7.100	10.200	7.000	9.200	4.600	6.000
Shoes, thousand pairs	1.093	0.791	0.847	1.112	1.244	1.925	2.738
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Polyurethane Procesing, kt	0.755	1.046	1.312	2.068	2.016	1.244	1.544
Polystyrene Processing, kt	1.463	2.671	3.794	4.151	4.289	3.776	4.878
Rubber Processing, kt	2.259	0.090	0.316	0.573	0.214	0.044	0.049
Pharmaceutical Products Manufacturing, kt	0.328	0.399	0.446	0.717	1.947	2.057	0.979
Paints Manufacturing, kt	5.136	6.269	8.319	11.045	11.557	11.315	12.229
Leather Tanning, kt	0.021	0.024	0.042	0.063	0.090	0.031	0.000
Refurbished Tyres, thousand pieces	7.128	10.699	11.191	11.762	11.821	8.842	9.815
Shoes, thousand pairs	3.033	3.650	3.673	3.796	3.832	2.050	2.156

Source: NBS of the RM, Statistical Yearbooks for 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 (pages 311) and 2011 (pages 305); Official Letter No. 06-39/08 from 23.02.2011, as a response to Letter No. 03-07/175 dated 02.02.2011 from the MoEN of the RM; Official 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 by the MoEN of the RM.

5.4.3 Uncertainties Assessment and Time-Series Consistency

Uncertainties related to activity data on manufacturing and processing of chemical products in the RM are considered to be relatively low, ±5 per cent for paints and varnishes, rubber products and shoes, respectively ±10 per cent for tanned leather and ±20 per cent for refurbished tyre production, in particular due to use of conversion coefficients, that bring additional uncertainties to initial AD from the statistical publications of the RM. Uncertainties related to NMVOC content fraction are considered relatively low (±10 per cent), while uncertainties related to the emission factors are considered to be medium (±25 per cent).

The combined uncertainties associated with GHG emissions from the 3C 'Chemical Products, Manufacture and Processing' source category may be considered medium, varying from ±25.49 per cent for varnishes and paints production, rubber products and shoes, up to ±32.02 per cent for refurbished tyre, leather products, polyurethane and polystyrene processing. At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±0.3295 per cent for polyurethane processing, ±0.5205 per cent for polystyrene processing, ±0.0006 per cent for rubber processing, ±0.4159 per cent for pharmaceutical products manufacturing, ±0.1905 per cent for varnishes and paint production, ±0.0027 per cent for refurbished tyre, respectively ±0.1374 per cent for shoes manufacture. Uncertainties introduced in trend in sectoral emissions are considered extremely low, varying from a minimum of ±0.0039 per cent for leather tanning, up to a maximum of ±0.4310 per cent for shoes manufacture (**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 GPG (IPCC, 2000).

5.4.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under the 'Solvents and Other Product Use' Sector, following a Tier 1 approach (IPCC, 2000). Also, the AD and methods used for estimating NMVOC and CO_2 emissions under the category 3C 'Chemical Products, Manufacture and Processing' were documented and archived both in hard copies and electronically. For identifying the data quality, emission factors and emission estimation process related errors there were applied verifications and quality control procedures.

Following the recommendations included into the GPG (IPCC, 2000), verification was focused on ensuring correct use of the default EFs available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009); correct use of AD obtained from different sources of reference, and on consistent converting of mass units.

5.4.5 Recalculations

GHG emissions from the source category 3.C 'Chemical Products, Manufacture and Processing' were recalculated for the 1990 through 2005 time period, in particular due to employing a new emission factor for 3C1 'Paints Manufacturing' category: in TNC - 11 g NMVOC per kg of product, available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009), while in the SNC – 15 g NMVOC per kg of product, available in the EMEP/CORINAIR Atmospheric Emissions Inventory Guidebook (1996); as well as due to considering, for the first time, new source categories (e.g. 3C2 'Leather Tanning', 3C3 'Refurbished Tyer', 3C4 'Rubber Soles Production', 3C5 'Shoes Manufacture') and as a consequence of using an updated data set on chemical products manufacture in the RM.

In comparison with results recorded in the SNC of the RM under the UNFCCC, the changes made in the process of compiling the current inventory resulted in significantly increased NMVOC emissions over the period 1990 through 2005, varying from a minimum of 581.7 per cent in 2005, up to a maximum of 3075.2 per cent in 1998 (Table 5-33).

Table 5-33: Comparative Results of NMVOC Emissions from 3C 'Chemical Products, Manufacture and Processing' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	0.1755	0.1320	0.0645	0.0345	0.0150	0.0090	0.0075
TNC	1.8704	1.6726	0.7646	0.4881	0.2853	0.2356	0.1976
Difference, %	965.8	1167.1	1085.5	1314.7	1802.2	2518.3	2534.4
	1997	1998	1999	2000	2001	2002	2003
SNC	0.0076	0.0056	0.0101	0.0308	0.0431	0.0614	0.0516
TNC	0.1708	0.1762	0.2493	0.2451	0.2947	0.4135	0.4469
Difference, %	2136.9	3075.2	2365.8	695.5	584.6	573.1	765.3
	2004	2005	2006	2007	2008	2009	2010
SNC	0.0694	0.0940					
TNC	0.4888	0.6411	0.7799	1.0110	1.3865	1.2113	1.0052
Difference, %	604.4	581.7					

As for the CO_2 emissions, comparing with the SNC of the RM under the UNFCCC, the performed recalculations resulted in significantly increased values, varying from a minimum of 554.5 per cent in 2005, up to a maximum of 2948.2 per cent in 1998 (Table 5-34).

Table 5-34: CO_2 Emissions from 3C 'Chemical Products, Manufacture and Processing', Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	0.5470	0.4114	0.2010	0.1075	0.0468	0.0281	0.0234
TNC	5.5962	5.0043	2.2878	1.4603	0.8537	0.7051	0.5912
Difference, %	923.1	1116.4	1038.0	1258.1	1726.2	2413.6	2429.1
	1997	1998	1999	2000	2001	2002	2003
SNC	0.0238	0.0173	0.0315	0.0960	0.1342	0.1914	0.1610
TNC	0.5110	0.5273	0.7459	0.7333	0.8817	1.2371	1.3371
Difference, %	2047.4	2948.2	2267.2	663.7	557.2	546.2	730.7
	2004	2005	2006	2007	2008	2009	2010
SNC	0.2163	0.2931					
TNC	1.4625	1.9181	2.3334	3.0250	4.1484	3.6242	3.0075
Difference, %	576.2	554.5					

For the 2006-2010 time series, the GHG emissions resulting from solvents use for manufacturing and processing of chemical products were estimated for the first time. The results allow assert that over the period 1990 through 2010, NMVOC and CO_2 emissions resulting from 3C 'Chemical Products, Manufacturing and Processing' category decreased by 46.3 per cent.

5.4.6 Planned Improvements

For the next inventory cycle there are planned activities on updating the AD to be used for estimating the GHG emissions from category 3C 'Chemical Products, Manufacture and Processing'. Additionally, if possible, there will be collected activity data related to other source categories for which, currently, there is no information available.

5.5 Other (Category 3D)

5.5.1 Source Category Description

Under the 3D 'Other' source category there were reported non-CO_2 emissions (in particular NMVOC, but also NO_x and CO), as well as direct GHG emissions (in particular CO_2, but also N_2O) from the following sources: 3D1 'Printing' (SNAP 060403) (use of solvents in printing process); 3D2 'Domestic Solvent Use' (SNAP 060408) (other than paints application; e.g. cosmetics and perfumes; car care products (antifreeze, car waxes and polishes, engine degreasers, etc.; households products like aerosols; glass and furniture cleaning, air freshener, disinfectants, waxes and polishes etc.); 3D3 'Other Product Use' (SNAP 060402 – use of hexane in seed oil extraction; SNAP 060405 – industrial application of glues and adhesives in industries like: construction, shoes manufacture, adhesive substances and furniture manufacture; SNAP 060406 – preservation of wood; SNAP 060407 – underseal treatment and conservation of vehicles; SNAP 060409 – vehicle dewaxing; SNAP 060411 – domestic use of pharmaceutical products, SNAP 060412 – preservation of

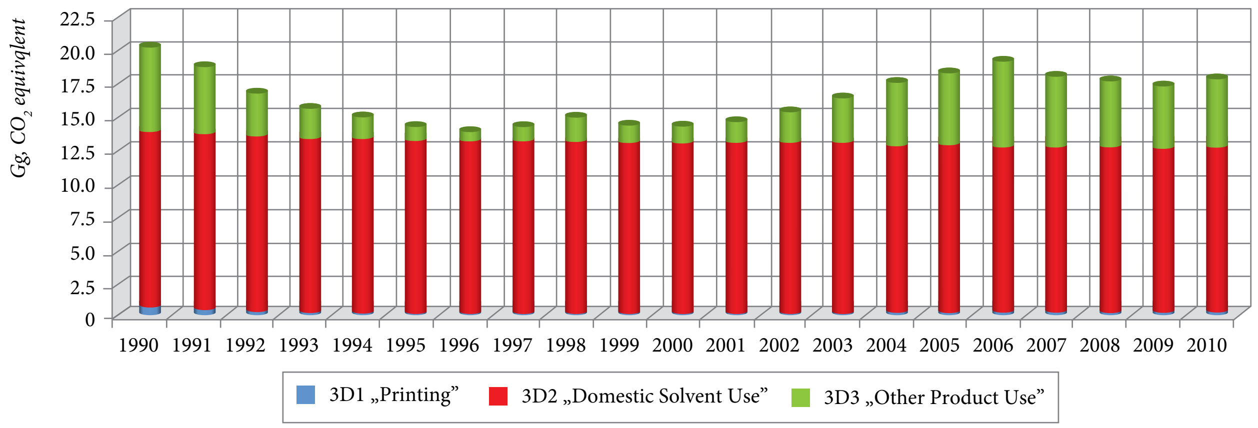


Figure 5-6: Direct GHG Emissions from Category 3D 'Other', by Source, within 1990-2010 time periods, Gg CO_2 equivalent

Table 5-35: Direct GHG Emissions from Category 3D ,Other', by Source, 1990-2010, Gg CO_2 equivalent

Category	1990	1991	1992	1993	1994	1995	1996
3D1 'Printing'	0.7352	0.5566	0.3968	0.2532	0.1625	0.1063	0.1307
3D2 'Domestic Solvent Use'	13.0499	13.0640	13.0424	13.0086	13.0233	13.0089	12.9685
3D3 'Other Product Use'	6.3314	5.0212	3.2380	2.2637	1.6897	1.0395	0.7135
3D 'Other'	20.1165	18.6418	16.6773	15.5255	14.8754	14.1547	13.8128
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
3D1 'Printing'	0.0956	0.1186	0.0877	0.1056	0.1500	0.1920	0.2174
3D2 'Domestic Solvent Use'	12.9254	12.8797	12.8447	12.8102	12.7986	12.7501	12.6924
3D3 'Other Product Use'	1.1444	1.8824	1.3316	1.2885	1.6082	2.2771	3.3795
3D 'Other'	14.1655	14.8807	14.2640	14.2044	14.5568	15.2193	16.2893
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
3D1 'Printing'	0.2839	0.3839	0.2937	0.3413	0.3607	0.3234	0.4021
3D2 'Domestic Solvent Use'	12.4521	12.4105	12.3585	12.3109	12.2678	12.2373	12.2124
3D3 'Other Product Use'	4.6883	5.3523	6.3653	5.2579	4.9284	4.6301	5.1280
3D 'Other'	17.4244	18.1468	19.0175	17.9101	17.5569	17.1908	17.7426

seeds; SNAP 060508 – N_2O use in anesthesia; SNAP 060602 – tobacco combustion, SNAP 060603 – use of shoes, etc.).

Between 1990 and 2010, direct GHG emissions from 3D 'Other' source category decreased by circa 11.8 per cent (Figure 5-6, Table 5-35).

In 1990, the sources with the largest share in the structure of total CO_2 emissions within this category were: 3D2 'Domestic Solvent Use' (64.9 per cent), 3D3 'Other Product Use' (31.5 per cent), respectively 3D1 'Printing' (3.7 per cent). By 2010, the trend changed as it follows: 3D2 'Domestic Solvent Use' (68.8 per cent), 3D3 'Other Product Use' (28.9 per cent), respectively 3D1 'Printing' (2.3 per cent).

In comparison with the 2008 year level, in 2009 CO_2 emissions decreased by 2.1 per cent. At the same time, compared to 2009 year level, in 2010 these emissions increased by 3.2 per cent. A decreasing trend was established for the non-CO_2 emissions from this category, which, between 1990 and 2010 time series decreased by 22.1 per cent in case of NMVOC emissions, respectively by 75.7 per cent for CO and NO_x emissions (no N_2O emissions are registered since 2007) (Tables 5-36 and 5-37).

Table 5-36: NMVOC Emissions from Category 3D 'Other', by Source, within 1990-2010 time periods, Gg

Category	1990	1991	1992	1993	1994	1995	1996
3D1 Printing	0.2457	0.1860	0.1326	0.0846	0.0543	0.0355	0.0437
3D2 Domestic Solvent Use	4.3616	4.3663	4.3591	4.3478	4.3527	4.3479	4.3344
3D3 Other Product Use	2.8737	2.2605	1.4971	1.0304	0.7462	0.4640	0.3164
3D Other	7.4810	6.8129	5.9888	5.4628	5.1532	4.8474	4.6945
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
3D1 Printing	0.0320	0.0396	0.0293	0.0353	0.0501	0.0642	0.0727
3D2 Domestic Solvent Use	4.3200	4.3047	4.2930	4.2815	4.2776	4.2614	4.2421
3D3 Other Product Use	0.5273	0.8838	0.6181	0.5969	0.7362	1.0438	1.5361
3D Other	4.8793	5.2282	4.9404	4.9137	5.0639	5.3694	5.8509
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
3D1 Printing	0.0949	0.1283	0.0982	0.1141	0.1205	0.1081	0.1344
3D2 Domestic Solvent Use	4.1618	4.1479	4.1305	4.1146	4.1002	4.0900	4.0817
3D3 Other Product Use	2.1279	2.4407	2.9285	2.4003	2.2471	2.1013	2.3627
3D Other	6.3846	6.7170	7.1572	6.6290	6.4678	6.2994	6.5788

Table 5-37: Non-CO_2 Emissions (other than NMVOC) from 3D3 'Other Product Use', by Source, within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
N_2O, Gg	0.000066	0.000055	0.000050	0.000060	0.000050	0.000001	0.000002
NO_x, Gg	0.000056	0.000056	0.000053	0.000054	0.000049	0.000043	0.000059
CO, Gg	0.001940	0.001961	0.001833	0.001876	0.001705	0.001514	0.002068
	1997	1998	1999	2000	2001	2002	2003
N_2O, Gg	0.000003	0.000005	0.000043	0.000044	0.000044	0.000044	0.000044
NO_x, Gg	0.000058	0.000076	0.000087	0.000071	0.000067	0.000043	0.000029
CO, Gg	0.002025	0.002647	0.003026	0.002489	0.002351	0.001497	0.001021
	2004	2005	2006	2007	2008	2009	2010
N_2O, Gg	0.000050	0.000061	0.000059	NO	NO	NO	NO
NO_x, Gg	0.000026	0.000029	0.000018	0.000015	0.000022	0.000017	0.000014
CO, Gg	0.000923	0.001001	0.000633	0.000529	0.000764	0.000598	0.000471

Abbreviations: NO – Not Occurring.

5.5.2 Methodological Issues, Emission Factors and Data Sources

3. D.1 'Printing'

The methodology used to estimate NMVOC emissions from source category 3D1 'Printing' is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009)[34], and is represented by the following formula:

$$E_{pollutant} = (AR_{product} \cdot EF_{technology\ pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from inks used in printing, t/yr;

$AR_{product}$ – activity rate for inks used in printing, t/yr;

$EF_{pollutant\ technology}$ – the emission factor for this pollutant technology, kg/t

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) provides default EFs and a Tier 1 methodological approach (Table 5-38).

[34] European Environment Agency : < http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>

Table 5-38: Tier 1 Default Emission Factors for Source Category 3D1 'Printing'

Source Category	EF_{NMVOC}	Unit
3D1 Printing	500	kg/t ink

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Source Category 3D1 'Printing', Table 3-1, page 11

No statistical data on solvents and/or printing inks used are available in the Republic of Moldova. In such conditions, the total inks consumption was estimated considering statistical data on production, import and export (in the RM, inks are not produced and there were no records on inks export) (Table 5-39).

$$Consumption_{ink} = Production_{ink} + Import_{ink} - Export_{ink}$$

Where:

$Consumption_{ink}$ – Total consumption of ink, kt/yr;
$Production_{ink}$ – the amount of ink produced, kt/yr;
$Import_{ink}$ – the amount of ink imported, kt/yr;
$Export_{ink}$ – the amount of ink exported, kt/yr.

Customs Service of the Republic of Moldova is a primary source of information on import-export operations ('print-

Table 5-39: Activity Data on Ink Import in the RM within 1990-2010 time periods

Category	1990	1991	1992	1993	1994	1995	1996
Inks for printing, writing and drawing, as well as other inks, kt	0.3557	0.2634	0.1817	0.1136	0.0688	0.0405	0.0577
Paints for artistic painting, for educational use, firms painting, amusement as well as similar paints, kt	0.1358	0.1086	0.0836	0.0557	0.0398	0.0306	0.0297
Total inks, kt	0.4914	0.3721	0.2652	0.1693	0.1086	0.0711	0.0874
Category	1997	1998	1999	2000	2001	2002	2003
Inks for printing, writing and drawing, as well as other inks, kt	0.0604	0.0596	0.0444	0.0553	0.0838	0.1024	0.1175
paints for artistic painting, for educational use, firms painting, amusement as well as similar paints, kt	0.0035	0.0197	0.0142	0.0152	0.0164	0.0259	0.0278
Total inks, kt	0.0639	0.0793	0.0586	0.0706	0.1002	0.1284	0.1453
Category	2004	2005	2006	2007	2008	2009	2010
Inks for printing, writing and drawing, as well as other inks, kt	0.1568	0.2260	0.1502	0.1925	0.1906	0.1721	0.2209
Paints for artistic painting, for educational use, firms painting, amusement as well as similar paints, kt	0.0330	0.0306	0.0462	0.0356	0.0505	0.0441	0.0479
Total inks, kt	0.1898	0.2566	0.1964	0.2281	0.2411	0.2162	0.2688

Source: Customs Service of the RM, Official Letter No. 28/07-1893 dated 23.02. 2011, answer to Letter No. 03-07/175 dated 02.02.2011 from the MoEN of the RM.

ing, writing or drawing', as well as 'other inks' – code 3215 10-90; paints for 'artistic painting, educational use, firms painting, amusement, as well as similar paints' - code 3213 10-90).

To be noted that the information on import-export activities for 1990-1994 time series is not available in the Customs Service database, thus, in order to fill this gap, following the GPG recommendations (IPCC, 2000, Chapter 7, Table 7-5, page 7.19), the trend extrapolation method was used (using the regression analysis).

CO_2 emissions were estimated based on the carbon content in NMVOC emissions (Table 5-12). By oxidizing, this carbon converts into CO_2 in atmosphere (it is assumed that all solvents from chemical products produced and processed, are of fossil origin).

CO_2 emissions were estimated by the following formula:

$$CO_2 = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 emissions – carbon dioxide emissions from inks use for printing, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC (81.6 per cent, see in Table 5-12);

44/12 = stoichiometric ratio of carbon content in CO_2 and NMVOC.

3. D.2 'Domestic Solvent Use'

No statistical data are available in the Republic of Moldova related to 'domestic solvents use' (other than for decorative paint application), in particular, regarding cosmetics and toiletries, as well as on household products.

AD on certain categories can be generated indirectly, considering statistical data on production, import and export, by the following formula:

$$Consumption_{dsu} = production_{dsu} + import_{dsu} - export_{dsu}$$

Where:

$Consumption_{dsu.}$ – total consumption of domestic solvents, kt/yr;

$Production_{dsu}$ – amount of domestic solvents produced, kt/yr;

$Import_{dsu}$ – amount of domestic solvents imported, kt/yr;

$Export_{dsu.}$ – amount of domestic solvents exported, ktyr

To be noted that the production of domestic solvents in the RM is insignificant and the Statistical Yearbooks do not specify it, as well as domestic solvents exports. Customs Service of the Republic of Moldova is a primary source of information on national import operations (Table 5-40).

Table 5-40: Activity Data on Domestic Solvents Import in the RM within 1990-2010 time periods

Category	1990	1991	1992	1993	1994	1995	1996
Mixtures of odoriferous substances and mixtures based on one or more of these substances, kt	0.3180	0.2706	0.2353	0.2046	0.1779	0.1547	0.0712
Parfumes and eau de toilette, kt	0.3303	0.2541	0.1954	0.1503	0.1156	0.0925	0.1429
Beauty or make-up products and skin care, manicure or pedicure products, kt	0.7031	0.5208	0.3472	0.2042	0.1135	0.0667	0.0713
Hair care products, kt	2.1210	1.6315	1.1654	0.7284	0.4046	0.2130	0.3283
Oral or dental hygiene products, kt	0.8651	0.6180	0.3862	0.2414	0.1509	0.1006	0.1131
Pre-shave, shave or after-shave products, deodorants, bath products, depilatories, other perfumery or toiletries and other cosmetics, air freshener , kt	1.2637	0.8424	0.4434	0.1928	0.0838	0.0399	0.0397
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Mixtures of odoriferous substances and mixtures based on one or more of these substances, kt	0.0725	0.0681	0.0808	0.0641	0.1758	0.2351	0.1789
Parfumes and eau de toilette, kt	0.1454	0.0068	0.0170	0.0991	0.1585	0.2607	0.2364
Beauty or make-up products and skin care, manicure or pedicure products, kt	0.1068	0.0580	0.0532	0.0800	0.1974	0.3326	0.5557
Hair care products, kt	0.3816	0.3358	0.5573	1.0675	1.2892	1.5030	1.8767
Oral or dental hygiene products, kt	0.0831	0.1041	0.4581	0.3640	0.3424	0.3902	0.5015
Pre-shave, shave or after-shave products, deodorants, bath products, depilatories, other perfumery or toiletries and other cosmetics, air freshener , kt	0.0807	0.0687	0.0478	0.0864	0.1897	0.4108	0.6529
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Mixtures of odoriferous substances and mixtures based on one or more of these substances, kt	0.2038	0.2532	0.1875	0.2009	0.1696	0.1371	0.2009
Parfumes and eau de toilette, kt	0.2087	0.2404	0.2858	0.4660	0.2012	0.1323	0.1114
Beauty or make-up products and skin care, manicure or pedicure products, kt	0.5567	0.7338	0.8086	0.9913	1.0283	0.8313	0.8856
Hair care products, kt	1.9802	2.3080	2.4143	2.8395	2.6788	2.6876	2.7463
Oral or dental hygiene products, kt	0.4623	0.5381	0.5588	0.5750	0.6192	0.5212	0.6211
Pre-shave, shave or after-shave products, deodorants, bath products, depilatories, other perfumery or toiletries and other cosmetics, air freshener , kt	0.7696	1.2069	1.3931	1.6538	1.8950	1.5354	1.6036

Source: Customs Service of the RM, Official Letter No. 28/07-1893 dated 23.02. 2011, answer to Letter No. 03-07/175 dated 02.02.2011 from the MoEN of the RM.

Information on import activities for 1990-1994 time series is not available in the Customs Service database, so, in order to fill this gap, following the GPG recommendations (IPCC, 2000, Chapter 7, Table 7-5, page 7.19), the trend extrapolation method was used (using the regression analysis).

Considering the above mentioned, it is necessary to specify that although AD on certain consumer products consumption have been collected, since the solvents share in these products is unknown, it has not been possible yet to apply a higher estimation methodology.

For now, the methodology used to estimate NMVOC emissions from source category 3D2 'Domestic Solvents Use' is the one available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) and is represented by the following equation:

$$E_{pollutant} = (P \bullet EF_{pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from domestic solvents use, t/yr;

P – population, thousand inhabitants/yr (Table 5-42);

$EF_{pollutant}$ – the emission factor for this pollutant gas, kg/person/yr.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) provides default EFs and a Tier 1 methodological approach (Table 5-41).

Table 5-41: Tier 1 Default Emission Factors for Source Category 3D2 'Domestic Solvents Use'

Source Categories	EF_{NMVOC}	Unit
3D2 Domestic Solvents Use	1.0	kg/person/yr

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Source Category 3D2 'Domestic Solvents Use', Table 3-1, page 6.

CO_2 emissions were estimated based on the carbon content in NMVOC emissions (Table 5-12). By oxidizing, this carbon converts into CO_2 in atmosphere (it is assumed that all solvents from household waste products are of fossil origin).

CO_2 emissions were estimated by the following equation:

$$CO_2 = NMVOC \bullet CC \bullet 44/12$$

Where:

CO_2 emissions – carbon dioxide emissions from domestic solvents use, kt/yr;

NMVOC – total NMVOC emissions within the respective category, kt/yr;

CC – carbon content in NMVOC (81.6 per cent, see in Table 5-12);

44/12 – stoichiometric ratio of carbon content in CO_2 and NMVOC.

3. D.3 'Other Product Use'

'Seed Oil Extraction'

A certain amount of solvents, hexane in particular, is used in extracting oil from seeds (mechanical extraction does not require the use of solvents). The cleaned and prepared seeds are washed several times in warm hexane solvent until all the oil is extracted, while the remaining seeds residue is treated with steam to capture the solvent and oil remains in it. After drying, the remaining seed residue may be used as animal feed. 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 the enterprises in this branch. The oil is further refined.

The methodology used to estimate NMVOC emissions from source category 3D3 'Other' (seed oil extraction) is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) [35], and is represented by the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{technology\ pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from solvents use in seed oil extraction, t/yr;

$AR_{product}$ – activity rate for solvents consumption in seed oil extraction, t/yr;

$EF_{pollutant\ technology}$ – the emission factor for this pollutant technology, kg/t

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) provides default EFs and a Tier 2 methodological approach (Table 5-43). In order to estimate NMVOC emissions, statistical data on the amount of oil extracted at the Moldovan enterprises are used.

[35] European Environment Agency: <http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>.

Table 5-42: Republic of Moldova's Population within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Total Population (including ATULBD), thousand inhabitants	4361.6	4366.3	4359.1	4347.8	4352.7	4347.9	4334.4
	1997	1998	1999	2000	2001	2002	2003
Total Population (including ATULBD), thousand inhabitants	4320.0	4304.7	4293.0	4281.5	4277.6	4261.4	4242.1
	2004	2005	2006	2007	2008	2009	2010
Total Population (including ATULBD), thousand inhabitants	4161.8	4147.9	4130.5	4114.6	4100.2	4090.0	4081.7

Source: Statistical Yearbooks of the RM for 1990 (page 20), 1993 (page 60), 1994 (page 52), 1995 (page 49), 1997 (page 59), 1999 (page 42), 2003 (page 45), 2006 (page 37), 2007 (page 33), 2008 (page 32), 2009 (page 32), 2010 (page 32), 2011 (page 32); Statistical Yearbooks of the ATULBD for 2000 (page 27), 2006 (page 27), 2007 (page 27), 2009 (page 28), 2010 (page 28), 2011 (page 28), 2012 (page 28).

Table 5-43: Tier 2 Default Emission Factors for Source Category 3D3 'Other' (seed oil extraction)

Source Categories	EF_{NMVOC}	Unit
3D3 Seed Oil Extraction	3.0	kg/t seeds

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Source Category 3D3 'Other', Table 3-2, page 13.

In conformity with the information received from the Ministry of Agriculture and Food Industry of the RM, there are more than 45 enterprises specialized in oil production, the biggest being 'Floarea-Soarelui' J.S.C. in Balti. Current technologies used in the RM in seed oil extraction by use of solvents allow obtain around 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 5-44).

Table 5-44: Activity Data on Oil Production and Quantity of Seeds Used for Oil Extraction in the RM within 1990-2010 time periods, kt

Category	1990	1991	1992	1993	1994	1995	1996
Total oil produced, inclusive:	125.6	117.9	38.2	39.3	51.4	31.5	23.5
refined oil obtained by extraction	47.7	44.2	14.1	14.3	18.5	11.2	8.2
Quantity of seeds used for oil extraction	106.1	98.3	31.4	31.9	41.2	24.9	18.3
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total oil produced, inclusive:	19.3	18.1	17.5	22.5	37.7	51.7	72.8
refined oil obtained by extraction	6.6	5.3	3.9	4.4	9.0	13.1	24.6
Quantity of seeds used for oil extraction	14.6	11.8	8.6	9.7	20.0	29.1	54.6
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total oil produced, inclusive:	91.3	83.2	81.2	84.7	79.2	82.7	64.7
refined oil obtained by extraction	36.3	37.1	36.5	38.5	36.4	38.5	30.4
Quantity of seeds used for oil extraction	80.8	82.5	81.2	85.6	81.0	85.5	67.6

Source: NBS of the RM, Statistical Yearbooks for 1994 (page 289), 1999 (page 304), 2003 (page 394) and 2006 (page 309); as well as Official Letters No. 06-06/12 dated 23.06.2006 and No. 06-39/08 from 23.02.2011.

'Use of Glues and Other Adhesives'

The methodology used to estimate NMVOC emissions from source category 3D3 'Other' (use of glues and other adhesives) is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009), and is represented by the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{technology\ pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – *pollutant gas emissions from use of glues and other adhesives, t/yr;*

$AR_{product}$ – *activity rate for consumption of glues and other adhesives, t/yr;*

$EF_{pollutant\ technology}$ – *the emission factor for this pollutant technology, kg/t*

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) provides default EFs and a Tier 2 methodological approach (Table 5-45).

Table 5-45: Tier 2 Default Emission Factors for Category 3D3 ‚Use of Glues and Other Adhesives'

Source Categories	EF_{NMVOC}	Unit
3D3 Use of Glues and Other Adhesives	780	kg/t glue

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Source Category 3D3 'Other', Table 3-8, page 16.

For most activities related to other solvent use in the RM, there are no reliable statistical sources of reference. Under such circumstances, the total consumption of glues and other adhesives was estimated based on information on production, import and export, following the equation:

$$Consumption_{glue} = Production_{glue} + Import_{glue} - Export_{glue}$$

Where:

$Consumption_{glue}$ – total consumption of glues and other adhesives, kt/yr;

$Production_{glue}$ – amount of glues and other adhesives produced, kt/yr;

$Import_{glue}$ – amount of glues and other adhesives imported, kt/yr;

$Export_{glue.}$ – amount of glues and other adhesives exported, kt/yr.

To be noted that production of glues and other adhesives in the RM is insignificant and the SYs do not specify it. Customs Service of the RM is a primary source of information on national import-export operations (Table 5-46).

Table 5-46: AD on Glues and Other Adhesives Import within 1990-2010 time periods

Category	1990	1991	1992	1993	1994	1995	1996
Glues and Other Adhesives, kt	3.2508	2.5006	1.7862	1.1908	0.7938	0.4962	0.3323
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Glues and Other Adhesives, kt	0.6172	1.0852	0.7549	0.7264	0.8643	1.2217	1.3874
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Glues and Other Adhesives, kt	1.7522	1.9457	1.9679	1.9609	1.9713	1.4342	1.8004

Source: Customs Service of the RM, Official Letter No. 28/07-1893 from 23.02. 2011, answer to Letter No. 03-07/175 dated 02.02.2011 From the MoEN of the RM. NBS of the RM, Official Letter No 06-39/08 dated 23.02.2011, answer to Letter No. 03-07/175 dated 02.02.2011 from the MoEN of the RM; Official Letter No. 06-39/38 dated 22.09.2011, answer to Letter No. 101/2011-09-01 dated 02.09.2011 from the CCO of the MoEN.

Information on import activities for 1990-1994 time series is not available in the Customs Service database, thus in order to fill the gap, following the GPG recommendations (IPCC, 2000, Chapter 7, Table 7-5, page 7.19), the trend extrapolation method was used (using the regression analysis).

'Vehicles Dewaxing'

The methodology used to estimate NMVOC emissions from source category 3D3 'Other' (vehicles dewaxing after long storage and long-distance transport) is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009)[36], and is represented by the following equation:

$$E_{pollutant} = (AR_{product} \bullet EF_{technology\ pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from vehicles dewaxing, t/yr;

$AR_{product}$ – activity rate for new vehicles import, units/yr;

$EF_{pollutant\ technology}$ – the emission factor for this pollutant technology, kg/t

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) provides default EFs and a Tier 2 methodological approach (Table 5-47).

Table 5-47: Tier 2 Default Emission Factors for Category 3D3 'Vehicles Dewaxing'

Source Categories	EF_{NMVOC}	Unit
3D3 'Vehicles Dewaxing'	1.0	kg/car

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Source Category 3D3 'Other', Table 3-6, page 15.

No vehicles are produced in the RM. Customs Service of the Republic of Moldova is a primary source of information on national import operations (Table 5-48).

Table 5-48: AD on New Cars Import, 1990-2010

Category	1990	1991	1992	1993	1994	1995	1996
Imported vehicles – total, units	19790	15223	9515	5947	3498	2332	2334
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Imported vehicles – total, units	1922	1947	3281	1161	1841	3503	8431
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Imported vehicles – total, units	7768	10030	7477	10523	14368	7832	7923

Source: Custom Service of the RM, Official Letter No. 28/07-1893 dated 23.02. 2011, answer to Letter No. 03-07/175 dated 02.02.2011 from the MoEN of the RM.

Information on import activities for 1990-1994 time series is not available in the Customs Service database, thus in order to fill this gap, following the GPG recommendations (IPCC, 2000, Chapter 7, Table 7-5, page 7.19), the trend extrapolation method was used (using the regression analysis).

'Tobacco Combustion'

The methodology used to estimate NMVOC emissions from source category 3D3 'Other' (tobacco combustion) is available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009)[37], and is represented by the following formula:

$$E_{pollutant} = (AR_{product} \bullet EF_{technology\ pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from tobacco combustion, t/yr;

$AR_{product}$ – activity rate for tobacco products combusted, t/yr;

$EF_{pollutant\ technology}$ – the emission factor for this pollutant technology, kg/t

The EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) provides default EFs and a Tier 2 methodological approach (Table 5-49).

Table 5-49: Tier 2 Default Emission Factors for Category 3D3 ‚Tobacco Combustion'

Source Categories	Gas	EF	Unit
3D3 Tobacco Combustion	NO_x CO NMVOC	3.5 122.0 4.8	g/ton of tobacco

Source: EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), Source Category 3D3 'Other', Table 3-9, page 17.

Statistical data regarding fermented tobacco, cigars and cigarettes production (Table 5-50) are available in the Statistical Yearbooks of the RM, as well as in the statistical database which can be accessed on-line on the NBS website[38].

Table 5-50: AD on Fermented Tobacco, Cigars and Cigarettes production in the RM within 1990-2010 time period

Category	1990	1991	1992	1993	1994	1995	1996
Cigars and Cigarettes, billion units	9.1	9.2	8.6	8.8	8.0	7.1	9.7
Fermented Tobacco, kt	15.9	16.1	15.0	15.4	14.0	12.4	16.9
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Cigars and Cigarettes, billion units	9.5	7.5	8.7	9.3	9.4	6.3	7.1
Fermented Tobacco, kt	16.6	21.7	24.8	20.4	19.3	12.3	8.4
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Cigars and Cigarettes, billion units	7.0	6.2	5.0	4.9	7.1	5.6	3.9
Fermented Tobacco, kt	7.6	8.2	5.2	4.3	6.3	4.9	3.4

Source: NBS of the RM, 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) and 2011 (page 304). NBS of the RM, Official Letter No. 06-39/38 dated 22.09.2011, answer to Letter No. 101/2011-09-01 dated 02.09.2011 from the Climate Change Office by the MoEN of the RM.

Use of N_2O in Anesthesia

The methodology used to estimate N_2O emissions from source category 3D3 'Other' (use of N_2O in anesthesia) is represented by the following formula:

$$E_{pollutant} = (AR_{product} \bullet EF_{technology\ pollutant}) / 10^3$$

Where:

$E_{pollutant}$ – pollutant gas emissions from N_2O use in anesthesia, t/yr;

[36] European Environment Agency: <http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>.

[37] European Environment Agency: <http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>.

[38] National Bureau of Statistics of the Republic of Moldova, 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>.

AR $_{product}$ – activity rate for N_2O consumption in anesthesia, 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 anesthesia is deemed to be emitted into the atmosphere).

Estimation of nitrous oxide emissions from use of N_2O in anesthesia was based on activity data provided by the Ministry of Health of the Republic of Moldova, as a response to the Official Letters of the Ministry of Environment (Table 5-51). In conformity with the response to the last Letter dated 1st of March 2011, since 2007 N_2O is not used in anesthesia anymore in the RM.

Table 5-51: Amount of Nitrous Oxide Used in Anesthesia in the Republic of Moldova, 1990-2006

Category	1990	1991	1992	1993	1994	1995	1996
N_2O consumption in anesthesia, kg	66	55	50	60	50	1	2
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
N_2O consumption in anesthesia, kg	3	5	43	44	44	44	44
Category	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
N_2O consumption in anesthesia, kg	50	61	59	NO	NO	NO	NO

Source: Ministry of Health of the RM, Official Letter No. 01-9/2513 dated 9.11.2007, as a response to Official Letter No. 01-07/1608 dated 15.10.2007 from the Ministry of Environment and Natural Resources of the RM, respectively, Official Letter No. 01-9/550 dated 01.03.2011, as a response to Official Letter No. 03-07/175 dated 02.02.2011 from the MoEN of the RM.

5.5.3 Uncertainties Assessment and Time-Series Consistency

Uncertainties related to the AD on other solvents use in the RM vary from low for 'ink use for printing', 'domestic solvent use', 'use of glues and other adhesives', 'vehicles dewaxing', 'tobacco combustion' and 'use of N_2O in anesthesia' (about ±5 per cent), to moderate for 'hexane use in seed oil extraction' (circa ±20 per cent), in particular due to the use of conversion coefficients, that bring additional uncertainties to the initial AD provided by the statistical publications of the RM.

Uncertainties related to EFs are considered to be low for 'use of N_2O in anesthesia' (±1 per cent), rather moderate for 'tobacco combustion' (±20 per cent), moderate for 'ink use for printing', 'use of glues and other adhesives', 'vehicles dewaxing' (±25 per cent), and average for 'domestic solvent use'(±50 per cent).

Thus, combined uncertainties related to GHG emissions from the 3D 'Other' source category can be considered low for those from the 'Use of N_2O in Anesthesia' (±5.10 per cent), rather moderate for 'tobacco combustion' (±20.61 per cent), moderate for 'ink use for printing', 'use of glues and other adhesives', 'vehicles dewaxing' (±25.50 per cent), respectively for 'seed oil extraction' (±32.02 per cent) and high for 'domestic solvent use' (±50 per cent). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at circa ±11.39 per cent for 'domestic solvent use', ±0.36 per cent for 'seed oil extraction', ±0.19 per cent for 'ink use for printing', respectively ±2.13 per cent for 'use of glues and other adhesives'. Uncertainties introduced in trend in sectoral emissions are rather low, the maximum value of ±2.63 per cent being registered for domestic solvent use (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 GPG (IPCC, 2000).

5.5.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under the 'Solvents and Other Product Use' Sector, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating GHG emissions under the category 3D 'Other' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), there were applied verifications and quality control procedures, such as: ensuring correct use of the default emission factors available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), correct use of AD obtained from different sources of reference, consistent converting in different mass units, etc.

5.5.5 Recalculation

3. D.1 'Printing'

The GHG emissions from the source category 3D1 'Printing' were recalculated for the period 1990 through 2005, in particular, due to employing a new EF (500 kg NMVOC/t ink used) within this source category, available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), in the detriment of the previously used (425 kg NMVOC/t ink for printing, respectively 54 kg NMVOC/t ink for writing or drawing), available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (1996); due to employing new values for carbon content in the solvents used in ink manufacture (81.6 per cent instead of 85.0 per cent previously used); as well as due to the use of an updated activity data set on ink import in the country, provided by the Customs Service.

In comparison with results recorded in the SNC of the RM under the UNFCCC, the changes made in the process of compiling the current inventory resulted in increased NMVOC emissions over the period 1990 through 2005, which varied from a minimum of 9.2 per cent in 1992, to a maximum of 96.7 per cent in 1995 (Table 5-52).

Table 5-52: Comparative Results of NMVOC Emissions from 3D1 'Printing' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	0.1735	0.1560	0.1214	0.0699	0.0354	0.0181	0.0248
TNC	0.2457	0.1860	0.1326	0.0846	0.0543	0.0355	0.0437
Difference, %	41.6	19.3	9.2	21.1	53.6	96.7	76.5
	1997	1998	1999	2000	2001	2002	2003
SNC	0.0266	0.0254	0.0192	0.0278	0.0440	0.0499	0.0584
TNC	0.0320	0.0396	0.0293	0.0353	0.0501	0.0642	0.0727
Difference, %	20.2	56.3	52.4	27.0	13.8	28.6	24.4
	2004	2005	2006	2007	2008	2009	2010
SNC	0.0761	0.1100					
TNC	0.0949	0.1283	0.0982	0.1141	0.1205	0.1081	0.1344
Difference, %	24.7	16.7					

As for the CO_2 emissions, in comparison with results recorded in the SNC of the RM under the UNFCCC, the changes made resulted in increased emissions, varying from a minimum of 4.8 per cent in 1992, up to a maximum of 88.8 per cent in 1995 (Table 5-53).

Table 5-53: Comparative Results of CO_2 Emissions from 3D1 'Printing' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	0.5408	0.4861	0.3785	0.2178	0.1102	0.0563	0.0772
TNC	0.7352	0.5566	0.3968	0.2532	0.1625	0.1063	0.1307
Difference, %	35.9	14.5	4.8	16.2	47.5	88.8	69.4
	1997	1998	1999	2000	2001	2002	2003
SNC	0.0829	0.0791	0.0600	0.0866	0.1372	0.1556	0.1821
TNC	0.0956	0.1186	0.0877	0.1056	0.1500	0.1920	0.2174
Difference, %	15.4	50.0	46.3	21.9	9.3	23.4	19.4
	2004	2005	2006	2007	2008	2009	2010
SNC	0.2371	0.3428					
TNC	0.2839	0.3839	0.2937	0.3413	0.3607	0.3234	0.4021
Difference, %	19.7	12.0					

For the 2006-2010 time series, the GHG emissions resulting from inks use for printing were estimated for the first time. The results allow assert that over the period 1990 through 2010, the NMVOC and CO_2 emissions resulting from 3D1 'Printing" decreased by 45.3 per cent.

3. D.2 'Domestic Solvent Use'

The GHG emissions from the source category 3D2 'Domestic Solvents Use' were recalculated for the period 1990 through 2005, in particular, due to employing a new EF (1.0 kg NMVOC/per capita) within this source category, available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), in the detriment of the previously used (1.8 kg NMVOC/per capita, for the Western European countries), available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (1996); also due to employing new values for the carbon content in the solvents used in domestic products manufacture (81.6 per cent instead of 85.0 per cent previously used); as well as due to the use of an updated activity data set on country's population (including the territory on the left bank of Dniester River).

In comparison with results recorded in the SNC of the RM under the UNFCCC, the changes made in the process of compiling the current inventory resulted in decreased NMVOC emissions, by 44.4 per cent, over the period 1990 through 2005 (Table 5-54).

Table 5-54: Comparative Results of NMVOC Emissions from 3D1 'Domestic Solvents Use' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	7.8509	7.8593	7.8464	7.8260	7.8349	7.8262	7.8019
TNC	4.3616	4.3663	4.3591	4.3478	4.3527	4.3479	4.3344
Difference %	-44.4	-44.4	-44.4	-44.4	-44.4	-44.4	-44.4
	1997	1998	1999	2000	2001	2002	2003
SNC	7.7760	7.7485	7.7274	7.7067	7.6757	7.6459	7.6347
TNC	4.3200	4.3047	4.2930	4.2815	4.2776	4.2614	4.2421
Difference %	-44.4	-44.4	-44.4	-44.4	-44.3	-44.3	-44.4
	2004	2005	2006	2007	2008	2009	2010
SNC	7.0879	7.4651					
TNC	4.1618	4.1479	4.1305	4.1146	4.1002	4.0900	4.0817
Difference %	-41.3	-44.4					

As for the CO_2 emissions, in comparison with results recorded in the SNC of the RM under the UNFCCC, the changes made resulted in a decrease by 46.7 per cent over the period 1990 through 2005 (Table 5-55).

Table 5-55: Comparative Results of CO_2 Emissions from 3D2 'Domestic Solvents Use' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	24.4686	24.4949	24.4546	24.3912	24.4186	24.3917	24.3160
TNC	13.0499	13.0640	13.0424	13.0086	13.0233	13.0089	12.9685
Difference %	-46.7	-46.7	-46.7	-46.7	-46.7	-46.7	-46.7
	1997	1998	1999	2000	2001	2002	2003
SNC	24.2352	24.1494	24.0837	24.0192	23.9227	23.8296	23.7948
TNC	12.9254	12.8797	12.8447	12.8102	12.7986	12.7501	12.6924
Difference %	-46.7	-46.7	-46.7	-46.7	-46.5	-46.5	-46.7
	2004	2005	2006	2007	2008	2009	2010
SNC	22.0905	23.2664					
TNC	12.4521	12.4105	12.3585	12.3109	12.2678	12.2373	12.2124
Difference %	-43.6	-46.7					

For the 2006-2010 time series, the GHG emissions resulting from 'domestic solvents use' were estimated for the first time. The results allow assert that over the period 1990 through 2010, the NMVOC and CO_2 emissions resulting from this category decreased by 6.4 per cent.

3. D.3 'Other Product Use'

'Seed Oil Extraction'

GHG emissions from the source category 3D3 'Seed Oil Extraction' were recalculated for the period 1990 through 2005, in particular due to employing a new EF (3.0 kg NMVOC/t of seeds) within this source category, available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), in the detriment of the previously used (6.0 kg NMVOC/t treated seeds, respectively 1.31 kg NMVOC/t dry seeds), available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (1996); due to employing new values for the carbon content in the solvents used in seed oil extraction (81.6 per cent instead of 85.0 per cent previously used); as well as due to the use of an updated activity data set on total oil produced in the country, respectively on the share of refined vegetable oil.

In comparison with results recorded in the SNC of the RM under the UNFCCC, the changes made in the process of compiling the current inventory resulted in decreased NMVOC emissions over the period 1990 through 2005, varying from a minimum of 49.8 per cent in 1990, to a maximum of 59.0 per cent between 1997 and 2005 (Table 5-56).

Table 5-56: Comparative Results of NMVOC Emissions from 3D3 'Seed Oil Extraction' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	0.6335	0.5937	0.1925	0.1978	0.2590	0.1587	0.1182
TNC	0.3182	0.2948	0.0943	0.0956	0.1235	0.0746	0.0548
Difference %	-49.8	-50.4	-51.0	-51.7	-52.3	-53.0	-53.7
	1997	1998	1999	2000	2001	2002	2003
SNC	0.1070	0.0860	0.0631	0.0708	0.1465	0.2127	0.3992
TNC	0.0439	0.0353	0.0259	0.0291	0.0601	0.0873	0.1638
Difference %	-59.0	-59.0	-59.0	-59.0	-59.0	-59.0	-59.0
	2004	2005	2006	2007	2008	2009	2010
SNC	0.5904	0.6029					
TNC	0.2423	0.2474	0.2436	0.2569	0.2429	0.2564	0.2027
Difference %	-59.0	-59.0					

As for the CO_2 emissions, the changes made resulted in a significant decrease, varying from a minimum of 51.8 per cent in 1990, to a maximum of 60.6 per cent between 1997 and 2005 (Table 5-57).

Table 5-57: Comparative Results of CO_2 Emissions from 3D3 'Seed Oil Extraction' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	1.9745	1.8504	0.5998	0.6164	0.8073	0.4946	0.3684
TNC	0.9520	0.8819	0.2821	0.2859	0.3694	0.2232	0.1639
Difference %	-51.8	-52.3	-53.0	-53.6	-54.2	-54.9	-55.5
	1997	1998	1999	2000	2001	2002	2003
SNC	0.3335	0.2681	0.1967	0.2207	0.4565	0.6629	1.2441
TNC	0.1314	0.1056	0.0775	0.0869	0.1798	0.2612	0.4902
Difference %	-60.6	-60.6	-60.6	-60.6	-60.6	-60.6	-60.6
	2004	2005	2006	2007	2008	2009	2010
SNC	1.8399	1.8791					
TNC	0.7249	0.7403	0.7289	0.7687	0.7267	0.7671	0.6066
Difference %	-60.6	-60.6					

For the 2006-2010 time series, the GHG emissions resulting from solvents use for seed oil extraction were estimated for the first time. The results allow assert that over the period 1990 through 2010, the NMVOC and CO_2 emissions resulting from this category decreased by 36.3 per cent.

'Use of Glues and Other Adhesives'

GHG emissions from the source category 3D3 'Use of Glues and Other Adhesives' were recalculated for the period 1990 through 2005, in particular due to employing a new EF (780 kg NMVOC/t of product) within this source category, available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), in the detriment of the previously used (600 kg NMVOC/t of product); due to employing new values for the carbon content in those solvents used in glues and other adhesives manufacture (57 per cent instead of 85.0 per cent previously used); as well as due to the use of an updated activity data set on glues and other adhesives import in the country, provided by the Customs Service of the RM.

In comparison with results recorded in the SNC of the RM under the UNFCCC, the changes made in the process of compiling the current inventory resulted in increased NMVOC emissions over the period 1990 through 2005 (Table 5-58), varying from a minimum of 4.0 per cent in 1998, to a maximum of 124.5 per cent in 2003.

Table 5-58: Comparative Results of NMVOC Emissions from 3D3 'Use of Glues and Other Adhesives' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	1.8900	1.7100	0.9900	0.6900	0.4500	0.2998	0.2023
TNC	2.5356	1.9505	1.3932	0.9288	0.6192	0.3870	0.2592
Difference %	3.2	14.1	40.7	34.6	37.6	29.1	28.2
	1997	1998	1999	2000	2001	2002	2003
SNC	0.4222	0.8136	0.4804	0.4967	0.5686	0.7387	0.4821
TNC	0.4814	0.8465	0.5888	0.5666	0.6741	0.9529	1.0822
Difference %	14.0	4.0	22.6	14.1	18.6	29.0	124.5
	2004	2005	2006	2007	2008	2009	2010
SNC	1.0915	1.2772					
TNC	1.3667	1.5177	1.5350	1.5295	1.5376	1.1187	1.4043
Difference %	25.2	18.8					

As for the CO_2 emissions, the changes made resulted in a significant decrease, varying from a minimum of 5.6 per cent in 1992, to a maximum of 30.2 per cent in 1998, except for 2003, when it was recorded an increase of CO_2 emissions by 50.5 per cent (Table 5-59).

Table 5-59: Comparative Results of CO_2 Emissions from 3D3 'Use of Glues and Other Adhesives' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	5.8905	5.3295	3.0855	2.1505	1.4025	0.9343	0.6304
TNC	5.2995	4.0765	2.9118	1.9412	1.2941	0.8088	0.5418
Difference %	-10.0	-23.5	-5.6	-9.7	-7.7	-13.4	-14.1
	1997	1998	1999	2000	2001	2002	2003
SNC	1.3157	2.5357	1.4971	1.5481	1.7721	2.3023	1.5027
TNC	1.0061	1.7691	1.2306	1.1842	1.4090	1.9917	2.2617
Difference %	-23.5	-30.2	-17.8	-23.5	-20.5	-13.5	50.5

	2004	2005	2006	2007	2008	2009	2010
SNC	3.4019	3.9807					
TNC	2.8565	3.1719	3.2081	3.1967	3.2136	2.3380	2.9350
Difference %	-16.0	-20.3					

For the 2006-2010 time series, the GHG emissions resulting from use of glues and other adhesives were estimated for the first time. The results allow assert that over the period 1990 through 2010, the NMVOC and CO_2 emissions resulting from this category decreased by 44.6 per cent.

'Vehicles Dewaxing'

GHG emissions from the 3D3 'Vehicles Dewaxing' were not recalculated as under the SNC of the RM under the UNFCCC, the respective emissions were not estimated. Within the current inventory cycle, the results allow assert that between 1990 and 2010, GHG emissions from 'vehicles dewaxing' decreased by 60 per cent (Table 5-60).

Table 5-60: GHG Emissions from 3D3 'Vehicles Dewaxing' within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
NMVOC, Gg	0.0198	0.0152	0.0095	0.0059	0.0035	0.0023	0.0023
CO_2, Gg	0.0592	0.0455	0.0285	0.0178	0.0105	0.0070	0.0070
	1997	1998	1999	2000	2001	2002	2003
NMVOC, Gg	0.0019	0.0019	0.0033	0.0012	0.0018	0.0035	0.0084
CO_2, Gg	0.0058	0.0058	0.0098	0.0035	0.0055	0.0105	0.0252
	2004	2005	2006	2007	2008	2009	2010
NMVOC, Gg	0.0078	0.0100	0.0075	0.0105	0.0144	0.0078	0.0079
CO_2, Gg	0.0232	0.0300	0.0224	0.0315	0.0430	0.0234	0.0237

'Tobacco Combustion'

GHG emissions from the 3D3 'Tobacco Combustion' were not recalculated, as under the SNC of the RM under the UNFCCC, the respective emissions were not estimated. Within the current inventory cycle, the results allow assert that between 1990 and 2010, GHG emissions from 'tobacco combustion' decreased by 75.7 per cent (Table 5-61).

'Use of N_2O in Anesthesia'

Within the current inventory cycle, no recalculations were performed for the N_2O emissions from the 3D5 'Use of N_2O in Anesthesia'.

The results allow assert that over the period 1990 through 2006, the respective emissions decreased by 10.6 per cent (Table 5-62), in particular, due to smaller quantity of N_2O used in health care facilities in the Republic of Moldova.

According to the information provided by the Ministry of Health of the RM, since 2007 N_2O is not used any more in anesthesia ("NO" – not occurring)

5.5.6 Planned Improvements

In the next inventory cycle there are planned activities focused on updating activity data used to estimate GHG emissions from category 3D 'Other' (other solvents use).

Table 5-61: GHG Emissions from 3D3 'Tobacco Combustion' within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
NMVOC, Gg	0.00008	0.00008	0.00007	0.00007	0.00007	0.00006	0.00008
NO_x, Gg	0.00006	0.00006	0.00005	0.00005	0.00005	0.00004	0.00006
CO, Gg	0.00194	0.00196	0.00183	0.00188	0.00171	0.00151	0.00207
CO_2, Gg	0.00023	0.00023	0.00022	0.00022	0.00020	0.00018	0.00024
	1997	1998	1999	2000	2001	2002	2003
NMVOC, Gg	0.00008	0.00010	0.00012	0.00010	0.00009	0.00006	0.00004
NO_x, Gg	0.00006	0.00008	0.00009	0.00007	0.00007	0.00004	0.00003
CO, Gg	0.00203	0.00265	0.00303	0.00249	0.00235	0.00150	0.00102
CO_2, Gg	0.00024	0.00031	0.00036	0.00029	0.00028	0.00018	0.00012
	2004	2005	2006	2007	2008	2009	2010
NMVOC, Gg	0.00004	0.00004	0.00002	0.00002	0.00003	0.00002	0.00002
NO_x, Gg	0.00003	0.00003	0.00002	0.00002	0.00002	0.00002	0.00001
CO, Gg	0.00092	0.00100	0.00063	0.00053	0.00076	0.00060	0.00042
CO_2, Gg	0.00011	0.00012	0.00007	0.00006	0.00009	0.00007	0.00005

Table 5-62: N_2O Emissions from 'Use of N_2O in Anesthesia' within 1990-2006 time periods

	1990	1991	1992	1993	1994	1995	1996
N_2O, Gg	0.000066	0.000055	0.00005	0.00006	0.00005	0.000001	0.000002
	1997	1998	1999	2000	2001	2002	2003
N_2O, Gg	0.000003	0.000005	0.000043	0.000044	0.000044	0.000044	0.000044
	2004	2005	2006	2007	2008	2009	2010
N_2O, Gg	0.00005	0.000061	0.000059	NO	NO	NO	NO

6. AGRICULTURE SECTOR

Agriculture sector plays a significant role in the national economy of the RM, contributing with 10 per cent to its GDP formation (NBS, 2012). Under the agriculture sector the plant production account for a relatively big share – 56.0 per cent, animal breeding – for 41.5 per cent, while the services – for circa 2.5 per cent (NBS, 2012). More than 27.5 per cent of active population is employed in agriculture sector (NBS, 2012). The overwhelming majority of agricultural workers represent small and medium agricultural production enterprises.

According to Land Cadaster of the RM, as of January 1, 2012 the total area of the country was 3384.6 thousand ha, including 2497.9 thousand ha (73.8 per cent) – agricultural lands; of which 1810.5 thousand ha (53.5 per cent) – arable lands; 298.7 thousand ha (8.8 per cent) – perennial plantations; 352.3 thousand ha (10.4 per cent) – hayfields and pastures; 36.5 thousand ha (1.1 per cent) – fallow lands; 462.7 thousand ha (13.7 per cent) – forests and lands covered with forest vegetation; 99.5 thousand ha (2.9 per cent) – rivers, lakes, water basins and bogs, and 324.4 thousand ha (9.6 per cent) – other lands.

Of the total agricultural lands of the country of 2497.9 thousand ha, in the management of agricultural land owners were 2008.9 thousand ha (59.3 per cent of the total area of the country, or 80.4 per cent of agricultural land), including 1651.1 thousand ha (66.2 per cent) arable land, 244.3 thousand ha (9.8 per cent) - perennial plantations, of which 120.2 thousand ha orchard and 113.6 thousand ha vineyards, 33.1 thousand ha (1.3 per cent) - hayfields and pastures from appropriate use categories lands.

The following agribusiness entities were active in the agriculture sector of the Republic of Moldova: 140 production cooperatives with a total area of 117.6 thousand ha (6.3 per cent); 146 joint stock companies with a total area of 39.9 thousand ha (2.0 per cent); 37.6 thousand limited liability companies with an area of de 688.9 thousand ha (34.0 per cent); 384.5 thousand peasant farms with an area of 547.2 thousand ha (27.6 per cent); lands in the vicinity of houses and gardens – 316.7 thousand ha (14.2 per cent); orchard and vegetable joint farms – 6 thousand ha (0.3 per cent); reserve fund and other lands – 292.6 thousand ha (15.6 per cent from agricultural lands). The surface of 'large' and 'medium' agricultural holdings represents 846.4 thousand ha (42.3 per cent).

6.1 Overview

The principal sources covered by 'Agriculture' Sector in the Republic of Moldova include methane emissions from animal breeding, in particular from 4A 'Enteric Fermentation' category, 4B 'Manure Management' category, and nitrous oxide emissions from 4B 'Manure Management', as well as 4D 'Agricultural Soils' category.

As in the Republic of Moldova it is not cultivated rice and there are no savannas, no greenhouse gas emissions covered by the categories 4C 'Rice Cultivation' and 4E 'Prescribed Burning of Savannas' were reported. GHG emissions covered by the source category 4F 'Field Burning of Agricultural Residues' were reported under 'Land Use, Land-Use Change and Forestry' Sector (i.e., under the 5B 'Cropland' category), following the recommendations set forth in the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003).

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.

6.1.1 Summary of Emission Trends

In 2010, 'Agriculture' Sector accounted for circa 16.1 per cent of total national direct greenhouse gas emissions (without LULUCF), being the second major source of GHG emissions after the 'Energy' Sector. To be noted that 'Agriculture' Sector was a major source of CH_4 and N_2O emissions, accounting for circa 24.5 per cent and respectively 91.9 per cent of total emissions reported at national level.

Between 1990 and 2010, the total GHG emissions originated from the 'Agriculture' Sector tended to lower values, decreasing from 5120.2 Gg in 1990 to 2132.4 Gg in 2010 (Table 6-1),

Table 6-1: Direct GHG Emissions from 'Agriculture' Sector in the Republic of Moldova within1990-2010 time periods, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996
CH_4	2089.2837	1933.9378	1886.5541	1743.1455	1704.2896	1492.4042	1373.6603
N_2O	3030.9232	3068.8355	2267.5961	2260.1846	1705.6264	1866.6654	1698.1370
Total	5120.2069	5002.7733	4154.1501	4003.3302	3409.9160	3359.0696	3071.7973
	1997	1998	1999	2000	2001	2002	2003
CH_4	1180.1335	1147.7802	1059.1586	983.2520	1001.6131	1019.7528	934.7036
N_2O	1807.2004	1584.0096	1429.2982	1293.7971	1452.5112	1504.8923	1262.1769
Total	2987.3339	2731.7897	2488.4568	2277.0491	2454.1243	2524.6451	2196.8805
	2004	2005	2006	2007	2008	2009	2010
CH_4	866.9360	843.3977	818.9564	657.3348	627.8618	656.6945	655.7653
N_2O	1534.2232	1529.9771	1449.2155	857.7512	1499.1182	1268.1567	1476.6572
Total	2401.1592	2373.3748	2268.1718	1515.0860	2126.9800	1924.8512	2132.4225

in particular, due to decreasing values of such indicators as: number of domestic livestock and poultry, amount of synthetic and organic nitrogen fertilizers applied to soils, quantities of agricultural crop residues returned to soil and carbon losses from land use change and soil management practices.

In 1990, CH_4 and N_2O emissions accounted for 40.8 per cent and respectively 59.2 per cent of total GHG emissions originated from the 'Agriculture' Sector. By 2010, the share of CH_4 emissions decreased to 30.8 per cent, while that of N_2O emissions, on the contrary, increased up to 69.2 per cent.

Over the 1990-2010 time periods, total GHG emissions from the 'Agriculture' Sector decreased by 58.4 per cent (Figure 6-1), while CH_4 and N_2O emissions decreased respectively, by 68.6 per cent and 51.3 per cent (Table 6-2).

Table 6-3 allow to assert that 4A 'Enteric Fermentation' source category was the largest source of CH_4 emissions in the time periods from 1990 through 2010 (with a share varying between 87.8 and 92.8 per cent of the total), while 4D 'Agricultural Soils' source category, was the most relevant source of N_2O emissions (with a share varying between 48.2 and 71.5 per cent of the total).

Table 6-2: Total Methane and Nitrous Oxide Emissions from 'Agriculture' Sector by Category, within 1990-2010 time periods

Year	CH_4 Emissions, Gg		Total	N_2O Emissions, Gg		Total
	4A	4B		4B	4D	
1990	87.3513	12.1384	99.4897	4.4577	5.3195	9.7772
1991	81.2128	10.8795	92.0923	4.0464	5.8531	9.8995
1992	79.7688	10.0671	89.8359	3.5097	3.8051	7.3148
1993	74.9883	8.0186	83.0069	2.9555	4.3354	7.2909
1994	73.2244	7.9323	81.1566	2.8481	2.6539	5.5020
1995	64.8018	6.2651	71.0669	2.7252	3.2963	6.0215
1996	59.6262	5.7862	65.4124	2.6551	2.8228	5.4779
1997	51.2098	4.9870	56.1968	2.2291	3.6005	5.8297
1998	49.8919	4.7643	54.6562	2.0630	3.0467	5.1097
1999	46.1429	4.2933	50.4361	1.8491	2.7615	4.6106
2000	43.3896	3.4319	46.8215	1.6077	2.5658	4.1735
2001	44.1737	3.5221	47.6959	1.6352	3.0503	4.6855
2002	45.0836	3.4761	48.5597	1.6711	3.1834	4.8545
2003	41.3224	3.1873	44.5097	1.5941	2.4774	4.0715
2004	38.3224	2.9603	41.2827	1.5650	3.3841	4.9491
2005	37.0653	3.0965	40.1618	1.7119	3.2235	4.9354
2006	35.8562	3.1418	38.9979	1.7803	2.8946	4.6749
2007	28.9918	2.3099	31.3017	1.3464	1.4205	2.7669
2008	27.6051	2.2931	29.8982	1.3758	3.4601	4.8359
2009	28.7010	2.5702	31.2712	1.5374	2.5534	4.0908
2010	28.4934	2.7336	31.2269	1.6095	3.1539	4.7634
1990-2010, %	-67.4	-77.5	-68.6	-63.9	-40.7	-51.3

Table 6-3: Breakdown of the Republic of Moldova's 'Agriculture' Sector Methane and Nitrous Oxide Emissions by Category within 1990-2010 time periods

Year	CH_4, % of the total		N_2O, % of the total	
	4A	4B	4B	4D
1990	87.8	12.2	45.6	54.4
1991	88.2	11.8	40.9	59.1
1992	88.8	11.2	48.0	52.0
1993	90.3	9.7	40.5	59.5
1994	90.2	9.8	51.8	48.2
1995	91.2	8.8	45.3	54.7
1996	91.2	8.8	48.5	51.5
1997	91.1	8.9	38.2	61.8
1998	91.3	8.7	40.4	59.6
1999	91.5	8.5	40.1	59.9
2000	92.7	7.3	38.5	61.5
2001	92.6	7.4	34.9	65.1
2002	92.8	7.2	34.4	65.6
2003	92.8	7.2	39.2	60.8
2004	92.8	7.2	31.6	68.4
2005	92.3	7.7	34.7	65.3
2006	91.9	8.1	38.1	61.9
2007	92.6	7.4	48.7	51.3
2008	92.3	7.7	28.5	71.5
2009	91.8	8.2	37.6	62.4
2010	91.2	8.8	33.8	66.2
1990-2010, %	3.9	-28.3	-25.9	21.7

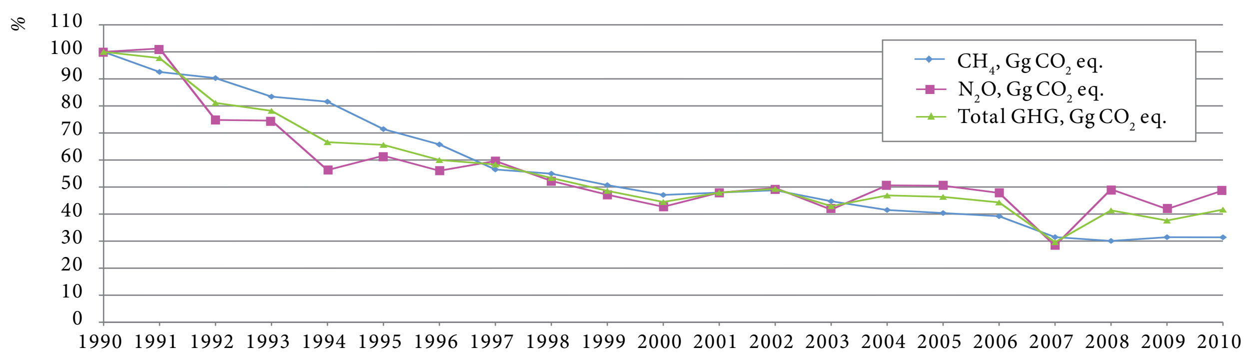


Figure 6-1: Trends in Direct GHG Emissions from 'Agriculture' Sector of the RM within 1990-2010 time periods (where 1990 represent 100 per cent)

6.1.2 Key Categories

The results of key source assessment (including LULUCF) carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the **Annex 1**. Table 6-4 provides information on identified key categories under the 'Agriculture' Sector of the RM (Table 6-4).

Table 6-4: Key Categories Identified under the Agriculture Sector of the RM

IPCC Category	GHG	Source Category	Key Source
4A	CH_4	CH_4 emissions from enteric fermentation	Yes (L, T)
4B	CH_4	CH_4 emissions from manure management	No
4B	N_2O	Direct N_2O emissions from manure management	Yes (L, T)
4B	N_2O	Indirect N_2O emissions from manure management	No
4D	N_2O	Direct N_2O emissions from agricultural soils	Yes (L, T)
4D	N_2O	Indirect N_2O emissions from agricultural soils	Yes (L, T)

Abbreviations: L – Level Assessment; T – Trend Assessment.

6.1.3 Methodological Issues

Emissions covered by source categories 4A 'Enteric Fermentation', 4B 'Manure Management' and 4D 'Agriculture Soils' were estimated using both, the Tier 1 methodological approach and default EFs values (IPCC, 2006), as well as the Tier 2 methodological approach (IPCC, 2006) and country specific emission factors, in particular for the key sources.

A summary description of methods used to estimate emissions by source categories is provided in Table 6-5, while a more detailed description is available in sub-chapters 6.2-6.4 of the NIR.

Table 6-5: Summary of Methods and EFs Used to Estimate GHG Emissions from the 'Agriculture' Sector of the Republic of Moldova

IPCC Category	Source Category	CH_4		N_2O	
		Method	EF	Method	EF
4A	Enteric Fermentation	T2, T1	CS, D		
4B	Manure management	T2, T1	CS, D	T2, T1	CS, D
4D	Agricultural soils			T3, T1	CS, D

Abbreviations: T1 – Tier 1 Method; T2 – Tier 2 Method; T3 – Tier 3 Method; CS – Country Specific; D – Default; EF – Emission Factors.

6.1.4 Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the 'Agriculture' Sector (by source categories) is described in detail in sub-chapters 6.2-6.4 of the NIR, as well as in the **Annex 5-3.4**. Combined uncertainties as a percentage of total direct sectoral emissions were estimated at ±18.3 per cent. The uncertainties introduced in trend in sectoral emissions were estimated at ±5.3 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 GPG (IPCC, 2000).

6.1.5 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for 'Agriculture' Sector, following a Tier 1 methodological approach (IPCC, 2000).

The AD and methods used to estimate GHG emissions under this sector were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), GHG emissions were estimated using AD and national factors and parameters from official sources of reference.

6.1.6 Recalculations

GHG emission recalculations performed under the 'Agriculture' Sector are due to the availability of an updated set of activity data (the Statistical Yearbooks of the RM and those of the ATULBD, other relevant publications in this field) changes and/or updates of estimation methodologies and EFs.

In comparison with the results included into the SNC of the RM under the UNFCCC, the performed recalculations resulted in decreased values of direct GHG emissions between 1990-1992, 1994-1995, in 2000 and 2003, varying from a minimum of 0.6 per cent in 1991, up to a maximum of 10.0 per cent in 1992, respectively, in increased values in 1993, as well as between 1996-1999, 2001-2002 and 2004-2005, varying from a minimum of 0.8 per cent to a maximum of 11.5 per cent in 2005 (Table 6-6).

Table 6-6: Recalculated GHG Emissions under the 'Agriculture' Sector for 1990-2005, included in the SNC of the RM under the UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	5323.9	5035.3	4615.1	3839.8	3599.8	3386.2	3046.5	2839.2
TNC	5120.2	5002.8	4154.2	4003.3	3409.9	3359.1	3071.8	2987.3
Difference, %	-3.8	-0.6	-10.0	4.3	-5.3	-0.8	0.8	5.2
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	2518.3	2438.0	2312.2	2217.4	2313.9	2254.8	2210.7	2127.8
TNC	2731.8	2488.5	2277.0	2454.1	2524.6	2196.9	2401.2	2373.4
Difference, %	8.5	2.1	-1.5	10.7	9.1	-2.6	8.6	11.5

Abbreviations: SNC – Second National Communication; TNC – Third National Communication.

The results of recalculations performed at the category level are presented in sub-chapters 6.2-6.4 of the NIR.

6.1.7 Assessment of Completeness

The current inventory covers greenhouse gas emissions from 3 source categories: 4A 'Enteric Fermentation', 4B 'Manure Management' and 4D 'Agricultural Soils' (Table 6-7). As in the RM there are no savannas and rice is not cultivated, respectively no GHG emissions have been registered from the 4C 'Rice Cultivation' and 4E 'Prescribed Burning of Savannas' source categories. GHG emissions from the 4F 'Field Burning of Agricultural Residues' source category were reported under LULUCF Sector, specifically under the 5B 'Cropland' source category. CH_4 emissions from 4D 'Agricultural Soils' source category were not estimated due to lack of estimation methodology.

6.1.8 Planned Improvements

Planned improvements at the source categories level within the Agriculture Sector are described in detail in respective sub-chapters (6.2-6.4) of this report.

Table 6-7: Assessment of Completeness of GHG Emissions under the 'Agriculture' Sector

IPCC Category	Source Category	CH_4	N_2O
4A	Enteric Fermentation	X	NO
4B	Manure Management	X	X
4C	Rice Cultivation	NO	NO
4D	Agricultural Soils	NE	X
4E	Prescribed Burning of Savannas	NO	NO
4F	Field Burning of Agricultural Residues	IE	IE

Abbreviations: X – source categories included in the inventory; NO – Not Occurring; NE – Not Estimated; IE – Included Elsewhere.

6.2 Enteric Fermentation (Category 4A)

6.2.1 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 (Figure 6-2), 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% CH_4 and 60-70% CO_2[39].

About 5 per cent of ingested feed gross energy is lost through gaseous emissions (Figure 6-3). Thus the problem of reducing the gas emissions within the feed fermentation process is important not only in terms of environmental protection, but also from economic point of view.

To be noted that ruminant livestock (cattle, sheep and goats) are major sources of methane emissions, with moderate amounts produced from non-ruminant livestock (pigs, horses and asses and mules). However, ruminant livestock account for a larger share of total CH_4 emissions resulting from 4A 'Enteric fermentation' source category. The amount of methane that is released depends on a number of factors, such as species, age, weight of the animal, the quality and quantity of the feed intake, etc.

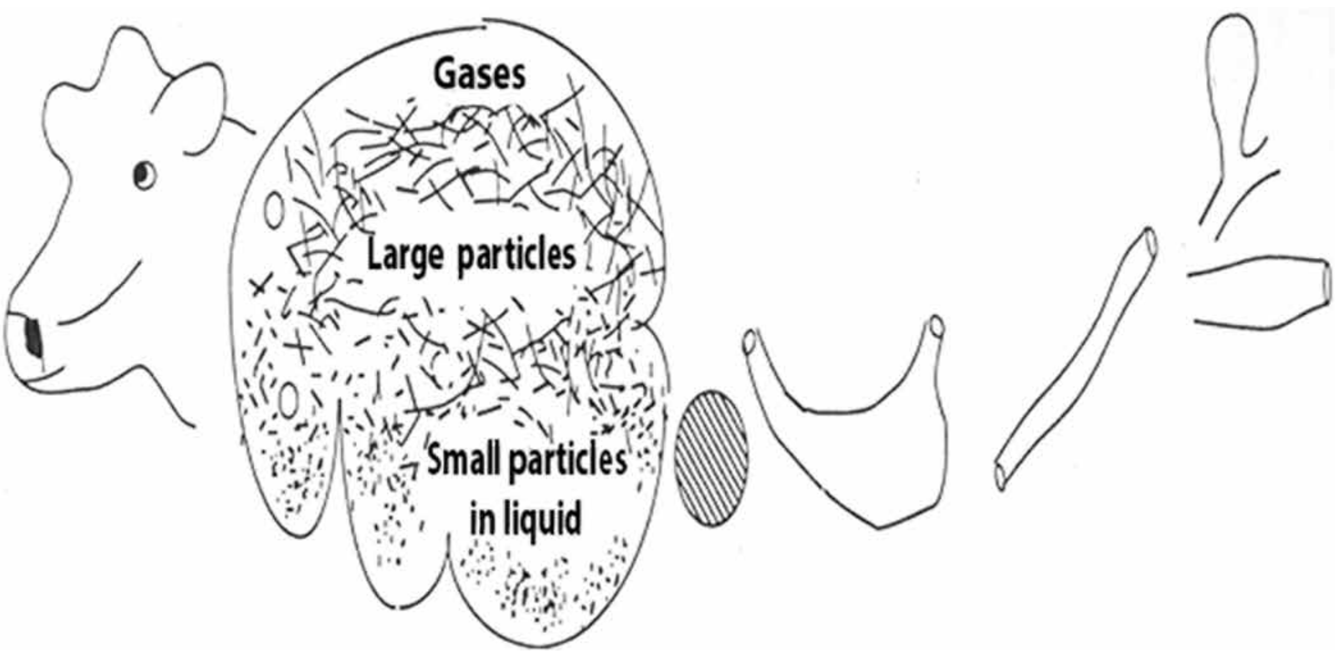
6.2.2 Activity Data, Methodological Issues and Emission Factors

Estimation of methane emissions covered by the 4A 'Enteric Fermentation' source category involved three basic steps:

(1) Divide the livestock population into subgroups and characterize each subgroup (see basic information on the livestock and poultry groups within the Republic of Moldova in the **Annex 3-3**);

(2) Estimate emission factors for each subgroup, as well as the average situation for the entire population, by age, in kilograms of CH_4/animal/year;

[39] „Technical Guideline for Milk Production", Babcock International Institute for Dairy Research and Development, USA, 1996 (<www.animals-feed.info>)



Oral cavity	Reticulorumen	Omasum	Abomasum	Small intestine	Large intestine
From 24 up to 48 hours		From 1 up to 3 hours		From 10 up to 20 hours	
1. Chewing reduces the forage particles size. 2. Saliva production up to 180 l/per day, the rate of saliva secretion will decrease sharply if the cow gets less cellulose. 3. Saliva is a good buffer (pH 8.2) to neutralize gastric acids in the stomach creating optimal conditions for development of the microflora.	1. The forage large particles return in the oral cavity for additional rumination. 2. Bacteria decompose forage proteins and carbohydrates. 3. Production of volatile fatty acids (VFA) as the final product of bacterial fermentation. 4. Synthesis of bacterial mass, rich in protein. 5. VFA absorption – the main energy source for ruminants. 6. Up to 1000 l gases (CO_2 and CH_4) produces per day.	1. Water and VFA absorption. 2. Large particles are stopped by omasum.	1.Hydrocloric Acid (HCl) and enzymes are eliminated 2. Digestion of those carbohydrates and proteins that have avoided the reticulorumen fermentation 3. Digestion of microbial protein mass from the rumen (1 to 2.5 kg).	1. Enzyme secretion. 2. Receiving pancreas and liver secretion. 3. Fermentative decomposition of: proteins, carbohydrates and lipids. 4. Absorption of: water, minerals, amino acids, glucose and fatty acids.	1. Bacterial fermentation of unabsorbed nutrients continues. 2. Water absorption and stool formation processes continue.

Figure 6-2: Organs, processes and timing for forage digestion by ruminant livestock

(3) Multiply the subgroup emission factors by the subgroup populations to estimate subgroup emissions, and sum across the subgroups to estimate total CH_4 emissions from the 4A 'Enteric Fermentation' category.

It was possible to carry out these steps for different levels of details and complexity, following two methodological approaches: Tier 1 and Tier 2 (IPCC, 2006). While following the Tier 1 methodology, CH_4 emissions from the source category 4A 'Enteric Fermentation' were estimated on the basis of equations 10.19 and 10.20 from 2006 IPCC Guidelines:

$$Total\ CH_{4\ enteric} = \Sigma_i E_i\ [EF_{(T)} \bullet (N_{(T)}/10^6)]$$

Where:

Total $CH_{4\ enteric}$ – total CH_4 emissions from Enteric Fermentation, Gg CH_4/yr;

E_i – is the emissions for the i livestock categories and subcategories;

$EF_{(T)}$ – emission factor for the defined livestock population, kg CH_4/head/yr;

$N_{(T)}$ – the number of head of livestock species/category T in the country;

T – species/category of livestock.

The Tier 1 methodology is a simplified approach based on use of default EFs (Table 6-8) multiplied by national AD on the animal population data (Table 6-9).

Table 6-8: Default EFs for Western Europe (WE) and Eastern Europe (EE) used to estimate CH_4 emissions from 4A 'Enteric Fermentation' Source Category

Categories	EF, kg CH_4/head/year		Comments
	WE	EE	
Dairy cows	109	89	Average Milk Production: WE – 6000 kg/head/year, EE – 2550 kg/head/year
Other cattle	57	58	Beef cows, including young cattle
Sheep	8	5	Average live weight: WE - 65 kg, EE - 45 kg
Goats	5	5	Average live weight – 40 kg
Horses	18	18	Average live weight – 550 kg
Asses and mules	10	10	Average live weight – 245 kg
Swine	1.5	1	Average live weight – 50 kg, breeding –180 kg

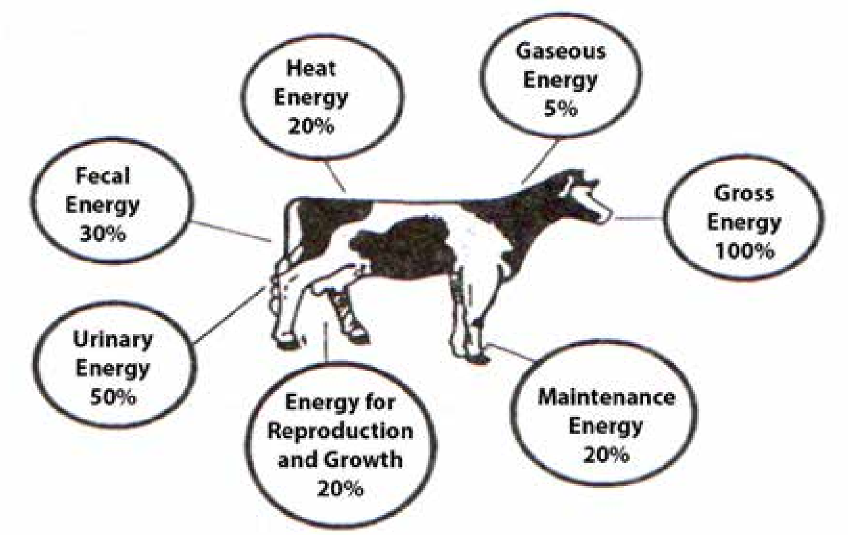


Figure 6-3: Intake Energy for Dairy Cows[40]

[40] Parvu Gh., Costea Mihaela, Parvu M., Nicolae B. '*Treaty on Animal Nutrition*' Bucuresti, 2003, page 368.

Table 6-9: Animal Population Data in the RM within 1990-2010 time periods, thousand heads

	1990	1991	1992	1993	1994	1995	1996
Cattle	1060.7	1000.5	970.1	882.6	832.0	729.5	646.3
...Dairy Cows	395.2	397.1	403.2	401.8	402.6	380.8	355.4
…Other Cattle	665.5	603.4	566.9	480.7	429.4	348.7	290.9
…Young Cattle	664.1	601.4	564.1	473.6	421.2	341.3	282.4
… Calves and Heifers up to 1 year	414.8	351.3	302.2	196.7	160.5	111.2	64.9
…Heifers between 12 and 18 months	115.0	119.7	118.8	122.7	115.8	93.4	90.6
…Heifers between 18 and 24 months	58.2	61.8	70.2	83.3	69.7	64.6	58.5
…Heifers between 24 months and more	76.0	68.6	73.0	70.9	75.1	72.2	68.4
…Breeding Males	1.2	1.7	2.1	5.4	5.9	5.0	5.7
…Work Bullocks	0.2	0.3	0.7	1.8	2.4	2.4	2.8
Swine	1850.1	1753.0	1487.4	1082.3	1046.8	1014.6	950.1
…Female sows	155.3	159.9	147.4	132.8	130.6	122.9	121.2
…Swine over 4 months	137.0	151.8	139.3	124.1	129.8	129.3	122.3
…Other Swine	1557.7	1441.3	1200.7	825.4	786.4	762.3	706.5
Sheep and Goats	1281.9	1288.8	1357.2	1437.0	1501.9	1423.0	1372.4
Sheep	1244.8	1239.3	1294.3	1362.5	1410.4	1328.2	1273.7
…Mature Ewes and Ewe Lambs ≥ 1 year	986.0	1029.1	1067.1	1091.0	1045.0	1080.7	1047.1
…Breeding Rams	37.3	37.2	38.8	40.9	42.3	39.8	38.2
…Growing lambs up to 1 year	221.5	173.0	188.3	230.7	323.0	207.6	188.4
Goats	37.1	49.5	62.9	74.7	91.5	94.7	98.7
…Mature females ≥ 1 year	29.7	39.6	51.4	57.1	71.5	71.4	72.1
…Breeding males	1.1	1.5	1.9	2.2	2.7	2.8	3.0
…Growing kids up to 1 year	6.3	8.4	9.6	15.4	17.3	20.5	23.6
Horses	47.2	48.4	51.4	54.5	58.2	61.6	63.3
…Draft horses	35.2	36.1	38.3	40.6	43.3	45.9	47.2
…Female horses ≥ 3 years	15.6	16.3	17.5	19.4	21.4	23.3	24.5
…Other Horses	12.0	12.4	13.1	13.9	14.8	15.7	16.2
Poultry	24625.0	23715.0	17128.0	12809.2	13448.3	13744.9	12364.9
…Chickens and roosters	20234.4	19607.1	13271.0	9516.6	9957.4	10199.5	9137.4
…Geese	1335.5	1321.8	1300.4	1378.9	1457.0	1487.2	1357.9
…Ducks	2165.7	1914.7	1736.5	1198.9	1284.8	1293.1	1166.6
…Turkeys	889.3	871.3	820.2	714.8	749.0	765.1	703.0
Asses and Mules	1.7	1.8	2.1	2.2	2.9	3.2	3.1
Rabbits	283.0	250.8	298.5	262.4	237.2	209.3	189.8
…Female rabbits ≥ 1 year	122.1	112.1	142.5	121.3	119.1	103.8	92.2
…Other rabbits	160.9	138.6	156.0	141.0	118.0	105.5	97.6
	1997	1998	1999	2000	2001	2002	2003
Cattle	549.7	532.4	482.4	445.4	453.6	454.7	409.1
...Dairy Cows	323.7	318.4	306.9	298.5	300.1	304.8	277.7
…Other Cattle	226.0	214.0	175.5	146.9	153.5	149.9	131.5
…Young Cattle	218.7	206.1	167.9	140.5	147.5	144.3	126.9
… Calves and Heifers up to 1 year	61.0	58.0	42.5	24.6	49.4	52.1	44.4
…Heifers between 12 and 18 months	40.8	30.4	23.2	19.7	24.5	22.1	21.5
…Heifers between 18 and 24 months	54.8	56.5	56.6	58.8	40.8	38.6	35.5
…Heifers between 24 months and more	62.2	61.2	45.6	37.4	32.8	31.5	25.5
…Breeding Males	5.1	5.6	5.4	4.5	4.4	4.0	3.4
…Work Bullocks	2.1	2.3	2.2	1.9	1.6	1.6	1.2
Swine	797.5	928.0	751.3	492.7	489.2	550.1	476.4
…Female sows	108.4	135.2	108.9	75.3	81.1	89.8	70.1
…Swine over 4 months	101.6	148.6	215.1	186.4	275.4	311.1	309.7
…Other Swine	587.6	644.2	427.3	231.0	132.6	149.3	96.7
Sheep and Goats	1235.3	1147.2	1055.5	962.1	971.7	978.4	958.4
Sheep	1139.3	1050.5	953.2	850.7	857.0	849.1	834.8
…Mature Ewes and Ewe Lambs ≥ 1 year	939.6	866.5	780.2	697.1	710.5	694.0	680.2
…Breeding Rams	34.2	31.5	28.6	25.5	25.7	25.5	25.0
…Growing lambs up to 1 year	165.6	152.4	144.4	128.0	120.9	129.7	129.6
Goats	95.9	96.7	102.4	111.4	114.6	129.2	123.6
…Mature females ≥ 1 year	74.0	76.4	78.9	86.3	92.0	100.3	94.3
…Breeding males	2.9	2.9	3.1	3.3	3.4	3.9	3.7
…Growing kids up to 1 year	19.1	17.4	20.4	21.8	19.2	25.1	25.6
Horses	65.4	68.5	72.0	76.0	81.6	82.6	81.4
…Draft horses	48.7	51.0	53.7	56.6	60.8	61.6	63.0

	1997	1998	1999	2000	2001	2002	2003
…Female horses ≥ 3 years	25.9	29.0	27.5	29.3	43.4	32.1	31.2
…Other Horses	16.7	17.5	18.4	19.4	20.8	21.1	18.5
Poultry	12363.9	13046.0	13730.1	13624.9	14730.4	15535.4	16195.5
…Chickens and roosters	9112.0	9557.0	9992.5	9952.9	10947.5	11484.2	12183.9
…Geese	1372.3	1470.0	1581.6	1550.6	1589.2	1777.4	1780.1
…Ducks	1169.5	1264.8	1349.4	1325.3	1367.5	1423.7	1462.2
…Turkeys	710.1	754.2	806.6	796.2	826.2	850.1	769.4
Asses and Mules	3.0	3.2	3.4	3.8	4.3	4.0	4.3
Rabbits	176.8	185.9	182.6	161.3	191.4	190.7	205.4
…Female rabbits ≥ 1 year	85.9	94.3	86.0	86.8	96.1	93.3	96.8
…Other rabbits	90.9	91.6	96.6	74.5	95.3	97.3	108.7
	2004	2005	2006	2007	2008	2009	2010
Cattle	359.5	339.8	326.9	253.7	238.4	243.0	236.4
...Dairy Cows	249.0	233.1	222.0	180.8	171.8	173.2	166.1
…Other Cattle	110.5	106.7	104.9	72.9	66.6	69.8	70.3
…Young Cattle	106.9	103.4	102.4	71.2	65.1	68.5	69.1
… Calves and Heifers up to 1 year	32.6	36.5	35.9	25.4	24.6	25.1	25.0
…Heifers between 12 and 18 months	19.8	16.0	21.4	13.3	11.5	13.7	13.4
…Heifers between 18 and 24 months	30.3	28.8	27.0	19.1	17.3	17.8	18.9
…Heifers between 24 months and more	24.2	22.1	18.1	13.3	11.7	11.9	11.8
…Breeding Males	2.7	2.4	1.9	1.2	1.0	1.0	1.0
…Work Bullocks	0.9	0.9	0.6	0.5	0.5	0.3	0.2
Swine	422.3	493.0	568.3	320.8	302.9	403.6	511.7
…Female sows	62.9	76.6	80.9	42.4	39.4	52.0	62.1
…Swine over 4 months	280.2	317.5	370.4	212.6	184.0	265.7	331.9
…Other Swine	79.2	98.9	117.0	65.8	79.5	85.9	117.7
Sheep and Goats	959.8	954.3	962.5	866.4	879.5	929.7	920.6
Sheep	838.1	832.8	848.7	765.5	774.0	816.7	801.2
…Mature Ewes and Ewe Lambs ≥ 1 year	683.1	681.7	675.7	617.4	638.2	670.8	662.5
…Breeding Rams	25.1	25.0	25.5	23.0	23.2	24.5	24.0
…Growing lambs up to 1 year	129.9	126.1	147.5	125.1	112.6	121.5	114.6
Goats	121.7	121.5	113.8	100.9	105.6	112.9	119.4
…Mature females ≥ 1 year	94.6	94.5	87.9	81.0	84.2	90.1	92.6
…Breeding males	3.7	3.6	3.4	3.0	3.2	3.4	3.6
…Growing kids up to 1 year	23.4	23.3	22.5	16.9	18.2	19.4	23.2
Horses	75.8	72.0	69.3	60.5	57.4	56.1	53.6
…Draft horses	61.8	57.0	57.0	50.9	48.7	47.6	46.3
…Female horses ≥ 3 years	29.6	27.9	27.6	24.3	24.1	23.2	23.3
…Other Horses	14.0	15.0	12.2	9.6	8.7	8.5	7.2
Poultry	17883.9	22773.6	23017.2	17544.1	18830.5	22986.6	23811.3
…Chickens and roosters	13558.7	17195.3	17320.1	14161.4	15463.5	18835.6	19497.4
…Geese	1828.0	2120.3	2112.0	1342.2	1277.2	1497.4	1530.1
…Ducks	1592.9	2394.1	2551.1	1436.0	1502.1	1981.8	2094.3
…Turkeys	904.4	1063.9	1034.0	604.6	587.9	671.9	689.6
Asses and Mules	4.0	3.7	3.6	3.1	3.2	2.9	2.8
Rabbits	239.1	278.9	326.0	263.4	248.5	274.5	277.0
…Female rabbits ≥ 1 year	117.3	125.9	147.4	115.7	117.1	130.3	125.2
…Other rabbits	121.8	152.9	178.6	147.7	131.4	144.2	151.8

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector", the number of livestock and poultry in all Households Categories as of 1st of January (annually for 1990-2011 time periods); Statistical Yearbooks of the ATULBD 1998 (page. 224), 2000 (page 114), 2002 (page 118), 2006 (page 109), 2010 (page 110), 2011 (page 111), 2012 (page 115).

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 (in particular, for cattle and sheep, which have a larger share in the total methane emissions from the 4A 'Enteric Fermentation' source category).

Divide livestock population into subgroups. Following IPCC GPG (2000) and 2006 IPCC Guidelines recommendation, it is *good practice* to divide the livestock population into sub-categories (Table 6-9).

Average daily feed intake per day. For each representative animal categories defined, is required the information on average daily feed intake (IPCC, 2006). Generally, data on average daily feed intake are not available in statistical sources, and it was necessary to infer this information indirectly. The following general data were collected for each representative animal category: weight of a typical animal in the category (kg), average weight gain per day (g), feeding situation (confined, grazing, pasture conditions), 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 (units), and feed digestibility (%).

Weight (W) and Mature Weight (MW) in livestock and poultry. The information on the weight of the most prevalent breeds of livestock and poultry is provided by statistical sources (Table 6-10), as well as by the scientific literature.

Table 6-10: Livestock and Poultry Weight, by species and sub-categories, in the RM within 1990-2010 time periods, kg

	1990	1991	1992	1993	1994	1995	1996
Average Weight per head at the end of the year, kg:							
Cattles from all sub-categories, including:	325	320	316	310	295	279	264
Dairy Cows	476	443	430	415	413	412	411
Breeding Males	580	562	550	545	540	539	537
Swine from all sub-categories, including:	145	143	132	140	118	109	100
Female sows	189	186	181	185	176	169	162
Sheep and Goats	43	44	43	43	44	39	39
Horses, including:	376	326	341	344	369	356	340
Female horses older than 3 years and Stallions	433	381	396	399	414	401	382
Poultry of all ages	1.74	1.69	1.54	1.49	1.50	1.43	1.28
Average weight per head sold to population, kg:							
Cattles, including	81	92	107	100	139	167	182
Dairy Cows	475	430	425	414	398	396	392
Swine	10	10	10	11	11	11	12
Sheep and Goats	20	21	22	21	23	27	27
Horses	161	167	179	171	170	213	220
Poultry of all ages	0.15	0.11	0.14	0.20	0.24	0.21	0.18
Average weight per head bought from population, kg:							
Cattles, including	403	380	391	370	323	271	245
Dairy Cows	526	443	396	405	397	393	391
Swine	145	143	132	140	110	105	107
Sheep and Goats	43	44	43	43	44	44	44
Horses	391	316	297	344	352	329	318
Poultry of all ages	1.61	1.59	1.54	1.49	1.50	0.96	0.68
Average weight per head sold for slaughter, kg:							
Cattles, including	NA	NA	NA	NA	288	266	264
Dairy Cows	NA	NA	NA	NA	400	395	391
Swine	NA	NA	NA	NA	119	98	100
Sheep and Goats	NA	NA	NA	NA	31	29	29
Horses	NA	NA	NA	NA	358	355	340
Poultry of all ages	NA	NA	NA	NA	1.67	1.58	1.65
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Average Weight per head at the end of the year, kg:							
Cattles from all sub-categories, including:	307	308	303	294	297	294	290
Dairy Cows	452	443	439	435	434	434	431
Breeding Males	551	542	539	533	535	534	532
Swine from all sub-categories, including:	55	51	46	56	49	47	54
Female sows	144	141	137	145	139	137	145
Sheep and Goats	35	35	35	35	33	33	33
Horses, including:	276	282	279	285	283	277	277
Female horses older than 3 years and Stallions	308	314	311	317	315	309	309
Poultry of all ages	1.38	1.62	1.65	1.62	1.57	1.60	1.29
Average weight per head sold to population, kg:							
Cattles, including	196	187	239	258	193	176	246
Dairy Cows	387	395	392	394	338	391	384
Swine	14	13	23	27	18	17	32
Sheep and Goats	27	29	29	29	28	26	29
Horses	227	257	270	282	285	270	256
Poultry of all ages	0.15	0.14	0.16	0.14	0.17	0.21	0.21
Average weight per head bought from population, kg:							
Cattles, including	219	236	308	283	293	286	283
Dairy Cows	389	391	392	393	383	414	402
Swine	109	85	62	83	51	47	62
Sheep and Goats	44	37	34	31	30	30	31
Horses	306	304	281	284	278	285	290
Poultry of all ages	0.41	0.47	0.10	0.39	0.10	0.12	0.30

	1997	1998	1999	2000	2001	2002	2003
Average weight per head sold for slaughter, kg:							
Cattles, including	248	245	257	244	241	261	252
Dairy Cows	385	375	381	384	372	387	374
Swine	102	92	68	62	63	77	71
Sheep and Goats	25	24	26	24	25	26	24
Horses	306	269	250	307	267	365	285
Poultry of all ages	1.39	1.44	1.51	1.35	1.69	1.61	1.65
	2004	2005	2006	2007	2008	2009	2010
Average Weight per head at the end of the year, kg:							
Cattles from all sub-categories, including:	300	293	297	284	286	289	291
Dairy Cows	435	429	427	425	405	409	420
Breeding Males	535	531	529	475	480	478	480
Swine from all sub-categories, including:	51	50	51	51	56	56	55
Female sows	141	138	140	137	141	137	141
Sheep and Goats	33	33	34	33	33	35	35
Horses, including:	282	275	297	297	308	302	307
Female horses older than 3 years and Stallions	314	307	322	339	342	346	345
Poultry of all ages	1.35	1.39	1.50	1.36	1.26	1.28	1.28
Average weight per head sold to population, kg:							
Cattles, including	183	161	163	229	170	209	176
Dairy Cows	365	346	373	398	364	423	410
Swine	23	13	30	33	22	19	27
Sheep and Goats	25	29	27	28	30	26	29
Horses	254	246	274	272	290	303	269
Poultry of all ages	0.20	0.27	0.35	0.41	0.39	0.34	0.30
Average weight per head bought from population, kg:							
Cattles, including	276	253	282	303	268	265	275
Dairy Cows	397	400	406	408	375	390	417
Swine	51	45	57	69	38	33	34
Sheep and Goats	26	32	36	32	32	32	30
Horses	254	296	332	293	310	265	298
Poultry of all ages	0.06	0.14	0.78	0.12	0.15	0.16	0.17
Average weight per head sold for slaughter, kg:							
Cattles, including	247	264	285	297	273	306	292
Dairy Cows	382	386	361	372	395	412	386
Swine	73	82	87	92	89	95	94
Sheep and Goats	26	25	24	26	24	26	28
Horses	261	273	309	244	255	316	297
Poultry of all ages	1.67	1.80	1.92	1.91	2.02	1.88	1.91

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector". Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM (annually for 1990-2011).

As for cattle[41], 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 6-11. At present most of animals in the RM is not pure blood, but rather different half-breeds obtained by crossbreeding (Bucataru, Rodionov, 1999). So, the productivity indicators for half-breeds have average values.

Information regarding typical weight of sheets and goats at different stages of their ontogenesis (at birth, at weaning, at one year of age and at slaughtering is provided by the specialty literature (Bucataru, Radionov, Varban, 2003). According to these sources, the weight of sheep and goats at birth in the RM is circa 2-4 kg, the lambs are weaned at 3-4 months when they reach 18-23 kg, while kids at 2-3 months when they reach 13-15 kg. Growing lambs not meant for breeding are fed intensely until the age of 6-7 months when they reach the weight of 30-35 kg, and then slaughtered.

[41] 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*)*.

Table 6-11: Weight of the most Prevalent Cattle Breeds 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

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) [42], g/day. The information on daily actual weight gain reported in RM within 1990-2010 periods for cattle and swine is presented in Table 6-12.

Table 6-12: Average Daily Weight Gain Characteristic for Cattle and Swine in the RM within 1990-2010 time periods

Indicator	Category	1990	1991	1992	1993	1994	1995	1996
Daily weight gain, g	cattle	515	421	425	376	363	223	203
	swine	304	117	110	89	94	148	171
Indicator	**Category**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Daily weight gain, g	cattle	181	230	192	217	260	287	262
	swine	189	222	117	107	134	147	136
Indicator	**Category**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Daily weight gain, g	cattle	275	321	323	297	325	378	345
	swine	166	187	200	218	268	311	317

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector". Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM (annual reports for 1990-2011).

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 the maximum of 3735 kg of milk per year in 1990 and a minimum of 1957 kg of milk per year in 1997 (Table 6-13) although the potential is much higher (**Annex 3-3**).

Table 6-13 shows that the average milking productivity featured over the period since 1993 to 2003 is much lower than the one reported at the beginning of '90s, comparable with milking productivity reported in the '60-'70 of the past century when the cattle stock in the RM was preponderantly represented by Red Estonian (8 per cent), Simmental (35-37 per cent) and Steppe Red (48-53 per cent) (Bucataru, Cosman, Holban, 2006).

Table 6-13: Average Annual Milk Production per one Cow in the Republic of Moldova, 1990-2010, kg/head/yr

Indicator	1990	1991	1992	1993	1994	1995	1996
Total national average annual milk production per one cow	3735	3248	2841	2398	2189	2043	2021
Average annual milk production per one cow at agricultural enterprises and farm households	3975	3394	3026	2413	2245	2207	2051
Average annual milk production per one cow at individual farms	2940	2815	2421	2100	2097	2125	2029
Indicator	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total national average annual milk production per one cow	1957	2040	2030	2039	2072	2111	2126
Average annual milk production per one cow at agricultural enterprises and farm households	1687	2001	2036	2179	2447	2710	2493
Average annual milk production per one cow at individual farms	2038	2048	2038	2028	2052	2081	2110
Indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total national average annual milk production per one cow	2480	2800	2807	2871	3011	3316	3435
Average annual milk production per one cow at agricultural enterprises and farm households	2561	3018	2913	2710	2743	3098	2993
Average annual milk production per one cow at individual farms	2477	2792	2803	2877	3020	3323	3449

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector". Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM (annual reports for 1990-2011)

Since 1970, the breed Spotted Black started to be massively imported in the country. A program to crossbreed all public stock with this breed, considered to be one of the most productive in the world, was developed. 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.

Holstein breed was also intensely used to improve the breed, in particular in 1980' – 1990' of the past century. Thus, developing an immense stock of half-breeds of different generations and a good organization of foddering allowed obtain a national average daily milk yield of 10-11 kg per head, by 1990 in the RM (Table 6-14).

Table 6-14: Average Daily Milk Production per one Cow in the Republic of Moldova within 1990-2010 time periods, kg/head/day

Indicator	1990	1991	1992	1993	1994	1995	1996
Total national average daily milk production per one cow	10.2	8.9	7.8	6.6	6.0	5.6	5.5
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
Average daily milk production per one cow at individual farms	8.1	7.7	6.6	5.8	5.7	5.8	5.6
Indicator	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total national average daily milk production per one cow	5.4	5.6	5.6	5.6	5.7	5.8	5.8
Average daily milk production per one cow at agricultural enterprises and farm households	4.6	5.5	5.6	6.0	6.7	7.4	6.8
Average daily milk production per one cow at individual farms	5.6	5.6	5.6	5.6	5.6	5.7	5.8
Indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total national average daily milk production per one cow	6.8	7.7	7.7	7.9	8.2	9.1	9.4
Average daily milk production per one cow at agricultural enterprises and farm households	7.0	8.3	8.0	7.4	7.5	8.5	8.2
Average daily milk production per one cow at individual farms	6.8	7.6	7.7	7.9	8.3	9.1	9.4

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector". Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM (annual reports for 1990-2011).

Further, once the big collective farms collapsed and the livestock concentrated in private sector (at present, according to the NBS, circa 94 per cent of total cattle of the RM is in

[42] 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).

the private sector[43]), the average productivity of dairy cows decreased a lot, in particular as a consequence of poor organization of foddering and inappropriate animal feeding and maintenance conditions in the private sector. To 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, milking productivity drops by up to 50 per cent.

In the recent years the protein deficit in the cattle diet in the RM exceeds 20 per cent (Bucataru, Cosman, Holban, 2006), being the main reason of poor productivity indicators, in particular during the period from 1993 through 2003. Over the period 2004 through 2010, the average productivity of dairy cows in the RM 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, Rodionov, 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 6-15 provide statistical data on the average production of milk in sheep and goats at the individual farms in the RM, in the time series since 1990 to 2010.

Table 6-15: Average Milk Production in Sheep and Goats at the Individual Farms in the Republic of Moldova within 1990-2010 time periods, kg/head/yr

Indicator	1990	1991	1992	1993	1994	1995	1996
Total national average annual milk production per one goat	62.0	75.0	88.0	101.0	114.0	127.0	131.0
Total national average annual milk production per one sheet	15.9	16.0	16.1	16.2	16.3	16.1	16.3
Indicator	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total national average annual milk production per one goat	145.0	125.0	106.0	57.0	57.0	59.0	58.0
Total national average annual milk production per one sheet	16.2	18.9	20.0	20.0	20.0	24.0	26.0
Indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total national average annual milk production per one goat	65.0	112.0	137.0	143.0	139.0	147.0	149.0
Total national average annual milk production per one sheet	21.0	32.0	30.0	33.0	35.0	36.0	36.0

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector". Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM (annual reports for 1990-2011)

Average Wool Production per Sheep. The default value used is 4 kg/year/head (*IPCC, 2000*). According the statistical data, in the RM the value of this indicator varied over the period from 1990 through 2010 between 1.8 and 2.3 kg of wool collected per year from one sheep (Table 6-16). Local goats can yield 1-2 kilograms of wool per year.

Table 6-16: Average Wool Production from Sheep at the Individual Farms in the Republic of Moldova within 1990-2010 time periods, kg/head/yr

Indicator	1990	1991	1992	1993	1994	1995	1996
Average annual amount of wool sheared per sheep	2.30	2.30	2.10	1.90	2.00	2.00	1.90
Indicator	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Average annual amount of wool sheared per sheep	2.00	2.00	1.90	1.80	2.30	2.20	2.00
Indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Average annual amount of wool sheared per sheep	2.10	2.20	2.00	1.80	1.70	1.80	1.76

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector". Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM (annual reports for 1990-2011)

Climate Conditions. Feeding situation of animals is greatly dependent on climate conditions, in particular, on average annual temperature in areas where livestock is bred. In conformity with the 2006 IPCC Guidelines, the data on the average annual temperature in areas with animal population have to be used as follows: areas with average annual temperatures <15^{0}C are defined as cold climate areas; areas with average annual temperatures between 15^{0}C and 25^{0}C inclusively are defined as moderate climate areas, and areas with average annual temperatures >25^{0}C are defined as warm climate areas. In conformity with data on the average annual temperature in Celsius degrees available in the Statistical Yearbooks, the RM refers to Eastern European countries with cold climate (Table 6-17).

Table 6-17: Average Annual Temperature in Different Regions of the RM within 1990-2010, in ^{0}C

Geographic areas	1990	1991	1992	1993	1994	1995	1996
North	9.5	8.0	8.5	7.8	9.5	8.4	7.1
Centre	11.3	9.4	10.1	9.4	11.3	10.0	9.1
South	11.4	9.3	10.2	9.3	11.3	10.0	9.1
Geographic areas	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
North	7.7	8.2	9.2	9.7	8.8	9.5	8.6
Centre	9.4	10.3	11.0	11.2	10.3	10.8	9.8
South	9.1	10.1	10.9	11.2	10.4	11.0	10.3
Geographic areas	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
North	9.0	8.7	8.4	10.1	9.7	9.6	8.9
Centre	10.3	10.5	10.2	12.1	11.3	11.4	10.6
South	10.9	10.8	10.8	12.3	11.8	11.8	11.2

Source: NBS, Statistical Yearbooks of the RM for years 1991 (page 207), 1994 (page 31), 1999 (page 13), 2006 (page 15), 2011 (page 15).

Percentage of females that give birth in a year (%). Table 6-21 below provide statistical data on live products produced by 100 females at publicly owned agricultural enterprises in the RM over the period from 1990 through 2010.

To be noted, that the birth rate of some local breeds of sheep and goats is much higher than the officially reported one: featuring circa 115 lambs per 100 Karakul breed female sheep giving birth; circa 120 lambs per 100 Tigae breed fe-

[43] NBS on-line database: < http://statbank.statistica.md/pxweb/Database/RO/16%20AGR/AGR03/AGR03.asp>.

male sheep giving birth; and circa 165 kids per 100 local female goats giving birth (see **Annex 3-3**).

Table 6-18: Live Products Produced by 100 Females at Publicly Owned Agricultural Enterprises in the Republic of Moldova within 1990-2010 time periods

Indicators	1990	1991	1992	1993	1994	1995	1996
Calves from cows	86	80	79	75	72	66	65
Pigs from sows	1466	1317	1569	1223	989	983	1019
Lambs from sheep giving birth	91	84	80	79	78	76	75
Young equines	25	24	23	23	23	21	19
Indicators	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Calves from cows	58	61	55	58	65	69	63
Pigs from sows	892	1187	772	434	869	967	558
Lambs from sheep giving birth	73	75	68	71	79	81	75
Young equines	19	20	17	18	23	22	21
Indicators	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Calves from cows	60	72	66	63	62	67	63
Pigs from sows	689	997	949	782	1015	1222	1040
Lambs from sheep giving birth	79	84	80	73	81	83	73
Young equines	18	23	19	17	18	19	18

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector". Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM (annual reports for 1990-2011)

Feed Digestibility (DE)[44]. The portion of gross energy (GE) in the feed not excreted in the faeces is known as digestible feed. That percentage of feed that is not digested represents the per cent of dry matter intake that will be excreted as faeces (50-60 per cent for crop by-products and range lands, 60-75 per cent for good pastures, good preserved forages, and grain supplemented forage-based diets and 75-85 per cent for grain-based diets fed in feedlots). In the RM, the value of this indicator varied over the years, so for the reference year, when the livestock maintenance conditions, foddering and feeding situation were optimal, the DE value was admitted 67 per cent; for 1991-1992, DE – 68 per cent; for 1993, DE – 67 per cent; for 1994-1996, DE – 65 per cent; for 1997-2004, DE – 66 per cent; for 2005-2008, DE – 67 per cent and for the period 2009 through 2010 the average value of DE was accepted at the level of 68 per cent.

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 GPG (IPCC, 2000) and 2006 IPCC Guidelines (IPCC, 2006) provide equations (Table 6-19) that were used to calculate the average amount of gross energy required for animal maintenance and other relevant vital activities.

[44] Default values available in *2006 IPCC Guidelines*, Vol. 4, Ch. 10, Table 10.2, Page 10.14.

Table 6-19: Summary of Equations Used to Estimate Daily Gross Energy Intake for Cattle, Sheep and Goats for maintenance and other relevant vital activities

Metabolic Function	Equations for cattle		Equations for sheep and goats	
	IPCC, 2000	IPCC, 2006	IPCC, 2000	IPCC, 2006
Maintenance (NE_m)	4.1	10.3	4.1	10.3
Activity (NE_a)	4.2a	10.4	4.2b	10.5
Growth (NE_g)	4.3a	10.6	4.3b	10.7
Weight loss ($NE_{mobilised}$)	4.4a and 4.4b	NA	NA	NA
Lactation (NE_l)	4.5a	10.8	4.5b and 4.5c	10.9 and 10.10
Draft Power (NE_w)	4.6	10.11	NA	NA
Wool Production (NE_{wool})	NA	NA	4.7	10.12
Pregnancy (NE_p)	4.8	10.13	4.8	10.13
REM {NE_{ma}/DE}	4.9	10.14	4.9	10.14
REG {NE_{ga}/DE}	4.10	10.15	4.10	10.15
Gross Energy *(GE)*	4.11	10.16	4.11	10.16

Net energy for maintenance (NE_m). Net energy required for maintenance, which is the amount of energy needed to keep the animal in equilibrium where body energy is neither gained nor lost. NE_m was calculated on the basis of Equation 10.3 in IPCC 2006 Guidelines.

$$NE_m = Cf_i \bullet (Weight)^{0.75}$$

Where:

NEm – net energy required by the animal for maintenance, MJ/day

Cf_i – a coefficient which varies for each animal category[45], 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 conformity with Equation 10.4, while for sheep and goats in conformity with Equation 10.5 in IPCC 2006 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[46], default values used are as follows: C_a – 0, cattle is

[45] Default values available in *IPCC 2006 Guidelines*, Volume 4, Chapter 10, Table 10.4, Page 10.16

[46] Default values available in *2006 IPCC Guidelines*, Volume 4, Chapter 10, Table 10.5, Page 10.17.

confined to a small area (i.e., tethered, pen, barn) with the result that they expend very little or no energy to acquire feed; C_a – 0.17, cattle is confined in areas with sufficient forage requiring modest energy expense to acquire feed; C_a – 0.36, cattle graze in open range land or hilly terrain and expend significant energy to acquire feed; keeping 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 C_a coefficient for conditions of the RM were estimated as: C_a – 0.098 for 1990-1991 period and C_a – 0.207 for 1992-2010;

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[47], default values used are as follows: C_a – 0.0090, when animals are confined due to pregnancy in final trimester, 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 5000 meters per day and expend significant energy to acquire feed and C_a – 0.0067, when animals are housed for fattening, MJ/kg day; keeping 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 on the basis of 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 – a coefficient with a value of 0.8 for females, 1.0 for castrates and 1.2 for breeding bulls[48];

MW – the mature live body weight of an adult female in moderate body condition, kg;

WG – the 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} – the average weight gain (BW_f-BW_i), kg/year;

BW_i – the average live body weight at weaning, kg;

BW_f – the 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[49].

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 conformity with Equation 10.7 in the 2006 IPCC Guidelines.

$$NE_l = Milk \bullet (1.47+0.40 \bullet Fat)$$

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 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 to produce 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) require circa 10 per cent of the net daily energy for maintenance (NE_m). NE_{work} shall be calculated in conformity with Equation 10.11 in the IPCC 2006 Guidelines.

$$NE_{work} = 0.10 \bullet NE_m \bullet Hours$$

Where:

NE_{work} – net energy for work (cattle), MJ/days;

[47] Default values available in *IPCC 2006 Guidelines*, Volume 4, Chapter 10, Table 10.5, Page 10.17.

[48] Default values available in *2006 IPCC Guidelines*, Volume 4, Chapter 10, Equation 10.6, Page 10.17.

[49] Default values available in *2006 IPCC Guidelines*, Volume 4, Chapter 10, Table 10.6, Page 10.18.

NE_m – net energy required by the animal for maintenance (from Equation 10.3), MJ/day;

Hours – number of hours of work per day[50]; this inventory cycle used 2 hours of work per day regarding the 1990-1991 time period and 3 hours of work per day for 1992-2010.

Net energy for wool production: (NE_{wool}) is the average daily net energy required for sheep to produce a year of wool. The NE_{wool} was calculated in conformity with Equation 10.12 from 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[51] and shall be calculated in conformity with Equation 10.13 in 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, the NE_p requirement is similarly estimated for the 144-154-days gestation period, although the percentage varies with the number of lambs born[52].

$$NE_p = C_{pregnancy} \bullet NE_m$$

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 conformity with Equation 10.14 in the IPCC 2006 Guidelines.

$$REM = [1.123-(4.092 \bullet 10^{-3} \bullet DE\%)+[1.126 \bullet 10^{-5} \bullet (DE\%)^2]-(25.4/DE\%)]$$

Where:

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 conformity with Equation 10.15 in the IPCC 2006 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 conformity 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 for the Republic of Moldova are provided in Table 6-20.

Table 6-20: Gross Energy (GE) Values Calculated for Animal Categories in the RM following a Tier 2 Methodology, MJ/head/day

	1990	1991	1992	1993	1994	1995	1996
Dairy cows	245.8	229.0	227.5	219.8	217.8	213.2	211.9
Other cattle (average)	118.4	116.1	116.8	122.4	125.9	123.3	129.4
Calves and heifers up to 1 year	100.2	94.6	95.0	95.4	96.7	78.5	75.4
Heifers between 12 and 18 months	131.0	131.0	126.7	127.2	127.4	127.4	125.7
Heifers between 18 and 24 months	156.8	152.3	147.2	142.7	146.4	146.4	146.4
Heifers between 24 months and more	167.2	165.0	158.8	158.8	160.2	160.2	164.4
Breeding males	207.9	204.9	191.9	194.2	190.4	188.3	184.2
Work bullocks	182.5	182.4	172.9	176.2	178.0	178.0	178.0
Sheep (average)	16.3	16.8	16.3	16.1	16.6	15.6	15.6
Mature ewes and Ewe lambs ≥ 1 year	17.0	17.3	16.7	16.7	17.4	16.0	16.0

[50] Default value available in *2006 IPCC Guidelines*, Volume 4, Chapter 10, Table 10A-2, Page 10.73.

[51] Default value available in *2006 IPCC Guidelines*, Volume 4, Chapter 10, Table 10A-7, Page 10.20.

[52] $C_{pregnancy}$ default values were estimated regarding average prolificacy of the local breeds in the RM: $C_{pregnancy}$ – 0.087 for sheep, respectively $C_{pregnancy}$ – 0.109 for goats.

	1990	1991	1992	1993	1994	1995	1996
Breeding rams	23.9	24.3	23.9	23.8	24.4	23.1	23.1
Growing lambs up to 1 year	12.3	12.6	12.2	12.1	12.7	12.1	12.1
Goats (average)	15.1	15.6	15.2	15.3	15.6	14.8	14.7
Mature females ≥ 1 year	16.3	16.9	16.4	17.0	17.3	16.8	16.9
Breeding males	16.1	16.5	15.9	15.6	15.3	14.7	14.7
Growing kids up to 1 year	9.2	9.2	8.8	8.8	8.5	8.0	8.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Dairy cows	211.4	212.1	212.5	213.7	216.2	218.9	219.4
Other cattle (average)	124.6	123.2	123.5	128.8	124.5	127.3	126.3
Calves and heifers up to 1 year	69.9	77.4	71.6	75.5	81.5	85.0	81.7
Heifers between 12 and 18 months	120.8	114.8	114.8	114.8	120.8	129.4	129.4
Heifers between 18 and 24 months	142.7	136.1	136.1	136.1	142.7	147.9	147.9
Heifers between 24 months and more	158.7	152.0	152.0	152.0	160.1	161.5	161.5
Breeding males	178.2	178.2	178.2	178.2	178.2	180.3	180.3
Work bullocks	174.2	172.1	170.1	168.0	170.1	172.1	174.2
Sheep (average)	14.8	15.1	15.2	15.1	15.2	15.2	15.3
Mature ewes and Ewe lambs ≥ 1 year	15.2	15.6	15.6	15.6	15.6	15.8	15.9
Breeding rams	22.4	22.4	22.3	22.3	21.9	21.9	21.8
Growing lambs up to 1 year	11.1	10.7	11.4	10.6	11.2	11.1	10.7
Goats (average)	14.2	14.2	13.9	13.3	13.3	13.6	13.4
Mature females ≥ 1 year	15.9	15.7	15.4	14.4	14.2	14.7	14.6
Breeding males	13.6	14.1	14.4	15.4	15.4	16.0	15.2
Growing kids up to 1 year	7.5	7.8	8.0	8.5	8.5	8.7	8.7
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Dairy cows	227.3	229.8	228.7	230.1	231.0	232.2	237.6
Other cattle (average)	131.6	129.3	130.1	127.6	120.5	120.6	121.7
Calves and heifers up to 1 year	83.5	86.7	87.0	83.9	87.2	90.5	87.1
Heifers between 12 and 18 months	128.3	130.1	132.5	130.1	119.4	114.9	120.5
Heifers between 18 and 24 months	151.5	149.2	154.1	152.1	142.1	143.3	144.6
Heifers between 24 months and more	166.8	166.3	170.3	166.3	151.9	150.3	153.6
Breeding males	182.3	178.5	180.4	180.4	182.4	180.6	180.6
Work bullocks	176.2	174.5	174.5	174.5	176.5	174.8	174.8
Sheep (average)	14.9	15.7	15.5	15.6	15.5	16.1	16.1
Mature ewes and Ewe lambs ≥ 1 year	15.3	16.4	16.3	16.3	16.2	16.9	16.8
Breeding rams	21.9	21.4	21.6	21.5	20.8	21.3	21.2
Growing lambs up to 1 year	11.4	10.8	10.5	11.0	10.1	10.8	11.4
Goats (average)	13.6	14.2	14.3	14.9	14.8	15.3	15.4
Mature females ≥ 1 year	14.7	15.6	15.8	16.3	16.2	16.8	17.1
Breeding males	16.0	15.3	14.8	15.1	15.1	15.5	15.7
Growing kids up to 1 year	8.8	8.3	8.0	8.1	8.1	8.2	8.3

For animal categories "other cattle"[53], "sheep" and "goats"[54] GE values are weighted averages, taking into account the specific GE values for each subcategory of animals, respectively the percentage distribution of their population (Table 6-21).

[53] 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).

[54] According to the literature in the field (Bucătaru et al., 2003), the reproduction structure at local sheep and goats is: breeding males – *circa 3%*, mature females – *circa 75%*, breeding youngsters – *circa 22%*.

Table 6-21: Distribution of Animal Population by Sub-Categories in the RM within 1990-2010, %

	1990	1991	1992	1993	1994	1995	1996
Other cattle, including:	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
Heifers between 12 and 18 months	17.3	19.8	21.0	25.5	27.0	26.8	31.1
Heifers between 18 and 24 months	8.7	10.2	12.4	17.3	16.2	18.5	20.1
Heifers between 24 months and more	11.4	11.4	12.9	14.8	17.5	20.7	23.5
Breeding males	0.2	0.3	0.4	1.1	1.4	1.4	1.9
Work bullocks	0.0	0.0	0.1	0.4	0.5	0.7	1.0
Sheep, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mature ewes and Ewe lambs ≥ 1 year	79.2	83.0	82.4	80.1	74.1	81.4	82.2
Breeding rams	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Growing lambs up to 1 year	17.8	14.0	14.6	16.9	22.9	15.6	14.8
Goats, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mature females ≥ 1 year	80.0	80.0	81.7	76.4	78.1	75.3	73.0
Breeding males	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Growing kids up to 1 year	17.0	17.0	15.3	20.6	18.9	21.7	24.0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Other cattle, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calves and heifers up to 1 year	27.0	27.1	24.2	16.8	32.2	34.7	33.7
Heifers between 12 and 18 months	18.0	14.2	13.2	13.4	15.9	14.7	16.3
Heifers between 18 and 24 months	24.2	26.4	32.3	40.0	26.6	25.8	27.0
Heifers between 24 months and more	27.5	28.6	26.0	25.4	21.4	21.0	19.4
Breeding males	2.3	2.6	3.1	3.0	2.8	2.7	2.6
Work bullocks	0.9	1.1	1.3	1.3	1.1	1.0	0.9
Sheep, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mature ewes and Ewe lambs ≥ 1 year	82.5	82.5	81.9	82.0	82.9	81.7	81.5
Breeding rams	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Growing lambs up to 1 year	14.5	14.5	15.1	15.0	14.1	15.3	15.5
Goats, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mature females ≥ 1 year	77.1	79.0	77.1	77.5	80.3	77.6	76.3
Breeding males	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Growing kids up to 1 year	19.9	18.0	19.9	19.5	16.7	19.4	20.7
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Other cattle, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calves and heifers up to 1 year	29.5	34.2	34.2	34.8	37.0	35.9	35.5
Heifers between 12 and 18 months	17.9	15.0	20.4	18.3	17.2	19.6	19.1
Heifers between 18 and 24 months	27.4	27.0	25.7	26.2	25.9	25.5	26.9
Heifers between 24 months and more	21.9	20.7	17.3	18.3	17.6	17.0	16.7
Breeding males	2.4	2.2	1.8	1.7	1.6	1.4	1.4
Work bullocks	0.8	0.9	0.5	0.7	0.7	0.4	0.3

	2004	2005	2006	2007	2008	2009	2010
Sheep, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mature ewes and Ewe lambs ≥ 1 year	81.5	81.9	79.6	80.7	82.4	82.1	82.7
Breeding rams	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Growing lambs up to 1 year	15.5	15.1	17.4	16.3	14.6	14.9	14.3
Goats, including:	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mature females ≥ 1 year	77.8	77.8	77.3	80.3	79.8	79.8	77.5
Breeding males	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Growing kids up to 1 year	19.2	19.2	19.7	16.7	17.2	17.2	19.5

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector", the Number of Livestock and Poultry in all Households Categories as of 1st January (annually for 1990-2011).

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 2006 IPCC Guidelines were used for cattle[55]: 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[56]: 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 information above, country specific national factors were developed for the 4A 'Enteric Fermentation' source category (for cattle, sheep and goats). The emission factor for each animal category was developed following the Equation 10.21 in the 2006 IPCC Guidelines.

$$EF = [GE \bullet (Y_m/100) \bullet 365/55.65]$$

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.

[55] Default values used for cattle available in *IPCC 2006 Guidelines,* Volume 4, Chapter 10, Table 10.12, Tables 10A-1 and 10A-2, Pages 10.30, 10.72-10.73;

[56] Default values used for sheep and goats available in *IPCC 2006 Guidelines,* Volume 4, Chapter 10, Table 10.13, Page 10.31.

Table 6-22 features country specific emission factor for cattle bred in the RM, developed by using a Tier 2 simplified methodology.

Table 6-22: Country Specific Emission Factors for Enteric Fermentation, Calculated for Cattle Population in the RM following a Tier 2 methodology, kg CH_4/head/yr

	1990	1991	1992	1993	1994	1995	1996
Dairy cows	104.78	97.61	96.99	93.70	92.84	90.89	90.34
Other cattle (average)	50.47	49.50	49.79	52.20	53.67	52.58	55.15
Calves and heifers up to 1 year	42.73	40.35	40.51	40.66	41.22	33.48	32.13
Heifers between 12 and 18 months	55.86	55.84	54.03	54.22	54.29	54.29	53.59
Heifers between 18 and 24 months	66.84	64.92	62.77	60.82	62.42	62.42	62.42
Heifers between 24 months and more	71.30	70.35	67.70	67.69	68.31	68.31	70.07
Breeding males	88.64	87.34	81.82	82.80	81.16	80.29	78.54
Work bullocks	77.79	77.76	73.70	75.12	75.88	75.88	75.88
	1997	1998	1999	2000	2001	2002	2003
Dairy cows	90.12	90.41	90.57	91.09	92.19	93.31	93.54
Other cattle (average)	53.11	52.52	52.67	54.91	53.09	54.27	53.82
Calves and heifers up to 1 year	29.79	32.99	30.53	32.17	34.76	36.25	34.84
Heifers between 12 and 18 months	51.50	48.95	48.95	48.95	51.50	55.15	55.15
Heifers between 18 and 24 months	60.82	58.01	58.01	58.01	60.82	63.04	63.04
Heifers between 24 months and more	67.66	64.81	64.81	64.81	68.25	68.84	68.84
Breeding males	75.99	75.99	75.99	75.99	75.99	76.85	76.85
Work bullocks	74.25	73.38	72.51	71.63	72.51	73.38	74.25
	2004	2005	2006	2007	2008	2009	2010
Dairy cows	96.91	97.97	97.49	98.11	98.50	98.99	101.28
Other cattle (average)	56.10	55.14	55.47	54.40	51.37	51.42	51.89
Calves and heifers up to 1 year	35.61	36.97	37.10	35.79	37.17	38.59	37.15
Heifers between 12 and 18 months	54.72	55.46	56.48	55.46	50.91	48.96	51.38
Heifers between 18 and 24 months	64.60	63.59	65.70	64.86	60.60	61.10	61.66
Heifers between 24 months and more	71.12	70.89	72.61	70.89	64.77	64.06	65.48
Breeding males	77.71	76.09	76.93	76.93	77.76	76.99	76.99
Work bullocks	75.12	74.39	74.39	74.39	75.23	74.52	74.52

Table 6-23: Country Specific EFs Used by Different Annex I Parties for National GHG Inventories under the 4A 'Enteric Fermentation' Source Category, kg CH_4/head/yr

Categories	Russia		Lithuania		Latvia		Poland		Czech Republic	
	1990	2010	1990	2010	1990	2010	1990	2010	1990	2010
Dairy cows	99.63	100.19	90.68	102.63	95.58	117.56	91.62	97.36	82.35	114.26
Other cattle	48.20	53.52	49.44	50.94	52.16	52.16	41.14	49.21	39.25	47.91
Categories	Hungary		Italy		Portugal		Austria		Ireland	
	1990	2010	1990	2010	1990	2010	1990	2010	1990	2010
Dairy cows	113.07	133.82	94.54	119.86	94.93	138.81	97.10	115.97	101.38	112.09
Other cattle	57.47	58.30	45.59	45.88	50.05	54.62	48.38	56.21	48.92	46.94

Source: National Inventory Reports: 1990-2010 (2012 year submission) of Russia, Lithuania, Latvia, Poland, Czech Republic, Hungary, Italy, Portugal, Austria and Ireland.

The obtained results are comparable with emission factors values for cattle used by a number of Annex I Parties in national greenhouse gas inventories for the 1990-2010 time series (Table 6-23).

Table 6-24 features country specific emission factors calculated for sheep and goats in the Republic of Moldova.

Table 6-24: Country Specific Emission Factors for Enteric Fermentation, Calculated for Sheep and Goat Populations in the RM following a Tier 2 Methodology, kg CH_4/head/yr

	1990	1991	1992	1993	1994	1995	1996
Sheep, including:	6.68	6.94	6.71	6.60	6.68	6.40	6.41
Mature ewes and Ewe lambs ≥ 1 year	7.23	7.36	7.13	7.11	7.43	6.81	6.80
Breeding rams	10.21	10.36	10.18	10.15	10.40	9.86	9.84
Growing lambs up to 1 year	3.64	3.73	3.60	3.58	3.76	3.58	3.57
Goats, including:	6.22	6.43	6.31	6.26	6.43	6.08	6.02
Mature females ≥ 1 year	6.95	7.20	6.98	7.24	7.38	7.14	7.21
Breeding males	6.88	7.02	6.77	6.63	6.52	6.28	6.28
Growing kids up to 1 year	2.70	2.70	2.60	2.60	2.50	2.35	2.35
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Sheep, including:	6.11	6.22	6.24	6.21	6.27	6.27	6.29
Mature ewes and Ewe lambs ≥ 1 year	6.49	6.64	6.66	6.65	6.67	6.72	6.78
Breeding rams	9.53	9.53	9.51	9.50	9.35	9.33	9.30
Growing lambs up to 1 year	3.27	3.16	3.35	3.14	3.30	3.28	3.16
Goats, including:	5.84	5.87	5.72	5.46	5.49	5.56	5.47
Mature females ≥ 1 year	6.77	6.68	6.57	6.16	6.07	6.26	6.22
Breeding males	5.80	6.02	6.14	6.56	6.56	6.83	6.47
Growing kids up to 1 year	2.22	2.31	2.35	2.51	2.51	2.56	2.56
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Sheep, including:	6.13	6.48	6.36	6.41	6.40	6.67	6.67
Mature ewes and Ewe lambs ≥ 1 year	6.54	6.99	6.97	6.95	6.91	7.21	7.16
Breeding rams	9.32	9.12	9.20	9.17	8.85	9.08	9.06
Growing lambs up to 1 year	3.36	3.20	3.08	3.25	2.99	3.18	3.35
Goats, including:	5.57	5.83	5.88	6.17	6.11	6.32	6.34
Mature females ≥ 1 year	6.25	6.64	6.76	6.95	6.89	7.15	7.31
Breeding males	6.82	6.50	6.33	6.43	6.42	6.60	6.71
Growing kids up to 1 year	2.61	2.45	2.36	2.41	2.41	2.43	2.45

The obtained results are intermediary to default values characteristic for developing countries (5 kg CH_4/head/year for sheep and goats), and developed countries (8 kg CH_4/head/year for sheep and 5 kg CH_4/ head/year for goats) (IPCC, 2006). The obtained results also fit into the range of country specific emission factors values for these animal categories used by some Annex 1 Parties for national GHG inventories for the period from 1990 through 2010 (Table 6-25).

6.2.3 Uncertainties Assessment and Time-Series Consistency

Uncertainties related to estimation of methane emissions from enteric fermentation, in particular depend on the accuracy of the livestock characteristic, and also on the emission factors used. The uncertainties associated with the animal population in the Republic of Moldova are higher than it is officially acknowledged (circa 10 per cent). It is quite likely that the reported data collected from current statistical reports are erroneous; in particular keeping in mind that seasonal variation in total animal population is not fully taken into account. To be noted that the accuracy of default EFs estimated by using a Tier 1 method is around ±30 per cent (IPCC, 2006). As this methodology does not rely on country specific values and does not take account of country's livestock characteristics, general uncertainty of results obtained by using this approach could reach up to ±50 per cent (IPCC, 2006). 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. The accuracy of EFs estimated by using a Tier 2 methodology are likely to be in the order of ±20 per cent (IPCC, 2006).

The combined uncertainties associated with methane emissions from enteric fermentation can be considered moderate for cattle, sheep and goats (±22.36 per cent) and medium for other animal categories (±31.62 per cent for swine and horses, ±36.06 per cent for rabbits, asses and mules). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±5.56 per cent for cattle, ±1.09 per cent for sheep, ±0.16 per cent for goats, ±0.38 per cent for horses, ±0.01 per cent for asses and mules, ±0.17 per cent for swine and ±0.27 per cent for

Table 6-25: Country Specific EFs Used by Different Annex I Parties for National GHG Inventories under the 4A 'Enteric Fermentation' (Sheep and Goats) Source Categories, kg CH_4/head/yr

Categories	Ukraine		Lithuania		Poland		Bulgaria		Ireland	
	1990	2010	1990	2010	1990	2010	1990	2010	1990	2010
Sheep	7.98	9.44	10.37	10.24	7.76	7.86	6.89	6.66	6.13	6.14
Goats	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Categories	**Portugal**		**Denmark**		**Switzerland**		**Australia**		**New Zeeland**	
	1990	**2010**	**1990**	**2010**	**1990**	**2010**	**1990**	**2010**	**1990**	**2010**
Sheep	8.46	9.04	12.75	13.14	9.57	10.02	6.96	6.95	9.73	11.37
Goats	7.19	7.56	13.15	13.06	10.38	10.24	5.00	5.00	7.40	8.60

Source: National Inventory Reports, 1990-2010 (2012 year submission) of Ukraine, Lithuania, Poland, Bulgaria, Ireland, Portugal, Denmark, Switzerland, Australia and New Zeeland.

rabbits. Uncertainties introduced in trend in sectoral emissions were estimated at ±1.71 per cent for cattle, ±0.35 per cent for sheep, ±0.07 per cent for goats, ±0.14 per cent for horses, ±0.003 per cent for asses and mules, ±0.10 per cent for swine and ±0.11 per cent for rabbits.

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 GPG (IPCC, 2000).

6.2.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for 4A 'Enteric Fermentation' source category, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating GHG emissions under this category were documented and archived both in hard copies and electronically. For identifying the data entry and the CH_4 emissions estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), GHG emissions were estimated using AD and country specific factors and parameters from official sources of reference.

6.2.5 Recalculations

Methane emissions from the 4A 'Enteric Fermentation' source category were recalculated for the 1990 through 2010 time series, in particular due to use of an updated set of activity data on animal population (available into the Statistical Yearbooks of the RM and those of the ATULBD, statistical Sectoral Reports, as Statistical Annual Report Nr. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all households categories as of 1st of January" and "Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM"), as well as a result of using a Tier 2 methodology and country specific EFs for several animal categories (in particular for cattle, sheep and goats).

Default emission factors were used for other livestock categories: 18 kg CH_4/head/year for horses and 10 kg CH_4/head/year for asses and mules (IPCC, 1997, 2000, 2006). For swine, there was used the default emission factor specific to Western European countries (1.5 kg/head/year), also preferred by other Eastern European countries (e.g., by Ukraine, Russia, Lithuania and Estonia). As no default EFs is available in case of rabbits, the Russian country specific emission factor (0.59 kg/head/year) was used (the coefficient used by Russia for its 1990-2010 GHG Emissions Inventory is an average value comparing with other countries in the same region: Lithuania – 0.26 kg/head/yr, respectively Ukraine – 0.70 kg/head/year).

For more accurate estimates of intake energy required for animals activities, there were revised the grazing and confinement periods (210 days in TNC, compared to 180 days in SNC; respectively 155 days in TNC compared to 185 days used in the SNC), as well as digestible energy values (in the TNC were used DE values varying between 65-70 per cent for different years, taking into account the specific conditions of animal maintenance, proceeding from the climate conditions of those years, while in the SNC it was used an average DE value for all animal categories (65 per cent).

In comparison with emissions estimates included into the SNC of the RM under the UNFCCC, the changes performed resulted in insignificant decreased methane emissions over the period 1990 through 1991, 1995, 1997 and 2004-2005, with a variation from a minimum of 0.2 per cent in 1997 to a maximum of 3.6 per cent in 1990; and increased values over the period from 1992 through 1994, 1996 and 1998-2002, with a variation from a minimum of 0.7 per cent in 1999, to a maximum of 10 per cent in 1993 (Table 6-26).

Table 6-26: Comparative Results of CH_4 Emissions from 4A 'Enteric Fermentation' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	90.6384	83.3580	78.9349	68.1893	68.9186	65.9346	58.8935
TNC	87.3513	81.2128	79.7688	74.9883	73.2244	64.8018	59.6262
Difference, %	-3.6	-2.6	1.1	10.0	6.2	-1.7	1.2
	1997	1998	1999	2000	2001	2002	2003
SNC	51.3233	46.8051	45.8021	43.0030	41.6103	43.4618	42.6594
TNC	51.2098	49.8919	46.1429	43.3896	44.1737	45.0836	41.3224
Difference, %	-0.2	6.6	0.7	0.9	6.2	3.7	-3.1
	2004	2005	2006	2007	2008	2009	2010
SNC	40.1884	37.7552					
TNC	38.3224	37.0653	35.8562	28.9918	27.6051	28.7010	28.4934
Difference, %	-4.6	-1.8					

For the period 2006-2010, methane emissions resulting from enteric fermentation were estimated for the first time. The results allow assert that within the 1990-2010 time series methane emissions from 4A 'Enteric Fermentation' source category decreased by 67.4 per cent, in particular due to reduced animal population, but also due to evolution of the principal productivity indicators in the livestock sector of the Republic of Moldova.

To be noted that over the period under review the share of different livestock categories in the overall methane emissions from the 4A 'Enteric Fermentation' source category has changed significantly. By 2010, the percentage of such categories as 'other cattle' and 'swine' decreased considerable against 1990 year level, while the percentage of other categories such as 'dairy cows', 'sheep', 'goats', 'horses', 'asses and mules', 'rabbits' increased (Table 6-27).

To be noted also 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 source category 4A "Enteric fermentation", this reduction varying between a minimum of 8.0 per cent in 1990 and a maximum of 15.0 per cent in 1997 (Table 6-28).

Table 6-27: Breakdown of the Methane Emissions from 4A 'Enteric Fermentation' by Livestock Category within 1990-2010 time periods, %

Categories	1990	1991	1992	1993	1994	1995	1996
Dairy cows	47.4	47.7	49.0	50.2	51.0	53.4	53.9
Other cattle	38.4	36.8	35.4	33.5	31.5	28.3	26.9
Sheep	9.5	10.6	10.9	12.0	12.9	13.1	13.7
Goats	0.3	0.4	0.5	0.6	0.8	0.9	1.0
Horses	1.0	1.1	1.2	1.3	1.4	1.7	1.9
Asses and mules	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Swine	3.2	3.2	2.8	2.2	2.1	2.3	2.4
Rabbits	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Categories	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Dairy cows	57.0	57.7	60.2	62.7	62.6	63.1	62.9
Other cattle	23.4	22.5	20.0	18.6	18.4	18.0	17.1
Sheep	13.6	13.1	12.9	12.2	12.2	11.8	12.7
Goats	1.1	1.1	1.3	1.4	1.4	1.6	1.6
Horses	2.3	2.5	2.8	3.2	3.3	3.3	3.5
Asses and mules	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Swine	2.3	2.8	2.4	1.7	1.7	1.8	1.7
Rabbits	0.2	0.2	0.2	0.2	0.3	0.2	0.3
Categories	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Dairy cows	63.0	61.6	60.4	61.2	61.3	59.7	59.0
Other cattle	16.2	15.9	16.2	13.7	12.4	12.5	12.8
Sheep	13.4	14.6	15.1	16.9	17.9	19.0	18.8
Goats	1.8	1.9	1.9	2.1	2.3	2.5	2.7
Horses	3.6	3.5	3.5	3.8	3.7	3.5	3.4
Asses and mules	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Swine	1.7	2.0	2.4	1.7	1.6	2.1	2.7
Rabbits	0.4	0.4	0.5	0.5	0.5	0.6	0.6

Table 6-28: Comparative Results of CH_4 Emissions from 4A 'Enteric Fermentation' Source Category, estimated using Tier 1 and Tier 2 Methodologies, Gg

	1990	1991	1992	1993	1994	1995	1996
Tier 1, Gg	94.9625	91.5052	90.2826	85.2558	82.8881	75.2674	68.7138
Tier 2, Gg	87.3513	81.2128	79.7688	74.9883	73.2244	64.8018	59.6262
Difference, %	-8.0	-11.2	-11.6	-12.0	-11.7	-13.9	-13.2
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Tier 1, Gg	60.2710	58.5543	54.1593	50.5151	51.2459	51.6685	47.4008
Tier 2, Gg	51.2098	49.8919	46.1429	43.3896	44.1737	45.0836	41.3224
Difference, %	-15.0	-14.8	-14.8	-14.1	-13.8	-12.7	-12.8
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Tier 1, Gg	42.9314	40.9976	39.8649	32.2473	30.9083	31.7614	31.0382
Tier 2, Gg	38.3224	37.0653	35.8562	28.9918	27.6051	28.7010	28.4934
Difference, %	-10.7	-9.6	-10.1	-10.1	-10.7	-9.6	-8.2

6.2.6 Planned Improvements

As, 'cattle' and 'sheep' animal categories account for the largest share in the structure of total methane emissions originated from the 4A 'Enteric Fermentation' source category it is planned to continue activities focused on obtaining more precise values for the main indicators and parameters used to develop the country specific emission factors for respective animal categories following a Tier 2 methodology. Also there are planned activities focused on updating the activity data set for the livestock breeding sector of the Republic of Moldova for the whole period under review.

6.3 Manure Management (Category 4B)

The 4B 'Manure Management' source category 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 great amounts of CH_4 and smaller amount of N_2O; while well aerated systems generate less CH_4 emissions and more N_2O emissions.

6.3.1 Methane Emissions

6.3.1.1 Source Category Description

When manure decomposes anaerobically (in absence of oxygen), methanogenic bacteria produce methane. The main factors affecting production of CH_4 emissions from manure are the amount of manure produced and the share (or percentage) of manure decomposed anaerobically.

On the national level manure production depends on the number of livestock and poultry, and, in particular, on average amount of waste produced per animal per year. The share of manure that decomposes anaerobically depends on how the manure is managed – collected, stored and used. When manure is stored or treated as a liquid (e.g., in lagoons, ponds, tanks, or pits), it decomposes anaerobically and can produce a significant quantity of CH_4. When manure is handled as a solid (e.g., in stacks or piles) or when it is deposited on pastures and paddocks, it tends to decompose under more aerobic conditions and less CH_4 is produced. To estimate methane emissions from manure management the total animal population was divided in 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.

6.3.1.2 Activity Data, Assessment Methodologies and Emission Factors

While following a Tier 1 methodology, there are required livestock population data by animal species/category (identical to those used to estimate CH_4 emissions from the 4A 'Enteric Fermentation') and climate region or temperature (RM corresponds to countries with cold climate - the average annual temperature being less than 15°C), in combination with IPCC default emission factors to estimate emissions (see Equation 10.22, 2006 IPCC Guidelines).

$$CH_4\,emissions = \Sigma_{(T)}\,[(EF_{(T)} \bullet N_{(T)})/10^6]$$

Where:

CH_4 emissions – CH_4 from manure management, for a defined population, Gg CH_4/yr;

$EF_{(T)}$ – emission factor for the defined livestock population, kg CH_4/head/yr;

$N_{(T)}$ – the number of head of livestock species/category T in the country;

T – species/category of livestock.

Since the source category 4B "Manure Management" represents a significant share of 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 GPG (IPCC, 2000) for estimating CH_4 emissions a Tier 2 methodology was used (for cattle and swine).

Methane Emission Factors (EF). 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 characteristic for 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 CH_4 forming process were identified for each type of manure management system.

CH_4 emission factors under the 4B 'Manure Management' source category were calculated by using the Equation 10.23, 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 6-29);

Table 6-29: Daily Volatile Solid Excreted (VS) Calculated for 1990-2010 time series, kg dry matter/day

Categories	1990	1991	1992	1993	1994	1995	1996
Cattle							
Dairy cows	4.15	3.98	3.95	4.03	4.10	4.01	3.99
Other cattle	1.99	2.00	2.02	2.23	2.36	2.31	2.42
Swine							
Market swine	0.85	0.84	0.83	0.83	0.82	0.81	0.81
Fattening swine	0.30	0.30	0.29	0.29	0.28	0.28	0.28
Categories	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Cattle							
Dairy cows	3.87	3.89	3.89	3.92	3.96	4.01	4.02
Other cattle	2.27	2.25	2.25	2.35	2.27	2.32	2.30
Swine							
Market swine	0.82	0.82	0.82	0.82	0.82	0.83	0.83
Fattening swine	0.28	0.28	0.28	0.28	0.29	0.29	0.29
Categories	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Cattle							
Dairy cows	4.17	4.10	4.08	4.11	4.12	4.03	4.13
Other cattle	2.40	2.30	2.31	2.26	2.14	2.08	2.10
Swine							
Market swine	0.83	0.83	0.84	0.84	0.84	0.84	0.84
Fattening swine	0.29	0.29	0.29	0.30	0.30	0.30	0.30

$B_{0(T)}$ – maximum methane producing capacity for manure produced by livestock category T, m^3 CH_4/kg of VS excreted;

0.67 – conversion factor 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 manure management system S in climate region k, dimensionless.

Volatile Solids Excretion Rate (VS) was calculated in conformity with the equation below (see Equation 10.24, Chapter 10, Volume 4, 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 [57] (see country specific values in Table 6-29).

GE – gross energy intake, MJ/day; the same values as those used under the 4.A 'Enteric Fermentation' source category;

DE – digestibility of the feed in per cent; for cattle the same values were used as under the 4A 'Enteric Fermentation'; for fattening swine, DE – 75 per cent, while for market swine, accounting for 15 per cent of the total population of swine, DE – 60 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 1990-2010 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 (IPCC, 2006);

18.45 – conversion factor 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, there were used default values characteristic for Eastern European countries (Tables 6-30 and 6-31).

Methane Conversion Factors (MCF) values vary by different manure management systems and by annual average temperatures. Because of unavailability of country specific methane conversion factors (MCF), the default values provided in 2006 IPCC Guidelines were used, to replace those proposed in the GPG (IPCC, 2000) and Revised 1996 IPCC Guidelines (IPCC, 1997) (Tables 6-32 and 6-33).

[57] 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, Ch. 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, Ch. 10, Table 10A-8, Page 10.81 and Table 10A-7, Page 10.80).

Table 6-30: Coefficients and Default Emission Factors Used Under the 4B 'Manure Management' Source Category for Cattle and Swine

Categories	Mass, kg	Digestibility, %	Energy, MJ / day	Daily feed intake, kg	Manure, kg / day (dry basis)	VS, kg / day	B0, m^3 CH_4 / kg VS	FE, 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 6-31: Coefficients and Default Emission Factors Used Under the 4B 'Manure Management' Source Category (Developed Countries)

Categories	Mass, kg	Digestibility, %	Daily feed intake, kg	% Ash dry basis	VS per day, kg VS	B_0, m^3/kg VS	FC CH_4, %	FE, 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 factor (MCF) represents the extent to which maximum methane producing capacity (B_0) is attained. So, measurement of the 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.

The default values of methane conversion factor for cattle and swine are presented in the Table 6-34, while the percentage of using different manure management systems in Eastern Europe Countries, respectively in the Table 6-35 below.

Based on country specific information (identical to that used for the enteric fermentation), as well as on default EFs and coefficients, there were developed country specific CH_4 EFs for 4B 'Manure Management' source category (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 private sector; the share of liquid manure management, contributing to a greater extent to generation of CH_4 emissions, decreased; while the share of solid manure management systems, less responsible for generation of CH_4 emissions, increased), as well as a consequence of non-compliance of actual manure management systems in the RM with the ones described in the 2006 IPCC Guidelines, it was not deemed necessary to use default values in terms of share of different manure management systems (MS%) characteristic to Eastern European countries.

Table 6-32: Default Values of Methane Conversion Factor for Manure Management Systems non-specified in the Revised 1996 IPCC Guidelines

Additional animal waste management systems		MCF, % IPCC, 2000	MCF, % IPCC, 2006
Pit storage below animal confinements (cattle and swine): collection and storage of manure with little or no added water typically below a slatted floor in an enclosed animal confinement facility, usually for periods less than one year	< 30 days	0	3
	> 30 days	39	17
Composting - Intensive Windrow: composting in windrows with regular (at least daily) turning for mixing and aeration			0.5
Composting - Passive Windrow: composting in windrows with infrequent turning for mixing and aeration			0.5
Poultry manure with litter: similar to cattle and swine deep bedding except usually not combined with a dry lot or pasture; typically used for all poultry breeder flocks and for the production of meat type chickens (broilers) and other fowl			1.5
Poultry manure without litter: may be similar to open pits in enclosed animal confinement facilities or may be designed and operated to dry the manure as it accumulates; the latter is known as a high-rise manure management system and is a form of passive windrow composting when designed and operated properly			1.5
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		0.1	0

Table 6-33: Default Values of Methane Conversion Factor (MCF) for Manure Management Systems, (IPCC, 1997, 2000, 2006)

Manure Management System		MCF, %		
		IPCC, 1997	IPCC, 2000	IPCC, 2006
Pasture/Range/Paddock: the manure from pasture and range grazing animals is allowed to lie as deposited, and is not managed		1	1	1
Daily Spread: manure is not routinely removed from a confinement facility and is applied to cropland or pasture within 24 hours of excretion		0.1	0.1	0.1
Solid Storage: the storage of manure, typically for a period of several months, in unconfined piles or stacks; manure is able to be stacked due to the presence of a sufficient amount of bedding material or loss of moisture by evaporation		1	1	2
Dry lot: a paved or unpaved open confinement area without any significant vegetative cover where accumulat-ing manure may be removed periodically		1	1	1
Liquid/Slurry: manure is stored as excreted or with minimal addition of water in either tanks or earthen ponds outside the animal housing, usually for periods less than one year	with natural crust cover	10	39	10
	without natural crust cover			17
Anaerobic Lagoon: a type of liquid storage system designed and operated to combine waste stabilization and storage; lagoon supernatant is usually used to remove manure from the associated confinement facilities to the lagoon; anaerobic lagoons are designed with varying lengths of storage (up to a year or greater), depending on the climate region, the volatile solids loading rate, and other operational factors; the water from lagoons may be recycled as flush water or used to irrigate and fertilize fields		90	0-100	66
Pit Storage below animal confinements: collection and storage of manure usually with litter or no added water typically below a slatted floor in an enclosed animal confinement, usually for periods less than one year	< 1 month	5	0	3
	> I month	10	39	17
Anaerobic Digester: the dung and urine in liquid/slurry are collected and anaerobically digested; methane may be burned flared or vented.		5-15	0-100	0-100
Burned for Fuel: the dung and urine are excreted on fields; the sun dried dung cakes are burned for fuel		5-10	10	10

Table 6-34: Manure Management Systems MCFs for Different Animal Categories

Manure Management Systems	MCF for different animal categories , %			
	Revised 1996 IPCC Guidelines		2006 IPCC Guidelines	
	Cattle	Swine	Cattle	Swine
Anaerobic Lagoon	47	19	66	66
Liquid/Slurry	39	39	17	17
Solid Storage	1	1	2	2
Dry lot	1	1	1	1
Pasture/Range/Paddock	1	0	1	0
Pit Storage below animal confinements < 1 month	0	0	0	3
Pit Storage below animal confinements > 1 month	0	39	0	17
Daily Spread	0.1	0.1	0.1	0.1
Anaerobic Digester	0	0	10	10
Burning for fuel	10	0	10	0
Other Systems	1	1	1	1

Source: *Revised 1996 IPCC Guidelines* (1997), Vol. 3, Tab. B-3, Page 4.43, Tab. B-4 and Tab. B-6; *2006 IPCC Guidelines*, Vol. 4, Chap. 10, Tab. 10A-4, 10A-5, Tab. 10A-7 and Tab. 10A-8.

Table 6-35: Default Manure Management Systems Usage in the Eastern Europe (MS%)

Category	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
Category	**Anaerobic Lagoon**	**Liquid / Slurry**	**Solid Storage**	**Pits<1 month**	**Pits>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: *IPCC 2006 Guidelines*, Vol. 4, Chap. 10, Tab. 10A-4, 10A-5, Tab. 10A-7 and Tab. 10A-8.

So, to calculate CH_4 emissions from the 4B 'Manure Management' source category (for cattle and swine), country specific values were used on the manure management systems usage in the Republic of Moldova (specialist from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine were consulted) (Table 6-36).

Country specific EFs, calculated following a simplified Tier 2 approach (Equation 10.23 from the 2006 IPCC Guidelines) are provided below (Table 6-37).

For cattle and swine population, the share of animal population by sub-categories was taking into account for estimating average national EFs (see Table 6-21 for 'other cattle' and Table 6-38 for 'swine').

To be noted that country specific CH_4 EFs values for cattle and swine, calculated by following a simplified Tier 2 methodology (see Table 6-37), can be considered intermediary to the CH_4 EFs values used by a number Annex I Parties under the UNFCCC in their national GHG inventories for the period from 1990 through 2010 (Table 6-39).

6.3.1.3 Uncertainties Assessment and Time-Series Consistency

Uncertainties related to estimation of methane emissions from 4B 'Manure Management' source category, depend on the accuracy of the livestock characterization, and also on the default emission factors used. The uncertainties associated with the total animal population in the Republic of Moldova are higher than it is officially acknowledged (circa 10 per cent). It is quite likely that the reported data collected from current statistical reports are erroneous; in particular keeping in mind that seasonal variation in total animal population is not taken into account.

Table 6-36: Manure Management Systems Usage (MS%) in the RM within 1989-2011time periods

Animal categories (T) and Management systems (S)	1989/ 1990	1991/ 1992	1993/ 1994	1995/ 1997	1998/ 1999	2000/ 2001	2002/ 2003	2004/ 2005	2006/ 2007	2008/ 2009	2010/ 2011
	MS $_{(T, S)}$ values										
Dairy cows	100	100	100	100	100	100	100	100	100	100	100
Pasture/Range/Paddock	12	14	18	22	24	24	24	24	23	23	24
Liquid/Slurry	18	16	12	7	5	3	2	2	2	2	2
Solid Storage	70	70	70	71	71	73	74	74	75	75	74
Other cattle	100	100	100	100	100	100	100	100	100	100	100
Pasture/Range/Paddock	10	12	16	18	20	21	22	22	22	22	22
Liquid/Slurry	20	18	13	10	7	5	3	2	2	2	2
Solid Storage	70	70	71	72	73	74	75	76	76	76	76
Swine	100	100	100	100	100	100	100	100	100	100	100
Liquid/Slurry	24	22	20	18	16	14	12	10	10	12	12
Solid Storage	76	78	80	82	84	86	88	90	90	88	88
Sheep and Goats	100	100	100	100	100	100	100	100	100	100	100
Pasture/Range/Paddock	26	26	22	24	22	22	22	22	22	22	22
Solid Storage	74	74	78	76	78	78	78	78	78	78	78
Horses, Asses and Mules	100	100	100	100	100	100	100	100	100	100	100
Pasture/Range/Paddock	24	22	20	20	18	18	18	18	18	18	18
Solid Storage	76	78	80	80	82	82	82	82	82	82	82
Rabbits	100	100	100	100	100	100	100	100	100	100	100
Solid Storage	100	100	100	100	100	100	100	100	100	100	100
Poultry	100	100	100	100	100	100	100	100	100	100	100
Pasture/Range/Paddock	2	2	2	2	3	3	3	3	3	3	3
Liquid/Slurry	20	15	13	10	8	7	7	7	7	7	7
Solid Storage	78	83	85	88	89	90	90	90	90	90	90

Table 6-37: Country Specific Methane EFs for the 4B 'Manure Management', Calculated following a Tier 2 Methodology for Cattle and Swine Population in the RM

Categories	1990	1991	1992	1993	1994	1995	1996
Dairy cows	11.15	9.94	9.88	8.56	8.70	6.66	6.62
Other cattle (average)	4.05	3.82	3.84	3.52	3.71	3.18	3.34
Swine (average)	2.13	2.03	2.03	1.95	1.93	1.78	1.79
Market swine	5.21	4.92	4.87	4.55	4.52	4.21	4.20
Fattening piglets	1.85	1.74	1.71	1.59	1.56	1.45	1.44
Categories	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Dairy cows	6.44	5.73	5.74	5.08	5.14	4.85	4.86
Other cattle (average)	3.13	2.66	2.67	2.48	2.40	2.15	2.13
Swine (average)	1.83	1.75	1.74	1.65	1.69	1.57	1.54
Market swine	4.22	3.96	3.95	3.69	3.70	3.45	3.47
Fattening piglets	1.45	1.37	1.37	1.28	1.29	1.21	1.21
Categories	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Dairy cows	5.04	4.96	4.96	4.99	5.01	4.90	4.99
Other cattle (average)	2.07	1.99	2.00	1.96	1.85	1.80	1.82
Swine (average)	1.43	1.45	1.43	1.41	1.53	1.53	1.53
Market swine	3.21	3.21	3.22	3.23	3.52	3.52	3.53
Fattening piglets	1.12	1.13	1.13	1.14	1.24	1.24	1.25

Table 6-38: Swine Population Distribution by Sub-categories in the RM within 1990-2010, %

	1990	1991	1992	1993	1994	1995	1996
Swine, total	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
Piglets	91.6	90.9	90.1	87.7	87.5	87.9	87.2
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Swine, total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Market swine	13.6	14.6	14.5	15.3	16.6	16.3	14.7
Piglets	86.4	85.4	85.5	84.7	83.4	83.7	85.3
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Swine, total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Market swine	14.9	15.5	14.2	13.2	13.0	12.9	12.1
Piglets	85.1	84.5	85.8	86.8	87.0	87.1	87.9

Source: NBS, Statistical Annual Report Nr. 24-agr „Animal Breeding Sector", the Number of Livestock and Poultry in all Households Categories as of 1st of January (annually for 1990-2011).

To be noted that the uncertainty range for the default emission factors calculated by using a Tier 1 method is estimated to be ±30 per cent (IPCC, 2006). Since this approach is not based on the country specific data and the characteristics of livestock from particular countries are not taken into account, the general uncertainty related to the use of this methodology can get to ±50 per cent (IPCC, 2006). If a Tier 2 methodology is to be used, uncertainties related to manure management systems to great extent depend on the characteristic features of the livestock breeding sector and how information on manure management systems is collected in the RM. Because lately the RM uses preponderantly two manure management systems (pasture/range/paddock and solid storage), uncertainties related to manure management systems can be considered relatively small (circa ±10 per cent), however, due to the fact that previously a wide spectrum of manure management systems was used, the uncertainties on these are considered to be average (up to ±30 per cent).

Table 6-39: Country Specific Methane EFs Values Under the 4B "Manure Management' used by a number Annex I Parties in their National GHG Inventories, kg CH_4/head/yr

Categories	Austria		Portugal		Italy		Hungary		New Zeeland	
	1990	2010	1990	2010	1990	2010	1990	2010	1990	2010
Dairy cows	8.73	9.00	2.31	7.81	15.04	11.23	6.90	7.72	2.88	3.39
Other cattle	3.31	4.13	1.33	1.35	7.47	5.78	2.05	2.08	0.65	0.75
Swine	1.59	1.28	20.44	21.30	8.11	5.88	10.87	10.87	5.94	5.94
Categories	Russia		Latvia		Estonia		Poland		Denmark	
	1990	2010	1990	2010	1990	2010	1990	2010	1990	2010
Dairy cows	4.77	4.65	5.49	10.60	7.85	10.43	5.63	13.76	21.05	33.19
Other cattle	5.83	4.13	4.00	4.00	3.58	3.42	1.61	2.56	5.96	9.48
Swine	6.72	5.95	4.00	4.00	1.93	2.06	5.24	5.97	2.12	2.20

Sources: National Inventory Reports for 1990-2010 (submission of 2012 year) of Austria, Portugal, Italy, Hungary, New Zeeland, Russia, Latvia, Estonia, Poland and Denmark.

Combined uncertainties associated with methane emissions from manure management can be considered moderate for cattle and swine (±31.62 per cent) and medium for other animal categories (±50.99 per cent for sheep, goats, horses and ±53.85 per cent for poultry, rabbits, asses and mules). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±0.41 per cent for cattle, ±0.07 per cent for sheep, ±0.007 per cent for goats, ±0.05 per cent for horses, ±0.001 per cent for asses and mules, ±0.29 per cent for swine, ±0.26 per cent for poultry and ±0.05 per cent for rabbits. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.33 per cent for cattle, ±0.01 per cent for sheep, ±0.003 per cent for goats, ±0.02 per cent for horses, ±0.0002 per cent for asses and mules, ±0.34 per cent for swine, ±0.07 per cent for poultry and ±0.02 per cent for rabbits.

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 GPG (IPCC, 2000).

6.3.1.4 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 (IPCC, 2000). To be noted, that the AD and methods used for estimating CH_4 emissions under this category were documented and archived both in hard copies and electronically. For identifying the data entry and GHG emissions estimation process related errors there were applied AD and EFs verifications and quality control procedures.

6.3.1.5 Recalculations

Methane emissions from the 4B 'Manure Management' source category were recalculated for the 1990 through 2010 time series, in particular due to use of an updated set of activity data on animal population (available into the Statistical Yearbooks of the RM and those of the ATULBD, Statistical Sectoral Reports, as Statistical Annual Report Nr. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all Households Categories as of 1st of January" and "Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM"), use of new EFs related to the Tier 2 method (for categories like 'diary cows', 'other cattle' and 'swine'), as well as a result of using updated set of data on manure management systems in the RM (MS%).

For other categories of livestock, default EFs characteristic to cold climate were used: 0.19 kg CH_4/head/year for sheep, 0.13 kg CH_4/head/year for goats, 1.56 kg CH_4/head/year for horses, 0.76 kg CH_4/head/year for asses and mules, 0.08 kg CH_4/head/year for rabbits, 0.03 kg CH_4/head/year for chickens, 0.02 kg CH_4/head/year for ducks and geese and 0.09 kg CH_4/head/year for turkeys (IPCC, 2006).

In comparison with emissions estimates included into the SNC of the RM under the UNFCCC, the changes performed resulted in significant decreased methane emissions from 4B 'Manure Management' over the period 1990 through 2010, with a variation from a minimum of 6.1 per cent in 1998 to a maximum of 34.2 per cent in 1990 (Table 6-40).

Table 6-40: Comparative Results of CH_4 Emissions from 4B 'Manure Management' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	18.4577	14.8059	13.9289	10.2705	9.7638	7.6557	6.9880
TNC	12.1384	10.8795	10.0671	8.0186	7.9323	6.2651	5.7862
Difference, %	-34.2	-26.5	-27.7	-21.9	-18.8	-18.2	-17.2
	1997	1998	1999	2000	2001	2002	2003
SNC	6.1837	5.0729	5.5576	4.6448	3.8854	3.8472	3.8759
TNC	4.9870	4.7643	4.2933	3.4319	3.5221	3.4761	3.1873
Difference, %	-19.4	-6.1	-22.7	-26.1	-9.3	-9.6	-17.8
	2004	2005	2006	2007	2008	2009	2010
SNC	3.5686	3.3608					
TNC	2.9603	3.0965	3.1418	2.3099	2.2931	2.5702	2.7336
Difference, %	-17.0	-7.9					

For the period 2006-2010, methane emissions resulting from manure management were estimated for the first time. The obtained results allow assert that within the 1990-2010 time series methane emissions from 4B 'Manure Management' source category decreased by 77.5 per cent, in particular due to reduced animal population, to negative changes in the productivity of this sector but also due to changes in the share of animal waste management systems in the livestock breeding sector of the RM. To be noted that over the period under review the share of different animals in the structure of methane emissions from the 4.B 'Manure Management' source category has changed significantly. By 2010, the share of such livestock categories as 'dairy cows', 'other cattle', 'sheep' and 'swine' decreased significantly in comparison with the 1990 year level, while the share of other livestock and poultry categories ('sheep', 'goats', 'horses', 'asses and mules', 'rabbits' and 'poultry') increased considerably (Table 6-41).

Table 6-41: Breakdown of the Methane Emissions from 4B 'Manure Management' by Livestock and Poultry Category within 1990-2010 time periods, %

Categories	1990	1991	1992	1993	1994	1995	1996
Dairy cows	36.3	36.3	39.6	42.9	44.2	40.5	40.7
Other cattle	22.2	21.2	21.6	21.1	20.1	17.7	16.8
Sheep	1.9	2.2	2.4	3.2	3.4	4.0	4.2
Goats	0.0	0.1	0.1	0.1	0.2	0.2	0.2
Horses	0.6	0.7	0.8	1.1	1.1	1.5	1.7
Asses and mules	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Swine	32.5	32.7	29.9	26.3	25.5	28.9	29.4
Rabbits	0.2	0.2	0.2	0.3	0.2	0.3	0.3
Chickens	5.0	5.4	4.0	3.6	3.8	4.9	4.7
Geese	0.2	0.2	0.3	0.3	0.4	0.5	0.5
Ducks	0.4	0.4	0.3	0.3	0.3	0.4	0.4
Turkeys	0.7	0.7	0.7	0.8	0.8	1.1	1.1
Categories	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Dairy cows	41.8	38.3	41.0	44.2	43.8	42.5	42.4
Other cattle	14.2	12.0	10.9	10.6	10.4	9.3	8.8
Sheep	4.3	4.2	4.2	4.7	4.6	4.6	5.0
Goats	0.3	0.3	0.3	0.4	0.4	0.5	0.5
Horses	2.0	2.2	2.6	3.5	3.6	3.7	4.0
Asses and mules	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Swine	29.3	34.1	30.5	23.7	23.5	24.9	23.1
Rabbits	0.3	0.3	0.3	0.4	0.4	0.4	0.5
Chickens	5.5	6.0	7.0	8.7	9.3	9.9	11.5
Geese	0.6	0.6	0.7	0.9	0.9	1.0	1.1
Ducks	0.5	0.5	0.6	0.8	0.8	0.8	0.9
Turkeys	1.3	1.4	1.7	2.1	2.1	2.2	2.2
Categories	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Dairy cows	42.4	37.3	35.0	39.1	37.5	33.0	30.3
Other cattle	7.7	6.8	6.7	6.2	5.4	4.9	4.7
Sheep	5.4	5.1	5.1	6.3	6.4	6.0	5.6
Goats	0.5	0.5	0.5	0.6	0.6	0.6	0.6
Horses	4.0	3.6	3.4	4.1	3.9	3.4	3.1
Asses and mules	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Swine	20.4	23.1	25.9	19.6	20.2	24.1	28.6
Rabbits	0.6	0.7	0.8	0.9	0.9	0.9	0.8
Chickens	13.7	16.7	16.5	18.4	20.2	22.0	21.4
Geese	1.2	1.4	1.3	1.2	1.1	1.2	1.1
Ducks	1.1	1.5	1.6	1.2	1.3	1.5	1.5
Turkeys	2.7	3.1	3.0	2.4	2.3	2.4	2.3

With reference to animal categories 'dairy cows', 'other cattle' and 'swine', the Tier 2 impact is much greater than in case of Tier 1 methodology. The use of a Tier 2 method, an approach that reflects country specific conditions, in particular related to manure management systems (MS%), has contributed to much lower values of CH_4 emissions within the 4B 'Manure Management' source category, varying between a minimum of 31.4 per cent in 1992 to a maximum of 57.2 per cent in 2002 (Table 6-42).

Table 6-42: Comparative Results of CH_4 Emissions from 4B 'Manure Management' Source Category, estimated using Tier 1 and Tier 2 Methodologies, Gg

	1990	1991	1992	1993	1994	1995	1996
Tier 1, Gg	19.0817	16.0707	14.6785	12.4115	13.4547	11.1497	10.2145
Tier 2, Gg	12.1384	10.8795	10.0671	8.0186	7.9323	6.2651	5.7862
Difference, %	-36.4	-32.3	-31.4	-35.4	-41.0	-43.8	-43.4
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Tier 1, Gg	8.8426	9.2438	9.2475	7.6652	6.9640	8.1178	6.5699
Tier 2, Gg	4.9870	4.7643	4.2933	3.4319	3.5221	3.4761	3.1873
Difference, %	-43.6	-48.5	-53.6	-55.2	-49.4	-57.2	-51.5
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Tier 1, Gg	5.9633	6.1896	6.3635	5.2758	4.8208	5.4919	5.9680
Tier 2, Gg	2.9603	3.0965	3.1418	2.3099	2.2931	2.5702	2.7336
Difference, %	-50.4	-50.0	-50.6	-56.2	-52.4	-53.2	-54.2

6.3.1.6 Planned Improvements

As, 'cattle' and 'swine' livestock categories account for the largest share in the structure of total methane emissions originated from the 4B 'Manure Management' source category it is planned to continue activities focused on obtaining more precise values for the main indices and parameters used to develop country specific emission factors for respective animal categories following a Tier 2 method, also there are planned activities focused on updating the activity data set for the livestock breeding sector of the Republic of Moldova.

6.3.2 Nitrous Oxide Emissions

6.3.2.1 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. To be noted that nitrification is the aerobic oxidation of ammonia nitrogen (NH_4^+) to nitrate nitrogen (NO_3^-), while nitrites and nitrates are transformed to N_2O and dinitrogen (N_2) during the naturally occurring process of denitrification, that is an anaerobic process: $NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$.

The direct emission of N_2O from manure during storage and treatment depends on the nitrogen and carbon content of manure, and on the duration of the storage and type of treatment within the animal waste management systems. It is considered that sufficient supply of oxygen to 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.

In summary, 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[58] 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.

6.3.2.2 Activity Data, Assessment Methodologies and Emission Factors

N_2O emissions from the 4B 'Manure Management' source category were estimated based on a Tier 2 methodology (IPCC, 2006). To estimate direct N_2O emissions from manure management it was necessary to collect information on the total livestock population (identical to those used for the 4.A 'Enteric Fermentation' source category), information on the amount of produced manure per head in a year, as well as information on manure management systems usage in the RM.

The following five steps were used to estimate direct N_2O emissions from 4B 'Manure Management':

(i) collect livestock population data from the livestock population characterization;

(ii) develop the annual average nitrogen excretion rate per head ($Nex_{(T)}$) 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) for each manure management system type S, multiply the emission factor ($FE_{3(S)}$) by the total amount of nitrogen managed (from all livestock species/categories) in that system, to estimate N_2O emissions from that manure management system, then sum over all manure management systems.

[58] Leaching – the loss of mineral and organic solutes due to water or other liquids percolation from soil.

The calculation of direct N_2O emissions from manure management is based on the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equation 10.25):

$$N_2O_{D(mm)} = [\Sigma_{(S)} [\Sigma_{(T)} (N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)})] \bullet FE_{3(S)}] \bullet 44/28$$

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;

$Nex_{(T)}$ – 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 $Nex_{(T)}$ is based on the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equation 10.30):

$$Nex_{(T)} = N_{rate(T)} \bullet (TAM/1000) \bullet 365$$

Where:

$Nex_{(T)}$ – 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/yr.

Based on information on the typical (average) weight of livestock and poultry in the Eastern European countries and default values of nitrogen excretion rate (kg N/1000 kg of animal mass/yr) characteristic for the same region, country specific $Nex_{(T)}$ values were calculated (Table 6-43).

Table 6-43: Average Annual N Excretion by main livestock and poultry categories in Eastern European countries

Categories	$N_{rate(T)}$, kg N/ 1000 kg/day	TAM, weigh, kg	$N_{ex(T)ANIMAL}$, kg N/ head/year
Dairy cows	0.35	550	70.3
Other cattle	0.35	395	50.5
Sheep	0.90	28	9.2
Goats	1.28	30	14.0
Horses	0.30	238	26.1
Asses and mules	0.30	130	14.2
Swine	0.74	70	18.8
Fattening swine	0.55	50	10.0
Market swine	0.46	180	30.2
Rabbits	7.40	3.0	8.1

Categories	$N_{rate (T)}$, kg N/ 1000 kg/day	TAM, weigh, kg	$N_{ex (T) ANIMAL}$, kg N/ head/year
Chicken	0.82	1.8	0.5
Geese	0.83	4.0	1.2
Ducks	0.83	3.0	0.9
Turkeys	0.74	7.0	1.9

Source: *IPCC 2006 Guidelines*, Volume 4, Chapter 10, Table 10.19, Page 10.59, Table 10A-9, Page 10.82.

The $Nex_{(T)}$ country specific values (Table 6-44) were estimated using this approach, default values for N excretion values for Eastern European countries, as well as country specific information on the typical animal mass (TAM) in the RM during the period under review (see Table 6-10).

Table 6-44: Average Annual $Nex_{(T)}$ Excretion by main livestock and poultry categories in the RM, within 1990-2010, kg N/head/year

Categories	1990	1991	1992	1993	1994	1995	1996
Dairy cows	60.8	56.6	54.9	53.0	52.8	52.6	52.5
Other cattle	49.9	46.7	43.5	42.0	40.4	40.6	41.9
Sheep	14.1	14.5	14.1	14.1	14.5	12.8	12.8
Goats	17.8	18.2	17.8	17.8	18.2	15.9	15.9
Horses	42.8	34.6	37.3	37.7	40.4	39.0	37.2
Asses and mules	14.3	13.8	13.6	13.7	13.5	13.1	12.5
Swine	26.5	24.4	22.3	21.3	20.3	22.4	25.9
Rabbits	8.1	8.0	7.8	7.7	7.6	7.4	7.3
Chicken	0.6	0.6	0.6	0.5	0.5	0.5	0.5
Geese	1.2	1.2	1.2	1.1	1.1	1.0	1.1
Ducks	0.8	0.8	0.8	0.8	0.7	0.7	0.8
Turkeys	1.8	1.8	1.8	1.7	1.6	1.5	1.6
Categories	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Dairy cows	57.7	56.6	56.1	55.6	55.4	55.4	55.1
Other cattle	40.6	39.3	38.7	37.6	37.9	37.6	37.0
Sheep	11.5	11.5	11.5	11.5	10.8	10.8	10.8
Goats	14.0	14.0	14.0	14.0	13.1	13.1	13.1
Horses	33.5	33.3	30.8	31.2	31.0	31.2	31.8
Asses and mules	12.3	12.2	11.4	11.6	11.5	11.6	11.7
Swine	23.0	16.7	15.4	14.0	13.4	12.7	13.2
Rabbits	7.3	7.3	7.5	7.4	7.3	7.4	7.4
Chicken	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Geese	1.0	1.0	1.1	1.0	1.1	1.1	1.1
Ducks	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Turkeys	1.5	1.6	1.6	1.6	1.6	1.5	1.6
Categories	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Dairy cows	55.6	54.8	54.5	54.3	51.7	52.2	53.7
Other cattle	38.3	37.4	37.9	36.3	36.5	36.9	37.2
Sheep	10.8	10.8	11.2	10.8	10.8	11.5	11.5
Goats	13.1	13.1	13.5	13.1	13.1	14.0	14.0
Horses	30.9	32.4	36.4	32.5	33.7	33.1	33.6
Asses and mules	11.4	12.0	12.2	12.1	12.4	12.2	12.4
Swine	13.8	13.5	13.8	13.8	15.1	15.1	14.9
Rabbits	7.3	7.4	7.4	7.3	7.4	7.6	7.7
Chicken	0.5	0.5	0.5	0.6	0.6	0.6	0.6
Geese	1.1	1.2	1.2	1.2	1.2	1.2	1.2
Ducks	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Turkeys	1.6	1.7	1.7	1.8	1.8	1.8	1.8

To be noted that where organic forms of bedding material (straw, sawdust, chippings, etc.) are used, the additional nitrogen from the bedding should also be considered as part of the managed manure N applied to soils. Based on information from scientific literature, country specific values on average annual N excretion ($N_{ex(T)}$) from manure were calculated following an alternative methodological approach (Table 6-45).

Although the average annual N excretion values $Nex_{(T)}$ were calculated by different methods, the obtain results are still comparable. As values featured in Table 6-45 are not available for all animal categories, $Nex_{(T)}$ values set forth in Table 6-44 were used to calculate the direct N_2O emissions from manure management in the RM.

Information on manure management systems usage is identical to that used earlier in sub-chapter 6.3.1. To 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 Revised 1996 Guidelines (IPCC, 1997)[59], so their use was deemed to be inappropriate.

To estimate direct N_2O emissions from the 4B 'Manure Management' source category there were used country specific information (identified following experts opinions – the experts from the specialist from the Scientific-Practical Institute of Biotechnology in Animal Breeding and Veterinary Medicine from Maximovca, Anenii Noi District were consulted) on the manure management systems usage in the RM (see Table 6-37).

A *good practice* is to estimate emissions from manure management systems keeping account of duration of the storage and type of treatment. While identifying types of treatment, account should be taken of temperature and aeration. As it was not possible to use country specific EFs, the default values provided into the 2006 IPCC Guidelines were used in the RM (Table 6-46).

A significant portion 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 nitrogen losses occurring through volatilization (NH_3, NO_x), as well as runoffs and leaching.

Indirect N_2O emissions from the source category 4B 'Manure Management' were estimated by using a Tier 1 methodology (IPCC, 2006). Indirect N_2O emissions ($N_2O_{G(mm)}$) from volatilization of N in forms of NH_3 and NO_x were estimated by using the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equations 10.26 and 10.27):

$$N_2O_{G(mm)} = [\Sigma_{(S)} [\Sigma_{(T)} (N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}) \bullet (Frac_{GasMS} / 100)_{(T,S)}] \bullet FE_4 \bullet 44/28$$

Where:

$N_2O_{G(mm)}$ – indirect N_2O emissions due to volatilization of N from Manure Management in the country (kg N_2O/yr);

[59] *Revised 1996 Guidelines*, Volume 3, Table 4-21, Page 4.101.

Table 6-45: Average Annual N Excretion for a Typical Animal, Nex $_{(T)}$ Calculated Based on Country Specific Data

Categories	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/tone	$N_{ex\,(T)}$ with/without bedding kg N/head/yr
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.

Table 6-46: Default EFs for N_2O Emissions from Manure Management Systems

Manure Management System		FE_3, kg N_2O-N / kg N excreted	Uncertainty ranges of FE_3
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 treated in 'N_2O from agricultural soils'	cattle, swine, poultry	0.020	0.007-0.06
	sheep, goats, horses, asses and mules	0.010	0.003-0.03
Solid Storage: The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure is able to be stacked due to the presence of a sufficient amount of bedding material or loss of moisture by evaporation		0.005	Factor of 2
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
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 Emissions are considered to be insignificant due to absence of oxidized forms of nitrogen, combined with the low nitrification and denitrification potential in this manure management system	With natural crust cover	0.005	Factor of 2
	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
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
	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
Composting - Static Pile: Composting in piles with forced aeration but no mixing		0.006	Factor of 2
Composting – Intensive Windrow: Composting in windrows with regular turning for mixing and aeration		0.100	Factor of 2
Composting – Passive Windrow: Composting in windrows with infrequent turning for mixing and aeration		0.010	Factor of 2
Poultry manure with litter: Manure is excreted on floor with bedding, birds walk on manure		0.001	Factor of 2
Poultry manure without bedding: Manure is excreted on floor without bedding, birds do not walk on manure		0.001	Factor of 2
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
	Forced aeration systems	0.005	Factor of 2

$N_{(T)}$ – number of head of livestock species/category T in the country;

$Nex_{(T)}$ – 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 NH_3 and NO_x in the manure management system S, per cent (see in Table 6-47);

Table 6-47: Default Values for Total Nitrogen Loss, that Volatilize in NH_3 and NO_x from Manure Management S, %

Categories	Manure Management System (MMS)	Total N loss from MMS due tovolatilization of N-NH_3 and N-NO_x (%), $Frac_{GasMS}$ (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	Deep bedding	25% (10-30)
	Solid storage	12% (5-20)
Poultry	Poultry without litter	55% (40-70)
	Anaerobic lagoon	40% (25-75)
	Poultry with litter	40% (10-60)

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-N)(mm) emissions to N_2O (mm) emissions.

Indirect N_2O emissions ($N_2O_{L(mm)}$) from leaching and runoff were estimated by using the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equations 10.28 and 10.29):

$$N_2O_{L(mm)} = [\Sigma_{(S)} [\Sigma_{(T)} (N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}) \bullet (Frac_{leach\ MS} /100)_{(T,S)}] \bullet FE_5 \bullet 44/28$$

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;

$Nex_{(T)}$ – 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;

$Frac_{leach\ MS}$ – 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) $_{L(mm)}$ emissions to $N_2O_{L(mm)}$ emissions.

From the scientific literature it is known that in drier climates, runoff losses are smaller (circa 3-6 per cent of N excreted) than in high rainfall areas (5-19 per cent, respectively). Leaching losses of nitrogen depend on weather conditions, varying between 5 to 16 per cent (IPCC, 2006).

Table 6-48 presents 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.

Table 6-48: Default Values (IPCC, 2006) for Total Nitrogen Loss from Manure Management S, %

Animal Categories	Manure Management System (MMS)	Total N loss from MMS (%), $Frac_{LossMS}$ (Range of Frac)
Dairy Cow	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 & Mules	Deep bedding	35% (15-40)
	Solid storage	15% (5-20)
Poultry	Poultry without litter	55% (40-70)
	Anaerobic lagoon	77% (50-99)
	Poultry with litter	50% (20-80)

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 excretion of the manure. Losses also occur in the form of NO_3, N_2O, and N_2, in particular from leaching and runoff that occurs where manure is stored in piles. The values included in the table reflect average values for typical housing/storage combinations for each animal category.

Following storage in any system of manure management, nearly all the manure is applied to land. The N_2O emissions that subsequently arise from application of the manure to soil should be reported under the category 4D 'Agricultural Soils'.

The estimate of managed manure N available for application to managed soils was based on the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equation 10.34):

$$N_{MMS\_Avb} = \Sigma_{(S)} \{\Sigma_{(T)} [(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}) \bullet (1\text{-}Frac_{leach\ MS}/100)] + [N_{(T)} \bullet Nex_{(T)} \bullet N_{bending\ MS}]\}$$

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;

$Nex_{(T)}$ – 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; limited data from scientific literature indicates the amount of nitrogen contained in organic bedding material applied for dairy cows and heifers is usually around 7 kg N/animal/year, for other cattle is 4 kg N/animal/year, for market and breeding swine is around 0.8 and 5.5 kg N/animal/year, respectively; for deep bedding systems, the amount of N in litter is approximately double these amounts (Webb, 2001; Döhler et al., 2002); cited from 2006 IPCC Guidelines);

S – manure management system;

T – species/category of livestock.

6.3.2.3 Uncertainties Assessment and Time-Series Consistency

Uncertainties related to estimation of N_2O emissions from 4B 'Manure Management' source category, depend on the accuracy of the livestock characterization (±10%), and also on the default emission factors used. Uncertainty ranges for the default N excretion rates ($Nex_{(T)}$) are estimated at about ±50 per cent and they can be reduced by ±25 per cent using country specific values.

To be noted that uncertainties associated with the default emission factors for direct N_2O emissions from manure management are large (-50 per cent to +100 per cent). Uncertainties associated with the default emission factors for indirect N_2O emissions from manure management, in particular, 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 quite large. The uncertainty associated with default emission factors for nitrogen volatilization and re-deposition (EF_4), as well as for leaching and runoff (EF_5), are also quite high, from -100 per cent, to +200 per cent.

The combined uncertainties associated with direct N_2O emissions from manure management can be considered medium for 'cattle', 'sheep' and 'swine' (±50.99 per cent), as well as for 'poultry' (±53.85 per cent), and high for other animal categories: ±75.66 per cent for 'goats', 'horses', and respectively ±77.62 per cent for 'rabbits', 'asses and mules'. At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±3.58 per cent for cattle, ±1.46 per cent for 'sheep', ±0.37 per cent for 'goats', ±0.88 per cent for 'horses', ±0.008 per cent for 'asses and mules', ±1.52 per cent for 'swine', ±2.26 per cent for 'poultry' and ±0.61 per cent for 'rabbits'. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.62 per cent for 'cattle', ±0.26 per cent for 'sheep', ±0.15 per cent for 'goats', ±0.30 per cent for 'horses', ±0.002 per cent for 'asses and mules', ±0.68 per cent for 'swine', ±0.64 per cent for 'poultry' and ±0.17 per cent for 'rabbits'.

Combined uncertainties associated with indirect N_2O emissions from manure management can be considered high for 'cattle', 'sheep' and 'swine' (±100.50 per cent), as well as for 'poultry' (±101.98 per cent), and very high for other animal categories:±150.33 per cent for 'goats', 'horses', and respectively ±151.33 per cent for 'rabbits', 'asses and mules'. At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±1.35 per cent for 'cattle', ±0.47 per cent for 'sheep', ±0.12 per cent for 'goats', ±0.28 per cent for 'horses', ±0.003 per cent for 'asses and mules', ±0.71 per cent for 'swine', ±1.09 per cent for 'poultry' and ±0.19 per cent for 'rabbits'. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.32 per cent for 'cattle', ±0.07 per cent for 'sheep', ±0.05 per cent for 'goats', ±0.09 per cent for 'horses', ±0.001 per cent for 'asses and mules', ±0.41 per cent for 'swine', ±0.22 per cent for 'poultry' and ±0.05 per cent for 'rabbits'.

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 GPG (IPCC, 2000).

6.3.2.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the respective category under the 'Agriculture' Sector, following a Tier 1 approaches (IPCC, 2000). Also, the AD and methods used for estimating N_2O emissions under the category 4B 'Manure Management' were documented and archived both in hard copies and electronically. For identifying the data entry and N_2O emission estimation process related errors there were applied verifications and quality control procedures.

6.3.2.5 Recalculations

N_2O emissions from the 4B 'Manure Management' source category were recalculated for the 1990 through 2010 time series, in particular due to use of an updated set of activity data on animal population (available into the Statistical Yearbooks of the RM and those of the ATULBD, Statistical Sectoral Reports, as Statistical Annual Report Nr. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all Households Categories as of 1st of January" and "Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM"), use of revised EFs calculated following a Tier 2 methodology (for categories 'dairy cows', 'other cattle' and 'swine'), due to use of country specific value data on N excretion (kg N/1000 kg animal mass/year), as well as a result of using revised information on manure management systems in the RM (MS%).

The obtained results allow assert that compared with SNC of the RM under the UNFCCC, within the current inventory cycle, the direct $N_2O_{D(mm)}$ and indirect $N_2O_{IND(mm)}$ emissions slowly increased between 1990-1991 (Table 6-49 and 6-50), varying from a minimum of 0.7 per cent in 1991 to a maximum of 4.9 per cent in 1990 for $N_2O_{D(mm)}$, respectively, from a minimum of 1.3 per cent in 1991 and a maximum of 6.2 per cent in 1990 for $N_2O_{IND(mm)}$.

Table 6-49: Comparative Results of Direct $N_2O_{D(mm)}$ Emissions from 4B 'Manure Management' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	3.4334	3.2613	3.1303	2.5800	2.5221	2.4704	2.3046
TNC	3.6011	3.2827	2.8580	2.4284	2.3436	2.2452	2.1846
Difference, %	4.9	0.7	-8.7	-5.9	-7.1	-9.1	-5.2
	1997	1998	1999	2000	2001	2002	2003
SNC	2.1212	1.8819	1.9223	1.7768	1.5650	1.6247	1.6800
TNC	1.8360	1.7051	1.5302	1.3367	1.3589	1.3902	1.3258
Difference, %	-13.4	-9.4	-20.4	-24.8	-13.2	-14.4	-21.1
	2004	2005	2006	2007	2008	2009	2010
SNC	1.5835	1.5134					
TNC	1.3012	1.4185	1.4748	1.1177	1.1155	1.2721	1.3297
Difference, %	-17.8	-6.3					

Over the period from 1992 through 2005, direct and indirect N_2O emissions from the 4B 'Manure Management' source category decreased, varying from a minimum of 5.2 per cent in 1996 to a maximum of 24.8 in 2000 for $N_2O_{D(mm)}$ emissions, respectively from a minimum of 4.0 per cent in 1996 to a maximum of 26.5 per cent in 2000 for$N_2O_{IND(mm)}$ emissions.

Table 6-50: Comparative Results of Indirect $N_2O_{IND(mm)}$ Emissions from 4B 'Manure Management' Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	0.8064	0.7539	0.7216	0.5686	0.5478	0.5238	0.4900
TNC	0.8566	0.7637	0.6517	0.5271	0.5045	0.4800	0.4705
Difference, %	6.2	1.3	-9.7	-7.3	-7.9	-8.4	-4.0
	1997	1998	1999	2000	2001	2002	2003
SNC	0.4500	0.3929	0.4059	0.3688	0.3209	0.3306	0.3437
TNC	0.3931	0.3579	0.3189	0.2710	0.2763	0.2809	0.2683
Difference, %	-12.6	-8.9	-21.4	-26.5	-13.9	-15.0	-21.9
	2004	2005	2006	2007	2008	2009	2010
SNC	0.3224	0.3095					
TNC	0.2639	0.2934	0.3055	0.2287	0.2603	0.2653	0.2798
Difference, %	-18.1	-5.2					

For the period 2006-2010, direct $N_2O_{D(mm)}$ and indirect $N_2O_{IND(mm)}$ emissions resulting from manure management were estimated for the first time. The obtained results allow assert that within the 1990-2010 time series these emissions from 4B 'Manure Management' source category decreased by 63.1 per cent, respectively 67.3 per cent, of which indirect $N_2O_{G(mm)}$ emissions from volatilization of ammonia and nitrogen oxides decreased by 68.8 per cent, while $N_2O_{L(mm)}$ emissions from leaching and runoff of nitrogen have decreased by 57.1 per cent (Table 6-51).

Table 6-51: Indirect N_2O Emissions from Volatilization of Ammonia and Nitrogen Oxides, as well as from Leaching and Runoff of Nitrogen, within the 4B 'Manure Management' Source Category, within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
Indirect $N_2O_{(G)}$	0.7510	0.6662	0.5647	0.4500	0.4295	0.4098	0.4035
Indirect $N_2O_{(L)}$	0.1056	0.0975	0.0870	0.0771	0.0750	0.0702	0.0669
	1997	1998	1999	2000	2001	2002	2003
Indirect $N_2O_{(G)}$	0.3356	0.3029	0.2684	0.2250	0.2293	0.2330	0.2224
Indirect $N_2O_{(L)}$	0.0576	0.0549	0.0506	0.0460	0.0470	0.0480	0.0459
	2004	2005	2006	2007	2008	2009	2010
Indirect $N_2O_{(G)}$	0.2186	0.2443	0.2549	0.1896	0.2213	0.2213	0.2345
Indirect $N_2O_{(L)}$	0.0453	0.0491	0.0506	0.0392	0.0390	0.0440	0.0453

This evolution was possible due to the decrease of animal population, to negative changes in the productivity of animal breeding sector and also due to changes in the share of animal waste management systems in the RM.

Table 6-52 below presents the total amounts of nitrogen generated by all manure management systems, as well as the amounts of N from animal waste available for application to managed soils in the Republic of Moldova, estimated in conformity with the methodology set forth in the IPCC 2006 Guidelines.

Table 6-52: Amount of Managed Manure N Available for Application to Managed Soils within 1990-2010 time periods

Categories	1990	1991	1992	1993	1994	1995	1996
$Nex_{(T)}$, kt N/yr	145.7	131.8	115.4	98.0	94.7	89.3	86.6
N_{MMS_Avb}, kt N/yr	82.2	78.3	73.5	64.5	63.3	58.9	54.2
Categories	1997	1998	1999	2000	2001	2002	2003
$Nex_{(T)}$, kt N/yr	73.0	69.6	62.6	52.7	53.4	54.3	51.6
N_{MMS_Avb}, kt N/yr	48.1	48.1	44.2	39.5	40.6	41.8	39.4
Categories	2004	2005	2006	2007	2008	2009	2010
$Nex_{(T)}$, kt N/yr	50.1	53.9	55.7	42.4	42.3	47.9	50.0
N_{MMS_Avb}, kt N/yr	37.7	39.7	40.5	31.1	30.6	34.0	35.0

6.3.2.6 Planned Improvements

Category 4B 'Manure Management' is a relevant source of N_2O emissions in the Republic of Moldova. Following the *good practices* (IPCC, 2000) the direct N_2O emissions from manure management (a key source) were estimated by using a simplified Tier 2 methodology (the indirect N_2O emissions were estimated based on a Tier 1 methodology). For the next inventory cycle the possibility to collect additional data, in particular on country specific manure management systems, will be considered, as well as those related to country specific N excreted rates for different categories (kg N/head/year), aiming at improving the general inventory quality and for reducing inventory uncertainties.

6.4 Agricultural Soils (Category 4D)

Direct and indirect N_2O emissions are monitored under the 4D 'Agricultural Soils' category. 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.

$$N_2O_{direct} = N_2O_{(SN)} + N_2O_{(ON)} + N_2O_{(PRP)} + N_2O_{(CR)} + N_2O_{(SOM)}$$

Where:

$N_2O_{(SN)}$ – annual N_2O emissions from the amount of synthetic fertilizer N applied to soils; Gg/yr;

$N_2O_{(ON)}$ – annual N_2O emissions from the amount of animal manure, compost, sewage sludge and other organic N additions applied to soils, Gg/yr;

$N_2O_{(PRP)}$ – annual N_2O emissions from urine and dung inputs to grazed soils, Gg/yr;

$N_2O_{(CR)}$ – annual 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, Gg/yr;

$N_2O_{(SOM)}$ – annual 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), Gg/yr

To be noted, that within the 1990-2010 time series, direct N_2O emissions from 4D 'Agriculture Soils' category decreased by 37.6 per cent, from 4.07 Gg in 1990 up to 2.54 Gg in 2010 (Figure 6-3).

The contribution of different emission sources in the structure of total direct N_2O emissions has changed significantly. So, the share of $N_2O_{(SN)}$, $N_2O_{(ON)}$, $N_2O_{(CR)}$ and $N_2O_{(PRP)}$ emissions has decreased significantly, by 64.1 per cent, 99.7 per cent, 18.4 per cent and respectively, by 18.4 per cent, while the share of $N_2O_{(SOM)}$ emissions increased 7 times (Table 6-53).

Table 6-53: Breakdown of the Direct N_2O Emissions from 4D 'Agriculture Soils' by Source within 1990-2010 time periods, %

	1990	1991	1992	1993	1994	1995	1996
N_2O_{SN}	35.5	28.6	33.0	12.1	10.5	6.3	9.2
N_2O_{ON}	21.0	16.7	15.9	10.8	6.7	5.9	3.5
N_2O_{PRP}	7.3	6.7	9.9	9.3	14.7	11.7	12.5
N_2O_{CR}	26.8	25.2	28.2	27.7	27.3	24.1	21.3
N_2O_{SOM}	9.4	22.7	12.9	40.2	40.8	52.0	53.5
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
N_2O_{SN}	6.2	6.5	4.2	7.8	8.1	11.0	11.5
N_2O_{ON}	1.1	0.8	0.5	0.4	0.4	0.2	0.2
N_2O_{PRP}	8.7	11.8	12.0	10.7	9.1	8.8	10.5
N_2O_{CR}	18.2	16.4	17.5	16.3	16.4	15.9	16.5
N_2O_{SOM}	65.8	64.5	65.8	64.9	66.1	64.1	61.3
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
N_2O_{SN}	9.2	9.7	9.3	26.2	12.3	13.0	12.8
N_2O_{ON}	0.1	0.1	0.0	0.1	0.0	0.0	0.1
N_2O_{PRP}	7.1	7.4	7.9	12.9	5.0	7.2	5.9
N_2O_{CR}	15.8	16.9	18.1	17.1	17.3	16.0	15.5
N_2O_{SOM}	67.7	65.9	64.6	43.7	65.4	63.8	65.8

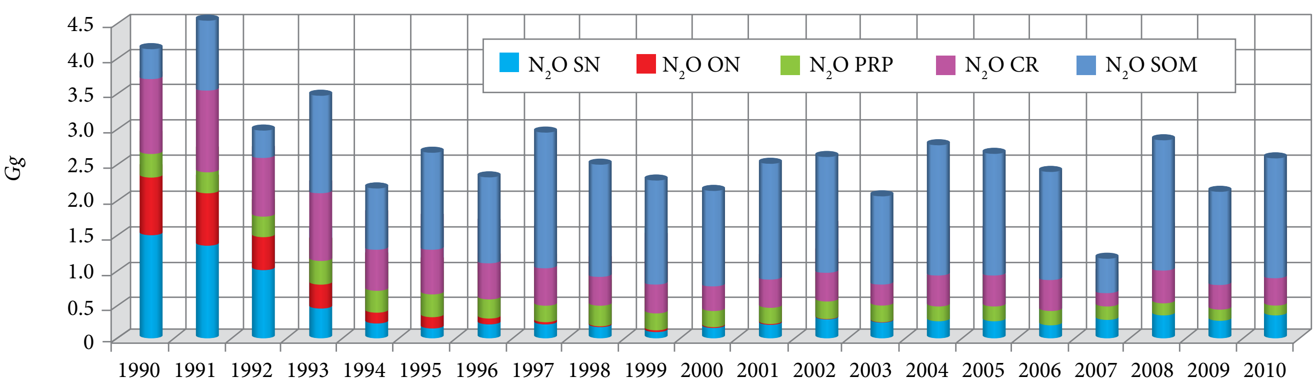


Figure 6-3: Direct N_2O emissions from the 4D 'Agricultural Soils' within 1990-2010

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 (2006 IPCC Guidelines, Volume 4, Chapter 11, Equations 11.09, 11.10 and 11.11):

$$N_2O_{\ indirect} = N_2O_{\ (ATD)} + N_2O_{\ (L)}$$

Where:

$N_2O_{\ (ATD)}$ – indirect N_2O emissions, produced from atmospheric deposition of nitrogen as ammonia (NH_3), oxides of N (NO_x), and their products NH_4^+ and NH_3^- onto soils and the surface of lakes and other waters; deposition of agriculturally derived NH_3 and NO_x, 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.

Over the period from 1990 through 2010, indirect N_2O emissions from the 4D 'Agricultural Soils' source category decreased by 50.9 per cent (Figure 6-4).

The contribution of emission sources in the structure of total indirect N_2O emissions has changed between 1990 and 2010 time series. So, the share of $N_2O_{\ (ATD)}$ emissions has decreased by 70.0 per cent, while the share of $N_2O_{\ (L)}$ emissions has increased by 27.8 per cent (Table 6-54).

Table 6-54: Breakdown of the Indirect N_2O Emissions from 4D 'Agriculture Soils' by Source, within 1990-2010, %

	1990	1991	1992	1993	1994	1995	1996
$N_2O_{\ (ATD)}$	28.4	24.3	26.3	17.3	16.8	13.2	13.0
$N_2O_{\ (L)}$	71.6	75.7	73.7	82.7	83.2	86.8	87.0
	1997	1998	1999	2000	2001	2002	2003
$N_2O_{\ (ATD)}$	8.1	9.8	8.8	9.0	8.3	9.2	10.3
$N_2O_{\ (L)}$	91.9	90.2	91.2	91.0	91.7	90.8	89.7
	2004	2005	2006	2007	2008	2009	2010
$N_2O_{\ (ATD)}$	7.7	8.0	8.1	16.6	7.8	9.3	8.5
$N_2O_{\ (L)}$	92.3	92.0	91.9	83.4	92.2	90.7	91.5

6.4.1 Direct N_2O Emissions from Managed Soils

6.4.1.1 Applied Synthetic Nitrogen Fertilizer

Source Category Description

Considerable amounts of nitrogen are applied to soils with synthetic N fertilizer. Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification. The amount of emissions from fertilizers consumption depends on a number of factors, such as: the amount and type of N fertilizers applied, crops type, soil type, climate and other environment related conditions. N_2O emissions from synthetic N fertilizer vary a lot over a year.

Methodological Issues, Emission Factors and Data Sources

Direct N_2O emissions from applied synthetic fertilizer were estimated by using a Tier 1 methodology (IPCC, 2006). The following equation was used to calculate N_2O emissions:

$$N_2O_{\ SN} = F_{SN} \bullet EF_1 \bullet 44/28$$

Where:

$N_2O_{\ SN}$ – N_2O emissions from applied synthetic fertilizer (Gg/yr);

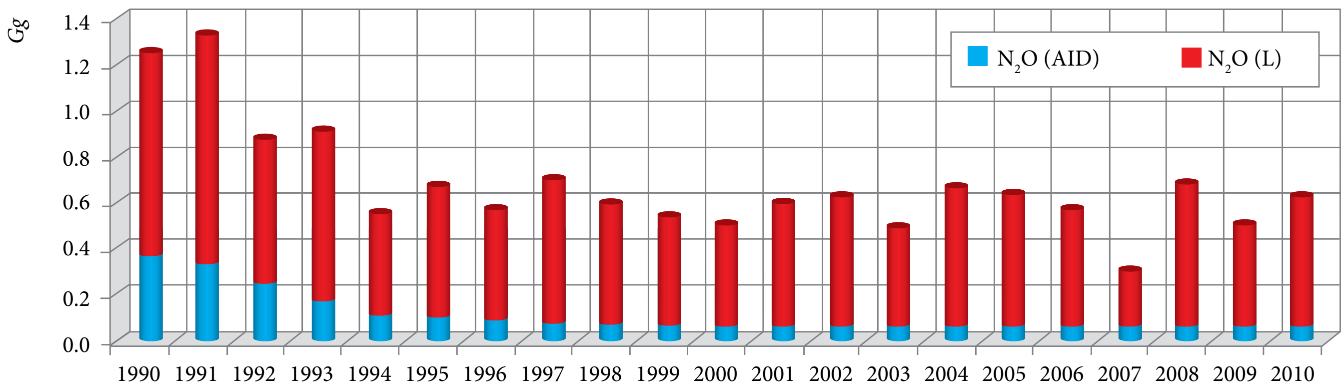


Figure 6-4: Indirect N_2O emissions from the 4D 'Agricultural Soils', 1990-2010.

F_{SN} – annual amount of synthetic fertilizer N 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] – stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

Table 6-55 provides a short overview of synthetic N fertilizers, including complex fertilizers most commonly used in the Republic of Moldova.

Information on the amounts of applied synthetic N fertilizers (active substance) on managed soils in the RM 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 1993-2010 time series).

Table 6-56 indicates that in the period from 1990 through 2010 there was a significant decrease (by circa 9 times) of the amounts of synthetic fertilizers used in the agriculture sector of the RM.

The amounts of synthetic fertilizers used in the agriculture sector of the RM decreased by 5 times, from 136 kg a.s./ha in 1990, to 26 kg a.s./ha in 2010, while the average consumption of nutrients, in kg of nitrogen per 1 tone 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 in winter wheat, 4.5-6.4 t/ha in grain maize, 2.1-3.5 t/ha in sunflower, 26.8-37.0 t/ha in sugar beets, etc.

A sharp reduction in fertilizer consumption occurred due to a number of reasons, such as: a drop in import of synthetic fertilizer in the country, lack of financial resources by farmers in certain times of the year, in particular in the context of the breakdown of agriculture during transition to market economy.

Table 6-56: Applied Synthetic Fertilizers in the RM within 1990-2010, kt (active substance)

	1990	1991	1992	1993	1994	1995	1996
Applied Synthetic N Fertilizer, F_{SN}	92.1	82.7	61.8	26.4	14.1	10.5	13.2
Total Applied Synthetic Fertilizer	232.4	191.4	127.6	44.9	20.0	12.5	14.3
kg applied for 1 sown ha	136.0	124.0	86.0	27.4	11.0	8.8	10.3
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Applied Synthetic N Fertilizer, F_{SN}	11.4	10.2	5.9	10.2	12.7	18.0	14.6
Total Applied Synthetic Fertilizer	12.1	10.3	6.1	10.3	12.8	18.4	15.4
kg applied for 1 sown ha	9.2	8.1	5.3	10.5	14.5	18.3	18.5
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Applied Synthetic N Fertilizer, F_{SN}	16.1	16.1	13.8	18.8	21.9	17.0	20.6
Total Applied Synthetic Fertilizer	17.5	18.1	16.6	22.4	24.7	19.9	25.5
kg applied for 1 sown ha	18.9	20.7	19.8	26.7	29.1	23.5	26.0

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) and 2012 (page 348); Statistical Yearbooks of the ATULBD for 1998 (page 230), 2000 (page 107), 2002 (page 111), 2006 (page 108), 2009 (page 107), 2010 (page 109), 2011 (page 110), 2012 (page 114).

To be noted that in conformity with the National Complex Soil Fertility Enhancing Program for 2001-2020, it is planned to increase the annual amount of synthetic N fertilizer up to 120-130 thousand tons of nitrogen by 2020.

Uncertainties Assessment and Time-Series Consistency

Uncertainties related to activity data on applied synthetic N fertilizer in the RM are considered to be low (±5 per cent). Uncertainties associated with the default emission factor (EF_1 for F_{SN}) may reach up to ±6 per cent. The combined uncertainties associated with the direct N_2O emissions from applied synthetic N fertilizer are considered to be low (±7.81 per cent). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±0.33 per cent while uncertainties introduced in trend in total GHG sectoral emissions were estimated at ±0.18 per cent.

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period

Table 6-55: Overview of Synthetic N 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, brown soils, and phosphor deficient soils.
Nitroammophos (nitrophoska)	Complex formula	N: P: K 13-19 each	Pellets of different colors	Efficient on all soils and used for all crops.
Diammophos (diammophoska)	Complex formula	N: P: K 10:26:26	Pellets of different colors	Efficient on all soils and used for all crops.

under review, in conformity with the recommendations included in the GPG (IPCC, 2000).

Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for 4D 'Agriculture Soils' source category, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating N_2O emissions originated from this source under the 4D 'Agriculture Soils' category were documented and archived both in hard copies and electronically. For identifying the data entry and GHG emissions estimation process related errors there were applied AD and EFs verifications and quality control procedures.

Following the recommendations included into the GPG (IPCC, 2000), GHG emissions were estimated using AD and national EF from official sources of reference.

Recalculations

Direct N_2O emissions from the 4D 'Agriculture Soils' source category were recalculated for the 1990 through 2005 time series, in particular due to revised activity data on synthetic fertilizers consumption for several years (in particular, for 1990, 1993 and 1994 years), in Statistical Yearbooks of the RM and those of the ATULBD.

The obtained results allow assert that compared with SNC, within the current inventory cycle N_2O emissions from applied synthetic fertilizers decreased between 1993 and 1994, varying from a minimum of 8.2 per cent in 1993 to a maximum of 13.1per cent in 1994, respectively increased by 4.9 per cent in the 1990 year (Table 6-57).

Table 6-57: Comparative Results of Direct N_2O Emissions from Applied Synthetic N Fertilizer under the 4D 'Agriculture Soils' Category Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
$N_2O_{(SN)}$ (SNC)	1.3797	1.2996	0.9711	0.4514	0.2552	0.1652	0.2077
$N_2O_{(SN)}$ (TNC)	1.4473	1.2996	0.9711	0.4145	0.2217	0.1652	0.2077
Difference, %	4.9	0.0	0.0	-8.2	-13.1	0.0	0.0
	1997	1998	1999	2000	2001	2002	2003
$N_2O_{(SN)}$ (SNC)	0.1795	0.1600	0.0929	0.1609	0.1994	0.2823	0.2298
$N_2O_{(SN)}$ (TNC)	0.1795	0.1600	0.0929	0.1609	0.1994	0.2823	0.2298
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2004	2005	2006	2007	2008	2009	2010
$N_2O_{(SN)}$ (SNC)	0.2524	0.2530					
$N_2O_{(SN)}$ (TNC)	0.2524	0.2530	0.2168	0.2959	0.3446	0.2674	0.3241
Difference, %	0.0	0.0					

For the period 2006-2010, direct N_2O emissions from applied synthetic N fertilizer on managed lands in the RM, were estimated for the first time. The results allow assert that within the 1990-2010 time series, direct N_2O emissions from applied synthetic N fertilizer on managed lands under 4D 'Agriculture Soils' source category decreased by circa 77.6 per cent.

Planned Improvements

Activities aiming at précising and updating the activity data used to estimate direct N_2O emissions from applied synthetic N fertilizers under the 4D 'Agriculture Soils' category, are planned as future improvements.

6.4.1.2 Applied Organic Nitrogen Fertilizers

Source Category Description

Applied organic nitrogen fertilizer may enhance the processes of nitrification and denitrification, thus contribute to increasing N_2O emissions from managed soils. While calculating emissions covered by this source category, activity data on generation diverse organic matter should be taken into account.

In the RM, 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, poultry manure, sewage sludge applied to soil, crop residues based composts applied to soil, manure slurry, delluvial soil, alluvium from water basins, as well as other organic amendments (e.g., rendering waste, brewery waste, liquid waste from sugar beet refineries and wineries, etc.).

Methodological Issues, Emission Factors and Data Sources

N_2O emissions from applied organic N fertilizer were estimated by using a Tier 1 methodology. The following equation was applied:

$$N_2O_{ON} = F_{ON} \bullet EF_1 \bullet 44/28$$

Where:

N_2O_{ON} – N_2O emissions from applied organic N fertilizer (Gg/yr);

$F_{ON} = (F_{AM} + F_{SEW} + F_{COMP} + F_{OOA})$, total annual amount of organic N fertilizer 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] – stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

Data on total amount of organic fertilizer (preponderantly, manure with bedding[60]) applied on managed lands are available in the SYs of the RM and those of the ATULBD (Table 6-58).

[60] In early 1990', the share of animal bedding manure (4-6 kg bedding/animal/day) in Moldova was circa 37.6% 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) was circa 26.7%, and the share of manure without bedding, respectively circa 35.4% (Turcan et al., 1984; Balteanskyi, 1986).

Table 6-58: Applied Organic Fertilizers in the Republic of Moldova within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Applied organic N fertilizer, kt	9740.0	8600.0	5300.0	4200.0	1620.0	1779.2	905.7
Tones/1 sown ha	5.60	5.10	3.40	3.11	1.19	1.21	0.61
	1997	1998	1999	2000	2001	2002	2003
Applied organic N fertilizer, kt	352.9	227.3	122.1	83.3	98.2	54.2	47.3
Tones/1 sown ha	0.23	0.13	0.12	0.07	0.10	0.04	0.05
	2004	2005	2006	2007	2008	2009	2010
Applied organic N fertilizer, kt	42.2	44.2	10.5	7.9	8.0	6.9	17.7
Tones/1 sown ha	0.04	0.05	0.02	0.01	0.01	0.01	0.02

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) and 2012 (page 348); Statistical Yearbooks of the ATULBD for 1998 (page. 230), 2000 (page 107), 2002 (page 111), 2006 (page 108), 2009 (page 107), 2010 (page 109), 2011 (page 110), 2012 (page 114).

The table shows that that in the period from 1990 through 2010 there was a significant reduction, by circa 243 times, of the amounts of organic N fertilizers applied per hectare of sown fields: from 5.6 t/ha in 1990, to 20 kg/ha in 2010, while in conformity with crop rotation structure the need for organic fertilizer, is 10-15 t/ha for a neutral humus balance, and 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 opinion, the stabilization of humus content in soil on arable lands and horticultural plantations require annual application of circa 20-22 million tons of organic fertilizer, while current resources of organic matter can ensure application of as much as 3.5 million tons 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.

From scientific literature[61] it is known that 1 tone of cattle manure with bedding contain circa 5.6 kg of nitrogen (sheep manure with bedding –9.5 kg of nitrogen, horse manure with bedding – 6.0 of kg nitrogen, swine manure with bedding –8.2 kg of nitrogen, poultry manure with bedding –16.3 kg of nitrogen), 1 tone of slurry – circa 3 kg of nitrogen, and 1 tone of sewage sludge – 20 kg of nitrogen.

To calculate the F_{ON} values (Table 6-59), the applied amount of organic fertilizer was multiplied by the conversion factor from bedding manure to nitrogen – 5.6 kg N/t of manure with bedding (Banaru, 2003).

Uncertainties Assessment and Time-series Consistency

Uncertainties related to activity data on applied organic N fertilizer in the RM are considered to be medium (±30 per cent). Uncertainties associated with the default emission factor (EF_1 for F_{ON}) may reach up to ±6 per cent. The combined uncertainties associated with direct N_2O emissions from applied organic N fertilizer are considered to be large (±30.59 per cent). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±0.006 per cent while uncertainties introduced in trend in sectoral emissions were estimated at ±0.14 per cent.

[61] 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 6-59: Annual Amount of Organic Nitrogen Applied to Soils in the RM within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
F_{ON}, kt	54.5440	48.1600	29.6800	23.5200	9.0720	9.9635	5.0719
	1997	1998	1999	2000	2001	2002	2003
F_{ON}, kt	1.9762	1.2729	0.6838	0.4665	0.5499	0.3035	0.2649
	2004	2005	2006	2007	2008	2009	2010
F_{ON}, kt	0.2363	0.2475	0.0588	0.0442	0.0448	0.0386	0.0991

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 GPG (IPCC, 2000).

Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for 4D 'Agriculture Soils' source category, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating N_2O emissions originated from applied organic fertilizers were documented and archived both in hard copies and electronically. For identifying the data entry and GHG emissions estimation process related errors there were applied AD and EFs verifications and quality control procedures.

Following the recommendations included into the GPG (IPCC, 2000), GHG emissions were estimated using AD and national EF from official sources of reference.

Recalculations

N_2O emissions from applied organic fertilizers were recalculated, in particular due to revised (more precise) activity data being available for the reference year (1990) in the official statistical source of reference. In comparison with the results included in the SNC of the RM under the UNFCCC, the changes revealed an insignificant increase of N_2O emissions (Table 6-60).

Table 6-60: Comparative Results of Direct N_2O Emissions from Applied Organic N Fertilizer under the 4D 'Agriculture Soils' Category Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
$N_2O_{(ON)}$ (SNC)	0.8536	0.7568	0.4664	0.3696	0.1426	0.1566	0.0797
$N_2O_{(ON)}$ (TNC)	0.8571	0.7568	0.4664	0.3696	0.1426	0.1566	0.0797
Difference, %	0.4	0.0	0.0	0.0	0.0	0.0	0.0
	1997	1998	1999	2000	2001	2002	2003
$N_2O_{(ON)}$ (SNC)	0.0311	0.0200	0.0107	0.0073	0.0086	0.0048	0.0042
$N_2O_{(ON)}$ (TNC)	0.0311	0.0200	0.0107	0.0073	0.0086	0.0048	0.0042
Difference, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2004	2005	2006	2007	2008	2009	2010
$N_2O_{(ON)}$ (SNC)	0.0037	0.0039					
$N_2O_{(ON)}$ (TNC)	0.0037	0.0039	0.0009	0.0007	0.0007	0.0006	0.0016
Difference, %	0.0	0.0					

For the period 2006-2010, N_2O emissions from applied organic N fertilizer on managed lands were estimated for the first time. The results allow assert that within the 1990-2010 time series, N_2O emissions from applied organic N fertilizer on managed lands under 4D 'Agriculture Soils' category decreased by 99.8 per cent. The significant decrease in emissions is due to a drastic drop in amount of organic fertilizers applied to soils, in particular, as a result of collapse of the animal breeding sector during the period of transition to market economy.

To be noted also, in early 1990' the collective farms were regularly collecting the manure from big feeding lots and applying it to soil, while private farmers (at present circa 95 per cent of the total livestock, the principal source of manure is concentrated in private sector) are more reluctant to do the same due to high transportation costs.

Planned Improvements

Activities aiming at précising and updating the activity data used to estimate direct N_2O emissions from applied organic N fertilizers under the 4D 'Agriculture Soils' category, are planned as future improvements.

6.4.1.3 Urine and Dung Inputs to Grazed Soils

Source Category Description

By 2012, hayfields and pastures occupied circa 352.3 thousand ha (10.4 per cent of the country's area). Worldwide, permanent grasslands, hayfields and pastures generally occupy a surface twice as big as arable lands, in the RM however this surface is 5 times smaller (Table 6-61).

Generally, the surface of land occupied by pastures vary between 0.3 and 300 ha, these being the pastures on the 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 during 8-9 months (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

N_2O emissions from urine and dung inputs to grazed soils were estimated by using a Tier 1 methodology (IPCC, 2006). The following equation was applied:

$$N_2O_{PRP} = F_{PRP} \bullet EF_{3\ (PRP)} \bullet 44/28$$

Where:

N_2O_{PRP} – N_2O emissions from urine and dung inputs to grazed soils;

F_{PRP} – annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/yr);

$F_{PRP} = \Sigma_{(s)} [(N_{(T)} \bullet Nex_{(T)}) \bullet MS_{(T, PRP)}]$;

$N_{(T)}$ – number of head of livestock species/category T in the country (see 4A source category);

$Nex_{(T)}$ – annual average N excretion per animal of species/category T in the country (kg N/animal/yr) (see 4B source category);

$MS_{(T, PRP)}$ – 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 4B source category);

$EF_{3\ (PRP)}$ – 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] – stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

To calculate the amount of nitrogen from urine and dung inputs to grazed soils (Table 6-62), there were used activity data on the total population of livestock and poultry from the Statistical Annual Report Nr. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all Households Categories as of 1[st] of January" (annual for 1990-2011 time periods), Statistical Yearbooks of the ATULBD (identical AD to those used under the source categories 4A 'Enteric Fermentation' and 4B 'Manure Management'), coun-

Table 6-61: Available Lands by Use in the Republic of Moldova within 1992-2012, thousand ha

	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	2012
Total lands:	3376.0	3384.0	3385.1	3384.4	3384.4	3384.4	3384.6	3384.6	3384.6	3384.6	3384.6
Agricultural lands	2565.9	2557.3	2556.7	2556.6	2550.3	2533.8	2528.3	2518.2	2506.2	2501.1	2498.0
including:											
arable land	1736.3	1744.5	1758.7	1809.9	1813.8	1842.6	1845.4	1833.2	1821.7	1816.7	1810.5
perennial plantations:	474.8	448.2	430.7	370.7	352.3	300.8	298.0	299.0	302.8	301.0	298.7
including:											
orchards	224.5	216.6	208.3	179.8	170.8	137.5	134.8	131.1	132.7	132.5	134.5
vineyards	215.8	205.5	202.6	176.9	168.9	152.8	153.0	157.3	157.5	153.5	147.3
pastures	350.5	362.0	365.2	373.7	373.9	379.7	374.1	368.1	357.9	352.1	350.3
hayfields	4.3	2.6	2.1	2.3	2.5	2.4	2.8	2.1	2.1	2.2	2.0
fallow lands	0.0	0.0	0.0	0.0	7.8	8.3	8.0	15.8	21.7	29.1	36.5
Forests and forest lands	421.7	420.7	425.3	422.9	422.7	426.6	433.5	443.3	456.2	462.8	462.7
Rivers, lakes and bogs	88.7	90.4	92.6	93.5	95.5	97.5	96.3	96.1	96.3	96.4	99.5
Other lands	299.7	315.6	310.5	311.4	315.9	326.5	326.5	327.0	325.9	324.3	324.4

try specific data on nitrogen excretion rate $Nex_{(T)}$ (in kg N/head/yr) and country specific values of the different manure management systems usage in the RM (identical to those used under the 4B 'Manure Management' source category).

Table 6-62: Annual Amount of Urine and Dung Nitrogen Deposited by Grazing Animals on Pasture, Range and Paddock in the Republic of Moldova within 1990-2010, kt

	1990	1991	1992	1993	1994	1995	1996
F_{PRP}, kt	12.0528	12.3633	11.9998	12.7915	12.7413	12.2641	11.4151
	1997	1998	1999	2000	2001	2002	2003
F_{PRP}, kt	10.0176	12.0370	11.1315	8.5147	8.5374	8.6661	8.0813
	2004	2005	2006	2007	2008	2009	2010
F_{PRP}, kt	7.5994	7.4764	7.3355	5.8736	5.6637	6.1007	6.1708

Uncertainties Assessment and Time-Series Consistency

There is a high degree of uncertainties related to N_2O emissions estimations within this source category due to high uncertainties associated with direct N_2O emissions from N urine and dung inputs to grazed soils (±50%) and uncertainties associated with the default emission factor (EF_3 for F_{PRP}) also may reach up to ±50 per cent. The combined uncertainties associated with direct N_2O emissions from N urine and dung inputs to grazed soils are considered to be quite high (±70.71 per cent). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±1.38 per cent while uncertainties introduced in trend in sectoral emissions were estimated at ±0.63 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 GPG (IPCC, 2000).

Quality Assurance and Quality Control

Standard verification and quality control forms and checklist were filled in for this source category within the 'Agriculture' Sector, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating N_2O emissions from N urine and dung inputs to grazed soils under this category were documented and archived both in hard copies and electronically. For identifying the data entry and GHG emissions estimation process related errors there were applied AD and EFs verifications and quality control procedures.

Following the recommendations included into the GPG (IPCC, 2000), N_2O emissions from urine and dung inputs to grazed soils were estimated using AD and national EF from official sources of reference.

Recalculations

N_2O emissions from urine and dung inputs to grazed soils were recalculated for the 1990 through 2005 time series, in particular due to use of an updated set of activity data on animal population, (available into the Statistical Yearbooks of the RM and those of the ATULBD, Statistical Sectoral Reports, as Statistical Annual Report Nr. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all Households Categories as of 1st of January" and "Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM"), due to country specific value data on N excretion (kg N/1000 kg animal mass/year), as well as a result of using updated set of data on manure management systems in the RM (MS%).

The obtained results allow assert that compared with SNC of the RM under the UNFCCC, within the current inventory cycle the direct N_2O emissions from urine and dung inputs to grazed soils significantly decreased between 1990-2005, varying from a minimum of 21.3 per cent in 1990 to a maximum of 36.8 per cent in 1997 (Table 6-63).

Table 6-63: Comparative Results of Direct N_2O Emissions from Urine and Dung Nitrogen Deposited by Grazing Animals on Pasture, Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
$N_2O_{(PRP)}$ (SNC)	0.3766	0.4010	0.3893	0.4156	0.4328	0.4756	0.4356
$N_2O_{(PRP)}$ (TNC)	0.2965	0.3058	0.2911	0.3179	0.3098	0.3079	0.2838
Difference, %	-21.3	-23.7	-25.2	-23.5	-28.4	-35.3	-34.9
	1997	1998	1999	2000	2001	2002	2003
$N_2O_{(PRP)}$ (SNC)	0.4006	0.3759	0.3626	0.3404	0.3183	0.3269	0.3302
$N_2O_{(PRP)}$ (TNC)	0.2534	0.2902	0.2684	0.2216	0.2237	0.2273	0.2097
Difference, %	-36.8	-22.8	-26.0	-34.9	-29.7	-30.5	-36.5
	2004	2005	2006	2007	2008	2009	2010
$N_2O_{(PRP)}$ (SNC)	0.3080	0.2874					
$N_2O_{(PRP)}$ (TNC)	0.1952	0.1915	0.1852	0.1457	0.1386	0.1485	0.1511
Difference, %	-36.6	-33.3					

The obtained results allow assert that within the 1990-2010 time series N_2O emissions from urine and dung inputs to grazed soils under 4D 'Agriculture Soils' source category decreased by circa 49 per cent. The decrease in emissions is due to significant reduction in total population of livestock over the period under review. Despite the fact that the share of this type of manure management system (grazing) increased in comparison to 1990's level, it did not have any major impact on the trend of N_2O emissions from urine and dung inputs to grazed soils.

Planned Improvements

It is planned to undertake activities on obtaining more precise country specific values for nitrogen excretion $Nex_{(T)}$ rates (in kg N/head/year) for animal categories and manure management systems usage in the Republic of Moldova in the next inventory cycles.

6.4.1.4 Nitrogen in 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. Emissions estimation require 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, burned for heating and cooking, etc.

Methodological Issues, Emission Factors and Data Sources

N2O emissions from this source category were estimated by using the “Methodology of determining the carbon balance in agricultural soils to assess the GHG emissions” (see Annex A3-4.2)[62].

The following equation 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] – stoichiometric 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:

$$F_{CR} = (Crop_{(T)} \bullet R_{AG\,(T)} \bullet (1\text{-}Frac_{Remove\,(T)}) + Crop_{(T)} \bullet R_{BG\,(T)}) \bullet (P_{CR}/10^2) \bullet (k_6/10^2)$$

Where:

$Crop_{(T)}$ – harvested annual dry matter yield for crop T t.d.m./ha;

$Crop_{(T)}$ = Yield $Fresh_{(T)}$ x 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[63] (see Table 6-64);

$R_{AG\,(T)}$ – ratio of above-ground residues dry matter to harvested yield for crop T ($Crop_{(T)}$), t.d.m_{AG}/t.d.m[64] (see Table 6-64);

$R_{BG\,(T)}$ – ratio of below-ground residues to harvested yield for crop T, t.d.m_{BG}/t dm[65] (see Table 6-64);

$Frac_{Remove\,(T)}$ – fraction of above-ground residues of crop T removed and used for other purposes[66] (see Table 6-64);

P_{CR} – amount of Nitrogen in crop residues (% a.s.) (Table 6-65);

k_6 – coefficient reflecting the N in crop residues (Banaru, 2002)[67] (Table 6-65).

Indices used to estimate N_2O emissions from crop residues returned to soils come from different sources of reference, including the 2006 IPCC Guidelines.

[62] Banaru, Anatol (2000), *Methodology to Calculate CO_2 Emissions from Agricultural Soils,* In the collection of papers “Climate Change: Research, Studies, Solutions”, Ministry of Environment / UNDP Moldova. „Bons Offices” S.R.L. Chişinău, 2000, pp. 115-123

[63] *2006, IPCC Guidelines*, Volume 4, Chapter 11, Table 11.2, Page 11.17.

[64] Nicolaev N., Boincean B., Sidorov M., Vanicovici Gh., Coltun V. (2006), *Agrotechnics.* Ministry of Education and Youth of the Republic of Moldova – Balti: Presa universitara balteană, 2006, P. 298.

[65] *2006 IPCC Guidelines*, Volume 4, Chapter 11, Table 11.2, Page 11.17.

[66] Expert opinion, Prof. Valerian Cerbari, Institute of Pedology, Agrochemistry and Soil Protection „Nicolae Dimo”

[67] 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, P.23

Table 6-64: Indices Used to Estimate Amount of N in Crop Residues Returned to Soils

Crop	DRY	$R_{AG\,(T)}$	$R_{BG\,(T)}$	$Frac_{Remove(T)}$
Winter wheat	0.89	1.43	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
Sun flower	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
Legumes	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	0.87	1.48	0.22	0.80
Perennial grasses for green fodder, silage and fodder	0.90	0.34	0.40	0.80
Annual grasses (oat and vetch) for green fodder	0.90	0.20	0.80	0.80
Annual grasses (oat and peas) for green fodder	0.90	0.30	0.80	0.80

Table 6-65: Amount of N in Crop Residues (country specific average values).

Crop	P_{CR}, % (a.s.)		k_6
	Fertilized soils	Unfertilized soils	
Winter wheat	1.00	1.10	Use of N from vegetal residues represents 25 per cent from the total contents
Winter rye	1.00	1.10	
Winter barley	1.00	1.10	
Oat	1.00	1.10	
Millet	1.25	1.23	
Buckwheat	1.05	1.05	
Leguminous crops	2.08	2.08	
Grain maize	1.08	1.11	
Grain sorghum	1.00	1.05	
Other cereal crops	1.00	1.05	
Sugar beet	1.50	1.40	
Sun flower	0.95	1.10	
Soybeans	2.08	2.08	
Tobacco	1.30	1.30	
Grain Rapeseed	1.05	1.05	
Potatoes	1.19	1.19	
Legumes	2.09	2.09	
Melons and gourds	1.19	1.19	
Root crops for fodder	1.26	1.26	
Maize for silo and green fodder	1.08	1.11	
Perennial grasses for green fodder, silage and fodder	1.90	1.90	
Annual grasses for green fodder	1.06	1.18	
Vetch green manure, above-ground dry mass	4.20	NA	
Vetch green manure, below-ground dry mass	1.40	NA	

Activity data on areas sown with crops and average yield per ha for the main crops is available in Statistical Yearbooks of the RM and those of the ATULBD (Tables 6-66, 6-67 and 6-68).

Table 6-66: Areas Sown with Crops within 1990-2010 time series, thousand hectares

	1990	1991	1992	1993	1994	1995	1996
Sown Areas – total	**1733.1**	**1717.0**	**1711.1**	**1779.5**	**1715.5**	**1725.4**	**1717.4**
Cereals and leguminous crops – total	**745.7**	**837.0**	**746.6**	**910.7**	**830.1**	**920.5**	**902.4**
Wheat (Winter and Spring)	286.7	303.0	281.7	345.9	300.4	394.1	380.9
Winter rye	0.9	0.8	0.7	1.1	1.7	2.7	4.7
Barley (Winter and Spring)	120.4	134.0	123.0	139.0	147.0	135.1	108.7
Oat	2.1	3.0	3.0	4.0	5.0	5.9	3.7
Millet	0.1	0.1	0.1	0.1	0.1	0.2	0.3
Buckwheat	3.6	6.0	7.0	7.0	8.0	5.5	7.4
Leguminous crops	72.6	77.0	71.2	70.7	65.5	53.6	44.6
Grain maize	258.0	310.0	259.4	342.6	283.4	321.3	350.0
Grain sorghum	1.2	3.1	0.5	0.3	1.2	1.1	0.3
Other cereal crops	0.1	0.0	0.0	0.0	17.8	1.4	2.8
Industrial crops– total	**295.3**	**277.0**	**275.3**	**262.7**	**263.5**	**283.6**	**333.7**
Sugar beet	81.5	79.9	82.6	83.0	83.0	90.4	83.9
Sun flower	134.1	126.9	130.9	125.5	139.5	163.2	225.1
Soybeans	26.5	24.1	16.6	9.3	5.6	3.3	2.3
Tobacco	32.1	32.5	28.1	31.2	28.4	20.1	16.4
Grain rapeseed	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other industrial crops	21.1	13.6	17.1	13.7	7.0	6.6	6.0
Potatoes, vegetables and melons & gourds – total	**131.8**	**141.0**	**143.1**	**156.9**	**140.4**	**140.3**	**130.3**
Potatoes	41.2	46.9	55.3	71.1	62.8	57.1	59.6
Vegetables	71.1	78.0	73.7	73.2	68.1	72.3	61.4
Melons and gourds	9.2	8.0	7.0	6.0	5.0	7.6	6.7
Other	10.3	8.1	7.1	6.6	4.5	3.3	2.6
Forage crops – total	560.3	462.0	546.1	449.2	481.5	381.0	351.0
Forage roots	**26.4**	**30.0**	**29.0**	**28.0**	**24.0**	**24.5**	**17.6**
Maize for silo and green fodder	292.3	302.5	299.3	215.9	265.5	181.2	181.0
Perennial grasses for green fodder, silage and fodder	206.3	97.2	179.6	169.4	153.5	144.7	124.0
Annual grasses for green fodder	31.4	32.3	38.2	35.9	38.5	29.3	27.0
Other	3.9	0.0	0.0	0.0	0.0	1.3	1.4

	1997	1998	1999	2000	2001	2002	2003
Sown Areas – total	**1726.3**	**1717.3**	**1662.9**	**1700.2**	**1711.2**	**1735.0**	**1593.1**
Cereals and leguminous crops – total	**1055.5**	**1039.0**	**1024.7**	**1077.4**	**1160.1**	**1165.7**	**940.6**
Wheat (Winter and Spring)	410.3	405.8	392.1	423.8	485.2	502.8	213.3
Winter rye	3.9	3.7	3.9	3.8	5.3	3.6	1.3
Barley (Winter and Spring)	129.5	134.0	128.5	125.0	113.9	133.7	96.1
Oat	6.5	6.1	4.9	4.2	4.8	4.3	4.6
Millet	0.3	0.3	0.2	0.4	0.0	0.4	0.4
Buckwheat	7.3	11.1	16.8	12.1	13.2	5.1	4.9
Leguminous crops	46.2	58.9	64.8	53.6	52.1	59.9	48.3
Grain maize	450.7	416.7	411.7	454.1	483.8	454.7	567.9
Grain sorghum	0.3	0.2	0.1	0.4	1.0	0.5	3.1
Other cereal crops	1.6	3.8	3.1	1.9	3.9	2.9	1.6
Industrial crops– total	**300.0**	**344.4**	**354.2**	**363.7**	**330.7**	**357.4**	**447.9**
Sugar beet	76.3	76.4	65.5	66.6	63.1	52.0	39.7
Sun flower	199.0	234.5	246.0	256.9	234.3	280.7	381.3
Soybeans	2.3	6.3	17.0	11.6	9.4	10.2	18.3
Tobacco	17.3	22.0	18.8	23.7	17.1	9.3	5.6
Grain rapeseed	0.0	0.0	1.0	1.0	1.0	1.0	1.0
Other industrial crops	5.1	5.2	5.9	3.9	5.8	4.2	2.0
Potatoes, vegetables and melons & gourds – total	**135.4**	**127.9**	**131.0**	**132.3**	**119.8**	**112.6**	**92.5**
Potatoes	62.3	62.0	66.6	65.4	42.8	45.1	38.6
Vegetables	63.5	58.6	56.3	56.8	67.2	58.7	43.7
Melons and gourds	7.9	5.2	6.0	7.9	7.4	6.5	8.7
Other	1.7	2.1	2.1	2.2	2.4	2.3	1.5
Forage crops – total	**235.4**	**206.0**	**153.0**	**126.8**	**100.6**	**99.3**	**112.1**
Forage roots	16.3	15.5	14.3	11.5	4.7	4.1	4.5
Maize for silo and green fodder	98.7	97.1	62.8	49.7	39.2	35.1	44.5
Perennial grasses for green fodder, silage and fodder	102.6	75.2	58.3	53.1	48.1	49.8	50.9
Annual grasses for green fodder	16.8	17.3	16.9	11.3	8.0	9.2	11.3
Other	1.0	0.9	0.7	1.1	0.6	1.1	0.9

	2004	2005	2006	2007	2008	2009	2010
Sown Areas – total	**1682.4**	**1625.5**	**1546.9**	**1552.3**	**1551.9**	**1523.2**	**1582.7**
Cereals and leguminous crops – total	**1144.6**	**1084.9**	**953.9**	**989.2**	**1034.8**	**990.1**	**989.8**
Wheat (Winter and Spring)	342.0	434.1	316.0	333.5	429.6	375.7	368.8
Winter rye	2.6	2.1	0.7	0.8	1.0	1.8	1.6
Barley (Winter and Spring)	140.8	133.5	123.2	138.2	139.5	167.2	150.3
Oat	5.9	6.2	4.5	4.4	2.8	2.3	2.8
Millet	0.5	0.3	0.2	0.4	0.3	0.5	0.6
Buckwheat	4.6	3.1	4.1	1.2	0.8	1.0	0.2
Leguminous crops	37.9	42.7	42.2	40.1	28.3	34.3	38.9
Grain maize	604.1	461.0	461.4	469.2	429.5	403.3	422.6
Grain sorghum	3.8	0.7	0.4	0.2	0.2	0.2	0.2
Other cereal crops	4.1	2.0	1.6	1.4	3.1	4.9	4.7
Industrial crops– total	**367.1**	**373.9**	**413.3**	**376.7**	**355.9**	**379.5**	**429.8**
Sugar beet	34.9	34.4	42.4	34.3	24.7	23.4	26.4
Sun flower	293.0	291.0	299.7	241.1	239.1	235.3	279.4
Soybeans	28.5	36.6	55.9	50.9	31.0	50.2	61.3
Tobacco	5.7	4.7	3.5	3.1	2.7	2.5	4.4
Grain rapeseed	1.0	2.0	7.1	41.3	53.5	62.1	48.5
Other industrial crops	4.0	5.2	4.7	6.0	4.9	6.0	9.8
Potatoes, vegetables and melons & gourds – total	**81.4**	**82.5**	**90.1**	**84.0**	**83.2**	**77.9**	**79.3**
Potatoes	34.8	36.6	34.8	35.8	31.3	28.3	27.8
Vegetables	38.2	38.6	44.4	39.7	41.7	36.6	39.8
Melons and gourds	7.3	5.1	9.1	7.1	8.8	11.7	10.3
Other	1.1	2.2	1.8	1.4	1.4	1.3	1.4
Forage crops – total	**89.3**	**84.2**	**89.6**	**102.4**	**78.0**	**75.7**	**83.9**
Forage roots	4.2	2.1	3.0	1.9	1.8	1.4	1.7
Maize for silo and green fodder	24.8	16.0	15.6	24.9	10.2	10.1	10.1
Perennial grasses for green fodder, silage and fodder	52.1	58.0	62.3	68.4	60.2	59.3	64.9
Annual grasses for green fodder	8.2	8.1	8.7	5.6	4.6	3.4	5.9
Other	0.0	0.0	0.0	1.6	1.2	1.4	1.3

Source: NBS on-line database, Section "Sown Area, crops average yield and harvest, 1980-2010": <http://statbank.statistica.md/pxweb/Database/RO/16%20 AGR/AGR02/AGR02.asp>; Statistical Yearbooks for ATULBD: 1998 (page 218), 2002 (page 113), 2005 (page 101), 2009 (page 97), 2010 (page 99), 2011 (page 100), 2012 (page 104).

Table 6-67: Gross Harvest of Agricultural Crops in the RM within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
Cereals and leguminous crops – total	**2538.6**	**3105.9**	**2099.8**	**3340.2**	**1753.8**	**2638.6**	**1981.2**
Wheat (Winter and Spring)	1129.0	1056.5	925.7	1392.5	658.8	1277.2	784.2
Winter rye	1.9	1.6	1.4	2.2	3.4	5.2	8.0
Barley (Winter and Spring)	417.9	427.0	405.0	481.0	324.9	311.3	136.7
Oat	3.8	5.0	7.0	11.0	7.0	8.3	3.4
Millet	0.1	0.1	0.1	0.1	0.1	0.2	0.3
Buckwheat	1.8	5.0	2.0	6.0	4.0	1.9	2.6
Leguminous crops	97.1	105.7	121.8	121.6	70.2	55.5	31.6
Grain maize	885.5	1501.2	635.4	1324.5	629.3	949.2	1008.6
Grain sorghum	1.2	3.1	0.5	0.3	1.2	1.1	0.3
Other cereal crops	0.3	0.7	0.9	1.0	54.9	2.0	1.1
Industrial crops– total							
Sugar beet	2374.5	1988.6	1784.0	1845.4	1526.7	1877.9	1682.1
Sun flower	252.2	151.4	176.2	173.7	149.2	208.1	284.0
Soybeans	23.8	33.4	7.9	9.3	4.0	2.9	2.4
Tobacco	66.2	62.8	45.0	50.2	41.5	27.0	19.5
Grain rapeseed	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Potatoes, vegetables and melons & gourds – total							
Potatoes	295.3	290.6	310.8	725.9	474.7	385.7	344.3
Vegetables	1177.3	989.2	787.5	777.2	598.5	529.3	362.4
Melons and gourds	34.4	35.6	9.3	18.6	12.6	23.8	25.2
Forage plants – total							
Forage roots	1171.8	1416.4	922.5	988.6	547.0	611.4	375.7
Maize for silo and green fodder	4509.0	4979.1	3025.8	3358.7	2286.0	2086.5	1462.6
Perennial grasses for green fodder, silage and fodder	4456.1	2866.2	3340.1	3404.2	1964.5	2040.3	1260.9
Annual grasses for green fodder	288.9	507.7	370.8	398.9	211.9	263.7	175.2

	1997	1998	1999	2000	2001	2002	2003
Cereals and leguminous crops – total	**3512.3**	**2751.9**	**2375.0**	**2070.2**	**2823.6**	**2791.2**	**1654.4**
Wheat (Winter and Spring)	1344.7	1104.7	922.4	813.0	1314.0	1254.4	103.4
Winter rye	8.3	7.0	6.3	5.0	9.1	5.9	0.8
Barley (Winter and Spring)	256.9	241.9	203.1	152.3	246.9	241.7	74.4
Oat	9.1	9.5	5.9	3.5	6.4	4.7	4.0
Millet	0.3	0.2	0.1	0.3	0.0	0.1	0.1
Buckwheat	3.9	4.3	6.1	8.0	5.6	1.4	1.6
Leguminous crops	63.2	76.9	61.6	30.9	79.1	50.2	30.2
Grain maize	1791.2	1272.7	1151.3	1050.4	1134.3	1206.3	1440.2
Grain sorghum	0.3	0.2	0.1	0.4	1.0	0.5	3.1
Other cereal crops	1.9	4.9	6.1	3.2	5.8	4.0	3.9
Industrial crops– total							
Sugar beet	1674.8	1356.8	956.4	982.5	1117.8	1157.4	660.3
Sun flower	174.3	196.4	291.6	305.1	275.6	340.9	421.4
Soybeans	2.7	5.9	13.7	11.6	9.5	12.6	19.4
Tobacco	23.7	24.6	22.6	25.4	16.2	11.9	6.9
Grain rapeseed	0.0	0.0	1.0	0.2	1.0	0.7	0.5
Potatoes, vegetables and melons & gourds – total							
Potatoes	392.6	372.5	330.1	330.4	385.3	326.0	303.2
Vegetables	393.6	565.6	531.8	394.6	472.3	408.4	371.7
Melons and gourds	33.4	27.2	36.1	33.3	38.8	29.0	72.7
Forage plants – total							
Forage roots	352.8	293.2	180.5	128.5	63.4	67.9	55.7
Maize for silo and green fodder	1326.2	825.6	469.8	334.7	306.7	322.8	327.9
Perennial grasses for green fodder, silage and fodder	1240.0	690.1	658.2	467.3	628.5	654.1	501.8
Annual grasses for green fodder	180.5	131.9	95.1	58.7	67.4	68.9	48.5
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Cereals and leguminous crops – total	**3178.0**	**2954.3**	**2371.2**	**932.4**	**3261.6**	**2277.4**	**2617.5**
Wheat (Winter and Spring)	943.9	1120.4	721.0	430.4	1345.8	807.1	871.4
Winter rye	5.1	3.5	1.1	0.8	1.9	3.2	2.4
Barley (Winter and Spring)	284.1	226.7	214.6	125.7	362.4	272.9	226.1
Oat	9.9	7.2	6.5	1.4	4.2	1.5	2.9
Millet	0.3	0.2	0.1	0.4	0.3	0.3	0.3
Buckwheat	1.1	1.0	1.0	0.4	0.5	0.1	0.1
Leguminous crops	51.0	66.4	68.4	14.4	38.0	30.3	39.7
Grain maize	1845.1	1502.7	1327.6	363.1	1484.2	1145.4	1453.8
Grain sorghum	3.8	0.7	0.4	0.2	0.2	0.2	0.2
Other cereal crops	10.9	12.0	14.3	0.6	7.9	6.3	8.1
Industrial crops– total							
Sugar beet	911.3	996.2	1177.3	612.3	960.7	337.4	837.6
Sun flower	354.8	347.7	396.1	158.7	387.2	294.1	429.1
Soybeans	40.2	66.1	80.2	40.0	58.9	50.0	112.8
Tobacco	7.9	6.7	4.8	3.6	3.9	4.4	7.6
Grain rapeseed	1.0	3.0	7.0	34.9	100.1	74.6	50.3
Potatoes, vegetables and melons & gourds – total							
Potatoes	321.8	388.9	384.0	200.9	273.7	262.1	284.6
Vegetables	328.7	405.9	490.6	220.9	381.8	307.8	348.8
Melons and gourds	57.3	48.7	92.6	41.2	70.0	102.1	104.4
Forage plants – total							
Forage roots	53.1	40.9	34.8	13.8	26.3	19.9	80.6
Maize for silo and green fodder	219.9	178.9	153.8	104.6	113.0	95.6	113.4
Perennial grasses for green fodder, silage and fodder	692.6	851.7	842.9	196.9	406.4	241.8	325.2
Annual grasses for green fodder	57.3	55.3	54.6	10.1	28.8	16.8	16.2

Source: NBS on-line database, Section "Sown Area, crops average yield and harvest, 1980-2010": <http://statbank.statistica.md/pxweb/Database/RO/16%20 AGR/AGR02/AGR02.asp>; Statistical Yearbooks for ATULBD: 1998 (page 218), 2002 (page 113), 2005 (page 101), 2009 (page 98), 2010 (page 100), 2011 (page 101), 2012 (page 105).

Table 6-68: Average Yield per Hectare of Agricultural Crops in the RM within 1990-2010, t/ha

	1990	1991	1992	1993	1994	1995	1996
Cereals and leguminous corps – total	**3.4**	**3.7**	**2.8**	**3.7**	**2.1**	**2.9**	**2.2**
Wheat (Winter and Spring)	3.9	3.5	3.3	4.0	2.2	3.2	2.1
Winter rye	2.1	2.0	2.0	2.0	2.0	1.9	1.7
Barley (Winter and Spring)	3.5	3.2	3.3	3.5	2.2	2.3	1.3
Oat	1.8	1.7	2.3	2.8	1.4	1.4	0.9
Millet	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Buckwheat	0.5	0.8	0.3	0.9	0.5	0.4	0.4
Leguminous crops	1.3	1.4	1.7	1.7	1.1	1.0	0.7
Grain maize	3.4	4.8	2.5	3.9	2.2	3.0	2.9
Grain sorghum	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Other cereal crops	3.0	3.1	2.6	2.8	2.1	1.4	1.4
Industrial crops– total							
Sugar beet	29.1	24.9	21.6	22.2	18.4	20.8	20.1
Sun flower	1.9	1.2	1.4	1.4	1.1	1.3	1.3
Soybeans	0.9	1.4	0.5	1.0	0.7	0.9	1.0
Tobacco	2.1	1.9	1.6	1.6	1.5	1.3	1.2
Grain rapeseed	2.0	2.0	1.6	1.2	1.0	0.8	0.7
Potatoes, vegetables and melons & gourds – total							
Potatoes	7.2	6.2	5.6	10.2	7.6	6.8	5.8
Vegetables	16.6	12.7	10.7	10.6	8.8	7.3	5.9
Melons and gourds	3.7	4.5	1.3	3.1	2.5	3.1	3.8
Forage plants – total							
Forage roots	44.4	47.2	31.8	35.3	22.8	25.0	21.4
Maize for silo and green fodder	15.4	16.5	10.1	15.6	8.6	11.5	8.1
Perennial grasses for green fodder, silage and fodder	21.6	29.5	18.6	20.1	12.8	14.1	10.2
Annual grasses for green fodder	9.2	15.7	9.7	11.1	5.5	9.0	6.5

	1997	1998	1999	2000	2001	2002	2003
Cereals and leguminous corps – total	**3.3**	**2.7**	**2.3**	**1.9**	**2.4**	**2.4**	**1.8**
Wheat (Winter and Spring)	3.3	2.7	2.4	1.9	2.7	2.5	0.5
Winter rye	2.1	1.9	1.6	1.3	1.7	1.6	0.6
Barley (Winter and Spring)	2.0	1.8	1.6	1.2	2.2	1.8	0.8
Oat	1.4	1.6	1.2	0.8	1.3	1.1	0.9
Millet	1.0	0.7	0.5	0.8	1.0	0.3	0.3
Buckwheat	0.5	0.4	0.4	0.7	0.4	0.3	0.3
Leguminous crops	1.4	1.3	1.0	0.6	1.5	0.8	0.6
Grain maize	4.0	3.1	2.8	2.3	2.3	2.7	2.5
Grain sorghum	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Other cereal crops	1.2	1.3	2.0	1.7	1.5	1.4	2.4
Industrial crops– total							
Sugar beet	22.0	17.8	14.6	14.8	17.7	22.3	16.6
Sun flower	0.9	0.8	1.2	1.2	1.2	1.2	1.1
Soybeans	1.2	0.9	0.8	1.0	1.0	1.2	1.1
Tobacco	1.4	1.1	1.2	1.1	1.0	1.3	1.2
Grain rapeseed	1.0	0.9	1.0	1.0	1.0	1.0	1.0
Potatoes, vegetables and melons & gourds – total							
Potatoes	6.3	6.0	5.0	5.1	9.0	7.2	7.9
Vegetables	6.2	9.7	9.5	7.0	7.0	7.0	8.5
Melons and gourds	4.2	5.2	6.0	4.2	5.2	4.5	8.4
Forage plants – total							
Forage roots	21.7	18.9	12.6	11.2	13.5	16.6	12.4
Maize for silo and green fodder	13.4	8.5	7.5	6.7	7.8	9.2	7.4
Perennial grasses for green fodder, silage and fodder	12.1	9.2	11.3	8.8	13.1	13.1	9.9
Annual grasses for green fodder	10.7	7.6	5.6	5.2	8.4	7.5	4.3

	2004	2005	2006	2007	2008	2009	2010
Cereals and leguminous corps – total	**2.8**	**2.7**	**2.5**	**0.9**	**3.2**	**2.3**	**2.6**
Wheat (Winter and Spring)	2.8	2.6	2.3	1.3	3.1	2.2	2.4
Winter rye	2.0	1.7	1.5	1.0	1.9	1.8	1.5
Barley (Winter and Spring)	2.0	1.7	1.7	0.9	2.6	1.6	1.5
Oat	1.7	1.2	1.4	0.3	1.5	0.7	1.0
Millet	0.6	0.7	0.5	1.0	1.0	0.6	0.5
Buckwheat	0.2	0.3	0.2	0.4	0.6	0.1	0.3
Leguminous crops	1.4	1.6	1.6	0.4	1.3	0.9	1.0
Grain maize	3.1	3.3	2.9	0.8	3.5	2.8	3.4
Grain sorghum	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Other cereal crops	2.7	2.0	2.0	0.4	2.1	1.7	1.8
Industrial crops– total							
Sugar beet	26.1	29.0	27.8	17.9	38.9	14.4	31.7
Sun flower	1.2	1.2	1.3	0.7	1.6	1.3	1.5
Soybeans	1.4	1.8	1.4	0.8	1.9	1.0	1.8
Tobacco	1.4	1.4	1.4	1.2	1.4	1.8	1.7
Grain rapeseed	1.0	1.5	1.0	0.8	1.9	1.2	1.0
Potatoes, vegetables and melons & gourds – total							
Potatoes	9.3	10.6	11.0	5.6	8.8	9.3	10.2
Vegetables	8.6	10.5	11.1	5.6	9.2	8.4	8.8
Melons and gourds	7.9	9.6	10.2	5.8	8.0	8.7	10.1
Forage plants – total							
Forage roots	12.6	19.5	11.6	7.3	14.6	14.2	47.4
Maize for silo and green fodder	8.9	11.2	9.8	4.2	11.1	9.5	11.2
Perennial grasses for green fodder, silage and fodder	13.3	14.7	13.5	2.9	6.8	4.1	5.0
Annual grasses for green fodder	7.0	6.9	6.3	1.8	6.3	4.9	2.8

Source: NBS on-line database, Section "Sown Area, crops average yield and harvest, 1980-2010": <http://statbank.statistica.md/pxweb/Database/RO/16%20AGR/AGR02/AGR02.asp>; Statistical Yearbooks for ATULBD: 1998 (page 218), 2002 (page 113), 2005 (page 101), 2009 (page 99), 2010 (page 101), 2011 (page 102), 2012 (page 106).

Table 6-69: Amount of Nitrogen in Crop Residues Returned to Soils within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
F_{CR}, kt	69.4119	72.8001	52.7932	60.5343	36.6364	40.5841	30.6685
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
F_{CR}, kt	33.7971	25.5865	24.9350	21.5554	25.7581	25.9508	21.0041
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
F_{CR}, kt	27.5471	28.0203	27.0043	12.3209	30.6838	20.9113	25.0419

Based on information provided in the Table 6-64 and Table 6-65, and activity data included into Tables 6-66, 6-67 and 6-68, it was calculated the total amount of nitrogen in crop residues returned to soils. The obtained results (Table 6-69) denote that over the period from 1990 through 2010, the total amount of nitrogen in crop residues returned to soils decreased by 63.9 per cent.

To be noted that implementation of activities aimed at reasonable distribution of soil resources in function of the volume and characteristics of agricultural production, the recommended crop structure (Figure 6-5) will allow to obtain the necessary amount of grain needed to ensure the food security of population, fodder for the animal breeding sector, industrial and leguminous crops to meet the needs of population and the processing industry. At the same time this structure will allow to use soil protective crop rotation, contributing to stabilizing the humus balance in soil and soil fertility conservation.

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 RM are considered to be low, up to ±5 per cent. Uncertainties related to coefficients used to calculate the amount of nitrogen in agricultural crop residues returned to soils are medium and were estimated at circa ±25 per cent. Uncertainties related to default emission factor (EF_1 for F_{CR}) may reach up to ±6 per cent. The combined uncertainties associated with direct N_2O emissions from crop residues may reach to ±25.49 per cent. At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at circa ±1.29 per cent while uncertainties introduced in trend in sectoral emissions were estimated at ±0.23 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 GPG (IPCC, 2000).

Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for this source category following a Tier 1 approach (IPCC, 2000). Te AD and methods used for estimating N_2O emissions from crop residues returned to soil under this category were documented and archived both in hard copies and electronically. For identifying the data entry and GHG emissions estimation process related errors there were applied AD and EFs verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), N_2O emissions from crop residues returned to soil were estimated using AD and national EF from official sources of reference.

Recalculations

Direct N_2O emissions from crop residues returned to soil were recalculated for the 1990 through 2005 time series, in particular due to use of an updated set of activity data on sown areas with crops, gross harvest of agricultural crops, average yield per hectare of agricultural crops (available in the NBS Database[69] as well as into the Statistical Yearbooks of the ATULBD), due to the use of a country specific methodology, similar with a Tier 3 approach (IPCC, 2006); respectively due to use of country specific values for the ratio of below-ground residues to harvested yield for crop (RBG) (IPCC, 2006); due to use of revised values for the fraction of above-ground residues of crop removed annually for other purposes (FracRemove), based on experts opinions from the Institute of Pedology, Agrochemistry and Soil Protection "Nicolae Dimo", as well as a result of using country specific values for the amount of N in crop residues (PCR, % a.s.), respectively due to use of a country specific coefficient on the amount of used N from vegetal residues from the total contents.

The obtained results allow assert that compared with SNC of the RM under the UNFCCC, within the current inventory cycle, the direct N_2O emissions from crop residues returned to soils decreased between 1992-1998, varying from a minimum of 1.3 per cent in 1996 to a maximum of 36.2 per cent in 1994; respectively increased between 1990-1991 and 1999-2005, varying from a minimum of 9.1 per cent in 2000 to a maximum of 32.5 per cent in 2003.

For the period 2006-2010, direct N_2O emissions from crop residues returned to soils were estimated for the first time. The results allow assert that within the 1990-2010 time series, direct N_2O emissions from this source category decreased by circa 63.9 per cent (Table 6-70).

[69] NBS on-line database, Section "Sown Area, crops average yield and harvest: 1980-2010": <http://statbank.statistica.md/pxweb/Database/RO/16%20AGR/AGR02/AGR02.asp>.

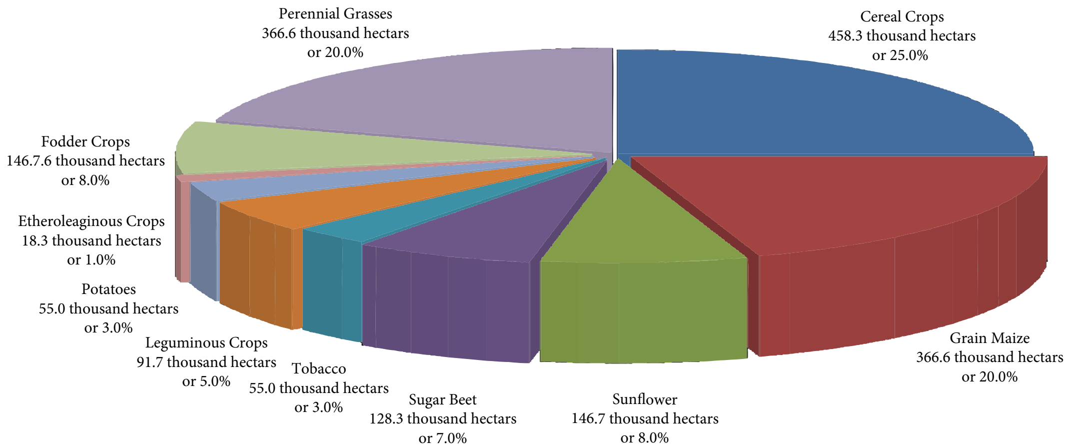


Figure 6-5: Recommended Crops Structure on Agricultural Lands in the RM[68].

[68] Buza, Vasile et al. (2007), *Disaster Risks Management in the Republic of Moldova*, National Agency for Rural Development from the RM, FAO, Chisinau, 2007, page 104.

Table 6-70: Comparative Results of Direct N_2O Emissions from Crop Residues Returned to Soils, Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
$N_2O_{(CR)}$ (SNC)	0.8321	1.0348	1.0552	1.0321	0.9027	0.7145	0.4882
$N_2O_{(CR)}$ (TNC)	1.0908	1.1440	0.8296	0.9513	0.5757	0.6378	0.4819
Difference, %	31.1	10.6	-21.4	-7.8	-36.2	-10.7	-1.3
	1997	1998	1999	2000	2001	2002	2003
$N_2O_{(CR)}$ (SNC)	0.7052	0.4672	0.3369	0.3104	0.3629	0.3649	0.2492
$N_2O_{(CR)}$ (TNC)	0.5311	0.4021	0.3918	0.3387	0.4048	0.4078	0.3301
Difference, %	-24.7	-13.9	16.3	9.1	11.5	11.7	32.5
	2004	2005	2006	2007	2008	2009	2010
$N_2O_{(CR)}$ (SNC)	0.3835	0.4018					
$N_2O_{(CR)}$ (TNC)	0.4329	0.4403	0.4244	0.1936	0.4822	0.3286	0.3935
Difference, %	12.9	9.6					

The decrease in emissions is due to both less area being sown with crops over the period under review (for example, over the period from 1990 through 2010 areas sown with fodder plants decreased by 85.0 per cent, with tobacco – by 86.3 per cent, with sugar beets – by 67.6 per cent, with leguminous crops – by 46.4 per cent, with vegetables – by 44.0 per cent, etc.), and lower yield per hectare of agricultural crops (for example, between 1990-2010 the average yield per hectare of winter wheat decreased by 40.0 per cent, barley – by 56.7 per cent, oat – by 43.2 per cent, leguminous crops – by 23.8 per cent, sunflower – by 18.3 per cent, tobacco – by 16.1 per cent, grain rapeseed – by 48.2 per cent, vegetables – by 47.1 per cent, maize for silo and green fodder – by 27.2 per cent, perennial grasses for green fodder, silage and fodder – by 76.8 per cent, annual grasses for green fodder – by 70.2 per cent, etc.).

Despite the fact that over the 1990-2010 time periods the areas sown with some crops increased: winter wheat – by 28.6 per cent, winter barley – by 24.8 per cent, grain maize – by 63.8 per cent, sunflower – by 108.4 per cent, soybeans – by 131.3 per cent and melons and gourds – by 12 per cent; also there was also an increase in yield per hectare in other crops, such as melons and gourds – by 171.1 per cent, soybeans – by 104.8 per cent, potatoes – by 42.8 per cent, sugar beets – by 8.9 per cent and forage roots crops – by 6.8 per cent, it did not considerable affect the decreasing trend in N_2O emissions from crop residues returned to soils.

Planned Improvements

Activities focused on obtaining more precise information, respectively on updating the activity data and country specific coefficients and parameters used to estimate direct N_2O emissions from crop residues returned to soils under the 4D 'Agriculture Soils' category, are planned as future improvements.

6.4.1.5 Nitrogen Mineralization Associated with Loss of Soil Carbon

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 intimately linked in soil organic matter (humus). Where soil carbon is lost through oxidation as a result of land-use or management practices 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 to N_2O (IPCC, 2006).

Methodological Issues, Emission Factors and Data Sources

The N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change were estimated by using a Tier 1 methodology (IPCC, 2006) and the following equation:

$$N_2O_{SOM} = F_{SOM} \bullet EF_1 \bullet 44/28$$

Where:

[44/28] – stoichiometric ratio between the content of nitrogen in N_2O-N and N_2O;

EF_1 – default 0.01 kg N_2O-N/kg N applied (range: 0.003-0.03 kg N_2O-N/kg N);

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);

Where:

$$F_{SOM} = \Sigma\, [(\Delta C_{mineral} \bullet 1/R)]$$

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, Gonenko, 1984; Banaru, 2002), 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 6-71) was estimated using the "Methodology for determining the carbon balance in agricultural lands for estimating GHG emissions" (see Annex A3-4.2)[70].

[70] Banaru Anatol (2000), *Methodology to Calculate CO_2 Emissions from Agricultural Soils,* In the collection of papers „Climate Change: Research, Studies, Solutions, Ministry of Environment / UNDP Moldova. „Bons Offices" S.R.L. Chisinau, 2000. P. 115-123.

Table 6-71: Annual Loss of Soil Carbon in the RM within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
ΔC mineral, kt C/yr	259.6872	701.9840	259.1199	939.8799	587.4570	935.6514	824.6388
	1997	1998	1999	2000	2001	2002	2003
ΔC mineral, kt C/yr	1304.9071	1080.0225	1000.7376	916.4764	1110.1568	1121.6140	833.2609
	2004	2005	2006	2007	2008	2009	2010
ΔC mineral, kt C/yr	1260.7229	1168.2943	1029.4213	336.4997	1242.4731	893.0133	1138.2800

Table 6-72: The Net Annual Amount of Nitrogen Mineralized in Mineral Soils as a Result of Loss of Soil Carbon in the RM within 1990-2010 time periods, kt

	1990	1991	1992	1993	1994	1995	1996
N mineralized, F_{SOM}	24.2698	65.6060	24.2168	87.8392	54.9025	87.4441	77.0691
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
N mineralized, F_{SOM}	121.9539	100.9367	93.5269	85.6520	103.7530	104.8237	77.8749
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
N mineralized, F_{SOM}	117.8246	109.1864	96.2076	31.4486	116.1190	83.4592	106.3813

The obtained results on the total amount of nitrogen mineralized (F_{SOM}) in mineral soils as a result of loss of soil carbon are provided in Table 6-72.

Uncertainties Assessment and Time-Series Consistency

Uncertainties related to activity data on arable lands' areas in the RM are considered to be low, up to ±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, while uncertainties related to default emission factor (EF_1 for F_{SOM}) may reach up to ±6 per cent. Combined uncertainties associated with direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change are considered to be moderate (±25.50 per cent). At the same time, combined uncertainties, presented as percentage of total sectoral emissions were estimated at ±5.49 per cent, while uncertainties introduced in trend in sectoral emissions were estimated at ±2.32 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 GPG (IPCC, 2000).

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 (IPCC, 2000). The AD and methods used for estimating direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change under the category 4D 'Agriculture Soils' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Following the recommendations included into the GPG (IPCC, 2000), N_2O emissions originated from the 4D 'Agriculture Soils' were estimated based on AD and EFs from official sources of reference.

Recalculations

Direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change were recalculated for the 1990 through 2005 time series, in particular due to use of an updated set of activity data on sown areas with crops, gross harvest of agricultural crops, yield per hectare of agricultural crops (available in the NBS on-line database as well as into the Statistical Yearbooks of the ATULBD), due to use of a country specific methodology, similar with a Tier 3 approach; respectively due to use of country specific values for the ratio of carbon and nitrogen in humus.

The obtained results allow assert that compared with SNC of the RM under the UNFCCC, within the current inventory cycle, the direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon decreased in 1990 and 1992 years, varying from a minimum of 53.2 per cent in 1990 to a maximum of 53.6 per cent in 1992; respectively increased in 1991 and between 1993 and 2005 years, varying from a minimum of 4.4 per cent in 1994 to a maximum of 127.2 per cent in 1997 (Table 6-73).

Table 6-73: Comparative Results of Direct N_2O Emissions from Nitrogen Mineralization Associated with Loss of Soil Carbon from Croplands, Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
$N_2O_{(SOM)}$ (SNC)	0.8142	0.8155	0.8193	0.8194	0.8260	0.8332	0.8383
$N_2O_{(SOM)}$ (TNC)	0.3814	1.0310	0.3805	1.3803	0.8628	1.3741	1.2111
Difference, %	-53.2	26.4	-53.6	68.5	4.4	64.9	44.5
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
$N_2O_{(SOM)}$ (SNC)	0.8434	0.8500	0.8519	0.8551	0.8640	0.8654	0.8667
$N_2O_{(SOM)}$ (TNC)	1.9164	1.5861	1.4697	1.3460	1.6304	1.6472	1.2237
Difference, %	127.2	86.6	72.5	57.4	88.7	90.3	41.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
$N_2O_{(SOM)}$ (SNC)	0.8643	0.8610					
$N_2O_{(SOM)}$ (TNC)	1.8515	1.7158	1.5118	0.4942	1.8247	1.3115	1.6717
Difference, %	114.2	99.3					

For the 2006-2010 time periods, the 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 were estimated for the first time. The results allow assert that within the 1990-2010 time series, the direct N_2O emissions from this source category increased by circa 4.4 times.

Planned Improvements

It is planned to undertake activities on obtaining more precise country specific values for rate of changing the soil carbon reserves and soil management practices in the RM in the next inventory cycles.

6.4.2 Indirect N_2O Emissions from Managed Soils

In addition to the direct emissions of N_2O from managed soils that occur through a direct pathway (i.e., directly from the soils to which N is applied), emissions of N_2O also take place through two indirect pathways.

The first of these pathways is the volatilization of N as NH_3 and oxides of N (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. The sources of N as NH_3 and NO_x are not confined to agricultural fertilizers and manures, but also include fossil fuel combustion, biomass burning, and some industrial processes. Thus, these processes cause N_2O emissions in an exactly analogous way to those resulting from deposition of agriculturally derived NH3 and NO_x, following the application of synthetic and organic N fertilizers and/or urine and dung deposition from grazing animals.

The second pathway is the leaching and runoff from land of N from synthetic and organic fertilizer additions, crop residues, 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. Some of the inorganic N in or on the soil, mainly in the NO_3^- form, 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^- to N_2O. This may take place in the groundwater below the land to which the N was applied, or in riparian zones receiving drain or runoff water, or in the ditches, streams, rivers and estuaries (and their sediments) into which the land drainage water eventually flows.

6.4.2.1 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 N or organic (manure) fertilizer 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 from atmospheric deposition of nitrogen volatilized from managed soil were estimated by using a Tier 1 methodology (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 synthetic N fertilizer applied to soils (t N/yr);

$Frac_{GASF}$ – fraction of synthetic fertilizer 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 synthetic N fertilizer applied to soils) (range from 0.03-0.3 t NH_3-N + NO_x-N/t N in synthetic N fertilizer 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 fertilizer 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] – stoichiometric 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 are available in Tables 6-56, 6-59, respectively in Table 6-62.

Uncertainties Assessment and Time-Series Consistency

Uncertainties related to estimation of indirect N_2O emissions from this source are very high. Uncertainties mostly pertain to estimating the amount of volatilized fertilizer, amount of N in manure and emission factors, for which it is extremely difficult to verify to what extent they reflect the conditions specific to Republic of Moldova. Also, the uncertainties associated with the estimation of the amount of nitrogen lost through volatilization of NO_x and NH_4 are quite high. Nitrogen volatilization fraction vary a lot, from negligible to very high, depending on environment conditions, soil characteristics, climate conditions, etc.

According to the GPG (IPCC, 2000) uncertainties related to estimating indirect N_2O emissions from this source can vary up to factor of 2. In the RM, combined uncertainties related to indirect N_2O emissions from this source category are considered to be very high (±211.90 per cent). Combined uncertainties presented as a per cent of total sectoral emissions were estimated at ±1.42 per cent while uncertainties introduced in trend in sectoral emissions were estimated at ±1.33 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 GPG (IPCC, 2000).

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 (IPCC, 2000). The AD and methods used were documented and archived both in hard copies and electronically. For identifying the data entry and GHG emission estimation process related errors there were applied verifications and quality control procedures.

Recalculations

Indirect N_2O emissions from atmospheric deposition of nitrogen volatilized from managed soils were recalculated for the period since 1990 to 2005, regarding F_{SN} – due to an updated set of activity data related to the amount of synthetic nitrogen applied to soils in 1990, 1993 and 1994 (available in the updated versions of the SYs of the RM and ATULBD); regarding F_{ON} – due to an updated activity data related to the amount of organic N fertilizers applied to soils in 1990 (available in the updated versions of the SYs of the RM); and in case of F_{PRP} – due to an updated set of activity data related to animal population in the RM (available in the updated versions of the SYs of the ATULBD), as well as in the Statistical Annual Report Nr. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all Households Categories as of 1st of January" and "Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM", due to use of country specific values on N excretion (kg N/1000 kg animal mass/year), as well as a result of using updated information on use of manure management systems in the RM (MS%).

The obtained results allow assert that compared with the SNC of the RM under the UNFCCC, the indirect N_2O emissions from atmospheric deposition of nitrogen oxides (NO_x) and ammonia (NH_4) significantly decreased within 1990-2005 time periods, varying from a minimum of 1.3 per cent in 1990 to a maximum of 28.0 per cent in 2000 (Table 6-74).

Table 6-74: Comparative Results of Indirect N_2O Emissions from atmospheric deposition of nitrogen oxides (NO_x) and ammonia (NH_4), included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
$N_2O_{(ATD)}$ (SNC)	0.3586	0.3331	0.2411	0.1729	0.1106	0.1092	0.0934
$N_2O_{(ATD)}$ (TNC)	0.3540	0.3202	0.2281	0.1556	0.0907	0.0864	0.0726
Difference, %	-1.3	-3.9	-5.4	-10.0	-18.0	-20.9	-22.3
	1997	1998	1999	2000	2001	2002	2003
$N_2O_{(ATD)}$ (SNC)	0.0769	0.0691	0.0585	0.0616	0.0627	0.0712	0.0662
$N_2O_{(ATD)}$ (TNC)	0.0556	0.0578	0.0464	0.0443	0.0485	0.0564	0.0492
Difference, %	-27.7	-16.3	-20.6	-28.0	-22.6	-20.7	-25.7
	2004	2005	2006	2007	2008	2009	2010
$N_2O_{(ATD)}$ (SNC)	0.0660	0.0640					
$N_2O_{(ATD)}$ (TNC)	0.0499	0.0496	0.0449	0.0482	0.0524	0.0460	0.0521
Difference, %	-24.4	-22.5					

For the 2006-2010 time periods, the indirect N_2O emissions from atmospheric deposition of nitrogen oxides and ammonia were estimated for the first time. The results allow assert that within the 1990-2010 time series, the indirect N_2O emissions from this source category decreased by circa 85.3 per cent. This significant decrease can be explained by a drastic drop in the amounts of synthetic nitrogen and organic fertilizer applied to soils, and due to a significant reduction of the total livestock population over the period under review.

Planned Improvements

Activities focused on obtaining more precise information and on updating the activity data used to estimate indirect N_2O emissions from atmospheric deposition of nitrogen oxides and ammonia under the 4D 'Agriculture Soils' category, are planned as future improvements.

6.4.2.2 Nitrogen Leaching and Runoff

Source Category Description

A big part of nitrogen applied to soil through application of synthetic and organic fertilizer addition, crop residues, mineralization of nitrogen associated with loss of soil carbon in mineral soils through land-use change or management practices, also through urine and dung deposition from grazing animals, is lost through leaching and runoff.

Some of the inorganic nitrogen in, or on the soil, mainly in the NO_3^- form, 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; the excess leaches through the soil profile. This may take place in the groundwater below the land, to which the nitrogen was applied, or in riparian zones receiving drain or runoff water, or in the ditches, streams, rivers and estuaries into which the land drainage water eventually flows, where biogenic production of N_2O emissions is more intense.

Methodological Issues, Emission Factors and Data Sources

The indirect N_2O emissions from leaching and runoff were estimated by using a Tier 1 methodology (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 synthetic nitrogen fertilizer 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 runoff, 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 runoff (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 runoff);

[44/28] – stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

Activity data on the amount of soil nitrogen from application of synthetic and organic fertilizer additions, crop residues, mineralization of nitrogen associated with loss of soil carbon in mineral soils through land-use change or management practices, and from urine and dung deposition, are available in Tables 6-56, 6-59, 6-62, 6-69, respectively in Table 6-72.

Uncertainties Assessment and Time-Series Consistency

The uncertainties associated with the estimation of indirect N_2O emissions from leaching and runoff are very high, being caused by uncertainties related to natural variability and to the emission and leaching factors, activity data and lack of measurements. Additional uncertainty is introduced in the inventory, as values of emission factors might be not representative of all condition of the Republic of Moldova.

According the GPG (IPCC, 2000), uncertainties associated with estimation of indirect N_2O emissions from leaching and runoff may vary up to factor of 2. In the RM, combined uncertainties associated with indirect N_2O emissions from leaching and runoff are considered to be very high (±213.60 per cent). At the same time, combined uncertainties, presented as a per cent of total sectoral emissions were estimated at ±15.40 per cent while uncertainties introduced in trend in sectoral emissions were estimated at ±3.93 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 GPG (IPCC, 2000).

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 (IPCC, 2000). Also, the AD and methods used were documented and archived both in hard copies and electronically. For identifying the data entry and GHG emission estimation process related errors there were applied verifications and quality control procedures.

Recalculations

Indirect N_2O emissions from soil nitrogen leaching and runoff through synthetic (F_{SN}) and organic (F_{ON}) nitrogen fertilizer applied, urine and dung N deposited by grazing animals on pasture, range and paddock (F_{PRP}), crop residues returned to soils (F_{CR}), nitrogen mineralized in mineral soils associated to loss of soil carbon (F_{SOM}) were recalculated for 1990-2005 time series.

In case of F_{SN} the recalculations are due to an updated set of activity data related to the amount of synthetic nitrogen applied to soils in 1990, 1993 and 1994 years (available in the updated versions of the Statistical Yearbooks of the RM and ATULBD); in case of F_{ON} – due to an updated activity data on the amount of organic nitrogen fertilizers applied to soils in 1990 year (updated versions of the SYs of the RM); while in case of F_{PRP} – due to an updated set of activity data related to animal population in the RM (updated versions of SYs of the ATULBD; Statistical Annual Report Nr. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all Households Categories as of 1st of January" and "Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM", due to use of country specific values on N excretion (kg N/1000 kg animal mass/year), as well as a result of using a revised set of data on manure management systems in the RM (MS%).

In case of F_{CR} the recalculations are due to use of an updated set of AD on areas sown with crops, gross harvest of agricultural crops, average yield per hectare of agricultural crops (available in the NBS on-line database, as well as into the revised versions of the Statistical Yearbooks of the ATULBD); respectively due to use of country specific values for the ratio of above-ground residues to harvested yield for agricultural crops (R_{AG}); due to updated values for the ratio of below-ground residues to harvested yield for agricultural crops (R_{BG}), available in the 2006 IPCC Guidelines; due to use of updated values for the fraction of above-ground residues of crop removed annually for other purposes ($Frac_{Remove}$) based on experts opinions, as well as a result of using country specific values for the amount of nitrogen in crop residues (P_{CR}, % a.s.), respectively due to use of a country specific coefficient on use of nitrogen from crop residues;

In case of F_{SOM} the recalculations are due to use of an updated set of AD on areas sown with crops, gross harvest of agricultural crops, average yield per hectare of agricultural crops (available in the NBS on-line database, as well as into the revised versions of the Statistical Yearbooks of the ATULBD); due to the use of country specific methodology, similar with a Tier 3 approach (IPCC, 2006); respectively due to use of a country specific values for the ratio (R) of carbon and nitrogen in humus.

The obtained results allow assert that compared with the SNC of the RM under the UNFCCC, the indirect N_2O emissions from leaching and runoff decreased in 1990, 1992 and 1994, varying from a minimum of 3.9 per cent in 1990 to a maximum of 20.5 per cent in 1992, respectively increased in 1991, 1993 and during the 1995-2005 time periods, varying from a minimum of 6.2 per cent in 1991, to a maximum of 56.1 per cent in 2004 (Table 6-75).

Table 6-75: Comparative Results of Indirect N_2O Emissions from Soil Nitrogen Leaching and Runoff, included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
$N_2O_{(L)}$ (SNC)	0.9290	0.9373	0.8023	0.6619	0.5421	0.4897	0.4269
$N_2O_{(L)}$ (TNC)	0.8923	0.9958	0.6382	0.7463	0.4507	0.5684	0.4860
Difference, %	-3.9	6.2	-20.5	12.8	-16.9	16.1	13.8
	1997	1998	1999	2000	2001	2002	2003
$N_2O_{(L)}$ (SNC)	0.4552	0.3921	0.3437	0.3496	0.3690	0.3887	0.3514
$N_2O_{(L)}$ (TNC)	0.6335	0.5304	0.4815	0.4470	0.5349	0.5576	0.4308
Difference, %	39.2	35.3	40.1	27.9	45.0	43.5	22.6
	2004	2005	2006	2007	2008	2009	2010
$N_2O_{(L)}$ (SNC)	0.3834	0.3846					
$N_2O_{(L)}$ (TNC)	0.5985	0.5694	0.5106	0.2423	0.6168	0.4509	0.5598
Difference, %	56.1	48.0					

For the 2006-2010 time periods, the indirect N_2O emissions from leaching and runoff were estimated for the first time.

The results allow assert that within the 1990-2010 time series, the indirect N_2O emissions from this source decreased by circa 37.3 per cent.

This decrease can be explained by a drastic drop in amounts of synthetic and organic fertilizers applied to soils, a significant reduction of the total population of livestock over the period under review, as well as due to smaller amounts of crop residues returned to soils (as a consequence of irrational soil management and failure to respect the recommended crop rotation, with a strong negative effect on the stabilization of humus balance in soils), and due to significant soil carbon losses resulting from inefficient management of agricultural lands.

Planned Improvements

Activities focused on obtaining more precise information and on updating the activity data used to estimate indirect N_2O emissions from soil N leaching and runoff under the 4D 'Agriculture Soils' category, are planned as future improvements.

7. LAND USE, LAND-USE CHANGE AND FORESTRY SECTOR

7.1 Overview

Estimation of GHG emissions and CO_2 removals covered by the Land Use, Land-Use Change and Forests (LULUCF) Sector are described in the respective chapter.

GHG emissions/removals within this sector were estimated following the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003), 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and other relevant methodological publications.

The evolution of emissions/removals reported for the time period from 1990 through 2010 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 period in the Republic of Moldova (transition to market economy, land parceling as result of land reform, a sharp decrease in industrial manufacturing indicators, etc.).

Following the implementation of land reforms in the 90's of the last century, the land use in the RM was relatively stable in the last 10 years. The forest area was growing steadily. According to data provided by the General Land Cadaster, by 01.01.2010, forest lands accounted for 374.6 thousand ha or 11.4 percent of the country's surface. This indicator is much lower than the European average (about 30 percent), but it is close to the medium term target, established in a series of national policy documents (15 percent by 2020).

Most forest lands (87.2 percent) are under state ownership, while the rest belongs to local public authorities (12.2 percent) and 0.6 percent are in private property.

The total standing volume of wood mass in the forests of the RM is circa 46 million m^3, on average 124 m^3 per hectare. The average growth of forests is 3.3m^3/ha/year and the total average growth is circa 1240 thousand m^3/year.

7.1.1 Summary of CO_2 Emissions/Removals Trends

Over the period from 1990 through 2010, CO_2 net removals covered by LULUCF Sector tended to decrease. At the same time, during certain years (1997, 2004, 2008 and 2010), this sector, from a CO_2 sink category became a source category (Figure 7-1, Table 7-1).

This trend is due, first of all, to changes in forest management and forest land use (Category 5B 'Cropland'), which contributed to the significant decrease of organic carbon stocks in croplands[71], thus changing the balance of humus, from a positive one, specific to the period 1990-1992, in relatively neutral one, specific to the period 1993-1994, respectively in a negative one, specific to the period 1995-2010. This process was also influenced by some changes in forest management and forest land use (Category 5A 'Forest Land'), such as increasing authorized harvesting of wood mass, significant increase of illegal logging, increased conversion of forest land to agricultural lands, etc.

With respect to Category 5B, the situation described above continues for already two decades and could be solved only

[71] Organic carbon and nitrogen in soil are closely related to the humus content of soil; carbon loss through oxidation due to changes in soil management and agricultural land use are accompanied by the simultaneous nitrogen mineralization (biochemical decomposition).

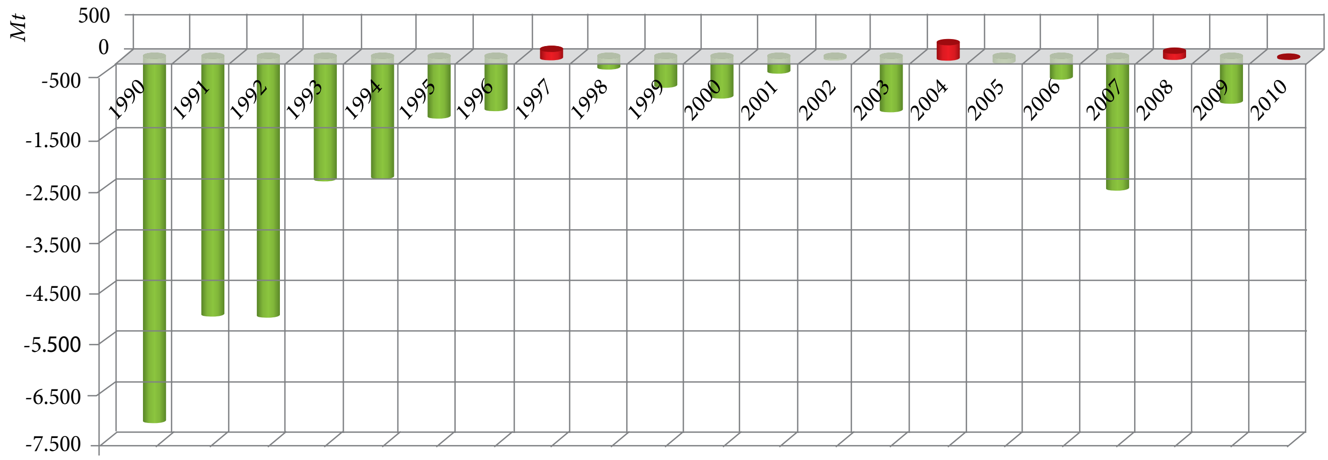


Figure 7-1: Net CO_2 Emissions/Removals within the LULUCF Sector in the RM within 1990-2010 time periods, Mt.

Table 7-1: CO_2 Emissions/Removals within the LULUCF Sector in the RM, by source and sink categories, within 1990-2010 time periods, Gg CO_2

Year	5A	5B1.1	5B1.2	5C1.1	5C1.2	5 Total	Compared with 1990, %
1990	-2197.5790	-725.2315	-3470.9538	-780.1200	-6.3800	-7180.2643	100.0
1991	-1924.1010	-613.0622	-1885.3809	-783.2000	125.6200	-5080.1241	-29.2
1992	-1766.5038	-613.9635	-2147.3512	-785.8400	202.1360	-5111.5226	-28.8
1993	-1491.3852	-611.8682	174.2778	-787.6000	299.8160	-2416.7596	-66.3
1994	-1743.7096	-590.3010	558.4259	-802.1200	198.4400	-2379.2647	-66.9
1995	-1620.7949	-598.6205	1678.1188	-808.0600	188.5180	-1160.8385	-83.8
1996	-1705.1295	-551.0146	1825.6843	-813.3400	235.2240	-1008.5757	-86.0
1997	-2132.2121	-573.4484	3607.4508	-818.4000	89.4740	172.8643	-102.4
1998	-2027.8925	-550.9832	3092.0822	-823.0200	119.6140	-190.1995	-97.4
1999	-2111.2238	-533.4373	2880.3349	-827.2000	30.8220	-560.7042	-92.2
2000	-2140.3185	-523.3924	2706.0275	-828.0800	2.5520	-783.2114	-89.1
2001	-2195.4199	-507.7310	3266.4584	-839.5200	-4.5907	-280.8032	-96.1
2002	-2134.8652	-477.5706	3321.1274	-781.2200	0.7480	-71.7804	-99.0
2003	-2135.8765	-473.9941	2431.3604	-840.6200	-27.4560	-1046.5861	-85.4
2004	-2183.7322	-466.3503	3786.8140	-829.4000	2.2440	309.5755	-104.3
2005	-2246.2332	-465.3288	3426.4452	-821.7000	2.2440	-104.5728	-98.5
2006	-2087.8823	-472.0698	2963.4636	-814.4400	7.7044	-403.2242	-94.4
2007	-2192.3574	-477.0847	855.5174	-801.2400	2.3936	-2612.7710	-63.6
2008	-2223.0019	-479.9904	3622.2260	-792.2200	2.9172	129.9309	-101.8
2009	-2251.7423	-483.5731	2645.0396	-785.6200	3.8148	-872.0809	-87.9
2010	-2193.2612	-470.5183	3447.5439	-779.4600	21.8416	26.1460	-100.4

with the implementation of certain actions concerning: (a) restoration of the livestock sector and the broader manure use as organic fertilizer[72]; (b) rational distribution of soil resources following the recommended structure for crops rotation, including the allocation of 15-20 percent of cropland for perennial grasses, green fodder, silage and forage[73]; (c) given the lack of needed manure as an alternative source of organic fertilizer, it is necessary to use on a larger scale sidereal crops as green manure[74]. These actions will help stabilize the humus balance in soil and its fertility preservation, ensuring the conversion from a carbon emission source category to a carbon emission sink category.

[72] For the neutral balance of humus, a fully compensation of humus loss in crop rotation, it is necessary to apply an average dose of organic fertilizer of circa 10 t/ha/year, while for a positive balance – circa 15 t/ha/yr.
[73] From 1990 through 2010, areas sown with perennial grasses decreased by 85.0 percent in the RM.
[74] Research carried out by a group of authors (Cerbari, Scorpan, Taranu, 2012), have established that the use of a single crop harvest in a sidereal cycle as green manure increases the soil organic content by 0.2 percent, contributing to improved physical quality of degraded arable layers of soils, but also to increased agricultural output by 20-30 percent.

With regard to the Category 5A 'Forest Land', the most serious situation was reported for forests and other types of forest vegetation managed by local public authorities. In particular due to the population's need to get fuel wood and construction materials, the total volume of illegal logging over the period from 1990 through 2010 was circa 1400 thousand m^3 (Figure 7-2).

In these terms, the forest areas managed by the state forest authorities lost circa 1 percent through illegal logging, while forests managed by other owners were destroyed at circa 13 percent.

Since 1997, the situation started to gradually improve, reaching the carbon removal level of 1990 (see also Table

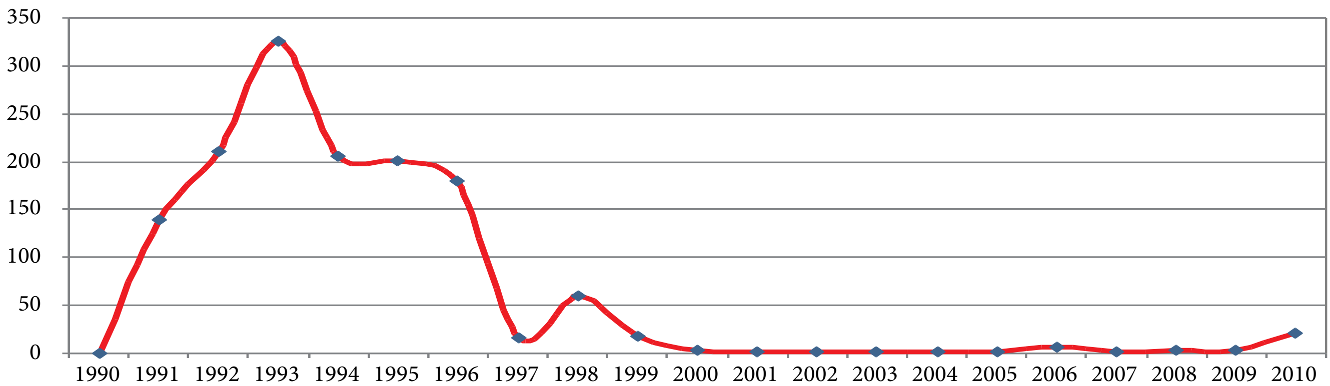


Figure 7-2: Volume of Illegal Logging of Forests and Other Forest Vegetation within 1990-2010 time periods, thousand m^3.

7-1). The above mentioned improvement was due to both gradual increase of forests (in comparison with 1990 there was a 15 percent increase), as well as due to a decisive decrease of illegal logging.

To be noted that in the base year 1990, the main source of CO_2 removals under the LULUCF Sector was the 5B 'Cropland' category (land covered with woody vegetation – perennial plantations, and soils with agricultural destination) with a share of about 58.4 percent of the total, followed by 5A 'Forest Land' category (forest vegetation - forests, protection forest belts, etc.) with a share of 30.6 percent, respectively 5C 'Grassland' category, with a share of 11.0 percent (Figure 7-3).

Since 1993, 5B 'Cropland' category becomes a source of CO_2 emissions as a result of a deeply negative balance of soils with agricultural destination[75], and due to the decrease of perennial plantations areas.

In some particular years (1997, 2004, 2008 and 2010), the total emissions recorded within the category 5B 'Cropland' prevail over net carbon removals within other categories (i.e., 5A 'Forest Land' and 5C 'Grassland'), and this despite the fact that contribution of areas covered by forest ecosystems in the process of carbon removals is constantly growing, in particular due to the expansion of areas covered with forest vegetation. In future, this growth may be enhanced at the expense of increased productivity of existing forests by a wider reconstruction of damaged and low productivity stands. Improved management of the national forestry resources will implicitly generate and enhance the climatic and oxical functions of forests in the Republic of Moldova.

[75] In particular, due to the severe decrease between 1990 and 2010 of the amount of synthetic and organic fertilizers applied to soil, by 77.6 percent and, respectively by 99.8 percent; irrational distribution of soil resources and improper crops structure: for example, areas sown with fodder plants decreased by 85.0 percent, with tobacco – by 86.3 percent, with sugar beet – by 67.6 percent, with grain leguminous crops – by 46.4 percent, with vegetables – by 44.0%, etc.; while areas sown with winter wheat increased by 28.6 percent, winter barley – by 24.8 percent, grain maize – by 63.8 percent, sunflower – by 108.4 percent, soybeans - by 131.3 percent, etc.

Given the biological features, productivity and areas occupied, the forest species within the national forest fund have different contribution to carbon dioxide removals. Thus, considering the occupied area[76], the largest share in the process of CO_2 removal rests with Quercus genus (45.9 percent) and Robinia pseudoacacia (32.3 percent), the remaining species accounting together for as much as circa 21.8 percent of the total amount of CO_2 removed (Figure 7-4).

7.1.2 Key Categories

The results of key source assessment carried out following a Tier 1 approach (IPCC, 2000), by level and trend, are provided in Table 7-2 under the LULUCF Sector.

Table 7-2: Key Source Categories under the LULUCF Sector

IPCC Category	GHG	Source Category	Key Source
5A1	CO_2	Forest Lands remaining Forest Lands	Yes (L, T)
5A1	non-CO_2	Forest Lands Remaining Forest Lands	No
5A2	CO_2	Lands Converted to Forest Lands	No
5B1	CO_2	Cropland Remaining Cropland	Yes (L, T)
5B1	non-CO_2	Cropland Remaining Cropland	No
5B2	CO_2	Land Converted to Cropland	No
5C1	CO_2	Grassland Remaining Grassland	Yes (L, T)
5C2	CO_2	Land Converted to Grassland	No
5D1	CO_2	Wetlands Remaining Wetlands	No
5D2	CO_2	Lands Converted to Wetlands	No
5E1	CO_2	Settlements Remaining Settlements	No
5E2	CO_2	Lands Converted to Settlements	No
5F1	CO_2	Other Lands Remaining Other Lands	No
5F2	CO_2	Lands Converted to Other Lands	No

7.1.3 Methodological Issues and Data Sources

Tier 1 and Tier 2 methodologies (IPCC, 2003, 2006), as well as default and country specific emissions/removals factors

[76] Circa 41.5 percent of the forest land is occupied by *Quercus spp*, 39.5 percent – by *Robinia spp*, circa 5.6 percent – by *Fraxinus spp.*, 2.4 percent – by *Populus spp./Salix spp.* etc.

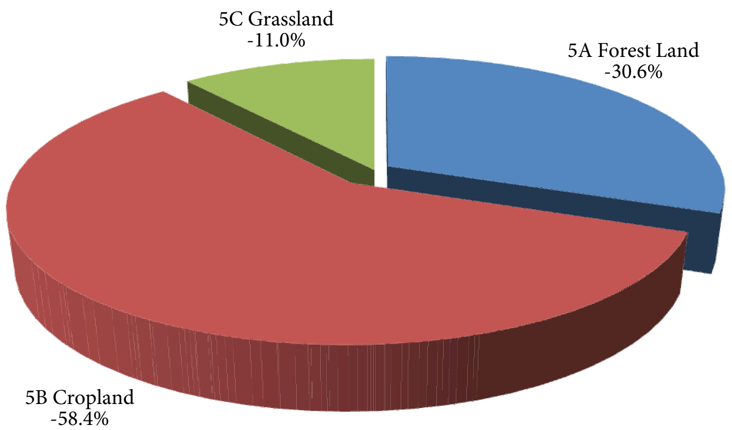


Figure 7-3: Breakdown of CO_2 Removals under LULUCF Sector in1990, %

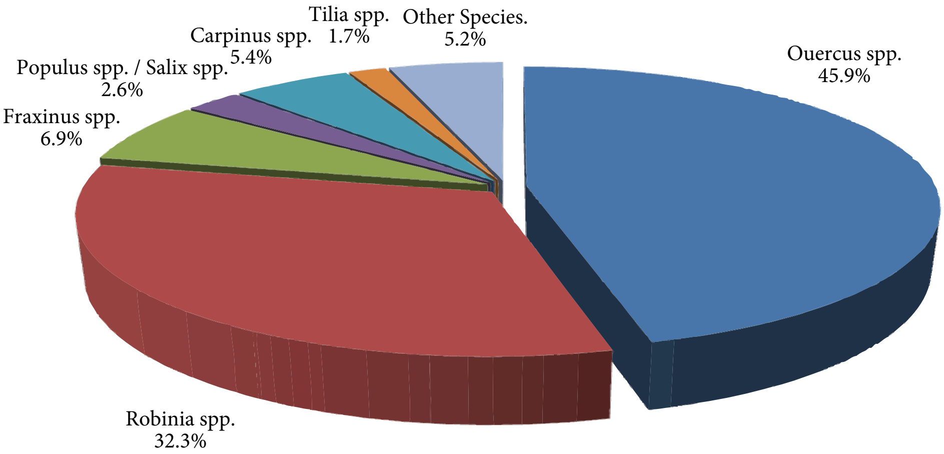


Figure 7-4: Share of Forest Species in CO_2 Removals within the 5A 'Forest Land' Category in the RM

(ex., average annual net increment in volume suitable for industrial processing; basic wood density; carbon fraction of dry matter, etc.) were employed to estimate emissions/ removals under LULUCF Sector.

The summary of estimation methods used to calculate emissions by source and sink categories are presented in Table 7-3, and a more detailed description is provided in sub-chapters 7.2-7.4 of the NIR.

The main sources of reference for the activity data used under the LULUCF Sector were: data pertaining to *Reports of State Accounting of Forest Resources*: areas occupied by forests, distribution by species, volume of standing wood mass, etc.; *Forest Planning Materials*: areas occupied and dendrometrical features of forests and other types of forest vegetation; *General Land Cadasters*: areas occupied by forest vegetation not included in forestry resources, grasslands, perennial plantations, arable lands, settlement lands, other land categories, etc.; *Statistical Reports of the State Agency "Moldsilva"*: the volumes of woody mass harvested during forest clearings (by categories and species); *Statistical Reports of State Agency "Moldsilva"*: illegal fellings from

Table 7-3: Summary of Methods Used to Estimate CO_2 Emissions/Removals from the LULUCF Sector

IPCC Categories	Subcategories	Method Used	EF	Notes
5A Forest Land	A1. Forest Lands Remaining Forest Lands	T1, T2	D, CS	Above-ground biomass (biomass increment in forests, carbon losses due to authorized commercial fellings, illegal logging and fuel wood gathering)
	A2. Lands Converted to Forest Lands	T2	D, CS	There was included in the category 'Forest Land Remaining Forest Land'
5B Cropland	B1. Cropland Remaining Cropland	T1, T2	D, CS	
	B1.1. Cropland Covered with Woody Vegetation	T1, T2	CS	Above-ground biomass (forest strips, other types of forest vegetation, orchards, vineyards, trees from individual gardens)
	B1.2. Annual Change in Carbon Stocks in Mineral Soils	T2	D, CS	Cropland: annual change in carbon stocks in mineral soils
	B2.Land Converted to Cropland	T2	CS	There was included in the category 'Cropland Remaining Cropland'
5C Grassland	C1. Grassland Remaining Grassland	T2	CS	Change in carbon stocks in living biomass from grassland covered with grasses (lands included in 'pastures' and 'hayfields')
	C2. Land Converted to Grassland	T2	CS	Change in carbon stocks in living biomass from area of land converted to grassland from some initial use (protection forest strips, other types of forest vegetation and degraded arable lands)
5D Wetlands	D1. Wetlands Remaining Wetlands	NE		
	D2. Lands Converted to Wetlands	NE		
5E Settlements	E1. Settlements Remaining Settlements	IE		Depending on the type of vegetation a part of settlement lands were included in the following categories: 5A 'Forest Land' (urban forests), 5B 'Cropland' (parks, squares, green spaces), 5C 'Grassland' (pastures and hayfields)
	E2. Lands Converted to Settlements	IE		
5F Other lands	F1. Other Lands Remaining Other Lands	NE		
	F2. Lands Converted to Other Lands Category	NE		

Abbreviations: T1, T2 – Tier 1 and Tier 2 Methods; CS – country specific emission/ removal factors; D –default emission/ removal factors; NE – Not Estimated; IE – Included Elsewhere.

the forestry resources managed by the Agency, as well as from forests and forest vegetation managed by other owners; *Reports of the State Ecological Inspectorate*: illegal fellings revealed by its territorial sub-divisions; *Reports of the State Ecological Inspectorate*: the volumes of wood mass subjected to authorized harvesting from forests and forest vegetation managed by local and central public authorities; *National Environment Reports of the Republic of Moldova*: areas where the stubble fields were burnt; *Statistical Yearbooks of the RM* 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.

7.1.4 Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of the CO_2 emissions/removals from the LULUCF Sector (by source and sink categories) is described in detail in the sub-chapters 7.2-7.4 of the NIR, as well as in the **Annex 5-3.5**. Combined uncertainties as a percentage of net sectoral emissions/removals were estimated at circa ±3000.2 percent. The uncertainties introduced in trend in total sectoral emissions/ removals were estimated at ±14.7 percent. 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 GPG (IPCC, 2000).

7.1.5 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 the LULUCF Sector, following a Tier 1 approach (IPCC, 2000). The AD and methods used for estimating CO_2 emissions/removals under the LULUCF Sector were documented and archived both in hard copies and electronically. To identify the data entry, as well as GHG emissions/removals estimation related errors there were applied AD and EFs verifications and quality control procedures. Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions under the LULUCF Sector were estimated based on AD and EFs from official sources of reference.

7.1.6 Recalculations

GHG emission recalculations under the LULUCF Sector are due to the use of a country specific method[77] (similar with a Tier 3 approach following the IPCC classification), for estimating CO_2 emissions/removals from 5B 'Cropland' category, replacing a Tier 2 approach and default EFs, used within the SNC of the RM under UNFCCC, respectively due to use of an updated set of activity data.

In comparison with the results included into the SNC of the RM under the UNFCCC, the performed recalculation resulted in a significant increase of CO_2 removals for the 1990-1995 time periods, varying from a minimum of 53.6 percent in 1995, up to a maximum of 458.0 percent in 1992, respectively in a significant decrease of CO_2 removals for the 1996-2005 time periods, varying from a minimum of 20.3 percent in 2003, up to a maximum of 123.5 percent in 2004 (Table 7-4).

The results of recalculations performed at the category level are presented in the sub-chapters 7.2-7.4 of the NIR.

7.1.7 Assessment of Completeness

The current inventory covers CO_2 emissions/removals from 4 source categories: 5A1 'Forest Lands Remaining Forest Lands', 5B1 'Cropland Remaining Cropland', 5C1 'Grassland Remaining Grassland' and 5C2 'Land Converted to Grassland'.

CO_2 emissions/removals from the source category 5A2 'Land Converted to Forest Land' were included in the source category 5A1 'Forest Land Remaining Forest Land', while CO_2 emissions/removals from the source category 5B2 'Land Converted to Cropland', were included in category 5B1 'Cropland Remaining Cropland'.

To be noted that CO_2 emissions/removals from the 5E1 'Settlements Remaining Settlements' and 5E2 'Land Converted to Settlements' categories were included in 5B1 'Cropland Remaining Cropland' category (Table 7-5).

[77] Banaru, Anatol (2000), *Methodology to Calculate CO_2 Emissions from Agricultural Soils,* In the collection of papers „Climate Change: Research, Studies, Solutions, Ministry of Environment / UNDP Moldova. „Bons Offices" S.R.L. Chisinau, 2000. P. 115-123.

Table 7-4: Recalculated CO_2 Emissions/ Removals included into the SNC of the RM under the UNFCCC in LULUCF Sector within 1990-2005 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	-1673.2	-1156.0	-916.0	-541.4	-873.0	-756.0	-739.6	-1324.9
TNC	-7180.3	-5080.1	-5111.5	-2416.8	-2379.3	-1160.8	-1008.6	172.9
Difference, %	329.1	339.5	458.0	346.4	172.5	53.6	36.4	-113.0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	-1156.5	-1310.9	-1353.2	-1388.3	-1231.9	-1313.9	-1319.0	-1381.1
TNC	-190.2	-560.7	-783.2	-280.8	-71.8	-1046.6	309.6	-104.6
Difference, %	-83.6	-57.2	-42.1	-79.8	-94.2	-20.3	-123.5	-92.4

Abbreviations: SNC – Second National Communication; TNC – Third National Communication.

Table 7-5: Assessment of Completeness under the LULUCF Sector in the RM

IPCC Category	Source Category	CO_2	CH_4	N_2O	NO_x	CO
5A1	Forest Land Remaining Forest Land	X	X	X	X	X
5A2	Land Converted to Forest Land	IE	NE	NE	NE	NE
5B1	Cropland Remaining Cropland	X	X	X	X	X
5B2	Land Converted to Cropland	IE	NE	NE	NE	NE
5C1	Grassland Remaining Grassland	X	NE	NE	NE	NE
5C2	Land Converted to Grasslands	X	NE	NE	NE	NE
5D1	Wetlands Remaining Wetlands	NE	NE	NE	NE	NE
5D2	Land Converted to Wetlands	NE	NE	NE	NE	NE
5E1	Settlements Remaining Settlements	IE	NE	NE	NE	NE
5E2	Land Converted to Settlements	IE	NE	NE	NE	NE
5F1	Other Land Remaining Other Land	NE	NE	NE	NE	NE
5F2	Land converted to Other Land	NE	NE	NE	NE	NE

Abbreviations: X – source categories included in inventory; IE – Included Elsewhere; NE – Not Estimated.

Non-CO_2 emissions from forest fires were estimated only for the 5A1 'Forest Lands Remaining Forest Lands' and 5B1 'Cropland Remaining Cropland' categories, being still quite insignificant in the RM.

7.1.8 Planned Improvements

Planned improvements at the source and sink category level within the LULUCF Sector are described in detail in sub-chapters 7.2-7.4 of the NIR.

7.2 Forest Land (Category 5A)

7.2.1 Source Category Description

The 5A 'Forest Land' category covers estimation 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 of fuel wood, forest damage by forest defoliating insects, etc.).

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 percent. The consistency requirement should apply only to trees and shrubbery with a natural potential to reach a minimum height of 5 meters at maturity.

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, recovering to 374.6 thousand ha in 2010 or circa 11.4 percent of the country's territory[78] (Figure 7-5).

In conformity with scientific research studies the current areas covered with forests are obviously insufficient to meet the ecological and social-economic needs of the Republic of Moldova. In order to ensure a constant ecological equilibrium and a stronger effect on the climate and hydrological conditions, enhance productivity of agricultural lands, forest lands should occupy at least 18 percent of the country's territory.

The dispersion and fragmentation of forest resources, their uneven distribution across the country represent a negative aspect for exercising beneficial eco-protective influences on the environment, creating comfortable living conditions for the population and providing wood and non-wood products.

The total volume of standing wood mass in the forests of the Republic of Moldova is circa 46 million m^3, on average 124 m^3 per hectare. The average forest increment is 3.3m^3/ha/year, and the total average increment is circa 1240 thousand m^3/year. The average production class is 2.3 (see **Annex A3-4.1**). The structure by age in all forest species is misbalanced, in particular in those of low productivity.

In conformity with Article 14 of the Forest Code, the forests in the Republic of Moldova are included in the functional group I, having exclusively environment protection functions.

[78] Gh. Vdovii, D. Galupa et al. (1997), National Report on the Conditions of the Forest Resources of Republic of Moldova, Galupa D., Talmaci I., Spitoc L. (2006), Forest Land Sector in the Republic of Moldova – issues, accomplishments, perspectives; Galupa Dumitru, Platon Ion et al. (2011), Report on the Conditions of the Forest Resources of Republic of Moldova: 2006-2010. 'Moldsilva' Agency; Ch., 48 p.

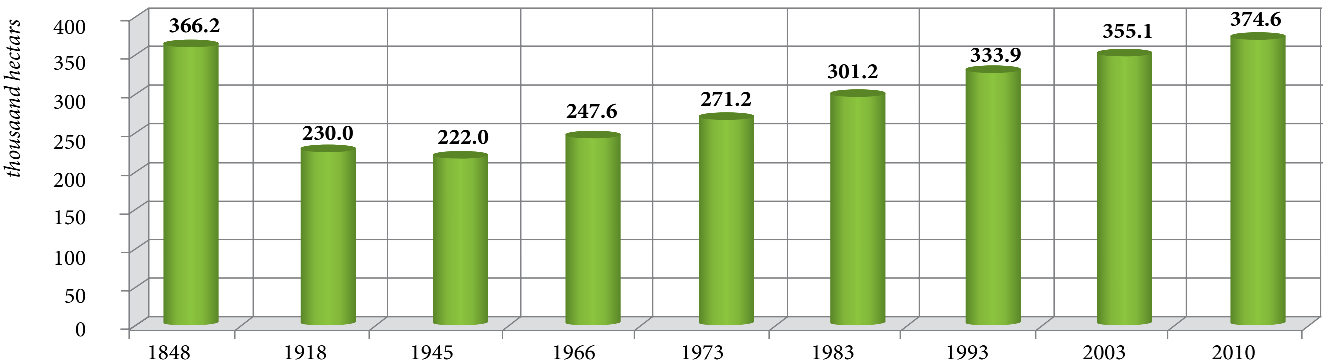


Figure 7-5: Evolution of Areas Covered with Forests in the RM within 1848-2010, thousand ha

In terms of functions, there are 5 functional sub-groups:

- forests with water protection functions – 1.6 percent;
- forests with lands and soils protection functions – 6.7 percent;
- forests with protection functions against harmful climatic and industrial factors– 48.6 percent;
- forests with recreational functions – 29.5 percent;
- forests presenting scientific interest and for protection of forestry genetic and ecological pool – 13.6 percent

In spring-summer 2007, a catastrophic drought was reported in the RM, affecting over 80 percent of the country territory. This phenomenon has substantially damaged the national forests over an area of circa 19 thousand ha or 5.5 percent of the forests, in particular in the southern and central regions of the country.

The drought affected about 20 forest species, both indigenous and non-native, such as: *Quercus robur L., Quercus petraea (Matt) Liebl., Quercus pubescens Willd, Fraxinus exelsior L., Acer platanoides L., Acer pseudoplatanus L., Robinia pseudoacacia L., Betula verrucosa Ehrh., Pinus sylvestris L., Pinus pallasiana [Lamb] Holmboe*. The most affected species was *Robinia spp*, representing 71.3 percent (13 thousand ha) of the total.

The 2007 year drought has long-lasting consequences, and these are visible over several years. According to air-visual forest pathology research data, in 2009 year the total area of damaged and dried rammels represented 17.9 thousand ha, while in 2010 year – 13.1 thousand ha.

7.2.2 Methodological Issues, Emission Factors and Data Sources

To estimate CO_2 removals from the category 5A1 'Forest Land Remaining Forest Land', current biomass increments in forests values were used (in conformity with production tables and forest planning materials on annual growth of species growing in the forests of the RM), losses from authorized and illegal harvesting of fuel wood, as well as from forest damage by forest defoliating insects.

The estimation process followed two steps:

1. Annual increase in carbon stocks due to biomass increment in forest land remaining forest land (in stem, branches, leaves, roots), using the following equation:

$$\Delta_{CFFG} = A \bullet G_{total} \bullet CF$$

Where:

A – area of forest land remaining forest land;

G_{total} – annual biomass increment above and belowground (t.d.m.[79]/ha/yr), calculated using the following equation:

$$G_{total} = G_w \bullet (1+R)$$

Where:

R – root-to-shoot ratio appropriate to increments, dimensionless;

G_w – average annual aboveground biomass increment, calculated using the following equation:

$$G_w = I_v \bullet D \bullet BEF_I$$

Where:

I_v – average annual net increment in volume suitable for industrial processing, m^3/ha/yr;

D – basic wood density, t.d.m./m^3;

BEF_I – biomass expansion factor for conversion of annual net increment to aboveground tree biomass increment, dimensionless;

CF – carbon fraction of dry matter

2. Annual decrease in carbon stocks due to biomass loss in forest land remaining forest land (from authorized fellings and illegal logging), estimated by the following formula:

[79] Constant mass (dry matter –d.m.)

Table 7-6: Groups of Forest Species and their Structure in the Republic of Moldova

Nr.	Groups of Species by Name		Species included in categories	Abbreviations
	Scientific	Common		
1.	Quercus spp.	Oak tree	Ilex, durmast, oak, red oak	QU
2.	Carpinus ssp.	Hornbeam	Hornbeam (Carpinus betulus)	CA
3.	Fraxinus spp.	Ash tree	Ash tree	FR
4.	Acer spp.	Sycamore maple	Field maple, Common maple, Mountain maple	AC
5.	Ulmus spp.	Elm	Field elm, Elm tree, Turkestan elm, etc.	UL
6.	Tilia spp.	Linden tree	Foul lime, Silver lime, big leaf linden tree	TI
7.	Salix spp.	Willow	Willow, Osier, etc.	SA
8.	Pinus spp.	Pine	Pine silvestre, Black pine, Spruce fir, Fir tree	PI
9.	Populus spp.	Poplar	Trembling poplar, Black poplar, Aspen tree	PO
10.	Robinia spp.	Acacia	Acacia, Honey locust, Sofora	RB
11.	Other species	Other species	Apple tree, Peer, Sweet cherry tree, Sour cherry tree magaleb, Apricot tree, sycamore, Weeping willow, Hazel tree, Corneal tree, Hawthorn, Sweet briar, Female cornel, etc.	OS

$$\Delta C_{FFL} = L_{fellings} + L_{fuel\ wood} + L_{other\ losses}$$

Where:

$L_{fellings}$ – annual carbon loss due to commercial fellings, calculated using the following equation:

$$L_{fellings} = H \bullet D \bullet BEF_{II} \bullet (1-f_{BL}) \bullet CF$$

Where:

H – annually extracted volume, round wood, m^3;

D – basic wood density, t.d.m./m^3;

BEF_{II} – biomass expansion factor for converting volumes of extracted round wood to total aboveground biomass, dimensionless;

f_{BL} – fraction of biomass left to decay in forest (transferred to dead organic matter);

$L_{fuelwood}$ – annual carbon loss due to fuel wood gathering, calculated using the following equation:

$$L_{fuel\ wood} = FG \bullet D \bullet BEF_{II} \bullet CF$$

Where:

FG – annual volume of fuel wood gathering, m^3;

$L_{other\ losses}$ – annual other losses of carbon (diseases and pests, natural disasters, drying, etc.)

These volumes were included in $L_{fellings}$ and $L_{fuel\ wood}$, as the forests in the RM are intensively managed, being regularly draw in cleaning cuttings (including selective sanitation treatments), forestry thinning (including clean sanitation cuttings) and various cuttings (including cleaning from fallen trees etc.).

Methodologies described in the Revised 1996 Guidelines (IPCC, 1996), GPG LULUCF (IPCC, 2003) and 2006 IPCC Guidelines were used in the Republic of Moldova in the inventory development process. Country specific removals factors on average annual net increment in volume suitable for industrial processing; basic wood density; carbon fraction of dry matter and others, were used, as well as sectoral activity data (forest land by species/categories of species, forest land areas, annual extracted volume of round wood, annual volume of fuel wood, etc.). The total wood mass harvested includes both wood mass harvested as authorized and planned fellings, as well as illegal logging revealed by forestry and environment protection authorities.

To simplify the inventory development process, eleven groups of species were formed, to include all diversity of forest species growing in the forests of the RM (Table 7-6).

To estimate biomass increments in forests and implicitly, resulting in CO_2 stocks, there were used data on the areas of forest land in the RM in the time series from 1990 through 2010, available into the National Report on Forestry Resources of the RM (2011) and General Land Cadasters of the RM (Table 7-7).

Final data on species distribution over the period of time under review was obtained by modelling using the primary data set obtained from the Records and Reports of Agency "Moldsilva", which featured the following distribution of forest species planted over the reference period: *Robinia*

Table 7-7: Evolution of Forest Land Areas in the RM within 1990-2010, thousand ha

Year	Total	Forest Land Areas by Species										
		OU	CA	FS	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	6.5
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	374.6	155.4	12.1	21.0	4.1	3.9	3.5	2.4	6.9	7.1	148.0	10.1

Source: National Report on Forestry Resources of the RM (2011), General Land Cadasters for 1990-2010 period; Records/Reports of Agency „Moldsilva" on afforestations over the 1990-2010 period.

species - accounted for circa 80 percent, *Juglans spp.* (regia and nigra) – for 8 percent, *Quercus species* – for 3 percent, *Populus* and *Salix species* – for 3 percent, *other species* – for 6 percent.

The volume of commercial timber, as well as the quantity of fuel wood gathered in the RM, there were identified based on statistical data and reports on commercial fellings in managed forest land (by species and sort categories, etc.), revealed illegal logging (on other owners lands, inclusively), data being provided by the Agency “Moldsilva”, and the State Ecological Inspectorate, on authorized fellings 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 fuel wood harvests in forests on the left bank of Dniester River (Table 7-8).

Table 7-8: Trends in Fuel Wood Harvests in the RM within 1990-2010 time series

Year	Commercial fellings, thousand m³	Fuel wood gathering, thousand m³	Illegal fuel wood logging, thousand m³	Total Fuel wood harvested, thousand m³
1990	39.4	184.2	0.6	184.8
1991	27.0	260.7	140.8	401.5
1992	27.4	314.7	213.4	528.1
1993	31.5	402.6	328.1	730.7
1994	39.8	347.4	210.7	558.1
1995	68.5	420.1	205.7	625.8
1996	51.7	402.5	187.4	589.9
1997	52.7	280.2	21.4	301.6
1998	38.0	332.4	64.2	396.6
1999	38.8	326.1	22.0	348.1
2000	39.7	330.5	7.5	338.0
2001	37.3	308.1	6.0	314.1
2002	50.4	337.3	5.4	342.7
2003	47.0	372.8	5.9	378.7
2004	43.5	372.3	4.4	376.7
2005	39.0	352.2	4.2	356.4
2006	44.4	419.8	7.2	427.0
2007	42.8	388.7	2.24	390.9
2008	37.3	400.3	2.72	403.0
2009	40.6	394.8	3.53	398.4
2010	44.4	415.4	20.43	435.9

Source: Statistical Records/Reports of “Moldsilva” Agency and of the State Ecological Inspectorate for the 1990-2010 time series; D. Galupa, I. Talmaci, L. Spitoc, Study for the Republic of Moldova “Ensuring sustainability of forests and livelihoods through improving governance and control of illegal logging”. Chisinau, Centrul editorial al UASM, 2005, 116 pages; Statistical Yearbooks of the ATULBD (2011); Galupa Dumitru, Ciobanu Anatol, Scobioala Marian et al. (2011), Illegal logging of forest vegetation in the Republic of Moldova. Analytical study, Chisinau, “Moldsilva” Agency, 38 pages

The Agency “Moldsilva” keeps records of harvested wood by species (except for some species suitable for industrial processing, ex.: (1) hardwood - oak, durmust, hornbeam, ash tree, sycamore maple tree, 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 percent). Distribution by species of wood suitable for industrial processing and fuel wood is presented in Tables 7-9 and 7-10. Data on the volume of fuel wood gathered also include the volume of twigs, boughs, branches, etc., which are also used as fuel. Taking into account 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 7-9: Trends in Commercial Fellings Harvest in the RM within 1990-2010, thousand m³

Species	1990	1991	1992	1993	1994	1995	1996
Quercus spp.	7.16	4.32	4.09	4.41	6.88	9.59	10.05
Carpinus spp.	1.05	0.71	0.72	0.83	1.04	1.79	1.35
Fraxinus spp.	3.65	2.99	3.24	3.94	4.03	8.56	4.47
Acer spp.	0.31	0.23	0.23	0.27	0.34	0.58	0.45
Ulmus spp.	0.17	0.10	0.10	0.12	0.15	0.26	0.19
Tilia spp.	3.78	2.48	2.52	2.90	3.66	6.31	4.70
Salix spp.	0.26	0.19	0.19	0.22	0.28	0.48	0.37
Pinus spp.	0.28	0.17	0.18	0.20	0.26	0.44	0.32
Populus spp.	4.87	3.20	3.26	3.74	4.73	8.14	6.07
Robinia spp.	16.74	12.02	12.26	14.18	17.54	30.83	22.66
Other species	1.15	0.59	0.60	0.69	0.89	1.51	1.06
Total	39.4	27.0	27.4	31.5	39.8	68.5	51.7
Species	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Quercus spp.	10.26	7.40	7.51	7.77	5.18	10.12	10.31
Carpinus spp.	1.39	1.00	0.99	1.07	1.09	1.85	1.00
Fraxinus spp.	4.47	3.23	3.49	3.17	2.96	4.45	3.41
Acer spp.	0.44	0.32	0.37	0.28	0.30	0.42	0.26
Ulmus spp.	0.21	0.15	0.13	0.18	0.19	0.24	0.22
Tilia spp.	4.91	3.54	3.34	3.97	4.86	4.82	4.22
Salix spp.	0.36	0.26	0.30	0.24	0.32	0.29	0.20
Pinus spp.	0.35	0.25	0.22	0.30	0.33	0.00	0.00
Populus spp.	6.33	4.56	4.32	5.11	2.89	5.82	8.28
Robinia spp.	22.70	16.37	17.67	16.13	18.19	19.94	16.43
Other species	1.28	0.92	0.45	1.46	0.97	2.46	2.66
Total	52.7	38.0	38.8	39.7	37.3	50.4	47.0
Species	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Quercus spp.	9.34	7.63	9.26	7.49	7.17	5.84	7.16
Carpinus spp.	0.92	1.05	1.28	0.92	1.13	0.77	0.87
Fraxinus spp.	3.03	3.12	5.57	5.94	6.02	5.70	5.83
Acer spp.	0.19	0.28	0.28	0.28	0.25	0.15	0.20
Ulmus spp.	0.22	0.18	0.27	0.31	0.20	0.17	0.19
Tilia spp.	4.47	3.90	4.06	3.45	3.84	3.24	3.42
Salix spp.	0.21	0.24	0.31	0.42	0.38	0.38	0.14
Pinus spp.	1.10	0.30	0.79	1.60	0.60	0.89	1.19
Populus spp.	6.62	5.02	7.81	6.44	6.09	4.87	6.32
Robinia spp.	15.93	15.85	15.68	16.58	16.01	14.34	14.41
Other species	1.44	1.44	1.22	1.01	1.10	0.98	0.89
Total	43.5	39.0	46.5	44.4	42.8	37.3	40.6

Source: Statistical Records/Reports of Agency “Moldsilva” and of the State Ecological Inspectorate for the 1990-2010 time-series.

Table 7-10: Trends in Fuel Wood Harvest in the RM within 1990-2010, thousand m³

Species	1990	1991	1992	1993	1994	1995	1996
Quercus spp.	30.1	50.4	49.3	51.1	39.1	63.6	59.0
Carpinus spp.	12.5	18.0	13.2	13.2	10.0	11.3	15.5
Fraxinus spp.	15.8	39.0	56.5	73.1	55.8	72.0	73.7
Acer spp.	8.7	11.4	6.6	6.2	4.7	5.3	5.0
Ulmus spp.	3.5	6.2	6.5	10.2	7.8	8.8	2.3
Tilia spp.	10.6	19.0	20.4	29.2	22.3	20.1	19.5
Salix spp.	3.4	6.7	8.0	12.4	9.5	10.6	4.1
Pinus spp.	0.4	2.1	4.1	6.6	5.0	5.6	3.8
Populus spp.	11.8	34.3	55.0	73.1	55.8	74.4	70.1
Robinia spp.	76.8	197.6	294.6	439.9	336.0	340.3	323.9
Other species	11.2	16.9	13.8	16.1	12.3	13.8	13.0
Total	184.8	401.5	528.1	731.0	558.4	625.7	589.8
Species	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Quercus spp.	49.1	64.6	55.3	53.7	48.3	56.9	65.5
Carpinus spp.	20.4	26.8	24.1	23.4	22.5	23.4	23.1
Fraxinus spp.	25.8	33.9	30.1	29.2	28.3	28.9	32.4
Acer spp.	14.1	18.6	16.6	16.2	14.2	17.5	16.5
Ulmus spp.	5.7	7.5	6.4	6.2	5.8	6.4	8.3
Tilia spp.	17.3	22.7	19.6	19.0	18.9	18.4	21.6
Salix spp.	5.6	7.3	6.3	6.1	5.5	6.5	6.3
Pinus spp.	0.7	0.9	0.7	0.7	1.4	0.0	0.0
Populus spp.	19.2	25.3	20.3	19.7	17.4	21.3	29.0
Robinia spp.	125.3	164.8	148.2	143.9	132.9	149.2	148.2
Other species	18.3	24.1	20.4	19.8	18.0	20.8	27.5
Total	301.6	396.6	348.1	338.0	313.1	349.3	378.3
Species	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Quercus spp.	64.2	56.6	71.6	57.0	59.8	59.4	65.7
Carpinus spp.	25.3	24.7	27.5	23.7	27.7	26.3	30.2
Fraxinus spp.	30.6	30.8	48.4	47.7	49.0	52.8	62.3
Acer spp.	17.1	17.0	23.1	21.4	23.5	23.3	23.8
Ulmus spp.	7.1	6.5	10.5	10.5	8.6	9.9	12.7
Tilia spp.	23.4	20.1	27.7	24.7	25.2	22.4	23.0
Salix spp.	8.2	6.5	10.0	8.4	7.8	4.7	5.4
Pinus spp.	2.1	0.8	3.1	2.8	2.7	3.9	4.8
Populus spp.	28.2	20.8	27.1	23.3	25.0	23.8	26.0
Robinia spp.	147.8	151.8	161.2	155.2	154.8	149.5	162.8
Other species	22.1	20.9	17.1	16.2	18.7	22.3	19.2
Total	376.0	356.4	427.0	390.9	403.0	398.4	435.9

Source: Statistical Records/Reports of Agency "Moldsilva" and of the State Ecological Inspectorate for the 1990-2010 time-series; Arcadie Capcelea, Aurel Lozan, Ion Lupu et al. (2011), *Analytical study on wood mass consumption in the RM*. "Moldsilva" Agency, Chisinau, 48 pages.

In order to estimate annual biomass increments and losses, country specific emission factors were calculated/developed (Tables 7-11 and 7-12).

In order to estimate/develop these, production tables were used, as well as data on actual productivity of stands in the RM, according to the forest planning records. At the same time, to ensure an appropriate quality of the sectoral GHG inventory, it is necessary to keep records for all reductions and emissions. An important section is the biomass loss due to forest damage by defoliator pests. Most areas affected are concentrated in oak and ash tree stands. To complete the national GHG emissions inventory, a number of bibliographic sources have been studied in this section, resulting in the final development of coefficients/factors that highlight the losses from current stands increment, losses that are caused by forest pests.

Table 7-11: Coefficients Used to Estimate CO_2 Emissions/Removals from the 5A1 'Forest Land Remaining Forest Land' Category

Species	Average annual net increments, m³/ha	Basic wood density, t.d.m./m³ fresh volume	Biomass expansion factor for conversion of annual net increment to aboveground tree increment, BEF_1	Biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass, BEF_2
Quercus spp.	3.0	0.835	1.20	1.20
Carpinus spp.	3.5	0.85	1.20	1.10
Fraxinus spp.	3.5	0.72	1.20	1.20
Acer spp.	2.6	0.75	1.20	1.15
Ulmus spp.	3.2	0.70	1.20	1.15
Tilia spp.	3.7	0.55	1.20	1.15
Salix spp.	7.4	0.38	1.20	1.20
Pinus spp.	2.8	0.535	1.15	1.10
Populus spp.	7.9	0.51	1.20	1.20
Robinia spp.	3.9	0.78	1.20	1.20
Other species	2.1	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); National Report on Forestry Resources of the Republic of Moldova, 1997; Osadcev V.G., Ivankov P.T., Sergovskii P.S. et al. (1955), 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); 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

Table 7-12: Coefficients Used to Estimate CO_2 Emissions/Removals from the 5A1 'Forest Land Remaining Forest Land' Category

Species	Root-shoot ratio appropriate to increments	Carbon fraction of dry matter	Fraction of biomass left to decay in forest	Average loss from current increments due to disturbances (forest pest), t/ha/yr
Quercus spp.	0.40	0.50	0.05	0.91
Carpinus ssp.	0.35	0.50	0.05	1.22
Fraxinus spp.	0.28	0.49	0.05	1.29
Acer spp.	0.28	0.49	0.05	0.67
Ulmus spp.	0.28	0.49	0.05	0.74
Tilia spp.	0.21	0.50	0.05	1.73
Salix spp.	0.21	0.49	0.05	1.70
Pinus spp.	0.46	0.51	0.05	0.46
Populus spp.	0.21	0.50	0.05	1.13
Robinia spp.	0.28	0.49	0.05	0.70
Other species	0.28	0.50	0.05	0.48

Source: Osadcev .G., Ivankov P.T., Sergovskii P.S. et al. (1955), Guidebook on Woodworking (for Forest Farms Consumer Goods Manufacturing Workshops). Moscow, 1955 (in Russian); Giurgiu V., Decei I., Armasescu S. Biometriy 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. (1949), Wood Science, Moscow (in Russian); Annex 4 to the Order of the Federal Forestry Agency dated 29.12.2007 No. 523, "Technical guidance on localization and liquidations of pests outbreaks" (in Russian).

The main source of reference was "Technical guidance on localization and liquidations of pests outbreaks"[80]. For estimating loss from current increment caused by the forest pests the following formula was used:

$$P = L \bullet (X / 100),$$

Where,

P – loss from current increment volume;

X – extent of the canopy damage;

L – empirical coefficient calculated by phonological group[81].

Non-CO_2 emissions from the 5A1 'Forest Land Remaining Forest Land' category were estimated by using a Tier 1 methodology (IPCC, 2006).

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

Where:

L_{fire} – amount of non-CO_2 greenhouse gas emissions from fire, t GHG/yr;

A – area burnt, ha/yr;

M_B – mass of fuel available for combustion (biomass, ground litter and dead wood), t/ha;

C_f – combustion factor; IPCC default value is 0.45 (IPCC, 2006);

$M_B \bullet C_f$ – amount of fuel actually burnt; IPCC default for 'Other temperate forests' under wildfire is 19.8 t.d.m./ha (IPCC, 2006);

G_{ef} – default EF (kg/t.d.m.) (IPCC, 2006) (Table 7-13).

Table 7-13: EFs for Various Types of Burning Vegetation, kg GHG / t.d.m.

Category	CO	CH_4	N_2O	NO_x
Temperate zone forests	107	4.7	0.26	3.0

Activity data on burnt forest land are available in Statistical Yearbooks of the Republic of Moldova and those of the ATULBD (Table 7-14).

Table 7-14: Forest Land Areas Affected by Fires in the RM, 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Forest land areas affected by fires, ha	120.10	20.10	22.00	1.50	33.50	1.93	11.20
	1997	1998	1999	2000	2001	2002	2003
Forest land areas affected by fires, ha	3.40	33.70	25.20	0.90	57.00	30.60	33.50
	2004	2005	2006	2007	2008	2009	2010
Forest land areas affected by fires, ha	88.00	8.40	90.80	791.3	55.0	134.2	46.9

Source: Statistical Yearbooks of the RM for 1994 (page 38), 1999 (page 20), 2007 (page 22), 2011 (page 22), 2012 (page 22); Statistical Yearbooks of the ATULBD for 2000 (page 88), 2002 (page 91), 2007 (page 81), 2009 (page 80), 2010 (page 81), 2011 (page. 82), 2012 (page 87).

7.2.3 Uncertainties Assessment and Time-Series Consistency

Uncertainties associated with the process of estimating the CO_2 emissions/removals from the 5A1 'Forest Land Remaining Forest Land' category at the beginning of the reference period, were rather low, circa ±5 percent. Since 1991, due to social-political developments, the level of uncertainties increased significantly. For 2010, the level of precision of activity data related to the production processes reached circa ±25 percent. Uncertainties related to emission/removals factors and coefficients in both cases are of circa ±5 percent.

General uncertainties on CO_2 removals from the 5A 'Forest Land category are affected by a number of factors. Thus, part of data needed to estimate CO_2 removals from forests in the RM need to be updated. The 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 statistic on the volumes of wood mass harvested during forest clearings. Some consolidated information in this field is available to the State Ecological Inspectorate (SEI) only, as an institution that authorizes fellings of any type of forest vegetation (based on Article 40 of the Law on Environment Protection, Article 22 of the Forest Code dealing with state control and state control data). Over the period from 2000 through 2010, the IES authorized harvesting of 88.9 thousand m^3 of wood mass from the forestry resources and other types of forest vegetation managed by local public authorities. At the same time, in conformity with some estimative studies, the annual volume of wood mass from unidentified sources represent circa 400-800 thousand m^3. The current system of monitoring and control of production processes in forestry sector is applied only in forests managed by the Agency "Moldsilva". The forest resources managed by local public authorities are practically beyond these activities. A considerable part of illicit logging is not even reported.

Combined uncertainties for 5A1 'Forest Land Remaining Forest Land' category represent circa ±25.5 percent, while, the combined uncertainties as a percentage of total sectoral emissions/ removals were estimated at ±2119.0 percent. The uncertainties introduced in trend in total sectoral direct GHG emissions/ removals were estimated at ±10.9 percent.

Uncertainties related to estimation of non-CO_2 emissions from forest areas 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 areas affected by fires are considered relatively small, up to ±10 percent. Uncertainties related to default emission factors for different types

[80] Annex 4 to the Order of the Federal Forestry Agency from 29.12.2007 Nr. 523, "Technical guidance on localization and liquidations of pests outbreaks"

[81] The main species of pests affecting forests in the RM are: *Tortrix viridana L., Operophtera brumata, Erannis defoliaria L.* (affect *Quercus spp.)* and *Stereonicus fraxini* (affects *Fraxinus spp.*) referring to the phenological group I, with an empirical coefficient (L) equal to 0.4.

of burnings (dry matter burnt), are moderate for CH_4 (±30 percent) and medium for N_2O (±50 percent). Combined uncertainties related to non-CO_2 emissions (CH_4 and N_2O) from 5A1 'Forest Land Remaining Forest Land' category are considered relatively high (±31.6 percent for CH_4 and ±51.0 percent for N_2O), while combined uncertainties as a percentage of total direct sectoral emissions/removals are quite insignificant (**Annex 5-3.5**).

7.2.4 Quality Assurance and Quality Control

Following the recommendations included into the GPG (IPCC, 2000), CO_2 removals under the 5A 'Forest Land' category were estimated based on AD and EFs from official sources of reference. Data on total forest area was 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.

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.

Data on the volume of wood mass was obtained from the following statistical reports by branches:

- 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';
- Statistical Report 2 g.s. 'Report on attaining production indicators in forestry' (section "Wood mass movement").

At the same time data on illicit logging revealed by the State Ecological Inspectorate were provided by the study *Illegal logging of forest vegetation in the Republic of Moldova*[82].

Standard verification and quality control forms and checklists were filled in for 5A 'Forest Land' category, following a Tier 1 approach (IPCC, 2000). Verification was focused on various aspects such as: ensuring correct use of estimation methodologies following the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG LULUCF (2003) and 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.

7.2.5 Recalculations

No recalculations were performed for CO_2 removals within the 5A 'Forest Land' sink category for the period 1990-2005. It has been used the same estimation approach, available in the GPG LULUCF (IPCC, 2003) and 2006 IPCC Guidelines, as well as the same AD set (area covered with forest vegetation, current biomass increment etc.). Within the 1990-2010, CO_2 removals from 5A 'Forest Land' sink category were relatively constant, decreasing by only 0.2 percent (Table 7-15).

Table 7-15: CO_2 Removals within the 5A 'Forest Land' sink category in the RM within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
CO_2, Gg	-2197.6	-1924.1	-1766.5	-1491.4	-1743.7	-1620.8	-1705.1
	1997	1998	1999	2000	2001	2002	2003
CO_2, Gg	-2132.2	-2027.9	-2111.2	-2140.3	-2195.4	-2134.9	-2135.9
	2004	2005	2006	2007	2008	2009	2010
CO_2, Gg	-2183.7	-2246.2	-2087.9	-2192.4	-2223.0	-2251.7	-2193.3

The graphical illustration of CO_2 removals evolution within the 5A 'Forest Land' sink category is provided by Figure 7-6.

From similar reasons, no recalculations were performed for non-CO_2 emissions within the 5A 'Forest Land' category in the RM (the same estimation approach and AD set were used).

Within the 1990-2010 time series, non-CO_2 emissions (CH_4, CO, N_2O and NO_x) from 5A 'Forest Land' category, were relatively constant, except for 2007 year, when, due to the severe drought, the forest areas affected by fires recorded an historical maximum of 791 ha or a 7 times increase compared to the 1990 year. At the same time, in comparison with the reference year, by 2010, the non-CO_2 emissions from forest areas affected annually by fires within the category 5A 'Forest Land' decreased by circa 60.9 percent (Table 7-16).

[82] Galupa Dumitru, Ciobanu Anatol, Scobioala Marian et al. (2011), *Illegal logging of forest vegetation in the Republic of Moldova. Analytical study*, Chisinau, "Moldsilva" Agency, 38 pages.

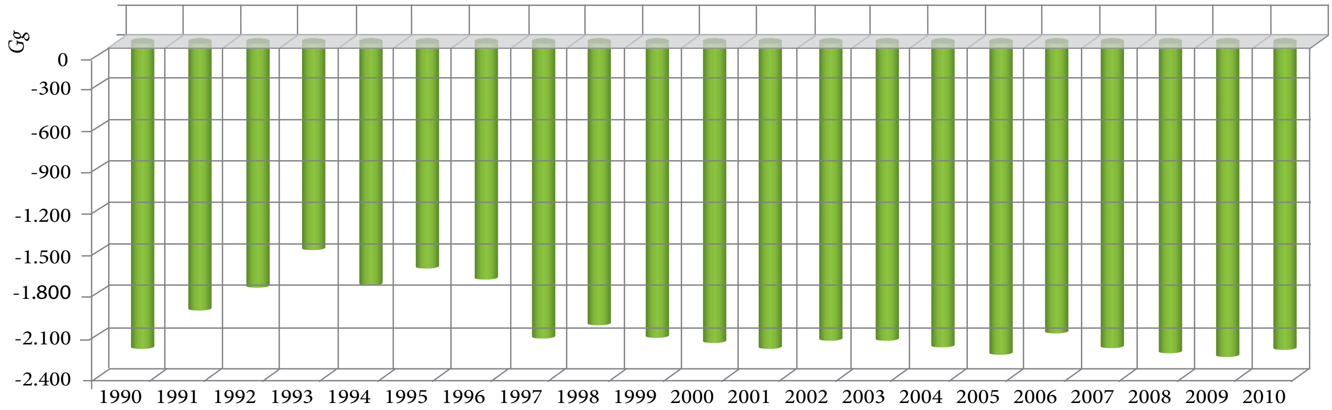


Figure 7-6: CO_2 Removals within the 5A 'Forest Land' sink category in the RM within 1990-2010 time periods

Table 7-16: Non-CO_2 Emissions from Areas Annually Affected by Fires in the Republic of Moldova within 1990-2010 time series, Gg

	1990	1991	1992	1993	1994	1995	1996
CH_4	0.0112	0.0019	0.0020	0.0001	0.0031	0.0002	0.0010
N_2O	0.0006	0.0001	0.0001	0.0000	0.0002	0.0000	0.0001
CO	0.2544	0.0426	0.0466	0.0032	0.0710	0.0041	0.0237
NO_x	0.0071	0.0012	0.0013	0.0001	0.0020	0.0001	0.0007
	1997	1998	1999	2000	2001	2002	2003
CH_4	0.0003	0.0031	0.0023	0.0001	0.0053	0.0028	0.0031
N_2O	0.0000	0.0002	0.0001	0.0000	0.0003	0.0002	0.0002
CO	0.0072	0.0714	0.0534	0.0019	0.1208	0.0648	0.0710
NO_x	0.0002	0.0020	0.0015	0.0001	0.0034	0.0018	0.0020
	2004	2005	2006	2007	2008	2009	2010
CH_4	0.0082	0.0008	0.0084	0.0736	0.0051	0.0125	0.0044
N_2O	0.0005	0.0000	0.0005	0.0041	0.0003	0.0007	0.0002
CO	0.1864	0.0178	0.1924	1.6764	0.1165	0.2843	0.0994
NO_x	0.0052	0.0005	0.0054	0.0470	0.0033	0.0080	0.0028

7.2.6 Planned Improvements

Possibilities to improve accounting of distribution of forest land by species, actual consumption of fuel wood from the managed forest land of the RM and undertake actions aimed at verification of C removals factors (annual net increment in volume suitable for industrial processing, basic wood density, biomass expansion factors, etc.) will be considered for the next inventory cycles.

7.3 Cropland (Category 5B)

7.3.1 Source Category Description

In the Republic of Moldova, under the 5B1 'Cropland Remaining Cropland' category there are reported CO_2 emissions/removals estimates originated from two sub-categories: 5.B.1.1 'Cropland Covered with Woody Vegetation' and 5.B.1.2 'Annual Change in Carbon Stocks in Mineral Soils', as well as non-CO_2 emissions from post-harvest field burning of agricultural residues (stubble fields burning).

'Cropland Covered with Woody Vegetation'

The 5.B.1.1 'Cropland Covered with Woody Vegetation' sink category comprises CO_2 removals from cropland covered with woody vegetation, including aboveground and belowground biomass in protection forest strips, woody crops and shrubs plantations, other types of forest vegetation, as well as from perennial plantations: orchards, vineyards, trees from private gardens.

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 percent.

Thus, according to the General Land Cadaster of the Republic of Moldova (standing as of 01.01.2010), the areas with forest vegetation not regarded as forest resources covered 49.1 thousand ha or 1.5 percent of the country's territory, including 29.85 thousand ha – protection forest strips (by the side of agricultural fields, roads, rivers and water pools, etc.), and 19.23 thousand ha – other types of forest vegetation (woody crops and shrubs plantations, green spaces, parks, squares, etc.), which also substantially contribute to maintaining the ecological balance.

In conformity with records available in the Republic of Moldova, forest vegetation not regarded as forest resources includes the following categories:

- protection forest strips by the side of agricultural fields;
- protection forest strips and woody crops and shrubs plantations along the communication ways;
- water protection forest strips;
- groups of trees and separately standing trees within the urban and settlement areas.

The Republic of Moldova has a relatively wide experience in planting protection forest strips (in particular after the Second World War period). At the time of starting and along the entire process, the main emphasis was laid on anti-erosion component, and partially, on obtaining additional amounts of food products, etc. This focus determined the composition of protection forest strips (Paladiiciuk, 1986), comprising: *Juglans spp.* – 38 percent; *Robinia spp.* – 36 percent; *Quercus spp.* – 9 percent; *Populus spp.* – 4 percent; other species – 13 percent. At the same time, in this sphere the Republic of Moldova has 301 thousand ha (8.8 percent of the country's territory) of perennial plantations (orchards, plantations of walnut species, vineyards, etc.).

'Annual Change in Carbon Stocks in Mineral Soils'

Under the 5.B.1.2 'Annual Change in Carbon Stocks in Mineral Soils' category there are reported CO_2 emissions/removals from mineral soils. This source has a significant share in the total national emissions from the LULUCF Sector, as according the Statistical Yearbooks of the Republic of Moldova (standing as of 01.01.2012), this source includes arable lands with a share of over 53 percent of the total, which occupy 1810.5 thousand ha or 53.5 percent of the territory of the country. It should be mentioned that over the period from 1990 through 2010, the areas of arable lands remained relatively constant, increasing only by circa 4.3 percent.

Cropland change and soil management change can considerably affect the organic carbon stocks in mineral soils[83]. Thus, for example, the conversion of native 'Grassland' and 'Forest Land' to 'Cropland', could determine the loss of 20-40 percent of the original soil carbon stocks (IPCC, 2006).

Soil organic C stocks can change with management or disturbance if the net balance between C inputs and C losses from soil is altered. Management activities influence or-

[83] 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.

ganic C inputs through changes in plant production (such as fertilization or irrigation to enhance crop growth), direct additions of C in organic amendments, and the amount of carbon left after biomass removal activities, such as crop harvest, timber harvest, fire, or grazing. Decomposition largely controls C outputs and can be influenced by changes in moisture and temperature regimes as well as the level of soil disturbance resulting from the management activities.

'Non-CO_2 Emissions from Post-Harvest Field Burning of Agricultural Residues'

'Post-Harvest Field Burning of Agricultural Residues' or stubble fields burning is a rather frequent practice, in particular, in developing countries. According to more recent estimations, in some developing countries, up to 40 percent of crop residues are burnt in fields (in developed countries this percentage is much smaller, less than 10 percent). It should be noted that in cases when 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 crops residues vary in different years, and depend on crops and management technologies.

Crop residues are burnt in fields to clear the stubble fields from the straw left after reaping (in the Republic of Moldova, stubble fields are most often burnt after reaping of wheat and barley) and to prepare the fields for the next agricultural cycle. It should be noted that though burning of stubble fields is prohibited by law, this practice still persist in the Republic of Moldova.

7.3.2 Methodological Issues, Emission Factors and Data Sources

'Cropland Covered with Woody Vegetation'

For estimating CO_2 emissions/removals within the source 5.B.1.1 'Cropland Covered with Woody Vegetation' under the 5.B.1 'Cropland Remaining Cropland' category, it was necessary to determine annual biomass increments in woody vegetation not included in forestry resources and perennial plantations (according to production tables and forest planning).

The calculations was done based on annual change in carbon stocks in as a result of perennial woody crops growth (in stem, shoots, leaves and roots), by using the following equation:

$$\Delta C_{C_B} = A \bullet (G + L)$$

Where:

A – area of cropland with perennial woody biomass;

G – annual biomass increments in perennial woody crops, t C/ha/yr;

L – annual volume of harvested biomass, t C/ha/yr.

Under the 5.B.1 'Cropland Remaining Cropland' category there were used estimation methods available in the Revised 1996 Guidelines (IPCC, 1996), GBP LULUCF (IPCC, 2003) and 2006 IPCC Guidelines. At the same time, country specific emission/removal factors were used, pertaining to annual growth rate of perennial woody biomass and annual carbon stock in biomass etc., as well as sectoral AD (areas covered with forests strips, trees and shrubs plantations, orchards, vineyards, wood harvesting, etc.).

Annual wood harvesting from orchards and vineyards occurs during the cleaning cuttings. Wood harvesting from forest strips and other types of vegetation, 95 percent of which are managed by local public authorities, is not specified statistically, as the national records for this type of vegetation are insufficient.

The volume of commercial timber and illegal logging from forests and other types of woody vegetation were included in 5.A.1 'Forest Land Remaining Forest Land' sink category. So, the total GHG balance reported under the LULUCF Sector is not affected.

Most industrial orchards follow the 4 x 3 m and 5 x 4 m planting schemes. In this case, the number of trees per 1 ha is respectively, 850 and 500. For estimating the number of trees growing in orchards, it was agreed to develop an average of the two schemes. Thus, the reference figure is 675 trees per 1 ha of orchards.

For estimating the participation level of trees growing in private rural orchards, there was used a conventional average number of 10 trees per household. For estimating removals, this vegetation was transformed, in conventional area, by considering the reference figure (675 trees per 1 ha of orchards).

In order to estimate the biomass increments in perennial woody crops on croplands, and implicitly, the resulting CO_2 removals, there were used activity data available in the General Land Cadaster of the Republic of Moldova on areas occupied by such crops over the period from 1990 through 2010 (Tables 7-17 and 7-18).

Table 7-17: Areas of Other Types of Woody Vegetation in the RM within 1990-2010, thousand ha

	1990	1991	1992	1993	1994	1995	1996
Total woody vegetation not included in forest resources, including:	47.0	47.0	47.8	48.5	47.0	54.1	45.2
Protection forest strips	31.4	31.0	31.7	31.5	30.6	30.4	30.6
Other types of forest vegetation	15.6	16.0	16.1	17.0	16.4	23.7	14.6
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total woody vegetation not included in forest resources, including:	54.6	51.5	49.4	50.9	50.5	50.0	50.5
Protection forest strips	30.8	30.6	31.0	30.7	31.1	30.7	30.6
Other types of forest vegetation	23.8	20.9	18.4	20.2	19.4	19.3	19.9

	2004	2005	2006	2007	2008	2009	2010
Total woody vegetation not included in forest resources, including:	49.1	49.3	50.5	51.1	51.5	52.1	49.1
Protection forest strips	30.5	30.8	30.9	31.0	30.9	30.9	29.8
Other types of forest vegetation	18.6	18.5	19.6	20.2	20.5	21.2	19.2

Source: General Land Cadaster for the period of time from 1990 through 2010.

Table 7-18: Area of Cropland with Perennial Woody Biomass in the RM within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Area of vineyards, thousand ha	211.5	212.8	213.0	212.0	205.5	201.6	195.9
Area of orchards, thousand ha	262.6	260.7	257.8	254.0	242.9	229.1	216.7
Area of trees growing in private gardens, thousand ha	12.4	12.4	12.4	12.7	13.0	13.1	13.3
	1997	1998	1999	2000	2001	2002	2003
Area of vineyards, thousand ha	191.4	185.8	176.9	168.7	162.2	153.6	152.8
Area of orchards, thousand ha	207.7	200.0	193.9	183.6	172.7	152.1	148.0
Area of trees growing in private gardens, thousand ha	13.5	13.5	13.4	13.4	13.4	12.3	11.9
	2004	2005	2006	2007	2008	2009	2010
Area of vineyards, thousand ha	153.0	155.5	157.3	158.6	157.5	155.7	153.6
Area of orchards, thousand ha	145.0	142.3	141.7	143.2	145.3	147.3	147.4
Area of trees growing in private gardens, thousand ha	12.6	12.3	14.4	14.6	14.6	14.6	14.8

Source: General Land Cadaster for the period of time from 1990 through 2010

For estimating annual biomass increments and losses in perennial woody crops, country specific emission factors were developed. Calculation of such factors was based on production tables, data on productivity of protection woody vegetation taken from data accounting and forest planning records, as well as data from scientific literature on perennial plantations management (Table 7-19).

Table 7-19: Emission/Removal Factors used under the 5.B.1 'Cropland Remaining Cropland' Category

Category	Annual biomass increments, t C/yr/ha	Annual volume of harvested biomass, t C/yr/ha
Protection forest strips	1.42	-
Other types of forest vegetation	0.98	-
Vineyards	0.20	0.08
Orchards	0.50	0.20
Trees in private gardens	0.50	0.20

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 Rammels 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

'Annual Change in Carbon Stocks in Mineral Soils'

In order to estimate emissions within the category 5.B.1.2 'Annual Change in Carbon Stocks in Mineral Soils' it was used the "Methodology for determining the carbon balance in agriculture soils for calculating GHG emissions" (see Annex A3-4.2) [84].

The following equation was used to calculate respective emissions:

$$CO_{2\ soils} = \pm B_C \bullet 44/12$$

Where:

$CO_{2\ soils}$ – CO_2 emissions from annual change in carbon stocks in soils due to land use change and soil management practices (Gg/yr);

$\pm B_C$ – carbon balance in arable soils (kt C/yr) (see Table 7-20; other relevant information is available in **Annex A3-4.2**, as well as in Chapter 6 "Agriculture Sector", see subchapters 6.4.1.1 'Applied Synthetic Nitrogen Fertilizer', 6.4.1.2 'Applied Organic Nitrogen Fertilizers', 6.4.1.4 'Crop Residues Returned to Soil', 6.4.1.5 'Nitrogen Mineralization Associated with Loss of Soil Carbon', including AD used for calculation exercise);

[44/12] – stoichiometric ratio of carbon fraction in CO_2 and C.

In the last two decades, in the Republic of Moldova, agriculture sector is based mainly on the exploitation of soils natural fertility (and/or existing content of humus in soil). As a result, any increase in harvest (such as, for example, in 2008, see Table 6-68 in Chapter 6 "Agriculture Sector"), caused particularly by favorable climatic conditions, if not followed by compensations for the losses of soil organic matter, used in crop formation, will lead to increased GHG emissions. Thus, the intensification of dehumification process (mineralization of soil organic matter) within the current subsistence agriculture leads to decreased carbon stocks in humus, respectively to increased CO_2 emissions in the atmosphere and reduced quality and fertility of agricultural soils.

The catastrophic decrease, between 1990 and 2010 of carbon return to soil through manure (by 99.8 percent), respectively through above and belowground crop residues (by 73.4 percent), led to the transition from a positive carbon balance (+0.56 t/ha in 1990, before the land reform was implemented in the RM) to a profoundly negative balance (-0.60 t/ha in 2010) (see Table 7-20).

To be noted that, if from 1990 through 1999, carbon balance in arable soils in the RM represented, on an average -0.10 t/ha annually, between 2000 through 2010, it was already circa -0.50 t/ha per year.

[84] Banaru, Anatol (2000), *Methodology to Calculate CO_2 Emissions from Agricultural Soils,* In the collection of papers „Climate Change: Research, Studies, Solutions, Ministry of Environment / UNDP Moldova. „Bons Offices" S.R.L. Chisinau, 2000. P. 115-123.

Table 7-20: Carbon Balance in Agriculture Soils of the RM within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Carbon returned to soil through organic fertilizer, kt	464.4	404.8	274.3	224.2	85.5	97.0	49.2
Carbon returned to soil through above and belowground crop residues, kt	742.0	811.4	570.5	668.1	349.6	380.9	277.5
Loss of soil carbon through the mineralization of humus, kt	-259.7	-702.0	-259.1	-939.9	-587.5	-935.7	-824.6
Carbon balance in agriculture soils, kt	946.6	514.2	585.6	-47.5	-152.3	-457.7	-497.9
Carbon balance in agriculture soils, t/ha	0.56	0.30	0.35	-0.03	-0.09	-0.27	-0.29
	1997	1998	1999	2000	2001	2002	2003
Carbon returned to soil through organic fertilizer, kt	19.4	13.2	7.1	4.8	5.7	3.1	2.7
Carbon returned to soil through above and belowground crop residues, kt	301.6	223.5	208.1	173.6	213.6	212.7	167.4
Loss of soil carbon through the mineralization of humus, kt	-1304.9	-1080.0	-1000.7	-916.5	-1110.2	-1121.6	-833.3
Carbon balance in agriculture soils, kt	-983.9	-843.3	-785.5	-738.0	-890.9	-905.8	-663.1
Carbon balance in agriculture soils, t/ha	-0.57	-0.50	-0.47	-0.44	-0.52	-0.52	-0.42
	2004	2005	2006	2007	2008	2009	2010
Carbon returned to soil through organic fertilizer, kt	2.6	2.6	0.6	0.5	0.5	0.4	1.0
Carbon returned to soil through above and belowground crop residues, kt	225.4	231.2	220.6	102.7	254.1	171.2	197.0
Loss of soil carbon through the mineralization of humus, kt	-1260.7	-1168.3	-1029.4	-336.5	-1242.5	-893.0	-1138.3
Carbon balance in agriculture soils, kt	-1032.8	-934.5	-808.2	-233.3	-987.9	-721.4	-940.2
Carbon balance in agriculture soils, t/ha	-0.62	-0.58	-0.52	-0.15	-0.64	-0.48	-0.60

'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues'

Non-CO_2 emissions from post-harvest field burning of crop residues (stubble fields burning) within the 5.B 'Cropland' were estimated by using a Tier 1 methodology (2006 IPCC Guidelines).

$$L\,fire = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

Where:

L_{fire} – amount of non-CO_2 greenhouse gas emissions from vegetation fires (field burning of crop residues or stubble fields burning), t/yr;

A – area burnt, ha/yr;

M_B – mass of fuel available for combustion, t/ha;

C_f – combustion factor; IPCC default value is 0.90 (IPCC, 2006);

$M_B \bullet C_f$ – amount of fuel actually burnt; default for 'Crop Residues" (post-harvest field burning), in particular, for wheat and barley residues, which are more frequently burned in the RM, is 4 t.d.m./ha (IPCC, 2006);

G_{ef} – default EF (kg/t.d.m.) (Table 7-21).

Table 7-21: EFs for Field Burning of Crop Residues, g/ kg d.m.

Category	CO	CH_4	N_2O	NO_x
Field Burning of Agricultural Residues	92	2.7	0.07	2.5

The activity data on areas sown with grain crops (wheat and barley) are available in the Statistical Yearbooks of the Republic of Moldova and those of ATULBD (the information is provided in Table 6-66, see Chapter 6 "Agriculture Sector" of the NIR).

The information on post-harvest field burning of crop residues (stubble fields burning) cases in the RM is reported annually by the State Ecological Inspectorate's territorial inspectors and it is provided in the Table 7-22.

Table 7-22: Stubble Fields Burning in the RM within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
Burnt stubble fields, thousand ha	12.213	13.110	12.141	14.547	13.422	15.800	18.600
Burnt stubble fields, % from total	3.0	3.0	3.0	3.0	3.0	3.0	3.8
	1997	1998	1999	2000	2001	2002	2003
Burnt stubble fields, thousand ha	20.700	21.500	24.000	11.500	9.500	1.960	0.100
Burnt stubble fields, % from total	3.8	4.0	4.6	2.1	1.6	0.3	0.0
	2004	2005	2006	2007	2008	2009	2010
Burnt stubble fields, thousand ha	0.400	2.200	0.890	2.650	4.465	0.892	0.627
Burnt stubble fields, % from total	0.1	0.4	0.2	0.6	0.8	0.2	0.1

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, Figure2.19, information covering the period 1995-2002); State Ecological Inspectorate (2011), SEI Yearbook - 2010 *„Environment Protection in the Republic of Moldova"*/ State Ecological Inspectorate; editorial board: Grigore Prisacaru, Valentina Tapis, Vadim Stingaci, et al. - Ch.: 2011 („Sirius" SRL). - 232 pages (page 59, Figure 5, information covering the period 2000-2010).

As activity data were not available for the period of time from 1990 through 1994, these data were 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).

The activity data on the amount of crop residues available to be combusted on field (Table 7-23) 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 7-23: Amount of Crop Residues Available for Combustion Onsite in the Republic of Moldova within 1990-2010, t.d.m./ha

	1990	1991	1992	1993	1994	1995	1996
Winter wheat	3.5047	3.1033	2.9246	3.5829	1.9518	2.8843	1.8323
Barley	3.0891	2.8360	2.9305	3.0798	1.9671	2.0508	1.1193
Average	3.2969	2.9696	2.9276	3.3313	1.9595	2.4675	1.4758
	1997	1998	1999	2000	2001	2002	2003
Winter wheat	2.9168	2.4228	2.0937	1.7073	2.4103	2.2204	0.4314
Barley	1.7656	1.6066	1.4067	1.0844	1.9292	1.6089	0.6890
Average	2.3412	2.0147	1.7502	1.3959	2.1698	1.9147	0.5602
	2004	2005	2006	2007	2008	2009	2010
Winter wheat	2.4563	2.2971	2.0307	1.1485	2.7881	1.9119	2.1028
Barley	1.7958	1.5113	1.5503	0.8098	2.3122	1.4528	1.3388
Average	2.1261	1.9042	1.7905	0.9791	2.5502	1.6824	1.7208

7.3.3 Uncertainties Assessment and Time-Series Consistency

'Cropland Covered with Woody Vegetation'

Uncertainties related to CO_2 emissions/removals from the 5.B.1 'Cropland Covered with Woody Vegetation' may be considered relatively acceptable, however exceeding values reported for other categories under the LULUCF Sector. Thus, for production processes the uncertainties account for circa ±25 percent, and uncertainties related to emission/removal factors are of circa ±10 percent.

The main uncertainty pertains to the actual volume of wood mass harvested from woody vegetation managed by local public authorities and other owners, as for this category there is no accurate statistics on the volume of wood mass harvested during forest clearings. Some consolidated information in this field is available at the State Ecological Inspectorate, which is as an institution that authorizes fellings of any type of forest vegetation (based on Article 40 of the Law on Environment Protection and Article 22 of the Forest Code, on state control and state control data).

For instance, over the period from 2000 through 2010, the IES authorized harvesting of 88.9 thousand m^3 of wood mass from the forestry resources and other types of forest vegetation managed by local public authorities. This volume was not separated by categories of woody vegetation. A considerable part of illicit logging is not even reported. As a consequence, it generates massive illegal logging on forest land managed by local public authorities.

According to a recent study, circa 12 percent (3.6 thousand ha) of areas of protection forest strips need partial reconstruction because of low consistency (of 0.3-0.6).

In this context, combined uncertainties for this source category were estimated at circa ±26.9 percent, while the combined uncertainties as a percentage of total annual direct sectoral emissions/removals were estimated at ±480.1 percent. The uncertainties introduced in trend in sectoral emissions/removals were estimated at ±2.4 percent (**Annex 5-3.5**).

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.

'Annual Change in Carbon Stocks in Mineral Soils'

Uncertainties related to activity data used to estimate CO_2 emissions/removals from 5.B.1.2 'Annual Change in Carbon Stocks in Mineral Soils' category are deemed to be low (±10 percent). 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 ±20 percent. Thus, combined uncertainties related to CO_2 emissions from the 'Annual Change in Carbon Stocks in Mineral Soils' can be regarded as being moderate (±14.1 percent), while the combined uncertainties as a percentage of total annual sectoral emissions/removals were estimated at ±1847.6 percent. The uncertainties introduced in trend in total sectoral emissions/removals were estimated at ±8.3 percent (**Annex 5-3.5**).

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.

'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues'

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 onsite, 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 ±10 percent. At the same time uncertainties related to estimation the areas of stubble fields actually burnt are considered to be medium, up to ±50 percent. Uncertainties associated with the default emission factors for various types of burning are moderate for CH_4 (±30 percent) and medium for N_2O (±50 percent), however, in agricultural seasons with high humidity these uncertainties can increase to higher levels. Thus, combined uncertainties related to non-CO_2 emissions from post-harvest field burning of agricultural residues are regarded to be relatively high (±31.6 percent for CH_4 and ±51.0 percent for N_2O), while the combined uncertainties as a percentage of total direct sectoral emissions/removals are quite insignificant (**Annex 5-3.5**).

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.

7.3.4 Quality Assurance and Quality Control

'Cropland Covered with Woody Vegetation'

The quality of assessment for 5.B.1.1 'Cropland covered with woody vegetation' category is provided by the fact that most of the AD used is taken from official records[85]. Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach (IPCC, 2000). Verification was focused on various aspects such as: ensuring correct use of estimation methodologies following the Revised 1996 IPCC Guidelines (IPCC, 1997) and GPG LULUCF (2003), correct use of national factors, their accuracy, as well as comparing them to the values used by other countries in the region.

'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 (IPCC, 2000). 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. To be noted that AD and methods used for estimating 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 included into the GPG (IPCC, 2000), CO_2 emissions within this sector resulting from land-use change and management practices were estimated based on AD from official sources of reference (Statistical Yearbooks of the RM and those of the ATULBD; General Land Cadasters of the RM, etc.).

'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues'

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. To be noted that AD and methods used for estimating non-CO_2 emissions from field burning of crop residues were documented and archived both in hard copies and electronically.

[85] I.e., the total area of protection forest strips and other types of forest vegetation, perennial plantations is provided annually by the General Land Cadasters, 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.

7.3.5 Recalculations

Cropland Covered with Woody Vegetation

No recalculations were performed for CO_2 removals within the 5.B.1.1 'Cropland Covered with Woody Vegetation' category in the RM, for the period 1990-2005. It has been used the same estimation approach, available in the Revised 1996 Guidelines (IPCC, 1996), GPG LULUCF (IPCC, 2003) and 2006 IPCC Guidelines, as well as the same AD set (area covered with forest vegetation, current biomass increment, etc.). Within the 1990-2010 time series, CO_2 removals from this category, decreased by circa 35.1 percent (Table 7-24).

Table 7-24: CO_2 Removals from 'Cropland Covered with Woody Vegetation' in the RM within 1990-2010 time periods

Source	1990	1991	1992	1993	1994	1995	1996
CO_2, Gg	-725.2	-613.1	-614.0	-611.9	-590.3	-598.6	-551.0
Source	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2, Gg	-573.4	-551.0	-533.4	-523.4	-507.7	-477.6	-474.0
Source	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO_2, Gg	-466.4	-465.3	-472.1	-477.1	-480.0	-483.6	-470.5

The graphical illustration of CO_2 removals evolution within the source category 5B11 'Cropland Covered with Woody Vegetation' is provided by Figure 7-7.

'Annual Change in Carbon Stocks in Mineral Soils'

GHG emission recalculations under the 5.B.1.2 'Annual Change in Carbon Stocks in Mineral Soils' category are due to the use of a country specific methodology[86] (similar with a Tier 3 approach, following the IPCC classification), for estimating CO_2 emissions/removals, replacing thus, the Tier 2

[86] Banaru Anatol (2000), *Methodology to Calculate CO_2 Emissions from Agricultural Soils,* In the collection of papers „Climate Change: Research, Studies, Solutions, Ministry of Environment / UNDP Moldova. „Bons Offices" S.R.L. Chisinau, 2000. P. 115-123.

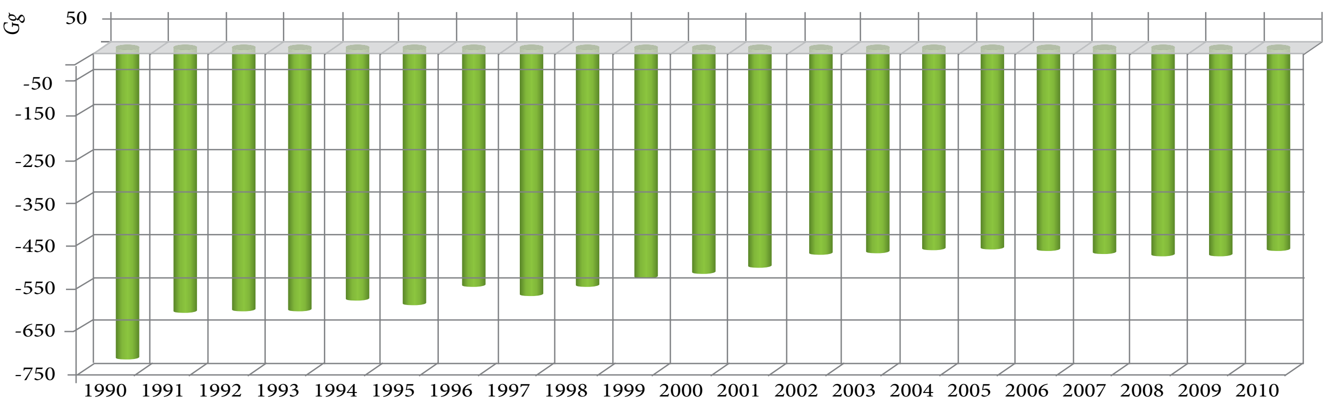


Figure 7-7: CO_2 Removals from 'Cropland Covered with Woody Vegetation' in the RM within 1990-2010 time periods

approach and default EFs, used within the SNC of the RM under UNFCCC, respectively due to use of an updated set of activity data.

In comparison with the results included into the SNC of the RM under the UNFCCC, the performed recalculation resulted in a significant decrease of CO_2 emissions for the 1990-1996 time periods, varying from a minimum of 12.8 percent in 1996, up to a maximum of 270.7 percent in 1990, respectively in a significant increase of CO_2 emissions for the 1997-2005 time periods, varying from a minimum of 12.4 percent in 2003, up to a maximum of 75.5 percent in 2004 (Table 7-25).

Table 7-25: Recalculated CO_2 Emissions/Removals from 5.B.1.2 'Annual Change in Carbon Stocks in Mineral Soils' included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	2032.8	2036.0	2045.6	2045.8	2062.3	2080.2	2092.9
TNC	-3471.0	-1885.4	-2147.4	174.3	558.4	1678.1	1825.7
Difference, %	-270.7	-192.6	-205.0	-91.5	-72.9	-19.3	-12.8
	1997	1998	1999	2000	2001	2002	2003
SNC	2105.8	2122.3	2126.9	2135.0	2157.2	2160.6	2163.9
TNC	3607.5	3092.1	2880.3	2706.0	3266.5	3321.1	2431.4
Difference, %	71.3	45.7	35.4	26.7	51.4	53.7	12.4
	2004	2005	2006	2007	2008	2009	2010
SNC	2157.8	2149.6					
TNC	3786.8	3426.4	2963.5	855.5	3622.2	2645.0	3447.5
Difference, %	75.5	59.4					

Abbreviations: SNC – Second National Communication; TNC – Third National Communication.

The graphical illustration of CO_2 emissions/removals evolution within the source category 5.B.1.2 'Annual Change in Carbon Stocks in Mineral Soils' is provided in Figure 7-8.

As it can be noted, by 2010 an amount of CO_2 emissions similar to 1990 year level removals was emitted in the atmosphere. Maintaining the existing system of agricultural exploitation of arable soils will lead to maintaining the same rate of CO_2 emissions from the humus reserves in soils as well as to the progressive degradation of their physical, chemical, biological and fertility qualities.

To be noted that attempts to increase the soils productivity by increasing the amount of synthetic fertilizers will not generate a positive result, since in the RM there are mostly argillaceous soils and the reduce flow of organic matter will lead to the degradation of their physical qualities, respectively will decrease the productivity potential.

Thus, for arable soils, any action leading to increased flow of organic matter will lead, at the same time, to long-term preservation of soil fertility, respectively to decreased CO_2 emissions.

'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues'

No recalculations were performed for non-CO_2 emissions within the source category 5B 'Cropland' (it has been used the same estimation approach and the same AD set).

In comparison with the reference year level, by 2010 the non-CO_2 emissions from stubble fields burning decreased in the RM by circa 97.3 percent (Tables 7-26 and 7-27). At the same time, from year to year, the volume fluctuates significantly due to adverse weather conditions and anthropogenic factors.

Table 7-26: Non-CO_2 Emissions from Stubble Fields Burning in the RM within 1990-2010, Gg

	1990	1991	1992	1993	1994	1995	1996
CH_4	0.0978	0.0946	0.0864	0.1178	0.0639	0.0947	0.0667
N_2O	3.3340	3.2236	2.9430	4.0126	2.1776	3.2281	2.2728
CO	0.0025	0.0025	0.0022	0.0031	0.0017	0.0025	0.0017
NO_x	0.0906	0.0876	0.0800	0.1090	0.0592	0.0877	0.0618
	1997	1998	1999	2000	2001	2002	2003
CH_4	0.1178	0.1053	0.1021	0.0390	0.0501	0.0091	0.0001
N_2O	4.0127	3.5866	3.4780	1.3291	1.7067	0.3107	0.0046
CO	0.0031	0.0027	0.0026	0.0010	0.0013	0.0002	0.0000
NO_x	0.1090	0.0975	0.0945	0.0361	0.0464	0.0084	0.0001
	2004	2005	2006	2007	2008	2009	2010
CH_4	0.0021	0.0102	0.0039	0.0063	0.0277	0.0036	0.0026
N_2O	0.0704	0.3469	0.1319	0.2148	0.9428	0.1243	0.0893
CO	0.0001	0.0003	0.0001	0.0002	0.0007	0.0001	0.0001
NO_x	0.0019	0.0094	0.0036	0.0058	0.0256	0.0034	0.0024

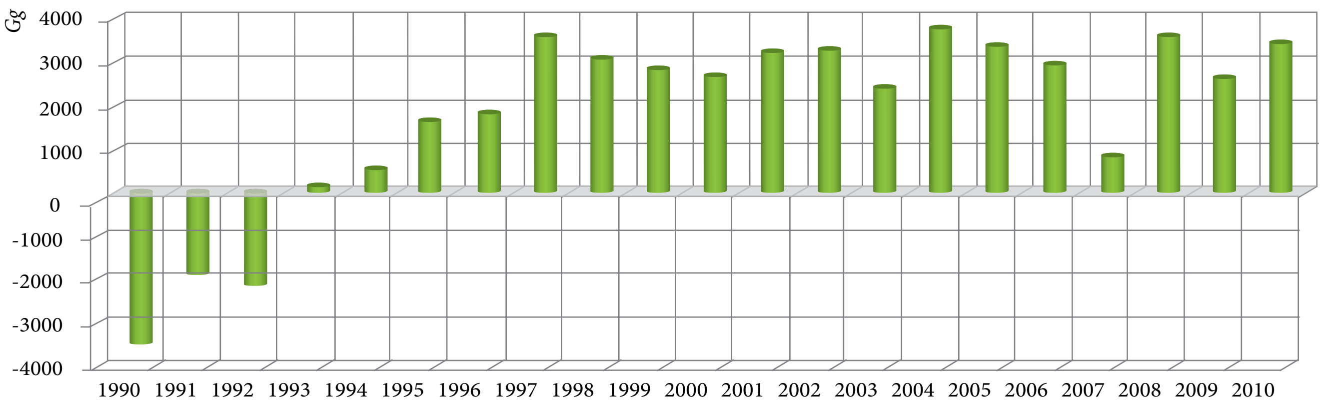


Figure 7-8: CO_2 Removals/Emissions from 'Annual Change in Carbon Stocks in Mineral Soils' category in the RM within 1990-2010 time periods

Table 7-27: Non-CO_2 Emissions Trend within this Category, comparative to the reference year level and inter-annual fluctuations, %

	1990	1991	1992	1993	1994	1995	1996
Comparative to 1990, %	100.0	-3.3	-11.7	20.4	-34.7	-3.2	-31.8
Inter-annual Fluctuations, %		-3.3	-8.7	36.3	-45.7	48.2	-29.6
	1997	1998	1999	2000	2001	2002	2003
Comparative to 1990, %	20.4	7.6	4.3	-60.1	-48.8	-90.7	-99.9
Inter-annual Fluctuations, %	76.6	-10.6	-3.0	-61.8	28.4	-81.8	-98.5
	2004	2005	2006	2007	2008	2009	2010
Comparative to 1990, %	-97.9	-89.6	-96.0	-93.6	-71.7	-96.3	-97.3
Inter-annual Fluctuations, %	1418.0	392.6	-62.0	62.8	338.8	-86.8	-28.1

7.3.6 Planned Improvements

'Cropland Covered with Woody Vegetation'

The possibility to improve records pertaining to actual consumption of fuel wood from forest strips and other types of woody vegetation, as well as pursue activities aimed at verification of the country specific emission/removal factors (annual biomass increments, biomass harvesting during the cleaning cuttings of perennial plantations, etc.), will be considered for the next inventory cycle.

'Annual Change in Carbon Stocks in Mineral Soils'

It is planned to carry out activities aimed at reducing uncertainties associated with the results obtained under the respective source category, inclusive by improving the country specific methodology (Banaru, 2000) and improving the quality of used activity data, in order to make possible estimation of CO_2 emissions/removals from 'Annual Change in Carbon Stocks in Mineral Soils'.

'Non-CO_2 Emissions from Post-Harvest Field Burning of Crop Residues'

It is planned to carry out activities aimed at updating activity data used to estimate non-CO_2 emissions from stubble fields burning in the next inventory cycle.

7.4 Grassland (Category 5C)

7.4.1 Source Category Description

5C 'Grassland' comprises GHG emissions/removals originated from two categories, 5C1 'Grassland Remaining Grassland' and 5C2 'Land Converted to Cropland'. Grassland is an area of land covered with perennial herbaceous vegetation used for grazing animals (pastures and hayfields).

Under the LULUCF Sector, in 1990 year the grassland accounted for 11.0 percent of the total CO_2 removals, being an important sink category in the Republic of Moldova. According to the General Land Cadaster (standing as of 01.01.2010), the grassland area was 354.3 thousand ha.

At current productivity level, 1 ha of grassland can provide feed for an average of 0.3 cows or 2 sheep. In optimal conditions, 1 ha of grassland could support 1.5-2.0 cows or 10-14 sheep. Activity data used within the development of inventory for the period of time from 1990 through 2010 are available in the General Land Cadasters of the RM, as well as in the Reports of the Agency "Moldsilva" and in the Reports of the State Ecological Inspectorate.

Current inventory comprised estimation of CO_2 removals from the 5C1 'Grasslands Remaining Grasslands' category, resulting from the growth of aboveground biomass included in "pastures" and "hayfields" categories, and CO_2 emissions/removals from the 5C2 'Lands Converted to Grassland' category resulting from growth of grassland vegetation after conversion of cropland to grassland, and from former forest land converted to grassland.

Conversion of cropland to grassland is a regular process over the past 20 years in the Republic of Moldova, because a considerable part of cropland is severely affected by erosion and reached to an extremely low level of economic efficiency of cropping.

Another negative process that started in the 1990' along with the social-political changes is conversion of lands with woody vegetation. This process mostly affected lands managed by local public authorities and agricultural enterprises (in particular in the time period from 1990 through 1996). Over 80 percent of such vegetation is *Robinia pseudoacacia* rammels. In most cases (90 percent of the total), the wood mass harvested on these lands is used as fuel used for heating. Circa 10 percent only (shoots, bark etc.) remain on the cutting site. Brush burning on site is not practiced. This process started in 1991, the lowest indicators being reported for the time period from 1993 through 1997.

7.4.2 Methodological Issues, Emission Factors and Data Sources

5C1 'Grassland Remaining Grassland'

For estimating CO_2 removals from the 5C1 'Grassland Remaining Grassland' category, it was necessary to determine average annual biomass growth of grasses in conformity with national available data.

The calculation was done based on annual change in carbon stocks in living biomass, by using the following equations:

$$\Delta C\ GG_{LB} = (\Delta B_{perennial} + \Delta B_{grasses}) \bullet CF$$

Where:

$\Delta B_{perennial}$ – change in above and belowground perennial woody biomass (in case of the RM, the respective areas were included under category 5B1 'Cropland Remaining Cropland'), t.d.m./ha/yr;

CF – carbon fraction of dry matter (0.5);

$\Delta B_{grasses}$ – change in belowground biomass of grasses, t.d.m./ha/yr, calculated using the following equation:

$$\Delta B_{grasses} = A_{grasses} \bullet (G_{grasses} - L_{grasses})$$

Where:

$A_{grasses}$ – area of grasslands covered with grasses, thousand ha;

$G_{grasses}$ – average annual biomass growth of grasses, t.d.m./ha/yr;

$L_{grasses}$ – average annual biomass loss of grasses, t.d.m./ha/yr.

Under the 5C 'Grassland' category there were used estimation methods available in the Revised 1996 Guidelines (IPCC, 1996), GBP LULUCF (IPCC, 2003) and 2006 IPCC Guidelines. At the same time, country specific emission/removal factors were used, pertaining to annual growth rate of perennial woody biomass and annual carbon stock in biomass, etc., as well as sectoral AD.

The main source of reference for the activity data on area of grassland covered with grasses and, implicitly, on CO_2 resulting, is the General Land Cadasters of the RM for the period under review (Table 7-28).

Table 7-28: Grassland Area in the RM within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Grassland, thousand ha	354.6	356	357.2	358.0	364.6	367.3	369.7
	1997	1998	1999	2000	2001	2002	2003
Grassland, thousand ha	372.0	374.1	376.0	376.4	381.6	355.1	382.1
	2004	2005	2006	2007	2008	2009	2010
Grassland, thousand ha	377.0	373.5	370.2	364.2	360.1	357.1	354.3

Source: General Land Cadasters for the period of time from 1990 through 2010.

Country specific emission factors were used (pertaining to average annual growth of grasses and carbon fraction of dry matter), as well as other relevant information (area covered with grasses), taking into account the distribution of grasslands by categories (meadows, grasslands on eroded soils, grasslands on slopes) and data from scientific literature in the Republic of Moldova.

According to the national sources of reference, the productivity of grasses on slopes is 0.4-1.2 t.d.m./ha/yr, the productivity of meadows is 2.0-4.2 t.d.m./ha/yr. Distribution by categories is as following: meadows – 15.3 percent (2.3 t.d.m./ha/yr); eroded soils – 31.7 percent (0.6 t.d.m./ha/yr); slopes – 53 percent (1.2 t.d.m./ha/yr). The average annual growth value used was 1.2 t.d.m./ha/yr and the carbon fraction of dry matter used was 0.5.

5C2 'Lands Converted to Grassland'

In order to estimate CO_2 removals from land converted to grassland, according to national available data, it was necessary to determine annual biomass increments in herbaceous vegetation on newly formed grasslands, as well as differences in initial biomass for land covered previously by forest.

The main source of reference for the activity data on lands converted to grassland is the General Land Cadasters of the RM, as well as the Reports of the "Moldsilva" Agency and the Reports of the State Ecological Inspectorate for the period under review. The respective areas were calculated as a difference between area of grassland in the period of years under review and similar values in the precedent years.

The calculation was done based on annual change in carbon stocks in living biomass, by using the following equations:

$$\Delta C_{C_B} = A \bullet (L_{Conversion} + \Delta C_{Growth})$$

Where:

A – area of lands converted to grasslands from some initial use, ha/yr;

$L_{Conversion}$ – carbon stock change per area for that type of conversion, when land is converted to grassland (t C/ha/yr), calculated using the following equation:

$$L_{Conversion} = C_{After} - C_{Before}$$

Where:

C_{After} – C stocks in biomass immediately after conversion to grassland, t C/ha;

C_{Before} – C stocks in biomass immediately before conversion to grassland, t C/ha;

ΔC_{Growth} – carbon stocks from one year of growth of grassland vegetation after conversion (t C/ha/yr).

In order to estimate CO_2 emissions/removals within this category, data on area of land converted to grassland and area of forest and other types of forest vegetation cleared through illegal logging were provided by the General Land Cadasters of the RM, as well as through Reports of the Agency "Moldsilva" and through Reports of the State Ecological Inspectorate (Table 7-29).

Table 7-29: Area of Lands Converted to Grassland in the RM within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
Area of forest land converted annually to grassland, thousand ha	-	1.690	2.720	4.020	2.750	2.560	3.180
Area of cropland converted annually to grassland, thousand ha	5.8	1.4	1.2	0.8	6.6	2.7	2.4
	1997	1998	1999	2000	2001	2002	2003
Area of forest land converted annually to grassland, thousand ha	1.230	1.630	0.440	0.040	0.020	0.010	0.030
Area of cropland converted annually to grassland, thousand ha	2.3	2.1	1.9	0.4	5.2	-26.5	27.0
	2004	2005	2006	2007	2008	2009	2010
Area of forest land converted annually to grassland, thousand ha	0.030	0.030	0.103	0.032	0.039	0.051	0.292
Area of cropland converted annually to grassland, thousand ha	-5.1	-3.5	-3.3	-6.0	-4.1	-3.0	-2.8

Source: General Land Cadasters of the RM for 1990-2010, Reports of "Moldsilva" Agency and Reports of State Ecological Inspectorate on the area of forest land and other types of forest vegetation cleared through illegal logging for 1990-2010.

Country specific emission factors were used to estimate annual changes in carbon stocks in living biomass on land converted to grassland from some initial use. Thus, for forest land converted to grassland, the amount of biomass before conversion to grassland (70 m^3/ha or 51 t.d.m./ha) was provided in conformity with the results of controls performed by the state forest authorities to reveal illegal logging. The default value of 10 t.d.m./ha used for biomass remaining after conversion of forest land to grassland (roots, grasses, etc.) was taken from GBP LULUCF (IPCC, 2003). The annual rate of biomass accumulation on cropland converted to grassland was the same as the one used for grassland on degraded land, which is 0.6 t.d.m./ha/yr (see Table 7-30).

7.4.3 Uncertainties Assessment and Time-Series Consistency

5C1 'Grassland Remaining Grassland'

Uncertainties associated with the CO_2 emissions/removals from 5C1 'Grassland Remaining Grassland', pertain mainly to the actual grassland productivity in the Republic of Moldova. Being situated in different pedoclimatic conditions the grasses productivity ranges from 0.4 to 4.2 t.d.m./ha.

By using the weighted average grasses productivity, the uncertainties have been reduced in some extent to relatively acceptable values: ±30 percent for production processes and ±10 percent for emission/removal factors. Thus, combined uncertainties related to CO_2 emissions/removals from the 5C1 'Grassland Remaining Grassland' can be regarded as being medium (±31.6 percent), while the combined uncertainties as a percentage of total annual sectoral emissions/removals were estimated at ±934.1 percent. The uncertainties introduced in trend in sectoral emissions/removals were estimated at ±4.7 percent.

5C2 'Land Converted to Grassland'

Uncertainties associated with the CO_2 emissions/removals resulted from 5C2 'Land Converted to Grassland' category are higher, however, within acceptable limits. To be noted that conversion of forest land to grassland started after 1990. At that moment, the uncertainty level was circa ±15 percent for production processes, due the fact that the state forestry authorities were responsible for regular (twice a year, in spring and autumn) total control of forest land and other woody vegetation land managed by local the public authorities and agricultural enterprises. By the end of the reference period (2010), the uncertainties increased up to ±30 percent, what is explained by lack of veridical records on evolution of land use of forest land damaged by illegal logging, as well as by grazing and cropping, etc. In both cases emission/removal factors have an uncertainty level of ±5 percent.

In conformity 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 7^0, where cropping is economically inefficient. Conversion of cropland was 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, etc.). Land cadasters contain only general information in this sense, without specifying to what categories the cropland (arable lands, perennial plantations, etc.) were converted to. One part of them was converted to forest land, while the other (depending on condition) was transferred to other categories (grassland, ravines, landslides, etc.). Practically, only the land-use category (in many cases determined by local traditions) to some extent reflects the condition of such land after conversion. The reference year for this category is considered to be 1993.

Taking into account all these information, the deviation from actual indicators can generate high uncertainties, exceeding ±70 percent for production processes, and ±5 percent for emission/removal factors. Thus, combined uncertainties related to CO_2 emissions/removals from the 5C2 'Land Converted to Grassland' source category can be regarded as medium (±30.4 percent), while the combined uncertainties as a percentage of total annual sectoral emissions/removals were estimated as relatively low (±25.2 percent). The uncertainties introduced in trend in total sectoral emissions/ removals were estimated at ±0.1 percent.

7.4.4 Quality Assurance and Quality Control

The quality of assessment for 5C 'Grassland' category is provided by the fact that most of the AD used is taken from official records. Thus, the total area of grassland is provided by the General Land Cadasters for each year. Data regarding area of forest land converted to grassland are provided by the Reports of the "Moldsilva" Agency (Statistical Report 5 "Statistic report on volumes of illegal logging", as well as by the Reports of the State Ecological Inspectorate. Data on annual biomass increment for forest land converted to

Table 7-30: EFs Used to Estimate Emissions/Removals from the 5C 'Grassland' Category

Categories	Carbon fraction in biomass	Carbon stocks in biomass after conversion to grassland, t C/ha/yr	Carbon stocks in biomass before conversion to grassland, t C/ha/yr	Carbon stocks from one year of growth of vegetation after conversion, t C/ha/yr
Cropland Converted to Grassland	0.5	-	-	0.6
Forest Land Converted to Grassland	0.5	5.0	26.0	0.3

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 Nr. 46-49, Government Resolution Nr. 367 from 13.04.2000, 'On approval the National Program to Combat Desertification 2000'; Postolache, Gh., Vegetation of the Republic of Moldova, 1995; Sabanova G. A., Bulat A., Tofan E., Report on Floral and Phytocenotical of the Herbaceous Stratum by Sectors under the "Soil Conservation Project in Moldova", 2005.

grassland are provided by 'Production Tables' and concrete 'Records'. For grassland, data were taken from the scientific literature in the field, as well as from Legislative, Normative and Technical Regulations Acts.

Within this category, verification was focused on various aspects such as: ensuring correct use of estimation methodologies following the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG LULUCF (2003) and 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.

Standard verification and quality control forms and checklists were filled in for this category, following a Tier 1 approach (IPCC, 2000). Following the recommendations included into the GPG (IPCC, 2000), CO_2 emissions within this sector resulting from land-use change and management practices in the RM were estimated based on AD from official sources of reference (General Land Cadasters of the RM and Statistical Yearbooks of the RM and those of AT-ULBD).

7.4.5 Recalculations

5C1 'Grassland Remaining Grassland'

No recalculations were performed for CO_2 removals within the source category 5C1 'Grassland Remaining Grassland' in the RM, for the period 1990-2005. It has been used the same estimation approach, available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG LULUCF (IPCC, 2003) and 2006 IPCC Guidelines, as well as the same AD set (grassland area, current biomass increment, etc.).

As can be noticed from Table 7-31, within the 1990-2010 time series, CO_2 removals from this category, increased periodically, but, by the end of the reference period, due to converting degraded grassland in forests, were recorded approximately similar values as in the reference year.

The graphical illustration of CO_2 removals evolution within the source category 5C1 'Grassland Remaining Grassland' is provided in Figure 7-9.

Table 7-31: CO_2 Removals under the Category 5C1 'Grassland Remaining Grassland' in the RM within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
CO_2, Gg	-780.1	-783.2	-785.8	-787.6	-802.1	-808.1	-813.3
	1997	1998	1999	2000	2001	2002	2003
CO_2, Gg	-818.4	-823.0	-827.2	-828.1	-839.5	-781.2	-840.6
	2004	2005	2006	2007	2008	2009	2010
CO_2, Gg	-829.4	-821.7	-814.4	-801.2	-792.2	-785.6	-779.5

5C2 'Land Converted to Grassland'

No recalculations were performed for CO_2 removals within the 5C2 'Land Converted to Grassland' category in the RM for the period 1990-2005. It has been used the same estimation approach, available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG LULUCF (IPCC, 2003) and 2006 IPCC Guidelines, as well as the same AD set (grassland area, current biomass increment).

To be noted that, although between 1990 and 2010 within this category it was revealed a CO_2 emissions increasing trend, the values recorded are insignificant at the sectoral level (Table 7-32).

Table 7-32: CO_2 Emissions/Removals under the 5C2 'Land Converted to Grassland' Category in the RM within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
CO_2, Gg	-6.4	125.6	202.1	299.8	198.4	188.5	235.2
	1997	1998	1999	2000	2001	2002	2003
CO_2, Gg	89.5	119.6	30.8	2.6	-4.6	0.7	-27.5
	2004	2005	2006	2007	2008	2009	2010
CO_2, Gg	2.2	2.2	7.7	2.4	2.9	3.8	21.8

To be mentioned, that the noted increase in CO_2 emissions over the period since 1991 to 1999 (Figure 7-9) is explained by reported problems encountered by the local public authorities and by the agricultural enterprises, in relation to the management of forest land and land covered with other type of forest vegetation, which resulted in a significant deforestation.

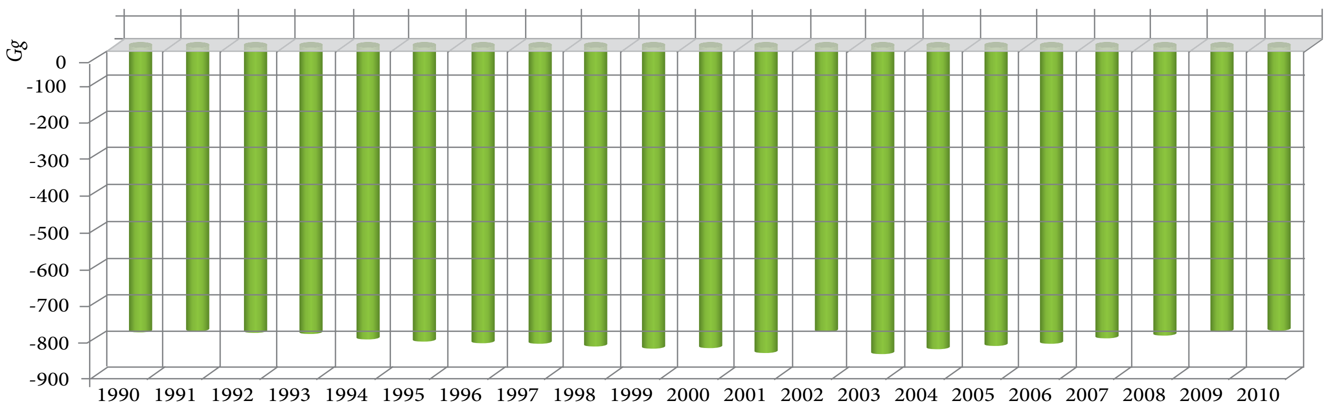


Figure 7-9: CO_2 Removals from 'Grassland Remaining Grassland' in the RM within 1990-2010

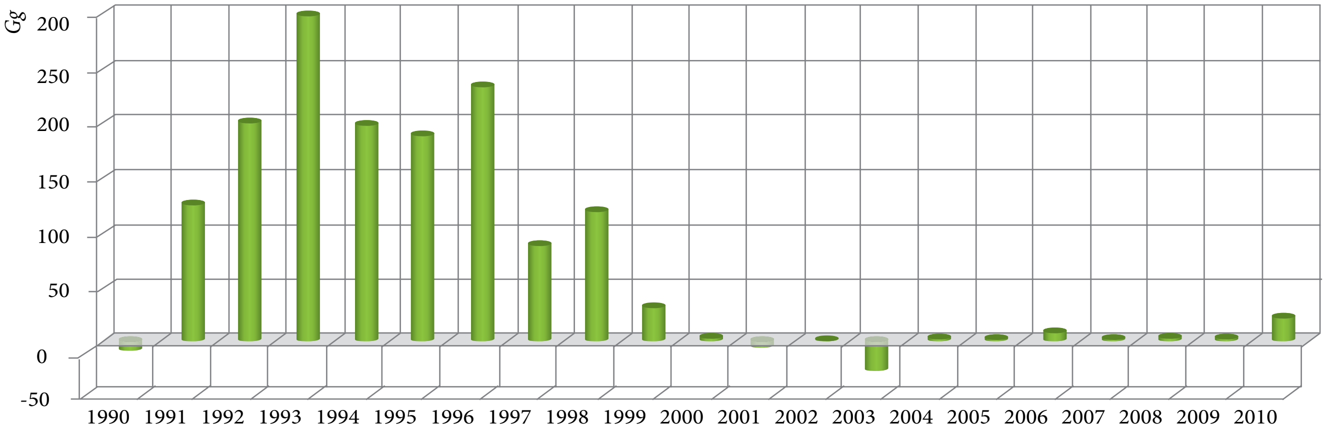


Figure 7-10: CO_2 Emissions/ Removals from 'Land Converted to Grassland' category in the RM, within 1990-2010 time periods

7.4.6 Planned Improvements

The possibility to improve the cadastral records pertaining to specification of land use categories to which converted lands are transferred to, will be considered for the next inventory cycles in the Republic of Moldova.

8. WASTE SECTOR

8.1 Overview

Waste Sector includes CH_4 emissions from the anaerobic decomposition of organic waste disposed in solid waste disposal sites (SWDS), CH_4 emission from handling domestic and industrial wastewater under anaerobic conditions, as well as N_2O emissions from human sewage. Direct GHG emissions resulted from Waste Sector have been estimated based on the Revised 1996 Guidelines (IPCC, 1997) and Good Practice Guidance and Uncertainty Management in National GHG Inventories (IPCC, 2000). The source categories covered by this sector are: 6A 'Solid Waste Disposal on Land' and 6B 'Wastewater Handling'. 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.

Human activities inevitably induce generation of different types of waste. Increased consumption over the past decades contributed to global increase of solid wastes. Most type of wastes can be recycled, however finally a large part goes to the solid waste disposal sites.

The lifestyle characteristic for the beginning of this century, to a great extent determined by increased wellbeing of the population, induced a quantitative and qualitative growth of waste generation process. World Bank's studies reveal that with the increase of population income, the waste generation rate per capita increase as well, being at the moment around 0.3-0.4 kg/per capita/day in rural areas and around 0.9 kg/per capita/day or more in urban areas. Though no statistical evidence on average daily waste generation rate is being performed in the Republic of Moldova, this indicator was inferred from data on waste disposal on land reported by sanitation services, varying from circa 0.25 kg/day in towns such as Nisporeni and Cimislia, up to circa 1.1 – 1.3 kg/day in municipalities such as Balti and Chisinau.

Specialized services in waste collection and disposal exist in municipalities, in all district centers, municipal waste management is carried out in an organized manner through these services, working on a contract basis with private clients, but the problem is that the system covers only 60-90 per cent of total municipal waste generators in urban areas.

In rural areas, in most settlements, there are virtually no organized waste management services, transport to the disposal sites is being made individually by each waste generator, except for the waste collecting services created in some rural settlements.

The number of people connected to such services in rural areas is relatively low, due to lack of financial resources. Only a small part of rural settlements, in particular those in immediate proximity to district centers are served by organized waste management services (Chisinau, Falesti, Ungheni, etc.)

Currently, the most widely 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. Annually, through urban sanitation services, about 1.14-2.21 million m^3 of waste is being transported to solid waste disposal sites.

8.1.1 Summary of Emission Trends

In 2010, Waste Sector accounted for circa 11.9 per cent of total national direct greenhouse gas emissions (without LULUCF), being the third major source of GHG emissions in the Republic of Moldova, following the Energy and Agriculture Sectors. To be noted that Waste Sector represents a major source of CH_4 and N_2O emissions, accounting for circa 55.8 per cent and respectively 5.1 per cent of total methane and nitrous oxide emissions reported at the national level.

Between 1990 and 2010, the total GHG emissions originated from the Waste Sector tended to lower values, decreasing from 1627.38 Gg in 1990 to 1578.30 Gg in 2010 (Table 8-1),

Table 8-1: Direct GHG Emissions from Waste Sector by Gas in the Republic of Moldova within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
CH_4, Gg CO_2 eq.	1535.6849	1667.7318	1787.4927	1784.7868	1740.4381	1703.9351	1736.1657
N_2O, Gg CO_2 eq.	91.6979	88.5671	85.1967	81.7599	80.8614	77.5562	78.1785
Total, Gg CO_2 eq.	1627.3829	1756.2989	1872.6894	1866.5467	1821.2994	1781.4913	1814.3442
	1997	1998	1999	2000	2001	2002	2003
CH_4, Gg CO_2 eq.	1666.6341	1608.8784	1677.1886	1585.9691	1475.0551	1403.0989	1385.1074
N_2O, Gg CO_2 eq.	76.5669	75.1935	73.1572	72.5958	76.6673	78.0742	79.8929
Total, Gg CO_2 eq.	1743.2010	1684.0719	1750.3457	1658.5649	1551.7223	1481.1731	1465.0002
	2004	2005	2006	2007	2008	2009	2010
CH_4, Gg CO_2 eq.	1363.0877	1326.2746	1349.9083	1388.4263	1419.3260	1484.5932	1495.8583
N_2O, Gg CO_2 eq.	79.9198	84.8450	84.3716	79.3645	81.4197	80.2863	82.4458
Total, Gg CO_2 eq.	1443.0074	1411.1196	1434.2799	1467.7908	1500.7458	1564.8796	1578.3041

Table 8-2: Breakdown of the Republic of Moldova's Waste Sector CH_4 and N_2O Emissions by Category within 1990-2010

Year	6A, CH_4, Gg CO_2 eq.	6B, CH_4, Gg CO_2 eq.	6B, N_2O, Gg CO_2 eq.	6, Total Emission, Gg CO_2 eq.	6A, CH_4, % from the total	6B, CH_4, % from the total	6B, N_2O, % from the total
1990	1320.0836	215.6014	91.6979	1627.3829	81.1	13.2	5.6
1991	1473.2762	194.4556	88.5671	1756.2989	83.9	11.1	5.0
1992	1632.0039	155.4889	85.1967	1872.6894	87.1	8.3	4.5
1993	1634.1746	150.6122	81.7599	1866.5467	87.6	8.1	4.4
1994	1607.4281	133.0100	80.8614	1821.2994	88.3	7.3	4.4
1995	1576.2543	127.6809	77.5562	1781.4913	88.5	7.2	4.4
1996	1617.3031	118.8626	78.1785	1814.3442	89.1	6.6	4.3
1997	1550.4190	116.2151	76.5669	1743.2010	88.9	6.7	4.4
1998	1510.7587	98.1197	75.1935	1684.0719	89.7	5.8	4.5
1999	1596.7936	80.3950	73.1572	1750.3457	91.2	4.6	4.2
2000	1509.0919	76.8772	72.5958	1658.5649	91.0	4.6	4.4
2001	1390.2296	84.8255	76.6673	1551.7223	89.6	5.5	4.9
2002	1319.8067	83.2922	78.0742	1481.1731	89.1	5.6	5.3
2003	1290.6115	94.4959	79.8929	1465.0002	88.1	6.5	5.5
2004	1257.9779	105.1098	79.9198	1443.0074	87.2	7.3	5.5
2005	1212.9287	113.3459	84.8450	1411.1196	86.0	8.0	6.0
2006	1239.9320	109.9763	84.3716	1434.2799	86.4	7.7	5.9
2007	1283.2945	105.1317	79.3645	1467.7908	87.4	7.2	5.4
2008	1308.6906	110.6355	81.4197	1500.7458	87.2	7.4	5.4
2009	1381.6433	102.9500	80.2863	1564.8796	88.3	6.6	5.1
2010	1388.0583	107.8000	82.4458	1578.3041	87.9	6.8	5.2
1990-2010, %	5.1	-50.0	-10.1	-3.0	8.4	-48.4	-7.3

in particular due to economic decline in the Republic of Moldova during the transition to a market economy. To be noted, however, that the economic growth recorded in the last decades (especially after 2000) resulted in a higher level of welfare, and to a greater capacity for waste generation. All these changes have contributed to an increasing trend of direct GHG emissions within the Waste Sector, in particular since 2006.

The 6A 'Solid Waste Disposal on Land' source category was the largest source of direct GHG emissions in the time segment from 1990 through 2010 (with a share varying between 81.1 to 91.2 per cent of the total), while the 6B 'Wastewater Handling' source category is the only source of N_2O emissions under Waste Sector (Table 8-2).

In 1990, CH_4 and N_2O emissions accounted for circa 94.4 per cent and respectively 5.6 per cent of the total GHG emissions from the Waste Sector. By 2010, the share of CH_4 increased to 94.8 per cent, while that of N_2O, on the contrary, dropped to 5.2 per cent.

As stated above, between the 1990-2010 time series, the total direct GHG emissions originated from the Waste Sector decreased by circa 3.0 per cent, while those of CH_4 and N_2O emissions, by circa 2.6 per cent and respectively, by 10.1 per cent (Figure 8-1).

8.1.2 Key Categories

The results of key source assessment (including LULUCF) carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the **Annex 1**. Table 8-3 provides information on identified key categories (by level and trend) under the Waste Sector of the Republic of Moldova.

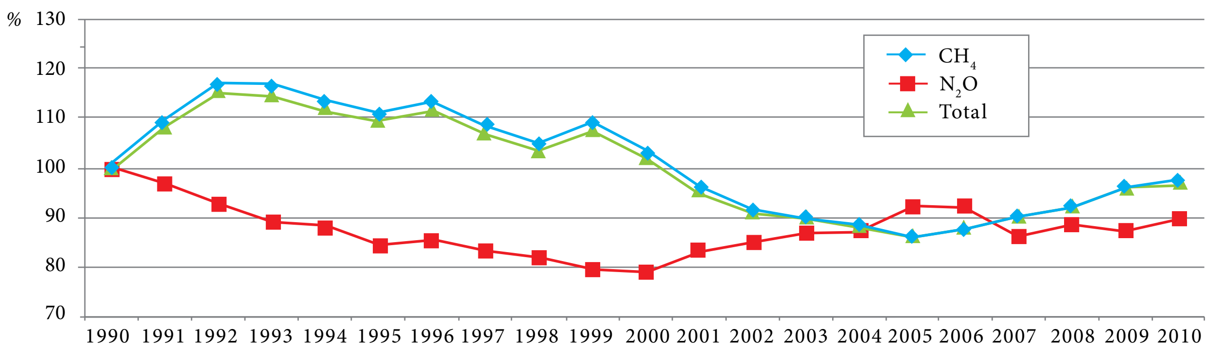


Figure 8-1: Direct GHG Emissions from Waste Sector by Gas in the Republic of Moldova within 1990-2010 time periods, where 1990 represent 100 per cent

Table 8-3: Key Categories Identified under the Waste Sector of the RM

IPCC Category	GHG	Source Category	Key Sources
6A	CH_4	Solid Waste Disposal on Land	Yes (L, T)
6B	CH_4	Wastewater Handling	Yes (L)
6B	N_2O	Human Sewage	No

Abbreviations: L – Level Assessment; T – Trend Assessment.

8.1.3 Methodological Issues

Emissions originated from the source categories 6A 'Solid Waste Disposal on Land' were estimated using both, the Tier 1 methodological approach and default EFs values (IPCC, 1997), as well as the Tier 2 methodological approach (IPCC, 2000) and country specific emission factors. Emissions originated from the source categories 6B 'Wastewater Handling' were estimated using the Tier 1 methodological approach (IPCC, 1997, 2000).

A summary description of methods used to estimate emissions by source categories is provided in Table 8-4, while a more detailed description is available in the sub-chapters 8.2-8.3 of the NIR.

Table 8-4: Assessment Methods Used to Estimate GHG Emissions from the Waste Sector

IPCC Category	Source Category	CH_4		N_2O	
		Method	EF	Method	EF
6A	Solid Waste Disposal on Land	T1, T2	D, CS	NA	NA
6B	Wastewater Handling	T1	D, CS	T1	D
6C	Waste Incineration	NO	NO	NO	NO

Abbreviations: T1 – Tier ; T2 – Tier 2; CS – country specific; D – default; NA – Not Applicable; NO – Not Occurring

8.1.4 Uncertainties Assessment and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the Waste Sector (including by source categories) is described in detail in the sub-chapters 8.2-8.3 of the NIR, as well as in the **Annex 5-3.6**. Combined uncertainties as a percentage of total direct sectoral emissions were estimated at ±20.6 per cent. The uncertainties introduced in trend in total direct sectoral emissions were estimated at ±24.4 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 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

8.1.5 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 Waste Sector, following a Tier 1 approach (IPCC, 2000). To be noted that AD and methods used for estimating GHG emissions under the Waste Sector were documented and archived both in hard copies and electronically. To identify the data entry, as well GHG emissions estimation related errors there were applied AD and EFs verifications and quality control procedures.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions from the Waste Sector were estimated based on AD and EFs from official sources of reference.

8.1.6 Recalculations

GHG emission recalculations under the Waste Sector are due to the availability of an updated set of activity data (Statistical Yearbooks of the RM and those of the ATULBD, other relevant sectoral data sources such as, data provided by the Municipal Enterprise "Autosalubritate"), also due to use of FAO database, in particular the indicator for protein consumption per capita, as well as due to use of country specific parameters under the 6B2 'Wastewater Handling' source category.

In comparison with the results included into the SNC, the performed recalculation resulted in an insignificant decrease of GHG emissions for the 1991-2004 time periods, varying from a minimum of 0.01 per cent in 1991, up to maximum of 4.5 per cent in 1998, respectively in an insignificant increase of direct GHG emissions in 1990 and 2005 (Table 8-5).

The results of recalculations performed at the category level are presented in the sub-chapters 8.2-8.3 of the NIR.

8.1.7 Assessment of Completeness

The current inventory covers greenhouse gas emissions from two source categories under the Republic of Moldova's Waste Sector (Table 8-6). As the waste incineration is not practiced in the Republic of Moldova, respectively no GHG

Table 8-5: Recalculated GHG Emissions under the Waste Sector, Included into the TNC of the RM under UNFCCC, 1990-2005, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	1627.3364	1756.5264	1874.8879	1891.9543	1859.2563	1827.5653	1876.5705	1820.1698
TNC	1627.3829	1756.2989	1872.6894	1866.5467	1821.2994	1781.4913	1814.3442	1743.2010
Difference, %	0.0	0.0	-0.1	-1.3	-2.0	-2.5	-3.3	-4.2
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	1763.3812	1830.5499	1731.2750	1602.7968	1529.1814	1499.3158	1452.0513	1399.9573
TNC	1684.0719	1750.3457	1658.5649	1551.7223	1481.1731	1465.0002	1443.0074	1411.1196
Difference, %	-4.5	-4.4	-4.2	-3.2	-3.1	-2.3	-0.6	0.8

Abbreviations: SNC – Second National Communication; TNC – Third National Communication.

emissions were reported under the 6C 'Waste Incineration' source category.

Table 8-6: Assessment of Completeness under the Waste Sector in the Republic of Moldova

IPCC Category	Source Categories	CO_2	CH_4	N_2O
6A	Solid Waste Disposal on Land	NE	X	NE
6B	Wastewater Handling	NE	X	X
6C	Waste Incineration	NO	NO	NO

Abbreviations: X – source categories included in the inventory; NO – Not Occurring; NE – Not Estimated.

8.1.8 Planned Improvements

Planned improvements at the source categories level within the Waste Sector are described in detail in sub-chapters 8.2-8.3 of the NIR.

8.2 Solid Waste Disposal on Land (Category 6A)

8.2.1 Source Category Description

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 most widely used method of MSW management is their disposal on the site, which often is a major source of soil pollution and groundwater contamination.

The total area of SWDS in urban and rural areas varies between 1300 and 1400 ha, the total number of such sites being approximately 1700. According the official statistical data (NBS, 2010), the area of authorized SWD sites represent only 200 ha, therefore, it can be inferred that circa 1100-1200 ha are occupied by the so called "dump sites" (unauthorized landfills) situated especially in the rural areas of the RM. Most landfills (3/4 of those existing) in the Republic of Moldova do not comply with sanitary and environment protection requirements and, the total amount of solid wastes accumulated on these sites cannot be estimated.

Annually, through urban sanitation services, about 1.14-2.21 million m^3 of waste is being transported to solid waste disposal sites (within 2000-2010 time periods).

No statistical records on disposed waste volume is being made, there are only some visual estimates of environment inspectors, who appreciate the total volume of SWD disposed at approximately 30-35 million tons. To be noted that only 10 per cent of SWD disposal sites are enacted.

By the way the landfills are organized and managed in the RM, they are far from meeting environmental requirements. It is acknowledged that only the landfill situated in Cretoaia village, Anenii Noi district was built in conformity with the designed project and is managed in conformity with in strata waste disposal technology, with compacting and using intermediary cover material. Though some other landfills are authorized to operate as well, they are not properly organized and managed, and inappropriate management entails soil and phreatic water contamination and emissions of GHG and other toxic gases, directly affecting the human health and the environment (Duca, Tugui, 2006).

Between 1990 and 2010, the methane emissions from the 6A 'Solid Waste Disposal on Land' source category increased by circa 5.1 per cent, from 62.86 Gg in 1990, up to 66.10 Gg in 2010 (Figure 8-2).

8.1.2 Methodological Issues, Emission Factors and Data Sources

According to the IPCC Guidelines (1997, 2000), GHG emissions from solid waste disposal on land can be estimated using two alternative methodological approaches: the Default Method (Tier 1) and the First Order Decay Method (Tier 2).

The main difference between the two approaches is that the First Order Decay (FOD) method produces a time-dependent emission profile that better reflects the true pattern

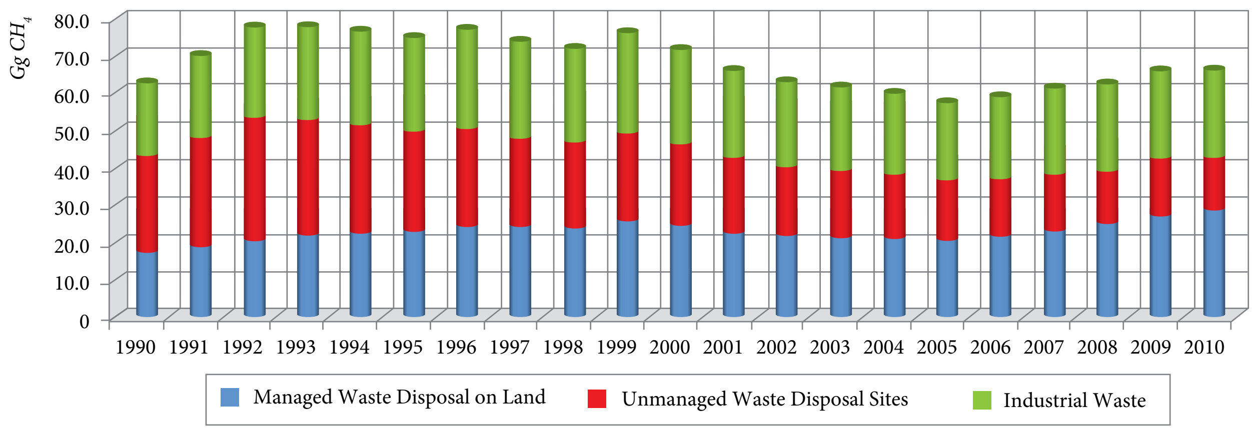


Figure 8-2: Methane Emissions from 6A 'Solid Waste Disposal on Land' source category in the RM, Estimated Using a Tier 2 Method within 1990-2010

of the degradation process over time, whereas the default method is based on the assumption that all potential CH_4 is released in the year the waste is disposed of.

The default method will give a reasonable annual estimate of actual emissions if the amount and composition of deposited waste have been constant or slowly varying over a period of several decades. If the amount or composition of waste disposed at SWDS is changing more rapidly over time, however, the IPCC default method (Tier 1) will not provide an accurate trend. It is *good practice* to use the FOD method, because it more accurately reflects the emission trend.

The use of the FOD method requires data on current, as well as historic waste quantities, composition and disposal practices for several decades.

8.1.2.1 First Order Decay Method

Republic of Moldova has used the FOD method to estimate the methane emissions from 6A 'Solid Waste Disposal on Land' source category for 25 years. Calculations have been performed by using the following equation:

$$CH_4 = \Sigma_x [(A \bullet k \bullet MSW_T(x) \bullet MSW_F(x) \bullet L_o(x)) \bullet e^{-k(t-k)}],$$

Where:

CH_4 – amount of methane generated in year t, Gg/yr;

Σ_x – amount of methane generated over a period of years x;

t – years of inventory;

x – years for which input data should be added;

A – $(1-e^{-k})$ /k; normalization factor which corrects the summation;

k – methane generation rate constant, 1/yr;

$MSW_T(x)$ – total MSW generated in year t, Gg/an;

$MSW_F(x)$ – fraction of MSW disposed at solid waste disposal sites in year x;

$L_o(x)$ – methane generation potential, Gg CH_4/Gg MSW.

Methane generation potential $L_o(x)$ depends on morphologic composition of municipal solid waste, disposal practices and landfill characteristics, being calculated by use the following equation:

$$L_o = [MCF \bullet DOC \bullet DOC_F \bullet F \bullet 16/12]$$

Where:

L_o – methane generation potential, Gg CH_4/Gg MSW;

$MCF_{(x)}$ – methane correction factor in year x (fraction);

DOC – degradable organic carbon (DOC) in year x (fraction), Gg C/Gg waste;

DOC_F – fraction DOC dissimilated;

F – fraction of CH_4 in landfill gas;

16/12 – conversion from C to CH_4.

Information available on landfill characteristics allows draw the conclusion that the Republic of Moldova does not have sites built and managed in conformity with the environmental requirements, except the landfill situated in Cretoaia village, Anenii Noi district, where more than ½ of CH_4 emissions originated from municipal solid waste per country are emitted.

Circa 3/4 of district town's landfills are being explored for circa 25-40 years at 80-100 per cent of their capacity, and currently need to be closed down and recovered. In most district towns the dump sites are overfilled, the disposed waste layer being 7-8 m deep (ex., in Ungheni, Cahul, Ocnita, etc.), at some landfills the layer is circa 10-15 m deep (ex., in Briceni, Balti, Ialoveni, etc.) and even 25-30 m deep (Cretoaia, Orhei).

The existent landfills were set into operation between 1960 and 1990 time series, sometimes without any execution project and proper arrangements, with no dam or fence. Mechanical compacting and isolation are occasional operations, and a part of waste is disposed beyond the authorized and specially arranged boundaries.

To be noted that until the year of 1990, the solid municipal waste generated in Chisinau was disposed to the unmanaged waste disposal site situated in the proximity of Singera village (MCF value used – 0.8), and since 1991 at the managed waste disposal site situated in the proximity of Cretoaia village, Anenii Noi district (MCF value used – 1.0) (Table 8-7).

Table 8-7: Methane Correction Factors Used to Estimate CH_4 Emissions from Solid Waste Disposal Sites in the RM, 1985-2010

SWDS Classification	MCF	SWD sites
Managed	1.0	Chisinau municipality , starting 1991
Unmanaged – deep (≥5 m waste)	0.8	Chisinau municipality, up to 1990
Unmanaged – shallow (<5 m waste)	0.4	
Uncategorized SWDS	0.6	Balti municipality and district towns

8.1.2.2 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. The following equation estimates DOC using carbon content values:

$$DOC = (0.4 \bullet A) + (0.17 \bullet B) + (0.15 \bullet C) + (0.3 \bullet D)$$

Where:

A – fraction of MSW that is paper and textiles (default value - 40 per cent DOC by weight);

B – fraction of MSW that is garden waste, park waste or other non-food organic putrescible (default value - 17 per cent DOC by weight),

C – fraction of MSW that is food waste (default value - 15 per cent DOC by weight);

D – fraction of MSW that is wood or straw (default value - 30 per cent DOC by weight).

Based on waste morphologic composition studies performed in the RM between 1986 and 2010 years, there were calculated the country specific DOC values. Bibliographical sources do not provide information on fraction of garden and park waste and other (non-food) putrescible disposed to sites. At the same time, under the current waste management practices applied in the RM, garden and park waste are not collected and consequently not disposed at the SWDS. In Chisinau, garden and park vegetal waste are disposed in special places meant for waste disposal, including the Purcel quarry. For these reasons, while estimating the DOC value, the product of (0.17 • B), characteristic to the fraction of MSW that is garden waste, was omitted from the equation presented above.

$$DOC = (0.4 \bullet A) + (0.15 \bullet C) + (0.3 \bullet D)$$

Figure 8-3 illustrates the shares of biodegradable fractions (food waste, paper, textiles and leather, wood and phytotechnical waste) in the waste stream in the RM, indicating a decrease from circa 77 per cent in 1986 to circa 54 per cent in 2001, a further increase to 72 per cent in 2005 and a decrease to circa 67 per cent in 2012.

In the current inventory cycle, a study was conducted on solid waste morphologic composition (Table 8-8). The technical team within the State Environmental Laboratory, previously trained in a similar waste management analysis in 2005 year, in fully cooperation with project experts have determined the morphology of household waste generated in Chisinau, and respectively in Balti, Leova and Causeni municipalities.

Table 8-8: Average annual WDS Morphological Composition in 2012 year

Morphological Composition of Municipal Waste, %					
		Chisinau	Balti	Leova/ Causeni	Average
Recyclable Waste	Paper	7.98	2.83	5.02	5.28
	Glass	8.06	5.17	5.13	6.12
	Plastics	7.30	3.76	2.92	4.66
	Metals and non-metals	1.98	1.99	1.04	1.67
Organic Waste	Food waste	46.24	63.14	28.79	46.06
	Phytotechnical Waste	4.30	5.01	23.00	10.77
	Textiles	3.28	2.66	1.84	2.59
	Leather products and shoes	0.57	0.20	0.29	0.35
Bulky Waste	Furniture	1.39	3.88	0.59	1.95
	EEE	1.66	1.01	0.97	1.21
Construction and Demolition Waste	Wood	1.87	1.85	1.55	1.76
	Other (construction waste)	15.37	8.50	28.86	17.58

Table 8-9: Degradable Organic Carbon (DOC) Country Specific Values for Major Waste Streams in the RM within 1985-2012

Years	Degradable Fractions (A / C / D)	DOC
1986	0.320 / 0.375 / 0.029	0.1930
1993	0.300 / 0.350 / 0.030	0.1815
1996	0.179 / 0.456 / 0.021	0.1463
1999	0.054 / 0.535 / 0.010	0.1049
2001	0.077 / 0.449 / 0.008	0.1006
2003	0.075 / 0.565 / 0.011	0.1181
2005	0.117 / 0.561 / 0.035	0.1415
2012	0.079 / 0.108 / 0.461 / 0.037	0.1371

Note: The values of degradable fractions for 1996 year were calculated by interpolation, based on data available for 1993 and 1999. The value of degradable fractions for 2012 were estimated based on the degradable fractions for paper, textiles, phytotechnical waste (garden and park waste), other degradable non-food waste, food waste and wood waste.

8.1.2.3 Fraction of Degradable Organic Carbon Dissimilated

Fraction of degradable organic carbon dissimilated (DOC_F) is an estimate of the fraction of carbon that is ultimately degraded and released from SWDS, and reflects the fact that some organic carbon does not degrade, or degrades very slowly, when deposited in SWDS. It is assumed that fraction of DOC_f depends on the temperature in the anaerobic zone of the site, characterized by the relation: 0.014T + 0.28 (Tabasaran, 1981).

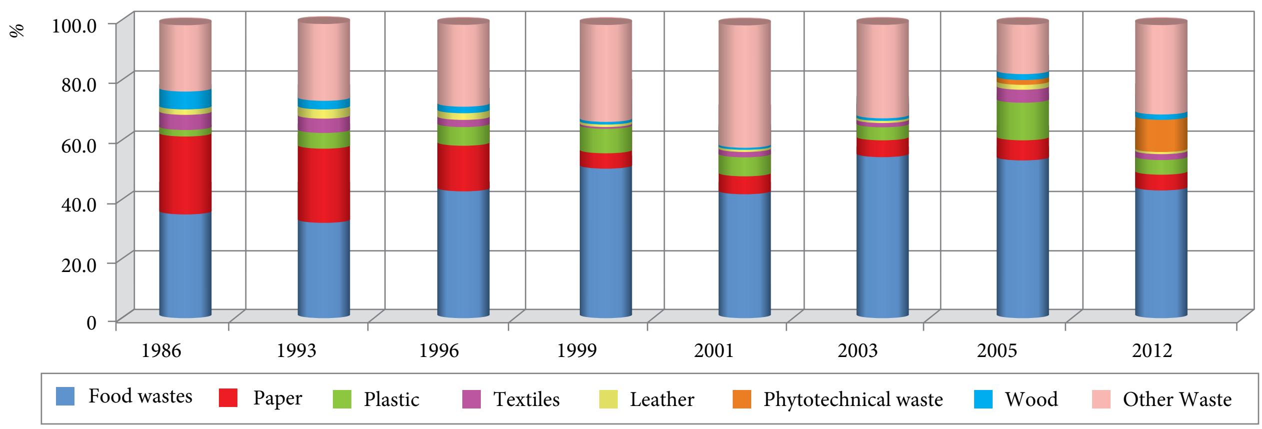


Figure 8-3: Biodegradable Waste in the Major Waste Streams in the Republic of Moldova.

The Revised 1996 IPCC Guidelines (IPCC, 1997) provide a default value of 0.77 for DOC_f, while the BPG (IPCC, 2000) stipulates that only 50-60 per cent of DOC degrades and is converted into landfill gas (DOC_f = 0.5-0.6). Therefore, it appears that the default value may be an overestimate. To avoid this, it is good practice to use an average value of 0.55 as a default.

In the RM, country specific DOC and DOC_f values were developed using „MSW Learning Tool" developed by Florida University (1996) on the base of laboratory experiments carried out by Dr. Morton Barlaz (1987, 1997) and investigations made by Chandler, Van Soest (1980).

Table 8-10: Country Specific DOC and DOC_f Values Used to Estimate CH_4 Emissions from 6A'Solid Waste Disposal on Land' within1985-2012 time periods

	1986	1993	1996	1999	2001	2003	2005	2012
DOC_f	0.518	0.525	0.562	0.630	0.613	0.621	0.585	0.531
DOC	0.216	0.199	0.155	0.104	0.100	0.116	0.146	0.137

8.1.2.4 Fraction of CH_4 in Landfill Gas

The Revised 1996 IPCC Guidelines (IPCC, 1997) recommends using the CH_4 fraction F in SWD - 0.5, while the BPG (IPCC, 2000) state that F value can vary between 0.4 and 0.6, depending on several factors including waste composition (Bingemer, Crutyen, 1987).

The results of the measurements undertaken at the national level denote CH_4 concentrations in landfill gas varying between 53 and 66 per cent and CO_2 concentrations varying between 16 and 20 per cent (Ţugui, Duca, Ţăranu et al., 2005). To be noted that composition of landfill gas can be calculated also based on extended Buswell equation using the results of the waste morphologic composition, which also served as basis to estimate DOC and DOC_f values.

Evolution of the composition of the landfill gas emitted from the landfill situated in the proximity of Cretoaia village, Anenii Noi district is relatively constant, the ratio of CH_4 to CO_2 being 55/45. The results of the studies carried out in order to identify landfill gas composition at the SWDS in the Republic of Moldova revealed that the average ratio of CH_4 to CO_2 is 60/40.

In comparison with the results included in the FNC of the RM under the UNFCCC, calculated by using the default method (Tier 1), the use of the FOD method (Tier 2) and country specific values for the fraction of CH_4 in landfill gas (F = 0.6), methane correction factors (MCF), biodegradable organic carbon (DOC) and fraction of degradable organic carbon dissimilated (DOC_F) values, resulted in a significant increase in methane emissions within the Waste Sector.

8.1.2.5 Data Sources

In the frame of SNC of the RM under the UNFCCC, multiple statistical sources on waste management records were examined, such as, Statistical Forms: F-1 'Toxic Waste' and F-2 'Waste' and Statistical Form 'Special Road Transport', while since 2003, also the Statistical Form Nr.2–gc 'Urban Settlements Sanitation' reflecting the amounts of municipal solid waste transported to landfills. The performed analyzes

Table 8-11: Fractions of Gases in the Landfill Gas Composition from Different SWDS in the RM and Countries Abroad

Gases	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, %	Average landfill gas composition in the RM, %
CH_4	40-60	33-88	60-70[1]/ 63-65[2]	75-85	23-43	53-66
CO_2	40-60	35-89	15-18[1]/ 32-34[2]	14-19	20-22	16-20
N_2	2.4-5.0	87	7-19	11-38	38-69	18-42
O_2	0.16	20.9	1-8[1]/ 0,5-1[2]	0.5-16	0.5-19	0.7-14

Note: [1] – results obtained by national experts; [2] – results obtained by DEPA (Danish Environment Protection Agency) experts.

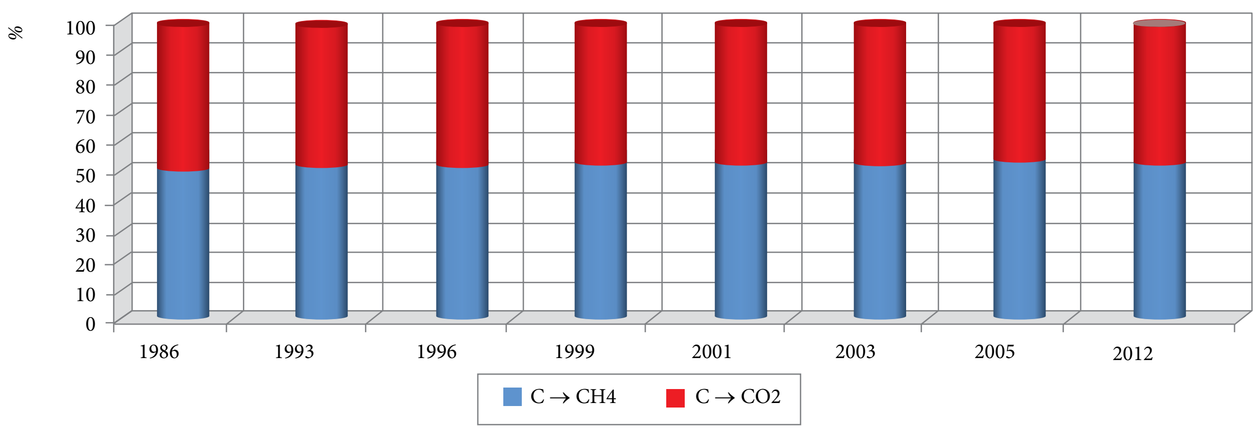


Figure 8-4: Biogas Composition in Landfill Gas Calculated Based on Extended Buswell Equation

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 are disposed as well to the dumps, however, due to the fact that these types of waste are transported to the landfills through beneficiary transport units and are not included in the Statistical Form Nr.2–gc 'Urban Settlements Sanitation'. In these conditions, data on the amount of waste from food processing industry, from animal breeding and phytotechnical waste disposed were collected through the Statistical Form F-2 'Waste'.

Under the current inventory cycle, the same approach regarding data sources was adopted, collecting data on solid waste disposed through the Statistical Form Nr.2–gc 'Urban Settlements Sanitation', approved by the Order of the Department of Statistics and Sociology, No. 83, from 01.08.2003.

AD of the ATULBD on waste generation and disposal to the SWDS were provided by the "The State Programme on Management the Household and Industrial Waste in the ATULBD"[87]. In this sector the situation is similar with the rest of the country; household and industrial waste being disposed to the SWDS. According to the Programme, each year about 450 thousand m3 of solid waste (135 thousand tons, using the factor 0.3t/m3) are disposed to 8 authorized landfills and about 90 unauthorized landfills. In fact, all active landfills were built between 1960 and 1990, do not comply with sanitary and environment protection requirements and should be considered unauthorized. In order to estimate GHG emissions, were used factors specific to unauthorized landfills. Unlike the SNC of the RM, when it was considered that on the left bank of Dniester river, the amount of SWD is constant (135kt/year), under the current inventory cycle, it was also considered the population trends in the respective region.

As for the industrial waste, statistical data reveal that the waste generation process is unstable in time and the uncertainty is quite high. At the same time, following the GPG recommendations (IPCC, 2000), AD must be consistent over time. Therefore, in order to estimate the amount of industrial waste for the right bank of Dniester river, after consulting the field experts, it was decided to use a share of 50 per cent of the biodegradable organic waste disposed to landfills between 1990 and 1999, a share of 60 per cent for the 2000-2008 time series, and a 50 per cent share for 2009-2010, based on the fact that the economic crisis strongly affected in 2009 the industrial sector of the RM, reducing the amount of industrial waste generated.

Table 8-12 provides AD on industrial waste generation, obtained by extrapolation from data regarding solid waste disposed on land (for the RBD).

[87] The State Programme on Management the Household And Industrial Waste in the ATULBD, Annex to the Law Nr. 698-3 from December 13, 2005 // Collection of Normative Acts of the ATULBD – 2006.- Nr. 51. – Page 2127

Table 8-12: Activity Data on the Amount of Solid Waste Disposed on Land in the RM, 1985-2010, thousand tonnes

Year	Managed SWDL	Unmanaged SW Sites	Industrial Waste	Total SWDL
1985	778.0	385.3	581.7	1745.0
1986	807.8	400.1	603.9	1811.8
1987	837.6	414.8	626.2	1878.7
1988	854.2	429.6	641.9	1925.7
1989	897.2	444.4	670.8	2012.3
1990	909.3	450.4	679.9	2039.6
1991	926.9	451.0	688.9	2066.8
1992	1085.8	351.8	718.8	2156.3
1993	279.8	416.9	565.8	1262.5
1994	256.5	392.1	546.2	1194.9
1995	216.2	350.5	526.7	1093.3
1996	237.1	370.1	531.9	1139.2
1997	193.2	324.8	513.2	1031.1
1998	196.2	326.5	513.2	1035.9
1999	337.6	301.4	507.0	1146.0
2000	293.7	291.3	526.7	1111.7
2001	285.2	289.6	521.7	1096.6
2002	296.4	305.3	527.6	1129.4
2003	300.8	299.1	527.9	1127.9
2004	309.2	297.2	541.5	1147.9
2005	408.4	315.6	613.0	1336.9
2006	435.6	334.7	641.7	1412.0
2007	476.8	365.3	685.6	1527.7
2008	584.0	375.7	672.7	1632.5
2009	590.0	411.0	605.1	1606.1
2010	597.6	440.4	620.2	1658.3

Note: The conversion factor used to generate the data included in the table above was 0.4 t MSW per 1 m^3 MSW

The central environmental authority of the RM does not have information on industrial waste generation in ATULBD. AD on waste generation and disposal to the SWDL in the region were provided by the "*The State Programme on Management the Household and Industrial Waste in the ATULBD*", which states that each year, about 252 thousand tons of industrial waste is disposed to the SWD on landfills. In this context, data provided by Table 8-12 refer to managed SWDL (for Chisinau municipality), unmanaged SWDS (for urban area on the right as well as on the left bank of Dniester River, where sanitation services are available and they report information on their activities to regional and central statistical authorities), as well as to the industrial waste disposed (for the entire territory).

8.2.3 Uncertainties Assessment and Time-Series Consistency

For countries with efficient statistical systems the GPG (IPCC, 2000) recommends using values implying circa ±5-10 per cent of uncertainties associated with AD. For countries with poor quality data, the uncertainties are more than a factor of two. In the Republic of Moldova it was deemed rational to use the value of ±15 per cent uncertainties related to 'Managed Waste Disposal on Land', respectively ±30 per cent for uncertainties related to 'Unmanaged Waste Disposal Sites'. To be noted that some types of waste (ex., waste from food processing industry, accounting for approximately 8-10 per cent of the total amount of solid waste generated in the country), were not taken into account while estimating the methane emissions from the 6A1 'Solid Waste Disposal on Land' source category.

Another important issue, is associated with the fact that according to the data gathered through the Statistical Form F-2 'Waste', a bigger amount of solid waste are disposed to land, than if consider the data gathered through the Statistical Form Nr. 2 – gc 'Urban Settlements Sanitation'. It should be also mentioned, that uncertainties associated with activity data on generation industrial waste are much higher (±50 per cent) than the uncertainties associated with the activity data on MSW. Taking into account the results of the studies undertaken in the RM to identify the waste morphologic composition, respectively the country specific values for Degradable Organic Carbon (DOC), Fraction of Degradable Organic Carbon Dissimilated (DOC_f), Fraction of Methane in Landfill Gas (F), it was deemed opportune to use the value of ±20 per cent for uncertainties related to emission factors. Therefore, combined uncertainties related to CH_4 emissions from 6A1 'Managed Solid Waste Disposal on Land' source category can be considered moderate (±25.00 per cent), uncertainties related to the CH_4 emissions from 6A2 'Unmanaged Waste Disposal Sites' can be considered medium (±36.06 per cent), while the respective uncertainties related to the CH_4 emissions from 6A3 'Other' (Industrial Waste) are considered high (±53.85 per cent). At the same time, combined uncertainties presented as a per cent of total direct sectoral emissions were estimated at ±9.66 per cent for 6A1 'Managed Solid Waste Disposal on Land' source category, ±6.66 per cent for 6A2 'Unmanaged Waste Disposal Sites', and ±16.60 per cent for the 6A3 'Other' (Industrial Waste) source category. Uncertainties introduced in trend in sectoral emissions were estimated at ±8.56 per cent for 6A1 'Managed Solid Waste Disposal on Land' source category, ±8.15 for the 6A2 'Unmanaged Waste Disposal Sites' source category, and ±21.17 per cent for the 6A3 'Other' (Industrial Waste) source category.

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 (IPCC, 2000).

8.2.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for the category 6A1 'Solid Waste Disposal on Land' following a Tier 1 approach (IPCC, 2000). Verification was focused on various aspects such as: on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and GPG (IPCC, 2000); use of country specific factors; correct use of AD obtained from different sources of reference, including the Statistical Yearbooks of the RM and other relevant sources; comparing the results obtained by using different estimating methodologies (Tier 1 and Tier 2), and explaining the identified discrepancies, etc.

The AD and methods used for estimating CH_4 emissions under the category 6A 'Solid Waste Disposal on Land' were documented and archived both in hard copies and electronically.

8.2.5 Recalculations

The CH_4 emissions from the category 6A1 "Solid Waste Disposal on Land' were recalculated for the 1990 through 2005 time series, in particular due to use of updated set of activity data, including for ATULBD. Aiming at optimizing the process of estimating methane emissions from the 6A1 'Solid Waste Disposal on Land' source category, a Swiss 'INFRAS' Estimation Tool was used, being provided to national experts under the UNDP-GEF RER/01/G31 Regional Project "Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region)".

The parallel use of Default (Tier 1) and FOD (Tier 2) methods resulted in significant discrepancies of obtained results. To be noted that as the methane estimates calculated through the use of the First Order Decay (FOD) method produces a time-dependent emission profile that better reflects the true pattern of the degradation process over time, within the current national greenhouse gas inventory of the Republic of Moldova there were included CH_4 emissions from the 6A1 'Solid Waste Disposal on Land' category calculate through the use of respective methodology. The obtained results allow assert that within the 1990-2010 time series CH_4 emissions from 6A1 'Solid Waste Disposal on Land' category, estimated using the Tier 1 approach, decreased by circa 28.1 per cent, from 117.60 Gg in 1990, to 84.52 Gg in 2005 (Table 8-13).

To be noted that some years were marked by large inter-annual fluctuations in CH_4 emissions: - 42.2 per cent in 1993, -16.1 per cent in 1996, -25.5 per cent in 1999, +16.1 per cent in 2003, and +34.8 per cent in 2005. The significant reduction of CH_4 emissions registered in 1993 is explained both, by smaller amounts of solid waste disposed on land within the country, as well as by the impact of not taking into consideration in full extent the statistical data for administrative territorial units on the left bank of the Dniester River (activity data have been extrapolated, however the related uncertainties to the official statistical data for this region are rather high). Further fluctuations are explained by the fact that the recycled fractions in waste stream for paper has dropped significantly within the period under review (for example, the fraction of paper in the waste stream constituted 25 per cent in 1993, 15 per cent in 1996, 4.8 per cent in 1999, 6.2 per cent in 2003, 7.0 per cent in 2005 and 5.3 per cent in 2012).

In the time period from 1990 through 2010, CH_4 emissions from the respective source category, estimated by using the FOD method increased by 5.1 per cent: from 62.86 Gg in

Table 8-13: CH_4 Emissions from the 6A 'Solid Waste Disposal on Land' Source Category Calculated by Using the Default Method (Tier 1) within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
Managed SWDL	32.2524	32.2925	31.4862	29.0624	27.7486	27.8522	22.4925
Unmanaged SW Sites	48.8362	49.7814	53.4785	14.0334	12.8620	10.8400	9.9147
Industrial Waste	36.5122	37.0009	38.6014	28.3737	27.3933	26.4130	22.2423
Total SWDL	117.6007	119.0748	123.5661	71.4696	68.0039	65.1051	54.6495
Compared to 1990, %	100	1.3	5.1	-39.2	-42.2	-44.6	-53.5
Inter-annual fluctuations, %	100	1.3	3.8	-42.2	-4.8	-4.3	-16.1
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Managed SWDL	22.9385	22.7406	16.3643	15.3935	13.5547	14.5355	17.3347
Unmanaged SW Sites	8.0766	15.0758	12.2232	11.8981	10.3964	10.3000	11.3276
Industrial Waste	21.4562	21.4604	15.5455	16.5639	15.1969	15.5235	18.2029
Total SWDL	52.4713	59.2768	44.1330	43.8556	39.1480	40.3590	46.8652
Compared to 1990, %	-55.4	-49.6	-62.5	-62.7	-66.7	-65.7	-60.1
Inter-annual fluctuations, %	-4.0	13.0	-25.5	-0.6	-10.7	3.1	16.1
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Managed SWDL	17.8188	27.9052	29.7637	32.5788	39.9036	40.3135	40.8328
Unmanaged SW Sites	9.9650	11.9197	12.4530	14.2694	15.3981	16.2807	18.2587
Industrial Waste	18.6717	22.8123	26.3060	28.1078	27.5802	24.8055	25.4279
Total SWDL	46.4556	62.6371	68.5227	74.9560	82.8818	81.3998	84.5194
Compared to 1990, %	-60.5	-46.7	-41.7	-36.3	-29.5	-30.8	-28.1
Inter-annual fluctuations, %	-0.9	34.8	9.4	9.4	10.6	-1.8	3.8

1990 to 66.10 Gg in 2010 (Table 8-14). In the time period from 1990 through 1993, as well as from 2005 through 2010, a clear increasing trend was recorded, while the decreasing trend can be explained by the severe economic decline during the transition to a market economy. To be noted that in comparison with results obtained by using the default method (Tier 1), the CH_4 emission annual fluctuations are much smaller in the case of using the FOD method (Tier 2). The analysis of obtained results reveal that the use of FOD method induces a slower evolution of emissions, avoiding thus the noted fluctuations in case of using the default method, reflecting thus the respective emissions in a more accurate way.

In comparison with the results reported in the SNC of the RM under the UNFCCC, the changes performed in the process of development the current greenhouse gas inventory resulted in an insignificant decrease of CH_4 emissions originated from the 6A 'Solid Waste Disposal on Land' Source Category between 1990-1991 and 1993-2003, varying from a minimum decrease of 0.1 per cent in 1991, up to a maxi-

Table 8-14: CH_4 Emissions from the 6A 'Solid Waste Disposal on Land' Source Category, Calculated by Using the FOD Method (Tier 2) within 1990-2010 time periods, Gg

	1990	1991	1992	1993	1994	1995	1996
Managed SWDL	17.2832	19.2310	20.8214	22.1357	22.8641	23.5114	24.8211
Unmanaged SWDS	26.0698	29.1469	32.9317	30.8665	28.5300	26.2344	25.7255
Industrial Waste	19.5081	21.7781	23.9614	24.8156	25.1501	25.3140	26.4678
Total SWDL	62.8611	70.1560	77.7145	77.8178	76.5442	75.0597	77.0144
Compared to 1990, %	100	11.5	23.5	23.7	21.7	19.3	22.4
Inter-annual fluctuations, %	100	11.6	10.8	0.1	-1.6	-1.9	2.6
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Managed SWDL	24.5768	24.3385	26.0392	24.6577	22.6938	21.6351	21.3227
Unmanaged SWDS	23.4351	22.3503	23.2956	21.8165	20.0188	18.7575	17.9698
Industrial Waste	25.8175	25.2520	26.7030	25.3873	23.4888	22.4553	22.1652
Total SWDL	73.8295	71.9409	76.0378	71.8615	66.2014	62.8479	61.4577
Compared to 1990, %	17.4	14.4	20.9	14.2	5.2	-0.1	-2.3
Inter-annual fluctuations, %	-4.1	-2.6	5.7	-5.5	-7.9	-5.1	-2.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Managed SWDL	20.8680	20.7374	21.9010	23.2867	25.3396	27.2828	29.0412
Unmanaged SWDS	17.3171	15.9475	15.3977	15.2513	13.9449	15.4401	13.8827
Industrial Waste	21.7186	21.0736	21.7456	22.5713	23.0341	23.0696	23.1741
Total SWDL	59.9037	57.7585	59.0444	61.1093	62.3186	65.7925	66.0980
Compared to 1990, %	-4.8	-8.2	-6.1	-2.9	-0.9	4.6	5.1
Inter-annual fluctuations, %	-2.5	-3.6	2.2	3.5	2.0	5.6	0.5

mum of 3.8 per cent in 1997, respectively in an insignificant increase in 1992 and between 2004-2005, varying from a minimum increase of 0.3 per cent in 2004, up to a maximum of 2.3 per cent in 2005 (Table 8-15).

Figure 8-5 provides the graphical illustration of results recorded within the SNC of the RM under the UNFCCC, compared to the estimations included into the TNC of the RM under the UNFCCC, using the Tier 1 and Tier 2 methods.

8.2.6 Planned Improvements

From sustainable development perspectives and 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 accounting of the generated waste, focused on the main criterion of relevance and comparability among the member states. At the same time, European environmental legislation is a benchmark for other numerous countries in developing national legislation on environment, thus representing an efficient model of interstate collaboration. Taking into account the international practice in municipal solid waste management and political declarations on the intended aligning to EU standards, the waste management in the Republic of Moldova has to be essentially restructured. In this context, it is deemed appropriate to transpose the Resolution of the EU Commission 2000/532/EC regarding the waste list, including hazardous waste.

Adoption of the waste list, including hazardous waste, will contribute to improving national statistical records on waste management, to comply with the EU requirements, and will allow fulfilling the commitments under the international environmental treaties, ratified by the RM, and efficient reporting on consistent implementation. In this context it is planned to improve the quality of activity data pertaining to the amount of generated and disposed municipal solid waste and industrial waste.

Strategic actions, including the modernization of legal and regulatory framework for waste management are included in recently developed documents related to strategic politics, such as the *Waste Management Strategy of the Republic of Moldova for 2013-2027 years*[88], which foresees the development of integrated municipal waste management through the harmonization of legal, institutional and regulatory framework to the EU standards, based on a regional approach (geographical position, economic development, the existence of access roads, pedological and hydrogeological conditions, population, etc.). The goal is to promote and implement selective collection in all areas both in household sector and in the production sector, as well as sorting, composting and recycling facilities; and the development of waste disposal capacity by creating 7 new SWD landfills at a regional level and 2 new mechanical-biological treatment plants.

[88] <http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=347341>.

Table 8-15: Comparative Results of CH_4 Emissions from 6A 'Solid Waste Disposal on Land' Category Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	62.9108	70.1993	77.1248	78.1765	77.7414	76.9801	79.5359	76.7563
TNC	62.8611	70.1560	77.7145	77.8178	76.5442	75.0597	77.0144	73.8295
Difference, %	-0.1	-0.1	0.8	-0.5	-1.5	-2.5	-3.2	-3.8
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	74.3283	77.9046	73.1627	66.8245	63.1911	61.6285	59.7384	56.4860
TNC	71.9409	76.0378	71.8615	66.2014	62.8479	61.4577	59.9037	57.7585
Difference, %	-3.2	-2.4	-1.8	-0.9	-0.5	-0.3	0.3	2.3

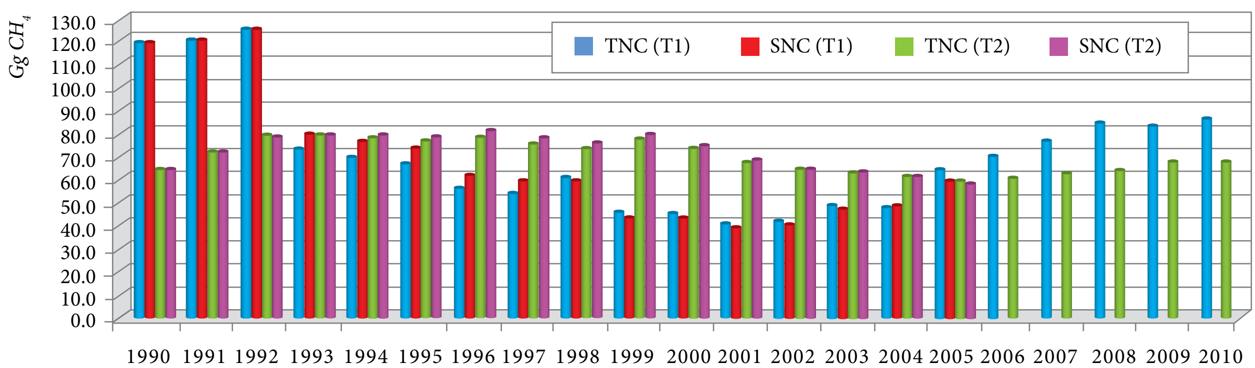


Figure 8-5: CH_4 Emissions from the 6A 'SWDL' Source Category, included into the SNC and TNC of the RM to the UNFCCC, Estimated Using the Tier 1 and Tier 2 Methodologies

8.3 Wastewater Handling (Category 6B)

A big influence on the quality of natural waters have untreated or insufficiently treated wastewater from sewage plants directly into the natural receivers. The largest volumes of untreated wastewater come from the domestic sewage systems.

In recent decades one can notice a quantitative reduction in wastewater discharges. Thus, the volume of wastewater discharged into surface basins between 1990 and 2010 decreased by approximately 74.7 per cent, from 2731 million m^3 to 691 million m^3 (Table 8-16). However, 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 91.6 per cent, from 89 million m^3 in 1990, to 7.5 million m^3 in 2010, including untreated water by 10.0 per cent, from 1.0 million m^3 in 1990, to 0.9 million m^3. Simultaneously, it can be noticed that the situation regarding the operation of treatment and pre-treatment plants did not improved in this periods, on the contrary, it got worse.

Wastewater treatment plants hold one of the most important places in water resources protection systems. Until the 90's of the last century, in the RM over 580 plants for wastewater biological treatment (BTP) were built, but by 2001, only 330 were operational, the rest being demolished[89].

In 2002, 106 BTP[90] operated, while in 2003 only 104 treatment plants existed (they used only a third of capacity, about 198 thousand m^3/day being treated, at a total capacity of circa 614 thousand m^3/day)[91].

In 2004, only 252 BTP existed, most of them presented a high attrition rate regarding the buildings. In reality, only 93 plants functioned, of which 89 were bellow normative requirements (mechanical treatment, biological partial treatment, with wastewater storage and/or discharge) [92].

By 2005, 84 BTP functioned, of which 79 were bellow normative requirements: 59 performed insufficient wastewater treatment, another 17 performed wastewater storage without discharging, while another 3 received wastewater and discharged them without treatment[93].

[89] State of the Environment in the Republic of Moldova in 2002: (National Report): [addressed to users working or studying in the field] – Ch.: Mediul Ambiant, 2003, - 116 p. (see page 55).

[90] State of the Environment in the Republic of Moldova in 2003: (National Report): [addressed to users working or studying in the field] – Ch.: National Institute of Ecology, 2004, - 130 p. (see page 49).

[91] State of the Environment in the Republic of Moldova in 2004: (National Report): [addressed to users working or studying in the field] – Ch.: National Institute of Ecology, 2005, - 123 p. (see page 54-55).

[92] State of the Environment in the Republic of Moldova in 2005: (National Report) – Ch.: Institute of Ecology and Geography, 2006, - 116 p. (see page 54).

[93] State of the Environment in the Republic of Moldova in 2006: (National Report) – Ch.: S.n., 2007, - 103 pages (see page 50).

Table 8-16: Wastewater Discharged into Surface Basins, million m^3

	1990	1991	1992	1993	1994	1995	1996
Discharged wastewater – total	2731	2486	2231	1993	1810	1381	1384
Conventional pure water (untreated)	2424	2173	1935	1717	1547	1120	1133
Polluted wastewater	90	69	41	21	16	15	12
untreated	1.0	1.0	0.0	0.0	0.4	0.4	0.5
insufficiently treated	89	68	41	21	15	14.6	11.5
Treated water according to normative requirements	216	244	255	255	247	245	238
Treated water according to normative, in % compared to the total volume of wastewater needing treatment	70	78	86	92	94	94	95
	1997	1998	1999	2000	2001	2002	2003
Discharged wastewater – total	1239	1030	794	740	708	696	685
Conventional pure water (untreated)	1007	802	593	569	557	560	558
Polluted water	11	12	10	9	13	19	48
untreated	0.3	0.4	0.4	0.5	0.3	0.5	0.8
insufficiently treated	10.7	11.6	9.6	8.2	12.6	18.9	47.5
Treated water according to normative requirements	222	215	191	162	138	116	79
Treated water according to normative, in % compared to the total volume of wastewater needing treatment	95	94	95	95	91	86	62
	2004	2005	2006	2007	2008	2009	2010
Discharged wastewater – total	688	690	695	687	686	685	691
Conventional pure water (untreated)	561	556	562	551	550	552	556
Polluted wastewater	42	9	7	10	14	10	8
untreated	0.5	0.6	0.5	0.7	0.8	0.8	0.9
insufficiently treated	41.4	8.3	6.7	9.2	13.3	9.5	7.5
Treated water according to normative requirements	85	124	119	119	115	116	119
Treated water according to normative, in % compared to the total volume of wastewater needing treatment	67	93	89	88	85	87	88

Source: NBS, Statistical Yearbooks of the RM for 1994 (page 41), 1999 (page 23), 2006 (page 27) and 2011 (page 24).

To be noted that between 1998 and 2005 the share of population connected to the sewage system in the total water supply system has not exceeded 39 per cent[94].

In 2006, 131 BTP existed, but functioned only 78 and just one was according to normative requirements; another 53 BTP were closed[95]. The closed plants presented a high rate of attrition and the restoration required major capital investments.

In 2007, 99 treatment plants functioned, of which only one according to normative requirements, the other 98 performed insufficient wastewater treatment[96]. Of the 103

[94] State of the Environment in the Republic of Moldova: 2007-2010. (National Report) – Ch.: S.n., („Nova-Imprim" SRL). – 2011. – 192 pages (see page 92).

[95] Environment Protection in the Republic of Moldova: (National Report for the Ministerial Conference in Belgrade, Serbia) – Chisinau, 2008, - 64 pages (see page 32).

[96] SEI Yearbook „Quality of the Environment and the State Ecological Inspectorate Activity – 2007" – Chisinau, 2008 – 202 pages (see page 8).

plants that were not operational, 44 only received and storage wastewater without discharging into natural receivers and this fact contributed to soil pollution and groundwater contamination, infiltrating through the walls and the bottom of the storage units, biological ponds and filtration fields), 21 were receiving wastewater and discharged them into natural receivers without treatment, while 27 were not operational since the respective enterprises did not functioned or due to lack of wastewater.

In 2008, 154 wastewater treatment plants functioned, most of them performed only insufficient treatment and only 28 plants performed wastewater treatment according to normative requirements[97]. Approximately 106 wastewater treatment plants were destroyed and another 116 plants required capital reconstruction including the technological modernization of treatment stages.

In 2009,172 water pipelines were provided with sewage systems, of which functioned 110 systems and 128 sewage systems were provided with wastewater treatment plants[98].

In 2010, 79 wastewater treatment plants had project documentation, 17 units operated according to normative requirements, 112 units performed insufficient treatment while 69 did not functioned[99].

The sewage systems have a high rate of attrition, physical degradation and are morally obsolete, since it operates for more than 25-30 years without reconstruction, requiring thus, a technological modernization of treatment stages.

The disastrous situation within this sector is determined primarily by divesting the wastewater plants to local public authorities, which lack the infrastructure, the professional staff with expertise and the financial resources needed to ensure proper operation; as well as by the essential decrease of wastewater volumes. Insufficient volume of wastewater and the excessive concentration of noxious substances received disturb the optimal functioning of the wastewater treatment plants.

In the last years, a clear trend of increasing the number of operational wastewater treatment plants was recorded. Recently, 18 wastewater treatment plants were opened in the following districts: Glodeni, Soldanesti, Riscani, Donduseni, Ocnita, Calarasi, Causeni, Orhei, Straseni, Drochia, Dubasari.

Construction works have started on new wastewater treatment plants: in Orhei municipality – CWWT type (Constructed Wetlands for Wastewater Treatment), in Ermoclia and Cioburciu villages, Stefan Voda district; Parata and Holercani villages, Dubasari district; Nihoreni village, Rascani district; Frunze town, Ocnita district; Vadul lui Isac village, Cahul district; Mandac and Pelenia villages, Drochia district; Magdacesti village, Criuleni district; Zaim, Baimaclia and Hagimus villages, Causeni district.

Wastewater treatment plants were reconstructed in: Bolotina, Cuhnesti and Fundurii Vechi villages, Glodeni district; Recea and Lozova villages, Straseni district, as well as in towns like Nisporeni and Ungheni. New wastewater treatment plants were opened recently in Cosnita village, Dubasari district and in Hirova village, Calarasi district. Also, some plants are at a project stage: in Briceni town; Tvardita village, Taraclia district; Marianca de Jos village, Stefan Voda district, in towns like Rezina and Cimislia, as well as in Budesti and Cruzesti villages, Chisinau municipality. Construction and renovation works were performed at several sewage systems: in districts Causeni, Criuleni, Donduseni, Ungheni, Straseni, Sangerei, Drochia, Rascani, Taraclia and municipality of Chisinau.

Currently, a strong reason for concern represents the ecological situation created by untreated wastewater discharged from Cantemir town into Prut river, from Cimislia town into Cogalnic river, from Rezina town into Dniester river, from Straseni town into Bic river, from Tvardita village, Taraclia district into Chirghij-Chitai river, as well as from Soroca town into Dniester river (since 2002, the wastewater treatment plant in Soroca is inoperable due to the deterioration of Soroca-Tekinovca (Ukraine) pressure manifold, therefore, the Soroca wastewater, accounting for circa 1000 m^3/day, are discharged to the main pumping plant through the sewage system and without treatment is subsequently discharged into the Dniester river.

An important issue in the wastewater treatment process greatly influencing the environment is the lack of modern sludge processing facilities within the wastewater plants. In order to overcome the existing situation, in 2009, the wastewater treatment plant in Chisinau implemented the pilot-project for raw sludge dewatering using the 'Geotube' method, the general goal being to process the sludge and to eliminate odor. The sludge dewatering project implied reconstructing 8 sludge platforms. This project implying the use of 'Geotube' bags has reduced the number of sludge platforms, as well as the odor emitted during the process of sludge fermentation. 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 storage the sludge from the 'Geotube' bags after the dewatering process.

8.3.1 Source Category Description

The source category 6B 'Wastewater Handling', deals with CH_4 emission from 6B1 'Industrial Wastewater' and 6B2 'Domestic Wastewater' categories under anaerobic conditions, as well as N_2O emissions from 'Human Sewage'.

6B1 'Industrial Wastewater'

In the RM the industrial wastewater are released into municipal sewer lines where it combines with domestic waste-

[97] State Ecological Inspectorate (2009), SEI Yearbook – 2008 "Environment protection in the Republic of Moldova" / Iurie Stamatin, Alexandru Apostol, Mihai Mustea [et al.]. – Ch. : "A.V.i.T. Publ" SRL, 2009 („Continental-Grup" SRL). – 288 pages (see pages 85-86).
[98] State Ecological Inspectorate (2011), SEI Yearbook - 2010 „Environment protection in the Republic of Moldova" / editorial board: Grigore Prisacaru, Valentina Tapis, Vadim Stingaci [et al.]. – Ch.: S.n., 2011 („Sirius" SRL) – 232 pages (see page 39).
[99] State Ecological Inspectorate (2012), SEI Yearbook – 2011 „Environment protection in the Republic of Moldova" / editorial board: Gr. Prisacaru, V. Tapis, V. Stangaci [et al.]. – Ch. : Continental Grup, 2012. – 248 pages (see pages 55-56).

water, the CH_4 emission generated being covered there. Under the 'Industry' Sector, the 'Food Processing Industry' generates most industrial wastewater with high content of biodegradable organic matter. In the RM, wastewater (a mix of industrial and domestic wastewater) is treated by classical aerobic method (mechanic and biological), however due to incorrect operation of the existent treatment facilities, a portion of wastewater (around 20 per cent of the total) is treated anaerobically. Within this sector, another relevant source of CH_4 emissions is the sludge removed from wastewater which is treated aerobically and anaerobically, and applied to land.

6B2 'Domestic Wastewater'

Domestic wastewater is the product of using water for domestic purposes. The process of treating domestic wastewaters and sludge[100] from treatment facilities implies CH_4 generation. The amount of CH_4 generated under this source category depends on domestic wastewater management practices used in the RM, as well as the degree to which population is covered by services of centralized sewer systems and wastewater treatment scope.

In the time period from 1990 to 1998, domestic wastewater treatment systems were managed by state enterprise „Apa-Canal". Later, these systems were divested to local public authorities, which were not ready to take over management of these systems, as they lacked the infrastructure and the financial resources needed to ensure proper operation. Under such circumstances the treatment facilities fell into disrepair and most of them are out of operation. Currently, domestic wastewater is treated in most urban settlements of the RM, but only partially. It should be mentioned that in most rural settlements sewage systems are also deteriorated.

In urban areas, where wastewater treatment facilities are operational, sludge is treated by placing it on sludge platforms. Starting from the point that project capacities of all existent treatment facilities, as a rule are bigger (by 2 to 10 times, and in some places even more) than the amount of actually generated wastewaters, all such facilities have spare space for sludge depositing. Only in big cities, such as Chisinau, Balti and Cahul, due to lack of sludge treatment technologies, sludge is deposited in layers thicker than 50 cm, what generates anaerobic processes and induces methane emissions. However, in comparison with the total area of deposited sludge, the areas with deposited sludge are insignificant and are not taken into account for emissions calculation.

[100] As mentioned above, domestic wastewater treatment is carried out jointly with industrial wastewater.

Under these circumstances, it was not deemed necessary to estimate methane emissions resulting from sludge treatment, in particular keeping in mind that the deposited sludge undergoes fermentation in aerobic conditions.

According to inventory results of existent wastewater treatment facilities it has been stated that due to small amounts of generated wastewater needed for adequate operation of domestic wastewater treatment facilities, "Apa-Canal" J.S.C. allowed to release wastewater produced by a number of industrial enterprises into the municipal sewage system, what entailed decreased amounts of industrial wastewaters being treated on-site.

In the frame of 6B "Wastewater Handling' category, the sludge resulting from human sewage treatment is a relevant source of N_2O emissions, being calculated based on activity data on the number of population and protein consumption per capita.

Between 1990 and 2010, the direct GHG emissions from 6B 'Wastewater Handling', have decreased by 38.1 per cent: from 307.30 Gg CO_2 eq. in 1990 to 190.25 Gg CO_2 eq. in 2010 (Figure 8-6). The share of CH_4 emissions decreased from 70.2 per cent in 1990, to 56.7 per cent in 2010, while the share of N_2O emissions increased from 29.8 per cent in 1990, up to 43.3 per cent in 2010.

8.3.2 Methodological Issues, Emission Factors and Data Sources

6B1 'Industrial Wastewater'

Methane emissions from the 6B1 'Industrial Wastewater' source category were estimated by following recommendations set forth in the Revised 1996 Guidelines (IPCC, 1997) and GPG (IPCC, 2000), based on a IPCC default method (Tier 1).

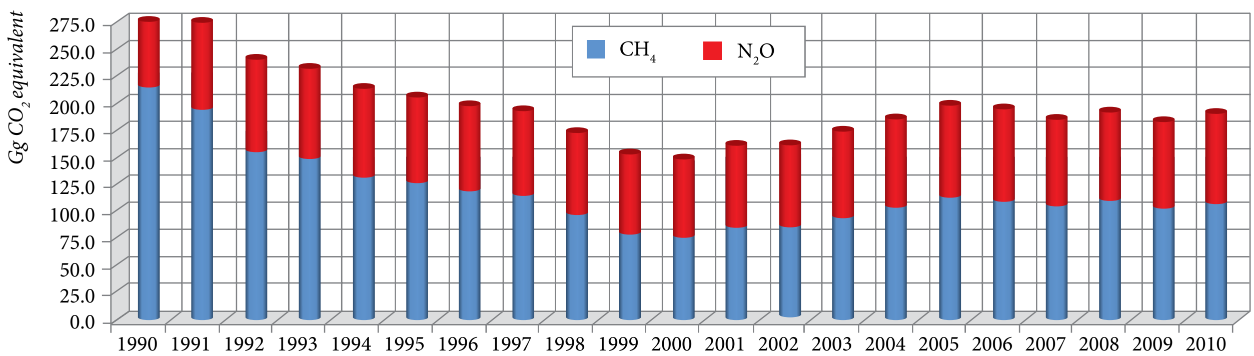


Figure 8-6: Direct GHG Emissions from 6B 'Wastewater Handling' Source Category in the Republic of Moldova within 1990-2010 time periods

The respective approach implies substitution of the organic load value from industry sector, by the equivalent number of population connected to centralized sewage systems. For this purpose, there were used activity data on industrial wastewater generation (by industry branches) and their discharging into the sewage systems.

Each industry branch was assigned a certain value for organic load in chemical oxygen demand (COD), expressed in kg COD_5/m^3 of industrial wastewater, amount of wastewater produced per industrial production output unit in m^3/t of product (Table 8-17), as well as the amount of annual output for each industry type (Table 8-18).

Table 8-17: Emission Factors Used to Estimate Methane Emissions from the 6B1 'Industrial Wastewater' Source Category

Industry Production by Type	COD value, kg COD_5/ m^3 wastewater	Wastewater Produced, m^3/t of product
Canned meat	2.0	20.5
Canned vegetables	1.7	15.0
Canned tomato	1.7	15.0
Canned fruit	1.7	15.0
Beer	1.5	7.6
Wine	13.0	4.0
Sparkling wine	13.0	4.0
Cognac	17.0	16.4
Brandy	11.0	24.0
Meat	2.0	20.5
Sausages	2.0	20.5
Butter	1.2	2.6
Cheese	3.0	4.3
Milk products	2.7	7.0
Sugar	5.0	3.4
Fish	2.5	8.0
Vegetable oil and fats	1.5	1.6
Soft drinks	1.0	3.8
Corrugated cardboard	4.0	23.8
Plastics and resins	3.7	0.6
Paint and varnishes	10.0	10.0
Detergents	1.2	5.0
Soap	1.2	5.0
Leather	7.0	4.2
Textiles	1.0	42.6

Source: Mircea Gh. Negulescu et al., 1968 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), 1982 Consolidated Norms in Water Supply and Water Disposal for Different Industries, Moscow, 1982; Sewage System for Populated Areas and Industrial Plants. Handbook. 'Stroyizdat' Moscow, 1981. Revised 1996 Guidelines (IPCC, 1997); GPG (IPCC, 2000).

Table 8-18: Activity Data on Industrial Output Used to Estimate CH_4 Emissions from the 6B1 'Industrial Wastewater' Source Category, kt

	1990	1991	1992	1993	1994	1995	1996
Canned meat	15.000	9.600	5.227	3.076	1.659	1.700	1.500
Canned vegetables and fruit	499.300	462.400	394.650	403.400	244.250	176.700	126.200
Fruit and vegetable juices	273.600	260.000	89.100	104.600	50.800	44.800	49.400
Canned vegetables	149.600	143.000	74.300	72.000	62.400	41.100	20.500
Processed and canned fruit	81.458	62.660	48.200	53.900	17.600	10.600	17.600
Beer	76.000	66.000	43.000	36.000	28.500	30.290	25.600
Grapes wine	163.000	143.000	92.000	103.000	97.780	99.690	145.800
Sparkling wine	8.040	7.830	8.540	8.880	7.420	9.480	14.190
Cognac	13.940	14.020	7.500	7.400	7.930	10.270	4.570
Brandy and liqueurs	5.590	5.560	6.760	13.940	26.470	41.270	33.580
Meat	257.900	218.500	136.000	114.200	85.900	58.400	52.600
Sausages	50.000	52.900	27.300	14.700	9.000	8.900	8.000
Butter	27.000	21.833	18.803	11.052	9.660	6.800	4.700
Margarine	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
Curd, curd cream, yogurt, kefir, sour cream	138.000	115.400	70.100	65.100	48.800	21.700	11.900
Ice cream	11.520	9.600	6.400	2.900	2.500	2.400	3.000
Milk and whipped cream with a fat content <6 %	454.800	382.600	180.500	175.100	86.700	39.500	36.100
Milk and whipped cream in solid form	15.500	12.000	9.200	4.300	4.700	4.400	3.100
Crude oil, not chemically modified	125.600	117.900	57.300	60.300	50.400	50.700	39.400
Granulated sugar	435.800	236.900	208.000	230.200	166.700	218.700	264.500
Fish and fish products	9.500	5.200	6.500	9.500	2.100	1.400	1.100
Mineral and aerated water	51.924	34.616	19.774	13.749	11.382	10.003	10.120
Other non-alcoholic drinks	131.330	86.220	32.407	18.703	17.081	20.490	15.080
Paper and corrugated cardboard	5.340	4.650	1.110	1.020	0.240	0.420	0.510
Synthetic resins	17.500	14.600	5.839	4.792	1.510	1.104	0.040
Paint and Varnishes	11.700	8.800	6.000	3.100	1.200	0.800	0.700
Soap	11.700	8.000	4.800	2.700	0.700	0.600	0.500
Washing and cleaning products	15.000	10.100	9.900	4.900	1.200	1.400	1.600
Rough leather goods	0.439	0.404	0.106	0.064	0.027	0.047	0.054
Leather boxing clothes	1.174	1.173	0.897	0.611	0.182	0.143	0.177
Cotton yarn	31.600	32.600	16.668	8.561	4.252	2.655	6.524
Fabrics	33.540	16.770	11.372	7.575	5.048	3.761	7.681

	1997	1998	1999	2000	2001	2002	2003
Canned meat	3.100	2.340	1.860	2.740	2.020	2.100	3.100
Canned vegetables and fruit	200.100	135.400	98.600	93.850	113.850	80.850	111.200
Fruit and vegetable juices	88.300	67.400	32.100	46.700	59.700	31.300	56.900
Canned vegetables	26.600	27.200	36.700	19.400	20.300	22.700	25.500
Processed and canned fruit	18.200	6.600	5.200	6.100	6.300	5.200	16.100
Beer	26.270	30.010	21.910	25.920	33.620	46.240	59.910
Grapes wine	194.150	123.960	69.250	108.900	156.420	149.400	193.180
Sparkling wine	13.450	5.190	6.750	4.160	5.840	6.130	7.390
Cognac	5.860	4.970	4.860	7.177	9.556	10.381	13.611
Brandy and liqueurs	23.700	17.410	8.700	4.890	6.470	7.790	19.660
Meat	50.800	27.300	25.700	13.400	7.400	11.300	14.900
Sausages	9.600	8.000	9.400	10.200	11.700	13.800	14.900
Butter	3.000	2.900	2.400	2.800	3.400	2.700	2.900
Margarine	0.000	0.000	0.000	0.020	1.000	2.600	3.300
Cheese and cottage cheese	1.200	1.300	1.300	1.200	1.441	1.943	1.859
Curd, curd cream, yogurt, kefir, sour cream	20.500	26.800	20.700	17.100	21.900	16.800	22.300
Ice cream	3.300	4.400	4.300	4.400	5.200	6.300	8.100
Milk and whipped cream with a fat content <6 %	26.600	32.400	26.000	26.800	35.200	43.100	16.900
Milk and whipped cream in solid form	2.600	2.400	2.000	3.100	5.000	4.200	3.700
Crude oil, not chemically modified	35.200	28.700	24.300	31.300	43.500	53.600	76.800
Granulated sugar	213.300	194.500	100.500	105.400	132.600	167.600	107.100
Fish and fish products	0.900	0.800	1.000	1.900	2.300	2.700	2.700
Mineral and aerated water	9.772	18.578	24.375	31.317	39.449	53.772	62.774
Other non-alcoholic drinks	14.330	15.570	14.910	19.660	31.290	51.010	63.760
Paper and corrugated cardboard	0.720	0.390	0.180	0.180	0.390	0.270	0.180
Synthetic resins	0.000	0.000	0.000	0.000	0.000	0.776	0.708
Paint and Varnishes	0.500	0.400	0.700	2.100	2.900	4.100	3.400
Soap	0.600	0.300	0.200	0.200	0.300	0.200	0.300
Washing and cleaning products	0.300	0.200	0.300	0.400	0.800	0.300	0.200
Rough leather goods	0.053	0.055	0.018	0.013	0.012	0.004	0.002
Leather boxing clothes	0.214	0.095	0.040	0.043	0.060	0.135	0.042
Cotton yarn	5.364	10.552	8.131	13.030	12.400	12.501	13.300
Fabrics	7.297	13.644	11.486	17.064	16.335	16.837	19.292
	2004	2005	2006	2007	2008	2009	2010
Canned meat	2.200	0.680	1.080	1.300	1.460	1.130	1.482
Canned vegetables and fruit	80.400	86.200	99.900	94.950	102.600	60.150	67.150
Fruit and vegetable juices	36.900	30.000	29.700	53.800	38.993	28.119	30.299
Canned vegetables	22.700	33.000	44.400	23.700	41.900	26.400	26.400
Processed and canned fruit	18.600	18.300	17.300	16.500	17.800	3.700	4.200
Beer	69.570	77.780	90.840	101.160	86.640	77.880	94.800
Grapes wine	335.340	364.270	193.790	123.870	155.290	120.170	95.510
Sparkling wine	9.380	10.510	4.020	5.410	5.720	5.000	5.370
Cognac	14.280	17.108	7.910	8.240	10.370	6.980	7.500
Brandy and liqueurs	21.290	23.880	19.630	17.220	13.020	11.080	12.170
Meat	18.518	15.180	10.200	16.100	12.792	15.751	14.686
Sausages	15.600	17.200	18.000	20.700	22.438	16.783	15.195
Butter	3.800	3.600	3.500	3.600	4.659	4.205	4.587
Margarine	3.500	3.400	2.600	2.200	1.900	1.700	0.600
Cheese and cottage cheese	1.937	2.455	2.073	2.041	2.590	1.454	1.749
Curd, curd cream, yogurt, kefir, sour cream	21.000	26.500	28.300	32.400	32.339	32.997	33.244
Ice cream	7.300	8.100	8.600	8.200	7.679	6.971	8.164
Milk and whipped cream with a fat content <6 %	16.000	20.800	50.300	55.300	66.600	61.400	65.000
Milk and whipped cream in solid form	5.100	4.600	3.800	2.700	2.700	1.800	1.200
Crude oil, not chemically modified	96.100	83.400	81.500	85.000	79.319	82.903	64.735
Granulated sugar	110.900	133.500	149.000	74.000	134.000	42.400	90.800
Fish and fish products	2.700	3.000	2.500	2.300	4.600	3.700	1.300
Mineral and aerated water	75.527	97.319	109.597	136.141	130.456	119.608	107.773
Other non-alcoholic drinks	69.410	69.530	80.640	101.170	87.730	67.830	54.590
Paper and corrugated cardboard	0.480	0.600	1.950	2.700	1.140	0.870	1.290
Synthetic resins	0.910	1.048	0.825	1.026	0.961	0.773	1.516
Paint and Varnishes	5.100	6.300	8.300	10.800	11.600	11.300	12.200
Soap	0.400	0.300	0.500	0.600	0.400	0.400	0.400
Washing and cleaning products	0.500	0.500	0.800	1.000	0.500	0.500	0.200
Rough leather goods	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Leather boxing clothes	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cotton yarn	16.200	18.000	18.100	20.500	19.896	14.334	15.906
Fabrics	20.625	23.823	23.661	26.440	26.787	18.129	21.766

Source: NBS of the RM, Official Letter No. 06-39/08 dated 23.02.2011 (AD for 1992-2010 time series). Statistical Yearbooks of the ATULBD for 1998 (pages 176-184), 2000 (pages 99-100), 2002 (pages 103-104), 2006 (pages 93-94), 2009 (pages 92-93), 2010 (pages 93-95), 2011 (pages 94-96), 2012 (pages. 98-100).

The amount of total organic wastewater (TOW_{ind}) calculation was estimated using the following equations:

$$TOW_{ind\ (wastewater)} = O \bullet W_{ind} \bullet D_{ind} \bullet (1-DS) \text{ and } TOS_{ind\ (sludge)} = O \bullet W_{ind} \bullet D_{ind} \bullet DS$$

Where:

TOW_{ind} – total industrial organic wastewater, kg COD_5/year[101];

TOS_{ind} – total industrial organic sludge, kg COD_5/year;

O – total annual industrial output, t[102]/year;

W_{ind} – amount of wastewater consumed, m^3/t of industrial output;

D_{ind} – industrial degradable organic component, kg COD_5/m^3;

DS – fraction of organic component removed as sludge.

The obtained value for total industrial organic wastewater (TOW_{ind}) (Table 8-19) was converted in „Population Equivalent Number" (P_{EQ}).

$$P_{EQ} = TOW_{ind} / B / D$$

Where:

TOW_{ind} – total industrial organic wastewater, kg COD_5/year;

B – organic load in chemical oxygen demand per person, g COD/person/day, overall default – 60 g COD/person/day (IPCC, 2000); in the RM a country specific value was used: 75 g COD/person/day (SNIP 2.04.03.85);

D – number of days in a calendar year (365 days in normal years and 366 days in leap years: 1992, 1996, 2000, 2004, 2008).

Table 8-19: Total Industrial Organic Wastewater in the Republic of Moldova, 1990-2010

	1990	1991	1992	1993	1994	1995	1996
TOW_{ind}, kt COD/year	79.2265	67.6727	43.1847	43.8755	34.9556	35.3102	33.2612
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
TOW_{ind}, kt COD/year	35.6060	26.5291	17.6629	19.3957	24.7056	24.7602	32.1035
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
TOW_{ind}, kt COD/year	39.6931	43.9114	32.8672	28.7753	31.1080	22.9691	23.5579

The calculated population equivalent values (P_{EQ}) are added to the number of population connected to sewage systems (P_{WS}) (Table 8-20).

The sum obtained corresponds to the fictitious number of population (P) connected to sewage systems (Table 8-21). The respective figures were used to estimate CH_4 emissions from industrial and domestic wastewater handling.

[101] COD – Chemical Oxygen Demand;

[102] The following conversion factors were used: 1 jar equivalent = 0.5 kg; 1 m^2 fabric = 0.2 kg; 1m^2 of soft man made leather = 0.7 kg; 1 m^2 of corrugated cardboard = 0.3 kg; 1 dal of alcoholic drinks (wine, sparkling wine, brandy, brandies and liqueurs, beer) = 10 kg.

Table 8-20: Number of Population Connected to Sewage System in the RM

	1990	1991	1992	1993	1994	1995	1996
P, inhabitants[1]	4361600	4366300	4359100	4347800	4352700	4347900	4334400
P_{WS}, %[2]	68.0	64.4	60.9	57.3	53.7	50.2	46.6
P_{WS}, inhabitants	2965888	2813207	2652948	2490855	2338270	2180472	2018964
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
P, inhabitants[1]	4320000	4304700	4293000	4281500	4277600	4261400	4242100
P_{WS}, %[2]	43.0	39.4	35.9	32.3	32.8	31.9	32.9
P_{WS}, inhabitants	1858032	1697774	1539899	1382925	1403053	1359387	1395651
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
P, inhabitants[1]	4161800	4147900	4130500	4114600	4100200	4090000	4081700
P_{WS}, %[2]	33.9	35.6	43.3	43.9	45.7	47.9	50.7
P_{WS}, inhabitants	1410850	1476652	1788507	1806309	1873791	1959110	2069422

Source: 1 Statistical Yearbooks of the RM for 1990 (page 20), 1993 (page 60), 1994 (page 52), 1995 (page 49), 1997 (page 59), 1999 (page 42), 2003 (page 45), 2006 (page 37), 2007 (page 33), 2008 (page 32), 2009 (page 32), 2010 (page 32), 2011 (page 32); Statistical Yearbooks of the ATULBD for 2000 (page 27), 2006 (page 27), 2007 (page 27), 2009 (page 28), 2010 (page 28), 2011 (page 28), 2012 (page 28); 2 For 1990-1999 time series, the source is: http://www.ib-net.org/en/production/?action=country; for 2000-2010 time series – NBS database, revised indicators of the Millennium Development Goals, 2000-2010: <http://statbank.statistica.md/pxweb/Dialog/varval.asp?ma=ODM0101&ti=Indicatorii+revizuiti+ai +Obiectivelor+Dezvoltarii+ Mileniului %2C+2000-2011&path=../Database/RO/ODM/&lang=1>

Table 8-21: The Fictitious Number of Population Connected to Sewage Systems in the RM within 1990-2010

	1990	1991	1992	1993	1994	1995	1996
P_{WS}, inhabitants	2965888	2813207	2652948	2490855	2338270	2180472	2018964
P_{EQ}, inhabitants	2894119	2472062	1573212	1602759	1276917	1289872	1211700
P fictitious, inhabitants	5860007	5285269	4226160	4093614	3615188	3470344	3230664
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
P_{WS}, inhabitants	1858032	1697774	1539899	1382925	1403053	1359387	1395651
P_{EQ}, inhabitants	1300674	969101	645222	706584	902489	904481	1172730
P fictitious, inhabitants	3158706	2666875	2185121	2089509	2305541	2263868	2568381
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
P_{WS}, inhabitants	1410850	1476652	1788507	1806309	1873791	1959110	2069422
P_{EQ}, inhabitants	1446016	1604069	1200629	1051152	1133261	839052	860562
P fictitious, inhabitants	2856866	3080721	2989136	2857461	3007052	2798162	2929984

6B2 'Domestic Wastewater' (CH_4 Emissions)

Methane emissions from the 6B2 'Domestic Wastewater' source category were estimated by following recommendations set forth in the Revised 1996 Guidelines (IPCC, 1997) and GPG (IPCC, 2000), based on a IPCC default method (Tier 1).

Three basic steps are required for estimating CH_4 emissions from wastewater handling.

Step 1

Determine the total amount of organic matter in the wastewater produced under domestic wastewater handling system (TOW_{dom}) (Table 8-22).

Table 8-22: Activity Data Used to Estimate Methane Emissions from the 6B2 'Domestic Wastewater' Source Category

	1990	1991	1992	1993	1994	1995	1996
TOW_{dom}, kt BOD_5	106.9451	96.4562	77.1274	74.7084	65.9772	63.3338	58.9596
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
TOW_{dom}, kt BOD_5	57.6464	48.6705	39.8785	38.1335	42.0761	41.3156	46.8730
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
TOW_{dom}, kt BOD_5	52.1378	56.2232	54.5517	52.1487	54.8787	51.0665	53.4722

This value is influenced in particular, by the population (P) fictitious number connected to sewage system (Table 8-20), and respectively by the domestic degradable organic component (D); the default value for European countries is 18250 kg BOD_5/1000 persons/year (IPCC, 1997).

$$TOW_{dom\ (wastewater)} = P \bullet D_{dom} \bullet (1-DS_{dom}) \quad \text{and}$$
$$TOS_{dom\ (sludge)} = P \bullet D_{dom} \bullet DS_{dom}$$

Where:

TOW_{dom} – total domestic organic wastewater, kg BOD_5/year;

P – fictitious country population connected to sewage system: which is the actual number of country population connected to sewage systems (P_{WS}), plus population equivalent number (P_{eq}), calculated under the 6B1 'Industrial Wastewater', in 1000 persons/year;

D_{dom} – domestic degradable organic component, kg BOD/1000 persons/year;

DS_{dom} – fraction of domestic degradable organic component removed as sludge.

Step 2:

Estimate emissions factors for domestic and industrial wastewater handling system. The emission factors depend on the fraction of wastewater managed by domestic wastewater handling method, maximum CH_4 producing capacity of the wastewater, and the characteristics of the wastewater handling process (principally, the degree to which it is anaerobic). To calculate emission factors for domestic wastewater handling system, a weighted average of methane conversion factor (MCF) is calculated using estimates of wastewater managed by each wastewater handling method. The average MCF is then multiplied by the maximum methane producing capacity (B_0) of the wastewater type. Since aerobic and anaerobic handling are the only handling system considered, the CH_4 conversion rate can be used to characterize a broad range systems failing between aerobic and anaerobic handling system. The emission factor is being calculated using the following equations:

$$EF_i = B_{oi} \bullet \Sigma(WS_{ix} \bullet MCF_x) \quad \text{and}$$
$$EF_i = B_{oi} \bullet \Sigma(SS_{ix} \bullet MCF_x)$$

Where:

EF_{ij} – emissions factor for wastewater and sludge, kg CH_4/kg BOD;

B_{oij} – maximum methane producing capacity in wastewater and sludge, kg CH_4/kg BOD (default value is 0.6 kg CH_4/kg BOD);

MCF_{xj} – methane conversion factors for each wastewater handling system x or y (in the RM the used value of MCF_x was 80 per cent);

WS_{ix} – fraction of wastewater type i treated using wastewater handling system x (in the RM, the used value of WS_{ix} was 20 per cent);

SS_{jy} – fraction of sludge type j treated using sludge handling system y.

Step 3

Multiply the emission factors for each wastewater handling system by the total amount of organic material in the wastewater produced for each system, and sum across the wastewater systems to estimate CH_4 emissions. The amount of CH_4 that is recovered, and thus not emitted into the atmosphere should be subtracted. Equations below present how to estimate the total CH_4 emissions from wastewater and sludge handling:

$$TM = WM + SM,$$
$$WM = \Sigma\ (TOWi \bullet EF_i - MR_i),$$
$$SM = \Sigma\ (TOSi \bullet EF_i - MR_i)$$

Where:

TM – total methane from wastewater and sludge handling, kg CH_4/year;

WM – total methane emissions from wastewater, kg CH_4/year;

SM – total methane emissions from sludge, kg CH_4/year;

TOW_i – total organic waste for wastewater type i, kg BOD/year;

TOS_i – total organic waste for sludge type j, kg BOD/year;

EFi – EF from wastewater type i and for sludge type j, kg CH_4/kg BOD;

MR_i – total amount of methane recovered or flared from wastewater type i or from sludge type j, if no data are available, the default value of zero is used.

6B2 Nitrous Oxide from Human Sewage

Nitrous oxide emissions from the 6B2 'Domestic Wastewater' (Nitrous Oxide from Human Sewage) source category were estimated by following recommendations set forth in the Revised 1996 Guidelines (IPCC, 1997) and GPG (IPCC, 2000), based on a IPCC default method (Tier 1).

$$N_2O = PROTEIN \bullet Frac_{NPR} \bullet NR_{PEOPLE} \bullet EF_6 \bullet 44/28$$

Where:

N_2O – N_2O emissions from human sewage, kg N_2O/year;

PROTEIN – annual per capita protein consumption, kg/per capita/year;

NR_{PEOPLE} – number of people in the Republic of Moldova;

EF_6 – emission factor; default value is 0.01 kg N_2O-N/kg N sewage-N produced;

$Frac_{NPR}$ – fraction of nitrogen in proteins, default value is 0.16 kg N/kg proteins;

[44/28] – stoichiometric ratio of N_2O-N and N_2O.

To be noted that annual per capita protein consumption AD for the Republic of Moldova is available in the FAO database (Table 8-23). For 1990-1991 and 2010 years, activity data were extrapolated, since these are not available for the RM in the FAO database.

8.3.3 Uncertainties Assessment and Time-Series Consistency

The quality of GHG emissions estimates for wastewater handling is directly related to the assessment methodology, the emissions factors used to estimate emissions under this source category and to the quality and availability of data used to derive these estimates.

Uncertainties associated with the default emission factors used to estimate CH_4 and N_2O emissions from the 6B 'Wastewater Handling' source category reach up to ±30 per cent. Uncertainties related to activity data vary from low (±5 per cent) for number of population and industrial output (even when considering the uncertainties associated with the use of conversion factors, for transferring certain measurement units to other units) to medium (±30 per cent) for annual per capita protein consumption. Combined uncertainties associated with direct GHG emissions from the 6B2 'Wastewater Handling' source category vary from ±31.62 per cent for methane emissions, to ±42.43 per cent for nitrous oxide emissions. At the same time, combined uncertainties presented as a per cent of total direct sectoral GHG emissions were estimated at ±2.16 per cent for methane emissions and at ±2.22 per cent for nitrous oxide emissions. Uncertainties introduced in trend in total sectoral direct emissions were estimated at ±2.09 per cent for CH_4 emissions and at ±2.15 per cent for N_2O emissions (**Annex 5-3.6**).

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 (IPCC, 2000).

8.3.4 Quality Assurance and Quality Control

Standard verification and quality control forms and checklists were filled in for this category following a Tier 1 approach (IPCC, 2000). 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 of those of the ATULBD, as well as FAO database; using the scientific literature in the field regarding planning water norms for different industries; on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and GPG (IPCC, 2000), etc. The AD and methods used for estimating CH_4 emissions under the category 6B 'Wastewater Handling' were documented and archived both in hard copies and electronically.

Table 8-23: Activity Data Used to Estimate N_2O Emissions from 'Nitrous Oxide from Human Sewage' in the RM within 1990-2010 time periods

	1990	1991	1992	1993	1994	1995	1996
P_{RM}, inhabitants[1]	4361600	4366300	4359100	4347800	4352700	4347900	4334400
Proteins, g/per capita/day[2]	73.9	71.3	68.7	66.1	65.3	62.7	63.4
Proteins, kg/per capita/year	27.0	26.0	25.1	24.1	23.8	22.9	23.1
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
P_{RM}, inhabitants[1]	4320000	4304700	4293000	4281500	4277600	4261400	4242100
Proteins, g/per capita/day[2]	62.3	61.4	59.9	59.6	63.0	64.4	66.2
Proteins, kg/per capita/year	22.7	22.4	21.9	21.8	23.0	23.5	24.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
P_{RM}, inhabitants[1]	4161800	4147900	4130500	4114600	4100200	4090000	4081700
Proteins, g/per capita/day[2]	67.5	71.9	71.8	67.8	69.8	69.0	71.0
Proteins, kg/per capita/year	24.6	26.2	26.2	24.7	25.5	25.2	25.9

Source: [1]Statistical Yearbooks of the RM for 1990 (page 20), 1993 (page 60), 1994 (page 52), 1995 (page 49), 1997 (page 59), 1999 (page 42), 2003 (page 45), 2006 (page 37), 2007 (page 33), 2008 (page 32), 2009 (page 32), 2010 (page 32), 2011 (page 32); Statistical Yearbooks of the ATULBD for 2000 (page 27), 2006 (page 27), 2007 (page 27), 2009 (page 28), 2010 (page 28), 2011 (page 28), 2012 (page 28); [2]FAO database FAOSTAT, FAO Statistics Division 2013, 15 February 2013,< http://faostat.fao.org/site/609/DesktopDefault.aspx?PageID=609#ancor>.

8.3.5 Recalculations

The CH_4 emissions from the category 6B 'Wastewater Handling' were recalculated for the 1990 through 2005 time series, in particular due to use an updated set of activity data, in particular those related to industrial output in the RM, available in the SYs of the RM and those of the ATULBD; due to use of updated information regarding the share of population connected to an improved sewage system, as well as due to use of CS parameters (SNIP 2.04.03.85) related to the amount of COD released into the municipal sewage system replacing the default factor (IPCC, 2000).

In comparison with the previously obtained results for the 1990-1993 time periods, the above mentioned changes resulted in increased values of CH_4 emissions from 6B 'Wastewater Handling' source category, with a variation from a minimum of 1.4 per cent in 1993 to a maximum of 21.7 per cent in 1990. At the same time, within the 1994-2005 time series CH_4 emissions decreased, varying from a minimum of 0.4 per cent in 1995 up to a maximum of 34.4 per cent in 2000 (Table 8-24). The results allow assert that within the 1990-2010 time series CH_4 emissions from 6B 'Wastewater Handling' source category decreased by circa 50.0 per cent.

Table 8-24: Comparative Results of CH_4 Emissions from 6B 'Wastewater Handling' Source Category Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	8.4363	7.8254	7.0571	7.0749	6.6021	6.1063	5.9974
TNC	10.2667	9.2598	7.4042	7.1720	6.3338	6.0800	5.6601
Difference, %	21.7	18.3	4.9	1.4	-4.1	-0.4	-5.6
	1997	1998	1999	2000	2001	2002	2003
SNC	6.0032	5.7992	5.5714	5.5799	5.6748	5.6795	5.7338
TNC	5.5341	4.6724	3.8283	3.6608	4.0393	3.9663	4.4998
Difference, %	-7.8	-19.4	-31.3	-34.4	-28.8	-30.2	-21.5
	2004	2005	2006	2007	2008	2009	2010
SNC	5.4272	5.7626					
TNC	5.0052	5.3974	5.2370	5.0063	5.2684	4.9024	5.1333
Difference, %	-7.8	-6.3					

N_2O emissions from the 6B 'Wastewater Handling' (Human Sewage) were recalculated for the 1990 through 2005 time series, in particular due to use an updated set of activity data, available on FAO webpage.

In comparison with the with the results reported in the SNC of the RM under the UNFCCC, the changes performed in the process of development the current greenhouse gas inventory resulted in a decrease of N_2O emissions from the 6B 'Wastewater Handling' (Human Sewage), varying from a minimum of 2.7 per cent in 1996, up to a maximum of 28.9 per cent in 1990 (Table 8-25). The results allow assert that within the 1990-2010 time series N_2O emissions from 6B2 'Wastewater Handling: Human Sewage' source category decreased by circa 10.1 per cent.

Table 8-25: Comparative Results of N_2O Emissions from 6B2 'Wastewater Handling: Human Sewage' Source Category Included into the SNC and TNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996
SNC	0.4163	0.3807	0.3454	0.3280	0.2840	0.2669	0.2593
TNC	0.2958	0.2857	0.2748	0.2637	0.2608	0.2502	0.2522
Difference, %	-28.9	-24.9	-20.4	-19.6	-8.2	-6.3	-2.7
	1997	1998	1999	2000	2001	2002	2003
SNC	0.2652	0.2603	0.2502	0.2506	0.2591	0.2674	0.2733
TNC	0.2470	0.2426	0.2360	0.2342	0.2473	0.2519	0.2577
Difference, %	-6.9	-6.8	-5.7	-6.5	-4.5	-5.8	-5.7
	2004	2005	2006	2007	2008	2009	2010
SNC	0.2696	0.2992					
TNC	0.2578	0.2737	0.2722	0.2560	0.2626	0.2590	0.2660
Difference, %	-4.4	-8.5					

8.3.6 Planned Improvements

In order to improve the population's access to quality water supply and sanitation services, in the RM various actions of sector planning at different levels are adopted. At the national level, it has been developed an *Action Plan* regarding the new *Strategy on water supply and sanitation for 2014-2027*, which is now widely promoted for approval, while at the regional level (Central, Southern and Northern) there are ongoing efforts to develop *Regional plans for water and sanitation*. All these actions will ensure improvements within the wastewater handling sector, by applying clearly defined regulatory, institutional and economic instruments.

Regulatory instruments will focus on a set of normative laws (the Water Law No. 272 dated 23.12.2011, the draft *Law on municipal water supply and sanitation services*, the set of secondary legislation to the *Water Law*, regional plans drafts 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 regionalization process includes 6 water companies from Hancesti, Soroca, Floresti, Ceadar-Lunga and Orhei districts. These reforms will change the wastewater management system; leading thus, to decreased GHG emissions within this sector.

Another institutional reform planned for implementation within this sector refers to creating regulatory authorities by extending the responsibilities of the National Agency for Energy Regulation (ANRE), which will exercise a major impact in regulating the functioning of the sector. These institutional instruments will determine the sustainability of sector management.

Economic instruments will focus on the concept of "sustainable recovery of cost services" with three main characteristics: an appropriate combination of tariffs, taxes and transfers to finance recurrent and capital costs and to boost other forms of funding; the predictability of public subsidies in order to facilitate investments (planning); tariff policies to make services accessible to all, including to the poorest citizens, while, at the same time, ensuring the sustainability of service providers.

Sector planning can essentially improve the wastewater and sludge management from the 6B 'Wastewater handling' source category. Sludge handling actions will reduce the risk of water contamination, a problem that becomes increasingly sensitive to climate change. All these changes listed above will help the RM to fulfill its commitments within the Protocol on Water and Health, as well as within other international documents on reducing the share of population that lack the connection to drinking water sources and sewage systems, an, at the same time, the provisions under the UNFCCC.

Planning the actions to achieve the harmonization of nation legislation on water with the EU Directives, represents a strong instrument enhancing the implementation of best practices, of wastewater and sludge handling technologies, which would allow capturing and sustainable using of methane emissions from sludge platforms (including for heat and electric power production).

For the next inventory cycles it is planned to study the possibility of using country specific information on fraction of BOD removed with the sludge, maximum methane producing capacity, methane correction factor, fraction of wastewater and sludge treated by different handling systems and other relevant parameters used to estimate methane emissions from the 6B 'Wastewater Handling' source category.

9. RECALCULATIONS AND PLANNED IMPROVEMENTS

This chapter summarizes the explanations and justification for GHG emissions recalculations performed to the Republic of Moldova's GHG Inventory for the 1990-2005 time series, included in its Second National Communication under the UNFCCC, as well as planned improvements for the future inventory cycles. Specific information on the level of source categories associated with respective recalculations and planned improvements can also be found in Chapters 3-8 of the NIR.

9.1 Explanations and Justifications for Recalculations

The NITL revised and recalculated GHG emissions and removals for each calendar year covered by the GHG Inventory for the period from 1990 through 2005, a component part of the SNC of the RM under the UNFCCC. These activities were carried out during the on-going process of improving the quality of the National GHG Inventory (inclusive, by taking into account the updated activity data, new methodological approaches and emission factors used, and identified errors correcting actions).

Under the current inventory cycle, improvements were made in all sectors (move to higher tier methodologies, revision of previously used methodological approaches and emission factors, activity data, inclusion new emission sources, etc.), entailing the need to make recalculations of national GHG emissions for the time period from 1990 through 2005, reflected in the Chapter 2 'National GHG Inventory' of the SNC of the RM to the UNFCCC.

In comparison with the results reported under the SNC of the RM under the UNFCCC, the changes made during the development of the current inventory, resulted in increased values of total direct GHG emissions in the time period from 1990 through 2005, with a variation from a minimum of 0.5 per cent in 1992, to a maximum of 11.4 per cent in 1998 (Table 9-1).

With reference to the net direct GHG emissions included into the SNC of the RM under the UNFCCC, changes made in the development of the current inventory, resulted in a decreasing trend in GHG emissions during the 1990-1994 time periods, varying from a minimum of 2.4 per cent in 1994, up to 14.7 per cent in 1992 and in an increasing trend in GHG emissions during the 1995-2005 time periods, varying from a minimum of 1.4 per cent in 1995 to 24.1 per cent in 2004 (Table 9-2).

Table 9-1: Recalculations of Total Direct GHG Emissions included into the SNC of the RM under the UNFCCC, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	42.8860	38.1755	28.4969	22.7609	19.8476	16.7582	16.7713	14.6508
TNC	43.2598	38.8643	28.6479	23.1660	20.9036	17.3809	17.2985	16.0263
Difference, %	0.9	1.8	0.5	1.8	5.3	3.7	3.1	9.4
	1998	1999	2000	2001	2002	2003	2004	2005
SNC	12.6051	10.8223	9.8400	10.8259	10.9663	11.5323	11.6809	11.8835
TNC	14.0435	11.9511	10.9108	11.5891	11.3244	11.8425	12.5511	12.9399
Difference, %	11.4	10.4	10.9	7.0	3.3	2.7	7.5	8.9

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

Table 9-2: Results of the Total Net Direct GHG Emissions Recalculations included into the SNC of the RM under the UNFCCC, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	41.2128	37.0195	27.5809	22.2194	18.9747	16.0022	16.0317	13.3259
TNC	36.0795	33.7842	23.5364	20.7493	18.5244	16.2201	16.2899	16.1992
Difference, %	-12.5	-8.7	-14.7	-6.6	-2.4	1.4	1.6	21.6
	1998	1999	2000	2001	2002	2003	2004	2005
SNC	11.4486	9.5114	8.4868	9.4376	9.7344	10.2184	10.3618	10.5024
TNC	13.8533	11.3904	10.1276	11.3083	11.2526	10.7959	12.8607	12.8354
Difference, %	21.0	19.8	19.3	19.8	15.6	5.7	24.1	22.2

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

9.1.1 Energy Sector

Recalculations of GHG emissions from the Energy Sector were performed for the period 1994-2005 based on the following considerations:

1) For the source category 1A1 'Energy Industry' recalculations were performed for the period 1994-2005 as a result of the availability of updated activity data set for the ATULBD and due to the correction of some data entry errors (in particular for 1996 year).

2) Regarding the source category 1A2 'Manufacturing Industry and Construction", recalculations were performed for the period 1994-2005, due to the availability of an updated activity data set for the ATULBD.

3) For the source category 1A3 'Transport' recalculations were performed for the period 1995-2005 due to:

- availability of an updated set of activity data for the ATULBD for 1A3b source category 'Road Transport';
- availability of an updated set of activity data for the 2000-2002 years, provided by the company S.O.E. "Moldova's Railways" for 1A3c source category 'Railways';
- availability of an updated set of activity data for the 2000-2005 time periods, provided by the Ministry of Transport and Road Infrastructure for source category 1A3d 'Navigation';
- considering for the first time since 2001 year, the GHG emissions from the source category 1A3a 'Civil Aviation', calculated based on the information provided by the Civil Aeronautical Authority of the Republic of Moldova.

4) With reference to the source category 1A4 'Other Sectors', recalculations were performed for the period 1995-2005 as a result of the availability of an updated activity data set for the ATULBD:

- for source category 1A4a 'Commercial/Institutional' data on natural gas consumption for 1999-2005, provided by JSC "Moldova Gas";
- for 1A4b source category 'Residential Sector' data on the consumption of natural gas and liquefied petroleum gas, available in the Statistical Yearbooks of the ATULBD;
- for 1A4c source category 'Agriculture/Forestry/Fishing', data on gasoline and diesel consumption in the agricultural sector (available in the Statistical Yearbooks of the ATULBD) and as a result of identification and correction of some mechanical errors related to data entry for 1995 year;

5) For the source category 1A5 'Other' recalculations of GHG emissions were performed, but only for 2000 year, as a result of identification of a data entry related error.

6) With reference to the source category 1B2 'Fugitive Emissions from Oil and Natural Gas' recalculations were performed for the 2000-2005 time periods, due to the availability of an updated set of activity data related to quantities of oil and natural gas extracted in the RM, based on information available in the Republic of Moldova's Energy Balances.

Compared with the results recorded in the SNC of the RM under the UNFCCC, changes performed in the current inventory cycle (in the frame of the TNC of the RM under the UNFCCC) resulted in increased values of direct GHG emissions for the 1994-2005 time series, varying from a minimum of 3.1 per cent in 2002 up to a maximum of 22.5 per cent in 2000 (Table 9-3).

The results of recalculations performed by categories are presented also in the sub-chapters 3.2-3.9 of the NIR.

9.1.2 Industrial Processes Sector

Recalculations of total direct GHG emissions from the 'Industrial Processes' Sector were performed for the period 1990-2005 based on the following considerations:

1) For the source category 2A1 'Cement Production' recalculations of GHG emissions were performed due to:

- updated AD on clinker production at the Cement Plants in Rezina and Rabnita;
- the availability of new data on CaO and MgO content in clinker;
- use of country specific default correction factor (CKD) (IPCC, 2000).

2) For the source category 2A2 'Lime Production' recalculations of GHG emissions were performed due to:

- use of a more precise stoichiometric ratio, 0.7848 instead of 0.785 for the high-calcium lime (CO_2/CaO), respectively 0.9132 instead of 0.913 for the dolomitic lime (CO_2/CaO•MgO);

Table 9-3: Recalculations of Total Direct GHG Emissions included into the SNC of the RM under the UNFCCC within the Energy Sector, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	34.5204	30.2204	21.3842	16.4752	13.9752	11.1357	11.4303	9.5266
TNC	34.5204	30.2204	21.3842	16.4752	15.0077	11.7107	11.9417	10.7761
Difference, %	0.0	0.0	0.0	0.0	7.4	5.2	4.5	13.1
	1998	1999	2000	2001	2002	2003	2004	2005
SNC	7.9383	6.1847	5.4378	6.6399	6.7383	7.3284	7.4907	7.7248
TNC	9.2605	7.3728	6.6623	7.2653	6.9497	7.7622	8.2344	8.5189
Difference, %	16.7	19.2	22.5	9.4	3.1	5.9	9.9	10.3

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

- use of updated default EFs, 0.7456 instead of 0.75 t CO_2/t of high-calcium lime, respectively 0.7762 instead of 0.77 t CO_2/t of dolomitic lime;
- adjustment of activity data regarding the lime production in 2003 in the ATULBD.

3) CO_2 emissions within the source category 2A3 'Limestone and Dolomite Use' were estimated for the first time, due to the availability of data provided by the Agency for Geology and Mineral Resources.

4) CO_2 emissions within the source category 2A4 'Soda Ash Production and Use' were estimated for the first time, due to the availability of data provided by the Customs Service of the Republic of Moldova.

5) For the source category 2A7 'Other' (Bricks and Expanded Clay Production) recalculations of CO_2 emissions were performed due to:

- updated AD related to bricks production for 1998 and 2005 years;
- revised activity data set on the amount of clay used for brick production: a new conversion ratio was used, 3.2 kg of clay per one brick piece, in comparison with 2.25 kg of clay per one brick piece, used in the previous inventory cycle.

6) CO_2 emissions within the source category 2A7 'Other' (Expanded Clay Production) were estimated for the first time, due to the availability of data provided by the producer Macon J.S.C.

7) For the source category 2C1 'Iron and Steel Production' recalculations of GHG emissions were performed due to:

- move from a Tier 1 approach (IPCC, 2006) to a Tier 2 approach (IPCC, 2000), based on detailed information on carbon balance in the technological process;
- use of an EFs specific to the integrated facility in Ribnita on ATULBD, that replaced the default EFs, available in 2006 IPCC Guidelines (80 kg CO_2/ t steel) used within the SNC of the RM under the UNFCCC;
- use of updated activity data, available into the Statistical Yearbooks of the RM and those of the ATULBD.

8) For the source category 2F 'Consumption of HFCs and SF_6' recalculations of GHG emissions were performed due to:

- use of updated AD provided by the Customs Service, Ministry of Health, Ministry of Information Technology and Communications, Republican Association of Refrigeration Technicians, Annual Reports submitted by individual companies to the Ozone Office by the Ministry of Environment of the RM, and enterprises from the electrical industry, as Moldelectrica J.S.C., Red Union Fenosa J.S.C., etc.;
- considering, for the first time, the GHG emissions from 2F2 'Foam Blowing' source category;
- extending the inventorying period for F-gas emissions from 2000-2005, to 1995-2010 time periods.

In comparison with the results reported in the SNC of the RM under the UNFCCC, the changes performed in the current inventory development process (in the frame of the TNC of the RM under the UNFCCC), resulted in a significant increase of direct GHG emissions over the time period from 1990 through 1997, with a variation from a minimum of 12.0 per cent in 1996, to a maximum of 104.0 per cent in 1992, respectively in a decrease of direct GHG emissions over the period from 1998 through 2005, varying from a minimum of 2.3 per cent in 2005, up to a maximum of 17.7 per cent in 2001 (Table 9-4).

Table 9-4: Recalculations of Direct GHG Emissions included into the SNC of the RM under the UNFCCC within the Industrial Processes Sector, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	1.3487	1.1036	0.5758	0.5169	0.3821	0.3806	0.3898	0.4350
TNC	1.9010	1.8067	1.1743	0.7701	0.6230	0.4915	0.4368	0.4898
Difference, %	40.9	63.7	104.0	49.0	63.0	29.1	12.0	12.6
	1998	1999	2000	2001	2002	2003	2004	2005
SNC	0.3547	0.3393	0.3256	0.3311	0.3441	0.4080	0.4795	0.5819
TNC	0.3433	0.3086	0.2812	0.2727	0.3304	0.3828	0.4288	0.5684
Difference, %	-3.2	-9.0	-13.6	-17.7	-4.0	-6.2	-10.6	-2.3

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

The results of recalculations performed by categories are presented also in sub-chapters 4.2-4.6 of the NIR.

9.1.3 Solvents and Other Products Use Sector

Recalculations of total direct GHG emissions from the 'Solvents and Other Products Use' Sector were performed for the period 1990-2005 based on the following considerations:

1) For the source categories 3A 'Paint Application' and 3B 'Degreasing and Dry Cleaning' recalculations of GHG emissions were performed due to:

- employing new values for the content of solvents and carbon within the paints and varnishes, as well as within products used for degreasing and dry cleaning in the RM;
- updated AD regarding the production and imports of these products in the RM.

2) For the source category 3C 'Chemical Products, Manufacture and Processing' recalculations of GHG emissions were performed due to:

- replacing the estimation method available in the EMEP/CORINAIR Atmospheric Emissions Inventory Guidebook (1996, 1999), used within the SNC with a new estimation method available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009);
- employing an updated emission factor: in the TNC - 11 g NMVOC per kg of product for the source category 3C1 'Paints manufacturing' (available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009), while in the SNC – 15 g NMVOC per kg of product (avail-

able in the EMEP/CORINAIR Atmospheric Emissions Inventory Guidebook 1996);

- considering, for the first time, new source categories (e.g. 3C2 'Leather Tanning', 3C3 'Tyre Production and Reconditioning', 3C4 'Rubber Processing', 3C5 'Shoes Manufacturing');
- updated data set regarding chemical products manufacture in the RM.

3) For the source category 3D 'Other' recalculations of GHG emissions were performed due to:

- replacing the estimation method available in the EMEP/CORINAIR Atmospheric Emissions Inventory Guidebook (1996, 1999), used within the SNC of the RM under the UNFCCC, with a new estimation method available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009);
- employing an updated EF (500 kg NMVOC/t ink used) within the 3D1 'Printing' source category, available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), in the detriment of the previously used (425 kg NMVOC/t ink for printing, respectively 54 kg NMVOC/t ink for writing or drawing), available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (1996);
- employing an updated EF (1.0 kg NMVOC/per capita) within the 3D2 'Domestic Solvents Use' source category, available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), in the detriment of the previously used (1.8 kg NMVOC/per capita, for the Western Europe), available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (1996)
- employing an updated EF (3.0 kg NMVOC/t of seeds) within the 3D3 'Seed Oil Extraction' source category, available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), in the detriment of the previously used (6.0 kg NMVOC/t treated seeds, respectively 1.31 kg NMVOC/t dry seeds), available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (1996);
- employing an updated EF (780 kg NMVOC/t of product) within the 3D3 'Use of Glues and Other Adhesives' source category, available in the EMEP/EEA Atmospheric Emissions Inventory Guidebook (2009), in the detriment of the previously used (600 kg NMVOC/t of product), available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (1996);
- considering, for the first time, new source categories (e.g., 3D3 'Vehicle Dewaxing' and 3D3 'Tobacco Combustion');
- employing new values for the carbon content in the solvents used in ink and domestic products manufacture, in seed oil extraction: 81.6 per cent instead of 85.0 per cent previously used; as well as in glues and other adhesives: 57 per cent instead of 85.0 per cent previously used;
- updated activity data set on ink, domestic products, glues and other adhesives import in the country, provided by the Customs Service of the RM;
- using an updated activity data set on total oil produced in the country, respectively on the share of refined vegetable oil;
- using an updated activity data set on country's population (including the ATULBD).

In comparison with the results reported in the SNC of the RM under the UNFCCC, the changes performed in the current inventory cycle (in the frame of the TNC of the RM under the UNFCCC), presented an increasing trend of direct GHG emissions in the period from 1990 through 2005, with a variation from a minimum of 3.9 per cent in 1999, to a maximum of 39.1 per cent in 2005, except for 1997-1998 time series, 2000 and the period from 2002 through 2004, when the direct GHG emissions decreased, varying from a minimum of 0.1 per cent in 1997, up to a maximum of 21.5 per cent in 1998 (Table 9-5).

Table 9-5: Recalculations of Direct GHG Emissions Included into the SNC of the RM under the UNFCCC within the Solvents and Other Products Use Sector, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	0.0656	0.0597	0.0469	0.0371	0.0313	0.0281	0.0282	0.0299
TNC	0.0908	0.0782	0.0625	0.0508	0.0417	0.0382	0.0339	0.0299
Difference, %	38.3	31.1	33.3	37.1	33.3	36.1	20.1	-0.1
	1998	1999	2000	2001	2002	2003	2004	2005
SNC	0.0304	0.0298	0.0331	0.0347	0.0408	0.0417	0.0478	0.0490
TNC	0.0238	0.0309	0.0316	0.0453	0.0385	0.0357	0.0438	0.0682
Difference, %	-21.5	3.9	-4.3	30.5	-5.6	-14.4	-8.5	39.1

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

The results of recalculations performed by categories are presented also in the sub-chapters 5.2-5.5 of the NIR.

9.1.4 Agriculture Sector

Recalculations of total direct GHG emissions from the 'Agriculture' Sector were performed for the period 1990-2005 based on the following considerations:

1) For the source category 4A 'Enteric Fermentation' recalculations of methane emissions were performed due to:

- use of an updated set of activity data on animal population in the RM (available into the Statistical Yearbooks of the RM and those of the ATULBD, Statistical Annual Report No. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all Households Categories as of 1st of January" and "Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM");
- use of new EFs according to the Tier 2 method for several livestock categories (in particular for 'dairy cows', 'cattle', 'sheep' and 'goats');

- using new EFs for rabbits: 0.59 kg/head/year, used by the Russian Federation (the coefficient used by the Russian Federation for its 1990-2010 GHG Inventory is average comparing to other countries in the same region: Lithuania – 0.26 kg/head/year, respectively Ukraine – 0.70 kg/head/year), replacing the value used within the SNC - 3.63 kg/head/year;
- specifying the grazing and confinement periods (210 days in TNC, compared to 180 days in SNC; respectively 155 days in TNC compared to 185 days used in the SNC);
- specifying the digestible energy values (in the TNC were used DE values varying between 65-70 per cent for different years, considering the specific conditions of animal maintenance, proceeding from the climate conditions of those years, while the SNC used an average DE value for all animal categories (65 per cent).

2) For the source category 4B 'Manure Management' recalculations of methane and nitrous oxide emissions were performed due to:

- use of an updated set of activity data on animal population in the RM, (available into the Statistical Yearbooks of the RM and those of the ATULBD, Statistical Annual Report No. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all Households Categories as of 1st of January" and "Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM");
- use of new EFs related to the Tier 2 method (for categories like 'diary cows', 'other cattle' and 'swine');
- using country specific values for nitrogen excretion rate (kg N/1000 kg of animal mass/year);
- using an updated set of data on manure management systems in the RM (MS%).

3) For the source category 4D 'Agricultural Soils' recalculations of direct and indirect N_2O emissions were performed due to:

- obtaining more previse activity data on synthetic fertilizers consumption for several years (in particular, for 1990, 1993 and 1994 years), available in updated versions of the Statistical Yearbooks of the RM and those of the ATULBD;
- obtaining more precise AD for 1990 year regarding applied organic fertilizers in the RM;
- N_2O emissions from urine and dung inputs to grazed soils were recalculated for the 1990 through 2005 time series, in particular due to:
  - using an updated set of activity data on animal population (available into the Statistical Yearbooks of the RM and those of the ATULBD, Statistical Annual Report No. 24-agr „Animal Breeding Sector": "The Number of Livestock and Poultry in all Households Categories as of 1st of January" and "Basic Indicators of Animal Breeding Sector Development in all Households Categories in the RM");
  - using country specific values for nitrogen excretion rate (kg N/1000 kg of animal mass/year);
  - using an updated set of data on manure management systems in the RM (MS%);
- Direct N_2O emissions from crop residues returned to soil were recalculated for the 1990 through 2005 time series, in particular due to:
  - use of an updated set of activity data on sown areas with crops, gross harvest of agricultural crops, yield per hectare of agricultural crops (available in the NBS on-line database, as well as into the Statistical Yearbooks of the ATULBD);
  - use of a country specific method, replacing the Tier 1 approach and default EFs used within the SNC of the RM under the UNFCCC;
  - use of country specific values for the ratio of above-ground residues to harvested yield for crop (R_{AG}) in the RM;
  - use of updated data on the ratio of below-ground residues to harvested yield for crop (R_{BG}), available in the 2006 IPCC Guidelines;
  - updated values for the fraction of above-ground residues of crop removed annually for other purposes ($Frac_{Remove}$) based on experts opinions (experts from the Institute of Pedology, Agrochemistry and Soil Protection "Nicolae Dimo");
  - use country specific values for the amount of Nitrogen in crop residues (P_{CR}, % a.s.), respectively of country specific coefficient on use of Nitrogen from crop residues.
- The N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change were recalculated for the 1990 through 2005 time series due to:
  - use of an updated set of activity data on sown areas with crops, gross harvest of agricultural crops, yield per hectare of agricultural crops (available in the NBS on-line database, as well as into the Statistical Yearbooks of the ATULBD);
  - use of a country specific method (similar with the Tier 3 approach, following the IPCC classification), to estimate the N_2O emissions from nitrogen mineralization associated with loss of soil carbon, replacing the Tier 2 approach and default EFs used within the SNC of the RM under the UNFCCC;
  - use of a country specific value for the ratio of carbon and nitrogen in humus.

In comparison with the results reported in the SNC of the RM under the UNFCCC, the changes performed in the current inventory cycle (in the frame of the TNC of the RM under the UNFCCC), resulted in a decrease of direct GHG emissions in the period from 1990 through 1992, 1994-1995, 2000 and 2003, with a variation from a minimum of 0.6 per cent in 1991, to a maximum of 10.0 per cent in 1992, while an increasing trend was recorded in 1993, between 1996-1999, 2001-2002, 2004-2005, varying from a minimum of 0.8 per cent in 1996, up to a maximum of 11.5 per cent in 2005 (Table 9-6).

Table 9-6: Recalculations of Direct GHG Emissions Included into the SNC of the RM under the UNFCCC within the Agriculture Sector, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	5.3239	5.0353	4.6151	3.8398	3.5998	3.3862	3.0465	2.8392
TNC	5.1202	5.0028	4.1542	4.0033	3.4099	3.3591	3.0718	2.9873
Difference, %	-3.8	-0.6	-10.0	4.3	-5.3	-0.8	0.8	5.2
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	2.5183	2.4380	2.3122	2.2174	2.3139	2.2548	2.2107	2.1278
TNC	2.7318	2.4885	2.2770	2.4541	2.5246	2.1969	2.4012	2.3734
Difference, %	8.5	2.1	-1.5	10.7	9.1	-2.6	8.6	11.5

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

The results of recalculations performed by categories are presented also in sub-chapters 6.2-6.4 of the NIR.

9.1.5 Land Use, Land-Use Change and Forestry Sector

Recalculations of total net GHG emissions from the LULUCF Sector were performed for the period 1990-2005 only for 5B 'Cropland' source category based on the following considerations:

- use of a country specific method[103] (similar with the Tier 3 approach, following the IPCC classification), for estimating GHG emissions/removals from 5.B.1.2 category 'Annual Change in Carbon Stocks in Mineral Soils', replacing thus, the Tier 2 approach and default EFs, used within the SNC of the RM under UNFCCC;
- use of an updated set of activity data on sown areas with crops, gross harvest of agricultural crops, yield per hectare of agricultural crops (available in the NBS on-line database, as well as into the Statistical Yearbooks of the ATULBD).

[103] Banaru, Anatol (2000), *Methodology to Calculate CO_2 Emissions from Agricultural Soils,* In the collection of papers „Climate Change: Research, Studies, Solutions, Ministry of Environment / PUNDP Moldova. „Bons Offices" S.R.L. Chisinau, 2000. P. 115-123.

In comparison with the results reported in the SNC of the RM under the UNFCCC, the changes performed in the current inventory development process (in the frame of the TNC of the RM under the UNFCCC), presented an increasing trend of net CO_2 removals in the period from 1990 through 1996, with a variation from a minimum of 36.4 per cent in 1996 to a maximum of 458.0 per cent in 1992, while a decreasing trend was recorded between 1997-2005, varying from a minimum of 20.3 per cent in 2003, up to a maximum of 123.5 per cent in 2004 (Table 9-7).

The results of recalculations performed by categories are presented in the sub-chapters 7.2-7.4 of the NIR.

9.1.6 Waste Sector

Recalculations of total direct GHG emissions from the Waste Sector were performed for the period 1990-2005 based on the following considerations:

1) For the source category 6A 'Solid Waste Disposal on Land' recalculations of methane emissions were performed due to the availability of an updated set of activity data for the ATULBD.

2) For the source category 6B 'Wastewater Handling' recalculations of methane and nitrous oxide emissions were performed due to:

- obtaining more precise activity data related to the industrial output in the RM, available in the Statistical Yearbooks of the RM and those of the ATULBD;
- use updated information regarding the share of population connected to an improved sewage system, data available within national online reference sources[104], as well as in other international sources of reference[105];
- use of some country specific parameters (SNIP 2.04.03.85) related to the amount of COD released into the municipal sewage system, replacing a default factor (IPCC, 2000);
- use a new set of activity data on protein intake per capita, available on FAO webpage[106].

[104]<http://statbank.statistica.md/pxweb/Dialog/varval.asp?ma=ODM0101&ti=Indicatorii+revizuiti+ai+Obiectivelor+Dezvoltarii+Mileniului %2C+2000-2011&path=../Database/RO/ODM/&lang=1>.
[105] <http://www.ib-net.org/en/production/?action=country>.
[106] <http://faostat.fao.org/site/609/DesktopDefault.aspx?PageID=609#ancor>.

Table 9-7: Recalculations of Net CO_2 Removals Included into the SNC of the RM under the UNFCCC within the Land Use, Land-Use Change and Forestry Sector, Mt CO_2

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	-1.6732	-1.1560	-0.9160	-0.5414	-0.8730	-0.7560	-0.7396	-1.3249
TNC	-7.1803	-5.0801	-5.1115	-2.4168	-2.3793	-1.1608	-1.0086	0.1729
Difference, %	329.1	339.5	458.0	346.4	172.5	53.6	36.4	-113.0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	-1.1565	-1.3109	-1.3532	-1.3883	-1.2319	-1.3139	-1.3190	-1.3811
TNC	-0.1902	-0.5607	-0.7832	-0.2808	-0.0718	-1.0466	0.3096	-0.1046
Difference, %	-83.6	-57.2	-42.1	-79.8	-94.2	-20.3	-123.5	-92.4

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

In comparison with the results reported in the SNC of the RM under the UNFCCC, the changes performed in the current inventory cycle (in the frame of the TNC of the RM under the UNFCCC), resulted in a decrease of direct GHG emissions in the period from 1991 through 1994, with a variation from a minimum of 0.01 per cent in 1991, up to a maximum of 4.5 per cent in 1998, while an insignificant increase was recorded in 1990 and 2005 years (Table 9-8).

Table 9-8: Recalculations of Direct GHG Emissions Included into the SNC of the RM under the UNFCCC within the Waste Sector, Mt CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	1.6273	1.7565	1.8749	1.8920	1.8593	1.8276	1.8766	1.8202
TNC	1.6274	1.7563	1.8727	1.8665	1.8213	1.7815	1.8143	1.7432
Difference, %	0.003	-0.01	-0.1	-1.3	-2.0	-2.5	-3.3	-4.2
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	1.7634	1.8305	1.7313	1.6028	1.5292	1.4993	1.4521	1.4000
TNC	1.6841	1.7503	1.6586	1.5517	1.4812	1.4650	1.4430	1.4111
Difference, %	-4.5	-4.4	-4.2	-3.2	-3.1	-2.3	-0.6	0.8

Abbreviations: SNC – Second National Communication, TNC – Third National Communication.

The results of recalculations performed by categories are presented also in the sub-chapters 8.2-8.3 of the NIR.

9.2 Planned Improvements

A series of improvements is planned for the next inventory cycles. Below are presented the planned improvements by sectors.

9.2.1 Energy Sector

Monitoring the GHG emissions from the Energy Sector is planned to be improved along with:

- availability of new AD regarding the fuel consumption at MTTP (ATULBD) from 1999 through 2000;
- availability of updated AD on fuel consumption for electricity generation for the left bank of the Dniester river;
- availability of additional data on fugitive emissions originated from oil and natural gas distribution systems (from the entire infrastructure needed to produce, collect, process, refine and distribute oil products and natural gases to final consumers; from equipment leaks, evaporation losses, venting, flaring, incineration, accidental releases, etc.).

9.2.2 Industrial Processes Sector

Monitoring the GHG emissions from the Industrial Processes Sector is planned to be improved along with:

- updating the activity data used to estimate GHG emissions within the source categories 2A 'Mineral Products' and 2C 'Metal Production';
- collecting activity data of higher quality to be used to estimate GHG emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' category in the Republic of Moldova, as well as on specifying some EFs values (e.g. the volume and type of blowing agents used in foam blowing products imported in the country, etc.).

9.2.3 Solvents and Other Products Use Sector

Monitoring the GHG emissions from the Solvents and Other Product Use Sector is planned to be improved along with:

- obtaining higher quality activity data to be used to estimate GHG emissions from all source categories within the Solvents and Other Products Use Sector;
- collecting AD for other source categories, for which, currently, there are no information available in the statistical publications.

9.2.4 Agriculture Sector

Monitoring the GHG emissions from the Agriculture Sector is planned to be improved along with:

- updating the activity data set and the productivity indicator for the livestock breeding sector of the RM for the entire period under review;
- collecting higher quality information on the main indicators used to estimate the country specific emission factors following a Tier 2 methodology within the source categories 4A 'Enteric Fermentation' and 4B 'Manure Management';
- collecting additional data on country specific manure management systems, as well as data pertaining to revise country specific nitrogen excretion rate $Nex_{(T)}$ (kg N/head/year) for the main animal categories in the RM;
- collecting higher quality activity information and country specific parameters and coefficients used to estimate direct N_2O emissions from crop residues returned to soils in the RM.

9.2.5 Land Use, Land-Use Change and Forestry Sector

Monitoring the GHG emissions/removals from the Land Use, Land-Use Change and Forestry Sector is planned to be improved along with:

- improving record keeping pertaining to distribution of forests by species, actual consumption of fuel wood from the forests of the Republic of Moldova, as well as verification of country specific emission/removal factors and coefficients (annual net increment in volume suitable for industrial processing, basic wood density, biomass expansion factors, etc.) under the category 5A 'Forest Land';
- improving record keeping pertaining to actual consumption of wood mass from forest belts and other types of forest vegetation, as well as verification of country specific emission/removal factors and coefficients (such as: annual biomass increments, biomass harvesting during the cleaning cuttings of perennial plantations, etc.) under the category 'Cropland Covered with Woody Vegetation';

- improving the quality of activity data used to estimate CO_2 emissions/ removals within the category 'Annual Change in Carbon Stocks in Mineral Soils';
- improving the quality of activity data used to estimate non-CO_2 emissions from category 'Post-harvest field burning of agricultural residues' (stubble fields burning);
- improving the cadastral records (as a main source of activity data) pertaining to the category 'Grassland', by specifying the land use categories to which converted lands are transferred to.

9.2.6 Waste Sector

Monitoring the direct GHG emissions from the Waste Sector is planned to be improved along with:

- imposing a new approach to address the environmental issues, complying with the commitments under the ratified international conventions and agreements;
- the need to promote statistical accounting of the generated waste, focused on the main criterion of relevance and comparability among the EU member states, as well as to improve the quality of activity data pertaining to the amount of generated and disposed municipal solid waste and industrial waste;
- the essential restructuring of waste management in the RM through the transposition of the Resolution 2000/532/EC of the EU Commission regarding the 'Waste List';
- improving the national statistical records on waste generation and the quality of AD on the amount of generated and disposed municipal solid waste, industrial waste etc., used to estimate methane emissions within the source category 6A 'Solid Waste Disposal on Land';
- the adoption of the 'Waste List', and efficient reporting on its consistent implementation;
- proper implementation of *Waste Management Strategy of the Republic of Moldova for 2013-2027 years* and the development of integrated municipal waste management systems through the harmonization of legal, institutional and regulatory framework to the EU standards, based on a regional approach (geographical position, economic development, the existence of access roads, pedological and hydrogeological conditions, population, etc.);
    - to promote and implement selective waste collection in all areas, both in domestic sector and in the production sector, as well as waste sorting, composting and recycling facilities;
    - the development of waste disposal capacities by creating 7 new SWD landfills at a regional level and 2 new mechanical-biological treatment plants;
- proper implementation of the *Action Plan* to the *Strategy on Water Supply and Sanitation of the Republic of Moldova for 2014-2027 years*;
- developing, promoting and approving at the regional level (Central, South and North) the Regional Action Plans for Water and Sanitation;
- improving wastewater handling sector by applying clearly defined regulatory, institutional and economic instruments:
    - *Regulatory instruments* will focus on a set of normative laws (the *Water Law No. 272 dated 23.12.2011*, the draft *Law on municipal water supply and sanitation services*, the set of secondary legislation to the *Water Law*, draft regional action plans related to water and sanitation, etc.). These regulatory instruments through their provisions will improve the quality of water and sanitation services, of wastewater, rainwater 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 regionalization process includes 6 water companies from Hancesti, Soroca, Floresti, Ceadar-Lunga and Orhei districts. These reforms will change the wastewater management system; leading thus, to decreased GHG emissions within this sector.
    - *Economic instruments* will focus on the concept of "*sustainable recovery of cost services*" with three main characteristics: an appropriate combination of tariffs, taxes and transfers to finance recurrent and capital costs and to boost other forms of funding; the predictability of public subsidies in order to facilitate investments (planning); tariff policies to make services accessible to all, including to the poorest citizens, while, at the same time, ensuring the sustainability of service providers.
- implementing the provisions stipulated in the *Protocol on Water and Health*, as well as in other international documents on reducing the share of population that lack the connection to drinking water sources and sewage systems, and, at the same time, the provisions under the UNFCCC;
- progressive harmonization of nation legislation on water with the EU Directives, represents a strong instrument enhancing the implementation of best practices, of wastewater and sludge handling technologies, which would allow capturing and sustainable using of methane emissions from sludge platforms.

REFERENCES

1. **Agency 'Moldsilva',** *Statistical Records, Reports for the time period 1990-2010 (forms 1 g.s., 2 g.s., 3 g.s., etc.).*

2. **Andrieş, S., Rusu, A., Donos A., Constantinov, I. (2005),** *Management of Organic Waste, Nutrients and Soil Protection* (in Romanian). Control of Pollution in Agriculture Project. National Agency for Rural Development (ACSA). Ch.: S.E. F.E.-P. Central Printing House, 2005, 112 p.

3. **Arinushkina, E.V. (1961),** *Guidelines for Chemical Analysis of Soils* (in Russian). Moscow State University Press. Moscow, 1961. 491 p.

4. **Arinushkina, E.V. (1975)** *Guidelines for Chemical Analysis of Soils* (in Russian). Moscow State University Press. Moscow, 1975. 470 p.

5. **Australian Government, Department of the Environment and Heritage (1997),** *Methane Capture and Use - Waste Management Workbook, Methane Capture and Use, Organic solid waste management and energy recovery*, 36, pp. 1-16.

6. **Australian Government, Department of Climate Change and Energy Efficiency (2012),** *Australian National Greenhouse Accounts, National Inventory Report 2010.* April, 2012

7. **Babcock International Institute for Dairy Research and Development (1996),** *Technical Guideline for Milk Production.* USA, 1996 (www.animals-feed.info).

8. **Banaru, A. (2000),** Methodology to calculate CO_2 *Emissions from Agriculture Soils* (in Romanian). Collection of articles 'Climate change: Researches, studies, solutions', Ministry of the Environment / UNDP Moldova. „Bons Offices", Chisinau, 2000. p. 115-123.

9. **Banaru, A., Turcan, M., Arhip, O., Andries, S., Balteanschi, D. (2002),** *Methodological Guidelines to Determine Humus Balance in Agriculture Soils* (in Romanian). Ministry of Agriculture and Food Industry of the Republic of Moldova. 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.

10. **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.

11. **Barlaz M. A, Eleazer W. E., Odle W. S., Qian III. X., and Wang Y-S. (1997)**, "Biodegradative Analysis of Municipal Solid Waste in Laboratory-Scale Landfills", EPA 600/R-97-071.

12. **Bingemer, H.G., Crutzen, P.J. (1987),** *The production of methane from solid waste*, Journal of Geophysical Research, 92 (D2), pp.2181-2187.

13. **Bivol, E., Ciubotaru, V. (2005),** *Farmer's Book* (in Romanian). NGO "BIOS" supported by "CORDAID" and "NOVIB" Dutch Funds. Chisinau: Publishing House "Continental Grup", 264 p.

14. **Boinchan B.P. (1999),** *Organic Farming in the Republic of Moldova* (in Russian). Chisinau, Stiinta, 1999, p. 268.

15. **Bucataru, N., Radionov, V. (1999),** *Breeding Cattle for Milk* (in Romanian). Ministry of Agriculture and Food Industry, Institute for Management and Rural Development. Chisinau, 1999, 32 p.

16. **Bucataru, N., Radionov, V., Urzică, I. (2002),** *Races of Livestock, Poultry and Fish Species Homologated in the Republic of Moldova* (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, 2002, 16 p.

17. **Bucataru, N., Radionov, V., Varban, V. (2003),** *Breeding Sheep and Goats* (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, 72 p.

18. **Bucataru, N. (2003),** *Breeding Horses* (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, 61 p.

19. **Bucataru, N., Maciuc, V. (2005),** *Breeding of Rabbits and Animals for Fur* (in Romanian). National Agency for Rural Development (ACSA). Chisinau: S.E. F.E.-P. Central Printing House, 2005, 96 p.

20. **Bucataru, N., Cosman, S., Holban, D. (2006),** *Milk Production Business* (in Romanian). National Agency for Rural Development. Ch.: S.E. F.E.-P. Central Printing House, 2006, 136 p.

21. **Buza, V., et al. (2007),** *Disaster Risks Management in the Republic of Moldova*. National Agency for Rural Development from the RM / FAO. Chisinau, 2007. 104 p.

22. **Calos, S., Guvir, T. (2006),** *Methodology to Estimate National Greenhouse Gas Emissions (CH_4 and N_2O) from Waste Sector* (in Romanian). International Technical-Scientific Conference "Current Issues of Urbanism and Urban Planning". Collection of articles. Volume II. Section "Water Supply and Sewerage. Environment Protection". Technical University of Moldova, Faculty of Urbanism and Architecture / Engineering and Urban Management Institute. Chisinau, 2006.

23. **Capcelea A., Lozan A., Lupu I., et al. (2011),** *Analytical study on wood mass consumption in the RM* (in Romanian). Agency "Moldsilva", Chisinau, 48 p.

24. **Cascadia Consulting Groups Inc. (2001),** *Waste Composition Study South Hilo Landfill*, County of Hawaii, p. 3-11.

25. **CEC All Union Scientific Research Institute for Water Supply, Sewage, Hydraulic Engineering Works and Engineering Hydrogeology, (VNII VODGEO GOSSTROI of the USSR) (1982),** *Consolidated Norms on Water Supply and Sewerage for Different Branches of Industry* (in Russian). Moscow, 1982. (in Russian)

26. **Chandler, J.A., W.J. Jewell, J.M. Gossett, P.J. Van Soest, and J.B. Robertson. (1980)**. *Predicting methane fermentation biodegradability*. Biotechnology and Bioengineering Symposium No. 10, p. 93-107.

27. **Cerbari, V., Scorpan, V., Taranu, M. (2010),** *The potential for reducing the CO_2 emissions from agriculture 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.

28. **Cerbari, V., Scorpan, V., Taranu, M., Bacean, I. (2012),** *Remedy of the quality state and productivity capacity of common chernozems in the South of Moldova as influenced by some phytotechnology actions.* Mediul Ambiant (Environment), Scientific Journal of Information and Ecological Culture, No. 1 (61), February 2012, P. 38-43.

29. **Cerbari, V., Scorpan, V., Taranu, M., (2012),** *Changing properties of common chernozems in the South of Moldova as influenced by some phytotechnology actions.* In: „Academician I.A. Krupenikov – 100 years": Collection of Scientific Articles / Academy of Sciences of Moldova, Institute of Pedology, Agrochemistry and Soil Protection „N. Dimo", „Eco-TIRAS" International Environmental Association of Dniester River Keepers; Ch.: S.n., 2012, 184 p. (P. 68-76).

30. **Furniture and Wooden Goods Trial and Certification Centre (2003),** *Wood Samples Trial Report* (in Russian). Chisinau, 3 p.

31. **Czech Hydrometeorological Institute (2012),** *National Greenhouse Gas Inventory Report of the Czech Republic (Reported Inventory 2010).* The report was prepared in accordance with the UN Framework Convention on Climate Change related to national inventory submission 2012. Prague, April 2012.

32. **Danish Ministry of the Environment, Environment Protection Agency (2010),** The Greenhouse Gases HFCs, PFCs and SF_6. 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>.

33. **Department for Statistical Analysis of the Republic of Moldova (1994)**, *Energy Balance for 1993 for the Republic of Moldova (without ATULBD)* (in Romanian). Chisinau.

34. **Department for Statistical Analysis of the Republic of Moldova (1994)**, *Statistical Yearbook of the Republic of Moldova, 1993.* Chisinau: "Statistica", 1994, 448 p.

35. **Department for Statistical Analysis of the Republic of Moldova (1995)**, *Energy Balance for 1994 for the Republic of Moldova (without ATULBD)* (in Romanian). Chisinau.

36. **Department for Statistical Analysis of the Republic of Moldova (1995)**, *Statistical Yearbook of the Republic of Moldova, 1994.* Chisinau: Printing and Publishing, 1995, 420 p.

37. **Department for Statistical Analysis of the Republic of Moldova (1996)**, *Statistical Yearbook of the Republic of Moldova, 1995.* Chisinau: Printing and Publishing, 1996, 464 p.

38. **Department for Statistical Analysis of the Republic of Moldova, Main Computing Centre (1996)**, *Energy Balance for 1995 for the Republic of Moldova* (in Romanian). Chisinau.

39. **Department for Statistical Analysis of the Republic of Moldova (1997)**, *Statistical Yearbook of the Republic of Moldova, 1996.* Chisinau: Publishing House "Stiinta", 1997, 528 p.

40. **Department for Statistical Analysis of the Republic of Moldova (1997)**, *Energy Balance for 1996 for the Republic of Moldova* (in Romanian). Chisinau.

41. **Department for Statistical Analysis and Sociology of the Republic of Moldova, Main Computing Centre (1998)**, *Energy Balance for 1997 for the Republic of Moldova* (in Romanian). Chisinau.

42. **Department for Statistical Analysis and Sociology of the Republic of Moldova, Main Computing Centre (1999)**, *Energy Balance for 1998 for the Republic of Moldova* (in Romanian). Chisinau.

43. **Department for Statistical Analysis and Sociology of the Republic of Moldova, Main Computing Centre (2000)**, *Energy Balance for 1999 for the Republic of Moldova* (in Romanian). Chisinau.

44. **Department for Statistical Analysis and Sociology of the Republic of Moldova (2001)**, *Statistical Yearbook of the Republic of Moldova, 1999.* Chisinau: Statistica, 526 p

45. **Department for Statistical Analysis and Sociology of the Republic of Moldova (2001)**, *Energy Balance for 2000 for the Republic of Moldova* (in Romanian). Chisinau.

46. **Department for Statistical Analysis and Sociology of the Republic of Moldova (2002)**, *Energy Balance for 2001 for the Republic of Moldova* (in Romanian). Chisinau.

47. **Department for Statistical Analysis and Sociology of the Republic of Moldova (2003)**, *Statistical Yearbook of the Republic of Moldova, 2003.* Chisinau: Statistica, 704 p

48. **Department for Statistical Analysis and Sociology of the Republic of Moldova (2003)**, *Energy Balance for 2002 for the Republic of Moldova* (in Romanian). Chisinau.

49. **Department for Statistical Analysis and Sociology of the Republic of Moldova (2004)**, *Statistical Yearbook of the Republic of Moldova, 2004.* Chisinau: Statistica, 738 p

50. **Department for Statistical Analysis and Sociology of the Republic of Moldova (2004)**, *Energy Balance for 2003 for the Republic of Moldova* (in Romanian). Chisinau.

51. **Department for Statistical Analysis and Sociology of the Republic of Moldova (2005)**, *Statistical Yearbook of the Republic of Moldova, 2005.* Chisinau: Statistica, 555 p

52. **Diakonova K.V. et al. (1984),** *Recommendations for the Use of Balance and Organic Matter Transformation in Intensive Agricultural Use of Soils* (in Russian), Moscow, 1984, p. 96.

53. **Diakonova K.V. (1990),** *Evaluating the Humus Content and Quality in Soils for Production Models of Soil Fertility* (in Russian), Moscow, 1990, 25 p.

54. **Dobrova, B., Taranu, M. (2000a),** *The assessment of volatile organic compounds emissions from the food - stuffs and alcohol production during the period of 1990-1998.* Articles collection: "Climate change. Researches, studies, solutions", Chisinau, pp.159-160.

55. **Dobrova, B., Taranu, M. (2000b),** *The assessment of volatile organic compounds emissions from the synthetic detergent production during the time period of 1990-1998.* Articles collection: "Climate change. Researches, studies, solutions", Chisinau, pp. 157-158.

56. **Duca Gh., Tugui T.,** *Waste Management* (in Romanian). Chisinau, Publishing House "Stiinta", 2006, 248 p.

57. **ECE Convention on Long-Range Transboundary Air Pollution and European Environment Agency EMEP/CORINAIR (2000),** *Atmospheric Emission Inventory Guidebook.* Second Edition from September 1999, Volumes 1, 2 and 3.

58. **EEA (2005),** *EMEP/CORINAIR Emission Inventory Guidebook – 2005*, European Environment Agency, Technical report No 30. Copenhagen, Denmark, December 2005. (Available on: <http://reports.eea.eu.int/EMEPCORINAIR4/en>).

59. **EEA (2009),** *EMEP/EEA Air Pollution Emission Inventory Guidebook 2009, Technical guidance to prepare national emission inventories.* European Environment Agency, Technical Report No 9/2009. Copenhagen, Denmark, (available on: <http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>).

60. **Environment Protection Agency of Ireland (2012),** *Ireland National Inventory Report 2012.* Greenhouse Gas Emissions 1990-2010 reported to the UN Framework Convention on Climate Change. Johnstown Castle Estate, Co. Wexford, Ireland, 2012.

61. **Federal Office for the Environment FOEN (2012),** *Switzerland's Greenhouse Gas Inventory 1990-2010.* National Inventory Report 2012. Submission of 13 April 2012 to the UN Framework Convention on Climate Change and under the Kyoto Protocol. Bern, April 2012.

62. **Federal Service on Hydrometeorology and Environment Monitoring (Rosgidromet) (2012),** *National Inventory Report of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases not Controlled by the Montreal Protocol 1990-2010* (in Russian). Moscow, 2012.

63. **Food and Agriculture Organization of the United Nations (2013),** FAOSTAT / FAO Statistics Division, 15 February 2013: <http://faostat.fao.org/site/609/DesktopDefault.aspx?PageID=609#ancor>.

64. **Galupa D., Talmaci I., Spitoc L. (2005),** *Project Management Manual "Soil Conservation in Moldova"* (in Romanian). Chisinau, Publishing Centre of the State Agricultural University of Moldova, 206 p.

65. **Galupa D., Talmaci I., Spitoc L. (2005),** *Study for the Republic of Moldova "Ensuring Sustainability of Forests and Livelihoods through Improved Governance and Control of Illegal Logging"* (in Romanian). Chisinau, Publishing Centre of the State Agricultural University of Moldova, 116 p.

66. **Galupa D., Talmaci I., Spitoc L. (2006),** '*Moldova Soil Conservation' Project* (in Romanian). Chisinau, Publishing Centre of the State Agricultural University of Moldova, 18 p.

67. **Galupa D., Talmaci I., Spitoc L. (2006),** *Forestry Sector of the Republic of Moldova – Issues, Accomplishments, Perspectives* (in Romanian). Chisinau, Publishing Centre of the State Agricultural University of Moldova, 27 p.

68. **Galupa D., Talmaci I., Spitoc L., Rotaru P., Rusu A., Boaghie D. (2006),** *Forests and Public Grassland Development in the Republic of Moldova* (in Romanian). Chisinau, Publishing Centre of the State Agricultural University of Moldova, 19 p.

69. **Galupa D., Talmaci I., Spitoc L. (2008),** *Agroforestry Practices and Climate Change in Moldova* (in Romanian). Chisinau, Stiinta, 96 p.

70. **Galupa D., Capcelea A., Talmaci I., Spitoc L. (2010),** *CDM Projects in Afforestation – The Experience of the Republic of Moldova* (in Romanian). Chisinau, Stiinta, 92 p.

71. **Galupa D., Platon I. et al. (2011),** *Report on the Conditions of the Forest Resources in the Republic of Moldova: 2006-2010* (in Romanian). 'Moldsilva' Agency; Ch., 48 p.

72. **Galupa D., Ciobanu A., Scobioală M. et al. (2011),** *Illegal logging of forest vegetation in the Republic of Moldova. Analytical Study.* (in Romanian) Chisinau, Agency 'Moldsilva', 38 p.

73. **Giurgiu V., Decei I., Armăşescu S. (1972),** *Biometry of Trees and Rammels in Romania* (in Romanian). Bucharest, Ceres, p. 703, 728, 747.

74. **Giurgiu V. (1979),** *Dendrometry and Forest Auxology* (in Romanian), Publishing House Ceres, Bucharest.

75. **GOST 10178-95,** *Standard on M-400 Cement Production* (in Russian).

76. **Gumovschi, A. (2004),** *Training Material for the Seminar "Soil Fertility and Fertilization – a Basis for Sustainable and Performing Development of Moldovan Agriculture"* (in Romanian). Training Program for the Customers of 'Agrofos-Grup" J.S.C. Chisinau, 26 p

77. **Ham, R.K., Barlaz M.A. (1987),** *Measurement and Prediction of Landfill Gas Quality and Quantity,* ISWA Symposium on Precess, Technology and Environmental Impact of Sanitary Landfills, Cagliari, Sardinia, Italy, 20 - 23 October 1987, p.VIII, pp 1-24.

78. **Hungarian Meteorological Service (2012),** *National Inventory Report for 1985-2010, Hungary*. Submission under the UN Framework Convention on Climate Change and the Kyoto Protocol. Budapest. May, 2012.

79. **IBNET (2013),** International Benchmarking Network for Water and Sanitation Utilities, <http://www.ib-net.org/en/production/?action=country>.

80. **Iftodi, M., Tugui, T. Garaba, V. (2000),** *Waste ABC* (in Romanian), Chisinau, 2000, p. 12.

81. **Institute of Environmental Protection and Research (2012),** *Italian Greenhouse Gas Inventory 1990-2010. National Inventory Report* 2012. Submission under the UN Framework Convention on Climate Change and the Kyoto Protocol. Rome, Italy. April, 2012.

82. **IPCC (1997),** *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories Vol 1-3,* Intergovernmental Panel on Climate Change.

83. **IPCC/OECD/IEA (2000),** *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories,* Intergovernmental Panel on Climate Change, Organization for Economic Co-operation and Development, and International Energy Agency, Tokyo.

84. **IPCC (2003),** *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. [Internet] Intergovernmental Panel on Climate Change. Available from: <http://www.ipccnggip.iges.or.jp/lulucf/gpglulucf_unedit.html>.

85. **IPCC (2006),** *Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change. Prepared by the National Greenhouse Gas Inventories Programme. Published by Institute for Global Environmental Strategies (IGES). Available from: <http://www.ipcc-nggip.iges.or.jp>.

86. **Isaev, A.S., Korovin, G.H., et al. (1993),** *Estimating CO_2 Removals and Annual Biomass Deposits in Forest Lands of Russian Federation* (in Russian). Forest Science, Journal, Moscow, "Nauka", pp. 3-10.

87. **Isaev, A.S., Korovin, G.H., Suhih, G.I., et al., (1996),** *Ecological issues of CO_2 removals through refforestaration and afforestration in Russian Federation. (Analytical Review)* (in Russian). M., Centre of Ecologic Policy of Russia, 156 p.

88. **Jacobsen, S.T. (1992),** *Chemical Reactions and Air Change During Decomposition of Organics Matters*, Resources Conservation and Recycling, Vol. 6, pp. 259-266.

89. **Joint Stock Company „Moldova Steel Works" (2013),** *Specification for steel products of Moldova Steel Works*: <http://www.aommz.com/pls/webus/webus.main.show?main_id=10&m_id=14>.

90. **Land Relations and Cadaster Agency,** *General Land Cadasters of the Republic of Moldova for the period 1979-2010* (in Romanian).

91. **Law No. 698-3 dated December 13, 2005,** *The State Programme on Domestic and Industrial Waste Management in the ATULBD*: Annex to the Law No. 698-3 from December 13, 2005 // Collection of Normative Acts of the ATULBD – 2006.- Nr. 51. – p. 2127. (in Russian)

92. **Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D. et al. (2003),** The Baseline Study for the Soil Conservation Project in Moldova.

93. **Liurca, I., Ungureanu, D., Ionet, I., Calos, S. (2006),** *Projecting Urban Wastewater Treatment Stations* (in Romanian). Methodological Guidelines for the Wastewater Treatment Project. Technical University of Moldova. Urbanism and Architecture Faculty. Ecotechnics, Economic Management and Water Engineering Department, TUM, 2006.

94. **Kalinin M. I. (1989),** *Root Science* (in Russian), Kiev, Instructional Methodological Service, 194 p.

95. **Krupenkcov I.A. (1967),** *Moldova's Chernozems* (in Russian). Chisinau, 1967, 427 p.

96. **Krupenikov I.A., Gonenco V.P. (1984),** *Chernozems: Comparative Features, Genesis. Humus Conditions* (in Russian). In the book 'Soils of Moldova'. V.1, Chisinau, 1984, pp. 86-96.

97. **Kushudean P. R. (1974),** *Wood Pulp, Indicators of Physical and Mathematical Features* (in Russian). Moscow , TNIIMO.

98. **Lebko G. F., Kaplin N.F. (1996),** *Carbon stocking functions and ripeness of pine and spruce forests of the Russian European Plains. Forestry Economy.* Nr. 1. pp. 33-35.

99. **Likov A.M.** *Methods of Estimating the Humus Balance in Soils Used in Intensive Agriculture* (in Russian). Timiryazev Agricultural Academy Bulletin, 1979. Nr. 6, pp. 14-20.

100. **Lozanovskaia I.N., Orlov D.S., Popov P.D. (1987),** *Theory and Practice in the Use of Organic Fertilizers* (in Russian). Moscow, 1987, pp. 17-24.

101. **Mihailicenko, A.I., Smetanin, I.D. (1987),** *Wood Science and Commodity Science* (in Russian). Forestry Industry. Moscow.

102. **Ministry of Agriculture and Food Industry / Institute of Pedology, Agrochemistry and Hydrology „Nicolae Dimo" (2001),** *National Complex Program of Enhancing Soil Fertility for 2001-2020* (in Romanian). Responsible Editor - associate member of the ASM, Ph.D. S. Andries. Responsible compiler Ph.D., prof. V. Cerbari. Ch.: Pontos, 2001, (Publishing House Reclama).-130 p.

103. **Ministry of Agriculture and Food Industry / Land Relations and Cadaster Agency / Institute of Pedology and Agrochemistry "Nicolae Dimo" / Project Institute for Land Arrangement (2004),** *Complex Program for Degraded Lands Use and Enhancing Soil Fertility. Part I Improving Degraded Lands* (in Romanian). Responsible Editor - associate member of the ASM, Ph.D. S. Andries. Ch.: Pontos, 2004, (Publishing House Reclama).-212 p.

104. **Ministry of Agriculture and Food Industry / Land Relations and Cadastre Agency / Institute of Pedology and Agrochemistry "Nicolae Dimo" / Project Institute for Land Arrangement (2004),** *Complex Program for Degraded Lands Use and Enhancing Soil Fertility. Part II Enhancing Soil Fertility* (in Romanian). Responsible Editor - associate member ASM, Ph.D. S. Andries. Ch.: Pontos, 2004, (Publishing House Reclama). - 128 p.

105. **Ministry of Ecology and Territorial Development / UNDP Moldova (2000),** *First National Communication of the Republic of Moldova,* Submission to the UNFCCC COP-6 on 13th of November 2000.

106. **Ministry of Ecology, Construction and Territorial Development / UNDP Moldova (2002),** *Technological Needs and Development Priorities. Report developed under the United Nations Framework Convention on Climate Change,* Chisinau: Cartdidact, 2002 (Publishing House *Reclama*), 176 p.

107. **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.

108. **Ministry of Ecology, Construction and Territorial Development / National Institute of Ecology (2004),** *Identification, Description and Assessment of a Potential Direct or Indirect Environmental Impact of the Project "Management of Oil Deposits and Oil and Gas Prospecting in Valeni" by "REDECO Moldova" Company LTD* (in Romanian), Chisinau, 2004.

109. **Ministry of Ecology and Natural Resources / National Institute of Ecology (2004),** *State of the Environment in the Republic of Moldova in 2003 (National Report).* Chisinau, National Institute of Ecology, 2004, 130 p.

110. **Ministry of Ecology and Natural Resources / National Institute of Ecology (2005),** *State of the Environment in the Republic of Moldova in 2004 (National Report).* Chisinau, National Institute of Ecology, 2005, 123 p.

111. **Ministry of Ecology and Natural Resources / Academy of Sciences of the Republic of Moldova/ Institute of Ecology and Geography (2006),** *State of the Environment in the Republic of Moldova in 2005 (National Report).* Chisinau, Institute of Ecology and Geography, 2006, 116 p.

112. **Ministry of Ecology and Natural Resources / Academy of Sciences of the Republic of Moldova/ Institute of Ecology and Geography (2007),** *State of the Environment in the Republic of Moldova in 2006 (National Report).* Ch.: S.n., 2007, 103 p.

113. **Ministry of Ecology and Natural Resources of the Republic of Moldova (2008),** *Environment Protection in the Republic of Moldova: (National Report for the Ministerial Conference in Belgrade, Serbia)* – Chisinau, 2008, - 64 p.

114. **Ministry of Ecology and Natural Resources, State Ecological Inspectorate (2008),** *SEI Yearbook "Quality of the Environment and the State Ecological Inspectorate Activity – 2007"* – Chisinau, 2008 – 202 p.

115. **Ministry of Ecology and Natural Resources of Ukraine, State Environmental Investment Agency of Ukraine (2012),** National Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases in Ukraine for 1990-2010, Kiev, 2012.

116. **Ministry of Environment (2011),** *State of the Environment in the Republic of Moldova, 2007-2010. (National Report).* – Ch.: S.n., (Publishing House „Nova-Imprim"). – 2011. – 192 p.

117. **Ministry of Environment of Estonia (2012),** *Greenhouse Gas Emissions in Estonia 1990-2010.* National Inventory Report under the UN Framework Convention on Climate Change and the Kyoto Protocol. Common Reporting Formats (CRF) 1990-2010. Tallinn, 2012.

118. **Ministry of Environment of Lithuania (2012),** *Lithuania's National Greenhouse Gas Inventory Report 1990-2010.* Submission under the UN Framework Convention on Climate Change, Kyoto Protocol and EU Decision No 280/2004/EC. Vilnius, 2012.

119. **Ministry of Environment Protection and Regional Development of the Republic of Latvia (2012),** *Latvia's National Inventory Report 1990-2010.* Submission under the UN Framework Convention on Climate Change and the Kyoto Protocol. Common Reporting Formats (CRF) 1990-2010. Riga, 2012.

120. **Ministry of Environment Protection of the Republic of Kazakhstan, Republican State Enterprise "Kazakh Research Institute of Ecology and Climate" (2012),** *National Inventory Report of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases not Controlled by the Montreal Protocol for 1990-2010.* Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, Almaty, 2012. (in Russian)

121. **Ministry of Environment, Energy and Climate Change of Greece (2012),** *Climate Change Emissions Inventory.* Annual Inventory Submission under the UN Framework Convention on Climate Change and the Kyoto Protocol for Greenhouse and other Gases for the years 1990-2010. Athena, 2012.

122. **Ministry of Environment of New Zealand (2012),** *New Zealand's Greenhouse Gas Inventory 1990-2010.* Submission under the UN Framework Convention on Climate Change and Kyoto Protocol. Wellington, 2012.

123. **Ministry of Environment of Republic of Moldova / United Nations Environmental Programme (2009),** *Second National Communication of the Republic of Moldova under the UNFCCC.* Coord.: Violeta Ivanov, George Mangul. Synthesis team: Vasile Scorpan, Marius Taranu, Petru Todos, Ilie Boian. – Ch.: "Bons Offices" SRL, 2009. – 316 p.

124. **Ministry of Environment of Republic of Moldova / United Nations Environmental Programme (2009),** *National Inventory Report: 1990-2005. Greenhouse Gas Sources and Sinks in the Republic of Moldova.* Coord.: Violeta Ivanov, George Manful. Project team: Vasile Scorpan, Aliona Solomon. Authors: Marius Taranu, Vasile Scorpan, Elena Bicova, Vladimir Brega, Anatol Tarita, Ion Bacean, Violeta Paginu, Ion Talmaci, Anatol Banaru, Tatiana Tugui, Sergiu Calos.– Ch.: "Continental Grup" SRL, 2009. – 352 p.

125. **Ministry of Environment and Forests of Romania, National Environmental protection Agency (2012),** *Romania's Greenhouse Gas Inventory 1989-2010. National Inventory Report.* Submitted under the UNFCCC and its Kyoto Protocol. Bucuresti. March, 2012.

126. **Ministry of Environment and Water of the Republic of Bulgaria, Executive Environment Agency (2012),** *National Inventory Report 2012 for Greenhouse Gas Emissions.* Submitted under the UNFCCC. Sofia. April, 2012.

127. **Ministry of Industry of the Transnistrian Moldovan Republic (2003),** *Order No. 359/102 Temporary Provisions "On Industrial and Domestic Waste" and "On Organizations Involved in Waste Disposal and Neutralization".* (in Russian)

128. **Ministry of Industry of the Transnistrian Moldovan Republic (2005),** *Order No. 511 dated 25.05.2005 "Rules for urban improvements, landscaping, cleanliness and order maintaining on the territory of the TMR municipalities".* (in Russian)

129. **Ministry of Natural Resources and Environment Protection of Belarus, Scientific and Research Republican Unitary Enterprise BelNIT "Ecology" (2012),** *National Inventory Report of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases not Controlled by the Montreal Protocol for 1990–2010.* Submitted under the United Nations Framework Convention on Climate Change. Minsk, 2012. (in Russian)

130. **Ministère du développement durable et des infrastructures – Administration de l'Environnement (2012),** *Luxembourg's National Inventory Report 1990-2010.* Submission under the United Nations Framework Convention on Climate Change and under the Kyoto Protocol. Luxembourg, April 2012.

131. **National Agency for Energy Regulation (2009),** *Activity Report of the National Agency for Energy Regulation for 2008 year.* Chisinau, 2009. – 33 p.

132. **National Agency for Energy Regulation (2010),** *Activity Report of the National Agency for Energy Regulation for 2009 year.* Chisinau, 2010. – 55 p.

133. **National Agency for Energy Regulation (2011),** *Activity Report of the National Agency for Energy Regulation for 2010 year.* Chisinau, 2011. – 70 p.

134. **National Agency for Energy Regulation (2011),** *Activity Report of the National Agency for Energy Regulation for 2011 year.* Chisinau, 2011. – 57 p.

135. **National Agency for Energy Regulation (2012),** *Activity Report of the National Agency for Energy Regulation for 2012 year*. Chisinau, 2012. – 70 p.

136. **National Bureau of Statistics of the Republic of Moldova (2005)**, *Agricultural Activity of Households and Farms in the Republic of Moldova, in 2004 (Results of Statistic Survey).* Editorial Board: V. Valcov (Chairman), – Ch.: Statistica, 2005 (Publishing House S.A. "CRIO"), 58 p.

137. **National Bureau of Statistics of the Republic of Moldova (2005)**, *Energy Balance of the Republic of Moldova 2004.* Chisinau.

138. **National Bureau of Statistics of the Republic of Moldova (2006)**, *Agricultural Activity of Households and Farms in the Republic of Moldova, in 2005 (Results of Statistic Survey).* Editorial Board: V. Valcov (Chairman), – Ch.: Statistica, 2006 (Publishing House S.A. "CRIO"), 53 p.

139. **National Bureau of Statistics of the Republic of Moldova (2006)**, *Energy Balance for 2005 for the Republic of Moldova.* Chisinau.

140. **National Bureau of Statistics of the Republic of Moldova (2006)**, *Statistical Yearbooks of the Republic of Moldova, 2006.* Chisinau, (S.E.. F.E.-P. Central Printing House) – Statistics of Moldova, 560 p.

141. **National Bureau of Statistics of the Republic of Moldova (2007)**, *Energy Balance of the Republic of Moldova 2006. Collection of Statistics.* Chisinau: Statistica, 2007 (Printing and Publishing), 121 p.

142. **National Bureau of Statistics of the Republic of Moldova (2007)**, *Statistical Yearbooks of the Republic of Moldova, 2007.* Chisinau, 2007, 560 p.

143. **National Bureau of Statistics of the Republic of Moldova (2008),** *Agricultural Activity of Households and Farms in the Republic of Moldova, in 2007 (Results of Statistic Survey).* Editorial Board: V. Golovatiuc, O. Cara, E. Orlova [et al.] – Ch.: Statistica, 2008, (F.E.-P. Central Printing House). – (Statistics of Moldova) – 54 p.

144. **National Bureau of Statistics of the Republic of Moldova (2008)**, *Energy Balance of the Republic of Moldova 2007. Collection of Statistics.* Chisinau: Statistica, 2008 (Printing and Publishing), 129 p.

145. **National Bureau of Statistics of the Republic of Moldova (2008),** *Statistical Yearbooks of the Republic of Moldova, 2008*. Chisinau, 2008, (F.E.-P. Central Printing House). - (Statistics of Moldova). 580 p.

146. **National Bureau of Statistics of the Republic of Moldova (2009),** *Agricultural Activity of Households and Farms in the Republic of Moldova, in 2008 (Results of Statistic Survey).* Editorial Board: V. Golovatiuc, O. Cara, E. Orlova T. Bargan, A. Manziuc, M. Chiperi, T. Isac – Chisinau, 2009. – 53 p.

147. **National Bureau of Statistics of the Republic of Moldova (2009)**, *Energy Balance of the Republic of Moldova 2008. Collection of Statistics.* Chisinau: Statistica, 2009 (Printing and Publishing), 129 p.

148. **National Bureau of Statistics of the Republic of Moldova (2009),** *Statistical Yearbooks of the Republic of Moldova, 2009*. Ch.: Statistica, 2009 (F.E.-P. Central Printing House). - (Statistics of Moldova). 576 p.

149. **National Bureau of Statistics of the Republic of Moldova (2010),** *Agricultural Activity of Households and Farms in the Republic of Moldova, in 2009 (Results of Statistic Survey).* Editorial Board: L. Spoiala, O. Cara, E. Orlova T. Bargan, A. Manziuc, M. Chiperi, T. Isac – Chisinau, 2010. – 33 p.

150. **National Bureau of Statistics of the Republic of Moldova (2010)**, *Energy Balance of the Republic of Moldova 2009. Collection of Statistics.* Chisinau: Statistica, 2010 (Statistics of Moldova), 178 p.

151. **National Bureau of Statistics of the Republic of Moldova (2010),** *Statistical Yearbooks of the Republic of Moldova, 2010*. Ch.: Statistica, 2010 (F.E.-P. Central Printing House). - (Statistics of Moldova). 572 p.

152. **National Bureau of Statistics of the Republic of Moldova (2011),** *Results of Statistic Survey on Agricultural Activity of Households and Farms in the Republic of Moldova in 2010 (in tables).* Editorial Board: L. Spoiala, O. Cara, E. Orlova T. Bargan, A. Manziuc, M. Chiperi, T. Isac – Chisinau, 2011. – 30 p.

153. **National Bureau of Statistics of the Republic of Moldova (2011)**, *Energy Balance of the Republic of Moldova 2010. Collection of Statistics.* Chisinau: Statistica, 2011 (Statistics of Moldova), 71 p.

154. **National Bureau of Statistics of the Republic of Moldova (2011),** *Statistical Yearbooks of the Republic of Moldova, 2011*. Ch.: Statistica, 2011 (EUROPRES). - (Statistics of Moldova). 564 p.

155. **National Bureau of Statistics of the Republic of Moldova (1990-2011),** *Statistical Annual Report Nr. 24-agr „Animal Breeding Sector". The Number of Livestock and Poultry in All Households Categories as of 1st of January (Annual Reports for 1990-2011).*

156. **National Bureau of Statistics of the Republic of Moldova (1990-2011),** *Statistical Annual Report Nr. 24-agr „Animal Breeding Sector". Basic Indicators of Animal Breeding Sector Development in All Household Categories in the Republic of Moldova (Annual Reports for 1990-2011).*

157. **National Bureau of Statistics of the Republic of Moldova (2012),** *Agricultural Activity of Households and Farms in the Republic of Moldova in 2011 (in tables).* Editorial Board: L. Spoiala, O. Cara, E. Orlova T. Bargan, A. Manziuc, M. Chiperi, T. Isac – Chisinau, 2012. – 30 p.

158.**National Bureau of Statistics of the Republic of Moldova (2012)**, *Energy Balance of the Republic of Moldova 2011. Collection of Statistics.* Chisinau: Statistica, 2012 (Statistics of Moldova), 73 p.

159.**National Bureau of Statistics of the Republic of Moldova (2012),** *Statistical Yearbooks of the Republic of Moldova, 2012.* Ch.: Statistica, 2012 (S.E. F.E.-P. Central Printing House). - (Statistics of Moldova). 560 p.

160.**National Bureau of Statistics of the Republic of Moldova (2013),** Statistical Database: <http://statbank.statistica.md/pxweb/Dialog/varval.asp?ma=IND0301&ti=Productia+principalelor+produse+industriale%2C+1997-2011&path=../Database/RO/14%20IND/IND03/&lang =1>.

161.**National Bureau of Statistics of the Republic of Moldova (2013),** Statistical Database. Revised Indicators of the Millennium Development Goals, 2000-2010: <http://statbank.statistica.md/pxweb/Dialog/varval.asp?ma=ODM0101&ti=Indicatorii+revizuiti+ai+Obiectivelor+Dezvoltarii+Mileniului%2C+2000-2011&path=../Database/RO/ODM/&lang=1>

162.**National Centre for Emission Management (KOBiZE) at the Institute of Environment Protection – National research Institute (2012),** *Poland's National Inventory Report 2012. Greenhouse Gas Inventory for 1988-2010.* Submission under the UN Framework Convention on Climate Change and its Kyoto Protocol. Warsaw, Poland. May, 2012.

163.**National Environment Research Institute, Aarhus University (2012),** *Denmark's National Inventory Report 2012 – Emission Inventories 1990 – 2010 – Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol.* Scientific Report from DCE – Danish Centre for Environment and Energy No. 19. April 2012.

164.**National Institute for Public Health and the Environment, Ministry of Health, Welfare and Sport (2012),** *Greenhouse Gas Emissions in the Netherlands 1990-2010. National Inventory Report 2012.* Report prepared for submission in accordance with the UN Framework Convention on Climate Change and the European Union's Greenhouse Gas Monitoring Mechanism (including electronic Excel spreadsheet files containing the Common Reporting Format (CRF) data for 1990 to 2010). RIVM Report 680355007/2012. AH Bilthoven, the Netherlands. RIVM, 2012.

165.**Naziuta L.I. (2010),** *Analysis of the Ukrainian Market of Scrap Metal. Strategic Aspects* (in Russian). Ukrainian Steelmakers Association (USA). Press Portal on Ferrous and Nonferrous Metallurgy: <http://uas.su/articles/steelmaking/00002.php>.

166.**Negulescu M. Gh. et al. (1968),** I*ndustrial Wastewater Treatment (in Romanian).* Publishing House Tehnica, Bucharest, 1968.

167.**Nicolaev N., Boincean B., Sidorov M., Vanicovici G., Coltun V. (2006),** *Agrotechnics (in Romanian).* Ministry of Education and Youth of the Republic of Moldova. – Balti: Presa universitara balteana, 2006, - p. 298.

168.**Official Monitor Nr. 46-49 (27.04.2000),** *Government Resolution No. 367 as of 13.04.2000 on approving the 'National Action Plan to Combat Desertification'.*

169.**Order of the Federal Forestry Agency of the Russian Federation No. 523 dated 29.12.2007,** *Annex 4 "Technical guidance on localization and liquidations of pests outbreaks"* (in Russian).

170.**Osadchev, V.G., Ivankov, P.T., Sergovski, P.S., et al. (1955),** *Handbook on Woodworking (for Forest Farms Consumer Goods Manufacturing Workshops)* (in Russian). Moscow, 1955.

171.**Parvu Gh., Costea M., Pirvu M., Nicolae B. (2003),** *Treaty on Animal Nutrition*, Bucuresti, 2003, p. 368.

172.**Popov P.D., Chiukov A.I., Lukin S.M., Masaleva V.V. (1987),** *Calculation of Humus Balance and the Need for Organic Fertilizers* (in Russian). Vladimir, 1987, p. 15.

173.**Portuguese Environmental Agency (2012),** *Portuguese National Inventory Report on Greenhouse Gases, 1990-2010.* Submitted under the UN Framework Convention on Climate Change and the Kyoto Protocol. Amadora, Portugal. May, 2012.

174.**Postolache Gh. (1995),** *Vegetation of the Republic of Moldova (in Romanian).* Chisinau, "Stiinta", 340 p.

175. **Rusu M., Marghitas M., Oroian I., Mihailescu T., Dumitras A. (2005),** *Agrochemistry Treaty.* (in Romanian), Bucuresti, Publishing House Ceres, 2005. 672 p.

176.**Raileanu I., Jolondcovschi A., Arhip O., Botezatu S., Renita A. (2006),** *Practical Guidebook. Manure Management (in Romanian).* Ministry of Environment and Natural Resources of the Republic of Moldova. Ch.: Bons Offices, 2006. - 68 p.

177.**Shvidenko, A.Z., Savich, I.N. (1987),** *Reference Materials for Valuation of Forests in Ukraine and Moldova* (in Russian). "Urozhai", Kiev, Ukraine, pp. 162, 216, 232, 273, 320.

178.**State Committee on Statistics of the Moldavian Soviet Socialist Republic (1989),** *National Economy of MSSR, 1988. Statistical Yearbook (in Romanian).* Chisinau, Cartea Moldoveneasca, 1989. 387 p.

179.**State Committee on Statistics of the Transnistrian Moldovan Republic (1998),** *Statistical Yearbook of the Transnistrian Moldovan Republic, Statistical Collection (for 1990, 1995-1997).* TMR (ATULBD). – Tiraspol, 1998. – 254 p. (in Russian).

180.**State Committee on Statistics of the Transnistrian Moldovan Republic (2000),** *Statistical Yearbook of the Transnistrian Moldovan Republic, Statistical Collection* *(for 1990, 1995-1999).* TMR (ATULBD). – Tiraspol, 2000. – 185 p. (in Russian).

181. **State Department for Statistical Analysis of the Republic of Moldova (1992)**, *National Economy of the Republic of Moldova, 1991. Statistical Yearbook.* Ch.: C.P.C. Publishing House, 406 p.

182. **State Department for Statistical Analysis of the Republic of Moldova (1994)**, *Statistical Yearbook of the Republic of Moldova, 1992.* Ch.: Universitas, 1994, 372 p.

183. **State Ecological Inspectorate (2009),** *SEI Yearbook – 2008 „Environment Protection in the Republic of Moldova"* / Stamatin I., Apostol A., Mustea M. [et al.]. – Ch.: „A.V.i.T. Publ", 2009 (Publishing House "Continental-Grup"). – 288 p.

184. **State Ecological Inspectorate (2011),** *SEI Yearbook – 2010 „ Environment Protection in the Republic of Moldova"*; editorial board: Prisacaru G., Tapis V., Stangaci V. [et al.]. – Ch.: S.n., 2011 (Publishing House - "Sirius" SRL) – 232 p.

185. **State Ecological Inspectorate (2012),** *SEI Yearbook – 2011 „ Environment Protection in the Republic of Moldova"*; editorial board: Prisacaru G., Tapis V., Stingaci V. [et al.]. – Ch.: Continental Grup, 2012. – 248 p.

186. **Statistics Finland (2012),** *Greenhouse Gas Emissions in Finland 1990-2010.* National Inventory Report to the UN Framework Convention on Climate Change and the Kyoto Protocol. 13 April, 2012.

187. **State Statistical Service of the Ministry of Economy of the Transnistrian Moldovan Republic (2002),** *Statistical Yearbook of the Transnistrian Moldovan Republic -2002, Statistical Collection (for 1996-2001).* TMR (ATULBD). – Tiraspol, 2002. – 190 p. (in Russian).

188. **State Statistical Service of the Ministry of Economy of the Transnistrian Moldovan Republic (2005),** *Statistical Yearbook of the Transnistrian Moldovan Republic -2005, Statistical Collection (for 2000-2004).* TMR (ATULBD). – Tiraspol, 2005. – 189 p. (in Russian).

189. **State Statistical Service of the Ministry of Economy of the Transnistrian Moldovan Republic (2006),** *Statistical Yearbook of the Transnistrian Moldovan Republic -2006, Statistical Collection (for 2001-2005).* TMR (ATULBD). – Tiraspol, 2006. – 188 p. (in Russian).

190. **State Statistical Service of the Ministry of Economy of the Transnistrian Moldovan Republic (2010),** *Statistical Yearbook of the Transnistrian Moldovan Republic -2010, Statistical Collection (for 2005-2009).* TMR (ATULBD). – Tiraspol, 2010 – 181 p. (in Russian).

191. **State Statistical Service of the Ministry of Economy of the Transnistrian Moldovan Republic (2011),** *Statistical Yearbook of the Transnistrian Moldovan Republic -2011, Statistical Collection (for 2006-2010).* TMR (ATULBD). – Tiraspol, 2011 – 184 p. (in Russian).

192. **State Statistical Service of the Ministry of Economy of the Transnistrian Moldovan Republic (2012),** *Statistical Yearbook of the Transnistrian Moldovan Republic -2012, Statistical Collection (for 2007-2011).* TMR (ATULBD). – Tiraspol, 2012 – 188 p. (in Russian).

193. **State Statistical Service of the Transnistrian Moldovan Republic (2010),** *Socio-Economic Development of TMR (ATULBD) in 2009*. Tiraspol, 2010. 75 p. (in Russian).

194. **State Statistical Service of the Transnistrian Moldovan Republic (2011),** *Socio-Economic Development of TMR (ATULBD) in 2010*. Tiraspol, 2011. 79 p. (in Russian).

195. **State Statistical Service of the Transnistrian Moldovan Republic (2012),** *Socio-Economic Development of TMR (ATULBD) in 2011*. Tiraspol, 2012. 85 p. (in Russian).

196. **State University of Florida, (1996),** *Methodology for Conducting Composition Study for Discarded Solid Waste*, 1996.

197. **Stroiizdat (1981),** *Sewage Systems in Settlements and Industrial Enterprises* (in Russian). Projector's Guidebook. Moscow, 1981.

198. **Sabanova G. A., Bulat A., Tofan E. (2005),** *Report on Floristic and Plant Formation Diversity of Herbaceous Stratum by Sectors under the Project Conservation of Soils in Moldova* (in Romanian). Chisinau, ICAS.

199. **Talmaci I. (2006),** *Initial Stage of Moldova Soil Conservation Project Monitoring* (in Romanian). International Conference "Scientific and Practical Aspects of the Forestry Sector Sustainable Development". Chisinau, Publishing Centre of SAUM, pp. 58-64.

200. **Talmaci I. (2006),** *Aspects of the Forest Vegetation Contribution to GHG Removals in the Republic of Moldova* (in Romanian). International Conference "Scientific and Practical Aspects of the Forestry Sector Sustainable Development". Chisinau, Publishing Centre of SAUM, p. 65-68.

201. **Toma S. (2008),** *Fertilizers Use in Sustainable Agriculture.* (in Romanian) Chisinau, 2008. (Publishing Centre of ASM), -212 p.

202. **Toncea I. (2006),** *Pure and Simple Compost* (in Romanian). Bucharest, 2003. - 31 p.

203. **Tiurin I.V. (1965),** *Organic Matter in Soil and its Role in Soil Fertility* (in Russian). Moscow, 1965, 320 p.

204. **Taranu, M., Galitchii, S. (2000),** *The calculation of greenhouse gases emissions generated within the Metallurgical Industry during the years 1990-1998.* Articles collection: "Climate change: Researches, studies, solutions", Chisinau, pp.133-135.

205. **Taranu, M., Filatov, C. (2000),** *The calculation of greenhouse gases emissions from the industrial processes for the*

period 1990-1998. Articles collection: "Climate change. Researches, studies, solutions", Chisinau, pp.136-141.

206.Taranu, M., Scorpan, V., Duca, Gh., Tugui, T., Filatov, C. (2005), *The Assessment* of GHG Emissions from Ferrous Metal Production for the period of 1990-2002 in Moldova. The 3rd International Conference "Ecological Chemistry", May 20-21 2005, Chisinau, Moldova. Book of Proceedings, pp.368-376.

207.Taranu, M. (2006), *Development of the Republic of Moldova's Greenhouse Gas Inventory for 1990-2002.* Mediul Ambiant (Environment), Scientific Journal of Information and Ecological Culture, No. 4 (28), August 2006, ISSN: 1810-9551. pp. 42-46.

208.Taranu, M., Brega, V., Scorpan, V. (2007), *GHG Emissions from Cement Production in the Republic of Moldova in the time period from 1988 through 2005* (in Romanian). Environment (Mediul Ambiant), Scientific Journal of Information and Ecological Culture, Nr. 4 (34), August 2007, ISSN: 1810-9551. pp. 34-37.

209.Taranu, M., Brega, V., Scorpan, V., Paginu, V. (2007), *GHG Emissions from Bricks Production in the Republic of Moldova in the time period from 1988 through 2005* (in Romanian). Environment (Mediul Ambiant), Scientific Journal of Information and Ecological Culture, Nr. 5 (35), October 2007, ISSN: 1810-9551. pp. 36-38.

210.Tugui, T., Duca, Gh., Taranu, M., Mirza, V., Dragutan, I. (2004), *Municipal solid waste composition study.* The Bulletin of the Academy of Sciences of Moldova, Series „Biological, Chemical and Agricultural Sciences". Chisinau, N.4, pp. 114-119.

211.Tugui, T. (2005), *Solid Waste Management in the Republic of Moldova* (in Romanian). The 3rd International Conference "Ecological Chemistry", May 20-21 2005, Chisinau, Moldova. Abstracts, pp.364-365.

212.Tugui, T., Duca, Gh., Taranu, M., Copacinschi, Gh., Dragutan, I. (2005), *Landfill gas emissions measurements in the Republic of Moldova* (in Romanian). The 3rd International Conference „Ecological Chemistry", May 20-21 2005, Chisinau, Moldova. Abstracts, pp.365-366.

213.Tugui, T. (2005), *Strategic Elements in Planning Solid Waste Management in Compliance with EU Directives* (in Romanian). The 3rd International Conference „Ecological Chemistry", May 20-21 2005, Chisinau, Moldova. Book of Proceedings, pp.591-597.

214.Tugui, T., Duca, Gh., Taranu, M., Copacinschi, Gh., Dragutan, I. (2005), *Assessment of Landfill Gas Generation.* The International Conference „Hazards Mitigation", October 6-7 2005, Chisinau, Moldova. Abstracts and Communications, pp.219-225.

215.Tugui, T. (2007), *Landfill inventory in the Republic of Moldova: problems and solutions*, Environmental Engineering and Management Journal, „Gh. Asachi Technical University" of Iasi, July/August 2007, Vol. 6, no.4, pp.269-275.

216.Turcan M., Banaru A. (1994), *Methodological Guidelines for the Determination of Humus Content in Moldova's Soils* (in Romanian). Chisinau, 1994. p.-24.

217.Vanin S. I. (1949), *Wood Science* (in Russian). Moscow

218.Ukrainian Forest Management Enterprise, (1988), *Forestry Resources of the Moldovan SSR as of 1.01.1988* (in Russian). Irpeni.

219.Ukrainian Forest Management Enterprise (1987), *Joint Project on Management and Development of Forestry and Forest Enterprises of the Ministry of Forestry of the MSSR* (in Russian). Vol. 1, Irpeni.

220.Umweltbundesamt (Environment Agency Austria) (2012), *Austria's National Inventory Report 2012.* Submission under the UN Framework Convention on Climate Change. Report REP-0381. Vienna, 2012.

221.UNFCCC (2002), *Decision 17/CP.8: Guidelines for the preparation of the national communications from Parties not included in Annex I to the Convention.* Conference of Parties (COP 8) of the United Nations Framework Convention on Climate Change (UNFCCC), held in October-November 2002.

222.UNFCCC (2002), *User Manual for guidelines on national communications from non-Annex I Parties.* Climate Change Secretariat (UNFCCC), Bonn, Germany.

223.UNFCCC (2005), Consultative Group of Experts on National Communications from Parties not Included in Annex I to the UNFCCC (2005), *Handbook on Industrial Processes Sector*. 26 p.

224.UNFCCC (2005), Consultative Group of Experts on National Communications from Parties not included in Annex I to the UNFCCC, *Handbook on Agriculture Sector*. 33 p.

225.UNFCCC (2012), GHG Locator (v3.4), contains the submission year 2012 inventory data.

226.Ungureanu V.G., et al. (1997), *Ways to Control and Set-up a Positive Humus Balance in Moldova's Soils* (in Russian), Chisinau, 1997, 47 p.

227.Ungureanu V., Cerbari V., Magdil A., Gherman E. (2006), *Environmental Friendly Agricultural Practices Guidebook* (in Romanian). Pollution Control in Agriculture Project. National Rural Development Agency. Ch.: S.E. F.E.-P. Central Printing House, 2006, 96 p.

228.Utkin, A. I. (1995), *Carbon Cycle and Forestry Management* (in Russian). Forest Science, No. 5, pp. 3-20.

229.Utkin, A. I., Zamolodchikov, D. G., Gulbe T. A., Gulbe I. I. (1996), *Allometric Equations for Biomass Based on Data on Pines, Spruce, Birch Trees and Aspen in the European Part of Russia* (in Russian). Forest Science, Nr. 6, pp. 36-46.

ANNEXES

Annex 1. Key Categories

Annex 1-1: Key Categories - Methodology

Both the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000) and the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003) recommend as good practice the identification of key categories of emissions and removals. The intent is to help inventory agencies prioritize their efforts to improve overall estimates. A key category is defined as "one that is prioritize within the national inventory system because its estimates 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" (IPCC, 2000).

This annex describes the category analysis conducted for the Republic of Moldova's inventory (covering the 1990-2010 time-series), according to IPCC approaches.

Good Practice first requires that inventories be disaggregated into categories from which key sources and sinks may be identified. Source and sink categories are defined according to the following guidelines:

- IPCC categories should be used with emissions specified in CO_2 equivalent units according to standard GWPs;
- A category should be identified for each gas emitted by the source, since the methods, emission factors, and related uncertainties differ for each gas;
- Source categories that use the same emission factors based on common assumptions should be aggregated before analysis.

The analysis of categories for key sources and sinks proceeds according to the Tier 1 Good Practice Guidance approaches of IPCC (2000, 2003). Using the Tier 1 method, key categories were identified by quantitative methods using a predetermined cumulative emission threshold.

The quantitative approach identifies key categories from two perspectives. The first analyses the emission contribution that each category makes to the national total (with and without LULUCF). The second perspective analyses 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 (with and without LULUCF categories). The per cent contributions to both levels and trends in emissions are calculated and sorted from greatest to least. A cumulative total is calculated for both approaches. IPCC 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 method of determining key categories (IPCC, 2000). The 95 per cent cumulative contribution threshold has been used in this analysis to define an upper boundary for key category identification. 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 are considered quantitatively to be key.

Level contribution of each source is calculated according to Equation A1– 1, which follows IPCC (2000), whereas Equation A1– 2 is used to calculate the level contribution from both sources and sinks following IPCC (2003):

Equation A1-1.1 for source category level assessment:

$$L_{x,t} = E_{x,t} / E_t$$

Where:

$L_{x,t}$ – the level assessment for source x in year t;

$E_{x,t}$ – the emission estimate (CO_2 eq.) estimate of source category x in year t

E_t – the total inventory estimate (CO_2 eq.) in year *t*

Equation A1-1.2 for source/sink category level assessment:

$$L_{x,t}^* = E_{x,t}^* / E_t^*$$

Where:

$L_{x,t}^*$ – level assessment for source or sink x in year t. The asterisk (*) indicates that contributions from all categories (including LULUCF) are entered as absolute values (i.e. negative values are always recorded as the equivalent positive values);

$E_{x,t}^*$ – $E_{x,t}|$ the absolute value of the emission or removal estimate of source or sink category x in year t;

E_t^* – $\Sigma|E_t|$ total contribution, which is the sum of the absolute values of all emissions and removals in year t.

Trend contribution of each source is calculated according to Equation A1– 3, which follows IPCC (2000), whereas Equation A1– 4 is used to calculate the trend contribution from both sources and sinks following IPCC (2003):

Equation A1-1.3 for source category trend assessment:

$$T_{x,t} = L_{x,t} \bullet |\{[(E_{x,t} - E_{x,0})/E_{x,t}] - [(E_t - E_0)/E_t]\}|$$

Where:

$T_{x,t}$ – the contribution of the source category trend to the overall inventory trend (i.e. the trend assessment); the contribution is always recorded as an absolute value;

$L_{x,t}$ – the level assessment for source x in year t (derived in Equation A1-1.1);

$E_{x,t}$ and $E_{x,0}$ – the emissions estimates of source category x in years t and 0, respectively;

E_t and E_0 – the total inventory estimates in years t and 0, respectively.

Equation A1-1.4 for source and sink category trend assessment:

$$T_{x,t} = E_{x,t}^{*}/E_t \bullet |\{[(E_{x,t} - E_{x,0})/E_{x,t}] - [(E_t - E_0) / E_t]\}|$$

Where:

$T_{x,t}$ – trend assessment, which is the contribution of the source or sink category trend to the overall inventory trend (i.e. the trend assessment); the trend assessment is always recorded as an absolute value (i.e. the trend assessment); the contribution is always recorded as an absolute value);

$E_{x,t}^{*}$ – $|E_{x,t}|$: absolute value of the emission or removal estimate of source or sink category x in year t;

$E_{x,t}$ and $E_{x,0}$ – real values of estimates of source or sink category x in years t and 0, respectively;

E_t and E_0 – ΣE_t and ΣE_0 total inventory estimates in years t and 0, respectively; E_t differs from E_t^{*} in Equation A1-1.2 in that the removals are not entered as absolute values.

The key sources analysis was performed using the Key Emissions Estimation Tool developed by the United States Environment Protection Agency (US EPA).

Annex 1-2: 1990 Key Sources Category Tier 1 Analysis – Level Assessment, Without LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Energy Industries - Oil	Energy	6785.7360	15.69%	15.69%	key source
CO_2 Emissions from Energy Industries - Coal	Energy	6394.4000	14.78%	30.47%	key source
CO_2 Emissions from Energy Industries - Gas	Energy	6152.6295	14.22%	44.69%	key source
CO_2 Emissions from Other Sectors: Residential	Energy	4407.6336	10.19%	54.88%	key source
CO_2 Emissions from Mobile Combustion: Road Vehicles	Energy	3364.2178	7.78%	62.66%	key source
CO_2 Emissions from Manufacturing Industries and Construction	Energy	2188.7285	5.06%	67.71%	key source
CO_2 Emissions from Other Sectors: Agriculture / Forestry / Fishing	Energy	1942.3629	4.49%	72.20%	key source
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1834.3768	4.24%	76.45%	key source
CO_2 Emissions from Other Sectors: Commercial / Institutional	Energy	1412.4933	3.27%	79.71%	key source
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1320.0836	3.05%	82.76%	key source
N_2O Direct Emissions from Agricultural Soils	Agriculture	1262.6598	2.92%	85.68%	key source
N_2O Direct Emissions from Manure Management	Agriculture	1116.3560	2.58%	88.26%	key source
CO_2 Emissions from Cement Production	Industrial Processes	971.7056	2.25%	90.51%	key source
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	1.58%	92.08%	key source
CO_2 Emissions from Limestone and Dolomite Use	Industrial Processes	619.4745	1.43%	93.52%	key source
CO_2 Emissions from Mobile Combustion: Railways	Energy	452.3598	1.05%	94.56%	key source
N_2O Indirect Emissions from Agricultural Soils	Agriculture	386.3750	0.89%	95.46%	key source
N_2O Indirect Emissions from Manure Management	Agriculture	265.5323	0.61%	96.07%	non- key source
CH_4 Emissions from Manure Management	Agriculture	254.9068	0.59%	96.66%	non- key source
CH_4 Emissions from Other Sectors: Residential	Energy	230.2856	0.53%	97.19%	non- key source
CH_4 Emissions from Wastewater Handling	Waste	215.6014	0.50%	97.69%	non- key source
CO_2 Emissions from Other (Energy)	Energy	154.2715	0.36%	98.05%	non- key source
CO_2 Emissions from Lime Production	Industrial Processes	148.6611	0.34%	98.39%	non- key source
N_2O Emissions from Wastewater Handling	Waste	91.6979	0.21%	98.60%	non- key source
CO_2 Emissions from Mobile Combustion: Other (Pipeline Transport)	Energy	91.1782	0.21%	98.81%	non- key source

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Brick Production	Industrial Processes	74.8506	0.17%	98.99%	non- key source
N_2O Emissions from Mobile Combustion: Railways	Energy	54.1488	0.13%	99.11%	non- key source
N_2O (Non- CO_2) Emissions from Energy Industries	Energy	51.2316	0.12%	99.23%	non- key source
N_2O Emissions from Mobile Combustion: Road Vehicles	Energy	49.6041	0.11%	99.34%	non- key source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvent and Other Product Use	33.1963	0.08%	99.42%	non- key source
CO_2 Emissions from Soda Ash Production and Use	Industrial Processes	32.9560	0.08%	99.50%	non- key source
CO_2 Emissions from Expanded Clay Production	Industrial Processes	32.3512	0.07%	99.57%	non- key source
CO_2 Emissions from Paint Application	Solvent and Other Product Use	31.8675	0.07%	99.64%	non- key source
CH_4 Emissions from Mobile Combustion: Road Vehicles	Energy	24.4646	0.06%	99.70%	non- key source
CO_2 Emissions from Other Products	Solvent and Other Product Use	20.0960	0.05%	99.75%	non- key source
N_2O Emissions from Other Sectors: Residential	Energy	19.4047	0.04%	99.79%	non- key source
CO_2 Emissions from Mobile Combustion Water Borne Navigation	Energy	18.9048	0.04%	99.84%	non- key source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	11.7182	0.03%	99.86%	non- key source
CH_4 (Non- CO_2) Emissions from Energy Industries	Energy	9.2887	0.02%	99.89%	non- key source
CH_4 Emissions from Other Sectors: Agriculture / Forestry / Fishing	Energy	8.9856	0.02%	99.91%	non- key source
CO_2 Emissions from Mineral Wool Production	Industrial Processes	8.0816	0.02%	99.92%	non- key source
N_2O Emissions from Other Sectors: Commercial / Institutional	Energy	6.3499	0.01%	99.94%	non- key source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvent and Other Product Use	5.5962	0.01%	99.95%	non- key source
CH_4 Emissions from Other Sectors: Commercial / Institutional	Energy	5.2253	0.01%	99.96%	non- key source
N_2O Emissions from Manufacturing Industries and Construction	Energy	5.1641	0.01%	99.98%	non- key source
N_2O Emissions from Other Sectors: Agriculture / Forestry / Fishing	Energy	5.0378	0.01%	99.99%	non- key source
CH_4 Emissions from Manufacturing Industries and Construction	Energy	2.0005	0.00%	99.99%	non- key source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	0.00%	100.00%	non- key source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion: Railways	Energy	0.5323	0.00%	100.00%	non- key source
N_2O Emissions from Other (Energy)	Energy	0.4911	0.00%	100.00%	non- key source
N_2O Emissions from Mobile Combustion Water Borne Navigation	Energy	0.1582	0.00%	100.00%	non- key source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	0.1488	0.00%	100.00%	non- key source
CH_4 Emissions from Other (Energy)	Energy	0.1350	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion Water Borne Navigation	Energy	0.0375	0.00%	100.00%	non- key source
N_2O Emissions from Use of N_2O for Anesthesia	Solvent and Other Product Use	0.0205	0.00%	100.00%	non- key source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.00%	100.00%	non- key source
Total			**100.00%**		

Annex 1-3: 1990 Key Sources Category Tier 1 Analysis – Level Assessment, With LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Energy Industries - Oil	Energy	6785.7360	13.45%	13.45%	key source
CO_2 Emissions from Energy Industries - Coal	Energy	6394.4000	12.68%	26.13%	key source
CO_2 Emissions from Energy Industries - Gas	Energy	6152.6295	12.20%	38.33%	key source
CO_2 Emissions from Other Sectors: Residential	Energy	4407.6336	8.74%	47.06%	key source
CO_2 Removals from Croplands Remaining Croplands	LULUCF	-4196.1852	8.32%	55.38%	key source
CO_2 Emissions from Mobile Combustion: Road Vehicles	Energy	3364.2178	6.67%	62.05%	key source
CO_2 Removals from Forest Land Remaining Forest Land	LULUCF	-2197.5790	4.36%	66.41%	key source
CO_2 Emissions from Manufacturing Industries and Construction	Energy	2188.7285	4.34%	70.75%	key source
CO_2 Emissions from Other Sectors: Agriculture / Forestry / Fishing	Energy	1942.3629	3.85%	74.60%	key source
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1834.3768	3.64%	78.23%	key source
CO_2 Emissions from Other Sectors: Commercial / Institutional	Energy	1412.4933	2.80%	81.03%	key source
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1320.0836	2.62%	83.65%	key source
N_2O Direct Emissions from Agricultural Soils	Agriculture	1262.6598	2.50%	86.15%	key source
N_2O Direct Emissions from Manure Management	Agriculture	1116.3560	2.21%	88.37%	key source
CO_2 Emissions from Cement Production	Industrial Processes	971.7056	1.93%	90.29%	key source
CO_2 Removals from Grassland Remaining Grassland	LULUCF	-780.1200	1.55%	91.84%	key source
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	1.35%	93.19%	key source
CO_2 Emissions from Limestone and Dolomite Use	Industrial Processes	619.4745	1.23%	94.42%	key source
CO_2 Mobile Combustion: Railways	Energy	452.3598	0.90%	95.32%	key source
N_2O Indirect Emissions from Agricultural Soils	Agriculture	386.3750	0.77%	96.08%	non- key source
N_2O Indirect Emissions from Manure Management	Agriculture	265.5323	0.53%	96.61%	non- key source
CH_4 Emissions from Manure Management	Agriculture	254.9068	0.51%	97.12%	non- key source
CH_4 Emissions from Other Sectors: Residential	Energy	230.2856	0.46%	97.57%	non- key source
CH_4 Emissions from Wastewater Handling	Waste	215.6014	0.43%	98.00%	non- key source
CO_2 Emissions from Other (Energy)	Energy	154.2715	0.31%	98.31%	non- key source
CO_2 Emissions from Lime Production	Industrial Processes	148.6611	0.29%	98.60%	non- key source
N_2O Emissions from Wastewater Handling	Waste	91.6979	0.18%	98.78%	non- key source
CO_2 Emissions from Mobile Combustion: Other (Pipeline Transport)	Energy	91.1782	0.18%	98.96%	non- key source
CO_2 Emissions from Brick Production	Industrial Processes	74.8506	0.15%	99.11%	non- key source
N_2O Emissions from Mobile Combustion: Railways	Energy	54.1488	0.11%	99.22%	non- key source
N_2O (Non- CO_2) Emissions from Energy Industries	Energy	51.2316	0.10%	99.32%	non- key source
N_2O Emissions from Mobile Combustion: Road Vehicles	Energy	49.6041	0.10%	99.42%	non- key source

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Degreasing and Dry Cleaning	Solvent and Other Product Use	33.1963	0.07%	99.48%	non- key source
CO_2 Emissions from Soda Ash Production and Use	Industrial Pro-cesses	32.9560	0.07%	99.55%	non- key source
CO_2 Emissions from Expanded Clay Production	Industrial Pro-cesses	32.3512	0.06%	99.61%	non- key source
CO_2 Emissions from Paint Application	Solvent and Other Product Use	31.8675	0.06%	99.68%	non- key source
CH_4 Emissions from Mobile Combustion: Road Vehicles	Energy	24.4646	0.05%	99.72%	non- key source
CO_2 Emissions from Other Products	Solvent and Other Product Use	20.0960	0.04%	99.76%	non- key source
N_2O Emissions from Other Sectors: Residential	Energy	19.4047	0.04%	99.80%	non- key source
CO_2 Emissions from Mobile Combustion Water Borne Navigation	Energy	18.9048	0.04%	99.84%	non- key source
CO_2 Emissions from the Iron and Steel Industry	Industrial Pro-cesses	11.7182	0.02%	99.86%	non- key source
CH_4 (Non- CO_2) Emissions from Energy Industries	Energy	9.2887	0.02%	99.88%	non- key source
CH_4 Emissions from Other Sectors: Agriculture / For-estry / Fishing	Energy	8.9856	0.02%	99.90%	non- key source
CO_2 Emissions from Mineral Wool Production	Industrial Pro-cesses	8.0816	0.02%	99.92%	non- key source
N_2O Emissions from Other Sectors: Commercial / Institutional	Energy	6.3499	0.01%	99.94%	non- key source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvent and Other Product Use	5.5962	0.01%	99.95%	non- key source
CH_4 Emissions from Other Sectors: Commercial / Institutional	Energy	5.2253	0.01%	99.96%	non- key source
N_2O Emissions from Manufacturing Industries and Construction	Energy	5.1641	0.01%	99.97%	non- key source
N_2O Emissions from Other Sectors: Agriculture / For-estry / Fishing	Energy	5.0378	0.01%	99.98%	non- key source
CH_4 Emissions from Croplands Remaining Croplands	LULUCF	2.0547	0.00%	99.99%	non- key source
CH_4 Emissions from Manufacturing Industries and Construction	Energy	2.0005	0.00%	99.99%	non- key source
N_2O Emissions from the Iron and Steel Industry	Industrial Pro-cesses	1.0986	0.00%	99.99%	non- key source
N_2O from Croplands Remaining Croplands	LULUCF	0.7864	0.00%	99.99%	non- key source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion: Railways	Energy	0.5323	0.00%	100.00%	non- key source
N_2O Emissions from Other (Energy)	Energy	0.4911	0.00%	100.00%	non- key source
CH_4 Emissions from Forest Land Remaining Forest Land	LULUCF	0.2347	0.00%	100.00%	non- key source
N_2O Emissions from Forest Land Remaining Forest Land	LULUCF	0.1917	0.00%	100.00%	non- key source
N_2O Emissions from Mobile Combustion Water Borne Navigation	Energy	0.1582	0.00%	100.00%	non- key source
CH_4 Emissions from the Iron and Steel Industry	Industrial Pro-cesses	0.1488	0.00%	100.00%	non- key source
CH_4 Emissions from Other (Energy)	Energy	0.1350	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion Water Borne Navigation	Energy	0.0375	0.00%	100.00%	non- key source
N_2O Emissions from Use of N_2O for Anesthesia	Solvent and Other Product Use	0.0205	0.00%	100.00%	non- key source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.00%	100.00%	non- key source
Total			**100.00%**		

Annex 1-4: 2010 Key Sources Category Tier 1 Analysis – Level Assessment, Without LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Energy Industries - Gas	Energy	6152.6295	3564.3081	26.85%	26.85%	key source
CO_2 Emissions from Mobile Combustion: Road Vehicles	Energy	3364.2178	1792.4501	13.50%	40.35%	key source
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1320.0836	1388.0583	10.46%	50.80%	key source
CO_2 Emissions from Other Sectors: Residential	Energy	4407.6336	1017.2414	7.66%	58.47%	key source
N_2O Direct Emissions from Agricultural Soils	Agriculture	1262.6598	788.0248	5.94%	64.40%	key source
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1834.3768	598.3605	4.51%	68.91%	key source
CO_2 Emissions from Manufacturing Industries and Construction	Energy	2188.7285	539.2384	4.06%	72.97%	key source
CO_2 Emissions from Energy Industries - Coal	Energy	6394.4000	491.5622	3.70%	76.67%	key source
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	487.1800	3.67%	80.34%	key source
CO_2 Emissions from Other Sectors: Commercial / Institutional	Energy	1412.4933	480.8328	3.62%	83.96%	key source
N_2O Direct Emissions from Manure Management	Agriculture	1116.3560	412.2018	3.10%	87.07%	key source
CO_2 Emissions from Cement Production	Industrial Processes	971.7056	349.8365	2.64%	89.70%	key source
N_2O Indirect Emissions from Agricultural Soils	Agriculture	386.3750	189.6854	1.43%	91.13%	key source
CO_2 Emissions from Other Sectors: Agriculture/ Forestry/Fishing	Energy	1942.3629	155.8803	1.17%	92.31%	key source
CO_2 Emissions from Energy Industries - Oil	Energy	6785.7360	132.4424	1.00%	93.31%	key source
CO_2 Emissions from Other (Energy)	Energy	154.2715	124.4914	0.94%	94.24%	key source
CH_4 Emissions from Wastewater Handling	Waste	215.6014	107.8000	0.81%	95.05%	key source
N_2O Indirect Emissions from Manure Management	Agriculture	265.5323	86.7452	0.7%	95.71%	non- key source
N_2O Emissions from Wastewater Handling	Waste	91.6979	82.4458	0.6%	96.33%	non- key source
CO_2 Emissions from Limestone and Dolomite Use	Industrial Processes	619.4745	74.4613	0.6%	96.89%	non- key source
CO_2 Mobile Combustion: Railways	Energy	452.3598	67.1844	0.5%	97.40%	non- key source
HFCs Emissions from Refrigeration and Air Conditioning Equipment	Industrial Processes	0.0000	65.4178	0.5%	97.89%	non- key source
CH_4 Emissions from Manure Management	Agriculture	254.9068	57.4048	0.4%	98.32%	non- key source
HFCs Emissions from Foam Blowing	Industrial Processes	0.0000	36.9761	0.3%	98.60%	non- key source
CH_4 Emissions from Other Sectors: Residential	Energy	230.2856	29.1888	0.2%	98.82%	non- key source
N_2O Emissions from Mobile Combustion: Road Vehicles	Energy	49.6041	27.4502	0.2%	99.03%	non- key source
CO_2 Emissions from Paint Application	Solvent and Other Product Use	31.8675	20.7260	0.2%	99.18%	non- key source
CO_2 Emissions from Other Products	Solvent and Other Product Use	20.0960	17.7426	0.1%	99.32%	non- key source
CO_2 Emissions from Brick Production	Industrial Processes	74.8506	15.4882	0.1%	99.43%	non- key source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvent and Other Product Use	33.1963	12.3930	0.1%	99.53%	non- key source
CO_2 Emissions from Soda Ash Production and Use	Industrial Processes	32.9560	12.0466	0.1%	99.62%	non- key source
N_2O Emissions from Mobile Combustion: Railways	Energy	54.1488	8.0422	0.1%	99.68%	non- key source
CH_4 Emissions from Mobile Combustion: Road Vehicles	Energy	24.4646	7.2178	0.1%	99.73%	non- key source
N_2O (Non-CO_2) Emissions from Energy Industries	Energy	51.2316	4.7032	0.0%	99.77%	non- key source

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
N_2O Emissions from Other Sectors: Residential	Energy	19.4047	4.4858	0.0%	99.80%	non- key source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	11.7182	3.9938	0.0%	99.83%	non- key source
CO_2 Emissions from Expanded Clay Production	Industrial Processes	32.3512	3.4223	0.0%	99.86%	non- key source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvent and Other Product Use	5.5962	3.0075	0.0%	99.88%	non- key source
CH_4 Emissions from Other Sectors: Commercial/ Institutional	Energy	5.2253	2.6899	0.0%	99.90%	non- key source
CO_2 Emissions from Lime Production	Industrial Processes	148.6611	2.3140	0.0%	99.92%	non- key source
CO_2 Emissions from Mobile Combustion: Other (Pipeline Transport)	Energy	91.1782	1.8995	0.0%	99.93%	non- key source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	1.8608	0.0%	99.95%	non- key source
CH_4 (Non- CO_2) Emissions from Energy Industries	Energy	9.2887	1.5513	0.0%	99.96%	non- key source
N_2O Emissions from Other Sectors: Commercial/ Institutional	Energy	6.3499	1.1358	0.0%	99.97%	non- key source
N_2O Emissions from Manufacturing Industries and Construction	Energy	5.1641	0.9709	0.0%	99.97%	non- key source
CH_4 Emissions from Other Sectors: Agriculture/ Forestry/Fishing	Energy	8.9856	0.6082	0.0%	99.98%	non- key source
SF_6 Emissions from Electrical Equipment	Industrial Processes	0.0000	0.5545	0.0%	99.98%	non- key source
CH_4 Emissions from Manufacturing Industries and Construction	Energy	2.0005	0.4748	0.0%	99.99%	non- key source
N_2O Emissions from Other Sectors: Agriculture/ Forestry/Fishing	Energy	5.0378	0.4141	0.0%	99.99%	non- key source
N_2O Emissions from Other (Energy)	Energy	0.4911	0.4049	0.0%	99.99%	non- key source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	0.3744	0.0%	99.99%	non- key source
CO_2 Emissions from Mobile Combustion Water Borne Navigation	Energy	18.9048	0.2300	0.0%	100.00%	non- key source
CH_4 Emissions from Other (Energy)	Energy	0.1350	0.1583	0.0%	100.00%	non- key source
CO_2 Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.1376	0.0%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion: Railways	Energy	0.5323	0.0791	0.0%	100.00%	non- key source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	0.1488	0.0507	0.0%	100.00%	non- key source
PFCs Emissions from Electrical Equipment	Industrial Processes	0.0000	0.0273	0.0%	100.00%	non- key source
HFCs Emissions from Aerosols	Industrial Processes	0.0000	0.0232	0.0%	100.00%	non- key source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0047	0.0%	100.00%	non- key source
N_2O Emissions from Mobile Combustion Water Borne Navigation	Energy	0.1582	0.0019	0.0%	100.00%	non- key source
N_2O Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.0012	0.0%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0005	0.0%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.0000	0.0%	100.00%	non- key source
Total				**100.00%**		

Annex 1-5: 2010 Key Sources Category Tier 1 Analysis – Level Assessment, With LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Energy Industries - Gas	Energy	6152.6295	3564.3081	18.52%	18.52%	key source
CO_2 Emissions/Removals from Croplands Remaining Croplands	LULUCF	-4196.1852	2977.0255	15.47%	33.98%	key source
CO_2 Removals from Forest Land Remaining Forest Land	LULUCF	-2197.5790	-2193.2612	11.39%	45.38%	key source
CO_2 Emissions from Mobile Combustion: Road Vehicles	Energy	3364.2178	1792.4501	9.31%	54.69%	key source
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1320.0836	1388.0583	7.21%	61.90%	key source
CO_2 Emissions from Other Sectors: Residential	Energy	4407.6336	1017.2414	5.28%	67.19%	key source
N_2O Direct Emissions from Agricultural Soils	Agriculture	1262.6598	788.0248	4.09%	71.28%	key source
CO_2 Removals from Grassland Remaining Grassland	LULUCF	-780.1200	-779.4600	4.05%	75.33%	key source
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1834.3768	598.3605	3.11%	78.44%	key source
CO_2 Emissions from Manufacturing Industries and Construction	Energy	2188.7285	539.2384	2.80%	81.24%	key source
CO_2 Emissions from Energy Industries - Coal	Energy	6394.4000	491.5622	2.55%	83.80%	key source
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	487.1800	2.53%	86.33%	key source
CO_2 Emissions from Other Sectors: Commercial/Institutional	Energy	1412.4933	480.8328	2.50%	88.83%	key source
N_2O Direct Emissions from Manure Management	Agriculture	1116.3560	412.2018	2.14%	90.97%	key source
CO_2 Emissions from Cement Production	Industrial Processes	971.7056	349.8365	1.82%	92.78%	key source
N_2O Indirect Emissions from Agricultural Soils	Agriculture	386.3750	189.6854	0.99%	93.77%	key source
CO_2 Emissions from Other Sectors: Agriculture/Forestry/Fishing	Energy	1942.3629	155.8803	0.81%	94.58%	key source
CO_2 Emissions from Energy Industries - Oil	Energy	6785.7360	132.4424	0.69%	95.27%	key source
CO_2 Emissions from Other (Energy)	Energy	154.2715	124.4914	0.65%	95.91%	non- key source
CH_4 Emissions from Wastewater Handling	Waste	215.6014	107.8000	0.56%	96.47%	non- key source
N_2O Indirect Emissions from Manure Management	Agriculture	265.5323	86.7452	0.45%	96.93%	non- key source
N_2O Emissions from Wastewater Handling	Waste	91.6979	82.4458	0.43%	97.35%	non- key source
CO_2 Emissions from Limestone and Dolomite Use	Industrial Processes	619.4745	74.4613	0.39%	97.74%	non- key source
CO_2 Emissions from Mobile Combustion: Railways	Energy	452.3598	67.1844	0.35%	98.09%	non- key source
HFCs Emissions from Refrigeration and Air Conditioning Equipment	Industrial Processes	0.0000	65.4178	0.34%	98.43%	non- key source
CH_4 Emissions from Manure Management	Agriculture	254.9068	57.4048	0.30%	98.73%	non- key source
HFCs Emissions from Foam Blowing	Industrial Processes	0.0000	36.9761	0.19%	98.92%	non- key source
CH_4 Emissions from Other Sectors: Residential	Energy	230.2856	29.1888	0.15%	99.07%	non- key source
N_2O Emissions from Mobile Combustion: Road Vehicles	Energy	49.6041	27.4502	0.14%	99.21%	non- key source
CO_2 Emissions/Removals from Land Converted to Grassland	LULUCF	-6.3800	21.8416	0.11%	99.33%	non- key source
CO_2 Emissions from Paint Application	Solvent and Other Product Use	31.8675	20.7260	0.11%	99.43%	non- key source
CO_2 Emissions from Other Products	Solvent and Other Product Use	20.0960	17.7426	0.09%	99.53%	non- key source
CO_2 Emissions from Brick Production	Industrial Processes	74.8506	15.4882	0.08%	99.61%	non- key source

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Degreasing and Dry Cleaning	Solvent and Other Product Use	33.1963	12.3930	0.06%	99.67%	non- key source
CO_2 Emissions from Soda Ash Production and Use	Industrial Processes	32.9560	12.0466	0.06%	99.73%	non- key source
N_2O Emissions from Mobile Combustion: Railways	Energy	54.1488	8.0422	0.04%	99.78%	non- key source
CH_4 Emissions from Mobile Combustion: Road Vehicles	Energy	24.4646	7.2178	0.04%	99.81%	non- key source
N_2O (Non- CO_2) Emissions from Energy Industries	Energy	51.2316	4.7032	0.02%	99.84%	non- key source
N_2O Emissions from Other Sectors: Residential	Energy	19.4047	4.4858	0.02%	99.86%	non- key source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	11.7182	3.9938	0.02%	99.88%	non- key source
CO_2 Emissions from Expanded Clay Production	Industrial Processes	32.3512	3.4223	0.02%	99.90%	non- key source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvent and Other Product Use	5.5962	3.0075	0.02%	99.92%	non- key source
CH_4 Emissions from Other Sectors: Commercial/ Institutional	Energy	5.2253	2.6899	0.01%	99.93%	non- key source
CO_2 Emissions from Lime Production	Industrial Processes	148.6611	2.3140	0.01%	99.94%	non- key source
CO_2 Emissions from Mobile Combustion: Other (Pipeline Transport)	Energy	91.1782	1.8995	0.01%	99.95%	non- key source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	1.8608	0.01%	99.96%	non- key source
CH_4 (Non- CO_2) Emissions from Energy Industries	Energy	9.2887	1.5513	0.01%	99.97%	non- key source
N_2O Emissions from Other Sectors: Commercial/ Institutional	Energy	6.3499	1.1358	0.01%	99.98%	non- key source
N_2O Emissions from Manufacturing Industries and Construction	Energy	5.1641	0.9709	0.01%	99.98%	non- key source
CH_4 Emissions from Other Sectors: Agriculture/ Forestry/Fishing	Energy	8.9856	0.6082	0.00%	99.98%	non- key source
SF_6 Emissions from Electrical Equipment	Industrial Processes	0.0000	0.5545	0.00%	99.99%	non- key source
CH_4 Emissions from Manufacturing Industries and Construction	Energy	2.0005	0.4748	0.00%	99.99%	non- key source
N_2O Emissions from Other Sectors: Agriculture/ Forestry/Fishing	Energy	5.0378	0.4141	0.00%	99.99%	non- key source
N_2O Emissions from Other (Energy)	Energy	0.4911	0.4049	0.00%	99.99%	non- key source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	0.3744	0.00%	100.00%	non- key source
CO_2 Mobile Combustion Water Borne Navigation	Energy	18.9048	0.2300	0.00%	100.00%	non- key source
CH_4 Emissions from Other (Energy)	Energy	0.1350	0.1583	0.00%	100.00%	non- key source
CO_2 Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.1376	0.00%	100.00%	non- key source
CH_4 Emissions from Forest Land Remaining Forest Land	LULUCF	0.2347	0.0917	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion: Railways	Energy	0.5323	0.0791	0.00%	100.00%	non- key source
N_2O Emissions from Forest Land Remaining Forest Land	LULUCF	0.1917	0.0748	0.00%	100.00%	non- key source
CH_4 Emissions from Croplands remaining Croplands	LULUCF	2.0547	0.0551	0.00%	100.00%	non- key source

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	0.1488	0.0507	0.00%	100.00%	non- key source
PFCs Emissions from Electrical Equipment	Industrial Processes	0.0000	0.0273	0.00%	100.00%	non- key source
HFCs Emissions from Aerosols	Industrial Processes	0.0000	0.0232	0.00%	100.00%	non- key source
N_2O Emissions from Croplands Remaining Crop-lands	LULUCF	0.7864	0.0211	0.00%	100.00%	non- key source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0047	0.00%	100.00%	non- key source
N_2O Emissions from Mobile Combustion Water Borne Navigation	Energy	0.1582	0.0019	0.00%	100.00%	non- key source
N_2O Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.0012	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0005	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion: Civil Avia-tion	Energy	0.0000	0.0000	0.00%	100.00%	non- key source
Total				**100.00%**		

Annex 1-6: 2010 Key Sources Category Tier 1 Analysis – Trend Assessment, Without LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Energy Industries - Oil	Energy	6785.7360	132.4424	20.99%	20.99%	key source
CO_2 Emissions from Energy Industries - Gas	Energy	6152.6295	3564.3081	18.04%	39.02%	key source
CO_2 Emissions from Energy Industries - Coal	Energy	6394.4000	491.5622	15.83%	54.85%	key source
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1320.0836	1388.0583	10.58%	65.43%	key source
CO_2 Emissions from Mobile Combustion: Road Vehicles	Energy	3364.2178	1792.4501	8.18%	73.61%	key source
CO_2 Emissions from Other Sectors: Agricul-ture/Forestry/Fishing	Energy	1942.3629	155.8803	4.74%	78.35%	key source
N_2O Direct Emissions from Agricultural Soils	Agriculture	1262.6598	788.0248	4.31%	82.66%	key source
CO_2 Emissions from Other Sectors: Residential	Energy	4407.6336	1017.2414	3.61%	86.27%	key source
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	487.1800	2.99%	89.26%	key source
CO_2 Emissions from Manufacturing Industries and Construction	Energy	2188.7285	539.2384	1.43%	90.68%	key source
CO_2 Emissions from Limestone and Dolomite Use	Industrial Processes	619.4745	74.4613	1.24%	91.93%	key source
CO_2 Emissions from Other (Energy)	Energy	154.2715	124.4914	0.83%	92.76%	key source
CO_2 Emissions from Mobile Combustion: Railways	Energy	452.3598	67.1844	0.77%	93.53%	key source
N_2O Indirect Emissions from Agricultural Soils	Agriculture	386.3750	189.6854	0.77%	94.29%	key source
N_2O Direct Emissions from Manure Manage-ment	Agriculture	1116.3560	412.2018	0.75%	95.04%	key source
N_2O Emissions from Wastewater Handling	Waste	91.6979	82.4458	0.58%	95.63%	non- key source
CO_2 Emissions from Cement Production	Industrial Processes	971.7056	349.8365	0.56%	96.18%	non- key source
CO_2 Emissions from Other Sectors: Commer-cial/Institutional	Energy	1412.4933	480.8328	0.51%	96.69%	non- key source
CO_2 Emissions from Lime Production	Industrial Processes	148.6611	2.3140	0.47%	97.16%	non- key source
CH_4 Emissions from Wastewater Handling	Waste	215.6014	107.8000	0.45%	97.61%	non- key source
CH_4 Emissions from Other Sectors: Residential	Energy	230.2856	29.1888	0.45%	98.05%	non- key source

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1834.3768	598.3605	0.38%	98.43%	non- key source
CO_2 Emissions from Mobile Combustion: Other (Pipeline Transport)	Energy	91.1782	1.8995	0.28%	98.71%	non- key source
CH_4 Emissions from Manure Management	Agriculture	254.9068	57.4048	0.22%	98.94%	non- key source
N_2O Emissions from Mobile Combustion: Road Vehicles	Energy	49.6041	27.4502	0.13%	99.07%	non- key source
CO_2 Emissions from Other Products	Solvent and Other Product Use	20.0960	17.7426	0.12%	99.19%	non- key source
N_2O (Non- CO_2) Emissions from Energy Industries	Energy	51.2316	4.7032	0.12%	99.31%	non- key source
CO_2 Emissions from Paint Application	Solvent and Other Product Use	31.8675	20.7260	0.12%	99.43%	non- key source
N_2O Emissions from Mobile Combustion: Railways	Energy	54.1488	8.0422	0.09%	99.52%	non- key source
CO_2 Emissions from Brick Production	Industrial Processes	74.8506	15.4882	0.08%	99.60%	non- key source
CO_2 Emissions from Expanded Clay Production	Industrial Processes	32.3512	3.4223	0.07%	99.67%	non- key source
CO_2 Emissions from Mobile Combustion Water Borne Navigation	Energy	18.9048	0.2300	0.06%	99.73%	non- key source
N_2O Indirect Emissions from Manure Management	Agriculture	265.5323	86.7452	0.06%	99.79%	non- key source
CO_2 Emissions from Mineral Wool Production	Industrial Processes	8.0816	0.0000	0.03%	99.82%	non- key source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvent and Other Product Use	33.1963	12.3930	0.02%	99.84%	non- key source
CH_4 Emissions from Other Sectors: Agriculture/Forestry/Fishing	Energy	8.9856	0.6082	0.02%	99.86%	non- key source
CH_4 Emissions from Soda Ash Production and Use	Industrial Processes	32.9560	12.0466	0.02%	99.88%	non- key source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	1.8608	0.02%	99.90%	non- key source
N_2O Emissions from Other Sectors: Residential	Energy	19.4047	4.4858	0.02%	99.92%	non- key source
CH_4 (Non-CO_2) Emissions from Energy Industries	Energy	9.2887	1.5513	0.01%	99.93%	non- key source
CO_2Emissions from Chemical Products, Manufacture and Processing	Solvent and Other Product Use	5.5962	3.0075	0.01%	99.95%	non- key source
N_2O Emissions from Other Sectors: Agriculture/Forestry/Fishing	Energy	5.0378	0.4141	0.01%	99.96%	non- key source
CH_4 Emissions from Other Sectors: Commercial/Institutional	Energy	5.2253	2.6899	0.01%	99.97%	non- key source
N_2O Emissions from Other Sectors: Commercial/Institutional	Energy	6.3499	1.1358	0.01%	99.98%	non- key source
N_2O Emissions from Manufacturing Industries and Construction	Energy	5.1641	0.9709	0.01%	99.99%	non- key source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	11.7182	3.9938	0.00%	99.99%	non- key source
CH_4 Emissions from Mobile Combustion: Road Vehicles	Energy	24.4646	7.2178	0.00%	99.99%	non- key source
N_2O Emissions from Other (Energy)	Energy	0.4911	0.4049	0.00%	100.00%	non- key source
CH_4 Emissions from Manufacturing Industries and Construction	Energy	2.0005	0.4748	0.00%	100.00%	non- key source
CH_4 Emissions from Other (Energy)	Energy	0.1350	0.1583	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion: Railways	Energy	0.5323	0.0791	0.00%	100.00%	non- key source

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
N_2O Emissions from Mobile Combustion Water Borne Navigation	Energy	0.1582	0.0019	0.00%	100.00%	non- key source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	0.3744	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0005	0.00%	100.00%	non- key source
N_2O Emissions from Use of N_2O for Anesthesia	Solvent and Other Product Use	0.0205	0.0000	0.00%	100.00%	non- key source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	0.1488	0.0507	0.00%	100.00%	non- key source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0047	0.00%	100.00%	non- key source
HFCs Emissions from Refrigeration and Air Conditioning Equipment	Industrial Processes	0.0000	65.4178	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.0000	0.00%	100.00%	non- key source
HFCs Emissions from Foam Blowing	Industrial Processes	0.0000	36.9761	0.00%	100.00%	non- key source
CO_2 Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.1376	0.00%	100.00%	non- key source
N_2O Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.0012	0.00%	100.00%	non- key source
PFCs Emissions from Electrical Equipment	Industrial Processes	0.0000	0.0273	0.00%	100.00%	non- key source
HFCs Emissions from Aerosols	Industrial Processes	0.0000	0.0232	0.00%	100.00%	non- key source
SF_6 Emissions from Electrical Equipment	Industrial Processes	0.0000	0.5545	0.00%	100.00%	non- key source
Total				**100.00%**		

Annex 1-7: 2010 Key Sources Category Tier 1 Analysis – Trend Assessment, With LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Energy Industries - Oil	Energy	6785.7360	132.4424	17.34%	17.34%	key source
CO_2 Emissions from Energy Industries - Coal	Energy	6394.4000	491.5622	14.59%	31.93%	key source
CO_2 Emissions/Removals from Croplands Remaining Croplands	LULUCF	-4196.1852	2977.0255	14.14%	46.07%	key source
CO_2 Removals from Forest Land Remaining Forest Land	LULUCF	-2197.5790	-2193.2612	10.41%	56.48%	key source
CO_2 Emissions from Other Sectors: Residential	Energy	4407.6336	1017.2414	6.84%	63.32%	key source
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1320.0836	1388.0583	6.59%	69.91%	key source
CO_2 Emissions from Other Sectors: Agriculture/Forestry/Fishing	Energy	1942.3629	155.8803	4.40%	74.31%	key source
N_2O Direct Emissions from Agricultural Soils	Agriculture	1262.6598	788.0248	3.74%	78.05%	key source
CO_2 Removals from Grassland Remaining Grassland	LULUCF	-780.1200	-779.4600	3.70%	81.75%	key source
CO_2 Emissions from Manufacturing Industries and Construction	Energy	2188.7285	539.2384	3.23%	84.99%	key source
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1834.3768	598.3605	2.84%	87.83%	key source
N_2O Direct Emissions from Manure Management	Agriculture	1116.3560	412.2018	1.96%	89.79%	key source
CO_2 Emissions from Cement Production	Industrial Processes	971.7056	349.8365	1.66%	91.45%	key source
CO_2 Emissions from Other Sectors: Commercial/Institutional	Energy	1412.4933	480.8328	1.46%	92.90%	key source

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
N_2O Indirect Emissions from Agricultural Soils	Agriculture	386.3750	189.6854	0.90%	93.80%	key source
CO_2 Emissions from Mobile Combustion: Railways	Energy	452.3598	67.1844	0.88%	94.68%	key source
CO_2 Emissions from Energy Industries - Gas	Energy	6152.6295	3564.3081	0.63%	95.32%	key source
CH_4 Emissions from Wastewater Handling	Waste	215.6014	107.8000	0.51%	95.83%	non- key source
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	487.1800	0.51%	96.34%	non- key source
CH_4 Emissions from Other Sectors: Residential	Energy	230.2856	29.1888	0.47%	96.81%	non- key source
N_2O Indirect Emissions from Manure Management	Agriculture	265.5323	86.7452	0.41%	97.22%	non- key source
CO_2 Emissions from Mobile Combustion: Road Vehicles	Energy	3364.2178	1792.4501	0.40%	97.62%	non- key source
N_2O Emissions from Wastewater Handling	Waste	91.6979	82.4458	0.39%	98.01%	non- key source
CO_2 Emissions from Limestone and Dolomite Use	Industrial Processes	619.4745	74.4613	0.35%	98.36%	non- key source
CH_4 Emissions from Manure Management	Agriculture	254.9068	57.4048	0.27%	98.63%	non- key source
CO_2 Emissions from Mobile Combustion: Other (Pipeline Transport)	Energy	91.1782	1.8995	0.23%	98.86%	non- key source
CO_2 Emissions from Other (Energy)	Energy	154.2715	124.4914	0.18%	99.05%	non- key source
N_2O (Non- CO_2) Emissions from Energy Industries	Energy	51.2316	4.7032	0.11%	99.16%	non- key source
N_2O Emissions from Mobile Combustion: Railways	Energy	54.1488	8.0422	0.11%	99.27%	non- key source
CO_2 Emissions/Removals from Land Converted to Grassland	LULUCF	-6.3800	21.8416	0.10%	99.37%	non- key source
CO_2 Emissions from Paint Application	Solvent and Other Product Use	31.8675	20.7260	0.10%	99.47%	non- key source
CO_2 Emissions from Other Products	Solvent and Other Product Use	20.0960	17.7426	0.08%	99.55%	non- key source
CO_2 Emissions from Bricks Production	Industrial Processes	74.8506	15.4882	0.07%	99.63%	non- key source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvent and Other Product Use	33.1963	12.3930	0.06%	99.68%	non- key source
CO_2 Emissions from Soda Ash Production and Use	Industrial Processes	32.9560	12.0466	0.06%	99.74%	non- key source
CO_2 Emissions from Mobile Combustion Water Borne Navigation	Energy	18.9048	0.2300	0.05%	99.79%	non- key source
CH_4 Emissions from Mobile Combustion: Road Vehicles	Energy	24.4646	7.2178	0.03%	99.82%	non- key source
N_2O Emissions from Other Sectors: Residential	Energy	19.4047	4.4858	0.03%	99.85%	non- key source
CH_4 Emissions from Other Sectors: Agriculture/Forestry/Fishing	Energy	8.9856	0.6082	0.02%	99.87%	non- key source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	11.7182	3.9938	0.02%	99.89%	non- key source
CH_4 (Non-CO_2) Emissions from Energy Industries	Energy	9.2887	1.5513	0.02%	99.91%	non- key source
CO_2 Emissions from Expanded Clay Production	Industrial Processes	32.3512	3.4223	0.02%	99.92%	non- key source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvent and Other Product Use	5.5962	3.0075	0.01%	99.94%	non- key source
N_2O Emissions from Other Sectors: Commercial/Institutional	Energy	6.3499	1.1358	0.01%	99.95%	non- key source
N_2O Emissions from Other Sectors: Agriculture/Forestry/Fishing	Energy	5.0378	0.4141	0.01%	99.96%	non- key source

Inventory Categories	Inventory Sector	Basic Year Estimate, Gg CO_2 eq.	Current Year Estimate, Gg CO_2 eq.	Total	Cumulative Sum	Status
CO_2 Emissions from Lime Production	Industrial Processes	148.6611	2.3140	0.01%	99.97%	non- key source
N_2O Emissions from Manufacturing Industries and Construction	Energy	5.1641	0.9709	0.01%	99.98%	non- key source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	1.8608	0.01%	99.99%	non- key source
CH_4 Emissions from Manufacturing Industries and Construction	Energy	2.0005	0.4748	0.00%	99.99%	non- key source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	0.3744	0.00%	99.99%	non- key source
CH_4 Emissions from Other Sectors: Commercial/Institutional	Energy	5.2253	2.6899	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion: Railways	Energy	0.5323	0.0791	0.00%	100.00%	non- key source
N_2O Emissions from Mobile Combustion: Road Vehicles	Energy	49.6041	27.4502	0.00%	100.00%	non- key source
N_2O Emissions from Other (Energy)	Energy	0.4911	0.4049	0.00%	100.00%	non- key source
CH_4 Emissions from Forest Land Remaining Forest Land	LULUCF	0.2347	0.0917	0.00%	100.00%	non- key source
N_2O Emissions from Mobile Combustion Water Borne Navigation	Energy	0.1582	0.0019	0.00%	100.00%	non- key source
CH_4 Emissions from Other (Energy)	Energy	0.1350	0.1583	0.00%	100.00%	non- key source
N_2O Emissions from Forest Land Remaining Forest Land	LULUCF	0.1917	0.0748	0.00%	100.00%	non- key source
CH_4 Emissions from Croplands Remaining Croplands	LULUCF	2.0547	0.0551	0.00%	100.00%	non- key source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	0.1488	0.0507	0.00%	100.00%	non- key source
N_2O Emissions from Croplands Remaining Croplands	LULUCF	0.7864	0.0211	0.00%	100.00%	non- key source
CH_4 Emissions from Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0005	0.00%	100.00%	non- key source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0047	0.00%	100.00%	non- key source
CO_2 Emissions from Mineral Wool Production	Industrial Processes	8.0816	0.0000	0.00%	100.00%	non- key source
N_2O Emissions from Use of N_2O for Anesthesia	Solvent and Other Product Use	0.0205	0.0000	0.00%	100.00%	non- key source
SF_6 Emissions from Electrical Equipment	Industrial Processes	0.0000	0.5545	0.00%	100.00%	non- key source
HFCs Emissions from Refrigeration and Air Conditioning Equipment	Industrial Processes	0.0000	65.4178	0.00%	100.00%	non- key source
HFCs Emissions from Aerosols	Industrial Processes	0.0000	0.0232	0.00%	100.00%	non- key source
CO_2 Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.1376	0.00%	100.00%	non- key source
N_2O Emissions from Mobile Combustion: Civil Aviation	Energy	0.0000	0.0012	0.00%	100.00%	non- key source
HFCs Emissions from Foam Blowing	Industrial Processes	0.0000	36.9761	0.00%	100.00%	non- key source
PFCs Emissions from Electrical Equipment	Industrial Processes	0.0000	0.0273	0.00%	100.00%	non- key source
Total				**100.00%**		

Annex 2. Energy Balances of the Republic of Moldova for 1990, 1993-2010 (without ATULBD)

ENERGY BALANCE 1990 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	5380	804			4576	4623	1	7	173	749
including:										
anthracite	5201	799			4402	4449		6		746
brown coal	179	5			174	174		1		2
Brown Coal Briquettes, kt	33	2			31	31		2		
Ukraine Brown Coal, kt	33	2			31	31		2		
Coking Coal, kt	65	18			47	41				24
Diesel Oil, kt	1250	129			1121	1120				130
Oven Fuel, kt	104	17			87	93				11
Residual Fuel Oil, kt	2867	234			2633	2501				366
Jet Fuel, kt	7	6			1					7
Fuel for Diesel Engines, kt	76	14			62	61				15
Aviation Fuel, kt	2	1			1	2				
Gasoline, kt	841	48			793	796		1		44
Kerosene for Tractors, kt	31	5			26	26				5
Kerosene for Lighting, kt	12	3			9	11				1
Aviation Kerosene, kt	68	1			67	67				1
Lubricants, kt										
Natural Gas, million standard m^3	4077	73			4004	3908		97		72
Liquefied Petroleum Gas, kt	148	4			144	146				2
Fuel wood, thousand m^3 comp.	253	57	194		2	216				17
Wood and Agricultural Waste, kt c.e.	16		16			16				
Other Fuels, kt c.e.										
Electricity, million kWh	20161		156725		4489	11349	55	1221		7536
Heat, thousand Gcal	22213		22212		1	20983	16	1214		

ENERGY BALANCE 1993 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	2281.5	343.6			1937.9	2138.7		1.5		141.3
including:										
anthracite	225.5	79.1			146.4	185.1		0.5		39.9
brown coal	103.3	49.6			53.7	84.1		0.2		19.0
Coking Coal, kt	22.7	16.7			6.0	17.3			0.1	5.3
Diesel Oil, kt	535.1	40.7			494.4	468.4		1.2	11.1	54.4
Oven Fuel, kt	20.4	6.0			14.4	11.5			6.3	2.6
Residual Fuel Oil, kt	1401.6	356.5			1045.1	1296.9	2.6	1.5		100.6
Residual Fuel Oil for Ships, kt	0.2	0.2								0.2
Fuel for Engines, kt	3.6	1.7			1.9	2.8				0.8
Aviation Fuel, kt	0.5	0.2			0.3	0.4				
Gasoline, kt	242.5	19.6			222.9	219.6	0.1	1.1	0.1	21.7
Kerosene Oil, kt	53.8	2.7			51.1	41.5			5.5	6.8
Natural Gas, million standard m^3	3194.1	6.7			3187.4	2224.8		89.0	851.4	41.8
Liquefied Petroleum Gas, kt	41.5	1.8			39.7	39.9		0.4	0.1	1.1
Fuel wood, thousand m^3 comp.	148.2	9.5	137.1		1.6	130.1			1.9	16.2
Wood and Agricultural Waste, kt c.e.	12.7	0.2	12.5			10.6		0.5	0.3	1.3
Other Fuels, kt c.e.	1.1				1.1	1.0				0.1
Electricity, million kWh	15381.2		10368.7		5012.5	6122.2	5776.5	1359.0	2123.5	
Heat, thousand Gcal	10208.1		10208.1			8703.4		917.3	587.4	

ENERGY BALANCE 1994 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	918	131			787	476		2	333	107
including:										
anthracite	200	38			162	174				26
brown coal	57	21			36	44				13
Coking Coal, kt	21	5			16	12				8
Diesel Oil, kt	429	56			373	390		1		38
Oven Fuel, kt	6	3			3	4			1	1
Residual Fuel Oil, kt	590	104			486	363			102	125
Fuel for Engines, kt	2	1			1	1			1	
Gasoline, kt	236	22			214	211		2		23
Kerosene Oil, kt	20	6			14	16				4
Lubricants, kt	29	4			25	17				12
Natural Gas, million standard m^3	1882	41			1841	1213		112	555	2
Liquefied Petroleum Gas, kt	21	1			20	19			1	1
Fuel wood, thousand m^3 comp.	160	17	143			134			4	22
Wood and Agricultural Waste, kt c.e.	16	1	15			14			1	1
Other Fuels, kt c.e.	10				10	1			8	1
Electricity, million kWh	5820		1236	3967	617	4347	265	1208		
Heat, thousand Gcal	7507		7507			6658		849		

ENERGY BALANCE 1995 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	1026	109			917	269		1	647	109
including:										
anthracite	761	22			739	78		1	646	36
brown coal	46	12			34	34			1	11
Coking Coal, kt	30	8			22	14				16
Diesel Oil, kt	420	38			382	379	3	1		37
Residual Fuel Oil, kt	517	126			391	347		1	17	152
Gasoline, kt	283	26			257	223		2		58
Kerosene Oil, kt	16	5			11	13			2	1
Lubricants, kt	27	13			14	17			1	9
Natural Gas, million standard m^3	1876	2			1874	1227		169	477	3
Liquefied Petroleum Gas, kt	21	1			20	19			1	1
Fuel wood, thousand m^3 comp.	283	23	260			228				55
Wood and Agricultural Waste, kt c.e.	15	1	14			11			1	3
Other Fuels, kt c.e.	1	1							1	
Electricity, million kWh	5500		1176	2327	1997	4138	127	1235		
Heat, thousand Gcal	7097		7097			6126		971		

ENERGY BALANCE 1996 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	983	119			864	372		1	536	74
including:										
anthracite	642	43			599	84			536	22
brown coal	46	12			34	35				11
Coking Coal, kt	25	16			9	15			1	9
Diesel Oil, kt	341	39			302	323		1	1	16
Oven Fuel, kt	9	–			9	7			1	1
Residual Fuel Oil, kt	424	152			272	311		1	31	81
Gasoline, kt	241	60			181	214		3	1	23
Kerosene Oil, kt	21	1			20	20				1
Lubricants, kt	24	10			14	16			1	7
Natural Gas, million standard m^3	2052	3			2049	1349		204	484	15
Liquefied Petroleum Gas, kt	23	1			22	22				1
Fuel wood, thousand m^3 comp.	332	58	274			276				56
Wood and Agricultural Waste, kt c.e.	15	3	12			15				
Other Fuels, kt c.e.	6				6	2			1	3
Electricity, million kWh	5335		1398	2368	1569	4094	4	1237		
Heat, thousand Gcal	7077		7077			6027		1050		

ENERGY BALANCE 1997 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	627	75			552	265		1	236	125
including:										
anthracite	124	22			102	90				34
brown coal	35	8			27	25				10
Coking Coal, kt	17	9			8	12			1	4
Diesel Oil, kt	347	19			328	305		6	1	35
Oven Fuel, kt	11	1			10	6			1	4
Residual Fuel Oil, kt	356	81			275	224			18	114
Gasoline, kt	286	24			262	244		5		37
Kerosene Oil, kt	27	2			25	22			1	4
Lubricants, kt	24	8			16	15			1	8
Natural Gas, million standard m^3	2094	15			2079	1461		162	448	23
Liquefied Petroleum Gas, kt	31	3			28	26		1		4
Fuel wood, thousand m^3 comp.	355	57	298			274		1	1	79
Wood and Agricultural Waste, kt c.e.	18	1	17			13			1	4
Other Fuels, kt c.e.	12	3			9	9			1	2
Electricity, million kWh	4972		1450	1772	1750	3767		1178		
Heat, thousand Gcal	6590		6590			5552		1038		

ENERGY BALANCE 1998 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	478	150			328	197			173	108
including:										
anthracite	82	28			54	34			16	32
brown coal	25	11			14	20				5
Coking Coal, kt	11	4			7	10				1
Diesel Oil, kt	271	36			235	246		1	1	23
Oven Fuel, kt	13	4			9	10			1	2
Residual Fuel Oil, kt	262	123			139	172			23	67
Gasoline, kt	230	38			192	207		4		19
Kerosene Oil, kt	24	3			21	21				3
Lubricants, kt	17	8			9	11				6
Natural Gas, million standard m^3	1887	23			1864	1355		139	369	24
Liquefied Petroleum Gas, kt	30	6			24	25		2	1	2
Fuel wood, thousand m^3 comp.	344	79	265			280		2		62
Wood and Agricultural Waste, kt c.e.	13	4	9			7		1	2	3
Other Fuels, kt c.e.	6	2			4	4			1	1
Electricity, million kWh	4609		1246	1447	1916	3213		1396		
Heat, thousand Gcal	6120		6120			5173		947		

ENERGY BALANCE 1999 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	245	112			133	151			8	86
including:										
anthracite	80	33			47	51			7	22
brown coal	12	4			8	10				2
Coking Coal, kt	8	1			7	7				1
Diesel Oil, kt	192	25			167	178		1	1	12
Oven Fuel, kt	11	2			9	9			1	1
Residual Fuel Oil, kt	136	72			64	104		1	1	30
Gasoline, kt	139	19			120	119		1	1	18
Kerosene Oil, kt	24	3			21	22			1	1
Lubricants, kt	12	6			6	8				4
Natural Gas, million m^3 stand.	1561	24			1537	1150		126	271	14
Liquefied Petroleum Gas, kt	34	2			32	31	1	1		1
Fuel wood, thousand m^3 comp.	298	62	236			257				41
Wood and Agricultural Waste, kt c.e.	19	2	17			13		1		5
Other Fuels, kt c.e.	17	1			16	14			1	2
Electricity, million kWh	3752		1134	840	1778	2566		1186		
Heat, thousand Gcal	4647		4647			3899		748		

ENERGY BALANCE 2000 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	194	87			107	125			1	68
including:										
anthracite	87	20			67	70			1	16
brown coal	12	3			9	8				4
Coking Coal, kt	7	1			6	7				
Diesel Oil, kt	213	12			201	192		1		20
Oven Fuel, kt	20	1			19	14	1		1	4
Residual Fuel Oil, kt	67	30			37	47	1	2		17
Gasoline, kt	139	18			121	117		1		21
Kerosene Oil, kt	22	1			21	21				1
Lubricants, kt	9	4			5	7				2
Natural Gas, million standard m^3	1058	14			1044	928		102	16	12
Liquefied Petroleum Gas, kt	44	1			43	35	2	1	1	5
Fuel wood, thousand m^3 comp.	287	44	243			240			1	46
Wood and Agricultural Waste, kt c.e.	24	5	19			19		1		4
Other Fuels, kt c.e.	5	2			3	3			1	1
Electricity, million kWh	3379		904	690	1785	2244		1135		
Heat, thousand Gcal	3057		3057			2673		383	1	

ENERGY BALANCE 2001 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	209	69			140	108			34	67
including:										
anthracite	104	17			87	40			34	30
brown coal	9	5			4	5				4
Coking Coal, kt	9	1			8	8				1
Diesel Oil, kt	241	20			221	210		1		30
Oven Fuel, kt	19	4			15	15			1	3
Residual Fuel Oil, kt	65	17			48	45				20
Gasoline, kt	153	22			131	128		1		24
Kerosene Oil, kt	19	1			18	16			1	2
Lubricants, kt	11	3			8	7			1	3
Natural Gas, million standard m^3	1160	12			1148	1044		82	20	14
Liquefied Petroleum Gas, kt	56	6			50	47		1	1	7
Fuel wood, thousand m^3 comp.	296	46	250			222				74
Wood and Agricultural Waste, kt c.e.	33	2	31			26		1		6
Other Fuels, kt c.e.	3				3	1			1	1
Electricity, million kWh	3390		1263	1441	686	2208		1181	1	
Heat, thousand Gcal	3298		3298			2809		489		

ENERGY BALANCE 2002 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	217	67			150	151		1		65
including:										
anthracite	114	29			85	88				26
brown coal	5	4			1	3				2
Coking Coal, kt	9	1			8	8				1
Diesel Oil, kt	282	30			252	255		1	2	24
Oven Fuel, kt	7	3			4	6				1
Residual Fuel Oil, kt	50	20		7	23	33			1	16
Gasoline, kt	192	24			168	162		2		28
Kerosene Oil, kt	20	2			18	19				1
Lubricants, kt	10	3			7	7				3
Natural Gas, million standard m^3	1159	14			1145	1066		75	4	14
Liquefied Petroleum Gas, kt	56	7			49	48	1	2		5
Fuel wood, thousand m^3 comp.	320	74	246			270				50
Wood and Agricultural Waste, kt c.e.	32	4	27		1	26			1	5
Other Fuels, kt c.e.	2	1			1	1			1	
Electricity, million kWh	3781		1179	1615	987	2451		1045	285	
Heat, thousand Gcal	3217		3217			2699		518		

ENERGY BALANCE 2003 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Produc-tion	Inputs from Other National Sources	Import	Gross Domestic Consump-tion	Export	Losses	Other Distribu-tion Items	Stock at the End of the Year
Coal – total, kt	332	65			267	219		1		112
including:										
anthracite	236	31			205	160		1		75
brown coal	2	2				1				1
Coking Coal, kt	8	2			6	5			1	2
Diesel Oil, kt	323	25			298	287		1		35
Oven Fuel, kt	4	1			3	3				1
Residual Fuel Oil, kt	39	16	1		22	26		1		12
Gasoline – total, kt	230	27			203	192		2		36
including, Lead Free Gasoline	230	27			203	192		2		36
Kerosene Oil, kt	16	1			15	13				3
Lubricants, kt	14	3	1		10	11				3
Bitumen, kt	13				13	12				1
White Spirit, kt	1				1	1				
Other Petroleum Products, kt c.e.	2			1	1	2				
Natural Gas, million standard m³	1252	14			1238	1143		91		18
Liquefied Petroleum Gas, kt	62	6			56	50	1	2		9
Fuel wood, thousand m³ comp.	358	50	308			311				47
Wood Waste, kt c.e.	24	4	20			21				3
Agricultural Waste, kt c.e.	11		11			11				
Electricity, million kWh	4629		1046	1826	1757	2529	131	1047	922	
Heat, thousand Gcal	3347		3347			2799		548		

ENERGY BALANCE 2004 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Produc-tion	Inputs from Other National Sources	Import	Gross Domestic Consump-tion	Export	Losses	Other Distribu-tion Items	Stock at the End of the Year
Coal – total, kt	297	112			185	185		1		111
including:										
anthracite	216	74			142	144		1		71
brown coal										
Coking Coal, kt	2	2				2				
Oil, kt	8		8				5		1	2
Diesel Oil, kt	359	35			324	325		1	1	32
Oven Fuel, kt	3	1			2	3				
Residual Fuel Oil, kt	34	12		3	19	24				10
Jet Fuel, kt	15	2			13	14				1
Gasoline – total, kt	246	36			210	210		2		34
including, Lead Free Gasoline	246	36			210	210		2		34
Kerosene Oil, kt	1			1		1				
Lubricants, kt	15	4			11	11				4
Bitumen, kt	19	1			18	17			1	1
White Spirit, kt										
Paraffin Waxes, kt										
Processed Oils, kt c.e.										
Other Petroleum Products, kt c.e.	1				1	1				
Natural Gas, million standard m³	1281	18			1263	1167		96		18
Liquefied Petroleum Gas, kt	63	6			57	52	1	1	1	8
Fuel wood, thousand m³ comp.	317	47	270			251		1	1	64
Wood Waste, kt c.e.	19	3	15		1	16		1		2
Agricultural Waste, kt c.e.	16		16			16				
Electricity, million kWh	4383		1022		3361	2634	424	831	494	
Heat, thousand Gcal	3147		3147			2686		461		

ENERGY BALANCE 2005 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	276	110			166	180		2	1	93
including:										
anthracite	206	70			136	142		1	1	62
brown coal										
Coking Coal, kt										
Oil, kt	7	2	5			6				1
Diesel Oil, kt	366	32	1		333	331				35
Oven Fuel, kt	2				2	1				1
Residual Fuel Oil, kt	29	10	3	3	13	21	1			7
Jet Fuel, kt	16	1			15	15				1
Gasoline – total, kt	251	35			216	215		2	1	33
including, Lead Free Gasoline	251	35			216	215		2	1	33
Kerosene Oil, kt	1				1	1				
Lubricants, kt	17	4	1		12	11	1		1	4
Bitumen, kt	18	1		1	16	16				2
White Spirit, kt										
Paraffin Waxes, kt										
Processed Oils, kt c.e.										
Other Petroleum Products, kt c.e..	2				2	2				
Natural Gas, million standard m^3	1437	18			1419	1339		81		17
Liquefied Petroleum Gas, kt	62	8			54	53		1		8
Fuel wood, thousand m^3 comp.	330	64	266			253			1	76
Wood Waste, kt c.e.	17	2	14		1	13				4
Agricultural Waste, kt c.e.	16		16			16				
Electricity, million kWh	4196		1229		2967	2921	14	783	478	
Heat, thousand Gcal	3591		3591			3084		507		

ENERGY BALANCE 2006 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	266	94			172	189		1		76
including:										
anthracite	196	62			134	143		1		52
brown coal										
Coking Coal, kt										
Oil, kt	5	1	4			4				1
Diesel Oil, kt	361	35			326	334		1		26
Oven Fuel, kt	1	1				1				
Residual Fuel Oil, kt	27	7	2	1	17	17	2		1	7
Jet Fuel, kt	19	1			18	17				2
Gasoline – total, kt	226	33			193	198		1		27
including, Lead Free Gasoline	226	33			193	198		1		27
Lubricants, kt	19	4	1		14	12	2			5
Bitumen, kt	26	2			24	22				4
Paraffin Waxes, kt										
Processed Oils, kt c.e.										
Other Petroleum Products, kt c.e.										
Natural Gas, million standard m^3	1435	17			1418	1327		90		18
Liquefied Petroleum Gas, kt	58	8			50	50		1		7
Fuel wood, thousand m^3 comp.	383	76	307			313		1		69
Wood Waste, kt c.e.	18	4	14			13			1	4
Agricultural Waste, kt c.e.	16		16			16				
Electricity, million kWh	4074		1192		2882	3215		675	184	
Heat, thousand Gcal	3552		3552			2903		649		

ENERGY BALANCE 2007 (natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Produc-tion	Inputs from Other National Sources	Import	Gross Domestic Consump-tion	Export	Losses	Other Distribu-tion Items	Stock at the End of the Year
Coal – total, kt	256	76			180	129		1		126
including:										
anthracite	155	52			103	100				55
brown coal										
Coking Coal, kt										
Oil, kt	9	1	8			8				1
Diesel Oil, kt	386	26	3		357	351		1		34
Oven Fuel, kt	1			1		1				
Residual Fuel Oil, kt	22	7	5	2	8	14	1			7
Jet Fuel, kt	22	2			20	20			1	1
Gasoline – total, kt	231	26			205	203		1	1	26
including, Lead Free Gasoline	231	26			205	203		1	1	26
Kerosene Oil, kt										
Lubricants, kt	21	5			16	10	6			5
Bitumen, kt	30	4			26	26				4
White Spirit, kt										
Paraffin Waxes, kt										
Processed Oils, kt c.e.										
Other Petroleum Products, kt c.e.	1				1	1				
Natural Gas, million standard m^3	1323	18			1305	1213		93		17
Liquefied Petroleum Gas, kt	57	7			50	53		1		3
Fuel wood, thousand m^3 comp.	344	69	275			258				86
Wood Waste, kt c.e.	15	4	11			10			1	4
Agricultural Waste, kt c.e.	15		15			15				
Electricity, million kWh	4031		1100		2931	3364		667		
Heat, thousand Gcal	3094		3094			2554		540		

ENERGY BALANCE 2008 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Produc-tion	Inputs from Other National Sources	Import	Gross Domestic Consump-tion	Export	Losses	Other Distribu-tion Items	Stock at the End of the Year
Coal – total, kt	333	127			206	198				135
including:										
anthracite	154	56			98	88				66
brown coal										
Coking Coal, kt										
Oil, kt	16	1	15			14			1	1
Diesel Oil, kt	411	36	4		371	368		1		42
Oven Fuel, kt	1			1		1				
Residual Fuel Oil, kt	28	7	7		14	17	5			6
Jet Fuel, kt	22	1			21	18				4
Gasoline – total, kt	242	29			213	208		2		32
including, Lead Free Gasoline	242	29			213	208		3		33
Kerosene Oil, kt										
Lubricants, kt	16	5			11	11	1			4
Bitumen, kt	27	4			23	24				3
White Spirit, kt	1				1				1	
Paraffin Waxes, kt										
Processed Oils, kt c.e.										
Other Petroleum Products, kt c.e.	1				1	1				
Natural Gas, million standard m^3	1244	17			1227	1138		87	1	18
Liquefied Petroleum Gas, kt	63	3			60	55		1		7
Fuel wood, thousand m^3 comp.	370	86	284			289		3	1	77
Wood Waste, kt c.e.	17	4	13			12				5
Agricultural Waste, kt c.e.	21		21			20				1
Electricity, million kWh	4058		1096	4	2958	3428		630		
Heat, thousand Gcal	3074		3074			2553		520	1	

ENERGY BALANCE 2009 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	269	135			134	177		2		90
including:										
anthracite	170	74			96	109				61
brown coal										
Coking Coal, kt	2				2	2				
Oil, kt	18	1	17			17				1
Diesel Oil, kt	397	42	5		350	337		1	1	58
Oven Fuel, kt	4				4	1	1			2
Residual Fuel Oil, kt	64	7	16		41	36	9			19
Jet Fuel, kt	21	4			17	14	4			3
Gasoline – total, kt	248	32			216	207		1		40
including, Lead Free Gasoline	248	32			216	207		1		40
Kerosene Oil, kt										
Lubricants, kt	12	4			8	9	1			3
Bitumen, kt	11	3			8	10				1
White Spirit, kt	1				1	1				
Paraffin Waxes, kt										
Processed Oils, kt c.e.										
Other Petroleum Products, kt c.e.	2				2	2				
Natural Gas, million standard m^3	1145	18		1	1126	1068		58	1	18
Liquefied Petroleum Gas, kt	68	7			61	60	1	1	2	4
Fuel wood, thousand m^3 comp.	361	78	283			262			1	98
Wood Waste, kt c.e.	20	5	15			15				5
Agricultural Waste, kt c.e.	27	1	26			25			1	1
Electricity, million kWh	3974		1033	2934	7	3378		596		
Heat, thousand Gcal	2638		2638			2223		415		

ENERGY BALANCE 2010 (in natural units)

Type of Fuel and Energy	TOTAL	Resources				Distribution				
		Stock at the Start of the Year	Production	Inputs from Other National Sources	Import	Gross Domestic Consumption	Export	Losses	Other Distribution Items	Stock at the End of the Year
Coal – total, kt	271	90			181	186				85
including:										
anthracite	178	61			117	129				49
brown coal										
Coking Coal, kt	4				4	4				
Oil, kt	12	1	11			11		1		
Diesel Oil, kt	462	58	4		400	418		1		43
Oven Fuel, kt	3	2			1	2	1			
Residual Fuel Oil, kt	48	19	12		17	31	2			15
Jet Fuel, kt	20	3			17	13	5			2
Gasoline – total, kt	227	41			186	197		1	1	28
including, Lead Free Gasoline	227	41			186	197		1	1	28
Kerosene Oil, kt										
Lubricants, kt	17	3	5		9	10	4			3
Bitumen, kt	23	1			22	21				2
White Spirit, kt	1				1	1				
Paraffin Waxes, kt										
Processed Oils, kt c.e.										
Other Petroleum Products, kt c.e.	2				2	2				
Natural Gas, million standard m^3	1206	18			1188	1128		61		17
Liquefied Petroleum Gas, kt	72	5			67	64	2	1	2	3
Fuel wood, thousand m^3 comp.	330	99	231			267		1		62
Wood Waste, kt c.e.	12	5	7			10				2
Agricultural Waste, kt c.e.	27	1	26			21	5			1
Other Fuels, kt c.e.										
Electricity, million kWh	4097		1064	3008	25	3488		609		
Heat, thousand Gcal	2874		2874			2397		476	1	

Total Consumption as Fuel or Energy in 1990, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	4623	2521	136		1966	43		7	21	453	1429	13
including:												
anthracite	4449	2521	133		1795	42		3	21	452	1264	13
brown coal	174		3		171	1		4		1	165	
bituminous coal												
Briquettes, kt	31				31					2	29	
Ukraine Brown Coal, kt	31				31					2	29	
Coking Coal, kt	41			2	39	39						
Diesel Oil, kt	1120	1	7		1112	30	51	395	610	11	2	13
Oven Fuel, kt	93		10		83	11			25	17	28	2
Residual Fuel Oil, kt	2501	989	1130	4	378	348	2		6	21		1
Jet Fuel, kt												
Fuel for Diesel Engines, kt	61	1	43		17	7			2	4		4
Aviation Fuel, kt	2				2			2				
Gasoline, kt	796				796	5	8	655	7		117	4
Kerosene for Tractors, kt	26		1		25	15			8	1		1
Kerosene for Lighting, kt	11				11				1		10	
Aviation Kerosene, kt	67				67			67				
Lubricants, kt												
Natural Gas, million standard m³	3908	1527	1712	35	634	260	2	71	2	42	257	
Liquefied Petroleum Gas, kt	146				146			13	1	6	125	1
Fuel wood, thousand m³ comp.	216		1	37	178	15			4	37	117	5
Wood and Agricultural Waste, kt c.e.	16		2		14	6					8	
Other Fuels, kt c.e.												
Electricity, million kWh	11349	4			11345	5404	120	238	1670	1195	1763	955
Heat, thousand Gcal	20983				20983	10452	184	210	1631	2432	5228	843

Total Consumption as Fuel or Energy in 1993, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	2138.7	1629.2	90.3	0.2	419.0	15.0	0.2	4.1	10.0	200.5	172.3	16.9
including:												
anthracite	185.1	5.0	15.1		165.0	3.9	0.1		3.8	61.7	93.6	1.9
brown coal	84.1		15.8		68.3	2.9			1.4	41.0	16.9	6.1
bituminous coal	1869.5	1624.2	59.4	0.2	185.7	8.2	0.1	4.1	4.8	97.8	61.8	8.9
Coking Coal, kt	17.3		0.1		17.2	16.8	–	–	–	0.1	0.2	0.1
Diesel Oil, kt	468.4	0.3	5.7	0.4	462.0	12.0	6.9	214.6	218.1	3.4	1.0	6.0
Oven Fuel, kt	11.5		2.3		9.2	1.1	0.3		5.5	1.2	0.3	0.8
Residual Fuel Oil, kt	1296.9	657.9	546.9	0.7	91.4	63.0	2.7	7.4	5.0	12.6		0.7
Residual Fuel Oil for Ships, kt												
Fuel for Engines, kt	2.8		0.8		2.0	0.6	0.1	0.2	0.8	0.3		
Aviation Fuel, kt	0.4				0.4	0.1		0.3				
Gasoline, kt	219.6			0.3	219.3	0.2	0.4	209.8	1.3		6.7	0.9
Kerosene Oil, kt	41.5		3.2		38.3	4.5	0.1	20.6	5.7	1.1	0.6	5.7
Lubricants, kt												
Natural Gas, million standard m³	2224.8	1011.5	792.5		424.8	93.0		19.3	2.0	33.8	258.3	5.5
Liquefied Petroleum Gas, kt	39.9		0.8	0.1	39.0	0.3	0.1	8.4	0.3	1.0	28.6	0.3
Fuel wood, thousand m³ comp.	130.1		0.6	6.4	123.1	8.4			1.1	14.0	98.3	1.3
Wood and Agricultural Waste, kt c.e.	10.6		1.7	0.9	8.0	2.3			0.1	0.2	5.0	0.4
Other Fuels, kt c.e.	1.0				1.0				1.0			
Electricity, million kWh	6122.2		1.8		6120.4	2077.8	64.1	129.3	792.9	677.4	1913.4	465.5
Heat, thousand Gcal	8703.4				8703.4	3290.4	44.1	52.3	578.2	1824.7	2343.1	570.6

Total Consumption as Fuel or Energy in 1994, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Popuplation	For Other Works and Needs
Coal – total, kt	476		41		435	10		3	6	151	257	8
including:												
anthracite	174		7		167				2	27	136	2
brown coal	44		4		40	2		3	1	30	3	1
bituminous coal	258		30		228	8			3	94	118	5
Coking Coal, kt	12				12	12						
Diesel Oil, kt	390	1	7	1	382	12	6	144	212	2	5	1
Oven Fuel, kt	4		1		3	1			1	1		
Residual Fuel Oil, kt	363	27	304		32	12	1	2	2	6	1	8
Fuel for Engines, kt	1				1							1
Gasoline, kt	211				211		1	159	2		47	2
Kerosene Oil, kt	16		1		15	1		11	1			2
Lubricants, kt	17				17			9	7			1
Natural Gas, million m^3 standard	1213	138	711		364	66	1	52	2	18	217	8
Liquefied Petroleum Gas, kt	19				19			6			12	1
Fuel wood, thousand m^3 comp.	134		1	7	126	1			2	13	107	3
Wood and Agricultural Waste, kt c.e.	14		5	1	8	1					7	
Other Fuels, kt c.e.	1				1				1			
Electricity, million kWh	4347		2		4345	1036	37	101	586	896	1280	409
Heat, thousand Gcal	6658				6658	2110	14	28	322	1457	2405	322

Total Consumption as Fuel or Energy in 1995, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	269		25		244	6		3	4	149	74	8
including:												
anthracite	78		5		73	1			1	17	51	3
brown coal	34		2		32	1		3	1	24	2	1
bituminous coal	157		18		139	4				108	21	4
Coking Coal, kt	14				14	13						1
Diesel Oil, kt	379	1	7	1	370	12	6	139	201	2	7	3
Oven Fuel, kt	1		1		1	1			6			1
Residual Fuel Oil, kt	347	29	280		38	9	2	2		6		19
Gasoline, kt	223				223		1	143	2		75	2
Kerosene Oil, kt	13				13	1		11				2
Lubricants, kt	17				17			10	7		1	
Natural Gas, million standard m^3	1227	118	712		397	90	1	48	5	17	232	4
Liquefied Petroleum Gas, kt	19				19			4		1	12	2
Fuel wood, thousand m^3 comp.	228		1	4	223	4			3	16	195	5
Wood and Agricultural Waste, kt c.e.	11		3		8						7	1
Other Fuels, kt c.e.												
Electricity, million kWh	4138		2		4136	967	29	120	452	610	1527	431
Heat, thousand Gcal	6126				6126	1874	15	23	279	1134	2506	295

Total Consumption as Fuel or Energy in 1996, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	372		24		348	3		3	4	135	194	9
including:												
anthracite	84		2		82	1			1	18	60	2
brown coal	35		2		33	1		3		26	2	2
bituminous coal	253		20		233	1				91	132	5
Coking Coal, kt	15				15	14					1	
Diesel Oil, kt	323	1	5		317	10	5	124	157	2	15	4
Oven Fuel, kt	7		1		6	2			3			1
Residual Fuel Oil, kt	311	34	251		26	8	2	1		5		10
Gasoline, kt	214				214		1	135	5		73	
Kerosene Oil, kt	20				20			18				2
Lubricants, kt	16				16			8	6		1	1
Natural Gas, million standard m^3	1349	180	727		442	68	1	68	5	22	275	3
Liquefied Petroleum Gas, kt	22				22			4		1	15	2
Fuel wood, thousand m^3 comp.	276		1	1	274	4			2	19	238	11
Wood and Agricultural Waste, kt c.e.	15		3		12					1	11	
Other Fuels, kt c.e.	2				2				1			1
Electricity, million kWh	4094		1		4093	927	28	106	398	762	1402	470
Heat, thousand Gcal	6027				6027	1871	12	19	251	989	2570	315

Total Consumption as Fuel or Energy in 1997, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	265		21		244	3		5	2	117	111	6
including:												
anthracite	90		1		89	1			1	15	70	2
brown coal	25		2		23			4		15	3	1
bituminous coal	150		18		132	2		1		87	38	3
Coking Coal, kt	12				12	12						
Diesel Oil, kt	305	1	3		301	8	5	110	146	2	28	2
Oven Fuel, kt	6		1		5	3			2			
Residual Fuel Oil, kt	224	29	178		17	5	2	1	1	1		7
Gasoline, kt	244				244		1	112	3		127	1
Kerosene Oil, kt	22				22			21				1
Lubricants, kt	15				15			7	6		1	1
Natural Gas, million standard m^3	1461	226	743		492	97	1	30	10	22	330	2
Liquefied Petroleum Gas, kt	26				26			5			20	1
Fuel wood, thousand m^3 comp.	274		1	1	272	4			2	16	244	6
Wood and Agricultural Waste, kt c.e.	13		2		11						10	1
Other Fuels, kt c.e.	9		1		8	4			4			
Electricity, million kWh	3367		–		3767	887	25	114	283	702	1339	417
Heat, thousand Gcal	5552		–		5552	1769	11	11	208	866	2427	260

Total Consumption as Fuel or Energy in 1998, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	197		19		178	5			2	124	41	6
including:												
anthracite	34		1		33	3				13	17	
brown coal	20		2		18	1				13		4
bituminous coal	143		16		127	1				98	24	2
Coking Coal, kt	10				10	9						1
Diesel Oil, kt	246	1	1		244	4	3	93	107	1	32	4
Oven Fuel, kt	10		1		9	1			6	1		1
Residual Fuel Oil, kt	172	21	141		10	6	1	1		1		1
Gasoline, kt	207				207			93	2		110	2
Kerosene Oil, kt	21				21	1		17				3
Lubricants, kt	11				11			6	4		1	
Natural Gas, million standard m^3	1355	153	749		453	93	1	29	9	18	301	2
Liquefied Petroleum Gas, kt	25				25			4			20	1
Fuel wood, thousand m^3 comp.	280		2	1	277	2			2	17	252	4
Wood and Agricultural Waste, kt c.e.	7		1		6						6	
Other Fuels, kt c.e.	4		1		3	2			1			
Electricity, million kWh	3213				3211	803	17	116	213	550	1104	408
Heat, thousand Gcal	5173				5173	1495	10	12	142	759	2497	258

Total Consumption as Fuel or Energy in 1999, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	151		8		143	1			1	84	51	6
including:												
anthracite	51				51	1				13	37	
brown coal	10		1		9					6	1	2
bituminous coal	90		7		83					65	13	4
Coking Coal, kt	7				7	7						
Diesel Oil, kt	178	1	1		176	3	2	68	71	2	29	1
Oven Fuel, kt	9		1		8	3			3	1	1	
Residual Fuel Oil, kt	104	9	90		5	2	1			1		1
Gasoline, kt	119				119			56	1		61	1
Kerosene Oil, kt	22				22			21				1
Lubricants, kt	8				8			3	3			2
Natural Gas, million standard m^3	1150	174	553	1	422	90	1	31	5	15	278	2
Liquefied Petroleum Gas, kt	31				31			5			25	1
Fuel wood, thousand m^3 comp.	257		1	1	255	1			2	10	238	4
Wood and Agricultural Waste, kt c.e.	13		1		12						11	1
Other Fuels, kt c.e..	14	1	11		2	2						
Electricity, million kWh	2566				2566	715	14	65	115	540	774	343
Heat, thousand Gcal	3899				3899	1047	6	4	124	548	2022	148

Total Consumption as Fuel or Energy in 2000, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Popula-tion	For Other Works and Needs
Coal – total, kt	125		5		120	2				64	50	4
including:												
anthracite	70				70	1				25	44	
brown coal	8		1		7					5		2
bituminous coal	47		4		43	1				34	6	2
Coking Coal, kt	7				7	6						1
Diesel Oil, kt	192	1	1		190	3	2	74	57	1	52	1
Oven Fuel, kt	14		2		12	3			4	3	1	1
Residual Fuel Oil, kt	47	3	40		4	2	1			1		
Gasoline, kt	117				117			50	1		66	
Kerosene Oil, kt	21				21			20				1
Lubricants, kt	7				7			3	2		1	1
Natural Gas, million standard m^3	928	197	354	1	376	107		18	5	16	225	5
Liquefied Petroleum Gas, kt	35				35			6			28	1
Fuel wood, thousand m^3 comp.	240			1	239	1			1	12	220	5
Wood and Agricultural Waste, kt c.e.	19		2		17						17	
Other Fuels, kt c.e.	3		2		1						1	
Electricity, million kWh	2244				2244	627	11	61	71	393	790	291
Heat, thousand Gcal	2673				2673	909	4	3	38	428	1194	97

Total Consumption as Fuel or Energy in 2001, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	108		5		103	2				67	29	5
including:												
anthracite	40				40	1				11	28	
brown coal	5				5					4	1	
bituminous coal	63		5		58	1				52		5
Coking Coal, kt	8				8	8						
Diesel Oil, kt	210	1	1		208	3	2	79	55	1	67	1
Oven Fuel, kt	15		1		14	3			5	5		1
Residual Fuel Oil, kt	45	6	33		6	3	1			2		
Gasoline, kt	128				128			55	1		70	2
Kerosene Oil, kt	16				16			16				
Lubricants, kt	7				7			3	2		2	
Natural Gas, million standard m^3	1044	297	381	1	365	98	1	11	3	22	230	
Liquefied Petroleum Gas, kt	47				47	12		4			27	4
Fuel wood, thousand m^3 comp.	222				222	1			2	16	198	5
Wood and Agricultural Waste, kt c.e.	26		5		21						20	1
Other Fuels, kt c.e.	1				1					1		
Electricity, million kWh	2208		2		2206	648	10	60	59	347	813	269
Heat, thousand Gcal	2809				2809	984	3	4	18	582	1128	90

Total Consumption as Fuel or Energy in 2002, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:						
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade and Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	151		4		147	1				80	58	8
including:												
anthracite	88		2		86	1				27	57	1
brown coal	3				3					3		
bituminous coal	60		2		58					50	1	7
Coking Coal, kt	8				8	7						1
Diesel Oil, kt	255		1		254	3	2	118	73	1	56	1
Oven Fuel, kt	6		1		5	2			1	1		1
Residual Fuel Oil, kt	33	2	28		3		1			1		1
Gasoline, kt	162				162			80			82	
Kerosene Oil, kt	19				19			18				1
Lubricants, kt	7				7			3	2		1	1
Natural Gas, million standard m^3	1066	257	371	2	436	125	1	20	4	43	242	1
Liquefied Petroleum Gas, kt	48				48			5			42	1
Fuel wood, thousand m^3 comp.	270		1		269	1			2	20	242	4
Wood and Agricultural Waste, kt c.e.	26		8		18						17	1
Other Fuels, kt c.e.	1				1							1
Electricity, million kWh	2451		2		2449	733	9	61	63	566	774	243
Heat, thousand Gcal	2699				2699	987	3	4	13	422	1180	90

Total Consumption as Fuel or Energy in 2003, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:							
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade	For Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	219		5		214	1				2	115	91	5
including:													
anthracite	160		2		158	1				1	69	87	
brown coal	1				1						1		
bituminous coal	58		3		55					1	45	4	5
Coking Coal, kt	5				5	5							
Diesel Oil, kt	287		2	1	284	3	2	139	69		1	68	2
Oven Fuel, kt	3		1		2	1			1				
Residual Fuel Oil, kt	26	2	18		6	3	1				1		1
Gasoline – total, kt	192				192			99				92	1
including, Lead Free Gasoline	192				192			99				92	1
Kerosene Oil, kt	13				13			12					1
Lubricants, kt	11				11			3	2			2	4
Bitumen, kt	12			12									
White Spirit, kt	1			1									
Other Petroleum Products, kt c.e.	2			2									
Natural Gas, million standard m^3	1143	234	390	2	517	133	1	15	4	2	56	304	2
Liquefied Petroleum Gas, kt	50				50			6			1	42	1
Fuel wood, thousand m^3 comp.	311		1		310	2			2	2	49	252	3
Wood Waste, kt c.e.	21		1		20						5	15	
Agricultural Waste, kt c.e.	11		7		4							3	1
Electricity, million kWh	2529		2		2527	865	8	51	52	68	513	836	134
Heat, thousand Gcal	2799				2799	935	4	4	11	17	454	1288	86

Total Consumption as Fuel or Energy in 2004, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:							
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construc-tion	For Transport	For Agriculture	For Trade	For Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	185		6		179	6				1	100	70	2
including:													
anthracite	144		2		142	5				1	68	67	1
bituminous coal	41		4		37	1					32	3	1
Coking Coal, kt	2				2	2							
Oil, kt													
Diesel Oil, kt	325		2		323	4	2	141	62		1	111	2
Oven Fuel, kt	3				3	1					2		
Residual Fuel Oil, kt	24	2	16		6	4	1				1		
Jet Fuel, kt	14				14			11					3
Gasoline – total, kt	210				210			71				137	2
including, Lead Free Gasoline	210				210			71				137	2
Kerosene Oil, kt	1				1								1
Lubricants, kt	11				11			2	2			2	5
Bitumen, kt	17			17									
White Spirit, kt													
Paraffin Waxes, kt													
Processed Oils, kt c.e.													
Other Petroleum Products, kt c.e.	1			1									
Natural Gas, million standard m³	1167	247	359	6	555	138	1	23	7	2	65	316	3
Liquefied Petroleum Gas, kt	52				52			5			1	46	
Fuel wood, thousand m³ comp.	251			1	250	1			1	1	29	214	4
Wood Waste, kt c.e.	16		1		15	1					2	11	1
Agricultural Waste, kt c.e.	16		11		5							4	1
Electricity, million kWh	2634				2634	871	10	47	48	64	475	964	155
Heat, thousand Gcal	2686				2686	1011	4	2	14	18	418	1129	90

Total Consumption as Fuel or Energy in 2005, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:							
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construc-tion	For Transport	For Agricul-ture	For Trade	For Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	180		5		175	8				2	83	81	1
including:													
anthracite	142		3		139	6				1	54	77	1
bituminous coal	38		2		36	2				1	29	4	
Coking Coal, kt													
Oil, kt	6			6									
Diesel Oil, kt	331	1	2		328	4	3	155	56		1	107	2
Oven Fuel, kt	1				1								1
Residual Fuel Oil, kt	21	3	13		5	4							1
Jet Fuel, kt	15				15			12					3
Gasoline – total, kt	215				215			69				146	
including, Lead Free Gasoline	215				215			69				146	
Kerosene Oil, kt	1				1								1
Lubricants, kt	11			1	10			2	2			2	4
Bitumen, kt	16			16									
White Spirit, kt													
Paraffin Waxes, kt													
Processed Oils, kt c.e.													
Other Petroleum Products, kt c.e.	2			1	1								1
Natural Gas, million standard m³	1339	281	411	5	642	179	1	22	3	3	73	357	4
Liquefied Petroleum Gas, kt	53				53			5			1	45	2
Fuel wood, thousand m³ comp.	253			2	251	1			1	1	26	218	4
Wood Waste, kt c.e.	13		1		12	1					1	10	
Agricultural Waste, kt c.e.	16		8		8							7	1
Electricity, million kWh	2921				2921	974	10	50	51	90	581	1041	124
Heat, thousand Gcal	3084				3084	1007	5	2	20	24	544	1395	87

Total Consumption as Fuel or Energy in 2006, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which: For Electricity	For Heat	As Raw Material and for Non-Energy Purposes	As Fuel and Energy	Of which: For Industry	For Construction	For Transport	For Agriculture	For Trade	For Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	189		4		185	6				1	79	93	6
including:													
anthracite	143		2		141	6					44	90	1
bituminous coal	46		2		44					1	35	3	5
Coking Coal, kt													
Oil, kt	4			4									
Diesel Oil, kt	334		1		333	4	3	180	56		1	87	2
Oven Fuel, kt	1				1								1
Residual Fuel Oil, kt	17	1	11		5	4	1						
Jet Fuel, kt	17				17			12					5
Gasoline – total, kt	198				198			73				123	2
including, Lead Free Gasoline	198				198			73				123	2
Kerosene Oil, kt													
Lubricants, kt	12				12			4	2			3	3
Bitumen, kt	22			22									
White Spirit, kt													
Paraffin Waxes, kt													
Processed Oils, kt c.e.													
Other Petroleum Products, kt c.e.													
Natural Gas, million standard m^3	1327	274	400	3	650	179	2	5	2	4	79	375	4
Liquefied Petroleum Gas, kt	50				50			5			1	43	1
Fuel wood, thousand m^3 comp.	313			2	311	1			2	1	32	272	3
Wood Waste, kt c.e.	13				13						1	12	
Agricultural Waste, kt c.e.	16		7		9							8	1
Electricity, million kWh	3215				3215	1026	14	58	55	100	653	1154	155
Heat, thousand Gcal	2903				2903	932	6	4	10	26	480	1330	115

Total Consumption as Fuel or Energy in 2007, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which: For Electricity	For Heat	As Raw Material and for Non-Energy Purposes	As Fuel and Energy	Of which: For Industry	For Construction	For Transport	For Agriculture	For Trade	For Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	129		3		126	3					63	54	6
including:													
anthracite	100		2		98	3					39	51	5
bituminous coal	29		1		28						24	3	1
Coking Coal, kt													
Oil, kt	8			8									
Diesel Oil, kt	351		1		350	3	4	211	49			80	3
Oven Fuel, kt	1				1								1
Residual Fuel Oil, kt	14		7	3	4	2	1						1
Jet Fuel, kt	20				20			14					6
Gasoline – total, kt	203				203			80			1	121	1
including, Lead Free Gasoline	203				203			80			1	121	1
Kerosene Oil, kt													
Lubricants, kt	10			1	9			5	1			3	
Bitumen, kt	26			26									
White Spirit, kt													
Paraffin Waxes, kt													
Processed Oils, kt c.e.													
Other Petroleum Products, kt c.e.	1			1									
Natural Gas, million standard m^3	1213	269	351	3	590	176	1	5	1	4	87	314	2
Liquefied Petroleum Gas, kt	53				53			6			1	45	1
Fuel wood, thousand m^3 comp.	258			1	257				2	1	31	220	3
Wood Waste, kt c.e.	10				10						1	9	
Agricultural Waste, kt c.e.	15		8		7							7	
Electricity, million kWh	3364				3364	1049	15	65	50	115	630	1295	145
Heat, thousand Gcal	2554				2554	724	6	2	8	16	444	1274	80

Total Consumption as Fuel or Energy in 2008, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which: For Electricity	For Heat	As Raw Material and for Non-Energy Purposes	As Fuel and Energy	Of which: For Industry	For Construction	For Transport	For Agriculture	For Trade	For Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	198		4		194	84				1	57	45	7
including:													
anthracite	88		3		85	9				1	30	43	2
bituminous coal	110		1		109	75					27	2	5
Coking Coal, kt													
Oil, kt	14			14									
Diesel Oil, kt	368		1		367	3	4	218	47			92	3
Oven Fuel, kt	1				1								1
Residual Fuel Oil, kt	17	1	9		7	2	1				2		2
Jet Fuel, kt	18				18			14					4
Gasoline – total, kt	208				208			77			1	129	1
including, Lead Free Gasoline	208				208			77			1	129	1
Kerosene Oil, kt													
Lubricants, kt	11				11			6	1			3	1
Bitumen, kt	24			24									
White Spirit, kt													
Paraffin Waxes, kt													
Processed Oils, kt c.e.													
Other Petroleum Products, kt c.e.	1			1									
Natural Gas, million standard m^3	1138	240	355	4	539	103	1	5	3	5	87	332	3
Liquefied Petroleum Gas, kt	55				55			10			1	43	1
Fuel wood, thousand m^3 comp.	289			1	288				1	1	33	249	4
Wood Waste, kt c.e.	12				12						1	11	
Agricultural Waste, kt c.e.	20		12		8						1	7	
Electricity, million kWh	3428				3428	948	14	62	54	130	711	1371	138
Heat, thousand Gcal	2553				2553	730	5	2	11	20	452	1262	71

Total Consumption as Fuel or Energy in 2009, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which: For Electricity	For Heat	As Raw Material and for Non-Energy Purposes	As Fuel and Energy	Of which: For Industry	For Construction	For Transport	For Agriculture	For Trade	For Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	177		5		172	57				1	58	55	1
including:													
anthracite	109		4		105	3				1	45	55	1
bituminous coal	68		1		67	54					13		
Coking Coal, kt	2				2	2							
Oil, kt	17			17									
Diesel Oil, kt	337		1		336	2	3	186	43			101	1
Oven Fuel, kt	1				1								1
Residual Fuel Oil, kt	36	8	17	4	7	1					4		2
Jet Fuel, kt	14				14			14					
Gasoline – total, kt	207				207			64				142	1
including, Lead Free Gasoline	207				207			64				142	1
Kerosene Oil, kt													
Lubricants, kt	9				9			5	1			1	2
Bitumen, kt	10			10									
White Spirit, kt	1			1									
Paraffin Waxes, kt													
Processed Oils, kt c.e.													
Other Petroleum Products, kt c.e.	2			1	1						1		
Natural Gas, million standard m^3	1068	222	300		546	59		7	2	5	129	343	1
Liquefied Petroleum Gas, kt	60				60			10			8	42	
Fuel wood, thousand m^3 comp.	262			1	261				2	1	30	226	2
Wood Waste, kt c.e.	15				15						1	13	1
Agricultural Waste, kt c.e.	25		15		10						10		
Electricity, million kWh	3378				3378	872	13	50	59	171	695	1450	68
Heat, thousand Gcal	2223				2223	419	2	2	10	11	460	1291	28

Total Consumption as Fuel or Energy in 2010, by the Main Sectors of the National Economy (in natural units)

Type of Fuel and Energy	TOTAL Consumption	Of which:			As Fuel and Energy	Of which:							
		For Electricity	For Heat	As Raw Material and for Non-Energy Purposes		For Industry	For Construction	For Transport	For Agriculture	For Trade	For Utilities	Sold to Population	For Other Works and Needs
Coal – total, kt	186		3		183	52				1	42	83	5
including:													
anthracite	129		3		126	10					32	83	1
bituminous coal	57				57	42				1	10		4
Coking Coal, kt	4				4	4							
Oil, kt	11			11									
Diesel Oil, kt	418		1		417	4	3	249	44	1	2	113	1
Oven Fuel, kt	2				2	2					1		1
Residual Fuel Oil, kt	31	3	19	6	3	1	1			1			
Jet Fuel, kt	13				13			13					
Gasoline – total, kt	197				197			69				127	1
including, Lead Free Gasoline	197				197			69				127	1
Kerosene Oil, kt				1									
Lubricants, kt	10			21	9			6	1			1	1
Bitumen, kt	21			1									
White Spirit, kt	1												
Paraffin Waxes, kt													
Processed Oils, kt c.e.													
Other Petroleum Products, kt c.e.	2			2									
Natural Gas, million standard m^3	1128	216	321		591	79	1	2	3	10	130	364	2
Liquefied Petroleum Gas, kt	64				64	1	1	13		1	6	40	2
Fuel wood, thousand m^3 comp.	267				267	1			3	2	25	232	4
Wood Waste, kt c.e.	10				10					1		8	1
Agricultural Waste, kt c.e.	21		17		4					1		2	1
Electricity, million kWh	3488		2		3486	975	13	46	54	185	598	1514	101
Heat, thousand Gcal	2397				2397	531	2	1	8	16	457	1324	58

Annex 3. Additional Methodologies and Data Sources

Annex 3-1: Additional Methodologies and Data Sources for Energy Sector

Annex 3-1.1: Assessment Method Used to Estimate SO_2 Emissions within the Energy Sector

SO_2 emissions from 1A 'Fuel Combustion' were estimated following a Tier 1 method. The basic equations used to estimate SO_2 emissions are described as follows:

$$Emissions\ SO_2 (Gg) = \Sigma\ [Activity_{ab} (TJ) \bullet EF_{ab} (kg/TJ)]$$

$$Emission\ Factor = 2 \bullet (s/100) \bullet (1/Q) \bullet 10^6 \bullet (100-r)/100 \bullet ((100-n)/100,$$

Where:

Activity – Energy Input (TJ);

EF – Emission Factor (kg/TJ);

a – fuel type;

b – sector or activity;

2 – SO_2/S (kg/kg);

S – sulphur content in fuel (per cent);

r – retention of sulphur in ash (per cent);

Q – net calorific value (TJ/kt);

10^6 – conversion factor;

n – efficiency of abatement technology and/or reduction efficiency (per cent).

Default emission factors available in the Revised 1996 Guidelines (IPCC, 1997) and IPCC 2006 Guidelines were used to estimate SO_2 emissions (Table A3-1.1), except for the coefficient of sulphur fraction in fuels imported in the Republic of Moldova (these values were provided by the Customs Service of the Republic of Moldova).

Table A3-1.1: Emission Factors Used to Estimate SO_2 Emissions in the RM

Fuel Type	Sulphur Fraction in Fuel, %	Retention of Sulphur in Ash, %	Net Calorific Value, TJ/kg
Anthracite	1.5	5	25.70
Other Bituminous Coals	1.5	5	26.41
Lignite	1.5	30	11.68
Residual Fuel Oil	3	0	40.20
Diesel Oil	0.3	0	42.54
Gasoline	0.1	0	43.72
Natural Gas	0.3	0	33.86
Kerosene	0.05	0	43.13
Fire Wood	0.2	0	12.32

Source: Revised 1996 Guidelines, Vol. 3, Tab. 1-12, page1.44; National Bureau of Statistics of the RM and Customs Service of the RM

Annex 3-1.2: Additional Data Sources Used to Estimate GHG Emissions within the Energy Sector for the ATULBD

Table A3-1.2.1: Fuel Consumption for Heat and Power Generation (Source Category 1A1 'Energy Industries') in the ATULBD, 1994-2011

	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
Other plants in energy sector	267.95	0.00	49.70	148.10	224.73	187.20	262.40	250.40	143.20
	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	
MTPP Dnestrovsk	756.20	838.70	805.40	429.40	719.00	766.20	1267.20	1339.40	
Other plants in energy sector	175.30	151.80	166.70	181.70	166.70	189.00	181.10	210.10	
Residual Fuel Oil, kt						7.6057	19.7749	19.5171	16.2301
Bituminous coal, kt						115.4448	230.8896	201.1057	160.6409

Source: Official Letter from "Moldova Gaz" No. 06-1253 dated 27.09.2006 and No. 02/1476 dated 23.02.2011; State Statistical Service of the Transnistrian Moldovan Republic (2012), Socio-Economic Development of TMR in 2011, Chapter 4 "Material and Energy Resources", page 23. Tiraspol, 2012, 85 p.; State Statistical Service of the Transnistrian Moldovan Republic (2011), Socio-Economic Development of TMR in 2010, Chapter 4 "Energy Resources", page 21. Tiraspol, 2011, 79 p.; State Statistical Service of the Transnistrian Moldovan Republic (2010), Socio-Economic Development of TMR in 2009, Chapter 4 "Material Resources", page 23. Tiraspol, 2010, 75 p

Table A3-1.2.2: Fuel Consumption within the Source Category 1A2 'Manufacturing Industries and Construction' for the ATULBD, 1994-2011

	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	
Residual Fuel Oil, kt						0.8715	0.5705	0.3208	0.3089
Bituminous coal, kt						0.0737	0.1473	0.1108	0.1102

Source: Official Letter from "Moldova Gaz" No. 06-1253 dated 27.09.2006 and No. 02/1476 dated 23.02.2011; State Statistical Service of the Transnistrian Moldovan Republic (2012), *Socio-Economic Development of TMR in 2011, Chapter 4 "Material and Energy Resources", page 23*. Tiraspol, 2012. 85 p.; State Statistical Service of the Transnistrian Moldovan Republic (2011), *Socio-Economic Development of TMR in 2010, Chapter 4 "Energy Resources"*, page 21, Tiraspol, 2011. 79 p.; State Statistical Service of the Transnistrian Moldovan Republic (2010), *Socio-Economic Development of TMR in 2009, Chapter 4 "Material Resources", page 23*, Tiraspol, 2010. 75 p

Table A3-1.2.3: Fuel Consumption within the Source Category 1A3b 'Road Transportation' for the ATULBD, 1995-2010

	1995	1996	1997	1998	1999	2000	2001	2002
Diesel Oil, kt	2.9748	2.3819	3.1773	2.4552	2.2670	1.6176	1.5949	1.2404
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Diesel Oil, kt	0.8601	0.7708	0.5394	0.4471	0.3259	0.2945	0.3893	0.8235
Compressed Natural Gas, mil. m^3	0.0	0.0	0.0	0.0	0.0	0.0	4.1	6.9

Source: Statistical Yearbook of the ATULBD 2000 (page 106), 2006 (page 107), 2009 (page 106), 2010 (page 108), 2011 (page 109), 2012 (page 113); Official Letter from "Moldova Gaz" No. 06-1253 dated 27.09.2006 and No. 02/1476 dated 23.02.2011.

Table A3-1.2.4: Fuel Consumption within the Source Category 1A4a 'Commercial/ Institutional Sector' for the ATULBD, 1999-2010

	1999	2000	2001	2002	2003	2004
Natural Gas, million m^3	6.8	9.3	13.6	81.8	87.4	229.0
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Natural Gas, million m^3	181.6	151.9	14.4	19.8	16.1	37.7

Source: Official Letter from „Moldova Gaz" Nr. 06-1253 from 27.09.2006 and Nr. 02/1476 from 23.02.2011.

Table A3-1.2.5: Fuel Consumption within the Source Category 1A4b 'Residential Sector' for the ATULBD, 1995-2011

	1995	1996	1997	1998	1999	2000	2001	2002
LPG, kt *	2.5	2.3	1.4	1.3	0.8	0.5	0.3	0.4
Natural Gas, million m^3 *	216.6	163.4	354.8	321.6	293.2	NA	196.4	175.4
Natural Gas, million m^3 **					294.2	217.9	196.4	163.5
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
LPG, kt *	0.5	0.5	0.5	0.5	0.4486	0.4962	0.3869	0.5798
Natural Gas, million m^3 *	176.6	162.8	164.8	161.2	150.8	150.0	156.0	174.3
Natural Gas, million m^3 **	176.6	132.0	144.2	157.0	149.2	148.7	154.7	173.0

Source: * Statistical Yearbooks of the ATULBD for 2000 (page 22), 2006 (page 22), 2009 (page 23), 2010 (page 23), 2011 (page 23), 2012 (page 23); ** Official Letter from „Moldova Gaz" No. 06-1253 dated 27.09.2006 and No. 02/1476 dated 23.02.2011.

Table A3-1.2.6: Fuel Consumption within the Source Category 1A4c 'Agriculture/ Forestry/ Fishing Sectors' for the ATULBD, 1995-2010

	1995	1996	1997	1998	1999	2000	2001	2002
Diesel Oil, kt	26.7732	21.4371	28.5957	22.0698	20.4030	14.5584	14.3541	11.1636
Gasoline, kt	9.6830	6.1160	8.8580	5.7920	3.0730	1.7550	1.6930	1.2220
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Diesel Oil, kt	7.7409	6.9372	4.8546	4.0239	2.9331	2.6505	3.5037	7.4195
Gasoline, kt	1.2580	0.7810	0.6120	0.5740	0.3980	0.3340	0.4230	0.6460
Natural Gas, million m^3	0.9	0.7	0.4	0.1	0.0	0.1	0.0	0.1
Residual Fuel Oil, kt						0.0032	0.0032	0.0032
Coal, kt						0.0153	0.0115	0.0090

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). Official Letter from „Moldova Gaz" No. 06-1253 dated 27.09.2006 and No. 02/1476 dated 23.02.2011; State Statistical Service of the Transnistrian Moldovan Republic (2012), *Socio-Economic Development of TMR in 2011, Chapter 4 "Material and Energy Resources", page 23*, Tiraspol, 2012. 85 p.; State Statistical Service of the Transnistrian Moldovan Republic (2011), *Socio-Economic Development of TMR in 2010, Chapter 4 "Energy Resources"*, page 21, Tiraspol, 2011. 79 p.; State Statistical Service of the Transnistrian Moldovan Republic (2010), *Socio-Economic Development of TMR in 2009, Chapter 4 "Material Resources", page 23*, Tiraspol, 2010. 75 p

Table A3-1.2.7: Fuel Consumption within the Source Category 1A5 'Other' (Other Works and Needs) for the ATULBD, 1995-2010

	1995	1996	1997	1998	1999	2000	2001	2002
Lubricants, kt	1.065	1.119	1.574	1.188	1.133	0.605	0.756	0.615
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Lubricants, kt	0.403	0.316	0.220	0.148	0.153	0.079	0.107	0.194

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). Official Letter from "Moldova Gaz" No. 06-1253 dated 27.09.2006 and No. 02/1476 dated 23.02.2011.

Annex 3-2: Additional Data Sources for Industrial Processes Sector

Table A3-2.1: Chemical-Mineralogical Composition of Cement Powder Produced at Cement Plant in Rezina "LAFARGE CIMENT" J.S.C. [Filter Powder, Cement Mill Nr. 1]

Date	Time	SiO_2	Al_2O_3	Fe_2O_3	CaO	Free CaO	SO_2	MgO	K_2O	Na_2O	LOI
			Conveyor №1	+ Coveyor №2							
26.09.05	11-00	18.10	5.39	3.41	54.14	1.20	7.85	1.77	1.00	0.21	6.41
			Conveyor №1								
26.09.05	13-00	18.65	5.12	3.41	54.74	1.00	7.88	1.75	0.98	0.21	5.95
			Conveyor №2								
29.09.05	13-00	18.98	5.31	3.42	55.09	1.06	7.49	1.82	0.93	0.19	5.38
Date	**Time**	**Total**	**SM**	**AR**	**LSF**	**C3S**	**C2S**	**C3A**	**C4AF**	**Alkalis**	**I.R.**
			Conveyor №1	+ Coveyor №2							
26.09.05	11-00	98.28	2.06	1.58	89.74	14.41	41.01	8.53	10.38	0.87	0.09
			Conveyor №1								
26.09.05	13-00	98.69	2.19	1.50	89.23	15.27	41.95	7.81	10.37	0.85	0.09
			Conveyor №2								
29.09.05	13-00	98.61	2.17	1.55	88.00	13.68	44.12	8.30	10.41	0.80	0.09

Table A3-2.2: Chemical-Mineralogical Composition of Cement Produced at Cement Plant in Rezina "LAFARGE CIMENT" J.S.C. [Cement, Cement Mill Nr. 1]

Date	Time	SiO_2	Al_2O_3	Fe_2O_3	CaO	Free CaO	SO_2	MgO	K_2O	Na_2O	LOI
26.09.05	13-00	22.78	5.3	3.67	61.09	0.58	2.71	1.98	0.63	0.23	1.2
Date	**Time**	**Total**	**SM**	**AR**	**LSF**	**C3S**	**C2S**	**C3A**	**C4AF**	**Alkalis**	**I.R.**
26.09.05	13-00	99.58	2.54	1.45	83.84	24.6	46.77	7.85	11.16	0.64	0.2

Table A3-2.3: Raw Materials and Energy Balance for Cement Production at Cement Plant in Rezina "LAFARGE CIMENT" J.S.C

Nr.	Name	Measuring Units	Consumption Norm	Nr.	Name	Measuring 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 Suppments	- „ – „ -	185.4				
Fuel							
1	Total Fuel	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 A3-2.4: Raw Materials Consumption Norms for Cement Production at Cement Plant in Rezina "LAFARGE CIMENT" J.S.C

Nr.	Name	Supplier	Normative Acts	Measure Unit	Consumption Norm
1	**Raw Material**				
1.1	Limestone and red clay	Cement and slate works in Ribnita, ATULBD	CT 21 RSSM 115-87	kg/t clinker	1710
2	**Correction Supplements**				
2.1	Burning residues	Construction Materials Works in Evpatoria, Ukraine	CT 6-08-385-77	- „ – „ -	50
2.2	Lime residue	Metal Combined Works in Novolipetk, Ukraine	CT 14-106-198-83	- „ – „ -	50
2.3	Aluminised clay	Mining Department in Kirovograd, Ukraine	CT 14-8-419-83 CT 14 RSSU 136-82 CT 14-14-150-88	- „ – „ -	90
3	**Mineral Supplements**				
3.1	Granulated slag	Metal Works in Krivoi Rog, Ukraine	STaS 3476-74	kg/t cement	180
4	Gypsum	Gypsum quarries in Criva, Republic of Moldova	STaS 4013-82	- „ – „ -	56
4.	Additional Materials				

Nr.	Name	Supplier	Normative Acts	Measure Unit	Consumption Norm
5.	Refraction				
5.1	Alumosilicates, of normal size including : magnesial „Lovinit”	Donețk, Ukraine Czech Republic	STaS 21436-75	kg/t clinker	1.65 0.31 1.34 3.65
5.2	Crushing pieces including: steel balls	Dneprodzerjinsk, Ukraine, the Works in Kataev-Ivanovsk, Experimental Works in Malinsk, Jitomir region, Ukraine	STaS 7524-83 STaS 24384-80	kg/t cement - „ – „ - - „ – „ -	1.30 0.73 0.57
5.3	Steel-clad plates	Metallic Works in Volisk, Ukraine	STaS 26645-85	- „ – „ -	-
6.	Energy Sources				
6.1	Fuel for clinker drying Fuel for supplements drying	Petroleum tank farm in Kremenciug, Ukraine	STaS 10585	kg c.e./t clinker - „ – „ -	155.8 20.0
6.2	Electricity	Moldglavenergo, Republic of Moldova		kWh/t cement	164.0

Table A3-2.5: Average Concentration of CaO and MgO in Clay Used for Bricks Production at State Enterprises “Macon” J.S.C. in Chisinau, 1990-2010

Year	Average Concentration of CaO in Clay Used, %				Average Concentration of MgO in Clay Used, %			
	From Malo-Haruza Quarry	From Pruncul Quarry	From Micauti Quarry	From Purcel Quarry	From Malo-Haruza Quarry	From Pruncul Quarry	From Micauti Quarry	From Purcel Quarry
1990	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
1991	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
1992	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
1993	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
1994	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
1995	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
1996	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
1997	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.210
1998	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.210
1999	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.210
2000	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.210
2001	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.210
2002	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.210
2003	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.210
2004	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.210
2005	5.87-7.96	4.080	8.220	8.440	2.16-3.18	3.210	3.570	3.030
2006	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
2007	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
2008	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
2009	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030
2010	6.915	4.080	8.220	8.440	2.670	3.210	3.570	3.030

Annex 3-3: Additional Data Sources for Agriculture Sector

Features of Races of Livestock and Poultry Bred in the Republic of Moldova

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, Rodionov, 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*[107] has been crossbred as a result of cross-breeding of *Steppe Red* and *Simmental* with the improved races *Spotted Black* and *Holstein.*

[107] 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 A3-3.1: 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, Rodionov, 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" (Southern)	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, Tigai, Turcana* and *Frisian* (Table A3-3.3). The most typical colours 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. The sheep of *Tigai* race 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, Rodionov, Varban, 2003; Bivol, Ciubotaru, 2005).

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
Tigai	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

Goats

Most of the 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) color, 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, Rodionov, Varban, 2003; Bivol, Ciubotaru, 2005) (Table A3-3.4).

TableA3-3.4: 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[108] in the Central and Southern part of the country (Bucataru, Rodionov, 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).

[108] 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.

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 Chinchila	Meat and fur	3.5-5.5	6-8
Vienna Blue	Meat and fur	4.0-5.0	6-12
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 fur	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, Rodionov, 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
Cornisch	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, Rodionov, Urzica, 2002) (Table A3-3.7).

Geese

The most widely spread races of geese bred in the Republic of Moldova are: *Holmogor, White Italian, Kuban* and *Chinese* (Bucataru, Rodionov, Urzica, 2002) (Table A3-3.8).

Ducks

Preponderantly four races of ducks are bred in the Republic of Moldova: *Beijing, Mirror, Grey Ukrainian* and *Polish* (Bucataru, Rodionov, Urzica, 2002) (Table A3-3.9).

Table A3-3.7: Features of Turkey Races Bred in the Republic of Moldova

Races of Turkeys	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

Table A3-3.8: Features of Geese Races Bred in the Republic of Moldova

Races of Geese	Production	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

Table A3-3.9: Features of Ducks Races Bred in the Republic of Moldova

Races of Ducks	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	meat-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 LULUCF Sector

Annex A3-4.1: Average Dendrometrical Indicators of the Main Species of Trees Occurring in the Forests of the Republic of Moldova

Species	Average production class	Average consistency	Average amount per 1 ha of forest, m^3	Average amount per 1 ha of workable stands, m^3	Average total growth, thousand m^3	Average growth per ha of forest, m^3
Pine	2.1	0.64	34		16.5	2.8
Quercus species	2.8	0.73	150	92	415.4	3.0
Beech	1.7	0.78	281	1313	1.2	2.4
Hornbeam	2.4	0.78	178	234	33.3	3.5
Ash tree	2.1	0.78	177	235	56.0	3.5
Sycamore maple tree	1.7	0.69	55	200	44.4	2.6
Field maple	2.5	0.75	103	165	3.0	3.8
Elm tree	2.6	0.73	87	152	2.9	3.2
Acacia	1.6	0.75	69	132	276.6	3.9
Birch tree	1.6	0.63	50	100	2.0	3.3
Trembling poplar	1.1	0.70	204	237	1.0	5.0
Linden tree	2.2	0.76	171	239	10.7	3.7

Species	Average production class	Average consistency	Average amount per 1 ha of forest, m^3	Average amount per 1 ha of workable stands, m^3	Average total growth, thousand m^3	Average growth per ha of forest, m^3
Poplar	2.8	0.69	186	310	44.9	7.9
Willow	3.3	0.65	179	248	14.1	7.4
Total forests	2.3	0.73	124	180	1196.9	3.3
Recommendable indicators	1.7	0.8-0.9	140	216	1451	4.0

Annex A3-4.2: 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)[109] was used by the Republic of Moldova and Uzbekistan to compile their GHG emissions inventories within the Second National Communications (2009).

Recently, a group of authors[110] updated the evaluation methodology 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:

- 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).

[109] Banaru, Anatol (2000), *Methodology to Calculate CO_2 Emissions from Arable Soils,* In the collection of papers „Climate Change. Research, Studies, Solutions, Ministry of Environment / UNDP Moldova. „Bons Offices" S.R.L. Chisinau, 2000. P. 115-123.

[110] Cerbari, V., Scorpan, V., Taranu, M. (2010), *The potential for reducing the CO_2 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.

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, Gonenco, 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.

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, tone;

V_I – carbon entered into the soil through crop yield and organic matter humification, tons/yr;

C_O – carbon coming out from the soil through CO_2 emissions as a result of humus mineralization, tons/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, tons/yr;

V_2 – carbon returned to soils with organic fertilizers, tons/yr.

The amount of carbon in crop residues returned to soils (V1) can be estimated using the following equation:

$$V_1 = [(Crop_{(T)} \bullet R_{AG(T)} \bullet (1-Frac_{Remove(T)}) + Crop_{(T)} \bullet R_{BG(T)}) \bullet k_1] / 1.724$$ [111]

[111] Arinushkina E.V. *Guidelines for Chemical Analysis of Soils* (in Russian). Moscow, Moscow State University Press, 1961. p.136.

Where:

$Crop_{(T)}$ – harvested annual dry matter yield for crop *T* t.d.m./ha;

$$Crop_{(T)} = Yield\ Fresh_{(T)} \bullet DRY$$

Where:

$Yield\ Fresh_{(T)}$ – harvested fresh yield for crop *T*, t/ha;

DRY – dry matter fraction of harvested crop *T*, kg d.m./t of yield[112];

$R_{AG(T)}$ – ratio of above-ground residues dry matter to harvested yield for crop *T* (Crop(T)), t.d.mAG/t.d.m[113];

$R_{BG(T)}$ – ratio of below-ground residues to harvested yield for crop *T*, t.d.mBG/t dm[114];

$Frac_{Remove(T)}$ – fraction of above-ground residues of crop *T* removed and used for other purposes[115]

k_1 – coefficient reflecting the humificatin of crop residues[116];

1.724 – coefficient reflecting the conversion from humus to carbon[117].

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 3-4.2.1).

[112] 2006, IPCC *Guidelines,* Volume 4, Chapter 11, Table 11.2, Page 11.17.
[113] Nicolaev N., Boincean B., Sidorov M., Vanicovici Gh., Coltun V. (2006), *Agrotechnics*. Ministry of Education and Youth of the Republic of Moldova – Balti: Presa universitara balteană, 2006, P. 298.
[114] *2006 IPCC Guidelines*, Volume 4, Chapter 11, Table 11.2, Page 11.17.
[115] Expert opinion, Prof. Valerian Cerbari, Institute of Pedology, Agrochemistry and Soil Protection „Nicolae Dimo"
[116] Rusu M., Mărghitaş M., Oroian I., Mihăilescu T., Dumitraş A. (2005), *Agrochemistry Treaty*. (in Romanian), Bucuresti, Publishing House Ceres, 2005. 672 p.
[117] Arinushkina E.V. *Guidelines for Chemical Analysis of Soils* (in Russian). Moscow, Moscow State University Press, 1961. p 136.

Table 3-4.2.1: Coefficients Used to Estimate Amount of Carbon 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	1.43	0.23	0.75	0.11
Winter wheat (crop residues returned to soils with N inputs during stubble-turning)	0.89	1.43	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

Crop	DRY	$R_{AG (T)}$	$R_{BG (T)}$	$Frac_{Remove (T)}$	k_1
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
Legumes	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	0.87	1.48	0.22	0.80	0.17
Perennial grasses for green fodder, silage and fodder	0.90	0.34	0.40	0.80	0.25
Annual grasses (oat and vetch) for green fodder	0.90	0.20	0.80	0.80	0.22
Annual grasses (oat and peas) for green fodder	0.90	0.30	0.80	0.80	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;

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 humificatin of organic fertilizers (Table 3-4.2.2)[118];

1.724 – coefficient reflecting the transition from humus to carbon[119].

[118] 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.

[119] Arinushkina E.V. *Guidelines for Chemical Analysis of Soils* (in Russian). Moscow, Moscow State University Press, 1961. p 136.

Table 3-4.2.2: Normative of humus accumulation in the country's chernozems (black 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:

$$C = [E_R - (E_M + E_O + E_V + E_S)] \cdot r_1 \cdot r_2 \cdot R$$

Where:

E_R – the amount of N exported from the main and additional crop yield, t/yr; can be estimated using the following equation:

$$E_{r\,(T)} = (Yield\ Fresh_{(T)} \cdot k_{3\,(T)}) / 10^3$$

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 3-4.2.3)[120].

Table 3-4.2.3: Export of nitrogen with the crop yield, kg per 1 t 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
Perennial herbs for green mass	9
Vineyards	7
Orchards	2
Pastures and hay fields	18

E_M – the amount of N export from synthetic fertilizers can be estimated using the following equation:

$$E_M = F_{SN} \cdot k_4$$

Where:

F_{SN} – total amount of synthetic fertilizer N 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 chemical fertilizers applied to soils, t/yr;

P_{SN} – percentage share of N in chemical fertilizers, % of active substance (Table 3-4.2.4);

k_4 – coefficient reflecting the N use from chemical fertilizers; constitutes circa 50 per cent of the applied quantity (Banaru, 2002).

Table 3-4.2.4: Nitrogen content in chemical fertilizers applied in the country

Chemical Fertilizers	Chemical formula	Active substance, %
Anhydrous ammonia	NH_3	82.0
Sulhpate 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 sulfate	$NH_4NO_3{\cdot}(NH_4)_2SO_4$	26.0
Urea	$CO(NH_2)_2$	46.0
Calcium cyanide	$CaCN_2$	21.0
Ammonim 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 3-4.2.5);

k_5 – average coefficient reflecting the N content in organic fertilizers (Banaru, 2002) (Table 3-4.2.5).

The use of recalculation coefficients available in Table 3-4.2.6, enables the AD conversion related to the use of various organic fertilizers in stable waste with bed.

[120] Banaru A. (2002), *Methodological Guidelines to Determine Humus Balance in Agricultural Soils* (in Romanian). Ministry of Agriculture and Food Industry of the Republic of Moldova. 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.

Table 3-4.2.5: 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
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

Table 3-4.2.6: 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:

$$E_V = F_{CR} \cdot k_6$$

Where:

F_{CR} – annual amount of N in crop residues returned to soils annually, t N/yr; can be estimated using the following equation:

$$F_{CR} = (Cr_{op\,(T)} \bullet R_{AG\,(T)} \bullet (1\text{-}Frac_{Remove\,(T)}) + Crop_{(T)} \bullet R_{BG\,(T)}) \bullet (P_{CR}/10^2) \bullet (k_6/10^2)$$

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* ($C_{rop(T)}$), t.d.m_{AG}/t.d.m.[121];

$R_{BG\,(T)}$ – ratio of below-ground residues to harvested yield for crop *T*, t.d.m_{BG}/t d.m.[122];

$Frac_{Remove(T)}$ – fraction of above-ground residues of crop *T* removed and used for other purposes[123];

P_{CR} – amount of Nitrogen in crop residues, % active substance (see Table 3-4.2.7);

k_6 – coefficient reflecting the N in crop residues (Banaru, 2002) (see Table 3-4.2.7)

Table 3-4.2.7: Amount of N in Crop Residues (country specific average values).

Crop	Contents of Nitrogen, %		Amount of used N from Crop Residues, % from total
	Fertilized Soils	Unfertilized Soils	
Winter wheat	1.00	1.10	Amount of used N from crop residues represents 25 per cent from the total
Winter rye	1.00	1.10	
Winter barley	1.00	1.10	
Oat	1.00	1.10	
Millet	1.25	1.23	
Buckwheat	1.05	1.05	
Leguminous crops	2.08	2.08	
Grain maize	1.08	1.11	
Grain sorghum	1.00	1.05	
Other cereal crops	1.00	1.05	
Sugar beet	1.50	1.40	
Sun flower	0.95	1.10	
Soybeans	2.08	2.08	
Tobacco	1.30	1.30	
Grain Rapeseed	1.05	1.05	
Potatoes	1.19	1.19	
Legumes	2.09	2.09	
Melons and gourds	1.19	1.19	
Root crops for fodder	1.26	1.26	
Maize for silo and green fodder	1.08	1.11	
Perennial grasses for green fodder, silage and fodder	1.90	1.90	
Annual grasses for green fodder	1.06	1.18	
Vetch green manure, above-ground dry mass	4.20		
Vetch green manure, below-ground dry mass	1.40		

E_S – the amount of N fixation and export from soils by vegetables and perennial herbs; the quality of symbiotic nitrogen can be estimated using the following equation:

[121] Nicolaev N., Boincean B., Sidorov M., Vanicovici Gh., Coltun V. (2006), *Agrotechnics*. Ministry of Education and Youth of the Republic of Moldova. – Balti: Presa universitara balteana, 2006, - p. 298
[122] 2006 *IPCC Guidelines*, Volume 4, Chapter 11, Table 11.2, Page 11.17.
[123] Expert opinion, Prof. Valerian Cerbari, Institute of Pedology, Agrochemistry and Soil Protection „Nicolae Dimo"

$E_{S(T)}$ = Yield Fresh $_{(T)}$ • ($k_{7\ (T)}$ / 10^3) • ($k_{8\ (T)}$ / 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 3-4.2.8);

$k_{8(T)}$ – coefficients reflecting symbiotic nitrogen export for crop T (Banaru, 2002) (Table 3-4.2.8).

Table 3-4.2.8: Fixation and Export of Nitrogen by Vegetables and Perennial Herbs (averages from literature)

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[124] (Table 3-4.2.9).

Table 3-4.2.9: 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[125] (Table 3-4.2.10).

Table 3-4.2.10: 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, Gonenco, 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, tons;

[44/12] – stoichiometric ratio between C and CO_2.

Regarding the "*Methodology to Calculate CO_2 Emissions from Agricultural Soils*" (Banaru, 2000), it should also be mentioned the following:

- 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 negative value, the carbon balance should be considered negative and proves that the croplands represent a source of CO_2 emissions;
- In the case where the sum has a positive value, the carbon balance should be considered neutral or positive, which proves that the croplands represent a sink of CO_2 emissions.

[124] 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.
[125] Idem.

Annex 4. Quality Assurance and Quality Control

Annex 4-1: Forms and Checklist for Quality Control for Specific Source Categories

Annex 4-1.1: Tier 1 - Individual Source Category Checklist

National Inventory Report: 1990-2010 Source Category: ____________________

Title(s) and Date(s) of Inventory Spreadsheet(s): ____________________

Source category estimates prepared by (name/affiliation): ____________________

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is to be completed for each source category, and provides a record of the checks performed and any corrective actions taken. The form may be completed by hand or electronically. If appropriate actions to correct any errors that are found are not immediately apparent, the QC staff performing the check should discuss the results with the National Inventory Team Leader and the QA Expert. Once completed, the form should be filed in the project file, with copies to the National Inventory Team Leader.

The first page of this form summarizes the results of the checks (once completed) and highlights any significant findings or actions. The remaining pages in this form list categories of checks to be performed. The expert has discretion over how the checks are implemented. Not all checks will be applicable to every source category; checks/rows that are not relevant or not available should indicate "n/r" or "n/a" (not be left blank or deleted). Rows for additional checks that are relevant to the source category should be added to the form. Additional information on the activities indicated on the form may be found in the IPCC Good Practice Guidance.

The column for supporting documentation should be used to reference any relevant Supplemental Reports (Form 4A-5) or Contact Reports (Form 4A-4) providing additional information. Note that, if a source-category specific QC plan has been developed and implemented, this Tier 1 form should still be completed. Any documents associated with the source-category specific plan should be clearly referenced in the column for supporting documentation.

Summary of Tier 1 Source Category Checks and Corrective Action	
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:

Checklist for Tier 1: Individual Source Category:								
Item		**Check Completed**			**Corrective Action**		**Supporting documents (provide reference)**
		Date	**Individual (first initial, last name)**	**Errors (Y/N)**	**Date**	**Individual (first initial, last name)**	
DATA GATHERING, INPUT, AND HANDLING ACTIVITIES: QUALITY CHECKS							
1.	Check a sample of input data for transcription errors						
2.	Review spreadsheets with computerized checks and/or quality check reports						
3.	Identify spreadsheet modifications that could provide additional controls or checks on quality						
4.	Other (specify):						
DATA DOCUMENTATION: QUALITY CHECKS							
5.	Check project file for completeness						

Checklist for Tier 1: Individual Source Category:

Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
6.	Confirm that bibliographical data references are included (in spreadsheet) for every primary data element						
7.	Check that all appropriate citations from the spreadsheets appear in the *Inventory* document						
8.	Check that all citations in spreadsheets and inventory are complete (i.e., include all relevant information)						
9.	Randomly check bibliographical citations for transcription errors						
10.	Check that originals of new citations are in current docket submittal						
11.	Randomly check that the originals of citations (including *Contact Reports*) contain the material & content referenced						
12.	Check that assumptions and criteria for selection of activity data and emission factors are documented						
13.	Check that changes in data or methodology are documented						
14.	Check that citations in spreadsheets and inventory document conform to acceptable style guidelines						
15.	Other (specify):						
CALCULATING EMISSIONS AND CHECKING CALCULATIONS							
16.	Check that all emission calculations are included (i.e., emissions are not hard-wired)						
17.	Check whether emission units, parameters, and conversion factors are inappropriately hardwired						
18.	Check if units are properly labeled and correctly carried through from beginning to end of calculation						
19.	Check that conversion factors are correct						
20.	Check that temporal and spatial adjustment factors are used correctly						
21.	Check the data relationships (comparability) and data processing steps (e.g., equations) in the spreadsheets						
22.	Check that spreadsheet input data and calculated data are clearly differentiated						
23.	Check a representative sample of calculations, by hand or electronically						
24.	Check some calculations with abbreviated calculations						
25.	Check the aggregation of data within a source category						
26.	When methods or data have changed, check consistency of time series inputs and calculations						
27.	Check for consistency with IPCC inventory guidelines and good practices, particularly if changes occur						
28.	Other (specify):						

Annex 4-1.2: Tier 2 - Source Category Checklist

National Inventory Report: 1990-2010 Source Category: ____________________

Key source category (or includes a key source sub-category): (Y/N) ____________________

Title(s) and Date(s) of Inventory Spreadsheet(s):____________________

Source category estimates prepared by (name/affiliation): ____________________

GENERAL INSTRUCTIONS FOR COMPLETING THIS FORM:

Tier 2 checks focus on the data and methodology used for an individual source category. Not all Tier 2 checks occur each inventory cycle; the specificity and frequency of Tier 2 checks vary across source categories. The form may be completed by hand or electronically. Once completed, the form should be filed in the project file, with copies to the National Inventory Team Leader.

The first table on this form summarizes generally the results of the Tier 2 checks and highlights any significant findings or corrective actions. If appropriate actions—to correct any errors that are found or to follow up on the investigation—are not immediately apparent, the QC staff performing the check should discuss the results with the National Inventory Team Leader and the QA Expert.

The remaining pages in this form are lists of categories of checks to be performed or types of questions to be asked. PART A checks are designed to identify potential problems in the estimates, factors, and activity data. PART B checks focus on the quality of secondary data and direct emission measurement. The expert has discretion over how the checks are implemented. Checks/rows that are not relevant or not available should indicate "n/r" or "n/a" (not be left blank or deleted). Rows for additional checks that are relevant to the source category should be added to the form. Additional information on the activities indicated on the form may be found in the IPCC Good Practice Guidance.

The column for supporting documentation should be used to reference any relevant Supplemental Reports (Form 4A-5) or Contact Reports (Form 4A-4) that provide additional information. Other sources may be included here, if they can be clearly referenced. Note that, if a source-category specific QC plan has been developed and implemented, this Tier 2 form should still be completed. Any documents associated with the source-category specific plan should be clearly referenced in the column for supporting documentation.

Summary of All Tier 2 Activities **Individual Source Category:**	
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:

ADDITIONAL INSTRUCTIONS FOR PART A

The checklist below indicates the types of checks and comparisons that can be performed and is not intended to be exhaustive. Supplemental Reports, Contact Reports, or other documents may be used to report detailed information on the checks conducted. For example, a Supplemental Report could provide information on the variables or sub-variables checked, comparisons made, conclusions that were drawn and rationale for conclusions, sources of information (published, unpublished, meetings, etc.) consulted, and corrective actions required.

Checklist for Tier 2: Part A, Data Gathering and Selection
Individual Source Category:

Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
EMISSION DATA QUALITY CHECKS							
1.	Emission comparisons: historical data for source, significant sub-source categories						
2.	Order of magnitude checks						
3.	Reference calculations						
4.	Completeness checks						
5.	Other (detailed checks)						
EMISSION FACTOR QUALITY CHECK							
6.	Assess representativeness of emission factors, given national circumstances and analogous emissions data						
7.	Search for options for more representative data						
8.	Other (detailed checks)						
ACTIVITY DATA QUALITY CHECK: NATIONAL LEVEL ACTIVITY DATA							
9.	Check historical trends						
10.	Compare multiple reference sources						
11.	Check applicability of data						
12.	Check methodology for filling in time seies for data that are not available anually						
13.	Other (detailed checks)						
ACTIVITY DATA QUALITY CHECK: SITE-SPECIFIC ACTIVITY DATA							
14.	Inconsistencies across sites						
15.	Compare aggregated and national data						
16.	Other (detailed checks)						

ADDITIONAL INSTRUCTIONS FOR PART B

Completing the Tier 2 checks on secondary data and direct emission measurement may require consulting the primary data sources or authors. The checklist below is intended to be indicative, not exhaustive. Additional information on appropriate checks can be found in the Source Category Chapters of the IPCC Good Practice Guidance.

Additional documentation is likely to be necessary to record the specific actions taken to check the data underlying the source category estimates. For example, Supplemental Reports may be needed to record the data or variables that were checked, and the published references and individuals or organizations consulted as part of the investigation. Contact Reports should be used to report the details of personal communications. Supplemental Reports may also be used to explain the rationale for a finding reported in the summary, the results of research into the QC procedures associated with a survey, or checks of site measurement procedures. Be sure to provide references to all supporting documentation.

Checklist for Tier 2. Part B: Secondary Data and Direct Emission Measurement
Individual Source category:

Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
SECONDARY DATA: SAMPLE QUESTIONS REGARDING THE QUALITY OF INPUT DATA							
1.	Are QC activities conducted during the original preparation of the data (either as reported in published literature or as indicated by personal communications) consistent with and adequate when compared against (as a minimum), Tier 1 QC activities?						

Checklist for Tier 2. Part B: Secondary Data and Direct Emission Measurement Individual Source category:								
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
2.	Does the National Bureau of Statistics have a QA/QC plan that covers the preparation of the data?						
3.	For surveys, what sampling protocols were used and how recently were they reviewed?						
4.	For site-specific activity data, are any national or international standards applicable to the measurement of the data; if so, have they been employed?						
5.	Have uncertainties in the data been estimated and documented?						
6.	Have any limitations of the secondary data been identified and documented, such as biases or incomplete estimates? Have errors been found?						
7.	Have the secondary data undergone peer review and, if so, of what nature?						
8.	Other (detailed checks)						
DIRECT EMISSION MEASUREMENT: CHECKS ON PROCEDURES TO MEASURE EMISSIONS							
9.	Identify which variables rely on direct emision measurement						
10.	Check procedures used to measure emissions, including sampling procedures, equipment calibration and maintenance.						
11.	Identify whether standard procedures have been used, where they exist (such as IPCC methods or ISO standards).						
12.	Other (detailed checks)						

Annex 4-1.3: Data/Reference Tracking Sheet

This form illustrates a spreadsheet that was developed to track the data sources used for each variable in the inventory from one inventor cycle to another. The particular citation, reference, contact person, form in which data is received, or other information is indicated for each variable. This tracking is particularly useful for sources that have a large number of variables to be tracked. The spreadsheet can easily be expanded to include each new inventory cycle, and so is useful for tracking sources of data over time. In the table, color- and pattern-coding in a cell is used to indicate, for the current inventory cycle, whether the expert has received or is still waiting for data, or other “status” of the data. The columns within the table should be made wider to accommodate the necessary data. Different formats may be needed to accommodate sources with different data characteristics.

National Inventory Report: 1990-2010 Source Category: ____________________

Key source category (or includes a key source sub-category): (Y/N) ____________________

Title(s) and Date(s) of Inventory Spreadsheet(s):____________________

Source category estimates prepared by (name/affiliation): ____________________

Color key code

	No action yet taken
	Source investigated, but awaiting arrival or publication
	Source obtained
	Not obtained/needed

Spreadsheet Name	Worksheet Name	Data needed (variable/parameter)	1990 data source	2000 data source	2010 data source
Insert spread-sheet name	Insert name of worksheet within spreadsheet	Give name of data item on worksheet	Provide citation or individual	Provide citation or individual	Provide citation or individual

Annex 4-1.4: Contact Report

This form is used to record personal communications, including telephone conversations or meetings. It is used, as necessary, as a cover sheet for facsimile or e-mail communications.

Date: ________________________________ Originator ____

Contact by: Telephone _________________ Meeting _________________ Other (specify) ___________________

Contact Name:

Title and Organization:

Phone number:

Fax number:

Address:

E-mail address:

Purpose and/or Subject of contact:

Attendees or participants in meeting/telephone conversation (name, affiliation):

Summary of meeting:

Recommended Follow-up Actions:

Annex 4-1.5: Supplemental Report

This form is to be used as needed to provide additional documentation or explanation of QA/QC activities, and to supplement other checklists and forms that are completed. Among other uses, it can record information gathered from sources other than a personal communication (e.g., internet sites or published sources), describe in detail the results of an investigation, or be a cover page for other supporting documentation (such as a source category specific QA/QC plan).

Date:	Source Category:
Subject:	
If part of another report, provide the report name and purpose of supplemental report:	
If not part of another report, provide purpose:	
Sheet # __ of ______	Name, affiliation:

Discussion:

Annex 4-2: Forms and Checklist for Cross-Cutting Quality Control

Annex 4-2.1: Tier 1 - Overall Inventory and Cross-Source Category Checklist

National Inventory Report: 1990-2010 ____________________

Source Categories included in check: ____________________

____

____

Title(s) and Date(s) of Inventory Spreadsheet(s): ____________________

Source category estimates prepared by (name/affiliation):____________________

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is completed under each inventory cycle, and provides a record of the checks performed and any corrective actions taken. The form may be completed by hand or electronically. The checklist below is completed as a record of the checks conducted. It should include information on the variables or sub-variables checked, comparisons made, conclusions that were drawn and rationale for conclusions, sources of information (published, unpublished, meetings, etc.) consulted, and corrective actions required. If appropriate actions to correct any errors that are found are not immediately apparent, the QC staff performing the check should discuss the results with the National Inventory Team Leader and the QA Expert. Once completed, the form should be filed in the project file, with copies to the National Inventory Team Leader.

The first page of this form summarizes the results of the checks (once completed) and highlights any significant findings or actions. The remaining pages in this form list categories of checks to be performed. The expert has discretion over how the checks are implemented. Rows for additional checks that are relevant should be added to the form.

The column for supporting documentation should be used to reference any relevant *Supplemental Reports* (Form 4-2.5) or *Contact Reports* (Form 4-2.4) providing additional information.

Summary of Tier 1 Overall and Cross-Category Checks and Corrective Action	
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:

Detailed Checklist for Tier 1: Overall Inventory Quality and Cross-Source Categories								
Item		**Check Completed**			**Corrective Action**		**Supporting documents (provide reference)**
		Date	**Individual (first initial, last name)**	**Errors (Y/N)**	**Date**	**Individual (first initial, last name)**	
CHECKING EMISSION CALCULATIONS ACROSS SOURCE CATEGORIES							
1.	Check that sources using same data inputs report comparable values (i.e., analogous in magnitude)						
2.	Check across source categories that same electronic data set is used for common data						

Detailed Checklist for Tier 1: Overall Inventory Quality and Cross-Source Categories

Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
3.	Identify common parameters across source categories and check for consistency						
4.	Check that the number of significant digits or decimal places for common parameters, conversion factors, emision factors, or activity data is consistent across source categories						
5.	Check that total emissions are reported consistently (in terms of significant digits or decimal places) across source categories						
6.	Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels						
7.	Other (specify)						
DOCUMENTATION							
8.	Check if internal documentation practices are consistent across source categories						
9.	Other (specify)						
COMPLETENESS							
10.	Check for completeness across source categories and years						
11.	Check that data gaps are identified and reported as required						
12.	Compare current national inventory estimates with previous years'						
13.	Other (specify):						
MAINTAINING MASTER INVENTORY FILE: SPREADSHEETS AND INVENTORY DOCUMENT							
14	Have file control procedures been followed?						
15.	Other (specify)						
OTHER							
16.	Specify						
17.	Specify						
18.	Specify						

Annex 4-2.2: Master Tracking Sheet for Inventory

National Inventory Report: 1990-2010____

Tracking form prepared by (name/affiliation): ______________________________________

Date of most recent update: ____

INSTRUCTIONS FOR USING THIS TRACKING SHEET:

This form illustrates a spreadsheet that was developed to track the status of the inventory spreadsheets and inventory document during the process of developing and updating the greenhouse gas inventory each inventory cycle. The same form could be used to track either the inventory spreadsheets, or the text for the inventory document. Each row represents a sector or source category. Columns should be self-explanatory. The columns should be made wider to accommodate the necessary data. Different formats or columns may be used to reflect preferences of the National Inventory Team Leader or to accommodate changes in the methodological structure or organizational assignments of the inventory. The comment column can be used to record other relevant information, such as the cause of a delay, when new data supporting data is expected and from whom, when the revised document/estimates are expected, or dates on which revised drafts were submitted.

		Source Responsibilities						
Sector / Source Category	**Annex Included (letter)**	**National Inventory Team Staff**	**Contractor / Contact**	**Date due?**	**Delivered Date?**	**Expect mods?**	**Current Owner?**	**Comments**
Give sector & source category name	Give letter of relevant annex, if any	Lead at NIT for source category	Contractor involved in analysis, or other contact	Date that first draft was due	Date of most recent draft	Y/N—whether modifications to latest draft are expected	Who has the original spreadsheet or text, currently	Any other important information

Annex 4-2.3: Inventory Document Checklist - MSWord Document

National Inventory Report: 1990-2010 *Stage of Document:* ______________________________

Circle all categories of checks conducted: *Front Section, Tables & Figures, Equations, References, General Editing, Editing for Content*

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is to be completed each inventory cycle, and provides a record of the checks performed and any corrective actions taken. The form may be completed by hand or electronically. The checklist below should be completed as a record of the checks conducted. If appropriate actions to correct any errors that are found are not immediately apparent, the QC staff performing the check should discuss the results with the National Inventory Team Leader and the QA Expert. Once completed, the form should be filed in the project file, with copies to the National Inventory Team Leader.

The first page of this form summarizes the results of the checks (once completed) and highlights any significant findings or actions. The remaining pages in this form list categories of checks to be performed. The expert has discretion over how the checks are implemented. Rows for additional checks that are relevant should be added to the form.

The column for supporting documentation should be used to reference any relevant *Supplemental Reports* (Form 4-2.5) or *Contact Reports* (Form 4-2.4) providing additional information.

Summary of Document Check	
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:

Detailed Checklist for Inventory Document								
Item		**Check Completed**			**Corrective Action**		**Supporting documents (provide reference)**
		Date	**Individual (first initial, last name)**	**Errors (Y/N)**	**Date**	**Individual (first initial, last name)**	
FRONT SECTION							
1.	Cover page has correct date, title, and contact address						
2.	Document number listed on title page						
3.	Correct footer on every section (draft/date, correct Inventory title, page numbers)						
4.	Tables of contents/tables/figures are accurate: titles match document, page #s match; numbers run consecutively and have correct punctuation						
5.	The Executive Summary and Introduction are updated with appropriate years and discussion of trends						
TABLES AND FIGURES							
6.	All numbers in tables match numbers in spreadsheets						

Detailed Checklist for Inventory Document							
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
6a.	All numbers in tables match in the Executive Summary						
6b.	All numbers in tables match in the Changes Section						
6c.	All numbers in tables match in the Introduction						
6d.	All numbers in tables match in the Energy Chapter						
6e.	All numbers in tables match in the ndustrial Processes Chapter						
6f.	All numbers in tables match in the Solvent and Other Product Use Chapter						
6g.	All numbers in tables match in the Agriculture Chapter						
6h.	All numbers in tables match in the LULUCF Chapter						
6i.	All numbers in tables match in the Waster Chapter						
6j.	All numbers in tables match in the Annexes						
7.	Check that all tables have correct number of significant digits						
8.	Check alignment in columns and labels						
9.	Check all symbols in tables ("+")						
10.	Check bold in tables						
11.	Table formatting is consistent						
12.	Check that all figures are updated with new data and referenced in the text						
13.	Check table and figure titles for accuracy and consistency with content						
14.	Include all figures with drafts (they are in separate file)						
EQUATIONS-SHOULD ALL HAVE THE FOLLOWING TRAITS							
15.	Equation as follows: $z = x + y$						
16.	Use times symbol, not the letter x or the * symbol						
17.	Equation centered						
18.	Following the equation use: where, (return) (definition of variables)						
19.	Definition of variables are indented and in Table Text style (and first word capitalized)						
REFERENCES							
20	Check consistency of references used in multiple sections (e.g., IPCC Guidance not IPCC Guidelines)						
21.	In text, citations and references match						
22.	Style of references is consistent						
23.	Use of a,b,c is consistent for same author and year references						
24.	Web addresses should not be hyperlinks, should be enclosed with <> and not hyperlinked or underlined						

Detailed Checklist for Inventory Document							
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
GENERAL FORMAT							
25.	All acronyms are spelled out first time and not subsequent times throughout each chapter						
26.	All dashes are the same–use insert symbol to insert a long "em" dash (—)						
27.	All fonts in text, headings, and subheadings are consistent						
28.	All headers/titles are consistent						
29.	All highlighting, notes, and comments are removed from document						
30.	Annex referencing in text matches correct Annex letters						
31.	Auto numbering for tables and figures sometimes inserts hard return, check all table citations and fix						
32.	Heading formats are used appropriately						
33.	All gases, such as CO_2 and N_2O use the letter "O" rather than the number "0"						
34.	All occurrences of "per cent" are spelled out, not % (except in tables)						
35.	All numbers that should be subscripted are subscripted (e.g., CO_2, SF_6, CH_4, N_2O, etc.)						
36.	No comma in citations						
37.	Notes under tables should be in smaller font than text of document						
38.	Number of decimal points used in the text is consistent						
39.	Section breaks: (1) Each section starts on right-hand (i.e., "odd") side (2) All sections in landscape move to and from landscape properly						
40.	Size, style, and indenting of bullets are consistent						
41.	Spaces–two after a period, one everywhere else						
42.	Spelling check is complete						
43.	Table/figure/box numbering and referencing in text is correct						
OTHER ISSUES							
44.	All numbers in text match tables						
45.	Each section is updated with current year						
46.	In discussion of "Recent Trends in Greenhouse Gas Emissions," all years and explanations are updated						
47.	Other (specify)						
48.	Other (specify)						
49.	Other (specify)						
50.	Other (specify)						

Annex 4-2.4: Inventory Document Checklist - Page Maker Document

National Inventory Report: 1990-2010 *Stage of Document:* ______________________________

Circle all categories of checks conducted: *Front Section, Tables & Figures, Equations, References, General Editing, Editing for Content*

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is to be completed each inventory cycle, and provides a record of the checks performed and any corrective actions taken. The form may be completed by hand or electronically. The checklist below should be completed as a record of the checks conducted. If appropriate actions to correct any errors that are found are not immediately apparent, the QC staff performing the check should discuss the results with the National Inventory Team Leader and the QA Expert. Once completed, the form should be filed in the project file, with copies to the National Inventory Team Leader.

The first page of this form summarizes the results of the checks (once completed) and highlights any significant findings or actions. The remaining pages in this form list categories of checks to be performed. The expert has discretion over how the checks are implemented. Rows for additional checks that are relevant should be added to the form.

The column for supporting documentation should be used to reference any relevant *Supplemental Reports* (Form 4-2.5) or *Contact Reports* (Form 4-2.4) providing additional information.

Summary of Inventory Document Check: Page Maker Document	
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:

Detailed Checklist for Inventory Document								
Item		**Check Completed**			**Corrective Action**		**Supporting documents (provide reference)**
		Date	**Individual (first initial, last name)**	**Errors (Y/N)**	**Date**	**Individual (first initial, last name)**	
FRONT SECTION							
1.	Cover page has correct date, title, and contact address						
2.	Cover has the logo of the MENR						
3.	Correct footer on every section (correct Inventory title and page number)						
4.	Table of contents/tables/figures etc. is acurate						
TABLES AND FIGURES							
5.	Check alignment in columns and tables						
6.	Check all symbols in tables ("+")						
7.	Check bold in tables						
8.	All line widths are consistent in tables						
9.	All column widths are consistent in tables						
10.	Table formatting is consistent						
11.	All figures have been inserted into text and are accurate (correct proportions, etc.)						
EQUATIONS-SHOULD ALL HAVE THE FOLLOWING TRAITS							
12.	Equation as follows: $z = x + y$						

Detailed Checklist for Inventory Document								
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
13.	Equation centered						
GENERAL FORMAT							
14.	All dashes are the same–use insert symbol.						
15.	All fonts are consistent						
16.	All headers/titles are consistent						
17.	All numbers that should be subscripted are (CO_2, SF_6, CH_4, N_2O, etc.)						
18	Notes under tables should be in smaller font than text of document						
19.	All sections in Landscape go to and from landscape properly						
20.	Size and style of bullets is consistent						
21.	Spaces–two after a period, one everywhere else						
22.	No widows/orphans in document						
23.	Fractions are formatted correctly						
OTHER ISSUES							
24.	Bookmarks are correct and function properly						
25.	The entire document has been scanned for any erroneous looking items or data that may have been altered during the software transition						

Annex 4-2.5: Contact Report

This form is to be used to record personal communications, including telephone conversations or meetings. It can also be used, as necessary, as a cover sheet for facsimile or e-mail communications.

Date: ______________________________ Originator ____

Contact by: Telephone ________________ Meeting ___________________ Other (specify) ___________________

Contact Name:

Title and Organization:

Phone number:

Fax number:

Address:

E-mail address:

Purpose and/or Subject of contact:

Attendees or participants in meeting/telephone conversation (name, affiliation):

Summary of meeting:

Recommended Follow-up Actions:

Annex 4-2.6: Supplemental Report

This form is to be used as needed to provide additional documentation or explanation of QA/QC activities, and to supplement other checklists and forms that are completed. Among other uses, it can record information gathered from sources other than a personal communication (e.g., internet sites or published sources), describe in detail the results of an investigation, or be a cover page for other supporting documentation (such as a source category specific QA/QC and Uncertainty Management Plan).

Date:	Source Category:
Subject:	
If part of another report, provide the report name and purpose of supplemental report:	
If not part of another report, provide purpose:	
Sheet # __ of ______	Name, affiliation:

Discussion:

Annex 5. Uncertainty

Annex 5-1: Overall Inventory Uncertainty for 2010

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
1A1	Energy Industries	CO_2	19332.7655	4188.3127	5	5	7.0711	2.2263	-0.0810	0.1161	-0.4051	0.8208	0.9153
1A1	Energy Industries	CH_4	9.2887	1.5513	5	50	50.2494	0.0059	-0.0001	0.0000	-0.0026	0.0003	0.0026
1A1	Energy Industries	N_2O	51.2316	4.7032	5	50	50.2494	0.0178	-0.0004	0.0001	-0.0197	0.0009	0.0197
1A2	Manufacturing Industries and Construction	CO_2	2188.7285	539.2384	5	5	7.0711	0.2866	-0.0074	0.0149	-0.0371	0.1057	0.1120
1A2	Manufacturing Industries and Construction	CH_4	2.0005	0.4748	5	50	50.2494	0.0018	0.0000	0.0000	-0.0004	0.0001	0.0004
1A2	Manufacturing Industries and Construction	N_2O	5.1641	0.9709	5	50	50.2494	0.0037	0.0000	0.0000	-0.0013	0.0002	0.0013
1A3	Transport	CO_2	3926.6606	1861.9016	5	5	7.0711	0.9897	0.0115	0.0516	0.0573	0.3649	0.3694
1A3	Transport	CH_4	25.0344	7.2973	5	40	40.3113	0.0221	-0.0001	0.0002	-0.0021	0.0014	0.0026
1A3	Transport	N_2O	103.9112	35.4955	5	50	50.2494	0.1341	-0.0001	0.0010	-0.0039	0.0070	0.0080
1A4	Other sectors	CO_2	7762.4898	1653.9545	5	5	7.0711	0.8792	-0.0334	0.0458	-0.1670	0.3241	0.3646
1A4	Other sectors	CH_4	244.4965	32.4869	5	50	50.2494	0.1227	-0.0016	0.0009	-0.0799	0.0064	0.0801
1A4	Other sectors	N_2O	30.7924	6.0357	5	50	50.2494	0.0228	-0.0001	0.0002	-0.0074	0.0012	0.0075
1A5	Other	CO_2	154.2715	124.4914	5	5	7.0711	0.0662	0.0019	0.0035	0.0094	0.0244	0.0261
1A5	Other	CH_4	0.1350	0.1583	5	50	50.2494	0.0006	0.0000	0.0000	0.0002	0.0000	0.0002
1A5	Other	N_2O	0.4911	0.4049	5	50	50.2494	0.0015	0.0000	0.0000	0.0003	0.0001	0.0003
1B2	Fugitive Emissions from Fuels	CO_2	0.6377	1.8608	25	25	35.3553	0.0049	0.0000	0.0001	0.0011	0.0018	0.0021
1B2	Fugitive Emissions from Fuels	CH_4	682.2942	487.1800	25	25	35.3553	1.2948	0.0065	0.0135	0.1632	0.4774	0.5045
1B2	Fugitive Emissions from Fuels	N_2O	0.0002	0.0047	25	25	35.3553	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2.A.1	Cement Production	CO_2	971.7056	349.8365	3	2	3.6056	0.0948	-0.0002	0.0097	-0.0005	0.0411	0.0411
2.A.2	Lime Production	CO_2	148.6611	2.3140	8	2	8.2462	0.0014	-0.0015	0.0001	-0.0029	0.0007	0.0030
2.A.3	Limestone and Dolomite Use	CO_2	619.4745	74.4613	15	5	15.8114	0.0885	-0.0043	0.0021	-0.0213	0.0438	0.0487
2.A.4	Soda Ash Use	CO_2	32.9560	12.0466	15	2	15.1327	0.0137	0.0000	0.0003	0.0000	0.0071	0.0071
2.A.7	Other: Mineral Wool Production	CO_2	8.0816	0.0000	8	5	9.4340	0.0000	-0.0001	0.0000	-0.0004	0.0000	0.0004
2.A.7	Other: Brick Production	CO_2	74.8506	15.4882	15	5	15.8114	0.0184	-0.0003	0.0004	-0.0017	0.0091	0.0093
2.A.7	Other: Expanded Clay Production	CO_2	32.3512	3.4223	15	5	15.8114	0.0041	-0.0002	0.0001	-0.0012	0.0020	0.0023
2.C.1	Steel Production	CO_2	11.7182	3.9938	3	5	5.8310	0.0018	0.0000	0.0001	0.0000	0.0005	0.0005
2.C.1	Steel Production	CH_4	0.1488	0.0507	3	100	100.0450	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000
2.C.1	Steel Production	N_2O	1.0986	0.3744	3	150	150.0300	0.0042	0.0000	0.0000	-0.0001	0.0000	0.0001
2.F.1	Refrigeration and Air Conditioning Equipment	HFC	0.0000	65.4178	8	50	50.6360	0.2490	0.0018	0.0018	0.0906	0.0205	0.0929
2.F.2	Foam Blowing	HFC	0.0000	36.9761	25	50	55.9017	0.1554	0.0010	0.0010	0.0512	0.0362	0.0628

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
2.F.4	Aerosols	HFC	0.0000	0.0232	5	50	50.2494	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.8	Electric Equipment	PFC	0.0000	0.0273	3	50	50.0899	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.8	Electric Equipment	SF_6	0.0000	0.5545	3	50	50.0899	0.0021	0.0000	0.0000	0.0008	0.0001	0.0008
3.A.1	Conventional Solvent Paint Application	CO_2	31.1781	19.7188	5	25	25.4951	0.0378	0.0002	0.0005	0.0057	0.0039	0.0069
3.A.1	Waterborne Paint Application	CO_2	0.6894	1.0072	5	50	50.2494	0.0038	0.0000	0.0000	0.0010	0.0002	0.0011
3.B	Degreasing and Dry Cleaning	CO_2	33.1963	12.3930	5	20	20.6155	0.0192	0.0000	0.0003	0.0001	0.0024	0.0024
3.C	Polyurethane foam processing	CO_2	0.2544	0.5544	20	25	32.0156	0.0013	0.0000	0.0000	0.0003	0.0004	0.0005
3.C	Polystyrene foam processing	CO_2	0.2063	0.8758	20	25	32.0156	0.0021	0.0000	0.0000	0.0006	0.0007	0.0009
3.C	Rubber processing	CO_2	1.1226	0.0012	5	25	25.4951	0.0000	0.0000	0.0000	-0.0003	0.0000	0.0003
3.C	Pharmaceutical products manufacturing	CO_2	0.4454	0.8788	5	25	25.4951	0.0017	0.0000	0.0000	0.0005	0.0002	0.0005
3.C	Paints manufacturing	CO_2	0.3851	0.4025	5	25	25.4951	0.0008	0.0000	0.0000	0.0002	0.0001	0.0002
3.C	Leather tanning	CO_2	0.0237	0.0000	20	25	32.0156	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.C	Tyre production	CO_2	0.0351	0.0046	20	25	32.0156	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.C	Manufactory of shoes	CO_2	3.1236	0.2903	5	25	25.4951	0.0006	0.0000	0.0000	-0.0006	0.0001	0.0006
3.D.1	Printing industry	CO_2	0.7352	0.4021	5	25	25.4951	0.0008	0.0000	0.0000	0.0001	0.0001	0.0001
3.D.2	Domestic solvent use	CO_2	13.0499	12.2124	5	50	50.2494	0.0461	0.0002	0.0003	0.0103	0.0024	0.0105
3.D.3	Seed Oil Extraction and Seed Drying	CO_2	0.9520	0.6066	20	25	32.0156	0.0015	0.0000	0.0000	0.0002	0.0005	0.0005
3.D.3	Adhesives Use	CO_2	5.2995	4.4977	5	25	25.4951	0.0086	0.0001	0.0001	0.0018	0.0009	0.0020
3.D.3	Vehicles Dewaxing	CO_2	0.0592	0.0237	5	25	25.4951	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.D.3	Tobacco Combustion	CO_2	0.0002	0.0001	5	20	20.6155	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.D.3	Use of N_2O for Anaesthesia	N_2O	0.0205	0.0000	5	1	5.0990	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.A.1	Enteric Fermentation: Cattle	CH_4	1574.8883	429.8149	10	20	22.3607	0.7225	-0.0042	0.0119	-0.0835	0.1685	0.1880
4.A.3	Enteric Fermentation: Sheep	CH_4	174.6420	112.2508	10	20	22.3607	0.1887	0.0013	0.0031	0.0265	0.0440	0.0514
4.A.4	Enteric Fermentation: Goats	CH_4	4.8480	15.9093	10	20	22.3607	0.0267	0.0004	0.0004	0.0078	0.0062	0.0100
4.A.6	Enteric Fermentation: Horses	CH_4	17.8597	20.2574	10	30	31.623	0.0482	0.0004	0.0006	0.0114	0.0079	0.0139
4.A.7	Enteric Fermentation: Mules and Asses	CH_4	0.3551	0.5783	20	30	36.056	0.0016	0.0000	0.0000	0.0004	0.0005	0.0006
4.A.8	Enteric Fermentation: Swine	CH_4	58.2774	16.1173	10	30	31.623	0.0383	-0.0001	0.0004	-0.0045	0.0063	0.0077
4.A.9	Enteric Fermentation: Poultry	CH_4	0.0000	0.0000	20	30	36.056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.A.10	Enteric Fermentation: Rabbits	CH_4	3.5062	3.4325	20	30	36.056	0.0093	0.0001	0.0001	0.0018	0.0027	0.0032
4.B.1	Manure Management: Cattle	CH_4	149.1523	20.0779	10	30	31.623	0.0477	-0.0010	0.0006	-0.0290	0.0079	0.0301
4.B.3	Manure Management: Sheep	CH_4	4.9668	3.1968	10	50	50.990	0.0123	0.0000	0.0001	0.0019	0.0013	0.0023
4.B.4	Manure Management: Goats	CH_4	0.1013	0.3260	10	50	50.990	0.0012	0.0000	0.0000	0.0004	0.0001	0.0004
4.B.6	Manure Management: Horses	CH_4	1.5478	1.7556	10	50	50.990	0.0067	0.0000	0.0000	0.0016	0.0007	0.0018
4.B.7	Manure Management: Mules and Asses	CH_4	0.0270	0.0440	20	50	53.852	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
4.B.8	Manure Management: Swine	CH_4	82.7372	16.4302	10	30	31.623	0.0391	-0.0004	0.0005	-0.0117	0.0064	0.0134
4.B.9	Manure Management: Poultry	CH_4	15.8990	15.1089	20	50	53.852	0.0612	0.0003	0.0004	0.0128	0.0118	0.0174
4.B.10	Manure Management: Rabbits	CH_4	0.4754	0.4654	20	50	53.852	0.0019	0.0000	0.0000	0.0004	0.0004	0.0005
4.B.11a	Manure Management: Cattle	N_2O direct	417.0778	84.1563	10	50	50.990	0.3226	-0.0019	0.0023	-0.0964	0.0330	0.1019
4.B.11b	Manure Management: Sheep	N_2O direct	126.7716	70.0040	10	50	50.990	0.2683	0.0006	0.0019	0.0322	0.0274	0.0423
4.B.11c	Manure Management: Goats	N_2O direct	4.7478	12.7177	10	75	75.664	0.0723	0.0003	0.0004	0.0228	0.0050	0.0233
4.B.11d	Manure Management: Horses	N_2O direct	14.9787	14.3928	10	75	75.664	0.0819	0.0002	0.0004	0.0184	0.0056	0.0193
4.B.11e	Manure Management: Mules and Asses	N_2O direct	0.1796	0.2719	20	75	77.621	0.0016	0.0000	0.0000	0.0004	0.0002	0.0005
4.B.11f	Manure Management: Swine	N_2O direct	391.6369	67.3902	10	50	50.990	0.2583	-0.0021	0.0019	-0.1067	0.0264	0.1099
4.B.11g	Manure Management: Poultry	N_2O direct	138.6228	142.4913	20	50	53.852	0.5768	0.0025	0.0039	0.1266	0.1117	0.1689
4.B.11h	Manure Management: Rabbits	N_2O direct	22.3408	20.7776	20	75	77.621	0.1212	0.0003	0.0006	0.0261	0.0163	0.0307
4.B.12a	Manure Management: Cattle	N_2O indirect	94.5635	16.1232	10	100	100.499	0.1218	-0.0005	0.0004	-0.0519	0.0063	0.0523
4.B.12b	Manure Management: Sheep	N_2O indirect	20.6004	11.3757	10	100	100.499	0.0859	0.0001	0.0003	0.0105	0.0045	0.0114
4.B.12c	Manure Management: Goats	N_2O indirect	0.7715	2.0666	10	150	150.333	0.0234	0.0000	0.0001	0.0074	0.0008	0.0075
4.B.12d	Manure Management: Horses	N_2O indirect	2.4340	2.3388	10	150	150.333	0.0264	0.0000	0.0001	0.0060	0.0009	0.0061
4.B.12e	Manure Management: Mules and Asses	N_2O indirect	0.0292	0.0442	20	150	151.327	0.0005	0.0000	0.0000	0.0001	0.0000	0.0001
4.B.12f	Manure Management: Swine	N_2O indirect	106.9121	16.3884	10	100	100.499	0.1238	-0.0006	0.0005	-0.0638	0.0064	0.0641
4.B.12g	Manure Management: Poultry	N_2O indirect	36.5912	35.0320	20	100	101.980	0.2686	0.0006	0.0010	0.0597	0.0275	0.0657
4.B.12h	Manure Management: Rabbits	N_2O indirect	3.6304	3.3764	20	150	151.327	0.0384	0.0001	0.0001	0.0085	0.0026	0.0089

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
4.D.1a	Synthetic N Fertilizers Application	N_2O direct	448.6586	100.4781	5	6	7.810	0.0590	-0.0018	0.0028	-0.0108	0.0197	0.0225
4.D.1b	Organic N Applied as Fertilizer	N_2O direct	265.7072	0.4829	30	6	30.594	0.0011	-0.0027	0.0000	-0.0162	0.0006	0.0162
4.D.1c	Urine and Dung N Deposited on Pasture	N_2O direct	91.9302	46.8453	50	50	70.711	0.2490	0.0004	0.0013	0.0179	0.0918	0.0935
4.D.1d	N in Crop Residue	N_2O direct	338.1351	121.9896	5	25	25.495	0.2338	-0.0001	0.0034	-0.0018	0.0239	0.0240
4.D.1e	N Mineralization	N_2O direct	118.2288	518.2289	5	25	25.495	0.9932	0.0132	0.0144	0.3288	0.1016	0.3442
4.D.2a	Atmospheric Deposition of N volatilized	N_2O indirect	109.7501	16.1565	70	200	211.896	0.2574	-0.0007	0.0004	-0.1347	0.0443	0.1418
4.D.2b	N Leaching/Runoff from Managed Soils	N_2O indirect	276.6249	173.5290	75	200	213.600	2.7864	0.0020	0.0048	0.3965	0.5101	0.6461
5.A.1	Forest Land Remaining Forest Land	CO_2	-2197.5790	-2193.2612	25	5	25.495	-4.2035	-0.0384	-0.0608	-0.1918	-2.1490	2.1576
5.A.1	Non-CO_2 Emissions from Vegetation Fires	CH_4	0.2347	0.0917	10	30	31.623	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
5.A.1	Non-CO_2 Emissions from Vegetation Fires	N_2O	0.1917	0.0748	10	50	50.990	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
5.B.1	Cropland: Land Covered with Woody Vegetation	CO_2	-725.2315	-470.5183	25	10	26.9258	-0.9524	-0.0056	-0.0130	-0.0563	-0.4610	0.4645
5.B.2	Cropland: Annual Change in Carbon Stocks in Mineral Soils	CO_2	-3470.9538	3447.5439	10	10	14.1421	3.6651	0.1311	0.0955	1.3113	1.3512	1.8829
5.B.1	Non-CO_2 Emissions from Stubble Fields Burning	CH_4	2.0547	0.0551	10	30	31.6228	0.0001	0.0000	0.0000	-0.0006	0.0000	0.0006
5.B.1	Non-CO_2 Emissions from Stubble Fields Burning	N_2O	0.7864	0.0211	10	50	50.9902	0.0001	0.0000	0.0000	-0.0004	0.0000	0.0004
5.C.1	Grassland Remaining Grassland	CO_2	-780.1200	-779.4600	30	10	31.6228	-1.8529	-0.0136	-0.0216	-0.1363	-0.9165	0.9266
5.C.2	Land Converted to Grassland	CO_2	-6.3800	21.8416	30	5	30.4138	0.0499	0.0007	0.0006	0.0034	0.0257	0.0259
6.A.1	Managed Solid Waste Disposal on Land	CH_4	362.9476	609.8657	15	20	25.0000	1.1461	0.0132	0.0169	0.2638	0.3585	0.4452
6.A.2	Unmanaged Solid Waste Disposal on Land	CH_4	547.4656	291.5357	30	20	36.0555	0.7902	0.0025	0.0081	0.0497	0.3428	0.3464
6.A.3	Industrial Solid Waste Disposal on Land	CH_4	409.6703	486.6570	50	20	53.8516	1.9701	0.0093	0.0135	0.1860	0.9537	0.9717
6.B.2	Domestic and Commercial Wastewater	CH_4	215.6014	107.8000	10	30	31.6228	0.2563	0.0008	0.0030	0.0235	0.0423	0.0484
6.B.2	Domestic and Commercial Wastewater	N_2O	91.6979	82.4458	30	30	42.4264	0.2629	0.0013	0.0023	0.0404	0.0969	0.1050
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	Total		**36082.8090**	**13302.4940**				**7.7612**					**3.5527**

Annex 5-2: Summary of Direct Greenhouse Gas Uncertainties

Annex 5-2.1: Carbon Dioxide Uncertainties (CO_2)

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
1A1	Energy Industries	CO_2	19332.7655	4188.3127	5	5	7.0711	3.3234	-0.0679	0.1486	-0.3395	1.0511	1.1046
1A2	Manufacturing Industries and Construction	CO_2	2188.7285	539.2384	5	5	7.0711	0.4279	-0.0054	0.0191	-0.0271	0.1353	0.1380
1A3	Transport	CO_2	3926.6606	1861.9016	5	5	7.0711	1.4774	0.0220	0.0661	0.1099	0.4673	0.4800
1A4	Other sectors	CO_2	7762.4898	1653.9545	5	5	7.0711	1.3124	-0.0284	0.0587	-0.1418	0.4151	0.4386
1A5	Other	CO_2	154.2715	124.4914	5	5	7.0711	0.0988	0.0027	0.0044	0.0134	0.0312	0.0340
1B2	Fugitive Emissions from Fuels	CO_2	0.6377	1.8608	25	25	35.3553	0.0074	0.0001	0.0001	0.0015	0.0023	0.0028
2.A.1	Cement Production	CO_2	971.7056	349.8365	3	2	3.6056	0.1415	0.0015	0.0124	0.0030	0.0527	0.0528
2.A.2	Lime Production	CO_2	148.6611	2.3140	8	2	8.2462	0.0021	-0.0016	0.0001	-0.0032	0.0009	0.0033
2.A.3	Limestone and Dolomite Use	CO_2	619.4745	74.4613	15	5	15.8114	0.1321	-0.0043	0.0026	-0.0215	0.0561	0.0601
2.A.4	Soda Ash Use	CO_2	32.9560	12.0466	15	2	15.1327	0.0205	0.0001	0.0004	0.0001	0.0091	0.0091
2.A.7	Other: Mineral Wool Production	CO_2	8.0816	0.0000	8	5	9.4340	0.0000	-0.0001	0.0000	-0.0005	0.0000	0.0005
2.A.7	Other: Brick Production	CO_2	74.8506	15.4882	15	5	15.8114	0.0275	-0.0003	0.0005	-0.0015	0.0117	0.0118
2.A.7	Other: Expanded Clay Production	CO_2	32.3512	3.4223	15	5	15.8114	0.0061	-0.0002	0.0001	-0.0012	0.0026	0.0028
2.C.1	Steel Production	CO_2	11.7182	3.9938	3	5	5.8310	0.0026	0.0000	0.0001	0.0001	0.0006	0.0006
3.A.1	Conventional Solvent Paint Application	CO_2	31.1781	19.7188	5	25	25.4951	0.0564	0.0003	0.0007	0.0087	0.0049	0.0100
3.A.1	Waterborne Paint Application	CO_2	0.6894	1.0072	5	50	50.2494	0.0057	0.0000	0.0000	0.0014	0.0003	0.0014
3.B	Degreasing and Dry Cleaning	CO_2	33.1963	12.3930	5	20	20.6155	0.0287	0.0001	0.0004	0.0013	0.0031	0.0034
3.C	Polyurethane Foam Processing	CO_2	0.2544	0.5544	20	25	32.0156	0.0020	0.0000	0.0000	0.0004	0.0006	0.0007
3.C	Polystyrene Foam Processing	CO_2	0.2063	0.8758	20	25	32.0156	0.0031	0.0000	0.0000	0.0007	0.0009	0.0011
3.C	Rubber Processing	CO_2	1.1226	0.0012	5	25	25.4951	0.0000	0.0000	0.0000	-0.0003	0.0000	0.0003
3.C	Pharmaceutical Products Manufacturing	CO_2	0.4454	0.8788	5	25	25.4951	0.0025	0.0000	0.0000	0.0007	0.0002	0.0007
3.C	Paints Manufacturing	CO_2	0.3851	0.4025	5	25	25.4951	0.0012	0.0000	0.0000	0.0002	0.0001	0.0003
3.C	Leather Tanning	CO_2	0.0237	0.0000	20	25	32.0156	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.C	Tyre Production	CO_2	0.0351	0.0046	20	25	32.0156	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.C	Manufactory of Shoes	CO_2	3.1236	0.2903	5	25	25.4951	0.0008	0.0000	0.0000	-0.0006	0.0001	0.0006
3.D.1	Printing Industry	CO_2	0.7352	0.4021	5	25	25.4951	0.0012	0.0000	0.0000	0.0002	0.0001	0.0002
3.D.2	Domestic Solvent Use	CO_2	13.0499	12.2124	5	50	50.2494	0.0689	0.0003	0.0004	0.0143	0.0031	0.0147
3.D.3	Seed Oil Extraction and Seed Drying	CO_2	0.9520	0.6066	20	25	32.0156	0.0022	0.0000	0.0000	0.0003	0.0006	0.0007

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
3.D.3	Adhesives Use	CO_2	5.2995	4.4977	5	25	25.4951	0.0129	0.0001	0.0002	0.0025	0.0011	0.0027
3.D.3	Vehicles Dewaxing	CO_2	0.0592	0.0237	5	25	25.4951	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
3.D.3	Tobacco Combustion	CO_2	0.0002	0.0001	5	20	20.6155	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5.A.1	Forest Land Remaining Forest Land	CO_2	-2,197.5790	-2,193.2612	25	5	25.495	-6.2749	-0.0532	-0.0778	-0.2661	-2.7521	2.7650
5.B.1	Cropland: Land Covered with Woody Vegetation	CO_2	-725.2315	-470.5183	25	10	26.9258	-1.4217	-0.0086	-0.0167	-0.0856	-0.5904	0.5966
5.B.2	Cropland: Annual Change in Carbon Stocks in Mineral Soils	CO_2	-3,470.9538	3,447.5439	10	10	14.1421	5.4712	0.1615	0.1224	1.6152	1.7304	2.3671
5.C.1	Grassland Remaining Grassland	CO_2	-780.1200	-779.4600	30	10	31.6228	-2.7660	-0.0189	-0.0277	-0.1891	-1.1737	1.1888
5.C.2	Land Converted to Grassland	CO_2	-6.3800	21.8416	30	5	30.4138	0.0745	0.0008	0.0008	0.0042	0.0329	0.0332
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	TOTAL		**28175.8441**	**8911.3371**				**9.7044**					**4.0852**

Annex 5-2.2: Methane Uncertainties (CH_4)

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
1A1	Energy Industries	CH_4	9.2887	1.5513	5	50	50.2494	0.0291	-0.0008	0.0003	-0.0422	0.0024	0.0423
1A2	Manufacturing Industries and Construction	CH_4	2.0005	0.4748	5	50	50.2494	0.0089	-0.0002	0.0001	-0.0076	0.0007	0.0076
1A3	Transport	CH_4	25.0344	7.2973	5	40	40.3113	0.1097	-0.0016	0.0016	-0.0638	0.0112	0.0648
1A4	Other sectors	CH_4	244.4965	32.4869	5	50	50.2494	0.6089	-0.0240	0.0071	-1.2007	0.0500	1.2018
1A5	Other	CH_4	0.1350	0.1583	5	50	50.2494	0.0030	0.0000	0.0000	0.0009	0.0002	0.0009

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
1B2	Fugitive Emissions from Fuels	CH_4	682.2942	487.1800	25	25	35.3553	6.4247	0.0193	0.1061	0.4824	3.7521	3.7829
2.C.1	Steel Production	CH_4	0.1488	0.0507	3	100	100.0450	0.0019	0.0000	0.0000	-0.0008	0.0000	0.0008
4.A.1	Enteric Fermentation: Cattle	CH_4	1574.8883	429.8149	10	20	22.3607	3.5849	-0.1064	0.0936	-2.1272	1.3241	2.5056
4.A.3	Enteric Fermentation: Sheep	CH_4	174.6420	112.2508	10	20	22.3607	0.9362	0.0022	0.0245	0.0447	0.3458	0.3487
4.A.4	Enteric Fermentation: Goats	CH_4	4.8480	15.9093	10	20	22.3607	0.1327	0.0028	0.0035	0.0570	0.0490	0.0752
4.A.6	Enteric Fermentation: Horses	CH_4	17.8597	20.2574	10	30	31.623	0.2389	0.0021	0.0044	0.0642	0.0624	0.0895
4.A.7	Enteric Fermentation: Mules and Asses	CH_4	0.3551	0.5783	20	30	36.056	0.0078	0.0001	0.0001	0.0024	0.0036	0.0043
4.A.8	Enteric Fermentation: Swine	CH_4	58.2774	16.1173	10	30	31.623	0.1901	-0.0039	0.0035	-0.1171	0.0497	0.1272
4.A.9	Enteric Fermentation: Poultry	CH_4	0.0000	0.0000	20	30	36.056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.A.10	Enteric Fermentation: Rabbits	CH_4	3.5062	3.4325	20	30	36.056	0.0462	0.0003	0.0007	0.0090	0.0211	0.0230
4.B.1	Manure Management: Cattle	CH_4	149.1523	20.0779	10	30	31.623	0.2368	-0.0146	0.0044	-0.4379	0.0619	0.4422
4.B.3	Manure Management: Sheep	CH_4	4.9668	3.1968	10	50	50.990	0.0608	0.0001	0.0007	0.0032	0.0098	0.0104
4.B.4	Manure Management: Goats	CH_4	0.1013	0.3260	10	50	50.990	0.0062	0.0001	0.0001	0.0029	0.0010	0.0031
4.B.6	Manure Management: Horses	CH_4	1.5478	1.7556	10	50	50.990	0.0334	0.0002	0.0004	0.0093	0.0054	0.0107
4.B.7	Manure Management: Mules and Asses	CH_4	0.0270	0.0440	20	50	53.852	0.0009	0.0000	0.0000	0.0003	0.0003	0.0004
4.B.8	Manure Management: Swine	CH_4	82.7372	16.4302	10	30	31.623	0.1938	-0.0069	0.0036	-0.2084	0.0506	0.2144
4.B.9	Manure Management: Poultry	CH_4	15.8990	15.1089	20	50	53.852	0.3035	0.0013	0.0033	0.0634	0.0931	0.1126
4.B.10	Manure Management: Rabbits	CH_4	0.4754	0.4654	20	50	53.852	0.0093	0.0000	0.0001	0.0020	0.0029	0.0035
5.A.1	Non-CO_2 Emissions from Vegetation Fires	CH_4	0.2347	0.0917	10	30	31.623	0.0011	0.0000	0.0000	-0.0003	0.0003	0.0004
5.B.1	Non-CO_2 Emissions from Stubble Fields Burning	CH_4	2.0547	0.0551	10	30	31.6228	0.0006	-0.0002	0.0000	-0.0075	0.0002	0.0075
6.A.1	Managed Solid Waste Disposal on Land	CH_4	362.9476	609.8657	15	20	25.0000	5.6870	0.0866	0.1328	1.7322	2.8182	3.3079
6.A.2	Unmanaged Solid Waste Disposal on Land	CH_4	547.4656	291.5357	30	20	36.0555	3.9208	-0.0061	0.0635	-0.1227	2.6943	2.6971
6.A.3	Industrial Solid Waste Disposal on Land	CH_4	409.6703	486.6570	50	20	53.8516	9.7753	0.0538	0.1060	1.0769	7.4961	7.5730
6.B.2	Wastewater Handling	CH_4	215.6014	107.8000	10	30	31.6228	1.2715	-0.0039	0.0235	-0.1183	0.3321	0.3525
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	TOTAL		**4590.6562**	**2680.9697**				**14.1626**					**9.9064**

Annex 5-2.3: Nitrous Oxide Uncertainties (N_2O)

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
1A1	Energy Industries	N_2O	51.2316	4.7032	5	50	50.2494	0.1470	-0.0061	0.0014	-0.3034	0.0100	0.3035
1A2	Manufacturing Industries and Construction	N_2O	5.1641	0.9709	5	50	50.2494	0.0304	-0.0005	0.0003	-0.0231	0.0021	0.0232
1A3	Transport	N_2O	103.9112	35.4955	5	50	50.2494	1.1098	-0.0045	0.0107	-0.2240	0.0757	0.2365
1A4	Other sectors	N_2O	30.7924	6.0357	5	50	50.2494	0.1887	-0.0027	0.0018	-0.1340	0.0129	0.1346
1A5	Other	N_2O	0.4911	0.4049	5	50	50.2494	0.0127	0.0001	0.0001	0.0025	0.0009	0.0027
1B2	Fugitive Emissions from Fuels	N_2O	0.0002	0.0047	25	25	35.3553	0.0001	0.0000	0.0000	0.0000	0.0001	0.0001
2.C.1	Steel Production	N_2O	1.0986	0.3744	3	150	150.0300	0.0350	0.0000	0.0001	-0.0071	0.0005	0.0072
3.D.3	Use of N_2O for Anesthesia	N_2O	0.0205	0.0000	5	1	5.0990	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.B.11a	Manure Management: Cattle	N_2O direct	417.0778	84.1563	10	50	50.990	2.6700	-0.0355	0.0254	-1.7764	0.3589	1.8123
4.B.11b	Manure Management: Sheep	N_2O direct	126.7716	70.0040	10	50	50.990	2.2210	0.0026	0.0211	0.1291	0.2985	0.3252
4.B.11c	Manure Management: Goats	N_2O direct	4.7478	12.7177	10	75	75.664	0.5987	0.0031	0.0038	0.2356	0.0542	0.2417
4.B.11d	Manure Management: Horses	N_2O direct	14.9787	14.3928	10	75	75.664	0.6776	0.0022	0.0043	0.1613	0.0614	0.1726
4.B.11e	Manure Management: Mules and Asses	N_2O direct	0.1796	0.2719	20	75	77.621	0.0131	0.0001	0.0001	0.0042	0.0023	0.0048
4.B.11f	Manure Management: Swine	N_2O direct	391.6369	67.3902	10	50	50.990	2.1380	-0.0369	0.0203	-1.8434	0.2874	1.8657
4.B.11g	Manure Management: Poultry	N_2O direct	138.6228	142.4913	20	50	53.852	4.7744	0.0227	0.0430	1.1350	1.2153	1.6629
4.B.11h	Manure Management: Rabbits	N_2O direct	22.3408	20.7776	20	75	77.621	1.0035	0.0030	0.0063	0.2250	0.1772	0.2864
4.B.12a	Manure Management: Cattle	N_2O indi-rect	94.5635	16.1232	10	100	100.499	1.0082	-0.0090	0.0049	-0.8955	0.0688	0.8981
4.B.12b	Manure Management: Sheep	N_2O indi-rect	20.6004	11.3757	10	100	100.499	0.7113	0.0004	0.0034	0.0420	0.0485	0.0641
4.B.12c	Manure Management: Goats	N_2O indi-rect	0.7715	2.0666	10	150	150.333	0.1933	0.0005	0.0006	0.0766	0.0088	0.0771
4.B.12d	Manure Management: Horses	N_2O indi-rect	2.4340	2.3388	10	150	150.333	0.2188	0.0003	0.0007	0.0524	0.0100	0.0534
4.B.12e	Manure Management: Mules and Asses	N_2O indi-rect	0.0292	0.0442	20	150	151.327	0.0042	0.0000	0.0000	0.0014	0.0004	0.0014
4.B.12f	Manure Management: Swine	N_2O indi-rect	106.9121	16.3884	10	100	100.499	1.0248	-0.0107	0.0049	-1.0678	0.0699	1.0701
4.B.12g	Manure Management: Poultry	N_2O indi-rect	36.5912	35.0320	20	100	101.980	2.2229	0.0052	0.0106	0.5216	0.2988	0.6011
4.B.12h	Manure Management: Rabbits	N_2O indi-rect	3.6304	3.3764	20	150	151.327	0.3179	0.0005	0.0010	0.0731	0.0288	0.0786

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
4.D.1a	Synthetic N Fertilizers Application	N_2O direct	448.6586	100.4781	5	6	7.810	0.4883	-0.0352	0.0303	-0.2113	0.2142	0.3009
4.D.1b	Organic N Applied as Fertilizer	N_2O direct	265.7072	0.4829	30	6	30.594	0.0092	-0.0387	0.0001	-0.2319	0.0062	0.2320
4.D.1c	Urine and Dung N Deposited on Pasture	N_2O direct	91.9302	46.8453	50	50	70.711	2.0610	0.0007	0.0141	0.0346	0.9988	0.9994
4.D.1d	N in Crop Residue	N_2O direct	338.1351	121.9896	5	25	25.495	1.9351	-0.0126	0.0368	-0.3154	0.2601	0.4088
4.D.1e	N Mineralization	N_2O direct	118.2288	518.2289	5	25	25.495	8.2208	0.1389	0.1563	3.4735	1.1050	3.6450
4.D.2a	Atmospheric Deposition of N volatilized	N_2O indirect	109.7501	16.1565	70	200	211.896	2.1301	-0.0112	0.0049	-2.2326	0.4823	2.2841
4.D.2b	N Leaching/Runoff from Managed Soils	N_2O indirect	276.6249	173.5290	75	200	213.600	23.0625	0.0119	0.0523	2.3782	5.5500	6.0381
5.A.1	Non-CO_2 Emissions from Vegetation Fires	N_2O	0.1917	0.0748	10	50	50.990	0.0024	0.0000	0.0000	-0.0003	0.0003	0.0004
5.B.1	Non-CO_2 Emissions from Stubble Fields Burning	N_2O	0.7864	0.0211	10	50	50.9902	0.0007	-0.0001	0.0000	-0.0054	0.0001	0.0054
6.B.2	Wastewater Handling	N_2O	91.6979	82.4458	30	30	42.4264	2.1764	0.0115	0.0249	0.3437	1.0548	1.1093
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	TOTAL		**3316.3088**	**1607.1884**				**25.8304**					**8.3551**

Annex 5-3: Summary of Sector Uncertainties

Annex 5-3.1: Energy Sector

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
1A1	Energy Industries	CO_2	19332.7655	4188.3127	5	5	7.0711	3.3103	-0.0237	0.1213	-0.1184	0.8579	0.8661
1A1	Energy Industries	CH_4	9.2887	1.5513	5	50	50.2494	0.0087	0.0000	0.0000	-0.0012	0.0003	0.0013
1A1	Energy Industries	N_2O	51.2316	4.7032	5	50	50.2494	0.0264	-0.0002	0.0001	-0.0124	0.0010	0.0125
1A2	Manufacturing Industries and Construction	CO_2	2188.7285	539.2384	5	5	7.0711	0.4262	-0.0008	0.0156	-0.0041	0.1105	0.1105
1A2	Manufacturing Industries and Construction	CH_4	2.0005	0.4748	5	50	50.2494	0.0027	0.0000	0.0000	-0.0001	0.0001	0.0001
1A2	Manufacturing Industries and Construction	N_2O	5.1641	0.9709	5	50	50.2494	0.0055	0.0000	0.0000	-0.0005	0.0002	0.0006
1A3	Transport	CO_2	3926.6606	1861.9016	5	5	7.0711	1.4716	0.0244	0.0539	0.1221	0.3814	0.4005
1A3	Transport	CH_4	25.0344	7.2973	5	40	40.3113	0.0329	0.0000	0.0002	0.0009	0.0015	0.0018
1A3	Transport	N_2O	103.9112	35.4955	5	50	50.2494	0.1994	0.0002	0.0010	0.0124	0.0073	0.0144
1A4	Other Sectors	CO_2	7762.4898	1653.9545	5	5	7.0711	1.3072	-0.0103	0.0479	-0.0517	0.3388	0.3427
1A4	Other Sectors	CH_4	244.4965	32.4869	5	50	50.2494	0.1825	-0.0009	0.0009	-0.0447	0.0067	0.0452
1A4	Other Sectors	N_2O	30.7924	6.0357	5	50	50.2494	0.0339	-0.0001	0.0002	-0.0028	0.0012	0.0031
1A5	Other	CO_2	154.2715	124.4914	5	5	7.0711	0.0984	0.0024	0.0036	0.0122	0.0255	0.0283
1A5	Other	CH_4	0.1350	0.1583	5	50	50.2494	0.0009	0.0000	0.0000	0.0002	0.0000	0.0002
1A5	Other	N_2O	0.4911	0.4049	5	50	50.2494	0.0023	0.0000	0.0000	0.0004	0.0001	0.0004
1B2	Fugitive Emissions from Fuels	CO_2	0.6377	1.8608	25	25	35.3553	0.0074	0.0000	0.0001	0.0012	0.0019	0.0023
1B2	Fugitive Emissions from Fuels	CH_4	682.2942	487.1800	25	25	35.3553	1.9253	0.0090	0.0141	0.2247	0.4990	0.5472
1B2	Fugitive Emissions from Fuels	N_2O	0.0002	0.0047	25	25	35.3553	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MI	International Bunkers	CO_2	217.3668	82.7287	5	5	7.0711	0.0628	0.0007	0.0024	0.0035	0.0167	0.0171
MI	International Bunkers	CH_4	0.9036	0.0598	5	10	11.1803	0.0001	0.0000	0.0000	-0.0001	0.0000	0.0001
MI	International Bunkers	N_2O	2.1560	0.8581	5	100	100.1249	0.0092	0.0000	0.0000	0.0008	0.0002	0.0008
MI	CO_2 Emissions from Biomass	CO_2	210.8274	289.1029	80	80	113.1371	3.5097	0.0067	0.0083	0.5330	0.9358	1.0770
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	TOTAL (without „Memo Items")		**34951.6472**	**9319.2728**				**5.5793**					**1.5821**
	TOTAL (with „Memo Items")		**34520.3934**	**8946.5232**				**4.3367**					**1.1588**

Annex 5-3.2: Industrial Processes Sector

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
2.A.1	Cement Production	CO_2	971.7056	349.8365	3	2	3.6056	2.2325	0.0319	0.1840	0.0639	0.7807	0.7834
2.A.2	Lime Production	CO_2	148.6611	2.3140	8	2	8.2462	0.0338	-0.0220	0.0012	-0.0440	0.0138	0.0461
2.A.3	Limestone and Dolomite Use	CO_2	619.4745	74.4613	15	5	15.8114	2.0838	-0.0575	0.0392	-0.2874	0.8309	0.8792
2.A.4	Soda Ash Use	CO_2	32.9560	12.0466	15	2	15.1327	0.3227	0.0012	0.0063	0.0024	0.1344	0.1344
2.A.7	Other: Mineral Wool Production	CO_2	8.0816	0.0000	8	5	9.4340	0.0000	-0.0013	0.0000	-0.0063	0.0000	0.0063
2.A.7	Other: Brick Production	CO_2	74.8506	15.4882	15	5	15.8114	0.4334	-0.0036	0.0081	-0.0178	0.1728	0.1737
2.A.7	Other: Expanded Clay Production	CO_2	32.3512	3.4223	15	5	15.8114	0.0958	-0.0033	0.0018	-0.0163	0.0382	0.0415
2.C.1	Steel Production	CO_2	11.7182	3.9938	3	5	5.8310	0.0412	0.0003	0.0021	0.0013	0.0089	0.0090
2.C.1	Steel Production	CH_4	0.1488	0.0507	3	100	100.0450	0.0090	0.0000	0.0000	0.0003	0.0001	0.0004
2.C.1	Steel Production	N_2O	1.0986	0.3744	3	150	150.0300	0.0994	0.0000	0.0002	0.0038	0.0008	0.0039
2.F.1	Refrigeration and Air Conditioning Equipment	HFC	0.0000	65.4178	8	50	50.6360	5.8630	0.0344	0.0344	1.7206	0.3893	1.7641
2.F.2	Foam Blowing	HFC	0.0000	36.9761	25	50	55.9017	3.6585	0.0195	0.0195	0.9725	0.6877	1.1911
2.F.4	Aerosols	HFC	0.0000	0.0232	5	50	50.2494	0.0021	0.0000	0.0000	0.0006	0.0001	0.0006
2.F.8	Electric Equipment	PFC	0.0000	0.0273	3	50	50.0899	0.0024	0.0000	0.0000	0.0007	0.0001	0.0007
2.F.8	Electric Equipment	SF_6	0.0000	0.5545	3	50	50.0899	0.0492	0.0003	0.0003	0.0146	0.0012	0.0146
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	TOTAL		**1,901.0463**	**564.9866**				**7.5764**					**2.4433**

Annex 5-3.3: Solvents and Other Products Use Sector

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
3.A	Conventional Solvent Paint Application	CO_2	31.1781	19.7188	5	25	25.4951	9.3325	0.0134	0.2172	0.3340	1.5360	1.5719
3.A	Waterborne Paint Application	CO_2	0.6894	1.0072	5	50	50.2494	0.9395	0.0066	0.0111	0.3294	0.0785	0.3386
3.B	Degreasing and Dry Cleaning	CO_2	33.1963	12.3930	5	20	20.6155	4.7428	-0.0802	0.1365	-1.6039	0.9654	1.8720
3.C	Polyurethane Foam Processing	CO_2	0.2544	0.5544	20	25	32.0156	0.3295	0.0044	0.0061	0.1111	0.1728	0.2054
3.C	Polystyrene Foam Processing	CO_2	0.2063	0.8758	20	25	32.0156	0.5205	0.0083	0.0096	0.2075	0.2729	0.3428
3.C	Rubber Processing	CO_2	1.1226	0.0012	5	25	25.4951	0.0006	-0.0073	0.0000	-0.1831	0.0001	0.1831
3.C	Pharmaceutical Products Manufacturing	CO_2	0.4454	0.8788	5	25	25.4951	0.4159	0.0068	0.0097	0.1692	0.0685	0.1825
3.C	Paints Manufacturing	CO_2	0.3851	0.4025	5	25	25.4951	0.1905	0.0019	0.0044	0.0479	0.0314	0.0573
3.C	Leather Tanning	CO_2	0.0237	0.0000	20	25	32.0156	0.0000	-0.0002	0.0000	-0.0039	0.0000	0.0039
3.C	Tyre Production	CO_2	0.0351	0.0046	20	25	32.0156	0.0027	-0.0002	0.0001	-0.0045	0.0014	0.0047
3.C	Manufactory of Shoes	CO_2	3.1236	0.2903	5	25	25.4951	0.1374	-0.0172	0.0032	-0.4304	0.0226	0.4310
3.D.1	Printing Industry	CO_2	0.7352	0.4021	5	25	25.4951	0.1903	-0.0004	0.0044	-0.0094	0.0313	0.0327
3.D.2	Domestic Solvent Use	CO_2	13.0499	12.2124	5	50	50.2494	11.3919	0.0492	0.1345	2.4576	0.9513	2.6353
3.D.3	Seed Oil Extraction and Seed Drying	CO_2	0.9520	0.6066	20	25	32.0156	0.3605	0.0005	0.0067	0.0115	0.1890	0.1893
3.D.3	Adhesives Use	CO_2	5.2995	4.4977	5	25	25.4951	2.1287	0.0149	0.0495	0.3724	0.3504	0.5113
3.D.3	Vehicles Dewaxing	CO_2	0.0592	0.0237	5	25	25.4951	0.0112	-0.0001	0.0003	-0.0031	0.0018	0.0037
3.D.3	Tobacco Combustion	CO_2	0.0002	0.0001	5	20	20.6155	0.00002	0.0000	0.0000	0.0000	0.0000	0.00002
3.D.3	Use of N_2O for Anesthesia	N_2O	0.0205	0.0000	5	1	5.0990	0.0000	-0.0001	0.0000	-0.0001	0.0000	0.00013
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	TOTAL		**90.7765**	**53.8690**				**15.6701**					**3.7079**

Annex 5-3.4. Agriculture Sector

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
4.A.1	Enteric Fermentation: Cattle	CH_4	1630.8944	598.4914	10	20	22.3607	5.5616	-0.0282	0.1139	-0.5630	1.6108	1.7064
4.A.3	Enteric Fermentation: Sheep	CH_4	166.7501	116.8926	10	20	22.3607	1.0863	0.0077	0.0222	0.1542	0.3146	0.3504
4.A.4	Enteric Fermentation: Goats	CH_4	4.4486	16.6848	10	20	22.3607	0.1550	0.0028	0.0032	0.0558	0.0449	0.0716
4.A.6	Enteric Fermentation: Horses	CH_4	17.5014	28.8414	10	30	31.6228	0.3790	0.0040	0.0055	0.1189	0.0776	0.1420
4.A.7	Enteric Fermentation: Mules and Asses	CH_4	0.4200	0.4200	20	30	36.0555	0.0063	0.0000	0.0001	0.0013	0.0023	0.0026
4.A.8	Enteric Fermentation: Swine	CH_4	64.4175	13.3025	10	30	31.6228	0.1748	-0.0031	0.0025	-0.0925	0.0358	0.0992
4.A.9	Enteric Fermentation: Poultry	CH_4	0.0000	0.0000	20	30	36.0555	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.A.10	Enteric Fermentation: Rabbits	CH_4	18.9736	18.2266	20	30	36.0555	0.2731	0.0018	0.0035	0.0545	0.0981	0.1122
4.B.1	Manure Management: Cattle	CH_4	191.0580	31.0258	10	30	31.6228	0.4077	-0.0107	0.0059	-0.3223	0.0835	0.3329
4.B.3	Manure Management: Sheep	CH_4	5.2109	3.3448	10	50	50.9902	0.0709	0.0002	0.0006	0.0091	0.0090	0.0128
4.B.4	Manure Management: Goats	CH_4	0.0874	0.3311	10	50	50.9902	0.0070	0.0001	0.0001	0.0028	0.0009	0.0029
4.B.6	Manure Management: Horses	CH_4	1.5168	2.4996	10	50	50.9902	0.0530	0.0003	0.0005	0.0172	0.0067	0.0184
4.B.7	Manure Management: Mules and Asses	CH_4	0.0319	0.0319	20	50	53.8516	0.0007	0.0000	0.0000	0.0002	0.0002	0.0002
4.B.8	Manure Management: Swine	CH_4	170.9211	19.2442	10	30	31.6228	0.2529	-0.0112	0.0037	-0.3369	0.0518	0.3409
4.B.9	Manure Management: Poultry	CH_4	16.2771	11.6885	20	50	53.8516	0.2616	0.0008	0.0022	0.0403	0.0629	0.0747
4.B.10	Manure Management: Rabbits	CH_4	2.5089	2.4101	20	50	53.8516	0.0539	0.0002	0.0005	0.0120	0.0130	0.0177
4.B.11a	Manure Management: Cattle	N_2O direct	467.1252	168.7875	10	50	50.9902	3.5767	-0.0086	0.0321	-0.4291	0.4543	0.6249
4.B.11b	Manure Management: Sheep	N_2O direct	107.6465	69.0965	10	50	50.9902	1.4642	0.0038	0.0132	0.1884	0.1860	0.2647
4.B.11c	Manure Management: Goats	N_2O direct	3.0678	11.6290	10	75	75.6637	0.3657	0.0019	0.0022	0.1459	0.0313	0.1493
4.B.11d	Manure Management: Horses	N_2O direct	16.8890	27.8321	10	75	75.6637	0.8752	0.0038	0.0053	0.2869	0.0749	0.2965
4.B.11e	Manure Management: Mules and Asses	N_2O direct	0.2490	0.2490	20	75	77.6209	0.0080	0.0000	0.0000	0.0019	0.0013	0.0023
4.B.11f	Manure Management: Swine	N_2O direct	307.1506	71.5496	10	50	50.9902	1.5162	-0.0131	0.0136	-0.6573	0.1926	0.6849
4.B.11g	Manure Management: Poultry	N_2O direct	142.5865	101.1546	20	50	53.8516	2.2638	0.0068	0.0193	0.3411	0.5445	0.6425
4.B.11h	Manure Management: Rabbits	N_2O direct	19.6425	18.8691	20	75	77.6209	0.6087	0.0019	0.0036	0.1409	0.1016	0.1737
4.B.12a	Manure Management: Cattle	N_2O indirect	105.8732	32.3370	10	100	100.4988	1.3506	-0.0031	0.0062	-0.3073	0.0870	0.3193
4.B.12b	Manure Management: Sheep	N_2O indirect	17.4926	11.2282	10	100	100.4988	0.4690	0.0006	0.0021	0.0612	0.0302	0.0683
4.B.12c	Manure Management: Goats	N_2O indirect	0.4985	1.8897	10	150	150.3330	0.1181	0.0003	0.0004	0.0474	0.0051	0.0477
4.B.12d	Manure Management: Horses	N_2O indirect	2.7445	4.5227	10	150	150.3330	0.2826	0.0006	0.0009	0.0932	0.0122	0.0940
4.B.12e	Manure Management: Mules and Asses	N_2O indirect	0.0405	0.0405	20	150	151.3275	0.0025	0.0000	0.0000	0.0006	0.0002	0.0007
4.B.12f	Manure Management: Swine	N_2O indirect	83.8484	17.0849	10	100	100.4988	0.7136	-0.0041	0.0033	-0.4056	0.0460	0.4082

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
4.B.12g	Manure Management: Poultry	N_2O indirect	36.2794	25.7707	20	100	101.9804	1.0922	0.0017	0.0049	0.1743	0.1387	0.2227
4.B.12h	Manure Management: Rabbits	N_2O indirect	3.1919	3.0662	20	150	151.3275	0.1928	0.0003	0.0006	0.0458	0.0165	0.0487
4.D.1a	Synthetic N Fertilizers Application	N_2O direct	448.6586	100.4781	5	6	7.8102	0.3261	-0.0200	0.0191	-0.1198	0.1352	0.1806
4.D.1b	Organic N Applied as Fertilizer	N_2O direct	265.7072	0.4829	30	6	30.5941	0.0061	-0.0231	0.0001	-0.1383	0.0039	0.1384
4.D.1c	Urine and Dung N Deposited on Pasture	N_2O direct	91.9302	46.8453	50	50	70.7107	1.3766	0.0009	0.0089	0.0452	0.6304	0.6320
4.D.1d	N in Crop Residue	N_2O direct	338.1351	121.9896	5	25	25.4951	1.2925	-0.0062	0.0232	-0.1562	0.1642	0.2266
4.D.1e	N Mineralization	N_2O direct	118.2288	518.2289	5	25	25.4951	5.4908	0.0883	0.0986	2.2076	0.6974	2.3151
4.D.2a	Atmospheric Deposition of N volatilized	N_2O indirect	109.7501	16.1565	70	200	211.8962	1.4227	-0.0065	0.0031	-1.2978	0.3044	1.3331
4.D.2b	N Leaching/Runoff from Managed Soils	N_2O indirect	276.6249	173.5290	75	200	213.6001	15.4040	0.0089	0.0330	1.7823	3.5029	3.9302
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	TOTAL		**5254.3785**	**2406.2530**				**18.2573**					**5.3124**

Annex 5-3.5: Land Use, Land-Use Change and Forestry Sector

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
5.A.1	Forest Land Remaining Forest Land	CO_2	-2197.5790	-2193.2612	25	5	25.4951	-2118.9996	0.3058	0.3056	1.5289	10.8044	10.9121
5.A.1	Non-CO_2 Emissions from Vegetation Fires	CH_4	0.2347	0.0917	10	30	31.6228	0.1098	0.0000	0.0000	-0.0004	-0.0002	0.0004
5.A.1	Non-CO_2 Emissions from Vegetation Fires	N_2O	0.1917	0.0748	10	50	50.9902	0.1446	0.0000	0.0000	-0.0005	-0.0001	0.0005
5.B.1	Cropland: Land Covered with Woody Vegetation	CO_2	-725.2315	-470.5183	25	10	26.9258	-480.0974	0.0659	0.0656	0.6586	2.3179	2.4096
5.B.2	Cropland: Annual Change in Carbon Stocks in Mineral Soils	CO_2	-3470.9538	3447.5439	10	10	14.1421	1847.6029	-0.4763	-0.4804	-4.7628	-6.7933	8.2966
5.B.1	Non-CO_2 Emissions from Stubble Fields Burning	CH_4	2.0547	0.0551	10	30	31.6228	0.0660	0.0000	0.0000	-0.0003	-0.0001	0.0003
5.B.1	Non-CO_2 Emissions from Stubble Fields Burning	N_2O	0.7864	0.0211	10	50	50.9902	0.0407	0.0000	0.0000	-0.0002	0.0000	0.0002
5.C.1	Grassland Remaining Grassland	CO_2	-780.1200	-779.4600	30	10	31.6228	-934.0662	0.1089	0.1086	1.0889	4.6077	4.7346
5.C.2	Land Converted to Grassland	CO_2	-6.3800	21.8416	30	5	30.4138	25.1732	-0.0030	-0.0030	-0.0152	-0.1291	0.1300
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	TOTAL		**-7176.9968**	**26.3886**				**3001.2335**					**14.7019**

Annex 5-3.6: Waste Sector

IPCC Classification	IPCC Source Categories	Pollutant	Base Year Emissions (1990)	Year t Emissions (2010)	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total Sectoral Emissions in the Year t (2010)	Type A Sensibility	Type B Sensibility	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by EF Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions Introduced by AD Uncertainty	Uncertainty Introduced in Trend in Sectoral Emissions
			Gg CO_2 eq.		%								
6.A.1	Managed Solid Waste Disposal on Land	CH_4	362.9476	609.8657	15	20	25.0000	9.6601	0.1581	0.3748	3.1620	7.9497	8.5555
6.A.2	Unmanaged Solid Waste Disposal on Land	CH_4	547.4656	291.5357	30	20	36.0555	6.6600	-0.1466	0.1791	-2.9325	7.6004	8.1465
6.A.3	Industrial Solid Waste Disposal on Land	CH_4	409.6703	486.6570	50	20	53.8516	16.6047	0.0548	0.2990	1.0952	21.1455	21.1739
6.B.2	Domestic and Commercial Wastewater	CH_4	215.6014	107.8000	10	30	31.6228	2.1599	-0.0622	0.0662	-1.8649	0.9368	2.0870
6.B.2	Domestic and Commercial Wastewater	N_2O	91.6979	82.4458	30	30	42.4264	2.2162	-0.0040	0.0507	-0.1195	2.1494	2.1527
			$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
	TOTAL		**1627.3829**	**1578.3041**				**20.5662**					**24.4312**