Ministry of Environment

and Climate Change

Romania’s Greenhouse Gas Inventory 1989-2012

National Inventory Report

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LIST OF ABBREVIATIONS

AD	Activity Data
AGB	Above Ground Biomass
ANMDM	National Agency for Medicines and Medical Devices
ANRE	Romanian Energy Regulatory Authority
APMCR	Romanian Association of Construction Materials Producers
AR	Afforestation/Reforestation
ASH	ASH content of the manure
AWMS	Animal Waste Management Systems
B_0	Maximum methane (CH4) producing capacity for manure produced by animal within defined population
BEF	Biomass Expansion Factor
BGB	Below Ground Biomass
BOD	Biochemical Oxygen Demand
BOF	Basic Oxygen Furnace
C	Carbon
C^{nat}	National Oxidation Factor expressed in Carbon content
C_2F_6	Hexafluoroethane
$CaCO_3$	Calcium Carbonate (limestone)
CaO	Calcium Oxide (lime)
CaO*MgO	Dolomitic lime
CAP	Agricultural Production Cooperatives
Cel B	Gross Pulp
CF_4	Tetrafluoromethane
CH_4	Methane
CHP	Co-generation Heat Plants
CIV	Identity Card Vehicle
CKD	Cement Kiln Dust
CLRTAP	Convention on Long-range Transboundary Air Pollution

CN	Combined Nomenclature
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
Coll	Collaboratores
CORINAIR	Coordination of Information on the Environment, sub-project: Air
CRF	Common Reporting Format
CS	Country Specific
CS EF_s	Country Specific Emission Factors
CWPB	Centre Worked Pre-baked
DDLVRC	Directorate on Driving Licenses and Vehicles Registration Certificates
D	Deforestation
DE	Digestible Energy
DOC	Degradable Organic Carbon
DOC_F	Fraction of DOC Dissimilated
DOM	Dead Organic Matter
DS_{dom}	Fraction of Degradable Organic Component
dm	decimeter
DW	Dead Wood
EAF	Electric Arc Furnace
EB	Energy Balance
EC	European Commission
EEA-UG	Environment Agency of Austria- University of Graz
EF	Emission Factor
EF^{nat}	National Emission Factor without Factor Oxidation
$EF\text{-}Ox^{nat}$	National Emission Factor with Factor Oxidation
EF_S	Emission Factors
EU	European Union
EUROSTAT	Statistical Office of the European Communities
ERT	Expert Review Team

EU-ETS	European Union-Emission Trading Scheme
FAO	Food and Agriculture Organization
FOD	First Order Decay
FFN	National Forest Fund
FLRFL	Forest Land Remaining Forest Land
FM	Forest Management
FORLUC	Forest Land Use
GB	Gross Fat
GD	Governmental Decision
GE	Gross Energy Intake
G	Grams
Gg	Giga gram
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GPG	Good Practice Guidance
GWP	Global Warming Potential
Ha	Hectares
HCFC	Fluorinated Gases
HFC_s	Hydro-fluorocarbons
ICAS	Forest Research and Management Planning Institute
ICIM	National Research and Development Institute for Environmental Protection
ICPA	National Institute of Research and Development in Soil Science, Agro-chemistry and Environment
ICPIL	Research and Design Institute of Wood Industry
IE	Included elsewhere
IEA	International Energy Agency
INSEMEX Petrosani	National Institute for Research and Development in Mine Safety and Protection to Explosion
IPCC 1996	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories -1996

IPCC GPG 2000	IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories -2000
IPCC GPG 2003	IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry -2003
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrating Pollution Prevention and Control
ISPB	Public Health Institute of Bucharest
ISPE	Institute for Studies and Power Engineering
IT	Information Technologies
ITRSV	Territorial Inspectorates on Forestry and Hunting Regime
JI	Joint Implementation
KP	Kyoto Protocol
KCA	Key Category Analysis
Kcal	Kilocalorie
Kg	Kilograms
Kj	Kilojoule
L	Level
L	liquid
LB	Loss in Biomass
LT	Litter
LTO	Landing/Taking Off
LULUCF	Land Use, Land Use Change and Forestry
M	meter
M^3	meter cubic
mm	milimeter
MADR	Ministry of Agriculture and Rural Development
MAI	Ministry of Administration and Interior
MCF	Methane Conversion Factor
MECC	Ministry of Environment and Climate Change
MEF	Ministry of Environment and Forests
$MgCO_3$	Magnesium Carbonate

MgO	Magnesium Oxide
MJ	Megajoule
MoEO	Ministry of Environment Order
MS	Fraction of minimal species/category manure handled using manure system
MSW	Municipal Solid Waste
N	Nitrogen
N.A. ”Romanian Waters”	National Administration ”Romanian Waters”
N_2O	Nitrous Oxide
NACE	National Classification of Economic Activities
NCV_s	Net Calorific Values
NEPA	National Environmental Protection Agency
N_{ex}	Available for annual average N excretion per head of species/category
NFI	National Forest Inventory
NGHGI	National Greenhouse Gas Inventory
NH_3	Ammonia
NIM	National Institute of Meteorology
NIR	National Inventory Report
NIS	National Institute for Statistics
NMVOC	Non-methane Volatile Organic Compound
NO	Not occured
NOx	Nitrogen Oxides
NS	National System for the estimation of anthropogenic emissions by sources and removals by skins of all greenhouse gases not controlled by the Montreal Protocol
NSCR	Non Selective Catalytic Reduction
NTPA - 011	Romanian Standard regarding wastewater treatment
PB	Gross Protein
PFC_s	Per-fluorocarbons
PRODCOM Codes	Codes of PRODucts of the European COMmunity

QA/QC	Quality Assurance/Quality Control
RAR	Romanian Automobile Register
Rev	Re-vegetation
RNP	Public National Forest Administration
S	Solid
Saturday paper	Problems and Further Questions from the ERT formulated in the course of the review of the submitted greenhouse gas inventories
SEF	Standard Electronic Files
SEN	Nitrogenous substances extractable
SF_6	Sulfur Hexafluoride
SILV 4	Statistical Report Forest regeneration works performed in the forestry fund, degraded lands and other lands outside the forest fund
SNAP	Selected Nomenclature for Air Pollution
SNFI 1984	Synthesis of National Forest Inventory, 1988
SO_2	Sulfur Dioxide
SOC	Soil Organic Carbon
SRC	Selective Catalytic Reduction
SWDS	Solid Waste Disposal Sites
SWPB	Side Worked Pre-baked
SY	Statistical Yearbook
T	Trend
t	tones
TOS	Total Organic Sludge
TOW	Total Organic Wastewater
UN	Nutritive Units
UNFCCC	United Nations Framework Convention on Climate Change
VFAFF	Forest Vegetation outside of the National Forest Fund
VS	Volatile Solid excretion per day on a dry-matter weight basis
WA	Weighted arithmetic average
WS_x	Fraction of wastewater treated anaerobically

Y_m		Methane conversion rate as the fraction of gross energy in feed converted to methane
YR		Year
%		Percent
Notation Keys	IE	Included elsewhere
	NA	Not Applicable
	NE	Not Estimated
	NO	Not occurring
	C	Confidential

ES EXECUTIVE SUMMARY

ES.1. Background information on greenhouse gas inventories, climate change and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

ES.1.1 Background information on climate change

Romania signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, and ratified it in 1994 by Law 24. Romania signed the Kyoto Protocol in 1999 and ratified it in January 2001, being the first Annex 1 Party that ratified it. Romania committed itself to reduce the greenhouse gas (GHG) emissions by 8% comparing to 1989 (base year) levels in the first commitment period 2008-2012.

The estimation on climate change impact on Romania has been realized through the elaboration of a study, by the Romanian Academy; in this sense, different atmosphere General Circulation Models were selected, models which reflect the best Romanian conditions. In accordance with the results generated by these models, presuming that the CO_2 atmospheric concentration would double, it is expected for the coming decades that the average global temperature will increase by 2.4-7.4^{0}C.

ES.1.2 Background information on greenhouse gas inventories

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), and its Kyoto Protocol, Romania is required to elaborate, regularly update and submit the National GHG Inventory.

In compliance with the reporting requirements, this is the 21st version of the National Inventory Report (NIR) submitted by Romania, covering the national inventories of GHG emissions/removals for the period 1989-2012.

This report documents Romania’s National Inventory of anthropogenic emissions/removals of direct GHGs: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and indirect GHGs: NO_x, CO, NMVOC and SO_2. This report includes descriptions of methods, data sources, key categories, quality assurance and quality control (QA/QC) activities carried out and a trend analysis.

The NIR also comprises a full quantitative assessment of the uncertainty; the uncertainty analysis is presented both on the sub- sectorial level and in the Annex 7.

ES.1.3 Background information on supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

Considering the provisions in Decision 15/CMP. 1, the report specifies the information required under Article 7.1 of the Kyoto Protocol; Romania is reporting also elements on Afforestation, Reforestation, Deforestation, Forest Management and Revegetation activities (KP Art. 3 paragraphs 3 and 4 activities), within the current NGHGI.

ES.2 Summary of national emission and removal related trends, and emission and removals from KP-LULUCF activities

ES.2.1 GHG inventory

For the trends analysis, the GHG emissions resulted from each sector were converted into CO_2 equivalent using the Global Warming Potential values provided by IPCC in the Second Assessment Report (the GWP values are presented in the Annex 6 of the NIR). The evolution of the total GHG emissions is presented in the next chart.
The GHG emissions trend reflects the main trends in the economic development of the country. The period is characterized by a process of transition to a market economy, restructuring of the economy, bringing into operation of the first reactor at the Cernavoda nuclear power plant (1996). The emissions have started to increase after 1999 as a consequence of the economy revitalization; in 2009, the emissions decreased significantly comparing to the level in 2008 while in 2010 they continued to decrease, due to the economic crisis. In 2011, the emissions started to increase again while in 2012 the emissions decreased, following the economic activities level.
The largest contributor to the total national GHG emissions is CO_2, followed by CH_4 and N_2O. The share of each direct GHG in total emissions in 1989 and, respectively 2012, and the average

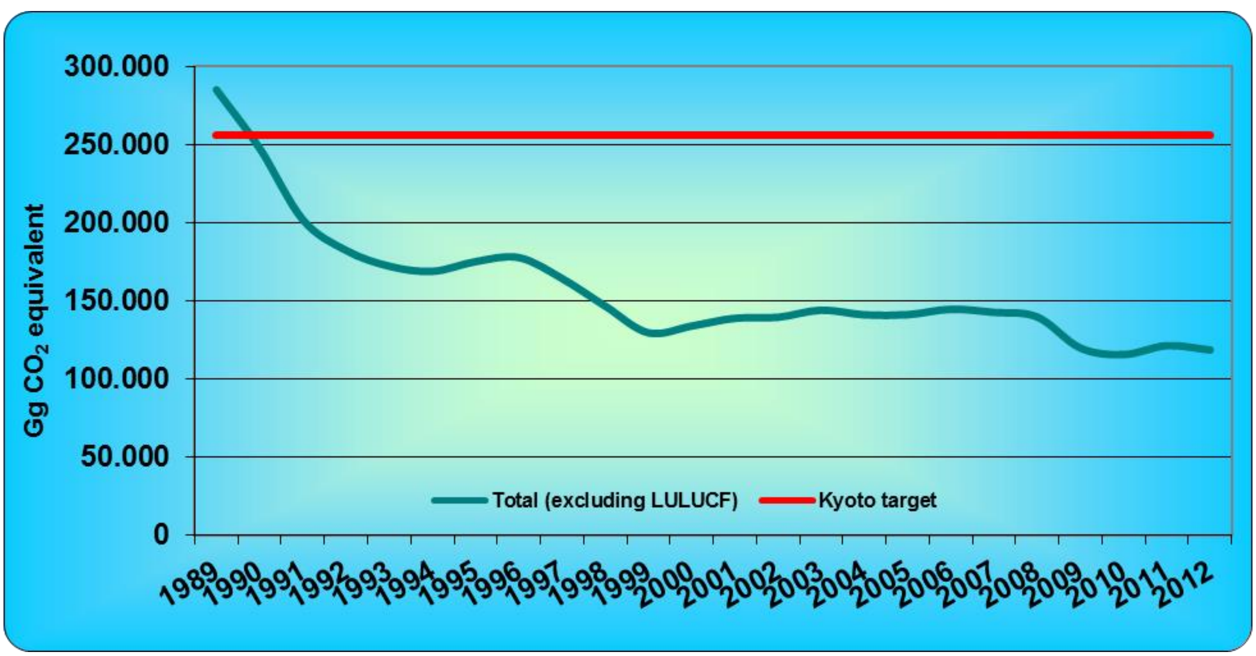
share of each direct GHG in total emissions for 1989-2012 period are presented in the Table ES.1.

The total GHG emissions excluding LULUCF, in CO_2 equivalent, during 1989-2012 period, are presented in the Figure ES.1.

Table ES 1 Share of each direct GHG in total emissions in 1989, 2010, respectively 1989-2012 period

GHG	1989 (%)	2012 (%)	Average share for 1989-2012 period
CO_2	72.62%	70.61%	71.02%
CH_4	16.34%	18.72%	18.30%
N_2O	9.86%	9.76%	9.89%
HFCs	0.0000%	0.0087%	0.2156%
PFCs	1.18%	0.01%	0.57%
SF_6	0.00000%	0.00034%	0.00968%

Figure ES 1 The total GHG emissions in CO_2 equivalent during 1989-2012 period



According to the figure above, there is a great probability for Romania to meet the Kyoto Protocol commitments on the limitation of the GHG emissions in the 2008-2012 commitment period. In 2012, the GHG emissions without LULUCF have decreased with 58.34% comparing with the base year level.

ES.2.2 KP-LULUCF activities

The data relevant to the KP LULUCF activities are presented within the Chapter 11.

ES.3 Overview of source and sink category emissions estimates and trends, including KP-LULUCF activities

ES.3.1 GHG inventory

The present NGHGI for 1989–2012 was compiled according to the recommendations for GHG inventories set out in the Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of Decision 14/CP. 11 (FCCC/SBSTA/2006/9) and in the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol, using the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1996) as well as the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC GPG 2000) and Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC GPG 2003).

The inventories cover all sectors and the majority of the IPCC categories. The direct GHGs (including groups of gases) included in the national inventory are:

- carbon dioxide (CO_2);
- methane (CH_4);
- nitrous oxide (N_2O);
- hydrofluorocarbons (HFCs);
- perfluorocarbons (PFCs);
- sulphur hexafluoride (SF_6).

The report also contains data on calculations of emissions of the indirect GHGs: NO_x, NMVOC, CO and SO_2, which should be included according to the reporting guidelines. Some minor IPCC source categories are not estimated, such as the direct GHG emissions from asphalt roofing and from road paving with asphalt due to the lack of default and national methods and emission factors.

GHG emissions inventories have been reported since the 2005 submission using the CRF Reporter software, delivered by the UNFCCC Secretariat. This version of NIR refers to figures in CRF table's generated using CRF Reporter version 3.7.3.

ES.3.2 KP LULUCF activities

The data relevant to the KP LULUCF activities are presented within the Chapter 11.

ES.4 Other information

The emissions of the indirect GHGs (NO_x, NMVOC, CO and SO_2) are included in the report, as requested by the UNFCCC reporting guidelines. A detailed description of the calculation methodologies for these gases is not included in this report.

Fuel combustion activities in the Energy sector are the major sources of SO_2, NO_x and CO emissions. Additional to the Energy sector, the NMVOC emissions are generated mainly through activities within the Solvent and Other Product Use sector.

PART 1 ANNUAL INVENTORY SUBMISSION

1 INTRODUCTION

1.1. Background information on greenhouse gas inventories, climate change and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

1.1.1. Background information on climate change

In Romania, the climate variability will have direct effects on certain sectors such as agriculture, forestry, water management, residential and infrastructure will lead to changes in the vegetation cycle and to movement of the demarcation lines between forests and meadows, will determine the increase of the frequency and of the intensity of the extreme meteorological events (storms, floods, droughts). The changes in the Romanian climate regime are framed within the global context, considering the regional conditions: the temperature increase will be more pronounced during the summer, while in north-western Europe the most pronounced temperature increase is expected in winter.

In Romania it is expected an increase of the average annual temperature compared to the 1980-1990 similar to that specific to the whole Europe, with small differences between the models results in respect to the first decades of the XXI century, and with larger differences in respect to the end of the same century:

- ❖ between 0.5°C and 1.5°C, for 2020-2029;
- ❖ between 2.0°C and 5.0°C, for 2090-2099, depending on the scenario (e.g. between 2.0°C and 2.5°C for the scenario foreseeing the lowest increase of the average global temperature and between 4.0°C and 5.0°C in case of the scenario with the most pronounced temperature increase).

Considering the pluviometrical view, over than 90% of the climate models forecasts for 2090-2099 pronounced droughts during the summer in Romania, especially in south and south-east (with negative deviations compared to 1980-1990 larger than 20%). Taking into account the winter precipitations, the deviations are smaller while the uncertainty is larger.

Effects on agriculture

The agriculture represents the most vulnerable sector, the elaborated studies highlighting the following aspects:

- wheat crop - a production increase with approximately 0.4-0.7 t/ha and the decrease of the vegetation season by 16-27 days;
- non-irrigated maize crop – the grains production increase with approximately 1.4-5.6 t/ha, a decrease of the vegetation season ranging between 2-32 days, a decrease of the vegetation cycle ranging between 2-19%; the estimated values depend on the model used;
- irrigated maize crop - the results depend on the models used and on the conditions of the locations chosen for data sampling;
- for analyzing the effects on the main crops agricultural productivity, several agro-meteorological models were used.

Effects on silviculture

Out of the national area, approximately 27% represent the area covered by forests; the forests are unevenly spread on the country's territory (approximately 51.9% in the mountain area, 37.2% in the hilly area and 10.9% in the plain area). In 2012 year, the forest fund area accounted for approximately 6 373 thousand ha; associated to that, an additional area was destined to forest crop, production and management. In the lower and hilly forested areas, a considerable drop of the forests productivity is foreseen after 2040, due to the increase of the temperatures and to the decrease of the precipitations volume.

Effects on the water management

The hydrological consequences of the increase of the CO_2 atmospheric concentration are significant. The modeling of the effects produced by this phenomenon was realized focusing on the main hydrographic basins. The modeling results show the probable effects of the changes in the precipitations volume and in the evapo-transpiration.

Effects on the human establishments

The industrial, commercial, residential and infrastructure sectors (including the supplying with energy and water, the transport and the waste disposal) are vulnerable to the climate change. The main impact of the climate change on urban areas, on infrastructure and on constructions is mainly linked to the effects of extreme meteorological events such as heat waves, pronounced snowfalls, storms, and floods, increase of the slopes instability and the modification of some geophysical properties. Thus, urban planning and designing of an appropriate infrastructure plays an important role in minimizing the impact of climate change and in reducing the risk on the anthropic environment.

1.1.2. Background information on greenhouse gas inventories

As a Party to the UNFCCC and its Kyoto Protocol, Romania is required to produce and regularly update the national GHG inventory. According to the COP decision regarding the UNFCCC guidelines on reporting and reviewing (FCCC/CP/1999/7), Parties shall submit a National Inventory Report (NIR) containing detailed and complete information on their inventories, in order to ensure the transparency of the inventory. This is the 21st complete submission of the National GHG Inventory of Romania. The structure of the National Inventory Report is in line with the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol, document provided by the UNFCCC Secretariat.

The submission of present inventory covers the obligation of Romania under the UNFCCC. It also constitutes Romania's submission under the Kyoto Protocol.

For this submission, Romania prepared: the CRF Reporter database and the CRF tables containing emissions/removals estimates and background data for 1989-2012 period and the National Inventory Report.

The greatest attention during the preparation was payed to the direct GHGs mentioned through Annex A of the Kyoto Protocol - CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. In addition, the indirect GHGs (NO_X, CO, NMVOCs, and SO_2) were also taken into account.

The GHG inventories submitted annually by Parties are subject to reviews by Expert Review Teams coordinated by the UNFCCC Secretariat.

Up to now, the GHG inventories of Romania were reviewed under Article 8 of the KP as presented in Table 1.1.

Table 1.1 Overview of the Romanian GHG Inventories review under Article 8 of the KP

Year	Submission	Review process
2002	CRF tables and draft NIR submitted (late submission)	No Review
2003	CRF tables and NIR submitted	In - country Review
2004	CRF tables and NIR submitted	Desk Review
2005	CRF Reporter database, CRFs for LULUCF and NIR submitted	Centralized Review
2007	2nd version of the 2006 submission: CRF Reporter database, CRF Tables and NIR + Initial Report of Romania under the Kyoto Protocol	In - country Review
2008	2007 and 2008 submissions: CRF Reporter database, CRF Tables and NIR	Centralized Review
2009	2009 submission: CRF Reporter database, CRF Tables and NIR	Centralized Review
2010	2010 submission: CRF Reporter database, CRF Tables and NIR	Centralized Review
2011	3rd version of the 2011 submission	In - country Review
2012	2nd version of the 2012 submission	Centralized Review
2013	1st version of the 2013 submission	Centralized Review

The reports on these reviews can be found on the UNFCCC website.

1.1.3. Background information on supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

The present NIR includes supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol as follows:

- information on anthropogenic greenhouse gas emissions by sources and removals by sinks from LULUCF activities under KP's Article 3, paragraphs 3 and 4, in accordance with the provisions in Section I.D of the Annex to Decision 15-CMP. 1;
- information on Kyoto units (emission reduction units (ERUs), certified emission reductions (CERs), temporary certified emission reductions (tCERs), long-term certified emission reductions (lCERs), assigned amount units (AAUs) and removal units (RMUs)), as set out in Section I.E of the Annex to Decision 15/CMP. 1;
- changes in national systems in accordance with Article 5, paragraph 1, of the Kyoto Protocol, as set out in Section I.F of the Annex to Decision 15/CMP. 1;
- changes in national registries as set out in Section I.G of the Annex to Decision 15/CMP. 1;
- minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol, as set out in Section I.H of the Annex to Decision 15/CMP. 1.

1.2. A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management

1.2.1. Overview of institutional, legal and procedural arrangements for compiling GHG inventory and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

The Governmental Decisions (GD) no. 120/2014 and 668/2012 for modifying and completing the GD no. 1570 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals by sinks, adopted in 2007, and the subsequent relevant procedures, and, respectively, the GD no. 48/2013 on the organization and functioning of the Ministry of Environment and Climate Change and for modifying some environment protection and climate change domain related legal acts are regulating all the institutional, legal and procedural aspects for supporting the Romanian authorities to estimate the greenhouse gas emissions/removals levels, to report and to archive the National Greenhouse Gas Inventory (NGHGI) information, including supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol. In this respect, the GD no. 48/2013 also modified the GD no. 1570/2007.

The system is based on Article 5 of the Kyoto Protocol and complies with the provisions of the subsequent decisions of the CMPs of the Kyoto Protocol, and with the provisions of the Regulation (EU) no. 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and relealing Decision no. 280/2004/EC and of the Decision no. 166/2005/EC of the European Commission concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol.

The main objective of the Governmental Decision no. 1570/2007, as ulteriorly modified and completed, is to ensure the fulfillment of the relevant provisions and the obligations of Romania under the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the European Union legislation.

Starting with 1 April 2013, the competent authority, which is responsible for administrating the National System, is the Ministry of Environment and Climate Change (MECC). Anteriorly, the competent authority was the National Environmental Protection Agency (NEPA), under the subordination of the MECC.

Based on the GD no. 48/2013, all NEPA climate change related structure, personnel, attributions and responsibilities were took over by MECC, in order to improve the institutional arrangements and capacity within the climate change domain, thus increasing the efficiency in activities implementation also in respect to the NS/NGHGI administration.

The definition and characteristics of the Romanian National system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol (NS) comprise:

- ❖ includes all institutional, legal and procedural arrangements made as a Party included in Annex I for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and for reporting and archiving inventory information;
- ❖ represents a system for the collection, processing and adequate presentation of data and information for the elaboration of the NGHGI;

- ❖ is designed and operated to ensure the transparency, consistency, comparability, completeness and accuracy of inventories as defined in the guidelines for the preparation of inventories by Parties included in Annex I, in accordance with relevant decisions of the COP and/or COP/MOP;
- ❖ is designed and operated to ensure the quality of the NGHGI through planning, preparation and management of inventory activities;
- ❖ is designed and operated to support compliance with the Kyoto Protocol and with the European Union legislation commitments related to the estimation of anthropogenic GHG emissions by sources and removals by sink;
- ❖ is designed and operated to consistently estimate anthropogenic emissions by all sources and removals by all sinks of all GHGs, as covered by the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and IPCC good practice guidance, in accordance with relevant decisions of the COP and/or COP/MOP.

The elements on the implementation of the NS general functions are described below:

A. Establish and maintain the institutional, legal and procedural arrangements necessary to perform the functions for national systems, as appropriate, between the government agencies and other entities responsible for the performance of all functions defined in these guidelines

Institutional arrangements

The elements characterizing the institutional arrangements comprise:

- ❖ according to the Governmental Decision no. 1570/2007 as ulteriorly modified and completed, the single national entity with overall responsibility for the national inventory, including with the responsibilities of administrating the NS and of preparation and management of the NGHGI, is the Ministry of Environment and Climate Change (MECC)

Before 1 April 2013, the competent authority was the National Environmental Protection Agency (NEPA), under the subordination of the MECC. Based on the GD no. 48/2013, all NEPA climate change related structure, personnel, attributions and responsibilities were took over by MECC, in order to improve the institutional arrangements and capacity within the climate change domain, thus increasing the efficiency in activities implementation also in respect to the NS/NGHGI administration.

- ❖ central and territorial public authorities, research and development institutes and other public organizations under the authority, in the subordination or in the coordination of central public authorities, owners and professional associations, economic operators and other relevant organizations have the obligation of providing to MECC the necessary activity data, emission factors and associated uncertainty data;
- ❖ the main activity data supplier is the National Institute for Statistics through the yearly-published documents as the National Statistical Yearbook and the Energy Balance and other documents;
- ❖ the characteristics of the institutional arrangements include:
  - ➢ centralized approach – MECC maintain a large degree of control and decision making authority over the inventory preparation process;
  - ➢ in-sourced approach, in majority – the major part of the inventory is prepared by MECC (governmental agency);
  - ➢ single agency – the single national entity is housed within a single governmental organization;
  - ➢ separate approach – the NGHGI related work is not integrated with other air pollutant inventories work; however, cross checking activities are periodically implemented.
- ❖ the institutional arrangements currently used in Romania are presented in the Figure 1.1;
- ❖ in 2011, the NGHGI Land Use, Land-Use Change and Forestry (LULUCF) Sector, both under the UNFCCC and KP, was administrated by the Forest Research and Management Planning Institute (ICAS), based on a contract with Ministry of Environment and Forests, in the context of the study “NGHGI LULUCF both under the UNFCCC and KP obligations”;
- ❖ in 2012-2014 period, the NGHGI LULUCF Sector, both under the UNFCCC and KP, is administrated by ICAS, based on the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS; ICAS also contributed by developing the studies:

- in 2012, “Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations” and “Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations” based on contracts with Ministry of Environment and Forests;
- in 2013, “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting” and “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”.

❖ on an undetermined period, the preparation of Road transport category estimates based on COPERT 4 model is administered also based on the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior;

❖ development of country-specific values associated to several NGHGI sectors has been also supported by the Institute for Studies and Power Engineering (ISPE) through the development of the studies:

- in 2011, “Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”;
- in 2013, “Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation”.

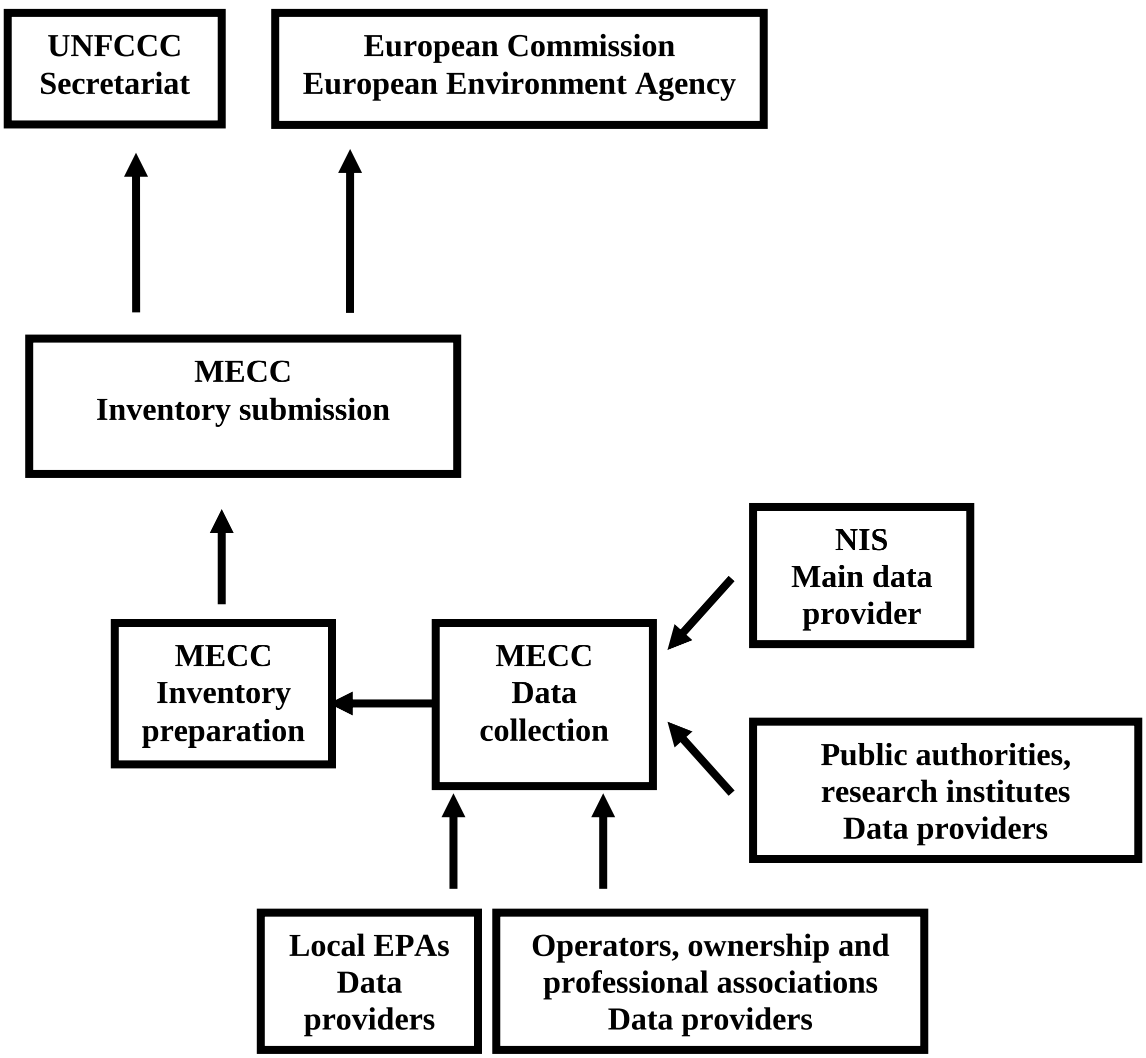
❖ based on the study “Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories:

Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)", Denkstat improved the system of administrating the HFCs, PFCs and SF_6 data and information.

- in 2012, the Environment Agency of Austria-University of Graz consortium, in the context of the study "Environmental Integrated Informational System", implemented by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, supported the improvement of the key category analysis and of the uncertainty analysis;
- the "Support for the implementation of the European Union requirements on the monitoring and reporting of the carbon dioxide (CO_2) and other greenhouse gas emissions" study was carried out in 2011 by the Institute for Studies and Power Engineering (ISPE); specific elements comprise:
  - package 1 activities – improving NS:
    - evaluation of NS and of the relevant technical assistance projects previously implemented;
    - establishing the measures necessary for improving the institutional capacity and structure for implementing the NS- the contractor identified the institutional, legal and procedural measures for assuring the compliance of the NGHGI with the applicable standards, including solutions for improving the sectorial databases;
    - elaboration of draft legal proposals for an efficient administration of the NGHGI. The GD no. 1570/2007 was updated accordingly;
    - general training session for improving the expertise of the personnel working in the climate change field, at the central administration and subsequent level.
  - package 2 activities – developing the institutional capacity for reporting the GHG emissions/removals:
    - evaluation of the Romanian capacity to report the GHG emissions according to the European Union requirements;
    - improving the reporting capacity of the authorities in Romania;
    - specific training session for improving the expertise of NEPA team on the attributions/responsibilities of administrating the NS/NGHGI.

  - package 3 activities-establishing the programs and measures necessary for determining the emission factors and other national relevant parameters.
- during 2011-january 2012, NEPA performed an analysis on improving the institutional and legal arrangements part of the NS;
- the results of previously two specified activities were corroborated and were also used for updating the GD no. 1570/2007;
- the Ministry of Environment and Climate Change officially considers, approves and submits the National GHGI to the UNFCCC Secretariat, the European Commission and the European Environment Agency taking into account the specific deadlines.

Figure 1.1 Current national inventory system description



Legal and procedural arrangements

The legal and procedural framework specific to the NS include:

- GD no. 120/2014 for modifying and completing the GD no. 1570/2007 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals by sinks of all GHGs, regulated through the KP, and also for establishing some measures on implementing the Regulation (EU) no. 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and relealing Decision no. 280/2004/EC and of the Decision no. 166/2005/EC of the European Commission concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol;
- GD no. 48/2013 on the organization and functioning of the Ministry of Environment and Climate Change and for modifying some environment protection and climate change domain related legal acts; it modified also the GD no. 1570/2007;
- GD no. 668/2012 for modifying and completing the GD no. 1570/2007 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals of CO_2 by sinks, regulated through the KP;
- GD no. 1570/2007 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals of CO_2 by sinks, regulated through the KP;
- Ministry of Environment Order (MoEO) no. 1376/2008 for approving the Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review;
- MoEO no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI;
- NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels;
- NEPA's President Decision no. 417/2012 on abrogating the NEPA's President Decision no. 119/2012 (on abrogating the QA/QC Procedure approved through the Decision no.

24/2009 and on approving a updated QA/QC Procedure related to the NGHGI) and on approving a updated QA/QC Procedure related to the NGHGI;

- Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS, on administrating the NGHGI LULUCF Sector both under the UNFCCC and KP;
- Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior, on the preparation of Road transport category estimates based on COPERT 4 model.

B. Ensure sufficient capacity for timely performance of the NS functions, including data collection for estimating anthropogenic GHG emissions by sources and removals by sinks and arrangements for technical competence of the staff involved in the inventory development process

Specific elements include:

- following the 2013 governmental decision on government restructuration, 14 posts are available in the National System for Estimating the GHG Emissions Unit–Climate Change General Directorate in the MECC, exclusively for administrating the NS/NGHGI; the activity continued in an optimal manner, considering also that the attributions and responsibilities have been reallocated to existing personnel;
- following the governmental approval of taking over the NEPA climate change related structure, personnel, attributions and responsibilities, starting with 1 April 2013, 14 people (out of 16 available posts) in the National System for Estimating the GHG Emissions Unit–Climate Change General Directorate in the MECC have exclusively the responsibilities of administrating the NS/NGHGI.

Taking over the NEPA climate change related structure, personnel, attributions and responsibilities by MECC, was performed in order to improve the institutional arrangements and capacity within the climate change domain, thus increasing the efficiency in activities implementation also in respect to the NS/NGHGI administration.

Appropriate working space, facilities and necessary IT equipment were provided to the MECC personnel took over from NEPA.

- following the governmental approval of establishing a new unit at NEPA and as a result of finalization of the recruitment procedure (end of August 2011), 16 people in the National System for Estimating the GHG Emissions Unit–Climate Change and Sustainable Development Directorate had exclusively the responsibilities of administrating the NS/NGHGI (previously, 5 out of maximum 14 people in the Climate Change Unit–Climate Change, Sustainable Development Directorate of NEPA had the responsibilities of administrating the NS/NGHGI while the Climate Change Unit covered also the administration of the European Union Emission Trading Scheme, of the National GHG Emissions Registry and of other climate change domain related issues);
- additionally to the elements presented at second point:
  - appropriate working space and facilities have been provided;
  - the necessary IT equipment has been procured through the support of study "Environmental Integrated Informational System";
  - training the dedicated staff was subject to the UNFCCC training courses and of the study performed in 2011 "Support for the implementation of the European Union requirements on the monitoring and reporting of the carbon dioxide (CO_2) and other greenhouse gas emissions"; additionally, the European Environment Agency (EEA) through the European Topic Centre for Air pollution and Climate change Mitigation provided both in 2011 and 2012 technical assistance to the NS/NGHGI dedicated team;
  - on contractual basis, the NEPA personnel administrating the NGHGI Energy Sector received in 2011 technical assistance from the Environment Agency of Austria, the results being incorporated in the NGHGI 2012;
  - training was based on the Schedule for training of new staff part of the NEPA team dedicated to the administration of the NS and the NGHGI, respectively (Table 1);
  - general training session for improving the expertise of the personnel working in the climate change field, at the central administration and subsequent level, including personnel from NGHGI data/information providers/potential providers, was held in 2011 in the context of the "Support for the implementation of the European Union

requirements on the monitoring and reporting of the carbon dioxide (CO_2) and other greenhouse gas emissions” study;

- training of NEPA team dedicated to the administration of the NS and the NGHGI and of other partners in the NS on key category analysis and uncertainty analysis related issues was also performed in 2012 by the Environment Agency of Austria and University of Graz consortium in the general framework of implementation of the study “Environmental Integrated Informational System” (by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium); additional training on the use of the key category analysis and, respectively, uncertainty analysis related software developed by the Environment Agency of Austria and University of Graz consortium, have been provided to NEPA team by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium in 2013.

❖ based on the GD no. 1570/2007 as ulteriorly modified and completed, all entities/ organizations involved in implementing the NS functions are obliged to ensure sufficient capacity for timely performance of NS functions and arrangements for technical competence of the staff involved in the inventory development process.

Table 1.2 Schedule of training of new staff part of the NEPA team dedicated to the administration of the NS and NGHGI

No.	Activity	Period/ Deadline	Persons subject to training	Responsible persons	Documents to be considered
1.	Improving the technical knowledge based on international and national documents related to the National System for Estimating the Greenhouse Gas Emissions/Removals (NS) and the Greenhouse Gas Inventory (NGHGI)	1 September 2011-10 March 2012	All new Sectorial Experts (SEs)	GHG Inventory coordinator	Governmental Decision (GD) no. 1570/2007, Ministry of Environment Order (MoEO) no. 1376/2008 for approving the Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review; MoEO no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI; NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels; NEPA's President Decision no. 24/2009 for approving the QA/QC Procedure related to the NGHGI, National Inventory Report-Romanian version-NGHGI 2009, NGHGI 2011, 2010, 2009, Updated UNFCCC reporting guidelines on annual
2.	Training in the context of the study "Support for the implementation of the European Union requirements on the monitoring and reporting of the carbon dioxide (CO2) and other greenhouse gas emissions"	31 October 2011	All new SEs	GHG Inventory coordinator	

No.	Activity	Period/ Deadline	Persons subject to training	Responsible persons	Documents to be considered
					inventories following incorporation of the provisions of decision 14/CP.11 (UNFCCC Reporting Guidelines), IPCC good practice guidance (IPCC GPG 2000), IPCC good practice guidance for LULUCF (IPCC GPG 2003), IPCC 1996
3.	On-line UNFCCC Secretariat and GHG Management Institute reviewer training courses	3 October-31 December 2011	All new SEs	GHG Inventory coordinator	UNFCCC Secretariat and GHG Management Institute on-line training courses, IPCC GPG 2000, IPCC GPG 2003, IPCC 1996
4.	Training provided by the - European Environment Agency and European Topic Centre for Air pollution and Climate change Mitigation in respect to Energy, Industrial processes, Solvents and other product use and Waste NGHGI Sectors; - European Commission-Joint Research Centre, in respect to the Agriculture and Land	15 October-31 December 2011	All new SEs	GHG Inventory coordinator	IPCC GPG 2000, IPCC GPG 2003, IPCC 1996

No.	Activity	Period/ Deadline	Persons subject to training	Responsible persons	Documents to be considered
	Use, Land-Use Change and Forestry (LULUCF) Sectors				
5.	Implementing together with the more senior staff, based on a sectorial approach, all activities pertaining to the NS and NGHGI administration, including the activities related to NGHGI preparation plan and NGHGI improvement plan	1 September 2011-10 May 2012	All new SEs	GHG Inventory coordinator, QA/QC coordinator, older SEs	All documents at point 1, as well as other relevant documents

C. Designate a single national entity with overall responsibility for the national inventory

According with the GD no. 1570/2007 as ulteriorly modified and completed, the single national entity with overall responsibility for the national inventory, including with the responsibility of administrating the NS, is MECC.

D. Prepare national annual inventories and supplementary information in a timely manner in accordance with Article 5 and Article 7, paragraphs 1 and 2, and relevant decisions of the COP and/or COP/MOP

Specific elements comprise:

- ❖ as a Party to the UNFCCC, KP and as a Member State of the European Union, Romania annually submits the GHGI;
- ❖ 2014 submission of the NGHGI constitutes the 21st complete submission of the NGHGI of Romania;
- ❖ Romania submits the NGHGI within the relevant deadline: 15 January and 15 March, to the European Commission and to the European Environment Agency, and 15 April, to the UNFCCC Secretariat;
- ❖ the NGHGI is prepared in accordance with Article 5 and Article 7, paragraphs 1 and 2, of the KP, and with relevant decisions of the COP and/or COP/MOP. Beginning with 2010, Romania reports supplementary information required under Article 7, paragraph 1, of the KP within the NGHGI.

E. Provide information necessary to meet the reporting requirements defined in the guidelines under Article 7 in accordance with the relevant decisions of the COP and/or COP/MOP

Romania report information necessary to meet the reporting requirements defined in the guidelines under Article 7 in accordance with the relevant decisions of the COP and/or COP/MOP. Beginning with 2010, Romania reports supplementary information required under Article 7, paragraph 1, of the KP within the NGHGI:

- ❖ information on anthropogenic greenhouse gas emissions by sources and removals by sinks from LULUCF activities under KP's Article 3, paragraphs 3 and 4, in accordance with the provisions in Section I.D of the Annex to Decision 15-CMP. 1;

- ❖ information on Kyoto units (emission reduction units (ERUs), certified emission reductions (CERs), temporary certified emission reductions (tCERs), long-term certified emission reductions (lCERs), assigned amount units (AAUs) and removal units (RMUs)), as set out in Section I.E of the Annex to Decision 15/CMP. 1;
- ❖ changes in national systems in accordance with Article 5, paragraph 1, of the Kyoto Protocol, as set out in Section I.F of the Annex to Decision 15/CMP. 1;
- ❖ changes in national registries as set out in Section I.G of the Annex to Decision 15/CMP. 1;
- ❖ minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol, as set out in Section I.H of the Annex to Decision 15/CMP.

1.2.2. Overview of inventory planning

The elements on the implementation of NS inventory planning specific functions are presented below:

A. Designate a single national entity with overall responsibility for the national inventory

According to the GD no. 1570/2007 as ulteriorly modified and completed, the single national entity with overall responsibility for the national inventory, including with the responsibility of administrating the NS, is MECC.

B. Make available the postal and electronic addresses of the national entity responsible for the inventory

The name and contact information for the national entity and its designated representative with overall responsibility for the national inventory are:

- ❖ national entity:
  - ➢ name: Ministry of Environment and Climate Change;

- address: Bd. Libertăţii no. 12, Sector 5, Bucharest;
- telephone/ fax: +40-21-4089550.

❖ designated representative with overall responsibility:

- name: Sorin Deaconu;
- telephone/fax: +40-21-4089550;
- e-mail: sorin.deaconu@mmediu.ro.

C. Define and allocate specific responsibilities in the inventory development process, including those relating to choice of methods, data collection, particularly activity data and emission factors from statistical services and other entities, processing and archiving, and QC and QA

Elements on defining and allocating specific responsibilities in the inventory development process include:

❖ the roles of, and cooperation between, government organizations and other entities involved in the inventory preparation, are established within the GD no. 1570/2007 as ulteriorly modified and completed;

❖ every person part of MECC team managing the NS/NGHGI has assigned specific/clear attributions/responsibilities comprising (through individual Job fiche):

- sector management;
- implementation of other sector relevant activities:
    - key category analysis;
    - uncertainty analysis;
    - QA/QC;
    - data/information archiving;
    - coordinating the team/activities relevant to the NS/NGHGI administration;
    - coordinating the QA/QC activities;
    - managing the archiving system.

D. *Elaborate an inventory QA/QC plan which describes specific QC procedures to be implemented during the inventory development process, facilitate the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establish quality objectives*

Specific elements comprise:

- ❖ QA/QC plan is part of the QA/QC Programme and of the NEPA's President Decision no. 417/2012 on abrogating the NEPA's President Decision no. 119/2012 (on abrogating the QA/QC Procedure approved through the Decision no. 24/2009 and on approving a updated QA/QC Procedure related to the NGHGI) and on approving a updated QA/QC Procedure related to the NGHGI;
- ❖ QA/QC plan is intended to ensure the fulfillment of the NGHGI principles in Romania.

Main objectives of the plan include:

- ❖ applying greater QC effort for key categories and for those categories where data and methodological changes have occurred recently;
- ❖ periodically checking the validity of all information as changes in reporting, methods of collection or frequency of data collection occur;
- ❖ conducting the general procedures outlined in QC procedures (Tier 1) on all parts of the inventory over a complete exercise.

Detailed specific elements are presented within Section 1.6.

E. *Establish processes for the official consideration and approval of the inventory, including any recalculations, prior to its submission and to respond to any issues raised by the inventory review process under Article 8*

Specific elements for the official consideration and approval of the inventory, including any recalculations, prior to its submission, comprise:

- ❖ defined within the GD no. 1570/2007 as ulteriorly modified and completed and within the MoEO no. 1376/2008;

- ❖ NGHGI verification and evaluation is performed at MECC level;
- ❖ MECC personnel with the attributions and responsibilities of preparing the NGHGI considers the observations and comments received, and as appropriate updates the NGHGI, aiming to its improvement, as soon as possible considering the relevant reporting guidelines.

In respect to the establishment of a process for responding to any issues raised by the inventory review process under Article 8:

- ❖ based on GD no. 1570/2007, as ulteriorly modified and updated, and on MoEO no. 1376/2008 for approving the Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review, MECC ensures the availability of human and financial resources for the implementation of review activities under Article 8 of the KP;
- ❖ MECC ensures an efficient collaboration with the review teams under the coordination of the UNFCCC Secretariat, through the provision of all information and responses to the associated observations and questions, according to the relevant legal provisions.

1.2.3. Overview of inventory preparation and management, including for supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

MECC has also the obligation of the preparation and management of the GHGI; in this sense, the Governmental Decision no. 1570/2007 as ulteriorly modified and completed and the subsequent relevant procedures supports MECC by defining a legal, institutional and procedural framework to involve actively all the relevant responsible public authorities, different research institutes, economic operators, and professional associations.

Central public authorities and the institutions under their authority, in their coordination or subordination, different research institutes, and the economic operators have the responsibility for submitting activity data needed for the GHG emissions/removals calculation.

The main activity data supplier is the National Institute for Statistics (NIS) through the yearly-published documents like the National Statistical Yearbook and the Energy Balance. In 2011 the Forest Research and Management Planning Institute administrated the NGHGI LULUCF Sector, both under the UNFCCC and the KP, based on a contract with MEF, in the context of the implementation of the study “NGHGI LULUCF both under the UNFCCC and KP obligations”; the main activities implemented comprise also:

- preparation of the LULUCF emissions/removals estimates according also with the provisions in the IPCC GPG 2003; consequently, the completion of databases and associated CRF Tables and elaboration of NIR;
- implementing the QC activities;
- documenting associated to the NGHGI LULUCF Sector;
- representing Romania during the annual review coordinated by the UNFCCC Secretariat.

During the period 2012-2014, ICAS is continuing the implementation of activities on administrating the LULUCF Sector, both under the UNFCCC and the KP, based on the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS; ICAS also contributed by developing, in 2012, the studies “Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations”, study concluded with the establishment of methodologies for determining national values for emissions/removals factors, and “Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations” based on contracts with Ministry of Environment and Forests.

In 2013, ICAS further contributed to the determination of country-specific emissions-removals factors, elaborating the study “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting” and contributed further to the compilation of the NGHGI LULUCF Sector through developing the study “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”.

The collection of necessary data/information and the use of appropriate methods for estimating the emissions for the KP Annex A key categories have been significantly improved during 2011 following the implementation by ISPE, based on a contract with the MEF, of the study

"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"; main activities part of the study comprised:

- ❖ collect/process/develop specific data/information in order to support the use of appropriate methods for key categories;
- ❖ document the collected/processed/developed data/information;
- ❖ implement QA/QC checks;
- ❖ provide associated uncertainty values.

ISPE contributed further to the development of country-specific data by developing in 2013 the study , "Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation".

Based on the implementation in 2013 of the study "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)", Denkstat improved the system of administrating the HFCs, PFCs and SF_6 data and information.

On an undetermined period, the preparation of Road transport category estimates based on COPERT 4 model is administered also based on the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior.

The Ministry of Environment and Climate Change submits officially the national GHGI to the UNFCCC Secretariat, the European Commission and the European Environment Agency taking into account the specific deadlines.

Elements relevant to the implementation of the NS specific inventory preparation functions are described below:

A. Identify key source categories following the methods described in the IPCC good practice guidance

Specific elements comprise:

- key category analysis (KCA) is performed according to the provisions in Chapter 7 of IPCC GPG 2000 and Chapter 5 of IPCC GPG 2003, both following the Tier 1 and Tier 2 approach;
- KCA was conducted both considering the exclusion and inclusion of the LULUCF sector and, also, both level and trend criteria;
- all IPCC sectors and categories, sources and sinks (as suggested in Table 7.1 of IPCC GPG 2000 and in Table 5.4.1 of IPCC GPG 2003), and gases were analyzed;
- KCA was conducted for every year of the characterized period;
- KCA was implemented using an integrated software application developed in 2012 by the Environment Agency of Austria-University of Graz consortium, in the context of the study "Environmental Integrated Informational System", implemented by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium; the application allow for:
  - automatic data import from the CRF Reporter application, through the use of CRF tables;
  - integrate both key category and uncertainty analysis performed following both Tier 1 and Tier 2 approach;
  - automatic export of results, data and information, within the relevant reporting templates.
- results are presented in NIR, within:
  - Chapter 1, at general level;
  - Annex 1, using also the guidance and/or template associated with the Tables 7A1-7A3 in IPCC GPG 2000, Tables 5.4.5, 5.4.7 and 5.4.8 of IPCC GPG 2003 and KP-LULUCF CRF table NIR. 3.
- KCA is used for prioritize efforts for improving the quality of the NGHGI-the relevant implemented and future studies refers mainly to the use of higher Tier methods on key categories.

Further elements are presented in Section 1.5.

B. Prepare estimates in accordance with the methods described in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, as elaborated by the IPCC good practice guidance, and ensure that appropriate methods are used to estimate emissions from key source categories

Specific elements comprise:

- emissions from KP Annex A Sectors are estimated following the IPCC 1996, as elaborated by IPCC GPG 2000;
- emissions/removals from LULUCF Sector are estimated following the IPCC GPG 2003;
- estimation methods selection is based on NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels;
- higher estimates/tier estimates and a significant decrease of the number of categories characterized using the NE notation key are available for the majority of Annex A key categories due to:
    - NEPA's/MECC's work;
    - to the implementation of dedicated studies,
        - in 2011, "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation";
        - in 2013, "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)" and "Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater

treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation".

  - to the implementation of the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior.

- development of emission/removal factors, higher estimates/tier estimates and a significant decrease of the number of categories characterized using the NE notation key are available for the LULUCF Sector under the UNFCCC and KP through the implementation of:
  - the studies:
    - in 2011, "NGHGI LULUCF both under the UNFCCC and KP obligations";
    - in 2012, "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" and "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations";
    - in 2013, "Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting" and "Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP".
  - the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS.
- CORINAIR methodology was applied in case of the NGHGI Solvent and Other Product Use Sector.

Further specific elements are presented in Section 1.4.

C. Collect sufficient activity data, process information and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks

Specific elements include:

- steps of data collection:
  - identification of data requirements;
  - identification of potential data suppliers;
  - preparation of specific templates;
  - submitting the requests and templates to the potential suppliers of data;
  - data collection;
  - data verification: activity data received are examined (time series discrepancies, large changes in values from the previous to the current inventory year), and double-checked against similar databases.
- the main activity data provider is the National Institute for Statistics;
- sources of emission factors/increment rates are: national studies, IPCC 1996, IPCC GPG 2000, IPCC GPG 2003, national research institutes and plants, in a limited number;
- data processing is performed according to the GD no. 1570/2007, as ulteriorly amended and completed, and to the MoEO no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI. Primary data processing is mostly carried out by MECC;
- emission factors (EFs) selection is performed according to the provisions in the NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels;
- a significant amount of activity data and emission factors has been collected/ processed/ developed, enabling the development of higher estimates/tier estimates and the significant decrease of the number of categories characterized using the NE notation key for the majority of Annex A key categories, due to:
  - NEPA's/MECC's work;
  - the implementation of dedicated studies:

        - in 2011, “Elaboration/ documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”;
        - in 2013, “Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)” and “Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation”.
    - the implementation of the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior.
- optimizing the informational fluxes on data collection from the operators for the Energy Industries, Manufacturing Industries and Construction categories in the Energy Sector and for the Solid Waste Disposal on Land and Waste Water Handling categories in the Waste Sector was implemented subject to the “Environmental Integrated Informational System” study by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, based on a contract with NEPA;
- a significant amount of activity data and emission factors has been collected/ processed/ developed, enabling the development of higher estimates/ tier estimates and a significant decrease of the number of categories characterized using the NE notation key for the LULUCF Sector, both under the UNFCCC and KP, through the implementation of:
    - the studies:

  - in 2011, "NGHGI LULUCF both under the UNFCCC and KP obligations";
  - in 2012, "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" and "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations";
  - in 2013, "Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting" and "Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP".
- the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS.

Further elements are presented within the Section 1.3.2.

D. Make a quantitative estimate of inventory uncertainty for each source category and for the inventory in total, following the IPCC good practice guidance

Elements specific to the implementation of the NGHGI uncertainty analysis comprise:

- based both on Tier 1 and Tier 2 method according to the provisions in Chapter 6 in the IPCC GPG 2000 and in Chapter 5 in the IPCC GPG 2003;
- performed for 2012, both excluding and including the LULUCF;
- based on national (NIS, "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation", "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of

halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)", "Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation", "NGHGI LULUCF both under the UNFCCC and KP obligations", "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations", "Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting" and "Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP" studies), study on Romanian uncertainty information and data performed in 2012 by the Environment Agency of Austria-University of Graz consortium (uncertainty data have been collected through interviews, based on the collaboration between "Environmental Integrated Informational System" study contractor, Environment Agency of Austria-University of Graz consortium, data providers and NEPA), and default AD and EFs uncertainty sources;

- except the Forest Land remaining Forest Land category, the disaggregation of the inventory into categories is equivalent to the key category analysis splitting;
- was implemented using an integrated software application developed in 2012 by the Environment Agency of Austria-University of Graz consortium, in the context of the study "Environmental Integrated Informational System", implemented by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium; the application allow for:
    - automatic data import from the CRF Reporter application, through the use of CRF tables;
    - integrate both key category and uncertainty analysis performed following both Tier 1 and Tier 2 approach;

- automatic export of results, data and information, within the relevant reporting templates.

❖ results are presented within the NIR, in:

➢ Uncertainties and time series consistency sub-sectorial sections;

➢ in Annex 7.

❖ uncertainty analysis results are used for prioritize efforts for improving the quality of the NGHGI-in the implementation of progresses, highest priority is attributed to categories having associated high uncertainty level.

Further elements are provided within the Section 1.7.

E. Ensure that any recalculations of previously submitted estimates of anthropogenic GHG emissions by sources and removals by sinks are prepared in accordance with the IPCC good practice guidance and relevant decisions of the COP and/or COP/MOP

The elements associated to the implementation of recalculations comprise:

❖ based on IPCC GPG 2000 and on IPCC GPG 2003, Romania implemented significant recalculations in order to account for better AD and/or EFs, mainly based on:
  - NEPA's/MECC's work;
  - on the studies implemented:
    - in 2011, "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation" and "NGHGI LULUCF both under the UNFCCC and KP obligations";
    - in 2012, "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations";
    - in 2013, "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier

methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)", "Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation", "Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting" and "Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP".

- on the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior, and on the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS.

❖ the recalculations resulted in significant increase of the accuracy, completeness and consistency of data series;

❖ the recalculations are presented in NIR in:

➢ Source-specific recalculations, including changes made in response to the review process sub-sectorial sections, including the quantified impact;

➢ Chapter 10 Recalculations.

F. Compile the national inventory in accordance with Article 7, paragraph 1, and relevant decisions of the COP and/or COP/MOP

Specific elements on the compilation of the national inventory include:

- ❖ NGHGI has been compiled based on Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11 (UNFCCC Reporting Guidelines);
- ❖ beginning with the 2010 submission, the NIR is compiled according to the recommendations for inventories set out in the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol;
- ❖ all additional reporting elements under Article 7 paragraph 1 of the KP are reported, beginning with the 2010 submission.

G. Implementing the QA/QC and verification procedures in accordance with its QA/QC plan following the IPCC good practice guidance

The elements specific to the implementation of QA/QC procedures are:

- ❖ the QA/QC Programme and the QA/QC Procedure comprise information on:
  - ➢ the national authority responsible for the coordination of QA/QC activities;
  - ➢ the objectives envisaged within the QA/QC framework;
  - ➢ the QA/QC Plan;
  - ➢ the QC procedures;
  - ➢ the QA procedures.
- ❖ according to the GD no. 1570/2007 as ulteriorly modified and completed establishing the national system and to those in the NEPA’s President Decision no. 417/2012 on abrogating the NEPA’s President Decision no. 119/2012 (on abrogating the QA/QC Procedure approved through the Decision no. 24/2009 and on approving a updated QA/QC Procedure related to the NGHGI) and on approving a updated QA/QC Procedure related to the NGHGI, MECC represents the competent authority responsible with the implementation of the QA/QC activities;
- ❖ the QA/QC coordinator is designated by MECC;
- ❖ QC activities were implemented:
  - ➢ by every sectorial expert during all phases of inventory preparation;
  - ➢ by NGHGI improvement studies contractors

- in 2011, “Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation” and “NGHGI LULUCF both under the UNFCCC and KP obligations”;
- in 2012, “Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations”;
- in 2013, “Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)”, “Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation”, “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting” and “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”.

➢ documented within sectorial QC lists consistently used across the dedicated NS/NGHGI dedicated team;

➢ greater effort was applied to key categories.

❖ QA activities:

➢ NGHGI was subject to the annual internal review under EU-Monitoring Mechanism;

  - ➢ in 2012, NGHGI was reviewed under the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020;
  - ➢ involvement of third party reviewers in the context of developing studies for NGHGI quality improvement;
  - ➢ based on previous bilateral cooperation;
  - ➢ based on annual review process under Article 8 of the KP.
- ❖ verification-where available, national versus international datasets are compared (e.g. comparison of national with Food and Agriculture Organization data);
- ❖ NGHGI improvement plan is annually updated by the QA/QC coordinator based on the results of the previously mentioned checks; the NGHGI improvement plan is linked with the NGHGI preparation plan administered by the NGHGI coordinator;
- ❖ greater effort was applied to the implementation of sector-specific QC, QA and verification activities.

Further relevant information is presented under Section 1.6.

Elements characterizing the implementation of the NS inventory management related functions are described below:

A. Archive inventory information for each year in accordance with relevant decisions of the COP and/or COP/MOP

Elements specific to the archiving of NGHGI data/information include:

- ❖ the activities are implemented based on the GD no. 1570/2007, as ulteriorly modified and completed, and on the MoEO no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI;
- ❖ both electronic and paper documentation, as far as needed to reconstruct and interpret inventory data and to describe the national system and its functions, is archived;

- ❖ the archive is managed by MECC and accessible at a single location at the MECC's headquarters in Bucharest;
- ❖ all information officially submitted is available in English, while not all background information is available in English;
- ❖ security of databases and confidentiality of the background data, both for electronic and paper data, are ensured through implementation of restricted access conditions;
- ❖ MECC designated the manager of the archiving system.

More relevant detailed elements are provided within Section 1.3.2.

B. Provide review teams under Article 8 with access to all archived information used by the Party to prepare the inventory, in accordance with relevant decisions of the COP and/or COP/MOP

Based on GD no. 1570/2007, as ulteriorly modified and completed, and on MoEO no. 1376/2008 for approving the Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review, MECC is providing review teams under Article 8 of KP with access to all archived information used to prepare the inventory, in accordance with relevant decisions of the COP and/or COP/MOP.

C. Respond to requests for clarifying inventory information resulting from the different stages of the review process of the inventory information, and information on the national system, in a timely manner in accordance with Article 8

Relevant elements comprise:

- ❖ based on GD no. 1570/2007, as ulteriorly modified and completed, and on MoEO no. 1376/2008 for approving the Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review, MECC ensures the availability of human and financial resources for the implementation of review activities under Article 8 of the KP;

- ❖ MECC ensures an efficient collaboration with the review teams under the coordination of the UNFCCC Secretariat, through the provision of all information and responses to the associated observations and questions, according to the relevant legal provisions.

1.3. Inventory preparation

1.3.1. GHG inventory and KP-LULUCF inventory

The present NIR was compiled according to the recommendations for inventories set out in the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol and includes detailed information on the inventories for all years from the base year to the year 2012, in order to ensure the transparency of the inventory. The emissions are estimated using the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1996), as well as the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC GPG 2000) and IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC GPG 2003).

According to the Governmental Decision no. 1570/2007 establishing the National System for the estimation of the GHG emissions levels from sources and removals by sinks, as ulteriorly modified and completed, the implementation of the National System ensures the NGHGI quality in three phases:

- ❖ planning;
- ❖ preparation;
- ❖ management of the NGHGI preparation activities.

1.3.2. Data collection, processing and storage, including for KP-LULUCF inventory

Data collection

Data collection process comprises the following steps:

- ❖ identification of data requirements;
- ❖ identification of potential data suppliers;

- preparation of specific questionnaires;
- submitting the questionnaires to the potential suppliers of data;
- data collection;
- data verification: activity data received are examined (time series discrepancies, large changes in values from the previous to the current inventory year).

Emission factors selection is performed according to the provisions in the NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels.

A significant amount of activity data and emission factors has been collected/ processed/ developed, enabling the development of higher estimates/tier estimates and the significant decrease of the number of categories characterized using the NE notation key for the majority of Annex A key categories, due to:

- NEPA's/MECC's work;
- the implementation of dedicated studies:
  - in 2011, "Elaboration/ documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation";
  - in 2013, "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)" and "Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation".
- the implementation of the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and

Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior.

A significant amount of activity data and emission factors has been collected/ processed/ developed, enabling the development of higher estimates/ tier estimates and a significant decrease of the number of categories characterized using the NE notation key for the LULUCF Sector, both under the UNFCCC and KP, through the implementation of:

- the studies:
    - in 2011, “NGHGI LULUCF both under the UNFCCC and KP obligations”;
    - in 2012, “Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations” and “Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations”;
    - in 2013, “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting” and “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”.
- the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS.

Optimizing the informational fluxes on data collection from the operators for the Energy Industries, Manufacturing Industries and Construction categories in the Energy Sector and for the Solid Waste Disposal on Land and Waste Water Handling categories in the Waste Sector was implemented subject to the “Environmental Integrated Informational System” study by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, based on a contract with NEPA.

Data processing and emissions/removals calculation

Data processing is done according to the provisions in the Ministry of Environment Order no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI. Primary data processing is mostly carried out by MECC.

Activities were carried out mostly at MECC, and at ISPE, ICAS and Denkstat, as contractors of studies:

- in 2011,
  - "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation";
  - "NGHGI LULUCF both under the UNFCCC and KP obligations".
- in 2012,
  - "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations";
  - "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations".
- in 2013,
  - "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)";
  - "Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation";

- “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting”;
- “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”.

Specific activities comprise:

- primary data processing;
- check the completeness of all data and information for all years and categories within the analyzed period;
- complete the datasets, using also default IPCC interpolation/extrapolation and/or alternative techniques;
- check the accuracy and consistency of datasets;
- values transformation in order to reach the measurement unit adequate within the method used;
- data aggregation/disaggregation considering the IPCC classification;
- calculation and/or adjustment of different parameters considering the available data.
- selection of the emission factors and of the methods;
- application of methods;
- emissions/removals estimates, using the most recent data;
- internal review (errors are rectified);
- preparation of the national inventory report.

Activities previously presented are also implemented within the collaboration between:

- MECC, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Internal Affairs, in the framework of the Protocol of collaboration no. 3136/MMP/9.07.2012, on preparation of Road transport category estimates based on COPERT 4 model;
- MECC, NEPA and ICAS, in the framework of the Protocol of collaboration no. 3029/MMP-RP/3.07.2012, on administrating by ICAS of the LULUCF Sector, both under UNFCCC and KP.

Data archive

Data archiving is done according to the provisions of the Ministry of Environment Order no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI.

MECC team manages and maintains the NGHGI database and the documentation of specific inventory information. According to the provisions in IPCC GPG 2000, the NGHGI documentation includes:

- ❖ assumptions and criteria for selection of AD and EF;
- ❖ EF used, including references to the IPCC documents for default factors or to published references or other documentation for emission factors used in higher tier methods;
- ❖ AD or sufficient information to enable activity data to be traced to the referenced source;
- ❖ information on the uncertainty associated with AD and EF;
- ❖ rationale for choice of methods;
- ❖ methods used, including those used to estimate uncertainty;
- ❖ changes in data inputs or methods from previous years;
- ❖ identification of individuals providing expert judgment for uncertainty estimates and their qualifications to do so;
- ❖ details of electronic databases or software used in production of the inventory, including versions, operating manuals, hardware requirements and any other information required to enable their later use;
- ❖ worksheets and interim calculations for category estimates and aggregated estimates and any recalculations of previous estimates;
- ❖ final inventory report and any analysis of trends from previous years;
- ❖ QA/QC plans and outcomes of QA/QC procedures.

All inventory information, as far as needed to reconstruct and interpret inventory data and to describe the national system and its functions, is accessible at a single location at the MECC's headquarters in Bucharest. While all information officially submitted according to the requirements of the Kyoto Protocol is translated into English, this is not possible for all background information made available during the review process as the official inventory documentation language is Romanian.

Specific NGHGI data are archived as follows:

- electronically – all available documents;
- on paper – the documents used for the NGHGI preparation unavailable in electronic format and the correspondence with different organizations.

In order to ensure the security of databases and the confidentiality of the background data, both paper and electronic data are kept under restricted access conditions. Furthermore, electronic data backup activities are undertaken on MECC's server with daily frequency during the generation of the official submission and weekly in rest of cases.

Considering the provisions of relevant regulations, MECC designated the manager of the archiving system.

1.3.3. QA/QC procedures and extensive review of GHG inventory and KP-LULUCF inventory

Romania established the QA/QC Procedure based on the UNFCCC and Kyoto Protocol's provisions related to the NGHGI and the NS, the IPCC 1996 and IPCC GPG 2000 provisions, and on the Governmental Decision no. 1570/2007 establishing the National System for the estimation of the anthropogenic GHG emissions levels from sources and removals by sinks, as ulteriorly modified and completed. QA/QC activities are both described within the QA/QC Programme (attached as Annex 6.1.2) and within the QA/QC Procedure related to the NGHGI, approved by the NEPA's President Decision no. 417/2012.

Further information is provided within Section 1.6.

1.4. Brief general description of methodologies and data sources used

1.4.1. GHG inventory

Estimation methods selection is done according to the provisions in the NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels. The emissions from KP Annex A Sectors are estimated following the IPCC 1996, as elaborated by IPCC GPG 2000.

Emissions/removals from LULUCF Sector are estimated using IPCC GPG 2003. CORINAIR methodology was applied in case of the NGHGI Solvent and Other Product Use Sector.
The main data sources used for activity data are presented within the following table.

Table 1.3 Main activity data sources

Sector	Data sources
Energy	National Institute for Statistics - Energy Balance Energy producers Ministry of Economy Romanian Civil Aviation Authority Transgaz SA National Authority on Regulating in Energy National Agency for Mineral Resources
Industrial Processes	National Institute for Statistics- Statistical Yearbook and other data sources Industrial operators through 42 Local/Regional Environmental Protection Agencies Direct information from industrial operators
Solvent and other product use	National Institute for Statistics Industrial operators through 42 Local/Regional Environmental Protection Agencies
Agriculture	National Institute for Statistics
LULUCF	National Institute for Statistics through Statistical Yearbook Ministry of Agriculture, Forests and Rural Development (MADR)-Forests General Directorate (2007-2008); Ministry of Environment and Forests-Forests General Directorate (2009-2011); MECC-Department for Waters, Forests and Fish Faming (2012) National Forest Administration (RNP)
Waste	National Institute for Statistics National Environmental Protection Agency Public Health Institute National Administration “Romanian Waters”

Sector	Data sources
	Food and Agriculture Organization Landfill operators through 42 Local/Regional Environmental Protection Agencies

A significant amount of activity data and emission factors has been also collected/processed/ developed through:

- ❖ the NEPA's/MECC's work and the implementation by ISPE, ICAS and Denkstat, of the studies:
  - ➢ in 2011,
    - ➢ "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation";
    - ➢ "NGHGI LULUCF both under the UNFCCC and KP obligations".
  - ➢ in 2012,
    - ➢ "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations";
    - ➢ "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations".
  - ➢ in 2013,
    - ➢ "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)";
    - ➢ "Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to

their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation”;

- “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting”;
- “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”.

❖ the implementation of the:

- Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior, on the preparation of Road transport category estimates based on COPERT 4 model;
- Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS, on administrating the LULUCF Sector, both under the UNFCCC and the KP.

The sources of the emission factors/increment rates used are: national studies, IPCC 1996, IPCC GPG 2000, IPCC GPG 2003, national research institutes and plants, in a limited number.

Higher estimates/tier estimates and a significant decrease of the number of categories characterized using the NE notation key are available for the majority of Annex A key categories have been achieved, due to:

- NEPA’s/MECC’s work;
- the implementation of dedicated studies:
  - in 2011, “Elaboration/ documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”;
  - in 2013, “Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and

SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)".

- the implementation of the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior.

Higher estimates/tier estimates and a significant decrease of the number of categories characterized using the NE notation key for the LULUCF Sector, both under the UNFCCC and KP, have been achieved through the implementation of:

- the studies:
  - in 2011, "NGHGI LULUCF both under the UNFCCC and KP obligations";
  - in 2012, "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" and "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations";
  - in 2013, "Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting" and "Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP".
- the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS.

Optimizing the informational fluxes on data collection from the operators for the Energy Industries, Manufacturing Industries and Construction categories in the Energy Sector and for the Solid Waste Disposal on Land and Waste Water Handling categories in the Waste Sector was implemented subject to the "Environmental Integrated Informational System" study by the SC

Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, based on a contract with NEPA.

1.4.2. KP-LULUCF activities

The data relevant to the KP LULUCF activities are presented within the Chapter 11.

1.5. Brief description of key categories, including KP-LULUCF key categories

1.5.1. GHG inventory

The key category analysis has been performed according to the provisions in Chapter 7 of IPCC GPG 2000 and Chapter 5 of IPCC GPG 2003, both following the Tier 1 and Tier 2 approach.
Separate key category analysis were conducted taking into account both the exclusion and inclusion of the LULUCF sector and also both level and trend criteria; all IPCC sectors and categories, sources and sinks (as suggested in Table 7.1 of IPCC GPG 2000 and in Table 5.4.1 of IPCC GPG 2003), and gases were analyzed. KCA was conducted for every year of the characterized period.
KCA was implemented using an integrated software application developed in 2012 by the Environment Agency of Austria-University of Graz consortium, in the context of the study "Environmental Integrated Informational System", implemented by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium; the application allow for:

- automatic data import from the CRF Reporter application, through the use of CRF Tables;
- integrate both key category and uncertainty analysis performed following both Tier 1 and Tier 2 approach;
- automatic export of results, data and information, within the relevant reporting templates.
- templates.
- templates.

Taking into account the Tier 1 analysis and the exclusion of the LULUCF sector, in 2012:

- 31 categories are considered as key ones both by level and trend;

- ❖ 45 categories are considered as key ones, only by level;
- ❖ 36 categories are considered as key ones, only by trend.

Taking into account the Tier 1 analysis and the inclusion of the LULUCF sector, in 2012:

- ❖ 33 categories are considered as key ones, both by level and trend;
- ❖ 49 categories are considered as key ones, only by level;
- ❖ 40 categories are considered as key ones, only by trend.

Taking into account the Tier 2 analysis and the exclusion of the LULUCF sector, in 2012:

- ❖ 25 categories are considered as key ones both by level and trend;
- ❖ 28 categories are considered as key ones, only by level;
- ❖ 36 categories are considered as key ones, only by trend.

Taking into account the Tier 2 analysis and the inclusion of the LULUCF sector, in 2012:

- ❖ 27 categories are considered as key ones, both by level and trend;
- ❖ 30 categories are considered as key ones, only by level;
- ❖ 39 categories are considered as key ones, only by trend.

The following categories were identified as key categories following the Tier 2 analysis and additionally to the Tier 1 related key categories:

- ❖ Oil-CO_2 emissions (IPCC category 1.B.2.a);
- ❖ Solvent and Other Product Use-CO_2 emissions (IPCC category 3);
- ❖ Residential-biomass-N_2O emissions (IPCC category 1.A.4.b);
- ❖ Other AWMS-N_2O emissions (IPCC category 4.B.14);
- ❖ Electrical Equipment-SF_6 emissions (IPCC category 2.F.8).

All identified key categories are presented in Table 1.4.

Table 1.4 Key categories associated with the 2014 NGHGI

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2012) Estimate Ex,t
1 A 1 a liquid	Public Electricity and Heat Production	CO_2	995
1 A 1 a solid	Public Electricity and Heat Production	CO_2	22.403
1 A 1 a gaseous	Public Electricity and Heat Production	CO_2	5.616
1 A 1 b liquid	Petroleum refining	CO_2	1.423
1 A 1 b gaseous	Petroleum refining	CO_2	561
1 A 1 c liquid	Manufacture of Solid fuels and Other Energy Industries	CO_2	701
1 A 1 c solid	Manufacture of Solid fuels and Other Energy Industries	CO_2	4
1 A 1 c gaseous	Manufacture of Solid fuels and Other Energy Industries	CO_2	686
1 A 2 a solid	Iron and Steel	CO_2	1.960
1 A 2 a gaseous	Iron and Steel	CO_2	1.055
1 A 2 c liquid	Chemicals	CO_2	579
1 A 2 c gaseous	Chemicals	CO_2	2.468

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2012) Estimate Ex,t
1 A 2 e gaseous	Food Processing, Beverages and Tobacco	CO_2	727
1 A 2 f liquid	Other	CO_2	2.211
1 A 2 f solid	Other	CO_2	2.356
1 A 2 f gaseous	Other	CO_2	2.870
1 A 3 b gasoline	Road Transportation	CO_2	4.253
1 A 3 b diesel oil	Road Transportation	CO_2	9.617
1 A 3 c liquid	Railways	CO_2	567
1 A 3 d residual oil	Navigation	CO_2	-
1 A 4 a gaseous	Commercial/Institutional	CO_2	1.778
1 A 4 b liquid	Residential	CO_2	524
1 A 4 b solid	Residential	CO_2	91
1 A 4 b gaseous	Residential	CO_2	5.919
1 A 4 c liquid	Agriculture/Forestry/Fisheries	CO_2	975

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2012) Estimate Ex,t
1 A 4 c gaseous	Agriculture/Forestry/Fisheries	CO_2	174
1 A 5 a liquid	Stationary	CO_2	558
1 A 5 a solid	Stationary	CO_2	-
1 B 2 a	Oil	CO_2	387
2 A 1	Cement Production	CO_2	3.150
2 A 2	Lime Production	CO_2	1.281
2 A 3	Limestone and Dolomite Use	CO_2	431
2 B 1	Ammonia Production	CO_2	2.728
2 C 1	Iron and Steel Production	CO_2	2.185
3	SOLVENT AND OTHER PRODUCT USE	CO_2	128
5 A 1	Forest land remaining forest land	CO_2	-19.482
5 A 2	Land converted to forest land	CO_2	-3.034
5 B 1	Cropland remaining cropland	CO_2	-1.661

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2012) Estimate Ex,t
5 C 1	Grassland remaining Grassland	CO_2	358
5 D 2	Land converted to Wetlands	CO_2	1.750
5 E 2	Land converted to Settlements	CO_2	422
5 F 2	Land converted to Other land	CO_2	877
1 A 4 b biomass	Residential	CH_4	866
1 B 1 a	Coal Mining	CH_4	810
1 B 2 a	Oil	CH_4	2.242
1 B 2 b	Natural gas	CH_4	3.141
1 B 2 c Venting	Venting	CH_4	1.101
4 A 1	Cattle	CH_4	3.199
4 A 3	Sheep	CH_4	3.682
4 A 4	Goats	CH_4	455
6 A	SOLID WASTE DISPOSAL ON LAND	CH_4	2.966

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2012) Estimate Ex,t
6 B	WASTEWATER HANDLING	CH_4	2.261
1 A 4 b biomass	Residential	N_2O	170
2 B 2	Nitric Acid Production	N_2O	953
4 B 13	Solid Storage and Dry Lot	N_2O	777
4 B 14	Other AWMS	N_2O	418
4 D 1	Direct Soil Emissions	N_2O	4.630
4 D 2	Pasture, Range and Paddock Manure	N_2O	834
4 D 3	Indirect Emissions	N_2O	2.788
6 B	WASTEWATER HANDLING	N_2O	614
2 F 1	Refrigeration and Air Conditioning Equipment	HFC	986
2 C 3	Aluminium production	PFC	6
2 F 8	Electrical Equipment	SF_6	41

The results of the key category analysis for 1989 and 2012 are presented in NIR within:

- ❖ Chapter 1, at general level;
- ❖ Annex 1, using also the guidance and/or template associated with the Tables 7A1-7A3 in IPCC GPG 2000, Tables 5.4.5, 5.4.7 and 5.4.8 of IPCC GPG 2003 and KP-LULUCF CRF Table NIR. 3.

KCA is used for prioritize efforts for improving the quality of the NGHGI-the relevant implemented and future studies referring mainly to the use of higher Tier methods in key categories; the KCA results were considered within activities part of the Romanian inventory improvement plan (including the prioritization plan for moving to higher tier methods for key categories) – 2013-20134– May 2013 (attached as Annex 6.1.3).

1.5.2. KP-LULUCF activities

The identification of the KP LULUCF key categories followed the procedure described within the Chapter 5 of the IPCC GPG 2003.

The data/information relevant to the KP LULUCF activities is presented within the NIR as part of Annex 1 and Chapter 11.

1.6. Information on the QA/QC plan including verification and treatment of confidentiality issues

1.6.1. QA/QC procedures

The QA/QC Programme and the QA/QC Procedure comprise information on:

- ❖ the national authority responsible for the coordination of QA/QC activities;
- ❖ the objectives envisaged within the QA/QC framework;
- ❖ the QA/QC Plan;
- ❖ the QC procedures;
- ❖ the QA procedures.

According to the provisions of the Governmental Decision no. 1570/2007 establishing the national system, as ulteriorly modified and completed, and to those in the NEPA’s President

Decision no. 417/2012, MECC represents the competent authority responsible with the implementation of the QA/QC activities under the NGHGI.

For this purpose, MECC is performing the following activities:

- ensures that specific QA/QC objectives are established;
- develops and regularly updates a QA/QC plan;
- implements the QA/QC procedures.

Considering the provisions of relevant regulations, MECC designated a QA/QC coordinator.

The overall objective of the QA/QC Programme is to develop the NGHGI in line with the requirements of the IPCC 1996, IPCC GPG 2000 and IPCC GPG 2003 and with the provisions of the Regulation no. 525/2013 of the European Parliament and of the Council and of the Decision 166/2005/EC of the European Commission.

Romania's QA/QC plan closely follows the definitions, guidelines and processes presented in Chapter 8 – Quality Assurance and Quality Control of the IPCC GPG 2000. The QA/QC plan constitutes the heart of the QA/QC procedures. It outlines the current and planned QA/QC activities. The specific QA/QC activities are performed during all stages of the inventory preparation.

The QA/QC plan is reviewed periodically, if needed, and can be modified as appropriate when changes in processes occur or based on the advice from independent reviewers.

The QA/QC plan is intended to ensure the fulfillment of the NGHGI principles in Romania. The objectives of the plan include:

- applying greater QC effort for key categories and for those categories where data and methodological changes have occurred recently;
- periodically checking the validity of all information as changes in reporting, methods of collection or frequency of data collection occur;
- conducting the general procedures outlined in QC procedures (Tier 1) on all parts of the inventory over a complete exercise;
- balancing efforts between development and implementation of QA/QC procedures and continuous improvement of inventory estimates;
- customizing the QC procedures to the resources available and the particular characteristics of Romania's greenhouse gas inventory;

- ❖ confirming that the national statistical institute and other agencies supplying activity data to MECC have implemented QC procedures.

QC activities

QC activities were implemented by every sectorial expert during all phases of inventory preparation, greater effort being applied to key categories.

The following QC activities are conducted annually before and during the preparation of estimates (15 September-30 October):

- ❖ checking the specific requirements regarding the reporting deadlines;
- ❖ verification of the collection of data against the information needed;
- ❖ checking the correct transcription of input data from the format they were provided into the calculation sheets;
- ❖ checking the correctness of conversion factors to be used in calculation;
- ❖ checking the data structures integrity and the disaggregation of activity data at calculation sheets level;
- ❖ checking the concordance between the measurement units of data in the calculation sheets and the equivalent data in the CRF Reporter format;
- ❖ checking the consistency and the data values magnitude order used in the AD and EF series, at the calculation sheets level;
- ❖ identifying parameters common to multiple source or sink categories and checking the values consistency between source or sink categories;
- ❖ checking the emissions/removals calculation into the calculation sheets by reproducing a representative sample calculation;
- ❖ checking the correctness of the aggregation of estimated emissions/removals at the calculation sheets level.

The following QC activities are conducted annually during and after the preparation of estimates (15 October -10 January-10 March):

- ❖ checking the emissions/removals estimates existence for all sources and sinks and for the entire time series;
- ❖ checking the explanations existence when the emissions/removals estimates are lacking;

- ❖ checking the correctness and consistency of choosing the AD, EF and methods used along the entire time series;
- ❖ checking the trends for identifying the outliers and re-analyze the values;
- ❖ checking the correctness of recalculations and the existence of explanations;
- ❖ checking the recording and archiving of AD, EF and methods used;
- ❖ checking the correctness and the completeness of the data transcription from the calculation sheets level to the CRF Reporter level;
- ❖ checking the correctness and the completeness of the data transcription from the CRF Reporter level to the CRF tables level;
- ❖ checking the data used in the NIR against the CRF tables and calculation sheets;
- ❖ checking the correctness of applied methods descriptions, at the NIR's level;
- ❖ checking the references completeness at the NIR's level;
- ❖ checking the archiving of the CRF tables, NIR, CRF Reporter's specific databases and the calculation sheets;
- ❖ checking the key categories persistency along the time series;
- ❖ checking the adequate qualification of individuals providing expert judgments on the uncertainty estimates and the archiving of documentation regarding the qualification and the expert judgments;
- ❖ checking the uncertainty calculation correctness by partially replying the Monte Carlo analysis;
- ❖ verification of the ERT recommendations implementation;
- ❖ checking the completeness of the QA/QC documentation archiving: QA/QC programme, checklists, ERT report, improvements lists;
- ❖ checking the QA/QC Programme performance and propose improvements.

Within the specified deadlines, the previously mentioned activities are performed at sectorial level. Based on specific sectorial responsibilities allocated within the sector, the QC checks are performed for certain category by a sectorial expert not being involved in the administration, including estimating emissions/removals, of that category (cross-checking approach).

The results of all checks outlined above are documented in the annual QC checklists for inventory preparation. For this purpose QC checklists are used consistently throughout the years by all experts involved in the inventory preparation.

Additionally, QC activities were performed by the study contractors implementing the NGHGI improvement studies:

- in 2011,
  - "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation";
  - "NGHGI LULUCF both under the UNFCCC and KP obligations".
- in 2012,
  - "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations";
  - "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations".
- in 2013,
  - "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)";
  - "Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation";
  - "Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting";
  - "Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP".

QA activities

By becoming an European Union Member State from the 1st of January 2007, Romania has the obligation to prepare and submit the NGHGI according to the Regulation no. 525/2013 of the European Parliament and of the Council and to the Decision 166/2005/EC of the European Commission, which provides for a QA activity after the first submission of data on 15th of January and a final QA for all 28 EU Member States during first half of March, for the preparation of the EC inventory. In this respect, starting with 2007, Romania has the possibility to verify the inventory twice before the official submission to the UNFCCC Secretariat.

In order to get an objective assessment of the inventory quality and for identifying areas where improvements can be made, MECC involve third party reviewers at the QA activities level according to the provisions in IPCC-GPG, depending on the availability of resources. In this scope, MECC is developing the specific procedural arrangements. MECC through its international contacts and bilateral agreements identifies the available processes for ensuring the implementation of QA activities.

Until now, NEPA was the beneficiary of technical support provided by the Austrian Environment Agency (as part of the twinning project RO/2006/IB/EN/09). One of the most important activities performed within this framework was the review of different sectors of the NGHGI. Austrian experts provided specific recommendations comprising:

- improvement of transparency at sectorial level considering the trend and recalculations description;
- improvement of transparency at sectorial level by providing a cumulative table on the status of emissions/removals estimation for every sub-sector;
- improvement on knowledge on practical ways of performing and documenting the QA/QC activities;
- improvement of the NGHGI archiving structure.

Until first half of 2011, NGHGI team was the beneficiary of a Netherlands Government to Government (G2G) project. One of its main aims is to develop the reporting capacity of the NGHGI team also by assessing the possibility to use higher tier methods. Specific activities comprised:

- ❖ advices on improving the NGHGI sectorial data documentation (through the use of the documentation list);
- ❖ training courses/presentations on use of data specific to other reporting mechanisms at the GHG Inventory level:
  - ➢ use of ETS data;
  - ➢ use of COPERT model.
- ❖ discussions/advices on methodological issues (data collection, emissions estimation) on GHG emissions recovery within the Industrial Processes and Waste activities;
- ❖ advices on moving to higher Tier levels in the Energy Sector:
  - ➢ calculation of specific emission factors;
  - ➢ use of COPERT model in estimating the Road Transport emissions.
  - ➢ advices on using national data for the calculation of natural gas transit fugitive emissions;
  - ➢ advices on moving on Tier 2 at the Enteric Fermentation, Manure Management and Agricultural Soils levels:
    - precise identification of activity data needs;
    - workshop on elaborating the specific requirements for a emission factors/other parameters study development;
    - other relevant advices.
- ❖ advices on moving on First Order Decay method at the Solid Waste Disposal Sites level;
- ❖ other advices relevant to the Waste Sector;
- ❖ identification of the practical ways to complete the estimation of emissions/ removals specific to Kyoto Protocol’s Art. 3.3 and 3.4 activities: afforestation/ reforestation/ deforestation, forest management and revegetation.

QA activities were also performed, according to the relevant provisions in IPCC GPG 2000, in the context of elaboration of the NGHGI improvement studies:

- ❖ in 2011,
  - o “Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”.

- in 2013,
    - “Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)”;
    - “Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation”;
    - “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting”;
    - “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”.

Additionally, in 2012, the NGHGI has been subject to a thorough review within the European Union, review under the Decision 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions to meet the Community’s greenhouse gas emission reduction commitments up to 2020.

National inventory submissions to the UNFCCC Secretariat are subject to the review under Article 8 of the Kyoto Protocol and procedures defined in the relevant COP/MOP decisions.

All recalculations planned and done (including those following the UNFCCC ERT review) are mentioned in the improvements lists.

The results of QA checks (excepting those of checks performed under Regulation no. 525/2013, Decisions 166/2005/EC and 406/2009/EC and, respectively, by ERT) are documented in the annual QA checklists for inventory preparation. For this purpose, QA checklists are used consistently throughout the years by all inventory experts involved in the inventory compilation.

1.6.2. Verification activities

Several verification activities were performed by the NGHGI team, as follows:

- ❖ Energy – comparison of activity data used with Eurostat equivalent data; additionally, comparison of country-specific CO_2 emission factors values with equivalent data in the NGHGI of Bulgaria;
- ❖ Agriculture - comparison of data sets used with relevant FAO and, respectively, Eurostat data; additionally, country-specific parameters were compared with similar parameters in the Bulgarian and Hungarian NGHGI and, respectively, with default parameters;
- ❖ Waste – comparison of data sets used with Eurostat and FAO data.

All verification activities are described in detail within the sectorial Category-specific QA/QC and verification sections.

1.6.3. Treatment of confidentiality issues

Due to the confidentiality clause assigned to some activity data on Industrial Processes activities, also in the Statistical Law context, all specific measures have been taken in this sense.
All aspects pertaining to assuring the data confidentiality are described within the Methodological issues sections of the relevant categories.

Greater effort has been applied to the implementation of sector-specific QC, QA and verification activities; the following sector-specific QC, QA and verification activities are conducted annually before, during and after the preparation of estimates:

- ❖ intra-sectoral activities
    - ➢ automated data validation within the Excel model-validation is implemented on the consideration of any activity data value provided through the Energy Balance and concerning an inventory specific activity, and on the range of the determined country-specific emission factors as defined within the relevant IPCC methodologies; the model is directly linked to the International Energy Agency and Eurostat versions

of the Energy Balance provided by the National Institute for Statistics and to the determination of the country-specific or default emission factors spreadsheets (Energy Sector-Stationary Combustion Subsector and Reference Approach);

- manual checks on all spreadsheets part of the model presented at the previous point (Energy Sector-Stationary Combustion Subsector and Reference Approach);
- manual checks on all spreadsheets on renewable fuel combustion; the spreadsheets are directly linked to the International Energy Agency and Eurostat versions of the Energy Balance and to the default emission factors spreadsheets (Energy Sector-Stationary Combustion Subsector and Reference Approach);
- manual checks on all spreadsheets on Fugitive Emissions Subsector; the spreadsheets are directly linked to the International Energy Agency and Eurostat versions of the Energy Balance and to the used emission factors spreadsheets (Energy Sector-Fugitive Emissions Subsector);
- implementing an analysis on the share of European Union-Emission Trading Scheme to Energy Balance fuel consumption data, in respect to equivalent activity categories (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- checks specific to country-specific emission factors determination, based on background data reported under the European Union Emission Trading Scheme and validated through the reports of Romanian Accreditation Association (RENAR) accredited verifiers (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- checks on the correlation between energy demand and energy resources data in the Energy Balance (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- implementation of a comparative analysis of country-specific emission factors and associated uncertainties with equivalent international data, mostly from the countries having similar national circumstances (technologies, the same fuels sources) (Energy Sector except the Fugitive Emissions Subsector);
- check on the potential double accounting cases through the use of carbon balance (Industrial Processes Sector);

- implement cross-category checks for emissions from categories calculated using Tier 1 default emission factors that do not specifically account for the sources of carbon (Industrial Processes Sector);
- implementing an analysis on the share of European Union-Emission Trading Scheme to National Greenhouse Gas Inventory data, in respect to equivalent activity categories (Industrial Processes Sector);
- comparison of the Enteric Fermentation and Manure Management Subsectors country-specific emission factors data and information with equivalent international data and information, especially in respect with elements available within countries with similar technical conditions (livestock characteristics, Animal Manure Management Systems characteristics) (Agriculture Sector-Enteric Fermentation and Manure Management Subsectors).

- intersectoral activities
  - checks of the outliers on the fuel mix and on the energy consumption data changes, and of double accounting potential cases (Energy Sector except the Fugitive Emissions Subsector and Reference Approach, and Industrial Processes Sector);
  - check on the correct allocation of the emissions estimates/potential double accounting cases associated with the recovery of the energy resulted from the biomass incineration (Energy Sector-Stationary Combustion Subsector and Agriculture Sector-Agricultural Soils Subsector);
  - check on the correct allocation of the emissions estimates/potential double accounting cases associated with the recovery of the energy resulted from the biomass incineration (Energy Sector-Stationary Combustion Subsector and Land-Use, Land-Use Change and Forestry Sector);
  - comparison of activity data on the CH_4 recovery for valorizing from solid waste disposal on land facilities with corresponding data in the Energy Sector (Energy Sector-Stationary Combustion Subsector and Waste Sector-Solid Waste Disposal on Land Subsector);
  - check on the correct allocation of the emissions estimates/potential double accounting cases associated with the recovery of the energy resulted from the waste

incineration (Energy Sector-Stationary Combustion Subsector and Waste Sector-Waste Incineration Subsector);

- check the potential occurrence of double accounting cases between the Agriculture and Land Use, Land-Use Change and Forestry Sectors (Agriculture and Land Use, Land-Use Change and Forestry Sectors);
- comparison between Agriculture and Waste Sectors data in the National Greenhouse Gas Inventory and at the level of Food and Agriculture Organization and Eurostat (Agriculture and Waste Sectors).

The QA/QC and verification activities have been enhanced as a result of:

- increased number of NEPA NS/NGHGI dedicated staff;
- training of NEPA and data providers representatives through several training instruments;
- using a cross-checking QC approach within MECC;
- applying on a significantly larger scale sector-specific QC, QA and verification activities;
- their implementation also in the context of development of the NGHGI improvement studies:
  - in 2011,
    - "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation";
    - "NGHGI LULUCF both under the UNFCCC and KP obligations".
  - in 2012,
    - "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations";
    - "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations".
  - in 2013,
    - "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for

the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)";

- "Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation";
- "Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting";
- "Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP".

- continuous consideration of QA, third party support (collaborations with Austria and Netherlands, implementation of the NGHGI improvement related studies, EU internal reviews, review under Article 8 of the KP).

NGHGI improvement plan, is annually updated by the QA/QC coordinator based on the results of the previously mentioned QA/QC and verification checks; the NGHGI improvement plan is linked with the NGHGI preparation plan (attached as Annex 6.1.4) administered by the NGHGI coordinator.

1.7. General uncertainty evaluation, including data on the overall uncertainty for the inventory totals

1.7.1. GHG inventory

The present NIR comprises a full quantitative assessment of the uncertainty. Romania carried out the uncertainty analysis on the basis of both Tier 1 and Tier 2 method according to the provisions in Chapter 6 of the IPCC GPG 2000, in the Chapter 5 of the IPCC GPG 2003.

The uncertainty calculation was performed for 2012, both excluding and including the LULUCF sector; it is based on national (NIS, “Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”, “Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)”, “Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation”, “NGHGI LULUCF both under the UNFCCC and KP obligations”, “Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations”, “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting” and “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP” studies), study on Romanian uncertainty information and data performed in 2012 by the Environment Agency of Austria-University of Graz consortium (uncertainty data have been collected through interviews, based on the collaboration between "Environmental Integrated Informational System" study contractor, Environment Agency of Austria-University of Graz consortium, data providers and NEPA), and default AD and EFs uncertainty values.

Except the Forest Land remaining Forest Land category, the disaggregation of the inventory into categories is equivalent to the key category analysis splitting.

The uncertainty analysis was implemented using an integrated software application developed in 2012 by the Environment Agency of Austria-University of Graz consortium, in the context of the study "Environmental Integrated Informational System", implemented by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium; the application allow for:

- automatic data import from the CRF Reporter application, through the use of CRF Tables;
- integrate both key category and uncertainty analysis performed following both Tier 1 and Tier 2 approach;
- automatic export of results, data and information, within the relevant reporting templates.

Considering the 2013 NGHGI and the Tier 1 method:

- the total NGHGI uncertainty for 2011 excluding LULUCF was 19.3%, while including LULUCF was 30.3%;
- the uncertainty introduced into the trend in total national emissions, for 2011, was 2.4% when considering excluding LULUCF criteria and 13%, including LULUCF.

Considering the 2014 NGHGI and the Tier 1 method:

- the total NGHGI uncertainty for 2012 excluding LULUCF was 17.3%, while including LULUCF was 28.9%;
- the uncertainty introduced into the trend in total national emissions, for 2012, was 2.1% when considering excluding LULUCF criteria and 12.1%, including LULUCF.

Based on data and information associated with the 2014 NGHGI, a important contribution of LULUCF Sector at the uncertainty data presented in paragraph above can be observed.

The results of the uncertainty analysis are presented within the NIR both at the Uncertainties and time series consistency sub-sectorial sections and in Annex 7.

- uncertainty analysis results are used for prioritize efforts for improving the quality of the NGHGI-in the implementation of progresses, highest priority is attributed to categories having associated high uncertainty level.

The data relevant to the KP LULUCF activities are presented within the Chapter 11.

1.8. *General assessment of the completeness*

1.8.1. GHG inventory

The inventory covers all sectors and all gases in the period 1989-2012 and is complete in terms of geographical coverage. Emissions are presented by sector, by sub-sector and by gas.
There are still some gaps in the inventory, such as the estimation of emissions from asphalt roofing and road paving with asphalt, due to the lack of national/default method and emission factors.

All the sources/sinks not covered and the relevant justifications are presented in the Annex 5.

1.8.2. KP-LULUCF

The data relevant to the KP LULUCF activities are presented within the Chapter 11.

2 TRENDS IN GREENHOUSE GAS EMISSIONS

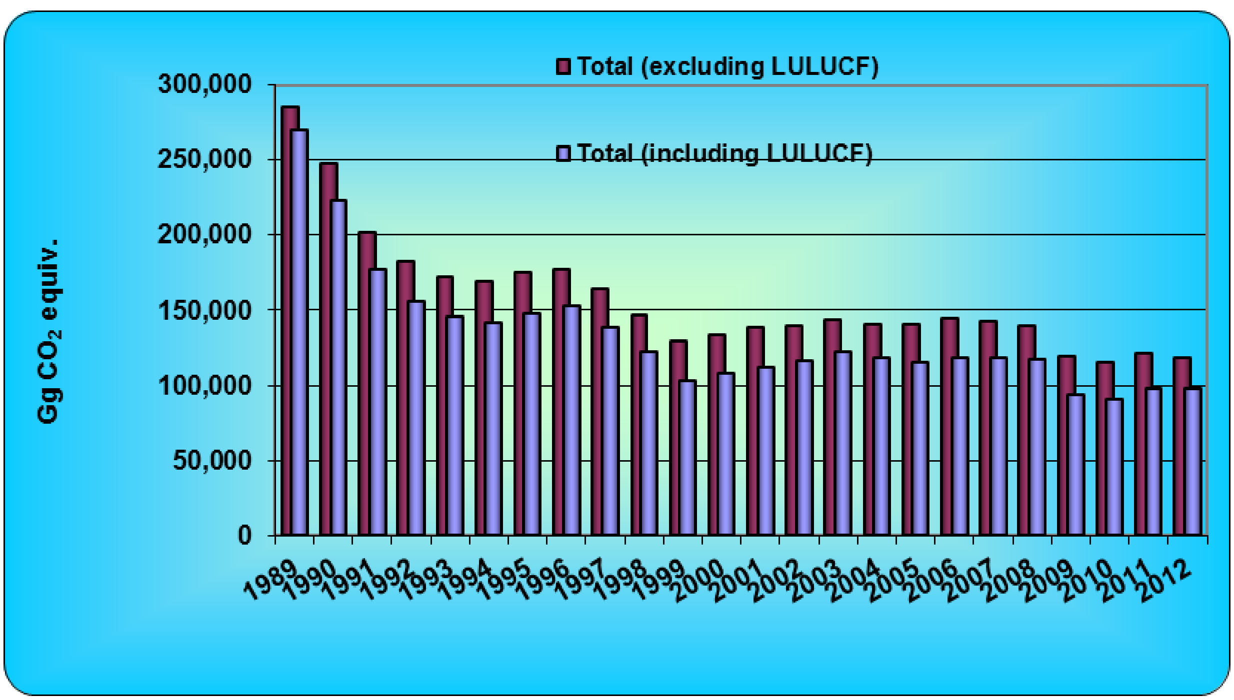
2.1 Description and interpretation of emissions trends for aggregated greenhouse gas emissions

The total GHG emissions in 2012, excluding removals by sinks, amounted to 118,764.15 Gg CO_2 equivalents.

According to the provisions of the Kyoto Protocol, Romania has committed itself to reduce the GHG emissions by 8% in 2008-2012 considering the base year (1989) levels.

The total GHGs emissions (without considering sinks) decreased with 58.34 % in 2012 in comparison to 1989 while the net GHG emissions/ removals (taking into account the CO_2 removals) decreased with 63.59%. Based on these observations, there is a great probability for Romania to meet the commitments to reduce the GHG emissions in the first commitment, 2008-2012.

Figure 2.1 Trends of the aggregated GHG emissions



The emissions trend reflects the changes in this period characterized by a process of transition to a market economy. The emissions trend can be split in three parts: the period 1989-1999, the period 1999-2008 and the year 2010. The decline of economic activities and energy consumption in the period 1989-1992 had directly caused the decrease of the total emissions in that period. With the entire economy in transition, some energy intensive industries reduced their activities and this is reflected in the GHG emissions reduction. Emissions have started to increase until 1996, because of the economy revitalization. Considering the starting of the operation of the first reactor at the Cernavoda nuclear power plant (1996), the emissions decreased again in 1997.

The decrease continued until 1999. The increased trend after 1999 reflects the economic development in the period 1999-2008. The limited decrease of GHG emissions in 2005, compared with 2004 and 2006 levels was caused by the record-breaking hydrological year positively influencing the energy produced in hydropower plants. Due to the economic crisis, the emissions have significantly decreased in 2012 comparing with 2008.

2.2 Description and interpretation of emissions trends by gas

All GHG emissions, except HFCs and SF_6, decreased comparing with the base year. The shares of GHG emissions have not significantly changed during the period. The largest contributor to total GHG emissions is CO_2, followed by CH_4 and N_2O. In the base year, the shares of GHG emissions were: 72.62% CO_2, 16.34% CH_4, 9.86% N_2O, 1.18% PFCs. In 2012, the shares of GHG emissions were: 70.61% CO_2, 18.72% CH_4, 9.76% N_2O, 0.01% PFCs.. The F gases started to be used as substitutes for ODS in refrigerating and air conditioning systems since 1995. In 2012, the contribution of these gases to the total GHG emissions is negligible: 0.8701% HFCs and 0.03434% SF_6. Next table presents the trend of the aggregated emissions, split by gas.

Table 2.1 Trends by gas [Gg CO_2 equivalent]

Year	**CO_2 including LULUCF**	**CO_2 excluding LULUCF**	**CH_4 excluding LULUCF**	**N_2O excluding LULUCF**	**HFCs**	**PFCs**	**SF_6**
1989	191,715.04	207,007.45	46,576.80	28,113.40	0.14	3349.56	0.38

Year	CO_2 including LULUCF	CO_2 excluding LULUCF	CH_4 excluding LULUCF	N_2O excluding LULUCF	HFCs	PFCs	SF_6
1990	153,847.40	178,134.39	42,945.27	24,467.47	0.16	2115.83	0.38
1991	121,280.25	146,153.09	35,825.89	18,095.06	0.26	1942.09	0.42
1992	105,490.95	132,039.85	31,764.84	17,266.53	0.41	1352.13	0.39
1993	96,960.30	123,243.69	30,439.55	17,211.99	0.69	1409.43	0.42
1994	94,084.89	121,128.31	30,463.48	15,965.32	1.16	1490.97	0.58
1995	99,238.28	126,316.40	30,596.36	16,575.16	2.37	1773.53	0.77
1996	104,943.39	129,618.14	30,151.05	16,284.76	4.35	1768.86	1.20
1997	92,637.97	118,467.62	28,701.24	15,471.62	9.48	1786.37	1.11
1998	79,087.70	103,798.00	26,709.34	14,489.15	21.76	1753.33	1.20
1999	62,173.49	88,268.84	25,873.19	13,925.02	36.17	1603.35	1.35
2000	67,165.07	92,856.95	26,414.60	13,439.88	63.52	1292.10	6.63
2001	71,047.75	97,850.78	26,436.54	13,579.19	100.26	1044.20	10.99
2002	75,515.89	98,331.41	27,231.49	13,579.19	148.28	717.86	9.44
2003	81,013.83	102,229.40	27,330.28	13,259.15	200.90	261.50	8.35
2004	77,486.47	99,910.29	26,428.82	14,188.87	258.04	132.12	11.09
2005	73,724.77	99,286.38	26,367.73	14,480.30	323.18	81.81	12.67
2006	78,069.47	103,978.94	26,036.06	15,242.04	423.33	55.01	19.10
2007	78,447.92	103,234.98	24,983.63	14,264.13	579.41	24.20	23.43
2008	77,006.21	99,417.74	25,113.22	13,957.87	826.26	15.34	26.68
2009	57,292.34	82,810.67	24,070.60	12,188.04	803.87	7.00	36.91
2010	55,288.41	79,879.81	22,590.41	12,417.89	855.50	7.84	47.53
2011	62,546.29	85,604.53	22,231.37	12,682.66	945.59	10.92	38.43
2012	63,289.81	83,860.59	22,237.24	11,585.82	1,033.33	6.38	40.79

Carbon dioxide (CO_2) – the most significant anthropogenic greenhouse gas is the carbon dioxide. The decrease of CO_2 emissions (from 207,007.45 Gg in 1989 to 83,860.59 Gg in 2012) is caused by the decline of the amount of fossil fuels burnt in the energy sector (especially in the public electricity and heat production, and manufacturing industries and constructions sectors) as a consequence of activity decline.

Methane (CH_4) – the methane emissions, related mainly to the Fugitive emissions from fossil fuels extraction and distribution and to the livestock, decreased in 2012 by 52.26% compared with the levels in 1989. The decrease of CH_4 emissions in Agriculture is due to the decrease of the livestock level.

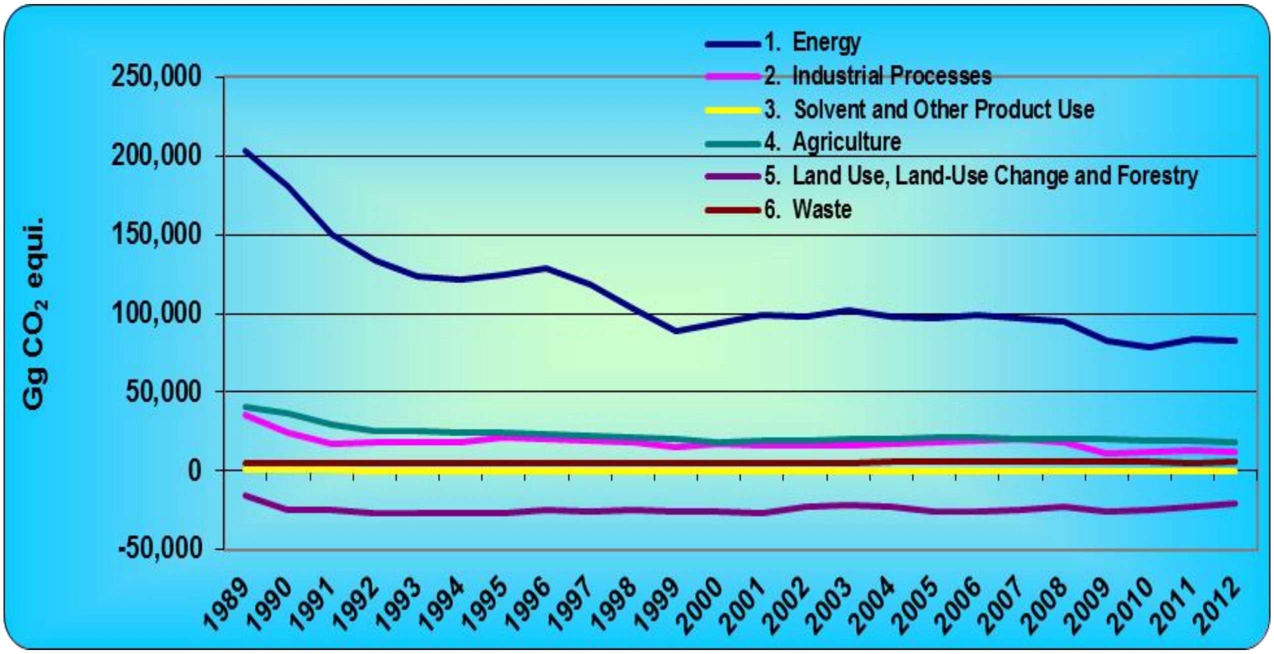
Nitrous oxide (N_2O) – the N_2O emissions are mainly generated within the Agricultural Soils activities in the Agriculture sector and within the Chemical industry activities in the Industrial Processes sector. The decline of these activities (decline of livestock, decline of N synthetic fertilizer applied on soils amounts, decrease of the crop productions level) is reflected in the N_2O emissions trend. The N_2O emissions in 2012 decreased with 58.79% in comparison with the level in the base year.

Fluorocarbons and SF_6 (HFCs, PFCs, SF_6) – the F-gases started to be used as substitutes for ODS in refrigerating and air conditioning systems since 1995; therefore the emissions resulted as a consequence of the use of these substances and are estimated beginning with the same year. The PFCs emissions generated in the production of the primary aluminium are reported for the entire analyzed period (1989-2012) and have decreased with 99.81% in 2012 comparing with the level in 1989).

2.3 Description and interpretation of emissions trends by category

The figure below shows the GHG emissions trends by each sector. The GHG emissions are expressed in Gg CO_2 equivalent.

Figure 2.2 Trends by sector



Energy represents the most important sector in Romania. The Energy sector accounted for 69.23% of the total national GHG emissions in 2012. The GHG emissions resulted from the Energy sector decreased with 59.60 % compared with the base year.

Industrial Processes contributes to total GHG emissions with 10.42%. A significant decrease of GHG emissions was registered in this sector (65.10% decreases in 2012 compared to the level in 1989) due to the decline or the termination of certain production activities.

Solvent and Other Product Use the trend of emissions resulted from this sector follows the general trend: emissions have decreased seriously after 1989, then the emissions were relatively stable from 1992 to 2002; after 2002, emissions started to increase, and due to the revitalization of the relevant economic activities (automobile manufacture, construction and buildings).

The GHG emissions level decreased in 2012 by 80.22% in comparison with the level recorded in 1989.

Agriculture GHG emissions have also decreased. The GHG emissions in 2012 are 55.35% lower in comparison with the 1989 emissions due to:

- the decline of livestock;
- the decrease of rice cultivated area;

- the decrease of crop productions level;
- the decline of N synthetic fertilizer applied amounts.

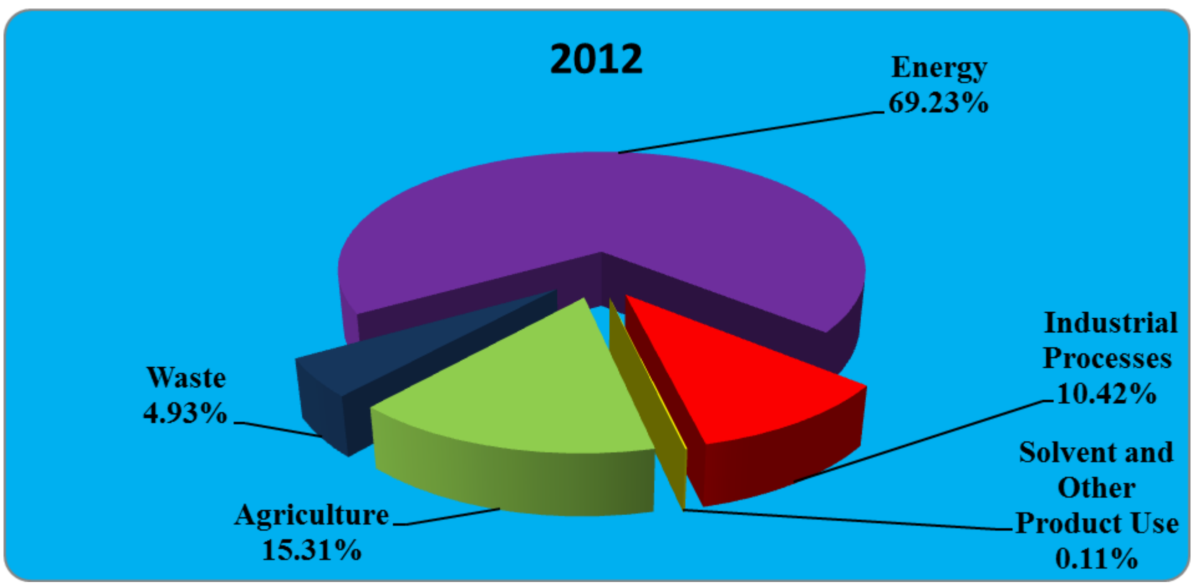
In 2012, 15.31 % of the total GHG emissions resulted from the agriculture sector.

LULUCF The net GHG removals/emissions level is 34.35% higher in 2012 in comparison with the level in the base year. The Romanian land use sector acts as a net sink, at an average uptake of 20,544.21 Gg/year, being relatively stable over the last 22 years.

Waste sector emissions have increased in 2012 with 25.62% in comparison with the level in 1989. The contribution of the waste sector to the total GHG emissions in 2012 is 4.93%.

The participation of sectors to GHG emissions (excluding LULUCF) is presented in the next figure.

Figure 2.3 Sectorial GHG emissions in 2012 [%]



2.4 Description and interpretation of emissions trends for indirect greenhouse gases and SO_2

The trends of the indirect GHGs are similar with the GHGs trends (Table 2.2), except for CO emissions, which strongly increased staring with 1995, due to the raise of the amount of the firewood used in households.

The NO_x, NMVOC and SO_2 emissions evolution follows the general direct GHG emissions trend. The SO_2 emissions decrease is caused by the decline of the fuels burnt for energy and the decrease of sulphur content in fuels.

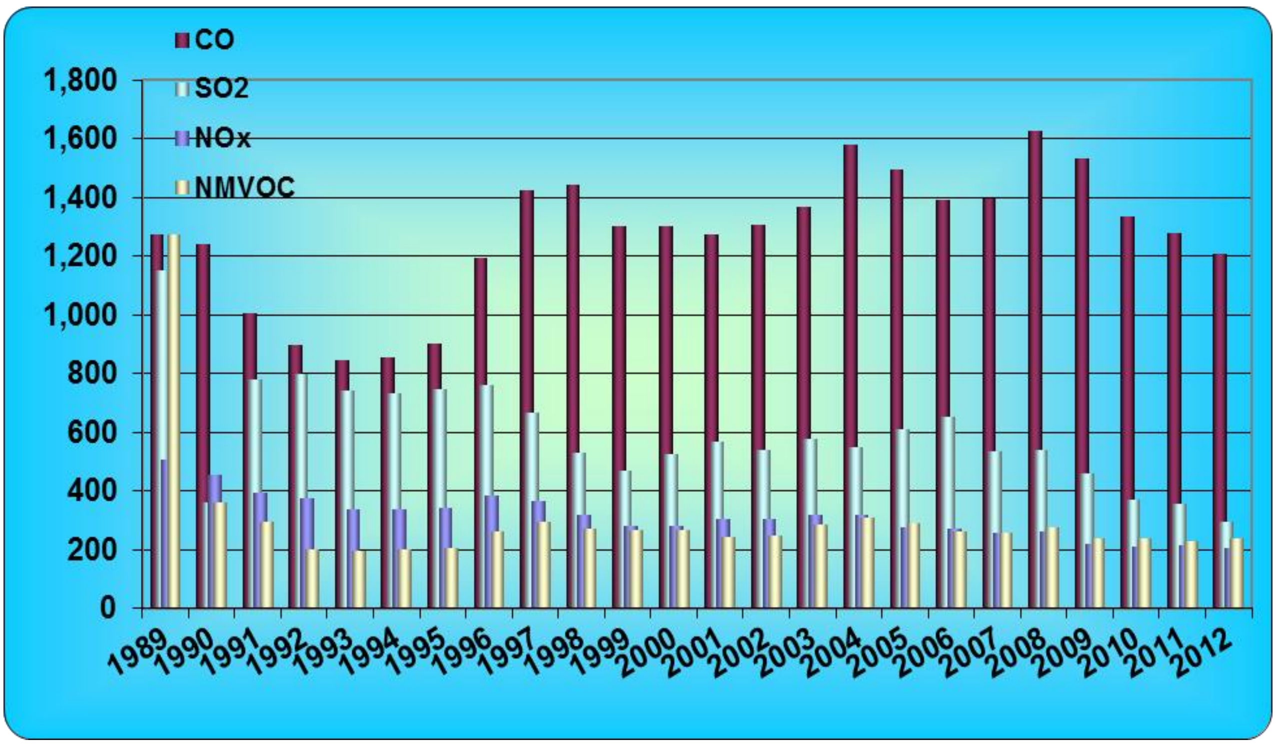
The indirect GHG emissions trends are presented in Figure 2.4.

Table 2.2 Indirect GHG emissions levels [Gg]

Year	**NO_x**	**CO**	**NMVOC**	**SO_2**
1989	504.61	1,273.48	1,273.48	1,150.00
1990	456.90	1,239.28	361.72	361.72
1991	394.60	1,007.29	297.12	779.48
1992	374.09	897.96	200.85	796.43
1993	338.04	843.15	196.97	739.76
1994	338.62	854.40	201.14	731.76
1995	340.83	900.80	205.92	747.60
1996	384.33	1,191.85	263.36	761.46
1997	367.46	1,421.84	292.86	665.61
1998	319.31	1,442.63	273.68	531.58
1999	282.71	1,301.52	265.65	470.60
2000	282.71	1,301.52	265.65	525.96
2001	305.80	1,271.80	242.25	568.05
2002	306.44	1,307.98	245.91	540.93
2003	319.79	1,367.70	286.72	577.55
2004	319.93	1,579.85	309.03	550.64
2005	274.70	1,492.07	290.21	607.81
2006	269.89	1,388.78	261.82	650.97
2007	256.55	1,396.44	255.84	535.51
2008	260.10	1,627.02	275.88	539.27

Year	NO_x	CO	NMVOC	SO_2
2009	221.53	1,533.97	239.97	459.95
2010	210.95	1,334.97	239.47	368.42
2011	217.03	1,276.90	228.79	357.17
2012	207.04	1,207.95	237.29	293.03

Figure 2.4 Indirect GHG emissions trends [Gg]



2.5 Description and interpretation of emissions trends for KP-LULUCF inventory in aggregate and by activity, and by gas

The data relevant to the KP LULUCF activities are presented within the Chapter 11.

3 ENERGY (CRF Sector 1)

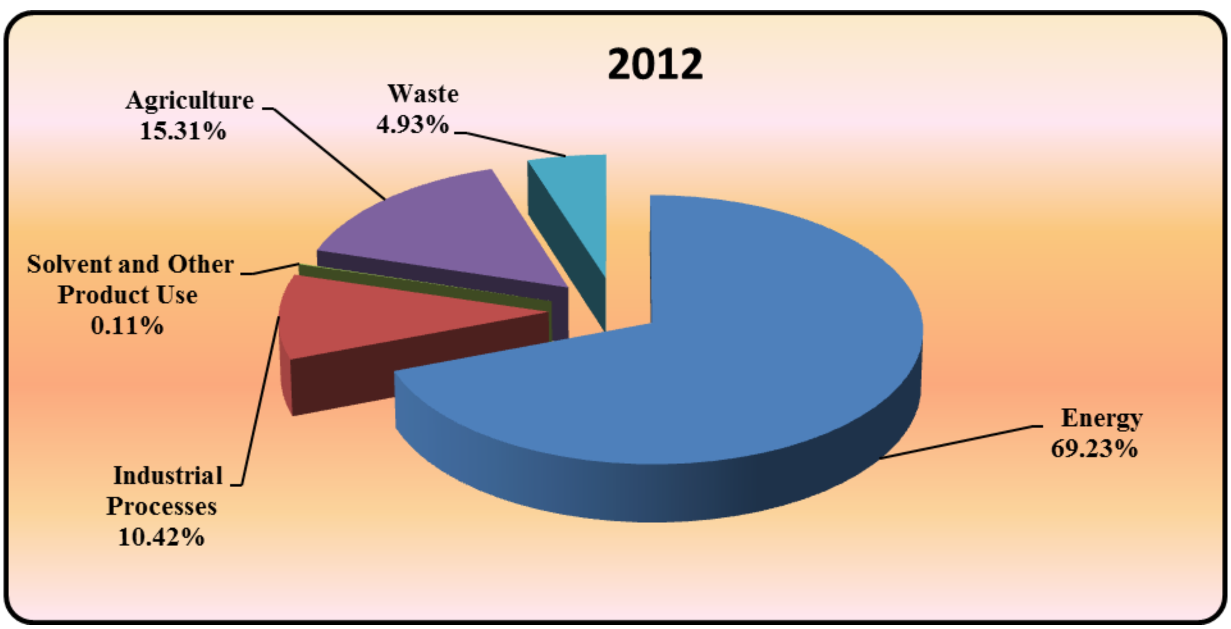
3.1 Overview of the sector

This chapter includes GHG emissions estimates in the Energy Sector. According to IPCC the following categories are included in this sector:

- 1.A.1 Energy industries;
- 1.A.2 Manufacturing Industries and Construction;
- 1.A.3. Transport;
- 1.A.4 Other sectors (commercial/institutional, residential, agriculture/ forestry/ fisheries);
- 1.A.5. Other (stationary, mobile);
- 1.B. Fugitive Emissions from Fuels.

Compared to the other GHG emissions sectors (Industrial Processes, Agriculture, LULUCF, Waste), the Energy sector represents the largest source of anthropogenic GHG emissions in Romania. In 2012, the Energy sector was responsible for about 69.23% of the total GHG emissions 118,764.15 Gg CO_2 equivalent.

Figure 3.1 The contribution of Energy Sector to the total GHG emissions in Romania, 2012



Emission trends

In 2012, emissions from the Energy sector have decreased by 59.59% (82,222.51Gg CO_2 equivalent) compared to 203,544.60 Gg CO_2 equivalent in 1989, base year.

Figure 3.2 Total GHG emissions from Energy Sector

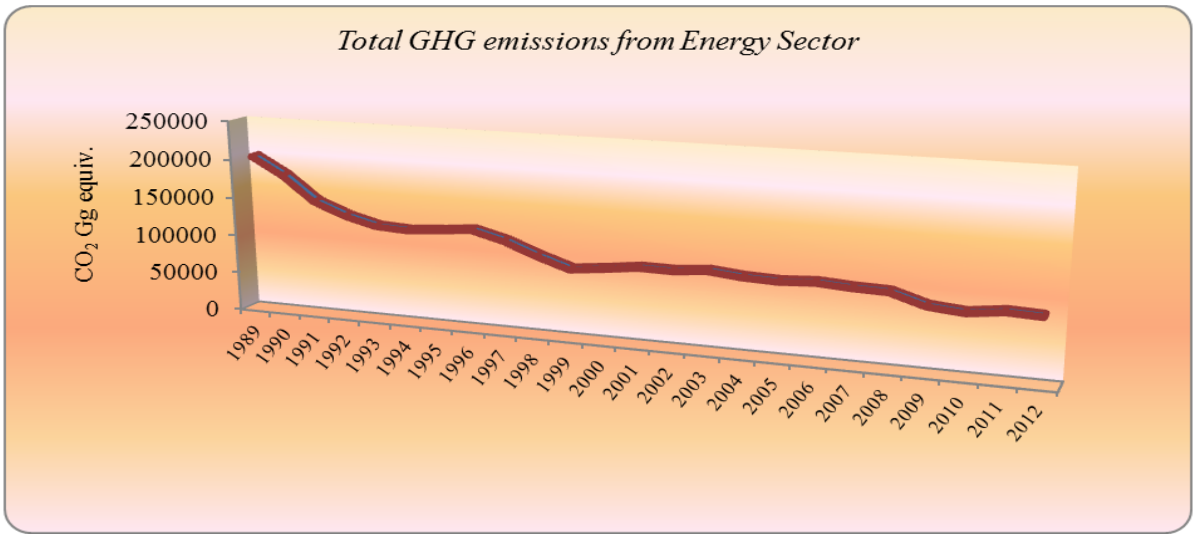
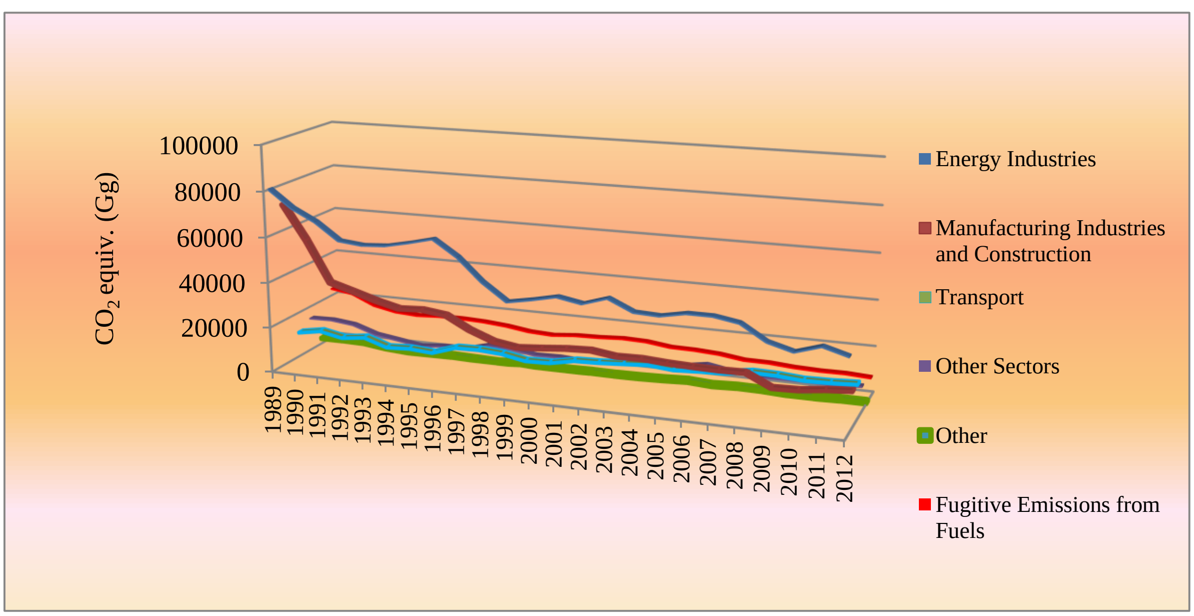


Figure 3.3 The energy sector emission trend for the period 1989-2012



The emissions trend reflects the changes in this period characterized by a process of transition to a market economy.

The emissions trend can be split in two parts: the period 1989-1996 and the period 1996-2004. The decline of economic activities and energy consumption in the period 1989-1992 had directly caused the decline in total emissions in that period. With the entire economy in transition, some energy intensive industries reduced their activities and this is reflected in the GHG emissions reduction.

Emissions have started to increase until 1994, because of economy revitalization. Considering the starting of the operation at the first reactor at the Cernavoda nuclear power plant (1996), the emissions started to decrease again. The decrease continued until 1999. The increased trend after 1999 reflects the economic development in the period 1999-2004.

At the end of 2007, the second unit of the Cernavoda nuclear plant was functioning, therefore the decrease in emission trend is not very noticeable; for 2008 it was noticed a slight tendency of decrease of emissions.

The firewood consumption in households increased in 2008 due to the increase of the inhabitable space in the rural area (according to the Energy Balance).

The decreased fuel consumptions, especially in industry, are due to the decrease of economic activities level in the second semester of 2008.

Available energy resources totaled, in 2011, 44.5 million tons of oil equivalent (tep), increasing with 2.08 thousands tons , compared to 2010.

Final energy consumption in 2011 was preserved, overall, the same level as in 2010, slight increases were recorded in agriculture and forestry (10.7%) and transport (+4.0%).

Exports of energy (including bunkers), of 4.163 million tons, compared to 2009 increased by 2.7%.

Electricity consumption in 2011 was, with 1506 GWh (2.4%) more higher than in 2010.

Consumption of energy production plants in 2011 was higher than 2010 with 1502 thousand toe (+15.7%).

Coal accounts for 54.5% in the consumption of energy production plants and 14.7% hydrocarbons.

In 2012, energy resources and primary energy production decreased slightly (- 2.4% and -1.3%) compared with 2011.

Imports of energy products increased slightly (+0.4%) compared to last year while final energy consumption remained at the same level as the previous year.

Available energy resources amounted, in 2012, 43.4 million tons equivalent petroleum (Toe), down 1.055 million toe (-2.4%) from the previous year, mainly due to lower primary energy production.

The decrease in oil resources (-6.8%) was accompanied by, among other things, the resources of the coal decrease (-5.4%) and natural gas (-0.7%).

Primary energy resources in 2012 were 41.728 million tonnes of oil equivalent, down with 70 toe the previous year. Of primary energy resources:

- Coal (excluding coke) 7846 mii toe 8298 mii toe in 2012 compared to 2011 (-5.4%);
- Oil: 9.718 million toe in 2012 compared to 10.426 million toe in 2011 (-6.8%);
- Gas utilizable s: 12.582 million toe in 2012 compared to 12.676 million toe in 2011 (-0.7%);
- Import coke from 470 ktoe in 2012 compared to 505 thousand toe in 2011 (-6.9%);
- Hydroelectric, wind, solar photovoltaic and nuclear power: 4101mii toe in 2012 compared to 4.286 million toe (-4.3%).

Primary energy production in 2012 of 27.1 million toe, had a slight decrease (-353 toe, representing -1.3%) compared to 2011, but continued to maintain a significant share in total energy resources, representing 62.5% of them.

Were all decreased production of primary energy carriers, except natural gas production increased 0.5% from the previous year.

Imports of energy products increased slightly (+0.4%) compared to last year, the decrease oil and gas imports was offset by increased imports of products petroleum and coal (including coke) with 13.8% and 12.2%.

Final energy consumption in 2012 remained at the same level as in 2011, increases in agriculture and forestry (15.2%), households (2.7%) and transport (0.7%) were offset by declines in industry and the tertiary sector.

Total final energy consumption in industry (including construction), which accounts for approximately 30% of total final energy consumption was down compared to the year previous (- 4.2%). In transport, the increase in consumption in road transport (+2.2% since 2011) consumption shortfall recorded in other types of transport.

Energy exports (including bunkers) of 3.798 million toe, fell to 8.8% in 2011.

Gross inland consumption of energy per capita in the year 20 12 was 1736 kg oil equivalent.

Industry (including construction and energy) still holds the largest share in structure of electricity consumption (57.9%), followed by the population (23.1%).

Consumption for power plants in 2012 was lower than in 2011 with 722 ktoe (-6.5%).

For power plants have been used 10.341 million toe, this consumption is included fuel for electricity generation in the nuclear plant. The share of coal consumption in thermoelectric energy consumption for production in 2012 was 56.1%, down from 2011 when it was 58.6%.

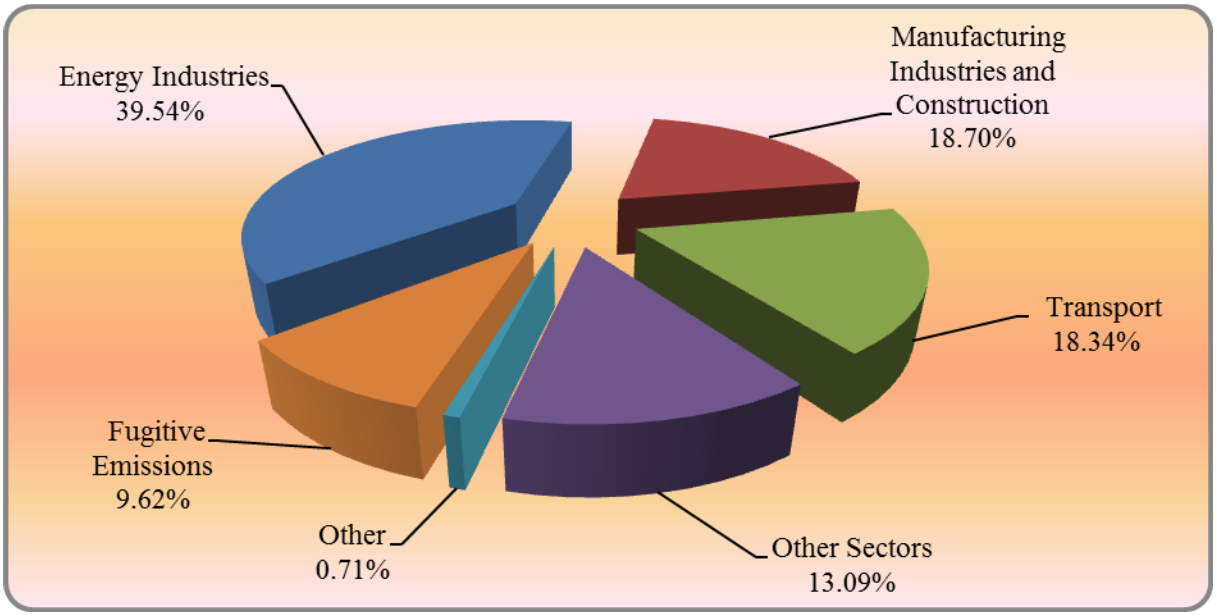
An opposite trend was gazoaze oil consumption, whose share increased in 2012 to 14.5% compared to 13.7% as were in use for the production energy plants in 2011. (Source - Romanian National Institute for Statistics).

Within the Energy sector, the GHG emissions are generated as presented in the next table.

Table 3.1 Shares of GHG emission categories within the Energy sector, in 2012

Energy sector-categories	**Percentages for 2012**
Energy industries	39.54%
Manufacturing Industries and Construction	18.70%
Transports	18.34%
Other sectors	13.09%
Other	0.71%
Fugitive emissions	9.62%

Figure 3.4 Shares of GHG emission categories within the Energy sector, in 2012



The most important GHG in the sector is CO_2; small amounts of CH_4 and N_2O are also emitted.

Figure 3.5 The different GHG's contribution to the 2012 Energy emissions

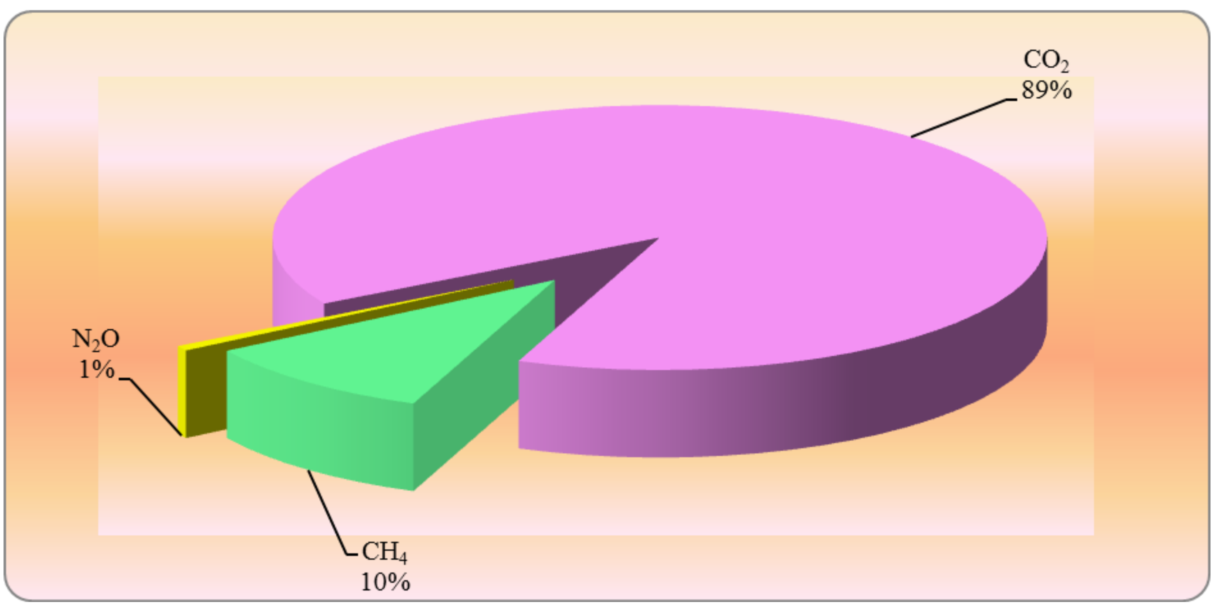


Table 3.2 Status of emissions estimation within the Energy Sector for 2012

IPCC category-Energy Sector	Emissions estimation status		
	CO_2	CH_4	N_2O
1AA Fuel Combustion – Sectorial Approach			
1.A.1. Energy Industries			
1.A.1.a. Public Electricity and Heat Production	✓	✓	✓
1.A.1.b. Petroleum Refining	✓	✓	✓
1.A.1.c. Manufacture of solid fuels and other energy industries	✓	✓	✓
1.A.2. Manufacturing Industries and Construction	✓	✓	✓
1.A.2.a. Iron and steel	✓	✓	✓
1.A.2.b. Non ferrous metals	✓, NO, IE	✓, NO, IE	✓,NO, IE
1.A.2.c. Chemicals	✓	✓	✓
1.A.2.d. Pulp paper and print	✓	✓	✓
1.A.2.e. Food processing, beverages and tobacco	✓	✓	✓
1.A.2.f. Other (as specified in table 1.A(a)s2)	✓	✓	✓
1.A.3. Transport			
1.A.3.a. Civil Aviation	✓	✓	✓
1.A.3.b. Road Transportation	✓	✓	✓
1.A.3.c. Railways	✓	✓	✓
1.A.3.d. Navigation	✓	✓	✓
1.A.3.e. Other Transportation - pipeline	✓	✓	✓
1.A.4. Other Sectors	✓	✓	✓
1.A.4.a. Commercial/institutional	✓	✓	✓
1.A.4.b. Residential	✓	✓	✓
1.A.4.c. Agriculture/Forestry/Fisheries	✓	✓	✓
1.A.5. Other	✓	✓	✓
1.A.5.a.Stationary	✓	✓	✓

IPCC category-Energy Sector	**Emissions estimation status**		
	CO_2	**CH_4**	**N_2O**
1.A.5.b.Mobile	✓	✓	✓
1B Fugitive Emissions from Fuels			
1.B.1.Solid Fuels			
1.B.1.a. Coal Mining and handling	NA	✓	NA
1.B.1.a.i. Underground mines	NA	✓	NA
1.B.1.a.i.1. Post - Mining Underground activites	NA	✓	NA
1.B.1.a.i.1. Surface mines	NA	✓	NA
1.B.1.a.i.1. Post - Mining Surface activites	NA	✓	NA
1.B.1.b. Solid fuel transformation	NA	NO	NA
1.B.1.c. Other	NA	NA	NA
1.B.2. Oil and Natural Gas			
1.B.2.a. Oil	✓	✓	✓
1.B.2.a.i. Venting oil	✓	✓	NA
1.B.2.a.ii. Flaring oil	✓	✓	✓
1.B.2.a.iii.1. Exploration	✓	✓	NA
1.B.2.a.iii.2. Production and upgrading	✓	✓	NA
1.B.2.a.iii.3. Transport	✓	✓	NA
1.B.2.a.iii.4. Refining and storage	NA	✓	NA
1.B.2.a.iii.5. Distribution of oil products	NA	NA	NA
1.B.2.a.iii.6. Other	NO	NO	NO
1.B.2.b. Natural Gas	✓	✓	✓
1.B.2.b.i. Venting gas	✓	✓	NA
1.B.2.b.ii. Flaring gas	✓	✓	✓
1.B.2.b.iii.1. Exploration	IE[1)]	IE[1)]	NA
1.B.2.b.iii.2. Production/Processing	NA	✓	NA
1.B.2.b.iii.3. Transmission	✓	✓	NA
1.B.2.b.iii.4. Distribution and storage	✓	✓	NA

IPCC category-Energy Sector	Emissions estimation status		
	CO_2	CH_4	N_2O
1.B.2.b.iii.5. Other Leakage	NE	✓	NA
1.B.2.b.iii.5.1. at industrial plants and power station	NE	✓	NA
1.B.2.b.5.iii.2. in the residential and commercial sectors	NE	✓	NA
1.B.2.d.iii.6. Other	✓	IE, NA	NA
1.C. Memo items			
1.C.1. International Bunkers			
1.C.1.a. Aviation	✓	✓	✓
1.C.1.b. Marine	✓	✓	✓
1.C.2. Multilateral Operations	NE	NE	NE
1.C.3. CO_2 Emissions from Biomass	✓	NA	NA
1.A.B. Fuel Combustion – Reference Approach	✓		

* CH_4 and CO_2 emissions from 1.B.2.b.iii.1. Exploration natural gas is reported under 1.B.2.a.iii.1. Exploration - Oil.

3.1.1 Key sources

Table 3.3 Key categories overview - Energy 2012

Key categories		GHG	Criteria	Contribution in total GHG emissions [%]
1 A 1 a solid	Public Electricity and Heat Production	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (L,T excluding; L, T including LULUCF)	18.90
1 A 3 b diesel oil	Road Transportation	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (L,T excluding; L,T	8.10

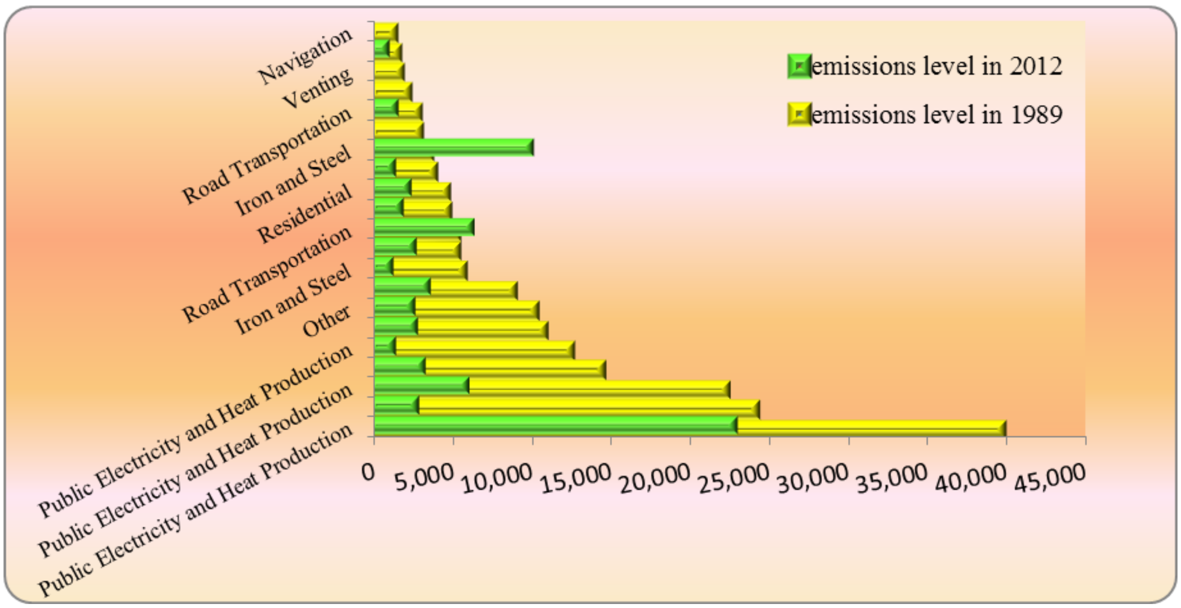
Key categories		GHG	Criteria	Contribution in total GHG emissions [%]
			including LULUCF)	
1 A 1 a gaseous	Public Electricity and Heat Production	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2(L,T excluding; T including LULUCF)	4.70
1 A 4 b gaseous	Residential	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (L,T excluding LULUCF)	5.00
1 A 3 b gasoline	Road Transportation	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (L,T excluding; L, T including LULUCF)	3.60
1 A 2 a solid	Iron and Steel	CO_2	Tier 1 (L excluding; L,T including LULUCF)	1.70
1 B 2 b	Natural gas	CH_4	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (L,T excluding; L,T including LULUCF)	2.60
1 A 2 c gaseous	Chemicals	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (T excluding; T including LULUCF)	2.10
1 A 2 f gaseous	Other	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (T excluding; T including LULUCF)	2.40
1 B 2 a	Oil	CH_4	Tier 1 (L excluding; L,T including LULUCF), Tier 2 (L,T excluding; L, including LULUCF)	1.90

Key categories		GHG	Criteria	Contribution in total GHG emissions [%]
1 A 2 f solid	Other	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (L,T excluding; T including LULUCF)	2.00
1 A 1 b liquid	Petroleum refining	CO_2	Tier 1 (L,T excluding; L,T including LULUCF)	1.20
1 A 4 a gaseous	Commercial/Institutional	CO_2	Tier 1 (L excluding; L including LULUCF)	1.50
1 A 2 f liquid	Other	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (T excluding, T including LULUCF)	1.90
1 A 2 a gaseous	Iron and Steel	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (T excluding, T including LULUCF)	0.90
1 B 2 c Venting	Venting	CH_4	Tier 1 (L including LULUCF), Tier 2 (L excluding; L including LULUCF)	0.90
1 A 1 a liquid	Public Electricity and Heat Production	CO_2	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (T excluding; T including LULUCF)	0.80
1 B 1 a	Coal Mining	CH_4	Tier 1 (L,T excluding; L,T including LULUCF), Tier 2 (L,T excluding; L,T including LULUCF)	0.70
1 A 1 b gaseous	Petroleum refining	CO_2	Tier 1 (L excluding; L including LULUCF)	0.50
1 A 4 b biomass	Residential	CH_4	Tier 1(L ,T excluding; L, T including LULUCF), Tier 2(L,T excluding; L, T including LULUCF)	0.70

Key categories		GHG	Criteria	Contribution in total GHG emissions [%]
1 A 2 e gaseous	Food Processing, Beverages and Tobacco	CO_2	Tier 1 (L excluding; L including LULUCF)	0.60
1 A 2 c liquid	Chemicals	CO_2	Tier 1 (L excluding; L including LULUCF)	0.50
1 A 1 c liquid	Manufacture of Solid fuels and Other Energy Industries	CO_2	Tier 1 (L, T excluding; L including LULUCF)	0.60
1 A 1 c gaseous	Manufacture of Solid fuels and Other Energy Industries	CO_2	Tier 1 (L excluding; L including LULUCF)	0.60
1 A 4 b liquid	Residential	CO_2	Tier 1 (L excluding; L including LULUCF)	0.40
1 A 3 c liquid	Railways	CO_2	Tier 1 (L, T excluding; L,T including LULUCF)	0.50
1 A 2 c solid	Chemicals	CO_2	Tier 1 (L excluding LULUCF)	0.40
1 A 4 b biomass	Residential	N_2O	Tier 2 (T excluding, T including LULUCF)	0.70
1 A 4 c liquid	Agriculture/Forestry/Fisheries	CO_2	Tier 1 (L, T excluding; L,T including LULUCF)	0.80
1 A 4 b solid	Residential	CO_2	Tier 1 (T excluding; T including LULUCF)	0.10
1 A 4 c gaseous	Agriculture/Forestry/Fisheries	CO_2	Tier 1 (T excluding; T including LULUCF)	0.10
1 A 5 a liquid	Stationary	CO_2	Tier 1 (L excluding; L including LULUCF)	0.50
1 A 1 c solid	Manufacture of Solid fuels and Other Energy Industries	CO_2	Tier 1 (T excluding; T including LULUCF)	0.00

Key categories		GHG	Criteria	Contribution in total GHG emissions [%]
1 B 2 a	Oil	CO_2	Tier 2 (L excluding, L including LULUCF)	0.30

Figure 3.6 Key categories, both by level and trend criteria, overview – Energy Sector, 2012



3.2 Fuel combustion (CRF 1.A)

3.2.1 Comparison of the sectorial approach with the reference approach

According to the IPCC documents ("Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, and "IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories"), two separate approaches have to be applied in order to estimate the emissions from fuel combustions activities.

In calculating GHG emissions from the Energy Sector, were used two methods indicated in the previously mentioned documents:

❖ Reference Approach;

- Sectorial Approach.

The Reference Approach is a top-down methodology, which uses a national balance (taking into account the non-energy use of fuels), calculated from the following quantities:

- Production;
- Import and export;
- Stock changes;
- International bunkers.

The Reference Approach (RA) is a method for estimating CO_2 combustion emissions using a simplified methodology. For the purpose of the RA the apparent consumption of each fuel is calculated. The Sectoral Approach is a more detailed methodology (a bottom-up method), using the fuel consumption for each of the Subsectors:

- Public Electricity and Heat Production;
- Manufacturing Industries and Construction;
- Transport;
- Commercial/Institutional;
- Residential;
- Agriculture/Forestry/Fisheries;
- Other Non–specified.

Methodology

The applied methodologies are in accordance with the IPCC Worksheets provisions. The activity data for the reference approach are provided through the Romanian Energy Balances.

The conversion factor used to calculate the apparent energy consumption for solid fuels was obtained calculating the NCV weighted average from the NCVs of production, imports and exports provided through the Energy Balance – solid fuels. For the liquid fuels, as conversion factors the average of net calorific values provided through the Energy Balance – liquid fuels are used to calculate the apparent energy consumption. For the liquid fuels reported on the EU-ETS monitoring reports, the national values for the the corresponding NCVs were derived and used as averages, as follows: for the Romanian EU-ETS reporting period, 2007-2012 years, annual averages of the NCVs were used; for the rest of the time series the averages of the reporting EU-

ETS period for the liquid fuels were used. The elements of the NCVs used within the Reference Approach are included in Annex 2.

For the fuels having associated determined country-specific emission factors (CS EFs) Tier 2 method is applied. For the fuels having associated default emission factors, Tier 1 method is applied.

According to the information provided by the NIS, some operators, reporting under the EU ETS for the years 2007–2012, had reported quantities of industrial waste co-incinerated in cement installations as biomass and not as industrial waste. In order to avoid the potential underestimation of emissions in the inventory, from these emissions was subtracted the percentage representing real biomass, and the CO_2 emissions were accounted under the energy sector – corresponding activity category (1A2f). In order not influence the RA-SA difference, the consumption and the corresponding CO_2 emissions were also added in the Reference Approach, as production of industrial wastes and corresponding emissions.

Regarding the previous ERT observation that the energy consumption values for several oil products are consistently higher in the IEA data than in the CRF tables (for lubricants, around 20 per cent higher; for bitumen, around 11 per cent; for residual fuel oil and gasoline around 1 to 2 per cent, respectively), Romania, as declared before, uses the National Statistics Institute activity data provided through the Energy Balance an reported also to EUROSTAT and IEA. Also, for the above type of fuels, as conversion factors, the NCVs reported through the Energy Balance-liquid fuels and assumed for the entire time series or national determined value, are used. In the same time, for the Reference Approach estimations, it was taken into account the default fraction of carbon stored in products which was subtracted from the carbon content.

Results of the Reference Approach

In the bellow graphs the emissions according to the both approaches in terms of all fuels, liquid fuels, solid fuels, gaseous fuels, other fuels, ar ecompared.

Figure 3.7 Comparisonof the sectorial approach with the reference approach

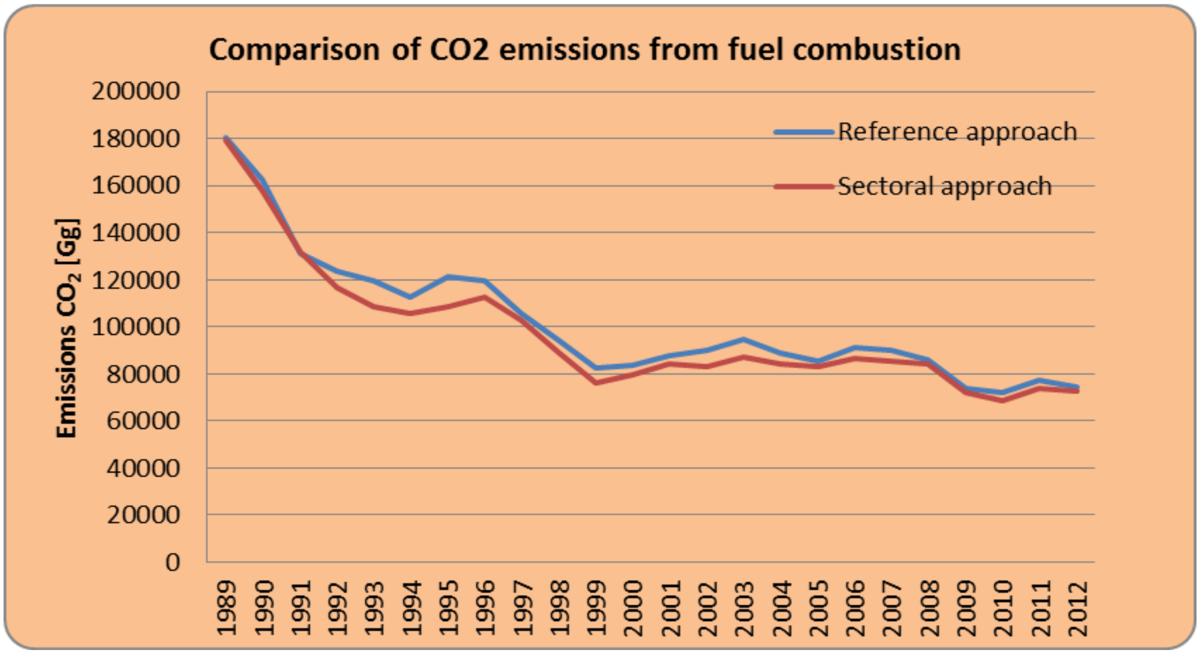


Figure 3.8 Comparisonof the sectorial approach with the reference approach – liquid fuels

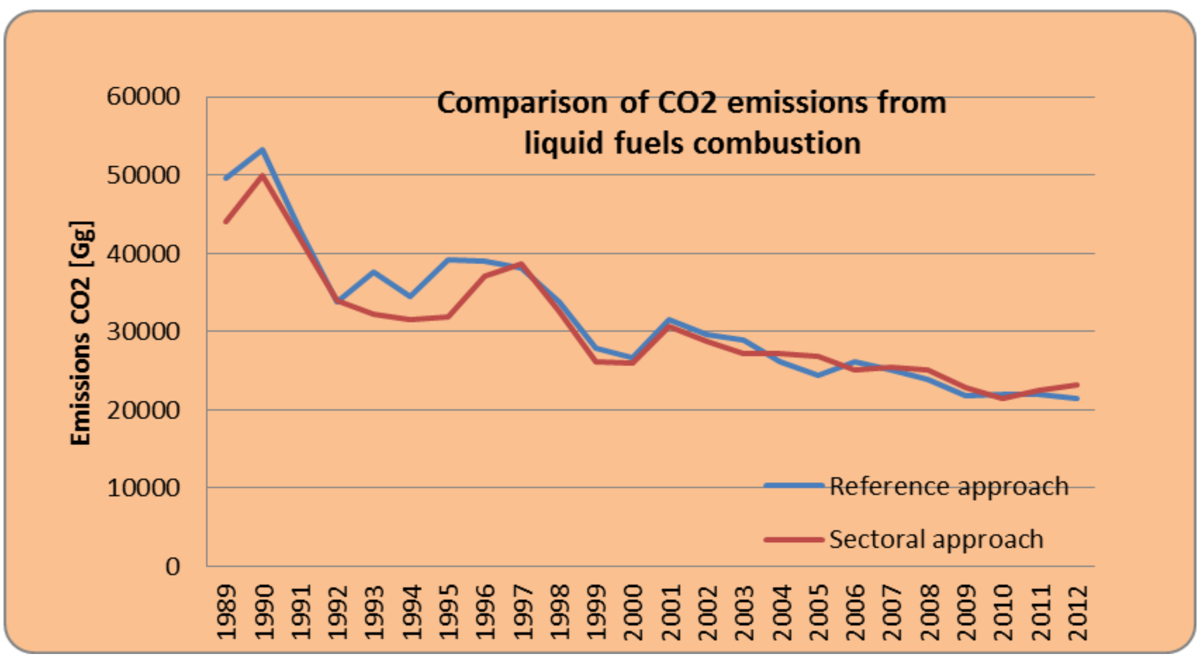


Figure 3.9 Comparisonof the sectorial approach with the reference approach – solid fuels

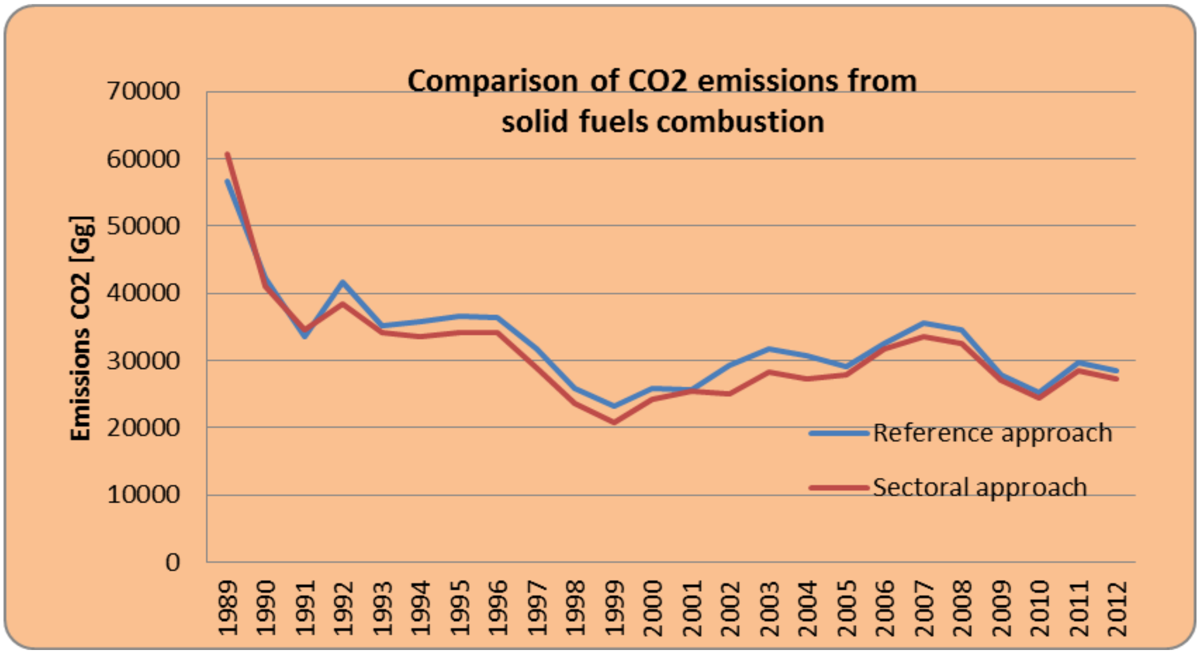
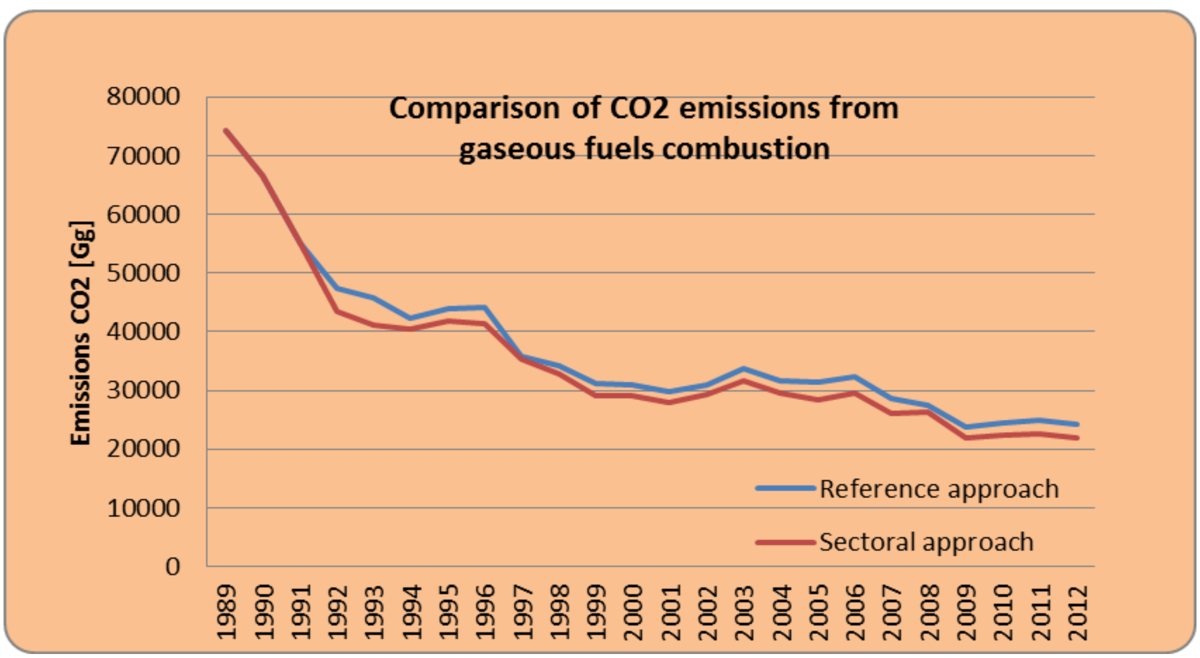


Figure 3.10 Comparisonof the sectorial approach with the reference approach – gaseous fuels



Explanation of Differences

A comparison between the RA and the SA indicates differences in both the energy consumption data and CO_2 emissions, -1.09 % in terms of energy consumption and, 2.43 % in terms of CO_2 emissions for 2012.

One of the reasons for these differences refers to the fact that the Reference Approach deals with the non-energy uses of fuels as if they are combustion activities. A correction is done by the carbon stored from non-energy use of fuel.

Due to the fact that recalculations were performed in the Sectoral Approach in regards of the subtraction of the non-energy use from the 1A1b Petroleum refining - petroleum coke, the RA-SA difference was affected in the sense of decreasing of this difference. Further to a dialog between energy sector experts and the operators from Refineries domain, it was concluded that the petroleum coke is reported in the Energy Balance as refinery fuel, in fact being the quantity of the "catalyst coke" deposited on the catalyst during refining processes and representing process emissions which are accounted as fugitive emissions.

Also, due to the fact that Coke Oven Coke is used as reduction agent in Blast Furnace, Iron and Steel Production activity, this non-energy use of the fuel from the Reference Approach, was subtracted. The result is a balanced approach in respect of the used methodology for the CO_2 emissions estimation in the Reference Approach in comparison with the Sectoral Approach.

An explanation for the differences between the two approaches is provided in the Energy Balance, for some of the years being a significant statistical differences reported, differences generated by the statistical investigation system (while the energy producers are exhaustive recorded, the consumers are inquired on census or on a sampling base, admitting a margin of error). Data are collected by county statistical offices (40 counties) and compiled to regional totals before being sent to the national agency. Electronic checking procedures allow to eliminate errors in compiling the national total. Statistical procedures allow to match missing data. The response rate is above 90%, however. Supply (from census) and consumption (from census and survey) are being reconciled by checking the energy balance. Transformation factors allow to assess losses, again input versus outputs are being checked. In reconciling, statistical errors are being corrected but company information is maintained.

The highest differences between the two approaches are observed in the period 1992-1996, and most notably in 1993 and in 1995. The analysis showed that the main reason for this are the differences in liquid fuels consumption resulting from the significant amounts of refinery loses reported (5.5% of total refinery intake in 1995 was reported as refinery losses) and the reported statistical differences.

For the natural gas consumption in the Petroleum Refineries category the Energy Balance – gaseous fuels provided revised values for the period of 2007-2011, the consumption being decreased on this years and having as results the increasing of the difference RA-SA on the natural gas consumption.

For the NCVs of the solid fuels a reconciliation between the national vaules determined in the Sectoral approach from the EU-ETS monitorin reports and the NCVs used in the corresponding activities, production, import, export, must be made for the next submission. It is the motivation for which in some years of the time series the consumption of the solid fuels in the sectoral approach is higher than those obtained for the reference approach (it is the case of the 1989-1996 period).

Recalculation performed in Reference Approach

- **Liquid Fuels**
  - **Activity data**
    - Motor Gasoline: Net Calorific Value, 1990-2004 period, Energy Balance parameter correction;
    - Kerosene Type Jet Fuel: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction;
    - Transport Diesel: Non-Energy Use in Transformation Sector, 2000, 2008 years - Energy Balance activity data correction;
    - Naphta: Non-Energy Use in Industry, 2008–2011 period - Energy Balance activity data correction;
    - White Spirit & SBP: Non-Energy Use in Industry, 2005–2011 period, Non-Energy Use in Other Sectors, 2005, 2006 years - Energy Balance activity data correction;

- For the fuels reported on the EU-ETS, the national parameter of the NCVs were determined and used: annualy for the EU-ETS period (2007-2012 years) and average of the EU-ETS period for the rest of the time series ; it is the case of the following fuels: Transport Diesel, Refinery Gas, Petroleum Coke, Residual Fuel Oil, Heating and Other Gasoil.

- **Solid Fuels**
  - **Activity Data**
    - Coke Oven Coke: Indigenous Production, 2010 year - Energy Balance activity data correction;
    - Other Bituminous Coal: Indigenous Production, 1992 year - Energy Balance activity data correction.

3.2.2 Source category - International Bunkers (CRF Sector 1.C.1)

The International Bunkers category comprise data and information on the fuels and the emissions resulting from international air and marine transport of passengers and cargo. These GHG related data and information are also subject to the inventory and they are reported, but the GHG emissions are not included in the total sum of the emissions of the country. The Energy Balance provides a split between the domestic and international fuel consumption.

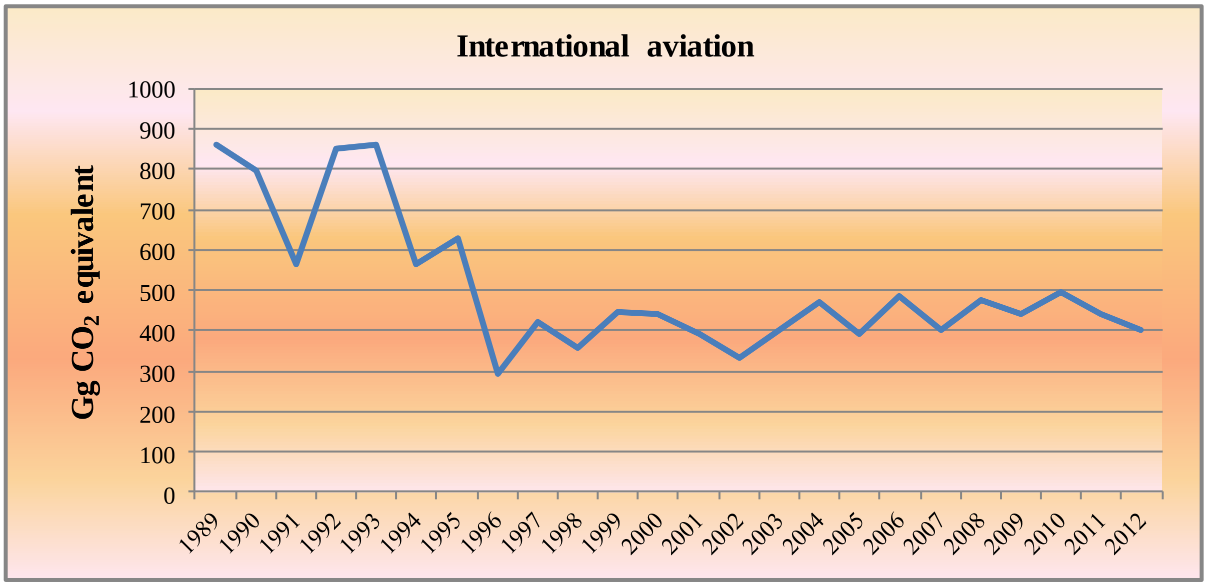
3.2.2.1 International Aviation (CRF Sector 1.C.1.A)

The activity data for International Aviation category were provided through the IEA/Eurostat Questionnaire and values for emissions factors used are provided through the IPCC 2006.

Starting with 2010 inventory submission, fuels consumption for domestic and international aviation were calculated for the cycles of the fly LTO (landing/take off) /Cruise. The fuel consumption/ LTO is provided through the Eurostat website /Aircraft traffic data by reporting country [avia_tf_acc] (see Annex 3.1).

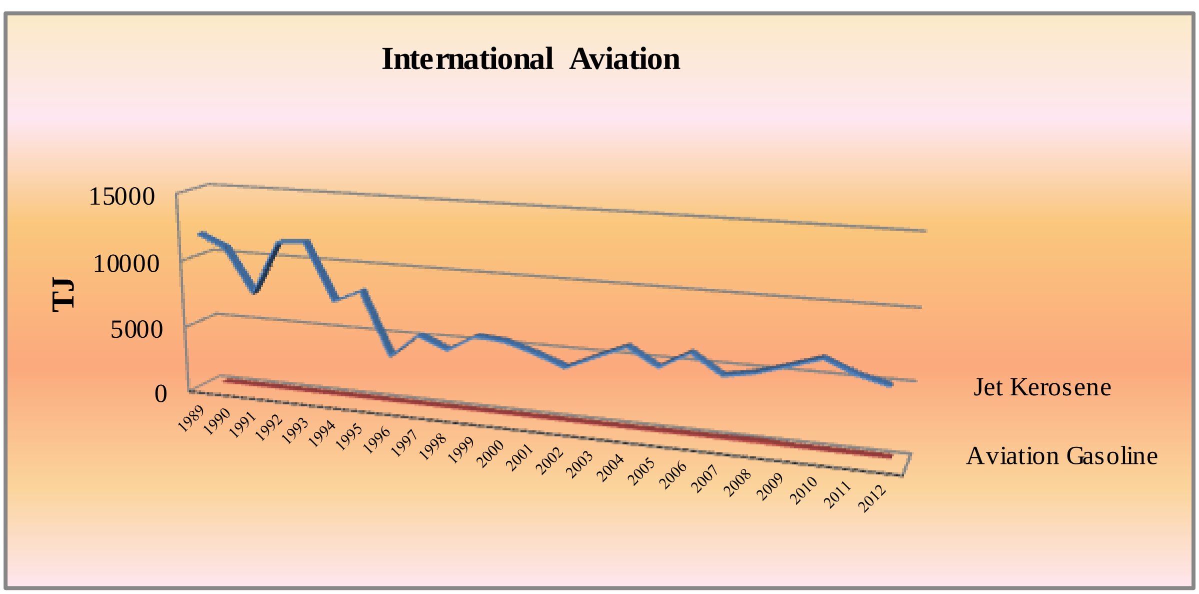
In 2012 the emissions from International Aviation Subsector represent 2.68% of total emissions from the transport sector (15,086.67 Gg CO_2 equivalent).

Figure 3.11 GHG emissions from International Aviation Subsector



In 2012 the emissions from the International Aviation subsector have decreased by 53.8% compared to the base year 1989 due to the fuel consumption decrease and due to new technologies implementation and to aircraft fleet improvement.

Figure 3.12 Fuel consumption associated with the International Aviation Subsector, 1989-2012 period



The Tier1 and Tier 2 method was used and are presented in section 3.2.9.2.2.

The values of CH_4 and N_2O emissions for Domestic and International Aviation were calculated for each cycle type of aircraft flight (kg fuel/ LTO) using the IPCC 2006 methodology vol 2, chapter 3 Table 3.6.9, page 3.70 (see Annex 3.1).

3.2.2.2 International Navigation (CRF Sector Marine 1.C.1.B)

The activity data for international navigation are provided through the IEA/Eurostat Questionnaire; emission factors values used are both country specific and default, provided through the IPCC 1996.

In 2012 the emissions from International Navigation Sub-sector represent 0.29% of total emissions from the transport sector (15086.67 Gg CO_2 equivalent).

Figure 3.13 The GHG emissions from International Navigation Subsector

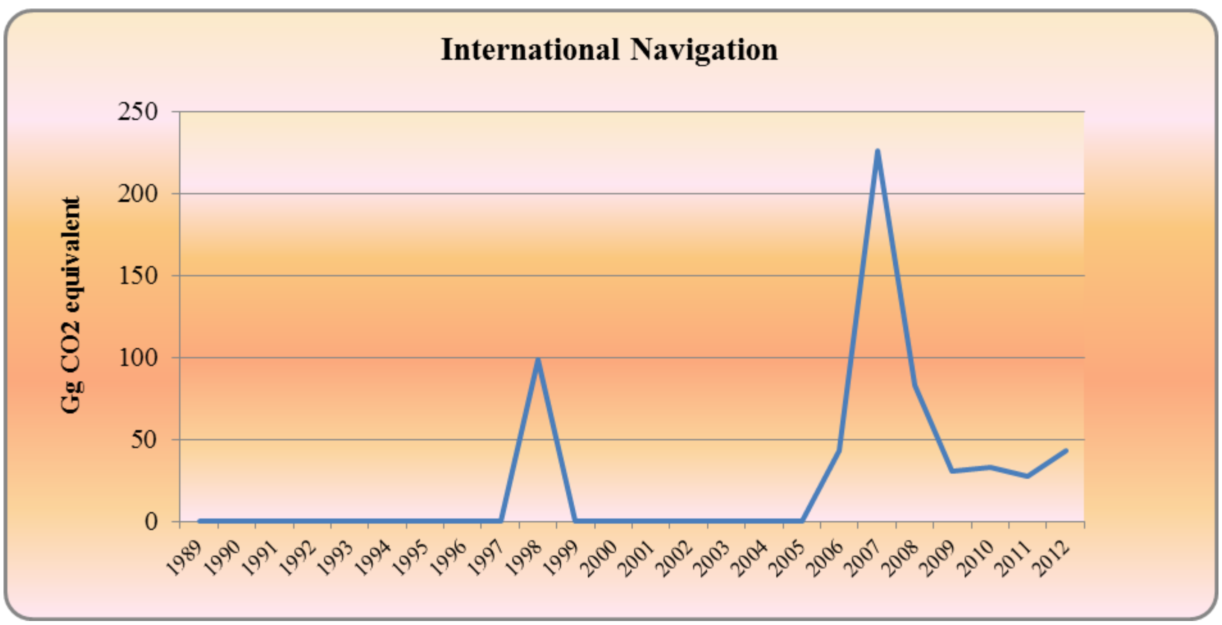
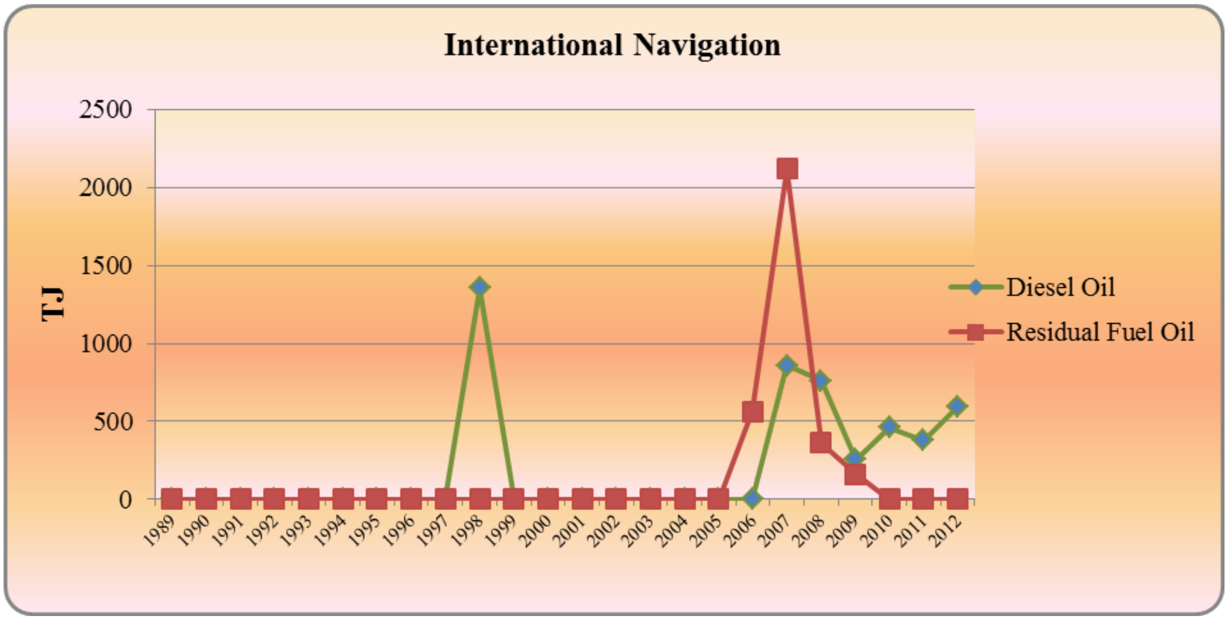


Figure 3.14 Fuel consumption associated with the International Navigation Subsector, 1989- 2012 period



In the period 1989-1997 and1999-2005 is not provided fuel consumption by NSI. In 1998 it is fuel consumption and appears peak of graphic. In 2006 increases fuel consumption by 2007 when we have again peak of graphic. Starting with year 2008 decreases fuel consumption implicitly the emissions value. In coordination with INS, we investigate the accuracy of the data provided.

In 2012, the fuel consumption level associated with the International Navigation Sub-sector increased by 36.39% compared with the one associated with 2011.

The Tier1 and Tier 2 method was used and are presented in section 3.2.9.4.2

3.2.3 Feedstock and non-energy use of fuels

The Energy Balance provides information concerning the non-energy use of the fuels.

In response of ERT recommendation, “Romania further investigate and elaborate on the non-energy use of fuels reported in the energy balance, which is not reported in the energy sector, and assess whether the country specific carbon storage factors are appropriate”, Romania investigated the non-energy use of fuels reported in the energy balance; consequently, Romania subtracted the non-energy use from the Sectoral Approach and the fraction of the carbon stored in the products in the Reference Approach. In the same time, the consumption reported as energy consumption in line with the Energy Balance completion methodology, in fact being used in industrial processes, was accounted as non-energy use and subtracted from the sectoral approach; it is the case of coke_oven_coke which is used as reduction agent in Blast Furnaces and petroleum coke, which is used as catalyst coke and is deposited on the catalyst during refining processes.

Methodology

Non-energy use of fuels is reported in the Energy balance for the following fuels:

- Lubricants;
- Bitumen;
- Naphtha;
- LPG;
- Refinery gas;
- Motor Gasoline;
- Kerosene Type Jet Fuel;
- Other Kerosene;
- Gas-Diesel Oil;
- Petroleum Coke;
- Residual Fuel Oil;
- Natural Gas as Feedstock;
- Other Products;
- Paraffin waxes;
- White spirit;
- Lignite;
- Brown Coal;
- Coal Oil and Tars (from coking coal);
- Other Bituminous Coal.

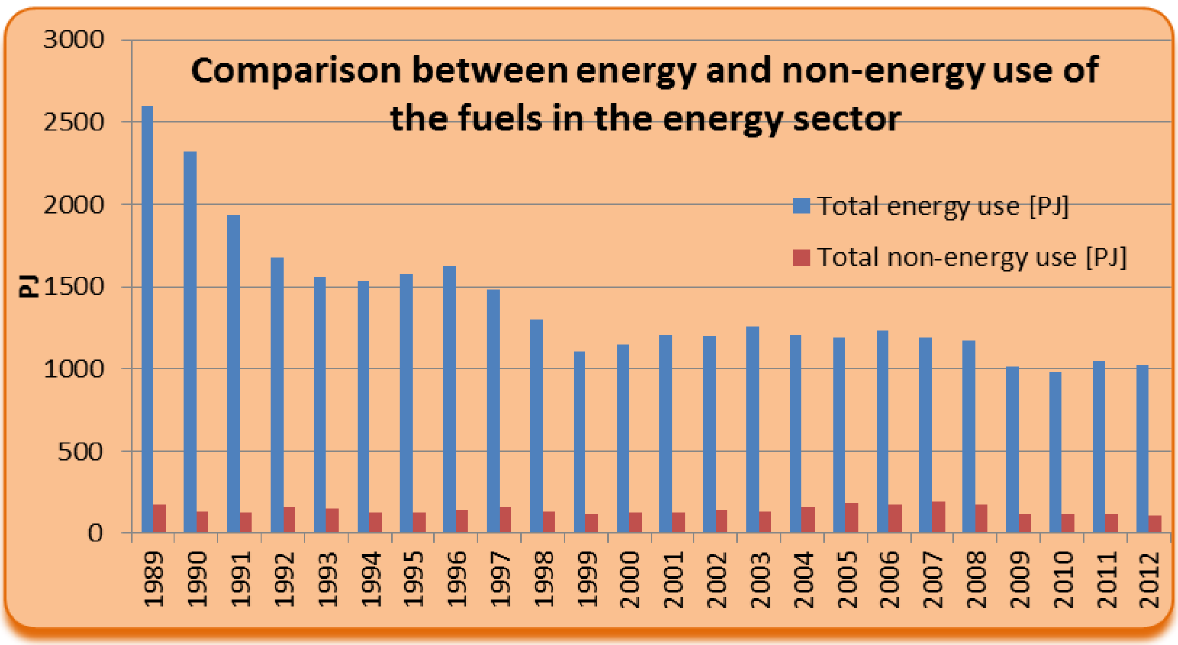
The following type of fuels have been added to the CRF1.AD.10, “Feedstock and non-energy use of fuels - Other fuels” category: Refinery gas, Motor Gasoline, Kerosene Type Jet Fuel, Other Kerosene, Petroleum Coke, Residual Fuel Oil, Other Products, Paraffin waxes, White spirit, Lignite/Brown Coal, Other Bituminous Coal, Coke Oven Coke.

Table 3.4 Non-energy use of fuels compared to total apparent energy consumption

Year	Non-energy use [PJ]	Apparent energy consumption incl. non-energy use [PJ]	[%]
1989	177.876	2,601.38	6.84
1990	138.149	2,325.41	5.94
1991	124.066	1,937.94	6.40
1992	157.638	1,678.07	9.39
1993	148.854	1,562.88	9.52
1994	124.283	1,529.86	8.12
1995	125.967	1,578.11	7.98
1996	144.722	1,626.31	8.90
1997	155.388	1,482.76	10.48
1998	134.859	1,298.86	10.38
1999	120.383	1,107.62	10.87
2000	128.89	1,145.70	11.25
2001	127.434	1,203.39	10.59
2002	141.184	1,198.86	11.78
2003	137.069	1,256.09	10.91
2004	158.302	1,210.05	13.08
2005	183.501	1,190.15	15.42
2006	178.922	1,228.22	14.57
2007	193.216	1,187.54	16.27
2008	177.345	1,172.93	15.12
2009	120.508	1,012.80	11.90

Year	Non-energy use [PJ]	Apparent energy consumption incl. non-energy use [PJ]	[%]
2010	117.67	977.02	12.04
2011	116.399	1,045.51	11.13
2012	104.712	1026.02	10.21

Figure 3.15 Comparison between the energy and non-energy use of the fuels in the energy sector



There are some fluctuations of the reported consumption of some of the fuels during the time series – unstable trends in the exports imports, or production.

The non-energy use of fuels is on average 10.8% of the total apparent energy consumption during the period 1989-2012, and a 10.21% for 2012.

The most significant fuels used as feedstock are natural gas, bitumen, naphtha and lubricants. Also, the Coke_Oven_Coke used as reduction agent in Blast Furnace, the associated emissions being accounted in Industrial Processes sector, represents an important non-energy use quantity.

For coal oil and tars the assumption suggested in the methodology (5.91 % from the coking coal consumption is assumed to be stored in products) was applied.

Figure 3.16 The CO_2 emissionsnot emitted and associated CO_2 emissions of the non-energy use of the fuels

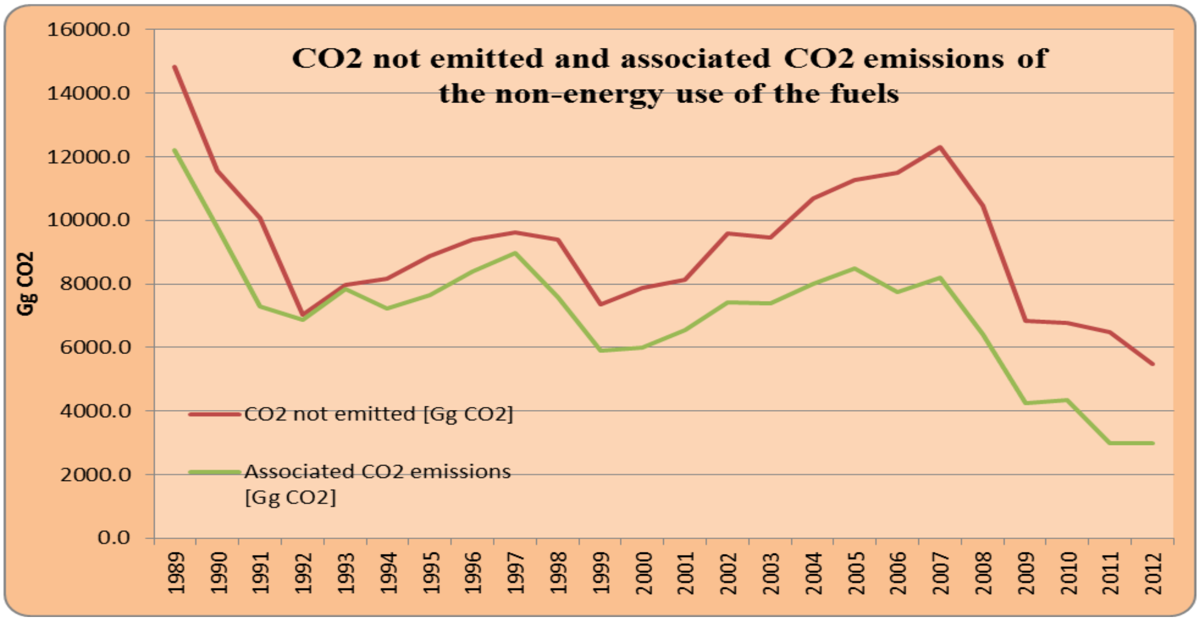
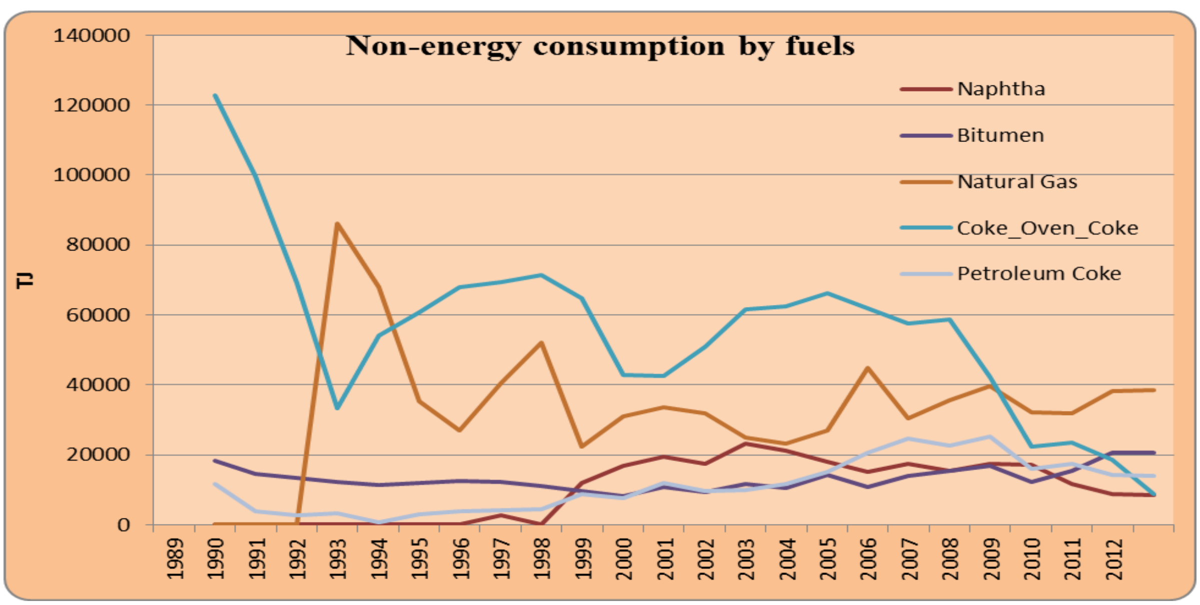


Figure 3.17 The most important non-energy consumption of the fuels



Recalculations performed on Feedstocks and non-energy use of fuels (1.AD category)

- ***Liquid Fuels***

- ***Activity data***
  - *Transport Diesel*: Non-Energy Use in Transformation Sector, 2000, 2008 years - Energy Balance activity data correction;
  - *Naphta:* Non-Energy Use in Industry, 2008–2011 period - Energy Balance activity data correction;
  - *White Spirit & SBP:* Non-Energy Use in Industry, 2005–2011 period, Non-Energy Use in Other Sectors, 2005, 2006 years - Energy Balance activity data correction.
  - For the liquid fuels reported on the EU-ETS, the national parameter of the NCVs were determined and used to calculate the non-energy use of the fuels: annualy for the EU-ETS period (2007-2012 years) and average of the EU-ETS period for the rest of the time series; it is the case of the following fuels: Transport Diesel, Refinery Gas, Petroleum Coke, Residual Fuel Oil, Heating and Other Gasoil.

3.2.4 CO_2 capture from flue gases and subsequent CO_2 storage

CO_2 capture from flue gases and CO_2 storage is not occurring in Romania.

3.2.5 Country-specific issues

Due to country-specific issues within the national statistics elements, different sources of information were used depending on the period and source categories.

For the stationary combustion the EUROSTAT/ IEA format of the energy balances prepared by the Romanian National Institute for Statistics were the most significant source of information and they were used for estimating the emissions for the years 1990-2012. The National Statistics have not prepared balances in the Eurostat format for the years before 1990, so the Romanian Energy balances transmitted by International Energy Agency (IEA), were used for the year 1989.

It was accomplished a study by the Romanian Institute for Studies and Power Engineering (ISPE), analysing the data from the operators reporting on EU ETS, conducting to the development of the Country Specific Emission Factors.

3.2.6 Source category - Fuel combustion (CRF sector 1.A.)

The fuel consumption of the following subcategories is included in this category:

- 1.A.1. Energy Industries;
- 1.A.2. Manufacturing Industries and Construction;
- 1.A.3. Transport;
- 1.A.4. Other Sectors;
- 1.A.5. Other.

3.2.6.1 Source category description

CO_2 emissions from fuel combustion activities accounted for 74,312.79 Gg CO_2 equivalent in 2012.

Within the fuel combustion sector, 43.8% of the CO_2 equivalent emissions correspond to Energy Industries category, 20.7% of the CO_2 equivalent emissions correspond to 1.A.2 Manufacturing Industries and Construction, 20.3% of the CO_2 equivalent emissions correspond to 1.A.3 Transport, 14.5% of the CO_2 equivalent emissions correspond to 1.A.4 Other Sectors and less than 1% from the CO_2 equivalent emissions correspond to 1.A.5 Other (Not specified elsewhere).

It is observed that Energy Industries are the main source of GHG emissions from fuel combustion with 43.8% of the emissions in 2012. In general, there is a notable drop in the country emissions after 1990-1991 due to the transition from planned economy to market economy, which happened in the country. Generally, there is a decrease of the GHG emissions up to 1999 and slow increase after 2000, after the national economy started to grow and due to the new technologies used. In the recent years (2009-2010) due to the economic crisis the emissions are decreasing again, under the 1999 levels.

Figure 3.18 Total GHG CO_2 equivalent. emissions associated with the Fuel Combustion Activities by categories

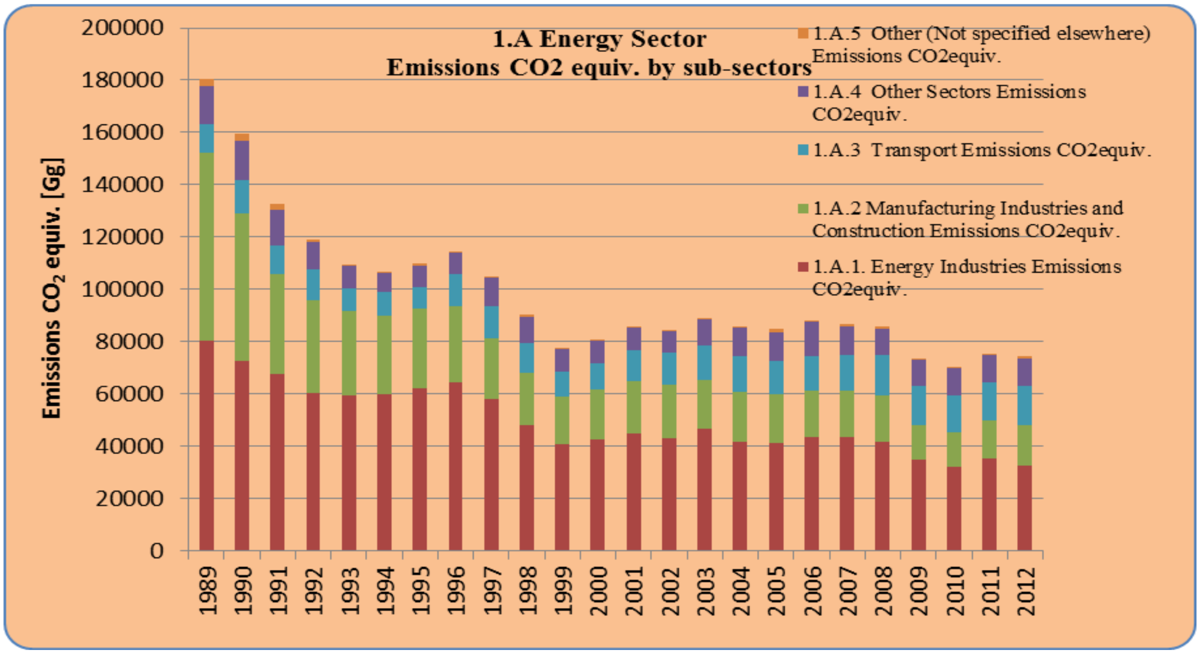
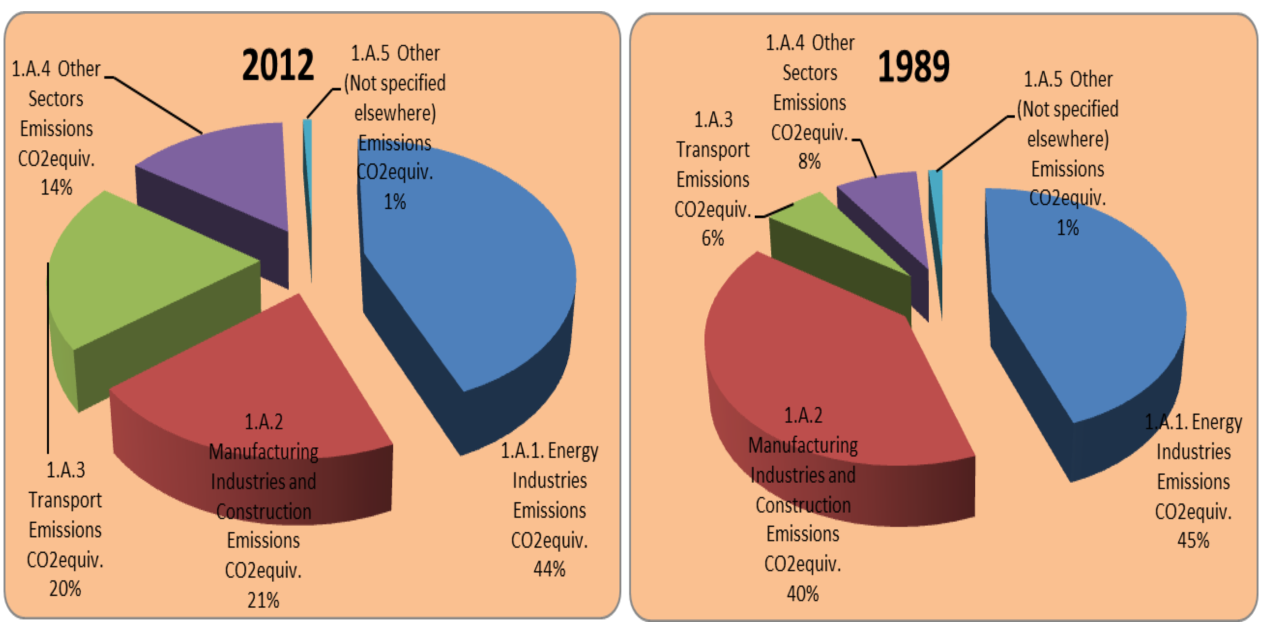


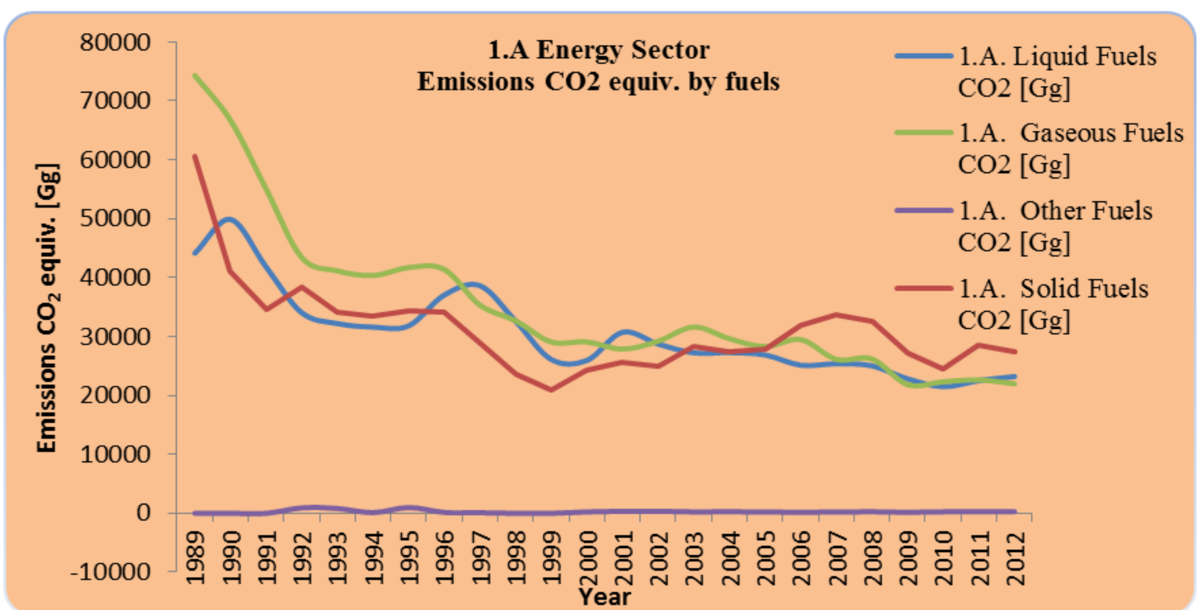
Figure 3.19 Base year and current year comparison in respect to the contribution of Fuel Combustion Activities Subsector categories emissions in total Subsector emissions



In 2012 a slight increase of the CO_2 equivalent is observed in 1.A.2 Manufacturing Industries and Construction with 5.71%, in 1.A.3 Transport with 3.7% and in 1.A.4 Other sectors with 5.43 %. A slight decrease of the CO_2 equivalent could be observed in the 1.A.1 Energy Industries with 8.46% and in 1.A.5 Other Not specified elsewhere with 2.5%. The demand for energy from fossil fuels is lower than in precedent year due to the fact that in 2012 the usage of the renewables sources (wind) registered an increasing; additional, the thermal regime was not very severe and the necessary of the energy for heating was slower than in precedent year. Overall, the fossil fuels emissions of the greenhouse gas have a descendent trend in 2012 in comparison with 2011.

Manufacturing industry and construction is the sector which changed drastically – compared to 1989, the emissions being decreased from 40% to 20.7%. In the same time the transport sub-sector has a substantial modification in the contribution to the overall energy emissions, rising from 6% in the base year up to 20.3% in 2012.

Figure 3.20 Total CO_2 emissions [Gg] from Fuel combustion by fuel type



Starting with 2003 the main contribution to CO_2 emissions was from solid fuels, having a pick in 2007-2008. In 2012 the contribution of the liquid fuel was about 32%, solid 38%, gaseous 30%. It could be observed that, the three main fuels have, each of them, a significant contribution to the total of the Energy Industry CO_2 emissions. Only within the period of 2005–2007, the trend presents an increase of the solid fuels, mostly due to the energy industries growth and a decrease in liquid and gaseous fuels share.

3.2.6.2 Methodological issues

Stationary Combustion

Methodology

In the development of estimates, it was primarily utilized default EFs obtained from the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and, in some cases (where the other two IPCC sources don't provide values), the IPCC 2006 Guidelines.
To achieve the estimations of the CO_2 emissions on the national circumstances, a study, "Elaboration/documentation of national emission factors/other parameters relevant to National Greenhouse Gas Inventory (NGHGI) Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher tier calculation methods implementation", has determined the national emission factors based on EU-ETS operators reporting on the period of 2007–2010. For the years 2011 and 2012, the estimations for the CO_2 emissions were determined using the national emission factors, these values being achieved by using the methodology provided through the same study.

A) Tier 1 methodology

The IPCC Tier 1 approach (Revised 1996 IPCC Guidelines) is used to calculate the emissions from fuel combustion in the sectors CRF 1.A.1, CRF 1.A.2., CRF 1.A.4 and CRF 1.A.5.
For the gases CO_2, CH_4, N_2O and the indirect GHGs, default emission factors are used.
The formula used in the calculations is the following:

Equation 3.1 CO_2 emission estimation Tier 1 methodology Stationary Combustion

$$E = F * EF_{default}$$

where:

- ❖ E = emissions
- ❖ F = fuel consumption
- ❖ $EF_{default}$ (fuel) = default (IPCC)

B) Tier 2 methodology

According to the provisions in the relevant decision trees in the IPCC GPG 2000, giving their status of key categories, both by level and trend criteria, the IPCC Tier 2 approach (Revised 1996 IPCC Guidelines) is used to calculate the CO_2 emissions from fuel combustion in the sectors CRF 1.A.1, CRF 1.A.2., CRF 1.A.4 and CRF 1.A.5.

For the CO_2 gas, Country Specific Emission Factors are used.

The formula used in the calculations is the following:

Equation 3.2 CO_2 emission estimation Tier 1 methodology Stationary Combustion

$$E = F * EF_{CS/\ default}$$

where:

- ❖ E = emissions
- ❖ F = fuel consumption
- ❖ EF(fuel) = CS (country specific)
- ❖ EF(fuel) = default (IPCC)

Activity Data

The activity data required for calculation of the emissions from stationary combustion is based on the National Energy Balances, which provide information about the indigenous production, imports, exports and inland consumption, by subsector, of all types of fuels.

Solid, liquid and gaseous fuels

The balances provide the consumption of fuels in natural units (mass or volume units – thousands of tones (Gg) for solid and liquid fuels, cubic meters for gaseous fuels) and the net calorific values for each fuel per subsector.

The energy balances prepared by the Romanian National Institute for Statistics in the Eurostat format, were used for estimating the emissions for the years 1990-2012. The National statistics have not prepared balances in the Eurostat format for the years before 1990, so the IEA Energy balances were used for the year 1989.

Other Fuels – Industrial Wastes

Additionally, since it was found that the usage of alternative fuels (industrial waste) is reported in the energy balances for the full time series, it were calculated the emissions associated with this kind of consumption. Romanian Institute for Statistics, NIS, provided the information that, the operators using the co-incineration in the cement plants have reported this activity to the Biomass section. Further to this information, it was taken into consideration their emissions too, to the activity CRF 1A.2.f. other fuels – industrial wastes, extracting from their reports the consumption associated with biomass.

According to the sectoral approach methodology for stationary combustion, only the fuel quantities that are combusted are relevant and thus considered for the emission calculations.

Reported quantities of fuels for non-energy use and feedstock use, international bunker fuels, transformation and distribution losses, transformations of fuels to other fuels and internal refinery processes which have been reported in the transformation sector of the energy balances were not considered.

Biomass

In order to estimate the emissions from biomass combustion activities a separated spreadsheet was completed, using the energetic quantities provided by Energy Balance.

A wide range of biomass sources can be used to produce bioenergy in a variety of forms. In Romania different types of biomass, solid, liquid and gaseous, are consumed in the energy sector. Solid biofuels comprises the following:

- wood and wood waste combusted directly for energy purposes;
- Liquid biofuels are bio gasoline, biodiesel and other bio liquids which are used mainly for transportation and they are analised in the corresponding sector;
- Landfill, sludge and other biogas are derived from anaerobic fermentation of biomass and solid wastes in landfills, from sludge and animal slurries and other sources, respectively.

All these types are combusted to produce heat and/or power. However, CO_2 emissions released from these processes are reported as an information item, as the CO_2 is naturally captured from the air. That is not applicable for the CH_4 and N_2O emissions, being reported and accounted for, in the total inventory emissions.

The correspondence between the energy balance categories and CRF categories can be reviewed in the ANNEX 2.

Choice of NCV

The net calorific values (NCVs) used for converting mass or volume units of the fuel quantities into energy units [TJ], excluding the fuels which are reported through the EU-ETS reports, are provided by NIS. For the solid fuels other bituminous coal, lignite, coke_oven_coke and for the liquid fuels transport diesel, refinery gas, residual fuel oil, petroleum coke, heating and other gasoil, national values of the NCV were derived from the EU-ETS reports. For EU-ETS period, 2007-2012, annualy determination of the NCVs weighted averages values were used and, for the rest of the time series, the averages of the EU-ETS period were used. All the used NCVs for the liquis and solids and presented in ANNEX 4. The corresponding Net Calorific Values (NCVs) from the Energy balances and from the corresponding EU-ETS determination were used in order to convert the fuel consumption reported in natural units to energy units.

For the solid fuels, not having NCVs determined from EU-ETS data**,** the balances provide NCVs values for the following activities:

- ❖ NCV for produced fuels - applied to Indigenous Production subcategory;
- ❖ NCV for imported fuels - applied to Total Imports subcategory;
- ❖ NCV for exported fuels - applied to Total Exports subcategory;
- ❖ NCV for fuels used in coke ovens - applied to Coke Ovens (Energy) subcategory;
- ❖ NCV for fuels used in blast furnaces - applied to Blast Furnaces (Energy) subcategory.
- ❖ NCV for fuels used in main activity plants - applied to:
  - Main Activity Producer Electricity Plants;
  - Main Activity Producer CHP Plants;
  - Main Activity Producer Heat Plants;
  - Own Use in Electricity, CHP and Heat Plants.
- ❖ NCV for fuels used in industry - applied to:
  - Auto producer Electricity Plants;
  - Auto producer CHP Plants;
  - Auto producer Heat Plants;
  - Iron and Steel;
  - Chemical (including Petrochemical);
  - Non-Ferrous Metals;
  - Non-Metallic Minerals;
  - Transport Equipment;
  - Machinery;
  - Mining and Quarrying;
  - Food, Beverages and Tobacco;
  - Paper, Pulp and Printing;
  - Wood and Wood Products;
  - Construction;
  - Textiles and Leather;
  - Non-specified (Industry).
  - NCV for fuels used for other uses - applied to:
    - o Commercial and Public Services;

- Residential;
- Agriculture/Forestry;
- Fishing;
- Non-specified (Other).

For liquid fuels the balances provide the average of NCVs, which were used in all calculations.

For gaseous fuels was used directly the amount in TJ as reported by the energy balances. Since the reported values are Gross Calorific Values, all numbers were multiplied by 90% in order to compute the NCV. (Revised 1996 IPCC GL: Reference manual, Ch. 1, p. 1.24, Table 1-4; IEA Energy Statistics Manual, p. 183, Table A3.12)

For all NCVs please consult ANNEX 4.

Emission factors

CO_2 emission factors

The default carbon emission factors according to the IPCC 1996 Guidelines, Vol. II, Ch. 1, Table 1-2, p.1.6 are used. The emission factors for CO2 were calculated based on the default carbon emission factors and default oxidation factors listed in the corresponding tables, using the following equation:

Equation 3.3 CO_2 emission factors for stationary sources

$$EF = \frac{C * 44 * Ox}{12}$$

where:

- C – carbon content in t/TJ;
- Ox - oxidation factor.

Oxidation factors

Oxidation factors	
Coal	0.98
Oil and Oil Products	0.99
Gas	0.995
Peat for electricity generation	0.99

The fraction of carbon oxidized is referenced in the IPCC 1996 Guidelines, Vol. II, Ch. 1, Table 1-4. The carbon emission factors are referenced in the IPCC 1996 Guidelines, Vol. II, Ch. 1, Table 1-2.

The default EFs were used for the calculations, except for the following fuels, for which country-specific EFs were used:

- Lignite;
- Natural gas;
- Refinery gas;
- Other bituminous coal;
- Coke oven coke;
- Transport diesel;
- Residual fuel oil;
- Heating and other gasoil;
- Petroleum coke;
- Motor gasoline
- Industrial waste.

For sludge gas and other biogas are used the new emission factors referenced in IPCC 2006 guidelines, Vol. II, Ch. 2, Table 2-2, Table 2-3, Table 2-4, Table 2-5. Emission factors for sludge gas and other biogas are not available in the 1996 Guidelines.

Emission data reported under the European Emission Trading Scheme

A sum of operators has provided their verified CO_2 emission reports required under the EU ETS for the years 2007-2012.

Data from the verified ETS reports were analyzed in order to use a Tier 2 methodology for emission calculations. The number of plants, using a plant specific methodologies, made possible to achieve country specific EFs for a sum of solid and liquid fuels and natural gas (listed above).

Also, the contry specific emission factor for the industrial wastes ETS reporting, was derived. These emission factors (without oxidation fraction included) are derived from the verified ETS reports as a weighted average from all operators which have declared that they have used plant-specific emission factors (Tiers 3 according to the Methodology for monitoring GHG emissions of operators participating in the ETS).

Table 3.5 Country-Specific CO_2 emission factors for stationary combustion, without oxidation included, from ETS verified reports

EF [t/TJ]	**Year**						
Type of Fuel	**2007**	**2008**	**2009**	**2010**	**2007-2010 WA EFs**	**2011**	**2012**
Lignite	102.14	98.87	97.70	96.55	98.96	94.49	94.38
Natural gas	55.20	55.58	55.49	55.78	55.49	55.52	55.58
Refinery gas	55.12	54.05	57.99	57.42	56.10	57.42	56.90
Other bituminous coal	93.24	94.34	95.20	94.88	94.55	91.80	87.91
Coke_Oven_Coke	92.92	84.33	92.89	92.65	91.22	95.16	93.88
Transport diesel	74.00	72.35	74.04	72.75	73.29	72.92	73.56
Residual fuel oil	78.58	76.81	77.97	79.69	78.15	79.49	79.48
Heating and other gasoil	74.46	77.87	74.45	73.66	74.19	73.31	74.08
Petroleum Coke	-	94.34	91.85	94.02	93.63	98.50	96.83
Industrial Wastes	83.49	83.51	83.18	84.36	83.71	83.50	83.81

The EFs having the oxidation included are calculated as the total sum of the verified CO_2 emissions divided by the total amount of the respective energetic fuel consumption, in the corresponding activity category, as reported by the operators. Further, the weighted average is applied on activity category where the type of fuel is reported.

Table 3.6 Country-Specific CO_2 emission factors for stationary combustion, oxidation included, from ETS verified reports

EF Ox [t/TJ]	Year						
Type of Fuel	**2007**	**2008**	**2009**	**2010**	**2007-2010 WA EFs**	**2011**	**2012**
Lignite	97.80	94.23	91.65	89.04	93.38	86.96	87.67
Natural gas	54.73	55.65	55.31	55.43	55.27	55.52	55.58
Refinery gas	54.89	56.92	58.00	57.08	56.44	57.42	56.90
Other bituminous coal	92.97	93.43	95.19	97.04	94.64	91.08	86.94
Coke_Oven_Coke	92.06	84.46	92.97	92.65	91.11	95.16	93.88
Transport diesel	73.95	73.43	74.22	73.29	73.74	72.92	73.56
Residual fuel oil	78.09	76.86	78.00	79.71	78.02	79.49	79.48
Heating and other gasoil	74.36	78.50	74.65	73.67	74.30	73.29	74.08
Petroleum Coke	0.00	94.52	91.85	94.02	93.73	98.50	96.83
Industrial Wastes	-	-	-	-	-	83.50	83.81

Country-Specific Emission Factors

In a similar way, country-specific emission factors were calculated as a weighted average for all the years (period of 2007–2010). The following country-specific emission factors were used for the calculations of the emissions for the 1989–2006 period and subsectors in CRF 1.A, except CRF 1.A.3. The country-specific emission factors are listed in the following table:

Table 3.7 Country-specific emission factors 2007-2010 period weighted averages

Fuel Type	EF CO_2 t/TJ (including oxidation factor)	EF CO_2 t/TJ (excluding oxidation factor)	Carbon Content t/TJ
Lignite	93.38	98.96	26.99
Natural gas	55.27	55.49	15.13
Refinery gas	56.44	56.10	15.30
Other bituminous coal	94.64	94.55	25.79
Coke oven coke	91.11	91.22	24.88
Transport diesel	73.74	73.29	19.99
Residual fuel oil	78.02	78.15	21.31
Heating and other gasoil	74.30	74.19	20.23
Petroleum Coke	93.73	93.63	25.54
Motor Gasoline*	71.62	71.62	19.53
Industrial Wastes	83.50	83.50	22.77

* **For the *Motor gasoline* fuel**, the country specific emission factor is calculated based on the content of the carbon, reported by Romanian authorities and using the formula provided by the above Study.

CH_4 emission factors for stationary sources

The following default emission factors for CH4 are applied (IPCC 1996 Reference Manual, Ch.1, Table 1-7, p. 1.35). For sludge gas and other biogas are used the new emission factors referenced in IPCC 2006 guidelines, Vol. II, Ch. 2, Table 2-2, Table 2-3, Table 2-4, Table 2-5. Emission factors for sludge gas and other biogas are not available in the 1996 Guidelines.

Table 3.8 Emission factors for CH_4 for different fuels

EF CH_4 [Kg/TJ]	**Coal**	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Other Biomass and Wastes**
Energy Industries	1	1	3	30	200	30
Manufacturing Industries and Construction	10	5	2	30	200	30
Commercial/Institutional	10	5	10	300	200	300
Residential	300	5	10	300	200	300
Agriculture/Forestry/Fishing	300	5	10	300	200	300

N_2O emission factors for stationary sources

The following emission factors for N_2O are default, referenced in IPCC 1996 Reference Manual, Ch.1, Table 1-8, p. 1.36. For sludge gas and other biogas emission factors are referenced in IPCC 2006 guidelines, , Vol. II, Ch. 2, Table 2-2, Table 2-3, Table 2-4, Table 2-5.

Table 3.9 Emission factors for N_2O for different fuels

EF N_2O [Kg/TJ]	**Coal**	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Other Biomass and Wastes**
Energy Industries	1.4	0.1	0.6	4	4	4
Manufacturing Industries and Construction	1.4	0.1	0.6	4	4	4
Commercial/Institutional	1.4	0.1	0.6	4	1	4
Residential	1.4	0.1	0.6	4	1	4
Agriculture/Forestry/Fishing	1.4	0.1	0.6	4	1	4

NO_x, CO, NMVOC, SO_2 emission factors for stationary sources

The following tables present the values of the emission factors used for the emissions estimations of the NO_x, CO and NMVOC indirect gases.

Table 3.10 NO_x emission factors for different fuels

EF NO_x [Kg/TJ]	**Coal**	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Other Biomass and Wastes**
Public electricity and heat production	300**	150**	200**	100**	100**	100**
Petroleum Refineries	300**	150**	200**	100**	100**	100**
Manufacture of Solid Fuels and Other Energy Industries	22*	150**	200**	100**	100**	100**
Manufacturing Industries and Construction	173*	70*	100*	150*	100**	100**
Commercial/Institutional	173*	70*	100*	150*	100**	100**
Residential	110*	57*	68*	74.5*	100**	100**
Agriculture/Forestry/Fishing	173*	70*	100*	150*	100**	100**

Table 3.11 CO emission factors for different fuels

CO [kg/TJ]	**Coal**	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Other Biomass and Wastes**
Public electricity and heat production	113*	39*	5*	258*	1000**	1000**
Petroleum Refineries	20**	39*	5*	1000**	1000**	1000**
Manufacture of Solid Fuels and Other Energy Industries	525*	20**	15**	1000**	1000**	1000**
Manufacturing Industries and Construction	931*	25*	40*	1596*	4000**	4000**

CO [kg/TJ]	**Coal**	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Other Biomass and Wastes**
Commercial/Institutional	931*	25*	40*	1600*	7000**	5000**
Residential	4600*	31*	46*	5300*	7000**	5000**
Agriculture/Forestry/Fishing	931*	25*	40*	1600*	7000**	5000**

Table 3.12 NMVOC emission factors for different fuels

NMVOC [Kg/TJ]	**Coal**	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Other Biomass and Wastes**
Public electricity and heat production	1.7*	1.5*	0.8*	7.3*	100**	50**
Petroleum Refineries	5**	1.5*	0.8*	50**	100**	50**
Manufacture of Solid Fuels and Other Energy Industries	2.4*	5**	5**	50**	100**	50**
Manufacturing Industries and Construction	88.8*	2.5*	10*	146.4*	100**	50**
Commercial/Institutional	88.8*	2.5*	10*	146*	100**	600**
Residential	484*	10.5*	15.5*	925*	100**	600**
Agriculture/Forestry/Fishing	88.8*	2.5*	10*	146*	100**	600**

Notes:

* *For the indirect gases, NO_x, CO, NMVOC, the emissions factors provided by the National Inventory of Air Pollutants under the CLRTAP, were used.*

** *The above default NOx, CO, NMVOC emission factors are in accordance with the IPCC 1996 Guidelines.*

For the 2005–2012 period, the NO_x emissions under CLRTAP reporting (based on measured emissions reported by the Large Combustion Plants), in the 1A1a activity category, were used.

In the 1A1c activity category, 1A2, 1A4 subsectors, 1A5a activity category, for the estimation of the NO_x emissions, the emission factors provided by the National Inventory of Air Pollutants under the CLRTAP, were used.

SO_2 Emission Factors

For the estimation of the SO_2 emissions, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook—2009 (bellow table), were analyzed.

Table 3.13 Default Emission Factors For SO_2 Emissions

EF SO_2 [g/GJ]	Hard Coal	Brown Coal	Natural Gas	Derived Gases	Heavy Fuel Oil	Other Liquid Fuels	Biomass
1.A.1.a Electricity and Heat Production	820	820	0.3	0.3	485	460	11
1.A.1.b Petroleum Refining	–	–	–	0.3	–	–	–
1.A.1.c Manufacture of Solid Fuels	55	55	–	–	–	–	–
1.A.2.a Manufacturing and Construction - Iron and Steel	900	900	0.5	0.5	140	140	38.4
1.A.4.b Residential combustion	900	900	0.5	0.5	140	140	20
1.A.4.a, 1.A.4.c, 1.A.5 Non-residential combustion	900	900	0.5	0.5	140	140	38.4

In order to have consistency in estimation of SO_2 emissions with the National Inventory of Air Pollutants under the CLRTAP, in the 1.A.1.a Electricity and Heat Production activity category, the country specific emission factors for solid fuels (being the most used type of fuel), calculated taking account national circumstances, were used. Therefore, based on the reporting of the Large Combustion Plants, for 2005 year, the SO_2 country specific emission factor was determined and used for the 1989–2004 time-series.

For the 2005–2012 period, the SO_2 emissions estimation, the reporting under CLRTAP (based on measured emissions reported by the Large Combustion Plants), in the 1A1a activity category, were used.

In the 1A1c activity category, 1A2, 1A4 subsectors, 1A5a activity category, for the estimation of the SO_2 emissions, the emission factors provided by the National Inventory of Air Pollutants under the CLRTAP, were used.

Table 3.14 Country Specific SO_2 emission factors – 1.A.1.a, solid fuel

EF SO_2 [Kg/GJ]	**1989-2003**	**2004**
COAL combusted in 1.A.1.a Electricity and Heat Production	1.782	1.782

3.2.6.3 Uncertainties and Time-Series Consistency in CRF 1.A

The values were collected/elaborated in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Based on the above background information, the results of the uncertainties associated to the GHG emissions estimates are as follows:

AD uncertainty

- Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;
- Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;
- Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;
- Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;
- Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 7%.

EFs uncertainty

- ***CO_2 gas:***
- ❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 0.8%;
- ❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 4%;
- ❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 0.5%;
- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 20%;
- ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 20%.

- ***CH_4 gas:***
- ❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- ❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- ❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%.

- ***N_2O gas:***
- ❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- ❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- ❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%.

Aggregated uncertainty

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

- ***CO_2 gas:***
- ❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3.1%;
- ❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 5.0%;

- ❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3.0%;
- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 20.2%;
- ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 21.2%.

- ***CH_4 gas:***
- ❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.1 %;
- ❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.1%;
- ❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.1%;
- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.1%;
- ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.5 %.

- ***N_2O gas:***
- ❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.1%;
- ❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.1%;
- ❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.1%;
- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.1%;
- ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.5 %.

3.2.6.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Program were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *Fugitive Emissions* category, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In order to have accounted in the sectoral approach only the emissions due to the fuel burning and not double account with other inventory sectors or other subsectors from the energy sector, a consultation with the refineries operators were started in order to find if the petroleum coke reported as refinery fuel is an energy consumption or is used in refinery processes; the conclusion of this consultation was that the petroleum coke reported in the energy balance as refinery fuel is used as catalyst coke and deposited on the catalyst during refining processes; this coke is not recoverable and represents process emissions. Thus, the petroleum coke was subtracted from 1A1b Petroleum Refineries category.

The energy balances present some format modifications, now the non-energy consumption not being included in the total energy consumption, being reported separately. In addition, modifications of how the values of some by-products are provided have been made. Energy balance provides some corrections of the NCV parameter for a sum of fuels. All modifications and corrections made in the energy balances provided activity data and parameters, are analyzed and incorporated in the energy sector emissions estimations.

The above corrections are described in the Chapter 3.2.6.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of this correction are described at the Chapter 3.2.6.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2012 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

The activity data series were also compared to those on EUROSTAT, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared with national emission factors values specific to Bulgaria, considering that similar activities are implemented. Further elements are presented within Annex 8.2."

Specific to the stationary combustion, for the calculation of the emissions from CRF category 1A, it was developed an Excel spreadsheet model, which was linked directly to the Eurostat format energy balances provided by the NIS. Wherever it was possible, automated data validation was implemented within the model, but many manual checks were performed, too.

Furthermore the background data for the emission factors calculations under the ETS, were used for further QA/QC checks.

In response to the ERT recommendation, there is presented in the bellow table an analysis resulting from the ISPE Study regarding the share of the EU-ETS fuel combustion to the Energy Balance reporting, within the corresponding activity category.

Table 3.15 Share of the EU-ETS installations to the National Energy Balance, 2008 year

CRF Category	Main activity	Share of the EU-ETS reporting to the EB [%]	Reporting Plants
1A1a	***Electricity and heat production***	**90,25**	
1A1 a - i	Electricity production	99,66	Nominal installed thermal power plants > 20 MWt reporting
1A1 a – ii	Electricity and heat production		
1A1 a - iii	Heat production	73,47	
1A1 b	Petroleum refining	74,15	Emissions from fuel combustion only
1A1 c	Manufacture of solid fuels and other industries		Nominal installed thermal power plants > 20 MWt reporting
1A2	***Manufacturing industry and Construction***	**60,60**	
1A2 a	Iron and Steel	53,92	Fuel combustion for the installations having production capacity greater than >2,5 tones/h and nominal installed thermal power plants > 20 MWt reporting
1A2 b	Non-ferrous metals (aluminum)		Nominal installed thermal power plants > 20 MWt reporting
1A2 c	Chemical	74,44	Nominal installed thermal power plants > 20 MWt reporting
1A2 d	Pulp, Paper and Print	90,43	Fuel combustion for the installations having production capacity greater than >20 tones/day and nominal installed thermal power plants > 20 MWt reporting

CRF Category	Main activity	Share of the EU-ETS reporting to the EB [%]	Reporting Plants
1A2 e	Food Processing, Beverages and Tobacco	15,10	Nominal installed thermal power plants > 20 MWt reporting
1A2 f	Other (cement, lime, ceramics, glass)	66,35	Fuel combustion for the installations having: o Installation for cement clinker production with capacity > 500 tones/day; o Installation for lime production with capacity > 50 tones/day; o Installation for glass production with capacity >20 tones/day; o Installation for ceramics production having a capacity >75 tones/day, o and having on sites nnominal installed thermal power plant > 20 MWt.

Activity data checks

Trend analysis was performed regarding the activity data for all subsectors and fuels separately. The most notable data peaks/drops were discussed and, further analysis will be conducted with the NIS in order to have an explanation of the variations.

Since the source of the activity is the IEA/EUROSTAT Energy Balance, there is a fully correspondence with the CRF and IPCC methodology concerning the fuels definition and the activity categories were these fuels are consumed.

Some changes in the activity data were necessary, because NCVs are not provided for some of the years for all reported fuels by the NIS. The changes consist of some assumptions of the NCVs for the years this information is not provided.

For some subsectors the activity data regarding the energy consumption and the resources were checked for correlation.

Activity data peaks/drops were discussed with industrial processes experts in order to identify sectorial restructuring (closing or opening of plants) or technological changes within specific plants, which result in fuel mix or energy consumption changes. Also, these discussions were conducted in order to avoid double accounting.

Calculations checks

Manual data checks are performed in order to prevent calculation errors:

- ❖ Unit conversion checks – activity data units are checked in order to verify that appropriate conversion units are applied.
- ❖ Calculation formulas checks – cell formulas are manually checked in order to ensure consistency.
- ❖ In order to assure integrity of the calculations and to prevent possible errors due to incomplete activity data, the automatic data validation checks were implemented in the Excel model. Each cell with a validation rule is colored red in case there is a logical problem with the calculations:
  - ➢ conversion from natural units to energy units – ensure all non-negative values reported in natural units are properly converted to energy units;
  - ➢ calculation of the emissions – ensure the corresponding emissions are calculated from all non-zero values in energy units;
  - ➢ emission factors validation – ensure chosen emission factors are within the IPCC 2006 GL ranges.

The model itself and the calculations were validated by international experts, and by national experts as part of the QA procedures implemented.

It was observed that in 2012 some country specific emission factors are outside of the IPCC 2006 GL range: it is the case of the lignite - CS EF 94.38 t/TJ, other bituminous coal - CS EF 87.91 t/TJ, lower than the limit of the range, Residual Fuel Oil - CS EF 79.48 t/TJ – higher than the range. Also, in some cases the oxidation factors reported by the operators under EU-ETS rules, were lower than the limit provided by the IPCC Guidelines, such us the oxidation factor of the lignite used as fuel in the electricity and heat production activity, having a country specific oxidation factor in 2012 of 0.92. In this respect, clarifications from the EU-ETS representatives were asked. The responses provided by the concerned operators clarified the obtained values of the fuels parameters.

For the oxidation factor the technical causes are linked with the following aspects: the installations combustion efficiency which could be much lower than optimum due to the old equipment or/and lower charge in functioning (due to the reducing of the energy demand); the aging of auxiliary equipment such are the coal crushing mills and the lower degree of grinding for some type of lignite conduct to an incomplete combustion and a decreased oxidation factor; the lower temperature of the air used to heat the coal before combustion, due to the aging of the concerned equipment, is an other factor causing a lower oxidation factor; some operators declared that, due to the raised price in the last years of the natural gas, used as adjuvant in combustion, they reduced the utilization of this under 1 per cent.

All the above technical situations conduct to an incomplete combustion and to an increased quantity of the carbon content in the slag and ashes, thus a lower oxidation factor.

For the deviation of the emission factors of the lignite, the operators responded that the quality of the fuel is very often altered by the substantially presence of the sterile, detailing the sources of the used coal, imported or acquired from internal market; also, it was explained that the stacks of coal became in time dry, by loosing the humidity, this having as consequences the decreasing of the calorific values and of the emission factors.

Following the above activities the unconformities has been noted and solved; currently, further to the quality/control assurance activities undertaken, as part of the GHG emissions estimates, there were no recalculations required.

- The calculation model is directly linked to the activity data.
- Currently the data from the calculation models is entered manually into CRF reporter. In order to ensure that there are no differences due to technical errors, additional comparisons were made between the numbers in the calculation models and the CRF tables generated by CRF application.

Transparency

All calculation sheets are linked to the necessary information for the estimating of the emissions, such as:

- the activity data (Energy Balance – transmitted by Romanian Institute for Statistics to the IEA/EUROSTAT);
- conversion factors (provided in Energy Balance) and determined from the EU-ETS reports;
- emission factors (default according to the IPCC methodology, CO_2 EFs - resulted from the ISPE Study and derived from the EU-ETS reports , SO_2 emission factors – resulted from the reporting of the Large Combustion Plants);
- all the results are summed in a global calculation sheet for Stationary Fuel Combustion, linked with the spreadsheets of the model (having results for all greenhouse gases emissions from solid, liquid and gaseous fuels on the entire time-series), other fuel – industrial wastes sheet, biomass sheets (having results for emissions accounted from solid and gaseous biomass combustion; liquid biofuels are not reported to the activity categories corresponding with the Stationary Combustion).

The EUROSTAT format of the Energy Balance made possible the achievement of the transparency and accuracy in usage of the Activity Data, linking in the worksheets all the available data and avoiding the occurrence of the transcription mistakes. Also, the definitions of the fuels are the same with UNFCCC, CRF tables.

Accuracy

The accuracy of the emissions estimation results from usage of the data at the most possible detailed level and from automatic character of the calculation.

Completeness

All occurring sources of emissions from 1.A Fuel stationary combustion are estimated for solid, liquid, gaseous fuels, biomass and other fuels (industrial waste). All emissions from CO_2, CH_4 and N_2O were accounted. Also, there are accounted emissions resulted from indirect GHG gases, NO_x, CO, NMVOC and SO_2.

Consistency

The methods used for estimation of the emissions are in accordance with the IPCC regulations on the entire-time series.

3.2.6.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In order to improve the emissions estimates quality, some important recalculations were made:

Activity Data

There are recalculations, by some Energy stationary combustion activity categories, on the entire 1989-2011 time-series, such as follows:

- ❖ Energy Balance correction;
- ❖ Avoiding double counting activity data with Fugitive Emissions Energy subsector from the usage of the Petroleum Coke as catalyst agent and deposited on catalyst in the refinery processes: the Petroleum Coke reported through the energy balance as refinery fuel was subtracted from the 1A1b activity category where it is reported, being a non-energy consumption; the associated emissions are reported under 1.B.2.a activity category, on the entire time-series.
- ❖ The national values of the net calorific power, determined from the EU-ETS reports, were used.

Further explanations of the performed recalculations will be found to the corresponding activity category description.

The effect of the recalculations due to the changes in the activity data is presented in the following tables:

Table 3.16 The effects of the activity data changes on CO_2 emissions estimation to the sub-sector 1.A 1. - Energy Industry

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	1014364.74	1,076,987.02	74118.64	80,137.67	8.12
1990	986243.32	1,002,441.33	70978.50	72,546.02	2.21
1991	906864.08	924,646.05	65712.61	67,400.10	2.57
1992	747919.61	803,908.53	54874.48	60,089.69	9.50
1993	764780.54	788,702.10	56797.85	59,052.04	3.97
1994	774029.34	798,301.61	57431.75	59,724.99	3.99
1995	806046.01	827,059.27	59903.14	61,889.83	3.32
1996	845365.75	864,718.02	62600.24	64,417.35	2.90
1997	761960.39	781,124.64	55859.49	57,656.85	3.22
1998	658992.13	667,291.72	47210.33	48,018.15	1.71
1999	575152.03	558,565.67	42219.43	40,694.84	-3.61
2000	576513.62	576,035.22	42621.32	42,614.55	-0.02
2001	571759.13	594,212.99	42755.56	44,887.58	4.99
2002	569435.57	578,941.04	42089.00	43,007.26	2.18
2003	636878.36	621,155.50	47764.67	46,333.80	-3.00
2004	576114.42	559,749.96	43067.69	41,585.68	-3.44
2005	552492.21	551,079.01	41203.20	41,131.58	-0.17
2006	574996.05	566,907.21	43904.12	43,191.68	-1.62
2007	551729.30	549,815.13	43312.25	43,182.42	-0.30
2008	540584.46	532,196.30	42155.77	41,406.62	-1.78
2009	459045.96	450,870.23	35526.92	34,918.23	-1.71
2010	439283.65	426,528.12	33037.88	32,006.81	-3.12
2011	484009.48	469,908.87	36474.64	35,383.22	-2.99

Table 3.17 The effects of the activity data changes on CH_4 emissions estimation to the sub-sector 1.A 1. - Energy Industry

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	1014364.74	1076987	1.38	1.45	4.64
1990	986243.32	1002441	1.54	1.56	1.78
1991	906864.08	924646	1.32	1.35	1.97
1992	747919.61	803909	1.01	1.07	5.93
1993	764780.54	788702	1.05	1.08	2.78
1994	774029.34	798302	1.07	1.10	2.76
1995	806046.01	827059	1.13	1.16	2.29
1996	845365.75	864718	1.21	1.24	2.06
1997	761960.39	781125	1.16	1.18	2.11
1998	658992.13	667292	0.93	0.93	0.19
1999	575152.03	558566	0.81	0.79	-2.54
2000	576513.62	576035	0.78	0.77	-1.41
2001	571759.13	594213	0.83	0.85	2.69
2002	569435.57	578941	0.78	0.79	0.80
2003	636878.36	621155	0.83	0.80	-2.87
2004	576114.42	559750	0.73	0.71	-3.78
2005	552492.21	551079	0.70	0.68	-2.64
2006	574996.05	566907	0.71	0.68	-4.55
2007	551729.30	549815	0.67	0.65	-3.43
2008	540584.46	532196	0.64	0.61	-5.11
2009	459045.96	450870	0.55	0.52	-4.89
2010	439283.65	426528	0.55	0.51	-5.88
2011	484009.48	469909	0.60	0.57	-4.38

Table 3.18 The effects of the activity data changes on N_2O emissions estimation to the sub-sector 1.A 1. - Energy Industry

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for N_2O [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	1014364.74	1,076,987.02	0.67	0.76	14.03
1990	986243.32	1,002,441.33	0.59	0.61	3.93
1991	906864.08	924,646.05	0.57	0.59	4.34
1992	747919.61	803,908.53	0.51	0.59	15.30
1993	764780.54	788,702.10	0.54	0.57	6.24
1994	774029.34	798,301.61	0.54	0.58	6.31
1995	806046.01	827,059.27	0.57	0.60	5.27
1996	845365.75	864,718.02	0.58	0.61	4.63
1997	761960.39	781,124.64	0.50	0.53	5.34
1998	658992.13	667,291.72	0.40	0.42	4.17
1999	575152.03	558,565.67	0.38	0.36	-5.12
2000	576513.62	576,035.22	0.40	0.40	1.47
2001	571759.13	594,212.99	0.41	0.44	8.33
2002	569435.57	578,941.04	0.40	0.41	4.17
2003	636878.36	621,155.50	0.47	0.45	-3.54
2004	576114.42	559,749.96	0.42	0.41	-3.82
2005	552492.21	551,079.01	0.40	0.41	1.90
2006	574996.05	566,907.21	0.45	0.46	0.10
2007	551729.30	549,815.13	0.45	0.45	1.46
2008	540584.46	532,196.30	0.45	0.45	-0.07
2009	459045.96	450,870.23	0.39	0.40	0.39
2010	439283.65	426,528.12	0.37	0.36	-1.09
2011	484009.48	469,908.87	0.43	0.43	-1.34

Table 3.19 The effects of the activity data changes on CO_2 emissions estimation to the sub-sector 1.A 2. - Manufacturing Industries and Constructions

Year	**Changes at AD level [TJ]**		**Effects of changes on emissions estimation for CO_2 [Gg]**		**Difference [%]**
	NGHGI 2013 v. 2.2	**NGHGI 2014 v. 1.4**	**NGHGI 2013 v. 2.2**	**NGHGI 2014 v. 1.4**	
1989	1114940	1132803.17	69842	71558.27	2.46
1990	902499	909756.61	55540	56226.47	1.24
1991	631572	634364.33	38044	38280.62	0.62
1992	573991	578874.02	34832	35277.12	1.28
1993	529812	532271.52	31976	32184.09	0.65
1994	498831	500814.30	29525	29702.18	0.60
1995	512025	513114.98	30143	30255.68	0.37
1996	487158	488540.59	28871	28988.58	0.41
1997	392804	394355.37	23400	23542.78	0.61
1998	321130	322080.47	19530	19633.18	0.53
1999	294451	296465.33	17844	18019.51	0.99
2000	307574	309588.21	18654	18858.30	1.10
2001	319882	321828.03	19644	19840.48	1.00
2002	336368	336808.81	20195	20265.28	0.35
2003	319185	319516.50	18756	18803.44	0.25
2004	303472	302383.73	19068	19023.74	-0.23
2005	289408	289691.69	18305	18341.04	0.20
2006	283459	284896.05	17780	17925.28	0.81
2007	278400	281985.68	17361	17727.00	2.11
2008	281259	281925.51	17855	17928.72	0.41
2009	205950	206183.50	12775	12815.66	0.32
2010	213892	213538.16	13129	13116.97	-0.09
2011	243552	230453.32	15663	14456.28	-7.70

Table 3.20 The effects of the activity data changes on CH_4 emissions estimation to the sub-sector 1.A 2. - Manufacturing Industries and Constructions

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	1114939.57	1132803	5.89	6.07	2.99
1990	902499.28	909757	4.73	4.80	1.42
1991	631571.89	634364	3.05	3.07	0.62
1992	573991.27	578874	3.15	3.19	1.23
1993	529812.11	532272	2.94	2.95	0.47
1994	498830.91	500814	2.62	2.63	0.42
1995	512024.93	513115	2.99	2.99	0.23
1996	487158.08	488541	2.54	2.55	0.31
1997	392804.17	394355	2.17	2.18	0.46
1998	321129.99	322080	1.75	1.76	0.62
1999	294451.19	296465	1.64	1.66	0.90
2000	307574.34	309588	1.79	1.80	0.74
2001	319882.27	321828	1.81	1.83	1.10
2002	336368.34	336809	2.15	2.16	0.58
2003	319184.63	319516	2.18	2.19	0.42
2004	303472.20	302384	1.98	1.98	0.22
2005	289407.87	289692	1.86	1.87	0.43
2006	283459.26	284896	1.92	1.93	0.83
2007	278400.03	281986	1.93	2.00	3.44
2008	281259.48	281926	1.85	1.89	2.12
2009	205949.93	206184	1.42	1.47	3.28
2010	213892.20	213538	1.65	1.70	3.30
2011	243551.77	230453	1.98	1.93	-2.54

Table 3.21 The effects of the activity data changes on N_2O emissions estimation to the sub-sector 1.A 2. - Manufacturing Industries and Constructions

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for N_2O [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	1114939.57	1132803	0.36	0.38	6.89
1990	902499.28	909757	0.26	0.27	3.72
1991	631571.89	634364	0.16	0.17	1.86
1992	573991.27	578874	0.23	0.23	2.67
1993	529812.11	532272	0.21	0.21	1.24
1994	498830.91	500814	0.17	0.17	1.44
1995	512024.93	513115	0.20	0.20	0.98
1996	487158.08	488541	0.17	0.17	0.98
1997	392804.17	394355	0.16	0.16	1.35
1998	321129.99	322080	0.14	0.14	1.38
1999	294451.19	296465	0.12	0.13	1.88
2000	307574.34	309588	0.14	0.15	1.48
2001	319882.27	321828	0.14	0.15	2.18
2002	336368.34	336809	0.18	0.18	1.18
2003	319184.63	319516	0.18	0.18	0.85
2004	303472.20	302384	0.17	0.17	0.73
2005	289407.87	289692	0.16	0.16	0.57
2006	283459.26	284896	0.18	0.18	1.30
2007	278400.03	281986	0.18	0.19	4.92
2008	281259.48	281926	0.16	0.16	3.17
2009	205949.93	206184	0.12	0.13	5.33
2010	213892.20	213538	0.14	0.15	5.22
2011	243551.77	230453	0.18	0.18	-3.81

Table 3.22 The effects of the activity data changes on CO_2 emissions estimation to the sub-sector 1.A 4. - Other Sectors

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	240681.71	242918	13968.97	14191.4	1.59
1990	243621.43	244828	14312.44	14434.3	0.85
1991	233768.83	234662	13301.94	13392.1	0.68
1992	169994.22	173071	9678.11	9975.6	3.07
1993	164216.89	164802	8402.55	8461.0	0.70
1994	151450.86	151641	6834.65	6852.8	0.27
1995	173214.95	173392	7865.32	7879.8	0.18
1996	214939.23	215217	7540.34	7568.7	0.38
1997	283331.95	283901	9936.63	9986.8	0.50
1998	271109.75	271372	9392.09	9412.7	0.22
1999	240490.55	240699	7940.83	7957.3	0.21
2000	241404.35	241676	8194.45	8215.2	0.25
2001	207310.60	207477	7767.57	7781.4	0.18
2002	208511.34	208764	7837.37	7855.7	0.23
2003	251677.36	251951	9253.14	9274.7	0.23
2004	281942.66	282003	9885.42	9896.5	0.11
2005	289036.72	289221	10177.09	10192.1	0.15
2006	315627.57	315713	11942.92	11951.8	0.07
2007	287230.11	287473	10024.46	10043.2	0.19
2008	296651.08	296644	8875.05	8874.6	0.00
2009	300581.33	300622	9088.98	9092.5	0.04
2010	305676.94	305643	9047.75	9045.5	-0.02
2011	290373.70	290422	9175.37	9179.8	0.05

Table 3.23 The effects of the activity data changes on CH_4 emissions estimation to the sub-sector 1.A 4. - Other Sectors

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	240681.71	242918	17.03	17.74	4.16
1990	243621.43	244828	17.11	17.50	2.26
1991	233768.83	234662	12.32	12.61	2.32
1992	169994.22	173071	11.76	12.67	7.76
1993	164216.89	164802	13.26	13.44	1.35
1994	151450.86	151641	12.80	12.86	0.43
1995	173214.95	173392	14.28	14.29	0.12
1996	214939.23	215217	29.77	29.86	0.31
1997	283331.95	283901	39.33	39.42	0.24
1998	271109.75	271372	35.20	35.21	0.04
1999	240490.55	240699	33.05	33.06	0.04
2000	241404.35	241676	32.17	32.18	0.03
2001	207310.60	207477	22.87	22.89	0.06
2002	208511.34	208764	23.43	23.43	-0.01
2003	251677.36	251951	28.69	28.70	0.05
2004	281942.66	282003	34.84	34.87	0.08
2005	289036.72	289221	35.52	35.53	0.03
2006	315627.57	315713	33.69	33.70	0.03
2007	287230.11	287473	35.29	35.30	0.01
2008	296651.08	296644	44.67	44.67	0.00
2009	300581.33	300622	43.89	43.89	0.01
2010	305676.94	305643	45.44	45.44	0.01
2011	290373.70	290422	40.79	40.80	0.04

Table 3.24 The effects of the activity data changes on N_2O emissions estimation to the sub-sector 1.A 4. - Other Sectors

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for N_2O [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	240681.71	242918	0.19	0.19	1.73
1990	243621.43	244828	0.18	0.18	0.97
1991	233768.83	234662	0.14	0.14	0.91
1992	169994.22	173071	0.14	0.15	2.98
1993	164216.89	164802	0.17	0.17	0.49
1994	151450.86	151641	0.18	0.18	0.15
1995	173214.95	173392	0.20	0.20	0.07
1996	214939.23	215217	0.39	0.40	0.11
1997	283331.95	283901	0.54	0.54	0.11
1998	271109.75	271372	0.49	0.49	0.04
1999	240490.55	240699	0.45	0.45	0.03
2000	241404.35	241676	0.44	0.44	0.04
2001	207310.60	207477	0.31	0.32	0.05
2002	208511.34	208764	0.32	0.32	0.04
2003	251677.36	251951	0.39	0.39	0.05
2004	281942.66	282003	0.47	0.47	0.05
2005	289036.72	289221	0.48	0.48	0.03
2006	315627.57	315713	0.46	0.46	0.02
2007	287230.11	287473	0.48	0.48	0.03
2008	296651.08	296644	0.60	0.60	0.00
2009	300581.33	300622	0.59	0.59	0.01
2010	305676.94	305643	0.61	0.61	0.00
2011	290373.70	290422	0.55	0.55	0.01

Table 3.25 The effects of the activity data changes on CO_2 emissions estimation to the sub-sector 1.A 5. - Other (non-specified elsewhere)

Year	**Changes at AD level [TJ]**		**Effects of changes on emissions estimation for CO_2 [Gg]**		**Difference [%]**
	NGHGI 2013 v. 2.2	**NGHGI 2014 v. 1.4**	**NGHGI 2013 v. 2.2**	**NGHGI 2014 v. 1.4**	
1989	26821.12	30015.39	2174.84	2484.72	14.25
1990	30090.56	30232.30	2502.28	2517.11	0.59
1991	34820.90	34780.60	2268.54	2265.16	-0.15
1992	8360.32	11673.00	671.29	990.39	47.54
1993	5772.01	5814.65	307.83	312.10	1.39
1994	7371.47	7504.84	429.37	440.43	2.58
1995	8829.36	8901.61	552.25	558.24	1.08
1996	6835.07	6844.65	276.01	277.08	0.39
1997	2281.87	2283.30	7.03	7.17	2.01
1998	10686.89	10677.38	699.20	698.65	-0.08
1999	3696.98	3694.24	109.64	109.44	-0.18
2000	3828.68	3824.37	238.42	238.11	-0.13
2001	10587.70	10580.71	383.00	382.48	-0.13
2002	9976.09	9969.64	268.90	268.42	-0.18
2003	11272.64	11263.96	378.40	377.76	-0.17
2004	14092.58	14078.82	681.69	680.68	-0.15
2005	24285.76	23228.52	1236.68	1160.39	-6.17
2006	14986.59	14052.23	570.08	502.23	-11.90
2007	18743.48	18896.92	939.43	950.78	1.21
2008	16706.07	16629.06	817.34	811.69	-0.69
2009	8603.71	8597.59	271.19	270.73	-0.17
2010	8888.20	8845.88	270.90	267.80	-1.14
2011	10364.88	10314.14	542.18	538.48	-0.68

Table 3.26 The effects of the activity data changes on CH_4 emissions estimation to the sub-sector 1.A 5. - Other (non-specified elsewhere)

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	26821.12	30015.39	0.12	0.15	26.78
1990	30090.56	30232.30	0.16	0.16	1.03
1991	34820.90	34780.60	2.24	2.24	-0.01
1992	8360.32	11673.00	0.34	0.37	9.69
1993	5772.01	5814.65	0.54	0.54	0.08
1994	7371.47	7504.84	0.53	0.53	0.12
1995	8829.36	8901.61	0.83	0.83	0.04
1996	6835.07	6844.65	0.96	0.96	0.01
1997	2281.87	2283.30	0.66	0.66	0.00
1998	10686.89	10677.38	0.39	0.39	0.01
1999	3696.98	3694.24	0.67	0.67	0.00
2000	3828.68	3824.37	0.45	0.45	0.00
2001	10587.70	10580.71	1.86	1.86	0.00
2002	9976.09	9969.64	1.99	1.99	0.00
2003	11272.64	11263.96	1.92	1.92	0.00
2004	14092.58	14078.82	1.61	1.61	0.00
2005	24285.76	23228.52	2.39	2.38	-0.09
2006	14986.59	14052.23	2.21	2.20	-0.08
2007	18743.48	18896.92	1.91	1.91	0.02
2008	16706.07	16629.06	1.77	1.77	-0.01
2009	8603.71	8597.59	1.56	1.56	0.00
2010	8888.20	8845.88	1.64	1.64	-0.01
2011	10364.88	10314.14	2.27	2.27	0.00

Table 3.27 The effects of the activity data changes on N_2O emissions estimation to the sub-sector 1.A 5. - Other (non-specified elsewhere)

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for N_2O [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	26821.12	30015.39	0.02	0.03	19.78
1990	30090.56	30232.30	0.03	0.03	0.79
1991	34820.90	34780.60	0.05	0.05	-0.07
1992	8360.32	11673.00	0.01	0.02	37.09
1993	5772.01	5814.65	0.01	0.01	0.62
1994	7371.47	7504.84	0.01	0.01	1.10
1995	8829.36	8901.61	0.01	0.01	0.42
1996	6835.07	6844.65	0.02	0.02	0.11
1997	2281.87	2283.30	0.01	0.01	0.02
1998	10686.89	10677.38	0.01	0.01	-0.01
1999	3696.98	3694.24	0.01	0.01	-0.02
2000	3828.68	3824.37	0.01	0.01	-0.04
2001	10587.70	10580.71	0.03	0.03	-0.02
2002	9976.09	9969.64	0.03	0.03	-0.01
2003	11272.64	11263.96	0.03	0.03	-0.02
2004	14092.58	14078.82	0.03	0.03	-0.03
2005	24285.76	23228.52	0.04	0.04	-1.53
2006	14986.59	14052.23	0.03	0.03	-1.66
2007	18743.48	18896.92	0.03	0.03	0.28
2008	16706.07	16629.06	0.03	0.03	-0.15
2009	8603.71	8597.59	0.02	0.02	-0.02
2010	8888.20	8845.88	0.02	0.02	-0.10
2011	10364.88	10314.14	0.04	0.04	-0.07

3.2.6.6 Source-specific planned improvements, if applicable, including those in response to the review process

Activity Data

The co-operation with Romanian authorities administrating the EU-ETS and National Institute for Statistics will be maintained in order to have a fully correspondence concerning the definitions (fuel's calorific power) and quantities of the fuels, between the declarations of the operators under EU-ETS and, respectively, to NIS.

A further analysis, in co-operation with the National Institute for Statistics, on the EU-ETS reporting will be conducted in order to take into consideration these emissions data, in the context of Tier 3 approach, on the activity category where these operators have to report.

Annualy analysis on the EU-ETS reporting in comparison with Large Combustion Plants reporting, in order to check the concistency of the reported data, will be performed.

Emission Factors

Following the same procedure used until now, based on EU-ETS operators reporting, the country-specific CO_2 emission factors will be calculated and included in the next inventory submission.

In response of ERT recommendation, "Romania further investigate and elaborate on the non-energy use of fuels reported in the energy balance, which is not reported in the energy sector, and assess whether the country specific carbon storage factors are appropriate", Romania analysed the non-energy use of the fuels as activity data provided through the energy balances and used national values for net calorific power and country specific emission factors for the fuels reported under the EU-ETS.

3.2.7 Source category - Fuel combustion, Energy Industry (CRF sub-sector 1.A.1.)

The following activity categories are included in this sub-sector:

- Conventional electricity, CHP and heat producer plants;

- ❖ Petroleum refining plants;
- ❖ Solid fuel transformation plants;
- ❖ Oil and gas extraction and coal mining;
- ❖ Own consumption of the energy sector.

Figure 3.21 Total GHG emissions trend for the subsector 1.A.1 Energy industries by category

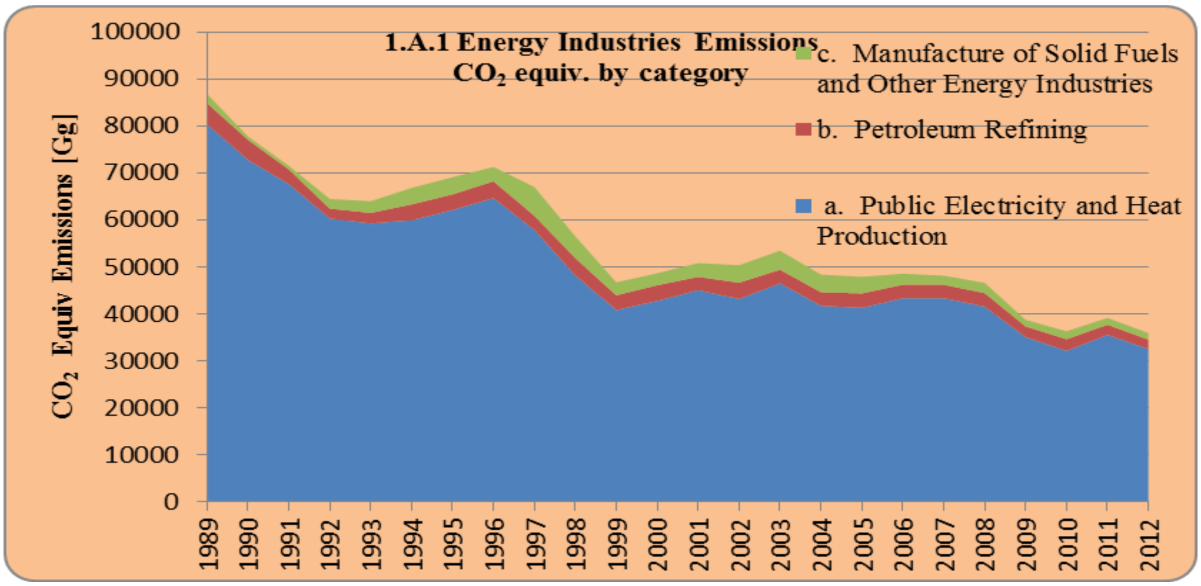
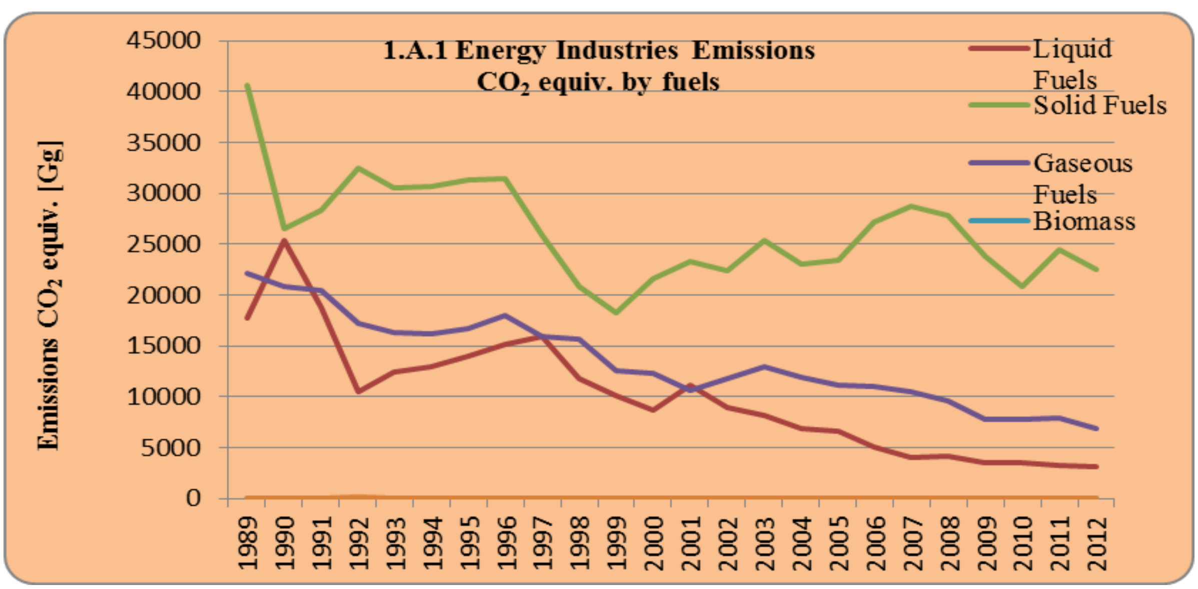


Figure 3.22 GHG emissions trend for the subsector 1.A.1 Energy industries by type of fuels



The general trend in CRF category 1.A.1 is a decrease in the emissions, but having a constant contribution to the total of 1A Fuel combustion emissions: 45% in the base year and a 43.76% in last year.

The contribution of this sub-sector to the 1.A. – Fuel combustion is, for the year 2012, about 32,521.62 Gg CO_2 equiv. having the main contributor the activity category 1.A.1.a – Electricity and Heat Production with 29140.29 Gg CO_2 equiv.

3.2.7.1 Source category - Public Electricity and Heat Production (CRF sector 1.A.1.a)

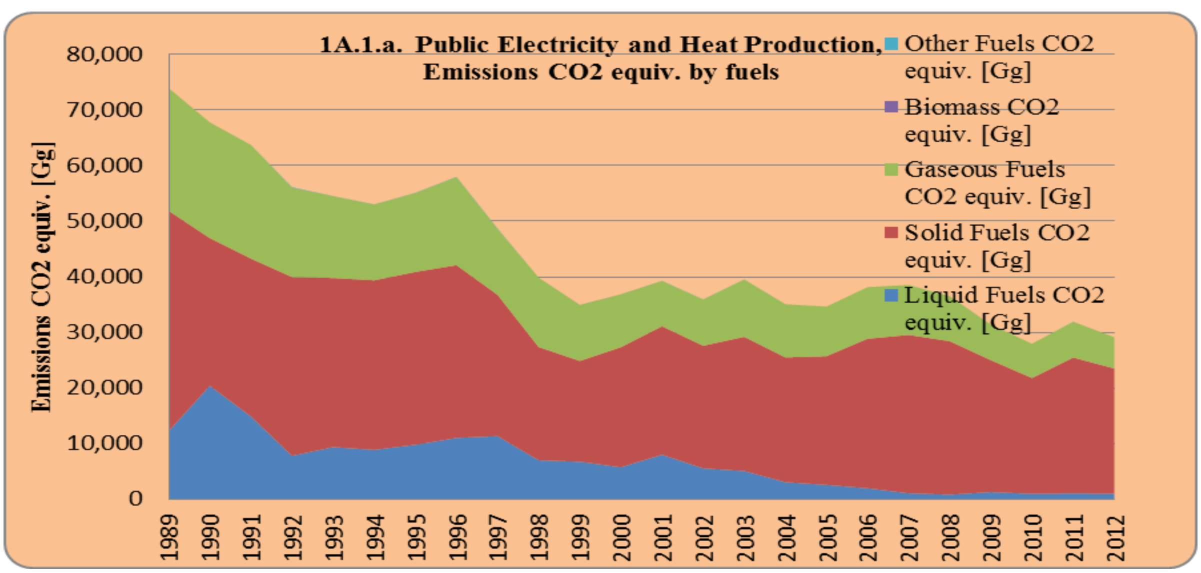
3.2.7.1.1 Source category description

Public Electricity and Heat Production, CRF - 1.A.1.a is a CO_2 key category by liquid, solid and gaseous fuels, level and trend, excluding and including LULUCF, as result of T1 approach.

Public Electricity and Heat Production, CRF - 1.A.1.a is a CO_2 key category by liquid - trend, solid and gaseous fuels - level and trend, excluding LULUCF and is a key category by liquid and gaseous - trend, solid – level and trend, including LULUCF, as result of T2 approach.

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.23 GHG emissions from 1.A.1.a Public Electricity and Heat Production



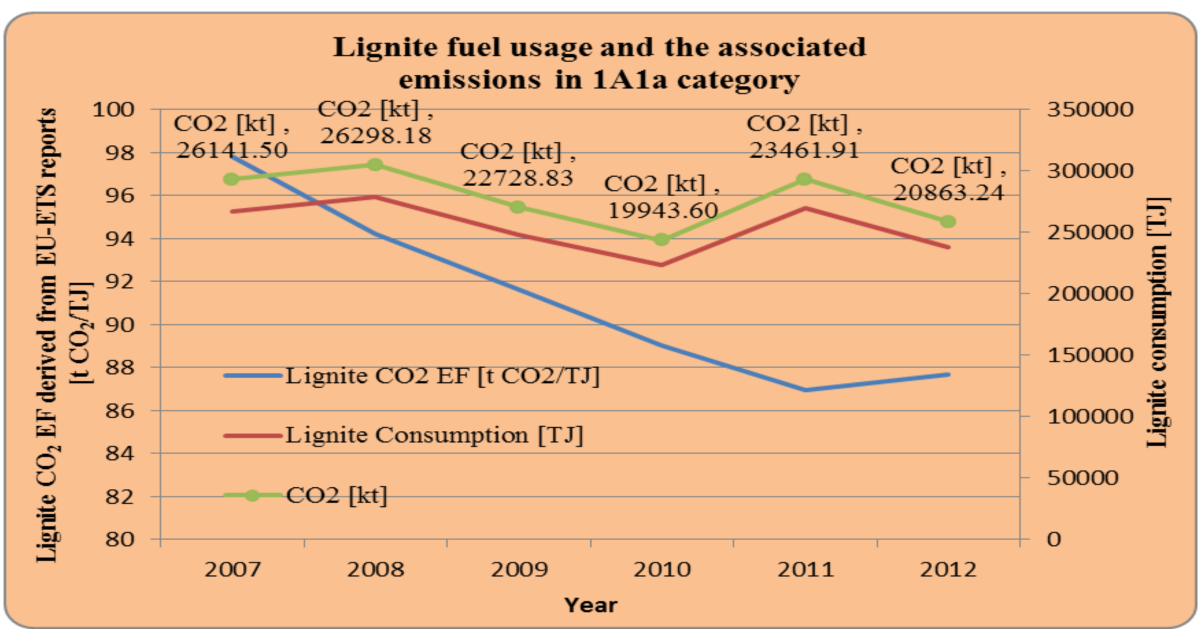
The 1.A.1.a. - Electricity and Heat Production activity category covers emissions from fuel combustion in Main Activity Producer Electricity Plants, Main Activity Producer CHP Plants, Main Activity Producer Heat Plants and Own Use in Electricity, CHP and Heat Plants.

The share to the total of GHG emissions 1A – Fuel Combustion, for CRF category 1.A.1.a is 41% in the base year and 39.2% for the year 2012. The share of this activity category to the 1.A.1. - Energy Industry is 92% for the base year and 89.6% for the year 2012 (about 32521.6 Gg CO_2 equiv.). The most quantity of combusted fuel in this activity is from solid fuel (aprox. 70%), for the entire time-series, being supplied mostly from national resources. The usage of the liquid fuels drastically decreased in the last years of the analyzed period.

The decreasing trend is observed for the all burned fuels, due to the fact that the demand of the energy slightly decreased in the 2012 and for the fact that the supply from wind resources has an ascendant trend.

Particularly, the case of the lignite usage in the 1.A.1.a category, the descent trend of the country specific CO_2 lignite emission factor derived from the EU-ETS reporting period and including the oxidation factor (as is explained in the 3.2.6.4. chapter - "*Source-specific QA/QC and verification*"), has an influence in the variation of the associated CO_2 emissions, the main cause being the variation of the consumption - see the bellow figure.

Figure 3.24 CO_2 emissions variation associated with the lignite usage in the 1.A.1.a - Public Electricity and Heat Production



3.2.7.1.2 Methodological issues

Tier 1 Methodology and Default emission factors for the fuels without analyze on EU-ETS reporting, or large combustion plants, are used. For the fuels reported in this activity category and having determined Country Specific Emission Factors, Tier 2 methodology is used.

CO_2 gas

For the 1989–2006 period

- **Solid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007-2012 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2012 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels,** EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Biomass,** entire time-series, EFs default are used.
- **Other fuels** – industrial wastes, entire time-series, CS EFs derived from the EU-ETS reports, are used.

CH_4, N_2O - EFs default are used.

NO_x, CO, NMVOC, SO_2 – default **EMEP** EFs are used.

SO_2 – CS emission factors for solid fuels are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT.
The NCVs used are those corresponding with that Used in Main Activity Plants (net).
See the Chapter 3.2.6.2 for more details.

3.2.7.1.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%;
- Solid Fuels – 5.0%;
- Gaseous Fuels - 3.0%;
- Biomass - 20.2%;
- Other (Industrial Wastes) - 21.2%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.1 %;
- Solid Fuels - 50.1%;
- Gaseous Fuels - 50.1%;
- Biomass - 50.1%;
- Other (Industrial Wastes) - 50.5 %.

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period.
See the chapter 3.2.6.3 for more details.

3.2.7.1.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission Sector.
See the Chapter 3.2.6.4 for more details.

3.2.7.1.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data (AD)

- *Lignite Brown Coal:* 2009, 2010 years - Energy Balance activity data correction;
- *Refinery Gas*: 2006 year - Energy Balance activity data correction*;*
- *Residual Fuel Oil:* Own Use in Electricity, CHP and Heat Plants, 1999, 2001 years - Energy Balance activity data correction;
- *Gas from Biomass:* 2007 – 2009 period - Energy Balance activity data correction*;*
- *Motor Gasoline:* Net Calorific Value, 1990 - 2004 period - Energy Balance parameters correction.
- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Solid Fuels

Activity data

- *Lignite Brown Coal:* 2009, 2010 years - Energy Balance activity data correction.
- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.6.5.

3.2.7.1.6 Source-specific planned improvements, if applicable

It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.

See the Chapter 3.2.6.6 for more details.

3.2.7.2 Source category - Petroleum Refining (CRF 1.A.1.b)

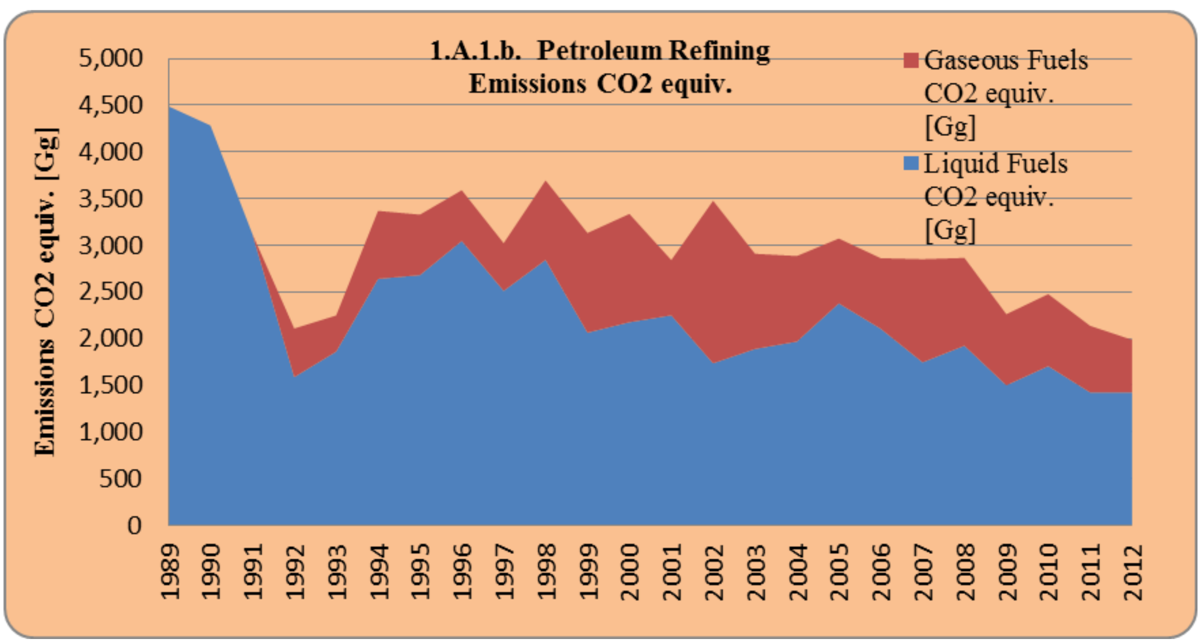
Category 1.A.1.b Petroleum refining covers emissions from fuel combustion in petroleum refineries and is a CO_2 key category by liquid fuels level and trend and gaseous fuels, level, including and excluding LULUCF.

1.A.1.b Petroleum refining is not a key category as result of T2 approach.

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF Sector 1.A.).

3.2.7.2.1 Source category description

Figure 3.25 GHG emissions from CRF 1.A.1.b Petroleum refining



The share in total GHG emissions 1.A – fuel Combustion of this activity is 2.49% for the year 1989 and 2.67% for the year 2012. The main fuels reported are liquids which are: Refinery gas, Transport diesel and Residual fuel oil, together with natural gas having a contribution about 1987.48 Gg equiv. in 2012.

3.2.7.2.2 Methodological issues

Tier 1 Methodology and Default emission factors for the fuels without analyze on EU-ETS reporting are used.
For the fuels reported in this activity category having determined Country Specific Emission Factors, Tier 2 methodology is used.

CO_2 gas

For the 1989–2006 period

- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007 - 2012 period

- **Liquid fuels,** EFs calculated as weighted arithmetic average (WA) on each year of 2007–2011 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2011 period, ALL EU-ETS reported category activities, oxidation included, are used.

CH_4, N_2O - default EFs are used.
NO_x, CO, NMVOC, SO_2 – Default EMEP EFs are used.

The activity data are provided within Romanian Energy Balance sent by NIS to IEA/ EUROSTAT. The NCVs used are those corresponding with the industry activities.

See the Chapter 3.2.6.2 for more details.

3.2.7.2.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%;
- Solid Fuels – 5.0%;
- Gaseous Fuels - 3.0%;
- Biomass - 20.2%;
- Other (Industrial Wastes) - 21.2%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.1%;
- Solid Fuels - 50.1%;
- Gaseous Fuels - 50.1%;
- Biomass - 50.1%;
- Other (Industrial Wastes) - 50.5%.

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period.
See the chapter 3.2.6.3 for more details.

3.2.7.2.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission Sector.

See the Chapter 3.2.6.4 for more details.

3.2.7.2.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data (AD)

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Natural Gas

***Activity data*:** 2007 – 2011 period, Energy Balance activity data correction

3.2.7.2.6 Source-specific planned improvements, if applicable

It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.

See the Chapter 3.2.6.6 for more details.

3.2.7.3 Source category - Manufacture of Solid Fuels and Other Energy Industries (CRF 1.A.1.c.)

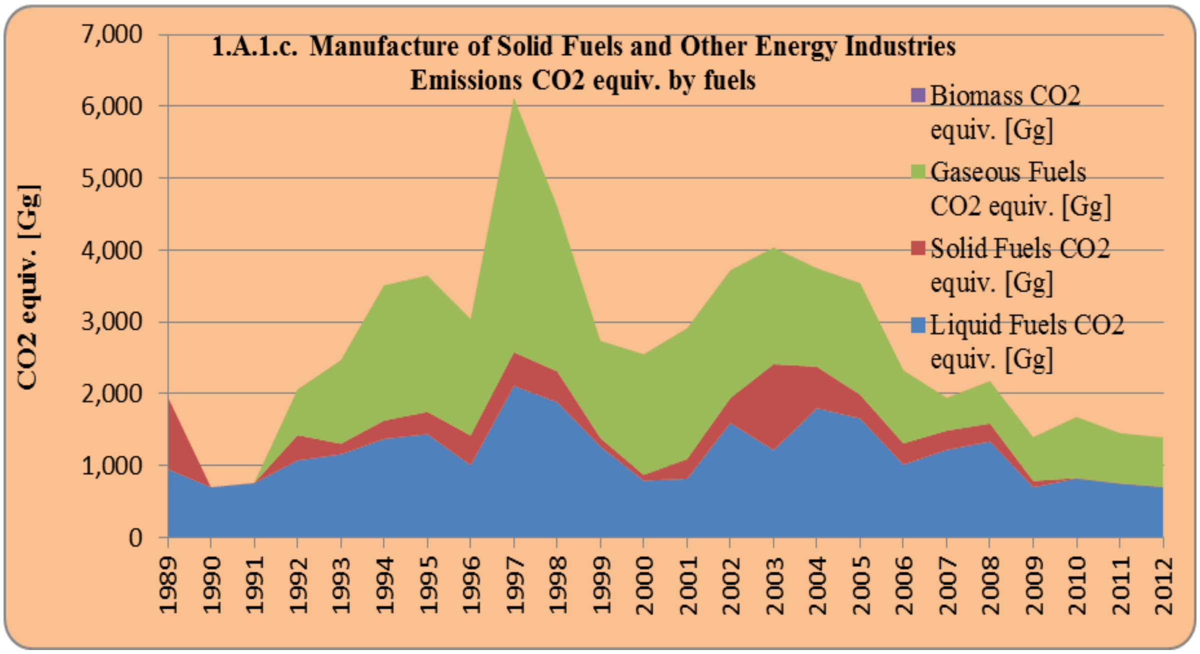
3.2.7.3.1 Source category description

Category 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries covers emissions from fuel combustion in Coal Mines, Patent Fuel Plants (Energy), Coke Ovens (Energy) and BKB Plants (Energy) and is a CO_2 key category by liquid fuels - level and trend, solid fuels – trend and gaseous fuels - level, excluding LULUCF and by liquid and gaseous fuels - level and solid fuels – trend including LULUCF, as result of T1 approach.

1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries is not a key category as result of T2 approach analysis.

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.26 GHG emissions from 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries



The share in total GHG emissions - sector 1A, is 1.88% for the year 2012, starting to a share of 1.09% in the base year, 1989. The emissions from this activity decreased by 28% compared to base year. This is also a result in the change in the fuel mix used in this activity category, which, from mostly solid and liquid used in the first years, has now shifted and mixed, being predominant liquid and natural gas.

The fluctuation of the fuels consumption level, especially for liquids fuels, could be explained by the fact that, when the economy is down like the Romanian economy (2010, 2011, being a deep crisis years), the internal and less expensive resources are preffered. The first which are not used anymore are the liquid fuels. In addition, the alternative sources of energy (renewable) are used. Therefore, in 2010 the economy was supported by the hydro energy production (being a good year from the hydrological point of view), in contrast with 2011 when a dry year imposed the usage of the fossil fuels. In 2012, the descendant trend is maintained.

3.2.7.3.2 Methodological issues

Tier 1 methodology and default emission factors for the fuels without analyze on EU-ETS reporting are used. For the fuels reported in this activity category having determined country specific emission factors, Tier 2 methodology is used.

CO_2 gas

<u>For the 1989–2006 period</u>

- ❖ **Solid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, on each EU-ETS reported activity category, oxidation included, are used.
- ❖ **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- ❖ **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

<u>For the 2007 - 2012 period</u>

- ❖ **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2012 period, on each EU-ETS reported activity category, oxidation included, are used.
- ❖ **Liquid fuels,** EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- ❖ **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- ❖ **Biomass,** entire time-series, EFs default are used.

CH_4, N_2O - default EFs are used.

NO_x, CO, NMVOC, SO_2 - default EMEP EFs are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT. The NCVs used are those corresponding with that Used in Main Activity Plants (net).

See the Chapter 3.2.6.2 for more details.

3.2.7.3.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- ❖ Liquid Fuels - 3.1%;
- ❖ Solid Fuels – 5.0%;
- ❖ Gaseous Fuels - 3.0%;
- ❖ Biomass - 20.2%;

CH_4 gas, N_2O gas

- ❖ Liquid Fuels - 50.1%;
- ❖ Solid Fuels - 50.1%;
- ❖ Gaseous Fuels - 50.1%;
- ❖ Biomass - 50.1%;

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period.
See the Chapter 3.2.6.3 for more details.

3.2.7.3.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission Sector.
See the Chapter 3.2.6.4 for more details.

3.2.7.3.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Activity data

- *Motor Gasoline:* Net Calorific Value, 1990 - 2004 period - Energy Balance parameter correction;
- *Residual Fuel Oil:* 1999 year - Energy Balance activity data correction.
- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Solid Fuels

Activity data

- Coke *Oven Gas*: 2010 year - Energy Balance activity data correction;
- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.6.5.

3.2.7.3.6 Source-specific planned improvements, if applicable

It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a higher tier approach in the estimation of the CO_2 emissions.

See the chapter 3.2.6.6 for more details.

3.2.8 Fuel combustion, Manufacturing Industries and Construction (CRF sub-sector 1.A.2.)

Figure 3.27 Total GHG emissions trend for the subsector 1.A.2. Manufacturing Industries and Constructions by category

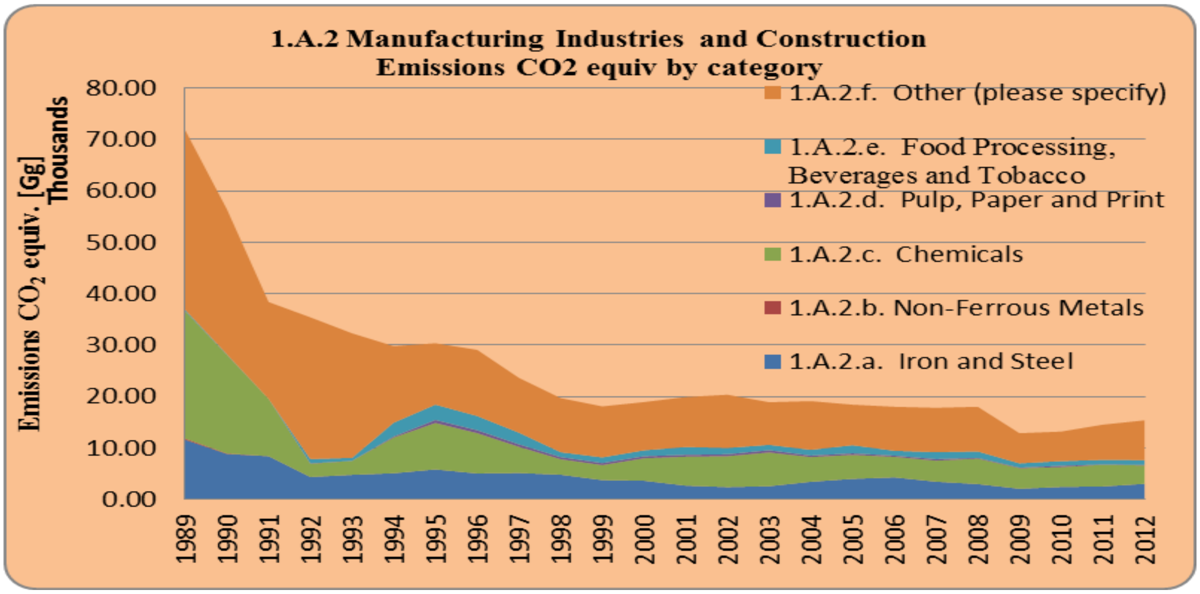
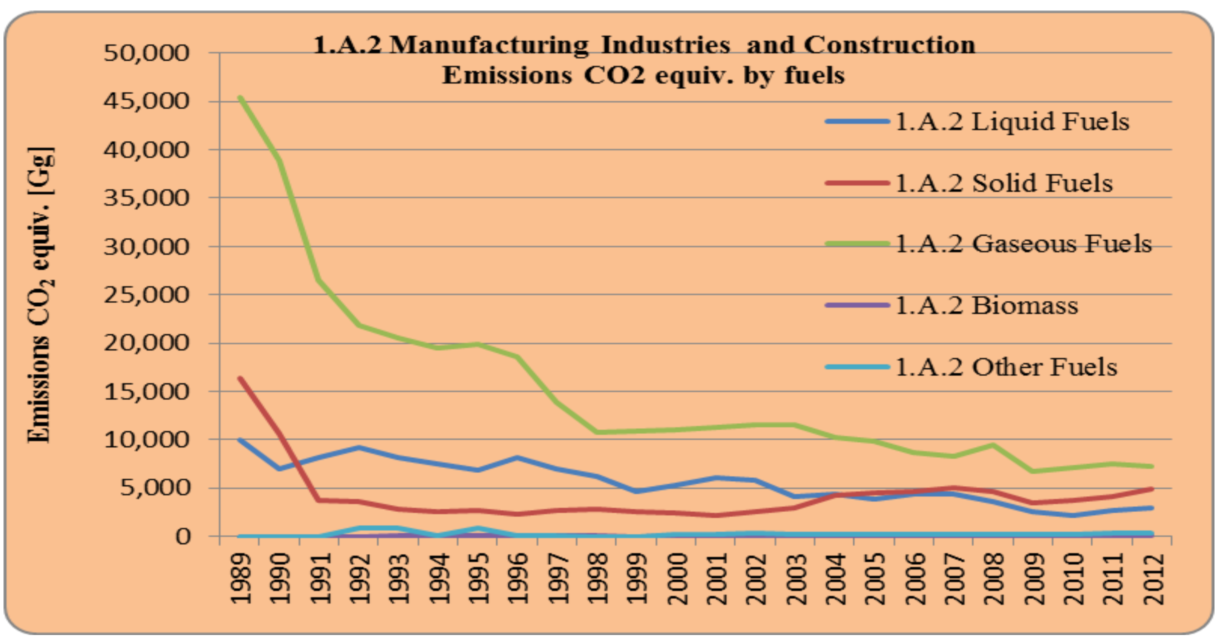


Figure 3.28 GHG emissions trend for the subsector 1.A.2. Manufacturing Industries and Constructions by fuels



The subsector Manufacturing Industries and Construction was responsible in 2012 for 20.7% of the total Energy Sector GHG emissions (about 15,382.11 Gg CO_2 equivalents).

The industries included in this sub-sector are the following:

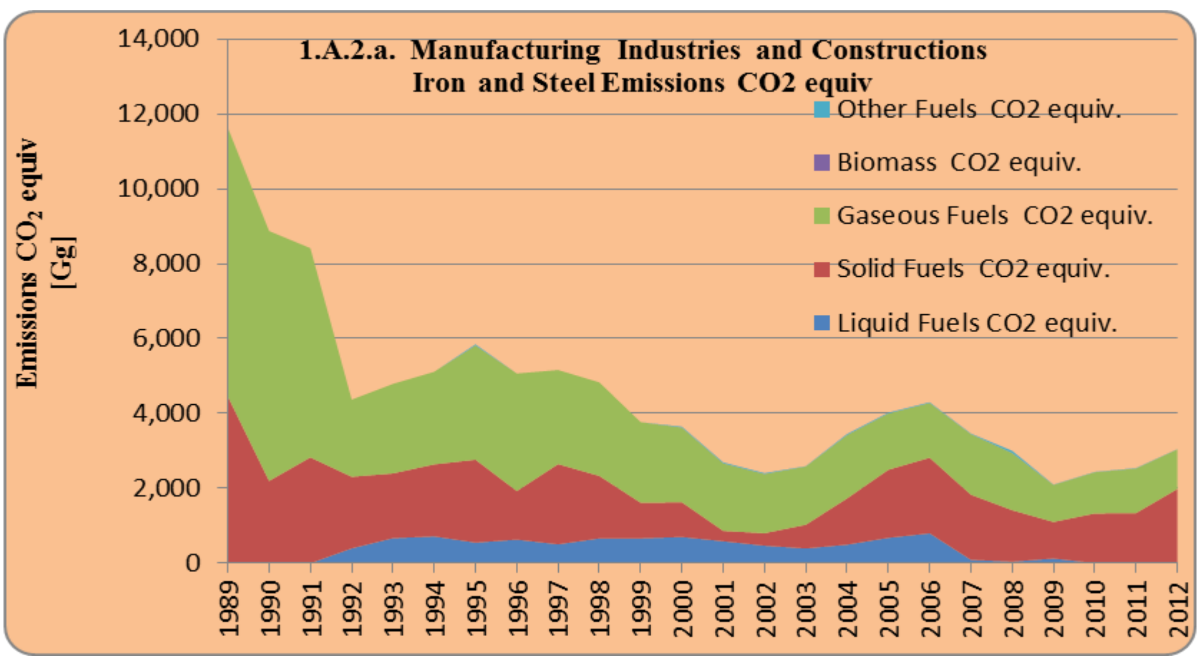
- ***Energy Use in the Petrochemical Sector***
- ***Energy Use in Transformation Sector, autoproducers:***
  - Auto producer Electricity Plants
  - Auto producer CHP Plants
  - Auto producer Heat Plants.
- ***Energy Sector - Blast Furnaces (Energy)***
- ***Industry Sector:***
  - Iron and Steel;
  - Chemical (including Petrochemical);
  - Non-Ferrous Metals;
  - Non-Metallic Minerals;
  - Transport Equipment;
  - Machinery;
  - Mining and Quarrying;
  - Food, Beverages and Tobacco;
  - Paper, Pulp and Printing;
  - Wood and Wood Products;
  - Construction;
  - Textiles and Leather.
  - Non-specified (Industry).

3.2.8.1 Source category – Iron and Steel (CRF 1.A.2.a)

3.2.8.1.1 Source category description

CRF 1.A.2.a - Iron and Steel is a CO_2 key category by solid fuels, level and gaseous fuels, level and trend, including LULUCF and by solid fuels – level and gaseous fuels level and trend excluding LULUCF, as result of T1 approach.
CRF 1.A.2.a - Iron and Steel is a CO_2 key category by gaseous fuels - trend, excluding and including LULUCF, as result of T2 approach.
See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.29 GHG emissions from 1.A.2.a – Iron and Steel, by fuels



The share of the total CO_2 equiv. emissions of the 1.A.2.a category to the 1.A.2 sub-sector, is 16.2% from the base year, to 19.8% - current year, 2012. The contribution of this category is about 3,046.10 Gg CO_2 equiv., in 2012.

3.2.8.1.2 Methodological issues

Tier 1 Methodology and Default emission factors for the fuels which are not reported under EU-ETS, are used.

For the fuels reported in this activity category having determined Country Specific Emission Factors, Tier 2 methodology is used.

CO_2 gas

For the 1989–2006 period

- **Solid fuels**, *EFs* calculated as weighted arithmetic average (WA), on 2007–2010 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007-2012 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2012 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Biomass,** entire time-series, EFs default are used.
- **Other fuels** – industrial wastes, entire time-series, CS EFs are used.

CH_4, N_2O - default EFs are used.

NOx, CO, NMVOC, SO_2 – default EMEP EFs are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT.

The NCVs used are those corresponding with that used in industry.
See the Chapter 3.2.6.2 for more details.

3.2.8.1.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%;
- Solid Fuels – 5.0%;
- Gaseous Fuels - 3.0%;
- Biomass - 20.2%;
- Other (Industrial Wastes) - 21.2%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.1%;
- Solid Fuels - 50.1%;
- Gaseous Fuels - 50.1%;
- Biomass - 50.1%;
- Other (Industrial Wastes) - 50.5%.

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period.
See the Chapter 3.2.6.3 for more details.

3.2.8.1.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission Sector.
See the Chapter 3.2.6.4 for more details.

3.2.8.1.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.
- *Motor Gasoline: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction;*
- *Petroleum Coke*: 2000–2004 period - Energy Balance activity data correction.

Solid Fuels

Activity data

- *For the solid fuels reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.*
- *Coke Oven Coke*: 2011 year - Energy Balance activity data correction.

3.2.8.1.6 Source-specific planned improvements, if applicable

It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a higher tier approach in the estimation of the CO_2 emissions.
See the Chapter 3.2.6.6 for more details.

3.2.8.2 Fuel combustion, Manufacturing Industries and Construction, Non-Ferrous metals (CRF activity category 1.A.2.b)

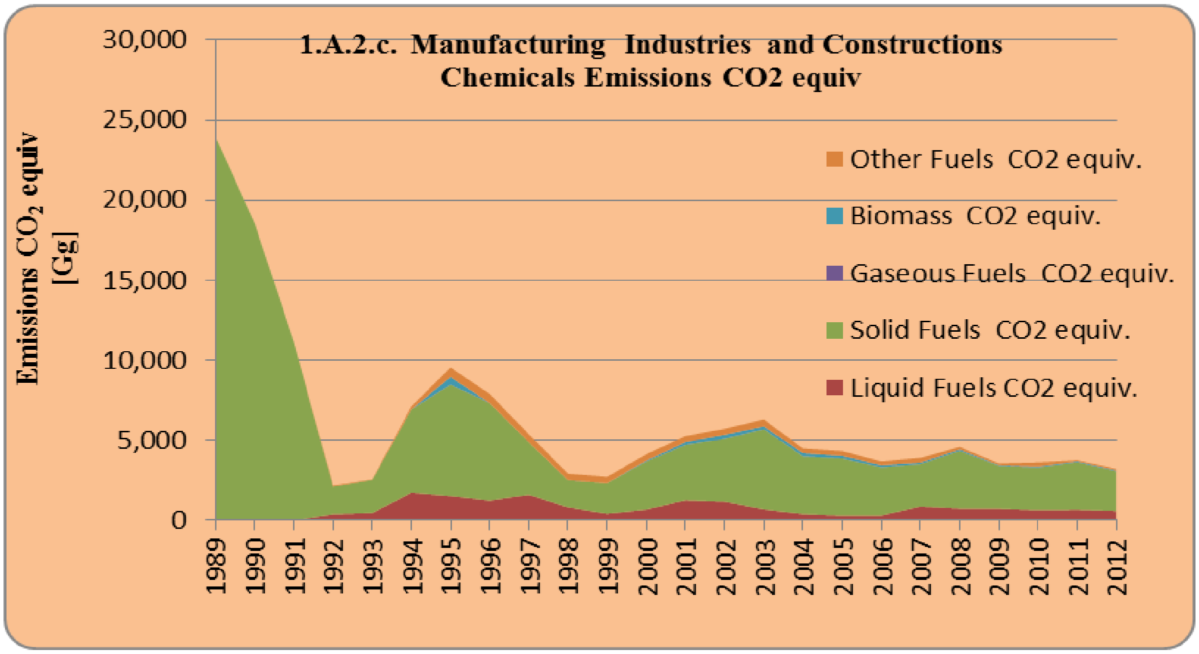
This activity category mostly is included in the 1.A.1.a Iron and steel reporting. The Energy Balance provided fuel consumption only on 1989, 1990, 2007 years. For the rest of the time-range the notation key is IE – included elsewhere.

3.2.8.3 Fuel combustion, Manufacturing Industries and Construction, Chemicals (CRF activity category 1.A.2.c.)

3.2.8.3.1 Source description

CRF category 1.A.2.c. – Chemicals is a CO_2 key category by liquid and solid fuels – level and gaseous fuels - level and trend, excluding LULUCF and by liquid fuels – level and gaseous fuels - level and trend including LULUCF, as result of T1 approach.
CRF category 1.A.2.c. – Chemicals is a CO_2 key category by gaseous fuels - trend, excluding and including LULUCF, as result of T2 approach.
See more details about trends and key categories in the Chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.30 GHG emissions from 1.A.2.c – Chemicals, by fuels



The share of the total GHG emissions of the 1.A.2.c category to the 1.A.2 sub-sector vary from the base year – 34.5% to 23.2% - current year, 2012. The contribution of this category is about 3,570.08 CO_2 equiv., in 2011.

3.2.8.3.2 Methodological issues

Tier 1 Methodology and Default emission factors for the fuels without analyze on EU-ETS reporting are used.

For the fuels reported in this activity category having determined Country Specific Emission Factors, Tier 2 methodology is used.

CO_2 gas

For the 1989–2006 period

- **Solid fuels**, *EFs* calculated as weighted arithmetic average (WA), on 2007–2010 period, on each EU-ETS reported activity category, oxidation included, are used.

- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

<u>For the 2007 - 2012 period</u>

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2012 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Biomass,** entire time-series, EFs default are used.
- **Other fuels** – industrial wastes, entire time-series, country specific EF calculated as weighted arithmetic average (WA), on 2011 EU-ETS reported category activities, are used.

CH_4, N_2O - default EFs are used.
NOx, CO, NMVOC, SO_2 – default EMEP EFs are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT.
The NCVs used are those corresponding with that used in industry (net).
See the Chapter 3.2.6.2 for more details.

3.2.8.3.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%;

- ❖ Solid Fuels – 5.0%;
- ❖ Gaseous Fuels - 3.0%;
- ❖ Biomass - 20.2%;
- ❖ Other (Industrial Wastes) - 21.2%.

CH_4 gas, N_2O gas

- ❖ Liquid Fuels - 50.1%;
- ❖ Solid Fuels - 50.1%;
- ❖ Gaseous Fuels - 50.1 %;
- ❖ Biomass - 50.1%;
- ❖ Other (Industrial Wastes) - 50.5%.

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period.
See the Chapter 3.2.6.3 for more details.

3.2.8.3.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission Sector.
See the Chapter 3.2.6.4 for more details.

3.2.8.3.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.
- *Refinery Gas*: 2004, 2005, 2006 years - Energy Balance activity data correction;

- *Motor Gasoline*: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction;
- *Naphta*: 1999, 2000 years - Energy Balance activity data correction;
- *White Spirit & SBP*: 2005 – 2011 period - Energy Balance activity data correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Biomass

Activity data

- *Gas from Biomass*: 2010, 2011 years - Energy Balance activity data correction.

3.2.8.3.6 Source-specific planned improvements, if applicable

It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.

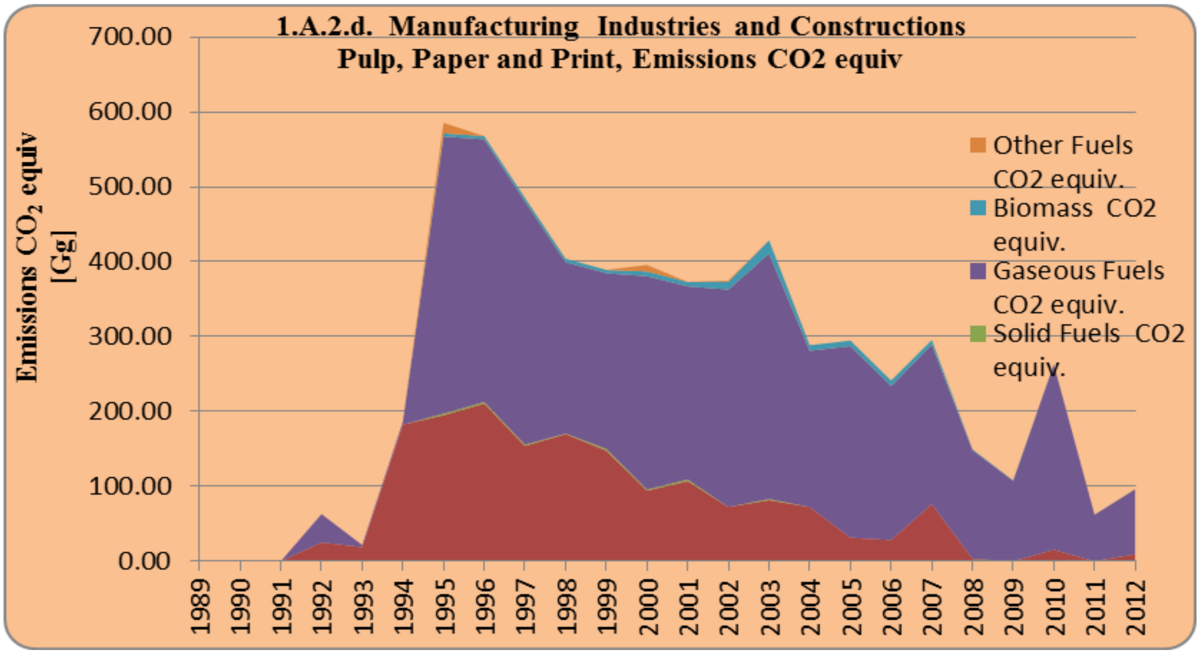
See the Chapter 3.2.6.6 for more details.

3.2.8.4 Fuel combustion, Manufacturing Industries and Construction, Pulp, Paper and Print (CRF activity category 1.A.2.d.)

3.2.8.4.1 Source description

1.A.2.d - Fuel combustion, Manufacturing Industries and Construction, Pulp, Paper and Print is not a key category as result of T1 or T2 approach.

Figure 3.31 GHG emissions from 1.A.2.d – Pulp, Paper and Print, by fuels



The activity data start to be recorded in this category with 1992 year. The share of the total GHG emissions of the 1.A.2.d category to the 1.A.2 sub-sector is about 0.63% - in the current year, 2012. The contribution of this category is about 44.97 Gg CO_2 equiv., in 2012.

See more details about trends in the Chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

3.2.8.4.2 Methodological issues

Tier 1 Methodology and Default emission factors for the fuels which are not reported under EU-ETS, are used.

For the fuels reported in this activity category having determined Country Specific Emission Factors, Tier 2 methodology is used.

CO_2 gas

For the 1989–2006 period

- **Solid fuels**, *EFs* calculated as weighted arithmetic average (WA), on 2007–2010 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007-2012 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2012 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Biomass,** entire time-series, EFs default are used.
- **Other fuels** – industrial wastes, entire time-series, country specific EF calculated as weighted arithmetic average (WA), on 2011 EU-ETS reported category activities, are used.

CH_4, N_2O - default EFs are used.

NOx, CO, NMVOC, SO_2 – default EMEP EFs are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT.
The NCVs used are those corresponding with that used in industry (net).
See the Chapter 3.2.6.2 for more details.

3.2.8.4.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%;
- Solid Fuels – 5.0%;
- Gaseous Fuels - 3.0%;
- Biomass - 20.2%;
- Other (Industrial Wastes) - 21.2%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.1 %
- Solid Fuels - 50.1 %
- Gaseous Fuels - 50.1 %
- Biomass - 50.1%
- Other (Industrial Wastes) - 50.5 %

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period.

See the Chapter 3.2.6.3 for more details.

3.2.8.4.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission sector.

See the Chapter 3.2.6.4 for more details.

3.2.8.4.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Biomass Fuel

Activity data

- *Solid biomass*: 2000, 2002 years - Energy Balance activity data correction.

For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.6.5.

3.2.8.4.6 Source-specific planned improvements, if applicable

It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a higher tier approach in the estimation of the CO_2 emissions.

See the Chapter 3.2.6.6 for more details.

3.2.8.5 Fuel combustion, Manufacturing Industries and Construction, Food Processing, Beverages and Tobacco (CRF category 1.A.2.e.)

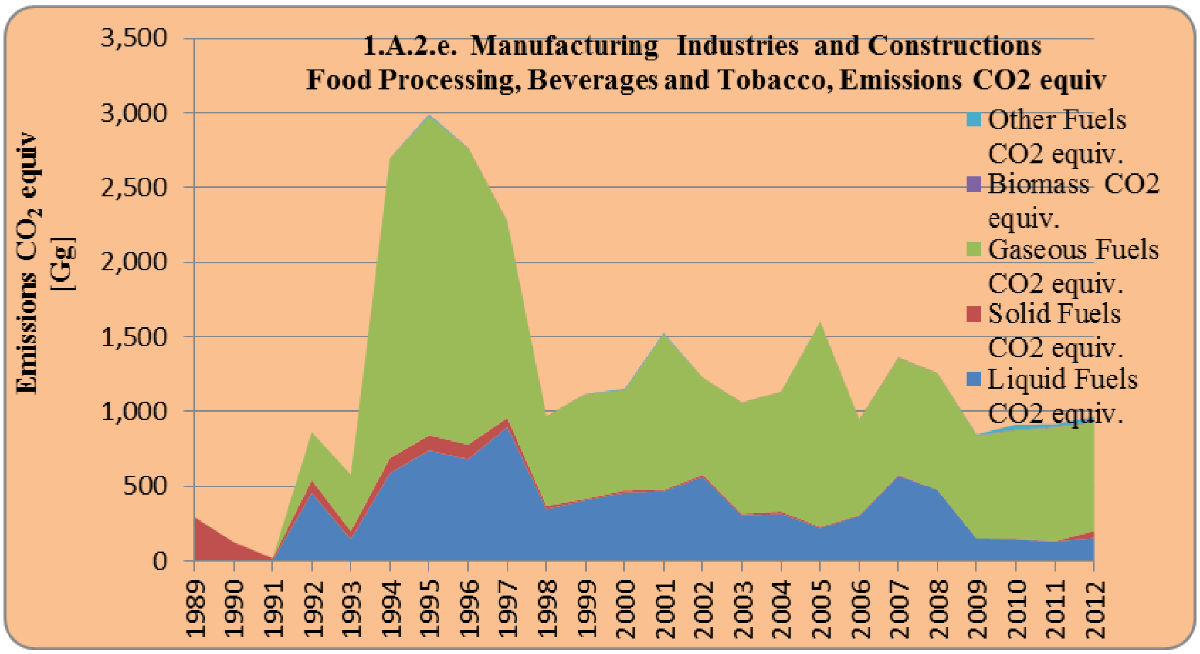
3.2.8.5.1 Source description

CRF category 1.A.2.e. - Food Processing, Beverages and Tobacco, is a CO_2 key category by gaseous fuel, level, including and excluding LULUCF, as result of T1 approach.

CRF category 1.A.2.e. - Food Processing, Beverages and Tobacco, is not a key category, as result of T2 approach.

See more details about trends and key categories in the Chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.32 GHG emissions 1.A.2.e – Food Processing, Beverages and Tobacco, by fuels



The share of the total GHG emissions of the 1.A.2.e category to the 1.A.2 sub-sector is about 0.41% - base year to the 6.26%, current year, 2012. The contribution of this category is about 962.30 Gg CO_2 equiv., in 2012. It is observed a rising of the natural gas usage as fuel in this activity category, mostly on the period 1993 - 1995. Also, starting to 1992 the biomass is used as combusted fuel for energy purposes. Secondly, the liquid fuels are burned in this category, together with the natural gas.

3.2.8.5.2 Methodological issues

Tier 1 Methodology and Default emission factors for the fuels without analyze on EU-ETS reporting are used.

For the fuels reported in this activity category having determined Country Specific Emission Factors, Tier 2 methodology is used.

CO_2 gas

For the 1989–2006 period

- **Solid fuels**, *EFs* calculated as weighted arithmetic average (WA), on 2007–2010 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007–2012 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2012 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Biomass,** entire time-series, EFs default are used.
- **Other fuels** – industrial wastes, entire time-series, country specific EF calculated as weighted arithmetic average (WA), on 2011 EU-ETS reported category activities, are used.

CH_4, N_2O - default EFs are used.

NOx, CO, NMVOC, SO_2 – default EMEP EFs are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT.
The NCVs used are those corresponding with this activity.
See the Chapter 3.2.6.2 for more details.

3.2.8.5.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%;
- Solid Fuels – 5.0%;
- Gaseous Fuels - 3.0%;
- Biomass - 20.2%;
- Other (Industrial Wastes) - 21.2%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.1%;
- Solid Fuels - 50.1%;
- Gaseous Fuels - 50.1%;
- Biomass - 50.1%;
- Other (Industrial Wastes) - 50.5%.

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period.

See the Chapter 3.2.6.3 for more details.

3.2.8.5.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission Sector.

See the Chapter 3.2.6.4 for more details.

3.2.8.5.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.
- *Naphta*: 2000 year - Energy Balance activity data correction;
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Biomass Fuel

Activity data

- *Gas biomass*: 2007, 2010, 2011 years - Energy Balance activity data correction.

For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.6.5.

3.2.8.5.6 Source-specific planned improvements, if applicable

It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.
See the Chapter 3.2.6.6 for more details.

3.2.8.6 Fuel combustion, Manufacturing Industries and Construction, Other (please specify) (CRF category 1.A.2.f.)

3.2.8.6.1 Source description

CRF category 1.A.2.f. - Other (please specify), is a CO_2 key category by liquid, solid, gaseous – level and trend, excluding and including LULUCF, as result of T1 approach.

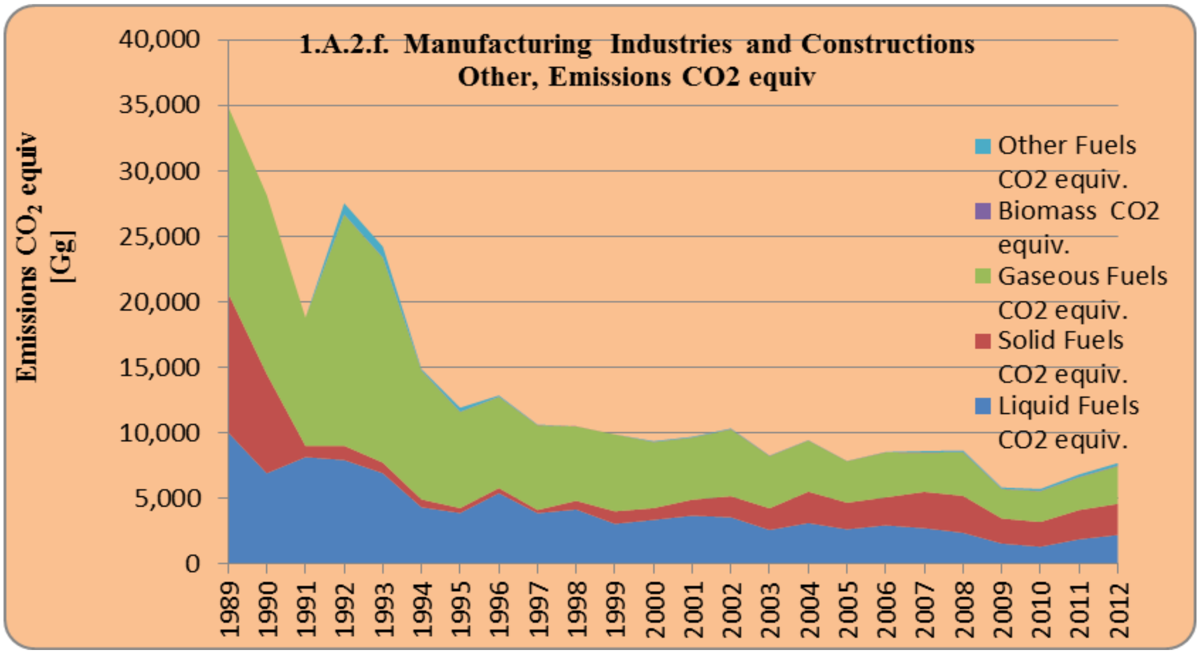
CRF category 1.A.2.f. - Other (please specify), is a CO_2 key category by liquid and gaseous fuels – trend and by solid fuels - level and trend, excluding LULUCF and is a key category by liquid, solid and gaseous fules – trend, including LULUCF, as result of T2 approach.

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

In this activity all type of fuels are consumed in a different proportion. Predominant is the usage of the liquid and gaseous fuels. It is observed a main contribution of the natural gas usage as fuel in this activity category, mostly on the period 1989 - 2003. In the last five years the gaseous, liquid and solid fuels have a comparable share to the category emissions and the same trend.

The share of the total GHG emissions of the 1.A.2.f category to the 1.A.2 sub-sector is about 48% - base year to the 50.1%, current year. The contribution of this category is about 7,707.16 Gg CO_2 equiv., in 2012.

Figure 3.33 GHG emissions from 1.A.2.f – Other, by fuels



3.2.8.6.2 Methodological issues

Tier 1 Methodology and Default emission factors for the fuels without analyze on EU-ETS reporting are used. For the fuels reported in this activity category having determined Country Specific Emission Factors, Tier 2 methodology is used.

CO_2 gas

For the 1989–2006 period

- **Solid fuels**, *EFs* calculated as weighted arithmetic average (WA), on 2007–2010 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007–2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007 - 2012 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2011 period, on each EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2011 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007–2011 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Biomass,** entire time-series, EFs default are used.
- **Other fuels** – industrial wastes, entire time-series, country specific EF calculated as weighted arithmetic average (WA), on 2011 EU-ETS reported category activities, are used.

CH_4, N_2O - default EFs are used.

NOx, CO, NMVOC, SO_2 – default EMEP EFs are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT.
The NCVs used are those corresponding with this activity.
See the Chapter 3.2.6.2 for more details.

3.2.8.6.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%;
- Solid Fuels – 5.0%;
- Gaseous Fuels - 3.0%;
- Biomass - 20.2%;
- Other (Industrial Wastes) - 21.2%.

CH_4 gas, N_2O gas

- ❖ Liquid Fuels - 50.1%;
- ❖ Solid Fuels - 50.1%;
- ❖ Gaseous Fuels - 50.1%;
- ❖ Biomass - 50.1%;
- ❖ Other (Industrial Wastes) - 50.5%.

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period.
See the Chapter 3.2.6.3 for more details.

3.2.8.6.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission Sector.
See the Chapter 3.2.6.4 for more details.

3.2.8.6.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Refinery Gas*: 2004, 2005, 2006 years - Energy Balance activity data correction;
- *LPG*: 2006 year - Energy Balance activity data correction.
- *Motor Gasoline*: Net Calorific Value, 1990 - 2004 period - Energy Balance parameter correction.

- *Petroleum Coke*: Non-Metallic Minerals, 2000 – 2004 period - Energy Balance activity data correction; Non-specified (Industry), 2000 – 2004 period - Energy Balance activity data correction;
- *Naphta*: Non-Metallic Minerals, 2000 year - Energy Balance activity data correction;
- *White Spirit & SBP*: Non-specified (Industry), 1998, 2005, 2010 years - Energy Balance activity data correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;

Biomass

Activity data

- *Solid biomass*: 2000, 2001, 2004 – 2008 period - Energy Balance activity data correction;
- *Gas from Biomass*: 2002 year, 2007 – 2011 period - Energy Balance activity data correction.

For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.6.5.

3.2.8.6.6 Source-specific planned improvements, if applicable

It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a higher tier approach in the estimation of the CO_2 emissions.
See the Chapter 3.2.6.6 for more details.

3.2.9 *Transport (CRF sector 1.A.3.)*

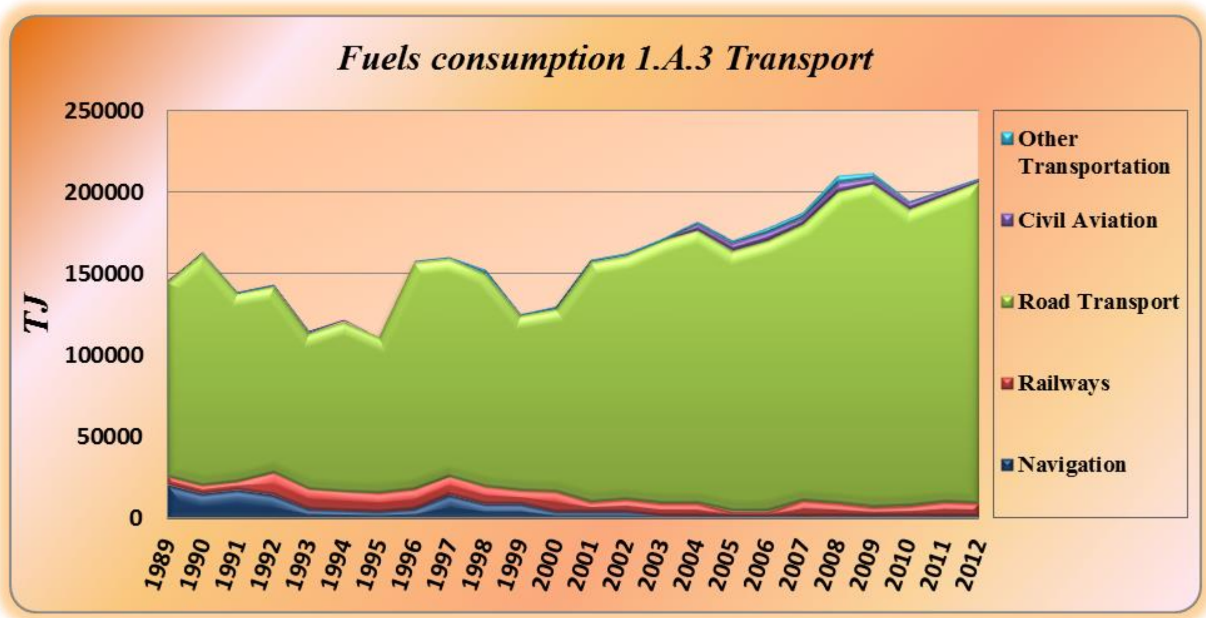
3.2.9.1 Source category description

The IPCC source category for transport covers all types of mobile sources including also the range of characteristics that affect the emission factors and consequently the emissions. Those are compiled in five categories, according to the source.

The direct GHG emissions originating from transport are carbon dioxide, methane and nitrous oxide; for the estimation of each the most appropriate method has been chosen based on the type of emission, transport category and data availability.

Emission trends over the years depend significantly on the amount of fuel consumed.

Figure 3.34 Contribution of each category to total fuel consumption in Transport Subsector

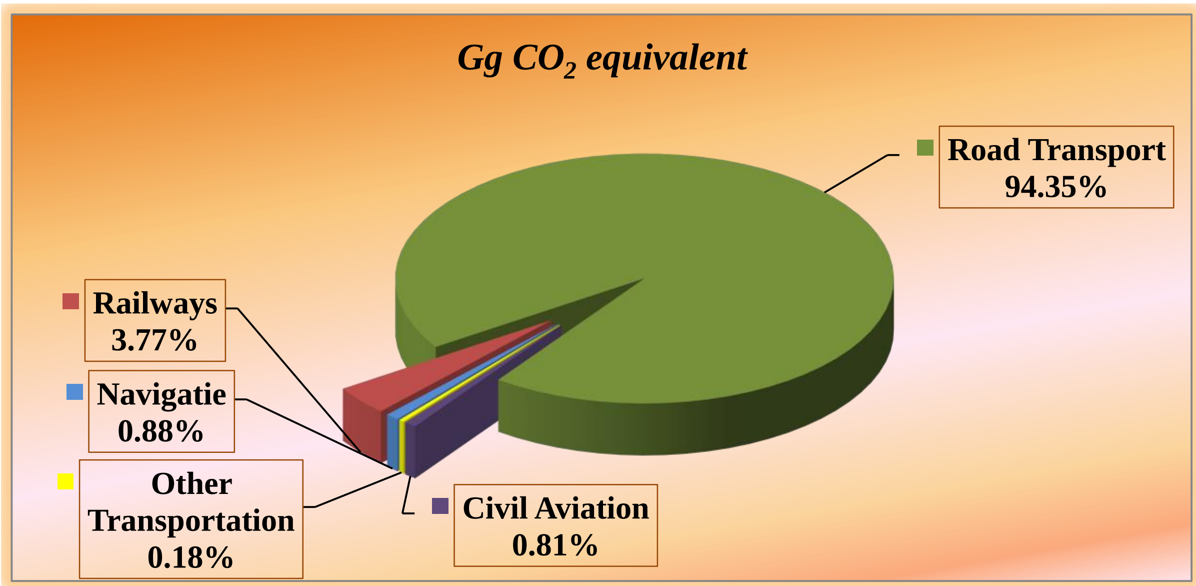


In 2012 year, the emissions from transport categories accounted for 15,062.17 Gg CO_2 equivalent.

The GHG characterized are: CO_2, CH_4, N_2O, NO_x, NMVOC, CO and SO_2.

Within the Energy Sector total emissions, 18.32% represents transport emissions. This sector includes emissions from road transportation, civil aviation, railways, navigation and pipeline transportation.

Figure 3.35 Transport Subsector emissions by sub-sectors, for 2012



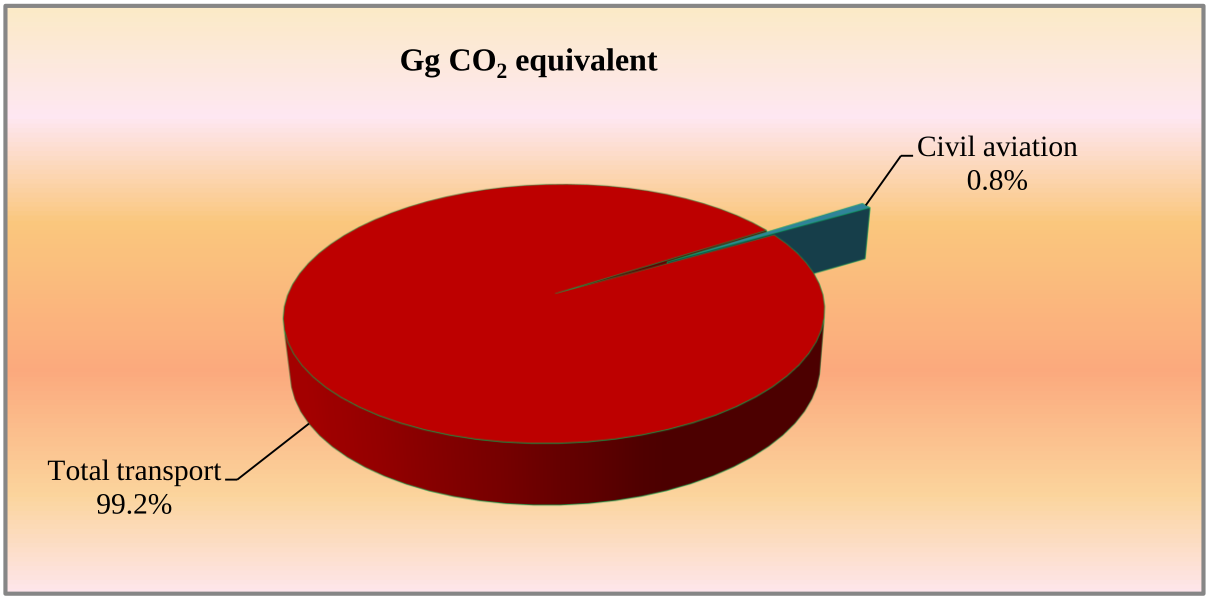
3.2.9.2 Source category Civil Aviation (CRF sector 1.A.3.a)

3.2.9.2.1 Source category description

Emissions from Aviation Subsector originate from the combustion of jet kerosene and aviation gasoline. Aircraft emit carbon dioxide, methane and nitrous oxide, as well as carbon monoxide, non-methane volatile organic compounds, sulphur dioxide, and nitrogen oxides.

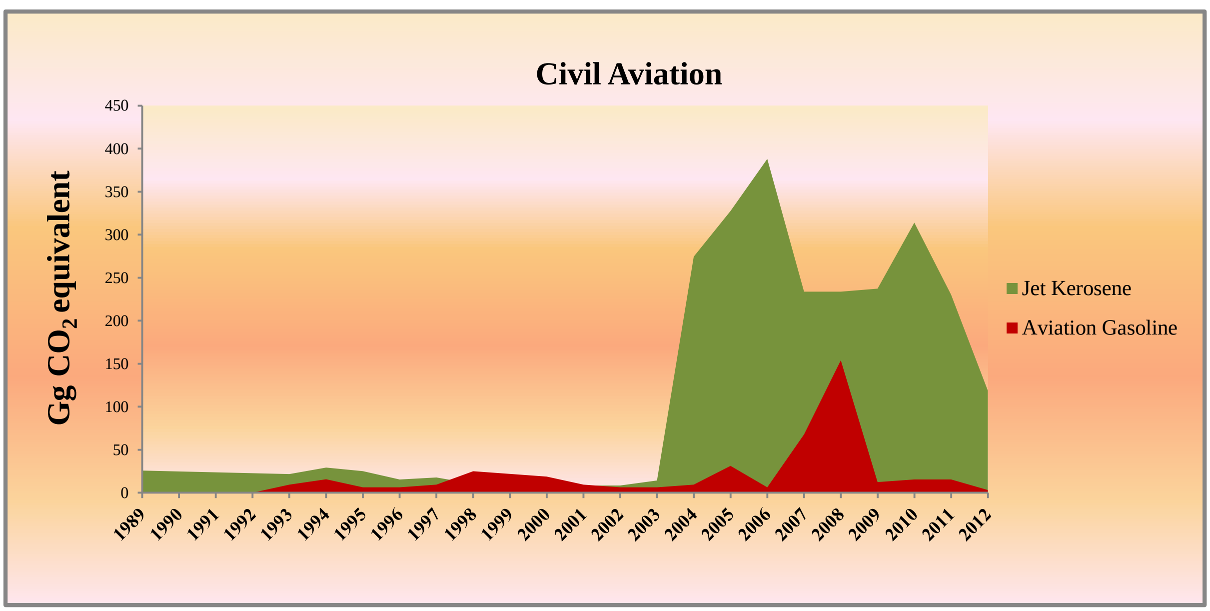
In 2012 year, the civil aviation related emissions represents 0.8% of total emissions from the transport sector (15,086.67 Gg CO_2 equivalent).

Figure 3.36 The contribution of Civil Aviation emissions in total GHG emissions from Transport subsector



Greenhouse gas emissions from aviation are low in comparison to emissions from the transport sector but show an increase from 1989 to 2012.

Figure 3.37 GHG emissions Trend from 1A3a – Civil Aviation



In the period 1989-2003 emissions remains broadly constant, the fuel consumption being constant. Starting with 2004 in Civil Aviation Subsector due to the economic development of the country more flights took place, and therefore fuel consumption and, implicitly, emissions, increased. In the 2005-2012 period increases and decreases of emissions due to fluctuations in the number of flights operated took place.

3.2.9.2.2 Methodological issues

Methodology

The GHG emissions from Civil Aviation category are calculated according to IPCC 1996 and IPCC 2006 provision. For the 1989-2003 period a Tier 1 method was applied as (no LTO data were available); for 2004-2012, a Tier 2 method was used.

Tier 1 method

The Tier 1 method is based on an aggregate quantity of fuel consumption data for aviation (LTO and cruise) multiplied by average emission factors.The direct greenhouse gas emissions are calculated according to Equation 3.6.1 in IPCC 2006-Volume 2, , chapter 3.6.1.1, page 3.59:

Equation 3.4 The direct calculation of greenhouse gas emissions

$$Emissions = Fuel\ Consumption * Emission\ Factor$$

The direct and indirect GHG emissions are calculated according to IPCC 1996 (CH_4 pag.1.34, Ch1.4.2.1 N_2O pag.1.36, Ch.1.4.2.2, NO_x pag.1.37,Ch.1.4.2.3,CO pag.1.39,Ch.1.4.2.4,NMVOC pag.1.41Ch 1.4.2.5,SO_2 pag.1.43,Ch1.4.2.6)

Equation 3.5 The indirect calculation of greenhouse gas emissions

$$Emissions(CH_4,N_2O, NOx,CO,NMVOCSO_2) = \sum (EFab\ x\ Activityab)$$

where:

EF = Emission Factor (kg/TJ);

Activity = Energy Input (TJ);

a = Fuel type; and

b = Sector-activity.

Tier 2 method

Tier 2 method splits the calculation of emissions from aviation into the following steps:

1. Estimate the domestic and international fuel consumption totals for aviation.
2. Estimate LTO fuel consumption for domestic and international operations.
3. Estimate the cruise fuel consumption for domestic and international aviation.
4. Estimate emissions from LTO and cruise phases for domestic and international aviation.

Tier 2 approach uses Equations 3.6.2 to 3.6.5 (page 3.59, Chapter 3.6.1.1, vol.2, 2006 IPCC GL) to estimate emissions:

Equation 3.6 The calculation of emissions from aviation for step 1

$$Total\ Emissions = LTO\ Emissions + Cruise\ Emissions$$

where:

Equation 3.7 The calculation of emissions from aviation for step 2

$$LTO\ Emissions = Number\ of\ LTOs \bullet Emission\ Factor\ LTO$$

Equation 3.8 The calculation of emissions from aviation for step 3

$$LTO\ Fuel\ Consumption = Number\ of\ LTOs \bullet Fuel\ Consumption\ per\ LTO$$

Equation 3.9 The calculation of emissions from aviation for step 4

Cruise Emissions = (Total Fuel Consumption – LTO Fuel Consumption)
• Emission Factor Cruise

The values of CH_4 and N_2O emissions for Domestic and International Aviation were calculated for each cycle type of aircraft flight (kg fuel/ LTO) using the IPCC 2006 methodology vol 2, Chapter 3 Table 3.6.9, page 3.70 (see Annex 3.1).

Emission factors

Default values of CO_2 emissions factor, according to 2006 IPCC GL (vol.2, ch 3.6.1.2,table 3.6.4, page 3.64.) for Tier 1 and Tier 2 methods, were used.

CO_2 emission factor	
Fuel	**Default (kg/TJ)**
Aviation Gasoline	70,000
Jet Kerosene	71,500

For Tier 1 the values of CH4, N_2O emissions factor for domestic and international aviation are default according to 2006 IPCC methodology, Table 3.6.5,pag 3.6.4, chapter 3, vol 2.

Default emission factor (kg/TJ) for all fuels	
CH_4	N_2O
0.5	2

For Tier 2 the values of CH_4, N_2O emissions factor for Domestic and International Aviation are default according to 2006 IPCC methodology, Table 3.6.9, page 3.70, Chapter 3, vol 2.(see annex.3.1).

The values of NO_x, CO, NMVOC emission factors are default and in according to IPCC 1996 Guidelines.

For the estimation of the SO_2 emissions were used the values of the Sulphur content provided by the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009 and in according to 1996 IPCC Guidelines. Determination of values emission factors and emissions were in according to 1996 IPCC Guidelines.

Activity Data

Fuel consumption data are provided through the Romanian Civil Aeronautical Authority and IEA/Eurostat Questionnaire, elaborated by NIS.

In respect to aviation gasoline data, for 1989-2006 period Romanian Civil Aeronautical Authority data were used; for 2007-2011 period IEA/Eurostat Questionnaire data were used.

In respect to jet kerosene : 1989-2003 period it use Domestic Energy Balance and for 2004-2011 period it use IEA/Eurostat Questionnaire.

Starting with 2010 inventory submission, fuels consumption for domestic and international aviation were calculated for the cycles of the fly LTO (landing/take off) /Cruise. The fuel consumption/ LTO is provided through the Eurostat website /Aircraft traffic data by reporting country [avia_tf_acc] (see Annex 3.1).

Figure 3.38 Fuel consumption(Aviation gasoline) for Civil Aviation -1.A.3.a

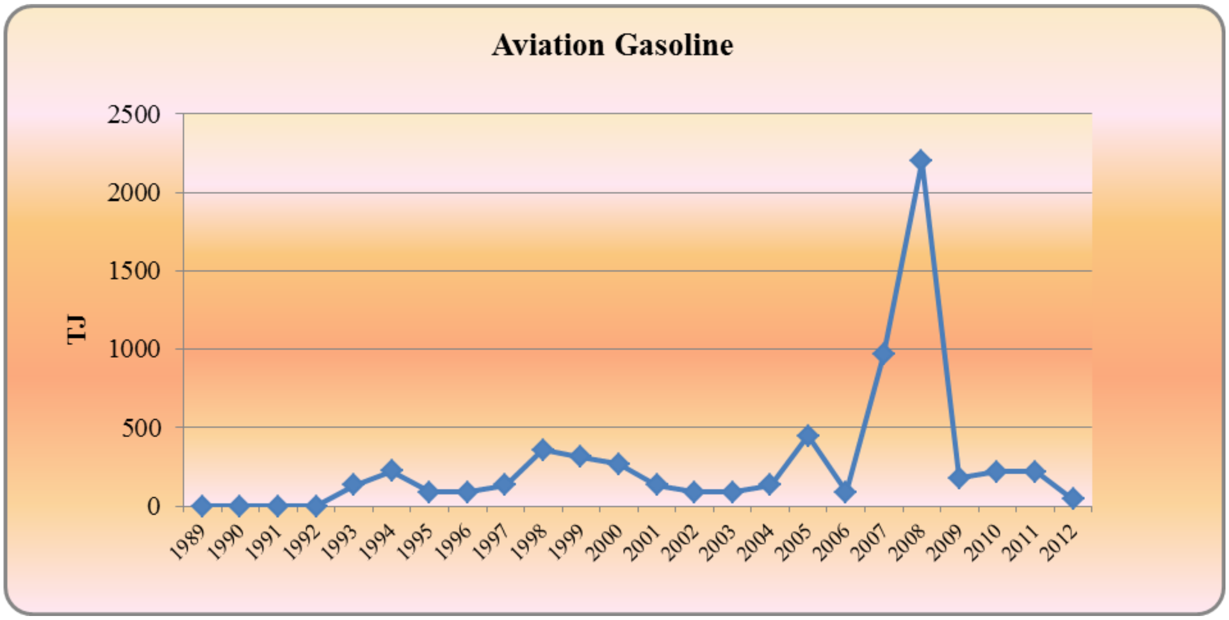
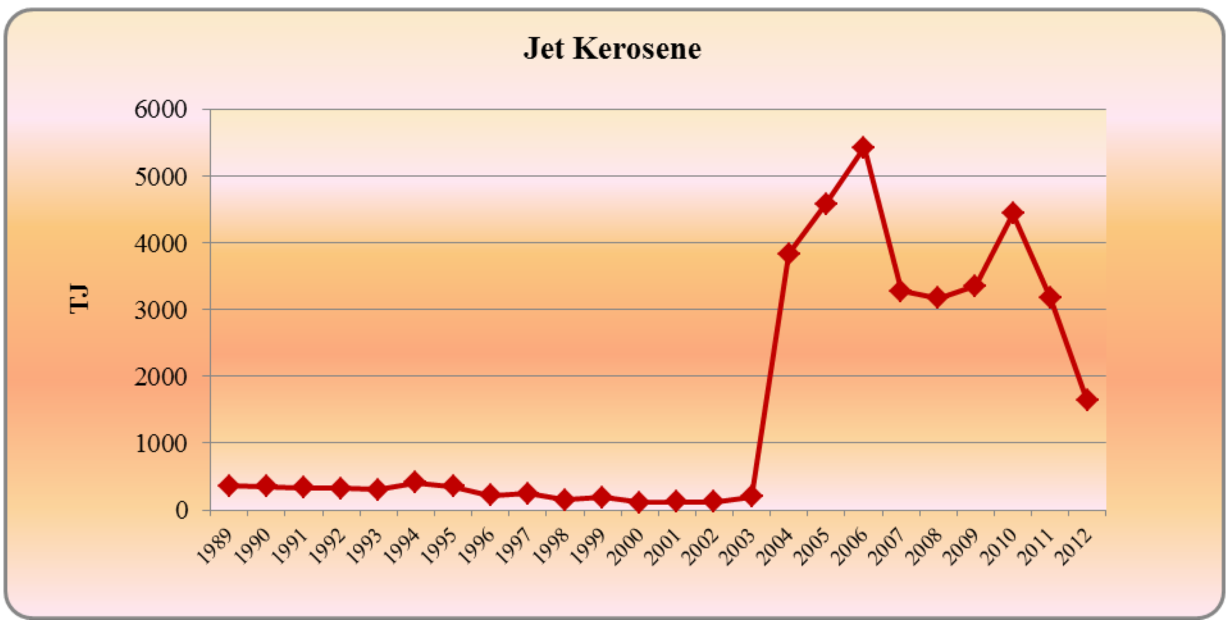


Figure 3.39 Fuel consumption(Jet Kerosene) for Civil Aviation -1.A.3.a



3.2.9.2.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

CO_2

- ***activity data***
  - aviation gasoline: 5 %;
  - jet kerosene: 5 %.
- ***emision* factors:**
  - Aviation gasoline: 5%;
  - Jet Kerosene: 5%.
  - 7.07% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4

- ***activity data***
  - aviation gasoline: 5 %;
  - jet kerosene: 5 %.
- ***emision factors***
  - Aviation gasoline: 150%
  - Jet Kerosene: 150%
  - 150% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC

N_2O

- ***activity data***
  - aviation gasoline: 5 %;

- jet kerosene: 5 %.

❖ ***emision factors:***

- Aviation gasoline: 150%
- Jet Kerosene: 150%
- 150% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

3.2.9.2.4 Source-specific QA/QC and verification, if applicable

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Road Transport Subsector the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 3.2.9.2.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.2.9.2.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

3.2.9.2.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In order to improve the emissions estimates quality some important recalculations were made:

- ❖ activity data

Jet Kerosene

Recalculation for the 2011 year at AD: due to changes of value AD by the National Institute of Statistics (NSI). Recalculation for year 2011 at CO_2,CH_4 and N_2O emissions due to change value AD for this year.

Table 3.28 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	362.88	362.88	25.69	25.69	0.00
1990	348.55	348.55	24.67	24.67	0.00
1991	334.21	334.21	23.66	23.66	0.00
1992	319.87	319.87	22.64	22.64	0.00
1993	439.14	439.14	30.89	30.98	0.00
1994	634.80	634.80	44.60	44.76	0.00

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1995	442.55	442.55	31.19	31.26	0.00
1996	305.61	305.61	21.50	21.56	0.00
1997	383.28	383.28	26.93	27.03	0.00
1998	501.79	501.79	34.99	35.24	0.00
1999	498.93	498.93	34.85	35.07	0.00
2000	375.98	375.98	26.22	26.40	0.00
2001	250.38	250.38	17.52	17.62	0.00
2002	207.33	207.33	14.54	14.61	0.00
2003	289.20	289.20	20.34	20.40	0.00
2004	323.26	3,971.34	22.68	283.75	0.00
2005	648.16	5,025.18	45.22	358.63	0.00
2006	255.37	5,515.33	17.94	394.21	0.00
2007	4,245.80	4,245.80	300.72	301.40	0.00
2008	5,374.30	5,374.30	386.00	387.54	0.00
2009	3,536.06	3,536.06	249.34	249.47	0.00
2010	4,660.49	4,660.49	329.12	329.27	0.00
2011	4,130.24	3,406.08	297.88	245.56	-21.31

Table 3.29 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	362.88	362.88	0.0002	0.0002	0.00
1990	348.55	348.55	0.0002	0.0002	0.00

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1991	334.21	334.21	0.0002	0.0002	0.00
1992	319.87	319.87	0.0002	0.0002	0.00
1993	439.14	439.14	0.0002	0.0002	0.00
1994	634.80	634.80	0.0003	0.0003	0.00
1995	442.55	442.55	0.0002	0.0002	0.00
1996	305.61	305.61	0.0002	0.0002	0.00
1997	383.28	383.28	0.0002	0.0002	0.00
1998	501.79	501.79	0.0003	0.0003	0.00
1999	498.93	498.93	0.0002	0.0002	0.00
2000	375.98	375.98	0.0002	0.0002	0.00
2001	250.38	250.38	0.0001	0.0001	0.00
2002	207.33	207.33	0.0001	0.0001	0.00
2003	289.20	289.20	0.0001	0.0001	0.00
2004	323.26	3,971.34	0.0027	0.0027	0.00
2005	648.16	5,025.18	0.0034	0.0034	0.00
2006	255.37	5,515.33	0.0040	0.0040	0.00
2007	4,245.80	4,245.80	0.0039	0.0039	0.00
2008	5,374.30	5,374.30	0.0045	0.0045	0.00
2009	3,536.06	3,536.06	0.0040	0.0040	0.00
2010	4,660.49	4,660.49	0.0050	0.0050	0.00
2011	4,130.24	3,406.08	0.0038	0.0034	-10.75

Table 3.30 Effects of data changes on N_2O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N2O [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	362.88	362.88	0.0007	0.0007	0.00
1990	348.55	348.55	0.0007	0.0007	0.00
1991	334.21	334.21	0.0007	0.0007	0.00
1992	319.87	319.87	0.0006	0.0006	0.00
1993	439.14	439.14	0.0009	0.0009	0.00
1994	634.80	634.80	0.0013	0.0013	0.00
1995	442.55	442.55	0.0009	0.0009	0.00
1996	305.61	305.61	0.0006	0.0006	0.00
1997	383.28	383.28	0.0008	0.0008	0.00
1998	501.79	501.79	0.0010	0.0010	0.00
1999	498.93	498.93	0.0010	0.0010	0.00
2000	375.98	375.98	0.0008	0.0008	0.00
2001	250.38	250.38	0.0005	0.0005	0.00
2002	207.33	207.33	0.0004	0.0004	0.00
2003	289.20	289.20	0.0006	0.0006	0.00
2004	323.26	3,971.34	0.0080	0.0080	0.00
2005	648.16	5,025.18	0.0015	0.0015	0.00
2006	255.37	5,515.33	0.0008	0.0008	0.00
2007	4,245.80	4,245.80	0.0027	0.0027	0.00
2008	5,374.30	5,374.30	0.0055	0.0055	0.00
2009	3,536.06	3,536.06	0.0015	0.0015	0.00
2010	4,660.49	4,660.49	0.0017	0.0017	0.00
2011	4,130.24	3,406.08	0.0013	0.0013	0.38

3.2.9.3 Road Transport (CRFcategory 1.A.3.b)

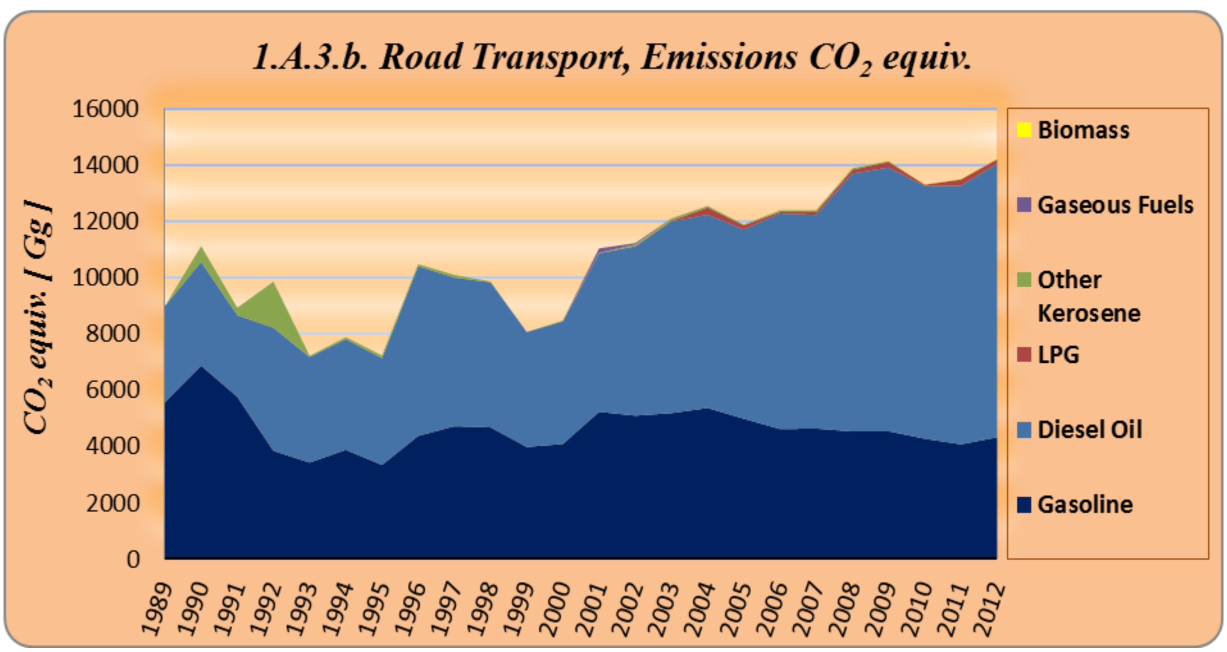
3.2.9.3.1 Source category description

Road Transport category, is a key category, by level, trend, including LULUCF and excluding LULUCF criteria.

Road Transport category includes emissions from all types of vehicles, light-duty vehicles such as automobiles and light trucks, and heavy-duty vehicles such as tractor trailers and buses; on-road motorcycles (including mopeds, scooters, and three-wheelers) related emissions are also included. Mobile sources produce direct greenhouse gas emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) from the combustion of various fuel types, as well as several other pollutants such as carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO_2), particulate matter (PM) and oxides of nitrate (NOx), which cause or contribute to local or regional air pollution.

Exhaust emissions from road transport arise from the engines internal combustion of fuels such as gasoline, diesel, liquefied petroleum gas, other kerosene and natural gas.

Figure 3.40 Road transport GHG emissions by fuels

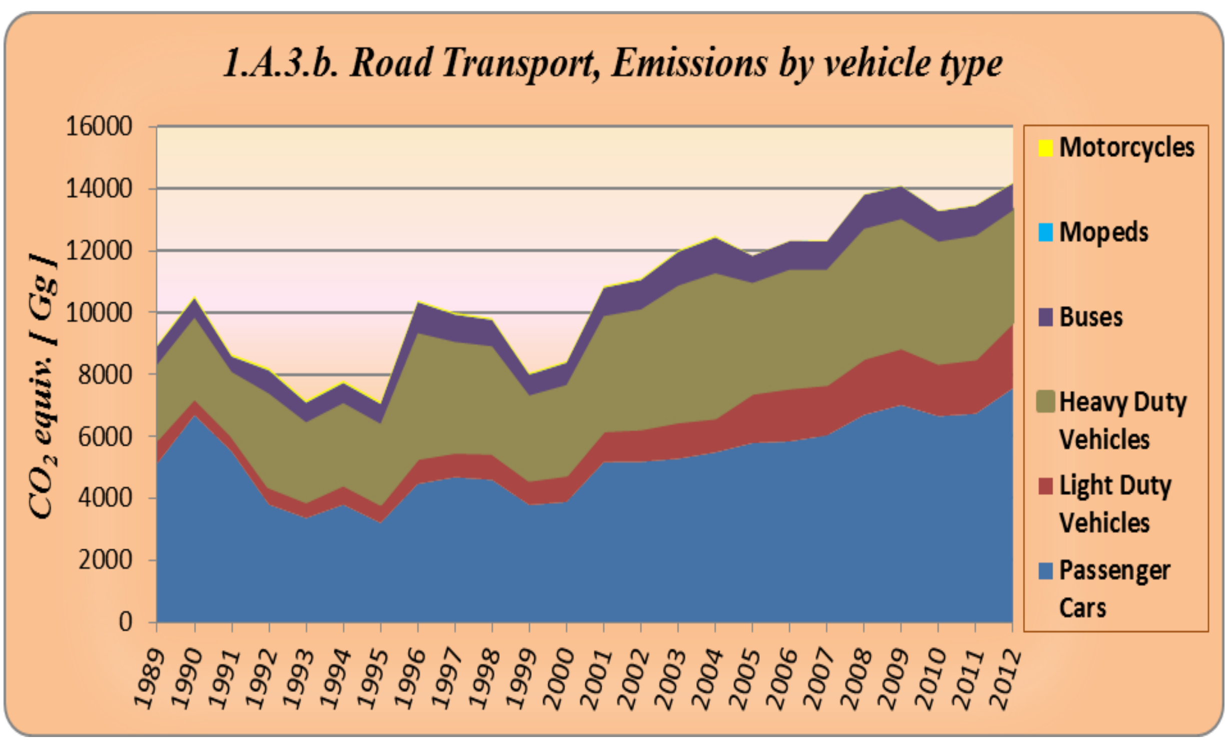


In Road Transport Subsector the emissions trend reflects the changes in period 1989–1999 characterized by a process of transition to a market economy. Roads in Romania had a low level of modernization. Massive development of trade and the industrial revolution led to improving the roads and to achieve efficient vehicles; therefore, the goods road transport services have experienced a considerable increase after 1989. In 1994 was launched the Logan brand Romania has contributed to a rise in the number of passenger cars, and in 2005 entered the diesel version, one of the factors that led to increased diesel consumption and CO_2 emissions.

A distinct uptrend of GHGs emissions could be noticed since 2000 to present. On the whole, increasing emissions trend from the Road Transport Sub–sector is due to the increasing trend of the number of vehicles and volume of goods transported, especially starting with 2000.

Afterwards, a period of stabilization began and continued to 2009 when there was a slight drop in the emissions mainly related to the economic crisis and the consequent decline in transportation. However, with the reviving economy CO_2 emissions grew constantly to 2010.

Figure 3.41 Road transport GHG emissions by vehicle type



Overall, the GHG emissions from road transport increased by 58,2% compared to base year levels being 8982,4 Gg CO_2e in 1989 and reached levels of 14211,2 Gg CO_2e in 2012.

The most important contributor to GHG emissions from passenger cars, followed by heavy vehicles, light commercial vehicles, motorcycles and mopeds. That as can be seen in 2012, passenger cars represent 53.24% and heavy duty vehicle 25% of total GHG emissions CO_2e respectively, according to the increase of passenger and freight. 21.76% were split between light commercial vehicles , buses, motorcycles and mopeds.

Figure 3.42 Road transport GHG emissions by vehicle type

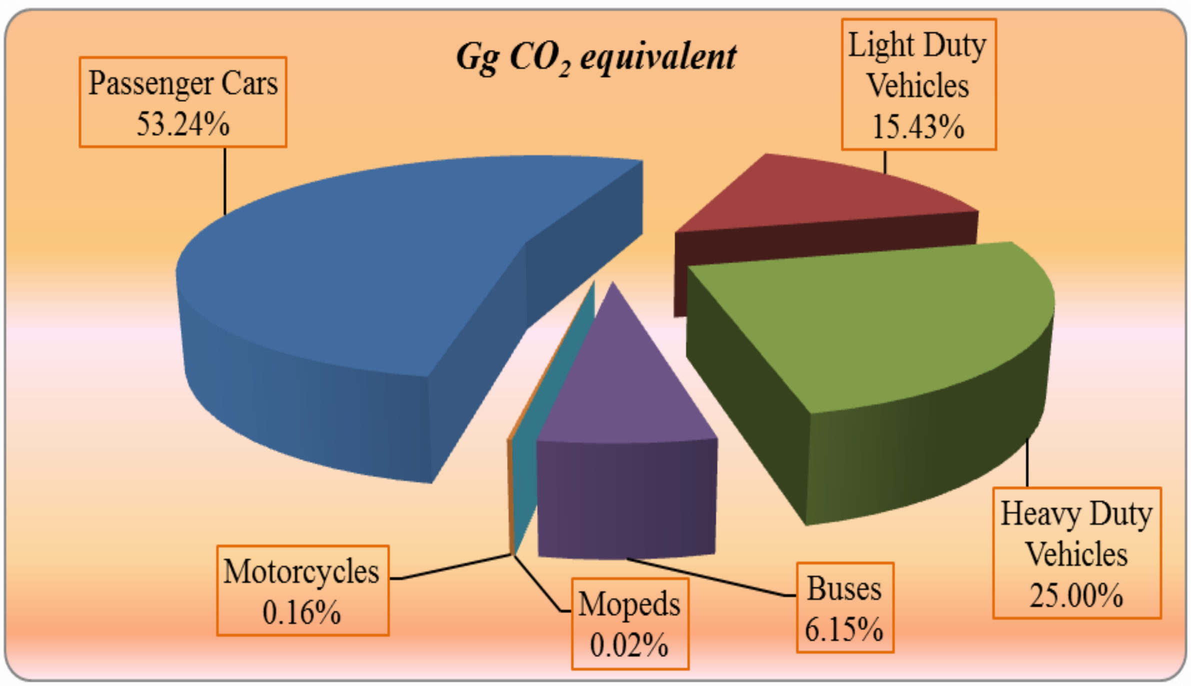
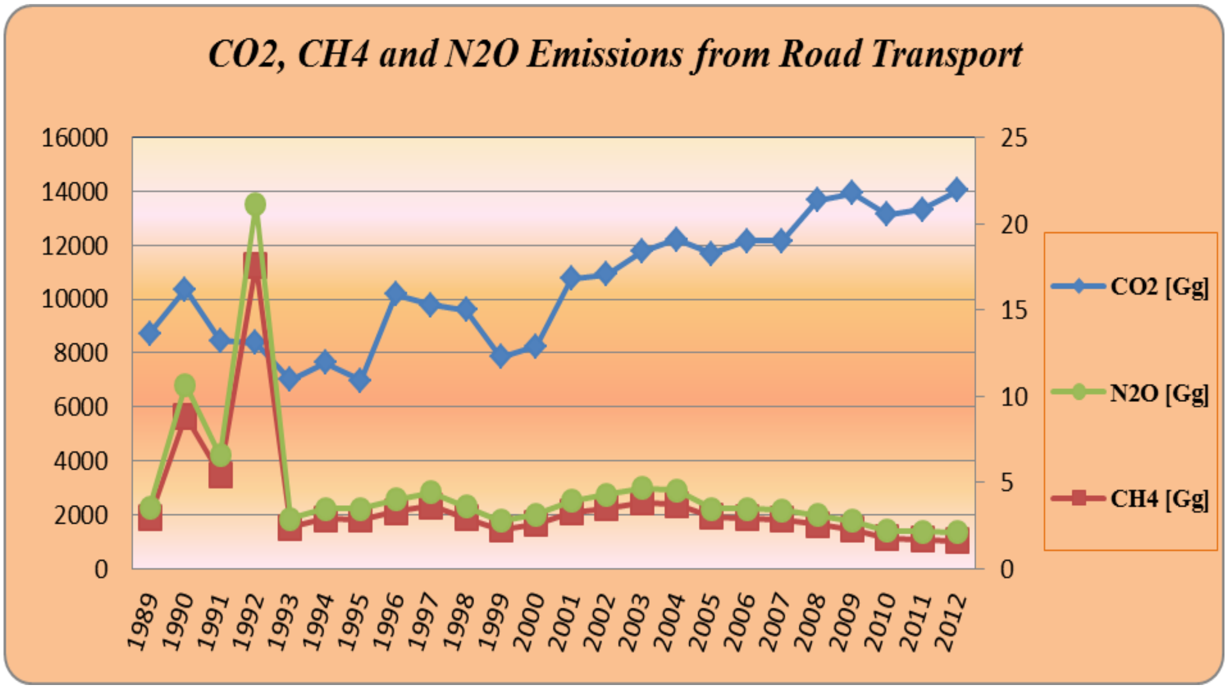


Figure 3.43 CO_2, CH_4, N_2O, [Gg] Emissions from Road Transport



Whereas CO_2 emissions are closely linked to fuel consumption, CH_4 and N_2O emissions are impacted and by the technology. N_2O emissions have a higher warming potential compared to CH4, hence, a slight increase in their release in the environment leads to a greater impact.

As it can be observed, N_2O and CH_4 emissions tend to fluctuate for the period of the inventory. However, there is an increase in the years 1989-1992 which is closely related to decline since 1989 as a result of the political and economic crisis, a distinct uptrend of GHGs emissions could be noticed for this period.

CH_4 and N_2O emissions peak growth in 1990 and 1992 respectively after the model of fuel consumption.

Compliance with emission standards raised significantly influence, CH_4 and N_2O thereby leading to low levels of methane and nitrous oxide.

In addition, the market penetration of Euro 2 and Euro 3 cars catalyst for better environmental performance in terms of curve influence emissions methane and nitrous oxide.

There is also increasing in the years 2000-2005, which is closely linked to the introduction of Euro 1 vehicles. This category is known for higher N_2O emissions.

As the technology improves over time, there is a noticeable decrease in the passage from Euro 1 to Euro 3, which could be detected clearly after 2005.

3.2.9.3.2 Methodological issues

Methodology

In the development of estimates, it was primarily utilized default EFs available in the IPCC 2006 and, in some cases (where the previous documents do not comprise values) from EMEP/EEA air pollutant emission inventory guidebook 2013.
Model Copert 4, Tier 1 was used in the absence of more detailed fleet data (for the period 1989-2004).
Model Copert 4, Tier 3 was used for the period 2005-2012, detailed statistics necessary to use higher level methods have allowed.

<u>For the 1989–2004 period</u>

A) Tier 1 methodology

Tier 1 methods apply simple linear relation between activity data and emission factors. The activity data is derived from readily available statistical information (consumtion energy statistics, fleet data, data on traffic counts etc).
The most common estimation approach is to combine information on the extent to which a activity takes place (called activity data or AD) with coefficients that quantify the emissions or removals per unit activity, called emission factors (EF), the default Tier 1 emission factors are chosen in way that they represent 'typical' or 'averaged' process conditions - they tend to be technology independent.
For this time period 1989-2004, was used default emission factors of EMEP/EEA emission inventory guidebook 2013, Tier 1. Emissions of CO_2, CH_4 and N_2O are calculated based on the amount and type of fuel combusted and its carbon content (for CO_2 gas).
The formula used in the calculations is the following:

Equation 3.10 CO_2, CH_4 and N_2O emissions estimation-Tier 1 methodology

$$Ei = \Sigma j\ (\Sigma m\ (FCj,m * EFi,j,m))$$

where:

- Ei = emission of pollutant i (Gg);
- FCj,m = fuel consumption of vehicle category j using fuel m (TJ);
- EFi,j,m = fuel consumption-specific emission factor of pollutant i for vehicle category j and fuel m (Gg).

The vehicle categories that have been considered are passenger cars, light commercial vehicles, heavy-duty vehicles, and two-wheel vehicles. The fuels that have been considered include gasoline, diesel, LPG.

This equation requires the fuel consumption of vehicle category, and national statistics do not provide vehicle category details.

Emission factors

CO_2, CH_4, N_2O and for the indirect greenhouse gases

The Tier 1 emission factors (EFi,j,m) have been calculated based on the Tier 3 method (actually Copert 4), so as to be applicable to countries with older vehicle fleets. The emission factors are given in Table 3-5 to Table 3-11.

However, a consequence of this approach, in the context of the legislative emission requirements for more modern vehicles, is that the Tier 1 emission factors will give somewhat higher emission values than a Tier 2 or 3 methodology for countries whose fleet comprises vehicles which comply with more recent (i.e. Euro 2 / Euro II and later) emission standards.

In Table 3-5 to Table 3-9, the maximum values correspond to uncontrolled vehicle technology, and the minimum values correspond to a European average in 2005 (before the introduction of Euro 4).

For the gases CO_2, CH_4, N_2O and for the indirect greenhouse gases default emission factors are used.

For the estimation of the CO_2, CH_4, N_2O, CO, NOx and NMVOC emissions were used the values of the provided by the site EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013 and in according to IPCC 2006 Guidelines.
(CO_2 ch. Road transport GB 2013, table 3-11 pag.27; CH_4 ch. Road transport GB 2013, table 3-70 pag.82; N_2O ch. Road transport GB 2013, table 3-7 pag.26; CO, NOx, ch. Road transport GB 2013, table 3-5 and table 3-6 pags.25-26; NMVOC ch. Gasoline evaporation GB 2013, pag.8-9; SO_2 IPCC 1996, Vol.III, pag.1.44 Guidelines table 1-12 Default Values of Sulphur Content in gasoline(road), diesel(road) and jet kerosene).

Activity data

Liquid and gaseous fuels

The energy balances prepared by the Romanian National Institute for Statistics in the Eurostat format (Eurostat Questionnaire), were used for estimating the emissions for the years in 1990-2012 period. NIS did not prepared balances in the Eurostat format for the years before 1990; therefore, the IEA Energy Balance (IEA Questionnaire) was used for the year 1989.
The other data, necessary for implementation of model COPERT- Tier 1, have been provided by national institutions: fleet data provided by Romanian National Institute for Statistics (NIS), were processed and completed by the Romanian Automobile Registry (RAR).

Biomass

In order to estimate the emissions from biomass combustion activities in road transport, data on energetic quantities provided through the Energy Balance were used.
Liquid biomass used comprise biogasoline, biodiesel and other bioliquids.
All these types are combusted to produce heat and/or power. However, CO_2 emissions released from these processes are reported as an information item, as the CO_2 is naturally captured from the air. That is not applicable for the CH_4 and N_2O emissions, being reported and accounted for, in the total inventory emissions.

The national energy balance is provided by NIS. The net calorific values (NCVs) used for converting mass or volume units of the fuel quantities into energy units [TJ] are provided by NIS.

Choice of NCV

For liquid fuels country specific NCVs values, derived for the corresponding liquid fuels from the EU-ETS reporting, are used.

For gaseous fuels was used directly the amount in TJ as reported by the energy balances. Since the reported values are Gross Calorific Values, all numbers were multiplied by 90% in order to compute the NCV.

For the 2005-2012 period

Methodology

For period 2005-2012 the emission calculations of road transport have been performed with the use of the version 9 of the European COPERT 4 software, model methodology corresponding to Tier 3, according to the IPCC GPG 2000 and IPCC 2006.
In the Tier 3 method, exhaust emissions are calculated using a combination of firm technical data (emission factors) and activity data (total vehicle km).
In the model emissions were calculated through the input of detailed data on average daily trip distance, the relative humidity per month, minimum and maximum temperatures per month, consumption and fuel specifications, vehicle fleet categorized in sectors, subsectors and technology (standard), vehicle stock and annual mileage, speed and driving shares.

Emission Factors

In the Tier 3 approach, total exhaust emissions from road transport are calculated as the sum of hot emissions (when the engine is at its normal operating temperature) and emissions during transient thermal engine operation (termed cold-start emissions).

The distinction between emissions during the hot stabilised phase and the transient warming-up phase is necessary because of the substantial difference in vehicle emission performance during these two conditions. Concentrations of some pollutants during the warming-up period are many times higher than during hot operation, and a different methodological approach is required to estimate the additional emissions during this period. To summarise, total emissions can be calculated by means of the following equation.

Equation 3.11 The calculation of the total exhaust emissions from road transport

$$E_{TOTAL} = E_{HOT} + E_{COLD}$$

where:

- E_{TOTAL} = total emissions (g) of any pollutant for the spatial and temporal resolution of the application;
- E_{HOT} = emissions (g) during stabilised (hot) engine operation;
- E_{COLD} = emissions (g) during transient thermal engine operation (cold start).

Vehicle emissions are heavily dependent on the engine operation conditions. Different driving situations impose different engine operation conditions, and therefore a distinct emission performance. In this respect, a distinction is made between urban, rural and highway driving.

As will be demonstrated later, different activity data and emission factors are attributed to each driving situation. Cold-start emissions are attributed mainly to urban driving (and secondarily to rural driving), as it is expected that a limited number of trips start at highway conditions. Therefore, as far as driving conditions are concerned, total emissions can be calculated by means of the equation.

Equation 3.12 The calculation of the total emissions from road transport

$$E_{TOTAL} = E_{URBAN} + E_{RURAL} + E_{HIGHWAY}$$

where:

- E_{URBAN}, E_{RURAL} and $E_{HIGHWAY}$ are the total emissions (g) of any pollutant for the respective driving situations.

Total emissions are calculated by combining activity data for each vehicle category with appropriate emission factors. The emission factors vary according to the input data (driving situations, climatic conditions). Also, information on fuel consumption and fuel specification is required to maintain a fuel balance between the figures provided by the user and the calculations.

Activity data

Fuel consumption (liquid, gaseous, LPG and biofuels) is obtained from Romanian Energy Balance IEA/Eurostat/UNECE format data and converted into energy units using the NCV. According to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the net (or lower) calorific value (NCV) should be used as the conversion factor for each fuel.

The other data, necessary for implementation of model COPERT have been provided by national institutions: Romanian National Institute for Statistics (NIS), Romanian Automobile Registry (RAR), Directorate for Driving Licenses and Registration Certificates (DDLRCV), National Institute of Meteorology (NIM).

A degree of expert judgment was necessitating as well.

The following input data is compiled for the emission calculations with the use of COPERT 4-Tier 3.

Activity data: fleet data, circulation data

Input data for Population, Annual Mileage (km/year), Mean fleet mileage (km), Speed (Km/h) and the mileage percentage driven by each vehicle technology per driving mode (urban, rural, highway), data collected by monitoring traffic systems (video cameras located on the public roads from the endowment Romanian Police) and through field surveys (made by partners from RAR) (see Annex 2.2).

Minimum and maximum temperatures and relative humidity

National Institute of Meteorology provided us data on maximum and minimum temperatures and relative humidity for each month of the period 2005-2012 in the 41 regions of Romania. These data used in Copert are calculated as an arithmetic average of the 41 regions of the country.

Fuel specifications

Fuel quality specification from liquid fuels, gasoline and diesel oil is regulated by Government Decision HG 15/2006:

Table 3.31 Country specific characteristics for gasoline and diesel oil according Decision no 689/ 2004, update by Decision no. 15/2006

	Sulfur (% m/m)		**Hidrocarbons**		**Benzene (% v/v)**	**E100 (% v/v)**	**E150 (% v/v)**	**Oxygen Content (%m/m)**
			aromatics (% v/v)	**olefins (% v/v)**				
< 1 january 2005								
Leaded gasoline	-	0.08	42	-	3	-	-	-
Unleaded gasoline	**Sulfur (mg/kg)**							
	min	max						
	-	150	42	-	3	-	-	-
Unleaded Gasoline								
≥ 1 january 2005	-	150	42	18	1	46	75	2.7
≥ 1 january 2007	-	50	35	18	1	46	75	2.7
≥ 1 january 2009	-	10	35	18	1	46	75	2.7
Diesel oil								
	Sulfur (mg/kg)		**PAH (% m/m)**		**Density (kg/m^3)**	**T95% C^0**	**Cetane number**	
			max.				**min.**	
< 1 january 2007	-	350	11		845	360	51	
≥ 1 january 2007	-	50	11		845	360	51	
≥ 1 january 2009	-	10	11		845	360	51	

Vehicle fleet

The data on fleet detailed on technology , necessary for implementation of model COPERT 4 have been provided by Romanian Auto Register (RAR).

Romanian Auto Register (RAR) is the technical body appointed by the Ministry of Transport as the competent authority in the field of road vehicles, road safety and environmental protection.

Individual approval is a legal requirement for vehicle registration and the procedure where by RAR shows that a vehicle meets individual constructive conditions and technical state under the regulations. Successful completion of individual approval procedure is materialized by issuing Identity Card Vehicle (CIV) that are registered on the technical data and vehicle identification. Database on registered fleet, detailed technical categories is thus achieved.

Data on fleet in circulation is provided by Directorate on Driving Licenses and Vehicles Registration Certificates (DDLVRC) data compiled and processed by registered fleet RAR (see Annex 2.2)

3.2.9.3.3 Uncertainties and time- series consistency for road transport

The uncertainty associated to the GHG emissions estimates are:

Table 3.32 Uncertainties for road transport

Road Transport 1.A.3.b.	**Uncertainty**				**Combined uncertainty**		
	Activity Data	**EF CO_2**	**EF N_2O**	**EF CH_4**	**EF CO_2**	**EF N_2O**	**EF CH_4**
Motor Gasoline	3	5	108	48	5.83	108.04	48.09
Gas Diesel Oil	3	4	50	50	5.00	50.09	50.09
Liquefied Petroleum Gases (LPG)	3	4	50	50	5.00	50.09	50.09
Other Liquid Fuels (Other Kerosene)	3	4	50	50	5.00	50.09	50.09
Gaseous Fuels	3	4	50	50	5.00	50.09	50.09
Biomass	3	20	50	50	20.22	50.09	50.09

Combined uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in ch. 6 of the IPCC GPG 2000.

3.2.9.3.4 Source- specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Civil Aviation, Railways, Navigation and Other Transportation, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

To the Road Transport, for the calculation of the emissions from CRF category 1.A.3.b, it was developed an Excel spreadsheet model, which was linked directly to the Eurostat format energy balances provided by the NIS. Wherever it was possible, automated data validation was implemented within the model, but many manual checks were performed, too.

Furthermore the background data for the emission factors calculations under the ETS, were used for further QA/QC checks.

The activity data series were compared with Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared with national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

The methods used for estimation of the emissions are in accordance with the IPCC regulations on the entire-time series**.**

3.2.9.3.5 Source- specific recalculation, if applicable, including changes made in response to the review process

Activity data

Road Transportation from Liquid Fuels (Gasoline, Diesel Oil, LPG and Other Kerosene) and Biomass

There are recalculations, by Road Transport activity categorie, on the entire 1989-2011 time-series, such as follows:

- Due to update of value of Net Calorific Value (NCV), country specific NCVs values are used;
- AD used in the model Copert 4, due to was changed of values for monthly average minimum and maximum temperatures, solving an error;
- Implementation of the model Copert 4, Tier 1 into the national road transport inventory (for time-series 1989-2004);
- Recalculations for 1989–2011 time-series: level of CO_2, CH_4 and N_2O emissions, the fuel consumption of the Other Kerosene from the Energy Balance was added;
- Recalculations for the 2007–2011 period AD due to update the Energy Balance for fuel Biomass.

Emission factors

Road Transportation from Liquid Fuels (Gasoline, Diesel Oil, LPG and Other Kerosene)

Road Transportation/ Liquid fuels

Motor Gasoline

✓ Recalculations for 1989–2004 time-series: level of CO_2, CH_4 and N_2O emissions, for CO_2, country specific EF and CH_4, N_2O default EF, was changed with a EMEP/EEA emission inventory guidebook 2013 EF, Tier 1.

Diesel Oil

✓ Recalculations for 1989–2004 time-series: level of CO_2, CH_4 and N_2O emissions, for CO_2, country specific EF and CH_4, N_2O default EF, was changed with a EMEP/EEA emission inventory guidebook 2013 EF, Tier 1.

LPG

✓ Recalculations for 2002–2004 time-series: level of CO_2, CH_4 and N_2O emissions, EF derived as average from COPERT III model usage in the 2012 mars transmission, was changed with a EMEP/EEA emission inventory guidebook 2013 EF, Tier 1.

Table 3.33 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	74,150.88	119,110.48	5,257.58	8,726.39	65.98
1990	139,704.12	141,408.85	9,986.78	10,364.28	3.78
1991	114,602.19	115,372.21	8,189.84	8,457.63	3.27
1992	109,147.81	114,253.11	7,835.79	8,376.17	6.90
1993	95,186.25	95,269.41	6,832.07	7,003.40	2.51
1994	103,656.88	103,822.71	7,436.80	7,625.21	2.53
1995	94,852.48	95,107.42	6,809.45	6,976.75	2.46
1996	138,153.70	138,299.14	9,928.95	10,176.73	2.50
1997	132,540.22	132,777.15	9,514.06	9,771.76	2.71
1998	130,402.05	130,425.27	9,359.80	9,590.47	2.46
1999	107,149.15	106,729.50	7,687.96	7,854.97	2.17
2000	111,811.27	111,843.78	8,023.94	8,238.08	2.67
2001	146,921.98	146,775.65	10,497.82	10,750.08	2.40
2002	148,410.49	148,510.55	10,641.85	10,907.78	2.50

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
2003	159,425.00	159,603.67	11,455.66	11,753.78	2.60
2004	166,397.04	166,488.45	11,969.01	12,202.59	1.95
2005	158,866.60	158,874.43	11,701.52	11,673.16	-0.24
2006	165,085.09	165,171.85	12,148.38	12,160.62	0.10
2007	167,150.47	168,479.35	12,149.54	12,164.84	0.13
2008	190,298.32	189,512.29	13,652.72	13,661.84	0.07
2009	197,399.53	197,256.59	13,938.09	13,941.07	0.02
2010	184,134.51	180,443.43	13,137.25	13,135.61	-0.01
2011	190,913.26	187,041.64	13,316.76	13,316.84	0.00

Table 3.34 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	74,150.88	119,110.48	1.48	2.92	97.29
1990	139,704.12	141,408.85	2.06	8.84	329.16
1991	114,602.19	115,372.21	1.71	5.44	217.93
1992	109,147.81	114,253.11	1.30	17.58	1,252.65
1993	95,186.25	95,269.41	1.15	2.39	108.01
1994	103,656.88	103,822.71	1.28	2.87	124.31
1995	94,852.48	95,107.42	1.13	2.86	153.08
1996	138,153.70	138,299.14	1.55	3.28	111.52
1997	132,540.22	132,777.15	1.59	3.62	127.47
1998	130,402.05	130,425.27	1.57	2.94	87.20

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1999	107,149.15	106,729.50	1.32	2.25	70.72
2000	111,811.27	111,843.78	1.36	2.58	89.37
2001	146,921.98	146,775.65	1.89	3.24	71.63
2002	148,410.49	148,510.55	1.79	3.51	95.98
2003	159,425.00	159,603.67	1.82	3.84	110.72
2004	166,397.04	166,488.45	1.97	3.73	89.16
2005	158,866.60	158,874.43	2.76	3.02	9.24
2006	165,085.09	165,171.85	2.43	2.94	20.88
2007	167,150.47	168,479.35	2.20	2.85	29.73
2008	190,298.32	189,512.29	2.02	2.54	25.76
2009	197,399.53	197,256.59	2.01	2.27	13.00
2010	184,134.51	180,443.43	1.74	1.75	0.80
2011	190,913.26	187,041.64	1.67	1.70	1.40

Table 3.35 Effects of data changes on N_2O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	74,150.88	119,110.48	0.04	0.63	1,469.89
1990	139,704.12	141,408.85	0.08	1.81	2,159.42
1991	114,602.19	115,372.21	0.07	1.12	1,495.47
1992	109,147.81	114,253.11	0.07	3.55	4,973.37
1993	95,186.25	95,269.41	0.06	0.51	743.81

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1994	103,656.88	103,822.71	0.06	0.61	909.45
1995	94,852.48	95,107.42	0.06	0.60	902.17
1996	138,153.70	138,299.14	0.08	0.71	792.93
1997	132,540.22	132,777.15	0.08	0.78	871.81
1998	130,402.05	130,425.27	0.08	0.64	702.93
1999	107,149.15	106,729.50	0.06	0.49	722.50
2000	111,811.27	111,843.78	0.07	0.56	704.11
2001	146,921.98	146,775.65	0.09	0.68	660.36
2002	148,410.49	148,510.55	0.09	0.76	743.48
2003	159,425.00	159,603.67	0.10	0.84	741.86
2004	166,397.04	166,488.45	0.12	0.82	587.22
2005	158,866.60	158,874.43	0.41	0.46	12.78
2006	165,085.09	165,171.85	0.41	0.51	24.38
2007	167,150.47	168,479.35	0.41	0.54	31.59
2008	190,298.32	189,512.29	0.45	0.56	24.47
2009	197,399.53	197,256.59	0.45	0.51	12.50
2010	184,134.51	180,443.43	0.42	0.43	2.36
2011	190,913.26	187,041.64	0.44	0.46	3.52

3.2.9.3.6 Source- specific planned improvements

In order to improve the inventory quality:

- implementation requirements and future recommendations consistent with IPCC 2006;
- database after 2005 will make the transition from model version 9.0 to version 10.0 Copert.

The results will be incorporate in the next NGHGI submission.

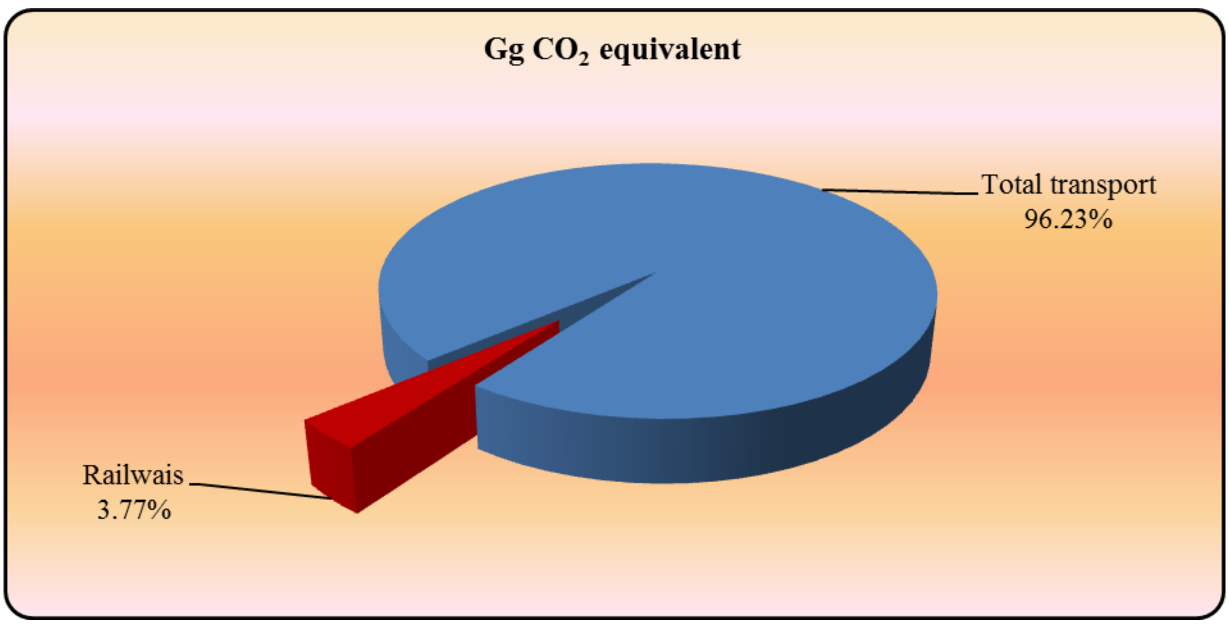
3.2.9.4 Source category Railways (CRF sector 1.A.3.c)

3.2.9.4.1 Source category description

The Railways Subsector includes emissions from following fuels: Diesel Oil,Gasoline, Residual Fuel Oil,Lignite -Brown coal, Sub-bitouminous Coal, Other bitouminous Coal, Coking Coal,Other Kerosene.

In 2012 year, the railways related emissions represents 3.77% of total emissions from the transport sector (15,062.17 Gg CO_2 equivalent).

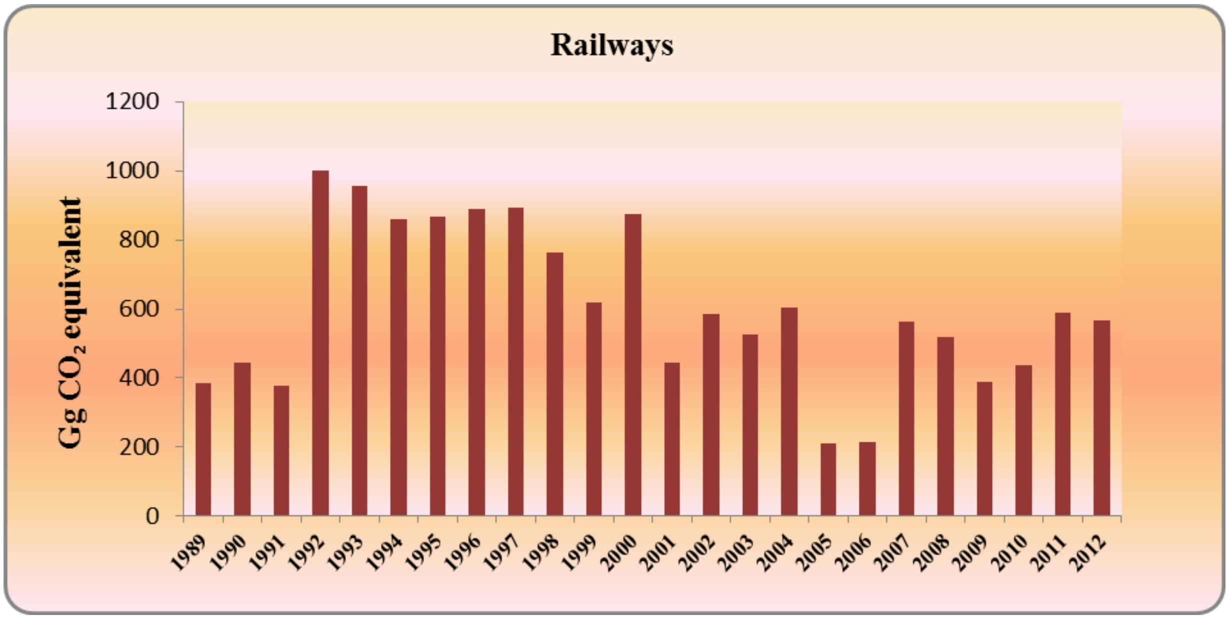
Figure 3.44 The contribution of Railwais emissions in total GHG emissions from Transport subsector



In Railways Subsector, the emissions trend reflects the changes in this period characterized by a process of transition to a market economy. In the 1989-2004 and 2006-2008 periods increases and decreases of emissions are due to fluctuations in the number of domestic trips.

In 2005 a decrease of the fuels consumption took place due to the decline of the economic and industrial activities. Starting with the 2009 until for 2011year the emissions were increasing that could be explained by the the fuel consumption growth. For 2012 an decrease compared to the 2011 has been observed, due to the domestic trips number decrease.

Figure 3.45 GHG emissions Trend from 1A3c – Railways



3.2.9.4.2 Methodological issues

Methodology

The GHG emissions from Railwais category are calculated according to1996 IPCC and IPCC Good Practice Guidance.

The activity data are provided by IEA/Eurostat Questionnaire and values for emissions factors used are provided by 1996 IPCC Guidelines.

Tier 1 method

The indirect GHG emissions are calculated according to IPCC 1996 and calculation formula is presented in Section 3.2.9.3.2.

Tier 2 method

According to the provisions in the relevant decision trees in the IPCC GPG 2000, giving their status of key categories, both by level and trend criteria, the IPCC Tier 2 approach (Revised 1996 IPCC Guidelines) is used to calculate the CO_2 emissions from fuel combustion in the sectors.
The CO_2 emissions, are calculated according to 1996 IPCC Guidelines (pag.1.30,ch 1.4.1.2)

Equation 3.13 The GHG direct emissions from Railways category

*Emission= □□ Fuel Consumption*EFCountry Specific/Default*Oxidation Factor*

The oxidation factor is referenced in the IPCC 1996 Guidelines, Vol. II, Ch. 1, Table 1-4.

Oxidation factors	
Coal	0.98
Oil and Oil Products	0.99
Gas	0.995
Peat for electricity generation	0.99

Emission factors

The values of CO_2 Emissions Factor is country specific.

Table 3.36 The values of CO_2 country specific emission factor

2012			
Fuel Type	**EF O_x included**	**EF without O_x**	**EF C**
Lignite	87.67	94.38	25.74
Natural gas	55.58	55.58	15.16

2012			
Fuel Type	**EF O_x included**	**EF without O_x**	**EF C**
Refinery gas	56.90	56.90	15.52
Other bituminous coal	86.94	87.91	23.97
Coke_Oven_Coke	93.88	93.88	25.60
Transport diesel	73.56	73.56	20.06
Residual fuel oil	79.48	79.48	21.68
Heating and other gasoil	74.08	74.08	20.20
Petroleum Coke	96.83	96.83	26.41
Motor Gasoline		71.62	19.53

The values of CH_4,N_2O NOx, CO, NMVOC emission factors are default and in according to IPCC 1996 Guidelines.

The values of CH_4 Emission Factor default accordind to 1996 IPCC Guidelines (tabel 1-7, ch.1, page 1.35).

Table 3.37 The values of CH_4 emission factors for different fuels

	Coal	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Other Biomass and Wastes**
Energy Industries	1	1	3	30	200	30
Manufacturing Industries and Construction	10	5	2	30	200	30
Commercial/Institutional	10	5	10	300	200	300
Residential	300	5	10	300	200	300
Agriculture/Forestry/Fishing	300	5	10	300	200	300

	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Other Biomass and Wastes
Aviation			0.5			
Road			Gasoline diesel 20 5			
Railways	10		5			
Navigation	10		5			

The values of N_2O emissions is default according to 1996 IPCC Guidelines (tabel 1-8, ch.1, page1.36).

Table 3.38 The values of N_2O emission factors for different fuels

	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Other Biomass and Wastes
Energy Industries	1.4	0.1	0.6	4	4	4
Manufacturing Industries and Construction	1.4	0.1	0.6	4	4	4
Commercial/Institutional	1.4	0.1	0.6	4	1	4
Residential	1.4	0.1	0.6	4	1	4
Agriculture/Forestry/Fishing	1.4	0.1	0.6	4	1	4
Aviation			2			
Road		0.1	Gasoline Diesel 0.6 0.6			

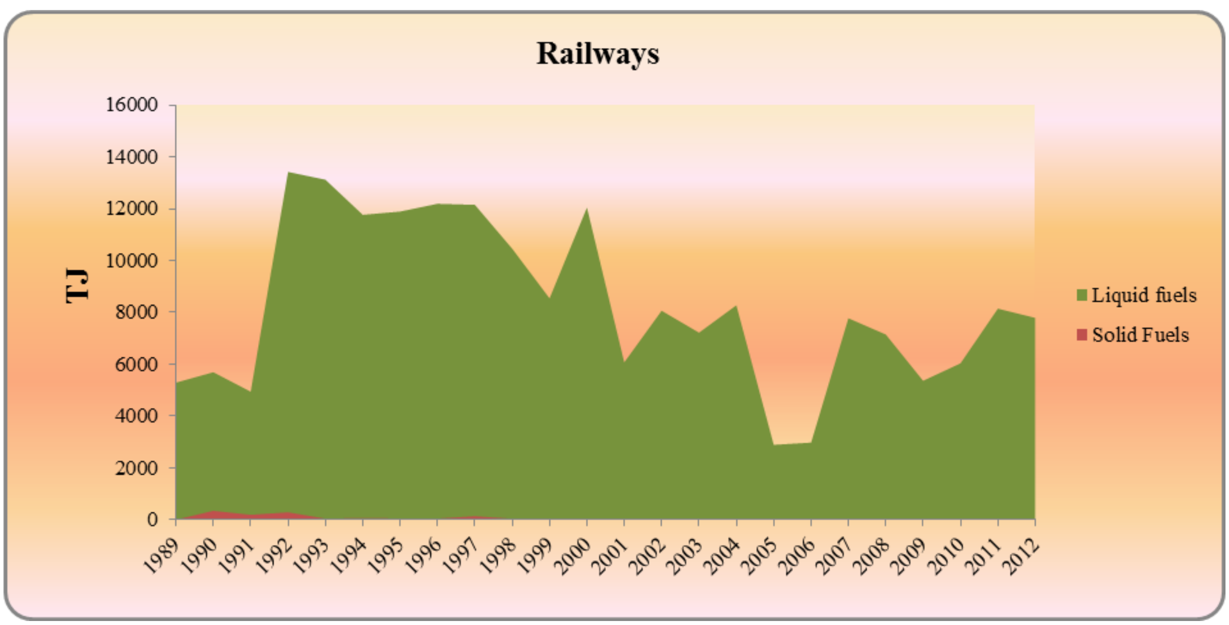
	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Other Biomass and Wastes
Railways	1.4		0.6			
Navigation	1.4		0.6			

For the estimation of the SO_2 emissions were used the values of the Sulphur content provided by the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009 and in according to 1996 IPCC Guidelines. Determination of values emission factor and emissions were in according to 1996 IPCC Guidelines.

Activity data

The activity data for Railways(1.A.3.c) are provided by IEA/Eurostat Questionnaire.

Figure 3.46 Fuel consumptionfor Railwais -1.A.3.c



The solid fuels were used in small quantities until 2004 after which were used liquid fuels and electricity.

3.2.9.4.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

CO_2

- ***activity data***
  - Liquid: 5%
  - Solid: 3%
- ***emision* factors**
  - Liquid: 3%
  - Solid: 2%
  - 5.83% liquid and 3.61% solid associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4

- ***activity data***
  - Liquid: 5%
  - Solid: 3%
- ***emision* factors**
  - Liquid: 50%
  - Solid: 50%
  - 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000

N_2O

- ***activity data***
  - Liquid: 5%
  - Solid: 3%
- ***emision* factors**
  - Liquid: 50%
  - Solid: 50%
  - 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

3.2.9.4.4 Source-specific QA/QC and verification, if applicable

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Road Transport Subsector the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved of the 2012 NGHGI; they are described in the Chapter

3.2.9.4.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.2.9.4.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

3.2.9.4.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In order to improve the emissions estimates quality some important recalculations were made:

Railways/ Liquid fuels 1.A.3c.

❖ ***activity data***

- ✓ recalculations for the 1989 – 2011 period at AD due to update of value of Net Calorific Value (NCV) for fuel used(Diesel Oil, Motor Gasoline, Residual Oil);
- ✓ recalculations for the 1989 – 2012 period at AD due to the introduction of the new fuel Other Kerosene from Energy Balance;
- ✓ recalculations for the 1989 – 2011 period at CO_2, CH_4 and N_2O emissions level due to changed AD.

Railways/ Solid fuels 1.A.A.3C.

- ✓ recalculation for the 1989-1997, 2001, 2003 period at AD due to update of value of Net Calorific Value for fuel used: (Lignit, Other bitouminous coal, Coking coal).
- ✓ recalculations for the 1989-1997, 2001, 2003 period at CO_2, CH_4 and N_2O emissions level due to changed AD.

The **Biomass fuel** started to be caracterized Other transport (please specify)/ Other non-specified/Biomass1.A3.e.

Table 3.39 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	9,106.20	9,106.20	660.68	383.78	-72.15
1990	10,127.76	10,127.76	742.26	445.15	-66.74
1991	8,832.68	8,832.68	645.05	376.27	-71.44
1992	13,592.83	13,592.83	990.72	1000.76	1.00
1993	13,171.02	13,171.02	956.48	955.82	-0.07
1994	11,789.60	11,789.60	856.83	859.87	0.35
1995	11,903.54	11,903.54	864.68	867.35	0.31
1996	12,197.05	12,197.05	885.78	888.62	0.32
1997	12,245.17	12,245.17	891.23	894.09	0.32
1998	10,498.68	10,498.68	762.46	761.95	-0.07
1999	8,269.52	8,269.52	599.94	619.75	3.20
2000	12,134.34	12,134.34	875.63	874.25	-0.16
2001	6,045.87	6,045.87	434.96	442.79	1.77
2002	8,224.25	8,224.25	585.48	585.08	-0.07
2003	7,358.30	7,358.30	524.74	524.34	-0.08
2004	8,310.07	8,310.07	603.13	602.59	-0.09
2005	2,915.74	2,915.74	209.67	209.70	0.01
2006	3,001.74	3,001.74	215.97	215.88	-0.04
2007	8,110.79	8,110.79	554.48	563.95	1.68
2008	7,194.79	7,194.79	519.56	518.58	-0.19
2009	5,329.21	5,329.21	386.43	388.80	0.61
2010	6,067.57	6,067.57	440.20	437.62	-0.59
2011	8216.495	8143.69	593.15	587.93	-0.89

Table 3.40 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Differences [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	11,903.54	11,903.54	0.046	0.0265	-72.13
1990	12,197.05	12,197.05	0.052	0.0319	-64.21
1991	12,245.17	12,245.17	0.045	0.0266	-69.67
1992	10,498.68	10,498.68	0.069	0.0699	1.31
1993	8,269.52	8,269.52	0.066	0.0660	-0.06
1994	12,134.34	12,134.34	0.059	0.0594	0.24
1995	6,045.87	6,045.87	0.060	0.0599	0.18
1996	8,224.25	8,224.25	0.061	0.0613	0.20
1997	7,358.30	7,358.30	0.062	0.0620	0.20
1998	8,310.07	8,310.07	0.053	0.0526	-0.07
1999	2,915.74	2,915.74	0.041	0.0427	3.20
2000	3,001.74	3,001.74	0.060	0.0602	-0.16
2001	8,110.79	8,110.79	0.030	0.0306	1.76
2002	7,194.79	7,194.79	0.040	0.0403	-0.07
2003	5,329.21	5,329.21	0.036	0.0362	-0.08
2004	6,067.57	6,067.57	0.042	0.0416	-0.09
2005	8216.495	8143.69	0.014	0.0144	0.01
2006	3,001.74	3,001.74	0.015	0.0149	-0.04
2007	8,110.79	8,110.79	0.038	0.0389	1.69
2008	7,194.79	7,194.79	0.036	0.0357	-0.19
2009	5,329.21	5,329.21	0.027	0.0268	0.61
2010	6,067.57	6,067.57	0.030	0.0302	-0.58
2011	8216.495	8143.69	0.041	0.0407	-0.89

Table 3.41 Effects of data changes on N_2Oemissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Differences [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	11,903.54	11,903.54	0.0055	0.0032	41.90
1990	12,197.05	12,197.05	0.0063	0.0039	38.68
1991	12,245.17	12,245.17	0.0054	0.0032	40.77
1992	10,498.68	10,498.68	0.0083	0.0085	-1.65
1993	8,269.52	8,269.52	0.0079	0.0079	0.06
1994	12,134.34	12,134.34	0.0071	0.0072	-0.40
1995	6,045.87	6,045.87	0.0072	0.0072	-0.33
1996	8,224.25	8,224.25	0.0074	0.0074	-0.35
1997	7,358.30	7,358.30	0.0075	0.0075	-0.35
1998	8,310.07	8,310.07	0.0063	0.0063	0.07
1999	2,915.74	2,915.74	0.0050	0.0051	-3.30
2000	3,001.74	3,001.74	0.0072	0.0072	0.16
2001	8,110.79	8,110.79	0.0036	0.0037	-1.78
2002	7,194.79	7,194.79	0.0048	0.0048	0.07
2003	5,329.21	5,329.21	0.0043	0.0043	0.08
2004	6,067.57	6,067.57	0.0050	0.0050	0.09
2005	8216.495	8143.69	0.0017	0.0017	-0.01
2006	3,001.74	3,001.74	0.0018	0.0018	0.04
2007	8,110.79	8,110.79	0.0046	0.0047	-1.71
2008	7,194.79	7,194.79	0.0043	0.0043	0.19
2009	5,329.21	5,329.21	0.0032	0.0032	-0.61
2010	6,067.57	6,067.57	0.0036	0.0036	0.58
2011	8216.495	8143.69	0.0049	0.0049	0.89

3.2.9.4.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

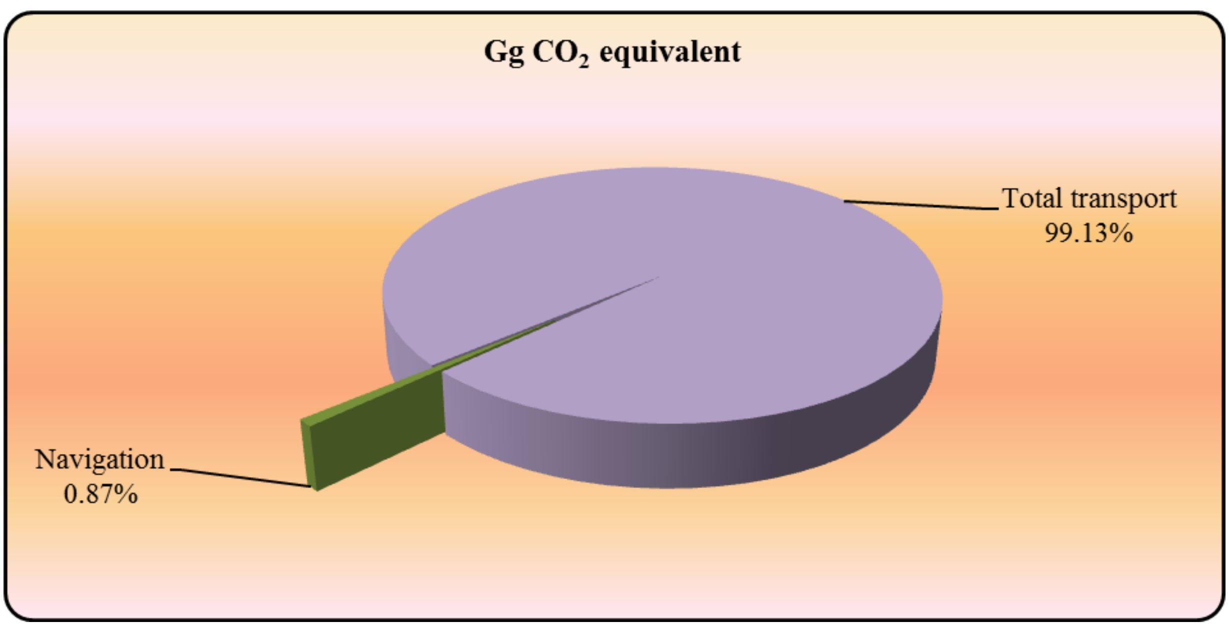
It is planned further investigations and co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.

3.2.9.5 Source category Navigation(CRF sector 1.A.3.d)

3.2.9.5.1 Source category description

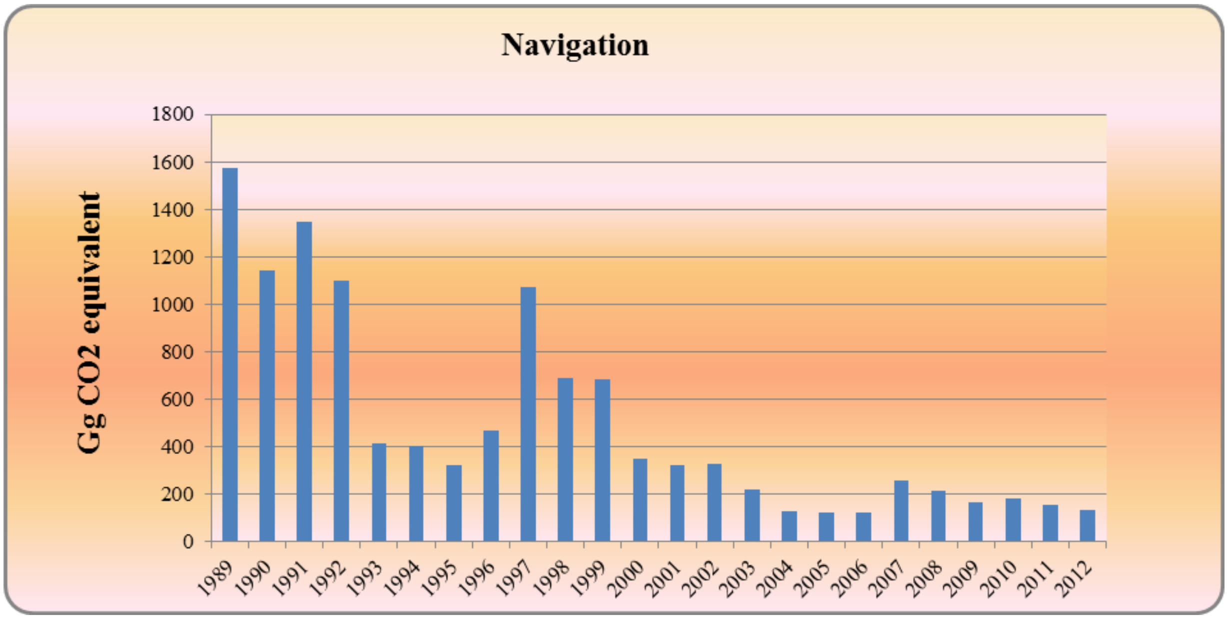
The Navigation sub-sector includes emissions from following fuels: Diesel Oil,Gasoline, Residual Fuel Oil.
The emissions from sub-sector Navigation represents 0.87% of total emissions from the transport sector (15,062.17 CO_2 equivalent).

Figure 3.47 The contribution of Navigation emissions in total GHG emissions from Transport subsector



In the Navigation Subsector, the decline of the economic and industrial activities and of the number of the maritime races caused the fuel consumption and GHG emissions reduction.

Figure 3.48 GHG emissions from 1A3a – Navigation



3.2.9.5.2 Methodological issues

The GHG emissions from Navigation are calculated according to1996 IPCC Guidelines and IPCC good practice guidance.

The Tier1 and Tier 2 method was used and are presented in section 3.2.9.4.2.

Emission Factors

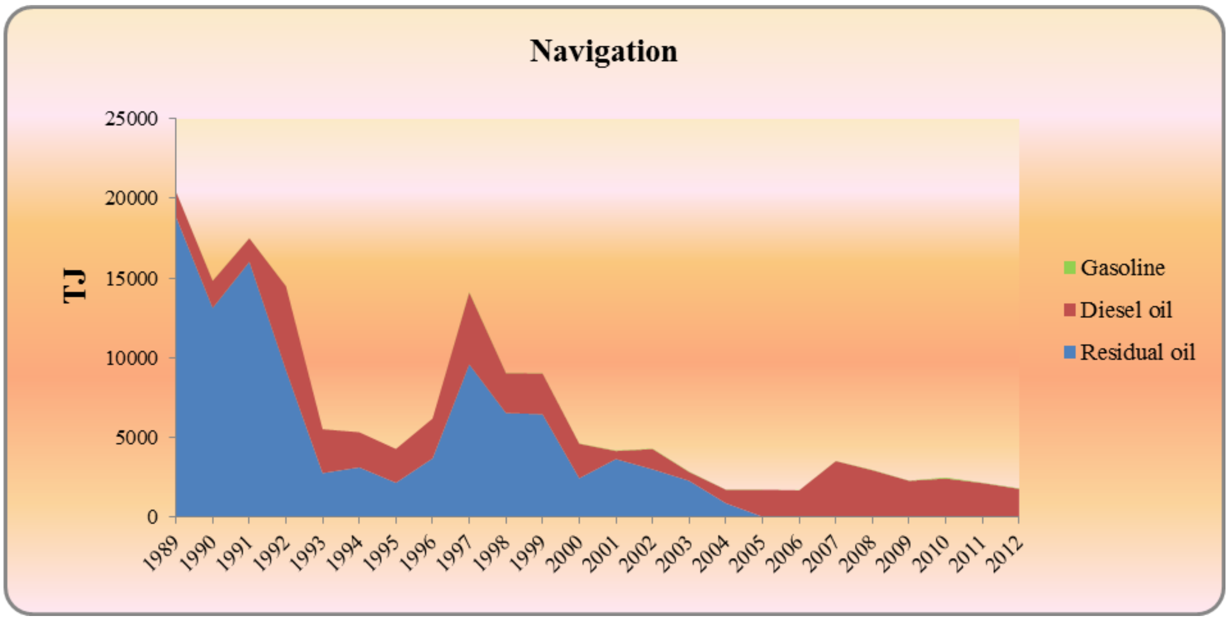
The CO_2 emission factor is country specific and is presented in section 3.2.9.4.2

The values of $CH_{4,}N_2O$ NOx, CO, NMVOC,SO_2 emission factors are default and in according to IPCC 1996 Guidelines and is presented in section 3.2.9.4.2

Activity Data

The activity data for Navigation(1.A.3.d) are provided by IEA/Eurostat Questionnaire instead of domestic Romanian Energy balance.

Figure 3.49 Fuel consumption 1.A.3.d Navigation 1989-2012



3.2.9.5.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

CO_2

❖ ***activity data***

- Residual Fuel Oil:5.0 %
- Diesel oil: 5.0%
- Gasoline:3.0%

- ***emision* factors**
  - Residual Fuel Oil:3 %
  - Diesel oil: 3.0%
  - Gasoline:0.8%
  - 5.83% Residual Fuel Oil,Diesel Oil and 3.10% Gasoline associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4

- ***activity data***
  - Residual Fuel Oil:5.0 %
  - Diesel oil: 5.0%
  - Gasoline:3.0%
- ***emision* factors**
  - Residual Fuel Oil:50 %
  - Diesel oil: 50%
  - Gasoline:50%
  - 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

N_2O

- ***activity data***
  - Residual Fuel Oil:5.0 %
  - Diesel oil: 5.0%
  - Gasoline:3%
- ***emision* factors**
  - Residual Fuel Oil:50 %

- Diesel oil: 50%
- Gasoline:50%
- 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

3.2.9.5.4 Source-specific QA/QC and verification, if applicable

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Road Transport Subsector the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 3.2.9.5.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.2.9.5.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

3.2.9.5.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In order to improve the emissions estimates quality some important recalculations were made:

Residual Oil

- ***activity data***
  - recalculation for the 1989-2006 period at AD due to update of value of Net Calorific Value for this fuel;
  - recalculations for the 1989-2006 period at CO_2, CH_4 and N_2O emissions level due to changed AD.

Diesel oil

- ***activity data***
  - recalculations for the 1989 – 2011 period period at AD due to update of value of Net Calorific Value for this fuel;
  - recalculations for the 1989-2011 period at CO_2, CH_4 and N_2O emissions level due to changed AD.

Motor Gasoline

- ***activity data***
  - recalculations for the 1989 – 2009 period period at AD due to update of value of Net Calorific Value for this fuel;
  - recalculations for the 1989-2009 period at CO_2 emissions level due to changed AD

Table 3.42 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	20,357.52	20,435.54	1,567.39	1,573.47	0.39
1990	14,579.75	14,850.67	1,119.80	1,140.76	1.84
1991	17,335.84	17,517.58	1,333.42	1,348.20	1.10
1992	14,320.28	14,508.13	1,082.59	1,097.14	1.33
1993	5,480.39	5,535.96	410.69	415.00	1.04
1994	5,277.79	5,341.22	397.71	402.62	1.22
1995	4,248.04	4,291.56	318.45	321.82	1.05
1996	6,124.52	6,199.40	461.80	467.60	1.24
1997	13,936.38	14,132.22	1,056.40	1,071.56	1.42
1998	8,934.71	9,068.65	679.12	689.50	1.50
1999	8,811.71	9,028.14	669.83	686.17	2.38
2000	4,583.50	4,632.81	344.08	347.91	1.10
2001	4,105.05	4,189.73	315.05	321.56	2.02
2002	4,247.28	4,308.83	322.34	327.10	1.46
2003	2,819.42	2,866.46	215.33	218.97	1.66
2004	1,728.22	1,745.96	129.54	130.91	1.05
2005	1,739.17	1,738.87	126.37	126.35	-0.01
2006	1,697.53	1,697.26	123.35	123.33	-0.01
2007	3,489.58	3,537.17	253.16	256.61	1.35
2008	2,973.79	2974.57	215.72	215.78	0.03
2009	2,291.25	2306.13	166.21	167.29	0.65
2010	2,515.59	2496.66	182.41	181.04	-0.76
2011	2,180.32	2168.08	157.39	156.50	-0.56

Table 3.43 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	20,357.52	20,435.54	0.102	0.0729	0.09
1990	14,579.75	14,850.67	0.052	0.0743	29.52
1991	17,335.84	17,517.58	0.045	0.0876	48.54
1992	14,320.28	14,508.13	0.069	0.0725	4.95
1993	5,480.39	5,535.96	0.066	0.0277	-138.63
1994	5,277.79	5,341.22	0.059	0.0267	-121.86
1995	4,248.04	4,291.56	0.060	0.0215	-178.43
1996	6,124.52	6,199.40	0.061	0.0310	-97.41
1997	13,936.38	14,132.22	0.062	0.0707	12.43
1998	8,934.71	9,068.65	0.053	0.0453	-16.18
1999	8,811.71	9,028.14	0.041	0.0451	8.40
2000	4,583.50	4,632.81	0.060	0.0232	-160.41
2001	4,105.05	4,189.73	0.030	0.0209	-43.51
2002	4,247.28	4,308.83	0.040	0.0215	-87.28
2003	2,819.42	2,866.46	0.036	0.0143	-152.51
2004	1,728.22	1,745.96	0.042	0.0087	-377.11
2005	1,739.17	1,738.87	0.014	0.0087	-66.05
2006	1,697.53	1,697.26	0.015	0.0085	-75.39
2007	3,489.58	3,537.17	0.038	0.0177	-116.07
2008	2,973.79	2974.57	0.036	0.0149	-140.68
2009	2,291.25	2306.13	0.027	0.0115	-130.97
2010	2,515.59	2496.66	0.030	0.0125	-143.03
2011	2,180.32	2168.08	0.041	0.0108	-278.98

Table 3.44 Effects of data changes on N_2O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	20,357.52	20,435.54	0.0122	0.0123	-0.50
1990	14,579.75	14,850.67	0.0087	0.0089	-2.42
1991	17,335.84	17,517.58	0.0104	0.0105	-1.06
1992	14,320.28	14,508.13	0.0086	0.0087	-1.22
1993	5,480.39	5,535.96	0.0033	0.0033	-0.65
1994	5,277.79	5,341.22	0.0032	0.0032	-0.15
1995	4,248.04	4,291.56	0.0025	0.0026	-3.00
1996	6,124.52	6,199.40	0.0037	0.0037	-0.53
1997	13,936.38	14,132.22	0.0084	0.0085	-0.94
1998	8,934.71	9,068.65	0.0054	0.0054	-0.76
1999	8,811.71	9,028.14	0.0053	0.0054	-2.21
2000	4,583.50	4,632.81	0.0028	0.0028	0.73
2001	4,105.05	4,189.73	0.0025	0.0025	-0.55
2002	4,247.28	4,308.83	0.0025	0.0026	-3.41
2003	2,819.42	2,866.46	0.0017	0.0017	-1.17
2004	1,728.22	1,745.96	0.001	0.0010	-4.76
2005	1,739.17	1,738.87	0.001	0.0010	-4.33
2006	1,697.53	1,697.26	0.001	0.0010	-1.84
2007	3,489.58	3,537.17	0.0021	0.0021	-1.06
2008	2,973.79	2974.57	0.0018	0.0018	0.85
2009	2,291.25	2306.13	0.0014	0.0014	1.17
2010	2,515.59	2496.66	0.0015	0.0015	0.13
2011	2,180.32	2168.08	0.0014	0.0013	7.08

3.2.9.5.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

It is planned further co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.

3.2.9.6 Source category - Other transportation- (CRF sector 1.A.3.e)

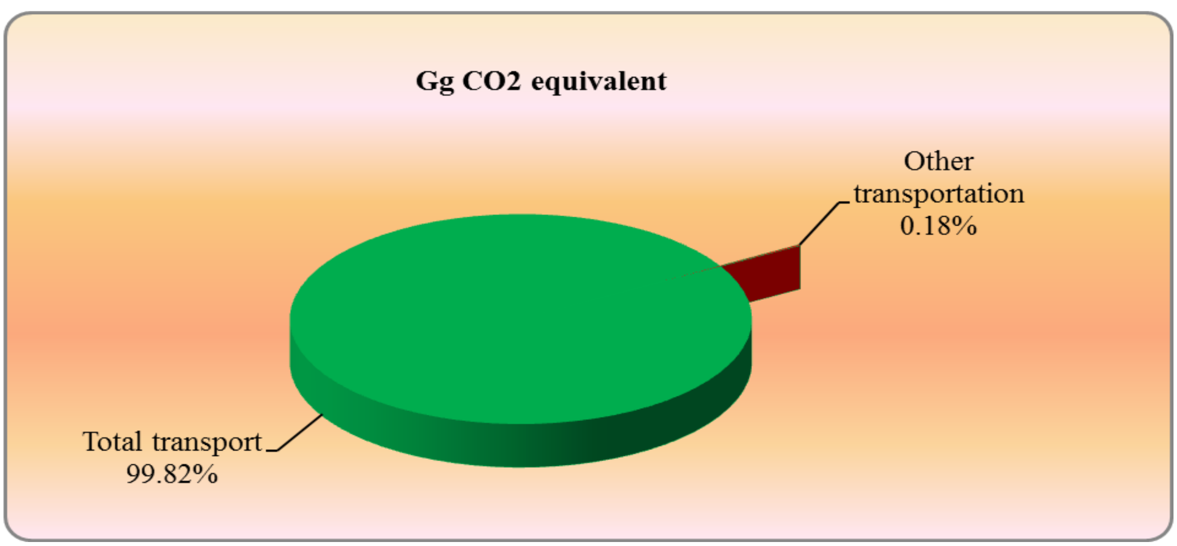
3.2.9.6.1 Source category description

This sub-sector includes emissions from following fuels: Diesel Oil,Gasoline, Natural Gas, Wood/ Wood Wastes.

This category includes combustion emissions from all remaining transport activities including pipeline transportation(the operation of pump stations and maintenance of pipelines), ground activities in airports (off –road activities) and emissions from the combustion of the fuels Wood/Wood Waste used in Railwais sub –sector.

The emissions from sub-sector Other transportation represents 0.18% of total emissions from the transport sector (15,062.17) Gg CO_2 equivalent.

Figure 3.50 The contribution of Other transportation emissions in total GHG emissions from Transport subsector



3.2.9.6.2 Methodological issues

The GHG emissions from Other Transportation are calculated according to1996 IPCC Guidelines and IPCC good practice guidance.
The Tier1 and Tier 2 method was used and are presented in section 3.2.9.4.2.

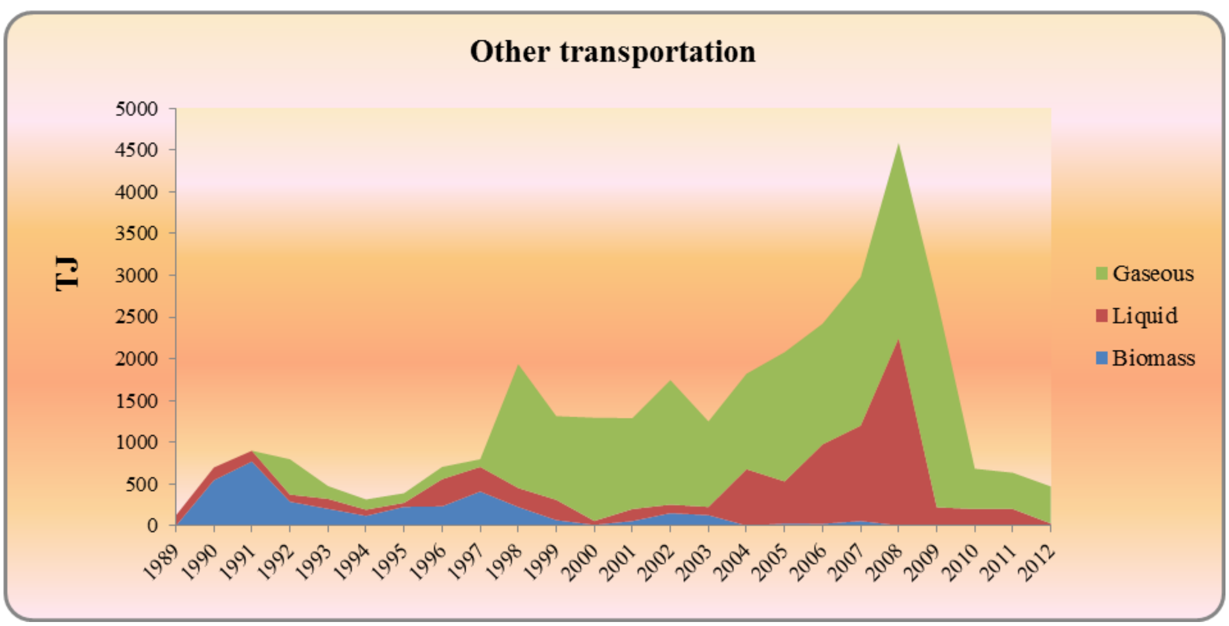
Emission Factors

The CO_2 emission factor is country specific and is presented in section 3.2.9.4.2.
The values of CH_4,N_2O NOx, CO, NMVOC,SO_2 emission factors are default and in according to IPCC 1996 Guidelines and is presented in section 3.2.9.4.2.

Activity Data

The activity data for Other transportation(1.A.3.e) are provided by IEA/Eurostat Questionnaire.

Figure 3.51 Fuel consumption 1.A.3.c Other transportation 1989 -2012



3.2.9.6.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

CO_2

- ***activity data***
    - Liquid: 3.0%
    - Gaseous: 3.0%
    - Biomass: 3.0%
- ***emision* factors**
    - Liquid: 3%
    - Gaseous:2 %
    - Biomass: 20%
    - 3% liquid ,2% gaseous and 20.22% biomass associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4

- ***activity data***
    - Liquid: 3.0%
    - Gaseous:3.0%
    - Biomass: 3.0%
- ***emision* factors**
    - Liquid: 50%
    - Gaseous:50 %
    - Biomass: 50%
    - 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

N_2O

- ***activity data*:**
  - Liquid: 3.0%
  - Gaseous: 3.0%
  - Biomass: 3.0%
- ***emision* factors:**
  - Liquid: 50%
  - Gaseous:50 %
  - Biomass: 50%
  - 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

3.2.9.6.4 Source-specific QA/QC and verification, if applicable

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Road Transport Subsector the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European

Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 3.2.9.6.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.2.9.6.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

3.2.9.6.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Other Transportation (please specify)/Other non-specified/Liquid fuels 1.A.3.e.

❖ ***activity data***

- ✓ recalculations for the 1989 – 2009, 2011 period period at AD due to update of value of Net Calorific Value for this fuel;
- ✓ recalculations for the 1989-2009, 2011 period at CO_2, CH_4 and N_2O emissions level due to changed AD.

Table 3.45 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	133.62	125.66	8.91	8.81	-1.13
1990	128.96	700.28	10.87	10.87	-0.04

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1991	920.66	900.34	9.1	9.10	-0.03
1992	370.08	798.51	29.42	29.41	-0.02
1993	19.81	477.35	16.97	16.96	-0.05
1994	1.58	317.32	12.13	12.12	-0.06
1995	1.26	392.16	9.83	9.83	-0.02
1996	1.70	706.60	31.49	31.47	-0.05
1997	1.58	798.58	26.04	26.03	-0.03
1998	1,301.54	1,937.43	98.08	98.07	-0.01
1999	885.39	1,315.38	72.7	72.69	-0.01
2000	1,043.81	1,295.76	71.55	71.55	0.00
2001	996.55	1,290.51	70.45	70.45	0.00
2002	865.17	1,745.49	89.53	89.53	0.00
2003	932.91	1,252.00	63.69	63.69	0.00
2004	530.04	1,440.97	84.16	111.84	24.75
2005	874.17	2,081.02	121.34	121.33	-0.01
2006	966.63	2,422.06	147.28	147.26	-0.01
2007	802.24	2,983.13	179.55	179.28	-0.15
2008	860.93	4,593.69	288.65	288.14	-0.18
2009	351.13	2,724.64	153.78	153.78	0.00
2010	439.09	685.62	182.41	41.03	-344.56
2011	439.09	685.62	157.39	38.27	-311.30

Table 3.46 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	125.66	124.26	0.002	0.0024	0.09
1990	700.28	700.24	0.019	0.0194	0.00
1991	900.34	900.30	0.026	0.0256	0.00
1992	798.51	798.49	0.012	0.0125	0.00
1993	477.35	477.30	0.009	0.0086	-0.01
1994	317.32	317.29	0.005	0.0050	-0.01
1995	392.16	392.13	0.008	0.0077	0.00
1996	706.6	706.42	0.011	0.0110	-0.01
1997	798.58	798.48	0.018	0.0180	-0.01
1998	1,937.43	1,937.35	0.018	0.0181	-0.01
1999	1,315.38	1,315.28	0.011	0.0106	-0.01
2000	1,295.76	1,295.75	0.007	0.0075	0.00
2001	1,290.51	1,290.43	0.009	0.0087	-0.01
2002	1,745.49	1,745.46	0.014	0.0140	0.00
2003	1,252.00	1,251.94	0.010	0.0096	0.00
2004	1,440.97	1,822.50	0.010	0.0117	16.28
2005	2,081.02	2,080.86	0.018	0.0180	-0.01
2006	2,422.06	2,421.80	0.026	0.0263	-0.02
2007	2,983.13	2,979.25	0.033	0.0328	-0.26
2008	4,593.69	4,586.52	0.056	0.0561	-0.25
2009	2,724.64	2,724.65	0.016	0.0164	0.00
2010	685.62	685.62	0.006	0.0065	0.00
2011	617.27	636.54	0.006	0.0062	6.19

Table 3.47 Effects of data changes onN_2O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	125.66	124.26	0.0001	0.0001	1.11
1990	700.28	700.24	0.0023	0.0023	0.00
1991	900.34	900.30	0.0032	0.0032	0.00
1992	798.51	798.49	0.0013	0.0013	0.00
1993	477.35	477.30	0.0009	0.0009	0.00
1994	317.32	317.29	0.0005	0.0005	0.00
1995	392.16	392.13	0.0010	0.0010	0.00
1996	706.6	706.42	0.0011	0.0011	0.01
1997	798.58	798.48	0.0018	0.0018	0.00
1998	1,937.43	1,937.35	0.0012	0.0012	0.00
1999	1,315.38	1,315.28	0.0005	0.0005	0.01
2000	1,295.76	1,295.75	0.0002	0.0002	0.00
2001	1,290.51	1,290.43	0.0004	0.0004	0.01
2002	1,745.49	1,745.46	0.0008	0.0008	0.00
2003	1,252.00	1,251.94	0.0007	0.0007	0.01
2004	1,440.97	1,822.50	0.0003	0.0005	-74.64
2005	2,081.02	2,080.86	0.0006	0.0006	0.02
2006	2,422.06	2,421.80	0.0008	0.0008	0.02
2007	2,983.13	2,979.25	0.0011	0.0011	0.21
2008	4,593.69	4,586.52	0.0016	0.0016	0.27
2009	2,724.64	2,724.65	0.0004	0.0004	0.00
2010	685.62	685.62	0.0002	0.0002	0.00
2011	617.27	636.54	0.0002	0.0002	-7.38

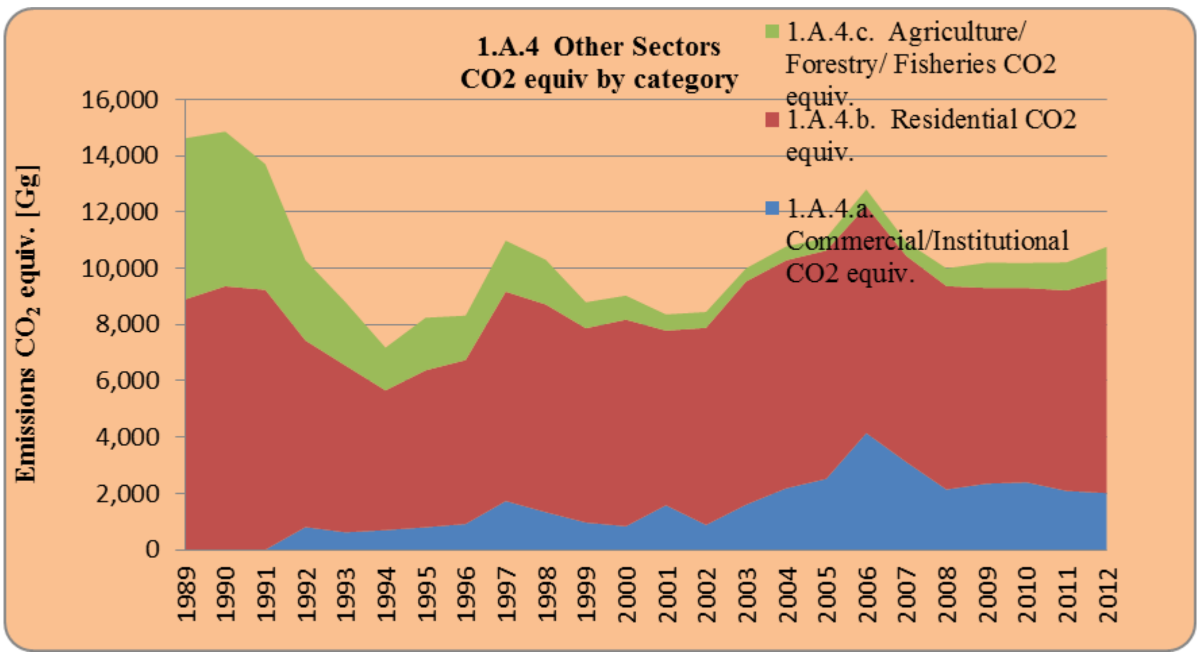
3.2.9.6.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

It is planned further co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.

3.2.10 Fuel combustion, Other Sectors (CRF sub-sector 1.A.4.)

3.2.10.1 Source description

Figure 3.52 GHG emissions from 1.A.4. – Other, by category



The fuel consumption in the following subcategories is included in this category:

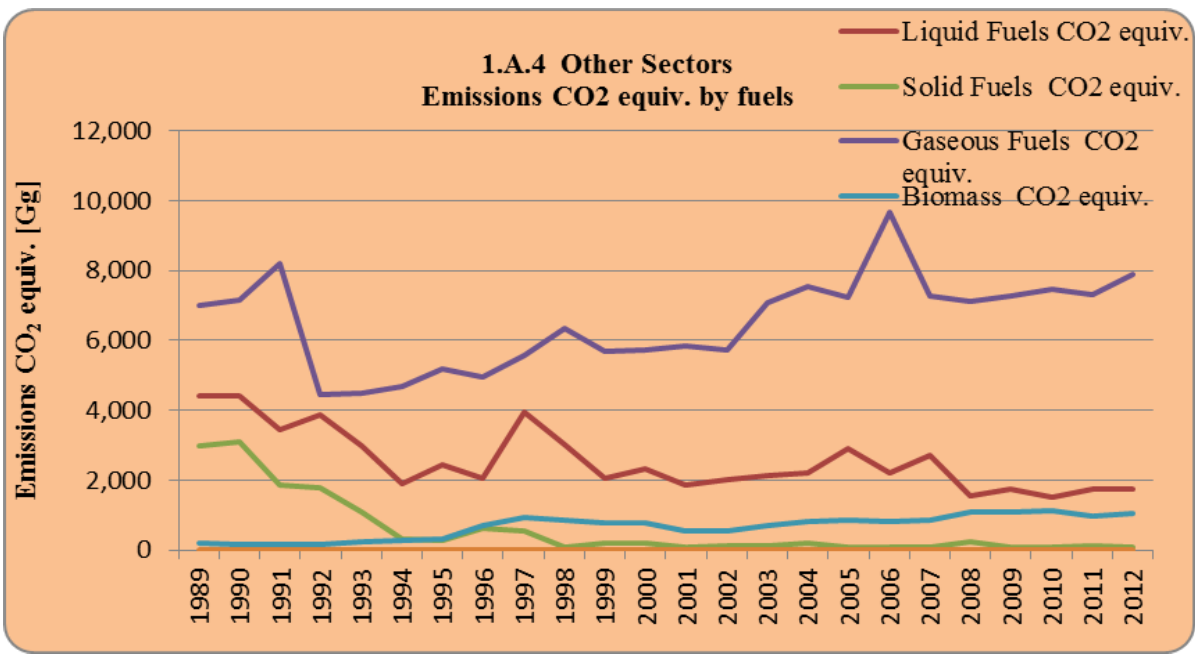
- Commercial/Institutional;
- Residential;
- Agriculture/ Forestry/ Fisheries.

The commercial/institutional category includes fuel consumptions declared by the economic agents in various activities, including: commerce, financial activities, banking and insurance, hotels and restaurants, real-estate transactions, rentals and services, public administration and defense, education, health and social assistance, other collective, social and personal services.

The residential category includes the quantities: the deliveries for open flame consumption for heating and cooking purposes, including energy consumption for residential space by the owners and the administration of the economic agents; the deliveries to population to produce heat and hot water in central heating and quantities of coal received by the miners as direct allowances (payment) from the mining companies; the heat delivered to the population for heating and hot water, both from the public and from auto producer sectors.

The agriculture and forestry category includes consumptions recorded in the following activity fields: agriculture, forestry, logging, hunting, fishing, and fuel consumption of the fishing ships.

Figure 3.53 GHG emissions from 1.A.4. – Other, by fuels



3.2.10.2 Fuel combustion, Other Sectors – Commercial/Institutional (CRF category 1.A.4.a)

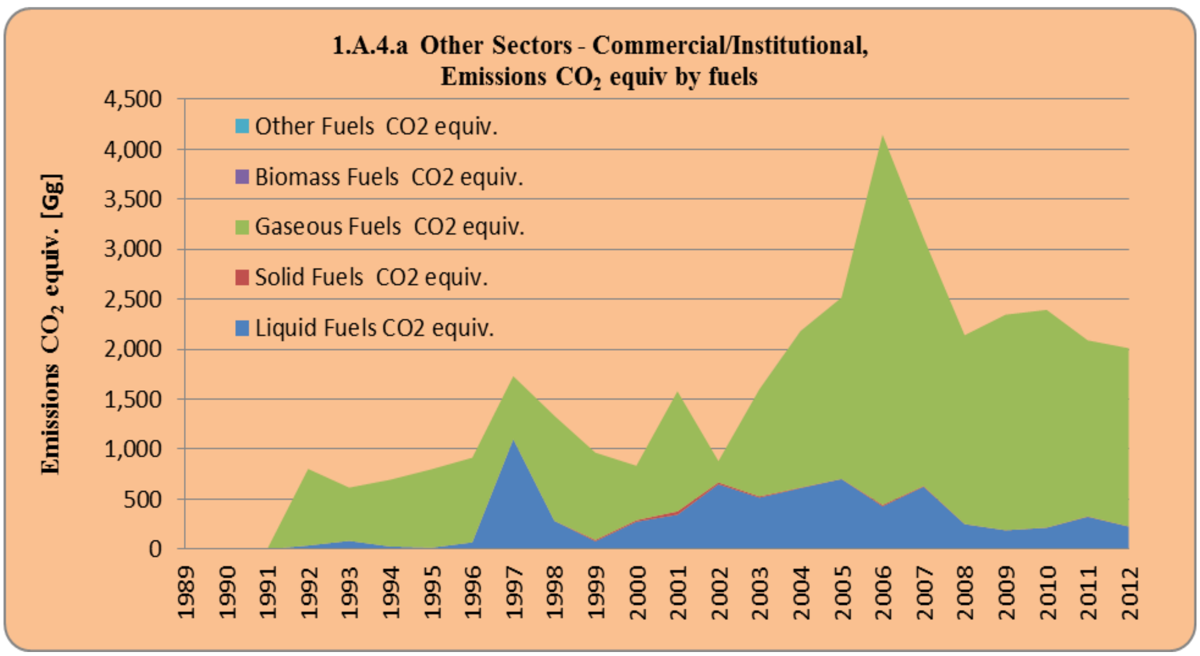
3.2.10.2.1 Source description

CRF category 1.A.4.a - Commercial/Institutional is a CO_2 key category by gaseous fuel - level, excluding and including LULUCF, as result of T1 approach.

CRF category 1.A.4.a - Commercial/Institutional is not a key category as result of T2 approach.

See more details about trends and key categories in the Chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.54 GHG emissions from 1.A.4.a – Commercial / Institutional, by fuels



The share of the total GHG emissions from the 1.A.4.a category to the 1.A.4 sub-sector is about 18.7%, current year, 2012.

The reporting of combustion on this category started with the 1992 year. The contribution of this category is about 2,010.77 Gg CO_2 equiv., in 2012.

It is observed a main contribution of the natural gas usage as fuel in this activity category, mostly on the period 2003 - 2012.

3.2.10.2.2 Methodological issues

Since the resources for solid fuels in the Romanian economy are mainly from the internal exploitations, the weighted arithmetic averages for the emission factors calculated based on all the EU-ETS activities reporting, are used in the 1.A.4 – Other Sectors.

For the liquid and gaseous fuels, being a mix between import and exports supply, result the same quality of this kind of fuels in the entire economy. Based on the recommendation of the ISPE Study, have been used the weighted arithmetic averages for the Emission Factors calculated based on the all the EU-ETS activities reporting.

Tier 1 Methodology and Default emission factors for the fuels which are not reported under EU-ETS, are used.

For the fuels reported in this activity category having determined Country Specific Emission Factors on EU-ETS reporting, Tier 2 methodology is used.

CO_2 gas

For the 1989 – 2006 period

- **Solid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007 - 2012 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007 – 2012 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- L**iquid fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2012 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2012 period, ALL EU-ETS reported category activities, oxidation included, are used.

- **Biomass,** entire time-series, EFs default are used.
- **Other fuels** – industrial wastes, entire time-series, country specific EF calculated as weighted arithmetic average (WA), on 2011 EU-ETS reported category activities, are used.

CH_4, N_2O - default EFs are used.
NOx, CO, NMVOC, SO_2 – default EMEP EFs are used.

The activity data are provided through the Romanian Energy Balance, sent by NIS to IEA/ EUROSTAT. The NCVs used are those provided in correspondence with this activity in the Energy Balance, and for the concerned fuels, the national weighted averages values derived from the EU-ETS reports, are used.
See the Chapter 3.2.6.2 for more details.

3.2.10.2.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%
- Solid Fuels – 5.0%
- Gaseous Fuels - 3.0%
- Biomass - 20.2%
- Other (Industrial Wastes) - 21.2%

CH_4 gas, N_2O gas

- Liquid Fuels - 50.1 %
- Solid Fuels - 50.1 %
- Gaseous Fuels - 50.1 %

- Biomass - 50.1%
- Other (Industrial Wastes) - 50.5 %

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period.
See the Chapter 3.2.6.3 for more details.

3.2.10.2.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectoral expert administrating the 1.B - Fugitive Emission sector.
See the chapter 3.2.6.4 for more details.

3.2.10.2.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period, Energy Balance parameters correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

For more details and effect of the activity data changes on the emissions estimation, see the chapter 3.2.6.5.

3.2.10.2.6 Source-specific planned improvements, if applicable

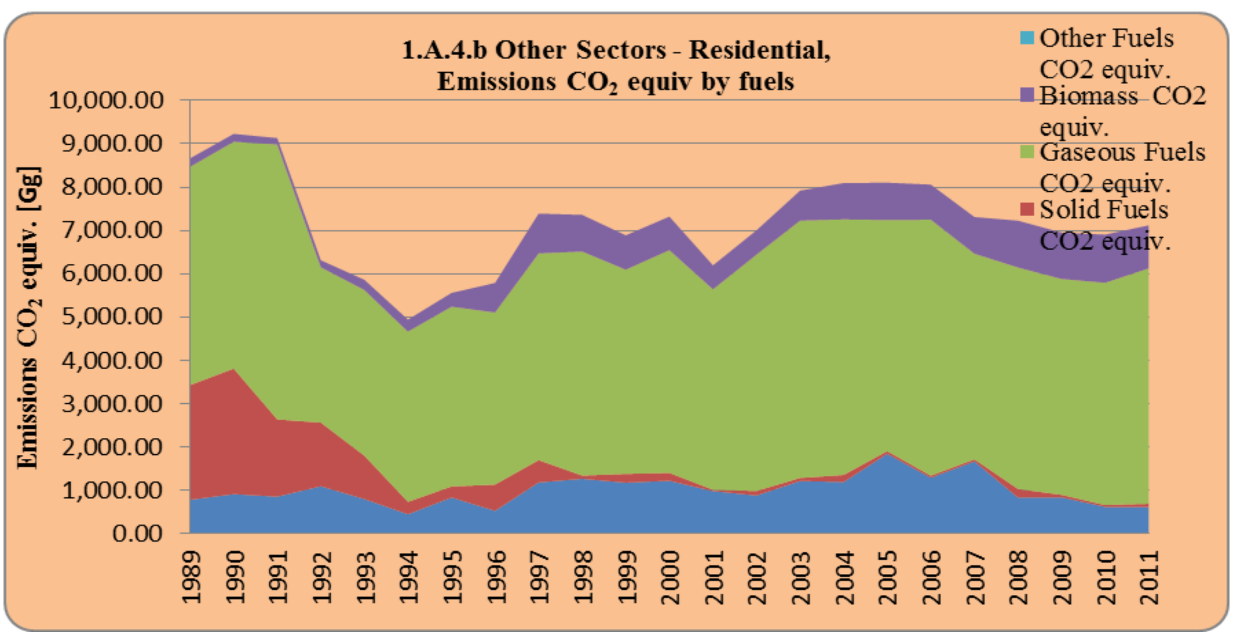
See the Chapter 3.2.6.6 for more details.

3.2.10.3 Fuel combustion, Other Sectors – Residential (CRF category 1.A.4.b)

3.2.10.3.1 Source description

CRF category 1.A.4.b - Residential is a CO_2 key category by liquid – level, solid – trend and gaseous fuels – level and trend, excluding and including LULUCF, as result of T1 approach.
CRF category 1.A.4.b - Residential is a CH_4 key category by biomass fuel – level and trend, excluding and including LULUCF, as result of T1 approach.
CRF category 1.A.4.b - Residential is a CO_2 key category by gaseous fuels – level and trend, excluding and including LULUCF, as result of T2 approach.
See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.55 GHG emissions from 1.A.4.b – Residential, by fuels



The share of the total GHG emissions of the 1.A.4.b category to the 1.A.4 sub-sector is about 60% - base year to the 70%, current year, 2012. The contribution of this category is about 7,593.13 Gg CO_2 equiv., in 2012.

It is observed a main contribution of the natural gas usage as fuel in this activity category, on the entire time-series. Also, the biomass has a significant ascendant contribution to the emissions (CH_4 and N_2O accounted).

3.2.10.3.2 Methodological issues

Tier 1 Methodology and default emission factors for the fuels without analyze on EU-ETS reporting are used.

For the fuels reported in this activity category having determined Country Specific Emission Factors on EU-ETS analyze, Tier 2 methodology is used.

CO_2 gas

For the 1989 – 2006 period

- **Solid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007 - 2012 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007 – 2012 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- L**iquid fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2012 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2012 period, ALL EU-ETS reported category activities, oxidation included, are used.

- **Biomass,** entire time-series, EFs default are used.
- **Other fuels** – industrial wastes, entire time-series, country specific EF calculated as weighted arithmetic average (WA), on 2011 EU-ETS reported category activities, are used.

CH_4, N_2O - default EFs are used.
NOx, CO, NMVOC, SO_2 – default EMEP EFs are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT. The NCVs used are those provided in correspondence with this activity in the Energy Balance, and for the concerned fuels, the national weighted averages values derived from the EU-ETS reports, are used.
See the chapter 3.2.6.2 for more details.

3.2.10.3.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%
- Solid Fuels – 5.0%
- Gaseous Fuels - 3.0%
- Biomass - 20.2%
- Other (Industrial Wastes) - 21.2%

CH_4 gas, N_2O gas

- Liquid Fuels - 50.1 %
- Solid Fuels - 50.1 %
- Gaseous Fuels - 50.1 %

- ❖ Biomass - 50.1%
- ❖ Other (Industrial Wastes) - 50.5 %

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period.

See the chapter 3.2.6.3 for more details.

3.2.10.3.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission sector.

See the Chapter 3.2.6.4 for more details.

3.2.10.3.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data

- For the liquid fuels reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- Motor Gasoline: Net Calorific Value, 1990-2004 period, Energy Balance parameters correction.

Solid Fuels

Activity data

- For the solid fuels reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

For more details and effect of the activity data changes on the emissions estimation, see the chapter 3.2.6.5.

3.2.10.3.6 Source-specific planned improvements, if applicable

See the Chapter 3.2.6.6 for more details.

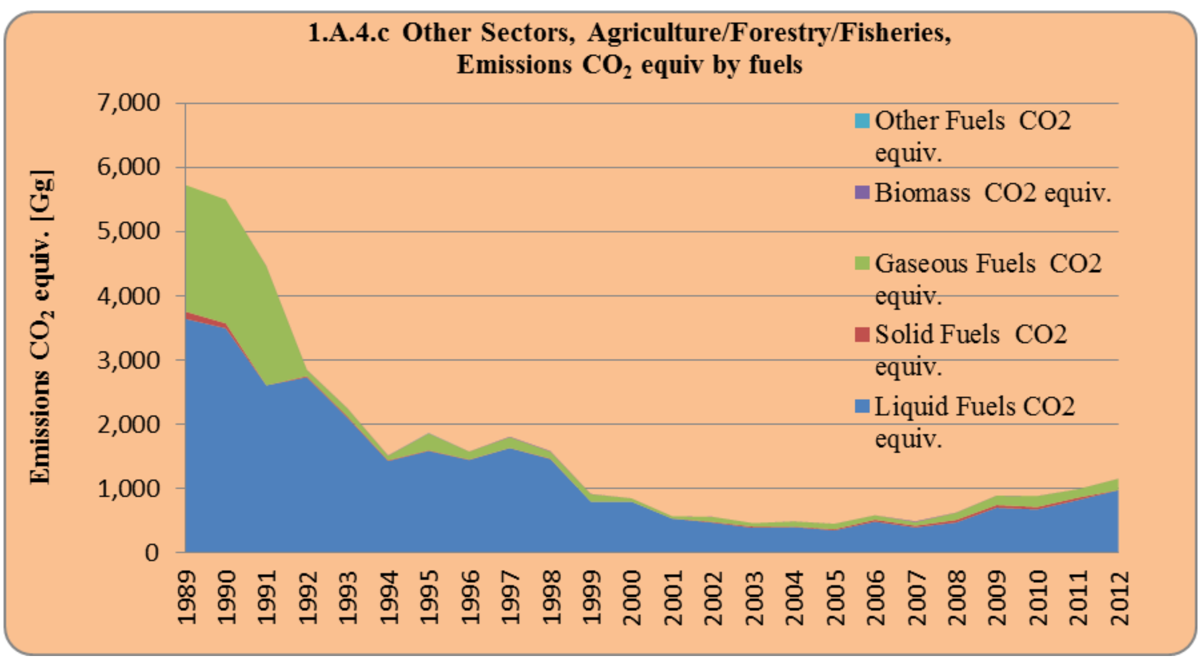
3.2.10.4 Fuel combustion, Other Sectors – Agriculture/ Forestry/ Fisheries (CRF category 1.A.4.c)

3.2.10.4.1 Source description

CRF category 1.A.4.c. - Agriculture/ Forestry/ Fisheries is a key category by liquid fuels – level and trend and gaseous fuels – trend, excluding and including LULUCF, as result of T1 approach. CRF category 1.A.4.c. - Agriculture/ Forestry/ Fisheries is not a key category, as result of T2 approach.

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.56 GHG emissions from 1.A.4.a – Agriculture/Forestry/Fisheries, by fuels



The share of the total GHG emissions of the 1.A.4.c category to the 1.A.4 sub-sector is about 39.2% - base year to the 10.8 %, current year, 2012. The contribution of this category is about 1,158.21 Gg CO_2 equiv., in 2012.
It is observed a main contribution of the liquid fuel combustion in this activity category, on the entire time-series. The ascendant trend is due to the fact that the last 2 years were good years for the agriculture sector.

3.2.10.4.2 Methodological issues

Tier 1 Methodology and default emission factors for the fuels which are not reported under EU-ETS, are used.
For the fuels reported in this activity category having determined Country Specific Emission Factors on EU-ETS analyze, Tier 2 methodology is used.

CO_2 gas

For the 1989 – 2006 period

- **Solid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007 - 2012 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007 – 2011 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- L**iquid fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2012 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2012 period, ALL EU-ETS reported category activities, oxidation included, are used.

- **Biomass,** entire time-series, EFs default are used.
- **Other fuels -** industrial wastes, entire time-series, country specific EF calculated as weighted arithmetic average (WA), on 2011 EU-ETS reported category activities, are used.

CH_4, N_2O - default EFs are used.
NOx, CO, NMVOC, SO_2 – default EMEP EFs are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT. The NCVs used are those provided in correspondence with this activity in the Energy Balance, and for the concerned fuels, the national weighted averages values derived from the EU-ETS reports, are used. See the chapter 3.2.6.2 for more details.

3.2.10.4.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%
- Solid Fuels – 5.0%
- Gaseous Fuels - 3.0%
- Biomass - 20.2%
- Other (Industrial Wastes) - 21.2%

CH_4 gas, N_2O gas

- Liquid Fuels - 50.1 %
- Solid Fuels - 50.1%
- Gaseous Fuels - 50.1%

- ❖ Biomass - 50.1%
- ❖ Other (Industrial Wastes) - 50.5 %

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period.
See the chapter 3.2.6.3 for more details.

3.2.10.4.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission sector.
See the chapter 3.2.6.4 for more details.

3.2.10.4.5 Source specific recalculation, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data

- For the liquid fuels reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- Motor Gasoline: Net Calorific Value, 1990-2004 period, Energy Balance parameter correction.

Solid Fuels

Activity data

- For the solid fuels reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

For more details and effect of the activity data changes on the emissions estimation, see the chapter 3.2.6.5.

3.2.10.4.6 Source specific planned imporvments, if applicable 1.A.4.c. Agriculture/ Forestry/ Fisheries

See the chapter 3.2.6.6 for more details.

3.2.11 Fuel combustion, Other Sectors (Not specified elsewhere) - Stationary (CRF sector 1.A.5.a)

3.2.11.1 Source description

CRF sector 1.A.5.a - Stationary is a CO_2 key category by liquid fules - level, including and excluding LULUCF, as result of T1 approach.

CRF sector 1.A.5.a - Stationary is not a key category, as result of T2 approach.

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

This activity category analyzes the fuels burned in the stationary installations not specified to the above sub-sectors. Mainly are combusted liquid fuels and secondly some solid fuels.

3.2.11.2 Methodological issues

Since the resources for solid fuels in the Romanian economy are mainly from the internal exploitations, the weighted arithmetic averages for the emission factors calculated based on all the EU-ETS activities reporting, are used in the 1.A.4 – Other Sectors.

For the liquid and gaseous fuels, being a mix between import and exports supply, result the same quality of this kind of fuels in the entire economy.

Based on the recommendation of the ISPE Study, have been used the weighted arithmetic averages for the Emission Factors calculated based on the all the EU-ETS activities reporting.

Tier 1 Methodology and Default emission factors for the fuels without analyze on EU-ETS reporting are used.

For the fuels reported in this activity category having determined Country Specific Emission Factors on EU-ETS reporting, Tier 2 methodology is used.

CO_2 gas

For the 1989 – 2006 period

- **Solid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

For the 2007 - 2012 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007 – 2012 period, ALL EU-ETS reported activity category, oxidation included, are used.
- **Liquid fuels,** EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Gaseous fuels**, EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2012 period, ALL EU-ETS reported category activities, oxidation included, are used.
- **Biomass,** entire time-series, EFs default are used.
- **Other fuels** – industrial wastes, entire time-series, country specific EF calculated as weighted arithmetic average (WA), on 2011 EU-ETS reported category activities, are used.

CH_4, N_2O - default EFs are used.

NOx, CO, NMVOC, SO_2 – default EMEP EFs are used.

The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT. The NCVs used are those provided in correspondence with this activity in the Energy Balance, and for the concerned fuels, the national weighted averages values derived from the EU-ETS reports, are used. See the chapter 3.2.6.2 for more details.

3.2.11.3 Uncertainties and time-series consistency

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000, are as follows:

CO_2 gas

- Liquid Fuels - 3.1%;
- Solid Fuels – 5.0%;
- Gaseous Fuels - 3.0%;
- Biomass - 20.2%;
- Other (Industrial Wastes) - 21.2%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.1%;
- Solid Fuels - 50.1%;
- Gaseous Fuels - 50.1%;
- Biomass - 50.1%;
- Other (Industrial Wastes) - 50.5%.

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period.
See the chapter 3.2.6.3 for more details.

3.2.11.4 Source-specific QA/QC and verification, if applicable

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the 1.B - Fugitive Emission sector.

See the chapter 3.2.6.4 for more details.

3.2.11.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Liquid Fuels

Activity data

- For the liquid fuels reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- White Spirit & SBP: Non-specified (Other), 2005, 2006 years - Energy Balance activity data correction;
- Motor Gasoline: Net Calorific Value, 1990 - 2004 period, Energy Balance parameter correction.

Solid Fuels

Activity data

- For the solid fuels reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.6.5.

3.2.11.6 Source-specific planned improvements, if applicable

See the Chapter 3.2.6.6 for more details.

3.3 Fugitive emissions from Solid Fuels and Oil and Natural Gas (CRF 1.B)

3.3.1 Overview of the subsector

This chapter provides information on the estimation of the greenhouse gas emissions associated with the Fugitive Emissions from Fuels Subsector.

The following direct GHG emissions and source categories are quantified and reported:

- CH_4 emissions from Solid Fuels;
- CH_4, CO_2 and N_2O emissions from Oil and Natural Gas.

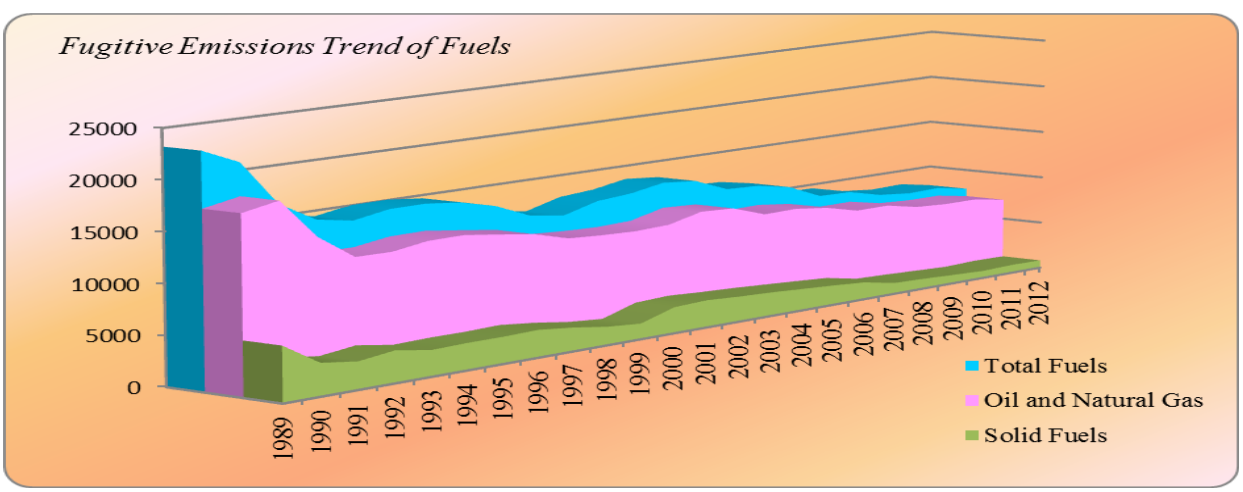
In 2012 GHG emissions from the Fugitive Emissions from Fuels. Subsector accounted for 7,909.72 Gg CO_2 equivalent, which represent 6.66% of the total national GHG emissions in this year. In the base year, the total GHG emissions from the Fugitive Emissions from Fuels Subsector amounted to 23,233.65 Gg CO_2 equivalent, which represent 8.15% of the total national GHG emissions in this year (Table 3.48).

Table 3.48 The contribution of Fugitive Emissions from Fuels Subsector emissions to the total GHG in Romania, for 1989–2012 period

Year	Total GHG emissions (excl. LULUCF) [Gg CO_2 equiv.]	GHG emissions from Fugitive Emissions [Gg CO_2 equiv.]	Contribution of Fugitive Emissions in total GHG emissions [%]
1989	285,047.74	23,233.65	8.15
1990	247,663.52	21,651.63	8.74
1991	202,016.80	17,128.97	8.48
1992	182,424.15	15,076.62	8.26
1993	172,305.77	14,448.71	8.39
1994	169,049.82	15,053.20	8.90
1995	175,264.58	15,068.82	8.60
1996	177,828.37	14,669.64	8.25
1997	164,437.44	13,792.74	8.39

Year	Total GHG emissions (excl. LULUCF) [Gg CO_2 equiv.]	GHG emissions from Fugitive Emissions [Gg CO_2 equiv.]	Contribution of Fugitive Emissions in total GHG emissions [%]
1998	146,772.78	12,297.29	8.38
1999	129,707.90	11,791.60	9.09
2000	134,073.69	12,745.10	9.51
2001	139,021.95	13,002.96	9.35
2002	139,697.63	13,621.65	9.75
2003	144,219.31	13,308.76	9.23
2004	141,220.66	11,941.30	8.46
2005	141,313.82	11,788.08	8.34
2006	144,776.56	11,144.00	7.70
2007	142,803.52	9,674.88	6.77
2008	139,811.77	9,583.19	6.85
2009	119,917.10	8,772.48	7.32
2010	115,798.97	8,431.28	7.28
2011	121,513.51	8,515.87	7.01
2012	118,764.15	7,909.72	6.66

Figure 3.57 Total GHG emissions from Fugitive Emissions from Fuels Subsector for 1989–2012 period



Mostly GHG emissions are resulting from Oil and Natural Gas category, responsible for 89.76% of total GHG emissions from Fugitive Emissions subsector, Solid Fuels category contributes with 10.24%.

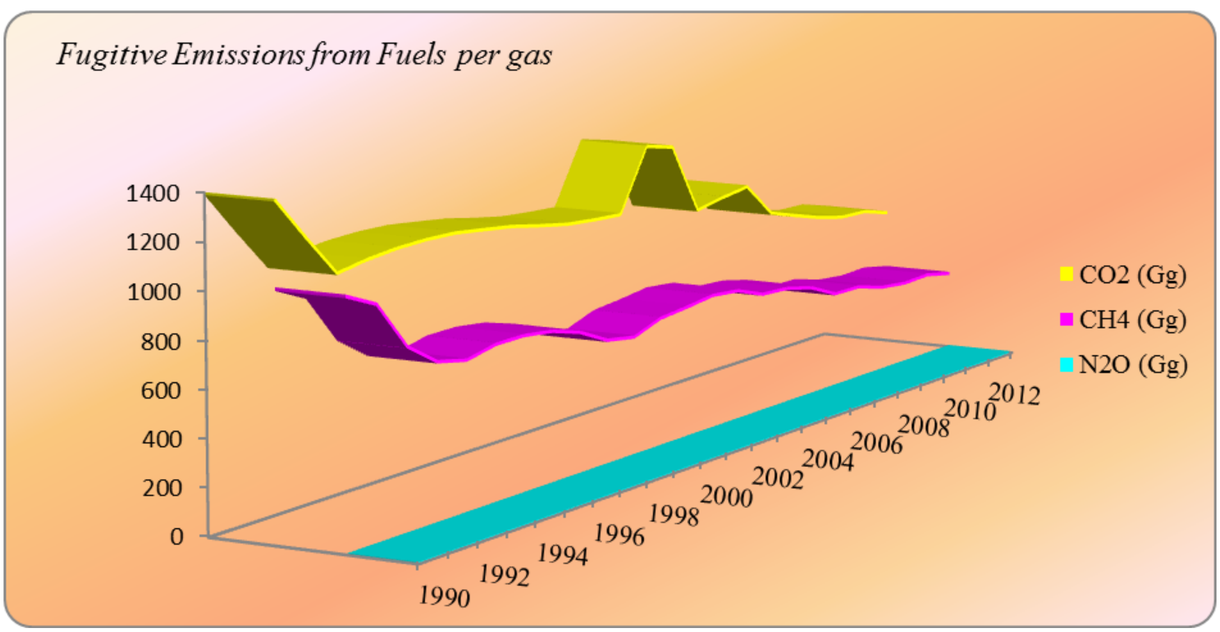
GHG emissions from Oil and Natural Gas and Solid Fuels categories are key category sources: by level for CH_4 emissions from *Venting* sub-source category and CH_4 and CO_2 emissions from *Oil* sub- source category and level and trend for CH_4 emissions from *Coal Mining and Handling* sub- source category and *Oil and Natural Gas* source category (see Table 3.4).

Table 3.49 GHG emissions from Fugitive Emissions from Fuels Subsector, per gas, and contribution of these in total GHG emissions from Fugitive Emissions from Fuels Subsector, for the 1989 – 2012 period

Year	Total emissions from Fugitive Emissions from Fuels Subsector [Gg CO_2 equiv.]	CH_4 emissions		CO_2 emissions		N_2O emissions	
		Gg CO_2 equiv.	%	Gg CO_2	%	Gg CO_2 equiv.	%
1989	23,233.65	21,829.55	93.96	1,399.87	6.03	4.23	0.018
1990	21,651.63	20,434.92	94.38	1,213.11	5.60	3.60	0.017
1991	17,128.97	16,090.94	93.94	1,034.95	6.04	3.09	0.018
1992	15,076.62	14,015.57	92.96	1,057.88	7.02	3.17	0.021
1993	14,448.71	13,374.70	92.57	1,070.80	7.41	3.21	0.022
1994	15,053.20	13,976.01	92.84	1,073.97	7.13	3.22	0.021
1995	15,068.82	13,997.17	92.89	1,068.44	7.09	3.21	0.021
1996	14,669.64	13,616.27	92.82	1,050.22	7.16	3.16	0.022
1997	13,792.74	12,758.69	92.50	1,030.94	7.47	3.10	0.022
1998	12,297.29	11,292.82	91.83	1,001.46	8.14	3.01	0.025
1999	11,791.60	10,813.16	91.70	975.50	8.27	2.94	0.025
2000	12,745.10	11,780.18	92.43	962.01	7.55	2.90	0.023
2001	13,002.96	12,047.37	92.65	952.73	7.33	2.87	0.022
2002	13,621.65	12,396.12	91.00	1,221.83	8.97	3.70	0.027

Year	Total emissions from Fugitive Emissions from Fuels Subsector [Gg CO_2 equiv.]	CH_4 emissions		CO_2 emissions		N_2O emissions	
		Gg CO_2 equiv.	%	Gg CO_2	%	Gg CO_2 equiv.	%
2003	13,308.76	12,116.16	91.04	1,189.00	8.93	3.60	0.027
2004	11,941.30	11,061.40	92.63	877.26	7.35	2.64	0.022
2005	11,788.08	10,884.30	92.33	901.06	7.64	2.72	0.023
2006	11,144.00	10,222.40	91.73	918.82	8.25	2.78	0.025
2007	9,674.88	8,905.68	92.05	766.89	7.93	2.31	0.024
2008	9,583.19	8,857.22	92.42	723.79	7.55	2.18	0.023
2009	8,772.48	8,088.08	92.20	682.34	7.78	2.06	0.023
2010	8,431.28	7,777.48	92.25	651.84	7.73	1.97	0.023
2011	8,515.87	7,867.68	92.39	646.24	7.59	1.95	0.023
2012	7,909.72	7,299.51	92.29	608.37	7.69	1.84	0.023

Figure 3.58 GHG emissions from Fugitive Emissions from Fuels Subsector, per gas



The inventory preparation, including identification of key categories, preparation of uncertainty estimates and implementation of QA/ QC procedures, have been performed according to IPCC GPG 2000.

3.3.2 Source category Solid Fuels (CRF sector 1.B.1)

3.3.2.1 Source category description

The source category "Solid Fuels" consists of three sub-source categories:

- "Coal Mining and Handling", "Solid Fuel Transformation" and "Other".

3.3.2.1.1 Coal mining and handling sub-source category

- Emission: CH_4;
- Key source: Yes.

The sub-source category "Coal Mining and Handling" is a key source of CH_4 emissions in terms of both emissions level and trend.

This sub-source category includes all fugitive emissions from coal.

Romania has superior coal (anthracite and coal) and lowers (brown coal and lignite). Besides these, there are peat coal and shale. Coal in the form of coking coal used in power plants.

In Romania, lignite resources are estimate at 1490 million tones, and coal resources are estimate at 1900 million tones.

After 1989 the extraction of coal was in a continuous process of restructuring in connection with the requirements of the electricity sector and thermal and other industries.

Since 1998, started a process of conservation and closing of unprofitable mines and quarries. By the end of 2006 mining activities were carried out in 12 mines (7 for coal and 5 for lignite) and in 24 quarries (1 for lignite and 23 for coal). Closing inefficient mines, led to a situation where only about 30% of the total geological reserves of coal is also found in the activity.

According to Domestic Energy Balance, in Romania only lignite brown coal, lignite and brown coal are extracting. Activity data used to estimate 1.B.1 category related emissions were provided by NIS in the form Eurostat Questionnaire for 1989 and International Energy Agency (IEA)/Eurostat Questionnaire for every year in the 1990-2012 periods.

Statistical data available and activity data assumptions from National Institute for Statistics (NIS) and Institute for Studies and Power Engineering (ISPE) study indicates that in Romania the shares of underground-mined coal and surface mined coal are the following: hard coal and 15% of the lignite (including brown coal) is extracted from underground mines and 85% of the lignite (including brown coal) is extracted from surface mines.

The activity data include:

❖ Eurostat/IEA Indigenous Production category data (Anthracite – 100 %, Coking Coal – 100 %, Other Bituminous Coal - 100 %, Sub-bituminous Coal - 100 %, Lignite/Brown Coal - 15 %) for underground mines;

❖ Eurostat/IEA Indigenous Production category data (Lignite/Brown Coal - 85 %) for surface mines.

These shares have been used for the entire 1989-2012 time series.

Consequence of the fact that values of the production of lignite (including the brown coal) for the period 1990-1999 were not available in the Eurostat/IEA data, the data were obtained by extrapolating existing data series, by applying a fraction of 0.85 to total amount of lignite extracted.

Figure 3.59 Lignite – Brown Coal Production trend

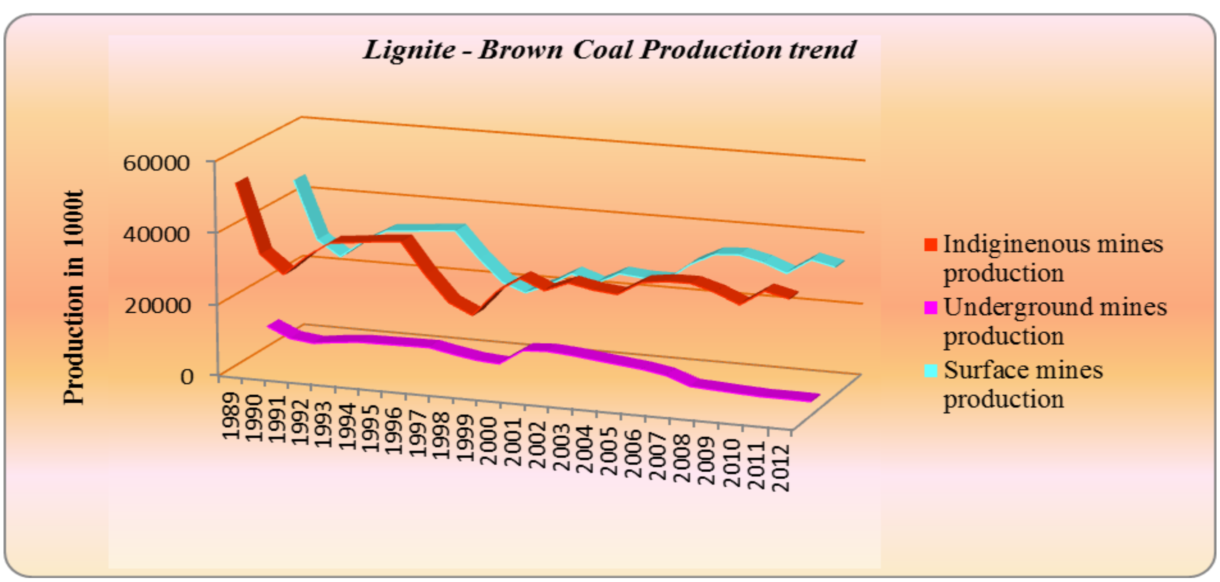
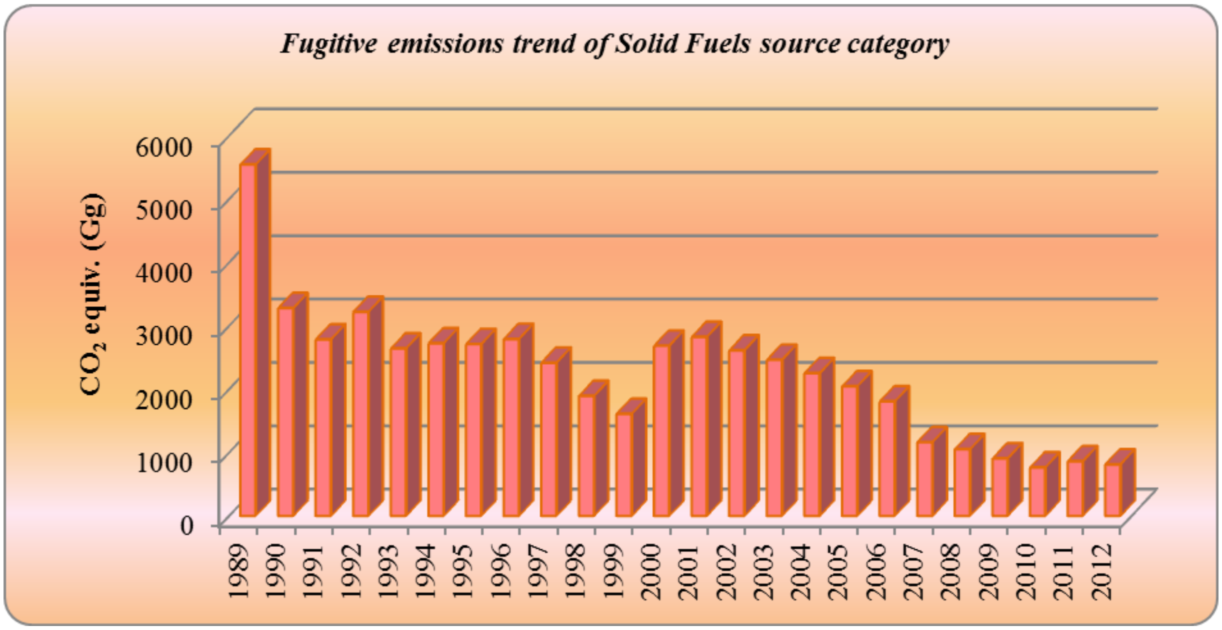


Figure 3.60 Fugitive Emissions of CH_4 from Solid Fuels (1.B.1)



The emissions of methane are the most important in respect to the solid fuels fugitive emissions. The emissions trend reflects the changes in this period characterized by a process of transition to a market economy; the trend can be split in three parts: the period 1989–1999, the period 2000–2010 and the period 2011–2012 years.

After 1989 the extraction of coal was in a continuous process of restructuring in connection with the requirements of the electricity sector and thermal and other industries.

Since 1998, a process of conservation and closing of unprofitable mines and quarries started. Closing inefficient mines, led to a situation where only about 30% of the total geological reserves of coal is subject to the activity.

Emissions have started to increase starting with 2000, because of economy revitalization.

In 2006, a reduction of primary energy production was registered, except for lignite and brown coal, where it increased (+19.7% compared to 2005).

From the 2007-2010 period the emissions started to decrease again after the begining of global financial crisis which conducted to economic contraction.

In 2011 there was an increase in coal resources (excluding coke) compared to 2010, along with the decrease of oil, hydro energy and natural gas resources.

In 2012, there were an decrease in coal resources (excluding coke) (-5,4% compared to 2011) and lignite and brown coal (-4% compared to 2011), along with the increase of imports of coal (including coke) (+12,2% compared to 2011) (Source – Romanian National Institute for Statistics).

Figure 3.59 shows the CH_4 emissions trend of Solid Fuels category.

3.3.2.2 Methodological issues

3.3.2.2.1 Coal mining and handling sub-source category

- Emission: CH_4;
- Key source: Yes.

Underground mines category:

- *Mining activities ((1.B.1.a.i.1);*
- *Post mining activities (1.B.1.a.i.2.)*

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors for the solid fuels reporting are used.

The formula used in the calculations is the following:

Equation 3.14 Emissions of CH4 in Underground mines category

$$\mathbf{CH_4\ emissions}\ (Gg) = [EF\ (m^3\ CH_4/\text{tonne of coal mined}) \times \text{Conversion Factor}\ (Gg/10^6\ m^3) \times \text{Underground Coal Production}\ (Mt)] \times 1000$$

where:

- *Default Emission Factor*: from 2006 IPCC GL, volume 2, chapter 4.1.3.2, page 4.12 (the same as 1996 IPCC GL);
- *The default value of 18 m^3/t* (average CH_4 Emission Factor) according to 2006 IPCC GL for “Mining Underground Coal Production” has been used.

- *The default value of 2.5 m^3/t* (average CH_4 Emission Factor) according to 2006 IPCC GL for "Post Mining Underground Coal Production" has been used;
- *Conversion Factor*: this is the density of CH_4 and converts volume of CH_4 to mass of CH_4. The density is taken at 20°C and 1 atmosphere pressure and has a value of 0.67 $Gg/10^6\ m^3$ (0.00000067 Gg/m^3).

***Activity Data*:** 1989_BAL_Romania have been used for 1989, and IEA/ Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

- *Underground Coal Production (Mt):* IEA/Eurostat Questionnaire 2012 - Indigenous Production (Anthracite – 100 %, Coking Coal – 100 %, Other Bituminous Coal - 100 %, Sub-bituminous Coal - 100 %, Lignite/Brown Coal - 15 %).

Surface mines category:

- *Mining activities (1.B.1.a.ii.1);*
- *Post mining activities (1.B.1.a.ii.2.).*

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors for the solid fuels reporting are used.
The formula used in the calculations is the following:

Equation 3.15 Emissions of CH_4 in Surface mines category

$$\mathbf{CH_4\ emissions}\ (Gg) = [EF\ (m^3\ CH_4/\text{tonne of coal mined}) \times \text{Conversion Factor}\ (Gg/10^6\ m^3) \times \text{Surface Coal Production}\ (Mt)] \times 1000$$

where:

- *Default Emission Factor*: from 2006 IPCC GL, volume 2, chapter 4.1.3.2, page 4.18 (the same as 1996 IPCC GL);
- *The default value of 1.2 m^3/t* (average CH_4 Emission Factor) according to 2006 IPCC GL for "Surface Coal Production" has been used;

- *The default value of 0.1 m^3/t* (average CH_4 Emission Factor) according to 2006 IPCC GL for "Post mining Surface Coal Production" has been used;
- *Conversion Factor*: this is the density of CH_4 and converts volume of CH_4 to mass of CH_4. The density is taken at 20°C and 1 atmosphere pressure and has a value of 0.67 $Gg/10^6\ m^3$ (0.00000067 Gg/m^3).

Activity Data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

- *Surface Coal Production (Mt):* IEA/Eurostat Questionnaire 2012 - Indigenous Production (Lignite/Brown Coal - 85 %).

According to the information supplied by the Ministry of Economy (MC), the National Coal Company and National Institute for Research and Development in Mine Safety (INSEMEX), there are provided values regarding the recovery of the methane in the mining activities. The recovered methane is reported in the Petrosani Mining Basin, the mines named Lupeni and Vulcan (Figure 3.60 and Table 3.50).

Figure 3.61 Underground Mines category and Solid Fuel Transformation sub-source category emissions trend

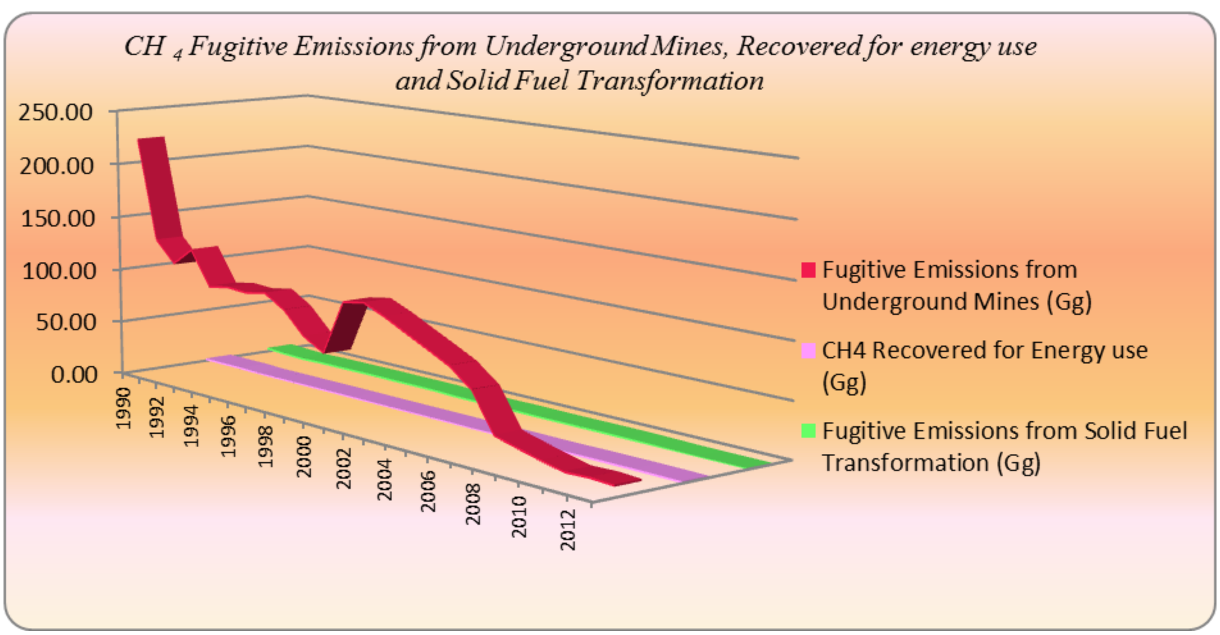


Table 3.50 Fugitive Emissions of CH_4 from Underground Mines and CH_4 Recovered for energy use

Year	**Underground mines**	
	CH_4 fugitive emissions (Gg)	**CH_4 Recovered for energy use (Gg)**
1989	221.92	1.36
1990	129.32	1.25
1991	110.31	1.25
1992	126.31	0.58
1993	95.61	0.58
1994	98.89	0.58
1995	97.54	0.58
1996	101.13	0.58
1997	89.52	0.58
1998	70.01	0.45
1999	59.50	0.45
2000	108.33	0.45
2001	111.64	0.45
2002	103.38	0.45
2003	93.53	0.19
2004	83.90	0.53
2005	73.94	0.59
2006	58.30	0.50
2007	24.83	0.58
2008	19.42	0.91
2009	14.24	0.95
2010	9.83	1.02
2011	10.74	0.93
2012	9.67	0.76

3.3.2.2.2 Solid Fuel Transformation sub-source category

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors for the Solid Fuels transformation reporting are used.
The formula used in the calculations is the following:

Equation 3.16 Emissions of CH_4 in Solid Fuel Transformation sub- source category

$$CH_4 \text{ emissions (Gg)} = [EF\ (m^3\ CH_4/\text{tonne of coal mined}) \times \text{Coking Coal Production (Mt)}] \times 1000$$

where:

- *Default Emission Factor*: EFDB of IPCC - Database on Greenhouse Gas Emission Factors;
- *The default value of 0.35 kg CH_4/t* according to EFDB of IPCC - Database on Greenhouse Gas Emission Factors has been used.

Activity Data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

- *Coking Coal Production (Mt):* IEA/Eurostat Questionnaire 2012 – Transformation Sector (Coking Coal – 100 %,).

3.3.2.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- ***Coal Mining and Handling sub-source category***
  - AD: 5%;
  - EF:
    - CO_2: 200%;
    - CH_4: 200%;
    - 200.06 % for CO_2 and 200 % for CH_4 associated with the overall uncertainty,

as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

❖ ***Solid Fuel Transformation sub-source category***

- AD: 1%;
- EF:
    - CO_2: 200%;
    - CH_4: 200%;
    - 200 % for CO_2 and 200 % for CH_4 values associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that all activity data were provided through the IEA/Eurostat Questionnaire 2012 and were obtained using the same method, that default emission factors were used for the whole time-series and the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

3.3.2.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *Stationary Combustion* categories, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

Recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European

Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted and solved as part of the 2012 NGHGI; these activities are described in the Chapter 3.3.2.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.3.2.5 – Source-specific recalculations, including changes made in response to the review process.

3.3.2.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In order to improve the emissions estimates quality some important recalculations were made:

❖ ***emissions***

- Underground Mining Activities (1.B.1.A.1.1.) category: due to a transcription error of the CH_4 emission from the spreadsheet in the CRF for 2011.

The implications of all changes made on emission estimates are described in Table 3.51.

Table 3.51 Change made at activity data and their effects on CH_4 emission estimates Sub-sector 1.B 1. - Solid Fuels

Year	**Effects of changes on CH_4 emission estimates [Gg]**		**Difference [%]**
	NGHGI 2013 v. 2.2	**NGHGI 2014 v. 1.4**	
1989	263.88	263.88	0.00
1990	155.97	155.97	0.00
1991	132.39	132.39	0.00
1992	153.19	153.19	0.00

Year	Effects of changes on CH_4 emission estimates [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1993	125.67	125.67	0.00
1994	129.58	129.58	0.00
1995	128.93	128.93	0.00
1996	132.74	132.74	0.00
1997	114.95	114.95	0.00
1998	89.99	89.99	0.00
1999	76.48	76.48	0.00
2000	127.73	127.73	0.00
2001	134.34	134.34	0.00
2002	124.29	124.29	0.00
2003	117.13	117.13	0.00
2004	107.03	107.03	0.00
2005	97.16	97.16	0.00
2006	85.90	85.90	0.00
2007	55.22	55.22	0.00
2008	49.94	49.94	0.00
2009	43.03	43.03	0.00
2010	36.26	36.26	0.00
2011	41.87	40.94	-2.27

3.3.2.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

It is necessary to realize a new data base for mining sector to increase the accuracy in determination of fugitive emissions.

3.3.3 Source category Oil and Natural Gas - (CRF 1.B.2)

3.3.3.1 Source category description

The source category "Oil and Natural Gas” is a key source of CH_4 and CO_2 emissions in terms of both emissions level and trend.

This source category comprises fugitive emissions from all oil and gas activities.

The primary sources of these emissions may include fugitive equipment leaks, evaporation losses, and venting, flaring and accidental releases.

The oil-pools deposits are limited on the terms in which were not identified new oil-pools deposits having an important potentially. Oil reserves in Romania have an estimated potential of about 74 million tones.

The National Society of Oil, PETROM S.A., has the exclusive right to extract oil from all of the Romanian oil-fields.

The most important companies of the fuel distribution in Romania are: OMV (PETROM), LUKOIL, ROMPETROL and MOL. In 2006, in Romania there were a total of 2,140 gas-stations.

According to the estimations of the 2007, the Romania’s natural gas pools reseves are limited and they were estimated at about 185 billions cubic metters taking into account of the domestic production decline.

According to the Romanian National Energy Regulatory Agency (ANRE) for repports of 2010, the domestic production of the natural gas was dominated by ROMGAZ S.A. with about 53.4 %, followed by OMV PETROM with 44.44 %; this production of the oil, ”coveres” of about 82.84 % of the total consumption, the rest being covered by import.

The National Society for Natural Gas Transportation TRANSGAZ S.A. has technical infrastructure so that it allows to ensure the transportation of the natural gas to the consumming areas of the 12,528 km of the transporting pipelines and of the feeding points plus over 553 km of pipelines also for the international transit of the gas at the level of.2012.

The information regarding the methane gas distribution is monitorized by the Romanian National Energy Regulatory Agency (ANRE).

Figure 3.62 Total GHG Oil and Natural Gas source category emissions trend

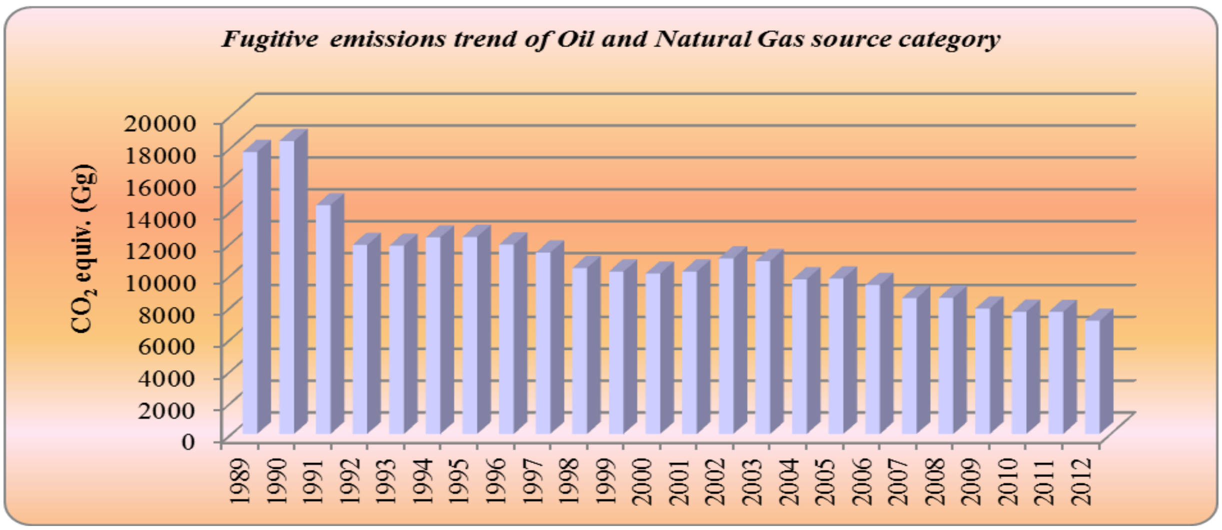
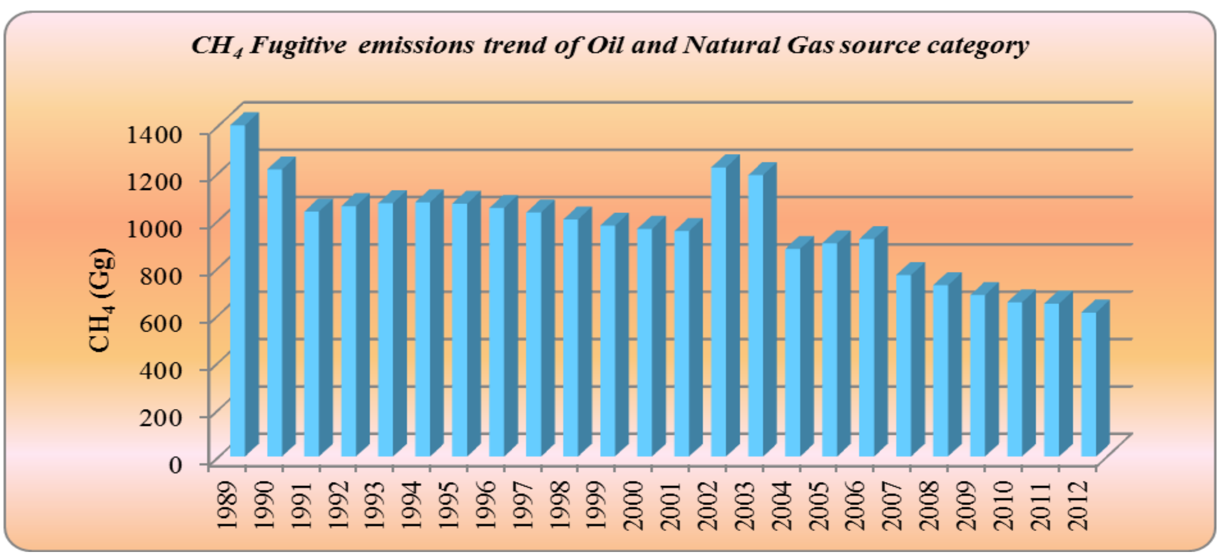


Figure 3.63 CH_4 Oil and Natural Gas source category emissions trend



The emissions trend for the entire period is characterized by a continuos decrease, which is due to a number of factors:

- the decline of economic activities and energy consumption;
- the economy being in transition, some energy intensive industries reduced their activities, this being reflected in the GHG emissions reduction especialy during 1989–1999 period;
- the decrease of the natural gas national reserves;
- increase of energy efficiency at the end consumer by changing the old technologies with new technologies, decreasing energy consumption in large cities due to drastic decline in thermal energy demand from industrial consumers, but also because disconnection of households from the public centralized heat supply system, combined with the increasing trend of using individual apartment heating systems;
- in 2006, the available energy resources rised over the level in the previous year. The increase was based mainly on the increased import of energy carriers (+3.1%), offsetting the small decrease of the primary energy production due to diminished crude oil (-8.1%),
- natural gas and hydroelectric power production,compared to 2005 (Source – Romanian National Institute for Statistics);
- the increase of natural gas resources in 2006 was driven by the significant increase in imports (+14.3 %);
- the decrease of crude oil and hydropower resources in 2011 was compensated by the increase of natural gas available for use;
- imports of natural gas have increased in 2011 over the level in the previous year, representing 35.7% of the total imports of energy products; meanwhile a decreased level was registred in case of imports of crude oil, which represent 47.1% of the total imports of energy products (Source – Romanian National Institute for Statistics);
- in 2012, the decrease of resources of crude oil (-6,8%) and natural gas (-0,7%) was been accompanied by the decrease of imports of crude oil (-5.9%) and natural gas (-6.7%) (Source – Romanian National Institute for Statistics) (Figure 3.61 and Figure 3.62).

3.3.3.2 Methodological issues

3.3.3.2.1 Oil sub-source category

- Emission: CH_4, CO_2, N_2O
- Key source: Yes

This *sub-source category* comprises emissions from venting, flaring and all other fugitive sources associated with exploration, production, transmission, upgrading, and refining of crude oil and distribution of crude oil products.
Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.
The formula used (*Equation 4.2.1 TIER 1: Estimating Fugitive Emissions from an Industry Segment*) in the calculations is the following:

Equation 3.17 Estimating Fugitive Emissions from an Industry Segment

$$E_{gas,\ industry\ segment} = A_{industry\ segment} * EF_{gas,\ industry\ segment}$$

$$E_{gas} = \sum_{industry\ segment} E_{gas,industry\ segment}$$

where:

- $E_{gas,\ industry\ segment}$ = Annual emissions (Gg)
- $EF_{gas,\ industry\ segment}$ = emission factor (Gg unit of activity)
- $A_{industry\ segment}$ = activity value (units of activity)

Venting Oil and *Flaring Oil*

Venting (1.B.2.a.i.)- Emissions from venting of associated gas and waste gas/vapour streams at oil facilities.

Flaring (1.B.2.a.ii.)- Emissions from flaring of natural gas and waste gas/vapour streams at oil facilities.

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission Factor

- *Default Emission Factor*: "Default weighted total" from 2006 IPCC GL, volume 2, chapter 4.2.2.3., page 4.55, table 4.2.5.
- *The default value of 0.0103500 Gg/10^3m^3* (Venting) for CH_4 (average CH_4 Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.
- *The default value of 0.0021500 Gg/10^3m^3* (Venting) for CO_2 (average CO_2 Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.
- *The default value of 0.0000250 Gg/10^3m^3* (Flaring) for CH_4 (average CH_4 Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.
- *The default value of 0.0405000 Gg/10^3m^3* (Flaring) for CO_2 (average CO_2 Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.
- *The default value of 0.0000064 Gg/10^3m^3* (Flaring) for N_2O (average N_2O Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.

***Activity Data*:** 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

According with the methodological provisions, activity data level used in *Venting Oil (1.B.2.a.i.)* and *Flaring Oil (1.B.2.a.ii.)* categories is the sum of Eurostat/IEA data on the following parameters values:

- Crude oil- indigenous production;
- Natural Gas Liquids - indigenous production;

❖ Other Hydrocarbons - indigenous production.

As long as, the density values for each fuel type are different and the activity data values are not unitary as content on the time series analyzed period, the implied emission factors of CO_2, CH_4 and N_2O are different.

Exploration oil

Exploration oil (1.B.2.a.iii.1): Fugitive emissions (excluding venting and flaring) from oil drilling, drill stem, and well completions.

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission Factor

- ❖ *The default value of 0.001702 Gg/10^{3}m^3* (Exploration) for CH_4 (average CH_4 Emission Factor) according to 2006 IPCC GL for "Oil extraction-well drilling, testing, servicing" has been used.
- ❖ *The default value of 0.080417Gg/10^{3}m^3* (Exploration) for CO_2 (average CO_2 Emission Factor) according to 2006 IPCC GL for "Oil extraction-well drilling, testing, servicing" has been used.
- ❖ *The default value of 0.000000584 Gg/10^{3}m^3* (Exploration) for N_2O (average N_2O Emission Factor) according to 2006 IPCC GL for "Oil extraction –well testing" has been used.
- ❖ *NCV* - from IEA/Eurostat Questionnaire 2012 - Petrol – Crude oil, Natural Gas Liquids and Other Hydrocarbons) in [kJ/kg].

***Activity Data*:** 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

According with the methodological provisions, activity data level used in Exploration Oil category is the sum of Eurostat/IEA data on the following parameters values:

- Crude oil- indigenous production, Natural Gas Liquids - indigenous production and Other Hydrocarbons - indigenous production

As long as, the density values for each fuel type are different and the activity data values are not unitary as content on the time series analysed period, the implied emission factors of CO_2, CH_4 and N_2O are different.

Production and upgrading

Production and upgrading (1.B.2.a.iii.2): Fugitive emissions from oil production (excluding venting and flaring) occur at the oil wellhead or at the oil sands or shale oil mine through to the start of the oil transmission system. This includes fugitive emissions related to well servicing, oil sands or shale oil mining, transport of untreated production (i.e., well effluent, emulsion, oil shale and oil sands) to treating or extraction facilities, activities at extraction and upgrading facilities, associated gas re-injection systems and produced water disposal systems.

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission Factor:

Emission factor for Oil production: "Default weighted total" from 2006 IPCC, volume 2, chapter 4.2.2.3, Table 4.2.5.

Fugitives (production): CH_4 0,0196000 Gg per 10^3 m^3

Fugitives (production): CO_2 0,0024900 Gg per 10^3 m^3

N_2O – NA

Activity data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

According with the methodological provisions, activity data level used in *Production and upgrading Oil* category is the sum of Eurostat/IEA data on the following parameters values:

- ❖ *Crude oil* - Indigenous Production - fugitive emissions from atmospheric distillation, *Residual Fuel Oil* - Refinery Gross Output - fugitive emissions from vacuum distillation and *Bitumen* - Refinery Gross Output - fugitive emissions from vacuum distillation.

NCV- from IEA/Eurostat Questionnaire 2012 - Petrol – Crude oil, Natural Gas Liquids and Other Hydrocarbons) in [kJ/kg].

Transport - N.O.

*Transport (1 B 2 a iii 3) - N.O.:*Fugitive emissions (excluding venting and flaring) related to the transport of marketable crude oil (including conventional, heavy and synthetic crude oil and bitumen) to upgraders and refineries. The transportation systems may comprise pipelines, marine tankers, tank trucks and rail cars. Evaporation losses from storage, filling and unloading activities and fugitive equipment leaks are the primary sources of these emissions.

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission Factor

The default value of 0,0000054 $Gg/10^3m^3$ (Oil Transport Pipelines) for CH_4 (average CH_4 Emission Factor) according to 2006 IPCC, volume 2, chapter 4.2.2.3, page 4.46, Tabel 4.2.5., page 4.61 (GPG 2000 IPCC, Table 2.16, page 2.87) has been used.

The default value of 0,00000049 $Gg/10^3m^3$ (Oil Transport Pipelines) for CO_2 (average CH_4 Emission Factor) according to 2006 IPCC, volume 2, chapter 4.2.2.3, page 4.46, Tabel 4.2.5., page 4.61 (GPG 2000 IPCC, Table 2.16, page 2.87) has been used.

N_2O – N.A.

Activity data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

From *IEA/Eurostat Questionnaire 2012 Petrol - Indigenous Production + Import + Export:*

- Crude Oil, Natural Gas Liquids and Other Hydrocarbons;

NCV- from IEA/Eurostat Questionnaire 2012 - Petrol – Crude oil, Natural Gas Liquids and Other Hydrocarbons) in [kJ/kg].

Refining / Storage

Refining / Storage (1 B 2 a iii 4): Fugitive emissions (excluding venting and flaring) at petroleum refineries. Refineries process crude oils, natural gas liquids and synthetic crude oils to produce final refined products (e.g., primarily fuels and lubricants). Where refineries are integrated with other facilities (for example, upgraders or co-generation plants) their relative emission contributions can be difficult to establish.

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission factor

Default Emission factor for Refining and Storage Tank: Revised 1996 IPCC, ch 1 Energy 21-40 RB Table 1-58, page 121

The default value of 745 kg/PJ (Refinery) for CH_4 (average CH_4 Emission Factor) has been used.

The default value of 135 kg/PJ (Storage Tank) for CH_4 (average CH_4 Emission Factor) has been used.

The default value of ***Combined EF*** **of 880** kg/PJ for CH_4 has been used.

EF CO_2 – N.D.

EF N_2O– N.A.

Activity data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

From *IEA/Eurostat Questionnaire 2012* Refinery Intake (Observed):

- ❖ Crude oil, Natural Gas Liquids and Other Hydrocarbons.

Distribution of oil products

Distribution of oil products (1 B 2 a iii 5)- N.A.- Distribution of Oil Products (Revised 1996 IPCC: 1B2a v Oil - Distribution of Oil Production)

This comprises fugitive emissions (excluding venting and flaring) from the transport and distribution of refined products, including those at bulk terminals and retail facilities. Evaporation losses from storage, filling and unloading activities and fugitive equipment leaks are the primary sources of these emissions.

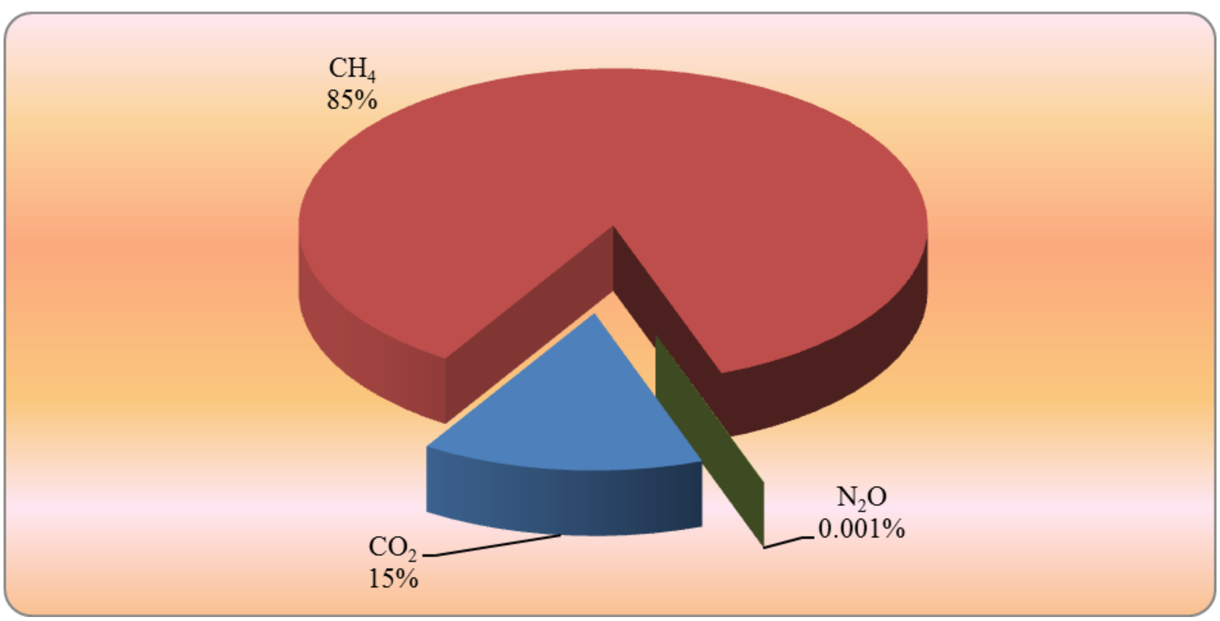
Refined Product Distribution: Gasoline, Diesel, Aviation Fuel, Jet Kerosene

CO_2 – N.A.

CH_4 – N.A.

N_2O – N.A.

Figure 3.64 The different GHG's Oil sub-source category Fugitive emissions contribution



The most important GHG in the Energy sector is CO_2 emissions and small amounts of CH_4 and N_2O are emitted in Fugitive emissions from Oil sub-source category also.

Figure 3.65 The different GHG's Venting oil emissions contribution

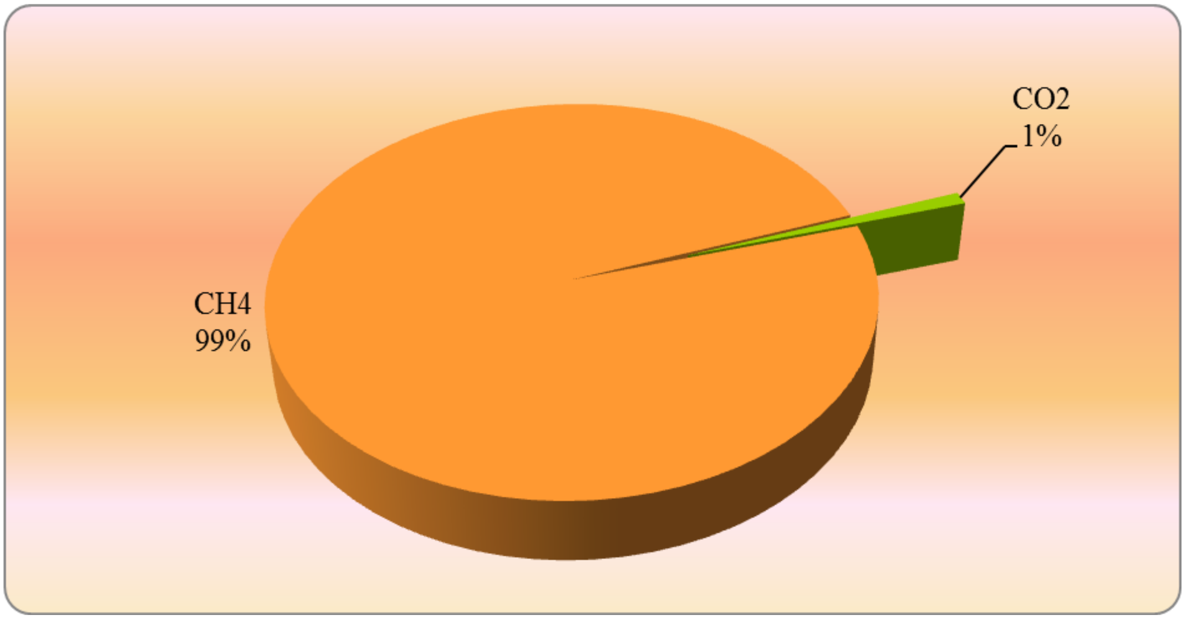
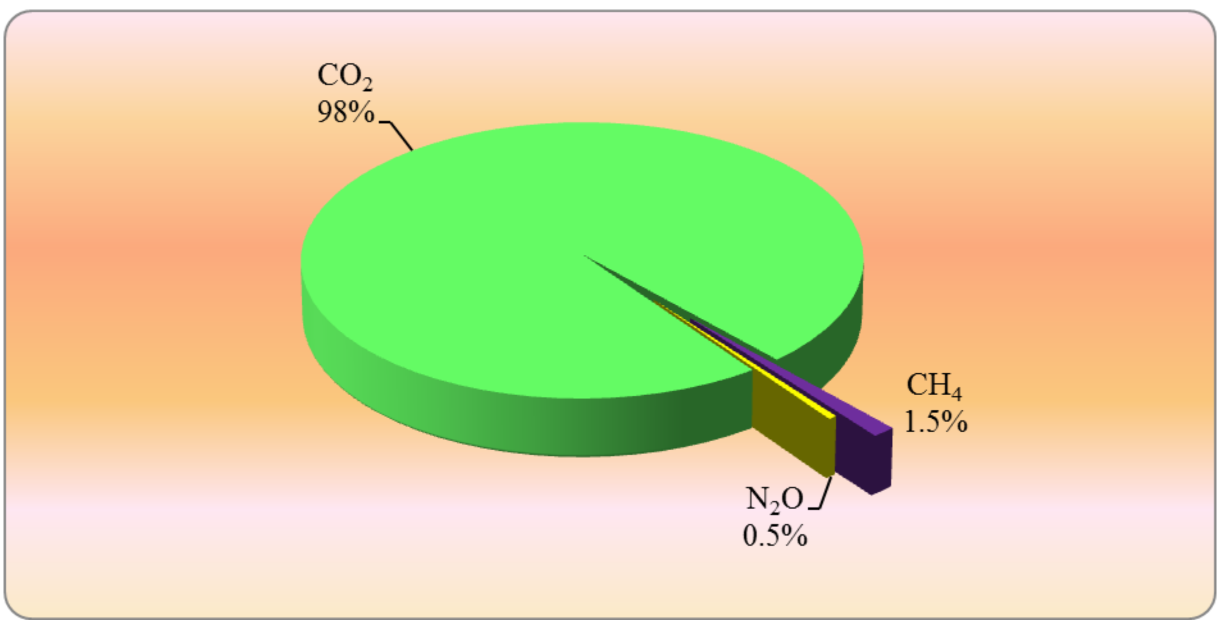


Figure 3.66 The different GHG's Flaring oil emissions contribution



3.3.3.2.2 Natural Gas sub-source category

- Emissions: CH_4, CO_2, N_2O
- Key source: Yes

This *sub-source category* ccomprises emission from venting, flaring and all other fugitive sources associated with the exploration, production, processing, transmission, storage and distribution of natural gas (including both associated and non-associated gas).
Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.
The formula used in the calculations is presented in ***Equation 3.17.***

Venting gas
Venting (1.B. 2. b. i.): Emissions from venting of natural gas and waste gas/vapour streams at gas facilities

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission factor

- *Emission factors - 2006 IPCC, Volume 2, chapter 4.2.2.3, Table 4.2.5, page 4.57*

Venting	**lower**	**upper**	**average**	**units**
CH_4	0.000044	0.00074	0.000392	Gg per 10^6 m^3
CO_2	0.000051	0.00014	0.0000955	Gg per 10^6 m^3

N_2O – N.A.

Activity data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

From *IEA/Eurostat Questionnaire 2012* Indigenous Production:

❖ Natural Gas– in both units – *10^6 m^3 and TJ (GCV) * 0.9 → TJ (NCV);*

Flaring gas

Flaring (1 B 2 b ii): Emissions from flaring of natural gas and waste gas/vapour streams at gas facilities.

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission factor

Default Emission Factors - 2006 IPCC, Volume 2, chapter 4.2.2.3, Table 4.2.5, pag 4.56

Flaring	lower	upper	average	units
CH_4	0.000002	0.0000028	0.0000024	Gg per 10^6 m^3
CO_2	0.003	0.0041	0.00355	Gg per 10^6 m^3
N_2O	0.000000033	0.000000045	0.000000039	Gg per 10^6 m^3

Activity data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

From *IEA/Eurostat Questionnaire 2012* Indigenous Production:

❖ Natural Gas– in both units – *10^6 m^3 and TJ (GCV) * 0.9 → TJ (NCV).*

Processing

Processing (1 B 2 b iii 3): Fugitive emissions (excluding venting and flaring) from gas processing facilities (Revised 1996 IPCC: 1B2b ii Natural Gas - Production/ Processing).

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission factor

❖ Emission factors - GPG 2000 IPCC, Table 2.16, page 2.86

Flaring	lower	upper	average	units
CH_4	0.0026	0.0029	0.00275	Gg per 10^6 m^3
CO_2	-	-	0.000095	Gg per 10^6 m^3

N_2O – N.A.

Activity data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

From *IEA/Eurostat Questionnaire 2012* Indigenous Production:

❖ Natural Gas– in both units – *10^6 m^3 and TJ (GCV) * 0.9 → TJ (NCV).*

Transmission and Storage

Transmission and Storage (1B2b iii 4):

❖ Fugitive emissions from systems used to transport processed natural gas to market (i.e., to industrial consumers and natural gas distribution systems).

❖ Fugitive emissions from natural gas storage systems should also be included in this category.

- Emissions from natural gas liquids extraction plants on gas transmission systems should be reported as part of natural gas processing (category 1.B.2.b.iii.3).
- Fugitive emissions related to the transmission of natural gas liquids should be reported under category 1.B.2.a.iii.3.

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission factor

Emission factors - GPG 2000 IPCC, Table 2.18, page 2.91		
CH_4	2000	m^3/km/yr
Emission factors - GPG 2000 IPCC, Table 2.16, page 2.86		
CO_2	0.000016	Gg/year/km transmission pipeline

N_2O – N.A.

Activity data:

- Use the length of pipeline of natural gas transit through the country and domestic transmission in km as activity data;
- Conversion factor - 0.67 Gg CH_4 /million m3.

Distribution gas

Distribution (1B2b iii5): Fugitive emissions (excluding venting and flaring) from the distribution of natural gas to end users.

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission factors

Emission factors - GPG 2000 IPCC, Table 2.18, page 2.91		
CH_4	1000	m^3/km/yr
Emission factors - 2006 IPCC, volume 2, chapter 4.2.2.3, page 4.46, Tabel 4.2.5., page 4.57		
CO_2	*0.0000955*	*Gg per 10^6 m^3*

N_2O – N.A.

Activity data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used.

From *IEA/Eurostat Questionnaire 2012* Indigenous Production+ Import:

- ❖ Natural Gas – in 10^6 m^3;
- ❖ Use the length of pipeline of natural gas for domestic distribution in km as activity data.

Other

Other (1B2b iii 6): Fugitive emissions from natural gas systems (excluding venting and flaring) not otherwise accounted for in the above categories.

This may include emissions from well blowouts and pipeline ruptures or dig-ins.

- ❖ Other Leakage

Industrial plants and power stations

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission factors

Default Emission factors - from Revised 1996 IPCC, RM, Table 1-6, page 1.121

Flaring	lower	upper	average	units
CH_4	175,000	384,000	**279,500**	kg/PJ

Activity data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used:

- ❖ Natural Gas– sheet “2ii_TFC_EnergyUse” row 5 (Transport Sector) + row 10 (Industry Sector) and from sheet “2iii_TFC_Non-EnergyUse” row 10 (Industry Sector) – in both units – 10^6 m^3 and TJ (GCV) * 0.9 → TJ (NCV).

Residential and commercial sectors

Methodology

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Emission factors

Default Emission factors – from Revised 1996 IPCC, RM, Table 1-6, page 1.121

Flaring	lower	upper	average	units
CH_4	87,000	192,000	**139,500**	kg/PJ

Activity data: 1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2012 - for entire 1990-2012 time series have been used:

- ***Natural Gas*** - sheet “2ii_TFC_EnergyUse” row 24 (Other sectors) – in both units – 10^6 m^3 and TJ (GCV) * 0.9 → TJ (NCV).

Figure 3.67 The different GHG’s Natural Gas sub-source category emissions contribution

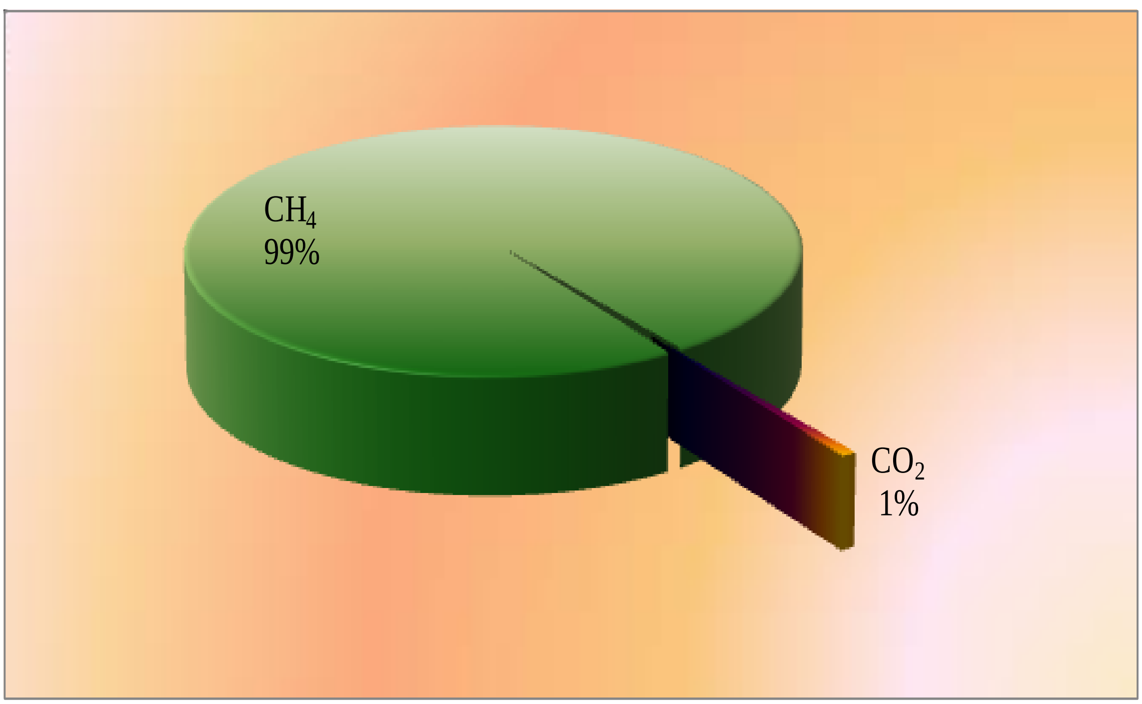


Figure 3.68 The different GHG's Venting gas emissions contribution

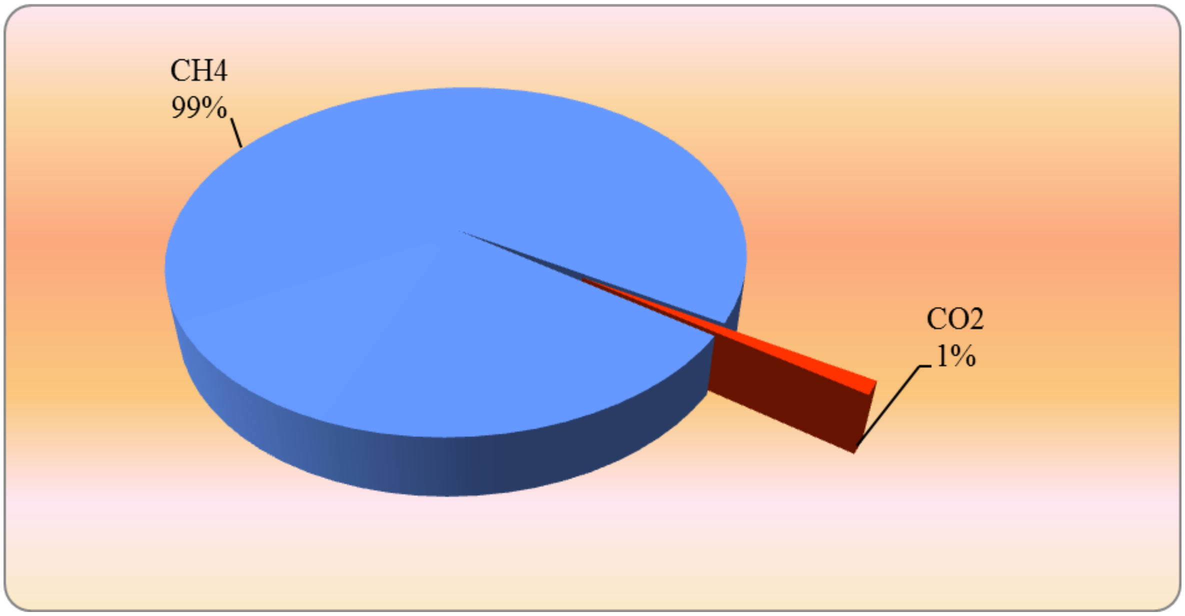
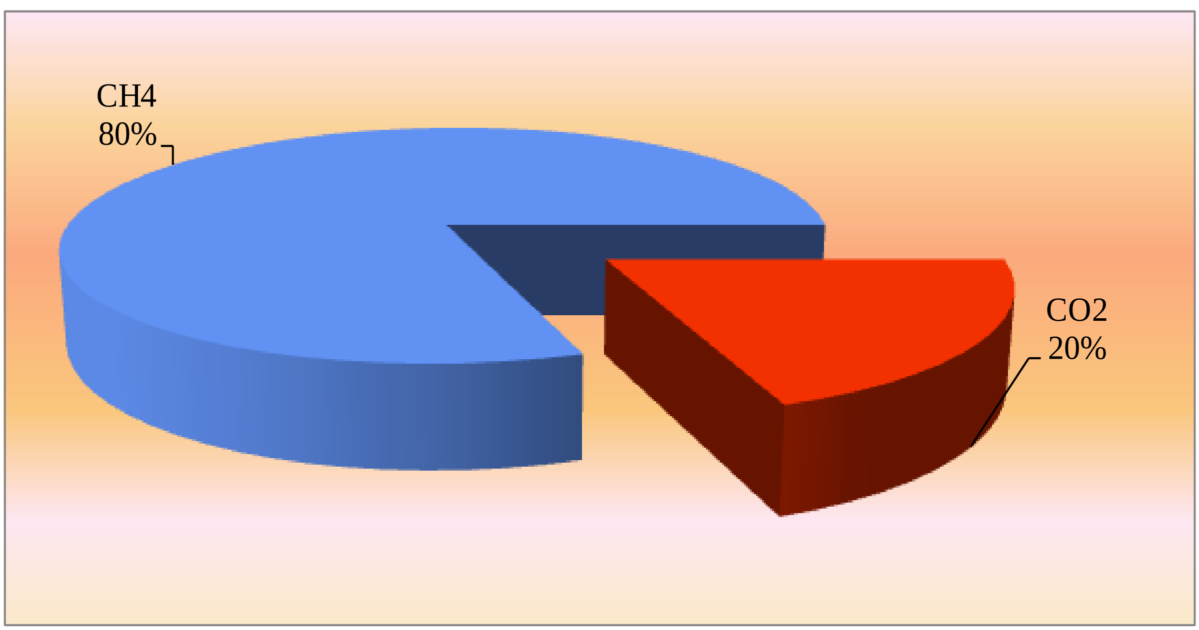


Figure 3.69 The different GHG's Flaring gas emissions contribution



3.3.3.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- ***Oil sub-source category***
  - AD: 3%;
  - EF:
    - CO_2: 50%;
    - CH_4: 50%;
    - N_2O: 50%.
    - 50.09 % for CO_2, 50.09 % for CH_4 and 50.09% for N_2O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.
- ***Natural Gas sub-source category***
  - AD: 2.24%;
  - EF:
    - CO_2: 50%;
    - CH_4: 50%;
    - 50.05 % for CO_2 and 50.05 % for CH_4 and 2.24% for N_2O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.
- ***Venting sub-source category*****:**
  - AD: 2.24%;
  - EF:
    - CO_2: 50%;
    - CH_4: 50%;
    - 50.05 % for CO_2, 50.05 % for CH_4 and 2.24% N_2O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

❖ ***Flaring sub-source category*:**

- AD: 3%;
- EF:
    - CO_2: 50%;
    - CH_4: 50%;
    - 50.09 % for CO_2, 50.09 % for CH_4 and 3% N_2O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that all activity data were provided through the IEA/Eurostat Questionnaire 2012 and were obtained using the same method, that default emission factors were used for the whole time-series and the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

3.3.3.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *Stationary Combustion* categories, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European

Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved as part of the 2012 NGHGI; they are described in the Chapter 3.3.3.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.3.3.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

3.3.3.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In order to improve the emissions estimates quality some important recalculations were made:

❖ ***activity data***

- Other Leakage (1.B.2.B.5.1- at industrial plants and power station-) category: the activity data values for 2007-2011 period have been updated due to the update of the associated domain in the IEA/Questionnaire for 2012;

❖ ***emissions***

- Other Leakage (1.B.2.B.5.1- at industrial plants and power station-) category: the emission values for 2007-2011 period have been update because the activity data values for 2007-2011 period have been updated of the associated domain in the IEA/Questionnaire for 2012.

The implications of all changes made on emission estimates are described in Tables 3.52 -3.54.

Table 3.52 Change made at activity data and their effects on CO_2 emission estimates Oil and Natural Gas category

Year	Effects of changes on CO_2 emission estimates [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	1.399,87	1,399.87	0.00
1990	1.213,11	1,213.11	0.00
1991	1.034,95	1,034.95	0.00
1992	1.057,88	1,057.88	0.00
1993	1.070,80	1,070.80	0.00
1994	1.073,97	1,073.97	0.00
1995	1.068,44	1,068.44	0.00
1996	1.050,22	1,050.22	0.00
1997	1.030,94	1,030.94	0.00
1998	1.001,46	1,001.46	0.00
1999	975,50	975.50	0.00
2000	962,01	962.01	0.00
2001	952,73	952.73	0.00
2002	1.221,83	1,221.83	0.00
2003	1.189,00	1,189.00	0.00
2004	877,26	877.26	0.00
2005	901,06	901.06	0.00
2006	918,82	918.82	0.00

Year	Effects of changes on CO_2 emission estimates [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
2007	766,89	766.89	0.00
2008	723,79	723.79	0.00
2009	682,34	682.34	0.00
2010	651,84	651.84	0.00
2011	646.24	646.24	0.00

Table 3.53 Change made at activity data and their effects on CH_4 emission estimate Oil and Natural Gas category

Year	Effects of changes on CH_4 emission estimates [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	775.63	775.63	0.00
1990	817.12	817.12	0.00
1991	633.84	633.84	0.00
1992	514.21	514.21	0.00
1993	511.22	511.22	0.00
1994	535.94	535.94	0.00
1995	537.60	537.60	0.00
1996	515.65	515.65	0.00
1997	492.61	492.61	0.00
1998	447.76	447.76	0.00

Year	Effects of changes on CH_4 emission estimates [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1999	438.43	438.43	0.00
2000	433.23	433.23	0.00
2001	439.35	439.35	0.00
2002	466.01	466.01	0.00
2003	459.83	459.83	0.00
2004	419.70	419.70	0.00
2005	421.14	421.14	0.00
2006	400.88	400.88	0.00
2007	369.13	368.86	-0.07
2008	372.50	371.83	-0.18
2009	342.95	342.12	-0.24
2010	334.88	334.10	-0.23
2011	334.55	333.72	-0.25

Table 3.54 Change made at activity data and their effects on N_2O emission estimates Oil and Natural Gas category

Year	Effects of changes on N_2O emission estimates [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	0,014	0,014	0
1990	0,012	0,012	0
1991	0,010	0,010	0.00

Year	Effects of changes on N_2O emission estimates [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1992	0,010	0,010	0.00
1993	0,010	0,010	0.00
1994	0,010	0,010	0.00
1995	0,010	0,010	0.00
1996	0,010	0,010	0.00
1997	0,010	0,010	0.00
1998	0,010	0,010	0.00
1999	0,009	0,009	0.00
2000	0,009	0,009	0.00
2001	0,009	0,009	0.00
2002	0,012	0,012	0.00
2003	0,012	0,012	0.00
2004	0,009	0,009	0.00
2005	0,009	0,009	0.00
2006	0,009	0,009	0.00
2007	0,007	0,007	0.00
2008	0,007	0,007	0.00
2009	0,007	0,007	0.00
2010	0,006	0,006	0.00
2011	0.006	0.006	0.00

3.3.3.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

It is necessary to realize a new data base for the length of distribution pipelines of natural gas.

4 INDUSTRIAL PROCESSES (CRF Sector 2)

4.1 Overview of the sector

Only the process related emissions are considered in this sector; emissions due to fuel combustion in manufacturing industries are allocated in the Fuel Combustion-Manufacturing Industries and Construction (IPCC category 1A2).

GHG emissions from Industrial Processes are grouped in the following Sub-sectors: Mineral Products (CRF 2.A), Chemical Industry (CRF 2.B), Metal Production (CRF 2.C), Other Production (CRF 2.D) and Consumption of Halocarbons and SF_6 (CRF 2.F).

The direct GHG emissions reported in this sector are associated with CO_2, CH_4, N_2O, HFCs, PFCs and SF_6.

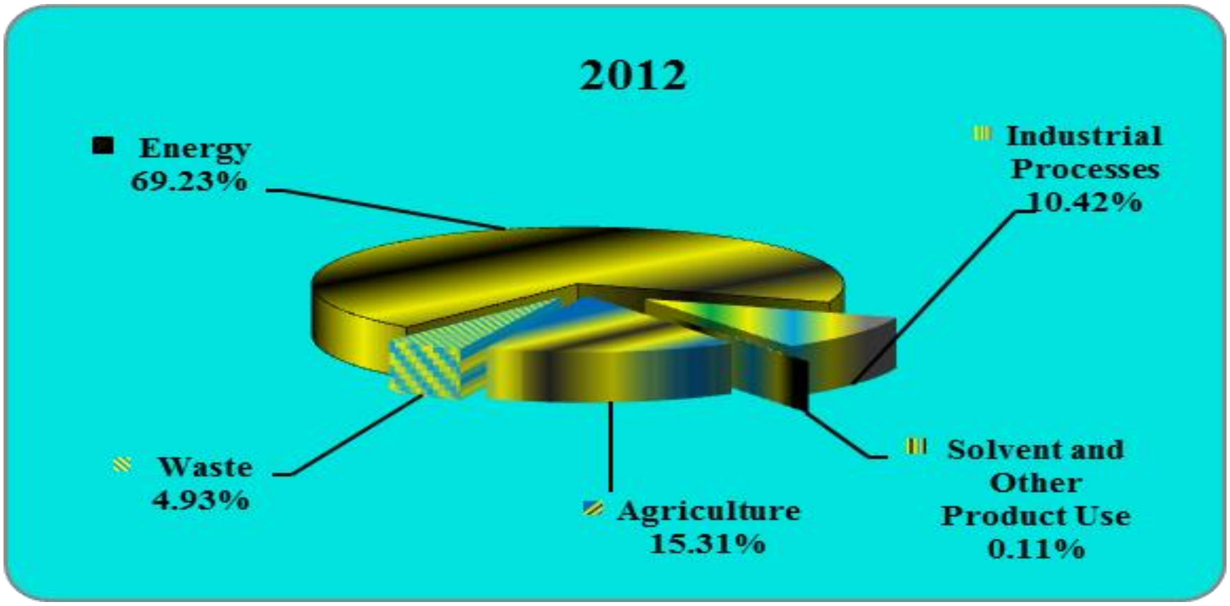
Table 4.1 Status of emissions estimation within the Industrial Processes Sector

2 INDUSTRIAL PROCESSES	Emissions estimation status			
IPCC category	**CO_2**	**CH_4**	**N_2O**	**PFC**
2.A MINERAL PRODUCTS				
2.A.1 CEMENT PRODUCTION	✓	NA	NA	NA
2.A.2 LIME PRODUCTION	✓	NA	NA	NA
2.A.3 LIMESTONE AND DOLOMITE USE	✓	NA	NA	NA
2.A.4 SODA ASH PRODUCTION AND USE	✓	NA	NA	NA
2.A.5 ASPHALT ROOFING	NE	NA	NA	NA
2.A.6 ROAD PAVING WITH ASPHALT	NE	NA	NA	NA
2.A.7 OTHER (GLASS PRODUCTION)	✓	NE	NE	NA
2.B CHEMICAL INDUSTRY				
2.B.1 AMMONIA PRODUCTION	✓	NE	NE	NA
2.B.2 NITRIC ACID PRODUCTION	NA	NA	✓	NA
2.B.3 ADIPIC ACID PRODUCTION	NO	NO	NO	NO

2 INDUSTRIAL PROCESSES	**Emissions estimation status**			
IPCC category	**CO_2**	**CH_4**	**N_2O**	**PFC**
2.B.4.1 SILICON CARBIDE PRODUCTION	IE	✓	NA	NA
2.B.4.2 CALCIUM CARBIDE PRODUCTION	NO	NO	NO	NO
2.B.5 OTHER	NE	✓	NE	NA
2.C METAL PRODUCTION				
2.C.1 IRON AND STEEL PRODUCTION	✓	NE	NA	NA
2.C.2 FERROALLOYS PRODUCTION	✓	NE	NA	NA
2.C.3 ALUMINIUM PRODUCTION	✓	NE	NA	✓
2.C.4 SF_6 USED IN ALUMINIUM AND MAGNESIUM FOUNDRIES	NO	NO	NO	NO
2.C.5 OTHER	NA	NA	NA	NA
2.D OTHER PRODUCTION				
2.D.1 PULP AND PAPER	NA	NA	NA	NA
2.D.2 FOOD AND DRINK	NE	NA	NA	NA
2.E PRODUCTION OF HALOCARBONS AND SULPHUR HEXAFLUORIDE				
2.E.1 BY-PRODUCT EMISSIONS	NO	NO	NO	NO
2.E.2 FUGITIVE EMISSIONS	NO	NO	NO	NO
2.E.3 OTHER	NO	NO	NO	NO
2.F CONSUMPTION OF HALOCARBONS AND SULPHUR HEXAFLUORIDE				
2.F.1 REFRIGERATION AND AIR CONDITIONING EQUIPMENT	NA	NA	NA	✓
2.F.2 FOAM BLOWING	NA	NA	NA	✓
2.F.3 FIRE EXTINGUISHERS	NA	NA	NA	✓
2.F.4 AEROSOLS	NA	NA	NA	✓
2.F.5 SOLVENTS	NA	NA	NA	✓
2.F.6 OTHER Please specify.	NA	NA	NA	✓
2.G OTHER	NA	NA	NA	NA

In 2012 the GHG emissions from Industrial Processes Sector contributed with 10.42% to the total GHG emissions in Romania.

Figure 4.1 The contribution of Industrial Processes Sector to the total GHG emissions in Romania, 2012



Emissions from this sector estimated in 2012 decreased by 65.10% compared with 1989 and decreased by 5.81% compared with 2011.

The decrease from 1989 to 2012 is the result of the restructuration and privatization in various activity sectors.

Starting with 2008 the emissions mainly decreased due to the reduction of various productions. In 2009 the emissions had also decreased due to the economic crisis reflected in many activity areas.

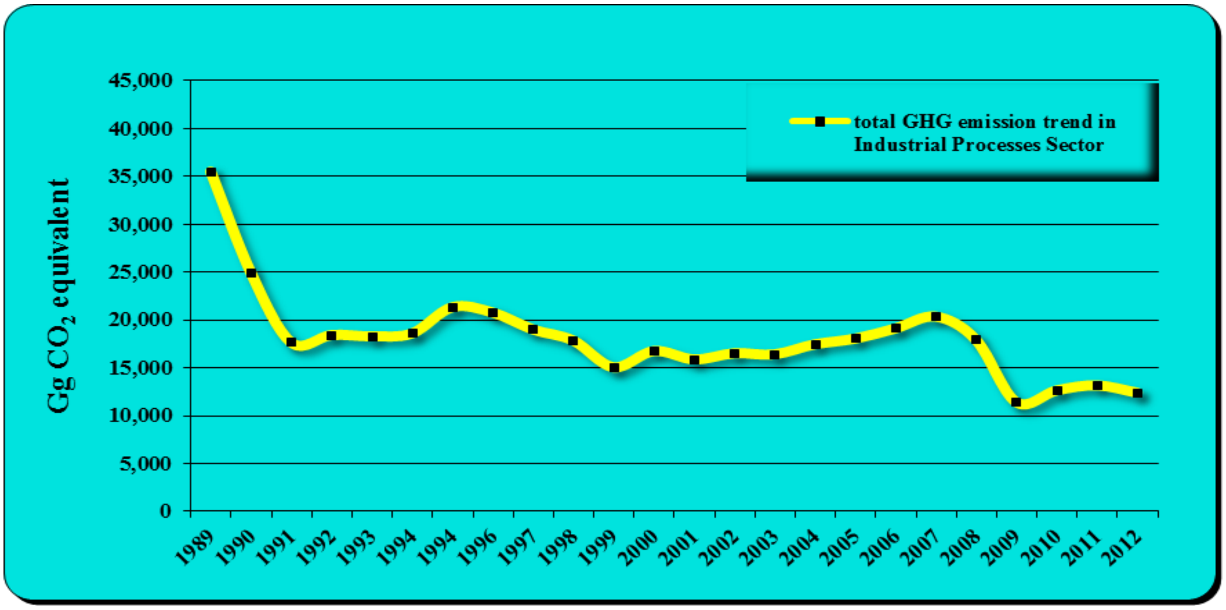
In 2011 the emissions have recorded a increase due to increase of various industry productions.

After 1989 the whole Romania recorded a decrease within the Industrial Processes, because many categories of industrial production have decreased (Chemical Production, Mineral Production and Metal Production):

- cement production, lime production, limestone and dolomite consumption, soda ash production and use, glass production recorded a decrease after 1989;

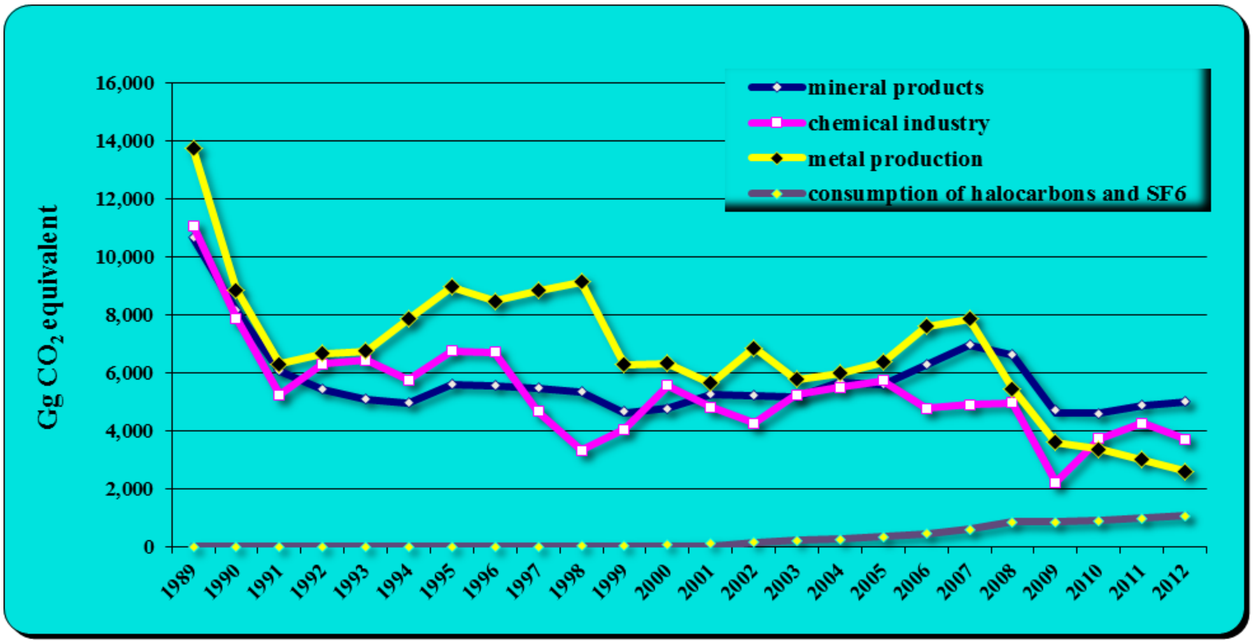
- starting with 2004 the cement production has recorded a minor increase;
- in 2008 a minor decrease was recorded in consumption of limestone and dolomite level;
- the lowest level of emissions from ammonia production was recorded in 1998, due to the activity data whose level decreased by almost a half compared to the previous and next year. This happened as one producing plant has stopped its activity since 1998 and another plant has been closed in 1998 and reopened in the next year;
- nitric acid production recorded a decrease after 1989. Starting with 2010 the nitric acid production level has recorded an increased;
- adipic acid production stopped at the end of 2001. Starting with 2002, the activity was suspended;
- calcium carbide production recorded a decrease after 1989 and the activity was suspended starting with 2007;
- iron and steel production recorded a decrease after 1989;
- ferroalloys production has recorded a decrease after 1989. The lowest level of emissions from ferroalloys production was recorded in 1999, due to the activity data whose level has decreased. This happened because ferroalloys production has stopped in 1999. In the next year (2000) the production was started again;
- the reduction of PFC emissions from production of aluminium due to changes in technologies, starting with 2003;
- in 2008 the trend of emission decreased due to reduction of production recorded for iron and steel production and ferroalloys production sub-sectors;
- for 2009 year a significant decrease of emissions level was recorded due to the economic crisis within many activity industries;
- in 2011 year the emissions have recorded an increase due to increase of various production activities level (soda ash production, glass production, cement production);
- in 2012 the emissions have recorded a decrease due to decrease of various industry productions.

Figure 4.2 Total GHG emissions trend in Industrial Processes Sector, for 1989–2012 period



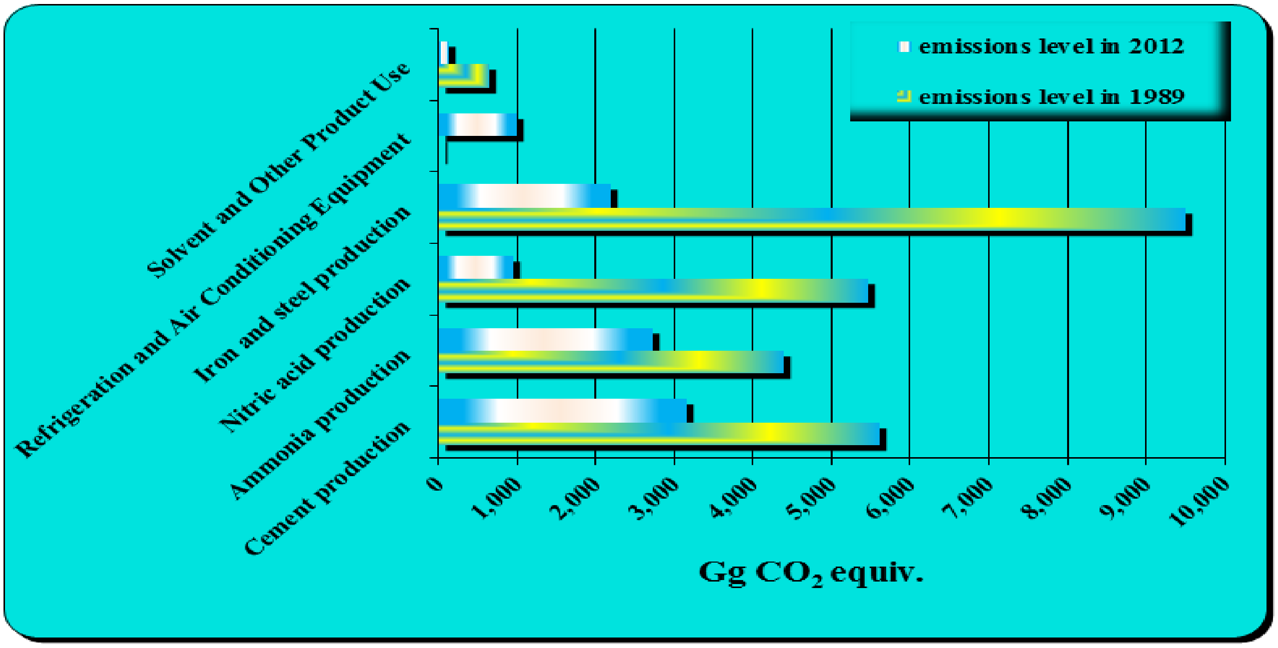
Metal Production contributes with 20.99% to the total GHG emissions from Industrial Processes Sector in 2012. Mineral Products and Chemical Industry are the two other main contributing Sub-sectors with 40.40% and 29.93%, respectively, of the total GHG emissions in this sector. The contribution of Consumption of Halocarbons and SF_6 Sub-sector to the overall sector is very low: 8.68%.

Figure 4.3 GHG emissions trends in Industrial Processes Sector, by sub-sectors, for 1989–2012 period



In the base year, various Industrial Processes Sub-sectors contributions were: Mineral Products 30.08%, Chemical Industry 31.23%, and Metal Production 38.69%, Consumption of Halocarbons and SF_6 0.00%.

Figure 4.4 Key categories in Industrial Processes Sector in 2012, both by level and trend criteria



The Tier 1 and Tier 2 key category analysis performed for 2012 has revealed the following key categories presented in the Table 4.2.

Table 4.2 Key categories in Industrial Processes Sector in 2012

Key category	GHG	Criteria	Contribution in total GHG emissions [%]
2.A.1 Cement Production	CO_2	L,T (Tier 1, excluding and including LULUCF)	2.7%
2.A.2 Lime Production	CO_2	L (Tier 1, excluding and including LULUCF)	1.1%
2.A.3 Limestone and Dolomite Use	CO_2	T (Tier 1, including LULUCF)	0.4%
2.B.1 Ammonia Production	CO_2	L, T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	2.3%

Key category	GHG	Criteria	Contribution in total GHG emissions [%]
2.B.2 Nitric Acid Production	N_2O	L, T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	0.8%
2.C.1 Iron and Steel Production	CO_2	L, T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	1.8%
2.C.2 Ferroalloys Production	CO_2	T (Tier 2, excluding LULUCF)	0.0%
2.C.3 Aluminium Production	PFC	T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	0.0%
2.F.1 Refrigeration and Air Conditioning Equipment	HFC	L, T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	0.8%
2.F.8 Electrical Equipment	SF_6	T (Tier 2, excluding and including LULUCF)	0.0%
3 Solvent and Other Product Use	CO_2	L, T (Tier 2, excluding and including LULUCF)	0.1%

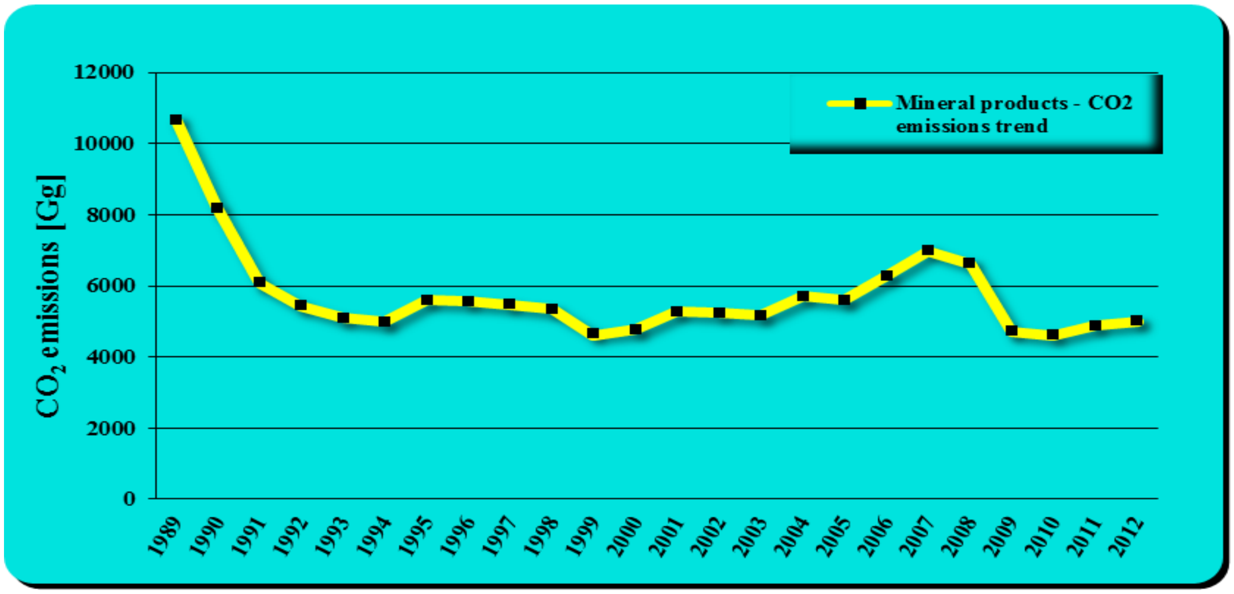
4.2 Source category Mineral Products (CRF Sector 2.A)

4.2.1 Source category description

GHG emissions reported include estimates for the following categories: Cement Production (IPCC category 2.A.1), Lime Production (IPCC category 2A2), Limestone and Dolomite Use (IPCC category 2A3), Soda Ash Production and Use (IPCC category 2A4), Asphalt Roofing (IPCC category 2A5), Road Paving with Asphalt (IPCC category 2A6) and Other: Glass Production (IPCC category 2A7).

CO_2 emissions from cement production represent an important key category of the inventory because of its contribution to the total inventory emissions level (in 2012 CO_2 emissions from production of cement contributed with 2.65% to total greenhouse gas emissions). In the base year, these emissions accounted for 1.97% from the total GHG emissions.

Figure 4.5 GHG emissions trend in the Mineral Products Sub-sector for 1989–2012 period [Gg CO_2]



GHG emissions in the Mineral Products Sub-sector were decreased during 1989–2011 period due to the decrease recorded after 1989 in Cement Production, Lime Production, Limestone and Dolomite Consumption, Soda Ash Production and Use, and Glass Production; the emissions were relatively stable during 1993–2007 period. Starting with 2004 the Cement Production has recorded a minor increase. In 2009 a significant decrease of emissions level was recorded in cement, lime, limestone and dolomite, soda ash and glass industries due to the economic crisis. In 2012 the emissions rised due to increase of cement production, lime production, limestone and dolomite use, soda ash production and use.

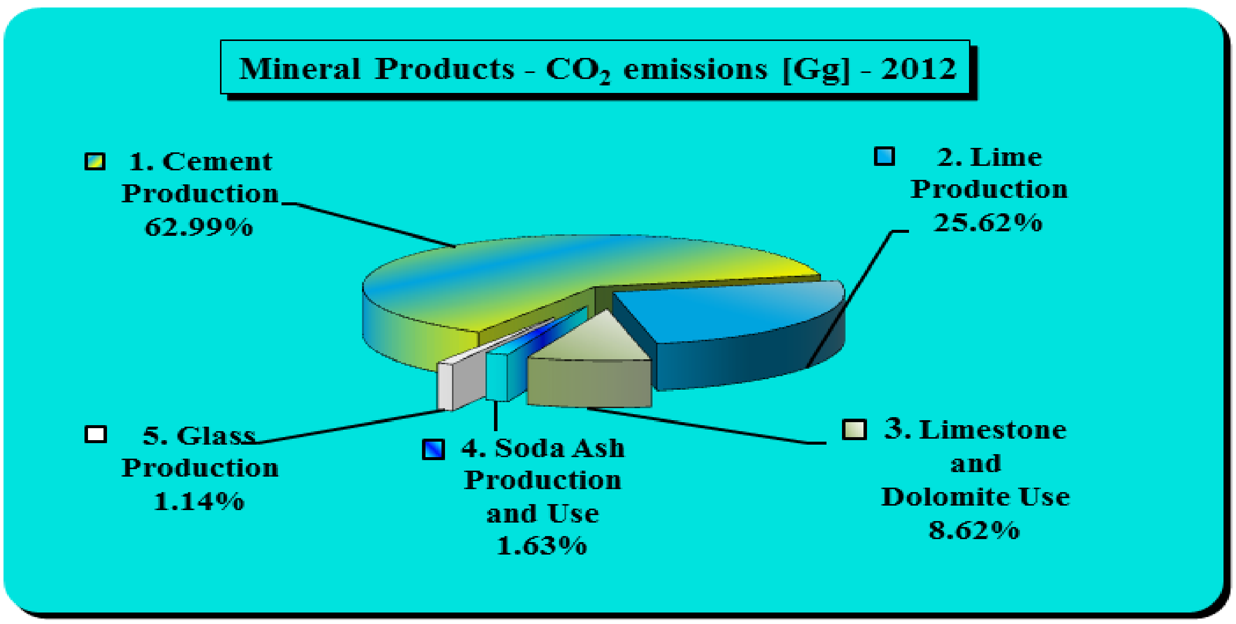
Mineral Products Sub-sector was responsible for 40.40% of the Industrial Processes Sector related GHG emissions in 2012.

Table 4.3 CO_2 emissions in the Mineral Products Sub-sector, in the year 2012

Sector	CO_2 emissions [Gg]
2.A Mineral Products	**5,000.96**

Sector	CO_2 emissions [Gg]
2.A.1 Cement Production	3,150.25
2.A.2 Lime Production	1,281.22
2.A.3 Limestone and Dolomite Use	431.01
2.A.4 Soda Ash Production and Use	81.34
2.A.7.1 Glass Production	57.14

Figure 4.6 Structure of the Mineral Products Sub-sector, in 2012



4.2.2 Methodological issues

Cement Production (IPCC category 2.A.1)

Methodology

The Cement Production is a key category from both level and trend point of view (Tier 1, excluding and including LULUCF). The method for calculating emissions of CO_2 from cement is in line with the IPCC GPG 2000 (Tier 2), considering the "Decision Tree for Estimation of CO_2 Emissions from Cement Production" from IPCC GPG 2000 - page 3.11 and taking into account all the parameters described below.

Activity data

The AD necessary to estimate emissions from this source category are provided by the economic agents (clinker production data) and the National Institute for Statistics (Cement Production). Process specific CO_2 is emitted during the production of clinker (calcination process) when calcium carbonate ($CaCO_3$) is heated in a cement kiln. During this process calcium carbonate is converted into lime (CaO - Calcium Oxide) and CO_2. Activity data related to the calcinations process were collected directly from the companies:

- clinker production data was provided by each company 1989-2011 period;
- plant specific content of CaO (%) in clinker was provided by each company (according with laboratory analyses) starting with 2008 year;
- plant specific content of MgO (%) in clinker was provided by each company (according with laboratory analyses) starting with 2008 year;
- cement kiln dust (CKD) is completely recycled in the kiln. Two plants reported **a** correction factor for discarded amounts of dust: one of them for the period 1989-2003 and other plant for 2006 year. Starting with 2007 year there was no reported correction factor for discarded amounts of dust.

Emission factors

The CO_2 EF has also been estimated considering the provisions in the “Decision Tree for Estimation of CO_2 Emissions from Cement Production” from IPCC GPG 2000 - page 3.11 and taking into account all the information provided by each cement company.

In 31 March 2005, a working meeting was held between the NEPA, National Institute for Research and Development in Environmental Protection and the representatives of cement industry, two methodologies for estimating CO_2 emissions from cement production being compared:

- IPCC Good Practice Guidence and Uncertainty Management in National Greenhouse Gas Inventories (IPCC GPG 2000);
- Cement CO_2 protocol, developed within the World Business Council for Sustainable Development (WBCSD), an instrument used by cement manufacturers throughout the world.

Concluding, according to the IPCC GPG 2000, CO_2 emissions from decarbonation of raw materials (from process) are calculated based on clinker production by multiplication with a factor of 510 kg CO_2/t clinker, enabling its correction if there are available input data with a higher precision. Also, it was agreed, based on cement CO_2 protocol, the correction of this factor to **525 kg/t clinker** due to $MgCO_3$ availability in raw material.

For 1989-2007 the default CO_2 emission factor (EF) **0.525 t CO_2/t clinker** was improved. The new specific EF was calculated considering the average between the base year 1989 implied EF (0.527 t CO_2/t clinker) and 2008 EF (the first year with laboratory analyses for plant specific CaO and MgO content in clinker), 0.530 t CO_2/t clinker. The resulted specific emission factor for 1989-2007 period is 0.5285 t CO_2/t clinker.

A value of the IEF has been calculated by dividing the emissions by clinker production data for 1989; the value differs comparing to the previously presented EF value considering the CKD correction factor value (provided by operators on a plant basis).

An average EF value has been calculated as arithmetic mean between the IEF value for 1989 and EF value for 2008 (please see the description below).

The value is used for every year of 1989-2007 period and is different comparing to the IEF values when the CKD correction factor value is not 1.

Starting with 2008, analyses have been made for CaO and MgO content and can be considered as representative in order to be used for calculating CO_2 emissions or plant specific clinker EF (plant specific content of CaO and MgO - % in clinker was provided by each company - according with laboratory analyses). We can't provide the CaO and MgO content values per each company because there data are confidential. We can provide the average values related with the plant specific content of CaO and MgO -% in clinker (0.651 for CaO and 0.017 for MgO for 2008 year, 0.656 for CaO and 0.015 for MgO for 2009 year, 0.655 for CaO and 0.015 for MgO for 2010 year, 0.656 for CaO and 0.015 for MgO for 2011 year). A weighted average related with the plant specific EF's for clinker production is presented in the Table 4.4.

CO_2 emissions from clinker are estimated using a combined **Tier 2** with **country specific method**, according to the formula 4.1.

Equation 4.1 Calculation of CO_2 emissions from clinker

$$Emissions_{Clinker\ Production} = EF_{clinker} \times Clinker\ Production$$

Starting with 2008 EF for clinker is calculated based on the below presented IPCC formula.

Equation 4.2 Calculation of EF for clinker

$$EF_{clinker} = 0.785 \times CaO_{Content\ (Weight\ Fraction)\ in\ Clinker} + 1.091 \times MgO_{Content\ (Weight\ Fraction)\ in\ Clinker}$$

For 1989-2007 period the CO_2 emission factor use for clinker was 0.5285 t CO_2/t clinker (average between the base year 1989 implied EF and 2008 EF (the first year with laboratory analyses for plant specific CaO and MgO content in clinker).

Equation 4.3 Calculation of CO_2 emissions from CKD (cement kiln dust)

$$Emissions_{CKD} = EF_{CKD} \times amount\ of\ CKD \times CKD_{Correction\ Factor}$$

Emissions resulted from discarded cement kiln dust were calculated separately taking into account its degree of calcinations and added to the CO_2 emissions resulted from calcinations (the production of clinker). The correction factor for discarded amounts of dust varies between 1.00 and 1.13 along all-time series and due to the small amount of CKD the default EF as clinker production 0.525 t CO_2 / t clinker was used starting with 2007.

Starting with 2008 emissions resulted from discarded cement kiln dust were calculated separately taking into account its degree of calcinations and added to the CO_2 emissions resulted from calcinations (the production of clinker). The value of correction factor for discarded amounts of dust is 1.

Equation 4.4 Calculation of CO_2 emissions

Emissions = Emissions from Clinker Production + Emissions from CKD

Emissions were calculated distinctly, for every plant; the activity and, respectively, emissions data were added and reported for the entire subsector. Starting with 2008 the figures related with clinker production, plant specific CO_2 EF for clinker production and CO_2 emissions from clinker production were compared with the data reported in monitoring plans associated with GHG emissions for the **EU-ETS cement production installations**. The data are similar.

Table 4.4 Clinker Production data and CO_2 emissions from Clinker Production in the period 1989–2012

Year	Activity data and CO_2 emissions from Cement Production Sub-sector		
	Clinker production [kt]	Emission factor [tCO_2/t clinker]	CO_2 Emissions [Gg]
1989	10,571.00	0.5285	5,609.10
1990	8,379.00	0.5285	4,445.30
1991	6,037.00	0.5285	3,200.75
1992	5,488.00	0.5285	2,905.96
1993	5,349.00	0.5285	2,833.43

Year	Activity data and CO_2 emissions from Cement Production Sub-sector		
	Clinker production [kt]	Emission factor [tCO_2/t clinker]	CO_2 Emissions [Gg]
1994	5,232.00	0.5285	2,770.91
1995	5,937.82	0.5285	3,145.84
1996	6,037.50	0.5285	3,200.04
1997	5,669.27	0.5285	3,004.94
1998	5,497.25	0.5285	2,915.95
1999	4,971.03	0.5285	2,644.77
2000	5,005.78	0.5285	2,655.96
2001	5,218.31	0.5285	2,768.36
2002	4,984.02	0.5285	2,642.09
2003	4,995.76	0.5285	2,650.04
2004	5,661.24	0.5285	2,992.09
2005	6,006.96	0.5285	3,174.81
2006	6,916.22	0.5285	3,655.57
2007	7,670.40	0.5285	4,053.98
2008	7,780.03	0.52997	4,142.66
2009	5,801.76	0.53092	3,093.07
2010	5,198.98	0.53097	2,777.89
2011	5,751.21	0.53165	3,088.84
2012	5,873.60	0.53196	3,150.25

SO_2 emissions from cement production are estimated using the following formula:

Equation 4.5 Calculation emissions of SO_2 from cement

$$SO_2\ [Gg] = Quantity\ of\ Cement\ Produced\ (t) \times Emission\ Factor \times 10^{-6}$$

The default emission factor of 0.3 kg SO_2/tonne cement is used.

Table 4.5 Cement Production data and SO_2 emissions from Cement Production in the period 1989–2012

Year	Activity data and SO_2 emissions from Cement Production Sub-sector		
	Cement production [kt]	**Emission factor [kg SO_2 /t cement]**	**SO_2 Emissions [Gg]**
1989	12,225.00	0.30	3.67
1990	9,468.00	0.30	2.84
1991	6,692.00	0.30	2.01
1992	6,271.00	0.30	1.88
1993	6,158.00	0.30	1.85
1994	5,998.00	0.30	1.80
1995	6,842.00	0.30	2.05
1996	6,956.00	0.30	2.09
1997	6,553.00	0.30	1.97
1998	6,577.00	0.30	1.97
1999	5,580.00	0.30	1.67
2000	6,058.00	0.30	1.82
2001	5,668.00	0.30	1.70
2002	5,680.00	0.30	1.70
2003	5,992.00	0.30	1.80
2004	6,239.00	0.30	1.87
2005	7,043.00	0.30	2.11
2006	8,253.00	0.30	2.48
2007	10,060.00	0.30	3.02
2008	10,660.00	0.30	3.20
2009	7,902.00	0.30	2.37
2010	6,992.00	0.30	2.10
2011	8,087.00	0.30	2.43
2012	8,223.00	0.30	2.47

The data on the amount of cement produced is provided by the National Institute for Statistics. The data set in case of Cement Production is complete.

Lime Production (IPCC category 2.A.2)

Methodology

The Lime Production is a key category only considering the level criteria (Tier 1, excluding and including LULUCF).

Total CO_2 emissions from Lime Production were estimated using production data and the emission factors, in line with the Good Practice Guidance - IPCC GPG 2000, considering the "Decision Tree for Lime Production" from IPCC GPG 2000 - page 3.21 and taking into account the information from "Table 3.4 - Basic Parameters for the Calculation of Emission Factors for Lime Production "– page 3.22 (IPCC GPG 2000).

Activity data

The ADs necessary to estimate emissions from this source category (quicklime and dolomite lime) are provided by the National Statistics. Starting with 2007 the data related with Lime Production are confidential.

Following consultation between experts in the National Environmental Protection Agency and in National Institute for Statistics, Romania corrected estimates of CO_2 emissions from Lime Production through the use of revised activity data (AD) in that calculation: dolomitic lime production (calcined/sintered dolomite and agglomerated dolomite).

Anteriorly emission estimation was based on AD mentioned above and on crude dolomite production.

For 1989 year and for the 1998 to 2000 period there is no data information on the production of calcined/sintered dolomite and agglomerated dolomite.

For these years an average percentage of dolomitic lime production excluding crude dolomite amount in total dolomitic lime production amount for years for which data on dolomitic lime production excluding crude dolomite amount is available was obtained and applied for 1989 and 1998–2000 years to total dolomitic lime production.

Emission factors

The CO_2 EF's are estimated considering the Equations 3.4, 3.5A, 3.5B, from IPCC GPG 2000, page 3.20. taking into account the default values from "Table 3.4 - Basic Parameters for the Calculation of Emission Factors for Lime Production" – page 3.22 (IPCC GPG 2000).

EF_1 = Stoichiometric Ratio $(_{CO2\,/\,CaO})$ • CaO $_{Content}$

EF_2 = Stoichiometric Ratio $(_{CO2\,/\,CaO \cdot MgO) \,\bullet\, (CaO \cdot MgO)\ Content}$

Where: EF_1 = emission factor for quicklime.

Where: EF_2 = emission factor for dolomitic quicklime.

For confidentiality reasons the presentation of CO_2 emission factor used to estimate emission from Lime Production is omitted.

Table 4.6 CO_2 emissions from Lime Production in the period 1989–2012

Year	**Emissions from Lime Production Sub-sector**
	CO_2 emissions [Gg]
1989	3,222.27
1990	2,389.47
1991	1,830.74
1992	1,529.98
1993	1,371.52
1994	1,281.56
1995	1,391.29
1996	1,374.67
1997	1,327.99
1998	1,477.36
1999	1,322.83

Year	Emissions from Lime Production Sub-sector
	CO_2 emissions [Gg]
2000	1,347.42
2001	1,620.66
2002	1,578.18
2003	1,581.22
2004	1,685.73
2005	1,482.76
2006	1,645.31
2007	1,940.95
2008	1,759.32
2009	1,185.85
2010	1,274.52
2011	1,260.41
2012	1,281.22

Limestone and Dolomite Use (IPCC category 2.A.3)

Methodology

Limestone and Dolomite Use is a key category only considering the trend criteria (Tier 1 including LULUCF). The IPCC methodology has been followed for estimating the CO_2 emissions from Limestone and Dolomite Used. According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the CO_2 emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.6 and Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual, page 2.10. The method estimates the amount of Limestone and Dolomite Used in the Iron and Steel Production, Pulp and Paper Production, sugar mills production, ceramics plants, for all-time series.

Activity data

The activity data were provided directly by the plants (iron and steel producers, pulp and paper producers, sugar mills producers, ceramics producers).

In order to estimate CO_2 emissions from Limestone and Dolomite Used Sub-sector it was made a questionnaire which it was sent to the Local Environmental Protection Agencies. Each agency manages all economic agents which are in its responsibility (iron and steel producers, pulp and paper producers, sugar mills producers, ceramics producers) in order to complete the needed data. The completed questionnaire has been sent to NEPA where the data are aggregated.

Considering the Iron and Steel Production data there was estimated the amount of lime used for each technological process and then it was aggregated all the amount of lime used. For avoiding the double counting with Lime Production category, the total amount of lime used in the two integrated iron and steel plants, was subtracted from the total consumption of limestone provided by economic agents.

Table 4.7 Amount of Limestone and Dolomite used and CO_2 emissions in the period 1989–2012

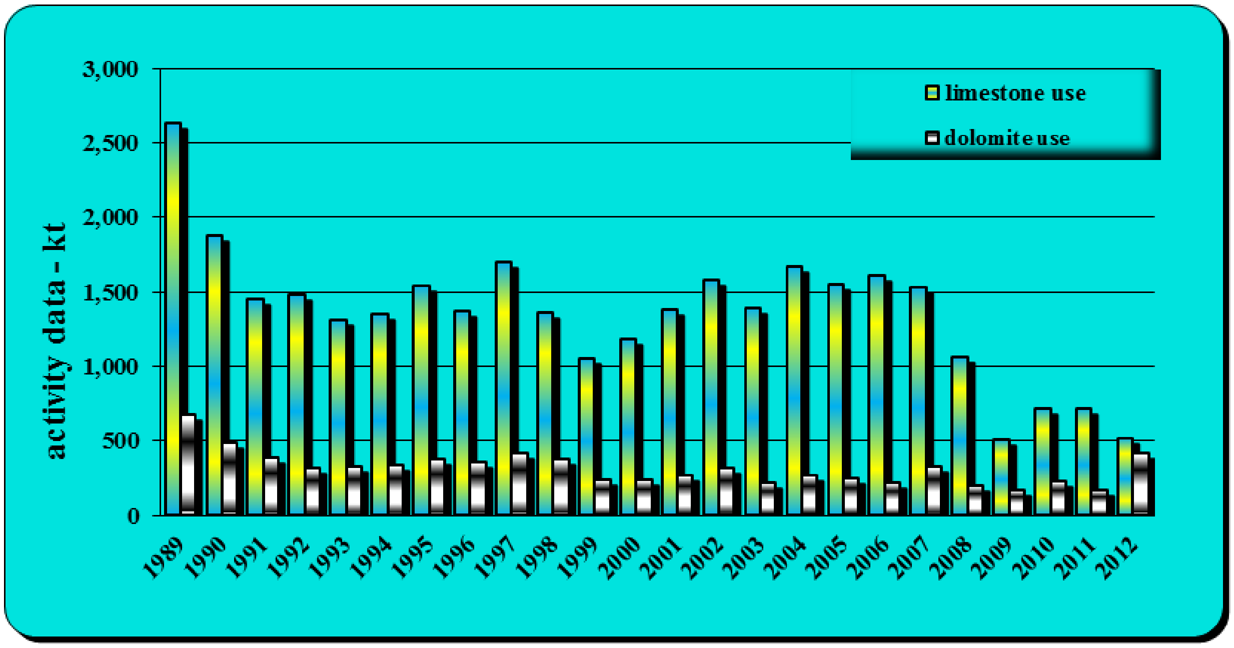
Year	**Activity data from Limestone and Dolomite Use Sub-sector**			
	Limestone Use	**Dolomite Use**	**Total Limestone and Dolomite Consumption**	**CO_2 emission from Limestone and Dolomite Consumption**
	[kt]			**[Gg]**
1989	2,633.01	680.28	3,313.29	1,483.02
1990	1,880.17	489.84	2,370.01	1,060.93
1991	1,448.95	386.41	1,835.36	821.85
1992	1,482.95	323.59	1,806.53	806.85
1993	1,316.30	330.03	1,646.33	736.59
1994	1,348.53	335.71	1,684.25	753.49
1995	1,542.57	382.23	1,924.80	861.05
1996	1,375.21	354.48	1,729.68	774.18

Year	**Activity data from Limestone and Dolomite Use Sub-sector**			
	Limestone Use	**Dolomite Use**	**Total Limestone and Dolomite Consumption**	**CO_2 emission from Limestone and Dolomite Consumption**
	[kt]			**[Gg]**
1997	1,703.77	421.32	2,125.09	950.63
1998	1,359.84	384.09	1,743.93	781.54
1999	1,059.28	241.20	1,300.48	581.14
2000	1,182.70	242.75	1,425.46	636.18
2001	1,384.10	272.90	1,657.00	739.18
2002	1,580.51	319.13	1,899.64	847.65
2003	1,390.25	219.40	1,609.65	716.37
2004	1,671.11	264.95	1,936.06	861.67
2005	1,548.25	247.50	1,795.76	799.29
2006	1,615.57	221.73	1,837.30	816.62
2007	1,535.29	332.00	1,867.29	833.89
2008	1,065.28	201.27	1,266.55	564.73
2009	513.37	168.70	682.06	306.35
2010	722.11	228.91	951.02	426.92
2011	719.53	172.34	891.86	398.80
2012	520.13	423.80	943.93	431.01

Emission factors

The default emission factors 477 kg CO_2/tonne dolomite and 440 kg CO_2/tonne limestone are used.

Figure 4.7 Amount of Limestone and Dolomite Used, related with Iron and Steel Production, Pulp and Paper Production, sugar mills production, ceramics plants in the period 1989–2012



Soda Ash Production and Use (IPCC category 2.A.4)

Methodology

According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the CO_2 emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.8 and Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual, pages 2.12–2.13.

Total CO_2 emissions from Soda Ash Production were estimated using the quantity of trona utilized and the emission factor, in line with the IPCC 1996. CO_2 emission from Soda Ash Use were estimated using the data provided directly from economic agents which use Soda Ash in their activities and the default emission factor, line with the IPCC 1996.

Activity data

Soda Ash Production data are annually provided by the National Statistics. Starting with 2007 the data related with Soda Ash Production are confidential. Data on Soda Ash Use were provided directly from economic agents who use soda ash in theirs activities (the soda ash consumption data has been provided by pulp and paper producers, chemicals producers, flue gas desulphurization, water treatment, and soap and detergents producers). In order to estimate CO_2 emissions from Soda Ash Use Sub-sector it was made a questionnaire which it was sent to the Local Environmental Protection Agencies. Each agency manages all economic agents which are in its responsibility (pulp and paper producers, chemicals producers, flue gas desulphurization, water treatment, and soap and detergents producers) in order to complete the needed data. The completed questionnaire has been sent to NEPA where the data are aggregated.

Emission factors

The default emission factors for Soda Ash Use 415 kg CO_2 / tonne of Soda Ash Use is used.
For confidentiality reasons the presentation of CO_2 emission factor used to estimate emission from Soda Ash Production is omitted.

Figure 4.8 CO_2 emissions from Soda Ash Production and Use in the period 1989–2012

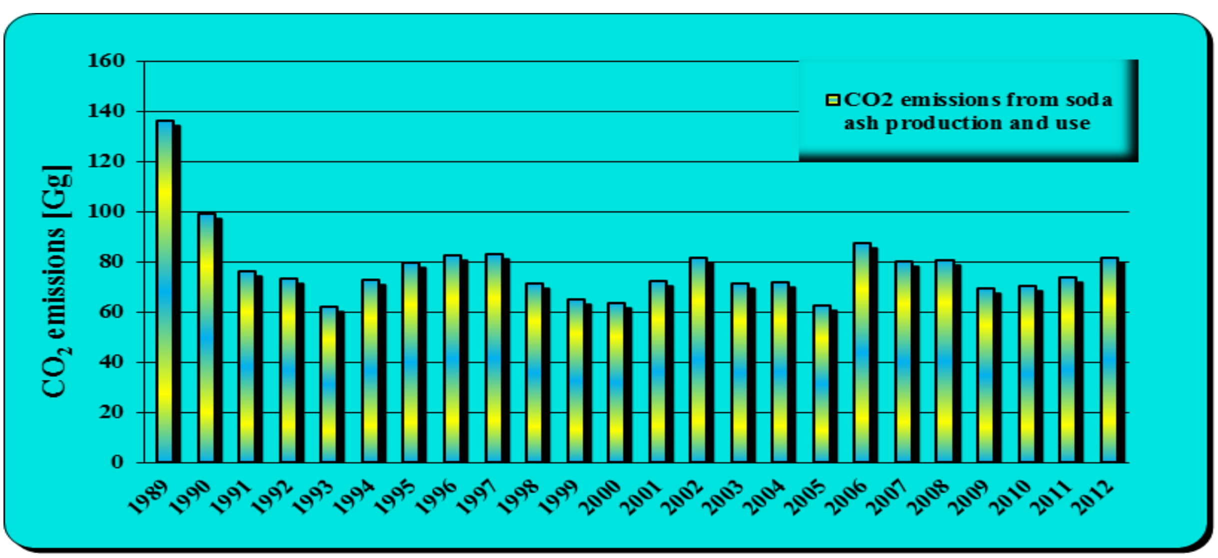


Table 4.8 CO_2 emissions from Soda Ash Production and Use in the period 1989–2012

Year	**Emissions from Soda Ash Production and Use Sub-sector**
	CO_2 emissions [Gg]
1989	136.35
1990	99.11
1991	75.90
1992	73.38
1993	61.92
1994	72.59
1995	79.43
1996	82.54
1997	83.08
1998	71.20
1999	64.88
2000	63.20
2001	72.18
2002	81.66
2003	71.43
2004	71.54
2005	62.71
2006	87.34
2007	79.84
2008	80.58
2009	69.53
2010	70.40
2011	73.80
2012	81.34

Asphalt Roofing Production (IPCC category 2.A.5)

Methodology

The default 1996 IPCC methodology for estimation the emissions from Asphalt Roofing Production Sub-sector has been used. According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the NMVOC emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.9, Tables 2–2 and 2–3.

Activity data

The data on Asphalt Roofing Production Sub-sector are provided by National statistics. These data are available starting with 2005 year.

The data taking into account in order to estimate CO and NMVOC emissions are: petroleum bitumen for materials insulation, petroleum bitumen for pipelines insulation, products based on bitumen – waterproofing, bitumen oil for industry, asphalt board. Starting with 2007 the data related with Asphalt Roofing Production are confidential.

Emission factors

The default IPCC emission factors were used in order to estimate NMVOC and CO emissions.

Table 4.9 Emission factors for NMVOC, CO from Asphalt Roofing Production Sector

EMISIONS FACTORS FOR ASPHALT ROOFING PRODUCTION–SATURATION PROCES [Kg/tone product]	
NMVOC	**0.0475**
CO	**0.0095**

EMISIONS FACTORS FOR ASPHALT BLOWING PROCESS – no control [Kg/tone product]	
NMVOC	**2.4**

Road Paving with Asphalt (IPCC category 2.A.6)

Methodology

The default CORINAIR emission inventory guidebook for estimation the emissions from Road Paving with Asphalt Sub-sector has been used.

Activity data

The data on Road Paving with Asphalt Sub-sector are provided by National statistics. These data are available starting with 1998 year. The activity data taking into account in order to estimate NMVOC emissions are: natural bitumen and asphaltic rocks, bituminous mixtures based on natural or artificial aggregate and bitumen or natural asphalt, petroleum bitumen road. Starting with 2007 the data related with Road Paving with Asphalt are confidential.

Emission factors

The default CORINAIR emission inventory guidebook EF was used in order to estimate NMVOC emissions: 0.016 kg NMVOC/ tone material used.

Others: Glass Production (IPCC category 2.A.7.1)

Methodology

CO_2 emissions are estimated for container glass, flat glass and glass wool. Total emissions from Glass Production were estimated using production data and the emission factors, in line with

CORINAIR methodology. According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the CO_2 emissions, therefore it was followed the CORINAIR and IPCC 2006 methodologies.

Activity data

Source of the data activity is the National Institute for Statistics. Starting with 2007 the data related with container glass, glass wool and flat glass production are confidential.

For the period **1989**–**2002** there is no data information on the production of glass wool and flat glass.

For the period **1989**–**2002** the productions of flat glass and glass wool were calculated by extrapolation.

Therefore we calculated an average percentage for the period 2003–2012 for each type of glass: container glass, flat glass and glass wool. The average percentage was applied to the production of container glass for the period 1989–2002 to calculate the production of flat glass and glass wool.

Emission factors

The emission factor was collected from the Emission Inventory Guidebook 2006 as being specific to the Netherlands.

For confidentiality reasons the presentation of CO_2 and NMVOC emission factors used to estimate emission from container glass, flat glass and glass wool production are omitted.

Table 4.10 CO_2 emissions from Container Glass and Flat Glass Production in the period 1989–2012

Year	Emissions from Glass Production Sub-sector
	CO_2 emissions [Gg]
1989	219.24

Year	Emissions from Glass Production Sub-sector
	CO_2 emissions [Gg]
1990	178.53
1991	145.38
1992	119.80
1993	95.95
1994	105.26
1995	118.05
1996	125.61
1997	104.68
1998	93.04
1999	55.25
2000	75.02
2001	77.93
2002	77.93
2003	154.11
2004	88.39
2005	77.34
2006	73.27
2007	69.20
2008	73.79
2009	55.60
2010	58.61
2011	59.15
2012	57.14

4.2.3 Uncertainties and time series consistency

Cement Production (IPCC category 2.A.1)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 2%;
- EF: 2%;
- 2.83% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Lime Production (IPCC category 2.A.2)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5%;
- EF: 2%;
- 5.39% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Limestone and dolomite use (IPCC category 2.A.3)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 3%;
- EF: 2%;
- 3.61% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Soda Ash Production and Use (IPCC category 2.A.4)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 20 %;
- 20.62% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Glass Production (IPCC category 2.A.7.1)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5%;
- EF: 20%;
- 20.62% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.
Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

4.2.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Chemical Industry, Metal Production and Other Production Sub-sectors, the results of these being mentioned on the Checklists level.
Following these activities there were unconformities recorded.
No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.
In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved as part of the 2012 NGHGI; they are described in the Chapter 4.2.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.2.5 – Source-specific recalculations, including changes made in response to the review process.
All noted unconformities following the UNFCCC review of the 2012 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.
Starting with 2008 year the data used in order to estimate CO_2 emissions from clinker production were compared with the data reported in monitoring plans of GHG emissions for the EU-ETS

cement production installations. The data are similar.

The CO_2 emissions from Lime Production, Limestone and Dolomite Use, Soda Ash Use and Glass Production, were compared with the emissions reported in monitoring plans of GHG emissions for the EU-ETS installations. Further elements are presented within Annex 8.3.

4.2.5 Source specific recalculation, including changes made in response to the review process

No recalculations were made relative to previous submission.

4.2.6 Source specific planned improvements, including those in response to the review process

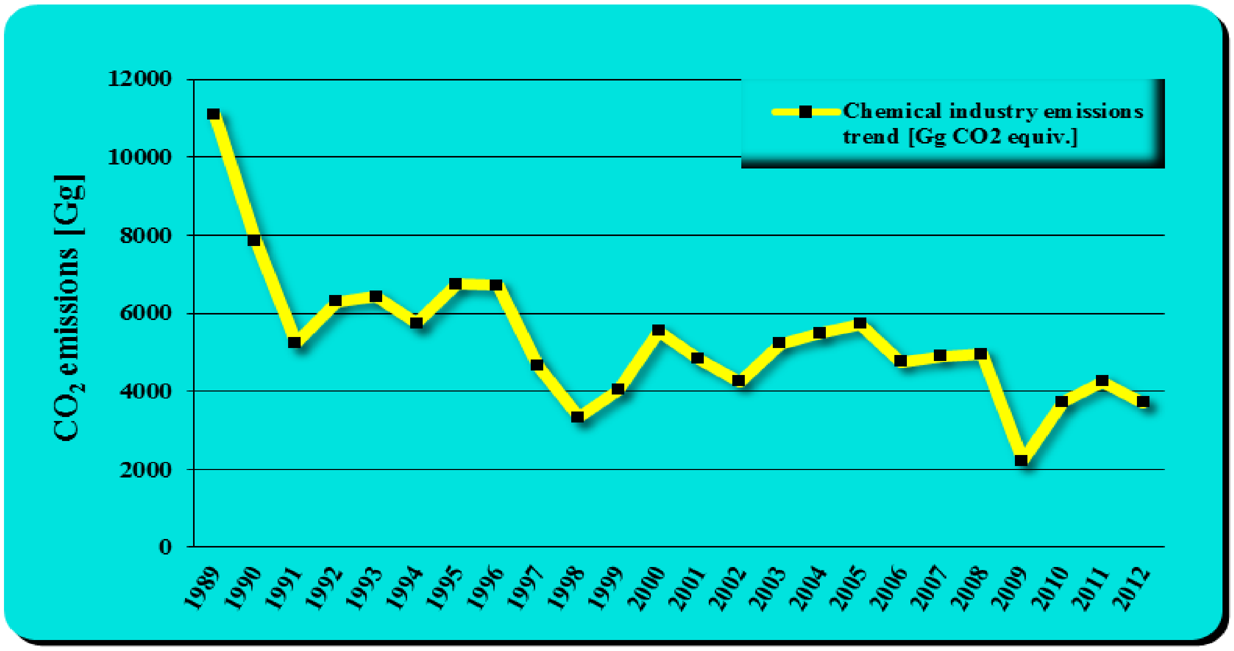
More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

4.3 Source category Chemical Industry (CRF Sector 2.B)

4.3.1 Source category Description

CRF Sector 2.B includes: Ammonia Production (IPCC category 2B.1), Nitric Acid Production (IPCC category 2B.2), Adipic Acid Production (IPCC category 2B.3) -until 2001, Silicon Carbide Production (IPCC category 2B.4.1) Calcium Carbide Production (IPCC category 2B.4.2) and Other Productions (IPCC category 2B.5): carbon black, methanol, ethylene, etc. Chemical Industry Sub-sector was responsible for 29.93% of the total Industrial Processes Sector GHG emissions in 2012.

Figure 4.9 GHG emissions trend in the Chemical Industry Sub-sector for 1989–2012 period [Gg CO_2 equiv.]



GHG emissions trend in the Chemical Industry Sub-sector for 1989–2012 period due:

- lowest level of emissions from the ammonia production was recorded in 1998 (production decreased by almost 50% compared to the previous and the next year) due to closing of a producing plant in 1998 and closing of another plant in 1998 and reopening it the next year;
- nitric acid production decreased after 1989;
- adipic acid production had stopped at the end of 2001;
- carbide production had recorded a decrease after 1989 and it was stopped starting with 2007;
- for 2009 a significant decrease of emissions level was recorded due to the economic crisis;
- in 2011 the emissions rised due to increase of various production activities (ammonia production, nitric acid production, silicon carbide production);
- in 2012 the emissions rised due to decrease of various production activities (ammonia production, nitric acid production, carbide production).

Table 4.11 GHG emissions from the Chemical Industry Sector, in 2012 (Gg)

Sector	CO_2	CH_4	N_2O
	[Gg]		
2.B Chemical Industry	2,737.13	0.68	3.07
2.B.1 Ammonia Production	2,727.74	0.00	0.00
2.B.2 Nitric Acid Production	0.00	0.00	3.07
2.B.3 Adipic Acid Production	NO	NO	NO
2.B.4.1 Silicon Carbide Production	IE	0.55	0.00
2.B.4.2 Calcium Carbide Production	9.39	NO	NO
2.B.5 Others (ethylene, carbon black, methanol, sulphuric acid)	0.00	0.12	0.00

4.3.2 Methodological issues

Ammonia Production (IPCC category 2.B.1)

All the issues related with the Ammonia Production category have been implemented following the elaboration of the study "Elaboration/documentation of national emission factors/other parameters relevant to National Greenhouse Gas Inventory (NGHGI) Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher tier calculation methods implementation". In all the Romania Ammonia Production installations the **Kellogg process** (see the Annex 3.2) is used. This type of technology is based on steam reforming of methane. There are some aspects related with upgrading the installations and the chemical solutions used to absorb carbon dioxide from synthesis gas of ammonia. All the solutions used in absorption of carbon dioxide contain the potassium carbonate-K_2CO_3. Carbon dioxide is resulted from the regeneration process of the absorption solution.

Typically, carbon dioxide resulting from the production process is used to manufacture of urea. If urea production plant is not functioning, carbon dioxide is released into the atmosphere.

Methodology

The Ammonia Production is a key category from both level and trend point of view (Tier 1, excluding and including LULUCF and Tier 2, excluding and including LULUCF).

The CO_2 emissions from ammonia production are estimated according to the Tier 1a methodology. According with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories - Industrial Processes, the relevant parameters used for estimation the CO_2 emissions in line with 1a method are:

- The annual amount of natural gas used as feedstock in Ammonia Production process, m^3/an;
- Carbon content of natural gas used as feedstock in Ammonia Production process, kg carbon/m^3 gas;
- The conversion factor of CO_2;
- CO_2 emissions.

Other relevant parameter than is not used in calculation of CO_2 emissions in line with 1a level is annual Ammonia Production.

Although emissions from Ammonia Production are decreasing along the time series, this source category results in a large amount of CO_2 emissions.

Within the chemical industry sector, Ammonia Production is one of the most important GHG emission source. The lowest level of emissions was recorded in 1998, due to the activity data decreased by almost a half compared to the previous and next year. This happened as one producing plant has stopped its activity since 1998 and another plant has been closed in 1998 and reopened in the next year.

Activity data

In order to estimate de CO_2 emissions have been taking into account the data provided directly from Ammonia Production plant considering the information from the questionnaires completed by all seven economic agents ammonia produces for all-time series 1989–2011. For each installation there were request the next parameters:

- Annual ammonia production, tonne/year;
- The annual amount of natural gas used as feedstock in Ammonia Production process, m^3/year;
- Carbon content of natural gas used as feedstock in Ammonia Production process, kg carbon/m^3 gas;
- Annual amount of CO_2 resulted from Ammonia Production process with is used in urea production, kg/year;
- Annul amount of urea production, kg/year.

Emission factors

The formula use in order to estimate the CO_2 emissions inside the Ammonia Production Sub-sector – the emissions estimated according with Tier 1a – IPCC 1996 is:

Equation 4.6 CO_2 emission estimation in Ammonia Production Tier 1.a

$$E_{CO2} = C_{natural\ gas} * CC_{natural\ gas} * 44/12$$

where:

E_{CO2} = CO_2 emissions;

$C_{natural\ gas}$ = the annual amount of natural gas used as feedstock in Ammonia Production process;

$CC_{natural\ gas}$ = Carbon content of natural gas used as feedstock in Ammonia Production process;

44/12 = the conversion factor of CO_2.

CO_2 emissions

- Unit measurement: Gg CO_2 emissions/ year;
- Carbon dioxide is formed by oxidation of carbon from the fuel (natural gas);
- CO_2 emissions estimation is done by calculations using Tier 1a compliance with IPCC.

Methodology

Annual amount of natural gas used as feedstock

- Unit measurement: Nm^3/year;
- Amount of natural gas is proportional to the production of ammonia 100% expressed in t / year;
- For accurate calculations, the amount of natural gas used as raw material is obtained from the operators;
- The amount of *natural gas use as fuel* is excluded from the CO_2 emissions calculation inside the Industrial Process Sector because this type of energetic gas is considering in Energy sector. The amount of *natural gas used as feedstock* is considering only within Industrial Process Sector, not to Energy sector.

Carbon content of natural gas used as feedstock

- Unit measurement: kg C / Nm^3 natural gas;
- In order to convert Nm^3 of natural gas in kg of natural gas, the density of the natural gas was used (ρ= 0.8779 kg/m^3);
- For accurate calculations, the Carbon content of natural gas used as feedstock is obtained from the operators;
- It is assumed that all carbon is transformed into carbon dioxide and then is emitted into the atmosphere.

Conversion factor of carbon in carbon dioxide

- Unit measurement: dimensionless;
- Conversion factor of carbon in carbon dioxide is stoichiometric ratio between molecular weight of carbon dioxide - CO_2 (44) and molecular weight of carbon - C (12). Value is 44/12.

Ammonia annual production

- Unit measurement: t/year (tone Ammonia Production 100%/year);
- Annual production is annually obtained from operators.

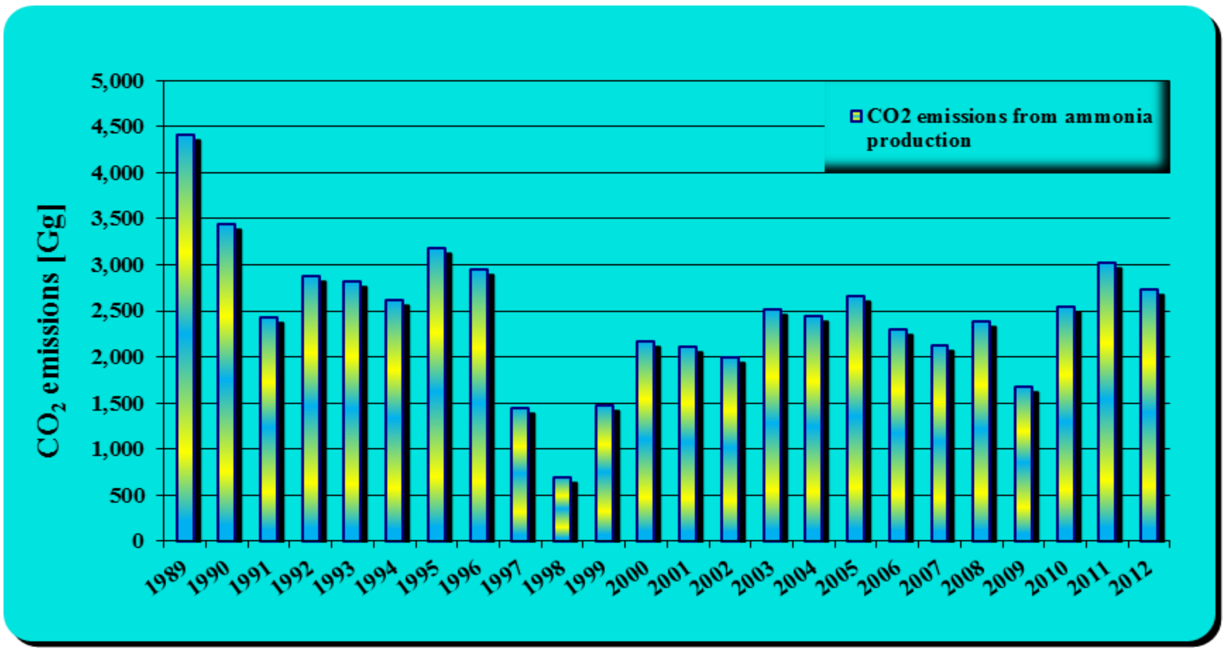
The CO and SO_2 emissions from Ammonia Production are estimated according to the revised methodology (default 7.9 kg CO/ tonne of product and 0.03 kg SO_2/ tonne of product).

Table 4.12 Ammonia Production related to the CO_2 emissions in the period 1989–2012

Year	**Activity data and emissions from Ammonia Production Sub-sector**	
	Natural gas consumption [kt]	**CO_2 emissions [Gg]**
1989	1,947.02	4,403.96
1990	1,510.90	3,438.34
1991	1,064.03	2,428.34
1992	1,261.58	2,883.47
1993	1,237.55	2,825.62
1994	1,147.35	2,620.00
1995	1,397.03	3,187.29
1996	1,287.90	2,948.14
1997	635.41	1,446.63
1998	305.00	696.36
1999	644.60	1,480.47
2000	945.06	2,163.33
2001	924.56	2,113.41
2002	872.56	1,998.39
2003	1,101.06	2,518.94
2004	1,070.13	2,442.19
2005	1,161.78	2,666.76
2006	1,003.98	2,305.40
2007	919.82	2,120.93
2008	1,038.18	2,380.62
2009	747.10	1,671.10
2010	1,081.52	2,542.69
2011	1,245.43	3,020.38

Year	Activity data and emissions from Ammonia Production Sub-sector	
	Natural gas consumption [kt]	CO_2 emissions [Gg]
2012	1,042.46	2,727.74

Figure 4.10 The trend of CO_2 emissions from Ammonia Production in the period 1989–2012



Nitric Acid Production (IPCC category 2.B.2)

Methodology

The nitric acid production is a key category, from both level and trend point of view (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF). Nitric Acid Production results in N_2O and NO_x emissions. Emissions have been calculated by multiplying annual Nitric Acid Production (tons HNO_3 100% by each plant) by a default emission factor, which reflects the process, in line with IPCC GPG 2000 and CORINAIR Methodology. According with the Decision Tree for N_2O Emissions from Adipic Acid and Nitric Acid Production from IPCC GPG 2000 – pg. 3.32, in order to use of a higher Tier calculation method it is need to collect the information regarding emissions and destruction data directly from plants, but the data on plant specific emissions there are not sufficiently documented and explained by operators, therefore the data emissions could not be used in this report 2013.

Activity data

Specific questionnaires have been sent to the local EPA in order to collect information on Nitric Acid Production from economic agents. Based on this survey, 7 manufacturers of Nitric Acid have been identified. From these 7 factories, one stopped its production in 1990 and other factory has stopped its activity during the 2006–2008 periods.

In order to estimate the N_2O and NO_x emissions, within the questionnaires the economic agents had been asked about the data related with the abatement techniques are used for NO_x or N_2O emissions reduction. In 2010 and 2011 years the production data are higher than the previous period because the national Nitric Acid Production increased significant.

Emission factors

The emission factors used reflects the production process:

- dual pressure type process (ammonia oxidation takes place at medium pressure and absorption takes place at high pressure) - this is the case of 6 factories. According to IPCC Good Practice Guidance, N_2O emission factor for European designed dual pressure plants is in the range from 8 to 10 kg N_2O /tonne nitric acid. The mean of this range (9 kg N_2O /tonne nitric acid) has been used to estimate N_2O emissions. The NOx emission factor used is according to CORINAIR methodology: 7.5 kg NOx/tonne nitric acid for medium pressure plants;
- plants without NSCR – this is the case of only one factory. According to IPCC Good Practice Guidance, N_2O emission factor for this plant is in the range from 10 to 19 kg N_2O /tonne nitric acid. The mean of this range (14.5 kg N_2O /tonne nitric acid) has been used to estimate N_2O emissions. An emission factor of 12 kg NO_x/tonne nitric acid has been used to estimate NO_x emissions from this factory.

The emissions have been estimated, considering the process type and the NO_x abatement technology installed at each plant:

- extended absorption for NO_x – used at one factory (it was used since 1997);
- selective catalytic reduction (SCR) for NO_x – used at one single plant since 2003;
- selective catalytic reduction (SCR) for N_2O - used at two plants starting with 2009.

These abatement techniques are used both for NO_x and N_2O reduction emissions.

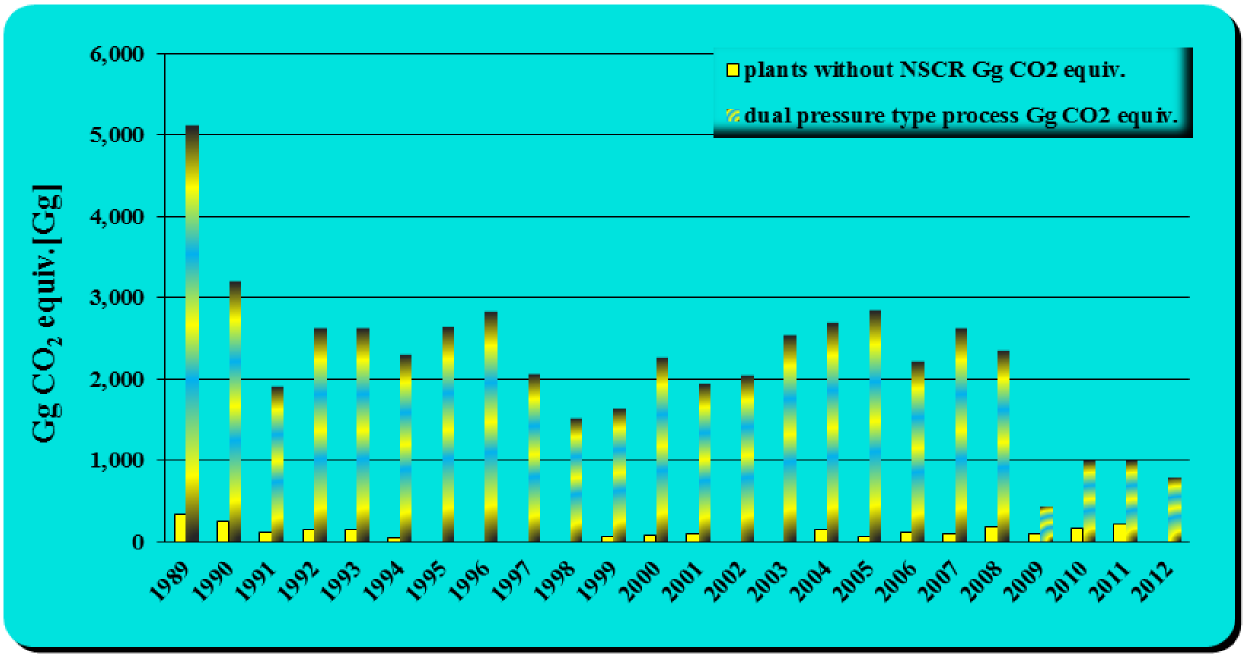
In the Table 4.13 are presented the estimations of the N_2O and NO_x emissions by type of technology, but from reason of confidentiality the nitric acid production is not split between both proceses (plants without NSCR and dual pressure type process - ammonia oxidation takes place at medium pressure and absorption takes place at high pressure).

Table 4.13 Nitric Acid Production related to the N_2O and NO_x emissions in the period 1989–2012

Years	Activity data and emissions from Nitric Acid Production Sub-sector				
	Nitric acid production [kt]	plants without NSCR		dual pressure type process (ammonia oxidation takes place at medium pressure and absorption takes place at high pressure)	
		N_2O emissions [Gg]	NO_x emissions Gg]	N_2O emissions [Gg]	NO_x Emissions [Gg]
1989	1,913.76	1.06	0.88	16.56	13.80
1990	1,205.92	0.81	0.67	10.35	8.63
1991	710.92	0.33	0.27	6.19	5.16
1992	979.13	0.46	0.38	8.52	7.10
1993	978.06	0.45	0.37	8.52	7.10
1994	837.50	0.14	0.12	7.45	6.21
1995	959.74	0.10	0.09	8.57	7.14
1996	1,020.64	0.05	0.04	9.15	7.63

Years	Activity data and emissions from Nitric Acid Production Sub-sector				
	Nitric acid production [kt]	plants without NSCR		dual pressure type process (ammonia oxidation takes place at medium pressure and absorption takes place at high pressure)	
		N_2O emissions [Gg]	NO_x emissions Gg]	N_2O emissions [Gg]	NO_x Emissions [Gg]
1997	749.26	0.07	0.06	6.70	4.72
1998	550.47	0.07	0.06	4.91	3.83
1999	603.48	0.17	0.14	5.33	3.96
2000	831.48	0.26	0.22	7.32	5.10
2001	720.62	0.31	0.26	6.29	4.62
2002	745.11	0.10	0.09	6.64	4.89
2003	917.50	0.07	0.06	8.22	2.01
2004	1,000.14	0.45	0.37	8.72	2.30
2005	1,037.32	0.21	0.17	9.21	3.01
2006	821.55	0.36	0.30	7.17	1.79
2007	962.52	0.28	0.23	8.49	2.31
2008	883.12	0.56	0.46	7.60	2.78
2009	589.89	0.31	0.25	1.36	1.68
2010	1,055.32	0.50	0.41	3.22	3.71
2011	1,076.97	0.68	0.56	3.23	3.33
2012	983.80	0.55	0.46	2.52	2.33

Figure 4.11 The trend of CO_2 emissions from Nitric Acid Production, 1989–2012 [Gg CO_2 equivalent]



Adipic Acid Production (IPCC category 2.B.3)

Methodology

The default methodology has been followed for estimating the emissions from Adipic Acid Production, according with the Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.17-2.18, considering that the Adipic Acid Production Sub-sector is not a key source category.

Activity data

Emissions are estimated based on national statistics for the period 1989–1997, after this year no reports on Adipic Acid Production are made. Based on response from the local Environment Protection Agencies that were requested to provide information on this activity (1998–2001), only one producer has been identified. The facility stopped its activity at the end of 2001. Starting 2002, this activity is suspended.

Emission factors

Table 4.14 The default EFs used to estimate emissions from Adipic Acid Production

EMISSION FACTORS FOR ADIPIC ACID PRODUCTION (KG/TONNE PRODUCT)			
N_2O	**NO_x**	**NMVOC**	**CO**
300	8.1	43.3	34.4

Silicon Carbide Production (IPCC category 2.B.4.1)

Methodology

Total CH_4 emissions from Silicon Carbide Production were estimated using the production data and the IPCC 1996 emission factor. According with Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.20 the default value on CH_4 emission factor was used, considering that the Silicon Carbide Sub-sector is not a key source category.

The CO_2 emissions from Silicon Carbide Production are noted as IE because the emissions related with coke consumption are accounted in Energy Sector.

Activity data

National Statistics provided annually the amount of Silicon Carbide Production starting with 2003 year.

In 2007 the production was stopped and was reopened in 2008.

The data related with Silicon Carbide Productions are confidential starting with 2008.

Emission factors

For confidentiality reasons the presentation of CH_4 emission factor used to estimate emission from Silicon Carbide Production is omitted.

Calcium Carbide Production (IPCC category 2.B.4.2)

Methodology

Total CO_2 emissions from Calcium Carbide Production were estimated using the production data and calcium carbide use data and the default emission factor, in line with IPCC 1996. According with Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.19 the default values on CO_2 emission factor were used (Table 2-8), considering that the Calcium Carbide Sub-sector is not a key source category.

Activity data

The calcium carbide used amount was obtained as balance of production, import and export data provided by the National Institute for Statistics (the amount used equals the production amount plus the imported amount minus the exported amount; starting with 2007 year, the production was stopped; for 1989, 1990, 1991 and 1993 years calcium carbide was not imported).

Emission factors

According with Revised 1996 IPCC in order to estimate CO_2 emission from Calcium Carbide Production default emission factors provided in production process of calcium carbide were used (CaO step and reduction step): 0.76 tonnes CO_2/tonne carbide and 1.09 tonnes CO_2/tonne carbide, the resulted EF is 1.85 tonnes CO_2/tonne carbide. Additionally, the default emission factor of 1,100 kg CO_2/tonne carbide corresponding to the use of product and presented in Table 2-8 in IPCC 1996-Workbook was used.

Table 4.15 CO_2 emissions from Calcium Carbide Production in the period 1989–2012

Year	**Emissions from Calcium Carbide Production Sub-sector**
	CO_2 emissions [Gg]
1989	425.57
1990	322.34
1991	248.01
1992	230.16
1993	226.19
1994	178.05
1995	231.89
1996	258.48
1997	220.77
1998	180.52
1999	132.19
2000	133.65
2001	131.12
2002	126.99
2003	100.68
2004	142.77
2005	86.72
2006	57.98
2007	21.68
2008	13.19
2009	15.82
2010	18.35
2011	13.61
2012	9.39

Other Production: carbon black, ethylene, methanol, propylene, polystyrene, polyethylene, sulphuric acid, phthalic anhydride, polypropylena, polyvinylchloride, 1, 2 dichloroethane, coke (IPCC category 2.B.5)

Methodology

Total emissions from Other Production were estimated using the production data and the emission factors, in line with IPCC 1996. According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.21-2.25 and Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual, pages 2.22-2.25.

Activity data

National Statistics provided annually the amounts of these production processes. Carbon black and sulphuric acid are not produce anymore.

Emission factors

For confidentiality reasons the presentation of emission factors used to estimate emission from those productions are omitted.
Emissions of CH_4, NO_x, CO, NMVOC, and SO_2 were estimated from those productions.

4.3.3 Uncertainties and time series consistency

Ammonia Production (IPCC category 2.B.1)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 10 %;

- 11.18% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Nitric Acid Production (IPCC category 2.B.2)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 40 %;
- 40% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Adipic Acid Production (IPCC category 2.B.3)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 15 %;
- EF: 10 %;
- 18% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Silicon Carbide Production (IPCC category 2.B.4.1)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 0 %;
- 5% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Calcium Carbide Production (IPCC category 2.B.4.2)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 2 %;
- 5.39% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Other Production (IPCC category 2.B.5)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 10 %;
- 11% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

4.3.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Mineral Industry Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted are described in the Chapter 4.3.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.3.5 – Source-specific recalculations, including changes made in response to the review process. All noted unconformities following the UNFCCC review of the 2012 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

4.3.5 Source specific recalculation, including changes made in response to the review process

No recalculations were made relative to previous submission.

4.3.6 Source specific planned improvements, including those in response to the review process.

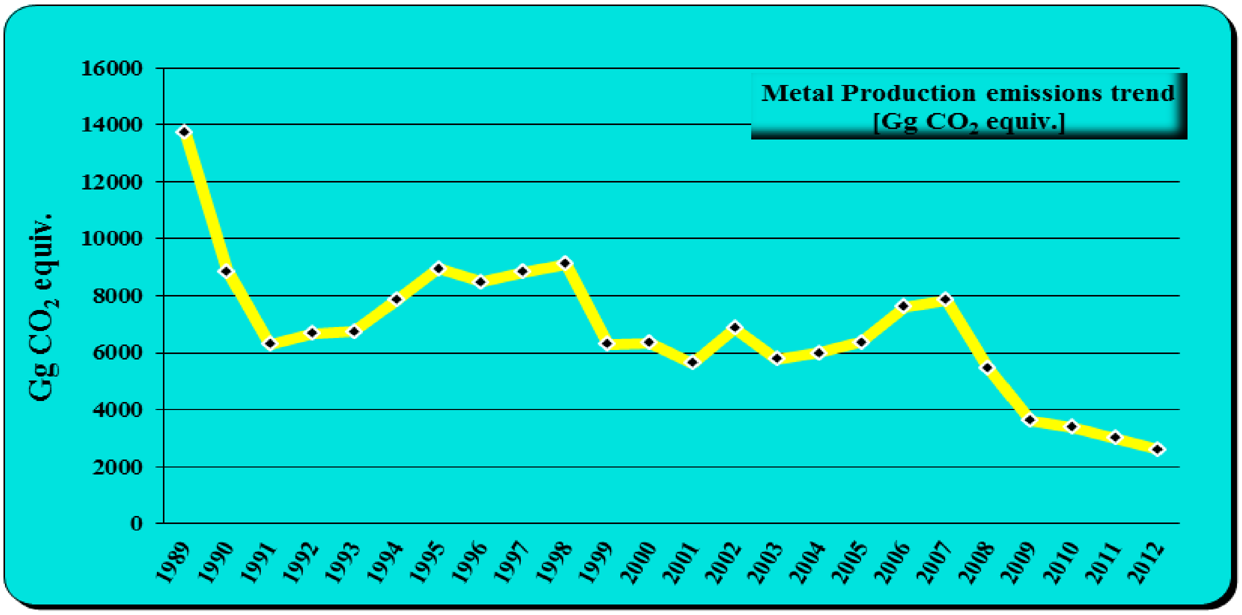
More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

4.4 Source category Metal Production (CRF Sector 2.C)

4.4.1 Source category description

The emission estimates cover sub-categories 2C.1 Iron and Steel Production, 2C.2 Ferroalloys Production and 2C.3 Aluminium Production. The use of SF_6 in Aluminium and Magnesium Foundries (2C.4 sub-category) is not applicable in Romania. Metal Production Industry Sub-sector is responsible for 20.99% of the total Industrial Processes Sector GHG emissions in 2012.
CO_2 emissions from Iron and Steel Production represent an important key category of the inventory because of its contribution to the total inventory level (in 2012 CO_2 emissions from production of iron and steel contributed 1.84% to total greenhouse gas emissions). In the base year, these emissions accounted for 3.33% from the total GHG emissions.
The CO_2 emissions from Ferroalloys Production have been included in the inventory. Aluminium Production results in a smaller quantity of CO_2 emissions and also PFCs emissions. PFCs emissions from Aluminium Production represent a significant source of emissions due to high GWP values.

Figure 4.12 GHG emissions trend in the Metal Production Sub-sector for 1989–2012 period [Gg CO_2 equiv.]



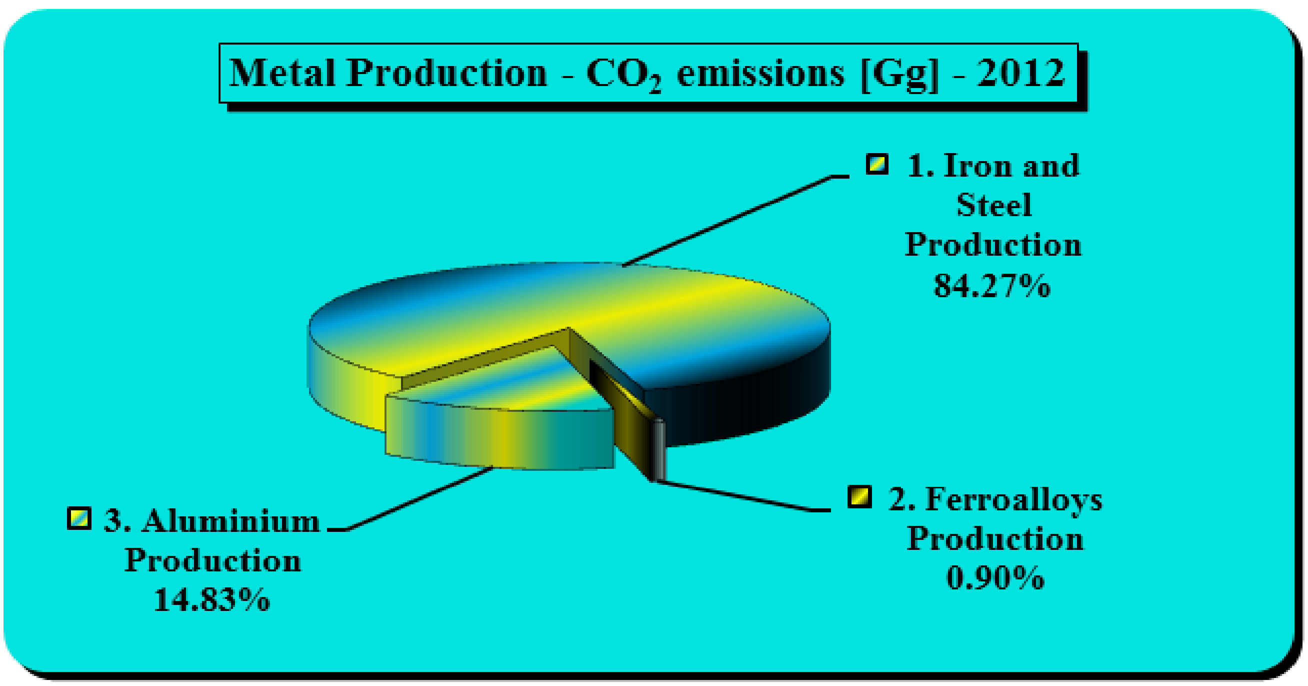
GHG emissions trend in the Metal Products Sub-sector for 1989–2012 period due:

- iron and steel production recorded decreases after 1989;
- ferroalloys production has recorded a decrease after 1989. The lowest level of emissions was recorded in 1999 due to the cease of production. In 2000 the production started again;
- the reduction of PFC emissions from production of aluminum due to changes in technology starting with 1997 and 2003;
- after 2008 the trend of emission decreases due to reduction of production level recorded in Iron and Steel Production and Ferroalloys Production Sub-sectors;
- in 2010 – 2012 period the emissions trends have recorded an decrease due to decreased of various production activities (iron and steel production, ferroalloys production and aluminium production sub-sectors).

Table 4.16 GHG emissions from Metal Production sub-sector, in the year 2012 [Gg CO_2 equiv.]

Sector	CO_2	PFCs
	CO_2 equivalent [Gg]	
2.C Metal Production	**2,592.44**	**6.38**
2.C.1 Iron and Steel Production	**2,184.73**	**0.00**
2.C.2 Ferroalloys Production	**23.21**	**0.00**
2.C.3 Aluminium Production	**384.50**	**6.38**

Figure 4.13 Structure of the Metal Production Sub-sector, in 2012



4.4.2 Methodological issues

Iron and Steel Production (IPCC category 2.C.1)

Methodology

Iron and Steel Production Sub-sector results in a large amount of CO_2 emissions, and it represents a key category within the Industrial Processes Sub-sector, from both level and trend point of view (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF).

The method for calculating emissions of CO_2 from Iron and Steel Production is in line with Good Practice Guidance 2000 (Tier 2 method), considering the "Decision Tree for Iron and Steel Industry" from IPCC GPG 2000 - page 3.27 and taking into account all the information provided by each Iron and Steel Production company.

IPCC Good Practice Guidance 2000 is more detailed in terms of CO_2 emissions and deal with aspects related methodologies, reporting and documentation, and insurance / quality control emissions inventory. This guide presents two methods for calculating emissions. Choice of calculation method depends on national circumstances.

Tier 1 method is a simplified method of calculation, based on the amount of reducing agent (coke, coke petroleum, coal, coal dust, etc.) used in the processes of development. This method does not distinguish between the production of iron and steel production, and does not consider any kind of technological flux.

Tier 2 method is similar to method Type 1, but also includes carbon remained in the metal product. The method is based on tracking carbon content in production processes and the different calculation methods for iron and steel. It is considered good practice estimating emissions based on data provided by the operators, due to substantial differences between the technologies.

Because, for Romania, iron and steel production is key category is required using this method.

Activity data

The recommended Tier 2 method, according to the IPCC Good Practice Guidance, is to base the calculations on the amount of reducing agent (coke oven coke) used in blast furnaces for the production of iron. Other information needed to use the Tier 2 method is the amount of pig iron produced as well as the amount used for steel production and produced steel (BOF and EAF), and the carbon content of all those parts. All these information have been collected at plant level.

The coke from coal is used to reduce the iron. Steel is also produced from ferrous scrap using a basic oxygen furnace (BOF) and electric arc furnace (EAF).

For 1989–2006 period the data related sinter consumption were provided by Ministry of Economy due to inconsistence in data provided by economic agents.

Starting with 2007 the data regarding sinter consumption were provided by economic agents and checked again with the data obtained from Ministry of Economy. The differences in AD generated by these two different data sources are negligible.

The coke consumption to reduce the iron has been subtracted from the Energy Sector consumption being considered within Iron and Steel Production category–Industrial Process Sector.

Emission factors

CO_2 emissions are calculated as the sum of emissions from the production of iron and emissions from steel production.

CO_2 emissions from Pig Iron Production

Emissions from the production of iron is calculated as the sum of emissions from reducing agents used in the production of iron and the difference between CO_2 emissions for carbon in ore and for carbon in iron resulting (3.6.A in IPCC GPG 2000), according to the formula:

Equation 4.7 Calculation of CO_2 emissions from Pig Iron Production

$$Emissions_{pig\ iron} = Emission\ Factor_{reducing\ agent} \times Mass\ of\ Reducing\ Agent + (Mass\ of\ Carbon\ in\ the\ ore - Mass\ of\ Carbon\ in\ the\ Crude\ Iron) \times 44/12$$

where:

- EF reducing agent (coke oven coke) = 3.1 tone CO_2 /tone reducing agent (default value);
- Mass of reducing agent: plant level data;
- Carbon content in ore in 2012: 0.24% (country specific value);
- Carbon content in iron in 2012: average 4.73% (country specific value).

Reducing agents are: coke, coal, petroleum coke, etc. In the Table 21 are the default values of emission factors for the most commonly used reducing agents.

Table 4.17 CO_2 emission factors for the reduction agents

Nr. Crt.	Name reducing agent	Emission factor t CO_2 /t reducing agent
1.	coke from coal	3.1

Amount of carbon in ore or iron crude is obtained by multiplying the carbon content of ore or pig iron with the quantities used, respectively produced. Carbon content of ore is very small (close to zero), and the carbon content of pig iron is approximately equal to 4%. Thus the second term of the above equation is always negative.

In the calculation of emissions for iron and in accordance with "Decision Tree for Iron and Steel Industry" from IPCC GPG 2000 - page 3.27, CO_2 emissions from blast furnace gas are included in this chapter, and therefore they should not be included in the Energy chapter.

CO_2 emissions from limestone use in the manufacture of pig iron relates to emissions from limestone and dolomite use in industrial processes category 2.A.3.

CO_2 emissions from Steel Production

Emissions from steel production are calculated as (3.6.B in IPCC GPG 2000), using Tier 2 approach:

Equation 4.8 Calculation of CO_2 emissions from Steel Production

$$Emissions_{\,crude\ steel} = (Mass\ of\ Carbon\ in\ the\ Crude\ Iron\ used\ for\ Crude\ Steel\ Production - Mass\ of\ Carbon\ in\ the\ Crude\ Steel) \times 44/12 + Emission\ Factor_{\,EAF} \times Mass\ of\ Steel\ Produced\ in\ EAF$$

where:

- Carbon content in crude iron used for crude steel in 2012: average 4.73% (country specific value);
- Carbon content in crude steel in 2012: average 0.11 % (country specific value);
- EF EAF=0.005 t/t (default value);
- Mass of steel produced in EAF: plant level data;
- Crude iron used for crude steel production: plant level data.

CO_2 emissions from steel production are the sum of emissions from conversion of pig iron into crude steel and emissions from electrode consumption in the production of steel in electric arc furnace.

The first part of the equation is based on the difference between the carbon content of iron and carbon content of steel. Amount of carbon in pig iron and crude steel is obtained by multiplying the carbon content of pig iron or crude steel with the quantities used, respectively and produced.

EAF emission factor refers to the amount of CO_2 emitted due to electrode consumption during production of steel in electric arc furnace (EAF). A rough estimate is **1 - 1.5 kg carbon / t steel**.

If no data are available nationally and at the operator may be used emission factors presented in the guide reducing agents (see Table 22).

On CO_2 emission factor associated with the consumption of electrodes in the manufacture of steel in electric arc furnaces is considered good practice to use emission factors from the economic operators. If these data are not available for Tier 2 method can be applied a factor of **5 kg CO_2 / t steel produced** in the EAF.

In Table 23 are presented the carbon content in crude iron and carbon content in steel (%). For the 1989-2006 period was calculated an average for carbon content of iron, respectively of steel, and this value was used for the entire time series (1989-2006) (country specific values). For the 2007-2012 period it was used country specific values.

Table 4.18 The carbon content in crude iron and carbon content in steel. in the period 1989–2012

Years	**Carbon content in crude iron**	**Carbon content in steel**
	%	
1989	3.6	0.7
1990	3.6	0.7
1991	3.6	0.7
1992	3.6	0.7
1993	3.6	0.7
1994	3.6	0.7
1995	3.6	0.7
1996	3.6	0.7
1997	3.6	0.7
1998	3.6	0.7
1999	3.6	0.7
2000	3.6	0.7
2001	3.6	0.7
2002	3.6	0.7
2003	3.6	0.7
2004	3.6	0.7
2005	3.6	0.7
2006	3.6	0.7
2007	3.6	0.3
2008	2.48	0.34

Years	Carbon content in crude iron	Carbon content in steel
	%	
2009	3.37	0.28
2010	3.11	0.26
2011	4.66	0.10
2012	4.73	0.11

Figure 4.14 The trend of CO_2 emissions from Iron and Steel Production (BOF and EAF) in the period 1989–2012

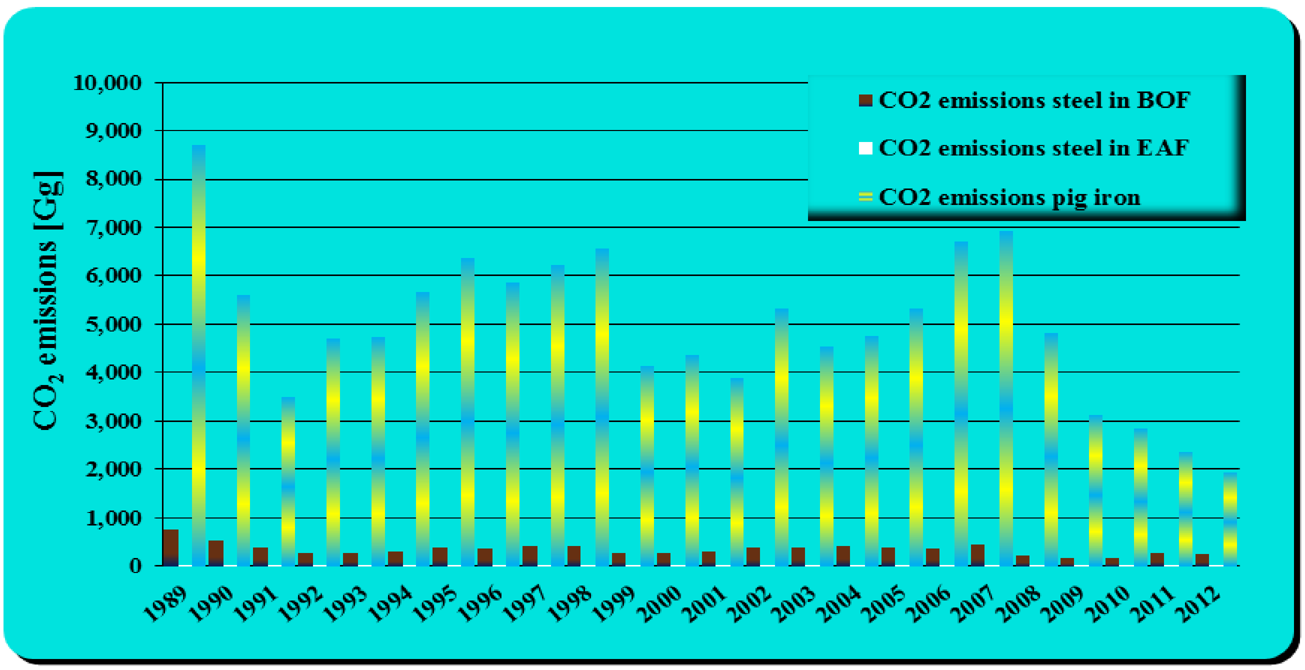


Figure 4.15 The trend of CO_2 emissions from Iron and Steel Production in the period 1989–2012

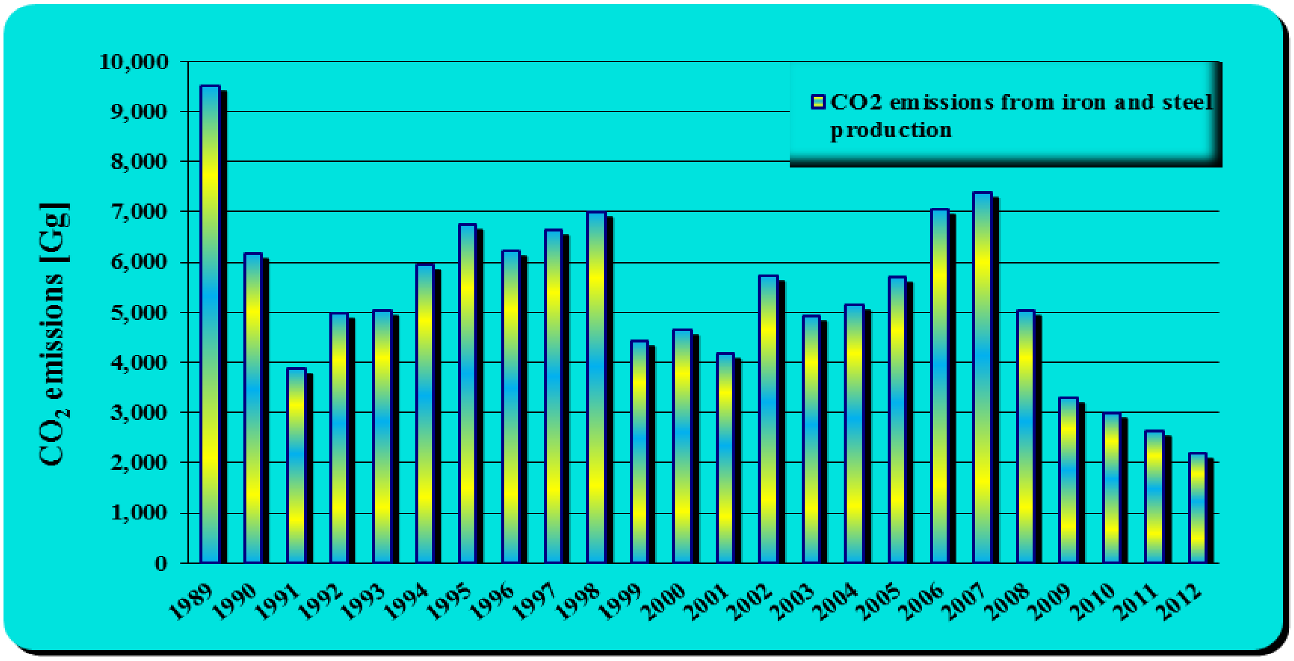


Table 4.19 CO_2 emissions from Iron and Steel Production subsector in the period 1989–2012

Years	CO_2 emissions from Iron and Steel Production Subsector		
	CO_2 emissions from pig iron production	CO_2 emissions from steel production in BOF	CO_2 emissions from steel production in EAF
	Gg		
1989	8,719.85	750.69	29.10
1990	5,605.06	530.93	18.36
1991	3,500.28	373.18	12.97
1992	4,701.86	259.15	10.35
1993	4,741.68	273.32	10.17
1994	5,646.62	299.71	11.21
1995	6,354.19	372.99	10.73
1996	5,858.30	357.73	9.42

Years	CO_2 emissions from Iron and Steel Production Subsector		
	CO_2 emissions from pig iron production	CO_2 emissions from steel production in BOF	CO_2 emissions from steel production in EAF
	Gg		
1997	6,228.28	408.57	9.28
1998	6,564.85	419.89	7.56
1999	4,142.28	273.77	4.91
2000	4,353.91	284.83	5.33
2001	3,883.01	302.02	5.46
2002	5,323.73	384.77	4.45
2003	4,537.24	393.40	5.51
2004	4,746.19	400.62	7.53
2005	5,313.69	379.79	8.76
2006	6,690.69	361.55	9.28
2007	6,927.68	446.16	9.58
2008	4,808.09	205.52	8.63
2009	3,117.84	164.22	5.23
2010	2,834.93	159.32	8.72
2011	2,361.31	261.00	9.77
2012	1,929.68	246.37	8.68

Table 4.20 The input data used to calculate emissions from Iron and Steel Industry in the period 1989–2012

Year	Activity data from Iron and Steel Production Sub-sector				
	steel production (BOF)	steel production (EAF)	pig iron production	sinter	coke
	[kt]				
1989	7,458.02	5,819.46	8,495.13	13,626.00	3,174.58
1990	5,274.49	3,671.84	5,916.27	11,357.00	2,060.00

Year	Activity data from Iron and Steel Production Sub-sector				
	steel production (BOF)	steel production (EAF)	pig iron production	sinter	coke
	[kt]				
1991	3,874.85	2,594.80	4,231.80	7,290.00	1,309.32
1992	2,827.47	2,070.69	3,001.32	4,761.00	1,644.53
1993	2,938.24	2,034.81	3,118.79	3,346.00	1,662.37
1994	3,274.90	2,242.51	3,421.21	5,452.00	1,967.17
1995	4,085.96	2,145.64	4,118.57	6,671.00	2,225.11
1996	3,846.69	1,883.99	3,905.79	5,449.00	2,056.08
1997	4,551.02	1,856.74	4,445.20	6,532.00	2,198.40
1998	4,688.11	1,512.28	4,463.69	6,514.00	2,307.76
1999	3,223.52	981.51	2,943.28	4,164.00	1,461.55
2000	3,445.78	1,066.00	3,041.54	3,875.00	1,534.00
2001	3,677.20	1,092.49	3,221.86	6,185.00	1,389.77
2002	4,507.26	889.75	3,969.80	6,979.00	1,886.37
2003	4,542.23	1,102.35	4,084.94	6,609.00	1,637.57
2004	4,676.31	1,506.46	4,246.50	6,601.00	1,711.85
2005	4,508.78	1,751.62	4,117.92	6,600.00	1,889.44
2006	4,369.39	1,856.83	3,984.65	5,780.00	2,327.96
2007	4,355.95	1,915.29	3,946.68	6,359.22	2,402.79
2008	3,343.00	1,725.86	3,238.79	3,445.55	1,646.00
2009	1,789.84	1,045.67	1,568.86	1,806.98	1,068.29
2010	1,989.57	1,745.00	1,721.75	1,977.60	977.83
2011	1,854.48	1,953.92	1,581.25	1,841.84	841.32
2012	1,710.94	1,736.49	1,468.16	1,705.94	699.74

The NMVOC, NO_x, CO, SO_2 emissions are estimated using the default emission factors applied to the first fusion raw Pig Iron Production.

Table 4.21 Emission factors for NMVOC, NOx, CO, SO_2 from Iron and Steel Production

The NMVOC, NOx, CO, SO_2 emission factors for Iron and Steel category			
g NMVOC/tonne produce	**g NOx/tonne produce**	**g CO/tonne produce**	**g SO_2/tonne produce**
20	76	112	30

Ferroalloys Production (IPCC category 2.C.2)

Methodology

The CO_2 emissions within the Production of Ferroalloys Sub-sector are calculated based on the production volume and the emission factors, in line with IPCC 1996. The Ferroalloys Production Sub-sector is a key source category only considering the trend criteria (Tier 2, excluding LULUCF).

In order to estimate the emission the production data are take into account in a disaggregate manner, by type of products (Ferromanganese Production, Ferrosilicon Production, Silicon Manganese Production, Ferrochromium Production).

During de time series the ferroalloys production have decreased therefore there were just Silicon Manganese and Ferrochromium Production, for 2007 and 2008 and only Ferrochromium Production for 2009.

In 2010 year the Ferroalloys Production and the CO_2 emissions have increased due to improve the Production of Silicon Manganese.

In 2011 - 2012 period the Ferroalloys Production and the CO_2 emissions have decreased due to decreasing of the Ferrochromium Production.

Activity data

The National Statistics reports the Ferroalloys Production for the period 1992–2008, in a disaggregate manner, by type of products. National Institute for Statistics did not provide any data for the periods 1989–1991. The activity data for the beginning of the time series (1989–1991) were provided by Ministry of Economy.

The lowest level of emissions was recorded in 1999. This happened because ferroalloys producing plant stopped its activity in 1999 and reopened in the next year.

Starting with 2007 the data related with Ferroalloys Production are confidential.

Emission factors

For confidentiality reasons the presentation of CO_2 emission factors used to estimate emission from Ferroalloys Production are omitted.

Table 4.22 CO_2 emission from Ferroalloys Production in the period 1989–2012

Year	Emissions from Ferroalloys Production Sub-sector
	CO_2 emissions[Gg]
1989	474.15
1990	331.19
1991	248.73
1992	192.81
1993	143.74
1994	225.69
1995	237.53
1996	271.31
1997	163.53
1998	120.61
1999	0.98
2000	141.53
2001	145.59
2002	144.02
2003	241.55

Year	Emissions from Ferroalloys Production Sub-sector
	CO_2 emissions[Gg]
2004	331.39
2005	201.43
2006	95.57
2007	45.68
2008	21.60
2009	19.99
2010	48.95
2011	40.04
2012	23.21

Aluminium Production (IPCC category 2.C.3)

Methodology

The Aluminium Production is a key category, only from trend point of view (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF).

Primary Aluminium Production is carried out in one facility in Romania, where the pre-baked process is used.

The most significant emissions process resulted are:

- **Carbon dioxide (CO_2)** emissions resulted from the consumption of carbon anodes in the reaction to convert aluminum oxide to aluminum metal. At these emissions are added the emission from decomposition of sodium carbonate (ash) used in electrolysis cell;
- **Perfluorocarbons (PFCs)** emissions of CF_4 and C_2F_6 during anode effects;

The PFC process emissions calculation taking into account the technology use within the facility along the time period 1989–2012:

- From **1989 to 1996**, the technology used was **SWPB** (Side Worked Pre-baked);
- From **1997 to 2002** the combined technology was used **(SWPB and CWPB)** in different percentages;
- **Starting with 2003**, the technology was changed to **CWPB** (Centre Worked Pre-baked).

- For the period **1989–2002 the CO_2** emissions within the production of primary aluminium are calculated based on the production volume in line with **IPCC 1996 Methodology (Tier 1b)** and the **PFC emissions** from aluminium production are calculated in line with **IPCC 1996 Methodology (Tier 1b Method) for C_2F_6** emissions and also **IPCC GPG 2000 Methodology (Tier 1 Method) for CF_4 emissions**, considering the type of technology use within the facility.
- **Starting with 2003 the CO_2** emissions within the production of primary aluminium are calculated in line with **IPCC 2006 Methodology (Tier 3 Method)** and the PFC **emissions** are calculated based on **GPG 2000 Methodology (Tier 2 Method)** using the technology specific over voltage coefficient and weight fraction C_2F_6/CF_4 from **IPCC 2006 Methodology (Tier 2 Method)**.

Activity data

Along the time period (1989–2012), the emissions processes within the Production of Primary Aluminium are calculated used the specific operating facility data in order to respect the IPCC Methodology as following:

- For the period **1989–1996** the technology used was **SWPB** (Side Worked Pre-baked). In this period the **CO_2 emissions** are calculated based on **Aluminium Production** in line with **IPCC 1996 Methodology (Tier 1b Method).** The calculation of CO_2 emissions does not include the emissions from anode baking. The **PFC emissions** are calculated based also on **Aluminium Production** and taking into account the **technology use** within the facility, in line with **IPCC GPG 2000 Methodology (Tier 1 Method) for CF_4 emissions and IPCC 1996 Methodology (Tier 1b Method) for C_2F_6** emissions;
- **From 1997 to 2002** the combined technology was used: **SWPB** (Side Worked Pre-baked) and **CWPB** (Center Worked Prebaked) in different percentages. **The CO_2 emissions** are also calculated based on **Aluminium Production** in line with **IPCC 1996 Methodology (Tier 1b Method).** The calculation of CO_2 emissions does not include the emissions from anode baking. The **PFC emissions** for this period were estimated based on **Aluminium Production** and taking into account a weighted average of the two **constants related technologies** applied SWPB and CWPB, in line with **IPCC GPG 2000 Methodology**

(Tier 1 Method) for CF_4 emissions and IPCC 1996 Methodology (Tier 1b Method) for C_2F_6 emissions;

- **Starting with 2003** the technology was changed to **CWPB** (Centre Worked Pre-baked). **The CO_2 emissions** within the Production of Primary Aluminium are calculated in line with **IPCC 2006 Methodology (Tier 3 Method –** Equation 4.21**)** taking into account the **specific operating facility data**. At these emissions are added the emission from **decomposition of sodium carbonate** used in electrolysis cell. The **PFC emissions** are calculated based on **GPG 2000 Methodology (Tier 2 Method –** Equation 3.11**)**, considering **the plant specific** data and using the technology specific over voltage coefficient and weight fraction C_2F_6/CF_4 from **IPCC 2006 Methodology**.

Table 4.23 The activity data, PFC and CO_2 emissions from Aluminium Production Sub-sector in the period 1989–2012

Year	**Emissions and activity data from Aluminium Production Sub-sector**			
	CF_4 emissions	**C_2F_6 emissions**	**CO_2 emissions**	**Aluminium Production**
	[tones]		**[Gg]**	**[kt]**
1989	451.42	45.14	398.31	265.54
1990	285.15	28.52	251.61	167.74
1991	261.74	26.17	230.94	153.96
1992	182.23	18.22	160.79	107.19
1993	189.95	19.00	167.60	111.74
1994	200.94	20.09	177.30	118.20
1995	239.02	23.90	210.90	140.60
1996	238.39	23.84	210.35	140.23
1997	240.75	24.08	245.56	163.70
1998	236.30	23.63	262.07	174.71
1999	216.08	21.61	261.12	174.08
2000	174.14	17.41	259.91	173.27
2001	140.73	14.07	269.73	179.82

Year	Emissions and activity data from Aluminium Production Sub-sector			
	CF_4 emissions	C_2F_6 emissions	CO_2 emissions	Aluminium Production
	[tones]		[Gg]	[kt]
2002	96.75	9.68	279.89	186.59
2003	34.35	4.16	334.96	198.05
2004	17.35	2.10	362.15	215.26
2005	10.75	1.30	372.62	239.01
2006	7.23	0.87	397.31	255.82
2007	3.18	0.38	402.14	262.51
2008	2.02	0.24	399.93	265.24
2009	0.92	0.11	299.04	200.56
2010	1.03	0.12	314.75	206.72
2011	1.44	0.17	335.98	224.51
2012	0.84	0.10	384.50	202.08

Emission factors

Along the period 1989–2012 the emissions processes within the production of primary aluminium are calculated used the specific operating facility data in order to respect the IPCC Methodology as following:

- For the period **1989–1996** the technology used was **SWPB** (Side Worked Pre-baked). For this period the **CO_2 emissions** are calculated based on primary Aluminium Production data and the **default EF (1.5 tonnes CO_2/tonne Al)** in line with **IPCC 1996 Methodology (Tier 1b Method).** The calculation of CO_2 emissions does not include the emissions from anode baking. The **PFC emissions** are calculated based also on Aluminium Production and taking into account the technology use within the facility, in line with **IPCC GPG 2000 Methodology (Tier 1 Method) for CF_4 emissions and IPCC 1996 Methodology (Tier 1b Method) for C_2F_6** emissions. **Emissions of CF_4** were estimated by multiplying annual primary Aluminium Production with the default emission factor **(1.7 kg CF_4/tonne Al)** provided by **IPCC GPG 2000 Methodology (Tier 1 Method)** and considering the technologies in this period, **SWPB** (Side Worked Pre-baked). Compliance with **IPCC**

1996 Methodology (Tier 1b Method) it is recommended that the default rate for **C_2F_6 emissions be 1/10 that of CF_4.**

- From **1997 to 2002** period the combined technology was used **SWPB** (Side Worked Pre-baked) and **CWPB** (Center Worked Prebaked) in different percentages. The **CO_2 emissions** are also calculated based on Aluminium Production data and the **default EF (1.5 tonnes CO_2/tonne Al)** in line with **IPCC 1996 Methodology (Tier 1b Method)**.The calculation of CO_2 emissions does not include the emissions from anode baking. The **PFC emissions** for this period were estimated based on Aluminium Production and taking into account a **weighted average** of the two constants related technologies applied **SWPB and CWPB**, in line with **IPCC GPG 2000 Methodology (Tier 1 Method) for CF_4 emissions and IPCC 1996 Methodology (Tier 1b Method) for C_2F_6** emissions; **Emissions of CF_4** were estimated by multiplying annual primary Aluminium Production with the default emission factors **(1.7 kg CF_4/tonne Al – SWPB technology and 0.31 kg CF_4/tonne Al – CWPB technology)** provided by **IPCC GPG 2000 Methodology (Tier 1 Method**) and considering the **percentage of each technology** for every period years (SWPB and CWPB). Compliance with **IPCC 1996 Methodology** it is recommended that the default rate for **C_2F_6 emissions be 1/10 that of CF_4.**
- **Starting with 2003** the technology was changed to **CWPB** (Centre Worked Pre-baked).

I. The **CO_2 emissions** within the production of primary aluminium are calculated in line with **IPCC 2006 Methodology,** considering the specific operating facility data **(Tier 3 Method**– Equation 4.21**).** The **parameters used** in order to estimate the **CO_2 emissions** are: total metal production (aluminium), net prebaked anode consumption , CO_2 molecular mass, ash content in baked anodes, sulphur content in baked anodes, compliance with the below equation. At these emissions are added the **emission from decomposition of sodium carbonate** used in electrolysis cell.

Equation 4.9 CO_2 emissions from prebaked anode consumption (Tier 3 Method – IPCC 2006 Methodology)

$$E_{CO_2} = NAC \cdot MP \cdot \frac{100 - S_a - Ash_a}{100} \cdot \frac{44}{12}$$

where:

- E_{CO2} = CO_2 emissions from prebaked anode consumption, tonnes CO_2;
- MP = total metal production, tonnes Al (plant specific data);
- NAC = net prebaked anode consumption per tonne of aluminium, tonnes C/ tonne Al (plant specific data);
- Sa = sulphur content in baked anodes, wt % (plant specific data);
- Ash_a = ash content in baked anodes, wt % (plant specific data);
- 44/12 = CO_2 molecular mass: carbon atomic mass ratio, dimensionless.

II. The PFC emissions are calculated based on **GPG 2000 Methodology (Tier 2 Method)** and **IPCC 2006 Methodology (Tier 2 Method)**, using **Overvoltage Method** and considering the plant specific data and also average parameters from measurements at numerous facilities.

In order to calculate **CF_4 emission** there was used **IPCC GPG 2000 Methodology (Tier 2 Method**–Equation 3.11) and default parameter obtain from measurements at numerous facilities compliance with **IPCC 2006 Methodology (Tier 2 Method).** The parameters used in order to estimate the CF_4 emissions are: Overvoltage coefficients, Anode effect over-voltage, Aluminium Production process current efficiency, total metal production (aluminium), compliance with the below equation.

Equation 4.10 CF_4 emissions by Overvoltage Method (Tier 2 Method – GPG 2000 Methodology)

$$EF\ (kg\ CF_4\ per\ tonne\ of\ Al) = Over\text{-}Voltage\ Coefficient * AEO / CE$$

$$E_{CF4} = EF_{CF4} * MP$$

where:

- EF (kg CF_4 per tonne of Al) = Emission factor for CF_4 using Overvoltage Method
- AEO = Anode effect over-voltage in mV/cell day (plant specific data);
- CE = Aluminium Production process current efficiency expressed in percent (plant specific data);
- E_{CF4} = CF_4 emissions from using Overvoltage Method;

- MP = total metal production, tonnes Al (plant specific data).

Measurement data are not available to determine smelter-specific Overvoltage coefficients, therefore default coefficients were used (an average parameters from measurements at numerous facilities), compliance with **IPCC 2006 Methodology (Tier 2 Method–Table 4.16)**: Overvoltage Coefficient = **1.16 [(kg CF_4/tAl) / (mV)]**

Anode effect overvoltage parameter greatly decreased due to changing production technology leading to lower emission factor for CF_4.

In order to **calculate C_2F_6 emission** there was used **IPCC 2006 Methodology (Tier 2 Method–** Equation 4.27).

Equation 4.11 C_2F_6 emissions by Overvoltage Method (Tier 2 Method - IPCC 2006 Methodology)

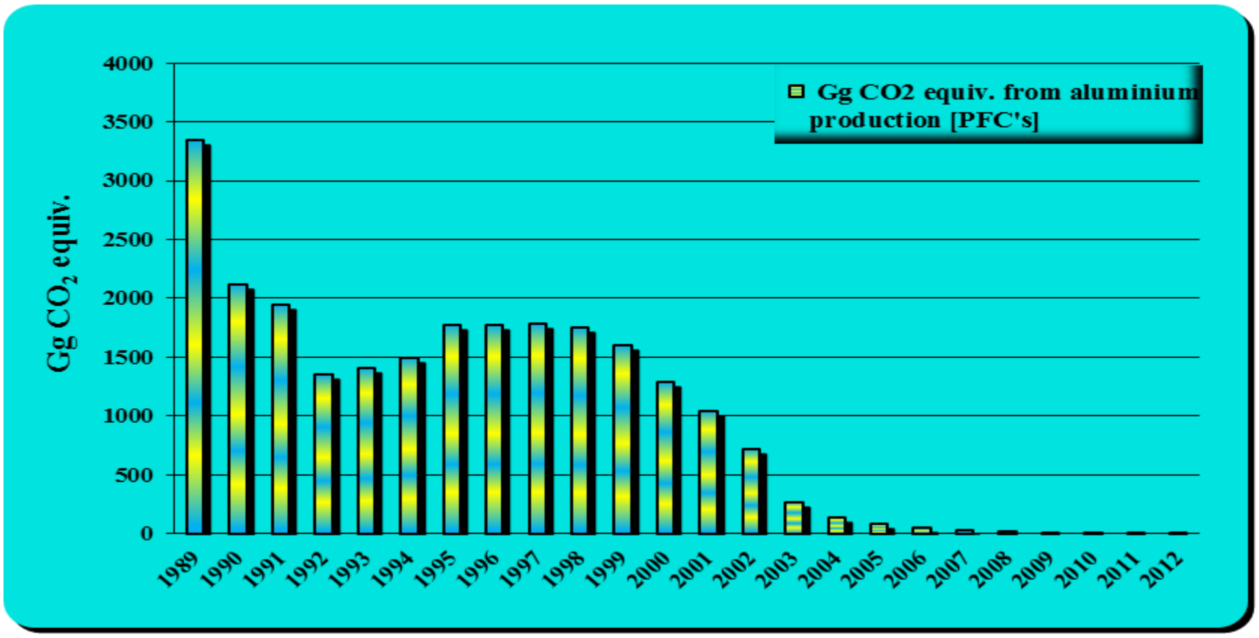
$$EC_2F_6 = ECF_4 \bullet FC_2F_6 / CF_4$$

where:

- E_{C2F6} = emissions of C_2F_6 from Aluminium Production, kg C_2F_6;
- $F_{C2F6/CF4}$ = weight fraction of C_2F_6/CF_4, kg C_2F_6/kg CF_4.

The data related with weight fraction of C_2F_6/CF_4, kg C_2F_6/kg CF_4 was in line with **IPCC 2006 Methodology (Tier 2 Method – Table 4.16):** weight fraction **C_2F_6/CF_4 = 0.121**

Figure 4.16 The trend of PFC emissions [GgCO$_2$ equiv] from Primary Aluminium Production Sub-sector in the period 1989–2012



The **CO, SO$_2$ emissions** are also estimated related to primary Aluminium Production.

Table 4.24 Emission factors for CO and SO$_2$ from primary Aluminium Production

Gas	Process	Emission Factor [Kg/tonne primary Al produced]
CO	**Anode baking**	**400**
SO$_2$	**Anode baking**	**0.9**

SF_6 used in Aluminium and Magnesium Foundries (IPCC category 2.C.4)

Methodology

The default IPCC methodology for estimation the emissions from this sub-sector cannot be applied because this activity is not applicable in the country.

Activity data

This activity is not applicable in the country.

Emission factors

The default IPCC emission factors cannot be used because this activity is not applicable in the country.

4.4.3 Uncertainties and time series consistency

Iron and Steel Production (IPCC category 2.C.1)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 1 %;
- EF: 10 %;
- 10.05% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Ferroalloys Production (IPCC category 2.C.2)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 30 %;
- 30.41% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Aluminium Production (IPCC category 2.C.3)

CO_2 emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 20 %;
- 20.62% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

PFC emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 50 %;
- 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

4.4.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Consumption of Halocarbons and SF_6 Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 4.4.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.4.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

AD on primary Aluminium Production obtained from economic agent has been checked against the data obtained from the National Statistics. The differences in AD generated by these two different data sources are negligible (there are some small differences in the first part of the time series, when statistical data are a little bit higher, but the data from plant are consider to be more reliable).

Both the operator, the data/information provider, and the National Environmental Protection Agency (NEPA), the inventory compiler, performs Quality Control checks as outlined within the IPCC GPG 2000 in relation to every inventory submission.

Considering that the latest available plant-specific data/information, provided by the operator, data used in emission estimation, and the quality control activities described above, the data series are considered to be consistent, according with the provisions in the IPCC GPG 2000.

AD on Iron and Steel Production obtained from local Environmental Protection Agencies has been checked against the data obtained from National Statistics and Ministry of Economy. The differences in AD generated by these three different data sources are negligible.

The CO_2 emissions from Iron and Steel Production were compared with the emissions reported in monitoring plans of GHG emissions for the EU-ETS installations. Further elements are presented within Annex 8.3.

4.4.5 Source specific recalculation, including changes made in response to the review process.

No recalculations were made relative to previous submission.

4.4.6 Source specific planned improvements, including those in response to the review process.

More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

4.5 Source category Other Production (CRF Sector 2.D)

4.5.1 Source category description

This sector includes NOx, CO, NMVOC and SO_2 emission resulted from the Pulp and Paper Production (IPCC category 2.D.1), alcoholic beverages Production and Food Production (IPCC category 2.D.2). The activity data necessary to estimate these emissions are provided in the Statistical Yearbook.

4.5.2 Methodological issues

Methodology

According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook and Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual.
In the Pulp and Paper Production (IPCC category 2.D.1) Sub-sector the Pulp Production was broken down by kraft and acid sulphite processes.
In the Food and Drink Production (IPCC category 2.D.2) Sub-sector the emission was estimated based on the total annual production of the particular food and drink manufacturing process.
The emissions of NOx, CO, NMVOC, and SO_2 within the Production of Pulp and Paper and Food and Drink Sub–sector are calculated based on the production volume and the emission factors, in line with the IPCC 1996.

Activity data

In the Pulp and Paper Production (IPCC category 2.D.1) Sub-sector, the emission was estimated based on the total annual production of dried pulp, provided by National Statistics.
Starting with 2009 the activity data are NO inside this category.

In the Food and Drink Production (IPCC category 2.D.2) Sub-sector the AD were provided by the National Statistics. The data set in case of Bread Production is not complete; the data for 1989–2000 are missing. A linear extrapolation was used to estimate Bread Production in order to complete the time series.

The NMVOC emissions resulted from: Beer/Whine/Meat/fish and poultry/Sugar/Margarine and solid cooking fast/Cakes, biscuits and breakfast cereals/Bread production.

Emission factors

For confidentiality reasons the presentation of NOx, CO, NMVOC, SO_2 emission factors used to estimate emission from the Production of Pulp and Paper and Food and Drink Sub-sector are omitted.

4.5.3 Uncertainties and time series consistency

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods were used for the entire time series 1989–2012.

4.5.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Consumption of Halocarbons and SF_6 Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 4.5.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.5.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

4.5.5 Source specific recalculation, including changes made in response to the review process

No recalculations were made relative to previous submission.

4.5.6 Source specific planned improvements, including those in response to the review process.

More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

4.6 Source category Production of Halocarbons and SF_6 (CRF Sector 2.E)

4.6.1 Source category description

F-gases are not produced in Romania and therefore there are no fugitive emissions from manufacturing. Additionally, there is no production of other fluorinated gases (HCFC) that could lead to by-product F-gas emissions.

4.7 Source category Consumption of Halocarbons and SF_6 (CRF Sector 2.F)

4.7.1 Source category description

Under this F-gases category are considered the following subcategories: Domestic refrigeration (CRF Category 2.F.1.1), Commercial and industrial refrigeration and air-conditioning (CRF Categories 2.F.1.2, 2.F.1.4, 2.F.1.5), Transport refrigeration (CRF Category 2.F.1.3), Domestic air-conditioning (CRF Category 2.F.1.5), Mobile air-conditioning (CRF Category 2.F.1.6), Foam blowing (CRF Category 2.F.2), Fire extinguishers (CRF Category 2.F.3), Aerosols/Metered dose inhalers (CRF Category 2.F.4), Electrical equipment (CRF Category 2.F.8).

In 2012 year, the actual emissions from CRF Category 2F equal to 1,074.12 Gg CO_2eq. and the potential emissions equal to 880.40 Gg CO_2eq are presented in the Table 4.25.

Figure 4.17 GHG emissions trend in the Consumption of Halocarbons and SF_6 Sub-sector for 1995–2012 period [Gg CO_2 equiv.]

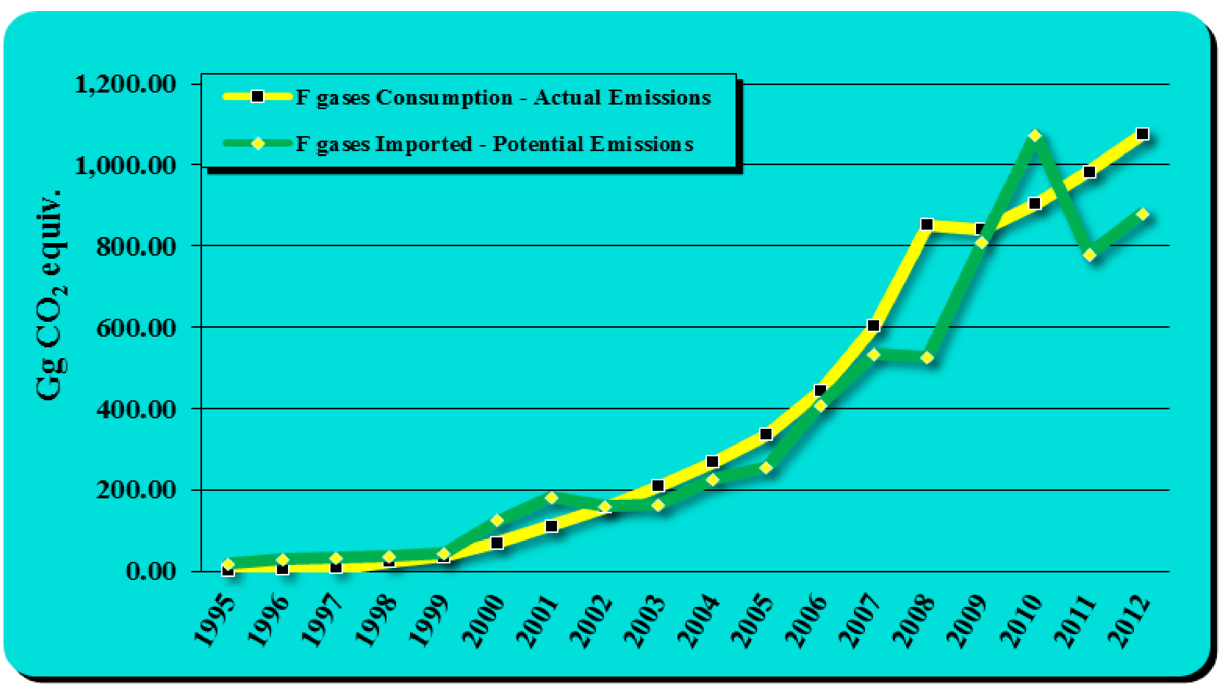
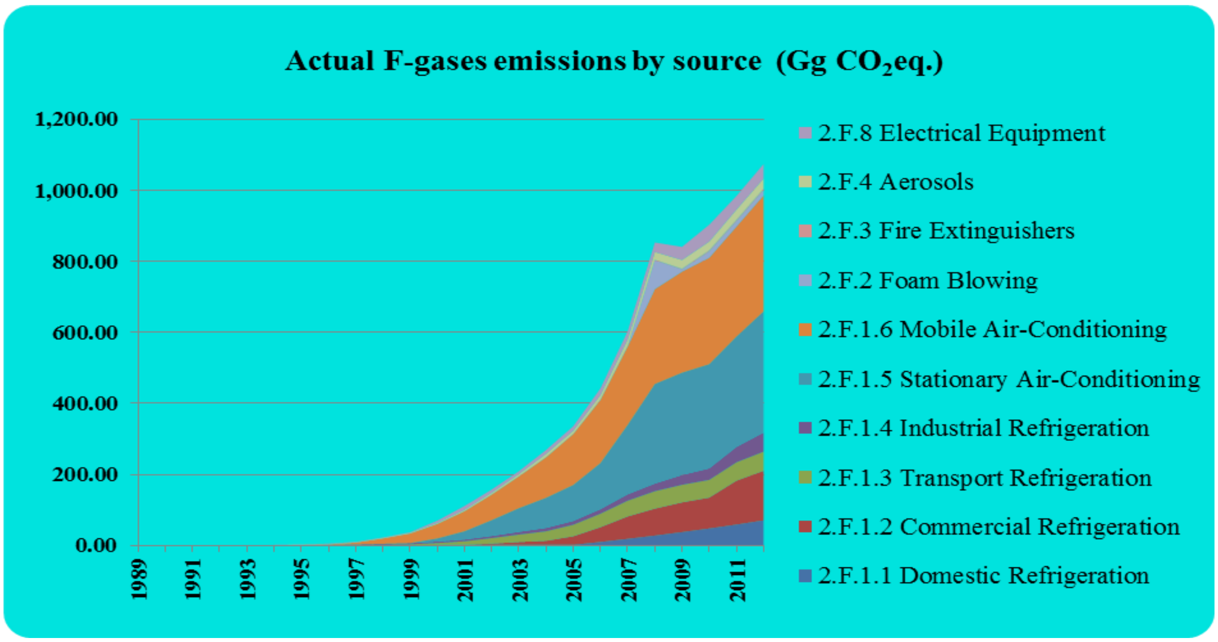


Table 4.25 The Actual and potential emissions in the Consumption of Halocarbons and SF_6 Sub-sector for 1989 – 2012 period

Year	Actual emissions (Gg CO_2eq.)	Potential emissions (Gg CO_2eq.)
1989	0.52	2.47
1990	0.55	3.22
1991	0.68	4.61
1992	0.80	5.44
1993	1.11	7.40
1994	1.74	11.48
1995	3.14	17.53
1996	5.55	27.20
1997	10.59	31.58
1998	22.96	36.28
1999	37.51	42.92
2000	70.15	123.11
2001	111.25	178.98
2002	157.72	159.74
2003	209.25	162.41
2004	269.13	225.93
2005	335.85	256.10
2006	442.43	407.94
2007	602.84	534.61
2008	852.95	526.07
2009	840.78	808.58
2010	903.03	1,072.04
2011	984.03	778.64
2012	1,074.12	880.40

There is a stable increasing trend for F-gases emissions, which is valid also for most of the subcategories (Figure 4.18). The major source of emissions is the refrigeration and air-conditioning sector, from which the most significant are mobile air-conditioning, stationary air-conditioning and commercial refrigeration subcategories.

Figure 4.18 Actual F–gases emissions by source for 1989–2011 period [Gg CO_2 equiv.]



The emission estimates include emissions from manufacturing, operation and decommissioning of equipment containing F-gases. The preferred approach for most of the subcategories is the bottom-up approach (Tier 2), while the choice of emission factors is mostly based on the default IPCC values or it is based on recent EU studies. The potential emissions have also been estimated individually for each subcategory, based on the quantities of new F-gases, introduced on the market (as a virgin chemical used for servicing or contained in equipment).

4.7.2 Methodological issues

Refrigeration and Air Conditioning Equipment (CRF Category 2.F.1)

Refrigeration and Air Conditioning (RAC) Equipment (2.F.1) is a key category from both level and trend point of view (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF).

Domestic Refrigeration (CRF Category 2.F.1.1)

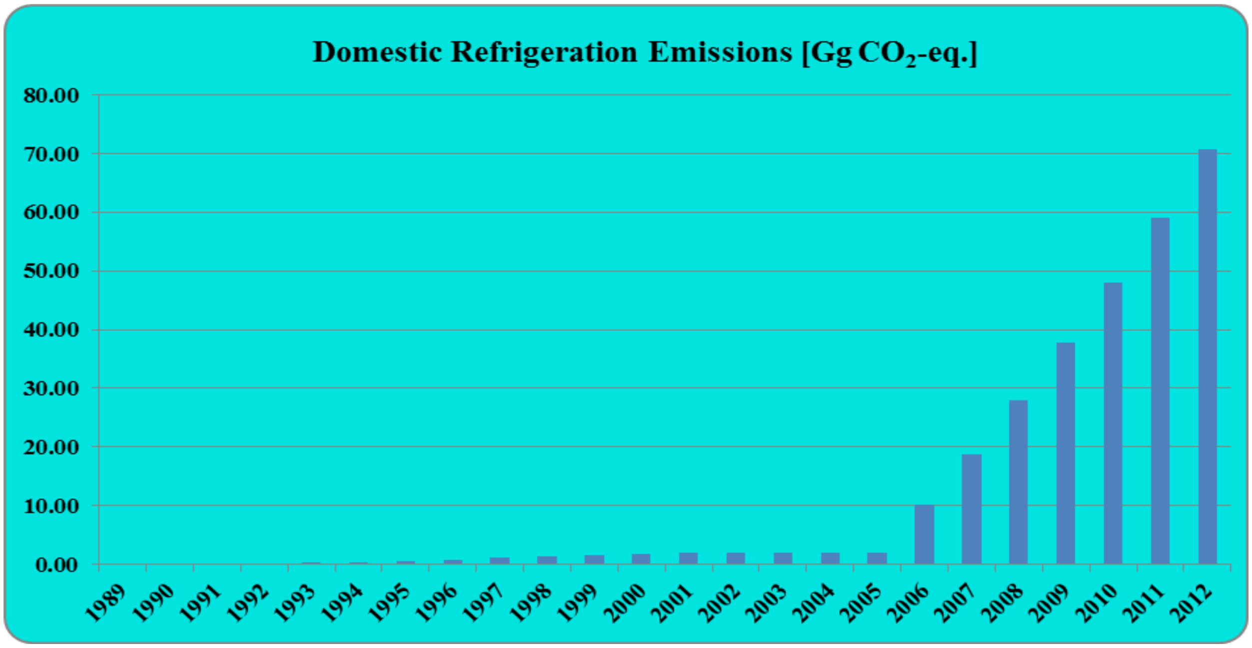
Methodology

Domestic refrigeration is an important source of F-gases emissions due to the large number of refrigerators in operation. Unlike other RAC equipment, domestic refrigerators usually contain a very small amount of refrigerants and do not require a regular maintenance or refilling of refrigerant.

In order to estimate the emissions from this subcategory was applied a bottom-up Tier 2 approach, which considers the emissions from manufacturing, operation and disposal of domestic refrigeration equipment.

The actual emissions for the period 1989 – 2012 are represented on the Figure 4.19.

Figure 4.19 Actual emissions of the Domestic Refrigeration for 1989–2012 period [Gg CO_2 equiv.]



The increase of the emissions after 2006 is due to the disposal of old equipment, as the first equipment introduced in the market in 1991 started to be decommissioned.

The actual emissions for 2012 year from production, operation and decommissioning are equal to 70.8 Gg CO_2eq., of which operation emissions are equal to 1.2 Gg.

The detailed results are presented in the Table 4.26.

Table 4.26 The result detailed of the Domestic Refrigeration for 1989-2012 period

Year	Produced units	Units placed on the market	HFCs used for production [t]	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC-134a]	Operation emissions [kg HFC-134a]	Disposal emissions [kg HFC-134a]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**
1990	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**
1991	18,181.00	54,428.00	2.00	7.00	7.00	13.00	20.00	0.00	**0.00**	**8.00**
1992	41,027.00	112,806.00	5.00	14.00	20.00	30.00	60.00	0.00	**0.00**	**18.00**
1993	69,253.00	174,916.00	8.00	21.00	41.00	50.00	123.00	0.00	**0.00**	**27.00**
1994	103,852.00	240,959.00	12.00	29.00	70.00	75.00	209.00	0.00	**0.00**	**38.00**
1995	145,893.00	310,973.00	18.00	37.00	107.00	105.00	321.00	0.00	**1.00**	**49.00**
1996	196,894.00	385,532.00	24.00	46.00	153.00	142.00	458.00	0.00	**1.00**	**60.00**
1997	258,996.00	465,793.00	31.00	56.00	208.00	186.00	625.00	0.00	**1.00**	**73.00**
1998	333,580.00	551,042.00	40.00	66.00	274.00	240.00	821.00	0.00	**1.00**	**86.00**
1999	323,440.00	490,780.00	39.00	59.00	332.00	233.00	995.00	0.00	**2.00**	**77.00**
2000	305,233.00	425,453.00	37.00	51.00	382.00	220.00	1 146	0.00	**2.00**	**66.00**
2001	277,187.00	354,929.00	33.00	43.00	423.00	200.00	1 270	0.00	**2.00**	**55.00**
2002	237,472.00	279,335.00	28.00	34.00	456.00	171.00	1 367	0.00	**2.00**	**44.00**
2003	147,929.00	161,146.00	18.00	19.00	474.00	107.00	1 421	0.00	**2.00**	**25.00**
2004	121,632.00	114,059.00	15.00	14.00	486.00	88.00	1 457	0.00	**2.00**	**18.00**
2005	43,075.00	40,087.00	5.00	5.00	489.00	31.00	1 468	0.00	**2.00**	**6.00**
2006	59,806.00	43,971.00	7.00	5.00	487.00	43.00	1 460	6 244	**10.00**	**7.00**
2007	67,442.00	59,430.00	8.00	7.00	479.00	49.00	1 438	12 940	**19.00**	**9.00**
2008	61,455.00	48,547.00	7.00	6.00	464.00	44.00	1 391	20 065	**28.00**	**8.00**
2009	58,843.00	34,436.00	7.00	4.00	439.00	42.00	1 317	27 641	**38.00**	**5.00**
2010	68,549.00	50,242.00	8.00	6.00	408.00	49.00	1 224	35 672	**48.00**	**8.00**
2011	76,357.00	37,497.00	9.00	4.00	367.00	55.00	1 101	44 225	**59.00**	**6.00**
2012	100,423.00	47,576.00	12.00	6.00	318.00	72.00	954.00	53 432	**71.00**	**7.00**

Activity data

The activity data for this category was received from the National Institute for Statistics (NIS). For some of the equipment types the data was not given in number of units, but instead in tons. In order to estimate the number of units per category was used data for imports in Bulgaria in units and kilograms, according to the assumptions presented in Table 4.27.

Table 4.27 Assumptions on data for imports in Bulgaria for Domestic Refrigeration

CN code	Equipment type	kg/unit
84181020	Combined refrigerator-freezers, of a capacity > 340 l, fitted with separate external doors	77
84181080	Combined refrigerator-freezers, of a capacity <= 340 l, fitted with separate external doors	60
841821	Household refrigerators, compression-type	45
84183020	Freezers of the chest type, of a capacity <= 400 l	50
84183080	Freezers of the chest type, of a capacity > 400 l but <= 800 l	60
84184020	Freezers of the upright type, of a capacity <= 250 l	45
84184080	Freezers of the upright type, of a capacity > 250 l but <= 900 l	67
841869	Refrigerating or freezing equipment (excl. refrigerating and freezing furniture)	31

The provided data for the production of domestic refrigerators was for the period 2003-2012, and for the imports and exports it was for the period 2000-2012. For the rest of the timeseries the number of units was estimated using regression analysis based on the data for the Gross Domestic Product (GDP) of Romania for the period 1989-2012.

For the last year the domestic production of refrigerators is around 2 mln. units, but the major part of those is exported. Around 950 000 units were placed on the market in 2012, but only a small amount (5%) is assumed to be HFC-containing units, while the rest are supposed to use hydrocarbons (HC-600a or HC-290). In order to estimate the quantity of F-gases, contained in domestic refrigeration equipment was assumed an average quantity of 0.12 kg of refrigerant agent per unit (EC 2011).

With the above assumptions it was estimated that for 2012 year around 12 t of refrigerant have been used for production of domestic refrigerators and around 6 t of refrigerants have been introduced to the market as contained in equipment.

To estimate the quantity of banks in a particular year n, the equation 4.12 has been used.

Equation 4.12 The quantity of banks for Domestic Refrigeration

$$Banks_n = Banks_{n-1} + HFC\ in\ new\ units_n – Emissions\ from\ operation_{n-1} - Disposal_n$$

For the disposal emissions was assumed that the equipment lifetime is 15 y, which is the upper range according to the 2000 IPCC GL. It is possible that the average equipment lifetime is actually higher in Romania, but since this assumption is hard to be verified, a conservative assumption was taken. Effectively, with this assumption the emissions from disposal are calculated as the remaining refrigerant in all the equipment, which was introduced in the market 15 years ago. Disposal emissions start to occur since 2006 year, following the assumption that the first HFC-containing equipment was introduced in the market in 1991 year.

Emission factors

The manufacturing emissions are calculated as a percentage of the initial charge that is released during assembly. The emission factor used for estimating the manufacturing emissions is the default Emission Factor (EF) of 0.6% from the 2000 IPCC GPG. The operation emissions are calculated based on The EF for operation is 0.3% annual leak rate as a percentage of total charge. This is the default EF from the 2000 IPCC GPG and the same EF is also used in various studies as EC 2011, the National Inventory Report (NIR) of Austria, Germany and others. Regarding the disposal EF - since the questionnaires sent to recycling companies did not provide any evidence that F-gases are reclaimed from WEEE, a conservative assumption that 100% of all remaining F-gases contained in the disposed equipment are emitted.

Commercial Refrigeration (CRF Category 2.F.1.2)

Methodology

Commercial refrigeration is an increasingly important source of Greenhouse Gas (GHG) emissions, which started to develop after 2000 with the replacement of R-22. A wide variety of installations is used - from small commercial appliances including refrigerated show-cases and counters, refrigerating furniture to large centralised supermarket refrigeration systems, which could contain from less than 3 kg to several hundred kilograms.

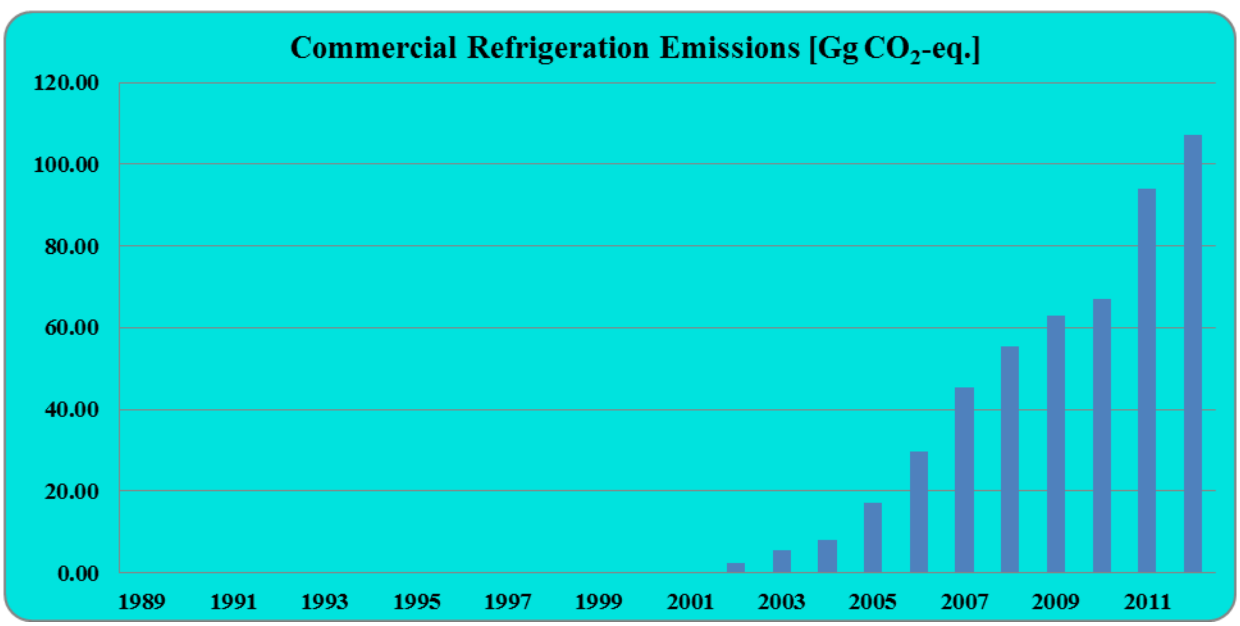
There is also a variety of HFC species, which are used for this sector, but most predominant are R-404A, R-410A, R-407C and HFC-134a.

In order to estimate the emissions from this subcategory was applied a top-down Tier 2 approach, estimating the emissions from installation and operation of equipment.

The aggregated actual emission estimates are equal to of 139.56 Gg CO_2eq. for 2012 year.

The actual emissions for the period are represented on the Figure 4.20.

Figure 4.20 Actual emissions of the Commercial Refrigeration for 1989–2012 period [Gg CO_2 equiv.]



The quantity of banked HFCs for this subcategory is estimated at 323 t in 2012 year and is presented in Table 4.28.

Table 4.28 The quantity of banked HFC of the Commercial Refrigeration for 1989-2012 period

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC]	Operation emissions [kg HFC]	Disposal emissions [kg HFC]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0	0	0	0	0	**0**	**0**
1990	0	0	0	0	0	**0**	**0**
1991	0	0	0	0	0	**0**	**0**
1992	0	0	0	0	0	**0**	**0**
1993	0	0	0	0	0	**0**	**0**
1994	0	0	0	0	0	**0**	**0**
1995	0	0	0	0	0	**0**	**0**
1996	0	0	0	0	0	**0**	**0**
1997	0	0	0	0	0	**0**	**0**
1998	0	0	0	0	0	**0**	**0**
1999	0	0	0	0	0	**0**	**0**
2000	0	0	0	0	0	**0**	**0**
2001	0	0	0	0	0	**0**	**1**
2002	6	7	0	1	0	**3**	**22**
2003	11	17	0	3	0	**8**	**51**
2004	12	26	0	4	0	**12**	**75**
2005	33	55	0	8	0	**24**	**156**
2006	48	94	0	14	0	**42**	**269**
2007	64	143	0	22	0	**63**	**411**
2008	56	178	0	27	0	**76**	**501**
2009	50	201	0	30	0	**84**	**556**
2010	41	211	0	32	0	**87**	**579**

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC]	Operation emissions [kg HFC]	Disposal emissions [kg HFC]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
2011	104	284	1	43	0	**124**	**809**
2012	83	323	0	49	0	**140**	**923**

Activity data

The task to estimate the emissions from this sector is complex because it is more heterogeneous in terms of equipment characteristics: design, size, type of refrigerant, the amount of losses and more. In contrast to household refrigeration equipment or automotive air conditioning systems, systems that are manufactured in batch production are in smaller quantities than those produced on demand.

Most of the emissions from this category would result from installations containing more than 3 kg of HFCs. Since those installations are regulated by the Romanian legislation implementing EU Regulation 842/2006, operators of commercial and industrial equipment should maintain records of the quantity and type of fluorinated greenhouse gases installed, any quantities added and the quantity recovered during servicing, maintenance and final disposal. However, according to the current Romanian legislation, operators are not obliged to report on an annual basis, which is the reason why it was not possible to apply a bottom-up methodology for this subsector.

In order to obtain the required activity data, was developed a questionnaire, which was sent to all servicing companies licensed to maintain equipment containing more than 3 kg of HFCs. It was assumed, that for the servicing companies it would not be feasible to disaggregate between refrigeration and air-conditioning equipment for the full time series, so it was decided the two subcategories - commercial refrigeration and air-conditioning to be grouped and evaluated together. Most of the licensed companies (about 66%) provided the quantities of HFCs they used for servicing commercial refrigeration and air-conditioning equipment, but 27 companies did not provide any data. In order not to avoid underestimation of the emissions, the reported quantities were increased by the percentage of companies, which did not provide an answer. The companies declared the use of more than 10 different blends of HFCs, which were converted the respective quantity of HFCs according to the information provided in Table 7.8, from vol. 3 of the 2006 IPCC guidelines.

For the estimate of the emissions was developed a special model, similar to the example spreadsheet provided with the 2006 IPCC guidelines, which estimates the banked quantities of HFCs based on the quantity of used HFCs for a particular year for each particular species of HFCs.

Emission factors

The 2000 IPCC GPG and the 2006 IPCC Guidelines provide a very broad range regarding the annual leakage rate – between 10 and 30%. The emissions estimates were prepared by using an annual leakage rate of 15%, based on information provided in various studies (EC 2011, National Inventory Reports of Germany, Austria and Estonia), which is a bit conservative estimate.

The installation emissions were estimated with an EF of 1% of the total charge, which is within the proposed default range.

Since HFC containing equipment is relatively new, the estimated equipment lifetime of 15 years (EC 2011) does not presume any emissions from disposal yet.

Transport Refrigeration (CRF Category 2.F.1.3)

Methodology

Transport refrigeration is usually a minor source of F-gas emissions. According to EC 2011 study, standard refrigerant of vans had been R-12, which was replaced in new systems by HFC-134a after 1995, while common refrigerant of trucks and trailers was R-22; new systems run with R-404A, from 2001 onwards, at the latest. R-410A plays a minor role in refrigerated road vehicles and is not separately considered in the estimate.

Following the approach of various studies on the topic, transport refrigeration was divided into two subcategories – vans (corresponding to N1 and N2 vehicle categories) and trucks and trailers (corresponding to N3 vehicle category).

The IPCC guidelines do not provide special guidance regarding different subcategories of transport refrigeration and there is no difference in the proposed ranges by the 2000 IPCC GPG and 2006 IPCC Guidelines.

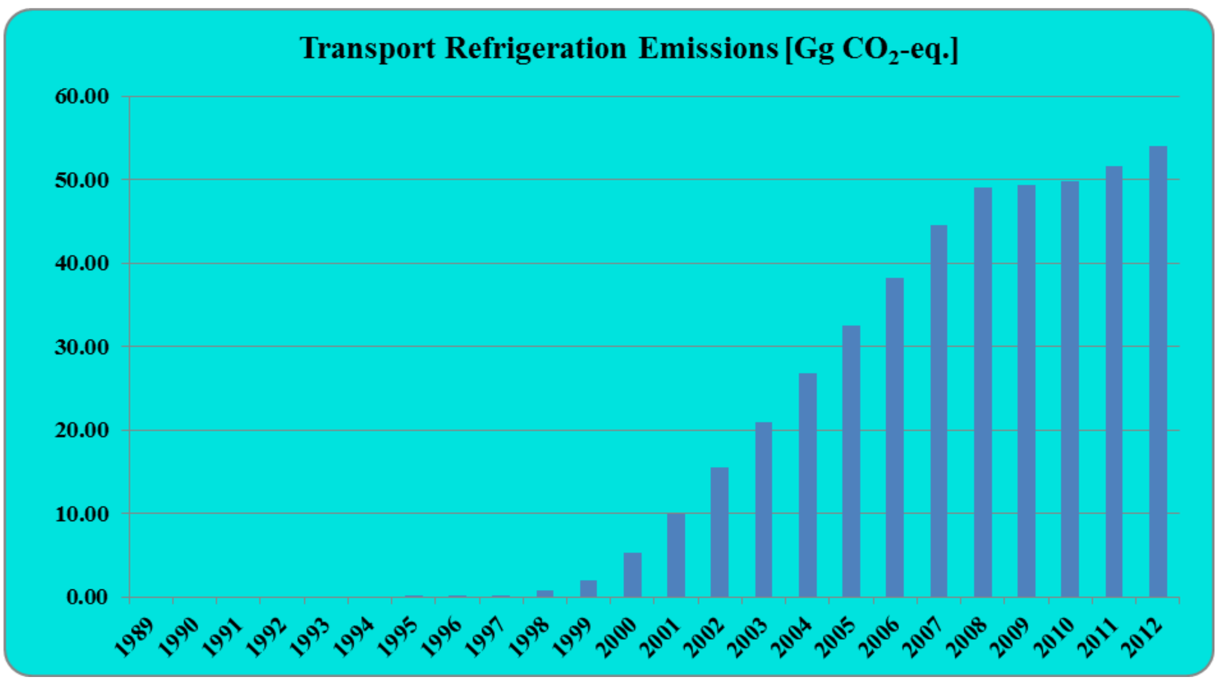
Transport refrigeration vehicles are not produced in the country, so no initial emissions were considered.

The aggregated emission estimates for the two subcategories result in total actual emissions of 54.00 Gg CO_2eq. for 2012 year, the majority of which are from refrigerated trucks.

In order to estimate the emissions from this subcategory was applied a bottom-up Tier 2 approach, estimating the emissions from operation and disposal of equipment.

The actual emissions for the period 1989–2012 are represented on the Figure 4.21.

Figure 4.21 Actual emissions of the Transport Refrigeration for 1989–2012 period [Gg CO_2 equiv.]



The quantity of banked HFCs for this subcategory is estimated at 90 t in 2012 year and is presented in Table 4.29.

Table 4.29 The quantity of banked HFC of the Transport Refrigeration for 1989-2012 period

Year	Number of trucks with HFC units	HFCs placed on the market [t]	Quantity of banks [t]	Operation emissions [kg HFC]	Disposal emissions [kg HFC]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0	0	0	0	0	**0**	**0**
1990	0	0	0	0	0	**0**	**0**
1991	0	0	0	0	0	**0**	**0**
1992	0	0	0	0	0	**0**	**0**
1993	0	0	0	0	0	**0**	**0**
1994	0	0	0	0	0	**0**	**0**
1995	20	0	0	9	20	**0**	**0**
1996	54	0	0	25	54	**0**	**0**
1997	215	0	0	97	215	**0**	**0**
1998	812	1	2	434	812	**1**	**2**
1999	1,596	1	4	947	1,596	**2**	**3**
2000	3,174	3	10	2,237	3,174	**5**	**9**
2001	5,221	4	17	3,968	5,221	**10**	**11**
2002	7,271	4	26	5,880	7,271	**15**	**10**
2003	9,376	3	35	7,805	9,376	**21**	**7**
2004	11,476	3	45	9,829	11,476	**27**	**9**
2005	13,591	3	54	11,815	13,591	**32**	**6**
2006	15,762	4	63	13,833	15,762	**38**	**10**
2007	17,903	6	73	15,969	17,903	**44**	**18**
2008	19,890	6	81	17,670	19,890	**49**	**18**
2009	20,291	1	82	17,857	20,291	**49**	**1**
2010	20,522	1	83	18,040	20,522	**50**	**2**
2011	21,559	3	86	18,774	21,559	**52**	**8**
2012	23,001	4	90	19,775	23,001	**54**	**11**

Activity data

Since the reporting of refrigeration vehicles is not obligated by the Romanian legislation, activity data for this subsector is hard to obtain. Having in mind that the possible large number of transport companies, it is not feasible to identify those companies and to collect activity data by questionnaires. There is no official data on the total number of refrigerated vehicles in the country and there are no separate CN codes for those vehicles, which could be tracked trough national statistics. Questionnaires were sent to railway freight operation companies – neither of the companies reported ownership of refrigerated cars or the usage of F-gases.

The emission estimates were prepared based on the total number of trucks in the country, provided by the National Environmental Protection Agency (NEPA). As with the mobile air conditioning sector, an attempt to analyse the vehicle sales websites was performed, but the available search filters were very limited in addition to the relatively small number of trucks being sold on most of the websites. Based on this data and on data on the number of refrigerated trucks in other countries (Germany, Bulgaria) was made an assumption, that the refrigerated vehicles are equal to 3% of all vans and 6% of all trucks, which would estimate the vehicle fleet in 2012 as about 12,000 refrigerated vans and 11,000 refrigerated trucks and trailers. As an additional check to confirm this estimate was analysed data about the total number of refrigerated vehicles in Europe, which according to the EU 2011 study consists of 400,000 vans, 200,000 trailers and 220,000 trucks. Based on whether we choose GDP or population, the Romanian share could be estimated between 11,000 and 38,000 refrigerated vehicles.

Compared to other subcategories from the refrigeration and air conditioning category, the transition from R-22 to HFCs happened with some delay, which might be even bigger for Romania. In order to estimate the total number of refrigeration trucks with HFC-containing units, was used the available data from the EC 2011 report – the estimated total number of refrigerated vehicles was multiplied by the respective percentage for the particular year. Numbers in bold were provided in the report, while the rest were interpolated (Table 4.30).

Table 4.30 The total number of Refrigeration trucks with HFC-containing units for 1993-2012 period

Year	**% N1 and N2 trucks with HFC units**	**% N3 trucks with HFC units**
1993	0%	0%
1994	0%	0%
1995	**13%**	**0%**
1996	26%	0%
1997	**38%**	**0%**
1998	51%	5%
1999	**63%**	**9%**
2000	76%	20%
2001	**88%**	**31%**
2002	94%	44%
2003	**100%**	**56%**
2004	100%	69%
2005	**100%**	**81%**
2006	**100%**	**91%**
2007	**100%**	**98%**
2008	**100%**	**100%**
2009	100%	100%
2010	100%	100%
2011	100%	100%
2012	100%	100%

For assessing the banked quantities of HFC in refrigerated vehicles were chosen the values of 1.5 kg of refrigerant per refrigerated van and 6.5 kg per truck or trailer (EC 2011).

For the estimate of the disposal emissions has to be considered the average vehicle lifetime. The 2000 IPCC GPG and the 2006 IPCC Guidelines provide a range of 6 to 9 years. However, the analysis of the data about the age distribution of the vehicle fleet in Romania (explained in detail in the mobile air conditioning category) suggests that the expected vehicle lifetime could be much higher, even by using the vehicle as a non-refrigerated vehicle at the end of its lifetime. An average vehicle lifetime of 15 years for both van and trucks was assumed for Romania. This would presume that decommissioning emissions started to occur in 2010. The model also assumes that the vehicle was not maintained (e.g. refrigeration unit has not been refilled) in the last 5 years before decommissioning.

Emission factors

Both the 2000 IPCC GPG and the 2006 IPCC Guidelines provide a very broad range regarding the annual leakage rate – between 15 and 50%. The emissions estimates were prepared by using an annual leakage rate of 30% for vans and 20% for trucks and trailers, as suggested by the EC 2011 study.

Since vehicle decommissioning companies in the country have not declared any reclaimed quantities of F-gases from decommissioned vehicles, it was assumed that 100% of the remaining quantities of F-gases are emitted at decommissioning.

Industrial Refrigeration (CRF Category 2.F.1.4)

Methodology

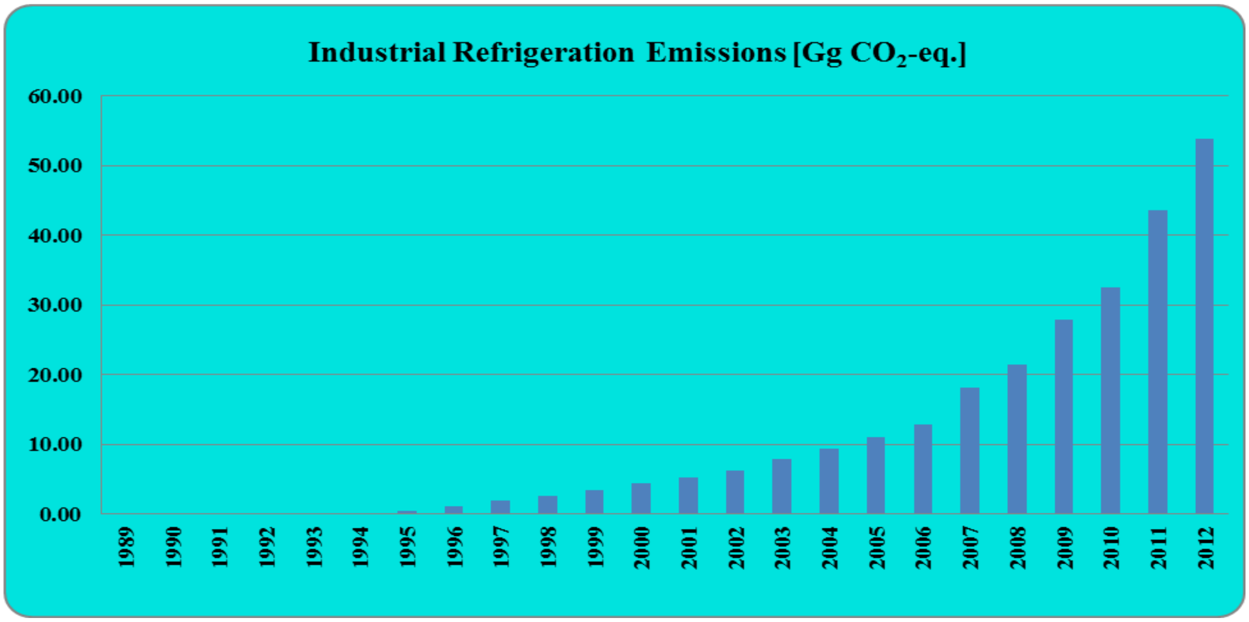
Industrial refrigeration is also an important source of HFC emissions. Similar to commercial refrigeration, after the ban on the CFCs use, imposed by the Montreal Protocol, the main substitute on the market became different types of HFCs. The transition seems to have started as early as 1995 for a limited number of installations, but the significant growth did not start until 2005. This subcategory is also characterised by a wide variety of installations in operation and also a variety of HFC species, with the most predominant being R-404A, HFC-134a, R-407C and R-410A.

The aggregated actual emission estimates are equal to of 53.87 Gg CO_2eq. for 2012 year.

In order to estimate the emissions from this subcategory was applied a top-down Tier 2 approach, estimating the emissions from installation and operation of equipment.

The actual emissions for the period 1989-2012 are represented in the Figure 4.22.

Figure 4.22 Actual emissions of the Industrial Refrigeration for 1989–2012 period [Gg CO_2 equiv.]



The quantity of banked HFCs for this subcategory is estimated at 192 t in 2012 year and is presented in Table 4.31.

Table 4.31 The quantity of banked HFC of the Industrial Refrigeration for 1989-2012 period

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC]	Operation emissions [kg HFC]	Disposal emissions [kg HFC]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0	0	0	0	0	**0**	**0**
1990	0	0	0	0	0	**0**	**0**
1991	0	0	0	0	0	**0**	**0**
1992	0	0	0	0	0	**0**	**0**
1993	0	0	0	0	0	**0**	**0**

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC]	Operation emissions [kg HFC]	Disposal emissions [kg HFC]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1994	0	0	0	0	0	**0**	**0**
1995	1	1	0	0	0	**0**	**4**
1996	2	3	0	0	0	**1**	**11**
1997	3	6	0	1	0	**2**	**18**
1998	3	8	0	1	0	**3**	**26**
1999	3	10	0	1	0	**3**	**34**
2000	4	13	0	1	0	**4**	**42**
2001	4	16	0	2	0	**5**	**51**
2002	5	20	0	2	0	**6**	**61**
2003	8	26	0	3	0	**8**	**78**
2004	8	32	0	3	0	**9**	**93**
2005	8	37	0	4	0	**11**	**108**
2006	10	43	0	4	0	**13**	**126**
2007	21	60	0	6	0	**18**	**176**
2008	19	72	0	7	0	**22**	**212**
2009	32	97	0	10	0	**28**	**272**
2010	28	115	0	12	0	**32**	**314**
2011	50	153	0	15	0	**44**	**416**
2012	55	192	0	19	0	**54**	**518**

Activity data

This subcategory is very similar to the commercial refrigeration, since the required data was collected with the same questionnaires and from the same servicing companies.

In the estimates for this category are also considered both the industrial refrigeration and air-conditioning systems. The quantities reported by the servicing companies were also increased with an appropriate percentage, in order not to avoid underestimation of the emissions due to missing information. The companies declared the use of more than 10 different blends of HFCs, which were converted the respective quantity of HFCs according to the information provided in Table 7.8, from vol. 3 of the 2006 IPCC guidelines.

For the estimate of the emissions was used the same model as for the commercial refrigeration, partly based on the example spreadsheet provided with the 2006 IPCC guidelines, which estimates the banked quantities of HFCs based on the quantity of used HFCs for a particular year for each particular species of HFCs. For a detailed description of the methodology please consult the commercial refrigeration subcategory.

Emission factors

The 2000 IPCC GPG and the 2006 IPCC Guidelines provide a very broad range regarding the annual leakage rate – between 7 and 25%. The emissions estimates were prepared by using an annual leakage rate of 10%, based on information provided in various studies (EC 2011, National Inventory Reports of Germany, Austria and Estonia).

The installation emissions were estimated with an EF of 1% of the total charge, which is within the proposed default range.

For this category the use of HFCs started a bit earlier compared to commercial refrigeration. Although according to the IPCC guidelines the equipment lifetime could be from 10 to 20 years, so an average equipment lifetime of 15 years was assumed. Emissions from disposal started to occur in 2010 year, but are relatively small. Since all operations are performed by trained personnel, the default assumption from the 2000 IPCC Guidelines about 85% recovery efficiency was adopted.

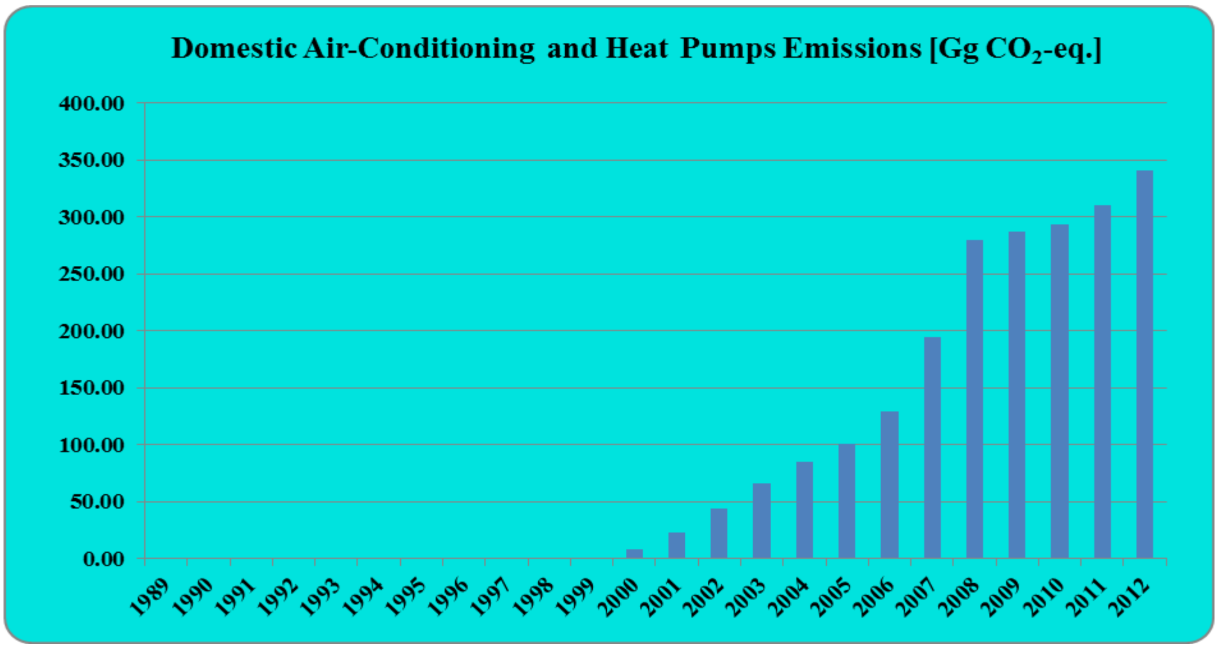
Domestic Air-Conditioning (CRF Category 2.F.1.5)

Methodology

Domestic air-conditioning is one of the fastest growing subsectors from all F-gas emissions, which is due to the rapidly increasing number of air-conditioning units in operation since 2000. Due to the relatively high annual leakages compared to domestic refrigeration, the units have to be serviced several times during their lifetime. In this subcategory are also considered heat pumps, which contain higher quantity of refrigeration agent, compared to air-conditioners. For this subcategory is followed the same methodological bottom-up Tier 2 approach, as for the domestic refrigeration.

The actual emissions for the period are represented in the Figure 4.23.

Figure 4.23 Actual emissions of the Domestic Air-Conditioning for 1989-2012 period [Gg CO_2 equiv.]



Compared to domestic refrigeration, although the domestic air-conditioning containing HFCs was introduced later in the market, it contains much higher refrigerant per unit, which leads to rapid build of HFC banks in AC equipment – in 2012 year banked quantities are equal to more than 3,800 tons, with additional 420 tons in heat pump units (Table 4.32). Combined with a higher operation emission factor (related to domestic refrigeration), this leads to significant emission equal to 316.2 Gg CO_2eq. from AC equipment and 24.7 Gg CO_2eq. from heat pumps, which are result of mostly operation emissions. Since this equipment is relatively new, it is not expected to produce decommissioning emissions until 2015, but after that the emissions from decommissioned stocks are expected to be significant, if the current decommissioning practices in Romania are not changed.

Table 4.32 The quantity of banked HFC of the Domestic Air-Conditioning for 1989-2012 period

Year	Produced units	Units placed on the market	HFCs used for production [t]	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFCs]	Operation emissions [kg HFCs]	Disposal emissions [kg HFCs]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0
2000	28	63,241	0	109	109	0	4,952	0	8	142
2001	112	115,162	0	187	292	1	13,572	0	23	270
2002	251	173,496	0	281	559	2	26,237	0	44	409
2003	447	188,789	1	300	832	4	39,387	0	66	450
2004	46	174,358	0	283	1,076	1	50,888	0	84	396
2005	0	151,391	0	244	1,292	0	61,097	0	101	369
2006	0	239,787	0	385	1,657	0	78,446	0	130	600
2007	5,298	532,436	8	820	2,459	48	117,827	0	195	1,360
2008	5,835	728,756	9	1,108	3,514	53	170,161	0	280	1,861
2009	2,991	129,844	4	202	3,607	27	174,605	0	288	391
2010	0	122,350	0	191	3,676	0	177,891	0	293	362
2011	0	199,237	0	309	3,890	0	188,307	0	310	591
2012	0	250,740	0	383	4,267	0	207,011	0	341	889

Activity data

As with the domestic refrigeration, the activity data for this category was also not given in number of units, but instead in tons. In order to estimate the number of units per category was used data for imports in Bulgaria in units and kilograms, according to the assumptions presented in Table 4.33.

Table 4.33 Assumptions on data for imports in Bulgaria for Domestic Air-Conditioning

CN code	Equipment type	kg/unit
841510	Window or wall air conditioning machines, self-contained or "split-system"	44
841581	Air conditioning machines incorporating a refrigerating unit and a valve for reversal of the cooling-heat cycle "reversible heat pumps" (excl. of a kind used for persons in motor vehicles and self-contained or "split-system" window or wall air conditioning	51
841582	Air conditioning machines incorporating a refrigerating unit but without a valve for reversal of the cooling-heat cycle (excl. of a kind used for persons in motor vehicles, and self-contained or "split-system" window or wall air conditioning machines)	51
841861	Heat pumps (excl. air conditioning machines of heading 8415)	64

The same data extrapolations for the period before 2000 year were made regarding the total number of air-conditioning units introduced in the market, although for this category this data is not relevant. According to UNEP report (UNEP 2010), nearly all air conditioners manufactured prior to 2000 year used HCFC-22. The phase-out of HCFC-22 in the manufacturing of new products in the EU was completed in 2004 year. In order to reflect this in the emission estimates a linear growth regarding the new air-conditioning units containing HFCs was assumed from year 2000 to 2004. For heat pumps it is assumed that all units manufactured after 2000 year are HFC-containing.

The domestic production has a very unstable trend and there is no production in the last 3 years. In general, the domestic production is insignificant compared to the imports. Around 244,000 AC units and 6,000 heat pumps were placed on the market in 2012 year, with the assumption that all of them are HFC-containing units.

In order to estimate the quantity of F-gases, contained in domestic air-conditioning equipment was assumed an average quantity of 1.5 kg of refrigerant agent per AC unit (EC 2011, UK GHG Inventory). For heat pumps the assumed average quantity of refrigerant is 2.6 kg (EC 2011). With the above assumptions it was estimated that for 2012 year around 366 t of refrigerant have been introduced to the market as contained in AC equipment and 17 t in heat pumps.

To estimate the quantity of banks in a particular year n, the equation 4.13 has been used.

Equation 4.13 The quantity of banks of the Domestic Air-Conditioning

$$Banks_n = Banks_{n-1} + HFC\ in\ new\ units_n + HFC\ for\ servicing_n -$$
$$- Emissions\ from\ operation_{n-1} - Disposal_n$$

The standard formula was extended in order for the model to reflect in a better way the servicing of equipment and to avoid overestimation of the emissions. Since the air-conditioning equipment needs to be refilled with refrigerant on a regular intervals in order to restore its efficiency, it was assumed that on average every 5 years the equipment has to be topped up to its original capacity, or in other words, in a particular year during servicing are refilled the lost quantities of refrigerant, which were emitted in the last 5 years.

For the disposal emissions was assumed that the equipment lifetime is 15 years, which is the upper range according to the 2000 IPCC GL. This value is higher than the assumed average European AC unit lifetime of 10 years (EC 2011), but it was chosen because of the assumption that the lower living standard in Romania leads to longer equipment lifetime. With this assumption the emissions from disposal are calculated as the remaining refrigerant in all the equipment, which was introduced in the market 15 years ago. Disposal emissions are expected to occur in 2015, when the first HFC-containing equipment introduced in the market is expected to be decommissioned.

Domestic air-conditioning equipment containing HFCs is distributed between R-407C and R-410A with assumed ratio 40:60 (AEA 2003). Each of those blends is disaggregated to HFC compounds (HFC-32, HFC-125 and HFC-134a) and total emissions are calculated separately based on the specific GWP of each gas.

For heat pumps studies have shown, that the refrigeration agents in use are R-407C, R-410A, R-404A, but their usage changes during the years. The refrigerant split is adopted from the EC 2011 study and are shown in Table 4.34.

Table 4.34 Assumptions on data for imports in Bulgaria for Domestic Air-Conditioning

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
R-407C	80%	77%	75%	70%	60%	55%	50%	45%	40%	30%
R-410A	0%	3%	5%	10%	30%	40%	45%	50%	60%	70%
R-404A	20%	20%	20%	20%	10%	5%	5%	5%	0%	0%

From 2009 year onwards, the refrigerant split remains constant.

Emission factors

The emission factor used for estimating the manufacturing emissions is the default EF of 0.6% from the 2000 IPCC GPG. The operation emissions are calculated based on The EF for operation is 5.0% annual leak rate for AC units and 3.5% for heat pumps as a percentage of total charge (EC 2011). This is within the default EF range from the 2000 IPCC GPG. Regarding the disposal EF is taken the same conservative assumption as with refrigeration equipment, that 100% of all remaining F-gases contained in the disposed equipment are emitted.

Mobile Air-Conditioning (CRF Category 2.F.1.6)

Methodology

In general, the emissions from Mobile Air Conditioning (MAC) units contribute a significant share from the total F-gases emissions due to the large number of vehicles and the relatively high annual leakage rate. For MAC units there is only one type of HFC, which is used – HFC-134a.

In order to precise the emission estimates, mobile air conditioners were divided into three subcategories – used in cars, trucks and buses, since each of them has its own specifics that need to be addressed, although the IPCC guidelines do not provide special guidance regarding different subcategories of mobile air conditioners. In addition, the IPCC guidelines also do not take into account the quantities of refrigerant over 1.5 kg and therefore offer no default emission factors for such systems, although quantities over 1.5 kg for bus air-conditioners are often used.

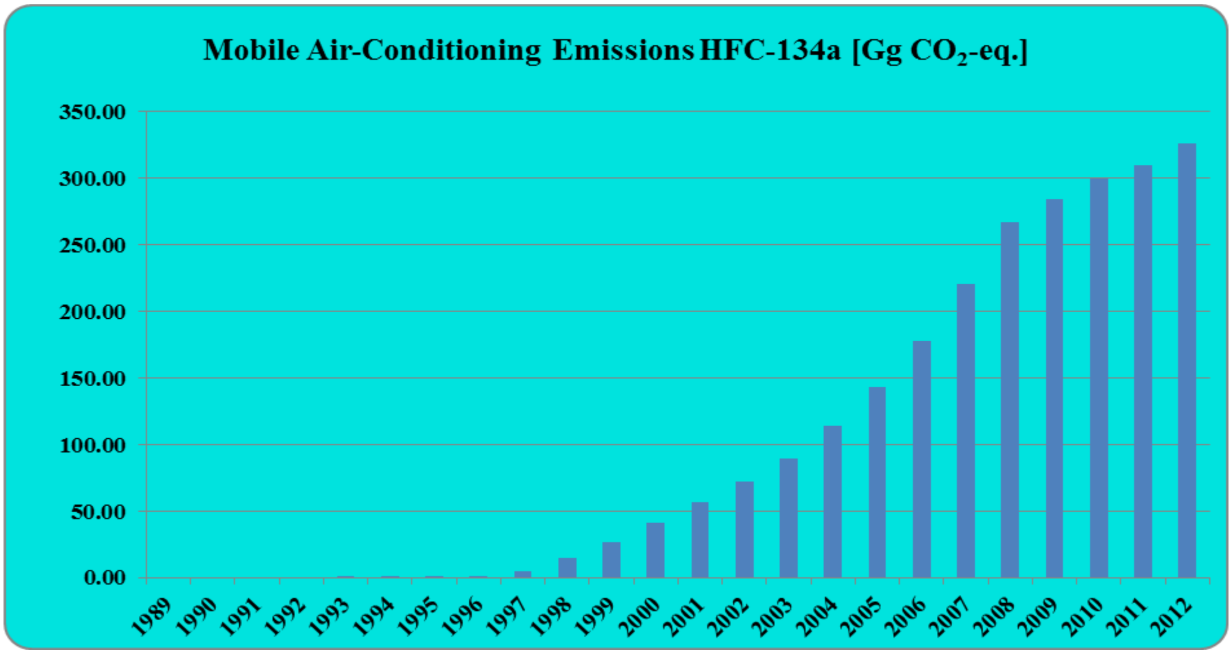
There are three major automobile producers in the country, so the emission estimates also consider initial emissions from mobile air conditioning production.

The aggregated emission estimates for all three subcategories result in total actual emissions of 326.66 Gg CO_2eq. for 2012, the majority of which are from passenger cars.

In order to estimate the emissions from the mobile air conditioning subcategory, was applied a bottom-up Tier 2 approach, which considers the emissions from manufacturing, operation and disposal of vehicles. This subcategory is a key category. A detailed model for the emissions calculation from each subsector had to be created in order to estimate the Romanian market.

The actual emissions for the period 1989–2012 are represented on the Figure 4.24.

Figure 4.24 Actual emissions of the Mobile Air-Conditioning for 1989–2012 period [Gg CO_2 equiv.]



The initial emissions are estimated to be around 1 t of HFC-134a, while the operation emissions are around 250 t. There is a large quantity of banked HFCs, estimated at 2,337 t in 2012 year and is presented in Table 4.35.

Table 4.35 The quantity of banked HFC of the Mobile Air-Conditioning for 1989-2012 period

Year	Produced vehicles with MAC units	Total number of vehicles with MAC units	HFCs used for production [t]	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC-134a]	Operation emissions [kg HFC-134a]	Disposal emissions [kg HFC-134a]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	2,258	202	2	0	0	11	53	0	0	0
1994	5,384	1,041	5	0	2	24	198	0	0	0
1995	8,577	3,240	8	1	4	39	514	0	1	1
1996	13,870	8,073	12	2	9	60	1,097	0	2	2
1997	20,927	34,636	18	19	35	88	3,918	0	5	24
1998	30,029	106,324	24	59	105	122	11,577	0	15	76
1999	41,511	188,082	33	68	184	164	20,565	0	27	88
2000	55,817	270,830	43	86	272	213	31,164	0	41	111
2001	66,997	367,328	50	85	372	250	43,175	0	56	110
2002	80,388	478,086	58	62	476	291	55,253	0	72	80
2003	68,298	621,622	48	52	597	241	68,784	0	90	67
2004	92,405	839,645	63	69	772	317	87,658	0	114	90
2005	170,519	1,117,594	114	74	982	570	109,948	0	144	97
2006	194,802	1,466,454	128	110	1,233	642	135,939	0	178	143
2007	224,742	1,927,514	146	140	1,553	730	168,990	0	221	182
2008	225,569	2,424,280	146	212	1,896	728	204,862	0	267	276
2009	274,307	2,658,759	175	88	2,027	874	218,061	0	285	114
2010	323,105	2,871,237	204	34	2,138	1,021	229,545	0	300	44
2011	309,193	3,015,105	195	19	2,214	977	237,454	0	310	25
2012	318,853	3,229,570	201	88	2,337	1,003	250,274	0	327	114

Activity data

In order to assess the manufacturing emissions, questionnaires were sent to the Romanian automobile producers, but since not all companies replied, the collected data was used only for verification purposes.

Two major sources of information were used – the NIS provided information regarding the production, import and export of vehicles, concerning 38 different CN codes and 24 PRODCOM codes. The data was available since 2000 regarding the imports and exports and since 2003 regarding the production. The missing data for the rest of the time series was produced using regression analysis based on the data for the GDP of Romania for the period 1989-2012.

Regarding passenger cars, for the period 2003-2012 around 30 to 50% of the newly registered vehicles were produced in Romania. From the imported cars around 80% are new cars, with 20% being second hand cars. Based on this, we could conclude that regarding newly registered vehicles, the Romanian fleet is not very different from the vehicle fleet in Europe, since the import of second hand passenger cars does not play a significant role. The situation with the trucks market is different – except for the N1 category trucks, which we believe are very similar to passenger cars, N2 and N3 category trucks are produced in very small numbers in Romania and are mostly imported.

The most important information was the data provided by NEPA, which was the number of registered passenger cars disaggregated by vehicle age, the number of trucks disaggregated by loading capacity and the number of busses for each year from 1993 to 2012. Since HFC usage in MAC units starts around 1993, the data for the previous years was not relevant.

The estimate on the number of cars with air conditioning units was based on several additional sources of information and data processing. The first source of information was the EC 2011 study, which provides an estimate of the average percentage of new cars with AC according to the year of production for selected years. Based on this data and the data about the age structure of the vehicle fleet, was calculated the MAC percentage for each year of the time series. The MAC quotas for trucks and busses were taken from the EC 2011 study and interpolated for the years, for which no data is provided.

Table 4.36 The number of new cars, all cars, trucks and busses with HFC-containing units of MAC for1993-2012 period

Year	% new cars with AC units produced in that year	% all cars with AC units from the total vehicle fleet	% new N1 trucks with AC units produced in that year	% all N1 trucks with AC units from the total vehicle fleet	% new N2 trucks with AC units produced in that year	% all N2 trucks with AC units from the total vehicle fleet	% new N3 trucks with AC units produced in that year	% all N3 trucks with AC units from the total vehicle fleet	% new busses with AC units produced in that year	% all busses with AC units from the total vehicle fleet
1993	**9%**	0%	**0%**	**1%**	**0%**	**2%**	**1%**	**3%**	**3%**	**34%**
1994	**18%**	1%	**0%**	**3%**	**1%**	**4%**	**5%**	**20%**	**7%**	**40%**
1995	**25%**	3%	**1%**	**4%**	**1%**	**8%**	**1%**	**3%**	**12%**	**44%**
1996	36%	5%	2%	6%	2%	10%	5%	20%	17%	46%
1997	47%	11%	3%	8%	4%	13%	1%	3%	22%	48%
1998	58%	15%	4%	9%	5%	15%	5%	20%	27%	50%
1999	69%	16%	5%	11%	7%	18%	1%	3%	32%	52%
2000	**80%**	16%	**6%**	**13%**	**8%**	**20%**	**5%**	**20%**	**37%**	**54%**
2001	83%	17%	8%	17%	11%	23%	1%	3%	40%	55%
2002	86%	19%	10%	20%	13%	26%	5%	20%	43%	55%
2003	88%	22%	13%	24%	16%	30%	1%	3%	47%	56%
2004	91%	27%	15%	27%	18%	33%	5%	20%	50%	56%
2005	**94%**	34%	**17%**	**31%**	**21%**	**36%**	**1%**	**3%**	**53%**	**57%**
2006	94%	40%	20%	34%	24%	37%	5%	20%	54%	57%
2007	95%	49%	24%	37%	27%	39%	1%	3%	55%	57%
2008	95%	54%	27%	39%	29%	40%	5%	20%	55%	57%
2009	96%	57%	31%	42%	32%	42%	1%	3%	56%	57%
2010	**96%**	60%	**34%**	**45%**	**35%**	**43%**	**5%**	**20%**	**57%**	**57%**
2011	96%	63%	36%	45%	36%	43%	1%	3%	57%	57%
2012	96%	65%	38%	45%	38%	43%	5%	20%	57%	57%

The EC 2011 study provides the values formatted in bold, while the rest of the values were interpolated. The MAC quotas for passenger cars (percentages of MAC-equipped cars from the total cars in the vehicle fleet) are calculated by applying the percentage of cars with MAC units for each particular year – e.g. if N_i is the number of cars from the vehicle fleet in year *y*, which were manufactured in year *i*, and P_i is the percentage of new cars with MAC manufactured in year *i*, then the total number of cars with MAC units in year *y* is equal to equation 4.14.

Equation 4.14 The total number of cars with Mobile Air-Conditioning units in year y

$$MAC_y = N_y * P_y + N_{y-1} * P_{y-1} + \dots + N_{1993} * P_{1993}$$

In order to confirm some of the assumptions were analysed the 10 largest Romanian websites for trade of new and used cars by performing different searches on the available ads. The total number of vehicles on sale was more than 180,000, but the level of ad details and the available search options were very limited in order to produce any significant results. Some of the websites showed that around 80% of the vehicles have air-conditioning units, while for some of the others the percentage was as low as 30%.

To assess the banked quantities of HFCs in MAC units, we need to consider the average quantity of refrigerant per MAC unit and vehicle type. The 2000 IPCC GPG propose an average value of 0.8 kg per MAC unit, which according to various studies is an overestimate for the recent passenger cars and underestimate for trucks and busses. The 2006 IPCC Guidelines provide a range of 0.5 to 1.5 kg per MAC unit. Another important fact is that the quantity of refrigerant decreases significantly during the time series, which leads to different values of refrigerant in new cars introduced in the market during a particular year and a higher average values concerning the whole fleet for the same year. For the selection of appropriate quantity of refrigerant, a number of foreign studies have been reviewed. A detailed information was found in a British study (AEAT, 2003), in which values are set for an average amount of agent 1.2 kg in 1993 year, declining to 0.8 kg in 2000 year, with expectations of this study for the amount to decrease to 0.6 kg in 2010 year. This is also confirmed by EC 2011 and OR 2003 studies.

In order to prepare an accurate estimate, the following values from the EC 2011 study were applied (see Table 4.37).

Table 4.37 The values from EC 2011 study

Year	average quantity of refrigerant in new cars	average quantity of refrigerant for all cars	average quantity of refrigerant in new N1 trucks	average quantity of refrigerant for all N1 trucks	average quantity of refrigerant in new N2 trucks	average quantity of refrigerant for all N2 trucks	average quantity of refrigerant in new N3 trucks	average quantity of refrigerant for all N3 trucks	average quantity of refrigerant in new busses	average quantity of refrigerant for all busses
1993	**0.94**	**0.94**	**1.00**	**1.00**	**1.00**	**1.00**	**1.20**	**1.20**	**12.00**	**12.00**
1994	**0.90**	**0.88**	**0.90**	**0.90**	**1.00**	**1.00**	**1.20**	**1.20**	**12.00**	**12.00**
1995	**0.89**	**0.88**	**0.90**	**0.90**	**1.00**	**1.00**	**1.20**	**1.20**	**12.00**	**12.00**
1996	0.87	0.86	0.90	0.90	1.00	1.00	1.20	1.20	12.00	12.00
1997	0.86	0.83	0.90	0.90	1.00	1.00	1.20	1.20	12.00	12.00
1998	0.84	0.81	0.90	0.90	1.00	1.00	1.20	1.20	12.00	12.00
1999	0.83	0.78	0.90	0.90	1.00	1.00	1.20	1.20	12.00	12.00
2000	**0.81**	**0.76**	**0.90**	**0.90**	**1.00**	**1.00**	**1.20**	**1.20**	**12.00**	**12.00**
2001	0.80	0.74	0.90	0.90	1.00	1.00	1.20	1.20	11.94	11.80
2002	0.78	0.72	0.90	0.90	1.00	1.00	1.20	1.20	11.88	11.60
2003	0.77	0.70	0.90	0.90	1.00	1.00	1.20	1.20	11.82	11.40
2004	0.75	0.68	0.90	0.90	1.00	1.00	1.20	1.20	11.76	11.20
2005	**0.74**	**0.66**	**0.90**	**0.90**	**1.00**	**1.00**	**1.20**	**1.20**	**11.70**	**11.00**
2006	0.73	0.65	0.88	0.88	1.00	1.00	1.20	1.20	11.54	10.88
2007	0.71	0.65	0.86	0.86	1.00	1.00	1.20	1.20	11.38	10.76
2008	0.70	0.64	0.84	0.84	1.00	1.00	1.20	1.20	11.22	10.64
2009	0.68	0.63	0.82	0.82	1.00	1.00	1.20	1.20	11.06	10.52
2010	**0.67**	**0.63**	**0.80**	**0.80**	**1.00**	**1.00**	**1.20**	**1.20**	**10.90**	**10.40**
2011	0.66	0.63	0.80	0.80	1.00	1.00	1.20	1.20	10.82	10.40
2012	0.65	0.63	0.80	0.80	1.00	1.00	1.20	1.20	10.74	10.40

For the estimate of the disposal emissions, the average vehicle lifetime in Romania has to be considered. The 2000 IPCC GPG gives an average value of 12 years, while the 2006 IPCC Guidelines provide a range of 9 to 16 years. However, the data about the age distribution of the vehicle fleet in Romania illustrates different situation – the weighted average vehicle age (not vehicle lifetime) in the country varies between 10 to 13 years for different years and there is no stable trend, since it seems to be influenced by the economic situation. There is also a huge number of vehicles (about 15% in 2012 year) which are above 20 years. The number of vehicles per each year of production was compared to the number of vehicles from the previous year. The analysis of the data revealed that all vehicles from ages below 17 to 18 years are increasing on an annual basis – e.g. vehicles start to be decommissioned at the age of 17 years, and only a small percentage of all vehicles at that age (2 to 4%) are decommissioned. While it is very hard to calculate the exact average vehicle lifetime from the available data, it could be clearly stated that the average vehicle lifetime is at least 20 years (e.g. most of the vehicles are not decommissioned until they reach at least 20 years). This is the reason why decommissioning emissions are expected to start occurring in 2013 or 2014 year. In order to confirm these observations were contacted licensed vehicle decommissioning companies in the country, which have not declared any reclaimed quantities of F-gases from decommissioned vehicles.

Emission factors

Only one vehicle production company provided information regarding the total number of produced vehicles, the nameplate capacity of the air-conditioning units and the amount of HFCs used for initial charge. The provided data was not sufficient in order to calculate a country specific emission factor for the first fill emissions. The default emission factor of 0.5% from the 2000 IPCC guidelines was used in order to estimate the initial emissions from all MAC subcategories (passenger cars, busses and trucks). Regarding the operation emissions, due to the large number of servicing companies of mobile air conditioning units and the necessity to perform significant number of consecutive measurements for a large set of vehicles, it is not feasible to use a country-specific emission factors. The IPCC guidelines provide a very broad range regarding the annual operation emissions. In reality, the actual emission factor is dependent on many conditions, like car make, vehicle age, total quantity of refrigerant contained in the MAC unit, engine size and fuel, number of kilometres driven per year, ambient temperature and so on. The results of the detailed study on the leakage rates of MAC of passenger cars by Öko-Recherche (OR 2003), prepared for the European Commission, show that on average annual leakage rate is 7.1%. We consider the results of this study to be more accurate than the proposed ranges by the IPCC, having in mind the technological advancements in the MAC units. However, to ensure comparability with the GHG inventories of other countries, an annual emission factor of 10% was chosen for the emission estimates from passenger cars.

There are similar results from another study by Öko-Recherche for Establishment of Leakage Rates of Mobile Air Conditioners in Heavy Duty Vehicles (OR 2007), which determined an annual leakage rate of 8.3%. However, the original authors produced a subsequent study for the European commission for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases (EC 2011), which defined slightly higher emission factors for different truck categories – for truck category N1 = 10% and for truck category N2 and N3 = 15%. This is consistent with the IPCC guidelines, and those emission factors were chosen by a number of other countries, which is the reason for them to be used for the emission estimates.

For busses was chosen an annual emission factor of 15%, sourced from the EC 2011 study. This is confirmed by the OR 2007 study, which found annual leakage rates of 13.3% and 13.7% for coaches and busses.

Regarding the percentage of HFCs, which are emitted at decommissioning of vehicles, since no company reported any reclaimed quantities of HFCs, we could assume that at the moment the recovery efficiency is 0%, which could also be explained by that fact that hardly any vehicle with MAC units are decommissioned.

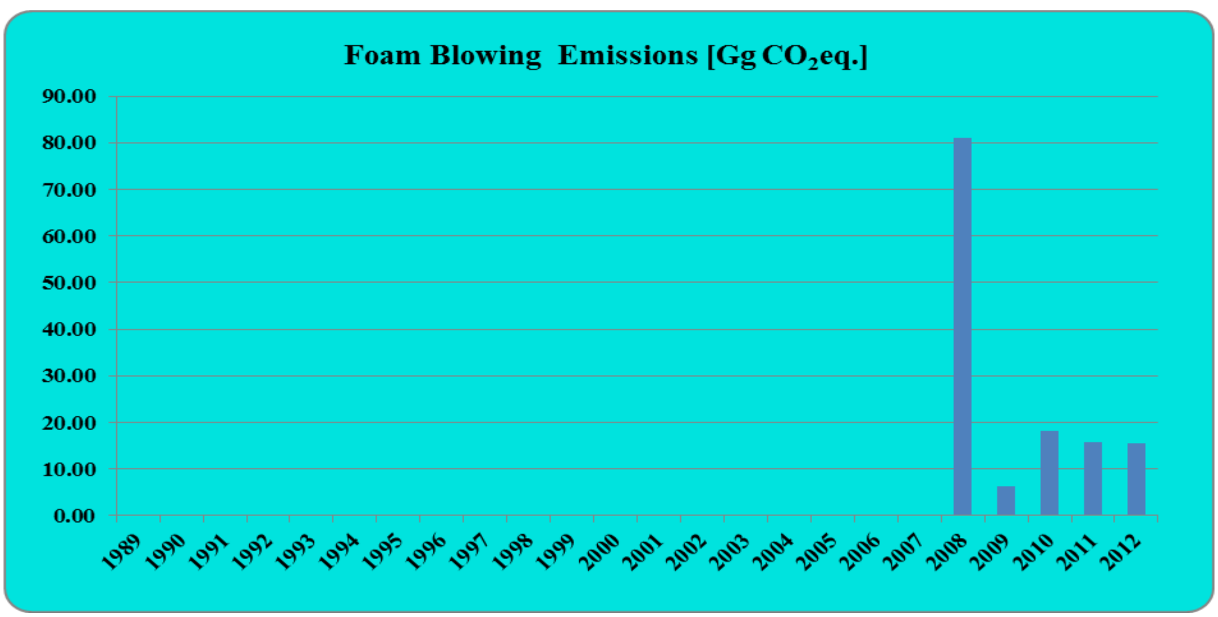
Foam Blowing (CRF Category 2.F.2)

Methodology

Several types of HFCs, CO_2 and/or water could be used in the manufacture of a wide variety of open-cell and closed cell foams (e.g. extruded polystyrene insulation foams, solid polyurethane foams, one component foams, etc.). In Romania, there is only one company, which was identified as a user of HFCs in their production of foams. The company is producing both open-cell (PU flexible) and closed-cell (PU spray) foams and the usage of HFCs (HFC-134a and HFC-227ea) started in 2008. Separate emission estimates were prepared for open-cell and closed-cell foams, since the two applications differ from methodological point of view – the emissions from open-cell foam production are considered prompt and they occur in the country of manufacture, while for closed-cell foams only part of the emissions occur during the production. In order to present the confidentiality of the producer, only aggregate data on the HFC use is provided. There is an unstable trend in the emissions, since the quantities of used HFCs very significantly on a yearly basis, following the market demand. In order to estimate the emissions from the foam blowing subcategory, was applied a bottom-up Tier 2 approach, which considers the emissions from manufacturing and usage of foams. Disposal emissions are not considered, since the product life is estimated to range from 20 to 50 years. This subcategory is a key category according to previous estimates. A detailed model for the emissions calculation from each type of foam (open-cell flexible foam and closed-cell spray foam) was created.

In 2012 year, the actual emissions from foam blowing were 15.44 Gg CO_2eq. (see Figure 4.25).

Figure 4.25 Actual emissions of the Foam Blowing for 1989–2012 period [Gg CO_2 equiv.]



The banked quantities of HFCs are estimated to be around 966 t in 2012 year and are shown in Table 4.38.

Table 4.38 The quantity of banked HFC of the Foam Blowing for 1989-2012 period

Year	HFCs placed on the market [kg]	Quantity of banks [t]	Initial emissions [kg HFCs]	Operation emissions [kg HFCs]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0.0	0.0	0	0	0.0	0.0
1990	0.0	0.0	0	0	0.0	0.0
1991	0.0	0.0	0	0	0.0	0.0
1992	0.0	0.0	0	0	0.0	0.0
1993	0.0	0.0	0	0	0.0	0.0
1994	0.0	0.0	0	0	0.0	0.0
1995	0.0	0.0	0	0	0.0	0.0
1996	0.0	0.0	0	0	0.0	0.0
1997	0.0	0.0	0	0	0.0	0.0
1998	0.0	0.0	0	0	0.0	0.0
1999	0.0	0.0	0	0	0.0	0.0
2000	0.0	0.0	0	0	0.0	0.0
2001	0.0	0.0	0	0	0.0	0.0
2002	0.0	0.0	0	0	0.0	0.0
2003	0.0	0.0	0	0	0.0	0.0
2004	0.0	0.0	0	0	0.0	0.0
2005	0.0	0.0	0	0	0.0	0.0
2006	0.0	0.0	0	0	0.0	0.0
2007	0.0	0.0	0	0	0.0	0.0
2008	62.3	0.0	62,299	0	81.0	81.0
2009	4.9	0.0	4,875	0	6.3	6.3
2010	13.9	0.0	13,877	0	18.1	18.1
2011	12.2	0.4	11,844	6	15.6	16.6
2012	12.2	1.0	11,607	14	15.4	17.1

Activity data

The data about quantities of HFCs were obtained from questionnaires sent to a large number of companies (above 500), which were chosen based on their NACE activity code. These included both companies from the chemical sector and from the industrial sector (like producers of matrasses, water heaters, etc.). Only one company declared the use of F-gases, which was also the observation from previously collected data by the Ministry of Environment and Climate Change and the Regional Environmental Agencies. Two types of HFCs are used in the production – HFC-134a for producing open-cell flexible foam and HFC-227ea for producing closed-cell spray foam. For the open-cell foam the emissions are considered prompt – e.g. all the used F-gases are considered to be emitted during the production. All occurring emissions are considered to be occurring in Romania, regardless that some of the production is being exported. A different approach is applied for the closed-cell foam – as occurring in Romania are considered only the emissions from the production, which have been placed on the Romanian market.

In order to clear the situation about the other possible use of F-gases in the foams sector as insulation materials, was contacted the Romanian Association of Construction Materials Producers (APMCR). No other producers of insulation materials containing F-gases were identified. There is no official statistics on the quantities of various types of foaming materials imported in the country and no estimate could be produced by the experts from APMCR. Additional complication is the fact that very often the importers/distributors of some foam materials used in the construction lack the knowledge if their products contain F-gases or not. Data about the reported emissions from other economies in transition in Central and Eastern Europe was analysed, which showed large differences in emission estimate per capita or per GDP. This could be explained by the fact that the large majority or emissions from the foaming sector occur from the production of foams, and not from the usage, and only a limited number of countries are producers of HFC-containing foams. Thus, we've concluded that it is not feasible to prepare an estimate of the imported foams, since it cannot be determined whether they contain F-gases or not and no reliable import data exists.

Emission factors

The emission estimates were prepared using the default emission factors from the 2000 IPCC GPG. For open-cell flexible foam was applied a 100% loss in the first year, while for closed-cell spray foam is assumed 25% loss for the first year and 1.5% per annum thereafter. This is a bit higher than the 15% first year loss proposed by the 2006 IPCC Guidelines, but the value was chosen for comparability reasons and it would be revised in future submissions.

Fire Extinguishers (CRF Category 2.F.3)

Methodology

HFC use in fire protection equipment is relatively limited – its main area of application is mostly in flooding systems in datacenters, server and computer rooms, where equipment protection is of extreme importance and this could justify the higher equipment cost. There is no production of such equipment in Romania and usually the pre-filled bottles containing F-gases are directly imported from the manufacturers and connected to the piping, thus manufacturing emissions does not occur. The same procedure is followed at decommissioning - the bottles are simply removed from the piping and returned to manufacturing for off-site reclamation. In addition, the equipment lifetime is estimated to be more than 20 years, thus no emissions from decommissioning are occurring.

The banked quantities of HFCs used in fire protection equipment are 25 t in 2012 year and while its usage in Romania started in 1996 year, the market started to grow significantly after 2006 year.

In order to estimate the emissions from fire protection equipment subcategory, was applied a bottom-up Tier 2 approach, although this subcategory is not a key category and the use of a higher tier methodology is not required. The choice of method was taken for practical reasons – the proposed Tier 1 approach would either demand data both on chemical sales particularly for fire protection sector and data on the imports of equipment, which is not possible to obtain, since there are no customs codes, which would allow differentiation between equipment containing HFCs substitutes and other compounds.

The actual emissions in 2012 year are estimated to be about 3.56 Gg CO_2eq (Figure 4.26).

Figure 4.26 Actual emissions of the Fire Extinguishers for 1989–2012 period [Gg CO_2 equiv.]

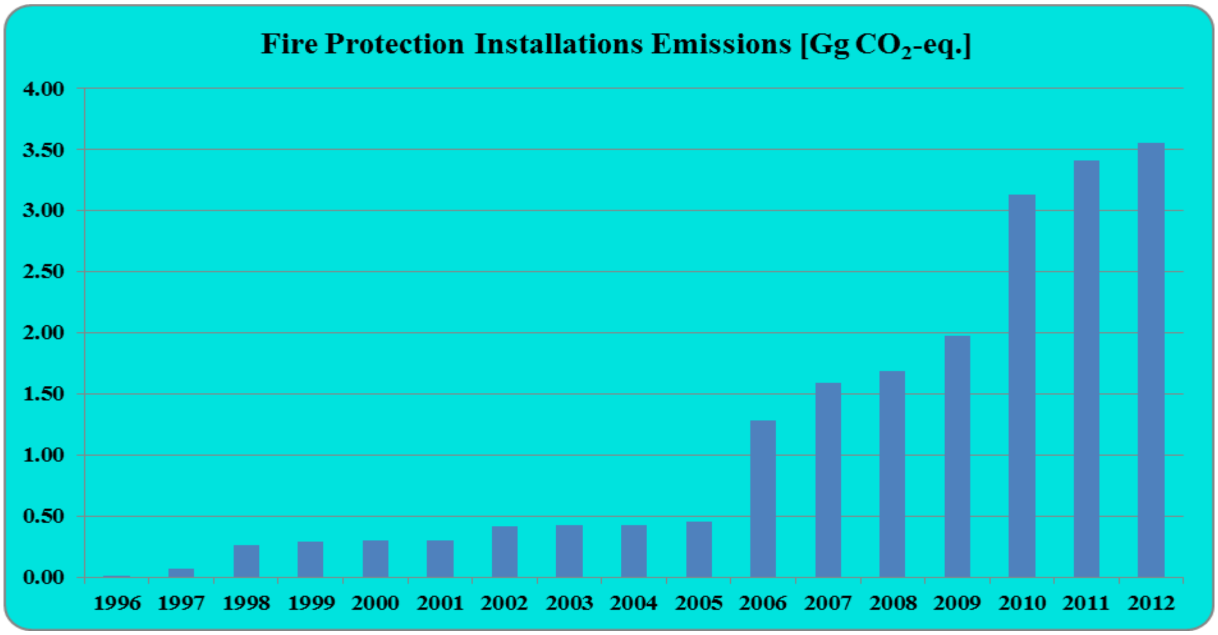


Table 4.39 The quantity of banked HFC of the Fire Extinguishers for 1989-2012 period

Year	HFCs placed on the market [t]	Quantity of banks [t]	Operation emissions [kg HFC]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0.0	0.0	0	0.0	0.0
1990	0.0	0.0	0	0.0	0.0
1991	0.0	0.0	0	0.0	0.0
1992	0.0	0.0	0	0.0	0.0
1993	0.0	0.0	0	0.0	0.0
1994	0.0	0.0	0	0.0	0.0
1995	0.0	0.0	0	0.0	0.0
1996	0.1	0.1	5	0.0	0.3
1997	0.3	0.4	22	0.1	1.0
1998	1.4	1.8	90	0.3	4.0

Year	HFCs placed on the market [t]	Quantity of banks [t]	Operation emissions [kg HFC]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1999	0.2	2.0	100	0.3	0.5
2000	0.1	2.1	104	0.3	0.2
2001	0.0	2.1	104	0.3	0.0
2002	0.8	2.8	142	0.4	2.2
2003	0.1	2.9	146	0.4	0.2
2004	0.0	2.9	146	0.4	0.0
2005	0.2	3.1	155	0.4	0.5
2006	5.7	8.8	442	1.3	16.6
2007	2.1	11.0	548	1.6	6.2
2008	0.7	11.6	582	1.7	2.0
2009	1.9	13.6	680	2.0	5.6
2010	8.0	21.6	1,080	3.1	23.2
2011	1.9	23.5	1,175	3.4	5.5
2012	1.0	24.5	1,226	3.6	3.0

Activity data

For the estimate of this subcategory was used data from the Ministry of Interior Affairs regarding all fire protection installations containing F-gases. Only the use of HFC-227ea (FM-200) was reported, while the reported quantities vary from 18 kg to 6,500 kg per installation. For each installation was provided the nameplate capacity and the year of installation. In some cases the installation capacity was provided in liters – in order to calculate the mass of the F-gas was used a density of 1.3886 kg/l1.

Emission factors

The 2000 IPCC GPG provide a default emission factor of 5% annually.

[1]http://www2.dupont.com/FE/en_US/assets/downloads/pdf_fm/k17649_FM-200_physical_properties_si.pdf

The 2006 IPCC Guidelines provide an updated range of 2 to 6% annual leakage. Recent research (EC 2011) suggests that the emission factor is 2.5%, which is twice as low compared to the default EF. However, in order to ensure comparability of the results, the estimates were prepared with the default EF of 5%.

Emissions from decommissioning are not considered, since the expected equipment lifetime of 20 years has not yet passed since the first installations were introduced in the country.

Aerosols/Metered Dose Inhalers (CRF Category 2.F.4)

Methodology

The research did not reveal any aerosol producers from Romania. This was confirmed by reviewing international sources (list of members of the European Aerosol Federation[2], FEA Statistics Report for 2008-2012[3], Aerosol Europe Market survey of European producers[4]). According to information from European Aerosol Federation, the European aerosol industry has primarily shifted to flammable liquefied propellants (hydrocarbons and dimethyl ether), although there are still some use of HFCs, where the use of non-flammable liquefied propellant is required, but this usually excludes the most widespread aerosol types like personal care products and household products. Since the research did not identify any evidence for the existence of Romanian aerosols producers, emissions from manufacturing are not occurring. In Romania, HFCs are mostly used as propellants in aerosol sprays for drug application in asthma therapy (e.g. metered dose inhalers). Generally, HFC-134a and HFC-227ea could be used as propellants, although the research showed only the use of HFC-134a. The emissions from use of MDIs were estimated based on questionnaires provided by pharmaceutical companies – for 2012 more than 1.2 mln. MDIs were sold on the market, the emissions from which amount to 28.58 Gg CO_2eq. Since for this subsector the accumulation of banks is limited to one year after the production of the aerosol, there are no large banked quantities accumulated.

Although the 2000 IPCC GPG does not distinguish between different methodological tiers, it defines two possible approaches whether the estimates are prepared on application or sub-

[2] http://www.aerosol.org/about-fea/members
[3] http://www.aerosol.org/publications-news/publications/statistics/statistics-2
[4] http://www.aerosoleurope.de/wp-content/uploads/MarketSurvey_AE0211.pdf

application level. In the 2006 IPCC Guidelines these approaches are defined as Tier 1a and Tier 2a, and both are based on the quantities of chemicals contained in aerosols. In order to estimate the emissions from the aerosols subcategory, was applied a bottom-up Tier 2a approach, which considers the aerosol use emissions. This subcategory is a not a key category.

Figure 4.27 Actual emissions of the Aerosols/Metered Dose Inhalers for 1989–2012 period [Gg CO_2 equiv.]

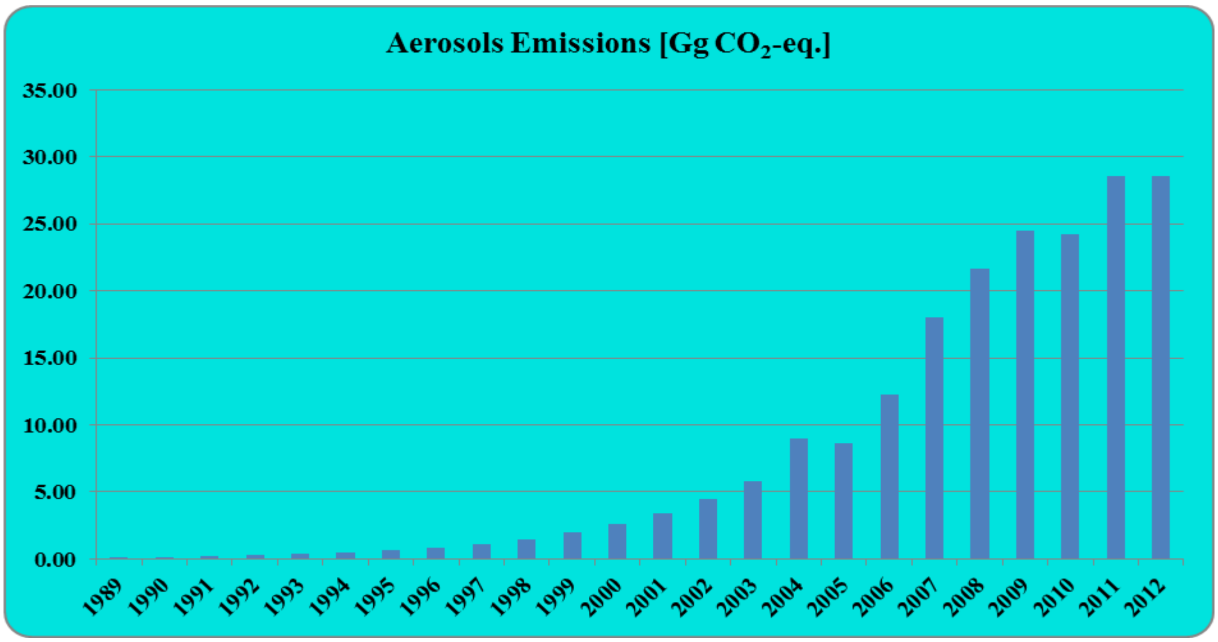


Table 4.40 The quantity of banked HFC of the Aerosols/Metered Dose Inhalers for 1989-2012 period

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC]	Operation emissions [kg HFC]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0.1	0.1	55	55	0.1	0.1
1990	0.1	0.1	72	55	0.2	0.2
1991	0.2	0.1	96	72	0.2	0.2
1992	0.3	0.1	126	96	0.3	0.3

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC]	Operation emissions [kg HFC]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1993	0.3	0.2	166	126	0.4	0.4
1994	0.4	0.2	218	166	0.5	0.6
1995	0.6	0.3	286	218	0.7	0.7
1996	0.7	0.4	375	286	0.9	1.0
1997	1.0	0.5	495	375	1.1	1.3
1998	1.3	0.7	652	495	1.5	1.7
1999	1.7	0.9	858	652	2.0	2.2
2000	2.3	1.1	1,127	858	2.6	2.9
2001	3.0	1.5	1,478	1,127	3.4	3.8
2002	3.9	1.9	1,939	1,478	4.4	5.0
2003	5.1	2.5	2,543	1,939	5.8	6.6
2004	8.7	4.4	4,375	2,543	9.0	11.4
2005	4.6	2.3	2,279	4,375	8.6	5.9
2006	14.4	7.2	7,175	2,279	12.3	18.7
2007	13.3	6.7	6,663	7,175	18.0	17.3
2008	20.0	10.0	10,017	6,663	21.7	26.0
2009	17.7	8.9	8,856	10,017	24.5	23.0
2010	19.6	9.8	9,798	8,856	24.3	25.5
2011	24.4	12.2	12,204	9,798	28.6	31.7
2012	19.6	9.8	9,780	12,204	28.6	25.4

Activity data

In order to identify all importers of MDIs in the country was requested a list of all registered drugs, which contain HFCs from the National Agency for Medicines and Medical Devices (ANMDM). The Agency provided a list of 24 different drugs from 7 pharmaceutical companies, registered on the Romanian market from 2004 on. All companies were sent questionnaires requesting them to provide the number of MDIs sold on the Romanian market and the quantities of HFCs per container. The available data about the number of MDIs sold on the market was for the period 2004-2012 – the data for the beginning of the timeseries was estimated using regression analysis based on the data for the GDP of Romania for the period 1989-2012. The pharmaceutical companies also provided information on the quantity of propellant per individual drug, which ranges from 5.6 to 17.9 grams per MDI. With this data, it was possible to calculate the exact quantity of HFCs introduced in the market for each year. The annual sales volumes per individual drug vary during the years, since new drugs are introduced or very often the same drug is offered in various packaging (e.g. concentration of the active substance or number of doses per MDI), but in general there is a strong increasing trend in the consumption of drugs.

Emission factors

According to the IPCC Guidelines, aerosol emissions are considered prompt, because all the initial charge escapes within the first year or two after the sale. Equation 3.35 form the 2000 IPCC GPG was applied with a default emission factor of 50% of the HFCs released in the first year, and the rest released on the following year.

Solvents (CRF Category 2.F.5)

HFC/PFC solvent uses could occur in four main areas: precision cleaning, electronics cleaning, metal cleaning or deposition applications. PFCs have little use in cleaning, as they are essentially inert, have very high GWPs and have very little power to dissolve oils. The pure material does not have the cleaning power of CFC-113, since no chlorine atoms are present in the molecule.

In general, based on information provided by Umweltbundesamt in Germany, the share of this subsector is insignificant.

The national statistics cannot provide any type of information regarding this application in Romania. Various companies identified by their activity and NACE code (electronics producers, etc.) were contacted in order to asses if they use of F-gases in their operations, neither of which confirmed the application – thus the emissions from this category are considered not occurring.

Other Applications (CRF Category 2.F.6)

Based on information collected through the years both with questionnaires from the Ministry of environment and Climate Change and the Regional Environmental Agencies, not other applications were identified in the country.

Semiconductor Manufacturing (CRF Category 2.F.7)

A research was conducted in order to identify whether there are any emissions occurring from this activity in Romania. Letters were sent to a large number of companies, identified from the national company register based on their NACE code. Neither of the received replies confirmed any HFC or PFC usage. In addition a desk research was conducted in order to identify existing producers of semiconductors or of photovoltaic panels. Regarding the production of semiconductors, analysis of potential emitters of these substances showed that in Romania there are currently no manufacturers of semiconductors. There used to be a manufacturing facility IPRS (Întreprinderea de piese radio și semiconductori), but the production ceased with the transition to market economy in the 90s and it was subsequently closed down. The solar producers did not declare any usage of HFCs or PFCs in their production, so emissions from this category are not occurring.

Electrical Equipment (CRF Category 2.F.8)

Methodology

Electrical Equipment (2.F.8) is a key category only considering the trend criteria (Tier 2, excluding and including LULUCF).

Sulphur hexafluoride (SF_6) is used for electrical insulation and current interruption in equipment used in the transmission and distribution of electricity. Emissions could occur during manufacturing, installation, servicing and disposal of the equipment. For the preparation of the emission estimates, this category was divided in two subcategories – sealed pressure equipment and closed pressure equipment. According to the collected data, SF_6 has been used from the beginning of the time series, but the usage started to grow significantly after 2000 year. In the recent years (2011 and 2012) the installation of new equipment has been slowing down, which leads to a decreasing trend in emissions.

Most of the banked quantities of SF_6 are contained in closed pressure equipment (around 70% of the total quantity or 67 t in 2012 year), while the rest is banked in sealed pressure equipment (28 t in 2012 year). There is a clear trend though for the percentage of closed pressure equipment to decrease and the sealed pressure equipment to increase. In terms of emissions, almost all of the emissions are generated by closed pressure equipment, since it generates both installation, operation and disposal emissions. For the sealed pressure equipment no installation emissions are occurring and the operation emissions are much lower. The total emissions from electrical equipment are equal to 40.79 Gg CO_2eq. in 2012 year.

Emissions from the electrical equipment subcategory were estimated using a bottom-up approach (Tier 2a lifecycle emission factor approach from the 2000 IPCC Guidelines, which is equal to Tier 1 method from the 2006 IPCC guidelines), which considers the emissions from installation, operation and disposal of equipment.

Figure 4.28 Actual emissions of the Electrical Equipment for 1989–2012 period [Gg CO_2 equiv.]

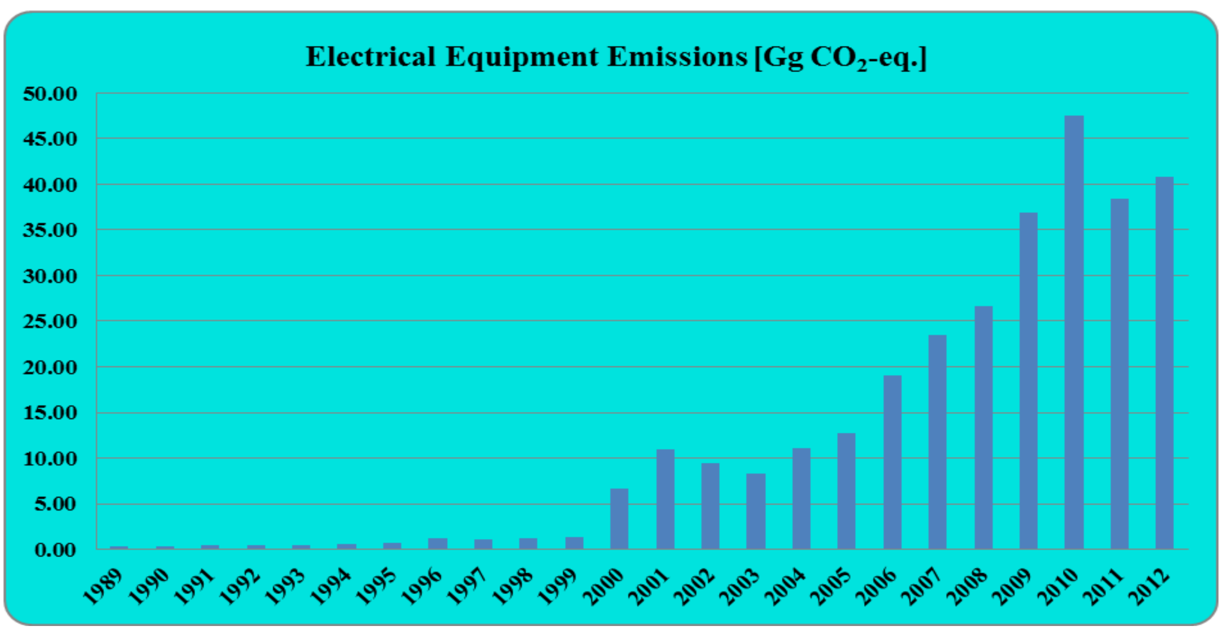


Table 4.41 The quantity of banked HFC of the Electrical Equipment for 1989-2012 period

Year	SF_6 placed on the market [t]	Quantity of banks [t]	Initial emissions [kg SF_6]	Operation emissions [kg SF_6]	Disposal emissions [kg SF_6]	Actual emissions [Gg CO_2eq.]	Potential emissions [Gg CO_2eq.]
1989	0.0	0.8	0.0	16.0	0.0	0.4	0.0
1990	0.0	0.8	0.0	16.0	0.0	0.4	0.0
1991	0.0	0.8	1.1	16.4	0.0	0.4	0.4
1992	0.0	0.8	0.0	16.4	0.0	0.4	0.0
1993	0.0	0.8	0.8	16.7	0.0	0.4	0.3
1994	0.1	0.9	5.8	18.6	0.0	0.6	2.3
1995	0.2	1.1	10.1	22.0	0.0	0.8	4.1
1996	0.4	1.5	21.1	29.0	0.0	1.2	8.7
1997	0.4	1.8	12.9	33.6	0.0	1.1	8.5
1998	0.3	2.1	12.2	37.9	0.0	1.2	7.5
1999	0.2	2.4	13.9	42.5	0.0	1.3	5.8
2000	3.1	5.4	175.9	101.4	0.0	6.6	73.1
2001	4.7	10.1	268.4	191.4	0.0	11.0	112.4
2002	3.0	13.1	152.0	242.9	0.2	9.4	70.6
2003	1.9	15.0	78.9	270.3	0.2	8.4	44.5
2004	3.1	18.0	143.6	319.5	0.9	11.1	73.1
2005	2.3	20.3	120.8	360.3	49.2	12.7	55.4
2006	6.1	26.4	295.8	461.2	41.9	19.1	145.3
2007	8.0	34.4	375.7	589.9	14.7	23.4	190.6
2008	9.2	43.6	374.7	720.7	21.2	26.7	219.5
2009	13.7	57.3	595.0	926.6	22.7	36.9	327.9
2010	21.4	78.6	780.6	1,203.5	4.4	47.5	510.3
2011	8.2	86.8	273.1	1,301.8	33.1	38.4	196.0
2012	8.0	94.9	277.7	1,401.2	27.7	40.8	191.9

Activity data

A special questionnaire was developed and sent to all electricity producers and distribution companies in the country, which were licensed by the Romanian Energy Regulatory Authority (ANRE). The aim of the questionnaire was to gather historical data on electrical equipment installations and to obtain the required activity data for the development of country-specific emission factors, so a higher tier methodology could be applied. While the companies were able to provide data regarding the nameplate capacity of the new and used equipment, the collected data about the used quantities of SF_6 for installation and maintenance was not complete. Some of the companies were able to provide the total nameplate capacity of their equipment, but not a split between sealed and closed pressure systems (around 1% of the total nameplate capacity of equipment). For those companies was used the average split from all reporting companies for that particular year. Sealed pressure equipment usually has a capacity of less than 5 kg per functional unit and it is used at a voltage below 52 kV. It does not require any maintenance during the period of operation and its operation emission factor is much lower. Systems capable of charge (closed pressure systems) are used in more than 52 kV tension and may contain amounts of 5 to several hundred kg. Although closed pressure system annual emission factor is higher, it could still have more than 10 years between its servicing intervals.

Since the electrical equipment is not manufactured in Romania, no manufacturing emissions are occurring. However, there are installation emissions from the closed pressure equipment, but not from the sealed pressure.

Emission factors

Since the equipment stock is growing relatively rapidly and due to the lack of sufficient data from the questionnaires, it was not possible to calculate country-specific EF.

For equipment installation emissions of closed pressure equipment was used a default EF of 6%, given by the 2000 IPCC GPG. Regarding the operation emissions, the 2000 IPCC GPG provides a default EF of 2%. For sealed pressure equipment is used the default emission factor from the 2006 IPCC Guidelines, equal to 0.2% per year.

Other (CRF Category 2.F.9)

In the previous submission some of the F-gases emissions were estimated based on the cluster method, so some emissions were reported in the Other category. As this submission followed a different methodological approach, implementing a Tier 2 methodology for almost all subcategories, all of the occurring sources of F-gases were distributed amongst the other categories – thus, other emissions are not known to be occurring.

4.7.3 Uncertainties and time series consistency

The uncertainty related values collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study (additional information are included in Annex 8.1), by the Austrian Environment Agency-University of Graz consortium, in 2012, were updated in the context of the implementation in 2013 of the study "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)"; the values elaborated in 2013 are presented in the current section and were used in the uncertainty analysis and in the key category analysis.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

Domestic Refrigeration (CRF Category 2.F.1.1)

Due to the large number of assumptions regarding this category, the uncertainty is assumed to be rather high. As sources on uncertainty in the activity data could be noted the primary activity data, which in some cases was not provided in number of units, but in kilograms. This might lead to uncertainty of the data of 20%. For the periods before 2000, where the activity data is extrapolated the uncertainty could increase with additional 20%, although there is a good correlation between the GDP and refrigeration manufacturing. Another source of uncertainty is the assumption about the percentage of HFC-containing equipment, especially for the beginning of the time-series. This could lead to an uncertainty of the activity data of 50 to 150%. The average quantity of refrigerant is also a source of uncertainty, although it should not be more than 20%. As a result, we estimate the total uncertainty of the activity data for this sector at 100%. The uncertainty of the EF is equal to the default uncertainty in the 2000 IPCC GL. The proposed ranges of the EF presume an uncertainty of 200%. This leads to a combined uncertainty of the emission estimates of 224%.

Commercial Refrigeration (CRF Category 2.F.1.2)

Because not all companies provided data about their HFC usage, the activity data had to be adjusted, which could lead to uncertainty close to 20%. Unlike other subsectors from the refrigeration and air conditioning sector, in this subsector there are no further assumptions regarding the quantity of refrigerant per unit, percentage of HFC-containing units, etc. However, the calculation of the banked quantities of HFCs based on the HFC usage reported by the companies could lead to an estimated additional uncertainty of 15%, depending on the actual operational emission factor. As a result, we estimate the total uncertainty of the activity data for this sector at 25%. Considering the available studies regarding the commercial refrigeration sector, it is possible that the used emission factors have an uncertainty of 25%. This leads to a combined uncertainty of the emission estimates of 35%.

Transport Refrigeration (CRF Category 2.F.1.3)

The data regarding the number of vehicles should have a relatively low uncertainty (around 2%), since it should be based on official vehicle registration data. The assumption about the percentage of refrigerated vehicles from all vehicles could lead to uncertainty of 30%. The assumption about the percentage of HFC-containing refrigerated vehicles could lead to uncertainty of additional 15%. The average quantity of refrigerant is also a source of uncertainty, although it should not be more than 15%. As a result, we estimate the total uncertainty of the activity data for this sector at 37%. Considering the available studies regarding the mobile air conditioning sector, it is possible that the used emission factors have an uncertainty of 25%. This leads to a combined uncertainty of the emission estimates of 44%.

Industrial Refrigeration (CRF Category 2.F.1.4)

The same uncertainty regarding the activity data as in the commercial refrigeration sector is applied – 20% because of the missing data from servicing companies with an additional uncertainty of 15% originating from the model for estimating the banked quantities. The total uncertainty of the activity data for this sector is estimated at 25%.
Considering the available information about the emission factors for the industrial refrigeration sector, it is assumed an uncertainty of 25%. This leads to a combined uncertainty of the emission estimates of 35%.

Domestic Air-Conditioning (CRF Category 2.F.1.5)

This category has lower uncertainty than the Domestic refrigeration, but shares most of the uncertainty sources.
The primary activity data is again not provided in number of units, but in kilograms, which might lead to uncertainty of the data of 20%.The assumption about the percentage of HFC-containing equipment, does not lead to high uncertainties, since for this subcategory there are no major technological alternatives regarding refrigeration agents. Nevertheless, different HFC blends used in this subcategory have different GWP, which could lead to an uncertainty of the activity data of 20 to 50%. The average quantity of refrigerant is also a source of uncertainty, although it should not be more than 20%. As a result, we estimate the total uncertainty of the activity data for this sector at 50%. The uncertainty of the EF is equal to the default uncertainty in the 2000 IPCC GL. The proposed ranges of the EF presume an uncertainty of 200%. This leads to a combined uncertainty of the emission estimates of 206%.

Mobile Air-Conditioning (CRF Category 2.F.1.6)

The uncertainty of this category is dependent on several factors.

The primary activity data regarding the number of vehicles is provided by the National Statistics and it should have a relatively low uncertainty (around 2%), the same should be valid for the age structure of the vehicle fleet, which should be based on official registration data. The assumption about the percentage of MAC-equipped vehicles is based on average European data, which could lead to uncertainty of 20%. The average quantity of refrigerant is also a source of uncertainty, although it should not be more than 15%. As a result, we estimate the total uncertainty of the activity data for this sector at 25%. Considering the studies by Öko-Recherche, it could be seen that the currently used emission factors are higher by as much as 25%. This leads to a combined uncertainty of the emission estimates of 36%.

Foam Blowing (CRF Category 2.F.2)

The uncertainty of the activity data is estimated to be low (5%), since data is obtained directly from producers and it is disaggregated by activity type. The uncertainty of the default emission factor is higher judging by the revised estimates provided in the 2006 IPCC Guidelines – it is estimated at 33%. The combined uncertainty of this sector is 33%.

Fire Extinguishers (CRF Category 2.F.3)

The uncertainty of the activity data is estimated to be relatively low (15%), since the fire protection installations have to be registered with the Ministry of Interior Affairs and because of the specific applications for HFC containing equipment. On the other hand, the uncertainty of the default emission factor is rather high – it is estimated at 100% based on information, which suggests that the default EF is probably twice bigger that current estimates. The combined uncertainty of this sector is 101%.

Aerosols/Metered Dose Inhalers (CRF Category 2.F.4)

The uncertainty of the activity data (number of sold MDIs) is estimated to be 10%, since the number of companies is not very large and data was obtained directly from them. Additional source of uncertainty is the data about the quantity of HFC per MDI, but since the data was provided with very high precision (in milligrams), we estimate the uncertainty at 5%.

The used methodological approach, which distributes the emissions in two consecutive years might lead to some uncertainty for a particular year compared to the next one does not presume any uncertainty in the long term, since all F-gas emissions are eventually accounted. Thus, we believe that for this particular case the used emission factor does not introduce uncertainty in the emission estimates. The combined uncertainty of this sector is 11%.

Electrical Equipment (CRF Category 2.F.8)

The activity data was obtained directly from operators, thus its uncertainty should be around 15%. The questionnaire specifically asked the companies to provide information since which year they are using electrical equipment in order to confirm the consistency of the provided data for the full time series. Since the emission estimates use the default emission factors, the uncertainty is estimated at 50%. The combined uncertainty is 52%.

4.7.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Metal Production Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

Recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

The unconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 4.7.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.7.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2012 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

4.7.5 Source specific recalculation, including changes made in response to the review process

In order to improve the emissions estimates quality some important recalculations were made:

- a recalculation of the HFC, PFC and SF_6 emission estimates is performed for the full time series following a methodological change. The applied methodology is a bottom-up Tier 2 method, considering the emissions from manufacturing, operation and disposal of equipment on a sub-application level (CRF categories 2.F.1, 2.F.2, 2.F.3, 2.F.4 and 2.F.8). Detailed information about each sub-sector is provided in chapters 4.7.2 from the NIR.

Table 4.42 The effects of recalculations in Consumption of Halocarbons and SF_6 Sub-sector

The effects of recalculations in Consumption of Halocarbons and SF_6 Sub-sector			
Years	**NGHGI 2013 v. 2.2**	**NGHGI 2014 v. 1.4**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	0.00	0.52	NO
1990	0.00	0.55	NO
1991	0.00	0.68	NO
1992	0.00	0.80	NO
1993	0.00	1.11	NO
1994	0.00	1.74	NO

The effects of recalculations in Consumption of Halocarbons and SF_6 Sub-sector			
Years	**NGHGI 2013 v. 2.2**	**NGHGI 2014 v. 1.4**	**Differences [%]**
	CO_2 emissions [Gg]		
1995	95.26	3.14	-96.70
1996	97.91	5.55	-94.33
1997	124.18	10.59	-91.48
1998	154.59	22.96	-85.15
1999	151.74	37.51	-75.28
2000	163.71	70.15	-57.15
2001	217.08	111.25	-48.75
2002	239.48	157.72	-34.14
2003	310.33	209.25	-32.57
2004	391.09	269.13	-31.18
2005	536.85	335.85	-37.44
2006	708.87	442.43	-37.59
2007	898.88	602.84	-32.93
2008	906.60	852.95	-5.92
2009	710.48	840.78	18.34
2010	700.23	903.03	28.96
2011	447.76	984.03	119.77
2012		1,074.12	

4.7.6 Source specific planned improvements, including those in response to the review process

Improve the emission estimation within this category.

More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

5 SOLVENT AND OTHER PRODUCT USE (CRF Sector 3)

5.1 Overview of the sector

The Solvent and Other Product Use is a key category from both level and trend point of view (Tier 2, excluding and including LULUCF).

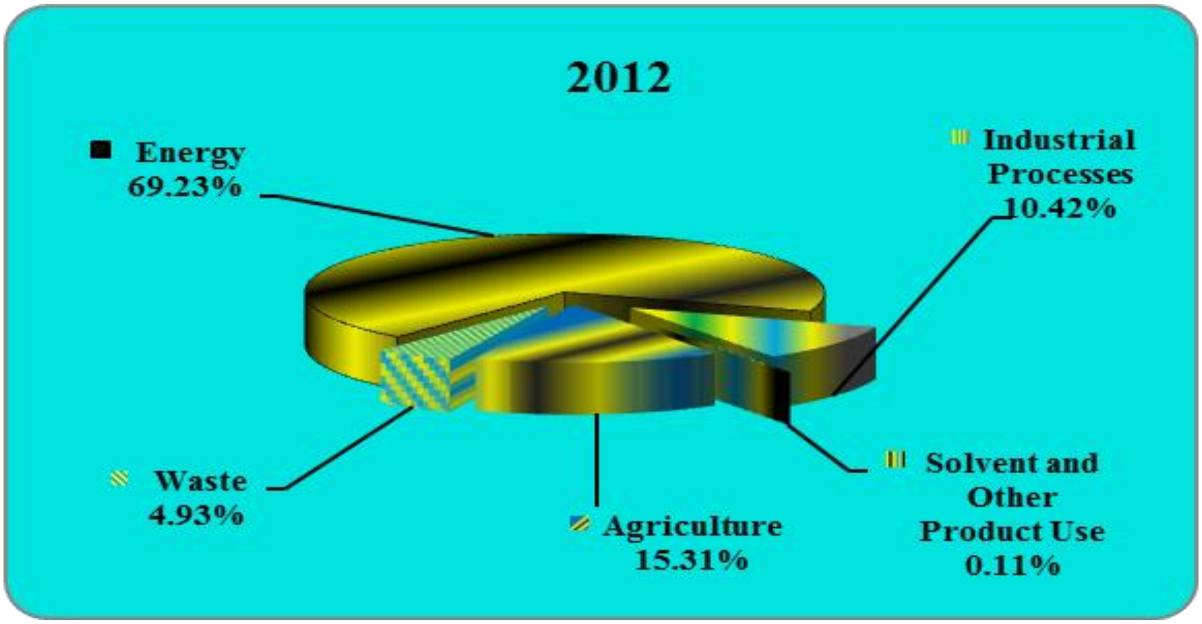
Solvents are chemical compounds, which are used to dissolve substances as paint, glues, ink, rubber, plastic, and pesticides or for cleaning purposes (degreasing). After application of these substances or other procedures of solvent use most of the solvent is released into air. The use of solvents leads to emissions of non-methane volatile organic compounds (NMVOC), which is regarded as an indirect greenhouse gas. The NMVOC emissions will over a period of time in the atmosphere oxidize to CO_2, which is included in the total greenhouse gas emissions reported to the UNFCCC Secretariat.

5.2 Source category

Paint Application (IPCC category 3A), Degreasing and Dry Cleaning (IPCC category 3B), Chemical Products, Manufacture and Processing (IPCC category 3C), Other (IPCC category 3D).

In 2012 the GHG emissions from Solvent and Other Product Use Sector contributed to 0.11% of the total GHG emissions in Romania.

Figure 5.1 The contribution of Solvent and Other Product Use Sector to the total GHG emissions in Romania, 2012



5.2.1 Source category description

- **3A** source category includes emissions resulted from: domestic use, automobile manufacture and repairing, construction and buildings;
- **3B** source category refers to emissions resulted from metal degreasing, dry cleaning, electronic components manufacturing, other industrial cleaning;
- **3C** source category includes emissions from chemicals manufacturing or processing: polyester processing, polyvinyl chloride processing, polyurethane foam processing, rubber processing, pharmaceutical products manufacturing, paints manufacturing, glues manufacturing;
- **3D** source category refers to emissions resulted from other use of solvents, such as: mineral wool induction, preservation of wood, domestic solvent use (other than paint application), under seal treatment and conservation of vehicles.

5.2.2 Methodological issues

Methodology

IPCC guidelines do not provide methodology to determine NMVOC emissions, which is the main source of emissions in this sector. Due to this reason, the NMVOC emissions resulted from Solvents and Other Product Use are estimated based on CORINAIR methodology, using the correspondence between IPCC categories and SNAP codes (Table 5.1).

Table 5.1 Correspondence between IPCC categories and SNAP codes

IPCC categories	SNAP codes
3A Paint application	0601 Paint application
3B Degreasing and Dry Cleaning	0602 Degreasing, dry cleaning and electronics
3C Chemical Products, Manufacture and Processing	0603 Chemical products manufacturing and processing
3D Other	0604 Other use of solvents & related activities

Activity data

For 2014 submission the AD used to calculate emissions are provided by the National Statistics and economic agents but the main data source is National Statistics.

Emission factors

CO_2 emissions from Solvent Use were calculated from NMVOC emissions of this sector. The following equation has been applied:

Equation 5.1 Calculation of CO_2 emissions from Solvent Use

$$CO_2 \text{ emissions} = 0,85 \times (44/12) \times \text{emissions of NMVOC}$$

where:

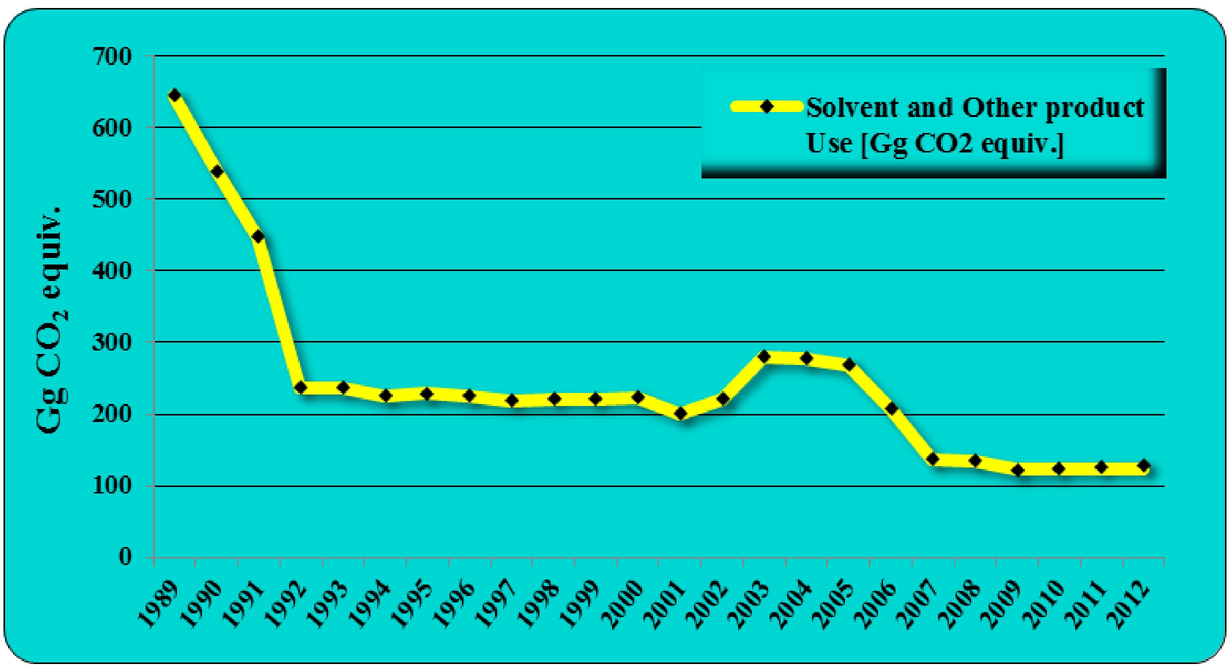
- 0.85 is carbon content conversion factor.

Table 5.2 CO_2 emissions resulted from Solvent and Other Product Use in the period 1989–2012

Solvents and Other Product Use					
Year	**3A**	**3B**	**3C**	**3D**	**Total**
	CO_2 emissions [Gg]				
1989	141.20	100.70	0.00	403.90	**645.80**
1990	111.60	88.20	0.00	340.70	**540.50**
1991	84.50	70.10	0.00	293.60	**448.20**
1992	52.00	31.00	0.00	154.60	**237.60**
1993	51.10	30.90	0.00	155.50	**237.50**
1994	41.50	30.90	0.00	153.00	**225.40**
1995	43.90	30.90	0.00	154.60	**229.40**
1996	39.60	30.80	0.00	154.90	**225.30**
1997	33.00	30.80	0.00	155.20	**219.00**
1998	31.50	30.80	0.00	159.60	**221.90**
1999	30.50	30.80	0.00	161.10	**222.40**
2000	32.70	30.80	0.00	160.80	**224.30**
2001	41.50	17.50	0.00	141.50	**200.50**
2002	45.50	17.80	0.00	159.00	**222.30**
2003	106.60	21.80	0.00	151.50	**279.90**
2004	99.80	25.80	0.00	151.80	**277.40**
2005	95.14	16.85	0.00	157.66	**269.65**
2006	162.42	16.82	0.00	29.26	**208.50**

Solvents and Other Product Use					
Year	**3A**	**3B**	**3C**	**3D**	**Total**
	CO_2 emissions [Gg]				
2007	35.37	20.18	0.00	82.26	**137.82**
2008	25.16	28.19	0.00	81.79	**135.14**
2009	11.05	25.43	0.00	85.85	**122.33**
2010	12.39	25.09	0.00	87.26	**124.74**
2011	10.17	26.82	0.00	88.62	**125.61**
2012	15.96	25.75	0.00	86.05	**127.77**

Figure 5.2 The trend of CO_2 emissions resulted from Solvent and Other Product Use Sector, in the year 2012



The trend of emissions resulted from this sector follow the general emission trend: emissions have been seriously decreased after 1989, then the emissions are relatively stable from 1992 to 2002 and after 2002, emissions are started to increase, as an increase in economic activities (automobile manufacture, construction and buildings).

5.2.3 Uncertainties and time series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 300 %;
- EF: 20 %;
- 300.67% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2012.

5.2.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Chemical Industry Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 5.2.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 5.2.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2012 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

5.2.5 Source specific recalculation, including changes made in response to the review process

There are no recalculations related with this submission.

5.2.6 Source specific planned improvement, including those in response to the review process.

More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

6 AGRICULTURE (CRF Sector 4)

6.1 Overview of sector

This chapter provides information on the estimation of the greenhouse gas emissions from the Agriculture Sector (being associated with the Common Reporting Format Table 4). The following source categories are quantified and reported:

- CH_4 emissions from enteric fermentation;
- CH_4 and N_2O emissions from manure management;
- CH_4 emissions from rice cultivation;
- N_2O emissions from agricultural soils;
- CH_4, N_2O, NO_x and CO emissions from field burning of agricultural residues.

The direct GHGs reported within this sector are CH_4 and N_2O while indirect gases comprise NO_x and CO.

Domestic livestock are the major source of CH_4 emissions from agriculture, both from enteric fermentation and manure management. Manure management also generates N_2O emissions.

Table 6.1 gives an overview of the IPCC categories included in this chapter and provides information on the status of related emissions estimates.

Table 6.1 Status of emissions estimation within the Agriculture Sector

IPCC category	Emissions estimation status	
	CH_4	N_2O
4.A Enteric fermentation		
4.A.1 Cattle	✓	NA
4.A.1.a Dairy cattle	✓	NA
4.A.1.b Non-dairy cattle	✓	NA
4.A.2 Buffalo	✓	NA
4.A.3 Sheep	✓	NA
4.A.4 Goats	✓	NA

IPCC category	Emissions estimation status	
4.A.5 Camels and lamas	NO	NO
4.A.6 Horses	✓	NA
4.A.7 Mules and asses	✓	NA
4.A.8 Swine	✓	NA
4.A.9 Poultry	✓	NA
4.A.10 Other livestock	NA	NA
4.B Manure management		
4.B.1 Cattle	✓	✓
4.B.1.a Dairy cattle	✓	✓
4.B.1.b Non-dairy cattle	✓	✓
4.B.2 Buffalo	✓	✓
4.B.3 Sheep	✓	✓
4.B.4 Goats	✓	✓
4.B.5 Camels and lamas	NO	NO
4.B.6 Horses	✓	✓
4.B.7 Mules and asses	✓	✓
4.B.8 Swine	✓	✓
4.B.9 Poultry	✓	✓
4.B.10 Other livestock	NA	NA
4.B.11 Anaerobic lagoon	NA	✓
4.B.12 Liquid/Slurry	NA	✓
4.B.13 Daily spread	NA	IE[1)]
4.B.14 Solid storage	NA	✓
4.B.15 Dry lot	NA	✓
4.B.16 Pasture/range/paddock	NA	IE[1)]
4.B.17 Pit storage	NA	✓
4.B.18 Poultry manure wit bedding	NA	✓
4.B.19 Poultry manure without	NA	✓

IPCC category	Emissions estimation status	
bedding		
4.C Rice cultivation		
4.C.1 Irrigated	✓	NA
4.C.1.1 Continuously flooded	NO	NA
4.C.1.2 Intermittently flooded	✓	NA
4.C.1.2.1 Single aeration	NO	NA
4.C.1.2.2 Multiple aeration	✓	NA
4.C.2 Rainfed	NO	NA
4.C.3 Deep water	NO	NA
4.C.4 Other	NO	NA
4.D Agricultural soils		
4.D.1 Direct soil emissions	NA	✓ , NO
4.D.1.1 Synthetic fertilizers	NA	✓
4.D.1.2 Animal manure applied to soils	NA	✓
4.D.1.3 N-fixing crops	NA	✓
4.D.1.4 Crop residue	NA	✓
4.D.1.5 Cultivation of Histosols	NA	NO
4.D.1.6 Other direct emissions	NA	NA
4.D.2 Pasture range and paddock manure	NA	✓
4.D.3 Indirect emissions	NE	✓
4.D.3.1 Atmospheric Deposition	NA	✓
4.D.3.2 Nitrogen Leaching and Run-off	NA	✓
4.D.4 Other	NA	NA

IPCC category	Emissions estimation status	
4.E Prescribed burning of savannas	NO	NO
4.F Field burning of agricultural residues	✓	✓

Observations

1) In respect to the IPCC GPG 2000 provisions, N_2O emissions from Daily spread and Pasture range and paddock AWMS are reported under 4D – Agricultural soils (see Chapter 6.5).

Figure 6.1 Total GHG emissions trend in Agriculture for 1989–2012 period

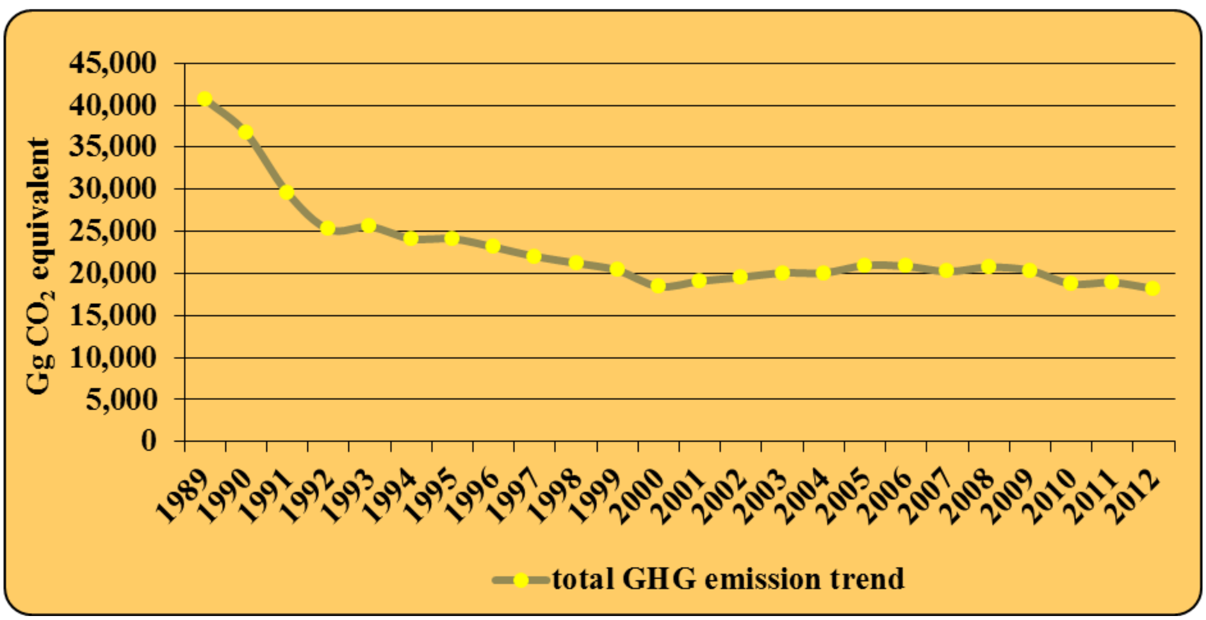
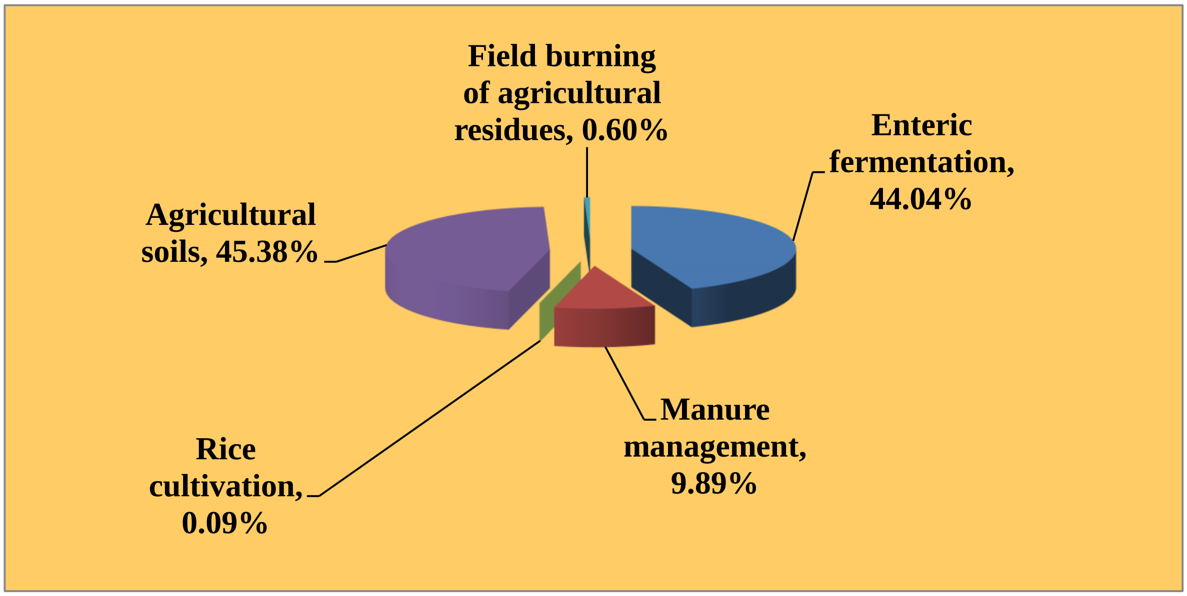


Figure 6.2 Contribution of the sub-sectors in the total GHG emissions from Agriculture, in 2012 year



Another source of methane is represented by anaerobic decomposition of organic material in flooded rice fields.

Microbiological processes in soil lead to N_2O emissions. Three N_2O sources are distinguished:

- ❖ direct soil emissions from agricultural soils (sources: synthetic fertilizers, animal waste applied to soil, biological nitrogen fixation, crop residue);
- ❖ direct soil emissions from animal production (from grazing animals);
- ❖ indirect soil emissions (atmospheric deposition, leaching and run off).

Cultivation of histosoils do not occur in Romania.

Burning of agricultural residues is a net source of CH_4, CO, N_2O and NO_x emissions for 1989-2012 period.

Emissions from prescribed burning of savannas do not occur in Romania.

The Agriculture Sector accounted for 15.32 % of the total GHG emissions in 2012, reaching 18,185.93Gg CO_2 equivalent (Table 6.2).

Within the GHG emissions from the agriculture sector, the N_2O emissions have the largest contribution (in 2012, N_2O emissions contribution is 52.21% to the total Agriculture Sector's

CO_2 equivalent emissions), followed by the CH_4 emissions (that account for the remaining 47.79%).

Over the period 1989 – 2012, the GHG emissions resulted from Agriculture Sector decreased by 55.35% (Figure 6.1).

The number of animals decreased in this period whatever of the species and type of operation. After a slight recovery of national livestock situation, another dramatic regression occured, result of economic situation extremely difficult Romania passed in the period 1997-2000. After the period 2001-2002 and in present, for the livestock species of interest there are recorded fluctuations in the livestock number influenced by the economic context, the emergence of various associative forms that have acquired economic power and by the interest shown by farmers for increasing the genetic value of the animals.

After 1989 the livestock from most Agricultural Production Cooperatives (C.A.P.) were attributed to rural population they being sacrificed in large numbers for meat. On the other hand, in most rural areas, a significant number of farmers have lost the interest in animal husbandry.

In case of emissions resulted from enteric fermentation and manure management, the descending trend reflects the decrease in animal population over the period. The number of all cattle categories decreased in the analyzed period.

Buffalo population was subject to the same reduction, the animals being privately owned both in subsistence farms and individual households. The lack of interest for these species is also due to the lack of associated governmental incentives.

After 1989 swine number decreased, from 1,023,000 heads breeding sows in 1989, to 335,000 heads in 2003; the number recorded a slight increase in years with high economic growth, 2004-2007, then decreased again, registering in 2010 355,000 heads; in 2012 there were registered 398,000 heads Annex 3.3 *(*sheet - *Data obtained through the study).*

The reducing of the swine number was due to (Dinu I. - *Swiniculture,* Ed. Coral Sanivet, Bucharest, 2002, pages. 28-29):

- ❖ the overgrowth of prices from upstream area, prices associated to the energy, to materials and services, while the price of meat has registered insignificant increases;
- ❖ significant mistakes in the restructuring and the liquidation of companies owned in majority by state;
- ❖ the liquidation almost entirely of the forms of financial farmers's support;

- ❖ the import of meat and meat products made an unfair competition to the local producers, on the internal market.

The sheeps's growth is characterized in some regions through extensivity, using primitive or slightly improved races and through the practice of transhumance.

After 1990, during the C.A.P, the sheep number have decreased continuously.

After 2004, the livestock begin to grow slowly, due to investors’s foreign in exploiting this species and , also due to the increased interest for sheep’s milk products.

In the 1989-2003 period, goats were represented, especially through White Goat of Banat and Carpathian races.

The horses number has increased from 1989, constant until 2003, because has changed the orientation in the horses's growth of traction, are abandons the species heavier of horses, less viable considering the economic criteria, and are used intermediary horses with mixed aptitude, wich moves and are easy maintenance (Creta V, Morar M., Culea C.- *General and special animal husbandry,* E.D.P., Bucharest, 1995).

From 2007 to present, horse number is decreasing due to the biological disappearance of population employed in agriculture and due to, the increased mechanization degree in agriculture.

On the other, the number of horses used to sport purposes and, in the people therapy and development increased.

The number of mules and asses varied over the period with maximum 8,000 heads. Mules and asses are found only in households, not being growth in farms.

Poultry for meat number decreased from 1989 to 1994, after which they slightly increased, the egg poultry decreased sharply in 1994, then begin to grow, due to the foreign investments. The sector is developed in Romania and there is in present concerns of development of the modern technologies exploitation of these categories.

For the 2004-2012 period, sheep and goats livestock number is only growing slightly; for the rest of species, their downward trend of 1989-2003 period continued.

Comparatively with the 2011 year, in 2012 were slowly increased some livestock categories for exemple: cattle, swine, sheeps, goats and poultry.

The rice cultivation generated in 2012 a significantly reduced emission compared to the base year 1989 due to the decrease of areas (72.49% decrease comparing with the base year).

In case of agricultural soils, the emissions decreased over the period (55.09% decrease in 2012 comparing with 1989), due to the decrease of the amount of the synthetic fertilizer applied, of the livestock populations and of the crop productions level.

Starting with the 2000 year, the N_2O emissions from Agricultural Soils fluctuates: increases until 2005 and then decreases. This is due variation of quantities of synthetic fertilizers, number of animals and of the crop productions.

The Agriculture sector's CH_4 emissions decreased in 2012 with 56.52% compared to basic (see Annex 3.3 - sheet *Distribution of N_2O and CH_4 emission*). Because the methane emissions are mainly resulted in domestic livestock, the decrease of their level is due to the decline of the domestic livestock.

The N_2O emissions from the Agriculture Sector decreased in 2012 with 54.23% comparing with the base year (see Annex 3.3 - sheet *Distribution of N_2O and CH_4 emission*). The reasons for this decrease are:

- ❖ the decrease of the amount of chemical fertilizers applied to soils;
- ❖ the decline of the domestic livestock (the details are presented above);
- ❖ the decrease of the crop productions level.

In the general context of the transition of the economy to a market based approach, the activity data level decreased substantially in the last years of the characterized period in comparison to the base year.

The livestock number decreased in the last years of the characterized period in comparison to 1989 mainly due to:

- ❖ the import of animals;
- ❖ the draught which affected the crop production levels and the crop production prices;
- ❖ state incentives in some periods;
- ❖ closing of the old/opening new facilities due to the restructuration of the economy.

The crop productions level decreased in the late years of the analyzed period in comparison to 1989 mainly due to the change in agricultural land property regime and to the transition to the market economy. Reasons for the inter-annual changes in crop production levels include:

- ❖ existence of draught periods;
- ❖ existence if state incentives for some periods;

- changes in the land property regime, including the disaggregation of large farms before 1990 and crystallization of new large farms in the late years.

The livestock number was decreased in the 2010 year comparative with the 2009 year due to:

- the deficiency precipitation that which led to decreased of production needed for feeding;
- the increases of price per food.

Table 6.2 Contribution of Agriculture sector in total GHG emissions, in 1989–2012

Year	Total GHG emissions [Gg CO_2 equivalent]	GHG emissions from Agriculture [Gg CO_2 equivalent]	Contribution of Agriculture in total GHG emissions [%]	Methane emissions from Agriculture [Gg CO_2 equivalent]	Contribution of methane emissions in total GHG emissions from Agriculture [%]	Nitrous oxide emissions from Agriculture [Gg CO_2 equivalent]	Contribution of nitrous oxide emissions in total GHG emissions from Agriculture [%]
1989	285,047.74	40,734.14	14.29	19,989.60	49.07	20,744.54	50.93
1990	247,663.52	36,708.34	14.82	17,781.78	48.44	18,926.56	51.56
1991	202,016.80	29,601.60	14.65	15,268.27	51.58	14,333.33	48.42
1992	182,424.15	25,251.76	13.84	13,125.02	51.98	12,126.74	48.02
1993	172,305.77	25,563.86	14.84	12,745.19	49.86	12,818.66	50.14
1994	169,049.82	24,130.83	14.27	12,141.50	50.32	11,989.32	49.68
1995	175,264.58	24,135.56	13.77	11,963.21	49.57	12,172.35	50.43
1996	177,828.37	23,153.24	13.02	11,529.01	49.79	11,624.23	50.21
1997	164,437.44	22,027.13	13.40	10,731.41	48.72	11,295.72	51.28
1998	146,772.78	21,241.10	14.47	10,314.84	48.56	10,926.27	51.44
1999	129,707.90	20,380.37	15.71	9,933.75	48.74	10,446.63	51.26
2000	134,073.69	18,455.10	13.76	9,356.50	50.70	9,098.59	49.30
2001	139,021.95	19,096.83	13.74	9,206.91	48.21	9,889.92	51.79

Year	Total GHG emissions [Gg CO_2 equivalent]	GHG emissions from Agriculture [Gg CO_2 equivalent]	Contribution of Agriculture in total GHG emissions [%]	Methane emissions from Agriculture [Gg CO_2 equivalent]	Contribution of methane emissions in total GHG emissions from Agriculture [%]	Nitrous oxide emissions from Agriculture [Gg CO_2 equivalent]	Contribution of nitrous oxide emissions in total GHG emissions from Agriculture [%]
2002	139,697.63	19,552.24	14.00	9,542.76	48.81	10,009.48	51.19
2003	144,219.31	20,073.19	13.92	9,725.66	48.45	10,347.53	51.55
2004	141,220.66	20,070.58	14.21	9,710.25	48.38	10,360.32	51.62
2005	141,313.82	20,949.57	14.82	9,792.49	46.74	11,157.08	53.26
2006	144,776.56	20,862.19	14.41	10,134.93	48.58	10,727.26	51.42
2007	142,803.52	20,236.92	14.17	10,210.62	50.46	10,026.30	49.54
2008	139,811.77	20,753.53	14.84	10,125.15	48.79	10,628.38	51.21
2009	119,917.10	20,353.84	16.97	9,861.40	48.45	10,492.44	51.55
2010	115,798.97	18,760.94	16.20	8,624.13	45.97	10,136.81	54.03
2011	121,513.51	18,941.46	15.59	8,616.63	45.49	10,324.83	54.51
2012	118,764.15	18,185.93	15.31	8,691.09	47.79	9,494.84	52.21

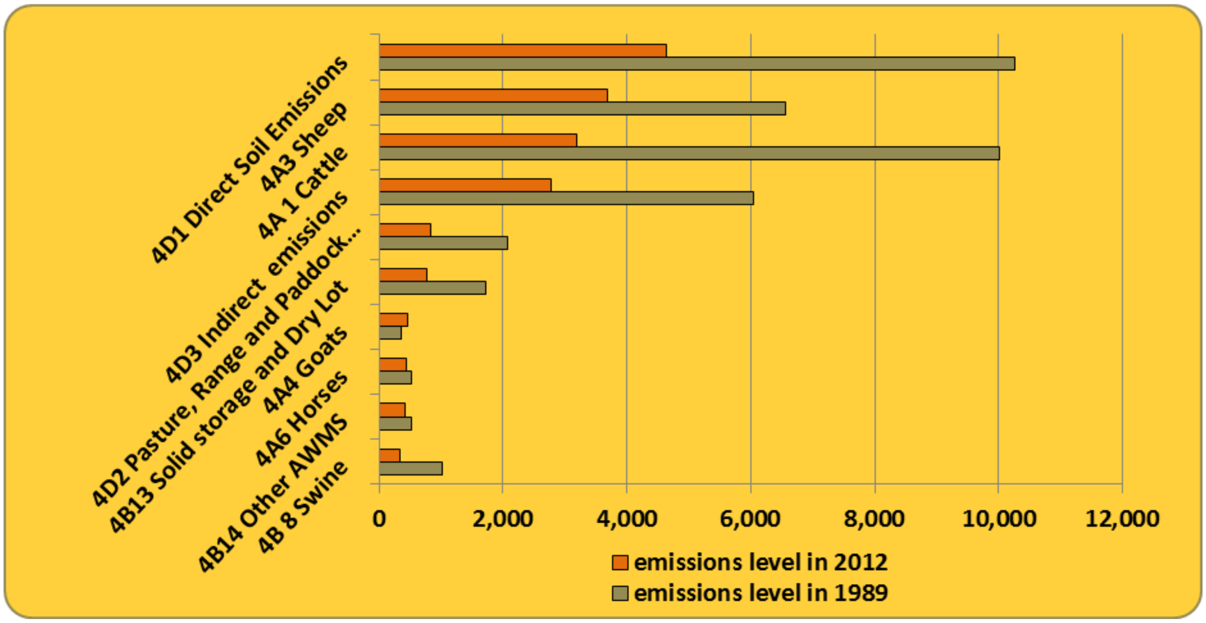
Table 6.3 and Figure 6.3 describe Key categories in Agriculture, both from level and trend and including and excluding LULUCF views.

Table 6.3 Key categories overview – Agriculture, 2012

Key categories	GHG	Criteria	Contribution in total GHG emissions [%]
4.D.1 Direct Soil Emissions	N_2O	L (Tier 1 including LULUCF); L,T (Tier 1, excluding LULUCF);L,T (Tier 2, excluding and including LULUCF)	**3.9**

Key categories	GHG	Criteria	Contribution in total GHG emissions [%]
4.A.3 Sheep	CH_4	L,T (Tier 1 and Tier 2 excluding and including LULUCF)	**3.1**
4.A.1 Cattle	CH_4	L,T (Tier 1 and Tier 2 excluding and including LULUCF)	**2.7**
4.D.3 Indirect emissions	N_2O	L,T (Tier 1, excluding LULUCF), L (Tier 1 including LULUCF); L,T (Tier 2, excluding and including LULUCF)	**2.3**
4.D.2 Pasture, Range and Paddock Manure	N_2O	L (Tier 1, excluding and including LULUCF); L,T (Tier 2, excluding and including LULUCF)	**0.7**
4.B.13 Solid storage and Dry Lot	N_2O	L (Tier 1, excluding and including LULUCF), L,T (Tier 2 including and excluding LULUCF)	**0.7**
4.A.4 Goats	CH_4	L,T (Tier 1 excluding and including LULUCF); T (Tier 2, excluding LULUCF)	**0.4**
4.A.6 Horses	CH_4	T (Tier 1, excluding LULUCF, T (Tier 2, excluding LULUCF)	**0.4**
4.B.14 Other AWMS	N_2O	L,T (Tier 2, excluding and including LULUCF)	**0.4**
4.B.8 Swine	CH_4	L (Tier 2, excluding LULUCF)	**0.3**

Figure 6.3 Key Categories in Agriculture, both by level and trend



6.2 Source category Enteric Fermentation (CRF source category 4.A)

6.2.1 Source category description

Methane is produced by herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. Although ruminants are the largest source, both ruminant and non-ruminant animals produce CH_4.

Enteric Fermentation:

- is the main source of CH_4 emissions in the Agriculture sector (in 2012, CH_4 emissions from Enteric Fermentation represented 92.15% of total CH_4 emissions in the Agriculture sector);
- is the second source in the Agriculture sector (in 2012, CH_4 emissions from Enteric Fermentation as CO_2 equivalent represented 44.06% from Total Agriculture emissions);
- contributed with 6.74% to Total GHG emissions of Romania.

Compared to 1989, total CH_4 emissions from Enteric Fermentation decreased with 55.49% in 2012 (Figure 6.4). The decreasing trend is in direct correlation with the dynamics of livestock.

The livestock number for all species of economic interest, except goats, due to increased interest in recent years for this species, declined; the interest for goats's products is a consequence of the consumers's taste refineries, especially for urban consumers, and of the requirements for milk and goat meat for export.

The administration of goat livestock is based also on valuable genetic biological material import, especially from breeds specialized in milk production.

Figure 6.4 Methane emission trend due to the Enteric Fermentation

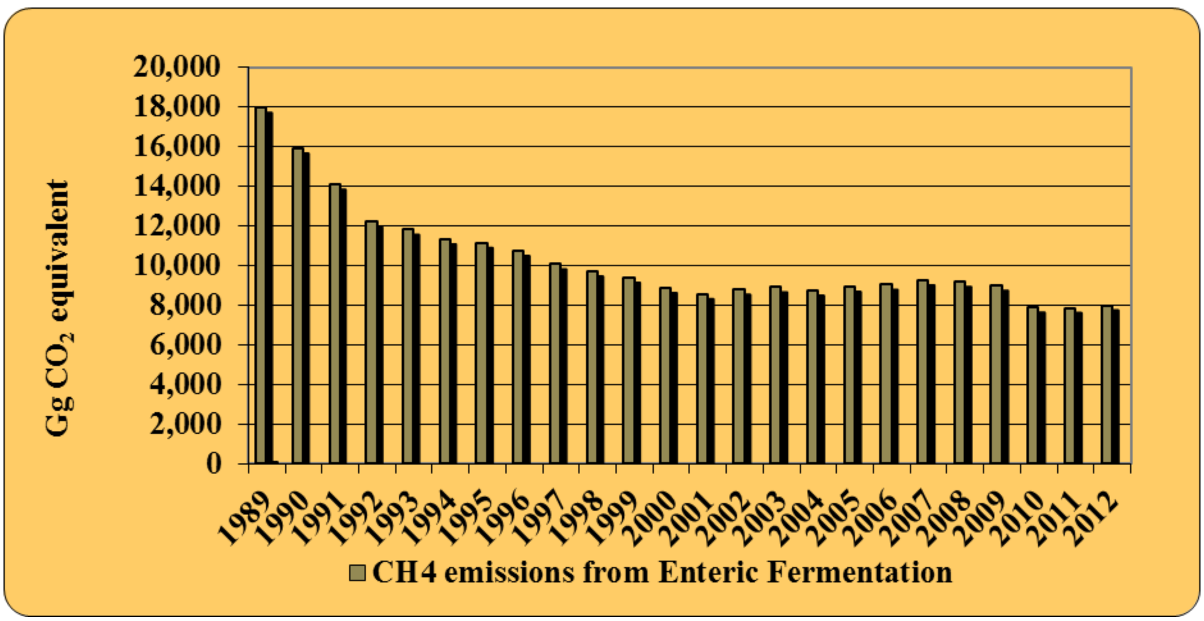


Table 6.4 Observations on source category 4A – "Enteric Fermentation"

Source indicative	Source (livestock) type	Observation	Data source
4.A.1	Cattle	Includes livestock data from nine different *cattle* categories: *dairy cows* and *non-dairy cattle*.	AD: NIS and expert judgment, 1989-2003; NIS, 2004-2012 EF: Country specific, expert judgment

Source indicative	Source (livestock) type	Observation	Data source
4.A.2	Buffalo	Includes livestock data from two different *buffalo*:buffalo milk and other buffalo	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2012; EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.A.3	Sheep	Includes livestock data from three different sheep: *Ewes of milk and fitted*, *reproducers rams* and *other sheep*	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2012; EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.A.4	Goats	Includes livestock data from two different *goats*: *Female goats for milk* and *females by first mount* and *other goats*	
4.A.6	Horses		
4.A.7	Mules and asses		AD: FAO, 2011; EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.A.8	Swine	Includes livestock data from five different *swine*: *pigs under 20 kg, pigs between 20 and 50 kg, pigs fattening, boars, breeding sows*	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2012 EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.A.9	Poultry	Includes livestock data from two different *poultry*: *adult poultry for eggs, poultry for meat*	

6.2.2 Methodological issues

Methodology

The amount of methane emitted from enteric fermentation is driven primarily by the number of animals, the type of digestive system, and the type and amount of feed consumed.

Emissions of methane from enteric fermentation were calculated using a Tier 2 method, for all species, according to the provisions in the IPCC GPG 2000 decision tree. There are national data available for every species and subcategory for to estimate the methane emission according with the level 2 method.

Emissions of methane from enteric fermentation were calculated using equations 4.12, 4.13 and 4.14 in the *IPCC GPG 2000.*

Equation 6.1 Emissions from a livestock category

$$Emissions = EF \bullet population/(10^6 kg/Gg)$$

where:

- Emissions = methane emissions from enteric fermentation, Gg CH_4/year;
- EF = emission factor for the specific population, kg/head/year;
- Population = the number of animals, head.

Equation 6.2 Total emissions from livestock

$$Total\ CH_4\ Emissions = \Sigma_i E_i$$

where:

- Total Emissions = total methane emissions from enteric fermentation, Gg CH_4/year;
- index *i* = sums all livestock categories and sub-categories;
- E_i = is the emissions for the *i* the livestock categories and sub-categories.

Equation 6.3 Emission factor development

$$EF = (GE \bullet Y_m \bullet 365\ days/yr) / (55.65\ MJ/kg\ CH_4)$$

where:

- EF = emission factor, kg CH_4/head/yr;
- GE = gross energy intake, MJ/head/day;
- Y_m = methane conversion rate which is the fraction of gross energy in feed converted to methane.

Emission factors

According to the provisions in IPCC GPG 2000, to use equation 4.14 have been considered national values for gross energy intake (GE) and default values for developed countries for methane conversion rate which is the fraction of gross energy in feed converted to methane (Y_m), default values provided through *IPCC GPG 2000* (Tables 4.8 and 4.9) and IPCC 1996-Reference Manual (Table A-4).

The calculation of gross energy intake an estimation method depending on the species and the category exploited, respectively based on an average ration, both in summer and in winter, was used

This rations can ensure the necessary of maintenance (allows normal animal organism functioning on basal metabolism level, assuring vital functions), and, respectively, for production in cattle, buffalo, sheep, goats and horses productions. For poultry and swine was proceeded similarly, taking into account mixed fodder prescriptions specific of categories of exploitation, according to nutritional requirements and standards in force.

The values of gross energy ingested were established correlating the nutritional requirements of each species and exploitation category with the food intake brought of through the rations and average prescriptions which were considered for ensuring the production level part of official statistics (elaborated by NIS).

For calculation of gross energy caloricity for each prescription or ration were took into account the following:

- 1g gross protein = 5.72 kcal;

- 1 g gross fat = 9.5 kcal;
- 1 g gross pulp = 4.79;
- 1 g SEN (unnitrous substances extractable) = 4.17 kcal.

The Calculation formula of energy gross is:

Equation 6.4 Calculation of energy gross intake

$$GE\ (kcal/kg) = 5.72 \bullet PB + 9.5 \bullet GB + 4.79 \bullet CelB + 4.17 \bullet SEN$$

(I.Stoica, Nutrition and feedingstuffs, 1997, pg.131)

where:

- GE = gross energy intake (kcal/kg);
- PB = gross protein;
- GB = gross fat;
- CelB = gross pulp;
- SEN = unnitrous substances extractable.

Rations were made up according of equation above, the protein gross values, gross fat, gross pulp and unnitrous substances extractable were used from the tables with chemical composition of the feeding (I.Stoica, *Nutrition and feedingstuffs*, 1997, pages 513-517). In these tables value of these nutritional principles is expressed as percentage (for 100 grams of exemple), so in the calculation of rations and prescriptions these values were multiplied with 10 for to express caloricity for 1 kg. The total value of ration, expressed in kcal it was divided to 239, to obtain equivalent in MJ (Mega Jouli).

The equivalence relations are the following:

- 1J = 1/41855Kcal, where J = joule and Kcal = kilocalorie;
- 1KJ = 0,239 Kcal, where KJ = Kilojoule and Kcal = kilocalorie;
- 1MJ = 239 Kcal, where MJ = Megajoule and Kcal = kilocalorie.

The values of protein gross, gross fat, gross pulp and unnitrous substances extractable were multiply with the specific caloricity of each nutritive principle (5,72 kcal for 1 g of gross protein, and so on). Then was calculated the sum of caloricity of each nutritive principle in order to obtain the caloricity of fodder. This value is multiplied by the number of pounds of fodder which is specified in ration.

Digestible energy (DE) is used to express the nutritional value of fodder and of rations, mainly for grazing animals. For calculating digestible energy are used mathematical equations considering the nutritive digestible content of nutrients, which multiply with the coefficients of specific digestibility each forage and each species (I.Stoica- *Nutrition and feedingstuffs*, 1997, pages 518-522), then are propagated with the energy equivalents for digestible energy, which are different per species, in the table below (Popa O, Milos M, Halga P, Bunicelul El., EDP., 1980, pages 101- *Livestock feeding*).

Table 6.5 Calculation of feed digestible energy

Specification	**Digestible PB**	**Digestible GB**	**Digestible CelB**	**Digestible SEN**
Symbol	$\mathbf{x_1}$	$\mathbf{x_2}$	$\mathbf{x_3}$	$\mathbf{x_4}$
Energy equivalent (e) to:				
Cattle	5.79	8.15	4.42	4.06
Swine	5.78	9.42	4.4	4.07
Poultry	5.72	9.5	4.23	4.23
Equation for calculating	$x_1 \bullet e_1$	$x_2 \bullet e_2$	$x_3 \bullet e_3$	$x_4 \bullet e_4$

The categories and subcategories for which were the calculated rations are given below:

- For ***calves for slaughter younger than 1 year***, with an average weight of 250 kg and average daily gain of 1000 g/day, it was considered a ration that may contain 3 kg mountain hay, 10 kg pickled corn, mixture of farm 3 kg, ration which corresponds to an energy intake of 143.07 MJ, DE (MJ) = 81.23 and DE (%)= 56.77.
- For ***young cattle of breeding under 1 year***, with an average weight of 250 kg and average daily gain of 600 g/day can be given a ration consisting of : 2 kg hill hay, 10 kg corn silage, 2.3 kg mixture of farm, meaning GE = 115.5 MJ, DE = 65.8 MJ and DE (%) =56.97.

- For ***young cattle of breeding between 1 and 2 years,*** with an average weight of 350 kg and average daily gain of 600 g/day, can be given a ration of type: 2 kg hill hay, 10 kg corn silage, 2 kg clover hay and 2.3 kg mixture of farm, with a GE = 146.83 MJ, DE = 81.49 MJ and DE (%) = 55.49.
- For ***young cattle of slaughter between 1 and 2 years*** was considered a subcategory**,** with an average weight of 400 kg and average daily gain of 1100 g/day. The ration contains 6 kg hay mountain, 2 kg clover hay, 10 kg pickled corn and 3 kg mixture of farm. The ration total caloricity is 531,36.58 kcal, equivalent to 222.33 MJ, DE = 152.63 MJ, DE (%) = 68.65.
- ***Cattle 2 years and over- Breeding bulls*** (815 kg average weight) ingest a ration of 8 kg hay of lucerne, 11 kg pickled corn, 4 kg feed carrots, 3.3 kg mixture of farm, ration, with a caloricity average GE = 241.68 MJ, DE = 132.94MJ, DE (%) = 55
- For **cattle 2 years and over** - ***heifers*** with an average weight of 490 kg, ration used is composed of 3 kg hill hay, 4 kg hay of lucerne, 13 kg pickled corn, 10 kg fodder beet, 1 kg mixture of farm, GE = 211.12 MJ, DE = 124.23 MJ, DE (%) = 58.84.
- A ration for ***dairy cattle*** with a mass of 650 kg/animal and a production of about 10-12 l milk/day (including calves consumption), containing 3 kg hay hill, 17,5 kg pickled corn, 4 kg hay of lucerne, 15 kg fodder beet and 2 kg mixture of farm, has an caloricity 54343.57 total kcal, equivalent to 227,37 MJ. Were worked with average caloricity between seasons summer-winter, capable ensures a production of about 10-12 l milk/head/day. The production of milk can vary within very large limits depending on geographic region, of race, the type of holding, level of education and training of farmers.

In zootechnics, feeding dairy cattle is differentiated according to milk production, but the ration is adjusted from 5 to 5 l production/head/day, supplementing the daily energy requirements by 0.5 UN/l milk (or 0.45 UN/l milk).

In the Table 6.6 are presented the milk productions per year, for the period 1989-2012 for dairy cows and, respectively, buffaloes.

For dairy cattle DE (MJ)=154.46 and DE (%) = 67.93.

Table 6.6 Milk production in cows and buffalo in the period 1989-2012 (NIS)

Year	Dairy cattle production (thousand hl)	Milk buffalo production (thousand hl)
1989	40,477	717
1990	39,698	613
1991	41,326	497
1992	40,659	420
1993	43,097	410
1994	49,235	397
1995	52,431	399
1996	53,085	392
1997	52,212	369
1998	50,544	358
1999	48,901	348
2000	48,191	327
2001	49,717	319
2002	51,472	328
2003	53,869	330
2004	55,107	337
2005	54,976	357
2006	57,981	326
2007	54,517	358
2008	52,761	327
2009	48,234	304
2010	42,585	239
2011	43,728	218
2012	41,823	212

- ***Males and females for sacrificed older than 2 years*** with an average weight of 500 kg, and average daily gain of 600 g/day, ingest a ratio of 3 kg mountain hay, 15 kg pickled corn, 3 kg mixture of farm, providing an caloricity average 166.72 MJ, DE = 95.15 MJ, DE (%) = 57.
- ***Cattle for work*** (800 kg average weight) ingest a ration of 10 kg hill hay, 5 kg coarse (oat straw), 15 kg fodder beet, 2 kg mixture of farm, ration with average caloricity 303.08 MJ, DE = 173.22 MJ, DE (%) = 57.15.
- The ratio ***buffalo female*** (500 kg average weight) considered is composed: 4 kg hill hay, 6 kg coarse chopped (oat straw), 20 kg succulents (corn silage), 1 kg concentrates, ration with an average caloricity 269.74 MJ, DE = 145 MJ, DE (%) = 53.75. Average milk production is 4.2 l/head/day, including calves consumption.
- The category ***other buffalo*** (400 kg average weight) has a ration composed of: 1 kg legumes hay, 1 kg hill hay, 2 kg coarse (oat straw), 6.8 kg corn silage, 4 kg root (fodder beet) and 1 kg mixture of farm. GE = 128.85 MJ, DE = 71.3 MJ, DE (%) = 55.34.
- For subcategory ***ewes of milk and fitted***, with an average weight of 60 kg and milk production 1.3 l/head/day were used ration: 1.6 kg clover hay, 0.4 kg oat straw, 2.5 kg fodder beet and 0.36 kg mixed fodder. The total caloricity of the ration is 42.78 MJ/head/day, DE = 19.7 MJ, DE(%) = 44.57.
- For subcategory ***reproducers rams*** (77 kg average weight) was used a ration composed of 2.5 kg hay hill, 2 kg succulents (corn silage) and 0.4 kg mixed fodder. GE = 50.23 MJ, DE = 30.07 MJ, DE (%) = 59.86.
- The ***other sheep*** subcategory (48 kg average weight) ingest a ration of 1.6 kg clover hay, 0.4 kg oat straw, 2.5 kg fodder beet and 0.516 kg mixed fodder, resulting GE = 45.27 MJ, DE = 20.84 MJ, DE (%) = 46.04.
- For ***female goats for milk and females by first mount*** (48 kg average weight and 1.8 l/head/day milk production) the ration contains: 2 kg clover of hay, 2.5 kg beet, 0.5 kg mixed fodder, 0.5 kg oat straw. The caloricity total is 52.88 MJ/head/day, DE = 23.91 MJ, DE(%) = 45.21.
- The ration for ***other goats*** (50 kg average weight) is: 0.27 mixed fodder, 2 kg clover of hay, 2.5 kg fodder beet, 0.5 kg oat straw, obtaining GE = 49.25 MJ, DE = 20.82 MJ, DE (%) = 42.27.]

- For ***pigs under 20 kg,*** GE = 8.18 MJ, DE = 6.7 MJ, DE (%) = 82.88, use are the ration 0-1, 0-2. Was chose a weight (14 kg).
- For ***pigs between 20 and 50 kg,*** GE = 13.49 MJ, DE = 11.70 MJ, DE (%) = 86.75, was used are the ration 0-3. Was chose an average weight (35kg).
- ***Pigs fattening*** (110 kg average weight) has GE = 46.86 MJ, DE = 40.66 MJ, DE(%) = 86.77, was used the ration 0-7.
- The was used ration 0-5 to ***boars*** (270 kg average weight), with a caloricity 15.62 Mj/1 kg ration (animal consume an average 2.9 kg mixed fodder/head/day), GE = 45.32 MJ, DE = 39.3 MJ, DE(%) = 86.72.
- For the ***sows of breeding*** (125 kg average weight) were used the ration 0-6 for ***breeding sows*** weight exceeding 110 kg, the ration with a total caloricity 16.19 MJ/1 kg ration (the animal consume in average 2.8 kg mixed fodder/head/day), so GE = 45.34 MJ, DE = 37.7 MJ, DE(%) = 83.14.
- For **horses** (500 kg average weight) the ration is: 10 kg hill hay, 7 kg fodder beet and 3.3 kg mixed fodder. The caloricity of ration is 53965.7 kcal, equivalent to 225.79 MJ , DE = 121.84 MJ, DE(%) = 53.96.
- For the category ***mules and asses*** (300 kg average weight) the ration is: 5 kg hay hill, 5 kg oat straw, 10 kg fodder beet, resulting a caloricity of GE = 181.18 MJ, DE = 99.2 MJ and DE (%) = 53.96.
- For the ***adult poultry for eggs*** (1.9 kg average weight) was used the ration 21-5, contains maize, barley, soy grits, sunflower meal, meat meal, oil, 10% premix hill and P.V.M A 6, resulting a caloricity 1872.38 kcal/1kg ration, respective 7.83 MJ/1 kg ration. An animal consumes on average 120 g of prescription/head/day), that is 1.83 MJ/head/day. DE = 1.5 MJ, DE (%) = 81.96.
- For ***poultry for meat*** (1.8 kg average weight) the rations contain maize, barley, wheat, soy grits, sunflower meal, meat meal, oil and animal protein/plant. For ration 1 kg, caloricity is 4122.97 kcal, equivalent to 17.25 MJ/1 kg ration. For an increase of 35 g, specific to this type of exploatation, average amount ingested is 75g/head/day, equivalent to 1.3 MJ, DE = 1.086 MJ, DE (%) = 83.53.

For values of methane conversion rate (Y_m) were used default values from *IPCC GPG 2000*, because there are no national studies on the rate of conversion of methane from gross energy intake (Table 4.8).

For cattle were used the value of 0.06 for all categories, the value which corresponds to the default value for developed countries.

For dairy cattle, Y_m value is 0.06 for developing countries.

For other categories Y_m values were used from IPCC 1996 -Reference Manual, Table A-4 (Y_m values for sheep, goats, horses and mules and asses are similar for developed countries and developing countries.

For swine was used value of Y_m of 0.6% (0.006), because GE value from our ration is similar to that given in Reference Manual (38 MJ/day for developed countries). For categories where GE value is close to 13 MJ/day (pigs under 20 kg, pigs between 20 and 50 kg) was worked with the value 1.3% (0.013) (Reference Manual, Table A-4).

The emission factors used for livestock are presented in Table 6.7.

The gross energy intake is in direct correlation with animal's weight.

Table 6.7 The factors emission (kg CH_4/head/year) used for calculation of methane emissions from enteric fermentation of livestock and data necessary for their calculation, in the 1989-2012 period

Source indicative	**Livestock (source) type**	**Emission Factors [kg CH_4/head/year]**	**Gross energy intake (GE) (Mj/head/day)**	**Methane conversion rate which is the fraction of gross energy in feed converted to methane (Ym fraction)**
4.A.1	**CATTLE**			
4.A.1.a	***Dairy cattle***	89.47	227.37	0.06
4.A.1.b	***Non dairy cattle***			
	Calves for slaughter younger than 1 year	56.30	143.07	0.06

Source indicative	Livestock (source) type	Emission Factors [kg CH_4/head/year]	Gross energy intake (GE) (Mj/head/day)	Methane conversion rate which is the fraction of gross energy in feed converted to methane (Ym fraction)
	Young cattle of breeding under 1 year	45.45	115.5	0.06
	Young cattle of breeding between 1 and 2 years	57.78	146.83	0.06
	Young cattle of slaughter between 1 and 2 years	87.49	222.33	0.06
	Cattle 2 years and over Breeding bulls	95.10	241.68	0.06
	Cattle 2 years and over Heifers	83.08	211.12	0.06
	Males and females for sacrificed older than 2 years	65.60	166.72	0.06
	Cattle for work	119.27	303.08	0.06
4.A.2	***BUFFALO***			
	Female buffalo	106.15	269.74	0.06
	Other buffalo	50.70	128.85	0.06
4.A.3	***SHEEP***			
	Ewes of milk and fitted	19.64	42.78	0.07

Table 6.7 (continued) The factors emission (kg CH_4/head/year) used for calculation of methane emissions from enteric fermentation of livestock and data necessary for their calculation, in the 1989-2012 period

Source indicative	Livestock (source) type	Emission Factors [kg CH_4/head/year]	Gross energy intake (GE) (Mj/head/day)	Methane conversion rate which is the fraction of gross energy in feed converted to methane (Ym fraction)
4.A.3	***SHEEP***			
	Reproducers rams	23.06	50.23	0.07
	Other sheep	20.78	45.27	0.07
4.A.4	***GOATS***			
	Female goats for milk and females by first mount	17.34	52.88	0.05
	Other Goats	16.15	49.25	0.05
4.A.6	***HORSES***	37.02	225.79	0.025
4.A.7	***MULES AND ASSES***	29.70	181.18	0.025
4.A.8	***SWINE***			
	Pigs under 20 kg	0.69	8.18	0.013
	Pigs between 20 and 50 kg	1.15	13.49	0.013
	Pigs fattening	1.84	46.86	0.006
	Boars	1.78	45.32	0.006
	Breeding sows	1.78	45.34	0.006
4.A.9	***POULTRY***			
	Adult poultry	0	1.83	0

Source indicative	Livestock (source) type	Emission Factors [kg CH_4/head/year]	Gross energy intake (GE) (Mj/head/day)	Methane conversion rate which is the fraction of gross energy in feed converted to methane (Ym fraction)
	for eggs			
	Poultry for meat	0	1.3	0

In the Table 6.8 are summarized the values energy digestible DE (Mj), the percentage of digestible energy DE (%) and the weight for each subcategory.

Table 6.8 The values energy digestible expressed in Mj/day and percent and weight (kg) for livestock, in the 1989-2012 period

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
4.A.1	***CATTLE***			
4.A.1.a	***Dairy cattle***	154.46	67.93	650
4.A.1.b	***Non dairy cattle***			
	Calves for slaughter younger than 1 year	81.23	56.77	250
	Young cattle of breeding under 1 year	65.8	56.97	250
	Young cattle of breeding between 1 and 2 years	81.49	55.49	350
	Young cattle of slaughter between 1 and 2 years	152.63	68.65	400
	Cattle 2 years and over Breeding bulls	132.94	55	815
	Cattle 2 years and over	124.23	58.84	490

Source indicative	**Livestock (source) type**	**Energy digestible DE (Mj/day)**	**Percentage of digestible energy DE(%)**	**Animal weight (kg)**
	Heifers			
	Males and females for sacrificed older than 2 years	95.15	57	500
	Cattle for work	173.22	57.15	800
4.A.2	***BUFFALO***			
	Female buffalo	145	53.75	500
	Other buffalo	71.3	55.34	400
4.A.3	***SHEEP***			
	Ewes of milk and fitted	19.7	44.57	60

Table 6.8 (continued) The values energy digestible expressed in Mj/day and percent and weight (kg) for livestock, in the 1989-2012 period

Source indicative	**Livestock (source) type**	**Energy digestible DE (Mj/day)**	**Percentage of digestible energy DE(%)**	**Animal weight (kg)**
4.A.3	***SHEEP***			
	Reproducers rams	30.07	59.86	77
	Other sheep	20.84	46.04	48
4.A.4	***GOATS***			
	Female goats for milk and females by first mount	23.91	45.21	48
	Other Goats	20.82	42.27	50
4.A.6	***HORSES***	121.84	53.96	500
4.A.7	***MULES AND ASSES***	99.2	54.75	300
4.A.8	***SWINE***			

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
	Pigs under 20 kg	6.7	82.88	14
	Pigs between 20 and 50 kg	11.7	86.75	35
	Pigs fattening	40.66	86.77	110
	Boars	39.3	86.72	270
	Breeding sows	37.7	83.14	125
4.A.9	***POULTRY***			
	Adult poultry for eggs	1.5	81.96	1.9
	Poultry for meat	1.086	83.53	1.8

Activity data

Primary livestock data

1989-2003

The primary data on all categories of animals have been provided by NIS through the Statistical Yearbook.

2004-2012

The primary data on all categories of animals have been provided by NIS; they were reported by NIS to EUROSTAT and, published by EUROSTAT, the total number for each livestock was published in the Statistical Yearbook of Romania.

In the Annex 3.3 (sheet *Primary data)* raw data on livestock in the period 1989-2012, are presented.

Livestock data primary obtained through the dedicated study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“

1989-2003

The data from the NIS by 2003, presents livestock aggregate per larger categories (the aggregation criterion is the operation production), was necessary an extrapolation in the past (1989-2003), of the subcategories of animals which appear in the Annex 3.3 (sheet - *Data obtained through the study*) and for which are official data for 2004-2012. Was considered the reference year for extrapolation, the *2004* year.

The extrapolation was made by the contractor, Institute for Studies and Power Engineering in the above study.

The categories and subcategories for which reports were made are given in the Annex 3.3 (sheet - *Data obtained through the study*).

Cattle

In this year, from total number of cattle were calculated the percentages other categories and subcategories, respectively the percentages of cattle, with all subcategories and the percentages of buffalo, with all subcategories.

Dairy cattle

For the period 1989-2003 was made an extrapolation, yielding the percentage of 55.79% of the total cattle (the expert opinion).

Non dairy cattle

Calves for slaughter younger than 1 year represents 10.03% of the *total bovines young cattle of breeding under 1 year* represents 15.3% of the *total bovines, young cattle of breeding between 1 and 2 years* represents 7.97% of the *total bovines, cattle 2 years and over - breeding bulls* 0.34% of the *total bovines, cattle 2 years and over - heifers* 5.83%, *males and females for sacrificed older than 2 years* 1%, *cattle for work* 1.94%.

Were kept the same percentage for the entire period, 1989-2003, because are significantly similar, considering that certain subcategories pass quickly from one subset to another. The categories with long operating (*dairy cattle, breeding bulls, cattle for work, female buffalo*) have similar percentages for all-time series; livestock structure does not change drastically during even if the number of livestock decreases. Most of buffalo and cattle for work exists only households, not sacrifice.

Buffalo

Total bovines data are provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook 1989-2012 and other relevant correspondence.

Beginning with 2004, NIS provides to Eurostat a more complete set of data, comprising also Buffalo data.

The *Buffalo* represents 1.2% of the *total bovines, female buffalo* are represents 0.89% of the *total bovines* and *other buffalo* represents 0.31% of the *total bovines.*

Swine

Similarly extrapolation was done and the number of *swine*, noting that of all the *swine* were decreased the number of breeding sows (are distinct in NIS` evidence for the period between 1989 to 2012), and then calculation percentages were applied for the 2004 year.

For *pigs under 20 kg* were obtained a percentage of 14.97 from the total swine were reduced breeding sows. For *pigs between 20 and 50 kg* were obtained 23.46%, *pigs fattening* 61.38% and boars 0.19%. Similarly to cattle subcategories of *pigs* pas quickly from one subset to another.

Sheep

For *sheep* and *goats* it was proceeded similar with *swine,* from the *swine total* it was decreased the number *ewes of milk and fitted*, and it was calculated the percentage for *reproducers rams* (15.92%) and *other sheep* (84.08%).

Goats

For *goats* it was decreased from the total number of *goats* the goats number and it was obtained *other goats.* Not applied any extrapolation, because these data were available at NIS.

Mules and asses

Due to impossibility of finding data from Romanian sources we used mules and asses data from FAO databases.

Horses and poultry

The livestock of *horses* and *poultry* (disaggregated in *poultry for eggs* and *poultry for meat*) were taken from NIS for entire period.

2004-2012

In the Annex 3.3 (sheet - *Data obtained through the study*) are presented livestock aggregate of the contractor, Institute for Studies and Power engineering in the above study.

Cattle under 1 year

The values for *calves for slaughter* were taken from the Annex 3.3 (sheet – *Primary data*), the values of *young cattle breeding* is the sum of *males* and *females* from Annex 3.3 (sheet – *Primary data*).

Cattle between 1 and 2 years

For of *young breeding cattle* the values males were calculated by summing with other from category *cattle between 1 and 2 years* from Annex 3.3 (sheet – *Primary data*). For *young cattle for slaughter* were used the values from in according with Annex 3.3 (sheet – *Primary data*).

Cattle 2 years and over

The values for *breeding bulls* took from the primary data table. For *heifers* were used the values from *breeding heifers* from primary data table.

The values for *Dairy cattle* were used from primary data table. For *males and females for sacrificed* were calculated the values summing from *males and females for sacrificed* from primary data table.

For *cattle for work* the values represents the sum between *cattle for work* and *other dairy cattle* from primary data table.

Buffalo

The values were used from primary data (NIS).

Swine

For all the subcategories presented in the Annex 3.3 (sheet - *Data obtained through the study*) are used in according with the Annex 3.3 (sheet – *Primary data*).

Sheep

The values for *ewes of milk and fitted* were taken from the Annex 3.3 (sheet – *Primary data*), from the category *Sheep ewes and ewe mounted- total (3+4)*. Remaining subcategories were taken from the same table.

Goats

The values for *female goats for milk and females by first mount* were taken from primary data table from *goats which have littered and goats fitted (9+10).* Other goats were taken from the table by primary data.

Poultry

For *adult poultry for eggs* the values were taken from the Annex 3.3 (sheet – *Primary data)*. The values for *poultry for meat* represent the difference between *total poultry* and *adult poultry for eggs*.

The values for *horses* and *mules and asses* were taken from the Annex 3.3 (sheet – *Primary data*).

6.2.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 10 %;
- EF: 20%;

- 22.4% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“* and were obtained using the same method (the use of one methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; detailed information is provided in Section 6.2.2), emission factors were obtained using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

6.2.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Rice Cultivation, Agricultural Soils and Filed Burning of Agricultural Residues categories, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Regulation 525/2013 of the European Parliament and of the Council regarding the mechanism of monitoring and reporting of emissions of greenhouse gases, and reporting, at national level and of the Union, of the other informations relevant for climate change and repealing of the Decision 280/2004/CE and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European

Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.2.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.2.6 Source-specific planned improvements, including those in response to the review process

Aiming to their incorporation into next inventory submissions, the development of national values for the methane conversion rate (Y_m), for significant categories, is envisaged.

6.3 Source category Manure Management (CRF source category 4.B)

6.3.1 Source category description

Managing a large number of animals in a confined area creates conditions for CH_4 emissions due to the anaerobic decomposition of manure. A part of the nitrogen from manure is converted to N_2O during storage of manure.

Manure Management:

- ❖ is the second source of CH_4 and the three source of N_2O emissions in the Agriculture sector (in 2012, CH_4 emissions from Manure Management represented 6.71% of total CH_4 emissions while N_2O accounted for 12.79% of total N_2O emissions in the Agriculture sector);
- ❖ is the third source in the Agriculture sector (in 2012, CH_4 and N_2O emissions from Manure Management as CO_2 equivalent represented 9.89% from Total Agriculture emissions);

- contributed with 1.51% to Total GHG emissions of Romania.

Emissions from manure management are declining since 1989 due to the decrease of the animal population, on the one hand due to lower number of animals, and on the other hand the switchover any part of it from traditional systems, economic in farms organized, in which is practiced different waste management systems (Figure 6.5).

The dynamic of emission of CH_4 from manure management reflect the livestock described situation in Romania.

The years 1997-2000 have been of Romania unfavorable, in terms economically, which is found both decrease the number of animals and implicitly the emissions.

After 2000, livestock will return with higher share, steps first taken by farmers of especially hens and the emissions increased to 2006, then again begin to fall.

The observations on source category 4B – “Manure Management” are presented in the Table 6.9.

And the of N_2O emission decreased due to the decrease the effective of livestock including per those them found on farms where it practice manure management system.

Figure 6.5 Overall trends of emissions from Manure Management

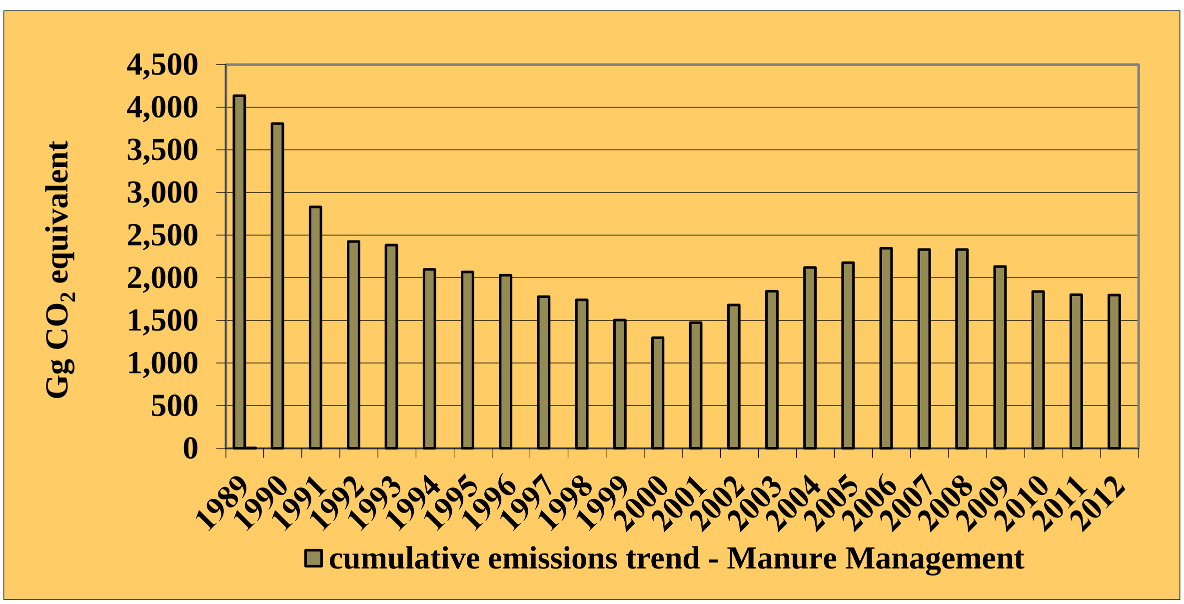


Table 6.9 Observations on source category 4B – "Manure Management"

Source indicative	Source type	Observation	Data source
Observations on source category 4B – "Manure Management – CH_4 and N_2O emissions"			
4.B.1	Cattle	Includes livestock data from nine different cattle categories: dairy cows and non-dairy cattle	AD: NIS and expert judgment, 1989-2003; NIS, 2004-2012 EF: Country specific, expert judgment
4.B.2	Buffalo	Includes livestock data from two different buffalo:buffalo milk and other buffalo	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2012; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.3	Sheep	Includes livestock data from three different sheep: Ewes of milk and fitted, reproducers rams and other sheep	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2012; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.4	Goats	Includes livestock data from two different goats: Female goats for milk and females by first mount and other goats	
4.B.6	Horses		
4.B.7	Mules and asses		AD: FAO, 2011; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.8	Swine	Includes livestock data from five different swine: pigs under 20 kg, pigs between 20 and 50 kg, pigs fattening, boars, breeding sows	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2012 EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.9	Poultry	Includes livestock data from two different poultry: adult poultry for eggs, poultry for meat	

Table 6.9 (continued) Observations on source category 4B – "Manure Management"

Source indicative	**Source type**	**Observation**	**Data source**
Observations on source category 4B – "Manure Management – N_2O emissions"			
4.B.1.1	Anaerobic Lagoon		AD: IPCC GPG 2000, IPCC 1996; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.1.2	Liquid/Slurry		
4.B.1.3	Daily Spread		
4.B.1.4	Solid storage		
4.B.1.5	Dry lot		
4.B.1.6	Pasture/range/paddock		
4.B.1.7	Pit storage		
4.B.1.8	Poultry manure wit bedding		
4.B.1.9	Poultry manure without bedding		

6.3.2 Methodological issues

CH_4 emissions

Methodology

The amount of methane emitted from manure management is driven primarily by the number of animals, the type of digestive system, and the type and amount of feed consumed.

Emissions of methane from manure management were calculated using a Tier 2 method, for all species, according to the provisions in the IPCC good practice guidance decision tree: dairy cows and sheep are significant species and national data and information to allow for the use of Tier 2 method for the other livestock were available. For these are available national data (GE, DE, VS, MS) for each category and subcategory to estimate methane emissions in according the method 2 using and default values (Bo – maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS and MCF - CH_4 conversion factors for each manure management system *j* by climate region k).

Emissions of methane from manure management were calculated using equations: 4.15, 4.16, 4.17 of *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000.*

Equation 6.5 CH_4 emission from manure management

$$CH_4\ Emissions_{(mm)} = Emission\ Factor \bullet Population\ /\ (10^6\ kg/Gg)$$

where:

- CH_4 Emissions$_{(mm)}$ = CH_4 emissions from manure management, for a defined population Gg/year;
- Emission Factor = emission factor for the defined livestock population, kg/head/year;
- Population = the number of head in the defined livestock population.

Equation 6.6 Volatile solid excretion rates

$$VS = GE \bullet (1\ kg\text{-}dm/18.45\ MJ) \bullet (1 - DE/100) \bullet (1 - ASH/100)$$

where:

- VS = volatile solid excretion per day on a dry-matter weight basis, kg-dm/day;
- GE = Estimated daily average feed intake in MJ/day;
- DE = Digestible energy of the feed in percent;
- ASH = Ash content of the manure in percent.

Equation 6.7 Emission factor from manure management

$$EF_i = VS_i \bullet 365\ days/year \bullet B_{oi} \bullet 0.67\ kg/m^3 \bullet \Sigma_{(jk)}\ MCF_{jk} \bullet MS_{ijk}$$

where:

- EF_i = annual emission factor for defined livestock population *i*, in kg;
- VS_i = daily VS excreted for an animal within defined population *i*, in kg;
- B_o = maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS;
- MCF_{jk} = CH_4 conversion factors for each manure management system j by climate region *k*;
- MS_{ijk} = fraction of animal species/category *i*'s manure handled using manure system *j* in climate region k (fraction).

Emission factors

According to the provisions of IPCC GPG 2000, to use equation 4.15, 4.16, 4.17 have been considered national values for gross energy intake, MJ/head/day (GE), digestible energy (DE), excretion rates (VS), fraction of animal species/category *i*'s manure handled using manure system (MS) and the default values for ASH, Bo and MCF used from *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000 and Manual Reference.*

The GE, DE, VS and MS values for all livestock were calculated in the context of implementing in 2011 the study `*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*`.

The gross energy intake (GE) and digestible energy (DE) calculation was presented detail in section 6.2.2 - "Enteric fermentation".

The fractions values of ashes (ASH) used in the VS calculation are default, with those in the IPCC and Reference Manual. For cattle were used for all categories 8%, for swine were chose the specific value of countries developed (2%), because the digestibility calculated (82-88%) is close to that date for developed countries (75%).

For other categories of animals, was choosing the default value from cattle.

The coefficient B_0 does not have specific national values, so its value has been used according IPCC 2000 and Reference Manual (Appendix B).

Were took the values of Eastern European region, respectively 0.24 for dairy cattle and 0.17 for other category of cattle, 0.1 for buffalo, 0.29 for swine (value for developing countries, because the value VS calculated is close of the value VS in Manual Reference for countries developing - 0.34).

For sheep, horses, goats and mules and asses it was chose the values Bo specific of developing countries, because this species are grown extensively or household. Not practice intensive growth, industrial to any of the species mentioned.

For poultry were chose the values for countries developing, because the VS value is close of the value these country.

In regarding manure management systems, in Romania were used all the systems described in *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000,* with the exception of the system "dry lot", which implies the letting for drying manure in refuge and their spread per field after a long time. The distribution of these types of manure management systems were made according expert opinion.

The conversion factors of methane for each manure system management (MCF), according to region, were taken from *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000,* considering Romania make part of the cold climate.

In the Table 6.10 are summarized the values used in the calculation of emissions factors for 1989-2012 period for each livestock and in the Table 6.11 are summarized the MCF (CH_4 conversion factors for each manure management system *j* by climate region *k*) values for each manure system management. Mention that MCF values are the same for each livestock and each year depending manure system management.

Table 6.10 The values used in the calculation of emissions factors from Manure management for 1989-2012

Source indicative	Livestock (source) type	Ash content of the manure in percent (%) (ASH)	Volatile solid excretion per day on a dry-matter weight basis, kg-dm/day (VS)	Maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS (B_0)
4.B.1	**CATTLE**			
4.B.1.a	***Dairy cattle***	8	3.63	0.24
4.B.1.b	***Non dairy cattle***			
	Calves for slaughter younger than 1 year	8	3.08	0.17
	Young cattle of breeding under 1 year	8	2.47	0.17
	Young cattle of breeding between 1 and 2 years	8	3.25	0.17
	Young cattle of slaughter between 1 and 2 years	8	3.47	0.17
	Cattle 2 years and over - Breeding bulls	8	5.42	0.17
	Cattle 2 years and over - Heifers	8	4.33	0.17
	Males and females for sacrificed older than 2 years	8	3.57	0.17
	Cattle for work	8	6.47	0.17

Table 6.10 (continued) The values used in the calculation of emissions factors from Manure management for 1989-2012

Source indicative	**Livestock (source) type**	**Ash content of the manure in percent (%) (ASH)**	**Volatile solid excretion per day on a dry-matter weight basis, kg-dm/day (VS)**	**Maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS (B_0)**
4.B.2	***BUFFALO***			
	Female buffalo	8	6.22	0.1
	Other buffalo	8	2.86	0.1
4.B.3	***SHEEP***			
	Ewes of milk and fitted	8	1.18	0.13
	Reproducers rams	8	1.00	0.13
	Other sheep	8	1.21	0.13
4.B.4	***GOATS***			
	Female goats for milk and females by first mount	8	1.44	0.13
	Other Goats	8	1.41	0.13
4.B.6	***HORSES***	8	5.18	0.26
4.B.7	***MULES AND ASSES***	8	4.08	0.26
4.B.8	***SWINE***			
	Pigs under 20 kg	2	0.07	0.29
	Pigs between 20 and 50 kg	2	0.09	0.29
	Pigs fattening	2	0.32	0.29

Table 6.10 (continued) The values used in the calculation of emissions factors from Manure management for 1989-2012

Source indicative	Livestock (source) type	Ash content of the manure in percent (%) (ASH)	Volatile solid excretion per day on a dry-matter weight basis, kg-dm/day (VS)	Maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS (B_0)
4.B.8	***SWINE***			
	Boars	2	0.31	0.29
	Breeding sows	2	0.40	0.29
4.B.9	***POULTRY***			
	Adult poultry for eggs	8	0.01	0.24
	Poultry for meat	8	0.01	0.24

Table 6.11 The values MCF used in calculation of emissions factor for each manure system management for all livestock in the 1989-2012 period

The period 1989-2012	CH_4 conversion factors for each manure management system (MCF)								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
	0.6	0.39	0.001	0.01	-	0.01	0	0.015	0.015

The values MCF used in calculation of emissions factor for manure system management anaerobic lagoon to swine is 0.39.

In the context of the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“,* in the Annex 3.3 (sheet- *Values MS*) are present MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS (Animal Waste Management Systems) in the 1989-2012 period, and in the Annex 3.3 (sheet- *Emission factor manure management*) are found emissions factors necessary for calculation of methane emissions from manure management.

The values of emission factors increases for sheep in the 1989-2012 period (from 0.3 to 0.38 kg CH_4/head/year) due to the variation in MS level associated to the Solide Storage, Daily spread and Pasture Range/Paddock AWMS.

Emission factors of CH_4 for dairy cattle in the 2004-2009 period decrease due to of the MS value in the Liquid/slurry system (in the 2004 year is 0.06, in the 2005 year is 0.02 and in the 2009 year is 0.03), the same for non-dairy cattle EF decrease having the same explanation (in the Liquid/slurry system the values in the 2004 year are between 0.05 - 0.06 and in the 2009 year are between 0 - 0.02, this the values have been elaborated in the context of implementing in 2011 the study `Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods.

The time series consistency of emissions trend is very fluctuating in 2004-2006 period, for non-dairy cattle, is due to the fluctuation of the national emission factors values based on the variation of MS values; the emission factors values have been calculated in the context of implementing in 2011 the study mentioned aboved.

Activity data

They were used the same activity data as for calculation of CH_4 emissions from enteric fermentation. Data are presented in Chapter 6.2.2.

N_2O emissions

Methodology

Emissions of nitrous oxide from manure management were calculated using the default method, for all species, according to the provisions in the IPCC Good Practice Guidance.

For these national data are available for annual average N excretion per head of species/category (kg N/animal/yr) (Nex), fraction of animal species/category *i*'s manure handled using manure system *j* in climate region k (MS) for to estimate the nitrous oxide emissions from manure management in according default method, using and default values (EF_3 - the Table 4.12 from *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, 2000).

The nitrous oxide emissions from manure management were calculated in according with the equation 4.18 from IPCC GPG, 2000.

Equation 6.8 N_2O emissions from manure management

$$(N_2O\text{-}N)_{(mm)} = \Sigma_{(S)} \{[\Sigma_{(T)} (N_{(T)} \bullet N_{ex(T)} \bullet MS_{(T,S)})] \bullet EF_{3(S)}\}$$

where:

- ❖ $(N_2O\text{-}N)_{(mm)}$ = N_2O-N emissions from manure management in the country (kg N_2O-N/yr);
- ❖ $N_{(T)}$ = Number of head of livestock species/category *T* in the country;
- ❖ $N_{ex(T)}$ = Annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);
- ❖ $MS_{(T,S)}$ = Fraction of total annual excretion for each livestock species/category *T* that is managed in manure management system S in the country;
- ❖ $EF_{3(S)}$ = N_2O emission factor for 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.

Conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions is performed by using the following equation:

Equation 6.9 Conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions

$$N_2O_{(mm)} = (N_2O\text{-}N)_{(mm)} \bullet 44/28$$

In respect to the IPCC GPG 2000 provisions, N_2O emissions from Pasture range and paddock AWMS are reported under 4D – Agricultural soils (see Chapter 6.5).

Emission factors

According to the provisions in IPCC GPG 2000, the calculation methodology took into account national the values for annual average N excretion per head of species/category (kg N/animal/yr) (Nex), fraction of animal species/category *i*'s manure handled using manure system *j* in climate region k (MS) and default values for emissions factor from IPCC, respectively EF_3 (Table 4 - 12 of IPCC GPG 2000 together with Table 4 - 22 of Reference Manual).

In CRF Report (Common Reporting Format) the nitrogen value of the management system solid manure storage nitrogen was added to value nitrogen management system „*dry lot*" manure, resulting a single value.

Also and the nitrogen value from other AWMS in report CRF is the result of sum between of nitrogen value from the manure management system „ *pit storage*" and the nitrogen values of the manure management system „ *poultry manure with bedding*" and „ *poultry manure without bedding*".

Considering membership of in Eastern Romania and developing countries, with cold climates the N_2O emission factors used in the calculation the emissions N_2O from manure management are presented in Table 6.12 depending to manure management system.

Table 6.12 N_2O emission factors [kg N_2O-N/kg N excreted] for animal waste per AWMS

Source indicative	AWMS (source) type	Emission factor EF_3 [kg N_2O-N/kg N excreted]
4B11	Anaerobic Lagoon	0.001
4B12	Liquid/Slurry	0.001
4B13	Daily Spread	0
4B14	Solid storage	0.02

Source indicative	AWMS (source) type	Emission factor EF_3 [kg N_2O-N/kg N excreted]
4B15	Dry lot	0.02
4B16	Pasture/range/paddock	0.02
4B17	Pit storage	0.001
4B18	Poultry manure wit bedding	0.02
4B19	Poultry manure without bedding	0.005

Activity data

They were used the same livestock population numbers as for calculation of CH_4 emissions from enteric fermentation. Data are presented in Chapter 6.2.2.

In the context of the implementation in 2011 of the study „Elaboration of national emission factors/other parameters relevant to NGHGI Sector Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“, the values Nitrogen excretion [kg N/head/year] were calculated according to solid manure and liquid manure using following equation:

Equation 6.10 Nitrogen excretion

$$N_{ex} = \textit{the amount of solid manure} \cdot 365 \cdot \textit{N\% from solid manure} /100 + \textit{the amount of liquid manure} \cdot 365 \cdot \textit{N\% from liquid manure}/100$$

The MS values were established by expert opinion in the context of the above study.

In the Table 6.13 are presented the values for N_{ex} and the data on the amount of solid manure, N% from solid manure, the amount of liquid manure, and N% from liquid manure (Daily quantities of solid manure (S) and liquid (L) of animals and their composition – by various authors, quoted by Dana Sandulescu, PhD Thesis, 2005).

In poultry the N_{ex} value is considered sum of solid manure with liquid manure. The phases are not separated physiological.

Table 6.13 Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2012 period

Source indicative	**Livestock (source) type**	**The amount of solid manure (kg)**	**The amount of liquid manure (l)**	**N% from solid manure**	**N% from liquid manure**	**Annual average N excretion per head of species/category N_{ex} (kg N/animal/yr)**
4 B1	***CATTLE***					
4 B1 a	***Dairy cattle***	23.5	9	0.4031	0.58	53.63
4 B1 b	***Non dairy cattle***					
	Calves for slaughter younger than 1 year	6.5	1.69	0.4031	0.58	13.14
	Young cattle of breeding under 1 year	13	3	0.4031	0.58	25.5
	Young cattle of breeding between 1 and 2 years	13	3	0.4031	0.58	25.5
	Young cattle of slaughter between 1 and 2 years	13	3	0.4031	0.58	25.5
	Cattle 2 years and over - Breeding bulls	24.26	9	0.4031	0.58	54.75

Table 6.13 (continued) Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2012 period

Source indicative	Livestock (source) type	The amount of solid manure (kg)	The amount of liquid manure (l)	N% from solid manure	N% from liquid manure	Annual average N excretion per head of species/category N_{ex} (kg N/animal/yr)
4 B1	***CATTLE***					
	Cattle 2 years and over-Heifers	23.5	9	0.4031	0.58	53.63
	Males and females for sacrificed older than 2 years	23.5	9	0.4031	0.58	53.63
	Cattle for work	23.5	9	0.4031	0.58	53.63
4 B2	***BUFFALO***					
	Female buffalo	23.5	9	0.4031	0.58	53.63
	Other buffalo	23.5	9	0.4031	0.58	53.63
4 B3	***SHEEP***					
	Ewes of milk and fitted	1.1	0.7	0.8	0.43	4.3
	Reproducers rams	1.183	0.7	0.8	0.43	4.55
	Other sheep	1.183	0.7	0.8	0.43	4.55
4 B4	***GOATS***					
	Female goats for milk and females by first mount	1.39	0.8	0.8	0.43	5.3
	Other Goats	1.4	0.78	0.8	0.43	5.3
4 B6	***HORSES***	16	3.6	0.6	1.55	55.4

Table 6.13 (continued) Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2012 period

Source indicative	Livestock (source) type	The amount of solid manure (kg)	The amount of liquid manure (l)	N% from solid manure	N% from liquid manure	Annual average N excretion per head of species/category N_{ex} (kg N/animal/yr);
4 B7	***MULES AND ASSES***	11	2.2	0.6	1.55	36.53
4 B8	***SWINE***					
	Pigs under 20 kg	1.4	0.94	0.55	1.95	9.5
	Pigs between 20 and 50 kg	2.65	1.75	0.55	1.95	17.8
	Pigs fattening	2.7	1.798	0.55	1.95	18.21
	Boars	3.549	2.5	0.55	1.95	24.91
	Breeding sows	2.7	1.798	0.55	1.95	18.21
4 B9	***POULTRY***					
	Adult poultry for eggs	0.175	-	1.7	-	1.08
	Poultry for meat	0.18	-	1.84	-	1.2

6.3.3 Uncertainties and time-series consistency

CH_4 emissions

- AD: 10 %;
- EF: 30%;
- 31.6% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*" and were obtained using the same method (the use of one methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; detailed information is provided in Section 6.2.2), emission factors were obtained using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

N_2O emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 10 %;
- EF: 30%;
- 10% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*" and were obtained using the same method (the use of two methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; detailed information is provided in Section 6.2.2), were used default emission factors using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

6.3.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *Rice cultivation, Agricultural soils* and *Field burning of agricultural residues* categories, the results of these being mentioned on the Checklists level.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. No unconformity has been noted following the UNFCCC review of the NGHGI.

The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.3.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.3.6 Source-specific planned improvements, including those in response to the review process

Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species are envisaged:

- ash content of the manure (ASH);
- maximum CH_4 producing capacity for manure produced by an animal within defined population (B_0);
- CH_4 conversion factors for each manure management system by climate region (MCF).

6.4 Source category Rice Cultivation (CRF source category 4.C)

6.4.1 Source category description

Anaerobic decomposition of organic material in flooded rice fields produces methane. Methane escapes to the atmosphere primarily by transport through the rice plants and its flux depends upon the input of organic carbon, water regimes, time and duration of drainage, soil type, etc.

Rice Cultivation:

- is the smallest source of CH_4 emissions in the Agriculture sector (in 2012, CH_4 emissions from Rice Cultivation represented 0.20% of total CH_4 emissions in the Agriculture sector);
- is the smallest source in the Agriculture sector (in 2012, CH_4 emissions from Rice Cultivation as CO_2 equivalent represented 0.09% from Total Agriculture emissions);
- contributed with 0.01% to Total GHG emissions of Romania.

Emissions from rice cultivation are declining since 1989 due to the decrease of rice cultivated area (Figure 6.6). The rice area cultivated with is decreased in 21.6 thousands ha in 1991 by 100 ha in 2003. In 2012 the rice area cultivated is 11.3 thousands ha. The reduction due to areas privatization process and concession of the land from state patrimony, which ended in 2004.
Due to natural conditions, Romania dispose a production of rice relatively balanced while the cultivated area and the emissions from rice continue to fall.

Figure 6.6 Methane emission trend due to the Rice Cultivation

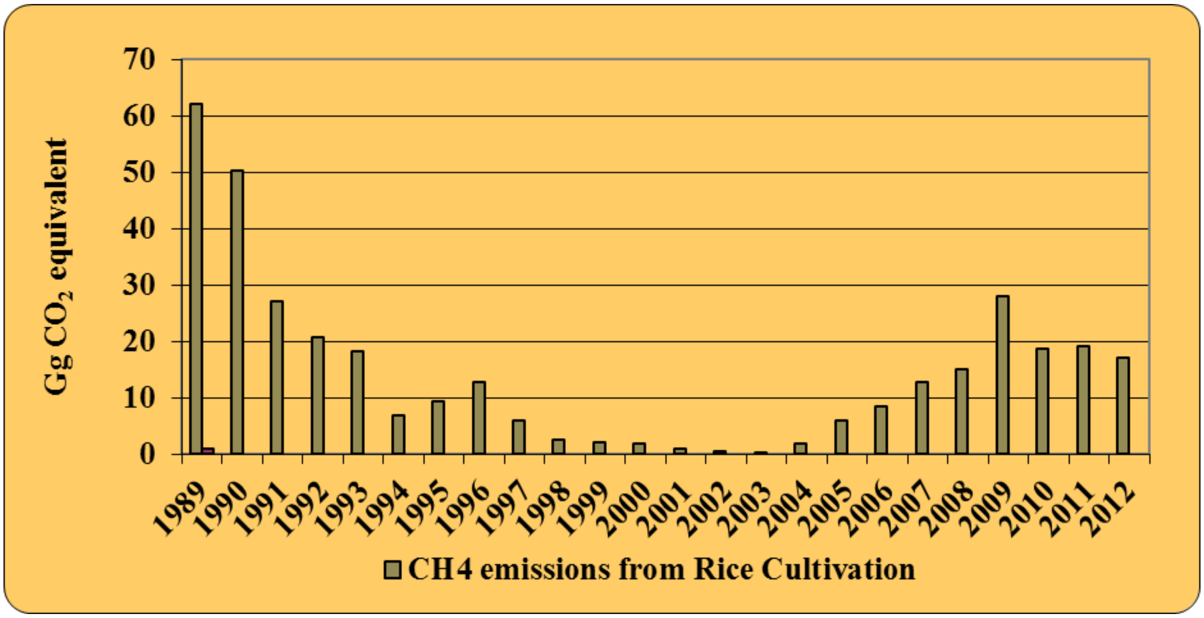


Table 6.14 Observations on source category 4C – "Rice Cultivation"

Source indicative	Source type	Observation	Data source
4.C.1.2.2	Rice harvested area		AD: SY, NIS, 1989-2012; expert judgment; EF: IPCC GPG 2000

6.4.2 Methodological issues

Methodology

Due to small importance of source category Rice Cultivation into Total GHG emission level (Rice Cultivation does not meet the key category thresholds) a Tier 1 method has been applied. For calculation of methane emissions from rice cultivation, the equations 4.41 and 4.42 of IPCC GPG 2000 were used.

Equation 6.11 CH_4 emissions from rice production

$$Emissions\ from\ Rice\ Production\ (Tg/yr) = \Sigma_i\ \Sigma_j\ \Sigma_k\ (EF_{ijk} \bullet A_{ijk} \bullet 10^{-12})$$

where:

- EF_{ijk} = a seasonally integrated emission factor for *i*, *j*, and *k* conditions, in g CH_4/m^2;
- A_{ijk} = annual harvested area for *i*, *j*, and *k* conditions, in m^2/yr;
- i, j, and k = represent different ecosystems, water management regimes, and other conditions under which CH_4 emissions from rice may vary (e.g. addition of organic amendments)

Equation 6.12 Adjusted Seasonally Integrated Emission Factor

$$EF_i = EFc \bullet SFw \bullet SFo \bullet SFs$$

where:

- EF_i = Adjusted seasonally integrated emission factor for a particular harvested area;
- EF_c = Seasonally integrated emission factor for continuously flooded fields without organic amendments;
- SF_w = Scaling factor to account for the differences in ecosystem and water management regime (from Table 4.20 from IPCC GPG 2000);
- SF_o = Scaling factors should vary for both types and amount of amendment applied (from Table 4.21, from IPCC GPG 2000 - Dose - Response Table for Non - Fermented Organic Amendments);
- = Scaling factor for soil type, if available.

Emission factors

Considering the provisions in IPCC GPG 2000 and the data provided by the Ministry of Agriculture, the calculation methodology took into account:

- a seasonally integrated emission factor value for continuously flooded fields without organic amendments (EF_c) of 20 g CH_4/m^2;

- a default value of 0.2 for the scaling factor to account for the differences in ecosystem and water management regime (SF_W) corresponding to lowland – irrigated – intermittently flooded – multiple aeration water management regime;
- yearly default values for the scaling factor to account for both type and amount of amendment applied (SF_O). Default values were selected after the estimation of the rice residues productivity values, considering that all rice residues were incorporated into the soil following the harvesting. Rice residues productivity values and default values for the scaling factor to account for the type and amount of amendment applied are presented in the Table 6.15.

Table 6.15 Rice residues productivity values and default values for the scaling factor to account for the type and amount of amendment applied (SF_O)

Year	Rice residues productivity [tones d.m./ha]	Scaling factor to account for the type and amount of amendment applied (SF_O)
1989	1.07	1.5
1990	1.25	1.5
1991	1.09	1.5
1992	1.78	1.5
1993	2.28	1.8
1994	2.48	1.8
1995	2.92	1.8
1996	2.04	1.8
1997	2.01	1.8
1998	2.25	1.8
1999	1.78	1.5
2000	1.93	1.5
2001	0.94	1
2002	0.90	1

Year	Rice residues productivity [tones d.m./ha]	Scaling factor to account for the type and amount of amendment applied (SF_O)
2003	2.25	1.8
2004	3.13	1.8
2005	2.75	1.8
2006	2.46	1.8
2007	2.46	1.8
2008	3.70	1.8
2009	4.08	2.5
2010	3.72	1.8
2011	3.86	1.8
2012	3.37	1.8

Activity data

Total rice cultivated area is provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook 1989-2012.

By expert judgment, total harvested area equals total cultivated area (the number of harvests per year equals 1).

Harvested area data series are presented in Table 6.16.

Table 6.16 Harvested area data series for 1989-2012

Year	Harvested area [10^8 m^2]
1989	4.93
1990	3.99
1991	2.16
1992	1.64

Year	**Harvested area [10^8 m^2]**
1993	1.2
1994	0.46
1995	0.62
1996	0.85
1997	0.4
1998	0.17
1999	0.16
2000	0.14
2001	0.12
2002	0.05
2003	0.01
2004	0.12
2005	0.39
2006	0.56
2007	0.84
2008	0.99
2009	1.33
2010	1.24
2011	1.27
2012	1.13

6.4.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 50%;

- 5% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that all activity data are provided by NIS and were obtained using the same method, that default emission factors were used and the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

6.4.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *Enteric fermentation, Manure management* categories, the results of these being mentioned on the Checklists level.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. No unconformity has been noted following the UNFCCC review of the NGHGI.

The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.4.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.4.6 Source-specific planned improvements, including those in response to the review process

In respect to the IPCC GPG 2000 provisions, more detailed data on rice cultivation techniques used are proposed to be obtained.

6.5 Source category Agricultural soils (CRF source category 4.D)

6.5.1 Source category description

Microbial processes of nitrification and denitrification in agricultural soils produce nitrous oxide emissions. There can be distinguished three types of emissions:

- ❖ direct soils emissions result from the following nitrogen input to soils:
  - ➢ synthetic fertilizers (F_{SN});
  - ➢ nitrogen from animal waste (F_{AM});
  - ➢ biological nitrogen fixation (F_{BN});
  - ➢ reutilized nitrogen from crop residues (F_{CR});
  - ➢ sewage sludge application.

Cultivation of organic soils may increase soil organic matter mineralization and, in effect, N_2O emissions.

- ❖ direct soil emissions from animal production include those emissions induced by grazing animals (Pasture, Range and Paddock Manure);
- ❖ indirect emissions take place after nitrogen is lost from the field as NO_x and NH_3 or after leaching or runoff.

Increases in the amount of nitrogen added to the soil generally result in higher N_2O emissions.

Direct soil emissions (4D1)

Direct soil emissions:

- ❖ is the first source of N_2O emissions in the Agriculture sector (in 2012, N_2O Direct soil emissions represented 48.76% of total N_2O emissions in the Agriculture sector);

- ❖ is the first source in the Agriculture sector (in 2012, N_2O Direct soil emissions as CO_2 equivalent represented 25.46% from Total Agriculture emissions);
- ❖ contributed with 3.90% to Total GHG emissions of Romania.

Pasture, Range and Paddock Manure (4D2)

Pasture, Range and Paddock Manure:

- ❖ is the third source of N_2O emissions in the Agriculture sector (in 2012, N_2O emissions from Pasture, Range and Paddock Manure represented 8.79% of total N_2O emissions in the Agriculture sector);
- ❖ is the fifth source in the Agriculture sector (in 2012, N_2O emissions from Pasture, Range and Paddock as CO_2 equivalent represented 4.59% from Total Agriculture emissions);
- ❖ contributed with 0.70% to Total GHG emissions of Romania.

Indirect soil emissions (4D3)

Indirect soil emissions:

- ❖ the second source of N_2O emissions in the Agriculture sector (in 2012, N_2O Indirect soil emissions represented 29.36 % of total N_2O emissions in the Agriculture sector);
- ❖ is fourth source in the Agriculture sector (in 2012, N_2O Indirect soil emissions as CO_2 equivalent represented 15.33 % from Total Agriculture emissions);
- ❖ contributed with 2.35 % to Total GHG emissions of Romania.

Emissions from Agricultural Soils are declining since 1989 (Figures 6.7 and 6.8) due to the decrease of the:

- ❖ amount of synthetic fertilizer applied;
- ❖ livestock populations (the details can be found in Chapter 6.1);
- ❖ crop productions level.

The amount of N_2O emissions from application of synthetic fertilizers have decreased from 11.76 Gg N_2O in 1989, to 5.13 Gg N_2O in 2012.

The quantity of synthetic fertilizer has decreased considerably after the 1989 year from 665,300 tonnes/year to 289,963 tonnes/year. This decrease is reflected in the decrease of the nitrogen fraction volatilized into the atmosphere as N_2O. The main cause was a decrease of crop production and the inability of farmers to use the agricultural technology correctly (Table 6.16).

The amount of N_2O emissions from N – fixing crop have decreased from 10.89 Gg N_2O in 1989, to 8.06 Gg N_2O in 1990, there was a slight increase in 1991, respectively 8.54 Gg N_2O, then were decreased to 5.97 Gg N_2O in 1992. Subsequent, in the period 1993-2012 largest increase in emissions N_2O was recorded in 1999, respectively 7.01 Gg N_2O, and the lowest it was recorded in 2007, 3.70 Gg N_2O.

The decrease of crops, for example in 1992 was caused by unfavorable weather conditions, while the situation was completely opposite in 2004. In the 2007 year, the crop was reduced from 2006 due to drought.

Cultivated areas were maintained crop except soybeans which recorded significant decreases.

Figure 6.7 Overall emissions trend of Agricultural Soils

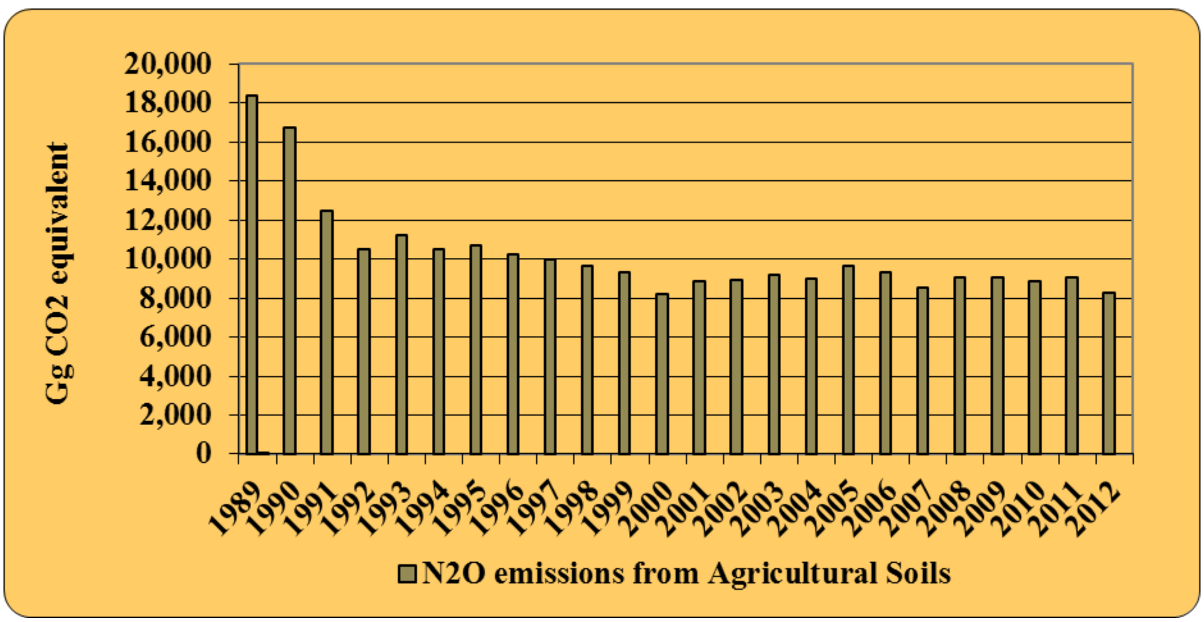


Figure 6.8 N_2O emissions trends – Agricultural Soils

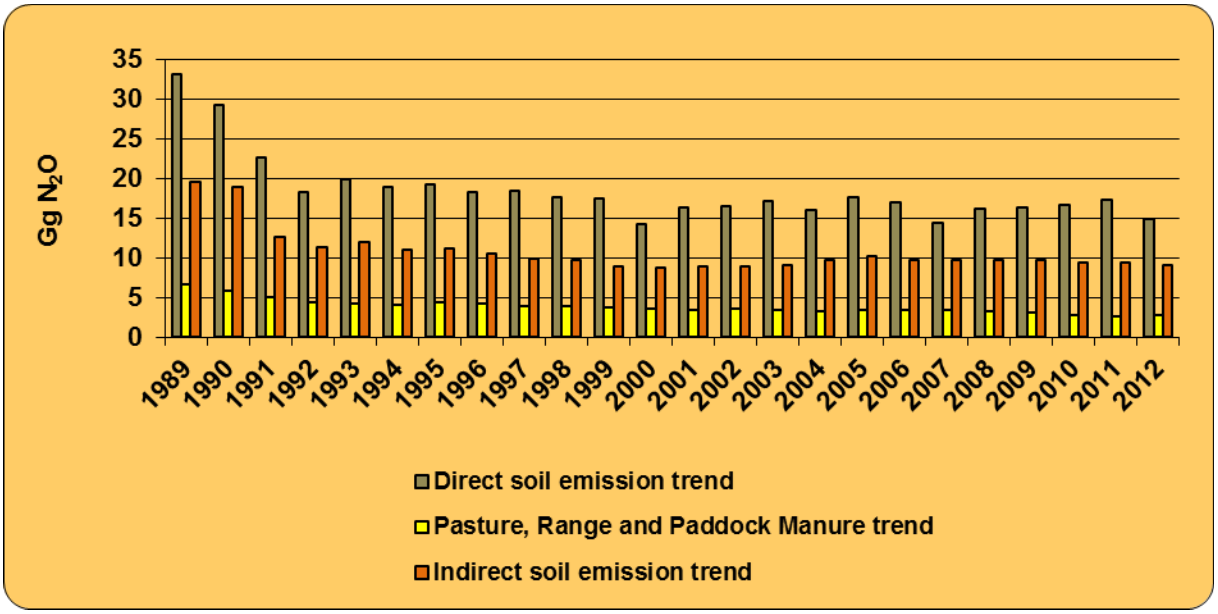


Table 6.17 Observations on source category 4D – "Agricultural Soils"

Source indicative	Source (livestock) type	Observation	Data source
4.D.1.1 **4.D.3**	Amount of N synthetic fertilizer used		AD: SY, NIS, 1989-2012; EF: IPCC GPG 2000
4.D.1.2 **4.D.2** **4.D.3**	Animals number by livestock	Includes data on eight different livestock types: cattle (Dairy cattle and Non-dairy cattle), buffalo (buffalo milk and other buffalo), sheep (Ewes of milk and fitted, reproducers rams and other sheep), goats (Female goats for milk and females by first mount and other goats), horses, mules and asses, swine (pigs under 20 kg, pigs between 20 and 50 kg, pigs fattening, boars, breeding	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2012; The study „*Elaboration of national emission factors /other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*"

Source indicative	Source (livestock) type	Observation	Data source
		sows) and poultry (adult poultry for eggs, poultry for meat).	EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.D.1.3	Productions of N-fixing crops	Includes data on four types of N-fixing crops: *pea beans, dry bean, other leguminous for dry bean, soybeans, Annual leguminous, lucerne, clover, other perennial leguminous.*	AD: SY, other correspondence, NIS, 1989-2012; The study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“ EF: IPCC GPG 2000
4.D.1.4	Production of non - N fixing crops	Includes data on 34 types of non-N-fixing crops: *rye, wheat, barley and two-row barley, oats, maize, sorghum, rice, other grains, rape, sunflower, flax for oil, other oilseed plants (castor), in fiber- textile plants, hemp for fiber - plant textiles, other textile plants – cotton, tobacco, hop, medicinal aromatic plants/spices grown, other industrial crops (sorghum for brooms, potatoes, sugar beet, fodder roots, tomatoes, eggplant, dry onion, dry garlic, cabbage, green peppers, cultivated mushrooms, root vegetables – edible roots, water melons and melons, other vegetables, annual grasses, other perennial grasses.*	AD: SY, other correspondence, NIS, 1989 -2012; The study „*Elaboration of national emission factors /other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“. EF: IPCC GPG 2000
4.D.1.5	Area of cultivated		AD: The study „*Elaboration of*

Source indicative	Source (livestock) type	Observation	Data source
	organic soils		*national emission factors/ other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods"* EF: IPCC GPG 2000

6.5.2 Methodological issues

N_2O Direct soil emissions

Methodology

Despite the fact that Direct soil emissions is a key category, both from level and trend views,Tier 2 method could not be applied, due to the lack of detailed data needed. Therefore, a Tier 1 method has been applied. For calculation of nitrous oxide Direct soil emissions, the equations 4.20 of IPCC GPG 2000 were used.

Equation 6.13 Direct N_2O emissions from agricultural soils

$$N_2O_{Direct}\text{-}N = [(F_{SN} + F_{AM} + F_{BN} + F_{CR}) \bullet EF_1] + (F_{OS} \bullet EF_2)$$

where:

- N_2O_{Direct} -N = Emission of N_2O in units of Nitrogen;
- F_{SN} = Annual amount of synthetic fertilizer nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x (kg N/year);
- F_{AM} = Annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilizes as NH_3 and NOx (kg N/year);

- F_{BN} = Amount of nitrogen fixed by N-fixing crops cultivated annually (kg N/year);
- F_{CR} = Amount of nitrogen in crop residues returned to soils annually (kg N/year);
- F_{OS} = Area of organic soils cultivated annually (ha);
- EF_1 = Emission factor for emissions from N inputs (kg N_2O-N/kg N input);
- EF_2 = Emission factor for emissions from organic soil cultivation (kg N_2O-N/ha-yr).

The conversion of emissions N_2O-N in the N_2O emissions in the view of reporting was realized for all the parameters, after equation:

Equation 6.14 Conversion of emissions N_2O-N in the N_2O emissions

$$N_2O = N_2O\text{-}N \bullet 44/28$$

For the calculation nitrogen from synthetic fertilizers (F_{SN}) application were used the equation 4.22 from IPCC GPG 2000:

Equation 6.15 N from synthetic fertiliser application

$$F_{SN} = N_{FERT} \bullet (1 - Frac_{GASF})$$

where:

- F_{SN} = Annual amount of synthetic fertiliser nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x;
- N_{FERT} = fertilizer nitrogen use in country (kg N/yr);
- $Frac_{GASF}$ = fraction of synthetic fertiliser nitrogen applied to soils that volatilises as NH_3 and NO_x (kg NH_3 – N and NO_x – N/kg of N input).

N from animal manure (F_{AM}) application was calculated using the equation 4.24 from IPCC GPG 2000:

Equation 6.16 N from animal manure application

$$F_{AM} = \Sigma_T(N_{(T)} \bullet Nex_{(T)}) \bullet (1 - Frac_{GASM}) \bullet [1 - (Frac_{FUEL\text{-}AM} + Frac_{PRP} + Frac_{FEED\text{-}AM} + Frac_{CNST\text{-}AM})]$$

where:

- F_{AM} = Annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilizes as NH_3 and NOx;
- $N_{(T)}$ = Number of head of livestock species/category *T* in the country;
- $N_{ex(T)}$ = Annual average N excretion per head of species/category T in the country (kg N/animal/yr);
- $Frac_{GASM}$ = fraction of livestock nitrogen excretion that volatilizes as NH_3 and NO_x (kg NH_3 – N and NO_x – N/kg of N excreted);
- $Frac_{FUEL\text{-}AM}$ = fraction of animal manure used as fuel (kg N/kg N totally excreted);
- $Frac_{PRP}$ = fraction of livestock nitrogen excreted and deposited onto soil during grazing (kg N/kg N excreted) country estimate;
- $Frac_{FEED\text{-}AM}$ = fraction of animal manure used as feed (kg N/kg N totally excreted);
- $Frac_{CNST\text{-}AM}$ = fraction of animal manure used as construction (kg N/kg N totally excreted).

For the amount estimation of fixed biologically annual nitrogen (F_{BN}) by the fixing crop of nitrogen was used equation 4.26 (IPCC GPG 2000):

Equation 6.17 N fixed by crops (Tier 1b)

$$F_{BN} = \Sigma i\ [Crop_{BFi} \bullet (1 + Res_{BFi}/Crop_{BFi}) \bullet Frac_{DMi} \bullet Frac_{NCRBFi}]$$

where:

- F_{BN} = Amount of nitrogen fixed by N-fixing crops cultivated annually (kg N/year);
- $Crop_{BFi}$ = products of all N-fixing crops (kg dry biomass/year);
- Res_{BFi}/ $Crop_{BFi}$ = residue to crop product mass ratio specific to each crop type *i;*
- $Frac_{DMi}$ = is the fraction of dry matter in the aboveground biomass of each crop type *i;*

- $Frac_{NCRBFi}$ = fraction of nitrogen in N- fixing crop type *i* (kg N/kg of dry biomass).
- i = indicative plants nitrogen fixed.

For the estimation amount of N results from incorporating in soil of crop residues (F_{CR}) were used the equation 4.29 (IPCC GPG 2000).

Equation 6.18 N in crop residue returned to soils (Tier 1b)

$$F_{CR} = \Sigma i\,[(Crop_{Oi} \bullet Res_{Oi}/Crop_{Oi} \bullet Frac_{DMi} \bullet Frac_{NCROi}) \bullet (1 - Frac_{BURNi} - Frac_{FUEL\text{-}Cri} - Frac_{CNST\text{-}CRi} - Frac_{FODi})] + \Sigma j\,[(Crop_{BFj} \bullet Res_{BFj}/Crop_{BFj} \bullet Frac_{DMj} \bullet Frac_{NCRBFj}) \bullet (1 - Frac_{BURNj} - Frac_{FUEL\text{-}CRj} - Frac_{CNST\text{-}CRj} - Frac_{FODj})]$$

where:

- F_{CR} = Amount of nitrogen in crop residues returned to soils annually (kg N/year);
- $Crop_{Oi}$ = represents nitrogen unfixed crop type *i* production (kg dry biomass/year);
- Res_{Oi} /$Crop_{Oi}$ = the residue to crop type *i* product mass ratio (fraction);
- $Frac_{DMi}$ = the dry matter content of the type *i* aboveground biomass (fraction);
- $Frac_{NCROi}$ = the nitrogen content of the type *i* aboveground biomass (kg N/ kg of dry biomass);
- $Frac_{BURNi}$ = the fraction of residue burned in the type *i* field before and after harvest (kg N/kg crop-N);
- $Frac_{FUEL\text{-}CRi}$ = the fraction of residue type *i* used as fuel (fraction);
- $Frac_{CNST\text{-}CRi}$ = the fraction of residue type *i* used for construction (fraction);
- $Frac_{FODi}$ = the fraction of residue type *i* used as fodder (fraction);
- $Crop_{BFj}$ = represents nitrogen fixed crop type *j* production (kg dry biomass/year);
- Res_{BFj}/$Crop_{BFj}$ = the residue to crop type *j* product mass ratio (fraction);
- $Frac_{DMj}$ = the dry matter content of the type *j* aboveground biomass (fraction);
- $Frac_{NCRBFj}$ = the nitrogen content of the type *j* aboveground biomass (kg N/kg of dry biomass);
- $Frac_{BURNj}$ = the fraction of residue burned in the type *j* field before and after harvest (kg N/kg crop-N);

- $Frac_{FUEL\text{-}CRj}$ = the fraction of residue type *j* used as fuel (fraction);
- $Frac_{CNST\text{-}CRj}$ =the fraction of residue type *j* used for construction (fraction);
- $Frac_{FODj}$ = the fraction of residue type *j* used as fodder (fraction).
- i = indicative plants nitrogen unfixed;
- j = indicative plants nitrogen fixed.

By expert judgment, $Frac_{PRP}$ values were calculated for every year using the following equation:

Equation 6.19 Calculation of fraction of livestock nitrogen excreted and deposited onto soil during grazing ($Frac_{PRP}$)

$$Frac_{PRP} = N_{ex}(Pasture\ Range\ and\ Paddock)/N_{ex}$$

where:

- $N_{ex(Pasture\ Range\ and\ Paddock)}$ = nitrogen excretion from Pasture Range and Paddock;
- N_{ex} = nitrogen excretion from all Animal Waste Management Systems.

Emission factors

The calculation methodology took into account IPCC GPG 2000 default emissions factors (Table 4.17 of IPCC GPG 2000):

- EF_1 = 0.0125 (fraction of N-input, kg N_2O-N/kg N);
- EF_2 = 8 (value specific to Middle-Latitude Organic Soils; kg N_2O-N/ha/year).

Activity data

Data used for calculation of the annual amount of synthetic fertilizer nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x (F_{SN})

The amount of synthetic fertilizer applied to soils data are provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook 1989-2012.

Data series are presented in Table 6.18.

Default IPCC GPG 2000 value of $Frac_{GASF}$ used is presented in Table 6.19.

Data used for calculation of the annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x and excluding manure produced during grazing (F_{AM})

Livestock data are presented in Chapter 6.2.2.

Nitrogen excretion per head of animal and fraction of nitrogen excretion produced in different AWMS values used are presented in Chapter 6.3.2.

Fraction of livestock nitrogen excreted and deposited onto soil during grazing ($Frac_{PRP}$) values are presented in Table 6.18.

Fraction of livestock nitrogen excretion contained in excrements burned for fuel ($Frac_{FUEL\text{-}AM}$) and fraction of livestock nitrogen excretion that volatilizes as NH_3 and NO_x ($Frac_{GASM}$) default values are presented in Table 6.19.

For fraction $Frac_{FEED\text{-}AM}$ and $Frac_{CNST\text{-}AM}$ were used the 0 value, because were not identified sources of national statistical data (the expert opinion).

The use or recycling manure by the introduction in manufacturing processes of materials building, although it is known the technique, not was used.

Table 6.18 Activity data series used for calculation of F_{AM} and F_{SN}, for 1989-2012

Year	Amount of synthetic fertilizer applied to soil [thousands tonnes/year]	Fraction of livestock nitrogen excreted and deposited onto soil during grazing [fraction]
1989	665.3	0.3006
1990	656.0	0.2758
1991	275.0	0.2645
1992	258.0	0.2633
1993	346.0	0.2734

Year	Amount of synthetic fertilizer applied to soil [thousands tonnes/year]	Fraction of livestock nitrogen excreted and deposited onto soil during grazing [fraction]
1994	313.0	0.2871
1995	306.0	0.2906
1996	268.0	0.2848
1997	262.0	0.2969
1998	254.0	0.2883
1999	225.0	0.3004
2000	239.0	0.3049
2001	268.0	0.3025
2002	239.0	0.2956
2003	252.0	0.2833
2004	270.0	0.2471
2005	299.0	0.2540
2006	252.0	0.2639
2007	265.0	0.2664
2008	279.8	0.2594
2009	296.06	0.2584
2010	306.0	0.2465
2011	313.0	0.2475
2012	289.9	0.2497

Table 6.19 Default IPCC values for specific fractions used (described in IPCC GPG 2000 and in Table 4-19 of Reference Manual)

Specific fraction	Default IPCC value	Associated measurement unit
$Frac_{BURN}$	0.1 or less in developed countries (accordingly to the provisions in page 4.89 of IPCC GPG	kg N/kg crop-N

Specific fraction	Default IPCC value	Associated measurement unit
	2000), for 1989 - 2001; 0 for 2002 - 2008	
$Frac_R$	0.5	kg N/kg crop-N
$Frac_{FUEL-AM}$	0	kg N/kg N excreted
$Frac_{GASF}$	0.1	kg NH_3-N + NO_x-N/kg of synthetic fertilizer N applied
$Frac_{GASM}$	0.2	kg NH_3-N + NO_x-N/kg of N excreted by livestock
$Frac_{NCRBF}$	0.03	kg N/kg of dry biomass
$Frac_{NCR0}$	0.015	kg N/kg of dry biomass

Data used for calculation of amount of nitrogen fixed by N-fixing crops cultivated annually (F_{BN})

Primary data

The primary data on Crop production of nitrogen fixing crop are obtained from the NIS through SY 1989-2012 and data base. They are presented in Table 6.20.

Based on questionnaire and of the database from NIS *other perennial forage* was obtained decreasing from *total perennial forage* the sum of the values of *lucerne* and *clover.*

Table 6.20 The primary data on Crop production of nitrogen fixing crop obtained from the NIS, in the 1989-2012 period

Year	Crop production of nitrogen fixing crop (tonnes/year)							
	Peas beans	Dry Bean	Total Leguminous for dry beans	Soy beans	Annual green fodder	Plant used for silage	Total Annual green fodder	Lucerne in equivalent green fodder
1989	98,500	143,600	255,900	303,900	9,705,200	6,096,600	15,801,800	11,131,700
1990	49,395	57,542	112,116	141,173	6,882,641	7,520,906	14,403,547	8,057,219
1991	32,292	46,019	79,491	178,593	5,645,816	5,390,442	11,036,258	9,661,207
1992	33,180	41,184	74,678	126,159	4,077,623	3,047,204	7,124,827	6,409,569
1993	36,406	48,421	85,232	95,370	3,971,900	3,029,541	7,001,441	6,879,385
1994	38,091	37,379	76,112	100,078	4,155,947	2,335,423	6,491,370	6,944,354
1995	54,262	41,769	97,017	107,861	4,127,358	1,892,078	6,019,436	7,081,202
1996	33,705	42,078	77,016	113,084	3,930,367	2,084,169	6,014,536	6,984,832
1997	27,263	50,194	78,560	121,148	3,741,430	1,602,720	5,344,150	7,727,622
1998	24,382	46,856	72,497	200,820	3,773,666	1,145,649	4,919,315	7,004,112
1999	27,011	47,698	76,755	183,403	4,334,489	1,028,431	5,362,920	7,737,980
2000	14,159	21,803	36,929	69,473	2,840,370	476,958	3,317,328	5,120,710
2001	21,661	36,492	61,174	72,688	3,146,175	579,428	3,725,603	6,476,805
2002	20,450	33,592	55,313	145,932	3,816,927	565,477	4,382,404	6,887,361
2003	23,497	36,679	60,645	224,908	4,118,584	606,706	4,725,290	7,237,492
2004	58,036	53,517	112,331	298,506	1,923,528	0	1,923,528	4,655,262
2005	39,096	41,733	80,913	312,781	2,454,958	0	2,454,958	6,274,555
2006	36,147	34,942	71,574	344,909	3,182,639	0	3,182,639	6,381,270
2007	17,748	18,014	36,185	136,094	2,222,483	0	2,222,483	4,166,344
2008	36,917	25,157	62,466	90,579	2,860,655	0	2,860,655	5,505,795
2009	30,009	22,348	52,918	84,268	2,898,188	0	2,898,188	5,642,588
2010	39,677	21,059	61,344	149,940	3,041,978	0	3,041,978	5,799,305
2011	55,076	21,351	76,830	142,636	3,371,352	0	3,371,352	6,015,839

Year	Crop production of nitrogen fixing crop (tonnes/year)							
	Peas beans	Dry Bean	Total Leguminous for dry beans	Soy beans	Annual green fodder	Plant used for silage	Total Annual green fodder	Lucerne in equivalent green fodder
2012	45,878	16,603	62,934	104,330	3,043,519	0	3,043,519	4,836,406

Table 6.20 (continued) The primary data on Crop production of nitrogen fixing crop obtained from the NIS, in the 1989-2012 period

Year	Crop production of nitrogen fixing crop (tonnes/year)		
	Clover in equivalent green fodder	Other perennial forage	Perennial forage
1989	2,937,100	3,988,200	18,057,000
1990	1,926,004	2,980,701	12,963,924
1991	2,054,329	3,513,112	15,228,648
1992	1,792,567	2,787,324	10,989,460
1993	1,988,099	2,890,764	11,758,248
1994	2,059,289	2,665,781	11,669,424
1995	2,367,015	2,761,694	12,209,911
1996	2,400,569	2,702,844	12,088,245
1997	2,725,409	2,848,141	13,301,172
1998	2,632,031	2,695,283	12,331,426
1999	2,863,116	2,908,083	13,509,179
2000	2,018,423	2,072,818	9,211,951
2001	2,494,521	2,564,330	11,535,656
2002	2,534,648	3,047,404	12,469,413
2003	2,421,292	2,955,120	12,613,904
2004	866,398	1,087,129	6,608,789
2005	1,601,385	2,251,574	10,127,514

Year	Crop production of nitrogen fixing crop (tonnes/year)		
	Clover in equivalent green fodder	Other perennial forage	Perennial forage
2006	1,779,417	2,461,604	10,622,291
2007	1,463,864	1,700,004	7,330,212
2008	1,751,484	2,016,050	9,273,329
2009	1,786,509	2,032,409	9,461,506
2010	1,949,735	2,224,993	9,974,033
2011	2,001,723	2,644,119	10,661,681
2012	1,598,254	2,047,590	8,482,250

The data on Crop production of nitrogen fixing crop obtained through the dedicated study *„Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods.“*

In the context of the study above, by expert opinion using the primary data from the Table 6.20 (NIS) for the calculation F_{BN} are used the data on Crop production of nitrogen fixing crop presented in the Table 6.21.

The values for *pea beans*, *dry bean*, *soybeans*, *lucerne* and *clover* were used in the primary data table (Table 6.20).

The values for *other leguminous for dry beans* were obtained from the difference between *total leguminous for dry beans* and the sum of the values from *pea beans* and *dry beans*.

In the context of the study above, by expert opinion were considered that the *Annual leguminous* were obtained by multiplying *annual green fodder* with 0.3.

In the context of the study above, by expert opinion the values for *other perennial leguminous* represent 40% from *other perennial forage*.

The value $Res_{BF}/Crop_{BFi}$, $Frac_{DMi}$ and $Frac_{NCRBFi}$ are default, they being taken from the Table 4.16 in IPCC GPG 2000 and the Table 4.19 from Reference Manual, 1996. They are presented in Table 6.28 for each plant.

The value $Res_{BF}/Crop_{BFi}$, $Frac_{DMi}$ and $Frac_{NCRBFi}$ for *peas beans* were used in IPCC GPG 2000,

Table 4.16.

For *dry bean* the value $Res_{BF}/Crop_{BFi}$, and $Frac_{DMi}$ were used in IPCC GPG 2000, Table 4.16. Were chose an average of the two values from $Frac_{DMi}$. For $Frac_{NCRBF}$ was used the value from Table 4.19, Reference Manual, 1996.

For *other leguminous for dry bean*, the value was defined in the context of the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods"depending* on the species considered. In the made estimation using the national data sources, *peas beans* and *dry bean* are included in the leguminous for *dry bean* category for whom were used the parameters presented in the Table 6.22, as average for two species.

For the soybeans were used the default parameters (the result of the $Frac_{DM}$ is average between two values).

The values $Frac_{NCRBFi}$ for *Lucerne in equivalent green fodder*, *Clover in equivalent green fodder*, *Annual leguminous* and *Other perennial leguminous* were used for Table 4.19 from Reference Manual 1996, and the value $Res_{BF}/Crop_{BFi}$ is considered to be 0, because they are used completely as feed (the expert opinion).

According to provisions in IPCC 1996, a default value of 0.85 was used to adjust for the default water content in crop productions.

Table 6.21 The data on Crop production of nitrogen fixing crop obtained through the dedicated study (tonnes/year), in the 1989-2012 period

Year	**Crop production of nitrogen fixing crop (tonnes/year)**							
	Peas beans	**Dry Bean**	**Other leguminous for dry beans**	**Soy beans**	**Lucerne in equivalent green fodder**	**Clover in equivalent green fodder**	**Annual leguminous**	**Other perennial leguminous**
1989	98,500	143,600	13,800	303,900	11,131,700	2,937,100	4,740,540	1,595,280
1990	49,395	57,542	5,179	141,173	8,057,219	1,926,004	4,321,064	1,192,280
1991	32,292	46,019	1,180	178,593	9,661,207	2,054,329	3,310,877	1,405,245

Year	Crop production of nitrogen fixing crop (tonnes/year)							
	Peas beans	Dry Bean	Other leguminous for dry beans	Soy beans	Lucerne in equivalent green fodder	Clover in equivalent green fodder	Annual leguminous	Other perennial leguminous
1992	33,180	41,184	314	126,159	6,409,569	1,792,567	2,137,448	1,114,930
1993	36,406	48,421	405	95,370	6,879,385	1,988,099	2,100,432	1,156,306
1994	38,091	37,379	642	100,078	6,944,354	2,059,289	1,947,411	1,066,312
1995	54,262	41,769	986	107,861	7,081,202	2,367,015	1,805,831	1,104,678
1996	33,705	42,078	1,233	113,084	6,984,832	2,400,569	1,804,361	1,081,138
1997	27,263	50,194	1,103	121,148	7,727,622	2,725,409	1,603,245	1,139,256
1998	24,382	46,856	1,259	200,820	7,004,112	2,632,031	1,475,795	1,078,113
1999	27,011	47,698	2,046	183,403	7,737,980	2,863,116	1,608,876	1,163,233
2000	14,159	21,803	967	69,473	5,120,710	2,018,423	995,198.4	829,127.2
2001	21,661	36,492	3,021	72,688	6,476,805	2,494,521	1,117,681	1,025,732
2002	20,450	33,592	1,271	145,932	6,887,361	2,534,648	1,314,721	1,218,962
2003	23,497	36,679	469	224,908	7,237,492	2,421,292	1,417,587	1,182,048
2004	58,036	53,517	778	298,506	4,655,262	866,398	577,058.4	434,851.6
2005	39,096	41,733	84	312,781	6,274,555	1,601,385	736,487.4	900,629.6
2006	36,147	34,942	485	344,909	6,381,270	1,779,417	954,791.7	984,641.6
2007	17,748	18,014	423	136,094	4,166,344	1,463,864	666,744.9	680,001.6
2008	36,917	25,157	392	90,579	5,505,795	1,751,484	858,196.5	806,420
2009	30,009	22,348	561	84,268	5,642,588	1,786,509	869,456.4	812,963.6
2010	39,677	21,059	608	149,940	5,799,305	1,949,735	912,593.4	889,997.2
2011	55,076	21,351	403	142,636	6,015,839	2,001,723	1,011,406	1,057,648
2012	45,878	16,603	453	104,330	4,836,406	1,598,254	913,056	819,036

Table 6.22 The values used in the calculation F_{BN} ($Res_{BF}/Crop_{BFi}$, $Frac_{DMi}$ and $Frac_{NCRBFi}$), in the 1989-2012 period

Parameters	***The values used in the calculation F_{BN}***							
	Peas beans	**Dry Bean**	**Other leguminous for dry beans**	**Soy beans**	**Lucerne in equivalent green fodder**	**Clover in equivalent green fodder**	**Annual leguminous**	**Other perennial leguminous**
$Res_{BF}/Crop_{BFi}$ (fraction)	1.5	2.1	1.8	2.1	0	0	0	0
$Frac_{DMi}$ (fraction)	0.87	0.85	0.85	0.865	0.85	0.85	0.85	0.85
$Frac_{NCRBFi}$ (kg N/kg of dry biomass)	0.0142	0.03	0.03	0.023	0.03	0.03	0.03	0.03

Data used for calculation of amount of nitrogen in crop residues returned to soils annually (F_{CR})

Primary Data

For the calculation F_{CR} are necessary and the nitrogen fixing crop production. The primary data on crop production of nitrogen fixing crop were presented in the Table 6.20 (Chapter 6.5.2).
The primary data on Crop production of nitrogen non-N-fixing crop are provided by NIS through SY 1989-2012 and data base. They are presented in Table 6.23.

Table 6.23 The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2012 period

Year	Productions of non-N-fixing crops (tonnes/year)							
	Rye	Wheat	Barley and two-row barley	Oats	Maize grains	Sorghum	Rice	Total Cereal grains
1989	0	0	3,436,300	167,800	6,761,800	7,600	70,100	18,379,300
1990	89,678	7,289,344	2,679,558	23,4025	6,809,604	3,500	66,460	17,173,539
1991	85,753	5,473,156	2,950,698	258,160	10,497,338	6,004	31,449	19,306,621
1992	21,232	3,206,382	1,677,956	507,733	6,828,270	4,532	38,920	12,288,452
1993	40,409	5,314,104	1,552,793	553,577	7,987,450	5,481	36,448	15,493,074
1994	51,201	6,135,299	2,133,563	496,803	9,343,224	7,128	15,229	18,183,777
1995	42,728	7,666,538	1,816,267	404,428	9,923,132	4,408	24,066	19,882,827
1996	20,240	3,143,818	1,107,547	290,505	9,607,944	4,295	23,100	14,199,688
1997	29,413	7,156,188	1,889,343	325,389	12,686,700	4,776	10,669	22,107,300
1998	26,088	5,181,823	1,238,001	362,137	8,623,370	11,369	5,142	15,452,719
1999	21,092	4,661,439	1,018,586	389,556	10,934,815	2,535	3,813	17,037,346
2000	21,802	4,434,438	867,018	243,830	4,897,603	1,479	3,551	10,477,506
2001	28,631	7,735,136	1,580,048	382,354	9,119,194	5,584	1,459	18,870,926
2002	20,079	4,420,995	1,160,387	327,444	8,399,779	2,557	597	14,356,504
2003	17,358	2,479,052	540,849	323,060	9,576,985	4,991	253	12,964,404
2004	55,000	7,812,428	1,405,996	447,079	14,541,564	28,374	4,963	24,403,005
2005	48,962	7,340,664	1,079,148	377,456	10,388,499	1,912	14,251	19,345,464
2006	35,720	5,526,190	772,929	346,918	8,984,729	1,331	18,420	15,759,324
2007	20,583	3,044,465	531,420	251,633	3,853,918	1,193	27,518	7,814,825
2008	31,446	7,180,984	1,209,411	382,030	7,849,083	20,899	48,917	16,826,441
2009	32,959	5,202,526	1,182,062	295,832	7,973,258	14,440	72,418	14,872,952
2010	34,281	5,811,810	1,311,035	304,462	9,042,032	18,677	61,588	1,6712,883

Year	Productions of non-N-fixing crops (tonnes/year)							
	Rye	Wheat	Barley and two-row barley	Oats	Maize grains	Sorghum	Rice	Total Cereal grains
2011	31,382	7,131,590	1,329,692	375,855	11,717,591	39,696	65,261	20,842,160
2012	18,236	5,297,748	986,361	338,998	5,953,352	37,481	50,862	12,824,138

Table 6.23 (continued) The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2012 period

Year	Productions of non-N-fixing crops (tonnes/year)							
	Wheat and rye	Triticale	Rape	Sunflower	Flax for oil	Total Oilseed plants	Soy beans	In fiber-textile plants
1989	7,935,200	0	18,000	655,800	48,900	1,034,300	303,900	127,200
1990	7,379,022	0	10,860	556,242	28,040	739,319	141,173	53,192
1991	5,558,909	0	8,764	611,956	22,766	823,375	178,593	15,438
1992	3,227,614	0	1,372	773,986	17,877	920,295	126,159	25,648
1993	5,354,513	0	1,355	695,833	28,036	820,786	95,370	7,237
1994	6,186,500	0	322	763,697	6,457	874,093	100,078	4,821
1995	7,709,266	0	357	932,932	4,744	1,055,371	107,861	7,246
1996	3,164,058	0	1,867	1,095,596	4,517	1,218,725	113,084	4,108
1997	7,185,601	3,657	11,646	858,060	4,758	1,001,845	121,148	1,884
1998	5,207,911	3,435	28,742	1,073,316	3,019	1,317,567	200,820	735
1999	4,682,531	3,634	108,221	1,300,929	2,773	1,606,642	183,403	690
2000	4,456,240	7,431	76,126	720,871	994	868,531	69,473	881
2001	7,763,767	17,055	101,789	823,549	1,985	1,005,541	72,688	388
2002	4,441,074	23,006	35,906	1,002,813	1,760	1,194,506	145,932	794
2003	2,496,410	19,473	8,080	1,506,398	1,498	1,760,436	224,908	710

Year	Productions of non-N-fixing crops (tonnes/year)							
	Wheat and rye	Triticale	Rape	Sunflower	Flax for oil	Total Oilseed plants	Soy beans	In fiber-textile plants
2004	7,867,428	100,997	98,661	1,557,813	2,465	1,995,056	298,506	1,060
2005	7,389,626	94,142	147,566	1,340,940	55	1,803,080	312,781	538
2006	5,561,910	71,285	175,050	1,526,232	321	2,050,088	344,909	1,522
2007	3,065,048	81,768	361,500	546,922	394	1,046,558	136,094	72
2008	7,212,430	100,818	673,033	1,169,936	221	1,942,289	90,579	96
2009	5,235,485	97,251	569,611	1,098,047	1,099	1,764,047	84,268	0
2010	5,846,091	123,120	943,033	1,262,926	1,817	2,377,651	149,940	0
2011	7,162,972	144,800	738,971	1,789,326	2,626	2,686,860	142,636	0
2012	5,315,984	133,931	157,511	1,398,203	3,553	1,667,601	104,330	20

Table 6.23 (continued) The primary data on Crop production of non- nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2012 period

Year	Productions of non-N-fixing crops (tonnes/year)							
	Hemp for fiber-Plant textiles	Cotton	Tobacco	Hop	Medicinal aromatic plants/spices grown	Sorghum for brooms	Potatoes	Sugar beet
1989	113,900	0	27,500	0	33,300	12,656	4,420,300	6,771,100
1990	72,105	484	14,168	2,451	20,459	6,505	3,185,624	3,277,705
1991	58,345	200	13,919	2,626	20,867	6,001	1,872,767	4,702,693
1992	38,554	75	7,574	2,638	21,517	9,272	2,601,648	2,896,691
1993	7,433	0	10,503	2,470	12,092	6,517	3,708,903	1,776,327
1994	4,492	40	12,993	1,559	6,257	7,387	2,946,721	2,763,783
1995	5,862	21	13,358	1,823	12,114	11,156	3,019,921	2,654,610
1996	12,953	0	12,092	1,455	6,565	9,875	3,591,378	2,848,169

Year	Productions of non-N-fixing crops (tonnes/year)							
	Hemp for fiber-Plant textiles	Cotton	Tobacco	Hop	Medicinal aromatic plants/spices grown	Sorghum for brooms	Potatoes	Sugar beet
1997	9,590	0	18,119	534	9,200	7,913	3,206,058	2,725,512
1998	11,137	0	17,536	206	19,876	9,155	3,319,150	2,361,359
1999	7,343	0	14,754	184	5,191	10,007	3,957,115	1,414,928
2000	1,398	0	10,869	142	1,397	6,300	3,469,805	666,870
2001	2,769	0	10,088	155	6,463	7,803	3,997,057	875,485
2002	5,586	0	15,979	142	5,351	7,342	4,077,633	954,630
2003	3,163	0	7,862	209	5,404	7,097	3,947,177	764,475
2004	1,868	0	7,471	37	9,240	11,813	4,230,210	672,723
2005	4,698	0	3,682	194	3,297	6,712	3,738,594	729,658
2006	2,415	0	1,686	435	16,969	8,716	4,015,899	1,152,200
2007	479	0	1,128	374	2,857	5,437	3,712,410	748,839
2008	181	0	2,366	257	7,488	3,170	3,649,020	706,660
2009	2	0	1,566	245	7,063	6,006	4,003,980	816,814
2010	45	0	2,971	232	15,828	5,392	3,283,866	837,895
2011	9	0	2,562	117	11,157	7,288	4,076,570	660,497
2012	0	0	1,341	173	4,293	5,793	2,465,150	719,788

Table 6.23 (continued) The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2012 period

Year	Productions of non-N-fixing crops (tonnes/year)							
	Fodder roots	Tomatoes	Eggplant	Dry onion	Dry garlic	Cabbage	Green peppers	Cultivated mushrooms
1989	4,094,200	1,011,300	0	412,700	46,600	877,300	253,300	0

Year	Productions of non-N-fixing crops (tonnes/year)							
	Fodder roots	Tomatoes	Eggplant	Dry onion	Dry garlic	Cabbage	Green peppers	Cultivated mushrooms
1990	2,575,013	813,561	51,951	225,440	30,611	551,914	182,033	0
1991	2,139,294	692,828	39,902	218,525	32,210	616,530	166,840	0
1992	1,343,408	830,980	59,659	339,266	43,537	676,197	181,660	901
1993	1,465,107	798,859	72,898	344,013	48,931	853,948	176,287	638
1994	1,245,305	716,354	73,759	310,938	56,387	711,335	163,154	570
1995	1,332,449	730,945	88,506	362,969	69,476	824,412	195,648	600
1996	1,301,142	689,325	90,360	305,610	54,108	857,435	186,575	587
1997	1,247,927	463,294	78,984	337,015	63,341	761,183	167,375	401
1998	1,119,479	677,517	91,180	365,162	71,960	837,824	191,376	176
1999	1,174,612	708,616	119,008	401,057	84,542	885,407	212,294	34
2000	800,587	628,675	94,823	296,297	68,338	731,897	174,836	3
2001	1,035,203	651,733	112,192	396,527	82,901	819,184	184,815	2
2002	1,042,467	658,777	121,576	340,784	72,423	821,419	197,442	5
2003	985,637	818,936	131,030	350,400	76,523	1,019,234	248,732	80
2004	280,348	1,330,085	149,681	332,827	65,884	919,092	237,240	7,050
2005	711,939	626,960	97,902	363,625	68,374	1,009,430	203,751	563
2006	776,951	834,968	101,159	390,694	64,222	1,106,006	279,126	2,559
2007	594,956	640,785	63,716	324,993	49,948	893,153	184,939	1,083
2008	756,292	814,376	153,677	395,579	72,333	964,625	238,682	1,664
2009	567,499	755,596	168,588	378,106	63,245	1,001,940	245,661	7,317
2010	489,740	768,532	144,391	369,142	67,215	981,219	243,493	9,973
2011	555,341	910,978	160,010	394,305	66,602	1,025,293	253,505	7,661
2012	335,497	683,282	126,005	345,340	59,368	987,900	207,072	9,311

Table 6.23 (continued) The primary data on Crop production of non- nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2012 period

Years	Productions of non-N-fixing crops (tonnes/year)						
	Root vegetables – Edible roots	Water melons and melons	Total vegetables	Annual green fodder	Plant used for silage	Annual green fodder new	Total Perennial forage
1989	251,900	215,700	4,195,600	9,705,200	6,096,600	15,801,800	18,057,000
1990	158,554	381,585	3,051,200	6,882,641	7,520,906	14,403,547	12,963,924
1991	193,047	740,464	3,246,400	5,645,816	5,390,442	11,036,258	15,228,648
1992	214,880	623,036	3,461,200	4,077,623	3,047,204	7,124,827	10,989,460
1993	256,907	601,429	3,992,100	3,971,900	3,029,541	7,001,441	11,758,248
1994	244,890	611,102	3,548,700	4,155,947	2,335,423	6,491,370	11,669,424
1995	281,339	639,352	3,868,500	4,127,358	1,892,078	6,019,436	12,209,911
1996	253,148	693,883	3,934,400	3,930,367	2,084,169	6,014,536	12,088,245
1997	273,629	625,663	3,559,600	3,741,430	1,602,720	5,344,150	13,301,172
1998	284,708	689,620	3,939,900	3,773,666	1,145,649	4,919,315	12,331,426
1999	308,408	853,231	4,365,600	4,334,489	1,028,431	5,362,920	13,509,179
2000	253,853	531,127	3,381,100	2,840,370	476,958	3,317,328	9,211,951
2001	301,749	550,503	3,848,300	3,146,175	579,428	3,725,603	11,535,656
2002	303,279	651,317	3,973,400	3,816,927	565,477	4,382,404	12,469,413
2003	332,795	764,585	4,684,500	4,118,584	606,706	4,725,290	12,613,904
2004	351,183	765,118	4,773,916	1,923,528	0	1,923,528	6,608,789
2005	229,569	691,760	3,624,612	2,454,958	0	2,454,958	10,127,514
2006	292,579	641,791	4,138,862	3,182,639	0	3,182,639	10,622,291
2007	209,029	407,973	3,116,801	2,222,483	0	2,222,483	7,330,212
2008	265,999	562,260	3,819,890	2,860,655	0	2,860,655	9,273,329
2009	238,748	652,844	3,901,862	2,898,188	0	2,898,188	9,461,506
2010	241,578	662,863	3,863,617	3,041,978	0	3,041,978	9,974,033
2011	275,145	645,486	4,176,298	3,371,352	0	3,371,352	10,661,681

Years	Productions of non-N-fixing crops (tonnes/year)						
	Root vegetables – Edible roots	Water melons and melons	Total vegetables	Annual green fodder	Plant used for silage	Annual green fodder new	Total Perennial forage
2012	275,145	554,588	3,535,316	0	0	3,043,519	8,482,250

The data on Crop production of non - nitrogen fixing crop obtained through the dedicated study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“

In the context of the study above, by expert opinion using the primary data from the Table 6.23 (NIS) were considered the data on Crop production of non - nitrogen fixing crop presented in the Annex 3.3 – sheet *Crop production of non N fixing.*

For the 1989 period the value of production of by *rye, wheat, cotton, hop* has made an extrapolation with reference year 1990.

The data on Crop production of nitrogen fixing crop were considered the presented in the Table 6.21 (Chapter 6.5.2).

For the calculation F_{CR} were used the data on Crop production of non - nitrogen fixing crop and the data on Crop production of nitrogen fixing crop.

The crop production values from the these plants (*rye, wheat, barley and two-row barley, oats, maize, sorghum, rice, rape, sunflower, flax for oil, in fiber- textile plants, hemp for fiber - plant textiles, tobacco, hop, medicinal aromatic plants/spices grown, potatoes, sugar beet, fodder roots, tomatoes, eggplant, dry onion, dry garlic, cabbage, green peppers, cultivated mushrooms, root vegetables – edible roots, water melons and melons)* were used from the primary data table (Table 6.23).

By expert opinion, the values for *other grains* were obtained from the difference between *total cereal grains* and the sum *wheat and rye, barley and two-row barley, oats, maize, sorghum, rice and triticale.*

The values for other oilseed plants (castor) were obtained from the difference between *total oilseed plants* and the sum *rape, sunflower, flax for oil and soya beans.*

By expert opinion, the values of *other textile plants* were taken from *castor*.

In the context of the study above, by expert opinion were taken from *sorghum for brooms*.

The values for *other vegetable* were obtained from the difference between *total vegetables* and the sum *tomatoes*, *eggplant*, *dry onion*, *dry garlic*, *cabbage*, *green peppers*, *cultivated mushrooms, root vegetables – edible roots, water melons and melons.*

In the context of the study above, by expert opinion, were considered that the *annual green fodder new* the values of *annual grasses* represent 70%.

The productions of *annual green fodder new* were obtained from the of sum *annual green fodder* and *plant used for silage*.

In the context of the study above, by expert opinion, were considered that the *other perennial forage* the values of *other perennial grasses* represent 60%.

The values for *other perennial forage* were obtained from the difference between *total perennial forage* and the sum *the lucerne in equivalent green fodder* and *clover in equivalent green fodder*.

$Res_O/Crop_O$

The values this parameter were used from the Table 4.16 (IPCC GPG 2000) and the Table 4.17 (Reference Manual, 1996).

In the context of the study noted, by expert opinion, for the calculation was used the average of values of the differents species. To textile plant species (*flax, hemp, cotton), sunflower, rape, flax for oil, other oilseed plants-castor, tobacco and vegetables*, were estimated the national values based on data of different parts of the productions presented in national bibliography.

To *other grains, other leguminous for dry beans, other oilseed plants (castor),* and *other industrial crops (sorghum for brooms),* were estimated the national values based on data of different parts of the productions presented in national bibliography.

For the category *other perennial leguminous, other perennial grasses* were used the 0 value, because they are fully used as feed.

$Frac_{DM}$

Were used the default values from the Table 4.16 (IPCC GPG 2000), the Table 4.17 (Manual

Reference) for some plants (*grains*), and the national values based on data presented in national bibliography.

$Frac_{NCRO}$

Were used the default values from the Table 4.16 (IPCC GPG 2000), the Table 4.17 (Reference Manual) and the Table 4.19 (Reference Manual) for all plants.

$Frac_{NCRBF}$

Were used the default values from the Table 4.16 (IPCC GPG 2000), the Table 4.17 (Reference Manual) and the Table 4.19 (Reference Manual) for all plants.

$Frac_{BURN}$

As the national level are reported the activities of burning of crop residues in the conditions compliance of the legislation in existing, for the considered period, were estimated at the value of the fraction 10% for majority cereal grains, for dry bean, sunflower, soybean, tobacco, potatoes, other industrial crops (Sorghum for brooms).
According to provisions in IPCC 1996, a default value of 0.85 was used to adjust for default water content in crop productions.

$Frac_{FUEL-CR}$

In rural areas subsistence farmers use *maize strains, sunflower, tobacco, rape, hemp for fiber* for production of warmth to burning furnaces. In the context of the study noted, by expert opinion, was estimated a 10% value for 1989-2012, and for hemp for fiber was used a 50% value.

Frac$_{CNST-CR}$

In the context of the study noted, by expert opinion, was estimated a the 0.0025 value for 1989-2012 to *wheat*, *barley* and *two-row barley*, to *rape*, *sunflower*, *other textile plant-cotton*, *other industrial crop-sorghum for brooms* was used 0.1, to *in fiber textile plants* and *hemp for fiber* was used 0.3

Frac$_{FOD}$

In the context of the study noted, by expert opinion were estimated the national values for some plants.
In the Table 6.24 are presented the values used in the calculation F_{CR} (kg N/year).

Table 6.24 The values used in the calculation F_{CR} (kg N/year) of non-nitrogen fixing crop, in the 1989-2012 period

Parameters	Rye	Wheat	Barley and two-row barley	Oats	Maize	Sorghum	Rice	Other cereals	Rape
$Res_O/Crop_O$	1.6	1.3	1.2	1.3	1	1.4	1.4	1	1.5
$Frac_{DM}$	0.9	0.85	0.85	0.92	0.78	0.91	0.85	0.85	0.85
$Frac_{NCRO}$	0.0048	0.0028	0.0043	0.007	0.0081	0.0108	0.0067	0.015	0.015
$Frac_{BURN}$	0.1	0.1	0.1	0	0.1	0.1	0	0.1	0
$Frac_{FUEL-CR}$	0	0	0	0	0.1	0	0	0	0.1
$Frac_{CNST-CR}$	0	0.0025	0.0025	0	0	0	0	0	0.1
$Frac_{FOD}$	0	0.25	0	0.2	0.2	0	0	0	0.3

Table 6.24 (continued) The values used in the calculation F_{CR}* (kg N/year) *of non-nitrogen fixing crop, in the 1989-2012 period

Parameters	Sunflower	Flax for oil	Other oilseed plants-castor	Flax fiber-textile plants	Hemp for fiber-Plant textiles	Other textile plants-cotton	Tobacco	Hop	Medicinal aromatic plants/ spices grown
$Res_O/Crop_O$	1	3.08	2	0.18	1	2	1	1	0
$Frac_{DM}$	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
$Frac_{NCRO}$	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
$Frac_{BURN}$	0.1	0	0	0	0	0	0.1	0	0
$Frac_{FUEL-CR}$	0.1	0	0	0	0.5	0.1	0.1	0	0
$Frac_{CNST-CR}$	0.1	0	0	0.3	0.3	0.1	0	0	0
$Frac_{FOD}$	0.3	0.1	0	0	0	0.2	0	0	0

Table 6.24 (continued) The values used in the calculation F_{CR}* (kg N/year) *of non-nitrogen fixing crop, in the 1989-2012 period

Parameters	Other industrial crops	Total potatoes	Sugar beet	Fodder roots	Tomatoes	Eggplant	Dry onion	Dry garlic	Cabbage
$Res_O/Crop_O$	1.4	0.33	0.3	0	0.3	0.3	0.3	0.3	0.2
$Frac_{DM}$	0.91	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
$Frac_{NCRO}$	0.0108	0.011	0.0228	0.0228	0.015	0.015	0.015	0.015	0.015
$Frac_{BURN}$	0.1	0.1	0	0	0	0	0	0	0
$Frac_{FUEL-CR}$	0	0	0	0	0	0	0	0	0
$Frac_{CNST-CR}$	0.1	0	0	0	0	0	0	0	0
$Frac_{FOD}$	0	0	0.4	0	0	0	0	0	0

Table 6.24 (continued) The values used in the calculation F_{CR} (kg N/year) ***of non - nitrogen fixing crop, in the 1989-2012 period***

Parameters	Green peppers	Cultivated mushrooms	Root vegetables-Edible roots	Water melons and melons	Other vegetables	Annual grasses	Other perennial grasses
$Res_O/Crop_O$	0.3	0	0.3	0.3	0.3	0	0
$Frac_{DM}$	0.85	0.85	0.85	0.85	0.85	0.85	0.85
$Frac_{NCRO}$	0.015	0.015	0.015	0.015	0.015	0.015	0.015
$Frac_{BURN}$	0	0	0	0	0	0	0
$Frac_{FUEL-CR}$	0	0	0	0	0	0	0
$Frac_{CNST-CR}$	0	0	0	0	0	0	0
$Frac_{FOD}$	0	0	0.1	0	0	0	0

Table 6.24 (continued) The values used in the calculation F_{CR} (kg N/year) ***of nitrogen fixing crop, in the 1989-2012 period***

Parameters	Other perennial leguminous	Annual leguminous	Peas beans	Dry Bean	Other leguminous for dry beans	Soy beans	Lucerne in equivalent green fodder	Clover in equivalent green fodder
$Res_{BF}/Crop_{BF}$	0	0	1.5	2.1	1.8	2.1	0	0
$Frac_{DM}$	0.85	0.85	0.87	0.85	0.85	0.865	0.85	0.85
$Frac_{NCRBF}$	0.03	0.03	0.0142	0.03	0.03	0.023	0.03	0.03
$Frac_{BURN}$	0	0	0	0.1	0	0.1	0	0
$Frac_{FUEL-CR}$	0	0	0	0	0	0	0	0
$Frac_{CNST-CR}$	0	0	0	0	0	0	0	0
$Frac_{FOD}$	0	0	0.1	0.025	0.1	0	0	0

Area of organic soils cultivated

Histosols of Romania occupy an area of 5.000 hectares (Florea and Buza, 2004) is spread in the mountains, lowlands, floodplain or delta.

Although the of organic matter large reserve is (over 500t/ha) soils are poor in humus and nutrients (Chirita, 1974; Puiu and coll., 1983).

The formats Histosols are maintained only in conditions of excessive moisture (Blaga and collaborators, 2008).

The fertility of Histosols is decreased and are used the pasture, but the quality is very low (Stanga,1971; Florea and Buza, 2004).

After the above citations, in Romania the not it cultivate histosols.

Pasture, Range and Paddock Manure emissions

Methodology

Despite the fact that Pasture, Range and Paddock Manure is a key category, by level view, Tier 2 method could not be applied, due to the lack of detailed data needed. Therefore, a Tier 1 method has been applied for the estimation of the emissions levels. The methodology described in Chapter 6.3.2 applies also in this case with the specification that it should be applied only for Pasture, Range and Paddock Manure system.

Emission factors

IPCC 1996 default emission factor used according to the provisions in IPCC GPG 2000 (the Table 4.12) is specified in Chapter 6.3.2 – N_2O emissions section.

Activity data

Activity data took into consideration are presented in Chapter 6.3.2 – N_2O emissions section.

Indirect soil emissions

Methodology

Method IPCC Guidelines for indirect estimating emission of nitrogen used in agriculture describe four methods different ways by which anthropic intake of nitrogen become available for the formation of N_2O:

- atmospheric deposition of NO_x and (NH_4) on soil, nitrogen source inputs including nitrogen volatilization from soil, and sources of combustion and industrial processes;
- the nitrogen leaching and runoff applied or stored on the soil;
- the resulted nitrogen of sludge elimination, not was considered this form of nitrogen because practice of using sludge in Agriculture is not yet in Romania; in next year is can appear value from this indicator, because in year 2012 in the new strategy is to apply sewage sludge management in Romania, method including;
- the formation of N_2O in atmosphere from emission of NH_3 original from anthropic activities;
- the elimination process of the resulting effluent from food processing.

Despite the fact that Indirect soil emissions is a key category, from level view, Tier 2 method could not be applied, due to the lack of detailed data needed. Therefore, a Tier 1 method has been applied. For calculation of indirect nitrous oxide soil emissions, the equations 4.30, 4.32 and 4.37 from IPCC GPG 2000 were used.

Equation 6.20 Indirect N_2O Emissions

$$N_2O\ indirect\text{-}N = N_2O_{(G)} + N_2O_{(L)} + N2O_{(S)}$$

where:

- N_2O indirect-N = Emissions of N_2O in units of nitrogen;
- $N_2O_{(G)}$ = N_2O produced from volatilization of applied synthetic fertilizer and animal manure N, and its subsequent atmospheric deposition as NOx and NH_4 (kg N/year);

- $N_2O_{(L)}$ = N_2O produced from leaching and runoff of applied fertilizer and animal manure N (kg N/year);
- $N_2O_{(S)}$ = N_2O produced from discharge of human sewage N into rivers or estuaries (kg N/year);

Conversion of N_2O-N emissions to N_2O emissions for reporting purposes is performed by using the following equation:

Equation 6.21 Conversion of N_2O-N emissions to N_2O emissions

$$N_2O = N_2O\text{-}N \bullet 44/28$$

To apply equation were calculated:

Equation 6.22 N_2O from Atmospheric Deposition of N (Tier 1b)

$$N_2O(_{G\text{-}SOIL})\text{-}N = \{(N_{FERT} \bullet Frac_{GASF}) + [\Sigma_T(N_{(T)} \bullet N_{ex(T))} + N_{SEWSLUDGE}\ ] \bullet Frac_{GASM}\} \bullet EF_4$$

where:

- $N_2O(_{G\text{-}SOIL})$-N = N_2O from Atmospheric Deposition of N;
- $N_{SEWSLUDGE\,=}$ the amount of sewage N that is applied to soils in the form of sewage sludge (kg N/year) ;
- $N_{FERT\,=}$ amount of N fertilizer applied (kg N/year);
- $Frac_{GASF\,=}$ fraction of synthetic fertiliser nitrogen applied to soils that volatilises as NH_3 and NO_x;
- $N(_T)$ = number of animals of type T in the country;
- $Nex_{(T)}$ = Annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);
- $Frac_{GASM}$ = fraction of livestock nitrogen excretion that volatilises as NH_3 and NO_x (kg NH_3 – N and NO_x – N/kg of N excreted);
- $EF_{4\,=}$ indirect emissions factor for nitrogen stored; is use default value this fraction (Table 4.18, pages 4.73) of Revised 1996 IPCC Guidelines for National Greenhouse Gas

Inventories, used value 0.01 N_2O-N/kg NH_4-N and NO_X-N stored.

Equation 6.23 Deposited N from Leaching/Runoff (Expanded for major animal species/categories)

$$N_2O(_{L\text{-}SOIL})\text{-}N = \{N_{FERT} + \Sigma_i (N_{(EX)i} \bullet [1 - (Frac_{(FUEL\text{-}AM)i} + Frac_{(FEED\text{-}AM)i} + Frac_{(CNST\text{-}AM)i})] + N_{SEWSLUDGE}\} \bullet Frac_{LEACH} \bullet EF_5$$

where:

- ❖ $N_2O(_{L\text{-}SOIL})$-N = Deposited N from Leaching/Runoff;
- ❖ N_{FERT} = amount of N fertilizer applied (kg N /year);
- ❖ $N_{ex(T)}$ = Annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);
- ❖ $Frac_{FUEL\text{-}AM}$ = fraction of animal manure used as fuel (kg N/kg N totally excreted);
- ❖ $Frac_{FEED\text{-}AM}$ = fraction of animal manure used as feed (kg N/kg N totally excreted);
- ❖ $Frac_{CNST\text{-}AM}$ = fraction of animal manure used as construction (kg N/kg N totally excreted);
- ❖ $N_{SEWSLUDGE}$ = the amount of sewage N that is applied to soils in the form of sewage sludge (kg N/year);
- ❖ $Frac_{LEACH}$ = fraction of N input to soils that is lost through leaching and runoff (kg N/kg of N applied);
- ❖ EF_5 = has value 0.025 kg N_2O-N/ kg N leaching/runoff factor of indirectly emission for nitrogen deposed, is used default value of this fraction (Table 4.23) of Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual 0.025 kg N_2O-N/ kg N leaching / runoff.

According to IPCC GPG 2000 provisions, N_2O produced from discharge of human sewage N into rivers or estuaries are to be reported under Domestic and Commercial Wastewater in Chapter 5.

Emission factors

The calculation methodology took into account IPCC GPG 2000 default emissions factors (Table

4.18 from IPCC GPG 2000):

- EF_4 = 0.01 [kg N_2O-N/kg NH_3-N and NO_x-N emitted];
- EF_5 = 0.025 [kg N_2O-N/kg N leaching/runoff].

Activity data

A default IPCC GPG 2000 value of 0.3, specific to the fraction of fertilizer and manure nitrogen that is lost through leaching and runoff, $Frac_{LEACH}$, was considered.

For the $Frac_{GASF}$ fraction was used the 0.1 value, $Frac_{GASM}$ was used 0.2 from the Table 4.19 (Reference Manual, 1996). For the other fractions were used to value 0, according to expert opinion.

The all activity data are presented in the relevant Direct soil emissions section and Chapter 6.3.2.

6.5.3 Uncertainties and time-series consistency

Direct soil emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;
- EF: 300%;
- 300.7% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*" were obtained using the same method (the use of two methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; the use of both national and default values associated to amount of nitrogen fixed by N-fixing crops (F_{BN}) cultivated annually (kg N/year) and amount of nitrogen in crop residues returned to soils annually (kg N/year) (F_{CR}); detailed information is provided in Section 6.2.2 and 6.5.2, default emission factors were used using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

Pasture, Range and Paddock Manure emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;
- EF: 300%;
- 300.7% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“ were obtained using the same method (the use of two methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; the use of national values associated to the fraction of animal species/category *i*’s manure handled using manure system *j* in climate region k (MS); detailed information is provided in Section 6.2.2 and 6.3.2, default emission factors were used using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

Indirect soil emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;
- EF: 300%;

- 300.7% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that all activity data are provided by NIS, FAO, MADR or ICPA and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“,* default emission factors were used using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

6.5.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the E*nteric Fermentation, Manure management* categories, the results of these being mentioned on the Checklists level.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

No unconformity has been noted following the UNFCCC review of the NGHGI.

The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.5.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.5.6 Source-specific planned improvements, including those in response to the review process

Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species, are envisaged:

- fraction that volatilizes as NH_3 and NO_x, specific to synthetic fertilizers nitrogen adjusted for volatilization ($Frac_{GASF}$);
- fraction that volatilizes as NH_3 and NO_x, specific to animal manure nitrogen used as fertilizer, adjusted for volatilization ($Frac_{GASM}$);
- national values for activity data in totality;
- fraction of N input that is last through leaching and runoff ($Frac_{LEACH}$).

6.6 Source category Prescribed Burning of Savannas (CRF source category 4.E)

Prescribed Burning of Savannas does not occur in Romania.

6.7 Source category Field Burning of Agricultural Residues (CRF source category 4.F)

6.7.1 Source category description

Burning of agricultural crop residues is a significant source of emissions of methane, carbon monoxide, nitrous oxide and nitrogen oxides. However, the burning of crop residues is not thought to be a net source of carbon dioxide because the carbon released to the atmosphere is reabsorbed during the next growing season.

Considering legislation which prohibits the burning of crop, were concluded that this the activity happening on a small scale, in the case of crop production (the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“.*

Emissions from field burning of agricultural residues in 2012 are lower than emissions in 1989 with 32.70 Gg CO_2 equivalent, due to the lower agricultural yields. The lowest emissions are found in years 2000 and 2007 (Figure 6.9).

Figure 6.9 Cumulative emissions trend - Field Burning of Agricultural Residues

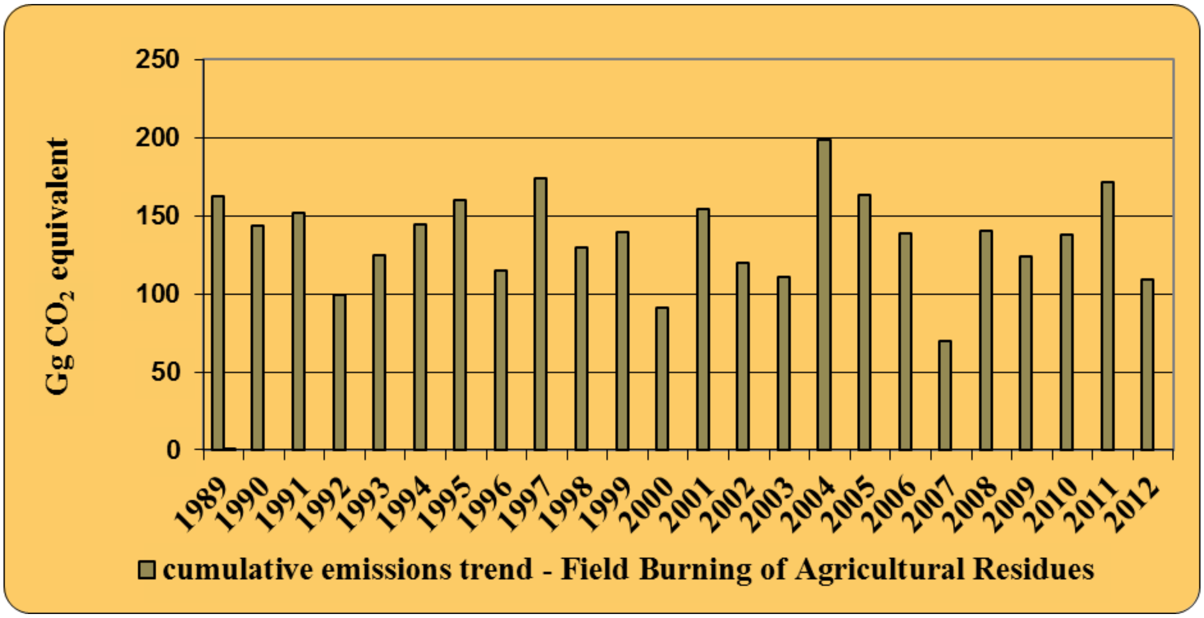


Table 6.25 Observations on source category 4F – "Field Burning of Agricultural Residues"

Source indicative	Source (livestock) type	Observation	Data source
4.F	Crop productions	Includes data on 12 types of crops productions: rye, wheat, barley and two-row barley, maize grains, sorghum, other cereals, sunflower, tobacco, other industrial crops- sorghum for brooms, potatoes, dry beans, soybeans.	AD: SY, other correspondence NIS, 1989-2012; the study „*Elaboration of national emission factors/ other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*" EF: IPCC GPG 2000, IPCC 1996

6.7.2 Methodological issues

Methodology

Due to the fact that CH_4 and N_2O emissions from field burning of agricultural residues are not key categories, neither from level nor from trend views, a Tier 1 method has been applied. For calculation of methane, carbon monoxide, nitrous oxide and nitrogen oxides emissions, the equation on page 4.82 of IPCC 1996 - Reference Manual was used.

Equation 6.24 Total carbon released

Total carbon released (tonnes of carbon) *= ∑ all crop types annual production (tonnes of biomass per year) • the ratio of residue to crop product (fraction) • the average dry matter fraction of residue (tonnes of dry matter / tonnes of biomass) • the fraction actually burned in the field • the fraction oxidised • the carbon fraction (tonnes of carbon / tonnes of dry matter)*

Emission factors

According to the provisions in IPCC GPG 2000, the calculation methodology took into account IPCC 1996 default emissions ratios (Table 4-16 of Reference Manual). Emission ratios are presented in Table 6.26.

Table 6.26 Default emission ratios for agricultural residue burning of residues calculations

Gas	Default IPCC 1996 emission ratios
Methane	0.005
Carbon monoxide	0.06
Nitrous oxide	0.007
Nitrogen oxides	0.121

Activity data

Crop Production

Crop production data are presented in Chapter 6.5.2.

Other parameters

Default IPCC 1996 values of Residue to crop ratios, Dry matter fraction of residue, Fraction burned in fields, Fraction oxidized, Carbon fraction of residue and Nitrogen - carbon ratios (partially described in Table 4-17 of Reference Manual) are presented in Table 6.27.

Table 6.27 Specific parameters used for calculation of Total carbon released

Type of crop production	**Parameters used for calculation of Total C released**					
	Residue to crop ratios [fraction]	**Dry matter fraction of residue [to. dry matter/to. Biomass]**	**Fraction burned in fields [fraction]**	**Fraction oxidized [fraction]**	**Carbon fraction of residue [to.C/to. dry matter]**	**Nitrogen-carbon ratio [fraction]**
Rye	1.6	0.9	0.1	0.9	0.4853	0.012
Wheat	1.3	0.85	0.1	0.9	0.4853	0.012
Barley and two-row barley	1.2	0.85	0.1	0.9	0.4567	0.015
Maize grains	1	0.78	0.1	0.9	0.4709	0.015
Sorghum	1.4	0.91	0.1	0.9	0.45	0.015
Other grains	1	0.85	0.1	0.9	0.45	0.015
Sunflower	1	0.85	0.1	0.9	0.45	0.015
Tobacco	1	0.85	0.1	0.9	0.45	0.02

Type of crop production	Parameters used for calculation of Total C released					
	Residue to crop ratios [fraction]	Dry matter fraction of residue [to. dry matter/to. Biomass]	Fraction burned in fields [fraction]	Fraction oxidized [fraction]	Carbon fraction of residue [to.C/to. dry matter]	Nitrogen-carbon ratio [fraction]
Other industrial crop- sorghum for brooms	1.4	0.91	0.1	0.9	0.45	0.02
Potatoes	0.33	0.85	0.1	0.9	0.4226	0.015
Dry bean	2.1	0.85	0.1	0.9	0.45	0.015
Soybeans	2.1	0.87	0.1	0.9	0.45	0.05

6.7.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;
- EF: 50%;
- 53.9% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

N_2O emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;
- EF: 50%;
- 53.9% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

Due to the fact that most of activity data are provided by NIS and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*" were obtained using the same method, is ensuring the consistency of data series considering the national circumstances (detailed information is provided in Section 6.5.2), default emission factors were used using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

6.7.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *Enteric Fermentation, Manure management* categories, the results of these being mentioned on the Checklists level.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. No unconformity has been noted following the UNFCCC review of the NGHGI.

The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.7.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.7.6 Source-specific planned improvements, including those in response to the review process

Aiming to their incorporation into next inventory submissions, the development of national values for activity data in totality, for to significant species, is envisaged.

7 LULUCF (CRF Sector 5)

7.1 Overview of sector

Agricultural lands, including arable, orchards, vineyards, pastures and hayfields makes up 61.3% of Romania's total national area. Forests cover 28.3% while constructed areas and road/railways, cover some 4.8%, humid areas, water and lakes some 3.5% and other land 2.1%. The official statistics provide annual data on land use categories for entire country territory since 1989. All of Romania's territory is included in the national GHG inventory.

Estimating emissions and removals of greenhouse gas (GHG) from the land use, land use change and forestry (LULUCF) follows the Guidelines 1996 methodology presented in Good Practice Guidance (GPG) for LULUCF, IPCC, 2003.

The net GHG emissions for LULUCF in Romania are presented in Table 7.1.

Table 7.1 Net GHGs emissions for the LULUCF Sector in 1989 (BY), 2000, 2008 and 2012

IPCC Subcategories	**Emission ("+") / removal ("-"), in GgCO_2eq**			
	BY	**2000**	**2008**	**2012**
5A1. Forest land remaining Forest Land	-18622.6	-22025.8	-20143.0	-19672.3
5A2. Land converted to Forest Land	138.9	-2801.0	-2923.2	-3047.7
5B1. Cropland remaining Cropland	-2219.8	-1526.5	-1607.1	-1660.7
5B2. Land converted to Cropland	-17.3	18.3	20.4	61.1
5C1. Grassland remaining Grassland	NO	NO	NO	NO
5C2. Land converted to Grassland	-35.5	135.0	188.4	138.2
5D1. Wetlands remaining Wetlands	NO	NO	NO	NO
5D2. Land converted to Wetlands	-214.5	-112.4	-130.1	-52.6
5E1. Settlements remaining Settlements	NO	NO	NO	NO
5E2. Land converted to Settlements	5663.7	423.2	429.5	410.9
5F1. Other land remaining Other Land	NO	NO	NO	NO
5F2. Land converted to Other Land	-29.7	1224.6	911.6	767.4

IPCC Subcategories	Emission ("+") / removal ("-"), in $GgCO_2eq$			
	BY	2000	2008	2012
Table I. Direct N_2O emissions from N fertilization of Forest Land and Other	IE	IE	IE	IE
Table II. Non-CO_2 emissions from drainage of soils and wetlands	0.0	0.0	0.0	0.0
Table III. N_2O emissions from disturbance associated with land-use conversion to cropland	0.0	0.0	0.0	0.0
Table IV. CO_2 emissions from agricultural lime application	44.5	25.6	14.8	1.0
Table V. Biomass Burning	3.2	7.0	104.9	227.2

CO_2 removals have increased in forestland while CO_2 emissions from land converted to settlements have decreased compared to base year (1989). The major GHG is CO_2, with non-CO_2 GHG having insignificant contributions (Table 7.2).

Table 7.2 LULUCF emissions for the period 1989-2012 ("-"CO_2 removal, "+" GHG emission, in $GgCO_2$ eq)

Reported year	Total GHGs	CO_2	CH_4	N_2O	NOx, CO, NMVOC	SO_2
BY (1989)	-13519.4	-15292.4	0.0	5.7	NA,NE	NA
1990	-22512.6	-24287.0	0.1	5.7	NA,NE	NA
1991	-23090.7	-24864.4	0.0	5.7	NA,NE	NA
1992	-24773.4	-26548.9	0.1	5.7	NA,NE	NA
1993	-24508.7	-26283.4	0.1	5.7	NA,NE	NA
1994	-25269.6	-27043.4	0.0	5.7	NA,NE	NA
1995	-25304.7	-27078.1	0.0	5.7	NA,NE	NA
1996	-22883.7	-24657.2	0.0	5.7	NA,NE	NA

Reported year	Total GHGs	CO_2	CH_4	N_2O	NOx, CO, NMVOC	SO_2
1997	-24023.8	-25796.6	0.0	5.7	NA,NE	NA
1998	-22937.1	-24710.3	0.0	5.7	NA,NE	NA
1999	-24321.2	-26095.3	0.1	5.7	NA,NE	NA
2000	-23904.9	-25691.9	0.5	5.7	NA,NE	NA
2001	-25007.4	-26784.1	0.1	5.7	NA,NE	NA
2002	-21028.6	-22815.5	0.5	5.7	NA,NE	NA
2003	-19439.8	-21215.6	0.1	5.7	NA,NE	NA
2004	-20650.5	-22423.8	0.0	5.7	NA,NE	NA
2005	-23652.5	-25426.1	0.0	5.7	NA,NE	NA
2006	-23482.2	-25258.8	0.1	5.7	NA,NE	NA
2007	-22309.0	-24093.6	0.4	5.7	NA,NE	NA
2008	-47383.7	-49160.1	0.1	5.7	NA,NE	NA
2009	-48031.1	-49807.8	0.1	5.7	NA,NE	NA
2010	-47386.9	-49160.6	0.0	5.7	NA,NE	NA
2011	-46123.1	-47908.1	0.4	5.7	NA,NE	NA
2012	-44859.5	-46658.7	0.9	5.7	NA,NE	NA

Emission factors are based on country specific data for forestland, while for the other land categories, a mixture of IPCC GPG for LULUCF (2003) default and country specific data is used. The GHG emissions estimates include all land categories and GHG (Table 7.3).

Table 7.3 Status of estimating emissions / removals by sinks in the LULUCF Sector (for completeness on C pools and GHG sources more information is available with the specific chapters in the NIR)

GHG source and sink categories	CO_2	CH_4	N_2O
5.A Forest Land			
5.A.1. Forest Land remaining Forest Land	**R**	**R**	**R**
NFF (national forest fund)			
Living biomass	R		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
VFAFF (forest vegetation outside the national forest fund)			
Living biomass	R		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5.A.2. Land converted to Forest Land	**R**	**NO**	**IE, NO**
5A2.1 Cropland converted to Forest Land			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5.A.2.2 Grassland converted to Forest Land			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5.A.2.3 Wetlands converted to Forest Land			

GHG source and sink categories	CO_2	CH_4	N_2O
Living biomass	R		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5.A.2.4 Settlements converted to Forest Land			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5.A.2.4 Other Land converted to Forest Land			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5.B Cropland			
5.B.1 Cropland remaining Cropland	**R**	**NO**	**NO**
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	R		
5.B.2 Land converted to Cropland	**R**	**NO**	**R**
5.B.2.1 Forest Land converted to Cropland			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5.B.2.2 Grassland converted to Cropland			
Living biomass	R		

GHG source and sink categories	CO_2	CH_4	N_2O
DOM	R		
SOMmin	R		
SOMorg	NO		
5.B.2.3 Wetlands converted to Cropland			
Living biomass	R		
DOM	NO		
SOMmin	R		
SOMorg	IE		
5.B.2.4 Settlements converted to Cropland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.B.2.5 Other Land converted to Cropland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.C Grassland			
5.C.1 Grassland remaining Grassland	**NO**	**NO**	**NO**
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	R		
5.C.2 Land converted to Grassland	**R**	**NO**	**NO**
5.C.2.1 Forest Land converted to Grassland			
Living biomass	NO		
DOM	R		

GHG source and sink categories	**CO_2**	**CH_4**	**N_2O**
SOMmin	R		
SOMorg	NO		
5.C.2.2 Cropland converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.C.2.3 Wetlands converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5.C.2.4 Settlements converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.C.2.5 Other Land converted to Grassland			
Living biomass	R		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.D Wetlands			
5.D.1. Wetlands remaining Wetlands	**NO**	**NO**	**NO**
Living biomass	NO		
DOM	NO		
SOM	NO		
5.D.2. Land converted to Wetlands	**R**	**NO**	**NO**

GHG source and sink categories	CO_2	CH_4	N_2O
5.D.2.1 Forest Land converted to Wetlands			
Living biomass	R		
DOM	R		
SOM	R		
5.D.2.2 Cropland converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	R		
5.D.2.3 Grasslands converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	NO		
5.D.2.4 Settlements converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	NO		
5.D.2.5 Other Land converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	R		
5.E Settlements			
5.E.1 Settlements remaining Settlements	**NO**	**NE**	**NE**
Living biomass	NO		
DOM	NO		
SOM	NO		
5.E.2 Land converted to Settlements	**R**	**NE**	**NE**
5.E.2.1 Forest Land converted to Settlements			
Living biomass	R		

GHG source and sink categories	CO_2	CH_4	N_2O
DOM	R		
SOM	R		
5.E.2.2 Cropland converted to Settlements			
Living biomass	R		
DOM	NO		
SOM	R		
5.E.2.3 Grassland converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5.E.2.4 Wetlands converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5.E.2.5 Other Land converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5.F Other Land			
5.F.1 Other Land remaining Other Land			
5.F.2 Land converted to Other Land	**R**	**NO**	**NO**
5.F.2.1 Forest Land converted to Other Land			
Living biomass	R		
DOM	R		
SOM	R		
5.F.2.2 Cropland converted to Other Land			
Living biomass	NO		
DOM	NO		

GHG source and sink categories	CO_2	CH_4	N_2O
SOM	R		
5.F.2.3 Grassland converted to Other Land			
Living biomass	R		
DOM	NO		
SOM	R		
5.F.2.4 Wetlands converted to Other Land			
Living biomass	NO		
DOM	NO		
SOM	R		
5.F.2.5 Settlements converted to Other Land			
Living biomass	NO		
DOM	NO		
SOM	R		
5.G Other	**NA**		
Harvested Wood Products	NA		
5(I) Direct N_2O emissions from N fertilization			IE
5(II) Non-CO_2 emissions from drainage of soils and Wetlands		NA, NO	R
5(III) N_2O emissions from disturbance associated with land-use conversions to cropland			R
5(IV) CO_2 emissions from agricultural lime application	R		
5(V) Biomass burning	R	R	R

* R- reported

Key categories in the national GHG inventory are 5.A.1 Forest Land remaining Forest Land, 5.A.2 Land converted to Forest Land, 5.B.1 Cropland remaining Cropland, 5.E.2 Land converted to Settlements and 5.F.2 Land converted to Other Land.

7.1.1 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The IPCC specify six land-use categories for the LULUCF sector: Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land.

Each of these categories is further divided into two subcategories:

i. Land remaining in the same category during the inventory year;

ii. Land converted from one category to another.

According to the GPG LULUCF (2003), the main requirement for reporting land-use is "consistency". This requires that land be well defined and correctly allocated to subcategory through time and prevent errors of omission or double accounting. This is important to avoid over- or under-estimation of emissions.

Reporting of land categories in Romania is based on two data sources:

i. National statistics on land-use categories (i.e. forest vegetation area on “national forest fund - NFF” and “forest vegetation outside the national forest fund - VFAFF”, arable, vineyard, orchards, pasture and hayfields, road and constructed areas, wetlands and waters, other land); from NIS, and,

ii. Forestry statistics on national forest fund, the afforestation area (afforestation of non-forest lands) and deforestation by forest authorities.

The National Institute of Statistics (NIS) is responsible for the annual compilation of land data of the national territory. Information is presented as the “net area” for each category of land at the end of the calendar year. The data sums to the country's total area, so that entire national territory is counted in the national GHG inventory. Time series are available since 1989 and are collected using constant definitions. Definitions are set according to the Law of Cadastre and Real Estate (Law 7/1996, consistent with previous laws). For non-forest land use categories, the NIS data allows for further disaggregation of the land use categories (e.g. ‘agricultural’ land is reported both as an aggregate and split in arable lands, vineyards and orchards) Table 7.4.

Table 7.4 National definitions of lands and correspondence with the IPCC land categories

NIS datasets / IPCC land category	**National land definitions**
Forestry land /Forest Land	This category includes: forest lands or those that serve the culture, production or administration of forest, lands for afforestation and unproductive lands comprising rocks, steep and stony slopes, ravines, gullies, torrents, if they are included in forestry planning (for better understanding of forest vegetation issue please check the section 5A1 Forest Land and descriptions of other land categories, i.e. Grassland).
Agricultural land / Cropland, Grassland	This category includes: arable land, vineyards, orchards, vineyards and orchards, nurseries, hops and mulberry trees, pastures, hayfields, greenhouses, solariums, greenhouses, the land covered with forest vegetation if it is not part of forest fund, wooded pastures, land occupied with agro-zoo-technical constructions and land improvements, fishery facilities, roads and technological storage.
Construction, road and railways land/ Settlements	This category includes all lands, regardless of the category of use, located in urban and rural area, inside a certain boundary according legal provisions. It also includes, special purpose land category used for roads, railways, air and water transport, those representing works of hydraulic engineering, heating systems, electricity and gas transport, mining and oil fields, those needed for the national defense; natural reserves and monuments as well as those for archaeological sites and historical ensembles and others alike.
Land permanently covered by water and humid zones / Wetlands	This category includes minor beds of watercourses, natural lakes and artificial basins at their maximum retention, arms and canals of the Danube Delta, the bottom of the inland maritime waters and territorial and contiguous sea.
Other lands/ Other Land	Lands which are not included under the other categories (i.e. small rocks and stony areas, river levees and deposits)

The data compiling system managed by NIS is implemented according to Law 226/2009 (Law on the organization and functioning of official statistics in Romania) which provides the legal framework, institutional responsibilities, reporting procedures and information processing, as well as own system of quality control and quality assurance. County and national level aggregated datasets are publicly available on the NIS site (www.insse.ro). Specific information on each of the classifiers mentioned in the Figure 7.1 above is further explained in the description of 5.A.1 Forest Land remaining Forest Land and KP-LULUCF sections of NIR.

Forest administration structures (forest districts) prepare annual sector statistical reports (SILV), based on annually updated management plans information. Conversions from/to national forest fund are operated at the end of each year in the management plan registry and related maps are updated with each new planning cycle. Forest districts provide data on the total area of forest fund under management at the end of each year. Data is centralized by NIS bodies, first at the county level and then at the national level.

The national statistics report the net area in each land category at the end of the year, but do not report change from one category to another. Nevertheless, starting 2010, NIS provides full land balance information, including conversions between categories. Additional information is used to show the lands in conversion subcategories at the national level. More detailed information from forestry sectorial statistics are incorporated to allow identification and consistency with land activities under Decision 16/CMP1. This data is available from the NIS (afforestation/ reforestation from the SILV 4 – "Forest regeneration works performed in the forestry fund, degraded lands and other lands outside the forest fund") and from central public authority responsible for forestry (synoptic of definitive "leaving land" from national forest fund which is equivalent to "deforestation"; statistics on forest fires affected areas). For these procedures there is a template officially approved by a Ministerial Order which is consistently used for reporting.

The Territorial Inspectorates for Forestry and Hunting Regime (ITRSV), which are the regional representative of the central public authority responsible for forestry, annually collect data and accurate information on forest land area and on conversions from/ to forest lands, as follows:

i. "National forest fund" area, which is continuously assessed on annually around 10% from the national forest fund area (i.e. forests status is described based on field assessments), along with the new forest management planning of the forest districts. However, the forest fund area is updated annually based on all conversions from/ to forest land (additions- as inputs/ subtraction-as exits from the forestry fund) operated into the management plans, including changes from “forest” to “other lands” within the national forest fund. Changes of areas associated to these conversions are measured by ground techniques, whenever they occur.

ii. Information on conversions to forest land by artificial plantation of non-forest lands (subject of afforestation/reforestation): legally approved detailed standard documentation about the exact location of the area (administrative and geographical location), the area of land involved.

iii. Information on conversions to the forest land by natural expansion of trees on non-forest lands (subject of non-human induced conversion to forest, which are conversions additional to afforestation/reforestation), which are included in the management plans (documentation includes exact location and description).

iv. Information on conversions from forest land: highly detailed standard documentation of "permanent “leaving land from national forest fund" (namely deforestation), the exact location of the land (i.e. administrative and geographical location), the surface, the subsequent destination of the land, as well as information on forest stand (e.g. full description of the stand and site characteristics). In the case of land conversion of areas affected by damaging factors (e.g. windfalls, fires) the same procedure is followed.

v. Land area with “forest vegetation outside the national forest fund” is also reported annually by the ITRSV based on compilations of data from local councils.

vi. ITRSV records data on conversions between any land, including “forest vegetation outside the national forest fund” and “wooded land” to any other land use. Permit granting requires a full documentation of location and description of stands. This is obligation under the Law 18/1991 when a land is subject of conversion from one use to another.

Such information is collected at national scale following officially approved procedures. Data is archived by the central public authority responsible for forestry in Romania and NIS. Also, a copy of each forest management plan, mentioned under (i), is archived by the Forest Research and Management Institute in Bucharest, since ~ 1950. The type of land information currently available in Romania allows an Approach 2 for forest land and conversions from/to forest land, seconded by explicit historical observation of all these three types of land. Further on, the national GHG inventory land datasets allows a level corresponding to Tier 2 for forest land and conversions, while a Tier 1 for the other land-use categories, according IPCC GPG LULUCF (2003).

The land-use and land-use change area matrix is built using the above data, ranking them according to their quality (i.e. ability to provide explicit location) and reporting requirement:

1. Annual net area of afforestation and deforestation, available from the forestry statistics (central public authority responsible for forestry).
2. Annual net area of the land use categories from the national statistics (NIS).
3. Share of land use categories converted to Forest Land. This is based on the results of a desk study on the change to forest land, complemented with expert judgment. This study reviewed the documentation of funding for afforestation projects from 2002 to 2005 (covering about one fifth from the total afforested area since 1990). This review found that afforestation occurred as follows: 80% on arable land (Cropland) and 20% on marginal pastures (Grassland). The exact method is detailed in "Romania Afforestation of Degraded Agricultural Land Project: Baseline Study, Emission Reductions Projections and Monitoring Plans", de S. Brown et al., May 2002. It was also assumed that this proportion remained constant for the entire afforested area for each year of the time series.
4. Land area permanently leaving the forest fund from the archives of the central public authority responsible for forestry. The most likely destination of lands converted from forest land is for construction areas and roads (e.g. residential, infrastructure). Also, Forest land can convert to "other land" taking into account natural causes (landslides, erosion of rivers banks) that cannot be associated with true deforestation (as non-human induced), but conservatively accounted for as conversion to the category "other land" by the national GHG inventory and "deforestation" under KP LULUCF. According the forest code interdiction of reducing the national forest fund area, the conversions of forestland to other land-use categories is not occurring.
5. The area of the most likely conversions among non-forest land categories was considered as following "expert judgments":

- The land area in conversion is estimated taking into consideration the maximum area of land possible to remain in the same category from one year to another;
- In the case of arable lands, the most likely conversion was assumed to occur to pastures/hayfields;
- In the case of pastures, the most likely conversion was assumed to occur to “forest vegetation outside the forest fund” under the natural expansion of forest vegetation into the abandoned pastures in the mountain and hilly areas, especially after 1991.
- Conversions from “forest vegetation outside the forest fund” to any land use category are reported as deforestation.
- In the Grassland category it was assumed that there were mainly transitions between subcategories within this category (from pastures to hayfields).
- Areas of “forests vegetation outside the forest fund” were considered to move to “national forest fund” (considered under Kyoto directly under FM) following the start of the implementation of management planning of such forest vegetation.
- In the case of construction land (e.g. waste dumps, industrial perimeters) the most likely conversion was assumed to occur to "other land", as far as large areas of industrial dumps were re-classified in the post-communist regime (early ‘90) with the privatization of industrial facilities (in order to not overcharge investors with environmental burdens of the past) or later on converted to settlements with the reactivation of industrial dump with increasing economic activity (i.e. dumps for ash or mining residues).
- The wetlands conversion was made most likely to pastures, “forests vegetation outside the forest fund” and "other land" categories.
- The "other land" category area is relatively constant over time and it is used in the matrix as a buffer for transitions that could not be attributed to other categories of land.

Also, in the very few cases of large differences of land category areas reported by the national statistics on consecutive years, these were considered as reporting errors and not real conversions.

This was the case for: i) “forest vegetation outside the forest fund" in 1999-2000 and 2003-2006; ii) pasture in 1999 and iii) other land in 1999-2003. In this case the chosen solution was to correct these values by replacing them with the simple arithmetic mean of the values from two years before and two years after the mentioned periods and allocate or subtract the land area from/to the category where the highest change was noticed (i.e. “forest vegetation outside the forest fund” to pasture or hayfields).

The land area matrix covers land that have been converted to another land use and moved to the relevant land remaining category after 20 years as per the IPCC GPG (2003).

The land area matrix is founded on the concept that the national total area must/does not change.

Therefore the sum of the six categories of land use must equal the national area. Further the area in each category at the end of the year must be equal to the value at the beginning of the year, plus/ minus conversions over the current year.

In 2013 the second cycle of NFI has started, data from first cycle is used only in the current submissions for comparison with statistics purposes (with advancing of data collection of the 2nd cycle a full shift to NFI data and reporting is expected).

The complete matrix can be found in Annex 8.5.1.

IPCC land-use category mapping with the categories seen in Annex 8.5.1 is as follows:

- 5A – Forest Land:
  - 5A1 – NFF: FF ;
  - 5A2 – VFAFF: VFAFF;
- 5B – Cropland: Arable + Vineyards + Orchards;
- 5C – Grassland: Pastures + Hayfields;
- 5D – Wetlands: Waters/ponds;
- 5E – Settlements: Construction + Roads/Railways;
- 5F – Other land: Other lands.

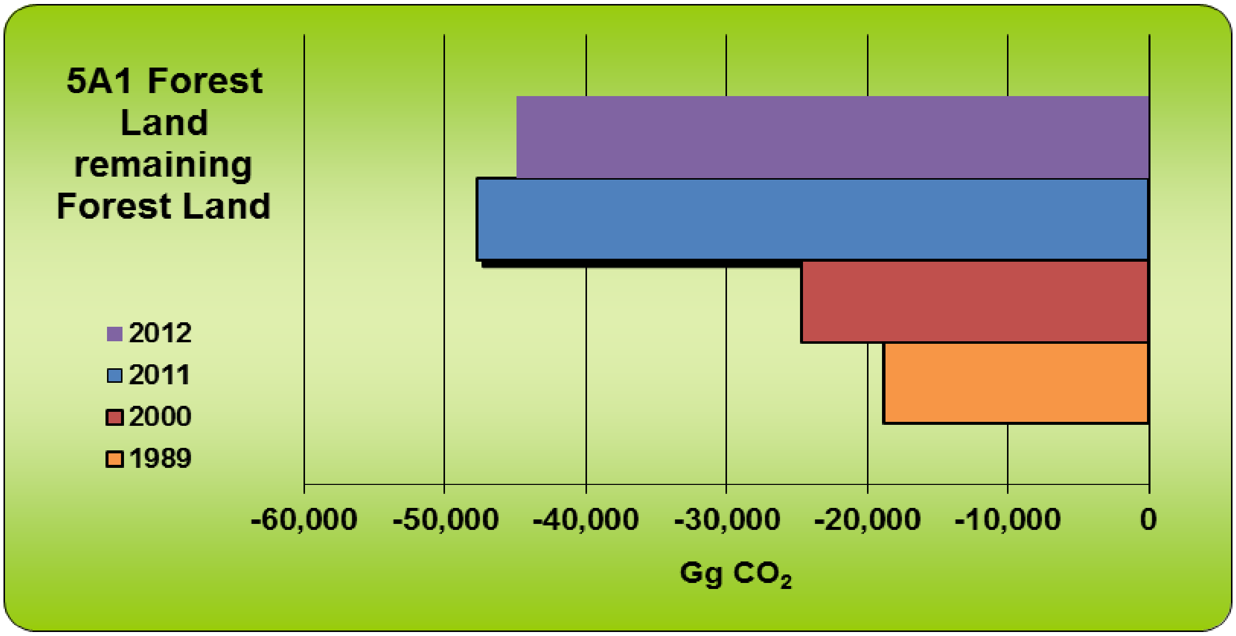
Table 7.5 describes the key categories in the LULUCF Sector, based on level and trend assessment, showing also the change of the annual removal compared to the base year.

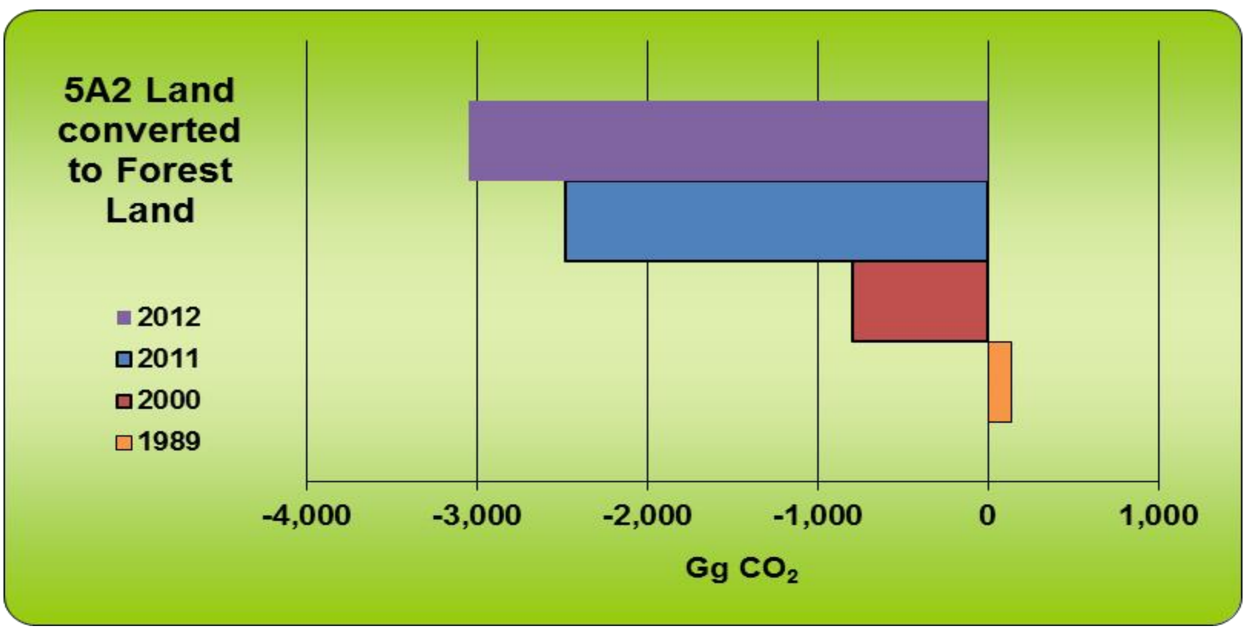
Both land sub-categories of Forest Land are key categories for CO_2 in the national GHG inventory, thus higher methodological levels is required.

Table 7.5 Key categories overview – LULUCF, 2012

Key categories	**GHG**	**Criteria**	**Contribution to the national GHG inventory [%]**
5A1 Forest Land remaining Forest Land	CO_2	L (Tier 1, including LULUCF; Tier 2, including LULUCF),)	**16.40**
5A2 Land converted to Forest Land	CO_2	L (Tier 2, including LULUCF),	**2.60**
5B1 Cropland remaining Cropland	CO_2	L (Tier 1, including LULUCF; Tier 2, including LULUCF),	**1.40**
5D2 Land converted to Wetlands	CO_2	L(Tier 2, including LULUCF)	**1.50**
5E2 Land converted to Settlements	CO_2	L (Tier 1, including LULUCF)	0.40
5F2 Land converted to Other Land	CO_2	L (Tier 2, including LULUCF	**0.70**

Figure 7.1 Major Key categories in LULUCF, both by level and trend





7.2 Forest Land (5.A)

7.2.1 Description

At the end of 2012, forest land area in Romania was about 6580 kha, which represents about 28% of the country area. The total area of forest land has increased by about 1% since 1990. The deciduous forests comprise 74% of forest area, while the Coniferous comprise 26%. In the deciduous forest, beech is the most common species (31% of the forest land), oak (17%), hardwood species (hornbeam, locust, maple, ash, etc. - 20%) and softwood species (poplar, willow, lime, etc. - 6%).

In the Coniferous forest, spruce is the most common species (21% of the forest land), followed by fir (5%) and other species (pine, larch, etc. – 5%). According to the inventory of the forest fund in 1984 the total standing wood volume was 1.341 million m^3, with an average of 218 m^3/ ha. Total annual growth of the forests was 34.6 million m^3 with an annual average increment of 5.6 m^3 / ha / year. Romanian forests grow more than is harvested from them, with a growing / harvesting ratio of about 2.

The stand age class structure reflects an unbalanced distribution of age classes, with a surplus in classes II and III and a deficit in classes I and V. According to the traditional forestry also stated in latest forest code all forest are managed following some basic prescriptions: rotation length ranging from 30 years of soft wood species (e.g. Robinia, poplar) 120-140 years for oak, beech and spruce forests under high forest regime. Coppice area is insignificant in Romania.

Forest fires do not occur frequently and affect only small scattered areas. Litter fires, which affect only the forest floor (litter and deadwood), are the most common, while crown fires rarely occur. Wildfires rarely affect annually more than 1,000 ha of forest land and always in a very high number of locations also spread around the country. Major fall and breakings due to wind or snow occur at least once in a decade, especially in the coniferous species forests, whose effect on the annual sink is estimated via harvest reported by the national statistics.

Figure 7.2 Emissions for 5A1 - Forest Land remaining Forest Land (Gg CO_2)

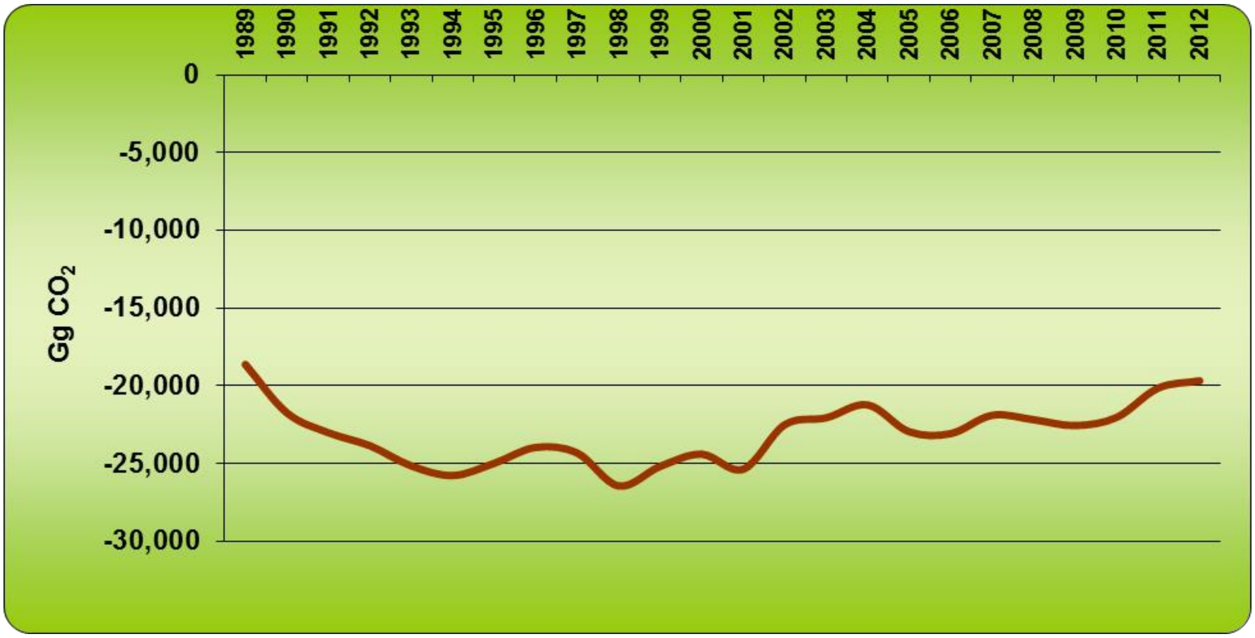
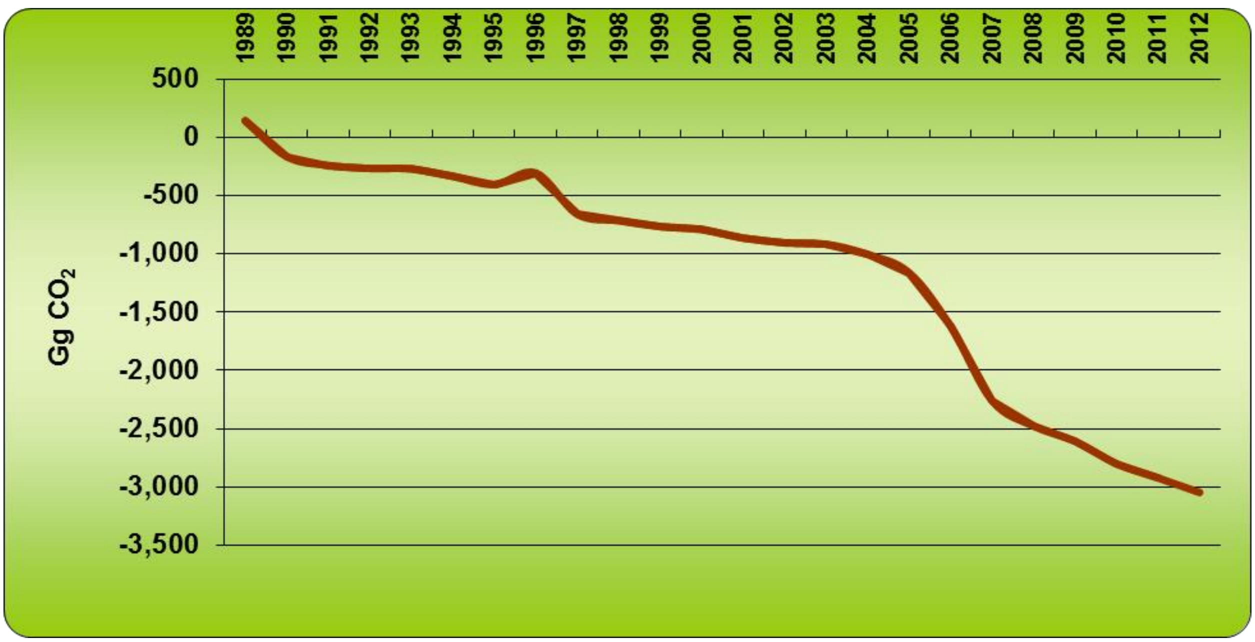


Figure 7.3 Emissions for 5A2 - Land converted to Forest Land (Gg CO_2)



Under the current data availability there is a change of annual removal estimate only given by the annual harvest variation (i.e. total volume harvested, share on species).

7.2.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

In Romania, the national statistics provides data on two types of land covered by forest vegetation (included into the forest vegetation terminology) (See also Chapter 7.1.1):

i. "National forest fund" (short NFF), which includes forest land subject to forest management planning; of which "lands covered by forest" are considered **managed forest land.** These lands are managed according management plans, which are renewed every 10 (5) years, and subject of approval by the central public authority responsible for forestry and implemented by the forest administrators (namely a state or private forest districts);.

ii. "Forest vegetation outside the national forest fund" (short VFAFF), made up of areas covered with forest vegetation which is not subject to forest management planning, which is further considered **unmanaged forest land**. Although national land statistics classify such areas under Grassland, for GHG inventory reporting purpose such forest vegetation areas are reported under 5A1 Forest Land, as far as they meet forest definition criteria (but not “forest management” national criteria). VFAFF historically is not a subject to forestry regime, and for which the development of management plans is not mandatory. Under much less management of grazing land after 1990 with the communist regime drop, such lands became covered by full standing forest vegetation (being especially in hilly and mountainous areas). With restitution of land to pre-communist owners, a very long process taking place practically since 1990 to some 2005 (or later), large areas of land were practically abandoned. They are under way to become subject to forest management, with the application of new forest code in force starting 2008, while NFI is able to identify all tree/forest vegetation in the country. As example, the conversion from VFAFF to FF increase from 1kha in 2004 to 150kha in 2011 (cumulated). Untill such lands will have a management plan they are considered "unmanaged forest lands" under the KP.

After 1991, by applying the laws on the rights of property restitution, many lands have been abandoned (pastures, hayfields, orchards, vineyards, croplands). Since these wooded lands are expected to be become managed forests, the forest code applies protective rules by conditioning wood harvesting and transport of wood on public roads, as well as on land conversions (e.g. deforestation). Under this approach, it also includes in NFF the protective forest belts, junipers area, and wooded pastures with the crown cover over 0.4 (which according to the Forest Law 1996 were included in the VFAFF), but they are still considered as "unmanaged" till management plans are prepared for them.

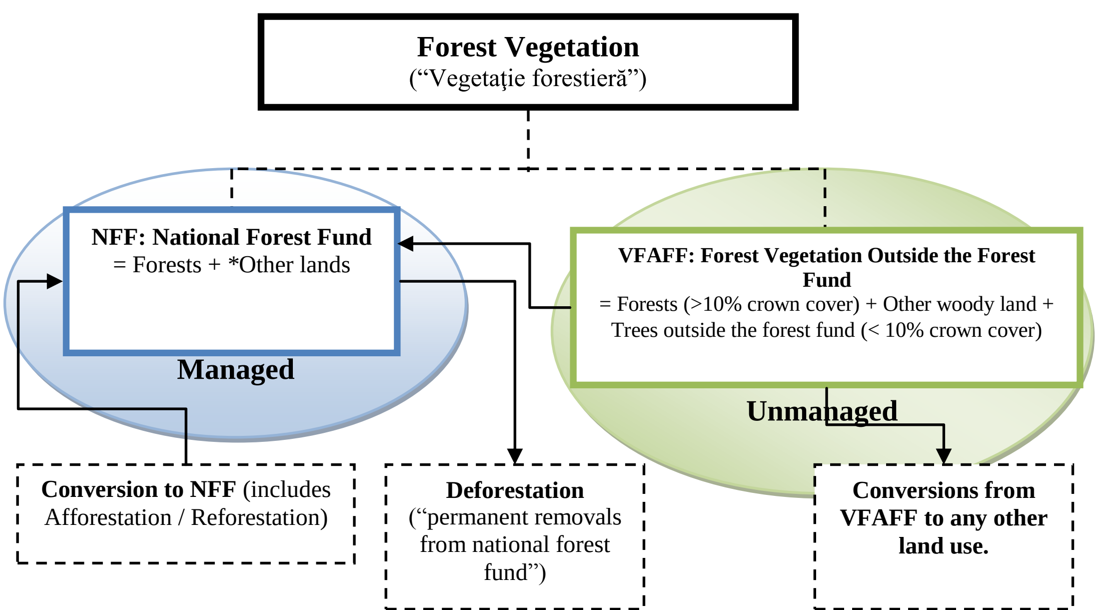
In many cases, on those lands, forest vegetation appeared by spontaneous regeneration. They cannot be mistaken with forest funds areas that are subject to a rigorous regime (e.g., are subject to forest management planning; strict regulations on land entries and leaving from the forest fund; mapped and land-marked boundaries in the field).

Data collected by the national and forest statistics are consistent with these definitions, and further on with the definitions implemented by the new NFI.

Since 2008, Romania began implementing a National Forest Inventory (NFI) based on statistical inventory of the all forest vegetation. NFI uses a forest definition harmonized with FAO's one and is fully consistent with the land categories used for defining the two categories above.

Figure 7.4 shows how the forest vegetation land is split into the NIS/IPCC land categories.

Figure 7.4 Forest vegetation definitions and data on associated land categories



* areas from the forest fund which are not covered by forests (e.g. unproductive lands, lands for forestry administration, forest roads, etc.). These areas are excluded from the calculation of GHG removal/emission estimation.

"Forest" is defined as forest vegetation land larger than 0.25 ha and tree height potentially superior to 5m. Although the new forest code in force since 2008 the crown cover criteria is not anymore explicitly defined, a crown cover criteria (>10 %) is implicitly implemented by forest management planning for land classified as "forest" under the national forest fund (otherwise the land is classified as "other lands from national forest fund"). According to the nationally approved technical norms, the stands showing lower density and vegetation status are automatically subject to ecological restoration (in regime of forest regeneration as artificial plantations, including change of the main species). NFI implements a similar threshold for differentiating "forest" for both NFF and VFAFF, on top of additional criteria defining the two forest vegetation land categories.

Also, although "forests" can occur under both "national forest fund" and "forest vegetation outside the national forest fund", the second category is considered unmanaged, under national definition of forest management (see further explanation under Ch. 11 KP LULUCF). Fact is that with latest forest code in force since 2008 all "forests" on" forest vegetation outside the forest fund" lands included in "forested pastures" with crown cover more than 40% are under the requirement to be identified and included in national forest fund and get managed in a short period of time, under a management plan (in which case they become automatically managed forests as parts of national forest fund). Noteworthy, any conversion to national forest fund by natural expansion on non-forest land, in some special circumstances (i.e. on newly formed alluvial deposits), is included by the procedure mentioned under i) above, thus not considered as direct human induced afforestation/reforestation. Changes of status of VFAFF are also subject to strict rules. According to the law, any change of any land use is subject to approval by the relevant authorities and recorded, further reflected in INS datasets. Thus, forest authority (ministry in charge with forests, by regional inspectorate - ITRSV) has to approve an officially required documentation related to any conversion, while it registers the change in its annual operational reports. Documentation for approval of land use change is submitted by the land owner and includes cadastral records and information on land use and cover. In any case, VFAFF area increased after 1989 by massive land abandonment. These lands are slowly moving into the national forest fund (e.g. see the increase of NFF from VFAFF).

Data sets currently available allow the use of different estimation methods for the two subcategories included in forest land: Forest Land remaining Forest Land (CRF 5A1) and Land converted to Forest Land (CRF 5A2).

7.2.3 Methodological issues

7.2.3.1 Forest Land remaining Forest Land (5A1)

CO_2 removals and emissions have been calculated following the default “gain-loss” method. The method involves estimating the C stock change for all C pools on all forest area (the activity data) and various proxy and parameters (used to estimate the emission/removal factors).

Actual and updated data was used for the estimation in the national GHG inventory, as currently available. Generally, a Tier 2 applies in the case of Forest Land remaining Forest Land sub-category, as long as the country specific estimates of activity data and emission/ removal factors are available.

7.2.3.1.1 Change of C stocks in living biomass

Estimation of C stock change uses equation 3.2.2, IPCC GPG LULUCF (2003):

Equation 7.1 Estimation of C stock change

$$\Delta CFF_{LB} = (\Delta CFF_G - \Delta CFF_L)$$

where:

- ΔCFF_{LB} = annual change in carbon stocks in living biomass (includes above- and belowground biomass) in forest land remaining forest land, tonnes C yr^{-1}

- ΔCFF_G = annual increase in carbon stocks due to biomass growth, tonnes C yr^{-1}. These estimates result from the multiplication of the activity data and country specific emission factors.
- ΔCFF_L = annual decrease in carbon stocks due to biomass loss, tonnes C yr^{-1}. These estimates are derived from statistics on removal of biomass (i.e. wood harvest) and other losses (i.e. forest fires).

Activity data

Forest Land area under the national GHG inventory is composed from “national forest fund”, respectively NFF area and “forest vegetation outside the national forest fund, respectively VFAFF area.

The national statistics provide time series of national forest fund area for the 1989-2010 period, both for the total Forest Land category and broken down on major species / groups of species (i.e. Coniferous, beech, oaks, deciduous hardwood and softwood). National forest fund area consists of two types of land:

i. "forest” area, which is the area actually covered with forests (softwood, hardwood and mixed), where forest vegetation meet the forest definition thresholds as being subject to forest management. If definition is not met, area is included under ii) below.

ii. “other lands from the forest fund”, which are areas from the forest fund which are not covered by forests (e.g. unproductive lands, lands for forestry administration, forest roads, etc.). These areas are excluded from the calculation of GHG removal/emission estimation.

In the land-use change matrix, the forest fund (called NFF) comprises of only "forest area", described under i) above, because only on these areas CO_2 removal occurs and GHG emission processes.

The other type of lands ("other lands” from the forest fund) is actually conventionally included in the land use change matrix under “forest vegetation outside the forest fund”, assuming that on such areas do not occur CO_2 removals and emissions. "Other lands from the forest fund" represents about 30% of the total surface of the VFAFF category, while the rest is represented by tree/forest vegetation on pasture and hayfields.

Further on, as there is no reliable historical data on "forest vegetation outside the national forest fund" and they result as land abandonment and not subject to any kind of management, its share of "forest" is computed based on NFI 2010 results as 71 % of this land category has over 10% crown cover (which explains the difference between VFAFF area in the CRF and "activity data" used for CO_2 removal estimation, mentioned in Table 7.7).

Activity data is provided by the land-use change matrix (the area, see Annex 8.5.1).

The area and the structure of the forest land by species/groups of species are annually obtained from the statistical survey SILV I, where there are presented annually updated data on the structure of the species / groups of species of the forest fund.

Table 7.6 Activity data on area of species/ groups of species used for calculation of the "increase" in carbon stocks due to living biomass growth

Year/ Parameter	Forest land [kha]						
	"Forests" area under		Forest land area structure on species				
	NFF	VFAFF	Coniferous	Beech	Oaks	Various Hardwood	Various Softwood
1989	6237	431	2017	1982	1200	1013	331
1990	6236	431	2019	1984	1198	1011	331
1991	6236	424	2018	1989	1194	1008	330
1992	6236	424	2014	1993	1195	1007	329
1993	6231	424	2003	2002	1191	1007	330
1994	6228	424	2000	1995	1196	1008	330
1995	6226	424	1989	2012	1184	1011	331
1996	6221	424	1975	2022	1182	1011	331
1997	6217	424	1974	2021	1181	1011	331
1998	6207	417	1963	2022	1177	1010	331

Year/ Parameter	Forest land [kha]						
	"Forests" area under		Forest land area structure on species				
	NFF	VFAFF	Coniferous	Beech	Oaks	Various Hardwood	Various Softwood
1999	6205	409	1948	2026	1175	1014	332
2000	6201	408	1940	2026	1170	1021	334
2001	6202	397	1934	2034	1167	1018	333
2002	6199	394	1929	2037	1163	1019	333
2003	6194	394	1926	2048	1159	1009	333
2004	6191	394	1914	2065	1153	1010	329
2005	6198	387	1929	2079	1144	1004	323
2006	6233	351	1958	2114	1133	984	326
2007	6274	310	1979	2120	1132	997	327
2008	6268	303	1991	2116	1115	998	325
2009	6308	279	2022	2140	1105	996	321
2010	6328	261	2018	2124	1123	1002	338
2011	6337	253	1939	2066	1058	957	317
2012	6348	232	1657	1968	1079	1238	406

Annual increase in C stocks in living biomass

Annual estimation of C stock increment uses country specific data, meeting the Tier 2 methodological level (with the exception of belowground biomass, where Tier 1 applies). Thus, the average annual increment in biomass (G_{TOTAL}) is calculated with the equation 3.2.5 from GPG LULUCF 2003, as follows:

$$G_{TOTAL} = I_v * D * (1+R)$$

where:

- G_{TOTAL} = average annual biomass increment above and belowground, tonnes d.m. $ha^{-1}yr^{-1}$
- I_V =average annual increment of the growing stock on species/group of species, $m^3ha^{-1}yr^{-1}$;
- R = root-to-shoot ratio appropriate to increments, dimensionless;
- D = basic wood density, tonnes d.m. m^{-3}.

Details of the country specific data used for estimation are as following:

- **Average annual increment in volume** (I_V) by species and groups of species is obtained from the „Summary of the Forest Fund Inventory of Romanian Socialist Republic" (by ICAS, Ministry of Forests, 1984) for the period before 2007. This report is based on forest inventory data drawn from the forest management plans for the national forest fund. Forest management plans are renewed every 10 (5) years and include specific estimates at the forest stands in terms of area, volume, species composition, current growth, etc. Growths values were calculated by summing the corresponding updated forest management plans data in force for the year 1984 (data from NFI1 (2008-2012) will be used once the NFI2 is finished, please see the improvements chapter).

Table 7.7 Parameter values used to estimate annual increment of the stock of C in biomass

Species / groups of species	**I_V [m^3/ha/yr]**	**D [tone d.m./m^3]**	**R [dimensionless]**
Coniferous	6.5	0.4	1.215
Beech	5.5	0.655	1.165
Oaks	4.7	0.645	1.185
Various hardwood	4.7	0.6	1.165
Various softwood	7.4	0.41	1.165

- GHG inventory follows exactly the same calculation and aggregations at national level for both data sources. For both estimates the annual growth value is the increase in the aboveground stand volume, including trunk and branches, with bark but not the foliage. C stock in the foliage is assumed to be constant in time and not change from a year to another. For this reason no biomass expansion factor (BEF) is applied. These data are the only data available at this time and are used in all national and international reporting (e.g. FAO).

- **Wood density** (D). Country specific values were obtained are available from "Studies and research for expansion of wood industry raw material base taking into account the structure, the physical-mechanical and technological characteristics of national forest tree species", ICPIL Manuscript, 1985. This data is provided by The National Institute of Wood (2008), which resulted from a national evaluation that took place as part of an assessment of the national forest resources, completed in 1985 (along with the Forest Fund Inventory). These values represent the best estimates for the breakdown used in forestry statistics and applied therefor in the national GHG inventory;
- **The values of the ratio "root-to-shoot"** (R) are country specific established as country wide average on group of species/major species. Data is derived “Biometrics Trees and Forest Stands from Romania, Dendrometric Tables”. These values are lower than those from Table 3A.1.8 of IPCC GPG 2003, previously used;
- **C fraction** (CF) is assumed to be 0.5 of the dry biomass according to the IPCC GPG LULUCF (2003).

Annual loss of C stock from living biomass

As the annual losses of living biomass C stocks, includes the effects of:

i. wood harvesting, according with management plans allowable cuts;
ii. disturbances (wind storms, unauthorized logging, forest fires).

Unlawful cutting of trees is accounted for separately using field check data collected by forest administrators. This data is summarized regionally by ITRSV offices, and then completed as national forestry statistics by the central public authority responsible for forestry. The volume of unauthorized harvested trees is finally estimated based on the official yield tables.

Wood obtained following windfalls is included in the national statistics as a normal harvest, in the year when the wood is harvested (not necessarily in the year of disturbance).

For forest fires CO_2, CH_4, N_2O emissions are calculated using country-specific activity data and default emission factors and are reported in CRF Table 5 (V) "Emissions from biomass burning".

The variation in C stocks due to losses, are calculated using equation 3.2.6-3.2.8 from IPCC LULUCF GPG (2003) and are tailored to specific available data. Currently available data allow the use of Tier 1, thus assuming that the belowground biomass C stock is entirely emitted in the same year. Also, under Tier 1 it is assumed that entire C stock in aboveground biomass is emitted in the event year, thus there is no debris or slash factor applied.

Annual decrease of carbon stock due to biomass loss (ΔL_{FF})

Equation 7.2 Annual decrease of carbon stock due to biomass loss

$$\Delta L_{FF} = L_{fellings} + L_{other\ losses}$$

where:

- $L_{felings}$= annual carbon loss due to wood harvesting [tC/year];
- $L_{other\ losses}$= other annual carbon losses, due to illegal logging [tC/year].

Further on, the annual carbon loss due to timber harvest ($L_{harvest}$) is computed as following:

Equation 7.3 Annual carbon loss due to wood harvesting

$$\boldsymbol{L_{fellings} = H \times D \times (1+R) \times CF}$$

where:

- H = annual volume of wood extracted [m^3/year].

Parameters D, R and CF have the same meaning as in the other equations in section 7.2.3.1.1. As well, for the estimation of the gain or loss, the values of these parameters are identical for same breakdown (i.e. on species/ group of species).

The NIS provides annual data on the volume of wood extracted from forests.

Data is collected and compiled at the same level of disaggregation as any other forest information following same procedure by the NIS. Worthy to notice, the suppliers of data on wood harvesting are forest land administrators (i.e. forest districts).

The statistics include i) the normal harvest, respectively the allowable cut composed by main and secondary products resulting from the implementation of management plans, and ii) any wood volume removed as a result of forest disturbances. The national statistics report entire wood volume extracted from forest, which non-explicitly include both commercial wood (for industrialization) and firewood (Table 7.8), with the specific destination that could be revealed from other statistics. Harvest statistics refer to entire aboveground volume of the stands, over-bark and include all branches (Technical Norms for commercial wood volume assessment, MAPPM 2000). Under intensive forest management in Romania the standing dead wood is also considered as part of the harvest as this is harvested and used as firewood. This way, the forest growth, standing volume and harvested volume are fully consistent within Romanian forestry.

Table 7.8 Activity data for harvested wood volume during 1989-2012 (thousands cubic meters/ year)

Year	**Harvest from national forest fund**					**unauthorized logging volume**	**Estimate of wood volume in "VFAFF"**	**Total**
	Coniferous	**Beech**	**Oaks**	**Various hardwood**	**Various softwood**			
1989	6516	6636	1842	2268	2004	83	1530	20879
1990	5813	4958	2045	2071	1762	121	1530	18300
1991	4956	4644	1919	2090	1769	187	1507	17071
1992	4418	4629	1739	2109	1524	282	1507	16208
1993	4564	4073	1629	1872	1452	158	1507	15256

Year	Harvest from national forest fund					unauthorized logging volume	Estimate of wood volume in "VFAFF"	Total
	Coniferous	Beech	Oaks	Various hardwood	Various softwood			
1994	4285	4037	1651	1741	1228	146	1507	14595
1995	4973	4215	1551	1774	1300	122	1507	15442
1996	5751	4266	1658	1876	1252	129	1507	16439
1997	5836	4263	1489	1757	1164	137	1506	16151
1998	5195	3635	1277	1491	1045	122	1506	14270
1999	5565	4115	1358	1588	1093	130	1454	15302
2000	5346	4508	1333	1731	1366	143	1450	15878
2001	4915	4260	1288	1673	1274	141	1416	14967
2002	7166	4439	1495	1805	1478	102	1405	17890
2003	7139	4748	1532	1823	1450	81	1405	18177
2004	6357	5412	1694	2031	1589	71	1405	18557
2005	6061	4794	1586	1852	1378	86	1405	17162
2006	5765	4997	1632	1915	1375	65	1405	17153
2007	7491	5182	1485	1668	1412	176	1405	18818
2008	6766	5208	1653	1760	1318	174	1381	18259
2009	6635	5489	1403	1845	1148	180	1382	18081
2010	6832	5654	1566	1784	1155	238	1387	18617
2011	7521	6175	1747	1946	1315	266	1387	20358
2012	7615	6332	1687	2014	1433	331.4	1387	20800

Other annual carbon losses* (unauthorized *logging)

Equation 7.4 Other annual carbon losses

$$L_{other\ losses} = H_i \times D \times (1+R) \times CF$$

where:

- H_i = volume extracted annually by illegal logging [m^3/year].

Other parameters have the same meaning as the previous equation.

Unauthorized logging statistics refer to entire aboveground volume of the stands/trees.

Losses from "forest" under "forest vegetation outside the national forest fund"

A very conservative annual harvest of 5 mc/year/ha is assumed to occur on such land, despite wood collection or harvesting may not occur at all. Assuming that, the annual harvest we applied Romania's weighted average of wood density (520 kg/m^3, root to shoot ratio (1.18)) and C content.

7.2.3.1.2 Change of C stocks in dead organic matter

It is assumed that the average transfer rates in and from the C pools in dead organic matter, are equal, and that annual net change is zero (Tier 1 according to the IPCC GPG LULUCF (2003)). This assumption is consistent with GPG as far as entire annual change of aboveground and belowground C stock in biomass is accounted as emission in the year of disturbance (i.e. for forestry operations), while there is also a rather constant annual rate of harvesting. As long as it is a key category, more information on how this assumption is supported with quantitative and qualitative information is shown under Ch. 11 on supplementary information on forest management activity.

7.2.3.1.3 *Change of C stocks in forest soils*

Forest land remaining forestland is a key category, for which reason assumption that SOC pool in ***mineral soils*** does not change is supported with additional quantitative and qualitative information in Ch. 11.

The area reported as ***drained organic soils*** on forest land in Romania is 95.3 kha. In previous submissions CO_2 and N_2O emissions were not estimated (reported as NO). Such areas were assumed as organic soils sites located in mountainous areas included under protected areas of the national forest fund. An ongoing analysis based on forest management plans has shown that this can be true for a small share of the total area of organic soils, while largest share might be actually represented by drained hydromorphic mineral soils (under excess of groundwater for at least part of the year), showing high clay and organic matter content. Drainage occurred mostly before 1990. Activity data and information of humus content (%) is available from the forest management plans and provided by National Forest Administration Romsilva which administrates all states forests, national parks and natural reserves containing forest vegetation in Romania (including NATURA2000 network). Nevertheless for a conservative approach in 2014 submission, entire area of 95.3kha is assumed as subject of drainage. Thus, associated CO_2 and N_2O emissions are recalculated for entire time series. IPCC 2003 default CO_2 emission factor for cool temperate forests of 0.68tC/year/ha and N_2O emission factor for mineral soils of 0.06 kg N_2O-N ha-1 yr-1 (from TABLE 3a.2.1 of Appendix 3a.2 of the GPG for LULUCF (2003)) were applied to drained area under forest management. All emissions estimates have been reported under 5.A.1 Forest Land remaining Forest Land - NFF/FM in Table 5(III).

7.2.3.2 Land converted to Forest Land (5A2)

Activity data

Conversion of land to forest land occurs in the ways, by:

i) artificial afforestation (which is later considered as afforestation/reforestation activity (A/R) under the Kyoto Protocol) where is classified as 5.A2.1 Cropland converted to Forest Land and 5.A2.2 Grassland converted to Forest Land, and

ii) natural expansion of forest reported under 5.A.2.3 Wetlands converted to Forest Land and 5.A.2.5 Other Land converted to Forest Land. Area of natural expansion of forest vegetation contributes to the increase of area of “forest vegetation outside the national forest fund”. Further on, under specific legal circumstances the natural expansion of forest vegetation is considered a conversion to ‘national forest fund’, if such areas are included in the forest management plans (e.g. transfers from VFAFF to NFF or new forest vegetation on alluvial deposits), then also considered under forest management activity (FM) under the Kyoto Protocol (which explains why FM area is higher than NFF area reported under 5A1).

We should also note the fact that a large area increase in the Other Land converted to Forest Land (5.A.2.5) sub-category, between the following years 2005-2011 following expansion of forest on non-forest lands, e.g. along Danube where forest vegetation encroaches on levees along existing islands. As these are lands in property of the state, they are included under “national forest fund” land as soon as covered by forest and become subject to forest management planning.

The activity data for conversions to forest land is detailed in the land area matrix (see Table 7.5). The total area converted to forest since 1990 is 151.4 kha, of which 28.15 kha are artificial plantations (eligible as A/R activity). These two cases are further down detailed.

GHG inventory emission/removal estimates were prepared as weighted over 3 major types of young forests assuming annually afforested area ratio of 20% Populus 50% Robinia and 30% Oak and other broadleaved species. The share corresponds to share of these species used in afforestation projects over the last 10 years.

Estimation of C stock change in living biomass

Annual change of C stock in living biomass in artificial plantations

The change of C stock in living biomass was determined based on the data and information from two research projects:

1) Reports on the implementation of the monitoring plan of the project "Afforestation of Degraded Agricultural Land Project in Romania" as a flexible mechanism of "Joint Implementation (JI)" under the Kyoto Protocol. The monitoring is carried out by the Forest Research and Management Institute (Romania) according to “Monitoring Plan for Changes in Carbon Stocks in Forest Plantations”, agreed by partners in the project. *Project related documents are available with Forest Research and Management Institute Bucharest.* This plan covers all issues related to sampling, measuring, processing, reporting and archiving data and information. Data from second verification of carbon stock accumulated in the

project was sampled in 2012. Second independent verification of the project was achieved in 2014, verification report is available on request.

2) The research project "Modelling Carbon Storage in the Transitional Ecosystem Structures Associated with Forest Land Use Change in Romania (FORLUC)" financed by the Ministry of Education and Research (Romania) during 2006-2009. The final report is available at ICAS Bucharest and some results were published in peer-review journals.

The data obtained in these two projects have allowed the development of biomass equations for the eight forest species most used in plantations on degraded lands in Romania. Both projects estimate changes of C stocks in the living biomass pools based on sampling in about 250 plots (all geo-referenced, with 176 subject to re-measurement in 2017 by the JI project). Relevant biometric data of trees in sampling plots were registered, as well as administrative information (parcel coding and location, age, etc.). Available stand data was pooled together based on shares of main tree species (i.e. Robinia, oak and softwoods-poplar and willows) allowing derivation of plantations/young stands biomass equations for 3 main types of plantations. Biomass equations were obtained with non-linear processing as Richard-Chapman function (stand biomass processing was part of another recent project “The determination of emission/removals of forest land and the land conversion from forest pools in accordance with its obligations as a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and its obligations as a party to Kyoto Protocol (KP) associated reporting of 2014” funded by the Ministry of Environment and Climate, 2013). Data is shown in Table 7.9 below.

Table 7.9 Annual amount of C (t/ha) sequestered in biomass in forestry plantations

Plantation age (years)	Poplar & Willow	Robinia	Oak
1	0,1	1,2	0,3
2	1,7	1,6	0,7
3	2,2	1,9	1,1
4	2,4	2,3	1,5
5	2,4	2,6	2,0

Plantation age (years)	Poplar & Willow	Robinia	Oak
6	2,4	3,0	2,4
7	2,4	3,3	2,9
8	2,3	3,7	3,5
9	2,3	4,0	4,0
10	2,2	4,3	4,5
11	2,1	4,5	4,9
12	2,0	4,6	5,3
13	1,9	4,6	5,7
14	1,8	4,6	5,9
15	1,7	4,5	6,0
16	1,6	4,3	6,1
17	1,5	4,0	6,0
18	1,4	3,8	5,9
19	1,3	3,4	5,8
20	1,3	3,1	5,6
21	1,2	2,8	5,3
22	1,1	2,5	5,1
23	1,1	2,2	4,8
24	1,0	1,9	4,5
25	0,9	1,7	4,2

The data collected allows a Tier 3 estimation of C stock change in living biomass for AR land under 5A2 Land converted to Forest Land. Average net annual removal in all pools in JI project was 7.5tCO_2/year over the CP1.

Based on detailed information from the JI project, while also confirmed by from afforestation projects design and experts, the pre-afforestation land use was also determined as 80 % coming from marginal arable land and 20 % from degraded pasture and hayfields.

Annual change of C stock in living biomass in conversions to forestland by natural expansion of forest vegetation on non-forest land

As far as such areas occur by natural expansion and sooner or later included in the forest fund they are assumed to behave as in a normal regeneration process (as they meet the forest definition). Structure of areas being under conversion to forestland by natural expansion of forest vegetation is not known, for which reason the same share of species is used as for artificial plantations. For estimation of annual C stock change the data as for direct human induced was used to report WL and OTL converted to FL.

Annual change of C stocks in the soils and dead organic matter

Data available from the JI project is used to report estimates of C stock change in litter pool (which is an annualy increasing sink) while no change for dead wood pool (from same project an extremely small sink is estimated, but conservatively assumed as NO). The net values of annual increase of the C stock are computed as a time average according to the plantation age, but not differentiated ~0.1 tC $ha^{-1}yr^{-1}$ on plantations type. For estimation, the same share of planted area on main tree species was used as for calculation of changes in living biomass pool.

Table 7.10 Annual change in litter pool

Age (years)	Annual change in Litter pool (tC/ha/an)
1	0,05

Age (years)	Annual change in Litter pool (tC/ha/an)
2	0,05
3	0,08
4	0,13
5	0,18
6	0,21
7	0,22
8	0,20
9	0,16
10	0,13
11	0,09
12	0,06
13	0,04
14	0,03
15	0,02
16	0,01
17	0,01
18	0,01
19	0,01

Annual change of C stocks in the soils

Conversion to forests occurs only on mineral soils.

Currently, the estimation of C stock change in mineral soils is estimated based on national level reference C stocks (Table 7.11), which are computed from "Monitoring soil quality in the Romania" (ICPA, 2006). For Forest Land, the value was provided from the Forest management plans database.

Table 7.11 National reference C stocks in mineral soils on land use categories (tC/ha) and annual C stock change (tC $ha^{-1}yr^{-1}$) in conversions from to, assuming 20 years transition period

Land categories / C stock		**from**					
		FL	**CL**	**GL**	**WL**	**SL**	**OTL**
to	**FL**	**85**	+1.85	+1.75	+1.75	+2.65	+2.2
	CL	-1.85	**48**	-0.1	-0.1	+0.8	+0.35
	GL	-1.75	+0.1	**50**	0	+0.9	+0.45
	WL	-1.75	+0.1	0	**50**	+0.9	+0.45
	SL	-2.65	-0.8	-0.9	-0.9	**32**	-0.45
	OTL	-2.2	-0.35	-0.45	-0.45	+0.45	**41**

Based on Table 7.11 there is a built up of C stock in all types of conversion to Forest Land. Under country level averaged data several assumptions have been made, like:

i) because majority of wetlands in Romania occur on mineral soils similar C stock was assumed as for Grassland;

ii) C stock in settlements has been estimated as 32t/h assuming that top 10 cm of the mineral soils have been removed in a cropland soil;

iii) 41tC/ha in soils under other land, computed as weighted average of stony areas (5t C/ha), deposits of interior rivers (10tC) and Danube (60 tC, each with 33 % of the total area of other land).

Definition adopted for reporting emissions from organic soils in the National GHG inventory is in line with nationally available soil data: organic soils under any land use which are classified as histosols and are characterized by more than 50 cm peat layer having over 20 % organic content. Additionally, peat lands occur in Romania on very small areas (under natural reserves) at high altitudes where there are no AR activities.

7.2.4 Uncertainties and time-series consistency

Preliminary estimates of the uncertainty determined for annual 5A1 Forest Land remaining Forest Land sink in 2011 was 33% (ranging between 25% and 50%) for growth of biomass and 35% for loss of biomass (between 26% and 54%). Under current completeness, total average net sink uncertainty in 2011 was 53%, ranging from 34% to 117%. Uncertainty estimation was done with the @Risk application (Palisade Corporation). It was assumed that all input parameters have normal distributions and they are not correlated (as far as data sources are fully independent in time and space). Nominal uncertainty of the parameters and proxies used in the GHG inventory range from 6% to 100% according to the specifications of data sources (Table 7.12).
A parallel investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project "Assessing the uncertainty of the Romanian Greenhouse Gas Inventory" which resulted in a relative uncertainty of 51%.

Table 7.12 Nominal uncertainty input parameters of national GHG inventory for 5A1 - Forest Land remaining Forest Land (95 % confidence interval, defined as ± 2 * StDev / mean, in %)

Parameter	Nominal uncertainty and 95% confidence interval (% of average)	Source
Annual increment in wood volume, Harvested wood volume	15	Assumed equal to volume standing stock. Technical standards for the forest management planning (Ministry of Forestry, 1986, 2000)
Activity data for living biomass	6	
Wood density	20 (16-25)	Values are-simulated based on average, min and max data, available from Mos (1985)
"Root-to-shoot" ratio	30 (22 - 39)	Values are-simulated based on IPCC data (Table 3A.1.8)

Parameter	Nominal uncertainty and 95% confidence interval (% of average)	Source
Unauthorized logging volume	100	Expert judgment (from experts from National Forest Administration Romsilva)
Forest fires emissions – activity data	30	
Forest fires emissions – emission factors	100	

For 5A2, there is an estimation of uncertainty for the afforestation land for plantations on some 7,000 hectares included under the JI project. The sampled based uncertainty estimate for C stock was ± 8.7% (for 95% confidence interval). The area of uncertainty was less than 1%.

7.2.5 Category-specific QA/QC verification

There are three levels of QA/QC currently implemented within the LULUCF Sector of the national GHG inventory.

The first level of QA/QC is conducted by the data providers. The data providers apply official procedures in order to ensure and control the quality of data provided to the GHG inventory compilers.

Secondly, LULUCF GHG inventory compilers perform basic checks consisting of various procedures currently applied to avoid errors associated with different stages of data processing or calculation. Currently these QA/QC checks are:

- Annual wood increment values currently used for estimation of the national GHG inventory are some 30% lower than the values estimated from the first cycle of sampling national forest inventory (achieved for 2008-2012). This might be explained by use of increment data determined on forests measured in ‘50-‘60 of past century (reflecting growth of forests in transformation from coppice and low consistency forests to old forests, compared to current mainly old forests). This issue would be solved once the NFI2 data would be available.

- Methods are established and followed step by step to avoid handling errors, especially by the implementation of complex excel spreadsheets.
- Verification of land use change matrix and land allocation according the predefined criteria according the procedures mentioned in the section 1.1.1.
- Expert consultation for specific issues (i.e. allocation of land under conversions among various categories; land definitions; forest data parameters and testing various proxies).
- Cross-checks of IEFs values (C stock change factors) against values from other EU countries.
- Graphic check of the smoothness of the time series for each land categories and emissions of each individual C pool, check and fix any outlier and provide the explanation in the text for any real outlier.
- Archiving of hard copies of the original data on the land categories (i.e. statistical reports).
- The completion of the “List for Quality Control of the Greenhouse Gas National Inventory” in accordance with the provisions on quality assurance and quality control, approved by NEPA President Decision no. 24/2009. A list that verifies entries regarding AD, EF, emissions, uncertainties and other, with 10 main categories, 18 secondary categories, and 106 rows with observations, checks carried out, rechecks and references.
  The list is completed and verified by different employees of Forest Research and Management Institute Bucharest.
- The project contractor on LULUCF sector, namely Forest Research and Management Institute Bucharest, implements steps to ensure that the staff involved has gradually increasing understanding of the national GHG inventory reporting requirements. This included short training sessions on the IPCC GPG for LULUCF 2003 guidelines and relevant UNFCCC decisions.

Third level of QA/QC is implemented by the Ministry of Environment – NGHGI, which consists of checks related to both CRF and NIR chapters. So far, there is no verification of the inventory estimate or the various parameters used in the inventory. Nevertheless, some scientific papers were issued recently on the sink in Romanian forests.

7.2.6 Category-specific recalculations, including changes made in response to the review process

With the 2014 submission there were only a few recalculations in 5.A.1 Forest Land remaining Forest Land and 5.A.2 Land converted to Forest Land driven by changes in C stock change/emission factors, and not at all on activity data except for year 2011 details can be seen in Chapter 10 - Recalculations and improvements.

The reasons for recalculation were:

- ✓ New estimates of CO_2 and N_2O emissions from drained organic soils.
- ✓ The current submission includes emissions/removals updated estimates of CO_2 removal by the JI project according to the most recent estimation as part the project verification for 2008-2012 (JI is included under AR, with individual estimates of area and emission/removal in the CRF tables). Estimates associated to JI are only reported in the year 2012 while for other years of the CP the estimates are reported as IE, in order to ensure easier check and full consistency with verification report.

7.2.7 Category-specific planned improvements, including those in response to the review process

Improvements cover preparation to shift to post-2012 reporting requirements spelled out in Decision 2/CMP7, IPCC's GL 2006, 2013 Wetland Supplement and the new 2013 KP accounting rules. One major expected improvement in GHG inventory is the reporting based on data from sampling national forest inventory (which performed the first measurement of the second NFI cycle in 2013).

7.3 Cropland (5.B)

7.3.1 Description

Cropland covers about 41% of the total country territory, and has decreased slightly since 1990. Of the total area, about 96% is arable land, 2% is orchards and 2% is land covered with vineyards. In 2012 there were some 9799 kha of cropland, including 1% lands in conversion from other categories.Cropland category also includes the lands subject to Revegetation activities eligible for reporting under the Kyoto Protocol. Such areas are reported in sectorial statistics as tree plantations (more information can be found at 11.1.3), but as a separate item than afforestation/reforestation. These areas are not included under the national forest fund, thus not mapped and not having forest management plans. Their administrators are always (small, large) farmers or local communities (thus managed as part of the agricultural land – mainly arable, or transport infrastructure) and not by forest administrators as it is the case of forestland. These areas were recorded in statistics because of public funding and a long standing policy to improve the tree cover in plain areas of Romania. In practice data is available at disaggregate level, able to be reported under Reporting Method 1. Revegetation occupies a very small area (less than 0.1% of total area of land included under 5.B.1 Cropland remaining Cropland category).

While area of 5B1 was steadily decreasing since the base year, the annual CO_2 removal generally also decreases (Figure 7.5).

Figure 7.5 Emissionsfor 5B1 - Cropland remaining Cropland (Gg CO_2)

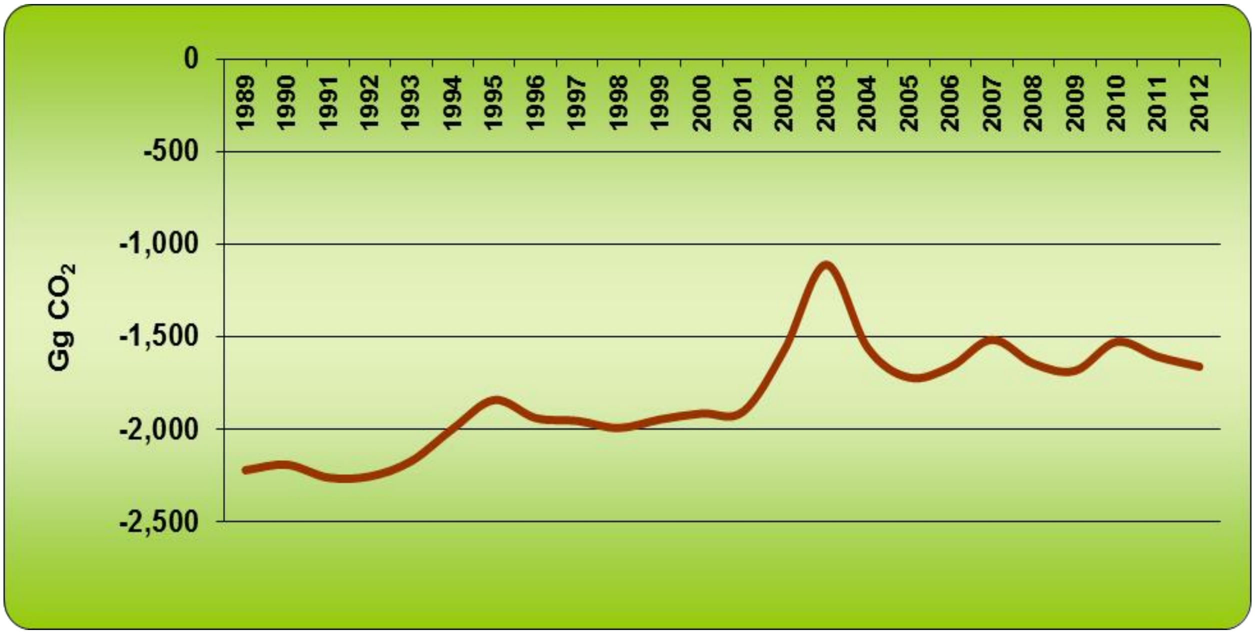
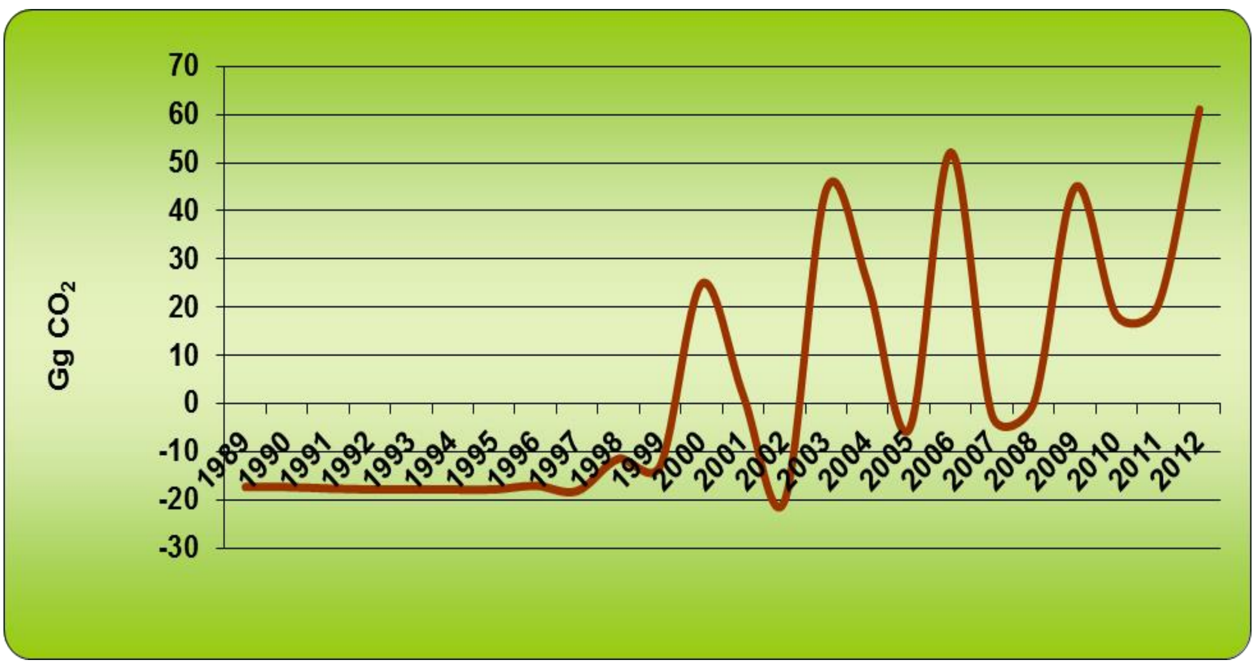


Figure 7.6 Emissions for 5B2 - Land converted to Cropland (Gg CO_2)



Trend in Cropland remaining Cropland is under the influence of two main components: permanent woody crops (orchards, vineyards) and “revegetation”.

Revegetated areas “behave” as forest plantations with regard to all pools, and same data and approach is used as for Land converted to Forest Land (5.A.2) and AR. The IEF living biomass spikes shown actually result from loss of living biomass in permanent woody crops (while annual growth is constant, i.e. the IPCC default), whose areas are decreasing drastically after 1990. Major drop of area is shown in several years (e.g. 30 kha in 1994 and 1995 and 75 kha in 2002-2004). The size of spike is also little compensated by the sink in revegetated area.

Annual variability of the sink is generated by the net change of total area occupied by permanent crops (vineyard, orchards) and the rate of the annual conversion to other land uses (i.e. to non-woody crops), under general decrease of its area, which is 24 % less compared to 1990.

Under significant drop of orchards and vineyards area in 2002 (by 5% compared to previous year) and 2003 (by 9 % compared to previous year), cropland category turns in emissions in 2003 (while in 2002 the emissions are compensated by sink in the area revegetated on 5.B.1 Cropland remaining Cropland).

5.B.1 - Cropland remaining Cropland is a key category based on level & trend assessment.

7.3.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The definition of this land category and the types of lands included in here are reported in section 7.1.1.

7.3.3 Methodological issues

Activity data (i.e. area) used to calculate GHG emissions for the lands included in this category is provided in land use change matrix, for both 5B1 Cropland remaining Cropland and 5B2 Land converted to Cropland subcategories. Activity data results from the land use change matrix, where same principles apply regarding the gross areas moving among various land. Estimation of carbon stock changes corresponds to Tier 1 or 2, estimating annual rates of growth and loss for national level data on the major type of crops.

7.3.3.1 Change of C stock in living biomass

Estimation of C stocks changes was made individually on each of the three different types of land included in the Cropland category:

Lands with woody perennial crops (vineyards and orchards):

Woody perennial species occupy about 38% of area of the Cropland. For the estimation of *annual* C stock changes on lands with woody perennial crops (vineyards and orchards) the following equation was applied:

Equation 7.5 Annual C stock changes on lands with woody perennial crops

$$C_{stock\ change} = C_{stock\ increase} - C_{stock\ decrease}$$

Equation 7.6 Annual C stock increase

$$C_{stock\ increase} = A_{CLp} * C_{biomass\ stock\ increment}$$

where:

- A_{CLp} – area of permanent cropland in a year [ha], which includes the old woody perennial crops (established in the previous years) and newest perennial crops established in the respective year (assumed in case of increase of area).
  - $C_{biomass\ stock\ increment}$ – annual growth of carbon stock in the living biomass [=0.3 tC ha^{-1} $year^{-1}$], for <15 years plantations (Perennial Woody - Hungary GHG Inventory).

When there is a decrease of area between successive years that is considered as permanent removal of woody crops as a conversion to other land use, in which case a C stock decrease is calculated in equation 7.5 above, as following:

Equation 7.7 Annual C stock decrease

$$C_{stock\ decrease} = (A_{CLp\ previous\ year} - A_{CLp\ current\ year})) * C_{standing\ C\ stock}$$

where:

- $A_{CLp\ current\ year}$ – area of permanent cropland in the current year [ha];
- $A_{CLp\ previous\ year}$ – area of permanent cropland in the previous year [ha];
- $C_{standing\ C\ stock}$ – default value for standing carbon stock of woody biomass in permanent croplands [=4.43 tC ha^{-1}], (Perennial Woody - Hungary GHG Inventory).

There is large fluctuation of annual removal in time and emissions in only two years, with a maximum in 2002 of some because of a sudden drop of area reported by national statistics.
Estimates also include conversions between arable and woody perennial crops, assuming a C stock for annual crops of 5tC/ha (as IPCC 3.3.8. of GPG for LULUCF 2003).

Lands which are subject to revegetation

These lands are included in the category 5.B.1 - Cropland remaining Cropland, but not highlighted as a specific land use in the land use change matrix (under scattered and non-identifiable locations) and such lands once covered by trees remain this way and not at all converted to arable lands. A specific line in 5B1 CRF tables is shown. Calculation of C stocks changes in all pools is identical with that for artificial afforestation reported in the subcategory 5.A.2 – Land converted to Cropland but averaged with equal weight across the 3 main types of plantations (see sub-chapter 7.2.3.2), as they differ only by land use category on which they occur. Average C stock change in biomass in such planted tree patches are 3 tC/ha/yr. for 25 years, which is quite realistic under these trees benefiting the fertilization and irrigation of neighbor agricultural crops.

Land in conversion to agricultural land

There is no conversion of Forest Land to Cropland.

For the conversions of non-forest lands to croplands, C stock changes in biomass are calculated assuming Tier 1 for all C pools. Conversion to Cropland occurs from Grassland, Wetlands, Settlements and Other land (i.e. industrial dumps and ecologization, reclamation of river deposits and islands along Danube). Conversions from settlements are negligible (2 kha in 20 years) and other lands (6 kha in 20 years), for which reasons they are reported as NO in the CRF Tables. For the other type of conversions, the estimation of C stock change in biomass relies on Tier 1, assuming an initial biomass C stock of 1.6 t dm/ha, respectively 0.8t C/ha, according Table 3.4.2 of IPCC GPG (2003), the default value for the warm temperate dry eco-region. Entire amount of C stock in biomass in grasslands is assumed to be lost in the moment of conversion to cropland (usually the technology implies deep soil preparation and removal of any pre-existing vegetation).

7.3.3.2 Change of C stock in dead organic matter and soil

Carbon stock change in ***mineral soils*** on land category 5.B.1 – Cropland remaining Cropland is currently estimated only for areas under revegetation which cumulates 103 kha over ~50 years. The assumption is that under cropland management by tree plantations there is an increase of soil C stock from value specific to arable land to that specific to forest (namely an increase of 1.85 tC/ha/year is assumed for 20 years).

Normally for such tree patches there is a management cycle of ~ 25 years when such plantations are cut and rejuvenated without the change of location and followed by regeneration of same spot (generally ensured by assisted natural regeneration). For this reason starting age of 25 years of plantations since the establishment it is assumed there is no change in the soils (i.e. C stock is constant in time). Same approach is applied for DOM which follows for first 25 years since the establishment the same accumulation pattern as forest plantations, after which it is assumed no change.

For the category 5.B.2 – Land converted to Cropland, there are available the average values of C stocks in soils under (Table 7.11), as reference values nationwide on major land use categories. Under conversion of land use, the change in the soil C stocks is considered occurring linearly over a transition period of 20 years. As such conversions do not occur, informatively and for comparison purpose to other national values in Europe or region, for land conversion from Forest Land to Grassland, there is expected an annual decrease in C stock of 1.75 tC $yr^{-1}ha^{-1}$. In conversions from grassland and wetlands, there is a decrease of 0.1 tC $yr^{-1}ha^{-1}$, while increase is expected in conversions from settlements (+0.8 tC) and other lands (+0.35tC).

Details about N_2O emissions from organic soils can be found in the Agricultural sector at 4.D.1.5 Cultivation of Histosols. CO_2 emissions from organic soils is reported as IE in 5.B.2.3 as included under estimates of emissions from area organic soils under 5.B.1 Cropland remaining Cropland (from 1990 there is no new drainage, or if there is then it is an insignificant area).

Total reported area is 5kha mentioned in the literature as being annually under arable land and reported under 5.B.1 Cropland remaining Cropland. For organic soils area, CO_2 emissions under LULUCF are estimated for the entire time series using IPCC default emission factor for Cropland under 'warm temperate dry' zone of 10 tC/ha/yr. This added emissions of some -50 $GgCO_2$ annually.

For conversions from GL to CL DOM changes are assumed negligible, and reported as NO.

7.3.4 Uncertainties and time series consistency

An investigation was done with support of a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project "Assessing the uncertainty of the Romanian Greenhouse Gas Inventory" which resulted in a relative uncertainty of 30%.

7.3.5 Category-specific QA/QC and verification

General QA/QC rules are mentioned in the section 7.2.5 subcategory, under Forest Land (5.A).

7.3.6 Category-specific recalculations, including changes made in response to the review process

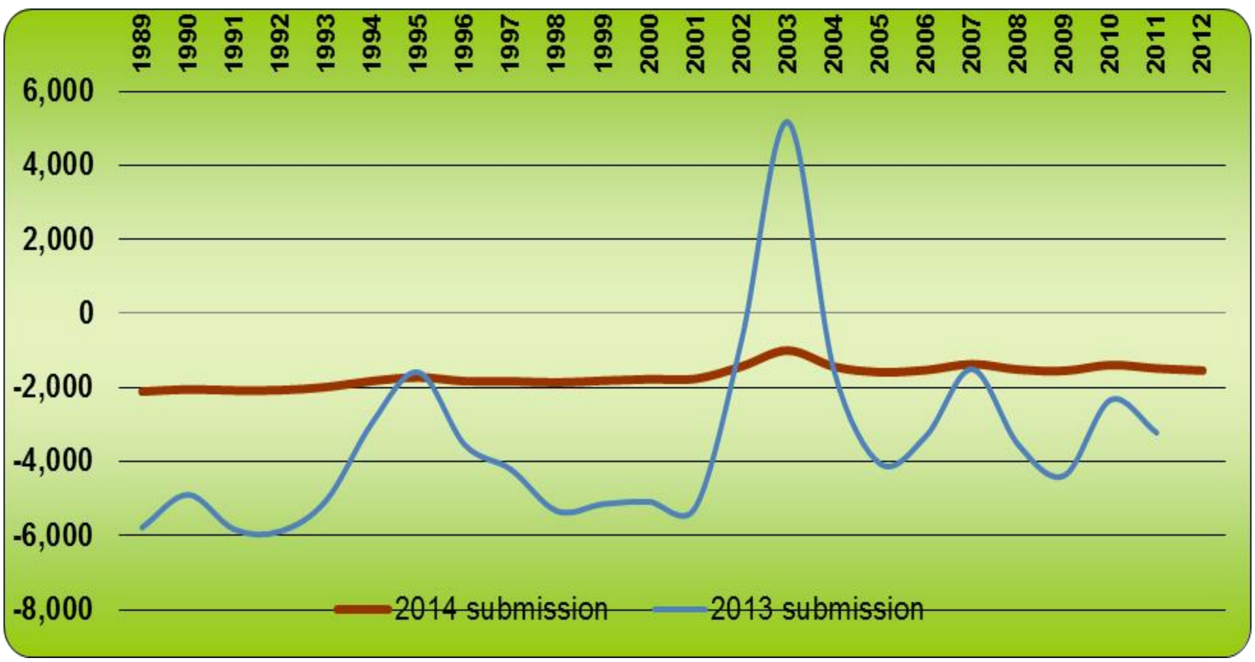
Revegetation removals and emissions related estimates were re-estimated by re-considering total area managed as revegetated land in each of the base year and commitment period years.

This was caused by the fact that previously for CP estimate only the areas established since 1990 were included, while in fact these areas have to be added to pre-1990 established area (so summed up), because such areas are maintained tree covered sites. Previous estimates for CP were derived only for post-1990 established area of revegetation, which underestimated the sink. This recalculation led to an increase of the annual sink by almost 400% compared to previous submissions, e.g. in 2013 submission. This also affects reporting activity "Revegetation" under KP LULUCF.

There have been recalculations in the current submission of about 2% for 5.B.1 – Cropland remaining Cropland and for 5.B.2 – Land converted to Cropland of about -65% for the year 2009 compared to the last submission.

5.B.1 - Cropland remaining Cropland changes were caused by the change of default emission factors to neighboring country EFs of woody perennial crops.

Figure 7.7 Recalculation of 5B1 - Cropland remaining Cropland sink (Gg CO_2)



7.3.7 Category-specific planned improvements, including those in response to the review process

Improvements cover preparation to shift to post-2012 reporting requirements as in Decision 2/CMP7, GL 2006 and EU commitments on Cropland Management.

7.4 Grassland (5.C)

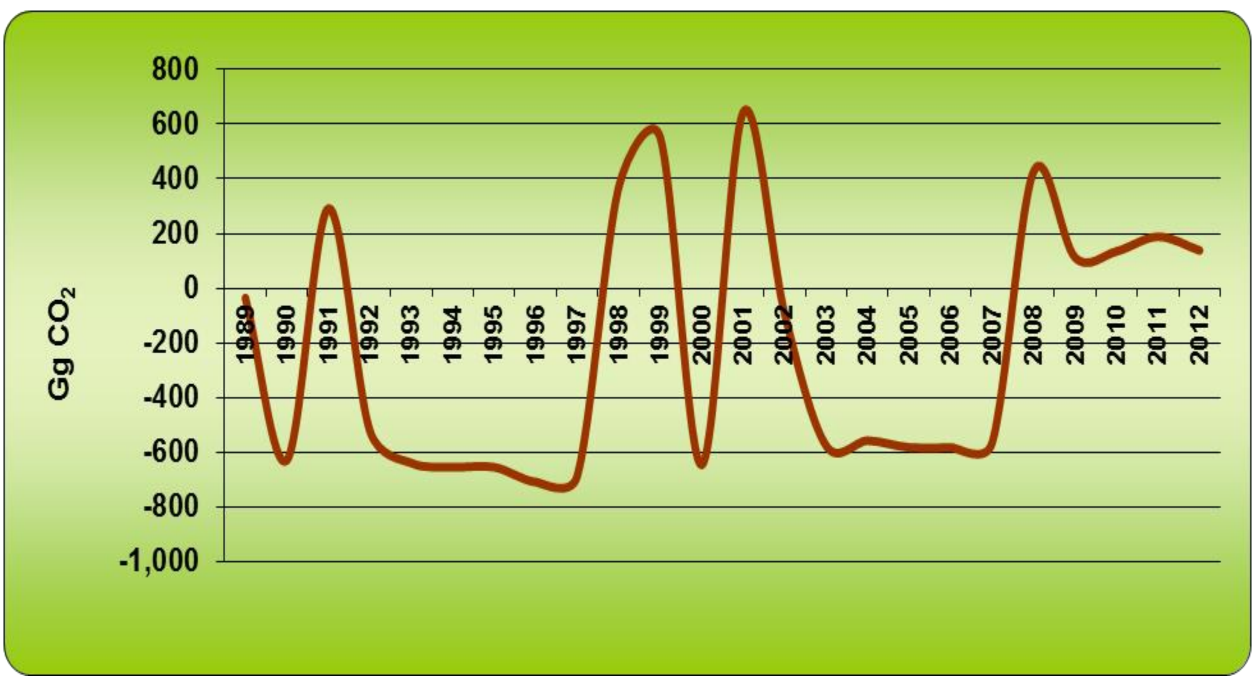
7.4.1 Description

Grassland remaining Grassland area is approximately 4602 kha, about 21% of the total country area. According to national land statistics, this category includes pastures (which represents 68 % of total area and it is mainly associated with grazing) and hayfields (31% of grassland area, mainly associated with harvesting hay and forage). The difference of 1% is represented by the lands reported under conversion among them, under versatile and local change of use.

According to the national legislation, “forest vegetation outside the forest fund, VFAFF” is also part of the grassland and not part of the national forest fund, thus being considered as unmanaged land from forestry point of view. Nevertheless, because such forest vegetation land meets the criteria for forest they are reported for the national GHG inventory purpose under Forest Land (see 5A1).

Lands in conversion to grassland sum up to around 93 kha over 24 years. The main transition is from Other Land and Cropland.

Figure 7.8 Emissions for 5C2 - Land converted to Grassland (Gg CO_2)



7.4.2 *Information on approaches used for representing land areas and on land-use databases used for the inventory preparation*

The definition of this land category and the types of lands included in here are reported in section **Error! Reference source not found.**. From GHG inventory perspective, it is assumed there is no difference between hayfield and pasture.

Land use change matrix reveals conversions from “forest vegetation outside the national forest fund” to “hayfield or pasture” or to “wetlands” which are conservatively associated with “deforestation” although VFAFF is not assimilated with forestland but with grassland and previously assumed they are not associated with factual land use change (based on assessment of the 1st NFI cycle).

7.4.3 *Methodological issues*

Activity data used to calculate GHG emissions for the land included in the Grassland category is provided by the land use change matrix, both for the 5C1 Grassland remaining Grassland and 5C2 Land converted to Grassland category. Estimation of carbon stock change in the Grassland category corresponds to Tier 1, with country specific data on reference C stock in soils.

7.4.3.1 *Change of C stock in living biomass*

Estimate of the change of C stocks vary by type of land included in this land category:

- *Land remaining under the same use.* In the case of grasslands where there are no changes in usage it was considered that there are no changes in the C stocks of any pool (aboveground, belowground);
- *Land in conversion to grassland.* There is no conversion of national forest fund land to grassland, while conversions from VFAFF to grassland are considered as deforestation For conversions from other, non-forest lands, the changes in the biomass C stocks are considered negligible, thus reported as NO. Major conversions occur from Other land, Cropland and Settlements (the last one by transfer of land from the industrial perimeters to local communities after 1989).

7.4.3.2 Change of C stock in dead organic matter and soil

For the estimation of C stock changes in soils of “land remaining grasslands” there is an improvement plan available. For land in conversion to Grassland the reference C stocks from Table 7.11 are used for the calculation of emissions and removals under various conversions to grassland (assuming 20 years transition period).

7.4.4 Uncertainties and time-series consistency

Relative uncertainty is estimated as 30% in an investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project “Assessing the uncertainty of the Romanian Greenhouse Gas Inventory”.

7.4.5 Category-specific QA/QC and verification

General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A). Area of organic soils and drained areas was subject of repeated checks and identification of most reliable data sources with the Ministry of Agriculture.

7.4.6 Category-specific recalculations, including changes made in response to the review process

Updated area of organic soils is reported in 5C1 Grassland remaining Grassland (still using IPCC default factors). With 2014 submission there were only a few recalculations in the Grassland category, details can be seen in Chapter 10 - Recalculations and improvements.

7.4.7 Category-specific planned improvements, including those in response to the review process

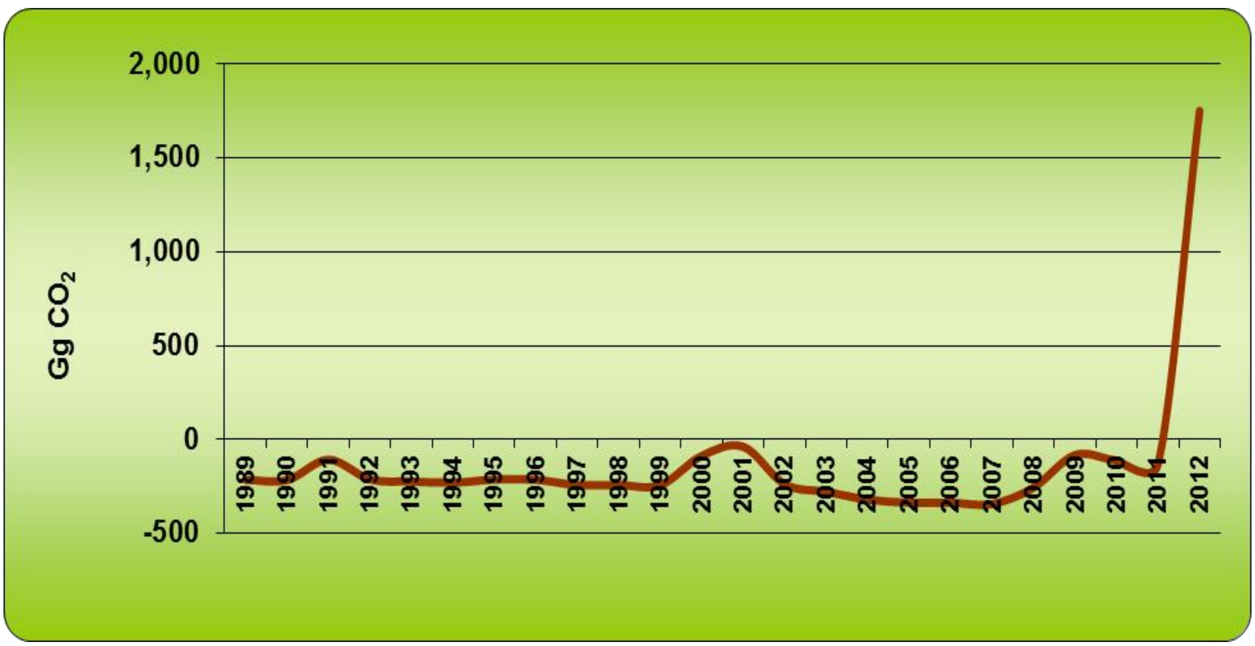
Improvements cover preparation to shift to post-2012 reporting requirements as in Decision 2/CMP7, GL 2006 and EU commitments on Grazingland Management.

7.5 Wetlands (5.D)

7.5.1 Description

Wetlands area is about 3.5% of total land area. Absolute area is about 665 kha, out of which 21% represents lands under conversion to wetlands cumulated during past 20 years. In Romania, peat bogs occupy very small area (as well as peat extraction activities) and do not associate with industrial activities. Also, in the last 20 years the area of drainage or flooding activities were rather small, compared to previous period 1970-1990 (under high intensification of agriculture and hydropower dam constructions), with such areas reported under CL or GL. Emissions related to these sources are discussed under Tables 5(II).

Figure 7.9 Emissions for 5D2 - Land converted to Wetlands (Gg CO_2)



7.5.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The definition of this land category and the types of lands included in here are reported under the section 7.1.1.

7.5.3 Methodological issues

7.5.3.1 Changes of C stock change in living biomass

According to the land use change matrix, there were conversions from, “Grassland" and "Other Lands", on some 155 kha over the 20 years transition period. A small area of conversion from “forest vegetation outside the national forest fund” to wetlands occurred on some 15 kha (over 20 years). This conversion is associated with total emission from C stock in biomass. Same national average values of C stocks in all pools used in the “conversions from Forest Land” are used also here for estimation of related emissions (later described under section “Forest converted to Settlements”).

7.5.3.2 Changes of C stock change in dead organic matter and soils

In case of forest land conversion, the emissions associated with dead organic matter pool are computed by same approach as in 5.E.2 Land converted to Settlements. Soils emissions under various conversions to wetlands are computed based on reference C stocks provided in Table 7.11 (assuming a 20 years transition).

7.5.4 Uncertainties and time-series consistency

An investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project “Assessing the uncertainty of the Romanian Greenhouse Gas Inventory” which resulted in an relative uncertainty of 30%.

7.5.5 Category-specific QA/QC and verification

General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A).

7.5.6 Category-specific recalculations, including changes made in response to the review process

With 2013 submission there were only a few recalculations in the Wetlands category, details can be seen in Chapter 10 - Recalculations and improvements.

7.5.7 Category-specific planned improvements, including those in response to the review process

Improvements cover preparation to shift to post-2012 reporting requirements spelled out in GL 2006 and previsions of Wetland supplement 2013.

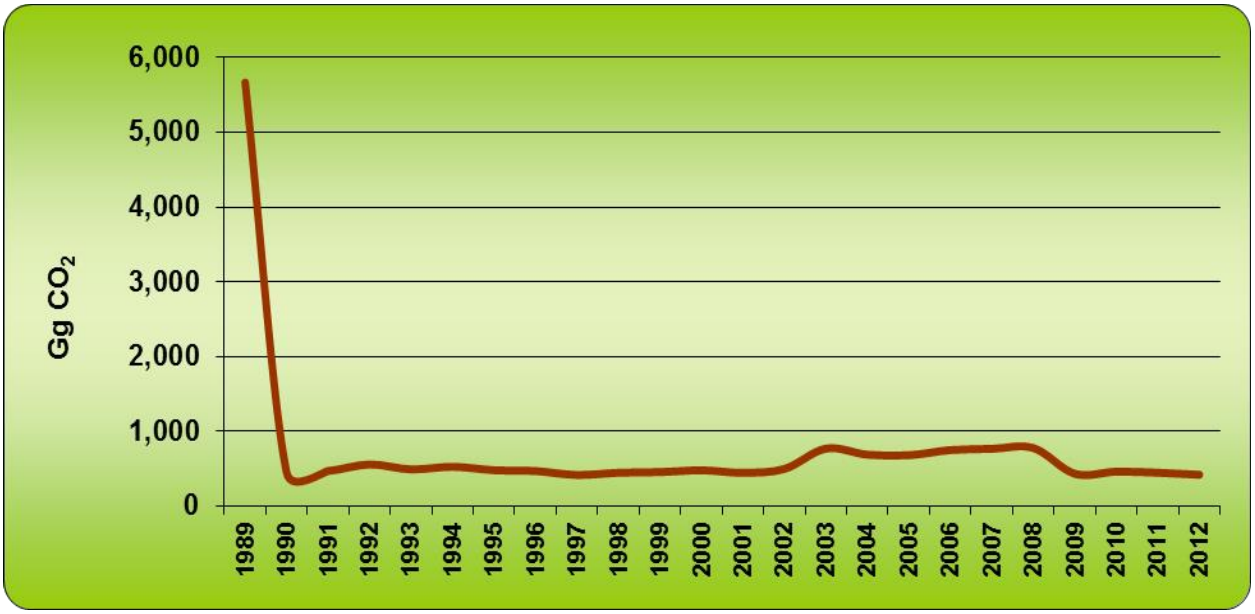
7.6 Settlements (5.E)

7.6.1 Description

Area of settlements is about 5% of the total land area, respectively 1140 kha. 160 kha conversions to "Settlements" during the last 20 years are about 14% of the total area of this category. From 1990 to 2012 there are reported conversions to "Settlements" from almost all land categories. For conversions to settlements, a small contribution occurs in the case of conversions from “Forest Land” (4 kha cumulated over 20 years) and a major one in the case of conversions from “Other land” (some 84 kha under reintroduction of old industrial dumps in the economic cycles).

Land conversion to Settlements is a key category based on trend assessment.

Figure 7.10 Emissions for 5E2 - Land converted to Settlements (Gg CO_2)



7.6.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The definition of this land category and the types of lands included here are reported under the section 7.1.1.

Area of forest leaving national forest fund to settlements is subject to national legislation on licensing land for constructions which generally requires the removal of trees and/or soils upper layers in few months since permit is issued. C stock for all pools is assumed emitted in the year of conversions (licence issuance).

7.6.3 Methodological issues

7.6.3.1 Changes of C stock in living biomass and dead organic matter and in soils

GHG emissions associated with the 5E1 are not estimated in the absence of an appropriate methodology in IPCC GPG LULUCF 2003. In the case of conversions from forest land it was considered that the emissions from biomass and dead organic matter (DW, LT) occur in the year of conversion.

To estimate LB carbon stock change in Forest Land converted to Settlements, we have considered instant oxidation of carbon stock in living biomass and litter & dead wood and 20 years transition for soil pools. Starting with 2009, in the 21st year, the area from 1989 is moved under 5.A.1 – Forest Land remaining Forest Land. Bellow it is an excerpt from the spread sheet. It should be noted the dominance of the very large conversion area in 1989 over entire time series in post-1990.

Table 7.13 Instant oxidation of CSC in LB in Forestland converted to Settlements

Area converted in (kha)	Cumulated area 1990-on (kha)	Comments on area	LB stock assumed as oxidized in that year (MC/ha)	Check of CSC LB input (Gg)	IEF (CSC / cumulated area since 1989)
1989	13.95	Area converted in 1989	-1343.88	-96.34	-96.34
1990	14.28	Sum of areas converted in 1989 and 1990	-31.81	-96.34	-2.23
1991	14.64	.....	-34.58	-96.34	-2.36
1992	14.84	Sum of areas converted in 1989, 1990, 1991 and 1992	-19.48	-96.34	-1.31
1993	15.16	.....	-30.63	-96.34	-2.02
1994	15.58	.....	-40.42	-96.34	-2.59
1995	15.84	.....	-25.16	-96.34	-1.59
1996	16.09	.....	-24.04	-96.34	-1.49

Area converted in (kha)	Cumulated area 1990-on (kha)	Comments on area	LB stock assumed as oxidized in that year (MC/ha)	Check of CSC LB input (Gg)	IEF (CSC / cumulated area since 1989)
1997	16.19	.....	-9.71	-96.34	-0.60
1998	16.33	.....	-13.24	-96.34	-0.81
1999	16.45	.....	-11.53	-96.34	-0.70
2000	16.59	.....	-13.68	-96.34	-0.82
2001	16.66	.....	-6.33	-96.34	-0.38
2002	16.77	.....	-11.10	-96.34	-0.66
2003	16.92	.....	-13.99	-96.34	-0.83
2004	17.19	.....	-25.99	-96.34	-1.51
2005	17.48	.....	-28.61	-96.34	-1.64
2006	17.66	.....	-17.34	-96.34	-0.98
2007	17.83	.....	-16.28	-96.34	-0.91
2008	17.95	Sum of areas converted in 1990, 1991 …. and 2008	-11.66	-96.34	-0.65
2009	4.12	Sum of areas converted in 1990, 1991 …. and 2009 minus the area converted in 1989	-11.27	-96.34	-2.74
2010	3.90	.....	-10.41	-96.34	-2.67
2011	3.59	.....	-4.93	-96.34	-1.37
2012	3.42	.....	-2.85	-96.34	-0.83

C stock change in biomass was estimated based on national average standing stock wood volume per hectare. According to the 1984 Forest Fund Inventory, this value is 218 m^3ha^{-1} (applied for 1990-2007) and 314 m^3ha^{-1} according to latest NFI (applied for 2008-on). Estimation also considered a weighted average of the wood density of 520 kg/m^3, as nationwide value and the default C fraction in dry matter. 1+R, root-to-shoot value was 1.18, also obtained as a weighted average among all species. No BEF was applied as the reported volume refers to aboveground wood standing stock. Consequently, country specific values of the wood standing stock in living biomass resulted of 66.88 $tCha^{-1}$ for 1990-2007 and 96.34 $tCha^{-1}$ for 2008-2012 are used.

Emissions from DOM were also estimated from two different databases: i) lying dead wood C pool from NFI as a national average of 0.75 tC/ha and ii) national average litter pool C stock of 7.42 tC/ha from ICP Forest database (author Surdu A., 2006).

Dead wood density was considered 400kg/m^3. An average standing dead wood stock is also estimated from NFI, but the standing dead wood is not included in this pool because it is assumed as subject to immediate harvesting, and it is already included in the regular harvest statistics, under very intensive forest management in Romania.

For conversions of non-forest lands to settlements, the CO_2 emissions from biomass and dead organic matter were considered negligible, with the exception of conversion from grassland where default value of the C stock in biomass was used (Tier 1), assuming an initial biomass C stock of 1.6 t dm/ha, respectively 0.8t C/ha, according Table 3.4.2 of IPCC GPG (2003), the default value for the warm temperate dry eco-region. Entire amount of C stock in the biomass in grasslands is assumed to be lost in the moment of conversion, so for years when such conversions do not occur NO is reported in the CRF. CO_2 emissions from soils under conversion to settlements were computed based on C stock data in Table 7.11 and it associated with emissions no matter of origin land category.

7.6.4 Uncertainties and time-series consistency

An investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project “Assessing the uncertainty of the Romanian Greenhouse Gas Inventory” which resulted in an relative uncertainty of 30%.

7.6.5 Category-specific QA/QC and verification

General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A).

7.6.6 Category-specific recalculations, including changes made in response to the review process

With 2013 submission there were only a few recalculations in the Settlements category, details can be seen in Chapter 10 - Recalculations and improvements.

7.6.7 Category-specific planned improvements, including those in response to the review process

Improvements under this land category are related to the targets assumed for the other land categories and expected under the same schedule (submission of 2013). Reference C stock in the soils under settlements could be reanalyzed as well as the transition period to this category.

7.7 Other land (5.F)

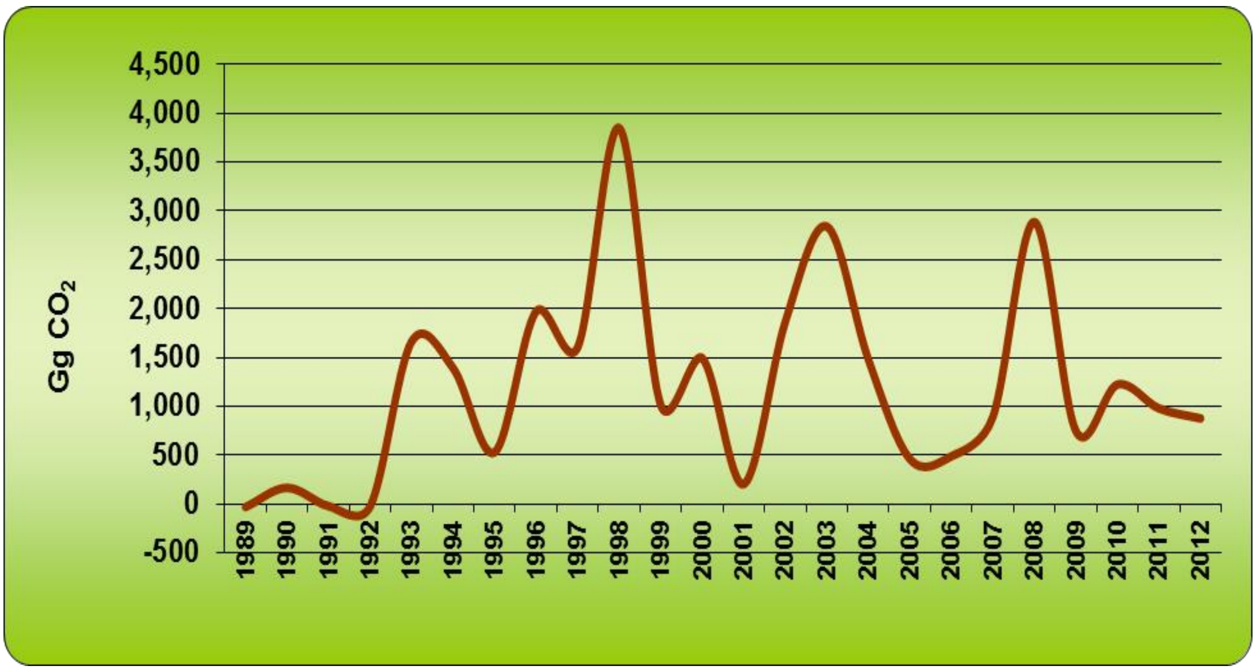
7.7.1 Description

Area occupied by "Other Lands" is about 2% of the total land area, 499 kha respectively. Out of this, 73% are areas under conversion to Other Land. This category was used as a "buffer" in the matrix of land use change (for relocation of areas among categories, so total area of land remaining in the same category and under conversion always equals to the net values reported by the national statistics at the end of each calendar year). It was also assumed that the country area is constant to 23839.1 kha, while sometimes the statistics varied in the narrow range of ±0.01%.
Thus, one of the features is the conversion to "Other Lands" of some 50kha of forest land (for a period of 20 years). This cannot be considered "definitive leave from the forest fund" respectively legal forest “leaving” (associated with "deforestation" under the Kyoto Protocol), as not being resulted from legal proceedings (which are strictly regulated). This is nevertheless

considered as “deforestation” under reduced area of “managed forestland”. Explaining the transition of the area concerned to "Other Lands" is, first, by the continuous erosion of the Danube banks on the Romanian side (the forest fund stretches along the Danube on a length of some 1000 km) and inland rivers, but most of this decrease is likely related to management planning cycle because of changing (improvements) the cartographical base used in the determination of the area of forest parcels in subsequent planning.

Land conversion to Other Land is a key category based on trend assessment.

Figure 7.11 Emissions for 5F2 - Land converted to Other land (Gg CO_2)



7.7.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The definition of this land category and the types of lands included in here are reported under section 7.1.1.

7.7.3 Methodological issues

7.7.3.1 Changes of C stock in living biomass and dead organic matter and in soils

For category 5.F.1 – Other Land remaining Other Land, GPG LULUCF IPCC does not recommend a method for calculating GHG emissions.

There were not calculated emissions from C stock change in biomass in conversions of non-forest lands.

In the case of Forest Land conversion to Other Land (5.F.2.1), CO_2 emissions from living biomass removal were estimated according to the national average standing wood volume per hectare, considering that the emission occurs in the year of conversion. The estimations of LB emissions of Forest Land converted to Other Land follows exactly the same data and estimation procedure as that used in Forest Land converted to Settlements at 7.6.3.1.

C stock changes in DOM pool were also reported as full emission in the event year. The parameters used and computation assumptions are reported in the section covering the category 5.E.2 – Land converted to Settlements.

Soils C stock changes are estimated based on C stock data in Table 7.11 and it is associated with emissions no matter of origin of the land category.

7.7.4 Uncertainties and time series consistency

An investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project "Assessing the uncertainty of the Romanian Greenhouse Gas Inventory" which resulted in a relative uncertainty of 30%.

7.7.5 Category specific QA/Qc and verification

General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A).

7.7.6 Category specific recalculations, including changes made in response to the review process

With 2013 submission there were only a few recalculations in the Other land category, details can be seen in Chapter 10 - Recalculations and improvements.

7.7.7 Category-specific planned improvements, including those in response to the review process

No specific improvements are envisaged.

7.8 GHG emission from sources

7.8.1 Direct N_2O emissions from N fertilization of Forest Land and Other (CRF Table 5(I))

Fertilization of forest land is extremely limited (i.e. rarely occurs in forest nurseries) under very extensive forest management practices in the country. In any case, although it may occasionally occur, the statistics on fertilizer amount applied is not breakdown on land uses. Thus related emissions are assumed as reported under Chapter 4 Agriculture of the national GHG inventory. Thus, these emissions are reported as “IE” in CRF Table 5(I).

7.8.2 Non-CO_2 emissions from drainage of soils and wetlands (CRF Table 5(II))

An area of 95.3 kha is reported as drained organic soils under forestland with CO_2 emissions reported under 5A1/FM and N_2O emissions in Table 5(II). Since 1989 there is not reported any activity of drainage of forest lands in Romania. Peatland area and related activities are insignificant. Floodings are also considered negligible.

7.8.3 N_2O emissions from disturbance associated with land-use conversion to cropland (CRF Table 5(III))

Land use change from forestland to cropland is not legally allowed, and does not occur in Romania.

Nevertheless, there are such conversions from grassland and wetlands, which summed some 94kha since 1989.

To this adds the drainage of non-forestlands, a total of some 215 kha in 1990 with some 65 % of total area as drainage of organic soils. In 2012 there are no new drained areas, but only areas under 20 years transition period (since drainage occurred).

Drainage leads to soil perturbation which associates with N_2O emissions by humus decomposition. According the land use matrix, from total cumulated area under conversion to arable land, in 2012, 53% were conversions from grasslands, 38 % from wetlands and 10 % from other land (they are all reported under 5.B.2 Land converted to Cropland). N_2O emissions are estimated assuming 20 years transition period.

N_2O emissions from areas GL, WL under conversions to CL was recalculated for the entire time series, because of an error (which drove IEF to be continually growing). Amount of soil C mineralized (kgC/yr) was 850KgC/ha/yr. IPCC default values were used: C/N ratio (~15) and emission factor for N (~0.0125 kg N_2O-N/kg N). Thus IEF is constant around 0.01 kg N_2O-N/ha.

There are no conversions on organic soils, and if there is any it is reported as IE in drained cropland. Also, conversions from WL to CL are assumed to only occur on mineral soils (as being lands under temporary floodings and classified as wetlands but not associated with mineral soils).

7.8.4 CO_2 emissions from agricultural lime application (CRF Table 5(IV))

Lime application occurs on small areas according data of Ministry of Agriculture and Rural Development and Ministry of Environmental and Climate Change.

An average amount of 88 000 Mg/yr was applied during the 1989-2012 time series on Grassland remaining Grassland. The CO_2 was calculated using the default EF of 12% for Limestone ($CaCO_3$) and 12,2% for Dolomite ($CaMg(CO_3)_2$).

In 2012, 81 3014 Mg of limestone were reported which resulted in 357.73 Gg of CO_2, with an additional 272 Mg of dolomite which resulted in 0.12 Gg of CO_2.

7.8.5 Biomass Burning (CRF Table 5(V))

Controlled biomass burning is not allowed in Romania, while the wildfire frequency is very limited. Nevertheless, occasionally it is practiced unlawfully on arable or grass lands (on which data is not yet available for reporting in the national GHG inventory).

For forestland, the area annually affected by wildfires is reported in sectoral forest statistics. Characteristically, the forest fires consist in ground floor dead mass burning (litter and lying dead wood), and in extremely few cases of the stand crown fires (in average 2 % of annually affected area).

As far as the wood is not qualitatively affected, it is harvested and reported in the annual wood harvest statistics (while the land remains forest land).

From all these reasons, CO_2, N_2O and CH_4 are all reported in CRF Table 5(V). Annually affected area on land categories is reported by the General Inspectorate of Emergency Situations.

In 2014 submission, separate estimates for forest remaining forests (5.A.1 – Forest Land remaining Forest Land) and lands under conversion to forests (5.A.2 – Land converted to Forest Land) are estimated. Although there are no reported fires on such lands, a conservative approach was taken by calculating GHG emissions assuming that officially reported wildfire burnt area is shared between AR areas and FM areas, in a ratio equal to AR share in total FM area. AR share is 4,2% from total wildfire area, while avoiding double accounting of area between FM and AR.

For 5.A.2 and AR estimation assumes that both DOM and standing living biomass pool are entirely burned. DOM estimate is 0.75 tC/ha and living biomass is 12.96 tC/ha at 10 years old plantations as resulted from a running JI afforestation project. This resulted in an increase of non-CO_2 emissions by some +4% in Table 5(V) and (KP-II)5, because of larger C stock in DOM+LB in AR than in DOM in FM (since only litter fires was previously assumed).

Table 7.14 Forest fires area

Year	Total affected area (ha)
1989	93
1990	444
1991	277
1992	729
1993	518
1994	312
1995	208
1996	227
1997	68
1998	137
1999	379
2000	3607
2001	1020
2002	3590
2003	762
2004	124
2005	212
2006	946
2007	2925
2008	844
2009	974
2010	206
2011	3057
2012	6624
Average area	1178

GHG emissions from forest fires are computed based on Eq. 3.2.19 of the IPCC GPG 2003.

Equation 7.8 GHG emissions from forest fires

$$L_{forest\ fires} = S_{forest\ fires}\ x\ M_f$$

where:

- $L_{forest\ fires}$ = total amount of C annually emitted (tC yr^{-1});
- $\boldsymbol{S}_{forest\ fires}$ = annually affected area (ha yr^{-1});
- $\mathbf{M}_f$ = amount of C in „dead wood lying on the soil surface” [MgC ha^{-1}].

For 5.A.1 and FM it is assumed that entire litter and dead wood is burning (both lying and standing dead wood). Emissions is computed from the nationally average C stock in litter (=7.42tC/ha) and dead wood volume preliminarily available from the NFI (0.74 tC/ha computed from 3.13 mc/ha of standing dead wood and 0.62 mc/ha lying dead wood). Conversion from dead wood volume to dead mass was done assuming 400 kg/m^3 (same input data as for the estimation of DOM related emissions in land converted to settlements 5E2). Carbon content was 0.5 according to the GPG LULUCF 2003. Finally, C stock in dead organic matter used was 8.18 tC/ha.

It was also assumed that there are no understory emissions.

For the calculation of absolute CO_2 and non-CO_2 emissions from forest fires, IPCC default factors are used in the formulas 3.2.19 of IPCC GPG 2003.

Equation 7.9 Calculation of absolute CO_2 and non-CO_2 emissions from forest fires

$$\textit{Emission of } CO_2\ [Gg\ yr^{-1}] = (C\ emitted)\ [tC\ yr^{-1}]\ x\ (44/12)/1000,$$
$$\textit{Emission of } CH_4\ [Gg\ yr^{-1}] = (C\ emitted)\ [tC\ yr^{-1}]\ x\ (emission\ ratio)\ x\ (16/12)/1000,$$
$$\textit{Emission of } CO\ [Gg\ yr^{-1}] = (C\ emitted)\ [tC\ yr^{-1}]\ x\ (emission\ ratio)\ x\ (28/12)/1000,$$
$$\textit{Emission of } N_2O\ [Gg\ yr^{-1}] = (C\ emitted)\ [tC\ yr^{-1}]\ x\ (N/C\ ratio)\ x\ (emission\ ratio)\ x\ (44/28)/1000,$$
$$\textit{Emission of } NOx\ [Gg\ yr^{-1}] = (C\ emitted)\ x\ [N/C\ ratio]\ x\ (emission\ ratio)\ x\ (46/14)/1000,$$

where:

- *(C emitted)* = $L_{forest\ fires}$, respectively total amount of C annual emitted (tC/year),

- *N/C ratio* = ratio of nitrogen/carbon in the burnt dead mass,
- *(emission ratio)* = default values of direct and indirect GHG emission factors from forest fires. According Table 3A.1.15 of IPCC GPG 2003 these values are: CH_4 – 0.012; CO – 0.06; N_2O – 0.007 and NOx – 0.121.

Emissions for Biomass Burning in the Cropland category are included under Agriculture Sector - 4.F Field Burning of Agricultural Residues. No activity data on woody perennial burning has been reported.

7.8.6 Category-specific planned improvements, including those in response to the review process

Despite small importance in the national GHG inventory accurate estimates are provided in 2012 submission following data provided by the Ministry of Agriculture, also because highlighted by the ERT's reports.

7.8.7 Recalculations of non CO_2 emissions from sources

For 5(IV) CO_2 emissions from agriculture lime application, new data reported by the Ministry of Agriculture shows that the soil amendments were applied on pastures and hayfields. This resulted in moving the amounts of lime from Cropland remaining Cropland to Grassland remaining Grassland. Additionally, in 2008 and 2012, some amount of lime was disaggregated to dolomite because of improved data.

Both for AR and FM activities, an error in calculation formula for CH_4 and N_2O was corrected in 2014 submission. Error consisted in wrong entering of CO_2 amount instead of C amount in equation; corrected estimates are 3.666 less now.

Split of forest fires emissions between 5.A.1 and 5.A.2 resulted in slight change in emissions of about 4% for the respective year for all the greenhouse gases.

8 WASTE (CRF Sector 6)

8.1 Overview of the sector

This chapter provides information on the estimation of the greenhouse gas emissions from the Waste Sector.

The following direct GHG emissions and source categories are quantified and reported:

- CH_4 and CO_2 emissions from Solid Waste Disposal on Land;
- CH_4 and N_2O emissions from Wastewater Handling;
- CO_2 and N_2O emissions from Waste Incineration.

Starting with 2012 submission NMVOC emissions from Solid Waste Disposal on Land ware estimated.

Table 8.1 Status of the direct GHG emissions estimation in the Waste Sector

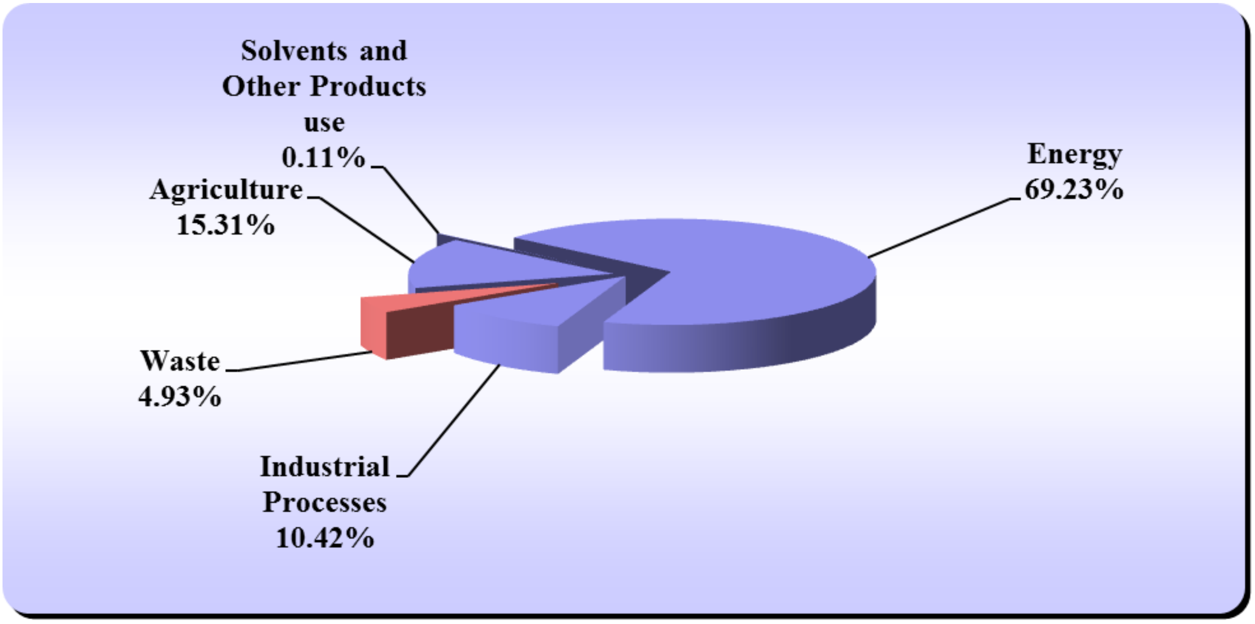
IPCC category	Emissions estimation status		
	CO_2	CH_4	N_2O
6.A Solid Waste Disposal on Land			
6.A.1 Managed Waste Disposal on Land	✓	✓	NA
6.A.2 Unmanaged Waste Disposal on Land	✓	✓	NA
6.A.2.1 deep (>5m)	✓	✓	NA
6.A.2.2 shallow (<5 m)	✓	✓	NA
6.A.3 Other	NA	NA	NA
6.B Wastewater Handling			
6.B.1 Industrial Wastewater	NA	✓	NE
6.B.1.a. wastewater	NA	✓	NE
6.B.1.b. sludge	NA	IE*	NE

IPCC category	Emissions estimation status		
	CO_2	CH_4	N_2O
B.2 Domestic and Commercial Wastewater			
6.B.2.1 Domestic and Commercial Wastewater (w/o human sewage)	NA	✓	NE
6.B.2.1.a wastewater	NA	✓	NE
6.B.2.1.b sludge	NA	✓	NE
6.B.2.2 Human sewage	NA	NA	✓
6.B.3 Other	NA	NA	NA
6.C Waste Incineration			
6.C.1 Biogenic	NE	NE	✓
6.C.2 Non-biogenic	✓	NE	✓
6.C.2.a. Hazardous waste	✓	NE	✓
6.C.2.b. Clinical waste	✓	NE	✓
6.D Other	NA	NA	NA

* CH_4 emissions from industrial sludge are reported under 6.B.1.a – Industrial wastewater.

In 2012 GHG emissions from the Waste Sector accounted for 5,849.583 Gg CO_2 equivalent, which represent 4.93 % of the total national GHG emissions in this year (Figure 8.1).

Figure 8.1 The contribution of Waste Sector to the total GHG emissions in Romania, 2012



In the base year (1989), the total GHG emissions from the waste sector amounted to 4,656.565 Gg CO_2 equivalent, which accounted for 1.63% of the total national GHG emissions in this year. Compared with the other sectors, emissions from the waste sector showed a significant increase from the base year, with 25.62%, due to increasing of incineration activities and waste generation rate in parallel with increasing of living standards (Table 8.2, Figure 8.2).

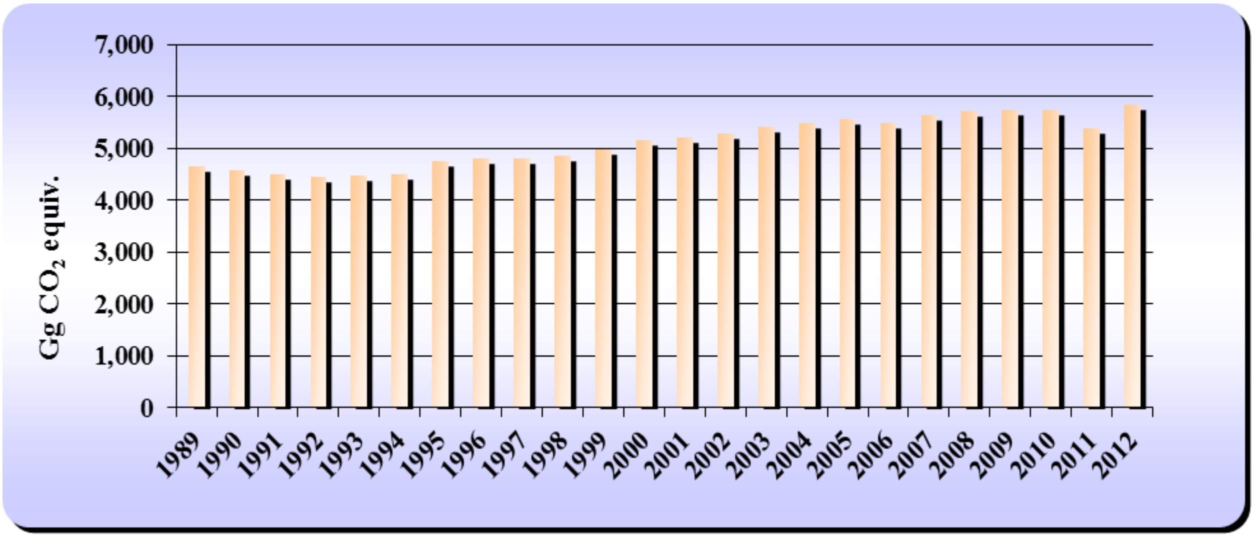
Table 8.2 The contribution of Waste Sector to the total GHG emissions in Romania, for 1989–2012 period

Year	Total GHG emissions (excl. LULUCF) [Gg CO_2 equiv.]	GHG emissions from Waste [Gg CO_2 equiv.]	Contribution of Waste in total GHG emissions [%]
1989	285,047.74	4,656.56	1.63
1990	247,663.52	4,566.84	1.84
1991	202,016.80	4,497.98	2.23

Year	Total GHG emissions (excl. LULUCF) [Gg CO_2 equiv.]	GHG emissions from Waste [Gg CO_2 equiv.]	Contribution of Waste in total GHG emissions [%]
1992	182,424.15	4,445.56	2.44
1993	172,305.77	4,465.79	2.59
1994	169,049.82	4,497.68	2.66
1995	175,264.58	4,756.21	2.71
1996	177,828.37	4,803.40	2.70
1997	164,437.44	4,813.23	2.93
1998	146,772.78	4,855.22	3.31
1999	129,707.90	4,972.36	3.83
2000	134,073.69	5,150.32	3.84
2001	139,021.95	5,221.68	3.76
2002	139,697.63	5,283.97	3.78
2003	144,219.31	5,418.77	3.76
2004	141,220.66	5,480.26	3.88
2005	141,313.82	5,571.57	3.94
2006	144,776.56	5,478.98	3.78
2007	142,803.52	5,627.79	3.94
2008	139,811.77	5,708.41	4.08
2009	119,917.10	5,730.27	4.78
2010	115,798.97	5,737.55	4.95
2011	121,513.51	5,376.19	4.42
2012*	118,764.15	5,849.58	4.93

* Preliminary data

Figure 8.2 Total GHG emissions trend from Waste Sector for 1989–2012 period



The most important contribution to GHG emissions from Waste Sector, in 2012 year, has Solid Waste Disposal on Land Subsector, contributing with 50.70 % in the total (Figure 8.3); Wastewater Handling Subsector contribute with 49.14 % and Waste Incineration Subsector accounts for only 0.16 %.

Wastewater Handling and Solid Waste Disposal on Land Subsectors are key category sources both by level and trend (Table 8.3 and Figure 8.4).

Figure 8.3 Contribution of the sub-sectors in the total GHG emissions from Waste Sector in 2012

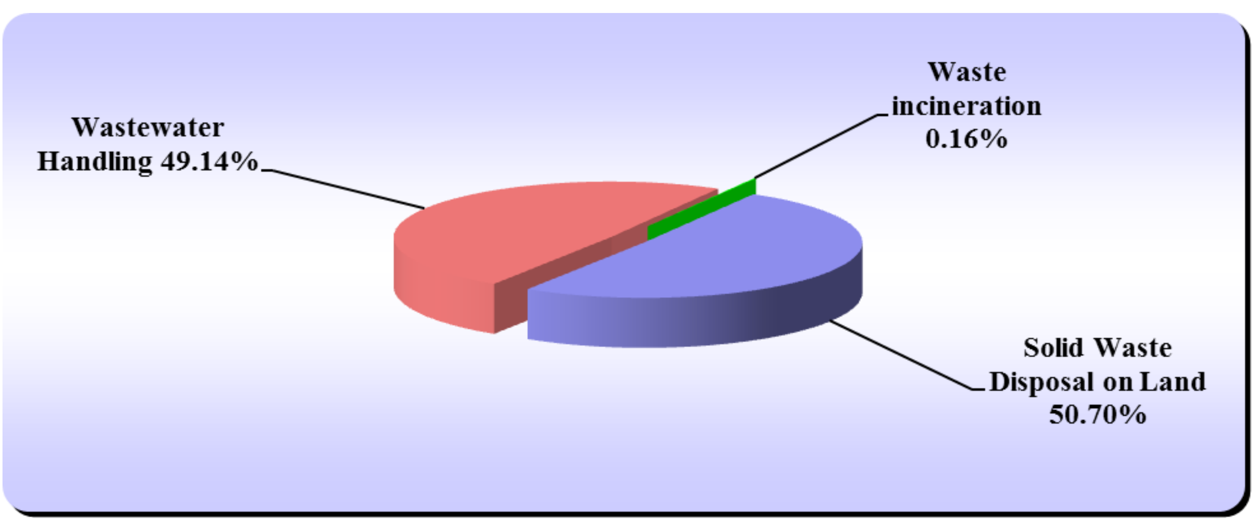
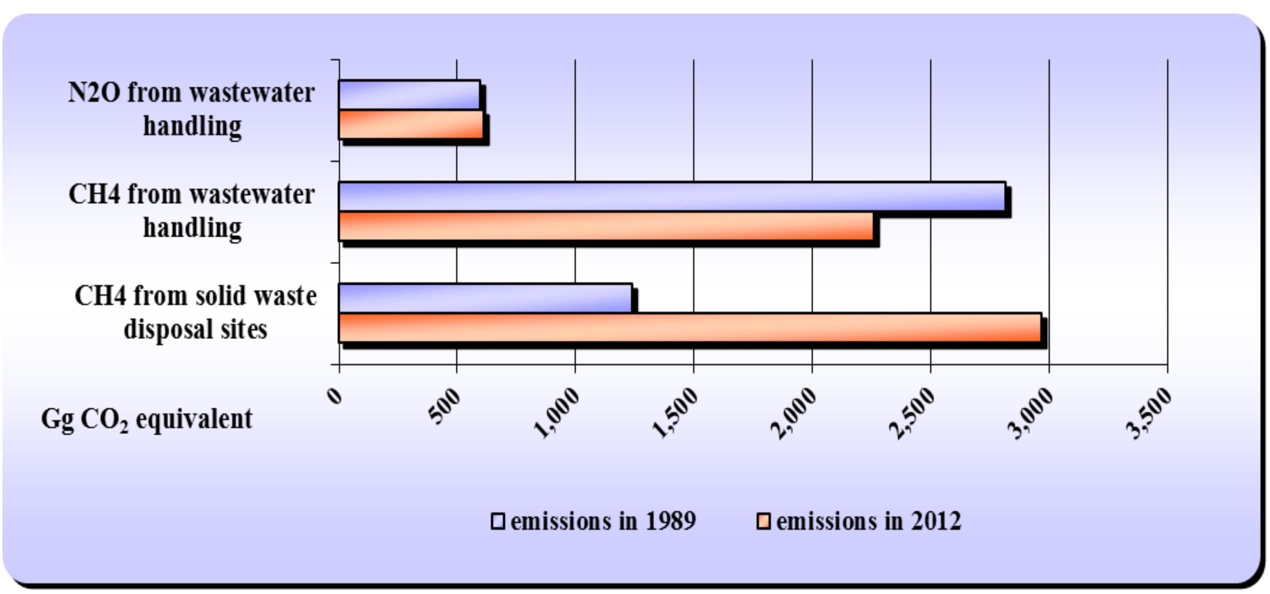


Table 8.3 Key categories in Waste Sector based on the level and trend assessment in 2012

Key category	Direct GHG	Criteria for identification	Contribution of key category in total GHG emissions [%] - (excluding LULUCF)
6.A Solid waste disposal sites	CH_4	L,T (Tier 1, excluding and including LULUCF, Tier 2, excluding and including LULUCF)	2.50
6.B Wastewater handling	CH_4	L,T (Tier 1, excluding and including LULUCF, Tier 2, excluding and including LULUCF)	1.90
	N_2O	L,T (Tier 1, excluding and including LULUCF, Tier 2, excluding and including LULUCF)	0.52

Figure 8.4 Key categories in Waste Sector both by level and trend criteria, in 2012



Methane represents the major greenhouse gas from Waste sector with a contribution of 23.50 % to the total methane emissions in Romania, in 2012. In the same year, nitrous protoxide has a contribution of 5.31 % to the total N_2O emissions in our country.

According to Revised 1996 IPCC Guidelines, CO_2 emissions from Solid Waste Disposal on Land category mainly derive from biomass sources and are not treated as net emissions. Only CO_2 emissions from Waste Incineration category are reported, these representing 0.01 % of total net CO_2 emissions in Romania.

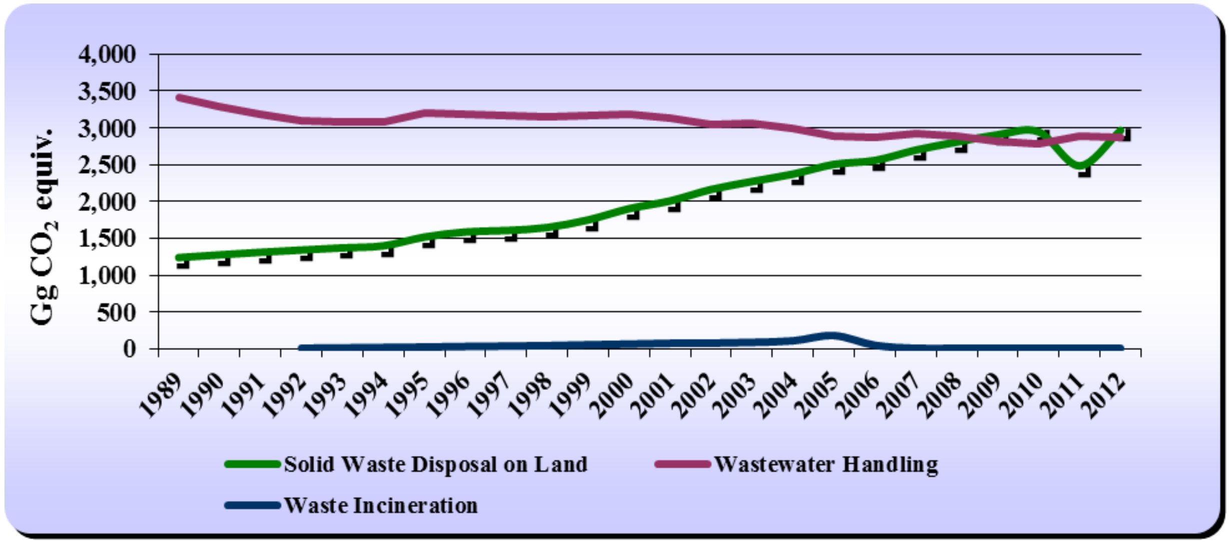
After 2000, Romania began to comply with EU standards, implementing European legislation both in waste and wastewater treatment management. However, the GHG emissions trend is different for the three subsectors of Waste Sector due to improvement of living standards which is reflected differently in the evolution of these subsectors.

GHG emissions trend from Solid Waste Disposal on Land category (SWDL) increased significantly in 2012 year comparing with the level in the base year, with a percentage of 138.99 % (Figure 8.5). This increase is due to the increasing trend of waste generation rate following the relatively increased trend of population consumption. Emissions from wastewater handling decreased with 15.84 % in 2012 compared to 1989. This decrease is due on the one hand to the decreasing number of population and the increase number of inhabitants connected to sewerage, and on the other hand to the decreasing level of industrial production.

Starting with the current submission, based on the study "Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N_2O emissions resulting from waste incineration", finished in 2013, in Waste Incineration category were described also the N_2O emissions, the various type of incinerated waste and in this context the GHG emissions trend decrease in 2012 year comparing with the level in 1992 year, with a percentage of 16.97 % (Figure 8.5).

In Waste Incineration Subsector the emissions trend has remained almost constant in 2012 year because the amount of waste destined for incineration was constantly, except for the period 2004-2006 when there was intensified burning of industrial hazardous waste due to compliance with Directive 2000/76/CE.

Figure 8.5 GHG emissions trend from Waste Sector, by sub-sectors for 1989–2012 period



8.2 Source category Solid Waste Disposal on Land (CRF Sector 6.A)

8.2.1 Source category description

Waste generation rate follows the consumption and production tendency. With increasing of living standards also the amount of generated waste increased. Over time the amounts of waste generated do not have a linear evolution due to variability of production.

Solid Waste Disposal on Land is responsible for CH_4 and CO_2 generation. To estimate CH_4 emissions from Solid Waste Disposal on Land category, were used the amounts of Municipal Solid Waste (MSW) deposited in Solid Waste Disposal Sites (SWDS) and also the amounts of sewage sludge deposited to SWDS. The amounts of sewage sludge deposited to managed and unmanaged SWDS were reconsidered by type of sludge, based on the study mentioned above, study finished in 2013.

According to the National Waste Management Plan, municipal solid waste includes household and similar waste (from population, economic and commercial units, offices, and institutions), waste from municipal services (waste from street cleaning, markets, gardens, parks and green spaces) and waste from construction and demolition activities. The quantities of municipal waste generated in Romania in 2011 followed the evolution of declining consumption due to economic crisis. Also, in this year the quantities of waste deposited, following the implementation of European legislation in this area, have decreased, and according to national legislation requirements, the amounts of waste recovered have increased.

In 2006-2011 period, the percentage of MSW collected from total MSW generated ranged between 77% and 86%. From the total amount of MSW collected in 2011, 88.48% was deposited and the rest was recovered. For 2012, the data regarding recovered/deposited MSW categories will finalized later this year after statistical survey. Concerning the ammounts of industrial waste with biodegradable content, in accordance with the study finished in 2013, the result of analyzing the collected data, followed by further discussion with the operators from different industrial activities, reveals that the quantities of biodegradable industry waste reported in questionnaires are temporally deposit on the site. These quantities are reused or deposited on municipal landfills. Therefore, in order to avoid double counting, the reported and estimated quantities of the biodegradable industry waste will not be taken into consideration for estimation of the greenhouse gases emissions.

During 2011 year, the quantity of waste generate by extractive industry, power and manufacturing was around 213 million tone, most of them (over 90%) are waste resulted from extractive activities (mining) and don’t content a biodegradable component. Rest of 21.3 million tone is managed in different ways (reusing, elimination trough incineration), the part there is deposit is treated to reduce the biodegradable organic C.

In Table 8.4 are presented the percentages of municipal solid waste categories which have been recovered and stored in 2011.

Table 8.4 Percentages of recovered and deposited MSW from the total amount of collected MSW, in 2009 (Source www.anpm.ro)

Municipal Solid Waste categories	Recovered from total collected MSW (%)	Deposited from total collected MSW (%)
Household and similar waste	6.84	92.96
Waste from municipal services	9.89	90.11
Waste from construction and demolition activities	47.68	53.67

After the implementation of European legislation, the percentage of population served by sanitation services increased to 90.45% in urban areas and 59.17% in rural areas for 2011 year.
Waste collection system, complies with European standards and the method is the most common, accounting for a share of about 75.69%. Newer methods of waste management such as selective collection and separate collection of bulky waste were implemented in very small shares, according to available data.
In Romania municipal solid waste are deposited both in managed and unmanaged SWDS. In the last years, in accordance with European regulations, the number of unmanaged SWDS decreased reaching a number of 70 sites in 2011 year (Table 8.5). In accordance with European regulations, the unmanaged SWDS are subject to a transition period, storage activity being stopped gradually until 2017.

Table 8.5 Number of Solid waste Disposal Sites (Source Waste Directorate of NEPA)

<table>
<tr><th>Type of SWDS/Year</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th><th>2012</th></tr>
<tr><td>Managed</td><td>20</td><td>20</td><td>20</td><td>26</td><td>27</td><td>31</td><td>33</td></tr>
<tr><td>Unmanaged deep</td><td>90</td><td>92</td><td>87</td><td>87</td><td>40</td><td rowspan="2">70</td><td rowspan="2">49</td></tr>
<tr><td>Unmanaged shallow</td><td>130</td><td>109</td><td>96</td><td>14</td><td>35</td></tr>
</table>

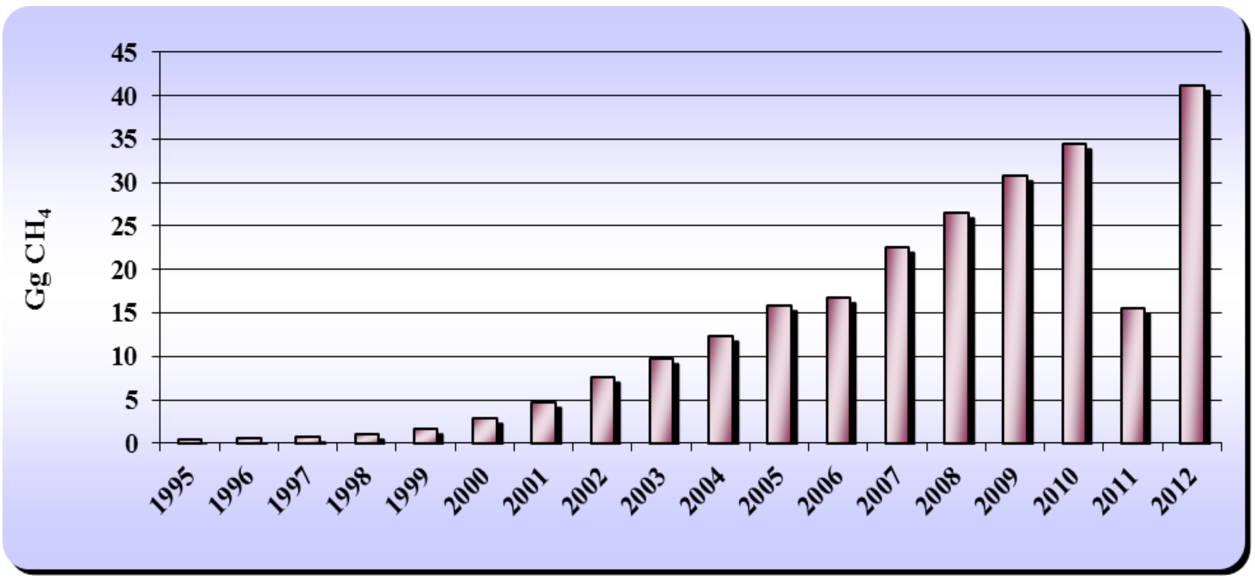
A large amount of recyclable materials (paper, cardboard, glass, plastics, metals) are not recovered but are finally stored together with other municipal wastes. The percentage of biodegradable waste in deposited waste is 63 % for 2011 year.

CH_4 emissions from SWDS

The methane emissions from Solid Waste Disposal to managed landfills were estimated for the period 1995-2012, because in 1995 year was opened the first managed SWDS.
The methane emissions from managed SWDS have an increasing trend between 1995 – 2010 period. The significant difference between the level in 2010 and 2011 years is associated to the amount of CH_4 recovered in 2011 which register a value of 42.59 Gg and determine in 2011 a lower level of CH_4 emissions from managed solid waste disposal sites of about 15.47 Gg. In

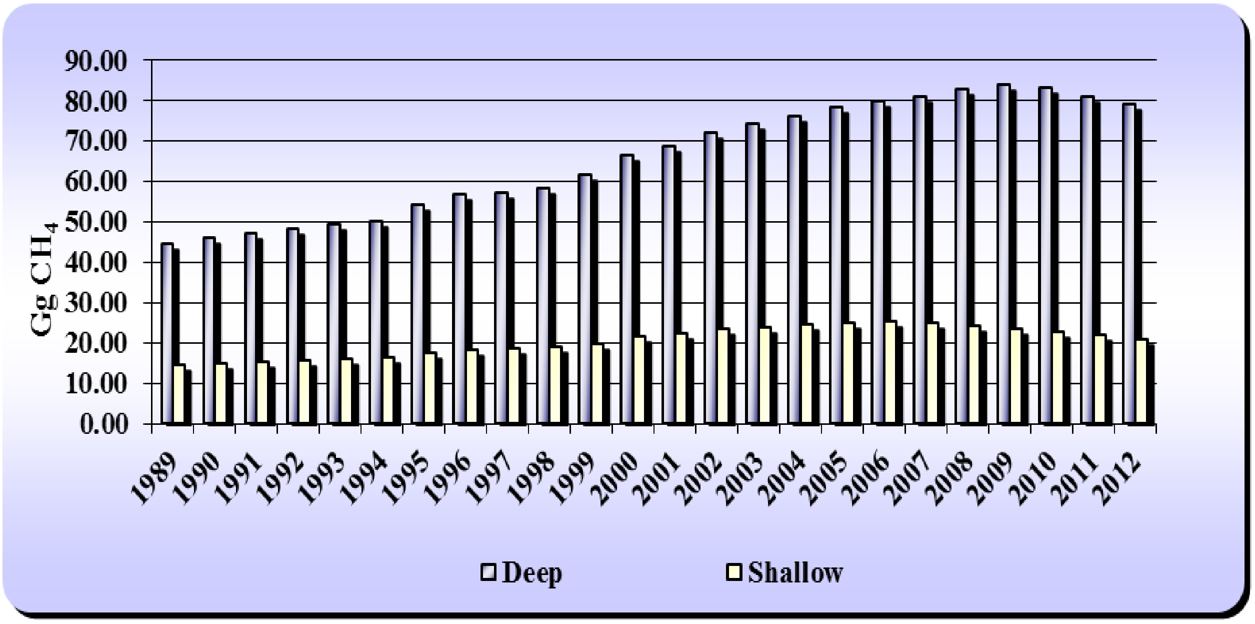
2012 year, the amount of CH_4 recovery register a sharp decrease coparing with 2011 year (from 42.59 Gg in 2011 to 16.91 Gg in 2012 year), determining a higher level of CH_4 emissions from managed solid waste disposal sites of about 41.19 Gg. The decrease associated to the amount of CH_4 recovery is due to the rearrangement of certain waste disposal sites that have stopped the recovery of methane created during the development works (Figure 8.6).

Figure 8.6 CH_4 emissions trend from waste disposed to managed sites for 1995–2012 period



During 1950-2009, CH_4 emissions from unmanaged deep SWDS had an increasing trend similar to the trend associated with the emissions from unmanaged shallow SWDS (Figure 8.7), following the increasing of the amounts of waste generated and storage in unmanaged landfills. After 2009 the CH_4 emissions had a decreasing trend due to the decrease of the amounts of waste stored in unmanaged landfills.

Figure 8.7 CH_4 emissions trend from waste disposed to unmanaged sites for 1989–2012 period



8.2.2 Methodological issues

Methodology

Given the key category status both by level and trend, CH_4 emissions from managed and unmanaged SWDS were calculated using First Order Decay method, in accordance with IPCC GPG 2000. To estimate methane emissions from managed landfills historical data prior to those associated with the 1995 year were not necessary, because the first managed landfill was opened in 1995 year.

For unmanaged SWDS methane emissions were estimated based on data associated with the 1950-2012 period, according to the IPCC GPG 2000 provisions, to achieve an acceptably accurate result.

In order to estimate CH_4 emissions from managed and unmanaged sites, were taken into account also the amount of sewage sludge deposited to SWDS.

The following equations were used in CH_4 emissions estimates:

Equation 8.1 CH_4 generated from managed and unmanaged SWDS

$$CH_4 \text{ generated in year } t \text{ (Gg/yr)} = \Sigma_x [(A \bullet k \bullet MSW_D(x) \bullet L_0(x)) \bullet e^{-k(t-x)}]$$

$$\text{for } x = \text{initial year to } t$$

where:

- $MSW_D(x)$ is representing the quantity of solid waste disposed in managed/ unmanaged (deep, shallow) landfills. In accordance with experts on waste management, $MSW_D(x)$ replace the product between $MSW_T(x)$ and $MSW_F(x)$.

Firstly, *CH_4 generated in year t* was calculated separately for sewage sludge and municipal waste, then the two values of CH_4 generated in year t were summed and applied in the following formula:

Equation 8.2 CH_4 emissions from managed and unmanaged SWDS

$$CH_4 \text{ emitted in year } t \text{ (Gg/yr)} = [(CH_4 \text{ generated from SWDL in year } t + CH_4 \text{ generated from sludge in year } t) - R(t)] \bullet (1\text{-}OX)$$

Emission factors

Municipal solid waste

Except Degradable Organic Carbon (DOC), country specific emissions factors and parameters were not available to estimate CH_4 emissions. DOC was calculated based on municipal waste composition, using estimated data associated with 1950-2002 period and data provided by NEPA Waste Directorate for period 2003-2012 (see the Table 8.6).

Given the statistical survey on waste for 2012 has not yet finalised, for this year it was considered the same value as in 2011.

Table 8.6 The percentage composition of municipal solid waste

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescible [%]	Food waste [%]	Wood/straw [%]	DOC	Source
1950	4.82	5.77	14.79	0.37	0.05	Study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"*
1951	4.88	5.83	14.95	0.37	0.05	
1952	5.00	5.97	15.33	0.38	0.05	
1953	5.12	6.11	15.69	0.39	0.06	
1954	5.22	6.24	16.02	0.40	0.06	
1955	5.33	6.37	16.34	0.41	0.06	
1956	5.30	6.34	16.27	0.40	0.06	
1957	5.53	6.61	16.96	0.42	0.06	
1958	5.61	6.70	17.20	0.43	0.06	
1959	5.67	6.78	17.40	0.43	0.06	
1960	5.79	6.92	17.74	0.44	0.06	
1961	5.86	7.00	17.95	0.45	0.06	
1962	5.90	7.06	18.10	0.45	0.06	
1963	5.97	7.13	18.30	0.46	0.06	
1964	6.02	7.19	18.45	0.46	0.07	
1965	6.07	7.25	18.60	0.46	0.07	

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescible [%]	Food waste [%]	Wood/straw [%]	DOC	Source
1966	6.35	7.59	19.48	0.48	0.07	Study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation" calculation methods implementation"*
1967	6.42	7.67	19.68	0.49	0.07	
1968	6.43	7.68	19.71	0.49	0.07	
1969	6.54	7.82	20.05	0.50	0.07	
1970	6.64	7.93	20.35	0.51	0.07	
1971	6.73	8.04	20.63	0.51	0.07	
1972	6.82	8.15	20.90	0.52	0.07	
1973	6.90	8.24	21.15	0.53	0.07	
1974	7.00	8.37	21.46	0.53	0.08	
1975	7.10	8.49	21.78	0.54	0.08	
1976	7.21	8.62	22.11	0.55	0.08	
1974	7.00	8.37	21.46	0.53	0.08	
1977	7.53	9.00	23.08	0.57	0.08	
1978	7.64	9.14	23.44	0.58	0.08	
1979	7.72	9.22	23.66	0.59	0.08	
1980	7.83	9.36	24.01	0.60	0.09	
1981	7.95	9.51	24.39	0.61	0.09	
1982	8.09	9.67	24.81	0.62	0.09	

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescible [%]	Food waste [%]	Wood/straw [%]	DOC	Source
1983	8.16	9.75	25.02	0.62	0.09	Study *“Elaboration/documentation of national emission factors/other parameters relevant to N GHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”*
1984	8.20	9.80	25.14	0.63	0.09	
1985	8.29	9.90	25.41	0.63	0.09	
1986	8.35	9.99	25.62	0.64	0.09	
1987	8.45	10.10	25.90	0.64	0.09	
1988	8.52	10.19	26.14	0.65	0.09	
1989	8.64	10.33	26.51	0.66	0.09	
1990	8.74	10.45	26.80	0.67	0.09	
1991	8.72	10.42	26.74	0.67	0.09	
1992	8.58	10.25	26.31	0.65	0.09	
1993	8.58	10.26	26.32	0.65	0.09	
1994	8.58	10.26	26.32	0.65	0.09	
1995	11.92	14.25	36.55	0.91	0.13	
1996	10.77	12.87	33.02	0.82	0.12	
1997	11.22	13.41	34.41	0.86	0.12	
1998	10.45	12.49	32.05	0.80	0.11	
1999	11.85	14.17	36.35	0.90	0.13	
2000	13.68	16.36	41.96	1.04	0.15	

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescible [%]	Food waste [%]	Wood/straw [%]	DOC	Source
2001	12.33	14.74	37.80	0.94	0.13	NEPA
2002	13.86	16.56	42.49	1.06	0.15	
2003	13.11	15.67	40.20	1.00	0.14	NEPA
2004	11.67	12.53	38.12	1.00	0.13	
2005	12.76	14.50	38.60	1.00	0.14	
2006	12.68	14.36	36.45	1.00	0.13	
2007	11.48	13.77	34.45	1.00	0.12	
2008	8.32	6.03	45.29	1.58	0.12	
2009	10.18	5.54	44.40	1.97	0.12	
2010	8.85	6.29	45.55	1.89	0.12	
2011	7.96	6.15	47.67	1.46	0.12	
2012*	7.96	6.15	47.67	1.46	0.12	

* Preliminary data

In order to calculate the CH_4 emissions from municipal solid waste, default values associated with the other parameters, provided through IPCC GPG 2000, taking into account the national circumstances, were used (Table 8.7).

Table 8.7 Other parameters used to calculate the emission factors (SWDS) for municipal solid waste disposed to SWDS

Type of site	**MCF**	**DOC_F**	**F**	**k**	**$A=(1-e^{-k})/k$**	**OX**
MSW disposed to managed SWDS	1.00	0.55	0.50	0.05	0.975	0.1
MSW disposed to unmanaged-deep	0.80	0.55	0.50	0.05	0.975	0.00
MSW disposed to unmanaged-shallow	0.40	0.55	0.50	0.05	0.975	0.00
Source	IPCC GPG 2000					

Sewage sludge disposed to SWDS

In order to estimate the CH_4 emissions from sewage sludge disposed to SWDS it has been used the default parameters from IPCC GPG 2000 and IPCC 2006, as presented in the Table 8.8.

Table 8.8 Parameters used to calculate the emission factors (SWDS) for sewage sludge disposed to SWDS

Type of site	**MCF**	**DOC**	**DOC_F**	**F**	**k**	**$A=(1-e^{-k})/k$**	**OX**
Sewage sludge disposed to managed SWDS	1.00	0.05	0.50	0.50	0.185	0.919	0.1

Type of site	MCF	DOC	DOC_F	F	k	$A=(1-e^{-k})/k$	OX
Sewage sludge disposed to unmanaged SWDS - deep	0.80	0.05	0.50	0.50	0.185	0.919	0.00
Sewage sludge disposed to unmanaged SWDS - shallow	0.40	0.05	0.50	0.50	0.185	0.919	0.00
Source	IPCC GPG 2000	IPCC 2006	IPCC 2006	IPCC GPG 2000	IPCC 2006	IPCC 2006	IPCC GPG 2000

Activity data

Municipal solid waste

For 2003-2011 period, the data on the amounts of MSW disposed to managed and unmanaged SWDS were provided by Waste Directorate from National Environmental Protection Agency, as a result of surveys conducted each year by NEPA and National Institute for Statistics (NIS). For 2012 the statistical survey on waste has not yet finalised in this case data estimated based on the waste generation rate being used.

The historical data on MSW storage were estimated in the context of implementing the study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation",* in 2011 year (see the Table 8.9).

Table 8.9 Total annual MSW disposed to Solid Waste Disposal Sites

Year	Amount of waste in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1950	NO	1,420.71	910.06	Study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"*
1951	NO	1,435.61	919.61	
1952	NO	1,472.02	942.93	
1953	NO	1,506.35	964.92	
1954	NO	1,538.18	985.31	
1955	NO	1,569.46	1005.35	
1956	NO	1,562.08	1000.62	
1957	NO	1,629.21	1043.62	
1958	NO	1,651.55	1057.93	
1959	NO	1,670.59	1070.13	
1960	NO	1,703.69	1091.33	
1961	NO	1,724.23	1104.49	
1962	NO	1,738.34	1113.53	
1963	NO	1,757.34	1125.70	
1964	NO	1,771.71	1134.91	
1965	NO	1,786.60	1144.44	
1966	NO	1,870.61	1198.26	
1967	NO	1,890.37	1210.91	
1968	NO	1,892.51	1212.29	
1969	NO	1,925.74	1233.57	
1970	NO	1,954.03	1251.69	

Year	Amount of waste in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1971	NO	1,981.17	1269.08	
1972	NO	2,006.88	1,285.55	Study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"*
1973	NO	2,031.14	1,301.09	
1974	NO	2,061.29	1,320.40	
1975	NO	2,091.78	1,339.93	
1976	NO	2,122.92	1,359.88	
1977	NO	2,216.33	1,419.72	
1978	NO	2,250.90	1,441.86	
1979	NO	2,272.55	1,455.73	
1980	NO	2,306.24	1,477.30	
1981	NO	2,342.09	1,500.27	
1982	NO	2,382.34	1,526.05	
1983	NO	2,402.33	1,538.86	
1984	NO	2,414.28	1,546.52	
1985	NO	2,439.76	1,562.84	
1986	NO	2,460.34	1,576.02	
1987	NO	2,487.09	1,593.16	
1988	NO	2,510.33	1,608.04	
1989	NO	2,545.70	1,630.70	
1990	NO	2,573.86	1,648.74	
1991	NO	2,567.78	1,644.84	
1992	NO	2,526.33	1,618.29	
1993	NO	2,527.31	1,618.92	

Year	Amount of waste in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1994	NO	2,527.45	1,619.01	
1995	150.00	3,418.33	2,189.67	
1996	235.00	3,027.61	1,939.39	
1997	320.00	1,883.49	1,206.51	
1998	405.00	2,584.57	1,655.60	
1999	490.00	3,192.01	2,044.70	
2000	565.66	3,684.89	2,360.43	
2001	1,500.00	2,791.10	1,787.89	
2002	1,705.00	3,145.04	2,014.62	
2003	1,723.55	2,810.00	1,800.00	NEPA
2004	1,933.00	2,850.00	1,850.00	
2005	2,079.84	3,020.00	1,780.00	
2006	2,558.26	2,817.22	1,392.41	
2007	2,841.68	2,874.98	1,132.44	
2008	3,024.99	3,506.79	754.62	
2009	3,158.06	3,022.59	574.24	
2010	3,169.37	1,836.43	364.50	
2011	3,110.61	1,108.77	279.92	
2012*	3,135.50	1,117.64	282.16	

* Preliminary data (final data for 2011 will b,e provided after statistical survey of the end of this year)

Sewage sludge disposed to SWDS

Data associated with the amounts of sewage sludge disposed to managed and unmanaged SWDS, were reconsidered through the study *"Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N_2O emissions resulting from waste incineration"*, implemented in 2013 year, based on the available data provided by National Institute of Statistics (NIS), regarding the total amounts of sewage sludge disposed to SWDS, for period 2006-2012 period. The estimation of industrial and domestic sludge disposed, for the period 1950-2005, was calculated by applying at the amount of industrial and domestic sludge reported by the operators of the average index obtained based on the average of annual index.

Equation 8.3 The calculation of the annual index

$$I_{annual\ index\ (in\ year\ n)} = Q_{sws\ tot\ disposed\ (t)} / Q_{sws\ tot\ disposed\ (t+1)}$$

where:

- $Q_{sws\ tot\ disposed\ (t)}$ – represent the quantity of sludge deposited in year t;
- $Q_{sws\ tot\ disposed\ (t+1)}$ – represent the quantity of sludge deposited in year t_{+1};

In order to obtain the necessary data, the experts used the following formula:

Equation 8.4 The calculation of the Sewage sludge disposed to unmanaged SWDS

$$Q_{industrial/domestic\ sws} = (Q_{industrial/domestic\ sws\ tot\ disposed\ (t)} * I_{medium\ index}$$

where:

- $Q_{industrial/domestic\ sws\ tot\ disposed\ (t)}$ - represent the quantity of industrial/domestic sludge deposited in year t in unmanaged landfills;

A similar formula was used in order to estimate the quantities of sewage sludge disposed in deep and shallow unmanaged landfills.

The amounts of sewage sludge disposed in managed landfills are based on the results of the study finished in 2012 and were reported by the operators.

The sewage sludge disposed in landfills is generated in the municipal/industrial sewage treatment plants.

By expert judgement, the NIS data on the total quantities of sewage sludge landfilled in the period 2006-2012 were considered in the emission estimation.

Taking into account that the statistical survey on waste has not yet finalized for 2012 year, was considered the preliminary value for sewage sludge landfilled, data provided by NIS.

The Table 8.10 shows the activity data for the period 1950-2012.

Table 8.10 Total annual sewage sludge disposed to Solid Waste Disposal Sites (1950–2012 period)

Year	Total amount of sewage sludge in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1950	NO	9.319	21.743	Study *"Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N_2O emissions resulting from waste incineration"*
1951	NO	9.446	22.041	
1952	NO	9.576	22.343	
1953	NO	9.707	22.649	
1954	NO	9.840	22.959	
1955	NO	9.975	23.274	
1956	NO	10.111	23.593	
1957	NO	10.250	23.917	
1958	NO	10.391	24.245	
1959	NO	10.533	24.578	
1960	NO	10.534	24.580	
1961	NO	11.562	26.978	
1962	NO	11.563	26.981	
1963	NO	11.564	26.984	
1964	NO	11.566	26.987	
1965	NO	11.567	26.990	Study *"Determining the quantities of industrial waste with biodegradable contents and the*
1966	NO	11.569	26.994	

Year	Total amount of sewage sludge in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1967	NO	10.544	24.603	*quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N_2O emissions resulting from waste incineration"*
1968	NO	10.546	24.608	
1969	NO	11.576	27.010	
1970	NO	11.578	27.016	
1971	NO	11.581	27.023	
1972	NO	11.585	27.031	
1973	NO	11.589	27.040	
1974	NO	11.593	27.050	
1975	NO	11.598	27.061	
1976	NO	11.603	27.074	
1977	NO	11.609	27.088	
1978	NO	11.616	27.104	
1979	NO	11.884	27.730	
1980	NO	15.052	35.121	Study *"Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in*
1981	NO	15.053	35.123	
1982	NO	15.251	35.585	
1983	NO	15.290	35.677	
1984	NO	15.295	35.687	

Year	Total amount of sewage sludge in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1985	NO	15.346	35.807	*compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N_2O emissions resulting from waste incineration"*
1986	NO	15.354	35.826	
1987	NO	15.379	35.883	
1988	NO	21.802	50.871	
1989	NO	21.782	50.824	
1990	NO	21.728	50.699	
1991	NO	23.236	54.218	
1992	NO	23.208	54.151	
1993	NO	23.185	54.098	
1994	NO	23.128	53.964	
1995	72.228	33.969	49.066	
1996	12.574	33.957	49.049	
1997	11.376	33.954	49.045	
1998	11.151	38.489	55.595	
1999	13.269	38.506	55.619	
2000	123.393	38.646	55.822	
2001	26.476	38.398	55.464	
2002	184.714	38.511	55.627	

Year	Total amount of sewage sludge in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
2003	169.262	37.520	54.195	
2004	306.887	32.527	46.983	
2005	443.495	31.126	44.960	
2006	438.663	36.355	52.512	
2007	572.074	4.992	5.914	
2008	1186.750	6.171	6.809	
2009	308.477	4.197	0.675	
2010	271.611	2.053	1.796	
2011	692.502	2.056	1.542	NIS
2012*	93.114	1.084	0.813	

* Preliminary data (final data for 2012 will be provided after statistical survey of the end of this year)

CH_4 recovery

Since 1996 to 2001, only a single landfill began to recover the methane emitted. In period 2001-2011 the amounts of methane recovered recorded a significant increase, because many more operators have reported their activity, except 2012 year, when certain operators has stoped the recovery of CH_4 emissions due to the rearrangement of sites.

The analysis of methane recovered data showed that there was an increased amount in 2006 which coming from a single operator. According to the explanations provided by this operator, the increased amount of methane recovered comes from the increased amount of MSW deposited in 2006 compared to 2005 (476,380.27 tones in 2005 and 561,427.36 tones in 2006) with a higher content of biodegradable waste due to increasing recovery activities of waste.

In 2012 the quantity of methane recovered from landfill register a significant decrease, determining a large difference between the CH_4 recovered in 2011 and 2012. This fact is due to the rearrangement of certain sites (Table 8.11).

Considering information from this time, the methane is recovered from 8 managed SWDS.

According to the data sources used there is no methane recovery from the unmanaged sites and the emissions are reported as NO.

Table 8.11 The amounts of CH_4 recovered from managed SWDS (Source: operators of landfills)

Year	Amount of CH_4 recovered (Gg)	Year	Amount of CH_4 recovered (Gg)
1989	NA	**2001**	3.27
1990	NA	**2002**	4.72
1991	NA	**2003**	6.40
1992	NA	**2004**	7.76
1993	NA	**2005**	8.91
1994	NA	**2006**	13.61
1995	NA	**2007**	13.09
1996	0.43	**2008**	15.91

Year	Amount of CH_4 recovered (Gg)	Year	Amount of CH_4 recovered (Gg)
1997	0.83	**2009**	15.99
1998	1.23	**2010**	16.37
1999	1.60	**2011**	42.59
2000	1.97	**2012**	16.91

CO_2 and NMVOC emissions from solid waste disposal on land

CO_2 and NMVOC emissions from managed and unmanaged SWDS were estimated based on the study “Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”, finished in 2011.

In accordance with 1996 IPCC Guidelines:

- ”In addition to CH_4, solid waste disposal sites can also produce substantial amounts of CO_2 and non-methane volatile organic compounds (NMVOCs). Decomposition of organic material derived from biomass sources (e.g., crops, forests) which are reground on an annual basis is the primary source of CO_2 released from waste. Hence, these CO_2 emissions are not treated as net emissions from waste in the IPCC Methodology“.
- “Organic waste in SWDS is broken down by bacterial action in a series of stages that result in the formation of CH4 and CO2 (termed biogas or landfill gas) and further bacterial biomass.

In the initial phase of degradation, organic matter is broken down to small soluble molecules including a variety of sugars. These are broken down further to hydrogen, CO_2 and a range of carboxylic acids. These acids are then converted to acetic acid which, together with hydrogen and CO_2, forms the major substrate for growth of methanogenic bacteria.

Landfill gas consists of approximately 50 per cent CO_2 and 50 per cent CH_4 by volume. However, the percentage of CO_2 in landfill gas may be smaller because of decomposition of substrates with a high hydrogen/oxygen ratio (e.g., fats, hemicelluloses) and because some of the CO_2 dissolves in water within the site.”

Taking into account these issues and considering the expert judgement, according to which CO_2

represent about 40% from landfill gas, there were estimated CO_2 emissions from SWDS, using CH_4 emissions already calculated (Table 8.12).

These emissions come mainly from biodegradable waste and a small part from waste with content of fossil C (plastics, certain textiles, rubber, waste oil, liquid solvents). On the other hand, according to the studies in this field, degradation of, is done in time periods of hundreds years. In consequence, CO_2 emissions from waste with fossil carbon content are insignificant and were not included in total emissions from Waste Sector.

By expert judgement, in the study mentioned above, NMVOC emissions from SWDS were considered to 0.7% from landfill gas and were estimated using CH_4 emissions.

The NMVOC emissions were updated based on revised methane emissions for the entire time series (Table 8.12).

Table 8.12 Percentage of direct and indirect Greenhouse Gas emissions from waste category 6A (Source: International Solid Waste Association – "Landfill Operational Guideline, 2nd Edition")

Year	Greenhouse Gas					
	CH_4		CO_2		NMVOC	
	Gg	%	Gg	%	Gg	%
1989	59.10	50	47.28	40	0.84	0.7
1990	60.89	50	48.71	40	0.86	0.7
1991	62.57	50	50.06	40	0.88	0.7
1992	64.01	50	51.21	40	0.90	0.7
1993	65.39	50	52.31	40	0.92	0.7
1994	66.69	50	53.35	40	0.94	0.7
1995	72.35	50	57.88	40	1.02	0.7
1996	75.64	50	60.51	40	0.83	0.7
1997	76.59	50	61.27	40	0.85	0.7
1998	78.57	50	62.85	40	0.88	0.7

Year	Greenhouse Gas					
	CH_4		CO_2		NMVOC	
	Gg	%	Gg	%	Gg	%
1999	83.44	50	66.75	40	0.90	0.7
2000	90.72	50	72.58	40	0.92	0.7
2001	95.69	50	76.55	40	0.93	0.7
2002	103.11	50	82.49	40	1.01	0.7
2003	108.25	50	86.60	40	1.06	0.7
2004	113.05	50	90.44	40	1.07	0.7
2005	119.32	50	95.45	40	1.10	0.7
2006	121.88	50	97.50	40	1.17	0.7
2007	128.57	50	102.86	40	1.27	0.7
2008	133.77	50	107.02	40	1.34	0.7
2009	138.47	50	110.77	40	1.44	0.7
2010	140.36	50	112.29	40	1.52	0.7
2011	118.42	50	94.74	40	1.58	0.7
2012*	141.23	50	112.99	40	1.67	0.7

* Preliminary data

8.2.3 Uncertainties and time series consistency

Accuracy in CH_4 and CO_2 emissions estimates from SWDS is determined by the available data on collected, recovered and stored municipal waste.

The uncertainty values were elaborated in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

The uncertainties associated to CH_4 emissions estimates on managed and unmanaged SWDS are presented in Table 8.13.

Table 8.13 Uncertainties associated with CH_4 emissions estimates from managed and unmanaged SWDS

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
CH_4 from managed solid waste disposal	CH_4	20.00	36.06	41.20
CH_4 from unmanaged solid waste disposal	CH_4	20.00	36.06	41.20

The percentages associated with the overall uncertainty, are based on the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.
Due to the fact that most of activity data are provided by NEPA and the contractor of the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“ and to the fact that they were obtained using the same method (the use of two methods for obtaining the quantities of MSW disposed in managed landfills in years 1996-1998 and 2000 is ensuring the consistency of data series considering the national circumstances), emission factors were obtained using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2012 is consistent.

8.2.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Wastewater Handling category, the results of these being mentioned on the Checklists level.
Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 166/2005/EC of the European Commission and in accordance with the Regulation 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change.

The data regarding total municipal solid waste deposited in SWDS in period 1995-2002 and total municipal solid waste deposited in period 1995-1997 are provided by EUROSTAT, other data sources not being available. Therefore, no difference between national and international data exist. For 2003-2012 period, the data regarding total municipal solid waste deposited in SWDS were provided by Waste Directorate from National Environmental Protection Agency and for this reason has not made any comparison with other data source.

8.2.5 Source specific recalculation, including changes made in response to the review process

In order to improve the quality emissions estimates the following recalculation was done:

- ❖ **activity data**
- ❖ activity data on the quantities of sewage sludge deposited in managed and unmanaged deep and shallow sites were estimated through the study *"Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N2O emissions resulting from waste incineration"*, finalized in 2013; CO_2 and NMVOC emissions from managed and unmanaged landfills were revised based on the revised data regarding methane emissions.

In Table 8.14 and Table 8.15 are described the CH_4 emissions from managed, respectively unmanaged sites. The differences between methane emissions in 2013 v.2.2 submission and 2014 v.1.4 submission can be explained by the introduction of revised data associated to sewage sludge disposed to SWDS (Table 8.14, Table 8.15).

Table 8.14 Changes made in AD and parameters and their effects on emission estimates

Year	Degradable Organic Carbon [%]		Municipal solid waste and sewage sludge disposed to managed sites [Gg]		Effects of recalculations at methane emissions level[Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	NO	NO	NO	NO	NO	NO	0
1990	NO	NO	NO	NO	NO	NO	0
1991	NO	NO	NO	NO	NO	NO	0
1992	NO	NO	NO	NO	NO	NO	0
1993	NO	NO	NO	NO	NO	NO	0
1994	NO	NO	NO	NO	NO	NO	0
1995	0.13	0.13	153.97	222.23	0.32	0.50	0.18
1996	0.12	0.12	238.58	247.57	0.37	0.54	0.17
1997	0.12	0.12	322.35	331.38	0.60	0.76	0.16
1998	0.11	0.11	408.20	416.15	0.93	1.08	0.15
1999	0.13	0.13	501.30	503.27	1.53	1.66	0.13
2000	0.15	0.15	578.14	689.05	2.44	2.83	0.39
2001	0.13	0.13	1,536.00	1,526.48	4.38	4.68	0.30
2002	0.15	0.15	1,741.38	1,889.71	6.92	7.55	0.63
2003	0.14	0.14	1,778.93	1,892.81	8.93	9.74	0.81
2004	0.13	0.13	2,006.66	2,239.89	11.12	12.39	1.27
2005	0.14	0.14	2,151.25	2,523.34	13.90	15.91	2.01
2006	0.13	0.13	2,757.67	2,996.93	14.51	16.79	2.28
2007	0.12	0.12	3,083.55	3,413.75	19.85	22.58	2.73
2008	0.12	0.12	3,549.84	4,211.74	22.59	26.55	3.96
2009	0.12	0.12	3,304.56	3,466.54	27.03	30.73	3.70
2010	0.12	0.12	3,331.94	3,440.98	31.03	34.39	3.36
2011	0.12	0.12	3,301.05	3,803.12	11.33	15.47	4.14

Table 8.15 Changes made at parameters level and their effects on emission estimates

Year	Municipal solid waste and sewage sludge disposed to unmanaged sites [Gg]		Methane Emissions [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1950	2392.42	2361.84	1.52	1.45	0.07
1951	2417.52	2386.71	2.98	2.86	0.12
1952	2478.83	2446.87	4.44	4.26	0.18
1953	2536.63	2503.62	5.88	5.67	0.21
1954	2590.24	2556.29	7.34	7.09	0.25
1955	2642.92	2608.06	8.76	8.47	0.29
1956	2630.48	2596.40	10.10	9.79	0.31
1957	2743.53	2707.00	11.52	11.18	0.34
1958	2781.15	2744.12	12.92	12.56	0.36
1959	2813.22	2775.84	14.30	13.92	0.38
1960	2868.94	2830.13	15.68	15.28	0.40
1961	2903.53	2867.25	17.04	16.63	0.41
1962	2927.30	2890.41	18.37	17.95	0.42
1963	2959.29	2921.58	19.68	19.25	0.43
1964	2983.50	2945.17	20.96	20.52	0.44
1965	3008.57	2969.60	22.22	21.76	0.46
1966	3150.04	3107.43	23.63	23.16	0.47
1967	3183.30	3136.42	25.02	24.53	0.49
1968	3186.92	3139.95	26.35	25.85	0.50
1969	3242.87	3197.89	27.70	27.19	0.51
1970	3290.51	3244.31	29.07	28.54	0.53
1971	3336.22	3288.85	30.44	29.94	0.50
1972	3379.51	3331.04	31.82	31.27	0.55
1973	3420.37	3370.86	33.19	32.64	0.55

Year	Municipal solid waste and sewage sludge disposed to unmanaged sites [Gg]		Methane Emissions [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1974	3471.14	3420.33	34.59	34.02	0.57
1975	3522.48	3470.37	36.01	35.43	0.58
1976	3574.92	3521.47	37.45	36.86	0.59
1977	3732.22	3674.75	39.11	38.50	0.61
1978	3790.43	3731.48	40.80	40.17	0.63
1979	3826.89	3767.90	42.47	41.82	0.65
1980	3883.61	3833.71	44.17	43.52	0.65
1981	3943.99	3892.54	45.90	45.25	0.65
1982	4011.76	3959.22	47.68	47.03	0.65
1983	4045.44	3992.16	49.44	48.79	0.65
1984	4065.56	4011.78	51.16	50.50	0.66
1985	4108.46	4053.75	52.87	52.21	0.66
1986	4143.13	4087.55	54.58	53.90	0.68
1987	4188.17	4131.51	56.29	55.61	0.68
1988	4227.30	4191.04	58.00	57.34	0.66
1989	4286.86	4249.00	59.75	59.10	0.65
1990	4334.29	4295.03	61.52	60.89	0.63
1991	4324.04	4290.07	63.18	62.57	0.61
1992	4254.25	4221.99	64.61	64.01	0.60
1993	4255.90	4223.52	65.97	65.39	0.58
1994	4256.14	4223.56	67.26	66.69	0.57
1995	5756.33	5691.03	72.47	71.86	0.61
1996	5101.01	5050.01	75.72	75.10	0.62
1997	3177.85	3173.00	76.37	75.82	0.55
1998	4359.83	4334.25	78.26	77.48	0.78
1999	5357.47	5330.84	82.27	81.77	0.50

Year	Municipal solid waste and sewage sludge disposed to unmanaged sites [Gg]		Methane Emissions [Gg]		Difference [%]
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
2000	6178.72	6139.79	88.70	87.89	0.81
2001	4688.88	4672.86	91.48	91.01	0.47
2002	5269.75	5253.80	96.01	95.56	0.45
2003	4758.13	4701.71	99.00	98.51	0.49
2004	4879.10	4779.51	101.26	100.66	0.60
2005	4964.79	4876.09	104.10	103.41	0.69
2006	4537.75	4298.50	106.14	105.09	1.05
2007	4348.52	4018.33	107.51	105.99	1.52
2008	4936.30	4274.39	109.85	107.22	2.63
2009	3763.68	3601.70	110.26	107.74	2.52
2010	2313.82	2204.78	108.30	105.97	2.33
2011	1473.71	1392.29	105.11	102.94	2.17

8.2.6 Source specific planned improvement including those in response to the review process

In order to improve the next submission, we will try to upgrade the reporting in accordance with IPCC 2006.

8.3 Source category Wastewater Handling (CRF sector 6.B)

8.3.1 Source category description

This sector includes methane emissions from industrial and domestic/commercial wastewater handling and nitrous oxide emissions from human sewage.

In Romania, the European legislation in the field of wastewater treatment and discharge into the environment has been implemented during 2002-2005, but further steps are necessary to comply fully implementing the requirements of the Directive. Final transition period for implementation of this Directive has been set at December 31, 2018 year, with intermediate deadlines for urban wastewater collection and treatment.

In 2012, from a total volume of 5,031.52 million m^3/year wastewater evacuated, 44.60% was wastewater which requiring treatment**.** From this, 13.83% was represented wastewater sufficient (appropriate) treated, 13.24% untreated wastewater and 17.52% insufficient treated wastewater (Table 8.16).

Table 8.16 Wastewater evacuated into Romania, in 2011 (Source: National Administration "Romanian Waters")

Wastewater category	Volume (mil. mc)	Percentage (%)
Total wastewater evacuated	5,031.52	-
Total domestic wastewater evacuated	1,147.56	22.81
Total industrial wastewater evacuated	3,862.17	76.76
Domestic wastewater treated	900.64	17.90
Industrial wastewater treated	657.62	13.07
Total wastewater requiring treatment	2,243.81	44.60
Sufficient treated wastewater	695.98	13.83
Insufficient treated wastewater	881.64	17.52
Untreated wastewater	666.18	13.24

Urban wastewater treatment plants can receive for treatment: wastewater from households or commercial institutions; water from streets cleaning; water from rainfall, and industrial wastewater. Industrial wastewater treatment plants are built on industrial sites and treats only industrial wastewater.

Discharge conditions of industrial wastewater in the sewage system and maximum concentrations of water quality indicators used are given in Standard NTPA 002.

Wastewater treatment processes are: mechanical, mechanical- chemical and mechanical - biological methods, most of the times using a combination of these.

According to data provided by N.A. "Romanian Waters", the largest amount of wastewater comes from industry, about 3,862.17 million cubic metres.

The public sewage system in Romania includes both the old network made before 1990, by simple concrete, reinforced and centrifuged concrete or pressurised concrete and networks that are currently running by polyvinyl chloride (PVC), polyethylene (PE), fibreglass reinforced polyester (GRP).

Unfortunately, for the period 1989-2000 there are insufficient data on sewage systems characteristics for our country.

Of the little information held shows that most public sewerage system were combined, a large number of households on the edge of cities were not connected to the sewerage system and the sewerage condition was unsatisfactory.

Between 2000 and 2012 the public sewerage system in Romania was characterized as follows:

- Development of sewerage networks, particularly those in rural areas.
- Crossing, where possible, the sewerage system separation.
- Execution of sewerage from modern materials, reliable, fitted with modern technology.
- Improving the functioning of existing drainage.
- Sizing sewers using computer programs.

The study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"* shows that in addition to households connected to public sewage systems, in Romania, are the following types of dwellings whose number is decreasing continuously:

- households without own sewage, with disposal of sewage into the ground, without treatment;
- households with its own sewage, connected to wastewater tanks that is periodically cleaned and wastewater is sent to urban wastewater treatment plants;

- dwellings owned stations with evacuation of treated wastewater in soil;
- households with their own treatment plants with discharge of wastewater in septic tanks which is regularly cleaned.

The coverage of population with sewerage services is between 1% and 100%, depending on location. The number of municipal and industrial wastewater treatment plants, classified by appropriate treatment stage, as follows:

- primary stage: 79 treatment plants;
- secondary stage: 395 treatment plants;
- tertiary stage: 23 treatment plants.

This situation is changing every year because the sewage system extends under projects financed by government programs, enhancing the connection to the sewerage and wastewater treatment.

CH_4 emissions from wastewater handling

CH_4 emissions from industrial wastewater and sludge (CRF 6.B.1)

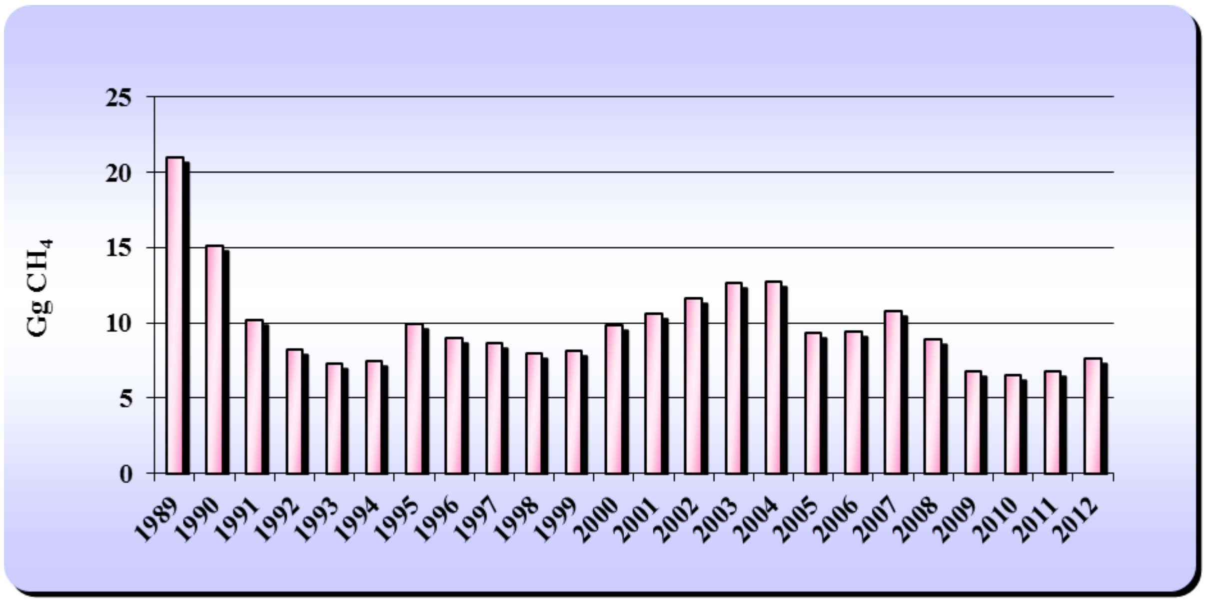
Depending on the industry of origin, industrial wastewaters have a different composition.

The sensitive issues of industrial wastewater treatment are associated with time-varying flows, extreme temperatures and excessive quantities of the following substances: petroleum products, organic oils, fats; acids and bases; materials in suspension; organic and inorganic substances; explosives and flammable materials; corrosive or volatile smelling gases.

Analysing the trend of methane emissions from industrial wastewater handling it can remark several periods when the emissions increased or decreased. These fluctuations are due to the increasing or decreasing of industrial production, reflecting in the emissions trend fluctuation (Figure 8.8, Table 8.19).

Since 2007, CH_4 emissions from industrial wastewater treatment have begun to fall due to the drastic decline of pulp production, industrial branch which produces wastewater with the highest organic load (Figure 8.8).

Figure 8.8 CH_4 emissions trend from industrial wastewater handling for 1989–2012 period



Compared with the base year (1989), CH_4 emissions from industrial wastewater treatment decreased with 63.80 %.

In 2012 year, the emissions trend register a slower increase due to the growth of industrial production.

CH_4 emissions from domestic and commercial wastewater and sludge (CRF 6.B.2.1)

In estimation of CH_4 emissions from domestic/commercial wastewater and sludge, was considered a large category of population including both the population connected to sewerage with treatment and population unconnected to sewerage. Domestic wastewater collected from the population connected to sewerage without treatment suffers a self-cleaning aerobic process with minor methane emissions. This wastewater is directly discharged into the environment (rivers or underground).

Analysing the chart below, it can observe a mainly decreasing trend due to the increasing number of population connected to sewerage *(Figure 8.9)*. The methane emissions level of 2012 compared to base year (1989) is in decreasing with 11.53 %.

Figure 8.9 CH_4 emissions trend from domestic/commercial wastewater and sludge treatment for 1989–2012 period

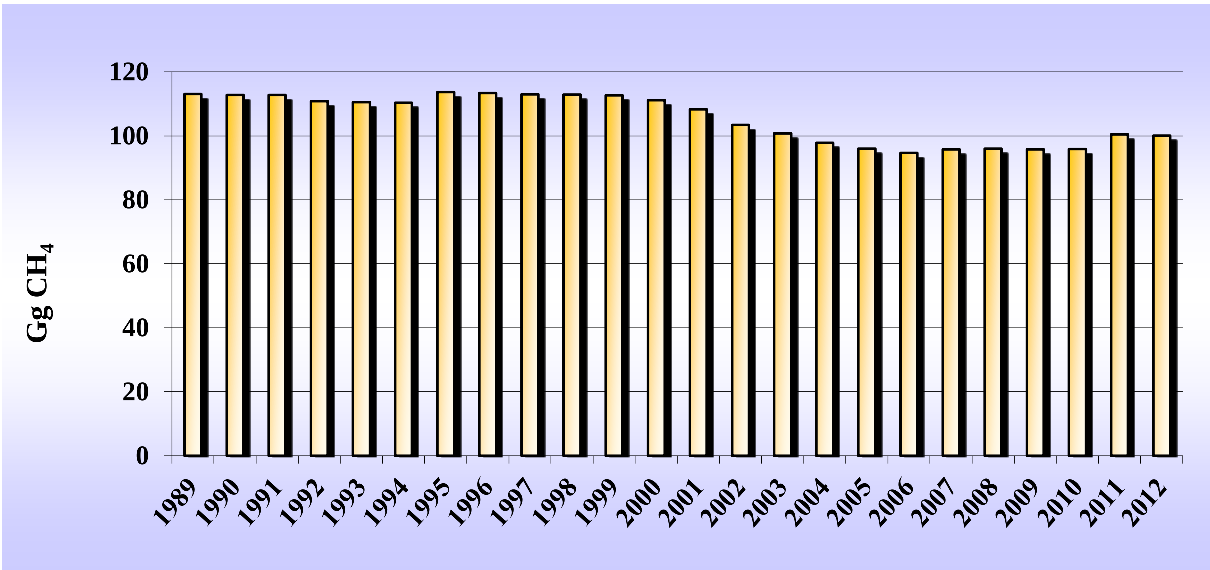
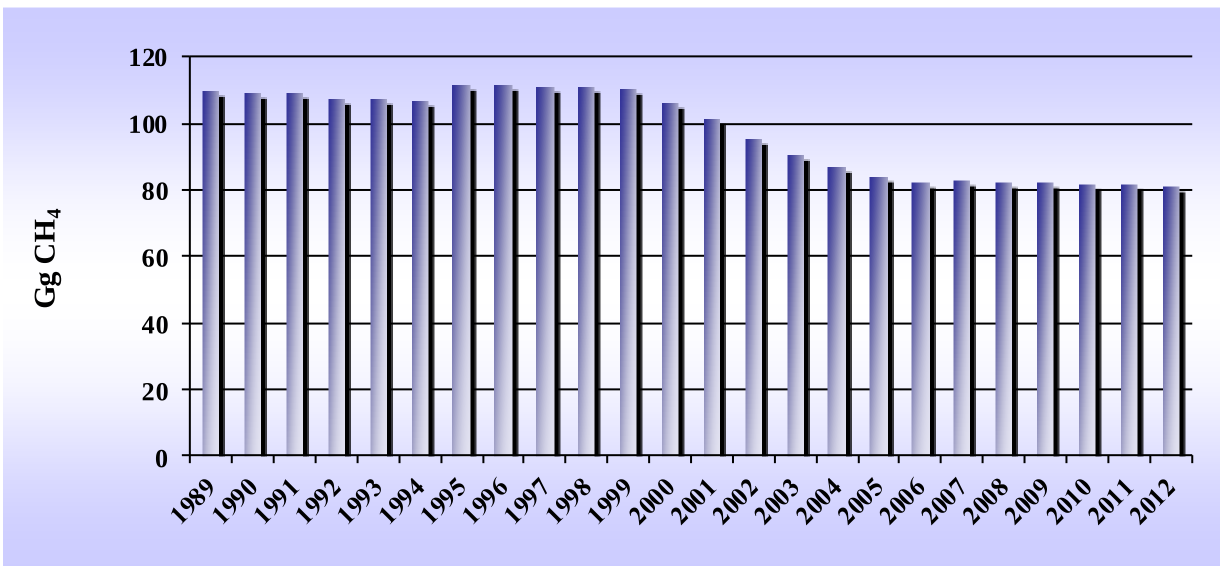


Table 8.17 Explanations on methane emissions estimates

Period	Methane emissions from industrial wastewater treatment - Explanations
1989-1996	Values between 21.01–8.96 Gg These values are decreasing following decreasing industrial production.
1997-2004	Values between 8.65–12.77 Gg These values are relatively higher than previous period due to: • progress in Romanian economy, increase of the production • increasing of fraction of wastewater treated anaerobically.
2005-2012	Values between 9.32–7.61 Relatively lower values compared with 1997-2004 period, but since 2009 following a sharp decline due to economic crisis

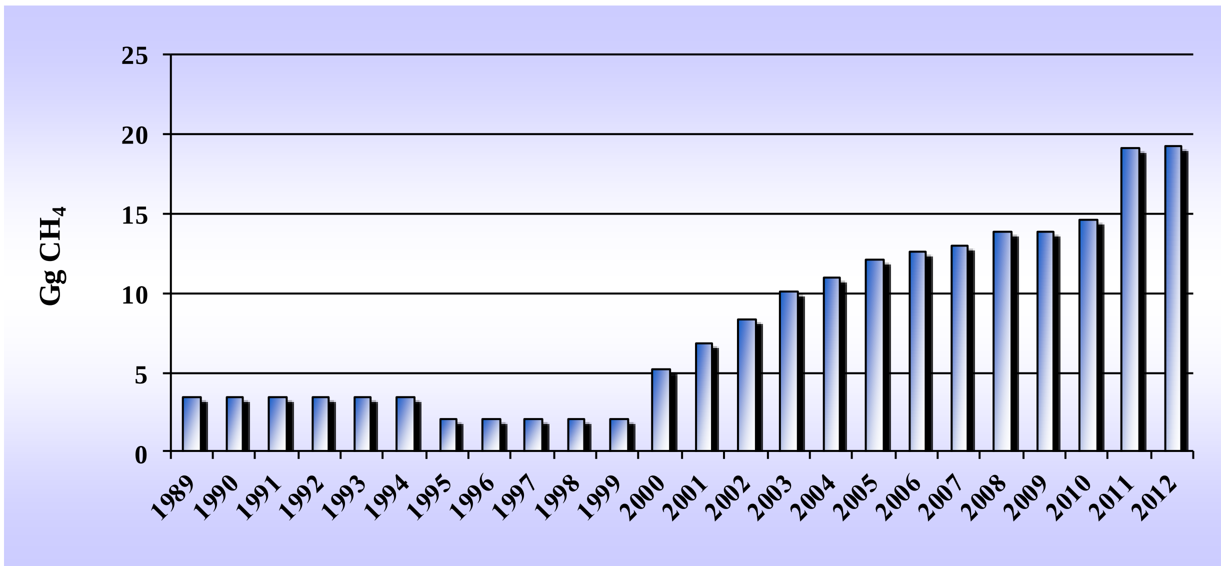
The same decreasing tendency is noted for CH_4 emissions from domestic/commercial wastewater without taking into account the emissions from domestic/commercial sludge (Figure 8.10).

Figure 8.10 CH_4 emissions trend from domestic/commercial wastewater treatment for 1989–2012 period



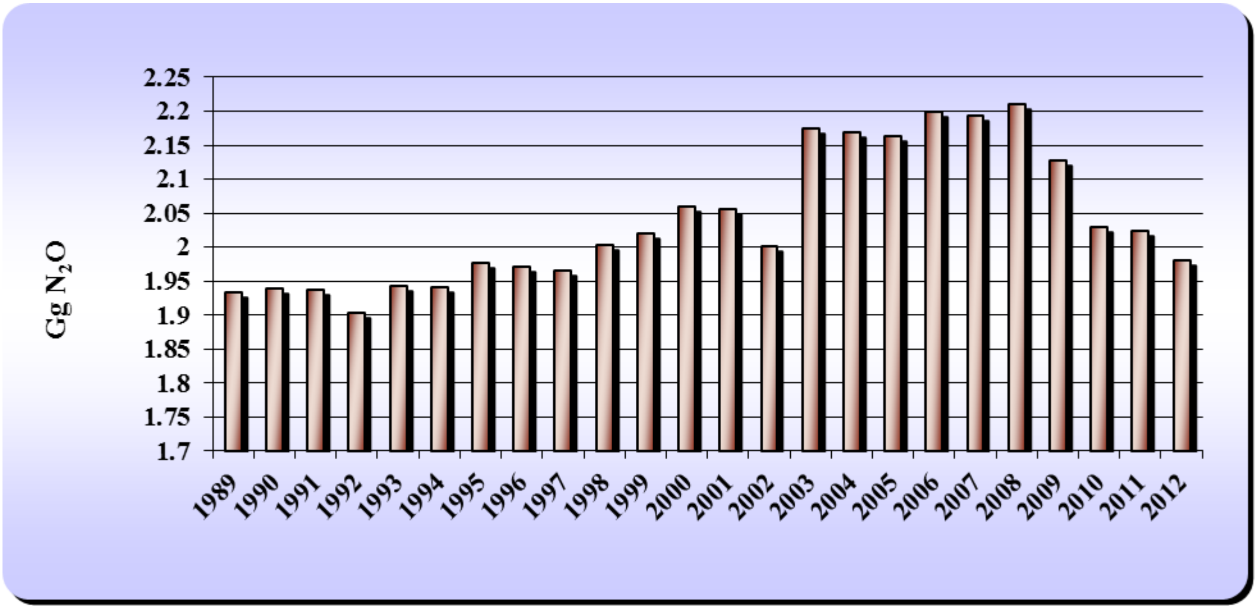
In 2012, CH_4 emissions from domestic/commercial sludge increased almost 6 times compared with 1989 (Figure 8.11). As for emissions from domestic/commercial wastewater treatment the explanation is the increasing of number population connected to sewerage, in particular connected to sewerage with treatment.

Figure 8.11 CH_4 emissions trend from domestic/commercial sludge treatment for 1989–2012 period



For estimate N_2O emissions from human sewage was used the total population of our country. The fluctuations are in generally due to the population consumption values provided by Food and Agriculture Organization of the United Nations and National Institute for Statistics. Over the 1989–2009 period, N_2O emissions from Human sewage category have maintained an increasing trend, due to the decreasing number of population, on the one hand and on the other hand due to the increasing values of protein consumption. The sharp decrease of N_2O emissions recorded in 2002, compared with 2001 year, is due to the severe loss of population number. Additional, the increasing trend of N_2O emissions recorded in 2003, compared with 2002 year is due to the increasing values of protein consumption. After 2009 year, the emissions register a sharply decrease, being influenced by the several decrease of protein consumption values, reflecting so the impact of recent economic crisis. (Figure 8.12 and Table 8.28).

Figure 8.12 N_2O emissions trend from human sewage for 1989–2012 period



8.3.2 Methodological issues

CH_4 emissions from industrial wastewater and sludge (CRF 6.B.1)

Methane is the result of anaerobic processes that occur during treatment of industrial wastewater in wastewater industrial treatment plants.

To establish the approach to estimate methane emissions from this sub-category we using the decision tree from IPCC Good Practice Guidance, figure 5.4, according which it is necessary to identify three or four industries that produce large quantities of wastewater with high content of degradable organic component.

By study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"* has been identified three industrial sectors with the greatest potential for methane emissions from wastewater treatment: brewing, pulp and paper, oil refining. These sectors have wastewater treatment plants containing potential biological treatment step in CH_4 emissions.

Classical procedures of wastewater treatment, available in almost all cases to municipal wastewater, offer limited opportunities for industrial wastewater treatment. Thus, these methods are not able to lower the dissolved mineral impurities content in wastewater, some organic substances, especially synthetic, are not being degraded by microorganisms and pass unchanged through wastewater treatment. These impurities remain in the water emissaries and are not eliminate during natural self-cleaning processes. The methods to remove pollutants from industrial wastewater are: physical, chemical and biological methods. Application of these methods depends on the composition of wastewater.

Methodology

Default method was used for calculating CH_4 emissions from industrial wastewater according to the IPCC GPG 2000.

After recent investigation, experts identified that only in several breweries wastewater is treated in anaerobic conditions. In pulp, paper and petroleum refining industries as well as in the most of breweries wastewater is treated in aerobic conditions with minor methane emissions.

For methane emissions from industrial wastewater calculation, the equation 5.5 from page 5.14 was used:

Equation 8.5 CH_4 emissions from industrial wastewater

*Emissions = (Total Organic Waste * Emission Factor) – Methane Recovery*

The following steps were considered:

1. Calculation of Total Organic Wastewater for each of the three industrial branches, using equation 8 from Revised 1996 IPCC Guidelines:

Equation 8.6 Total Organic Wastewater for each of the three industrial branches

$$TOW_{ind}\ (kg\ COD/yr) = W * O * D_{ind} * (1 - DS_{ind})$$

2. Calculation of Total Industrial Organic Wastewater for pulp, paper and petroleum refining, by summing TOW obtained for each industry in step 1.

Equation 8.7 Total Industrial Organic Wastewater for pulp, paper and petroleum refining

$$TOW_{ind\ total} = TOW_{beer} + TOW_{pulp\&paper} + TOW_{petroleum\ ref.}$$

Estimation of CH_4 emissions on the one hand for pulp, paper, petroleum refining and on the other hand separately for anaerobic and aerobic treatment in beer industry:

Equation 8.8 Estimation of CH_4 emissions

$$CH_{4emissions\ pulp,\ paper,\ petroleum\ ref} = (TOW_{beer} * EF_{pulp,\ paper,\ petroleum\ ref.})$$

$$CH_{4emissions\ anaerobic\ treat.\ beer} = (TOW_{beer} * EF_{anaerobic\ treat.}) - Methane\ Recovery$$

$$CH_{4emissions\ aerobic\ treat.\ beer} = (TOW_{beer} * EF_{aerobic\ treat.})$$

Methane is recovered only in beer industry which treating their wastewater in anaerobic conditions.

Emission factor

To calculate Emission Factor we used the equation 10 from Revised 1996 IPCC Guidelines:

Equation 8.9 The emission factor for industrial wastewater

$$EF_i = B_{oi} * \sum(WS_{ix} * MCF_x)$$

The fraction of wastewater treated anaerobically (WS anaerobic) was calculated based on the wastewater generated in beer industry with anaerobic treatment and the total wastewater generated in the beer industry (Table 8.18).

In accordance with IPCC 2006 Guidelines, Methane Conversion Factor for aerobic treatment is 0.05 and for anaerobic treatment is 0.80.

Table 8.18 The Emissions Factors for aerobic and anaerobic treatment

Industry - Period	**EMISSION FACTORS**						
	Fraction of wastewater treated anaerobically - WS anaerobic	**Fraction of wastewater treated aerobically - WS aerobic**	**Methane Conversion Factor in anaerobic treatment – MCF anaerobic**	**Methane Conversion Factor in aerobic treatment – MCF aerobic**	**Maximum methane producing capacity - Bo (kg CH_4/kg COD)**	**Emission factor for industrial wastewater treated anaerobically - EF (kg CH_4/kg COD) - ANAEROBIC**	**Emission factor for industrial wastewater treated aerobically - EF (kg CH_4/kg COD) - AEROBIC**
Beer industry							
1989-1997	0.000	1.000	0.800	0.050	0.250	0.000	0.013
1998	0.106	0.894	0.800	0.050	0.250	0.021	0.011
1999	0.103	0.897	0.800	0.050	0.250	0.021	0.011
2000	0.107	0.893	0.800	0.050	0.250	0.021	0.011
2001	0.124	0.876	0.800	0.050	0.250	0.025	0.011
2002	0.149	0.851	0.800	0.050	0.250	0.030	0.011
2003	0.144	0.856	0.800	0.050	0.250	0.029	0.011
2004	0.144	0.856	0.800	0.050	0.250	0.029	0.011
2005	0.155	0.845	0.800	0.050	0.250	0.031	0.011
2006	0.191	0.809	0.800	0.050	0.250	0.038	0.010
2007	0.212	0.788	0.800	0.050	0.250	0.042	0.010
2008	0.408	0.592	0.800	0.050	0.250	0.082	0.007
2009	0.447	0.553	0.800	0.050	0.250	0.089	0.007

Industry - Period	EMISSION FACTORS						
	Fraction of wastewater treated anaerobically - WS anaerobic	Fraction of wastewater treated aerobically - WS aerobic	Methane Conversion Factor in anaerobic treatment – MCF anaerobic	Methane Conversion Factor in aerobic treatment – MCF aerobic	Maximum methane producing capacity - Bo (kg CH_4/kg COD)	Emission factor for industrial wastewater treated anaerobically - EF (kg CH_4/kg COD) - ANAEROBIC	Emission factor for industrial wastewater treated aerobically - EF (kg CH_4/kg COD) - AEROBIC
2010	0.469	0.531	0.800	0.050	0.250	0.094	0.007
2011	0.462	0.538	0.800	0.050	0.250	0.092	0.007
2012	0.449	0.551	0.800	0.050	0.250	0.090	0.007
Pulp, paper and petroleum refinery							
1989-2012	0.000	1.000	0.800	0.050	0.250	0.000	0.013
Source	Expert judgement based on data provided by economic operators		IPCC 2006		IPCC GPG 2000, page 5.17	Calculated	

For Maximum methane producing capacity (B_{oi}) were not found national values, in this case has been used the default value of 0.25 kg CH_4/kg COD (Chemical Oxygen Demand) from IPCC GPG 2000.

The weighted MCF (Methane conversion factor) values were determined according to equation 5.8 from IPCC GPG 2000:

Equation 8.10 The weighted Methane Conversion Factor for industrial wastewater

$$Weighted\ MCF_i = \sum(WS_{ix} * MCF_x)$$

Activity data

The activity data as regard industrial production of sectors taking into account have been provided by National Institute for Statistics (Table 8.19).

Table 8.19 Industrial production of the industrial sectors with the greatest potential for methane emissions (source: NIS - Statistical Yearbook 2012)

Year	Production (t/year)			
	Beer	Paper	Pulp	Petroleum Refining
1989	1,151,300	552,000	574,000	30,615,000
1990	1,052,700	427,000	380,000	23,664,000
1991	980,300	307,000	235,000	15,191,000
1992	1,001,400	262,000	171,000	13,299,000
1993	992,900	248,000	132,000	13,191,000
1994	904,600	262,000	128,000	14,744,000
1995	876,800	332,000	194,000	15,259,000
1996	811,800	299,000	177,000	13,426,000
1997	765,100	306,000	154,000	12,429,000
1998	998,900	281,000	129,000	12,520,000
1999	1,113,300	276,000	144,000	9,894,000
2000	1,266,400	328,000	187,000	10,532,000
2001	1,266,300	388,000	172,000	10,948,000
2002	1,162,700	421,000	199,000	11,906,000
2003	1,329,200	457,000	212,000	10,736,000
2004	1,440,600	492,000	187,000	12,371,000

Year	Production (t/year)			
	Beer	Paper	Pulp	Petroleum Refining
2005	1,529,500	385,000	103,000	13,890,000
2006	1,748,400	401,000	80,000	13,237,000
2007	1,921,300	461,000	86,000	13,006,000
2008	2,024,000	369,000	22,000	13,095,000
2009	1,809,000	310,000	*	11,340,000
2010	1,665,600	325,000	*	9,931,000
2011	1,723,900	335,000	*	9,516,000
2012	1,832,500	343,000	*	9,142,000

* Confidential data

As regards Degradable Organic Component and Wastewater generated, we used the default values from IPCC GPG 2000 (Table 8. 20).

Table 8.20 Parameters used to estimate Total organic industrial wastewater (Source:IPCC GPG 2000, table 5-4)

Default Parameters	Industry type		
	Beer	Pulp &Paper	Petroleum Refineries
Degradable Organic Component – COD [g/l]	2.9	9.0	1.0
Wastewater Generation [m^3/Mg]	6.3	162	0.6

In estimation of methane emissions from industrial wastewater Degradable Organic Component removed as sludge was considered zero.

CH_4 recovery

Starting with the current submission, data on methane recovered from industrial wastewater treatment became available. Considering information that we have at this time, the methane is recovered by most important 4 operators of breweries (Table 8.21).

Table 8.21 The amounts of CH_4 recovered from industrial wastewater treatment (Source: economic operators)

Year	**Amount of Methane recovery Gg/year**
1989-1997	-
1998	0.18
1999	0.28
2000	0.41
2001	0.54
2002	0.60
2003	0.61
2004	0.74
2005	0.84
2006	1.02
2007	1.14
2008	1.62
2009	2.17
2010	2.54
2011	2.51
2012	1.95

CH_4 emissions from industrial sludge

CH_4 emissions from industrial sludge are reported IE because the emissions are included at the industrial wastewater level. According IPCC GPG 2000, the theoretical default Bo values for sludge and wastewater are the same and if default factors are being used, emissions from wastewater and sludge can be estimated together.

CH_4 emissions from domestic and commercial wastewater handling (CRF 6.B.2)

Domestic wastewater is treated in municipal treatment plants wastewater by the following processes: mechanical treatment, chemical-mechanical treatment or biological-mechanical treatment.

In biological treatment are two types of processes:

- aerobic processes, when result energy by oxidation of organic substances. Aerobic processes depend on the existence of aerobic bacteria, and these on the presence of dissolved oxygen. By aerobic treatment process organic material is removed from the wastewater.
- anaerobic processes, characterized by reducing oxygen and energy consumption. Anaerobic treatment of wastewater leads to nitrogen removal by nitrification and denitrification processes. During anaerobic processes occur methane emissions.

In Romania, most municipal treatment plants have old equipment and technologies, leading to low efficiency and quality of treated wastewater over the limit imposed by the Standard NTPA - 011. About 30% of treatment plants are equipped with sludge digestion tanks. Most of the sludge resulting from the treatment (70%) is deposited directly on drying platforms *(Source 2.13 – Development of national policy for managing sewage sludge, page 128).*

After 2000, number of projects for new wastewater plants and for rehabilitation and modernization begun to increase, in the period 2000-2007 the number of municipalities with wastewater treatment plants increasing to 45 cities.

Methodology

To estimate CH_4 emissions from domestic and commercial wastewater, we taking into account the decisions tree from IPCC GPG 2000, page 5.15 and we used the following equations from the same methodology:

Equation 8.11 CH_4 emissions from domestic and commercial wastewater

$$Emissions = (Total\ Organic\ Waste * Emission\ Factor) – Methane\ Recovery$$

Were estimated CH_4 emissions both from the population connected to sewerage with treatment and population unconnected to sewerage.

The following steps were considered:

1. Calculation of Total Organic Wastewater for population connected to sewerage with treatment, using equation 6 from Revised 1996 IPCC Guidelines:

Equation 8.12 Total Organic Wastewater

$$TOW_{dom} = P * D_{dom} *(1 - DS_{dom})$$

2. Calculation of Total Organic Wastewater for population unconnected to sewerage, using the same equation as in step 1.
3. Estimation of CH_4 emissions provided from the population connected to sewerage with treatment, using TOW_{dom} obtained in step 1 and the Emission Factor provided by study finished in 2011.
4. Estimation of CH_4 emissions provided from the population unconnected to sewerage, using TOW_{dom} obtained in step 2 and the Emission Factor provided by study finished in 2011.
5. Summing the CH_4 emissions provided from the population connected to sewerage with treatment and those provided from the population unconnected to sewerage.

Emission factor

To calculate Emission Factor we used the equation 10 from Revised 1996 IPCC Guidelines:

Equation 8.13 Emission Factor for domestic and commercial wastewater

$$EF_i = B_{oi} * \sum(WS_{ix} * MCF_x)$$

According to methodology it was taking in consideration only the fraction of domestic/commercial wastewater treated anaerobically because only in this case methane issue. The percentages of domestic/commercial wastewater treated anaerobically are presented in Table 8.22.

Table 8.22 Calculation of Emission Factors domestic/commercial wastewater, for 1989-2012 period

Parameter	**B_{oi}** **(**kg CH_4/kg BOD)	**WS_{ix}**	**MCF_x**	**EFs**
Population connected to sewerage with treatment	0.60	0.05	0.9	**0.03**
Population unconnected to sewerage	0.60	1.00	0.5	**0.30**
Source:	IPCC GPG 2000	Expert opinion	Expert opinion	-

The weighted MCF (Methane conversion factor) values were determined according to equation 5.8 from IPCC GPG 2000:

Equation 8.14 The weighted Methane Conversion Factor for domestic and commercial wastewater

$$Weighted\ MCF_i = \sum(WS_{ix} * MCF_x)$$

where:

- WS_{ix} *– fraction of wastewater type treated using wastewater handling system*
- MCF_x *– methane conversion factor of wastewater handling system*

Activity data

To estimates methane emissions from domestic/commercial wastewater handling were used data provided by study "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation".

The number of population connected to sewerage with treatment was calculated using total population and fraction of population connected to sewerage with treatment. The data on total population were obtained from National Institute for Statistics (NIS). The fraction of total population connected to sewerage with treatment is obtained by different sources (Table 8.24).

The data regarding population unconnected to sewerage were obtained making the difference between total population and population connected to sewerage (Table 8.23).

Table 8.23 Activity data for methane emissions estimates from domestic/commercial wastewater (Source: Study finished in 2011)

Year	Total population [1000 persons]	Total population connected to sewerage with treatment	Total population unconnected to sewerage
(1000 persons)			
1989	23,151.56	2,770.16	16,527.28
1990	23,206.72	2,836.99	16,472.95

Year	Total population [1000 persons]	Total population connected to sewerage with treatment	Total population unconnected to sewerage
(1000 persons)			
1991	23,185.08	2,824.29	16,473.23
1992	22,788.97	2,782.66	16,181.50
1993	22,755.26	2,791.40	16,137.56
1994	22,730.62	2,796.21	16,107.90
1995	22,680.95	1,744.01	16,880.17
1996	22,607.62	1,737.56	16,827.43
1997	22,545.93	1,736.66	16,772.75
1998	22,502.80	1,728.70	16,751.26
1999	22,458.02	1,722.38	16,724.51
2000	22,435.21	2,460.77	16,028.52
2001	22,408.40	3,254.53	15,311.64
2002	21,794.79	3,935.02	14,332.20
2003	21,733.56	4,788.86	13,616.12
2004	21,673.33	5,203.79	13,013.89
2005	21,623.85	5,738.36	12,547.12
2006	21,584.37	6,068.66	12,539.65
2007	21,537.56	6,130.40	12,369.22
2008	21,504.44	6,215.16	12,290.81
2009	21,469.96	6,236.53	12,246.79
2010	21,462.19	6,541.22	12,148.16
2011	21,413.82	8,568.77	12,094.59
2012	21,355.85	8,641.24	12,000.79

The data sources are presented in the next table:

Table 8.24 The sources of activity data used in methane emissions estimates from domestic/commercial wastewater treatment

Activity Data	Source
Total population [1000 persons]	*National Institute for Statistics*
Total population connected to sewerage with treatment [1000 persons] - $P_{tot\ tr}$	*1989 -2005 period:* $\boldsymbol{P_{tot\ tr} = P_{urb\ tr} + P_{rur\ tr}}$ *;* *2006 – 2012 : National Institute for Statistics*
Total population unconnected to sewerage [1000 persons] – $P_{tot\ uncon}$	*1989 -2005 period:* $\boldsymbol{P_{tot\ uncon} = P_{urb\ uncon} + P_{rur\ uncon}}$ *2006 – 2012 :* $\boldsymbol{P_{tot\ uncon} = P_{tot} - P_{tot\ tr}}$
Total population [1000 persons]	*National Institute for Statistics*

To calculate Total Organic Wastewater we used the parameters provided by the study (Table 8.25).

Table 8.25 Parameters used to estimate Total organic domestic/commercial wastewater (Source: Study finished in 2011)

Parameters	**Years**				
	1989-1999	**2000-2005**	**2006**	**2007**	**2008-2011**
Degradable Organic Component – BOD [kg/1000 persons/yr]	21,900	21,900	21,438	21,900	21,900
Fraction of BOD removed as sludge	0.35	0.60	0.60	0.60	0.63

The value of BOD for year 2006 is a single national value and was provided by NIS. The other value of BOD is assumed by expert judgement and is provided by study finished in 2011.

The fraction of BOD removed as sludge for 1989-2007 was provided by expert Prof. Dr. Vladimir Rojanschi and for 2008-2012 period was provided by NIS.

CH_4 from domestic/commercial wastewater recovered and/or flared are reported NO. In the future we will investigate this issue by sending the specific questionnaires to the operators of the municipal wastewater treatment plants.

CH_4 emissions from domestic and commercial sludge

Quantities of sludge retained in various stages of treatment are different from one source to another, depending on the physic-chemical characteristics of raw water, the method and degree of treatment required. Thus, in municipal wastewater treatment, the sludge quantities are between 65 and 90 g/person/day.

Methodology

To estimate methane emissions from domestic/commercial sludge we used the equations 13 from Revised 1996 IPCC Guidelines:

Equation 8.15 Methane emissions from domestic/commercial sludge

$$SM = \sum_j (TOS_j * EF_j - MR_j)$$

The following steps were considered:

1. Calculation of Total Organic Waste for sludge, using the equation 7 from Revised 1996 IPCC Guidelines:

Equation 8.16 Total Organic Waste for sludge

$$TOS_{dom} = P * D_{dom} * DS_{dom}$$

2. Calculation of Emission Factor, using the equation 11 from Revised 1996 IPCC Guidelines:

Equation 8.17 Emission Factor for sludge

$$EF_j = B_{oj} * \sum(SS_{jy} * MCF_y)$$

3. Estimation of CH_4 emissions from domestic/commercial sludge, using TOS_{dom} and EF_j obtained in previous steps.

Emissions factor

The emission factor was calculated as mentioned in the previous paragraph, using the following values of parameters describes in the next table. By expert opinion it was considered a percentage of 30% domestic/commercial wastewater sludge treated by anaerobic processes and 70% by aerobic processes.

Table 8.26 Calculation of Emission Factor for domestic/commercial sludge, for 1989-2012 period

B_{oi} (kg CH_4/kg BOD)	**SS_{jy}**	**MCF_y**	**EFs**
0.60	0.30	0.9	**0.162**
IPCC GPG 2000	Expert opinion	Expert opinion	-

The weighted MCF (Methane conversion factor) values were determined according to equation 5.8 from IPCC GPG 2000:

Activity data

The same activity data presented to CH_4 emissions from domestic/commercial wastewater were used in calculation of methane emissions from domestic/commercial sludge.

N_2O emissions from Human Sewage (CRF 6.B.2.2)

Methodology

To estimate N_2O emissions from human sewage, we used the equation 15 from Revised 1996 IPCC Guidelines:

Equation 8.18 N_2O emissions from human sewage

$$N_2O_{(S)} = Protein * Frac_{NPR} * NR_{people} * EF_6$$

Emissions factor

Default emissions factors according to the provisions in IPCC 1996 have been used.

The emissions factors are presented in Table 8.27.

Table 8.27 Parameters used to calculate emission factor from Human Sewage

Fraction of Nitrogen in Protein - $Frac_{NPR}$ **[g N/kg protein]**	**Emission factor - EF_6** **[kg N_2O-N/kg sewage=N produced]**
Source: IPCC 1996	Source: IPCC 1996
0.16	0.01

Activity data

In estimation of N_2O emissions from human sewage was taking into account the total population of our country. The number of population was provided by National Institute for Statistics for 1989-2012 period.

The data regarding Protein Consumption were provided by Food and Agriculture Organization site and by National Institute for Statistics being presented in the Table 8.28.

Table 8.28 Values of Protein Consumption for Romania in period 1989-2012

Year	Protein consumption [kg protein/person/yr]	Source
1989	33.215	Statistical Yearbook 2004-2006
1990	33.215	FAO - Romania Country Profile
1991	33.215	
1992	33.215	
1993	33.945	Interpolation between 1992 and 1994 by expert judgement
1994	33.945	Statistical Yearbook 2009
1995	34.675	FAO - Romania Country Profile
1996	34.675	
1997	34.675	
1998	35.405	Arithmetic average between 1997 and 1999
1999	35.770	Statistical Yearbook 2010
2000	36.500	FAO - Romania Country Profile
2001	36.500	
2002	36.500	
2003	39.785	Statistical Yearbook 2010
2004	39.785	
2005	39.785	
2006	40.515	FAO - Romania Country Profile
2007	40.515	
2008	40,880	National Institute for Statistics
2009	39,420	

Year	Protein consumption [kg protein/person/yr]	Source
2010	37,595	
2011	37,595	
2012*	36.865	*Preliminary data*

Table 8.29 The differences on N_2O emissions

Year	Protein consumption [Protein in kg/person/yr]		N_2O emissions [Gg]		Difference %
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	33.22	33.22	1.93	1.93	0.00
1990	33.22	33.22	1.94	1.94	0.00
1991	33.22	33.22	1.94	1.94	0.00
1992	33.22	33.22	1.90	1.90	0.00
1993	33.95	33.95	1.94	1.94	0.00
1994	33.95	33.95	1.94	1.94	0.00
1995	34.68	34.68	1.98	1.98	0.00
1996	34.68	34.68	1.97	1.97	0.00
1997	34.68	34.68	1.97	1.97	0.00
1998	35.41	35.41	2.00	2.00	0.00
1999	35.77	35.77	2.02	2.02	0.00
2000	36.50	36.50	2.06	2.06	0.00
2001	36.50	36.50	2.06	2.06	0.00
2002	36.50	36.50	2.00	2.00	0.00
2003	39.79	39.79	2.17	2.17	0.00
2004	39.79	39.79	2.17	2.17	0.00
2005	39.79	39.79	2.16	2.16	0.00

Year	Protein consumption [Protein in kg/person/yr]		N_2O emissions [Gg]		Difference %
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
2006	40.52	40.52	2.20	2.20	0.00
2007	40.52	40.52	2.19	2.19	0.00
2008	40.88	40.88	2.21	2.21	0.00
2009	39.42	39.42	2.13	2.13	0.00
2010	37.60	37.60	2.03	2.03	0.00
2011	37.60	37.60	2.02	2.02	0.00

8.3.3 Uncertainties and time series consistency

CH_4 emissions from industrial wastewater

The values were elaborated in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.
The uncertainties associated with CH_4 emissions from industrial wastewater are presented in the next table:

Table 8.30 Uncertainties for estimation of CH_4 emissions from industrial wastewater

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
CH_4 from industrial wastewater	CH_4	30.00	42.40	52.00

The percentages are associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4 from domestic and commercial wastewater

The values were elaborated in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.
In the table below are presented the uncertainties associated CH_4 emissions from domestic/commercial wastewater treatment.

Table 8.31 Uncertainties for estimation of CH_4 emissions from domestic/commercial Wastewater

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
CH_4 from domestic and commercial wastewater	CH_4	30.00	42.40	52.00

The percentages are associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

N_2O from human sewage

The values were elaborated in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1. In the table below are presented the uncertainties associated to N2O emissions from human sewage.

Table 8.32 Uncertainties for estimation of N_2O emissions from human sewage

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
N_2O from wastewater handling	N_2O	30.00	50.00	58.03

The percentages are associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

8.3.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in the QA/QC Programme have been undertaken. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Solid Waste Disposal on Land category, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 166/2005/EC of the European Commission and in accordance with the Regulation 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change.

The number of population was provided by National Institute for Statistics the same parameter being reported to EUROSTAT. The differences between the two data sources come from different reference data (Table 8.35).

The data reported to EUROSTAT were estimated for 1 January of each year considered while the data taking into account in NGHGI 2013 were estimated for 1 July of each year. Both data are corrected and are provided by NIS.

Table 8.33 Comparison between data provided by EUROSTAT and data provided by NIS

Year	Total number of population (1000 persons)		Difference (persons)
	NGHGI 2013 (Source NIS) *1 July*	EUROSTAT *1 January*	
1989	23,151.564	-	-
1990	23,206.720	23,211.395	4.675
1991	23,185.084	23,192.274	7.190
1992	22,788.969	22,811.392	22.423
1993	22,755.260	22,778.533	23.273
1994	22,730.622	22,748.027	17.405
1995	22,680.951	22,712.394	31.443
1996	22,607.620	22,656.145	48.525
1997	22,545.925	22,581.862	35.937
1998	22,502.803	22,526.093	23.290
1999	22,458.022	22,488.595	30.573
2000	22,435.205	22,455.485	20.280
2001	22,408.393	22,430.457	22.064
2002	21,794.793	21,833.483	38.690
2003	21,733.556	21,772.774	39.218
2004	21,673.328	21,711.252	37.924
2005	21,623.849	21,658.528	34.679
2006	21,584.365	21,610.213	25.848
2007	21,537.563	21,565.119	27.556
2008	21,504.442	21,528.627	24.185
2009	21,469.959	21,498.616	28.657
2010	21,462.186	21,462.186	0.000
2011	21,413.815	21,413.815	0.000

Taking into account the previous mentions we can consider that the two data sets are comparable.

8.3.5 Source specific recalculation, including changes made in response to the review process

In order to improve the quality emissions estimates the following recalculation was done:

- **activity data**
  - CH_4 emissions from domestic and commercial wastewater were recalculated for 2006-2010 period using the number of population connected to sewerage with treatment and the number of population unconnected to sewerage provided by NIS;
  - Were reviewed the data regarding Protein Consumption provided by Food and Agriculture Organization of the United Nations.
- **Emission Factor**
  - Based on country specific values for Fraction of industrial wastewater treated anaerobically and Fraction of industrial wastewater treated aerobically (WSx) and using values for Methane Conversion Factor (MCF) in accordance with IPCC 2006 Guidelines, new Emission Factors were calculated.
- **Methane recovery**
  - Data on methane recovered from industrial wastewater treatment were collected from the operators and used in the estimation of methane emissions.

Table 8.34 Effects of activity data on emission estimates from industrial wastewater

Year	CH_4 emissions		Difference (%)
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	21.01	21.01	0.00
1990	15.13	15.13	0.00
1991	10.22	10.22	0.00
1992	8.22	8.22	0.00
1993	7.25	7.25	0.00
1994	7.42	7.42	0.00

Year	CH_4 emissions		Difference (%)
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1995	9.90	9.90	0.00
1996	8.96	8.96	0.00
1997	8.65	8.65	0.00
1998	7.98	7.98	0.00
1999	8.10	8.10	0.00
2000	9.81	9.81	0.00
2001	10.57	10.57	0.00
2002	11.65	11.65	0.00
2003	12.62	12.62	0.00
2004	12.77	12.77	0.00
2005	9.32	9.32	0.00
2006	9.39	9.39	0.00
2007	10.76	10.76	0.00
2008	8.90	8.90	0.00
2009	6.75	6.75	0.00
2010	6.52	6.52	0.00
2011	6.79	6.79	0.00

Table 8.35 Changes made in activity data and their effects on emission estimates from domestic/commercial wastewater

Year	Fraction of wastewater treated anaerobically - WS_x		Methane Conversion Factor - MCF_x		Degradable Organic Component - D_{dom} [kg BOD/1000 persons/yr]		Fraction of BOD removed as sludge - DS_{dom}		CH_4 emissions		Difference (%)
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	109.65	109.65	0.00
1990	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	109.32	109.32	0.00
1991	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	109.31	109.31	0.00
1992	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	107.38	107.38	0.00
1993	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	107.1	107.1	0.00
1994	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	106.9	106.9	0.00
1995	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	111.57	111.57	0.00
1996	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	111.22	111.22	0.00
1997	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	110.86	110.86	0.00
1998	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	110.72	110.72	0.00
1999	0.050	0.050	0.9	0.9	21900	21900	0.35	0.35	110.54	110.54	0.00

Year	Fraction of wastewater treated anaerobically - WS_x		Methane Conversion Factor - MCF_x		Degradable Organic Component - D_{dom} [kg BOD/1000 persons/yr]		Fraction of BOD removed as sludge - DS_{dom}		CH_4 emissions		Difference (%)
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
2000	0.050	0.050	0.9	0.9	21900	21900	0.6	0.6	105.89	105.89	0.00
2001	0.050	0.050	0.9	0.9	21900	21900	0.6	0.6	101.37	101.37	0.00
2002	0.050	0.050	0.9	0.9	21900	21900	0.6	0.6	95.09	95.09	0.00
2003	0.050	0.050	0.9	0.9	21900	21900	0.6	0.6	90.59	90.59	0.00
2004	0.050	0.050	0.9	0.9	21900	21900	0.6	0.6	86.73	86.73	0.00
2005	0.050	0.050	0.9	0.9	21900	21900	0.6	0.6	83.79	83.79	0.00
2006	0.050	0.050	0.9	0.9	21438	21438	0.6	0.6	82.05	82.05	0.00
2007	0.050	0.050	0.9	0.9	21900	21900	0.6	0.6	82.72	82.72	0.00
2008	0.050	0.050	0.9	0.9	21900	21900	0.63	0.63	82.11	82.11	0.00
2009	0.050	0.050	0.9	0.9	21900	21900	0.63	0.63	81.83	81.83	0.00
2010	0.050	0.050	0.9	0.9	21900	21900	0.63	0.63	81.24	81.24	0.00
2011	0.050	0.050	0.9	0.9	21900	21900	0.63	0.63	81.34	81.34	0.00

Table 8.36 Changes made in activity data and their effects on emission estimates from domestic/commercial sludge

Year	Fraction of sludge treated anaerobically – SS_y		Methane Conversion Factor – MCF_y		Degradable Organic Component - D_{dom} [kg BOD/1000 persons/yr]		Fraction of BOD removed as sludge - DS_{dom}		CH_4 emissions		Difference (%)
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1989	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	3.44	3.44	0.00
1990	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	3.52	3.52	0.00
1991	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	3.51	3.51	0.00
1992	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	3.46	3.46	0.00
1993	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	3.47	3.47	0.00
1994	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	3.47	3.47	0.00
1995	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	2.17	2.17	0.00
1996	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	2.16	2.16	0.00
1997	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	2.16	2.16	0.00
1998	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	2.15	2.15	0.00

Year	Fraction of sludge treated anaerobically – SS_y		Methane Conversion Factor – MCF_y		Degradable Organic Component - D_{dom} [kg BOD/1000 persons/yr]		Fraction of BOD removed as sludge - DS_{dom}		CH_4 emissions		Difference (%)
	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	NGHGI 2013 v. 2.2	NGHGI 2014 v. 1.4	
1999	0.3	0.3	0.9	0.9	21900	21900	0.35	0.35	2.14	2.14	0.00
2000	0.3	0.3	0.9	0.9	21900	21900	0.6	0.6	5.24	5.24	0.00
2001	0.3	0.3	0.9	0.9	21900	21900	0.6	0.6	6.93	6.93	0.00
2002	0.3	0.3	0.9	0.9	21900	21900	0.6	0.6	8.38	8.38	0.00
2003	0.3	0.3	0.9	0.9	21900	21900	0.6	0.6	10.19	10.19	0.00
2004	0.3	0.3	0.9	0.9	21900	21900	0.6	0.6	11.08	11.08	0.00
2005	0.3	0.3	0.9	0.9	21900	21900	0.6	0.6	12.22	12.22	0.00
2006	0.3	0.3	0.9	0.9	21438	21438	0.6	0.6	12.65	12.65	0.00
2007	0.3	0.3	0.9	0.9	21900	21900	0.6	0.6	13.05	13.05	0.00
2008	0.3	0.3	0.9	0.9	21900	21900	0.63	0.63	13.89	13.89	0.00
2009	0.3	0.3	0.9	0.9	21900	21900	0.63	0.63	13.94	13.94	0.00
2010	0.3	0.3	0.9	0.9	21900	21900	0.63	0.63	14.62	14.62	0.00
2011	0.3	0.3	0.9	0.9	21900	21900	0.63	0.63	19.15	19.15	0.00

8.3.6 Source specific planned improvement including those in response to the review process

In order to improve the next submissions, we will include the parameters/emission factors associated on sludge that result from industrial wastewater treatment, the national authority analysing also the possibility to develop a study for estimates the CH4 emissions from industrial wastewater, in accordance with IPCC 2006.

8.4 Source category Waste Incineration (CRF sector 6.C)

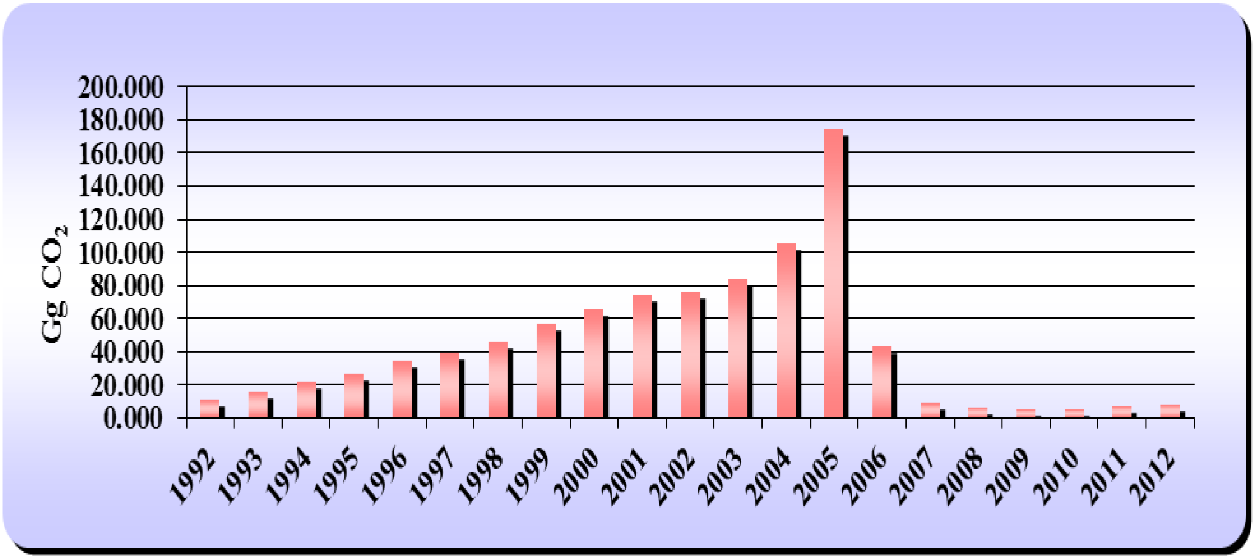
8.4.1 Source category description

Waste incineration includes emissions resulted from the incineration of clinical waste,hazardous waste, biogenic waste and, like other types of combustion, is a source of CO_2 and N_2O emissions. Based on the study "Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N_2O emissions resulting from waste incineration" finalized in 2013, were estimated the N_2O emissions by type of waste: industrial hazardous waste, industrial unhazardous waste, clinical waste, sewage sludge and other types of waste (slaughter waste, veterinary waste, waste from aircraft handling).

The biogenic emissions from waste incineration were estimated based on the study finalised in 2013, using the amounts of industrial unhazardous waste, veterinary waste, waste from aircrafts handling, sewage sludge and slaughter waste. In case of Romania, MSW are not incinerated due to the higher costs implied by this method in specific conditions of our country (humidity about 50% and calorific power < 8400 kJ/kg). As regards the clinical waste, this contain biogenic and fossil Carbon but we cannot determine with accurately in which proportion are each of these.

The CO_2 emissions from incinerated waste were calculated starting with 1992, because since this year we have activity data.

Figure 8.13 CO_2 emissions trend from waste incineration, for 1992–2012 period



The CO_2 emissions from waste incineration were calculated for hazardous and clinical waste.

In the estimation of CO_2 emissions from clinical waste incineration were used the amounts of waste incinerated provided by National Institute for Public Health.

Clinical waste are incinerated since 1996, but more accurate data became available after 2000. It can observe a period of increasing activity between 1999 and 2007. Since 2008 in Romania were closed all health units crematoria used to burn hazardous medical waste, in according with European regulations.

Based on the quantities of hazardous waste incinerated reported by NEPA(which include both with heat recovery and incineration without heat recovery), the study finalized in 2013 estimated the quantities of waste incinerated at national level without heat recovery.

Figure 8.14 CO_2 emissions trend from clinical waste incineration, for 1996–2012 period

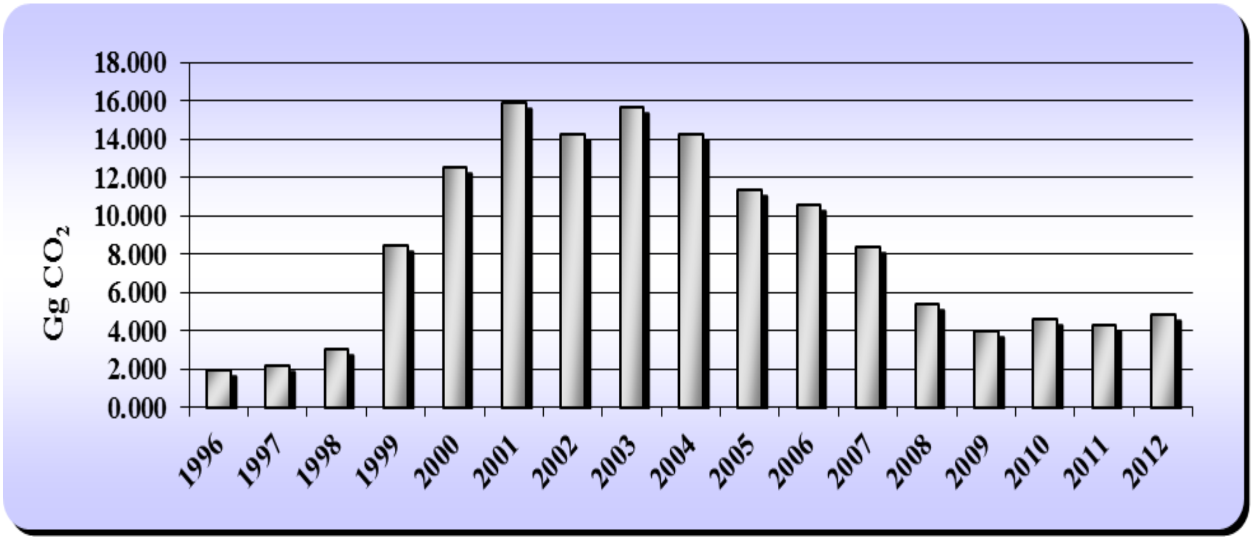


Figure 8.15 CO_2 emissions trend from hazardous waste incineration, for 1992–2012 period

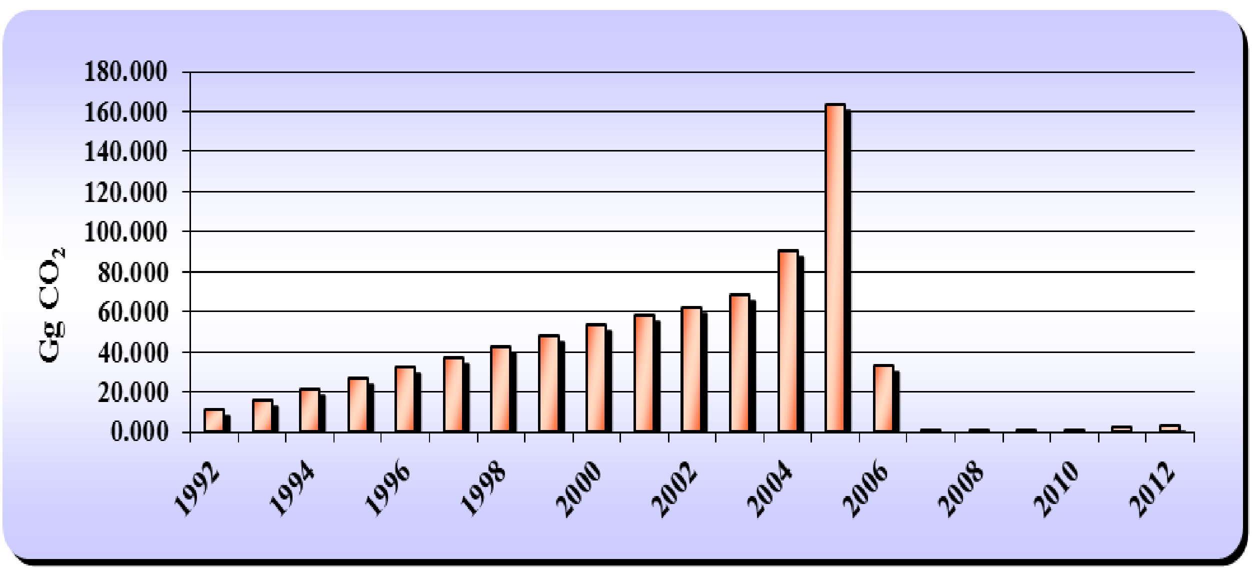
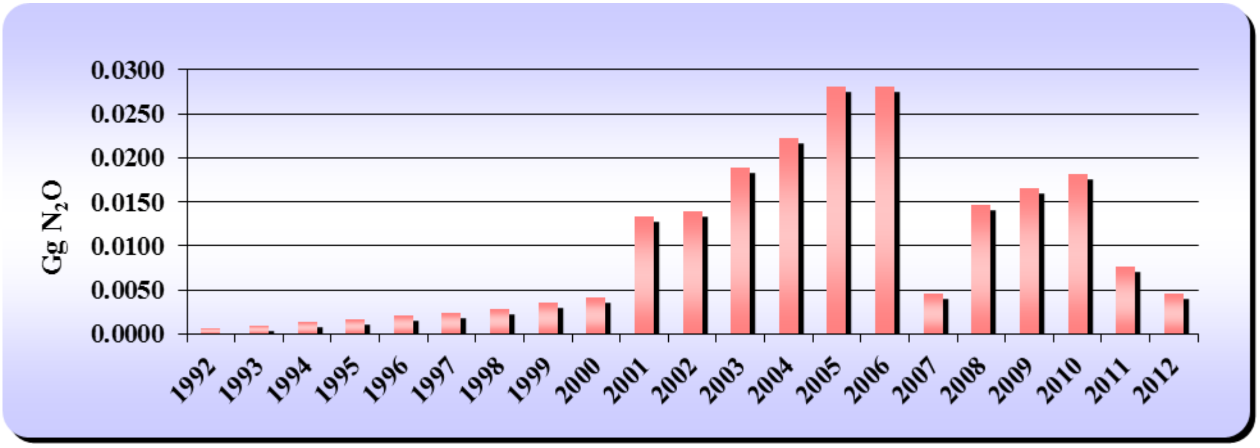


Figure 8.16 N_2O emissions trend from waste incineration, for 1992–2012 period



The N_2O emissions from waste incineration were calculated for hazardous , clinical and biogenic waste.

For estimation of N_2O emissions from clinical waste incineration were used the amounts of waste incinerated provided by National Institute for Public Health and for N_2O emissions from hazardous and biogenic waste we used the data provided by 2013 study.

Figure 8.17 N_2O emissions trend from clinical waste incineration, for 1996–2012 period

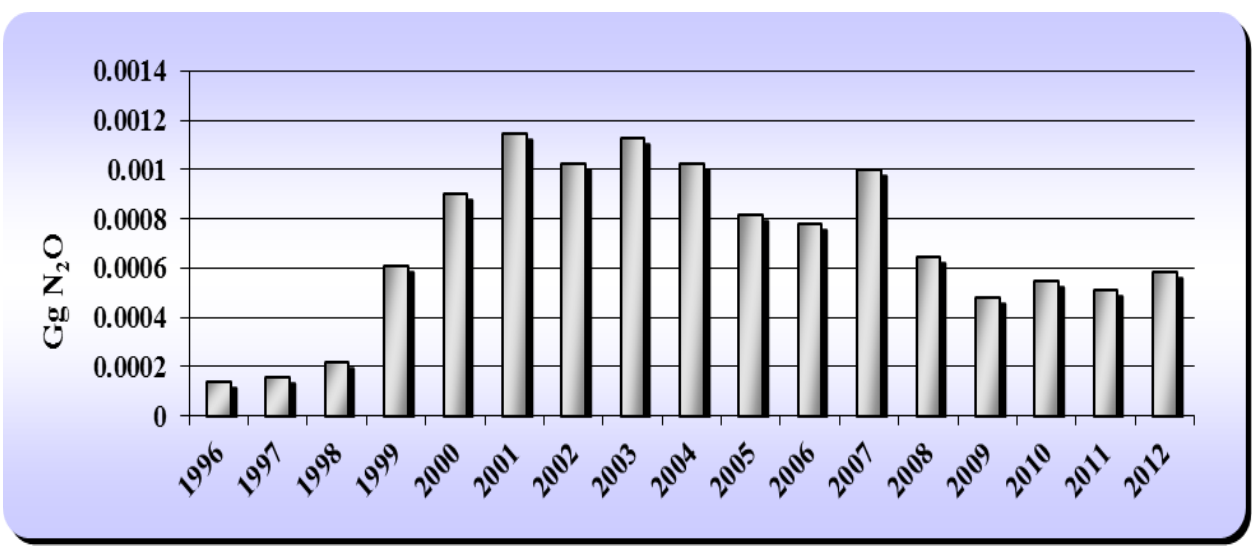


Figure 8.18 N_2O emissions trend from hazardous waste incineration, for 1992–2012 period

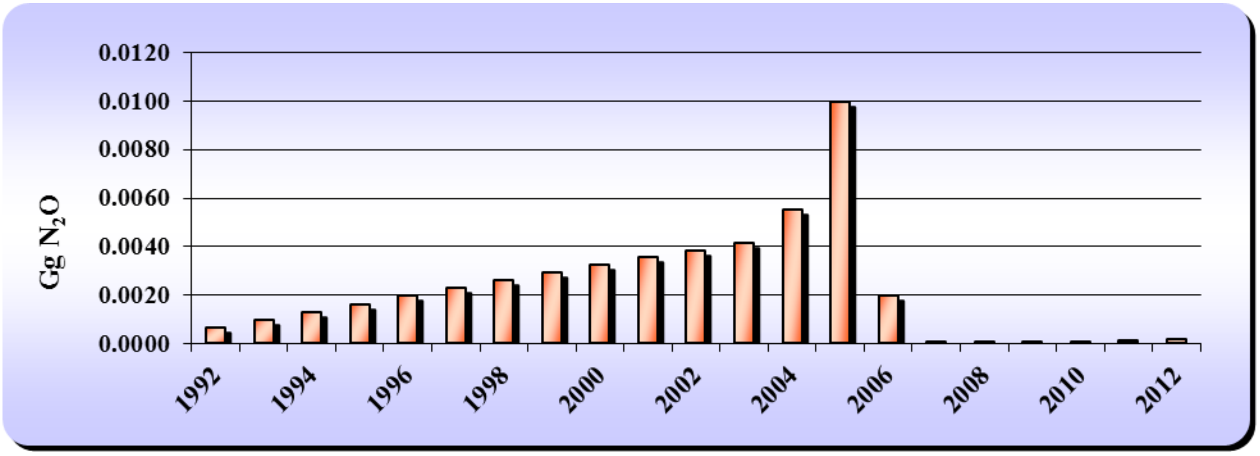
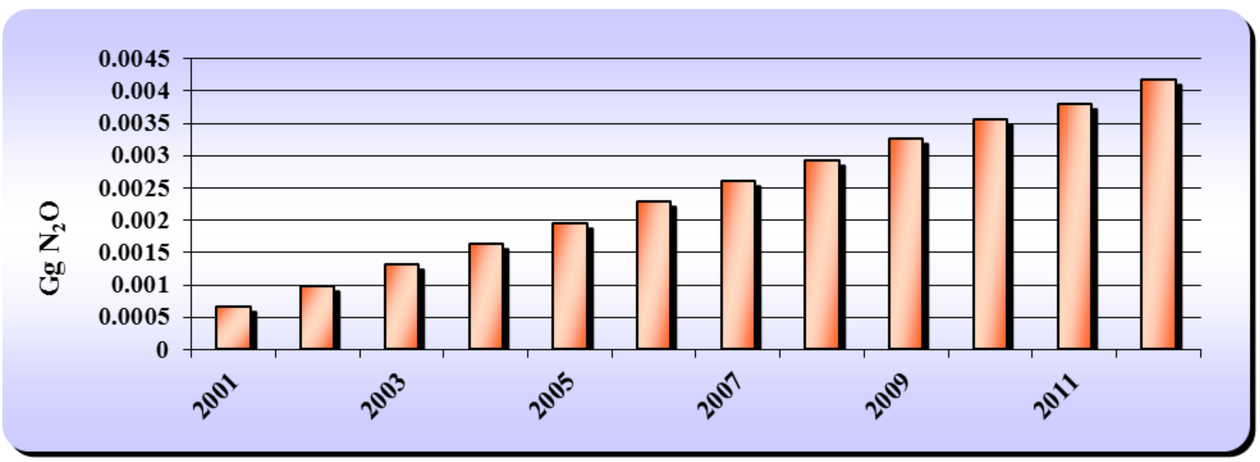


Figure 8.19 N_2O emissions trend from biogenic waste incineration, for 2001–2012 period



8.4.2 Methodological issues

Methodology

To calculate carbon dioxide emissions from waste incineration, the equation 5.11 from page 5.25 of IPCC GPG 2000 was used:

Equation 8.19 Carbon dioxide emissions from waste incineration

$$CO_2 \text{ emissions } (Gg/yr) = \sum_i (IW_i * CCW_i * FCF_i * EF_i * 44/12)$$

To calculate nitrous oxide emissions from waste incineration, the, Equation 5.5 from IPCC 2006 was used:

Equation 8.20 Nitrous oxide emissions from waste incineration

$$E_{N_2O}(Gg/an) = \sum (Wi \times FEi) \times 10^{-6}$$

Emissions factor

Default emission factors according to the provisions in IPCC GPG 2000 and IPCC 2006 have been used. The emissions factors are presented in Table 8.37 and Table 8.38.

Table 8.37 Default data for estimation of CO_2 emissions from waste incineration (Source: IPCC GPG 2000. table 5-6)

Emission Factors	Clinical Waste	Hazardous Waste
C content of Waste	60%	50%
Fossil Carbon as % of Total Carbon	40%	90%
Efficiency of Combustion	95%	99.5%

Table 8.38 Default data for estimation of N_2O emissions from waste incineration (Source: IPCC 2006)

Type of incinerated waste	N_2O emission factors, in gN_2O/t_{waste}	Source
Clinical waste	100	IPCC 2006, for industrial waste, all incinerator types
Industrial waste	100	IPCC 2006, for industrial waste, all incinerator types
Animal cremation waste	226	Study "Danish Emissions Inventory for Waste Incineration and other Waste"
Sludge from waste water treatment	900 (wet condition)	IPCC 2006, for incinerator plants

Activity data

Public Health Institute of Bucharest (ISPB) was provided the data on amounts of clinical waste generated and of clinical waste incinerated. From 2008, this type of waste was not burnt in improper installation. The data for 1996-1998 period were provided by National Research and Development Institute for Environmental Protection (see the Table 8.39).

Table 8.39 Amounts of clinical waste generated and incinerated (Source: ISPB and ICIM)

Year	Clinical waste generated	Clinical waste incinerated
	Unit [Gg/yr]	
1996	4.05	2.35
1997	4.96	2.63
1998	6.47	3.63
1999	10.15	10.15
2000	15.03	15.03

Year	Clinical waste generated	Clinical waste incinerated
	Unit [Gg/yr]	
2001	19.06	19.06
2002	17.60	17.03
2003	18.98	18.79
2004	17.55	17.03
2005	15.49	13.55
2006	14.84	12.61
2007	14.08	10.00
2008	11.11	6.44
2009	9.78	4.79
2010	10.50	5.46
2011	8.85	5.13
2012	8.93	5.81

Hazardous waste is generated by industrial sector. The amounts of hazardous waste incinerated without heat recovery were estimated by study finalized in 2013, based on data provided by Waste Directorate of NEPA for 2003-2012 and the amounts of incinerated hazardous waste estimated for 1992-2002 period, using backward trend extrapolation, by expert judgment.

The amount of industrial waste has been increased from 2003 until 2005 because operators must comply with European regulations and they incinerated a large amount of hazardous industrial waste.

Table 8.40 Amounts of hazardous, clinical and biogenic waste incinerated

Year	Hazardous waste		Clinical waste		Biogenic	
	Incinerated waste[Gg/yr]	Source	Incinerated waste[Gg/yr]	Source	Incinerated waste[Gg/yr]	Source
1992	6.64	Study 2013	-		-	-
1993	9.88		-	-	-	-
1994	13.11		-	-	-	-
1995	16.35		-	-	-	-
1996	19.58		2.35	ICIM	-	-
1997	22.82		2.63		-	-
1998	26.06		3.63		-	-
1999	29.29		10.15	Interpolation	-	-
2000	32.53		15.03	ISPB	-	-
2001	35.63		19.06		38.35	Study 2013
2002	38.06		17.03		40.42	
2003	41.70		18.79		60.02	
2004	55.33		17.03		69.42	
2005	99.54		13.55		76.33	
2006	20.06		12.61		218.40	
2007	0.45		10.00		17.04	
2008	0.75		6.44		63.18	
2009	0.53		4.79		73.31	
2010	0.56		5.46		78.58	
2011	1.50		5.13		32.95	
2012	1.79		5.81		19.61	

* Preliminary data (final data for 2010 will be provided after statistical survey of the end of this year)

8.4.3 Uncertainties and time series consistency

The values were elaborated in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.

In the table below are presented the uncertainties associated to CO_2 emissions from waste incineration.

Table 8.41 Uncertainties for estimation of CO_2 emissions from waste incineration

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
CO_2 from waste incineration	CO_2	5.00	20.00	20.62
N_2O from waste incineration	N_2O	5.00	50.00	50.2

The percentages are associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

8.4.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in the QA/QC Programme have been undertaken.

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectoral expert administrating the Solid Waste Disposal on Land category, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 166/2005/EC of the European Commission and in accordance with the Regulation 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change.

8.4.5 Source specific recalculation, including changes made in response to the review process

In order to improve the quality of emissions estimates the CO_2 emissions from hazardous waste incinerated without heat recovery were recalculated for 1992 – 2011 period based on the activity data provided by study *"Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N2O emissions resulting from waste incineration"*, finalized in 2013.

The differences between CO_2 emissions in 2013 v.2.2 submission and 2014 v.1.4 submission are presented in the table below.

Table 8.42 *Changes made in AD and their effects on emission estimates*

Year	**Amount of hazardous waste incinerated [Gg]**		**CO_2 emissions [Gg]**		**Difference**
	2013 v.2.2 submission	**2014 v.1.4 submission**	**2013 v.2.2 submission**	**2014 v.1.4 submission**	
1989	-	-	-	-	-
1990	-	-	-	-	-
1991	-	-	-	-	-
1992	6.64	6.64	10.90	10.90	0.00
1993	9.88	9.88	16.21	16.21	0.00

Year	Amount of hazardous waste incinerated [Gg]		CO_2 emissions [Gg]		Difference
	2013 v.2.2 submission	2014 v.1.4 submission	2013 v.2.2 submission	2014 v.1.4 submission	
1994	13.11	13.11	21.53	21.53	0.00
1995	16.35	16.35	26.84	26.84	0.00
1996	19.58	19.58	32.15	32.15	0.00
1997	22.82	22.82	37.47	37.47	0.00
1998	26.06	26.06	42.78	42.78	0.00
1999	29.29	29.29	48.09	48.09	0.00
2000	32.53	32.53	53.41	53.41	0.00
2001	35.77	35.63	58.72	58.49	-0.39
2002	39.00	38.06	64.03	62.48	-2.42
2003	42.74	41.70	70.17	68.47	-2.42
2004	56.70	55.33	93.09	90.83	-2.42
2005	102.00	99.54	167.47	163.41	-2.42
2006	215.59	20.06	353.94	32.93	-90.70
2007	1.38	0.45	2.26	0.75	-67.04
2008	1.95	0.75	3.21	1.22	-61.84
2009	2.27	0.53	3.73	0.87	-76.66
2010	29.99	0.56	49.23	0.93	-98.12
2011	80.86	1.50	132.76	2.46	-0.01

Starting 2014 submission, the N_2O emissions from hazardous, clinical and biogenic waste incinerated were estimated, taking into account the recommendations of Experts Review Team. The activity data were provided by 2013 study and the default emission factors and methodology according to IPCC 2006 were used.

8.4.6 Source specific planned improvement including those in response to the review process

In order to improve the next submission, we will try to upgrade the reporting in accordance with IPCC 2006.

9 OTHER (CRF sector 7)

There are no GHG emissions calculated, and could not be allocated to one of the categories.

10 Recalculations and improvements

This chapter presents the changes in GHG emissions/removals between the version 2.2 of the 2013 Greenhouse Gas Inventory submission and 2014 Greenhouse Gas Inventory submission. Since the 2013 version 2.2 submission, recalculations have been performed for almost all sectors. The recalculations have been carried out in order to account for better activity data (AD) and emission factors (EF) and to correct for some errors in the calculations.

The major changes in methodological descriptions in the present NIR, comparing to the NIR part of the version 2 of the 2013 NGHGI, are presented in Table 10.1.

Table 10.1 Major changes in methodological descriptions in the present NIR, comparing to the NIR part of the version 2 of the 2013 NGHGI, are presented in Table 10.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**DESCRIPTION OF METHODS**	**RECALCULATIONS**	**REFERENCE**
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (Sectoral Approach)			
1. Energy Industries			
2. Manufacturing Industries and Construction			
3. Transport	√	√	The major changes in methododological descriptions are associated to the Road Transport Subsector and to all gases; they are included in the NIR section 3.2.9.3.2 i-pages.
4. Other Sectors			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes			
A. Mineral Products			
B. Chemical Industry			
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF_6	√	√	A recalculation of the HFC, PFC and SF_6 emission estimates is performed for the full timeseries following a methodological change. The applied

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
			methodology is a bottom-up Tier 2 method, considering the emissions from manufacturing, operation and disposal of equipment on a sub-application level (CRF categories 2.F.1, 2.F.2, 2.F.3, 2.F.4 and 2.F.8). Detailed information about each sub-sector is provided in chapters 4.7.2 from the NIR.
G. Other			
3. Solvent and Other Product Use			
4. Agriculture			
A. Enteric Fermentation			
B. Manure Management			
C. Rice Cultivation			
D. Agricultural Soils			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry			
A. Forest Land			
B. Cropland			
C. Grassland			
D. Wetlands			
E. Settlements			
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
Land			
B. Waste-water Handling			
C. Waste Incineration			
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			
Aviation			
Marine			
Multilateral Operations			
CO_2 Emissions from Biomass			
NIR Chapter	**DESCRIPTION**		**REFERENCE**
	Please tick where the latest NIR		**If ticked please provide some more**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	Please tick where this is also reflected in recalculations compared to the previous year CRF	If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
	includes major changes in descriptions compared to the previous year NIR		detailed information for example reference to pages in the NIR
Chapter 1.2 Institutional arrangements			
Chapter 1.6 QA/QC plan			

10.1 Explanations and justifications for recalculations, including for KP-LULUCF activities

10.1.1 GHG Inventory

Recalculations by categories

The inventory contains improvements in the following sectors:

Energy

➢ **Public Electricity and Heat Production (1.A.1.a)**

Liquid Fuels

Activity data (AD)

- *Lignite Brown Coal:* 2009, 2010 years - Energy Balance activity data correction;
- *Refinery Gas*: 2006 year - Energy Balance activity data correction*;*
- *Residual Fuel Oil:* Own Use in Electricity, CHP and Heat Plants, 1999, 2001 years - Energy Balance activity data correction;
- *Gas from Biomass:* 2007 – 2009 period - Energy Balance activity data correction*;*
- *Motor Gasoline:* Net Calorific Value, 1990 - 2004 period - Energy Balance parameters correction.
- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Solid Fuels

Activity data

- *Lignite Brown Coal:* 2009, 2010 years - Energy Balance activity data correction.
- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

➢ **Petroleum Refineries (1.A.1.b)**

Liquid Fuels

Activity data (AD)

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Natural Gas

Activity data

- 2007 – 2011 period, Energy Balance activity data correction.

➢ **Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c)**

Liquid Fuels

Activity data

- *Motor Gasoline:* Net Calorific Value, 1990 - 2004 period - Energy Balance parameter correction;
- *Residual Fuel Oil:* 1999 year - Energy Balance activity data correction*;*
- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Solid Fuels

Activity data

- Coke *Oven Gas*: 2010 year - Energy Balance activity data correction;
- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

➢ **Iron and Steel (1.A.2.a)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Motor Gasoline: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction;*
- *Petroleum Coke*: 2000–2004 period - Energy Balance activity data correction.

Solid Fuels

Activity data

- *For the solid fuels reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;*
- *Coke Oven Coke*: 2011 year - Energy Balance activity data correction.

➢ **Manufacturing Industries and Construction, Chemicals (1.A.2.c)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Refinery Gas*: 2004, 2005, 2006 years - Energy Balance activity data correction;
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction;
- *Naphta*: 1999, 2000 years - Energy Balance activity data correction;
- *White Spirit & SBP*: 2005 – 2011 period - Energy Balance activity data correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Biomass

Activity data

- *Gas from Biomass*: 2010, 2011 years - Energy Balance activity data correction.

➢ **Fuel combustion, Manufacturing Industries and Construction, Pulp, Paper and Print (1.A.2.d)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Biomass Fuel

Activity data

- *Solid biomass*: 2000, 2002 years - Energy Balance activity data correction.

➢ **Manufacturing Industries and Construction, Food Processing, Beverages and Tobacco (1.A.2.e)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Naphta*: 2000 year - Energy Balance activity data correction;
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Biomass Fuel

Activity data

- *Gas biomass*: 2007, 2010, 2011 years - Energy Balance activity data correction.

- **Fuel combustion, Manufacturing Industries and Construction, Other (1.A.2.f)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Refinery Gas*: 2004, 2005, 2006 years - Energy Balance activity data correction;
- *LPG*: 2006 year - Energy Balance activity data correction;
- *Motor Gasoline*: Net Calorific Value, 1990 - 2004 period - Energy Balance parameter correction;
- *Petroleum Coke*: Non-Metallic Minerals, 2000 – 2004 period - Energy Balance activity data correction; Non-specified (Industry), 2000 – 2004 period - Energy Balance activity data correction;
- *Naphta*: Non-Metallic Minerals, 2000 year - Energy Balance activity data correction;
- *White Spirit & SBP*: Non-specified (Industry), 1998, 2005, 2010 years - Energy Balance activity data correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

Biomass

Activity data

- *Solid biomass*: 2000, 2001, 2004 – 2008 period - Energy Balance activity data correction;
- *Gas from Biomass*: 2002 year, 2007 – 2011 period - Energy Balance activity data correction.

Energy Transport

- **Civil aviation/Liquid fuels (1.A.3.A)**

Jet Kerosene

- recalculation for the 2011 year at AD: due to changes of value AD by the National Institute of Statistics (NSI). Recalculation for year 2011 at CO_2, CH_4 and N_2O emissions due to change value AD for this year.

- **Road Transportation/Liquid fuels (1.A.3.B)**

Motor Gasoline

- recalculations for the 1989 – 2011 period at AD due to update of value of Net Calorific Value (NCV);
- recalculations for 1989–2004 time-series: level of CO_2, CH_4 and N_2O emissions, fleet data from the National Institute of Statistics were processed and completed by the Romanian Auto Register (RAR) began to be used in the model Copert 4, Tier 1 (for $CO_{2,}$ country specific EF and $CH_{4,}$ N_2O default EF, was changed with a EMEP/EEA emission inventory guidebook 2013 EF, Tier 1);
- recalculations for 2005–2011 time-series: level of CO_2, CH_4 and N_2O emissions, AD used in the model Copert 4, due to was changed of values for monthly average minimum and maximum temperatures, solving an error.

Diesel Oil

- recalculations for the 1989 – 2011 period at AD due to update of value of Net Calorific Value (NCV);
- recalculations for 1989–2004 time-series: level of CO_2, CH_4 and N_2O emissions, fleet data from the National Institute of Statistics were processed and completed by the Romanian Auto Register (RAR) began to be used in the model Copert 4, Tier 1 (for $CO_{2,}$ country specific EF and $CH_{4,}$ N_2O default EF, was changed with a EMEP/EEA emission inventory guidebook 2013 EF, Tier 1);

- recalculations for 2005–2011 time-series: level of CO_2, CH_4 and N_2O emissions, AD used in the model Copert 4, due to was changed of values for monthly average minimum and maximum temperatures, solving an error.

LPG

- recalculations for 2002–2004 time-series: level of CO_2, CH_4 and N_2O emissions, EF derived as average from COPERT III model usage in the 2012 mars transmission, was changed with a EMEP/EEA emission inventory guidebook 2013 EF, Tier 1;
- recalculations for 2005–2011 time-series: level of CO_2, CH_4 and N_2O emissions, AD used in the model Copert 4, due to was changed of values for monthly average minimum and maximum temperatures, solving an error.

Other Kerosene

- recalculations for 1989–2011 time-series: level of CO_2, CH_4 and N_2O emissions, the fuel consumption of the Other Kerosene from the Energy Balance was added.

➢ **Road Transportation/Biomass (1.A.3.B)**

Biomass

- recalculations for the 2007–2011 period AD due to update the Energy Balance.

Railways (1.A.3.C)

➢ **Railways/ Liquid fuels (1.A.3.C)**

- recalculations for the 1989 – 2011 period at AD due to update of value of Net Calorific Value (NCV) for fuel used (Diesel Oil, Motor Gasoline, Residual Oil);
- recalculations for the 1989 – 2011 period at $CO_{2,}$ CH_4 and N_2O emissions level due to changed AD.

Other Kerosene

- recalculations for the 1989 – 2011 period at AD due to the introduction of the new fuel Other Kerosene from Energy Balance;

- recalculations for the 1989 – 2011 period at CO_2, CH_4 and N_2O emissions level due to changed AD

➢ **Railways/ Solid fuels (1.A.A.3.C)**

- recalculation for the 1989-1997, 2001, 2003 period at AD due to update of value of Net Calorific Value for fuel used: (Lignit, Other bitouminous coal, Coking coal);
- recalculations for the 1989-1997, 2001, 2003 period at CO_2, CH_4 and N_2O emissions level due to changed AD;
- The **Biomass fuel** started to be caracterized Other transport (please specify)/Other non-specified/Biomass1.A3.E.

Navigation (1A.3.D)

➢ **Navigation/Liquid fuels (1.A.3.D)**

Residual Oil

- recalculation for the 1989-2006 period at AD due to update of value of Net Calorific Value for this fuel;
- recalculations for the 1989-2006 period at CO_2, CH_4 and N_2O emissions level due to changed AD.

Diesel oil

- recalculations for the 1989 – 2011 period at AD due to update of value of Net Calorific Value for this fuel;
- recalculations for the 1989-2011 period at CO_2, CH_4 and N_2O emissions level due to changed AD.

Motor Gasoline

- recalculations for the 1989 – 2009 period at AD due to update of value of Net Calorific Value for this fuel;
- recalculations for the 1989-2009 period at CO_2 emissions level due to changed AD.

Other Transportation (please specify) (1.A.3.E)

- **Other Transportation (please specify)/Other non-specified/Liquid fuels (1.A.3.E)**

- recalculations for the 1989 – 2009, 2011 period at AD due to update of value of Net Calorific Value for this fuel;
- recalculations for the 1989-2009, 2011 period at CO_2, CH_4 and N_2O emissions level due to changed AD.

- **Other Sectors, Commercial/Institutional (1.A.4.a)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period, Energy Balance parameters correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

- **Other Sectors, Residential (1.A.4.b)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period, Energy Balance parameters correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

➢ **Other Sectors, Agriculture/ Forestry/ Fisheries (1.A.4.c)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period, Energy Balance parameter correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

➢ **Other (Not specified elsewhere), Stationary (1.A.5.a)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *White Spirit & SBP*: Non-specified (Other), 2005, 2006 years - Energy Balance activity data correction;
- *Motor Gasoline*: Net Calorific Value, 1990 - 2004 period, Energy Balance parameter correction.

Solid Fuels

Activity data

- *For the solid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used.

- **1AB – Reference Approach**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Motor Gasoline*: Net Calorific Value, 1990-2004 period, Energy Balance parameter correction;
- *Kerosene Type Jet Fuel*: Net Calorific Value, 1990-2004 period - Energy Balance parameter correction;
- *Transport Diesel*: Non-Energy Use in Transformation Sector, 2000, 2008 years - Energy Balance activity data correction;
- *Naphta*: Non-Energy Use in Industry, 2008–2011 period - Energy Balance activity data correction;
- *White Spirit & SBP*: Non-Energy Use in Industry, 2005–2011 period, Non-Energy Use in Other Sectors, 2005, 2006 years - Energy Balance activity data correction.

Solid Fuels

Activity Data

- *Other bituminous coal:* Indigenous Production, 1992 year - Energy Balance activity data correction;
- *Coke Oven Coke:* Indigenous Production, 2010 year - Energy Balance activity data correction.

- **Feedstocks and non-energy use of fuels (1.AD)**

Liquid Fuels

Activity data

- *For the liquid fuels* reported on the EU-ETS, national values of the net calorific power on the entire time-series, were used;
- *Transport Diesel*: Non-Energy Use in Transformation Sector, 2000, 2008 years - Energy Balance activity data correction;

- *Naphta:* Non-Energy Use in Industry, 2008–2011 period - Energy Balance activity data correction;
- *White Spirit & SBP:* Non-Energy Use in Industry, 2005–2011 period, Non-Energy Use in Other Sectors, 2005, 2006 years - Energy Balance activity data correction.

Solid Fuels

Activity data

- *Other bituminous coal:* Indigenous Production, 1992 year - Energy Balance activity data correction.

➢ **Fugitive Emissions from Solid Fuels (1.B.1.)**

Coal Mining and Handling

- recalculation in the Underground Mining Activities (1.B.1.A.1.1.) subcategory: due to a transcription error of the CH_4 emission from the spreadsheet in the CRF for 2011.

➢ **Fugitive Emissions from Oil and Natural Gas (1.B.2.)**

Natural Gas

- recalculation in the Other Leakage (1.B.2.B.5.1. at industrial plants and power station) subcategory: the activity data values for 2007-2011 period have been updated due to the update of the associated domain in the IEA/Questionnaire for 2012.

➢ **Aviation (1.C.1.A)**

Jet Kerosene

- recalculation for year 2011 at AD: due to changes of value AD by the National Institute of Statistics (NSI). Recalculation for year 2011 at CO_2, CH_4 and N_2O emissions due to change value AD for this year.

- **Marine (1.C.1.B)**

Diesel Oil

- recalculations for the 1998, 2007-2011 period at AD due to update of value of Net Calorific Value for this fuel;
- recalculations for the 1998, 2007-2011 period at CO_2, CO_2, CH_4 and N_2O emissions level due to changed AD;
- recalculations for the 1998, 2007-2011 period due to a transcription error of the CH_4 and N_2O emissions values from the spreadsheet in the CRF.

Residual Fuel Oil

- recalculations for the 2006-2009 period at AD due to update of value of Net Calorific Value for this fuel;
- recalculations for the 2006-2009 period at CO_2, CH_4 and N_2O emissions level due to changed AD;
- recalculations for the 2006-2009 period due to a transcription error of the CH_4 and N_2O emissions values from the spreadsheet in the CRF.

Industrial Processes

- **Refrigeration and Air-conditioning (2.F.1)**

- in the previous submission the actual emissions were estimated based on the cluster method for this category and emission estimates were not disaggregated by type of F-gas. For the current submission was collected detailed activity data for the full time series and was prepared a complete emission estimate by individual type of F-gas based on a bottom-up Tier 2 approach. For subcategories 2.F.1.1, 2.F.1.3, 2.F.1.5, 2.F.1.6 the activity data is based on official statistical information. For subcategories 2.F.1.2 and 2.F.1.4 the activity data was collected with questionnaires from licensed servicing companies.

➢ **Foam blowing (2.F.2)**

- in the previous submission the actual emissions were estimated based on the cluster method for this category and emission estimates were not disaggregated by type of F-gas. For the current submission was collected detailed activity data for the full time series and was prepared a complete emission estimate by individual type of F-gas based on a bottom-up Tier 2 approach. The activity data was collected with questionnaires from relevant production companies.

➢ **Fire extinguishers (2.F.3)**

- in the previous submission the actual emissions were estimated based on the cluster method for this category and emission estimates were not disaggregated by type of F-gas. For the current submission was collected detailed activity data for the full time series and was prepared a complete emission estimate by individual type of F-gas based on a bottom-up Tier 2 approach. The activity data was provided from relevant governmental institutions.

➢ **Aerosols / Metered dose inhalers (2.F.4)**

- in the previous submission the actual emissions were estimated based on the cluster method for this category and emission estimates were not disaggregated by type of F-gas. For the current submission was collected detailed activity data for the full time series and was prepared a complete emission estimate by individual type of F-gas based on a bottom-up Tier 2 approach. The activity data was collected with questionnaires from relevant importer companies.

➢ **Electrical equipment (2.F.8)**

- in the previous submission the actual emissions were reported as not occurring. For the current submission was collected detailed activity data for the full time series and was prepared a complete emission estimate based on a bottom-up Tier 2 approach. The activity data was collected with questionnaires from relevant operator companies.

- **Other (2.F.9)**

- in the previous submission in this category were reported the actual emissions collected through questionnaires from various economic entities. In the current submission no emissions are reported in this category, since all of the occurring submissions are allocated to the respective subcategory.

LULUCF

Regarding changes in AD for the year 2011, the official reporter (NSI) supplied an official response (5260/10.12.2013) to the NGHGI Compiler that explained the fact that a province of Romania has reported erroneous data regarding their land use areas. Changes that were recorded are the following (~kha): 42 for FL, 28 for CL, 3 for GL, 1 for WL, 12 for SL and 1 for OL. No impact on the trend has been registered.

For the entire time series many improvements have been recorded including:

- the change of C stock in living biomass in 5.A.2 was determined based on new data and information from two research projects. Data collected allowed derivation of plantations biomass equations for 3 major group of plantations (Robinia, oak, poplar and willows). New data from the JI project is now used to estimate the litter pool. More details can be found in Chapter 7.2.3.2. The following recalculations occurred:
    - 5.A.2 and AR: CSC in LB Gains led to ~ 35% difference; CSC in DOM ranged from -94% to -300%;
- after an expert meeting regarding the cultivation of histosols in Romania (no. 97901 / DGSC/ 17.02.2014) a conclusion has been reached that there is no cultivation of histosols as these activities are very expensive and that the official activity data for these soils is 5kha. This resulted in recalculations of the estimations on organic soils under 5.B.1 Cropland remaining Cropland and 5.C.1 Grassland remaining Grassland that were made to be consistent with FAOSTAT database. In conclusion, 5.C.1 reports NO for AD and emissions and 5.B.1 reports 5kha for AD and NO for carbon emissions;
- Biomass accumulation rate (0.3 tC/ha/year) for woody perennial crops is now used for 15 years also biomass C losses were changed from the default 63 tC/ha to 4.43 tC/ha. Both factors are from the neighboring country Hungary. This led to recalculations of about -

150% regarding LB gains and about -1500% regarding LB losses because of the huge difference between the default EFs. But this is now more consistent with the estimations of the majority of countries in Europe. No impact on the trend has been registered;

- Revegetation estimates for LB and DOM where recalculated by considering total area manages as revegetated land in the base year and commitment period years (previous estimates for CP years where derived only for post 1990 established area of revegetation);
- a change of 4.2% in wildfires areas in AR resulted from a conservative approach that was taken by assuming that officially reported wildfire burned area is shared between AR (4,2%) and FM (95.8%). This of course led to changes of about -4% in estimations for CO_2, CH_4 and N_2O in Table 5(V) in Forest Land remaining Forest Land and Kyoto Protocol FM activity. No impact on the trend has been registered;
- CO_2 emissions from organic soils is reported as IE in 5B2.3 as included under estimates of emissions from area organic soils under 5B1 (from 1990 there is no new drainage, or if there is then it is an insignificant area). For organic soils area, CO_2 emissions under LULUCF are estimated for the entire time series using IPCC default emission factor for cropland under 'warm temperate dry' zone of 10tC/ha/yr. No impact on the trend has been registered;
- for Table 5(III) N_2O emissions from areas GL, WL under conversions to CL was recalculated for the entire time series, because of an error (which drove IEF to be continually growing). Amount of soil C mineralized (kgC/yr) was 850 KgC/ha/yr. IPCC default values were used: C/N ratio (~15) and emission factor for N (~0.0125 kg N_2O-N/kg N). Thus IEF is constant around 0.01 kg N_2O-N/ha;
- for completeness we introduced estimations for living biomass losses when conversion to Forest Land occurred. For conversions from GL and WL an initial biomass equal to 1.7tDM/ha (=0.85tC/ha, updated from 0.8 previously) has been applied, The same value is applied for conversions to GL. We assumed no change between biomass in conversions between GL and WL. The changes applied to both UNFCCC and KP, for the entire time series.

Waste

- **Managed Waste Disposal on Land (6.A.1)**

- activity data on the quantities of sewage sludge deposited in managed were estimated through the study *"Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N_2O emissions resulting from waste incineration",* finalized in 2013;
- CH_4 emissions were recalculated for 2011 year because preliminary data related to both the amount of MSW and the amount of sewage sludge deposited to SWDS became final data.
- the amount of MSW deposited in managed SWDS in 2011 was updated based on annual statistical survey made by Waste directorate of NEPA
- the amount of MSW deposited in managed SWDS in 2012 was estimated by Waste Directorate of NEPA using the amount of MSW deposited in 2011 and the waste generation rate.
- the amount of CH_4 recovery was changed for 2011 year due to an error of reporting data in this year.

- **Unmanaged Waste Disposal on Land (6.A.2)**

- activity data on the quantities of sewage sludge deposited in unmanaged deep and shallow sites were estimated through the study *"Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N_2O emissions resulting from waste incineration",* finalized in 2013;
- CH_4 emissions were recalculated for 2011 year because preliminary data related to both the amount of MSW and the amount of sewage sludge disposal in deep and shallow unmanaged sites became final data.

- the amount of MSW deposited in unmanaged SWDS in 2011 was updated based on annual statistical survey made by Waste directorate of NEPA.
- the amount of MSW deposited in unmanaged SWDS in 2012 was estimated by Waste Directorate of NEPA using the amount of MSW deposited in 2011 and the waste generation rate.

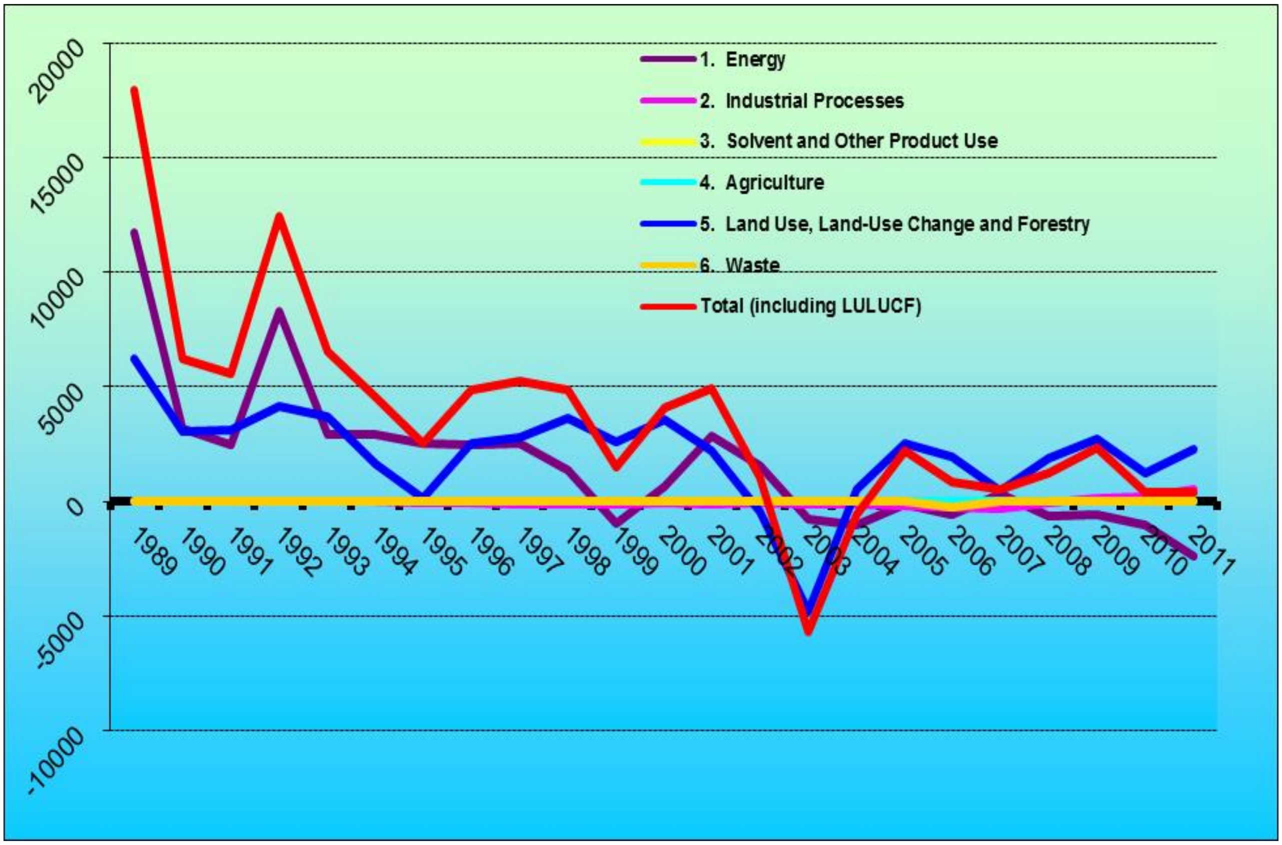
➢ **Wastewater Handling (6.B)**

- the N_2O emissions from human sewage were recalculated for 2012 year taking into account the final data associated to total number of population, data provided by National Institute of Statistics at the end of January 2014.

➢ **Waste Incineration (6.C)**

- the CO_2 emissions from hazardous waste incinerated without heat recovery were recalculated for 1992 – 2011 period based on the activity data provided by study *"Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012). Determining the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012. Assesing the N_2O emissions resulting from waste incineration"*, finalized in 2013;
- starting 2014 submission, the N_2O emissions from hazardous, clinical and biogenic waste incinerated were estimated, taking into account the recommendations of Experts Review Team. The activity data were provided by 2013 study and the default emission factors and methodology according to IPCC 2006 were used.

Figure 10.1 Change in pollutant specific total emissions/removals, for all source/absorber categories, and for the entire time series, in comparison to the 2013 version 2.2 report



Recalculations by gases

CO_2 recalculations were carried out in the following sectors:

- Civil Aviation (1.A.3.A);
- Road Transport (1.A.3.B);
- Railways (1.A.3.C);
- Navigation (1.A.3.D);
- Other Transportation (1.A.3.E);
- International Transport –Bunkers (1.C.1);
- Forest Land (5.A);
- Forest Lands remaining Forest Land (5.A.1);
- Land converted to Forest Land (5.A.2);

- Cropland (5.B);
- Cropland remaining Cropland (5.B.1);
- Grassland converted to Cropland (5.B.2.2);
- Grassland (5.C);
- Forest Land converted to Grassland (5.C.2.1);
- Cropland converted to Grassland (5.C.2.2);
- Settlements converted to Grassland (5.C.2.4);
- Other Lands converted to Grassland (5.C.2.5);
- Wetlands (5.D);
- Forest Land converted to Wetlands (5.D.2.1);
- Other Lands converted to Wetlands (5.D.2.5);
- Settlements (5.E);
- Forest Land converted to Settlements (5.E.2.1);
- Cropland converted to Settlements (5.E.2.2);
- Other Lands converted to Settlements (5.E.2.5);
- Other Lands (5.F);
- Forest Land converted to Other Lands (5.F.2.1);
- Cropland converted to Other Lands (5.F.2.2);
- Wetlands converted to Other Lands (5.F.2.4);
- Settlements converted to Other Lands (5.F.2.5);
- Waste incineration (6.C).

CH_4/N_2O recalculations were carried out in the following sectors:

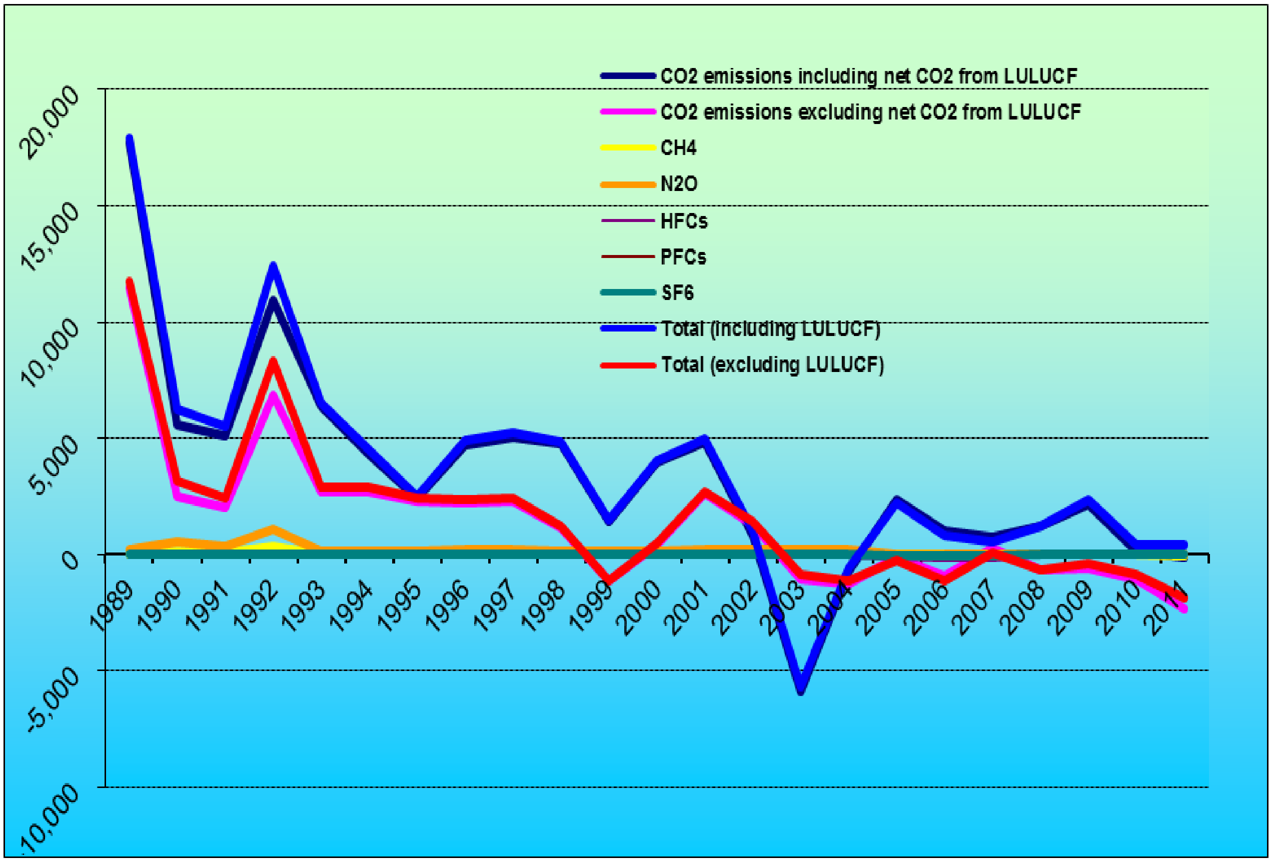
- Civil Aviation (1.AA.3.A);
- Road Transport (1.AA.3.B);
- Railways (1.AA.3.C);
- Navigation (1.AA.3.D);
- Other Transportation (1.AA.3.E);
- Road Transport (1.A.3.B);
- Underground Mines – Mining Activities (1.B.1.A.1.1.);

- Other Leakage (1.B.2.B.5.1.);
- International Transport –Bunkers (1.C.1);
- Cropland (5.B);
- Wetlands converted to Cropland (5.B.2.3);
- Solid Waste Disposal on Land (6.A);
- Wastewater Handling (6.B);
- Waste Incineration (6.C).

HFC/PFC/SF_6 recalculations were carried out in the following sectors:

- Refrigeration and Air-conditioning (2.F.1);
- Foam blowing (2.F.2);
- Fire extinguishers (2.F.3);
- Aerosols / Metered dose inhalers (2.F.4);
- Electrical equipment (2.F.8);
- Other (2.F.9);

Figure 10.2 Category total emissions/removals change, for all gases, and for the entire time series, in comparison to the figures in the 2013 version 2.2 submission



10.1.2 KP-LULUCF inventory

Recalculations by categories

The inventory contains improvements in the following sectors:

- recalculations were made on Change in Carbon Stock (emissions/removals) for 2008-2011 period in Afforestation and Reforestation (KP.A.1.);
- recalculations were made on Change in Carbon Stock (emissions/removals) for 2008-2011 period in Forest Management (KP.B.1);

Recalculations by gases

CO_2 recalculations were carried out in the following sectors:

- Afforestation and Reforestation (KP.A.1.);
- Deforestation (KP.A.2);
- Forest Management (KP.B.1);
- Revegetation (KP.B.4).

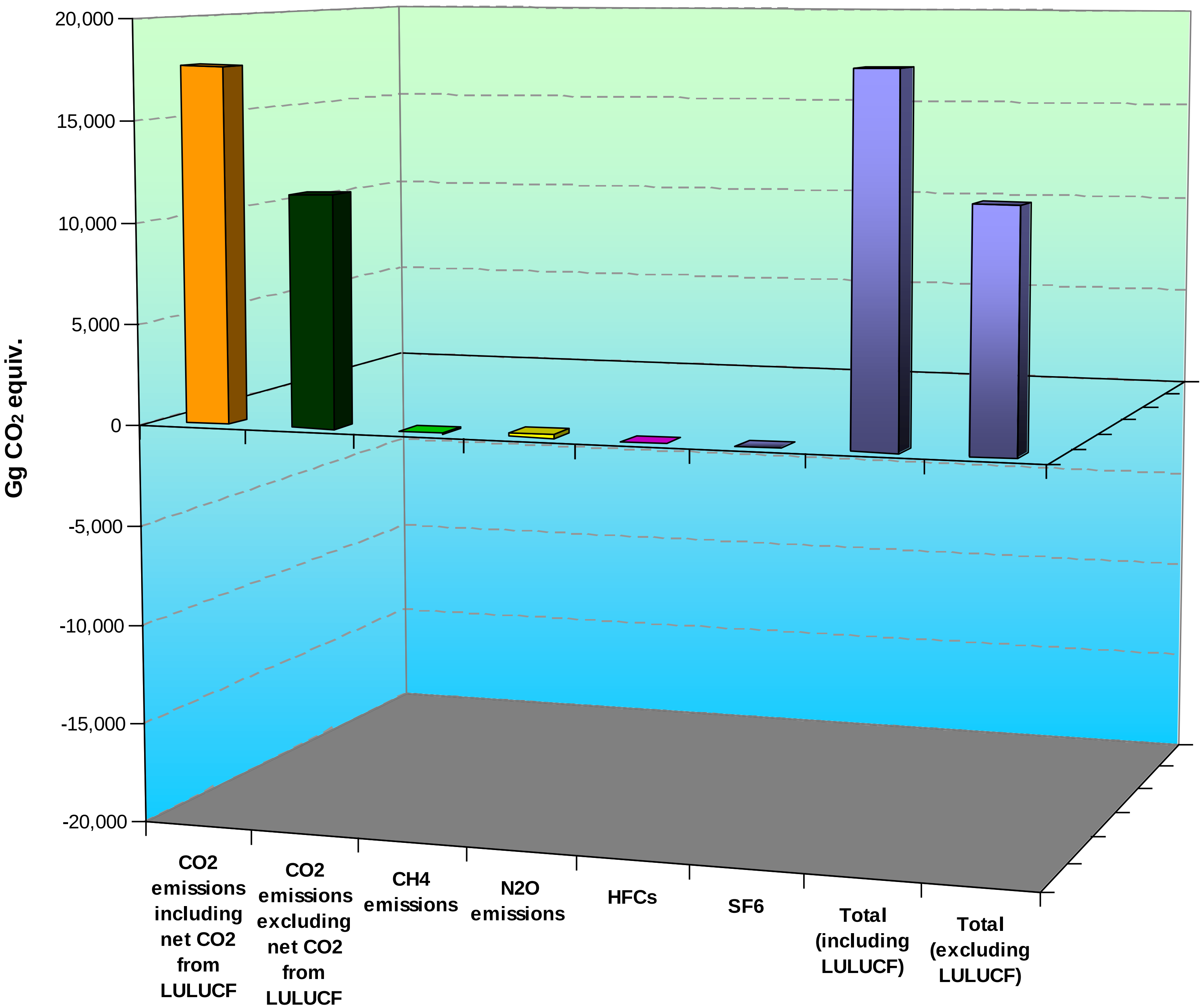
10.2 Implications for emissions levels, including on KP-LULUCF emissions levels

10.2.1 GHG inventory

Emissions changes due to recalculations, for 1989 are as follows:

- ➢ CO_2 including LULUCF (10.16%), CO_2 excluding LULUCF (5.86%);
- ➢ CH_4 (0.08%);
- ➢ N_2O (0.79%);
- ➢ HFC (100%);
- ➢ SF_6 (100%);
- ➢ Total GHG including LULUCF (7.13%);
- ➢ Total GHG excluding LULUCF (4.29%).

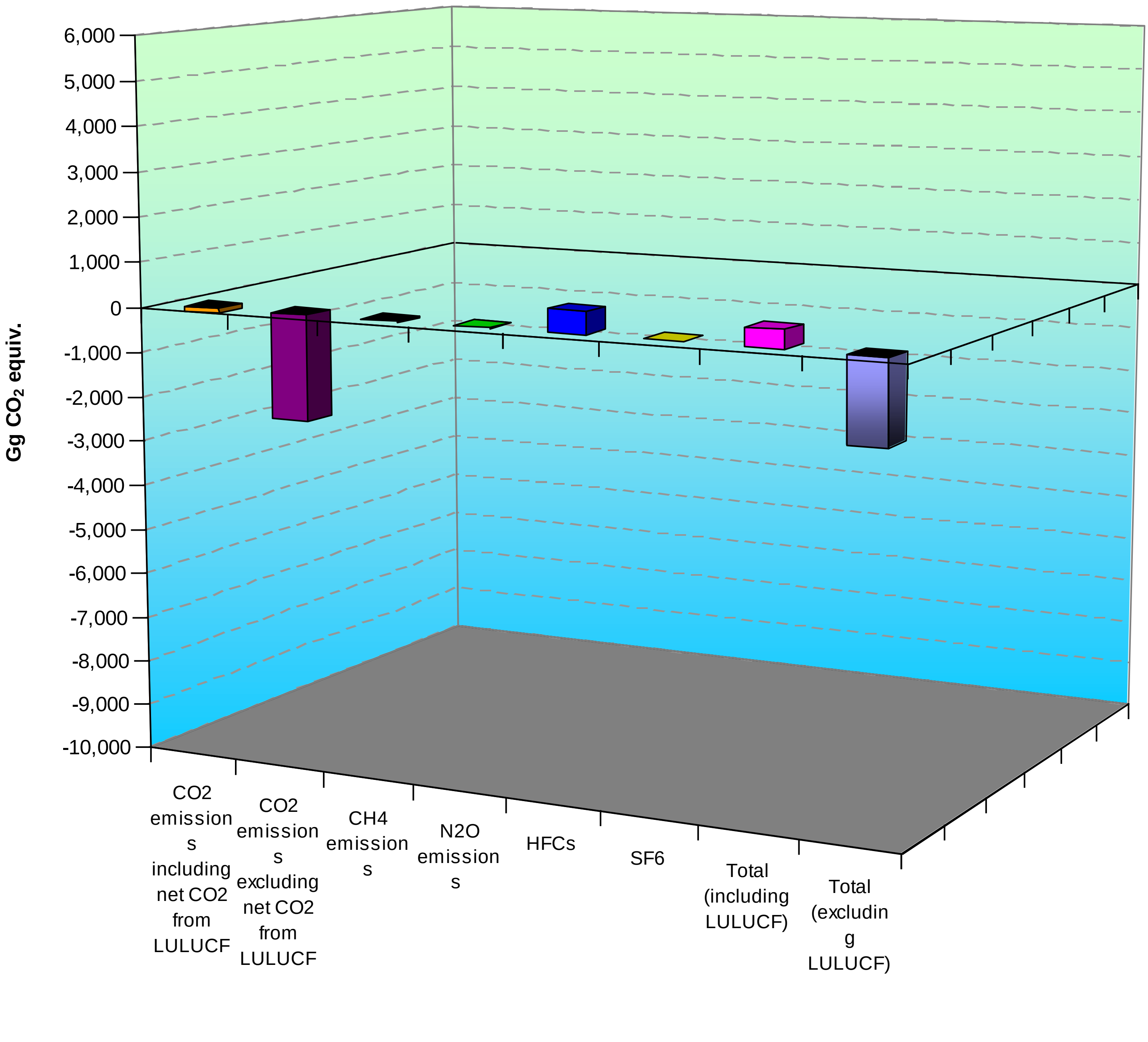
Figure 10.3 Effects of recalculations (presented in the 2014 submission) for 1989, by gas



Emissions changes due to recalculations, for 2011, are as follows:

- CO_2 including LULUCF (-0.17%), CO_2 excluding LULUCF (-2.68%);
- CH_4 including LULUCF (-0.08%), CH_4 excluding LULUCF (-0.12%);
- N_2O (0.03%);
- HFC (114.64%);
- SF_6 (433.36%);
- Total GHG including LULUCF (0.42%);
- Total GHG excluding LULUCF (-1.50%).

Figure 10.4 Effects of recalculations (presented in the 2014 submission) for 2011, by gas



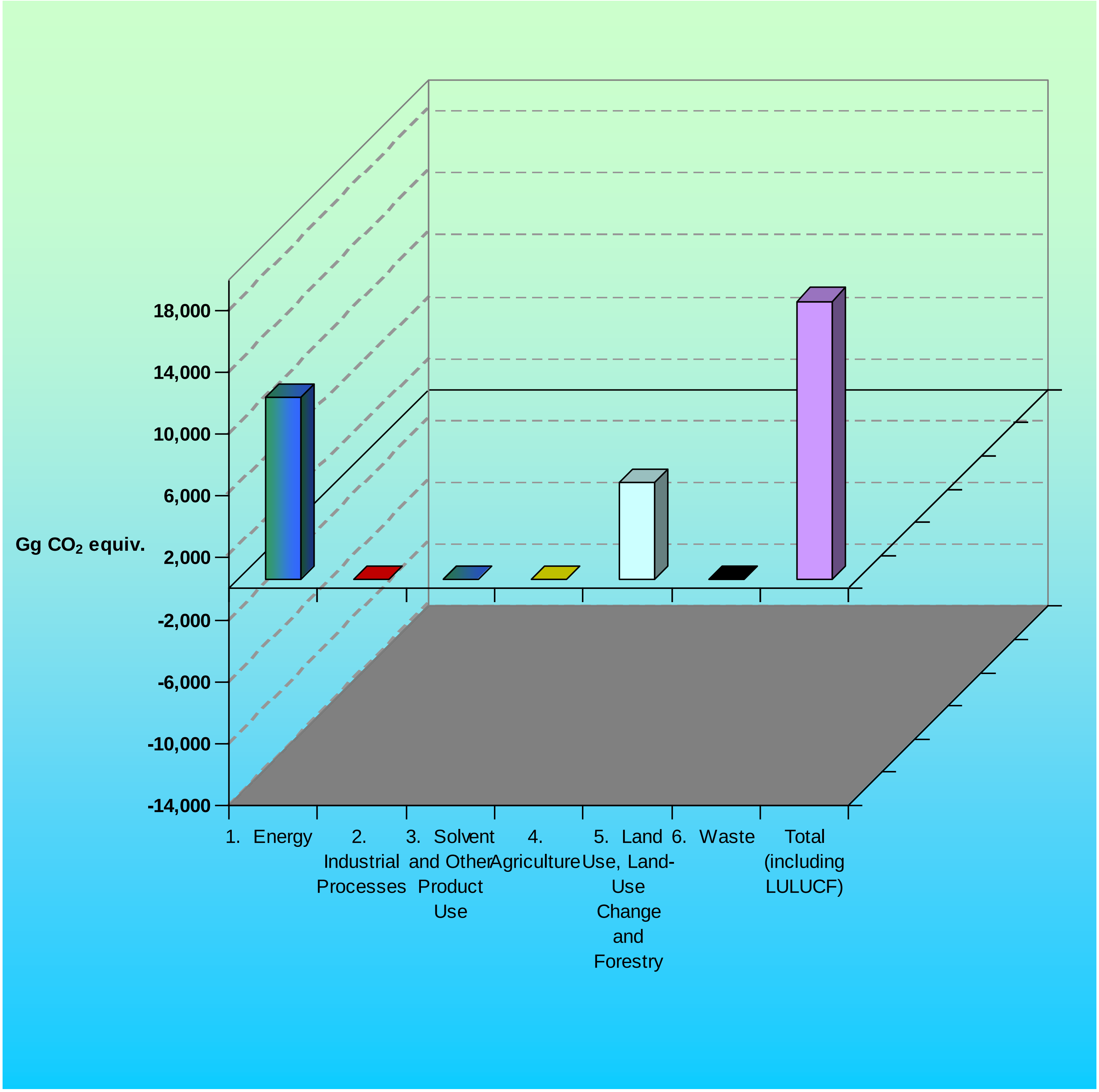
Impacts on 1989 emissions levels

Total emissions in 1989 including LULUCF have increased with 7.13% compared to the 2013 version 2.2 submission.

Table 10.2 Recalculation of total emissions/removals, by sector, for all gases, for 1989

Differences for 1989 estimates	**Differences**		**2014 v. 1.4**	**2013 v. 2.2**
	Gg CO_2 eq.	**%**	**Gg CO_2 eq.**	**Gg CO_2 eq.**
1. Energy	11,735.45	6.12	203,544.60	191,809.14
2. Industrial Processes	0.52	0.00	35,466.64	35,466.12
3. Solvent and Other Product Use	0.00	0.00	645.80	645.80
4. Agriculture	0.00	0.00	40,734.14	40,734.14
5. Land Use, Land-Use Change and Forestry	6,220.65	-28.92	-15,292.01	-21,512.67
6. Waste	0.00	0.00	4,656.56	4,670.31
Total (including LULUCF)	17,956.63	7.13	269,755.73	251,812.84

Figure 10.5 Changes of 1989 emissions/removals, in respect to the 2014 figures

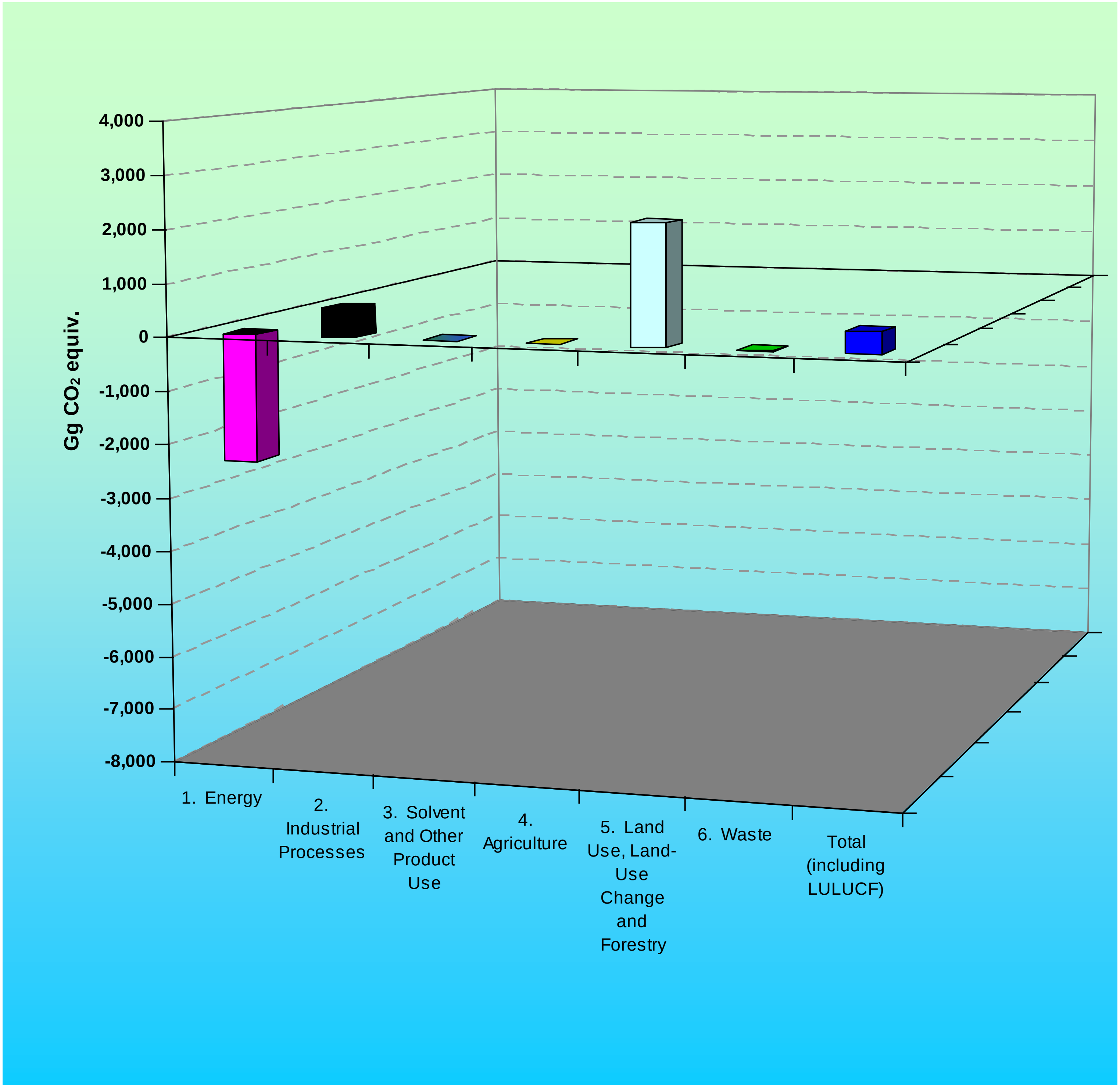


Total emissions in 2011, including LULUCF have increased with 0.42% compared to the 2013 submission Version 2.2.

Table 10.3 Recalculation of total emissions/removals, by sector, for all gases, for 2011

Differences for 2011 estimates	**Differences**		**2014 v.1.4**	**2013 v.2.2**
	Gg CO_2 eq.	**%**	**Gg CO_2 eq.**	**Gg CO_2 eq.**
1. Energy	-2,391.62	-2.77	83,928.84	86,320.46
2. Industrial Processes	536.27	4.25	13,141.40	12,605.14
3. Solvent and Other Product Use	0.00	0.00	125.61	125.61
4. Agriculture	0.00	0.00	18,941.46	18,941.46
5.Land Use, Land-Use Change and Forestry	2,259.12	-8.93	-23,045.82	-25,304.94
6. Waste	9.71	0.18	5,376.19	5,366.48
Total (including LULUCF)	413.48	0.42	98,467.69	98,054.21

Figure 10.6 Changes of 2011 emissions/removals, in respect to the 2014 figures



10.2.2 KP-LULUCF inventory

Emissions changes due to recalculations, as follows:

- Afforestation and Reforestation
  - compared to 2008 year, in 2011 year Net CO_2 equivalent emissions/removals have increased with 9%.
- Deforestation
  - compared to 2008 year, in 2011 year Net CO_2 equivalent emissions/removals have decreased with 79%.
- Forest Management
  - compared to 2008 year, in 2011 year Net CO_2 equivalent emissions/removals have increased with 3%.
- Revegetation
  - compared to 1989 year, in 2008 year Net CO_2 equivalent emissions/removals have decreased with 23%;
  - compared to 2008 year, in 2011 year Net CO_2 equivalent emissions/removals have increased with 2%.

10.3 Implications for emissions trends, including time series consistency, and also for KP-LULUCF trends and time series consistency

10.3.1 GHG inventory

The time-series consistency has been improved as a result of recalculations.

10.3.2 KP-LULUCF inventory

The time-series consistency has been improved as a result of recalculations.

10.4 Recalculations, including in response to the review process, and planned improvements to the inventory including for the KP-LULUCF activities

10.4.1 GHG inventory

The planned improvements for GHG Inventory activities are presented in table below:

Table 10.4 Summary of planned improvements GHG Inventory activities

No.	Category subject to improvement	Description of improvement
Energy		
1	Fuel combustion (CRF 1.A)	**Activity Data:** Further investigations and co-operation with Romanian Institute for Statistics will be conducted in order to have a fully correspondence, concerning the definitions (fuel's calorific power) and quantities of the fuels, between the declarations of the operators must report both, on EU-ETS and to NIS. The assumptions of NCVs associated to the Energy Balance consumption of the fuels, on a sum of years, will be submitted to the provider of the documents, in order to be approved and included in the future in the Energy Balance. ISPE Study provided an analysis regarding the share of EU-ETS reporting to the Energy Balance. A further analysis on the EU-ETS 2012 reporting (object of a further Study) will be conducted in order to take into consideration these emissions, as Tier 3 approach, on the activity category where these operators have to report.

No.	Category subject to improvement	Description of improvement
		Emission Factors: Further to the recommendation of the Study, regarding the National Emission Factors usage, annually, following the procedure provided by this document (or, as an object of further Study), will be calculated the emission factors resulting from the EU-ETS operators reporting.
2	Public Electricity And Heat Production (CRF 1.A.1.a)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
3	Petroleum Refining (CRF 1.A.1.b)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
4	Manufacture of Solid Fuels and Other Energy Industries (CRF 1.A.1.c.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
5	Fuel combustion, Manufacturing Industries and Construction - Iron and Steel (CRF 1.A.2.a)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.

No.	Category subject to improvement	Description of improvement
		See the chapter 3.2.6.6 for more details.
6	Fuel combustion, Manufacturing Industries and Construction, Chemicals (CRF 1.A.2.c.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
7	Fuel combustion, Manufacturing Industries and Construction, Pulp, Paper and Print (CRF 1.A.2.d.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
8	Fuel combustion, Manufacturing Industries and Construction, Food Processing, Beverages and Tobacco (CRF 1.A.2.e.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
9	Fuel combustion, Manufacturing Industries and Construction, Other (please specify) (CRF 1.A.2.f.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
10	Transport- Civil aviation (CRF 1.A.3.a)	It is planned further co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.
11	Transport - Road ransport	In order to improve the quality of inventory,

No.	Category subject to improvement	Description of improvement
	(CRF 1.A.3.b)	implementation requirements and future recommendations consistent with IPCC 2006.
12	Transport – Railways (CRF 1.A.3.c)	It is planned further co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.
13	Transport- Navigation (CRF 1.A.3.d)	It is planned further co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.
14	Transport - Other Transportation (CRF 1.A.3.e)	It is planned further co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.
15	Fuel combustion, Other Sectors – Commercial / Institutional (CRF 1.A.4.a)	See the chapter 3.2.6.6 for more details.
16	Fuel combustion, Other Sectors – Agriculture / Forestry / Fisheries (CRF 1.A.4.c)	See the chapter 3.2.6.6 for more details.
17	Fuel combustion, Other (Not specified elsewhere) – Stationary (CRF 1.A.5.a)	See the chapter 3.2.6.6 for more details.
Industrial Processes		
1	Iron and steel Production (CRF 2.C.1)	Will need investment of resources to address changes to be compliant with IPCC 2006.
2	Lime production (CRF 2.A.2)	Will need investment of resources to address changes to be compliant with IPCC 2006.
3	Glass production	Will need investment of resources to address

No.	Category subject to improvement	Description of improvement
	(2.A.7.1)	changes to be compliant with IPCC 2006.
4	Nitric acid production (CRF 2.B.2)	Will need investment of resources to address changes to be compliant with IPCC 2006.
Agriculture		
1	Source category Enteric Fermentation (CRF source category 4.A)	Aiming to their incorporation into next inventory submissions, the development of national values for the methane conversion rate (Y_m), for significant categories, is envisaged.
2	Source category Manure Management (CRF source category 4.B)	Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species, are envisaged: - ash content of the manure (ASH); - maximum CH_4 producing capacity for manure produced by an animal within defined population (B_0); - CH_4 conversion factors for each manure management system by climate region (MCF).
3	Source category Rice Cultivation (CRF source category 4.C)	In respect to the IPCC GPG 2000 provisions, more detailed data on rice cultivation techniques used are proposed to be obtained.
4	Source category Agricultural soils (CRF source category 4.D)	Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species, are envisaged: - fraction that volatilizes as NH_3 and NO_x, specific to synthetic fertilizers nitrogen adjusted for volatilization ($Frac_{GASF}$);

No.	Category subject to improvement	Description of improvement
		- fraction that volatilizes as NH_3 and NO_x, specific to animal manure nitrogen used as fertilizer, adjusted for volatilization ($Frac_{GASM}$); - national values for activity data in totality; - fraction of N input that is last through leaching and runoff ($Frac_{LEACH}$).
5	Source category Field Burning of Agricultural Residues (CRF source category 4.F)	Aiming to their incorporation into next inventory submissions, the development of national values for activity data in totality, for to significant species, is envisaged.
Waste		
1	Source category Solid Waste Disposal on Land (CRF sector 6.A)	In order to improve the next submission, we will try to upgrade the reporting in accordance with IPCC 2006.
2	Source category Wastewater Handling (CRF sector 6.B)	In order to improve the next submissions, we will include the parameters/emission factors associated on sludge that result from industrial wastewater treatment, the national authority analysing also the possibility to develop a study for estimates the CH_4 emissions from industrial wastewater, in accordance with IPCC 2006.
3	Source category Waste Incineration (CRF sector 6.C)	In order to improve the next submission, we will try to upgrade the reporting in accordance with IPCC 2006.
LULUCF		
1	Forest Land remaining Forest Land (CRF sector 5.A.1)	Romania is close in obtaining final results regarding a study which involves DOM/DW. LT on the 5A1 land/FM activity („The determination of emission/removals of forest land and the land conversion from forest pools

No.	Category subject to improvement	Description of improvement
		in accordance with its obligations as a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and its obligations as a party to Kyoto Protocol (KP) associated reporting of 2014”). With this, an entire recalculation procedure will take place by using NFI data to estimate the carbon pools by using CBM-CFS3 for the commitment period.

In response to the review process, recalculations were carried out as follows:

- the change of C stock in living biomass in 5.A.2 was determined based on new data and information from two research projects. Data collected allowed derivation of plantations biomass equations for 3 major group of plantations (Robinia, oak, poplar and willows). New data from the JI project is now used to estimate the litter pool. More details can be found in Chapter 7.2.3.2. The following recalculations occurred:
  - 5.A.2 and AR: CSC in LB Gains led to ~ 35% difference; CSC in DOM ranged from -94% to -300%;
- after an expert meeting regarding the cultivation of histosols in Romania (no. 97901/DGSC/ 17.02.2014) a conclusion has been reached that there is no cultivation of histosols as these activities are very expensive and that the official activity data for these soils is 5kha. This resulted in recalculations of the estimations on organic soils under 5.B.1 Cropland remaining Cropland and 5.C.1 Grassland remaining Grassland that were made to be consistent with FAOSTAT database. In conclusion, 5.C.1 reports NO for AD and emissions and 5.B.1 reports 5kha for AD and NO for carbon emissions;
- Biomass accumulation rate (0.3 tC/ha/year) for woody perennial crops is now used for 15 years also biomass C losses were changed from the default 63 tC/ha to 4.43 tC/ha. Both factors are from the neighboring country Hungary. This led to recalculations of about -150% regarding LB gains and about -1500% regarding LB losses because of the huge

difference between the default EFs. But this is now more consistent with the estimations of the majority of countries in Europe. No impact on the trend has been registered;

- Revegetation estimates for LB and DOM where recalculated by considering total area manages as revegetated land in the base year and commitment period years (previous estimates for CP years where derived only for post 1990 established area of revegetation);
- a change of 4.2% in wildfires areas in AR resulted from a conservative approach that was taken by assuming that officially reported wildfire burned area is shared between AR (4,2%) and FM (95.8%). This of course led to changes of about -4% in estimations for CO_2, CH_4 and N_2O in Table 5(V) in Forest Land remaining Forest Land and Kyoto Protocol FM activity. No impact on the trend has been registered;
- CO_2 emissions from organic soils is reported as IE in 5B2.3 as included under estimates of emissions from area organic soils under 5B1 (from 1990 there is no new drainage, or if there is then it is an insignificant area). For organic soils area, CO_2 emissions under LULUCF are estimated for the entire time series using IPCC default emission factor for cropland under 'warm temperate dry' zone of 10tC/ha/yr. No impact on the trend has been registered;
- for Table 5(III) N_2O emissions from areas GL, WL under conversions to CL was recalculated for the entire time series, because of an error (which drove IEF to be continually growing). Amount of soil C mineralized (kgC/yr) was 850 KgC/ha/yr. IPCC default values were used: C/N ratio (~15) and emission factor for N (~0.0125 kg N_2O-N/kg N). Thus IEF is constant around 0.01 kg N_2O-N/ha;
- for completeness we introduced estimations for living biomass losses when conversion to Forest Land occurred. For conversions from GL and WL an initial biomass equal to 1.7tDM/ha (=0.85tC/ha, updated from 0.8 previously) has been applied, The same value is applied for conversions to GL. We assumed no change between biomass in conversions between GL and WL. The changes applied to both UNFCCC and KP, for the entire time series.

10.4.2 KP-LULUCF inventory

The planned improvements for KP-LULUCF Inventory activities are presented in table below:

Table 10.5 Summary of planned improvements KP-LULUCF Inventory activities

No.	Category subject to improvement	Description of improvement
KP - LULUCF		
1	Forest Management	Romania is close in obtaining final results regarding a study which involves DOM/DW. LT on the 5A1 land/FM activity („The determination of emission/removals of forest land and the land conversion from forest pools in accordance with its obligations as a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and its obligations as a party to Kyoto Protocol (KP) associated reporting of 2014”). With this, an entire recalculation procedure will take place by using NFI data to estimate the carbon pools by using CBM-CFS3 for the commitment period.
2	Cropland Management	Improvements cover preparation to shift to post-2012 reporting requirements as in Decision 2/CMP7, GL 2006 and EU commitments on cropland management
3	Grazingland Management	Improvements cover preparation to shift to post-2012 reporting requirements as in Decision 2/CMP7, GL 2006 and EU commitments on grazingland management.

In response to the review process, recalculations were carried out as follows:

- Romania reports CO_2 emissions from organic soils, included in the land subject to FM activities as Tier 1 methods. For a conservative approach we have included emissions with the assumptions that some of the areas of organic soils (that in reality are mostly scattered in mountainous areas) have been the subject of drainage in the past (before 1990). Thus, CO_2 and N_2O emissions have been recalculated for the entire time series by using the default emission factor for cool temperate forests. Actual reporting in 2014 submission: CO_2 and N_2O emissions are reported an area of 95.3 kha under forest management, assuming that this entire area was subject to drainage. This emissions amount to 65 Gg of CO_2 and 5,8 Gg of N_2O emissions;

- as underlined by the review process, Romania wasn't reporting AD and emissions in the area subject to Biomass burning in ARD activities. First time estimate of non-CO_2 emissions in Table 5(V). 4% more emissions in Table 5(KP-II)5 by sharing burnt area between FM and AR and assuming on AR land both DW, LT and LB are burning completely. DOM (DW+LT) estimate is 0.75 t C/ha and living biomass is 14.02 t C/ha as resulted from a running JI afforestation project.

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11 KP-LULUCF

11.1 General information

Romania reports GHG emissions and CO_2 removal on the mandatory afforestation/reforestation and deforestation (ARD), and on the elected activities: forest management (FM) and revegetation (Rv). The accounting is done at the end of the commitment period (in 2014).
The land area reported and changes in land area subject to the various activities in the inventory year can be found in the KP-LULUCF NIR-2 table.

11.1.1 Definition of the forest and any other criteria

Reporting under Forest management refers to “national forest fund” (NFF), which includes lands under forestry use (forests, lands for afforestation, lands serving for the needs of forest administration, waters and unproductive lands) *included in* the forest management plans. The national forest fund is under the forest regime, which represents a system of technical, economical and juridical norms which ensure its sustainable management. The lands included in NFF are totally under management planning, which is based on plans regularly renewed and updated (every 10(5) years), for each forest management unit (forest district). Under this land category, only the lands being “forests” are considered "managed forest lands" under KP. The system allows identification of parcels and their history (which also allows making difference between A/R, non-AR conversion to forest and FM).
Forest Code (Law 46/2008), currently in force, defines the “forest” as "land area of 0.25 hectares at least, covered with trees whose height must be at least 5 m at maturity under normal conditions of vegetation". The current law does not specify a minimum width and crown cover thresholds for forest. A crown cover threshold of 10% is implicitly implemented by the inclusion of a ‘forest’ under a management plan, otherwise the land is declared “other area from forest fund” or subject to ecological reconstruction (under regeneration procedure). This definition is

consistent with the 1990 and post-1990 one in terms of minimum area, although it brings further specifications related to the minimum height of the trees in normal conditions of vegetation.

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

Romania has selected two types of activities related to land use in accordance with Article 3.4 of the Kyoto Protocol, namely:

- **Forest Management** (FM) - applied to managed forest lands, respectively the forests from the "national forest fund";
- **Revegetation** (Rev) - for the activities of establishment of woody plantations on lands outside the national forest fund.

11.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time.

According to the Romanian legislation, **"afforestation/reforestation"** means "conversion of non-forest land through forest plantations with the transfer of land in the forest fund", also called "entries into the forest fund". Such definition implies direct human intervention. These areas are annually reported in the statistical surveys SILV 4 – "Works of forest regeneration executed in the forest fund, on degraded lands and other lands from outside the forest fund". Specifically the statistical reports are built based on forest management planning documentation, which allows any parcel to be tracked back in time and down to the land. This activity is reported under SILV-4's Chapter 1 "Regenerated areas on land categories", under the following indicators:

i. unproductive lands;
ii. degraded lands included (transferred) into the national forest fund;
iii. degraded and unproductive lands;
iv. amelioration perimeters and unproductive lands;
v. degraded lands from the forest fund.

Forestry legislation in Romania does not distinguish between afforestation (A) and reforestation activities (R) in the sense of the Marrakesh Accord, so they were treated similarly in the national

GHG inventory and supplementary reporting. A/R works has been funded totally or partially from public funds, and it is considered directly human induced.

Once a piece of non-forest land is transferred into “national forest fund” its afforestation process has to be started in maximum two years, according to the Forest Code. This rule has to be implemented by the forestland administrator and is checked by forest authority.

Natural expansion of forest vegetation on other lands is not considered direct human induced action, what explains less “5.A.2 Land converted to Forest Land” area reported as AR. Further on, if area of natural expansion of forest is included under NFF these forests become automatically subject to management planning, for which reason these areas are included under FM area and not under AR, what explains larger area of FM under KP than under the 5.A.1 Forest Land remaining Forest Land.

Under strict regulation of deforestation, the human induced area leaving the national forest fund can only go to settlements category (roads, industrial sites), which makes very unlikely the return of such area into national forest fund.

According to Romanian legislation the "**deforestation**" (D) is identified with the "definitive leave of a land from the national forest fund”, which means permanent “change of the forest destination of a land to another destination by the law”. Definitive leave from the forest fund follows a procedure drawn by the forest laws. Noteworthy, this also includes area corrections caused by modern equipment re-measurements in post 1990 with the occasion last 10 years planning cycle land (this mapping modernization mostly occurred between 1990 and 2002).

This D activity corresponds to:

- sub-category 5.E.2.1. - Conversions to Settlements", as far as “permanent leave” of a land from the forest fund are only allowed for public works of infrastructures;
- significant part of the “definitive leave from forest fund” is reported also under 5.F.2.1 Forest Land converted to Other Land, under natural circumstances, which is also considered as deforestation as far as there is associated with a reduction of national forest fund and wood might have been removed;
- additionally, for KP supplementary reporting, the area of “forest vegetation outside the national forest fund” (VFAFF) which is converted to pastures and hayfield and settlements is considered as deforestation.

"**Forest management**" (FM) applies to the forest lands included under the national forest fund. The management of the NFF is regulated by forest management plans consistent with the environmental, economic and social objectives of the forests.

Forest management activity is associated with the subcategory "Forest Land remaining Forest Land - 5A1", which matches with the area reported under the Convention as NFF and conversions from VFAFF to NFF (over 1990-2012), plus area reported under 5.A.2.5 Other Land converted to Forest Land (as far as only natural expansion of forest vegetation on state owned land can automatically be transferred to NFF).

"*Revegetation"* ***doesn't have*** a specific correspondence in the national statistics**,** but as defined in Marrakech Accords**,** it is identified with areas created by planting of trees (thus directly human induced) outside the national forest fund (thus on land which do not belong to the NFF)**.** In the statistical report SILV 4, under same Chapter 1, there are reported following additional indicators:

i. plantations on excessively degraded lands outside the forest fund;

ii. plantations on degraded lands not included in the national forest fund;

iii. trees plantations including: tree lines (like along roads), belts for field protection (implemented according the Law 83/1993, Law 107/1999), green belts around urban and industrial platforms, anti-erosional plantations and land amelioration perimeters (implemented according the Law 18/1991, Law 107 / 1999).

This activity occurs on non-forest land categories, practically entirely associated with the subcategory "5B1 - Cropland remaining Cropland". They cannot be confounded with AR areas as far as they are not included under the national forest fund. They are not even confounded with VFAFF, as they result by plantation following grids and tree lines (while VFAFF is not accounted under the KP).

11.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

Assignment of the land with forest vegetation in one of the land uses and activities is done in the accordance with the criteria of "land classification by destination", stipulated in the Technical Norms for the Introduction of the General Cadastre, elaborated by the National Office for

Cadastre and Land Registration (ANCPI), according to the Law no. 7 / 1996. National statistics are consistent over time and there is no risk of double accounting or omission of a piece of land, as far as land assignment criteria are applied and verified, according to the Cadastre Law, across the system of data collection and reporting by the NIS.

Afforestation/reforestation and deforestation are provided by separate statistics which do not interfere with each other (in any case afforestation of a deforested land cannot occur under the allocation of such land for infrastructures). On the other hand, an area subject of AR could become subject of deforestation, which is also recorded in the “permanent leave” documentation (but this was not reported so far as AR areas are usually located in remote places and the plan for land infrastructure development is well known by local authorities who have to give their accord for afforestation of a land under their jurisdiction).

Revegetation activity is associated strictly with non-forest lands categories, and do not interfere with any other activity under the Kyoto Protocol, under strict implementation of forest regime. Revegetation can be easily identified through indicators outlined in Section 11.1.3 and is identified by NFI based on these indicators (planted trees on line or grids), while VFAFF results by spontaneous expansion of forest.

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

Estimation and reporting CO_2 emissions from the national GHG inventory for the KP activities is made at national boundary scale. Existing information on AR, D and FM allows "Reporting Method 2" based on administrative data, according to GPG LULUCF (IPCC 2003).

Afforestation and Reforestation

Definition of forest is implicitly met by the practice of afforestation/reforestation.

There isn’t any applicable minimum area threshold as all afforested lands which are subject to AR enter into forest fund. Furthermore, the lands subject to AR consist in large and compact areas of land, under future need of management, thus minimal area defined for forestland has no practical relevance. If exceptionally a very small area of afforestation occurs it is usually located next to an existing forest parcel, and it becomes part of a larger unit.

Noteworthy, Romania implements an afforestation/reforestation JI under Kyoto protocol. The emissions reduction associated to this project are highlighted in the Table 5(KP-I)A1.1. in a separate line.

Forest management

There isn’t any applicable area threshold for a land which is classified as forest fund. Furthermore, the forest fund consist in large pieces of land under forest planning and management, thus minimal area defined for forestland has no practical relevance. On a land which is national forest fund there is mandatory that the regeneration starts in 2 years from clearing (this is observed by state forest authorities). Such lands are landmarked, mapped and subject to decadal management plans.

Deforestation

Activity data for D were obtained from official documents for the approval of the “definitive leave from the forest fund” or for removal of tree vegetation on VFAFF lands, according the regulations in force. National law does not establish a minimum area for the land leaving the forest fund as subject to documentation. Very detailed information on such lands (i.e. location, limits, stands description – species, volume, soil type, etc.) is all specified in the documentation submitted for the approval of “definitive leave from the forest fund”. Official documentation is archived by the central public authority responsible for forestry in Romania and its regional branches.

The area of deforestation has been split in “deforestation from FM” and “deforestation from Other” with the latter including area of deforestation from VFAFF (non-FM area) to both Settlements and Grassland (although there is no evidence of biomass removal). Share of “deforestation from Other” was 11% from total deforestation in 2012. This change is reflected adequately in NIR-2, by the two values.

11.2.2 Methodology used to develop the land transition matrix

Methodology for the preparation of the land use change matrix is described in the section 7.2.2. There were 2 matrices developed: one that starts in 1989, developed for the inventory purpose and another one that starts in 1990 developed for the Kyoto reporting and accounting purpose. The two are fully consistent, the difference is that Convention's one implements 20 years transition period and under KP matrix some lands are relocated (i.e. lands under conversions to forestland resulted from natural expansion of forest are reported under FM). Since 1989 is the base year for Romania, data was needed to provide a net emission/removal estimate for the Revegetation activity in 1989.

The complete matrix used for estimation of emission/removal on KP eligible lands can be found in Annex 8.5.2.

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Afforestation and reforestation (AR) - mapping and identification

The identification of land area eligible as AR activities could be done based on forest management plans and their forest maps (1/5000), in which these areas are included after the conversion to the forest fund. Thus, the explicit location and plantation/stand description is available for each such area. The respective areas are included in the forest fund based on a set of legal documents, which allow funding of afforestation related work. The land "entering into the forest fund" are registered in the management plan documentation and are reported at the end of each year in the SILV 1, then after the initiation of plantation work in SILV 4. With the "entering into the forestry fund" the land is measured and temporarily mapped, while it is fully included in the forest maps with next management planning of the respective forest district.

Further on, such land can be tracked in time through the numbering systems of the forest parcels (compartments), as far as the number (code) remains unchanged over the planning cycles. A piece of land "entering" the forest fund is subject of plantation and, if necessary, repeated gap filling according technical norms for afforestation. If still the area is not covered by forest it will be declared “non-productive land” and further reported in statistics as part of “other lands from the forest fund”.

Deforestation (D) - mapping and identification

According to Romanian legislation the approval of areas less than 10 ha to “leave the forest fund” is directly approved by the central public authority responsible for forestry. In case of areas larger than 10 ha the approval is given by the Romanian Government. In any case, the data on the area annually “leaving the forest fund” is entirely collected by the central public authority responsible for forestry, which provides aggregated information in the "Annual Report on the status of Romanian Forests". Historical data are archived by the authority as forestry records.

Approval for an area to “leave the forest fund” is based on a special regulation which requires a standard documentation to be filed up and submitted for approval (license/permit procedure), including a map of respective area.

The approval specifies the time when land could be cleared by trees which is then registered as official “leaving” time. Documentation allows explicit identification of the location (i.e. forest district, production units, parcel and sub-parcel) and provides accurate quantitative data on area and stand description parameters. The areas “leaving the forest fund” under natural circumstances (i.e. Danube and internal rivers banks erosion, etc.) are also reported as “leaving the forest fund” (and transferred to “Other lands”), as far as they associate with a reduction of managed forest land area.

Removal of VFAFF is subject of approval by local authorities and registered as such by the local branches of the forest authority.

Revegetation (Rev) - mapping and identification

Activity data on land areas eligible for the revegetation activities are provided by SILV 4, with possibility to make an explicit location of all areas reported under such activities that can be identified based on initial plantation establishment documentation. SILV 4 is filled in by the forest authority.

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1 Description of the methodologies and the underlying assumptions used

Afforestation/reforestation

Area subject of human induced AR is some 27.52 kha in 2012 (since 1990), out of which **6.50** kha is the area under the Joint Implementation project hosted by Romania (see section below on article 6 implementation). AR area represents some 17% of 5.A.2 Land converted to Forest Land in 2012.

Net changes in C stocks in aboveground and belowground biomass, and for the litter and soil organic matter pools during each year of the annual commitment period are estimated and reported for accounting purposes under Tier 2.

DW is reported as NR (not reported) as such pool does not occur in young plantations (less than 20 years old), while in any case initial stock is zero and based on measurement in the JI project and reasoning based on ecosystem functioning it could only occur an increase of C stock in this pool.

Estimation methodology and data used are thoroughly described under chapter 5, section 5A2 - Land converted to Forest Land (artificial plantations). Currently there are no areas of afforestation which have been subject to harvest, as arguments is the normative techniques for production cycles on degraded lands in Romania (mainly supported by the fact that planted species have longer cycles then 1990-2012 time span).

The AR is a key category under KP.

Table 11.1 Correspondence between land areas reported under GHG Inventory and A/R activity reported under KP

Reporting Year	UNFCCC				KP			CHECK
	5A2				Afforestation and Reforestation			
	5A2.1		5A2.2		ROMANIA			
					CL to FL	GL to FL	Joint Implementation Project	
	Arable & vineyards & orchards -> NFF	Arable & vineyards & orchards -> VFAFF	Pastures & Hayfields -> NFF	Pastures & Hayfields -> VFAFF	Arable & vineyards & orchards -> NFF	Pastures & Hayfields -> NFF		
	A	B	C	D	E	F	G	(A+C) - (E+F+G)
1990	12.87	*0.00*	3.22	*2.09*	0.91	0.23		14.95
1991	13.66	*0.00*	3.42	*2.09*	1.70	0.43		14.95
1992	13.93	*0.00*	3.48	*3.09*	1.97	0.49		14.95
1993	14.16	*0.00*	3.54	*3.09*	2.20	0.55		14.95
1994	14.61	*0.00*	3.65	*3.09*	2.65	0.66		14.95
1995	15.03	*0.00*	3.76	*3.09*	3.07	0.77		14.95
1996	15.51	*8.38*	3.88	*3.09*	3.56	0.89		14.95
1997	15.85	*8.38*	3.96	*3.09*	3.89	0.97		14.95
1998	16.23	*8.38*	4.06	*3.09*	4.27	1.07		14.95
1999	16.74	*8.38*	4.19	*3.09*	4.78	1.20		14.95
2000	17.33	*8.38*	4.33	*3.09*	5.37	1.34		14.95
2001	18.10	*8.38*	4.52	*3.09*	6.14	1.53		14.95
2002	19.30	*8.38*	4.83	*3.09*	6.77	1.69	0.72	14.95
2003	21.99	*8.38*	5.50	*4.72*	8.33	2.08	2.13	14.95
2004	25.44	*8.38*	6.36	*4.72*	10.98	2.75	3.12	14.95
2005	28.24	*8.38*	7.06	*4.72*	12.85	3.21	4.29	14.95

Reporting Year	**UNFCCC**				**KP**			**CHECK**
	5A2				**Afforestation and Reforestation**			
	5A2.1		**5A2.2**		**ROMANIA**			
					CL to FL	**GL to FL**	**Joint Implementation Project**	
	Arable & vineyards & orchards -> NFF	**Arable & vineyards & orchards -> VFAFF**	**Pastures & Hayfields -> NFF**	**Pastures & Hayfields -> VFAFF**	**Arable & vineyards & orchards -> NFF**	**Pastures & Hayfields -> NFF**		
	A	**B**	**C**	**D**	**E**	**F**	**G**	**(A+C) - (E+F+G)**
2006	31.44	*8.38*	7.86	*4.72*	15.95	3.99	4.42	14.95
2007	32.52	*8.38*	8.13	*4.79*	16.92	4.23	4.56	14.95
2008	32.87	*8.38*	8.22	*4.79*	17.01	4.25	4.87	14.95
2009	21.16	*8.38*	5.29	*4.17*	17.16	4.29	4.99	**0.00**
2010	20.65	*8.38*	5.16	*2.70*	17.50	4.37	5.08	-1.14
2011	19.90	*8.38*	5.32	*3.54*	16.99	4.59	5.78	-2.13
2012	19.77	*8.38*	5.29	*2.54*	16.54	4.49	6.50	-2.46
	included under AR	FL non-AR (see explanation in Chapter 7.2)	included under AR	FL non-AR (see explanation in Chapter 7.2)	Difference between Convention's CL & GL converted to NFF area and AR area is explained by the area of 14.95 of conversion to FL in 1989, which is propagated for 20 years till 2009.			

Deforestation

The total deforested area from 1990 to 2012 is 109.55 kha including the areas deforested over the commitment period, 4.26 kha reported in the land subcategory 5.E.2 – NFF Land converted to Settlements and 50.83 kha in 5.F.2 – Forest Land converted to Other Land also 0.04 kha in 5E2 – Land converted to Settlements from VFAFF, 38.45 kha in 5C2 – Forest Land converted to Grassland and 15.96 kha in 5.D.2 – Forest Land converted to Wetlands.

Emissions are calculated using Tier 2 methods and input data as described under the chapter**Error! Reference source not found.**. All carbon pools are reported and D is not a key activity under KP.

Forest management

FM area is consistent with forest fund areas (NFF) reported under 5.A.1 – Forest Land remaining Forest Land in the convention tables (i.e. 6307.57 kha in 2009) which represent 6197.36 of NFF area remaining NFF in that year plus the conversion of VFAFF to NFF in that particular year of about 110.21 kha resulted by natural expansion of forest vegetation on state owned land that can be readily declared forest under national forest fund. Emissions/removals from FM activity have been calculated, using the same assumptions, formulas and parameters as used for the estimation under the convention (see section 7.2.2. of the NIR). C pools reported are aboveground and belowground biomass. Change in soil organic matter, dead wood and litter are reported under Ch.7.

Table 11.2 Correspondence between land areas reported under GHG Inventory and FM activity reported under KP

Reporting Year	UNFCCC				KP				CHECK
	5A1				Forest Management				
	NFF		VFAFF	TOTAL	ROMANIA			TOTAL	
	NFF remaining NFF	VFAFF in conversion to NFF	VFAFF remaining VFAFF		NFF	VFAFF -> NFF	Other Land -> FL		
	A	B	C	A+B+C	D	E	F	D+E+F	(A+B) - (D+E+F)
1990	6236.21	0.00	431.01	6667.22	6251.16	0.00	0.00	6251.16	14.95
1991	6235.85	0.46	424.15	6660.46	6250.80	0.46	0.00	6251.26	14.95
1992	6235.65	0.46	424.15	6660.26	6250.60	0.46	0.00	6251.06	14.95
1993	6231.00	0.46	424.15	6655.61	6245.95	0.46	0.00	6246.41	14.95

Reporting Year	UNFCCC				KP				CHECK
	5A1				Forest Management				
	NFF		VFAFF	TOTAL	ROMANIA			TOTAL	
	NFF remaining NFF	VFAFF in conversion to NFF	VFAFF remaining VFAFF		NFF	VFAFF -> NFF	Other Land -> FL		
	A	B	C	A+B+C	D	E	F	D+E+F	(A+B) - (D+E+F)
1994	6227.04	0.46	424.15	6651.65	6241.99	0.46	0.00	6242.45	14.95
1995	6225.51	0.46	424.01	6649.98	6240.46	0.46	0.00	6240.92	14.95
1996	6220.35	0.46	423.82	6644.63	6235.30	0.46	0.00	6235.76	14.95
1997	6216.37	0.46	423.82	6640.65	6231.32	0.46	0.00	6231.78	14.95
1998	6206.69	0.46	416.82	6623.97	6221.64	0.46	0.00	6222.10	14.95
1999	6204.42	0.46	409.07	6613.95	6219.37	0.46	0.00	6219.83	14.95
2000	6200.97	0.46	408.07	6609.50	6215.92	0.46	0.00	6216.38	14.95
2001	6200.90	1.49	397.39	6599.78	6215.85	1.49	0.00	6217.34	14.95
2002	6197.58	1.49	394.19	6593.26	6212.53	1.49	0.00	6214.02	14.95
2003	6192.38	1.49	394.19	6588.06	6207.33	1.49	0.00	6208.82	14.95
2004	6189.25	1.49	394.19	6584.93	6204.20	1.49	0.00	6205.69	14.95
2005	6188.85	8.88	386.80	6584.53	6203.80	8.88	0.00	6212.68	14.95
2006	6188.67	44.37	351.31	6584.35	6203.62	44.37	0.00	6247.99	14.95
2007	6188.50	85.73	309.95	6584.18	6203.45	85.73	0.00	6289.18	14.95
2008	6182.53	85.73	303.25	6571.51	6197.48	85.73	0.00	6283.21	14.95
2009	6197.36	110.21	279.09	6586.66	6197.36	110.21	0.00	6307.57	0.00
2010	6198.39	129.51	261.26	6589.16	6197.25	129.51	0.00	6326.76	1.14
2011	6199.66	137.61	253.12	6590.39	6197.07	138.07	0.02	6335.14	2.10
2012	6199.82	147.91	232.19	6579.92	6196.90	148.37	0.02	6345.27	2.44
	included under FM	included under FM (see	*FL non-FM*	FL remaining FL	Difference between Convention's FL remaining FL area and FM area is explained by the area of 14.95 of conversion to FL in 1989, which is				

Reporting Year	UNFCCC				KP				CHECK
	5A1				Forest Management				
	NFF		VFAFF	TOTAL	ROMANIA			TOTAL	
	NFF remaining NFF	VFAFF in conversion to NFF	VFAFF remaining VFAFF		NFF	VFAFF -> NFF	Other Land -> FL		
	A	B	C	A+B+C	D	E	F	D+E+F	(A+B) - (D+E+F)
		explanation in Chapter 7.2)			propagated for 20 years till 2009.				

Revegetation

For the KP-LULUCF reporting, data on “revegetation” established by tree planting reaches 103.15 kha in 2012 compared to 87.99 kha in January 1st 1990, taking into account the entire area planted since 1970.

Net estimate for the base year 1989 took into consideration all areas subject to revegetation established since 1970. Net estimate for the commitment period years takes into consideration all revegetated areas existing in the years of CP. This approach is consistent with GPG for LULUCF (IPCC, 2003), changed compared to previous submissions when all revegetated areas have been included in the estimate for 1989 (base year) while for the years 2008-2012 only those areas subject to this activity since 1990 have been included.

Actual revegetation data is drawn from statistics back till 1975, while for 1970-1974 data is linearly extrapolated. This activity is entirely associated with 5B1 Cropland where such emissions are reported in the national GHG inventory.

This activity is subject of “net-net accounting” (i.e. the difference between the annual sinks in 1989 and each of 2008, 2009, 2010, 2011, and 2012).

C pools are estimated exactly as in the case of 5A2 land converted to forestland (artificial plantations) under assumption that plantations differ only by their legal status (land classification).

This vegetation is cut and rejuvenated (not replaced with other crops) in cycles of about 25 years, thus it is estimated that after the first cycle of 25 years the biomass growth follows same pattern as in the initial plantation, while all other pools are assumed as not changing (following reasoning under Tier 1 of IPCC as supported by data shown under AR). These assumptions consisted in nil change for C stock change in SOC and LT for after 25 years old since the establishment. DW was always assumed nil. Revegetation is not a key activity under KP, but in any case a Tier 2 estimate is achievable under the type of data available for the estimation.

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

DW in Afforestation/Reforestation and Revegetation is reported as NR (as not occurring or it is considered as a very small sink since initial mass is null, then it could only increase in time, or in any case it cannot decrease).

Afforestation /Reforestation- Litter and dead wood pools

Litter becomes a measurable pool in AR lands as early as 4-5 years old (sampled data is available from JI and FORLUC project), thus C stock change is estimated and reported. Instead, dead wood can not be defined as a standing alone pool, also recalling that dead wood is considered under same definition and dimensional thresholds as in NFI. Nevertheless, by the age of 20 years old of stands, the dead treees bearly occur caused by natural mortality and especially by competition. This should lead to a continually increasing number of dead trees, thus expected that inputs are larger than decomposition. With such argumentation, we can safely assume that DW is not a net souce of emissions on AR lands.

Forest Management – C stock changes in organic matter pool of mineral soils

Quantitative and qualitative arguments are involved to demonstrate that SOC, DW and LT are not sources of emissions over CP.

Quantitative data

As explained in the chapter 7.2.3, the arguments are each based on own source and methodological approach, independent by each other, showing that mineral soil carbon pool most likely behave as an extremely small sink or rather as a neutral source, in which case “not a source” applies (key category NR is reported in NIR-2 and NO in sectorial table 5.A.1 Forest Land remaining Forest Land).

Recent improvement with regard to reporting CSC in **forest mineral soils** consisted in prioritizing quantitative assessments of several existing datasets, focusing on two approaches:

i. First approach. Simulation by CBM-CFS of C stocks in mineral soils with data from IFN 1984 and NFI 2010. Later validation exercise would also involve the actual NFI data of C stocks in available pools (dead wood and organic matter in mineral soils). Validation of simulations outputs is done with data from soil database of the forest management plans (FMP) combined with the 2010 NFI soil data.

ii. Second approach consisted in statistical analysis of forest soil records from the FMP database in a recent study (“The determination of emission/removals of forest land and the land conversion from forest pools in accordance with its obligations as a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and its obligations as a party to Kyoto Protocol (KP) associated reporting of 2014”, funded by the Ministry of Environment and Climate Change). It contains soil analysis to forest management plans since 1970 on. Datasets include humus (%, relative humus content for 30 cm depth), among many other soils chemical parameters, as well as site and stand descriptors. Limitation could come from the particularity of sampling points which were randomly and non-repetitively located. In Romanian forest management planning system, the country national forest fund was several times completely “screened” every 10 years since 1960, so a time series is available. Nevertheless, soil analysis data was retrieved for a number of 20 forest districts randomly spread in the country (together representing 0.8% (i.e. 60000 ha) of total national forests) and representing the major forest types, geographical regions and altitudinal gradient. Data was processed on strata fully consistent in time: 3 main types of forests (broadleaved, resinous and mixed forests), forest stand age (categories of 5 years till 150) and time since first measurement (TSFM, 22 years over 1979-2011 with few gaps) and 2 soils horizons (A horizon of 0-20 and B of 20-30 cm depth).

- Simple linear regressions of humus content (%) vs. TSFM shows a very small positive slope (e.g. almost horizontal), which can be interpreted as this pool most likely behaves as sink or source in time.
- Multiple analysis of variance of humus content (%) against all independent variables counted above also shown non-significant differences for humus content.

All these arguments support a not changing soil C pool, thus reported in CRF files as NO.

Qualitative information

This quantitative information to demonstrate that at national level mineral soils are not a source is further supported by a number of additional arguments of ecological reasoning nature:

a) intensification of forest management and halving wood harvesting in post- than pre-1990 (as shown by National Statistics), which led to an increase of standing stock and likely of the lying dead wood under natural competition;

b) very low rate of forest cover change as impact of forest management, i.e. annual clear cut area is reported by National Statistics around 25 kha/year, which is less than 1 % of the national forest fund area and also by independent studies (e.g. Olofsson et al., 2011 in Environ. Res. Lett. 6 (2011) 045202). Working with average standing stock results that only half of the annual harvest results from clear cut, while rest from other less intensive forest operations (thinning, extensive regenerations cuts).

c) negligible area of fire and non-fire disturbances over 1990-2012.

Forest management - Dead wood and Litter pools

There is no historical quantitative data on dead organic matter pool in Romanian forests, except time-point estimates from 1st NFI. In order to derive time series for 1990-2012, C stock change from dead wood pool is simulated with a model based on the forest inventory data. Pools were

finally validated against sampled NFI data and further judgment was made if changes in this pool are significant or negligible over CP. For such simulation, Forest Research and Management Institute Bucharest (FRMI) has retrieved entire database of the inventory of forest fund 1984 (e.g. standing volume, annual growth, species composition and age structure) at most disaggregate level available (namely 400 forest districts covering entire country), and ran CBM-CFS3 (Carbon Budget Model of the Canadian Forest Sector) developed by Werner A. Kurz and CFS Carbon Accounting Team of Natural Resources Canada, Canadian Forest Service, Victoria, BC).
Similar approach applied to Litter pool, modeled data is validated against sampled data from 1st NFI and further judgment was made if changes in this pool are significant or negligible over CP.
CBM outputs as well as additional ecological reasoning based information from points (a) to (c) under mineral soils item prove DW and LT are not net sources of emissions under Forest management lands.

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Available activity data and methodologies did not allow the exclusions of indirect and natural GHG emissions from the present estimation of anthropogenic GHG emissions for the relevant activities.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

New approach described above under 11.3.1.1. to estimate net –net for revegetation led to a change of some +336 % compared to previous submission (from a removal of 286.95 Gg CO_2 in 2011 to o new estimate for 2011 of 1249.72 Gg CO_2). Base year estimate did not change.

There were some recalculations regarding biomass burning (more is provided under 7.8.5 Biomass Burning (CRF Table 5(V)). Estimates of non-CO2 emissions in Table 5(V) by sharing burnt area between FM and AR and assuming on AR land both DW, LT and LB oxidize completely; 4% more emissions in Table 5(KP-II). Also for both activities, an error in

calculation formula for CH_4 and N_2O was corrected. Error consisted in introducing in formulas CO_2 amount instead of C amount, corrected estimates are 3.666 less now.
In the KP land use change matrix there were some corrections of activity data. Activity data for FM was reduced by 0.5 kha and D area in 2011 was increased by 0.04 kha of VFAFF converted to SL (roads). Changes affected NIR-2 and FM and D background tables, with negligible amounts of emissions/removals.
Also, entire time series of land changes from VFAFF to any other land use is now reported as deforestation (which doubled the entire area of deforestation previously reported).
Emissions from organic soils are recalculated for FM for the entire time series. IPCC 2003 default emission factor of 0.68 tC/year/ha was applied to organic soils area. Thus there is an additional emission of 237.69 Gg CO_2 annually.

11.3.1.5 Uncertainty estimates

As highlighted in the section 7.2.4, the uncertainty reported under 5A2 Land converted to Forest Land was estimated for the artificial plantations aged less than 10 years on some 6kha included under the JI project. The uncertainty of the cumulated C stock was ± 9% (for 95% confidence interval). The area the uncertainty was less than 1%.

11.3.1.6 Information on other methodological issues

Similar methodological approaches were implemented under the convention and KP reporting. Estimation of GHG emissions from sources is consistent with data and methods used in the convention estimation are described under section 72.9 of the NIR.

11.3.1.7 The year of the onset of an activity, if after 2008

Data on the year of onset of activity is reflected in the time series used to derive the activity data.

11.4 Article 3.3

11.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

Afforested areas are reported by the national statistics (SILV 4) in the year when the planting work starts, which may be later than the year when land entered into the forest fund, so true year of planting activity is reported (actually with soil preparation).

In any case, reporting of all AR and D related indicators is annual, which ensures the capture of the initiation of any activity. Afforestation could only occur on non-forest fund land, which is observed by the approval of documentation for funding and “entering the forest fund”.

Otherwise it is “reforestation after wood harvesting” under national forestry regime (and included under forest management).

D was forest area from 1 January 1990 to the moment in time (between 1 January 1990 and 31 December 2012) when were designated, by means of an administrative act (e.g., minister order, governmental decision), to a different land use category.

A land area is subject to FM as far as it has a management plan, which data is further aggregated bottom up to national level and reported in annual national statistics (SILV 1).

Tree plantations under Rv is identified exactly under same manner as AR, reported under different headings of statistical report SILV 4.

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

A land which is included in the national forest fund cannot leave this land category without following the legal deforestation procedure. The forest disturbance alone cannot trigger land conversions from forestland. Thus distinction between harvested and disturbance affected areas, on the one hand, and deforestation, on the other, is made as follows: for the former, there is legal obligation for the forest owner/administrator to maintain the land under forests category and forestry regime, to apply the forest management plans specifications and regenerate it within a given timeframe (maximum 2 years) and under specific conditions; for the latter, with the issuance of the approval, a new land use category is assigned to this land, and the forestry regime is no longer applicable.

11.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

A land which is included under the forest fund is under forestry regime (implemented through a forest management plan), which consists in the application of a set of administrative and technical norms. A basic requirement of the forest regime is that an area has to be afforested in maximum 2 years, since entered into the forest fund or after wood harvesting or disturbance, without reference to a minim area. In practice, such lands can regenerate either by plantations (usually followed by state forests) or by assisted natural regeneration (in private forests), or their mixture. Its implementation is observed by public authority responsible for forestry. These areas cannot be confounded with areas “leaving the forest fund, thus deforested” as far as they are subject to continuous planning and management (i.e. planting/gap filling, maintenance, etc).

11.5 Article 3.4

11.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Confirmation that the FM activity is human induced and occurred since 1990 is given by the fact that associated lands were reported as part of the national economic system by continuous planning and implementation of the management measures (in SILV 1).
Revegetation activity occurs on lands which resulted by tree plantations (also publically funded at the time of their establishment since 1970 on).

11.5.2 Information relating to Revegetation

This activity has no direct equivalent in Romanian forestry or land management system, but correspondences with plantation of trees on non-forest lands. Its election for KP compliance was

due under the initiative to develop a national forest belt system, initially thought flexible in terms of meeting forest definition thresholds, legal classification of the land, ownership, management obligations and administration patterns (which actually did not start yet).
Activity data is available either as number of planted trees or km of tree lines or ha (depending on the indicator in the statistical report SILV 4). Though information on these areas is available in SILV 4, their management is in the competence of the land owners of the agricultural land or companies that own/administrate infrastructure (e.g., railways, roads, etc.), and thus there is no guarantee that area initially planted is maintained but the acknowledged practice is that trees are always replanted (so this is the scenario we assume in estimations).

11.5.3 Information relating to Forest Management

Forest management activity refers to forest fund land for which a management plan has been set up and the forest regime is implemented. Such lands are managed according to management plans, continually surveyed for disturbances; forest harvesting is subject to planning; forest regeneration is closely and intensively assisted. Such lands are mapped, landmarked and annually up-dated in statistics. The forestry regime relies primarily on the forest law, then in subsequent legislation and technical norms, in order to ensure sustainable forests management at national scale.

11.6 Other information

11.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

In the national GHG inventory, the Tier 1 analysis (Level Assessment, including LULUCF), showed that the CO_2 removals from the category 5.A.1 Forest Land remaining Forest Land is a key category.
Country specific data is used for this category, noting that reporting some C pools is still achieved according Tier 1. Significant change regarding the two related estimates (“Forest Land

remaining Forest Land" under the Convention tables and "Forest Management" activity under the KP) are not expected for the following years.

11.7 Information relating to Article 6

Romania is implementing an AR activity project as Joint Implementation flexible mechanism under Article 3.3 of the Kyoto Protocol. The project lasts from 2002 to 2017.

The transaction of the emission reductions is subject to a commercial contract between RNP Romsilva (Romania) and Carbon Prototype Fund (managed by the World Bank).

Calculation of the emissions reduction is based on the partners agreed monitoring plan, while emission reduction amount is subject to an independent verification.

Project is subject to independent verification by DOE, first verification occurred in 2007 and second in 2012 (overlapping on pre-CP1 and CP1 (under JI Track II scheme). The estimates are calculated for the commitment period and reported in CRF, as a separate division under Table 5(KP-I) A1.1. This approach is consistent with GPG LULUCF (IPCC 2003), p. 4.19. CO_2 removal from the JI project activities will be further allocated to third parties (project partners) following internationally agreed procedures. Project methodology provides net removals and associated non-CO_2 emissions in pre and over 2008-2012. Meanwhile activity data is reported according the annual afforestation area in the project. Following this emission removal estimates are reported as IE in the CRF for 2008-2012 and the total project amount as an estimate in the year 2012. This avoids introducing artificial uncertainty in the annually estimate accounted amount.

Amount of tradable emission reduction associated with the project is determined for three consecutive stages:

- for the pre-commitment period (until the end of 2007) for which there is already an independent verification report available. The net removals reported for the period 1 January 2002 to 31 December 2007 are 10767 $MgCO_2$eq on a total area of 6.033 kha on which plantations have started in 2002 and are under various stages of development Uncertainty of the net removal estimate was ±15%;
- net removals for the Kyoto I commitment period (2008-2012) coinciding with the 2nd project verification period is also available, as follows:

- Verified amount for 2nd verification is 232799.1 tCO_2 with an uncertainty of ±8.7%. Largest contribution is given by removal of living biomass, DOM and SOM pools of 244,260 $MgCO_2$;
- project GHG emissions are nevertheless non-explicitly reported as they are already included by the national statistics under forest fire or fuel consumptions emissions.

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 Background information

The standard electronic format (SEF) for providing information on ERUs, CERs, tCERs, lCERs, AAUs and RMUs for the year 2013 for the Romanian registry is submitted together with this report (Annex 6.2.1). The data in the Romanian registry reflect the transactions to and from the Community registry and to and from ITL. Summary of information reported in the SEF tables for the Community Registry.

The SEF reporting software has been used for submission the standard electronic format tables for the Romanian registry. The tables include information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Romanian registry at 31.12.2013 as well as information on transfers of the units in 2013 to and from other Parties of the Kyoto Protocol (Table 12.1). Neither AAUs, nor RMUs have been issued in the Romanian Registry in 2013.

Table 12.1 Information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Romanian registry at 31.12.2013

Annual Submission Item	Reporting
15/CMP.1 annex I.E paragraph 11: Standard Electronic Format (SEF)	**12.2**. The Standard Electronic Format report for 2013 has been submitted to the UNFCCC Secretariat electronically and the contents of the report can also be found in annex 6.2.1 of this document.
15/CMP.1 annex I.E paragraph 12: List of discrepant transactions	**12.3.** No discrepant transaction occurred in 2013
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications	No CDM notifications occurred in 2013

Annual Submission Item	Reporting
15/CMP.1 annex I.E paragraph 15: List of non-replacement	No non-replacement occurred in 2013
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist as at 31 December 2013
15/CMP.1 annex I.E paragraph 17: Actions and changes to address discrepancies	No actions were taken or changes made to address discrepancies for the period under review
15/CMP.1 annex I.E Publicly accessible information	**12.4.** The information based on the requirements in the annex to decision 13/CMP is publicly available on the Romanian registry website: http://rnges.anpm.ro
15/CMP.1 annex I.E paragraph 18: CPR Calculation	**12.5.** Relevant data/information are presented below, under Section 12.5.

12.2 Summary of information reported in the SEF tables

The relevant information is present under Section 12.1.

12.3 Discrepancies and notifications

The relevant information is present under Section 12.1.

12.4 Publicly accessible information

The relevant information is present under Section 12.1.

12.5 Calculation of the commitment period reserve (CPR)

According to the relevant provisions in Decisions 11/CMP. 1 and 13/CMP. 1, Romania calculated the Commitment Period Reserve (CPR) based on the emissions level of 2012 excluding Land Use, Land Use Change and Forestry, as follows:

Equation 12.1 CPR (tonnes CO_2 equivalent)

*CPR (tones CO_2 equivalent) = 5 * GHG emissions level in 2012 (tones CO_2 equivalent)*

*CPR = 5 * 118,764,149.67= 593.820.748 tones CO_2 equivalent*

12.6 KP-LULUCF accounting

Romania selected accounting of activities under Art. 3, paragraphs 3 and 4 (forest management and revegetation), of the Kyoto Protocol, for the entire commitment period and intends to report the relevant data at the end of the commitment period.

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

Description of the National System

The elements on the Romanian NS, according to paragraphs 30 and 31 of Decision 15/CMP. 1, are described within Chapter 1.

Changes in the National System

Changes implemented after submitting the version 1 of the 2013 NGHGI

Changes implemented to the National system for the estimation of anthropogenic greenhouse gas emissions by sources and removals by sinks under Article 5, para. 1 of the Kyoto Protocol comprises:

- the implementation of the studies in Table 13.1 in order to strengthen the NS and to improve the NGHGI, by third party specialized organizations;
- the QA/QC and verification activities have been enhanced as a result of the implementation of the studies:
  - “Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)”;
  - “Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation”;

  - “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting”;
  - “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”.
- continuous consideration of QA, third party support (EU internal reviews, review under Article 8 of the KP);
- KP Annex A sources-ensuring that appropriate methods are used for key categories, improving the inventory accuracy, implementing improvements considering the previous plans and ERT recommendations: based on previously items;
- improvement/further enabling the improvement of the accuracy, completeness and transparency of KP-LULUCF data/information through the implementation of the studies “Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP” and “Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting”;
- following the 2013 governmental decision on government restructuration, 14 posts are available in the National System for Estimating the GHG Emissions Unit–Climate Change General Directorate in the MECC, exclusively for administrating the NS/NGHGI; the activity continued in an optimal manner, considering also that the attributions and responsibilities have been reallocated to existing personnel;
- generally, as a result of the implementation of the activities above presented, improving the implementation of the NS general functions:
  - ensure sufficient capacity for timely performance of the functions for national systems, including data collection for estimating anthropogenic GHG emissions by sources and removals by sinks and arrangements for technical competence of the staff involved in the inventory development process;

  - provide information necessary to meet the reporting requirements defined in the guidelines under Article 7 in accordance with the relevant decisions of the COP and/or COP/MOP.
- as a result of the implementation of the activities above presented, improving the implementation of the NS specific inventory preparation functions:
  - prepare estimates in accordance with the methods described in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, as elaborated by the IPCC good practice guidance, and ensure that appropriate methods are used to estimate emissions from key source categories;
  - collect sufficient activity data, process information and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks;
  - compile the national inventory in accordance with Article 7, paragraph 1, and relevant decisions of the COP and/or COP/MOP;
  - implementing the QA/QC and verification procedures in accordance with its QA/QC plan following the IPCC good practice guidance.

Table 13.1 Studies implemented for strengthening the NS and improving the GHG Inventory since the submission of version 1 of the 2013 NGHGI

No.	Study title	Objectives	Contractor	Status of implementation
1.	"Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods,	Increasing the accuracy and completeness of the estimates associated with the Production of halocarbons and sulphur hexafluoride and Consumption of halocarbons and sulphur hexafluoride categories	DENKSTAT BULGARIA OOD	Finalized

No.	Study title	Objectives	Contractor	Status of implementation
	higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF_6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)”			
2.	“Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N_2O emissions estimation”	Increasing the accuracy and completeness of the estimates associated with the Solid Waste Disposal on Land and Waste Incineration categories	ISPE	Finalized

No.	Study title	Objectives	Contractor	Status of implementation
3.	“Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”.	Improving the accuracy, completeness, consistency and transparency of the LULUCF Sector	ICAS	Finalized
4.	“Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting”	Improving the accuracy, completeness and transparency of the LULUCF Sector	ICAS	Finalized

Changes implemented after submitting the version 2 of the 2012 NGHGI

Changes implemented to the National system for the estimation of anthropogenic greenhouse gas emissions by sources and removals by sinks under Article 5, para. 1 of the Kyoto Protocol comprises:

- starting with 1 April 2013, the competent authority, which is responsible for administrating the NS/NGHGI, is the Ministry of Environment and Climate Change (MECC). Anteriorly, the competent authority was the National Environmental Protection Agency (NEPA), under the subordination of the MECC.

Based on the GD no. 48/2013, all NEPA climate change related structure, personnel, attributions and responsibilities were took over by MECC, in order to improve the institutional arrangements and capacity within the climate change domain, thus increasing the efficiency in activities implementation also in respect to the NS/NGHGI administration.

Appropriate working space, facilities and necessary IT equipment were provided to the MECC personnel took over from NEPA.

- the implementation of the studies in Table 13.2 in order to strengthen the NS and to improve the NGHGI, by third party specialized organizations;
- training of NEPA team dedicated to the administration of the NS and the NGHGI and of other partners in the NS on key category analysis and uncertainty analysis related issues was performed in 2012 by the Environment Agency of Austria-University of Graz (EAA-UG) consortium in the general framework of implementation of the study "Environmental Integrated Informational System" (by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium);
- development of the KCA integrated software by the EAA-UG consortium in the context of the study "Environmental Integrated Informational System", software allowing for:
    - automatic data import from the CRF Reporter application, through the use of CRF Tables;
    - integrate both key category and uncertainty analysis;
    - development of both Tier 1 and Tier 2 analysis;
    - automatic export of results, data and information, within the relevant reporting templates.
- development of the software to support the optimization of data collection from the operators for the Energy Industries, Manufacturing Industries and Construction categories in the Energy Sector and for the Solid Waste Disposal on Land and Waste Water Handling categories in the Waste Sector was implemented subject to the "Environmental Integrated Informational System"; additionally, software to support optimized informational fluxes from/to public institutions and to the general public have been developed;
- development of the uncertainty analysis integrated software by the EAA-UG consortium, in the context of the study "Environmental Integrated Informational System", software allowing for:

  - automatic data import from the CRF Reporter application, through the use of CRF tables;
  - integrate both key category and uncertainty analysis;
  - development of both Tier 1 and Tier 2 analysis;
  - automatic export of results, data and information, within the relevant reporting templates.
- analyzing/updating the activity data/emission factors related uncertainties values by the EAA-UG consortium following their collection also through interviews with data providers and NEPA, in the context of implementing in 2012 the study "Environmental Integrated Informational System";
- the QA/QC and verification activities have been enhanced as a result of the implementation of the:
  - Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, RAR and DRPCIV;
  - Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS;
  - "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations" study;
  - "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" study.
- continuous consideration of QA, third party support (EU internal reviews, review under Article 8 of the KP);
- KP Annex A sources-ensuring that appropriate methods are used for key categories, improving the inventory accuracy, implementing improvements considering the previous plans and ERT recommendations: based on previously items;
- improvement/further enabling the improvement of the accuracy, completeness and transparency of KP-LULUCF data/information through the implementation of the studies "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations" and "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations";

- as a result of the implementation of the activities above presented, improving the implementation of the NS general functions:
    - ensure sufficient capacity for timely performance of the functions for national systems, including data collection for estimating anthropogenic GHG emissions by sources and removals by sinks and arrangements for technical competence of the staff involved in the inventory development process;
    - provide information necessary to meet the reporting requirements defined in the guidelines under Article 7 in accordance with the relevant decisions of the COP and/or COP/MOP.
- as a result of the implementation of the activities above presented, improving the implementation of the NS specific inventory preparation functions:
    - identify key source categories following the methods described in the IPCC good practice guidance;
    - prepare estimates in accordance with the methods described in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, as elaborated by the IPCC good practice guidance, and ensure that appropriate methods are used to estimate emissions from key source categories;
    - collect sufficient activity data, process information and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks;
    - make a quantitative estimate of inventory uncertainty for each source category and for the inventory in total, following the IPCC good practice guidance;
    - compile the national inventory in accordance with Article 7, paragraph 1, and relevant decisions of the COP and/or COP/MOP;
    - implementing the QA/QC and verification procedures in accordance with its QA/QC plan following the IPCC good practice guidance.

Table 13.2 Studies ***implemented for strengthening the NS and improving the GHG Inventory since the submission of version 2 of the 2012 NGHGI***

No.	Study title	Objectives	Contractor	Status of implementation
1.	"Development of historical data, for the period 1989-2011, for allowing to estimate direct and indirect GHG emissions from Road Transport using the COPERT 4 model associated to the Tier 2 approach"	Increasing the accuracy of the Road transport estimates, using the COPERT 4 model	DRPCIV; the study related activities were implemented under the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, RAR and DRPCIV	Finalized
2.	"Environmental Integrated Informational System"	Optimizing the informational fluxes related to the NGHGI, including also data collection from the operators for the Energy Industries, Manufacturing Industries and Construction categories in the Energy Sector and for the Solid Waste Disposal on Land and Waste Water Handling categories in the Waste Sector, and data	SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium	Finalized

No.	Study title	Objectives	Contractor	Status of implementation
		collection from public authorities		
3.	"Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations" The study is also linked with the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS	Improving the accuracy, completeness, consistency and transparency of the LULUCF Sector	ICAS	Finalized
4.	"Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" The study is also linked with the Protocol of	Improving the accuracy, completeness and transparency of the LULUCF Sector	ICAS	Finalized

No.	Study title	Objectives	Contractor	Status of implementation
	collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS			

Changes implemented and presented into version 2 of the 2012 NGHGI and into previous than version 2 of the 2012 NGHGI inventories

Changes implemented to the NS comprises:

- updating the National Environmental Protection Agency NS/NGHGI dedicated structure as a result of:
    - governmental approval during June-July 2011 of establishing a new unit at NEPA having exclusively the responsibilities of administrating the NS and the NGHGI and allowing for an increased staff number, from 5 to 16;
    - employment of additional staff (11 people);
    - ensuring appropriate working space and facilities;
    - ensuring necessary IT equipment through the support of study 4 in Table 4;
    - training of all staff using the UNFCCC Secretariat and GHG management reviewer training courses, the collaboration with the European Environment Agency and the European Topic Centre for Air Pollution and Climate change Mitigation, the collaboration with the Austrian Federal Environmental Protection Agency and the support of study 3;
    - in addition to the planned training measures, the NEPA personnel administrating the NGHGI Energy Sector received technical assistance from the Environment Agency of Austria; the results are incorporated in the NGHGI 2012.
- update of the institutional, legal and procedural arrangements associated to the NS, through modifying and completing, as part of the GD no. 668/2012, the GD no. 1570/2007 for

establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals of CO_2 by sinks, regulated through the KP, including its Annexes,

- as outcome of study 3 in Table 13.3;
- based on NEPA analysis on improving the institutional and legal arrangements part of the NS, performed during 2011- january 2012;
- including:
  - an extended list of parameters, including associated institutional arrangements, especially for ensuring the use of higher (Tier) approaches;
  - optimized institutional arrangements:
    - private institutes developing data and information using public funds provide these data and information to NEPA for free;
    - data and information providers to NEPA can request data and information to other organizations;
    - updated arrangements were established on developing data and information not available: NEPA and/or public authorities and institutions,
- are establishing and implementing the procedures for their inclusion into the Annual Statistical Research Programme, or
- are establishing procedures for the elaboration of specific studies and the associated responsibilities:
    - new provision on the obligation to ensure consistency for similar data and information provided to several beneficiaries was included.

- update of NEPA’s President Decision no. 24/2009 for approving the QA/QC Procedure related to the NGHGI through the elaboration of NEPA’s President Decision no. 417/2012 on abrogating the NEPA’s President Decision no. 119/2012 (on abrogating the QA/QC Procedure approved through the Decision no. 24/2009 and on approving a updated QA/QC Procedure related to the NGHGI) and on approving a updated QA/QC Procedure related to the NGHGI, based on NEPA’s work following specific recommendations during the 2011 NGHGI “in-country” review and in the Report of the individual review of the annual submission of Romania submitted in 2011, review under KP Article 8;

- the QA/QC and verification activities have been enhanced as a result of:
    - increased number of NEPA NS/NGHGI dedicated staff;
    - training of NEPA and data providers representatives through several training instruments;
    - using a cross-checking QC approach within NEPA;
    - applying on a significantly larger scale sector-specific QC, QA and verification activities;
    - their implementation also in the context of development in 2011 of the NGHGI improvement studies: “Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation” and “NGHGI LULUCF both under the UNFCCC and KP obligations”;
    - continuous consideration of QA, third party support (collaborations with Austria and Netherlands, EU internal reviews, review under Article 8 of the KP).
- in the context of the last two points, the QC, QA and verification activities are:
    - automated data validation within the Excel model-validation is implemented on the consideration of any activity data value provided through the Energy Balance and concerning an inventory specific activity, and on the range of the determined country-specific emission factors as defined within the relevant IPCC methodologies; the model is directly linked to the International Energy Agency and Eurostat versions of the Energy Balance provided by the National Institute for Statistics and to the determination of the country-specific or default emission factors spreadsheets (Energy Sector-Stationary Combustion Subsector and Reference Approach);
    - manual checks on all spreadsheets part of the model presented at the previous point (Energy Sector-Stationary Combustion Subsector and Reference Approach);
    - manual checks on all spreadsheets on renewable fuel combustion; the spreadsheets are directly linked to the International Energy Agency and Eurostat versions of the Energy Balance and to the default emission factors spreadsheets (Energy Sector-Stationary Combustion Subsector and Reference Approach);
    - manual checks on all spreadsheets on Fugitive Emissions Subsector; the spreadsheets are directly linked to the International Energy Agency and Eurostat versions of the

Energy Balance and to the used emission factors spreadsheets (Energy Sector-Fugitive Emissions Subsector);

- implementing an analysis on the share of European Union-Emission Trading Scheme to Energy Balance fuel consumption data, in respect to equivalent activity categories (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- checks specific to country-specific emission factors determination, based on background data reported under the European Union Emission Trading Scheme and validated through the reports of Ministry of Economy accredited verifiers (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- checks on the correlation between energy demand and energy resources data in the Energy Balance (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- checks of the outliers on the fuel mix and on the energy consumption data changes, and of double accounting potential cases, together with the Industrial Processes Sector experts (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- check on the potential double accounting cases through the use of carbon balance (Industrial Processes Sector);
- implement cross-sectoral checks for emissions from categories calculated using tier 1 default emission factors that do not specifically account for the sources of carbon (Industrial Processes Sector);
- implementing an analysis on the share of European Union-Emission Trading Scheme to National Greenhouse Gas Inventory data, in respect to equivalent activity categories (Industrial Processes Sector);
- comparison of activity data on the CH_4 recovery for valorizing from solid waste disposal on land facilities and on the waste incineration with corresponding data in the Energy Sector (Waste Sector-Solid Waste Disposal on Land and Waste Incineration Subsectors);
- check the potential occurrence of double accounting cases between the Agriculture and Land Use, Land-Use Change and Forestry Sectors (Agriculture and Land Use, Land-Use Change and Forestry Sectors);

  - implementation of a comparative analysis of country-specific emission factors and associated uncertainties with equivalent international data, mostly from the countries having similar national circumstances (technologies, the same fuels sources) (Energy Sector except the Fugitive Emissions Subsector);
  - comparison of the Enteric Fermentation and Manure Management Subsectors country-specific emission factors data and information with equivalent international data and information, especially in respect with elements available within countries with similar technical conditions (livestock characteristics, Animal Manure Management Systems characteristics) (Agriculture Sector-Enteric Fermentation and Manure Management Subsectors);
  - comparison between Agriculture and Waste Sectors data in the National Greenhouse Gas Inventory and at the level of Food and Agriculture Organization and Eurostat.
- the implementation of the studies in Table 13.3 in order to strengthen the NS and to improve the NGHGI, by third party specialized organizations;
- administration in 2011 of the Land Use, Land Use Change and Forestry (LULUCF) Sector by the Forest Research and Management Planning Institute, on contractual basis, in the context of the study "NGHGI LULUCF both under the UNFCCC and KP obligations";
- in 2012-2014 period, the NGHGI LULUCF Sector, both under the UNFCCC and KP, is administrated by ICAS, based on the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS;
- on an undetermined period, the preparation of Road transport category estimates based on COPERT 4 model is administered also based on the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior;
- establishing in detail the coordinates and advancing the elaboration of elements of updating the informational fluxes related to NGHGI under the study 4 in Table 13.3, elements aiming to optimize the implementation of the key category analysis, of the uncertainty analysis, of data collection and of public presentation of NGHGI data; additionally, in the context of study 4 in Table 13.3, in 2012 uncertainty data will be collected also through

interviews, based on the collaboration between study contractor, Environment Agency of Austria, data providers and NEPA;

- KP Annex A sources-ensuring that appropriate methods are used for key categories, improving the inventory accuracy, implementing improvements considering the previous plans and ERT recommendations: based on previously items and on items on improving the NGHGI to be further described;
- improvement of the transparency in presenting the adequacy of funding to improve the NS through the planned studies and the specific changes to the NS to ensure its proper functioning, within the NIR part of version 3 of 2011 NGHGI;
- improvement of the accuracy of KP-LULUCF data/information through:
    - the development of Tier 2 estimates for biomass pools and Forest Management activity, based on study 2 in Table 13.3; estimates have been incorporated in version 3 of the NGHGI 2011. The elaboration of Tier 2 estimates has been supported by an improved land use change matrix (supporting also the consistency between the UNFCCC and KP estimates) developed within the study 2 in Table 13.3 and by an improved quality management performed by the study contractor and NEPA.
    - finalizing the preparation by NEPA of the Terms of References associated to the study 6 in Table 13.3; advancing the procurement procedure;
- improvement of the completeness of KP-LULUCF data/information as follows:
    - Tier 1 estimates associated to the carbon stock in litter and dead wood pools for Forest Management activity and in mineral soils pool for Revegetation activity, based on study 2 in Table 13.3 were developed and incorporated in version 4 of the 2011 NGHGI.

Observation:

Version 4 of the 2011 NGHGI comprises all elements of the responses provided to the potential problems the ERT has listed in the “Saturday paper” following the 2011 in-country review.

- updating the NEPA NS/NGHGI dedicated structure according to the previously presented relevant elements.

- improvement of the transparency of KP-LULUCF data/information, based on study 2 in Table 13.3, within the NIR part of version 3 of 2011 NGHGI;
- as a result of the implementation of the activities above presented, improving the implementation of the NS general functions:
    - establish and maintain the institutional, legal and procedural arrangements necessary to perform the functions for national systems, as appropriate, between the government agencies and other entities responsible for the performance of all functions;
    - ensure sufficient capacity for timely performance of the functions for national systems, including data collection for estimating anthropogenic GHG emissions by sources and removals by sinks and arrangements for technical competence of the staff involved in the inventory development process.
- as a result of the implementation of the activities above presented, improving the implementation of the NS specific inventory preparation functions
    - prepare estimates in accordance with the methods described in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, as elaborated by the IPCC good practice guidance, and ensure that appropriate methods are used to estimate emissions from key source categories;
    - collect sufficient activity data, process information and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks;
    - compile the national inventory in accordance with Article 7, paragraph 1, and relevant decisions of the COP and/or COP/MOP;
    - implementing the QA/QC and verification procedures in accordance with its QA/QC plan following the IPCC good practice guidance.

Table 13.3 Studies implemented/in implementation for strengthening the NS and improving the GHG Inventory (determining changes implemented and presented into version 2 of the 2012 NGHGI and into previous than version 2 of the 2012 NGHGI inventories)

No.	Study title	Objectives	Contractor	Status of implementation	Deadline for providing final results
1.	"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"	Improving the accuracy in key categories estimates, as previously presented	SC ISPE SA	Finalized	31 October 2011
2.	"NGHGI LULUCF both under the UNFCCC and KP obligations"	Improving the accuracy, completeness, consistency and transparency of the LULUCF Sector	ICAS	Finalized	31 October 2011
3.	"Support for the implementation of the European Union requirements on the monitoring and reporting of the carbon dioxide (CO_2) and other greenhouse gas emissions"	Strengthening the NS, including in respect to data collection	SC ISPE SA	Finalized	30 November 2011
4.	"Environmental Integrated Informational System"	Optimizing the informational	SC Asesoft International	On-going	September 2012

No.	Study title	Objectives	Contractor	Status of implementation	Deadline for providing final results
		fluxes related to the NGHGI, including data collection from the operators for the Electricity and heat production category (Energy) and data collection from public authorities.	SA-SC Team Net International SA-SC Star Storage SRL consortium		
5.	“Development of historical data, for the period 1989-2010, for allowing to estimate direct and indirect GHG emissions from Road Transport using the COPERT 4 model associated to the Tier 2 approach”	Increasing the accuracy of the Road transport estimates, using the COPERT 4 model	PoC between NEPA, RAR and DRPCIV	On-going	annualy, until 15 July
6.	“NGHGI LULUCF both under the UNFCCC and KP obligations”	Improving the accuracy, completeness, consistency and transparency of the LULUCF Sector	PoC between NEPA, ICAS and MEF; on-going Study 6 procurement procedure	On-going	31 October 2012

Further elements, including on the implementation of studies in Tables 13.1-13.3 are presented in Chapter 1 and within the relevant sectorial Sections.

Steps taken to improve the estimates

In order to improve the Greenhouse Gas estimates, several steps have been performed in order to strengthen the National systems for the estimation of anthropogenic greenhouse gas emissions by sources and removals by sinks under Article 5, para. 1 of the Kyoto Protocol (NS) and to improve the National GHG Inventory (NGHGI), including through the development of studies in Tables 13.1-13.3.

Elements on strengthening the NS

In order to strengthen the NS the activities described in the Changes in the National System Section in the current Chapter have been implemented.

Elements on improving the GHG Inventory

Improvements of the NGHGI comprise:

Progresses incorporated into the 2014 NGHGI

- ***improving the accuracy***
    - extending the use of COPERT 4 model in Road Transport to 1990-2004 period (due to data availability, previously the model was applied to 2005-20011 period; Energy);
    - continued determination and use of CO_2 country-specific emission factors in Fuel Combustion-Sectoral Approach (for 2012 year, Energy);
    - determination and use of country-specific net calorific values in Fuel Combustion-Sectoral Approach (Energy);
    - updating the data and information collection and processing and emissions estimation system, and, consequently, improved HFCs, PFCs and SF_6 emissions following the implementation of methodological changes, including, for example, the use of a bottom-up Tier 2 estimation method considering the emissions from manufacturing,

operation and disposal of equipment for the 2.F.1-2.F.4 and 2.F.8 categories (Industrial Processes-Consumption of halocarbons and SF_6);

- updating different parameters based on data derived through the first cycle of the new National Forest Inventory and from other two research projects (Land Use, Land-Use Change and Forestry);
- use of an improved characterization related to the disposal of sludge in the context of the Solid Waste Disposal on Land category (Waste);
- use of improved activity data related to CO_2 emissions estimates from Waste Incineration (Waste).

- ***improving the completeness***
  - estimation for the first time of N2O emissions associated with Waste Incineration (Waste).

- ***improving the transparency***
  - improving the documentation related to the waste with biodegradable content in the context of the Solid Waste Disposal on Land (Waste);
  - disaggregation at higher level of the activity data and emissions related to the sludge disposal in the context of the Solid Waste Disposal on Land (Waste);
  - disaggregating at higher level the CO_2 emissions estimates associated with the Waste Incineration (Waste).

Progresses incorporated into the 2013 NGHGI

- ***improving the accuracy***
  - beginning of use of COPERT 4 model in Road Transport (Energy);
  - continued determination and use of CO_2 country-specific emission factors in Fuel Combustion-Sectoral Approach (for 2011 year, Energy);
  - update of emission factors (Energy);
  - update of activity data mainly following the correction of the Energy Balance (Energy);

- use of improved activity data in Limestone and Dolomite Use and Glass Production (Industrial Processes);
- update of the activity data mainly following the correction of related national statistics data (Land Use, Land-Use Change and Forestry, Kyoto Protocol-Land-Use, Land Use Change and Forestry);
- use of improved activity and emission factors data (Waste).

- ***improving the completeness***
  - characterization for the first time of the coke production associated CH_4 emissions (Industrial Processes).

Progresses incorporated into the version 2 of the 2011 NGHGI

- ***improving the accuracy***

Based on the intermediary results of the study “NGHGI LULUCF both under the UNFCCC and KP obligations”:

- revised estimates associated to the Forest land remaining forest land category based on a revised land use change matrix (LULUCF under the UNFCCC);
  - new estimates of emissions/removals associated to the Land converted to Forest Land, Cropland, Grassland, Settlements and Other land categories (LULUCF under the UNFCCC);
  - new characterization of the activities pertaining to the Wetlands category (LULUCF under the UNFCCC);
  - implementation of a combined Tier 1-Tier 2 approach to estimate the emissions/removals from KP Article 3.4 Forest management activity (LULUCF under the KP).

Based on NEPA’s work

- Tier 2 CO_2 estimates for Public electricity and heat production (Energy);
- Tier 2 CO_2 estimates for Manufacturing industries and construction, Other sectors and Road transport (based on COPERT 3 model use)categories (Energy);

- Tier 3 CO_2 emissions estimates and Tier 2 PFC emissions estimates associated to the Aluminium production category (Industrial processes);
- Tier 2 estimates for Managed waste disposal on land category (Waste).

- ***improving the completeness***

Based on intermediary results of study "NGHGI LULUCF both under the UNFCCC and KP obligations":

- new estimates of emissions/removals associated to the Land converted to Forest Land, Cropland, Grassland, Settlements and Other land categories (LULUCF under the UNFCCC);
- new characterization of the activities pertaining to the Wetlands category (LULUCF under the UNFCCC);
- as a result of implementing the two activities mentioned above, the number of categories whose emissions/removals were not estimated (NE categories) decreased with 111 (from 127, for 2009, within the 2011 version 1.3 NGHGI submission, to 16, for 2009, within the version 2 of the 2011 NGHGI submission).

Based on NEPA's work

- the number of NE categories in the Energy Sector decreased with 20, from 64, for 2009, within the 2011 v. 1.3 NGHGI, to 44, for 2009, within the 2011 v. 2 NGHGI, as a result of an improved characterization of emissions/removals associated to several categories.
- in total, the number of NE categories decreased for 2009 with 131, from 247 within the 2011 v. 1.3 NGHGI submission (April 2011) to 116 within the 2011 v. 2 NGHGI submission (August 2011).

- ***improving the transparency***
    - the NIR's sections relevant for the LULUCF under the UNFCCC and, respectively, under the KP, have been updated by the Forest Research and Management Planning Institute, the contractor of the study "NGHGI LULUCF both under the UNFCCC and KP obligations", a third party organization with LULUCF advanced expertise, allowing for better transparency.

- ***improving the consistency***
  - as a result of the study “NGHGI LULUCF both under the UNFCCC and KP obligations”, the time series consistency and the consistency between the LULUCF under the UNFCCC and the LULUCF under the KP have been improved through revising the land use change matrix associated to the LULUCF under the UNFCCC and the land use change matrix associated to the LULUCF under the KP.

Progresses incorporated into the version 3 of the 2011 NGHGI

- ***improving the accuracy***
  - development of Tier 2 estimates for biomass associated to the Forest Management activity.

- ***improving the transparency***
  - Industrial Processes: improving the emissions and emission factors trend explanations in the NIR;
  - Agriculture: improving the activity data trend explanations and the explanations on selection of emission factors in the NIR;
  - NS: improve the presentation of funding dedicated to the improvement of the NS and improve the presentation of changes to the NS to ensure its proper functioning in the future, within the NIR;
  - KP-LULUCF: improve the transparency of data/information within the NIR, based on the study 2 in Table 13.3.

Progresses incorporated into the 2012 NGHGI

- ***improving the accuracy***

Based on study 1in Table 13.3

- Tier 2 in majority/Tier 1 estimates, for 1989-2010 period, for CO_2 emissions, and Tier 1 for CH_4 and N_2O emissions, for Public electricity and heat production, Manufacturing industries and construction, Other sectors (Energy);

- Tier 1a estimates for Ammonia production (Industrial processes);
- Tier 2/Tier 1/default method/Tier 1b with national/default parameter values estimates for Enteric fermentation, Manure management and Agricultural soils (Agriculture);
- Tier 2 estimates for CH_4 emissions and CO_2 estimates using the default method and national emission factors, for Solid waste disposal on land, and CH_4 and N_2O emissions estimates using the default method and national/default emission factors, for Wastewater treatment (Waste).

Based on NEPA work and on study 1 in Table 13.3

- Tier 2 in majority/Tier 1 CO_2 emissions estimates and Tier 1 CH_4 and N_2O emissions estimates, for Railways and Navigation categories (Energy).

- ***improving the completeness***
  - Energy: improving further the characterization of categories whose associated emissions are not estimated (NEs)-comparing with version 2 of the 2011 NGHGI, the characterization of NEs has been further improved within the 2012 NGHGI, based on NEPA work; the number of NEs decreased with 38 for the last characterized year (2009, associated to the version 2 of the 2011 NGHGI and, respectively, 2010, associated to the 2012 NGHGI), from 44 to 6;
  - analyze of improving the characterization of NEs within the 2012 NGHGI, compared to the version 1 of the 2011 NGHGI. As a result the number of NEs for the last characterized year (2009, associated to the version 1 of the 2011 NGHGI and, 2010, associated to the 2012 NGHGI), remained constant.

- ***improving the transparency***
  - Improvement of the Energy Sector transparency, including through the extended use of detailed data in the Energy Balance and through the inclusion in the NIR of the disaggregated data on transport and on other fuels and other petroleum oil, data provided by the National Institute for Statistics;
  - Improving the documentation of parameters, on their yearly variation and on envisaged improvements, within the NIR (Waste).

Additionally, all activities related to the NGHGI administration and part of the Greenhouse Gas Inventory preparation plan, GHG Inventory improvement plan (including the prioritization plan for moving to higher tier methods for key categories)-2011-2012 and of the Schedule for training of new staff part of NEPA team dedicated to the administration of the NS and, respectively, the Greenhouse Gas Inventory were implemented.

Elements pertaining to the studies administration

The studies in Tables 13.1-13.3 above have been officially approved by the designated national authority, the Ministry of Environment. The organization having the responsibility of implementing the acquisition procedure pertaining to the studies previously mentioned, including the contracting stage is the Ministry of Environment.

In respect to the provisions in the current Improvement Plan, the studies are meant to strengthen the NS and to improve the accuracy of the NGHGI through the use of higher Tier/higher methods according to the specific IPCC good practice guidance decision trees provisions, to improve its completeness by allowing for the estimation of all relevant emissions/removals, to improve the consistency of the data series and the associated transparency.

The scope of the studies is to provide additional data/information to the Romanian authorities and to optimize the NGHGI related informational fluxes in order to strengthen the compliance with the reporting obligations under the UNFCCC process and the EU monitoring mechanism. The Romanian authority in charge of the GHG emission reporting is the Ministry of Environment and Climate Change, and thus it ensures that the studies are providing adequate information. The results of the studies are providing the necessary data for the NGHGI to fully comply with the IPCC reporting requirements.

According to the specific provisions within the Romanian legislation, namely the Government Decision nr. 1635/2009, the Ministry of Environment and Climate Change is the responsible institution with implementation of UNFCCC and KP. In addition, MECC is the coordinator of funds distribution for studies in the field of environment and climate change.

MECC has also the tasks of the implementation of environment policy and legislation, including the entire responsibility regarding the NGHGI.

Therefore, Ministry of Environment is:

- the contracting authority in charge with the promotion of the different studies and is ensuring the elaboration of relevant documentation necessary for the acquirement of these studies, the formal approval of documents as well as with financial disbursement;
- the beneficiary of these studies and use the results to adequately meet the reporting obligations. MECC is ensuring the development of the Terms of Reference (ToRs) of the studies, including also drawing up the technical aspects of ToRs, in a way to comply with the needs and the provisions of reporting requirements.

Technical verification of the results of studies is also performed by MECC which use the results in the inventory preparation and hence the interest of MECC in participating in the process of contracting the best institution to perform the studies in a professional and timely manner.

The quality management from the initiation, throughout the completion of the studies themselves, and the quality assurance of the findings, is ensured as follows:

- *within the initiation phase* – when drawing up the relevant ToRs, MECC as a contracting authority and as the implementing agency is ensuring that the necessary data and information provided through the studies will support the Romanian authorities to fully comply with the reporting requirements;

The required quality of these studies is assured by the following legal procedure:

- the ToRs for each of these studies are elaborated, using technical elements with the aim to fill the gaps of recent inventory, approved and published by the MECC;
- the funding is provided by the MECC;
- the contractor is developing a work plan approved by the beneficiary observing the timeline indicated in ToRs;
- the implementation is carried out in intermediate steps followed by progress reports subject to the approval by MECC as the main beneficiary of these studies;
- during the implementation phase, the contractor is required to provide MECC, after the generation of the results, the proper documentation on the scope, methods, assumptions, key parameter values and data sources; further on, MECC is ensuring the adequate use, archive and storage of the information provided;
- the studies are providing also recommendation for long terms solutions in generating

similar information annually.

- *during the development phase of the studies*

The organizations/entities selected to develop the studies are performing QC activities through all the stages of the study development, are documenting all the activities performed and are providing MECC the specific documentation including the relevant methodology. In this respect, the contractor is asked to perform and document the QC activities through all stages of the study development and to provide relevant documentation to the beneficiary.

Also, through the contract, the organization elaborating the study is ensuring the implementation of QA activities in the preparation of the respective studies and is providing MECC with the relevant documentation.

The implementation of the studies is following the classic procedure: inception phase, progress phases and final phase, and thus offering the possibility to MECC to monitor closely their development and avoiding in this way the deviation from the initial scope of the studies.

- *within the reception phase*

MECC is making the payments for the contractor only after MECC's endorsement of results according to contract. Therefore, the studies are providing quality and useful information for the elaboration of GHG inventories in accordance with reporting requirements.

The entire documentation on the scope, methods, assumptions, key parameter values and data sources for each study is part of the electronic/paper archive stored within the MECC's headquarters, and are available for using further by experts and checked by review teams.

Giving its legally assigned task and its designation as the responsible authority for the National System and preparation of the National GHG Inventory management, MECC is responsible for the incorporation within the NGHGI of all studies results immediately after their delivery.

Sufficient funding to strengthen the NS and improve NGHGI including through the development of specific studies are available.

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of Romania have therefore occurred in 2013.

Table 14.1 Changes to the national registry

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	At the current moment, Romania does not have a National Registry Administrator. Romania do implement formalities to nominate a National Registry Administrator; name and contact information will be published on the National Registry website.
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	An updated diagram of the database structure is attached as Annex 6.2.2. Iteration 5 of the national registry released in January 2013 and Iteration 6 of the national registry released in June 2013 introduces changes in the structure of the database. Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. However, each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex 6.2.3). Annex 6.2.4 testing was carried out in February 2014 and the successful test report has been attached. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	Romania have no change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.

Reporting Item	**Description**
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex 6.2.3. Annex 6.2.4 testing was carried out in February 2014 and the successful test report has been attached.

15 INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

According to the Article 3.14 of the Kyoto Protocol, Annex I countries will take mitigation measures in such a way as to minimize adverse social, environmental and economic impacts on developing countries.

As Romania pointed out in the previous National Communications on Climate Change following the Article 12 of the UNFCCC and also to the European Commission and the European Environmental Agency, following the Regulation no. 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and the Decision no. 166/2005/EC, the levels of GHG emissions during 1989-2012 were far below the reduction commitment taken within the Kyoto Protocol.

This reduction was mainly the result of the reduction on the economic activities level, the upgrading of technologies and energy efficiency activities promoted in the European Union integration process.

Therefore we can appreciate that the national climate change policy developed so far to reduce GHG emissions has had no impact abroad and especially on developing countries.

The application of the Joint Implementation mechanism in our country aimed firstly at upgrading and refurbishment of old technologies and at improved energy efficiency, with no trans-boundary effects, as well as the implementation in Romania of the European Union Emission Trading Scheme.

Nevertheless Romania is of the opinion that the technical and financing assistance towards the developing countries is very important for the development international policy on climate change, and is willing to join the European Union initiative to provide a “fast start financing” for the developing countries.

Under the fast start financing Romania decided to focus its contribution for the benefit of developing countries associated to the Copenhagen Accord, countries which have committed to take GHG emissions reducing measures and have developed economic strategic partnership relations with our country.

The Republic of Moldavia has associated itself to the Copenhagen Accords and has committed to reduce the GHG emissions until 2020 by 25% in comparison with the 1990 level.

In this context the 15 million Euros Romanian contribution planned for the fast start financing mechanism will be used for energy efficiency and transport infrastructure projects with a view to develop climate change mitigation policy, efficiency of natural resources use and the European integration of the Republic of Moldavia.

16 OTHER INFORMATION

There is no other relevant information which needs to be reported.

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