



**Ministry of Environment,
Water and Forests**

**Romania's Greenhouse Gas Inventory
1989-2013**

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 (CH ₄) 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 ₂ F 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-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	National Research and Development Institute in Forestry "Marin Drăcea"
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
IPCCGPG 2006	IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories - 2006
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
KP Supplement	Good Practice Guidance Arising from the 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
MEF	Ministry of Environment and Forests
MEWF	Ministry of Environment, Water 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 ₂ O	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 occurred
NO _x	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
Wetlands Supplement	Supplement to the 2006 Guidelines for National Greenhouse Gas Inventories : Wetlands
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 (GHG) inventories and 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 of climate change impact in 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 CO₂ atmospheric concentration would double, it is expected for the coming decades that the average global temperature will increase by 2.4-7.4⁰C.

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 22nd version of the National Inventory Report (NIR) submitted by Romania, covering the national inventories of GHG emissions/removals for the period 1989-2013.

Following the issues on the current functioning status of the CRF Reporter application, this inventory is submitted by Romania under the UNFCCC provisions.

This report documents Romania's National Inventory of anthropogenic emissions/removals of direct GHGs: CO₂, CH₄, N₂O, HFCs, PFCs, SF₆, NF₃ and indirect GHGs: NO_x, CO, NMVOC and SO₂. 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; the reporting considers the elements that are available in accordance with the current functioning status of the CRF Reporter application.

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 CO₂ equivalent using the Global Warming Potential values provided by IPCC in the Forth Assessment Report (the GWP values are presented in the Annex 5 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

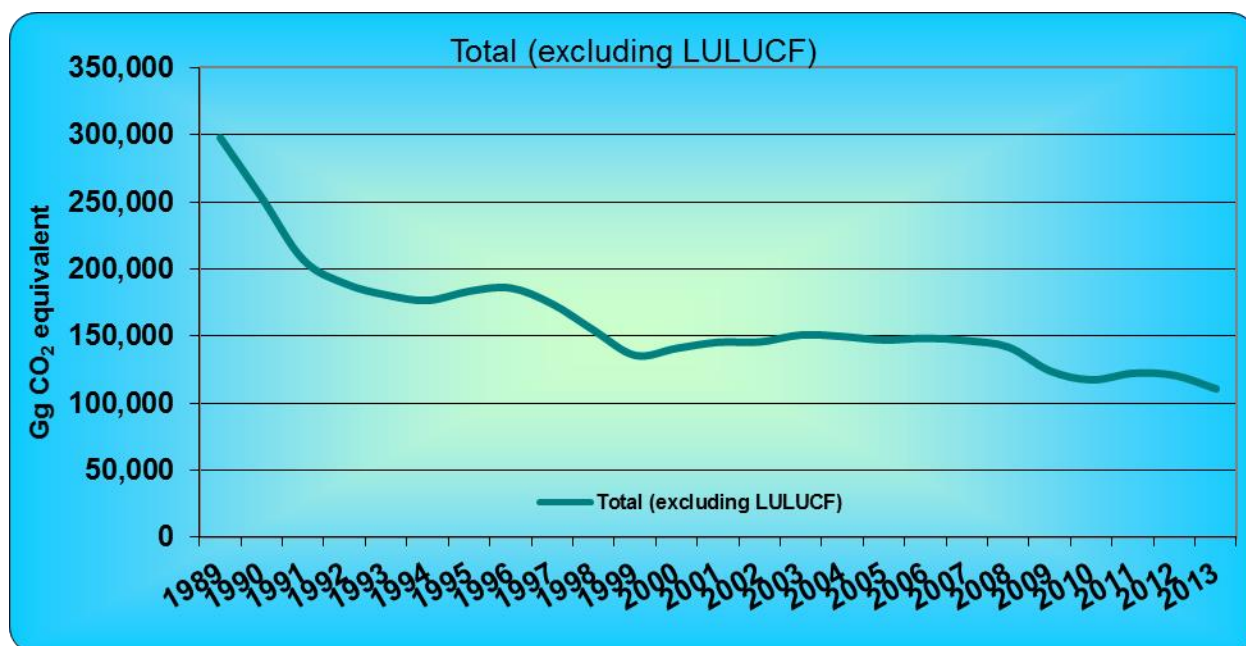
while in 2010 they continued to decrease, due to the economic crisis. In 2011, the emissions started to increase again while in 2012 and 2013 the emissions decreased, following the economic activities level.

The largest contributor to the total national GHG emissions is CO₂, followed by CH₄ and N₂O. The share of each direct GHG in total emissions in 1989 and, respectively 2013, and the average share of each direct GHG in total emissions for 1989-2013 period are presented in the Table ES.1.

The total GHG emissions excluding LULUCF, in CO₂ equivalent, during 1989-2013 period, are presented in the Figure ES.1.

Table ES 1 Share of each direct GHG in total emissions in 1989, 2013, respectively 1989-2013 period

GHG	1989 (%)	2013 (%)	Average share for 1989-2013 period (%)
CO₂	70.10%	66.20%	68.74%
CH₄	22.42%	25.88%	24.11%
N₂O	6.17%	6.69%	6.25%
HFCs	0.0000%	0.0117%	0.2789%
PFCs	1.30%	0.01%	0.60%
SF₆	0.00000%	0.00051%	0.01352%
NF₃	0.00%	0.00%	0.00%

Figure ES 1 The total GHG emissions in CO₂ equivalent during 1989-2013 period

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 1989–2013 was compiled according to the recommendations for GHG inventories set out in the Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories (FCCC/CP/2013/10/Add. 3) and in the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol, using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories as well as the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP

Supplement) and 2013 Supplement to the 2006 Guideliness for National Greenhouse Gas Inventories : Wetlands (Wetlands Supplement).

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 (CO₂);
- ❖ methane (CH₄);
- ❖ nitrous oxide (N₂O);
- ❖ hydrofluorocarbons (HFCs);
- ❖ perfluorocarbons (PFCs);
- ❖ sulphur hexafluoride (SF₆);
- ❖ nitrogen trifluoride (NF₃).

The report also contains data on calculations of emissions of the indirect GHGs: NO_x, NMVOC, CO and SO₂, which should be included according to the reporting guidelines.

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 5.10.1.

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 SO₂) 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 SO₂, NO_x and CO emissions. Additional to the Energy sector, the NMVOC emissions are generated mainly through activities within the Industrial Processes and Product Use sector.

PART 1 ANNUAL INVENTORY SUBMISSION

1 INTRODUCTION

1.1 Background information on GHG inventories and 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 2013 year, the forest land area accounted for approximately 7 228,3 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 CO₂ 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 Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories (FCCC/CP/2013/10/Add. 3), 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 22nd complete submission of the National GHG Inventory of Romania. The structure of the National Inventory Report is in line with the provisions in the Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories (FCCC/CP/2013/10/Add. 3) and in 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, following the issues on the current functioning status of the CRF Reporter application.¹

¹ According to Decision 13/CP.20 of the Conference of the Parties to the UNFCCC, CRF Reporter version 5.0.0 was not functioning in order to enable Annex I Parties to submit their CRF tables for the year 2015. In the same Decision, the Conference of the Parties reiterated that Annex I Parties in 2015 may submit their CRF tables after 15/April, but no longer than the corresponding delay in the CRF Reporter availability. "Functioning" software means that the data on the greenhouse emissions/removals are reported accurately both in terms of reporting format tables and XML format.

For this submission, Romania prepared the CRF tables and database containing emissions/removals estimates and background data for 1989 - 2013 period and the National Inventory Report.

The greatest attention during the preparation was paid to the direct GHGs mentioned through Annex A of the Kyoto Protocol - CO₂, CH₄, N₂O, HFCs, PFCs, SF₆ and NF₃. In addition, the indirect GHGs (NO_x, CO, NMVOCs, and SO₂) 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 UNFCCC and 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	2 nd 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

CRF reporter version 5.10 still contains issues in the reporting format tables and XML format in relation to Kyoto Protocol requirements, and it is therefore not yet functioning to allow submission of all the information required under Kyoto Protocol.

Recalling the Conference of Parties invitation to submit as soon as practically possible, and considering that CRF reporter 5.10 allows sufficiently accurate reporting under the UNFCCC (even if minor inconsistencies may still exist in the reporting tables, as per the Release Note accompanying CRF Reporter 5.10), the present report is the official submission for the year 2015 under the UNFCCC. The present report is not an official submission under the Kyoto Protocol, even though some of the information included may relate to the requirements under the Kyoto Protocol.

Year	Submission	Review process
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	3 rd version of the 2011 submission	In - country Review
2012	2 nd version of the 2012 submission	Centralized Review
2013	1 st version of the 2013 submission	Centralized Review
2014	1 st version of the 2014 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; the information is subject to the current functioning status of the CRF Reporter application;
- ❖ 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 national inventory arrangements and national system

1.2.1 Institutional, legal and procedural arrangements 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, 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 and the GD no. 38/2015 on the organization and functioning of the Ministry of Environment, Waters and Forests 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 National Inventory Arrangements (NIA) and the National System are based on the provisions in the Decision 24/CP. 19 on the Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention and on Article 5 of the Kyoto Protocol, and complies with the provisions of the subsequent decisions of the CMPs of the Kyoto Protocol, 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 repealing Decision no. 280/2004/EC and of the Commission Implementing Regulation (EU) no. 749/2014 on structure, format, submission processes and review of

information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council.

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 Inventory Arrangements and National System, is the Ministry of Environment and Climate Change (MECC), presently, following the reorganization of the institution, the Ministry of Environment, Waters and Forests (MEWF). 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.

National Inventory Arrangements are designed and operated:

- ❖ to ensure the transparency, consistency, comparability, completeness and accuracy of inventories;
- ❖ to ensure the quality of inventories through the planning , preparation and management of inventory activities.

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 NIA and NS and of preparation and management of the NGHGI, is the Ministry of Environment, Waters and Forests.

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.

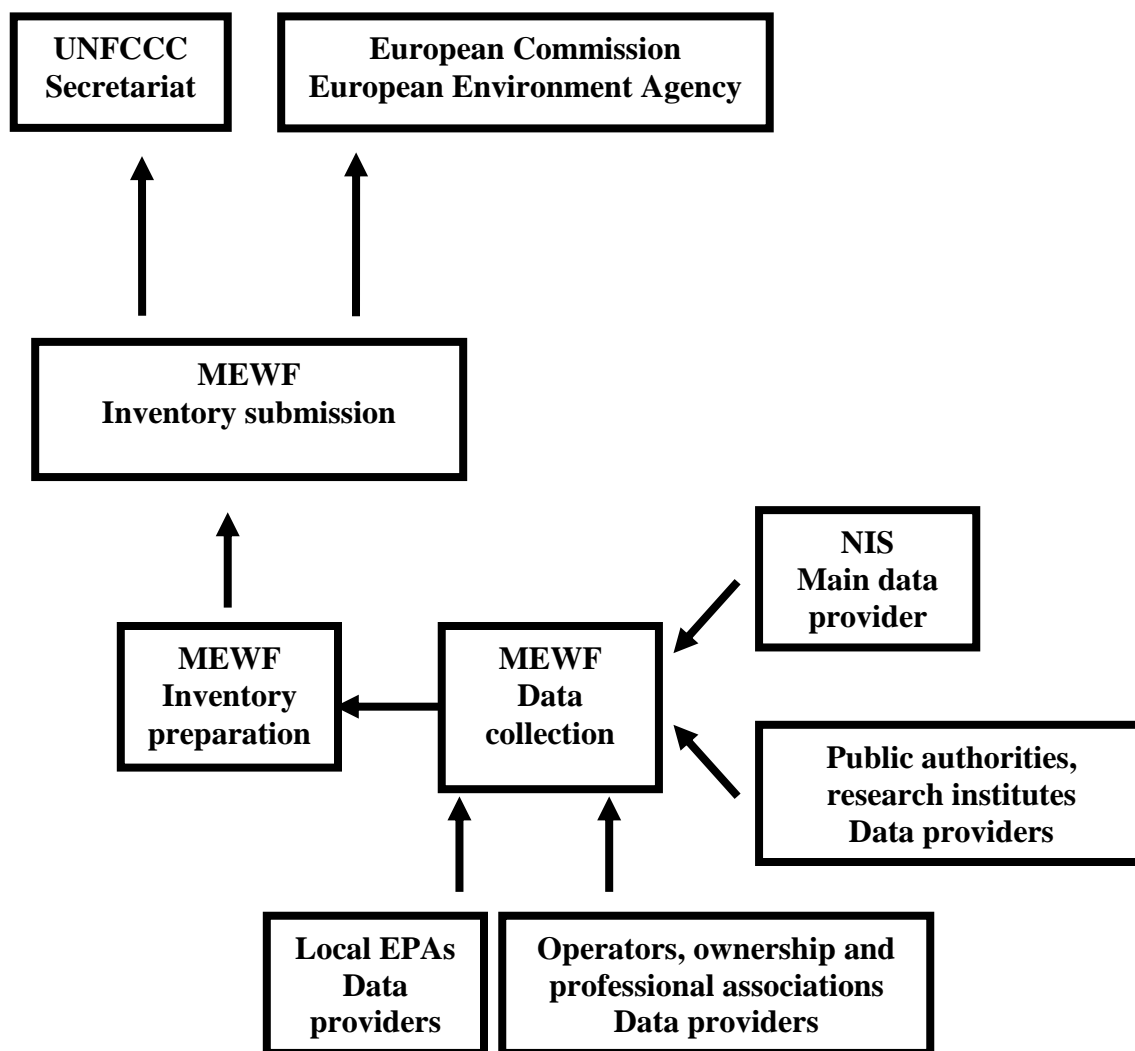
- ❖ central and territorial public authorities, research and development institutes and other public organizations under the authority, in the subordination or in the coordination of central public authorities, owners and professional associations, economic operators and other relevant organizations have the obligation of providing to MEWF 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 – MEWF 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 MEWF (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 N₂O emissions estimation”;
 - in 2014, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions

calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology” and “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”.

- ❖ 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 SF₆), 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 SF₆ data and information.
- ❖ the “Support for the implementation of the European Union requirements on the monitoring and reporting of the carbon dioxide (CO₂) 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 releasing Decision no. 280/2004/EC and the Commission Implementing Regulation (EU) no. 749/2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council;

- ❖ 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. 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. 38/2015 on the organization and functioning of the Ministry of Environment, Waters and Forests;
- ❖ 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 CO₂ 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 CO₂ 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;
- ❖ MoEO no. 1442/2014 on approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels;
- ❖ MoEO no. 1602/2014 on approving the Quality Assurance and Quality Control Plan associated to the National Greenhouse Gas Inventory;
- ❖ 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 and ulterior reorganizations, 12 posts are available in the National System for Estimating the GHG Emissions Unit–Climate Change General Directorate in the MEWF, exclusively for administrating the NIA and 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 had 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 NIA and 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

administering 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 (CO₂) 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 administering 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 (CO₂) 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 (CO ₂) 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 NIA and NS, is MEWF.

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;
- ❖ 2015 submission of the NGHGI constitutes the 22nd 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; in respect to the 2015 submission, the inventory is submitted considering also the current functioning status of the CRF Reporter;
- ❖ 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.

F. Undertake specific functions relating to inventory planning, preparation and management

Romania is undertaking all specific functions relating to inventory planning, preparation and management, in accordance with the specific provisions under the UNFCCC, KP and EU; their implementation is described below.

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 NIA and NS, is MEWF.

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, Waters and Forests;
 - address: Bd. Libertății no. 12, Sector 5, Bucharest;
 - telephone: +40-21-4089551; fax: +40-21-4089550.
- ❖ designated representative with overall responsibility:
 - name: Sorin Deaconu;
 - telephone: +40-21-4089551; 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 MEWF team managing the NIA and 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 NIA and 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 MoEO no. 1602/2014 on approving the Quality Assurance and Quality Control Plan associated to the National Greenhouse Gas Inventory;
- ❖ 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 1.2.3.

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

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 MEWF level;
- ❖ MEWF 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:

- ❖ 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, MEWF ensures the availability of human and financial resources for the implementation of review activities;
- ❖ MEWF 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.

Elements relevant to the implementation of the NIA and 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 4 in Volume 1 of IPCC 2006, following the Approach 1;
- ❖ 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 4.1 of Volume 1 of IPCC 2006), and gases were analyzed;
- ❖ KCA was conducted for every year of the characterized period;
- ❖ results are presented in NIR, within:
 - Chapter 1, at general level;
 - Annex 1.
- ❖ 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 agreed to be used under UNFCCC and KP, 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 2006;
- ❖ emissions/removals from LULUCF Sector are estimated following the IPCC 2006, Wetlands Supplement and KP Supplement;
- ❖ estimation methods selection is based on MoEO no. 1442/2014 on 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 SF₆), 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 N₂O emissions estimation”;
 - in 2014, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology” and “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”.

- 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”;
 - in 2014, “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.
 - 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 Sections 1.3 and 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 2006, 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 MEWF;
- ❖ emission factors (EFs) selection is performed according to the provisions in the MoEO no. 1442/2014 on 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/MEWF'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 SF₆), 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 N₂O emissions estimation”;
 - in 2014, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology” and “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”.
- 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”;
 - in 2014, “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.
 - 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 1.4.

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 on Approach 1 according to the provisions in Chapter 3 in Volume 1 of the IPCC 2006;
- ❖ performed for 2013, 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 SF₆), 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 N₂O 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”, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas

Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology” and “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol” 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;

- ❖ results are presented within the NIR, in:
 - Uncertainties and time series consistency sub-sectorial sections;
 - in Annex 2.
- ❖ 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 1.6.

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 2006 (and previous to 2015 submission 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/MEWF'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 SF₆), 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 N₂O 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";

- in 2014, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology” and “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.
 - 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 the relevant provisions under UNFCCC and KP*

Specific elements on the compilation of the national inventory include:

- ❖ NGHGI has been compiled based on Guidelines for the preparation of national communications by Parties included in Annex 1 to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories (FCCC/CP/2013/10/Add. 3; 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 inventory arrangements and national system and to the MoEO no. 1602/2014 on approving the Quality Assurance and Quality Control Plan associated to the National Greenhouse Gas Inventory, MEWF represents the competent authority responsible with the implementation of the QA/QC activities;
- ❖ the QA/QC coordinator is designated by MEWF;
- ❖ 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 SF₆), 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 N₂O 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”;
 - in 2014, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial

Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology” and “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.

- documented within sectorial QC lists consistently used across the dedicated NIA and 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 UNFCCC and 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 1.2.3.

Elements characterizing the implementation of the NIA and 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 inventory arrangements and national system and their functions, is archived;
- ❖ the archive is managed by MEWF and is accessible at a single location at the MEWF'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;
- ❖ MEWF designated the manager of the archiving system.

More relevant detailed elements are provided within Section 1.3.2.

B. Provide review teams 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, MEWF is providing review teams 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 inventory arrangements and national system, in a timely manner

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, MEWF ensures the availability of human and financial resources for the implementation of review activities;
- ❖ MEWF 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.

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

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 NIA and NS, is MEWF; more detailed elements of inventory planning are included in Section 1.2.1

MEWF 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 MEWF 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 continued 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 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 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”.

In 2014, ICAS contributed further by developing the study “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”; in this context activity data and emissions-removals factors continued to be developed while the compilation of the LULUCF Sector was continued.

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 N₂O emissions estimation”;
- in 2014, the studies “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology” and “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the

implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”.

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 SF₆), 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 SF₆ 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.

1.2.3 Quality assurance, quality control and verification plan on 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, NIA and NS, the IPCC 2006 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 and within the QA/QC Procedure related to the NGHGI, approved by the MoEO no. 1602/2014.

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 inventory arrangements and national system, as ulteriorly modified and completed, and to those in the MoEO no. 1602/2014 on approving the Quality Assurance and Quality Control Plan associated to the National Greenhouse Gas Inventory, MEWF represents the competent authority responsible with the implementation of the QA/QC activities under the NGHGI.

For this purpose, MEWF 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, MEWF 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 2006, Wetlands Supplement and KP Supplement and with the provisions of the Regulation no. 525/2013 of the European Parliament and of the Council and of the Commission Implementing Regulation (EU) no. 749/2014.

Romania's QA/QC plan closely follows the definitions, guidelines and processes presented in Chapter 6 – Quality Assurance/Quality Control and Verification in Volume 1 of IPCC 2006. 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 SF₆), 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 N₂O 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”.
- ❖ in 2014:
- “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”;
 - “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”;
 - “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.

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 Commission Implementing Regulation (EU) no. 749/2014, 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, MEWF involve third party reviewers at the QA activities level according to the provisions in IPCC good practice guidance, depending on the availability of resources. In this scope, MEWF is developing the specific procedural arrangements. MEWF 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 good practice guidance, in the context of elaboration 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”.
- ❖ 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 SF₆), 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 N₂O 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”.
- ❖ in 2014,
- “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”;
 - “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”;
 - “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.

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; also, in 2015, the inventory was reviewed in the context of annual monitoring and compliance cycle.

National inventory submissions to the UNFCCC Secretariat are subject to the review under UNFCCC and 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, Commission Implementing Regulation (EU) no. 749/2014 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.

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 CO₂ 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.

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 and Reference Approach);

- manual checks on all spreadsheets part of the model presented at the previous point (Energy Sector-stationary combustion 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 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 from Fuels 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 from Fuels 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 from Fuels Subsector, Reference Approach);
- checks on the correlation between energy demand and energy resources data in the Energy Balance (Energy Sector except the Fugitive Emissions from Fuels 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 from Fuels Subsector);

- check on the potential double accounting cases through the use of carbon balance (Industrial Processes and Product Use 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 and Product Use 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 and Product Use 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 from Fuels Subsector and Reference Approach, and Industrial Processes and Product Use 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 and Agriculture Sector-agricultural soils);
 - 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 and Land-Use, Land-Use Change and Forestry Sector);

- comparison of activity data on the CH₄ recovery for valorizing from solid waste disposal on land facilities with corresponding data in the Energy Sector (Energy Sector-stationary combustion and Waste Sector-Solid Waste Disposal 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-Incineration and Open Burning of Waste 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 SF₆), 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 N₂O 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”.
- ❖ in 2014,
 - “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”;
 - “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product

Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”;

- “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.

- ❖ 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.

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.

1.2.4 Changes in the national inventory arrangements and national system since previous annual GHG inventory submission

Changes in the national inventory arrangements and national system are presented in Chapter 13 of IPCC.

1.3 Inventory preparation, and data collection, processing and storage

1.3.1 GHG inventory and KP-LULUCF inventory

The present NIR was compiled according to the recommendations for inventories set out in the Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories (FCCC/CP/2013/10/Add. 3) and 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 2013, in order to ensure the transparency of the inventory. The emissions are estimated using the IPCC 2006, Wetlands Supplement and KP Supplement.

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 Inventory Arrangements and 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 MoEO no. 1442/2014 on 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/MEWF'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 SF₆), 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 N₂O emissions estimation";
 - in 2014, "Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology" and "Elaboration and documentation of values for the parameters relevant to the National Greenhouse

Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”.

- 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”;
 - in 2014, “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.
- 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 MEWF.

Activities were carried out mostly at MEWF, 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 SF₆), 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 N₂O 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”.
- ❖ in 2014,
- “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”;
 - “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”.
 - “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.

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:

- ❖ MEWF, 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;
- ❖ MEWF, 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.

MEWF team manages and maintains the NGHGI database and the documentation of specific inventory information. According to the provisions in IPCC 2006, 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 MEWF'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 MEWF's server with daily frequency during the generation of the official submission and weekly in rest of cases.

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

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 MoEO no. 1442/2014 on 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 2006. Emissions/removals from LULUCF Sector are estimated using IPCC 2006 and Wetlands Supplement. CORINAIR methodology was applied in case of the solvent use related categories in the NGHGI Industrial Processes and 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 and Product Use	National Institute for Statistics- Statistical Yearbook and other data sources Industrial operators through 42 Local/Regional Environmental Protection Agencies Direct information from industrial operators
Agriculture	National Institute for Statistics
LULUCF	National Institute for Statistics through Statistical Yearbook Ministry of Agriculture, Forests and Rural Development (MADR)-Forests

Sector	Data sources
	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” 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/MEWF’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 SF₆), 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 N₂O 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”.
- in 2014,
- “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”;
 - “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”.
 - “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations

Framework Convention on Climate Change, including those in the Kyoto Protocol”.

- ❖ 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 2006, Wetlands Supplement, KP Supplement, 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/MEWF'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 SF₆), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)”;
- in 2014, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions

calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology” and “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”.

- 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”;
 - in 2014, “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.

- 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 4 in Volume 1 of IPCC 2006, following the Approach 1.

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 4.1 of Volume 1 of IPCC 2006), and gases were analyzed. KCA was conducted for every year of the characterized period.

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 2 of the KP Supplement.

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

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

1.6.1 GHG inventory

The present NIR comprises a full quantitative assessment of the uncertainty. Romania carried out the uncertainty analysis on the basis of Approach 1 according to the provisions in Chapter 3 of Volume 1 of IPCC 2006.

The uncertainty calculation was performed for 2013, 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 SF₆), 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 N₂O 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”, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”, “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology” and “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol” 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;

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.

Considering the 2015 NGHGI and the Tier 1 method:

- ❖ the total NGHGI uncertainty for 2013 excluding LULUCF was 11.6%, while including LULUCF was 28.9%;
- ❖ the uncertainty introduced into the trend in total national emissions, for 2013, was 1.3% when considering excluding LULUCF criteria and 10.8%, 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 2.

- ❖ 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.

1.6.2 KP-LULUCF inventory

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

1.7 General assessment of the completeness

1.7.1 GHG inventory

The inventory covers all sectors and all gases in the period 1989-2013 and is complete in terms of geographical coverage. Emissions are presented by sector, by sub-sector and by gas.

All the sources/sinks not estimated or included elsewhere and the relevant justifications are presented in the Annex 5.

1.7.2 KP-LULUCF

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

2 TRENDS IN GREENHOUSE GAS EMISSIONS

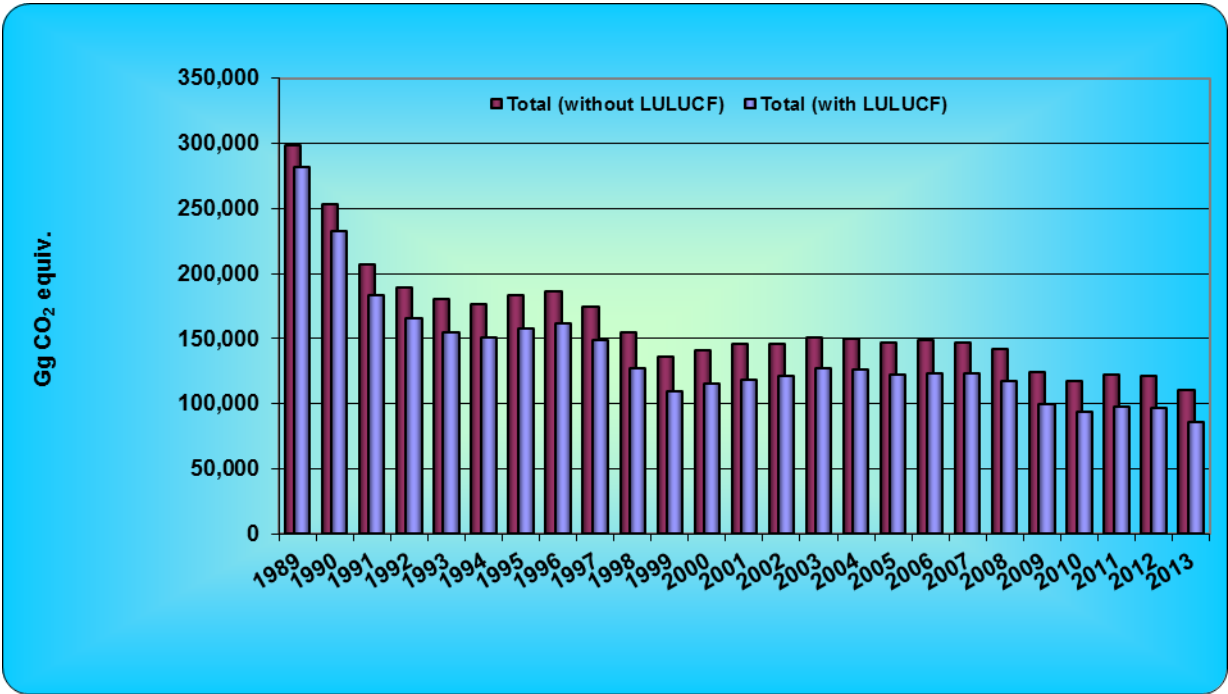
2.1 Description and interpretation of emissions trends for aggregated GHG emissions

The total GHG emissions in 2013, excluding removals by sinks, amounted to 73,437.39 kt CO₂ 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 64.85 % in 2013 in comparison to 1989 while the net GHG emissions/ removals (taking into account the CO₂ removals) decreased with 75.03%. 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 2013 comparing with 2008.

2.1.1 Description and interpretation of emissions trends by gas

All GHG emissions, except HFCs and SF₆, 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 CO₂, followed by CH₄ and N₂O. In the base year, the shares of GHG emissions were: 70.10% CO₂, 22.42% CH₄, 6.17% N₂O, 1.30% PFCs. In 2013, the shares of GHG emissions were: 66.20% CO₂, 25.88% CH₄, 6.69% N₂O, 0.01% PFCs. The F gases started to be used as substitutes for ODS in refrigerating and air conditioning systems since 1995. In 2013, the contribution of these gases to the total GHG emissions is negligible: 1.17% HFCs and 0.05% SF₆. Next table presents the trend of the aggregated emissions, split by gas.

Table 2.1 Trends by gas [kt CO₂ equivalent]

Year	CO₂ including LULUCF	CO₂ excluding LULUCF	CH₄ excluding LULUCF	N₂O excluding LULUCF	HFCs	PFCs	SF₆
1989	191,753.59	208,913.93	66,817.22	15,890.19	0.16	3,886.75	0.47

Year	CO₂ including LULUCF	CO₂ excluding LULUCF	CH₄ excluding LULUCF	N₂O excluding LULUCF	HFCs	PFCs	SF₆
1990	151,654.15	173,012.37	62,269.70	13,361.35	0.18	2,455.17	0.47
1991	117,771.23	142,141.46	51,507.86	10,239.34	0.29	2,253.56	0.52
1992	106,525.82	131,631.52	46,125.11	10,777.59	0.45	1,568.98	0.49
1993	97,324.50	123,824.70	43,996.90	10,184.41	0.73	1,635.47	0.52
1994	94,403.24	121,461.49	42,961.24	9,585.09	1.20	1,730.09	0.74
1995	100,884.59	127,358.19	42,912.07	10,307.56	2.53	2,057.96	0.98
1996	105,099.05	130,671.62	42,469.17	9,996.72	4.72	2,052.55	1.54
1997	96,328.24	122,318.21	39,291.64	9,625.41	10.36	2,072.87	1.41
1998	78,136.79	106,360.77	36,798.23	8,433.79	23.88	2,034.53	1.51
1999	62,614.16	89,732.13	35,273.47	8,069.96	39.73	1,860.49	1.70
2000	67,469.24	94,162.78	36,037.50	8,488.26	70.82	1,499.32	8.68
2001	71,619.44	99,503.03	35,489.41	8,255.27	112.87	1,211.66	14.33
2002	74,607.99	99,756.69	36,521.16	7,711.56	168.16	832.99	12.10
2003	79,784.65	104,630.32	36,692.55	8,307.59	228.75	304.54	10.54
2004	79,219.03	103,518.23	35,403.70	9,510.76	293.93	153.86	14.10
2005	75,337.47	101,215.34	32,710.85	9,205.29	368.91	95.28	15.67
2006	78,709.39	104,542.71	34,732.03	8,262.69	484.20	64.06	24.13
2007	78,824.93	103,308.98	33,598.89	8,215.14	665.63	28.18	29.88
2008	75,114.93	99,944.59	32,966.01	6,957.18	946.95	17.87	33.83
2009	59,552.78	84,415.70	31,442.70	6,225.70	924.42	8.16	47.03
2010	54,839.99	79,723.02	29,295.78	6,389.55	982.47	9.13	60.71
2011	59,591.21	84,799.78	28,651.17	6,686.99	1,092.41	12.72	47.83
2012	57,918.47	83,182.25	29,292.16	6,068.10	1,197.73	7.43	50.76
2013	47,883.39	73,436.96	28,709.80	6,021.14	1,298.84	6.15	57.08

Carbon dioxide (CO₂) – the most significant anthropogenic greenhouse gas is the carbon dioxide. The decrease of CO₂ emissions (from 208,913.93 kt in 1989 to 73,437.39 kt in 2013) 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 (CH₄) – the methane emissions, related mainly to the Fugitive emissions from fossil fuels extraction and distribution and to the livestock, decreased in 2013 by 57.03% compared with the levels in 1989. The decrease of CH₄ emissions in Agriculture is due to the decrease of the livestock level.

Nitrous oxide (N₂O) – the N₂O 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 N₂O emissions trend. The N₂O emissions in 2013 decreased with 59.67% in comparison with the level in the base year.

Fluorocarbons and SF₆ (HFCs, PFCs, SF₆) – The PFCs emissions generated in the production of the primary aluminium are reported for the entire analyzed period (1989-2013) and have decreased with 99.84% in 2013 comparing with the level in 1989).

2.1.2 Description and interpretation of emissions trends for indirect greenhouse gases and SO₂

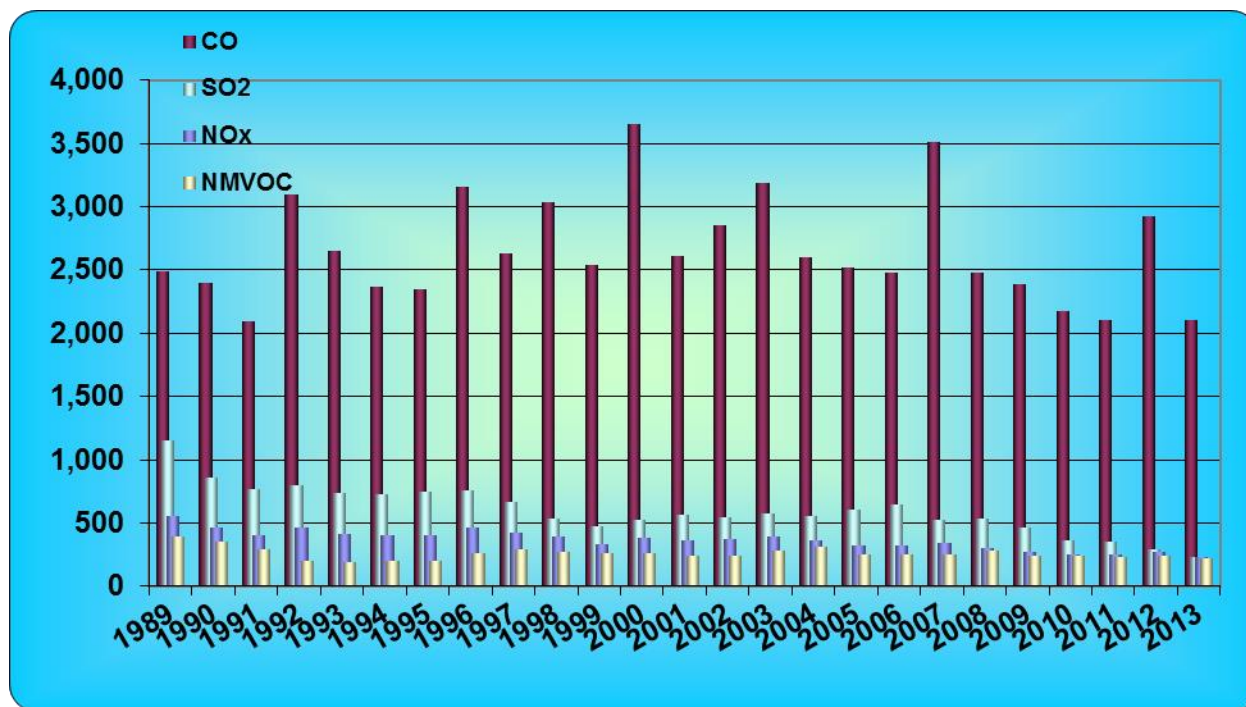
The trends of the indirect GHGs are similar with the GHGs trends (Table 2.2), except for CO emissions, which strongly increased starting with 1995, due to the raise of the amount of the firewood used in households.

The NO_x, NMVOC and SO₂ emissions evolution follows the general direct GHG emissions trend. The SO₂ 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 2.2

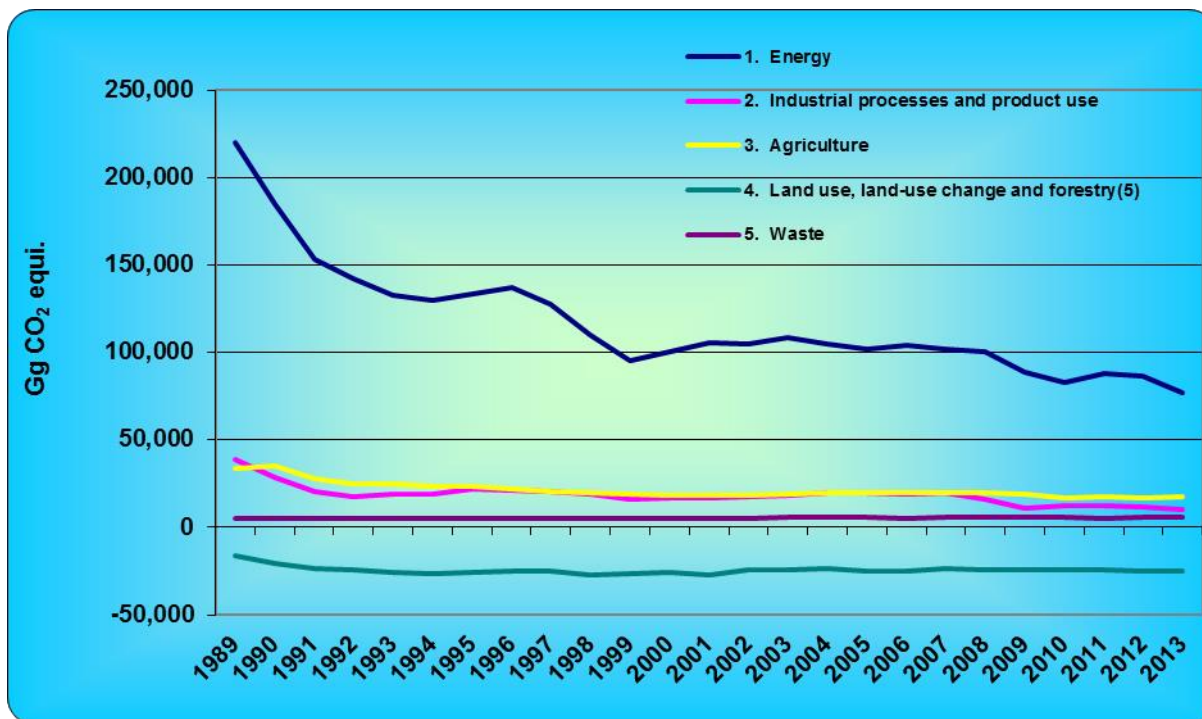
Table 2.2 Indirect GHG emissions levels [kt]

Year	NO_x	CO	NMVOC	SO₂
1989	559.14	2488.19	390.95	1150.07
1990	466.02	2397.43	356.15	854.03
1991	406.77	2093.54	292.09	764.74
1992	467.48	3099.22	196.21	796.19
1993	411.71	2648.58	194.80	739.73
1994	400.97	2364.37	198.98	731.73
1995	400.38	2345.17	204.35	747.60
1996	464.72	3156.53	261.19	761.46
1997	424.41	2631.19	291.32	665.72
1998	391.88	3033.17	272.66	531.74
1999	329.75	2536.30	262.52	470.51
2000	381.74	3654.66	265.78	526.01
2001	364.83	2615.00	243.08	567.63
2002	374.93	2857.48	246.45	540.92
2003	396.83	3186.52	284.45	577.54
2004	366.51	2601.16	310.03	551.90
2005	319.61	2515.76	251.96	607.26
2006	317.52	2474.27	256.55	650.90
2007	345.05	3509.52	256.23	529.70
2008	302.89	2477.48	278.51	536.23
2009	271.73	2389.72	239.93	462.41
2010	246.64	2176.75	241.23	365.19
2011	251.76	2108.10	229.25	353.65
2012	275.93	2923.13	236.62	289.74
2013	233.48	2105.65	219.85	229.08

Figure 2.2 Indirect GHG emissions trends [kt]

2.2 Description and interpretation of emissions trends by sector

The figure below shows the GHG emissions trends by each sector. The GHG emissions are expressed in kt CO₂ equivalent.

Figure 2.3 Trends by sector

Energy represents the most important sector in Romania. The Energy sector accounted for 69.41% of the total national GHG emissions in 2013. The GHG emissions resulted from the Energy sector decreased with 65.00% compared with the base year.

Industrial processes and product use contributes to total GHG emissions with 9.41%. A significant decrease of GHG emissions was registered in this sector (73.26% decreases in 2013 compared to the level in 1989) due to the decline or the termination of certain production activities.

Agriculture GHG emissions have also decreased. The GHG emissions in 2013 are 47.87% 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.

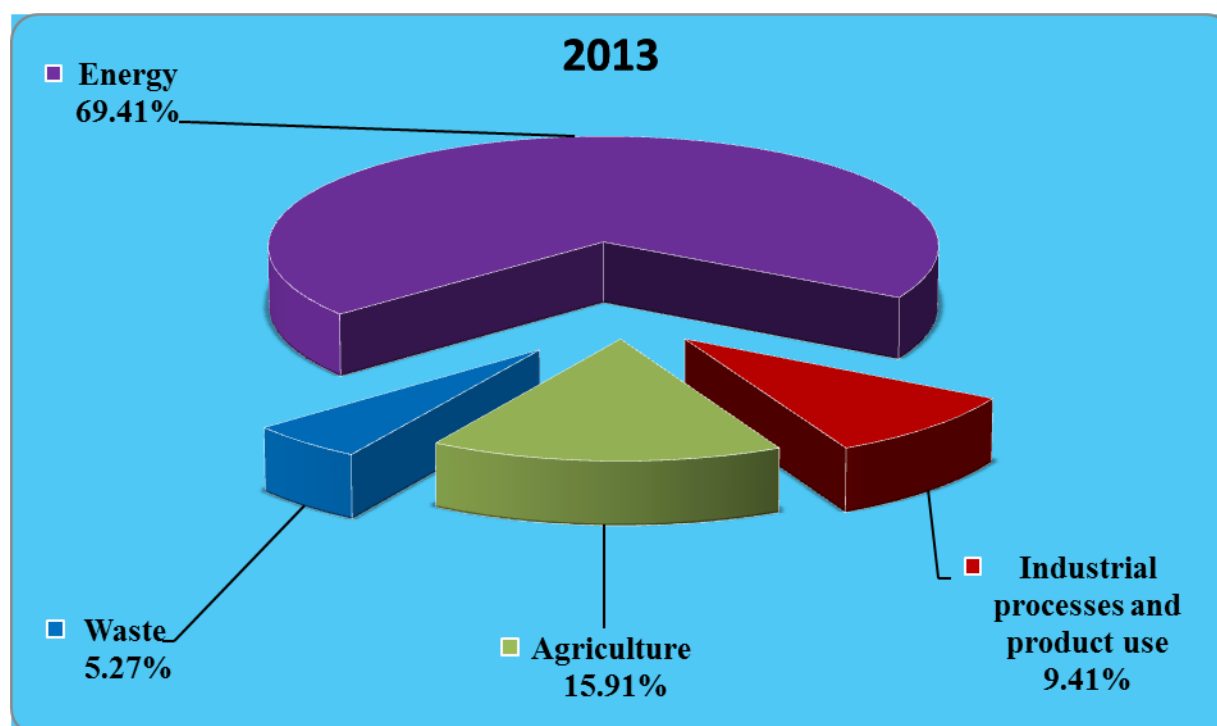
In 2013, 15.91 % of the total GHG emissions resulted from the agriculture sector.

LULUCF The net GHG removals/emissions level is 52.85% higher in 2013 in comparison with the level in the base year.

Waste sector emissions have increased in 2013 with 13.88% in comparison with the level in 1989. The contribution of the waste sector to the total GHG emissions in 2013 is 5.27%.

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

Figure 2.4 Sectorial GHG emissions in 2013 [%]



2.2.1 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)

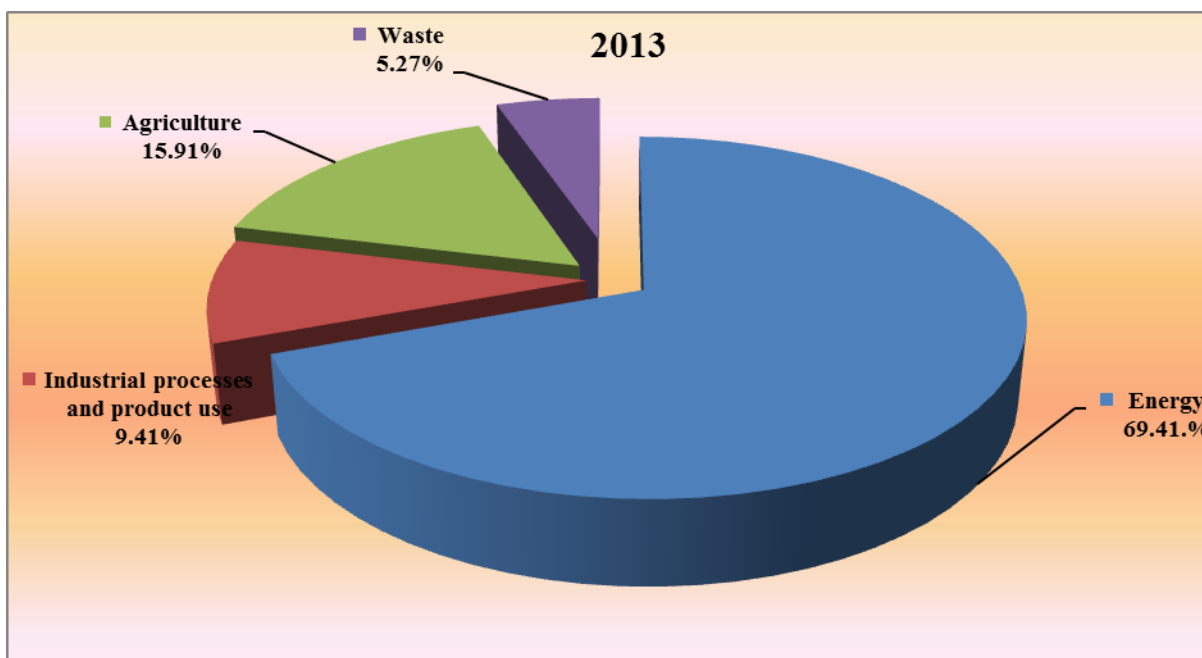
3.1 Overview of the sector

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 2013, the Energy sector was responsible for about 69.41% of the total GHG emissions 110929.045 kt CO₂ equivalent.

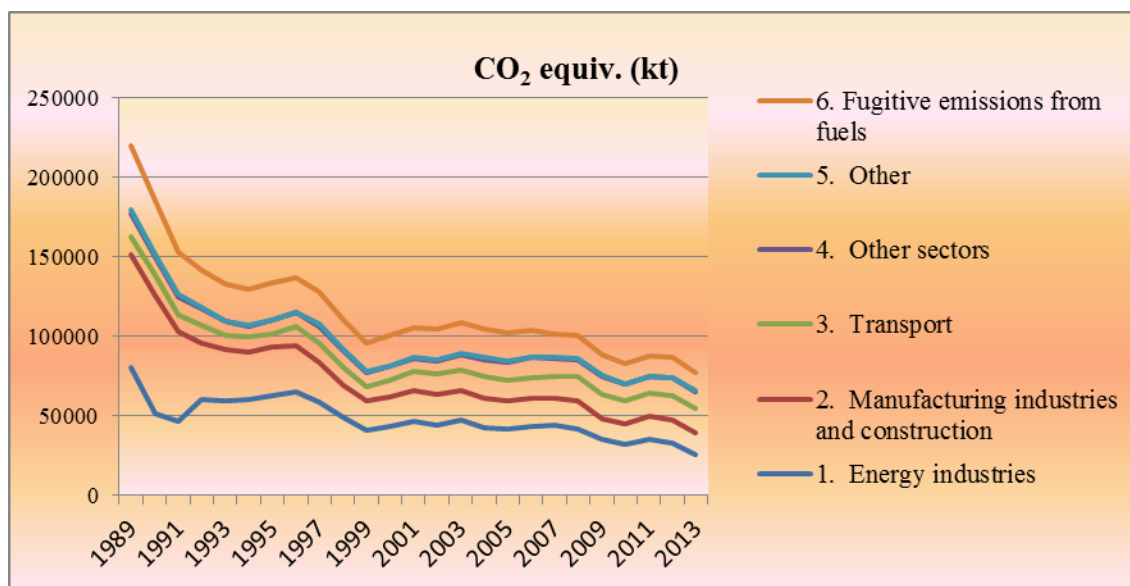
Figure 3.1 The contribution of Energy Sector to the total GHG emissions in Romania, 2013



Emission trends

In 2013, emissions from the Energy sector have decreased by 65.01% (76,996.22 kt CO₂ equivalent compared to 220,008.16 kt CO₂ equivalent in 1989, base year).

Figure 3.2 The energy sector emission trend for the period 1989-2013



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.

In 2013, industry (including construction and energy sector) still holds the largest share in structure of electricity consumption (56.1%), followed by the population (23.9%).

Exports of energy (including bunkers), compared to 2012 increased by 2.7%; total consumption of public lighting decreased with 12.7% compared to previous year; the coal consumption share in 2013, was 48.7% from the thermoelectric energy consumption compared to 56.1% in 2012.

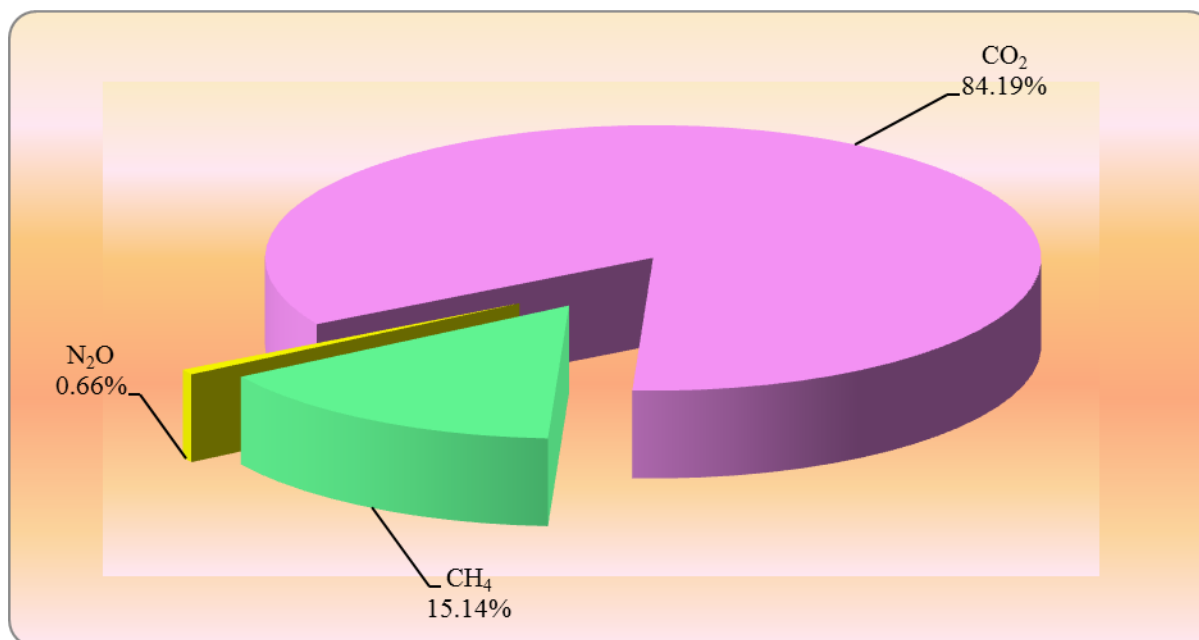
In 2013, energy resources and primary energy production decreased slightly (- 2.4% and -1.3%) compared with 2012 and imports of energy products decreased slightly (-14%) compared to last year while final energy consumption decreased (-3.9%) compared with 2012.

(Source - Romanian National Institute for Statistics).

Table 3.1 Shares of GHG emission categories within the Energy sector, in 2013

Energy sector-categories	Percentages for 2013
<i>Energy industries</i>	33.06
<i>Manufacturing Industries and Construction</i>	18.20
<i>Transports</i>	19.60
<i>Other sectors</i>	13.70
<i>Other</i>	0.58
<i>Fugitive emissions</i>	14.87

The most important GHG in the sector is CO₂; small amounts of CH₄ and N₂O are also emitted.

Figure 3.3 The different GHG's contribution to the 2013 Energy emissions**Table 3.2 Status of emissions estimation within the Energy Sector for 2013**

IPCC category-Energy Sector	Emissions estimation status		
	CO ₂	CH ₄	N ₂ O
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	✓	✓	✓

IPCC category-Energy Sector	Emissions estimation status		
	CO ₂	CH ₄	N ₂ O
1.A.2.e. Food processing, beverages and tobacco	✓	✓	✓
1.A.2.f.	✓	✓	✓
1.A.2.g 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	✓	✓	✓
1.A.5.b. Mobile	✓	✓	✓
1B Fugitive Emissions from Fuels			
<i>1.B.1. Solid Fuels</i>			
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 activities	NA	✓	NA
1.B.1.a.i.1. Surface mines	NA	✓	NA
1.B.1.a.i.1. Post - Mining Surface activities	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			
<i>1.B.2.a. Oil</i>	✓, NO	✓	✓

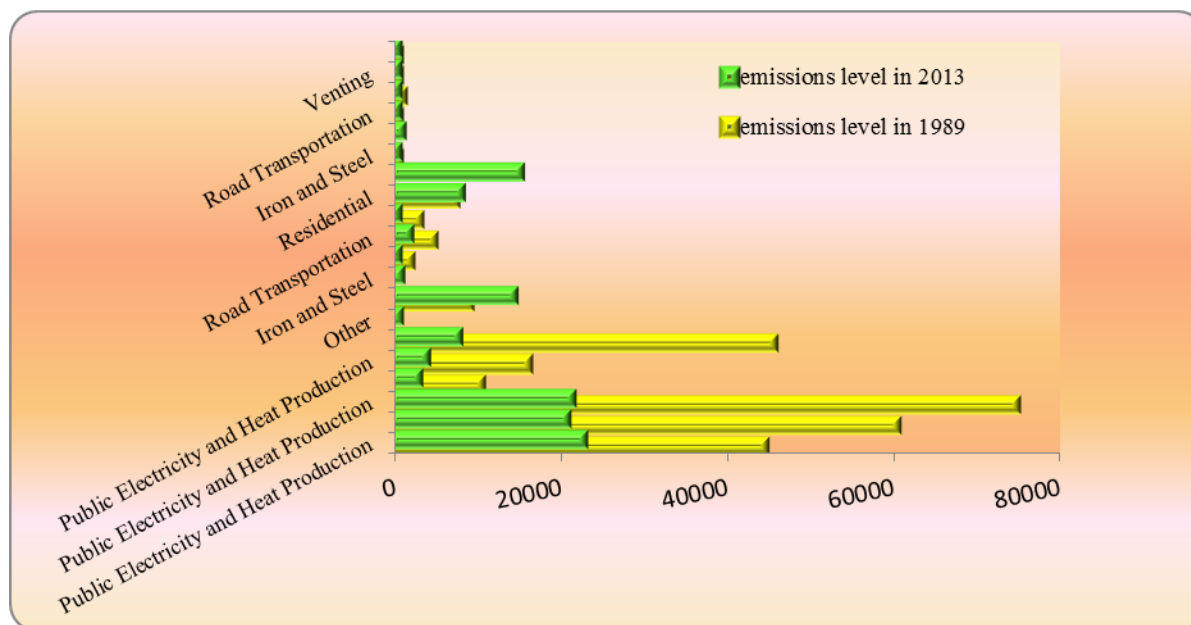
IPCC category-Energy Sector	Emissions estimation status		
	CO ₂	CH ₄	N ₂ O
1.B.2.a.i. Venting oil	✓, NO	✓	NA
1.B.2.a.ii. Flaring oil	✓, NO	✓	✓
1.B.2.a.iii.1. Exploration	✓, NO	✓	NA
1.B.2.a.iii.2. Production and upgrading	✓, NO	✓	NA
1.B.2.a.iii.3. Transport	✓, NO	✓	NA
1.B.2.a.iii.4. Refining and storage	✓, NO	✓	NA
1.B.2.a.iii.5. Distribution of oil products	NO	NO	NO
1.B.2.a.iii.6. Other	✓, NO	IE	NA
<i>1.B.2.b. Natural Gas</i>	✓	✓	✓
1.B.2.b.i. Venting gas	✓	✓	NA
1.B.2.b.ii. Flaring gas	✓	✓	✓
1.B.2.b.iii.1. Exploration	IE, NO	IE	NA
1.B.2.b.iii.2. Production	✓, NO	✓	NA
1.B.2.b.iii.3. Processing	NO,IE	IE	NA
1.B.2.b.iii.4. Transmission	✓, NO	✓	NA
1.B.2.b.iii.5. Distribution and storage	✓, NO	✓	NA
1.B.2.b.iii.6. Other	NO	✓	NA
1.B.2.d.Other	✓, NO	✓	NA
1.D. Memo items			
1.D.1. International Bunkers			
1.D.1.a. Aviation	✓	✓	✓
1.D.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	✓		

3.1.1 Key sources

Table 3.3 Key categories overview - Energy 2013

Key categories	GHG	Criteria	Contribution in total GHG emissions [%]
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO ₂	LT	20.17
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO ₂	LT	18.29
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO ₂	LT	18.84
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO ₂	LT	2.36
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO ₂	LT	3.18
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO ₂	LT	6.73
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO ₂	LT	3.18
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO ₂	LT	6.73
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO ₂	T	0.30
1.A.3.b Road Transportation	CO ₂	LT	12.66

Key categories	GHG	Criteria	Contribution in total GHG emissions [%]
1.A.3.c Railways	CO ₂	T	0.46
1.A.3.d Domestic Navigation - Liquid Fuels	CO ₂	T	0.14
1.A.4 Other Sectors - Liquid Fuels	CO ₂	L	1.42
1.A.4 Other Sectors - Solid Fuels	CO ₂	T	0.08
1.A.4 Other Sectors - Gaseous Fuels	CO ₂	LT	6.91
1.A.4 Other Sectors - Biomass	CH ₄	LT	13.30
1.B.1 Fugitive emissions from Solid Fuels	CH ₄	LT	0.03
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CO ₂	LT	0.61
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH ₄	LT	0.10
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH ₄	LT	0.17
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH ₄	LT	0.05
1.B.2.d Fugitive Emissions from Fuels - Other	CH ₄	LT	0.04

Figure 3.4 Key categories, both by level and trend criteria, overview – Energy Sector, 2013

3.2 Fuel combustion (CRF 1.A)

3.2.1 Comparison of the sectorial approach with the reference approach

According to the IPCC documents (“IPCC 2006 Guidelines”), 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;
- ❖ Sectoral 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 CO₂ 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:

- ❖ Energy Industries (Public Electricity and Heat Production, Petroleum refining, Manufacture of the solid fuels and other energy industries);
- ❖ Manufacturing Industries and Construction (Iron and steel, Non-ferrous metals, Chemicals, Pulp, paper and print, Food processing, beverages and tobacco, Non-metallic minerals, Other);
- ❖ Transport (Domestic aviation, Road transportation, Railways, Domestic navigation, Other transportation);
- ❖ Other Sectors (Commercial/Institutional, Residential, Agriculture/Forestry/Fisheries);
- ❖ Other (Stationary, Mobile).

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 3 and Annex 4.

For the fuels having associated determined country-specific carbon content, Tier 2 method is applied. For the fuels having associated default carbon content values, Tier 1 method is applied.

According to the information provided by the National Institute for Statistics, 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 CO₂ emissions were accounted under the energy sector – corresponding activity category (1A2g). In order not influence the RA-SA difference, the consumption and the corresponding CO₂ 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 and 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.

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, are compared.

Figure 3.5 Comparison of the sectorial approach with the reference approach

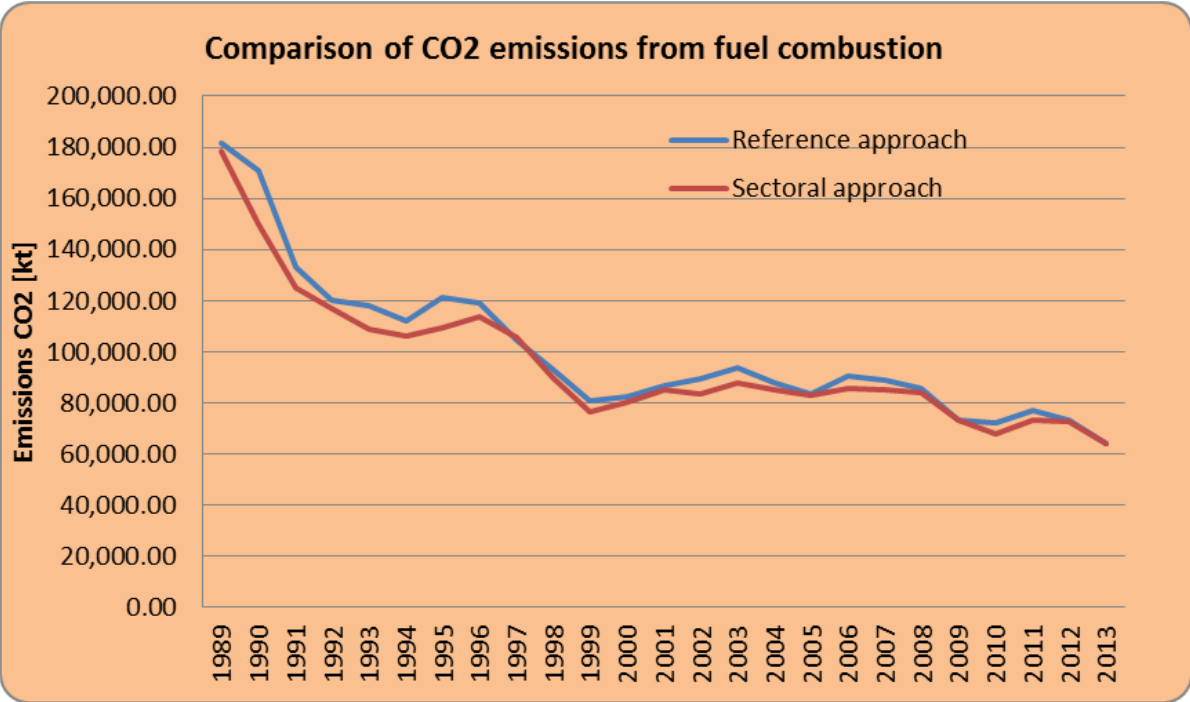


Figure 3.6 Comparison of the sectorial approach with the reference approach – liquid fuels

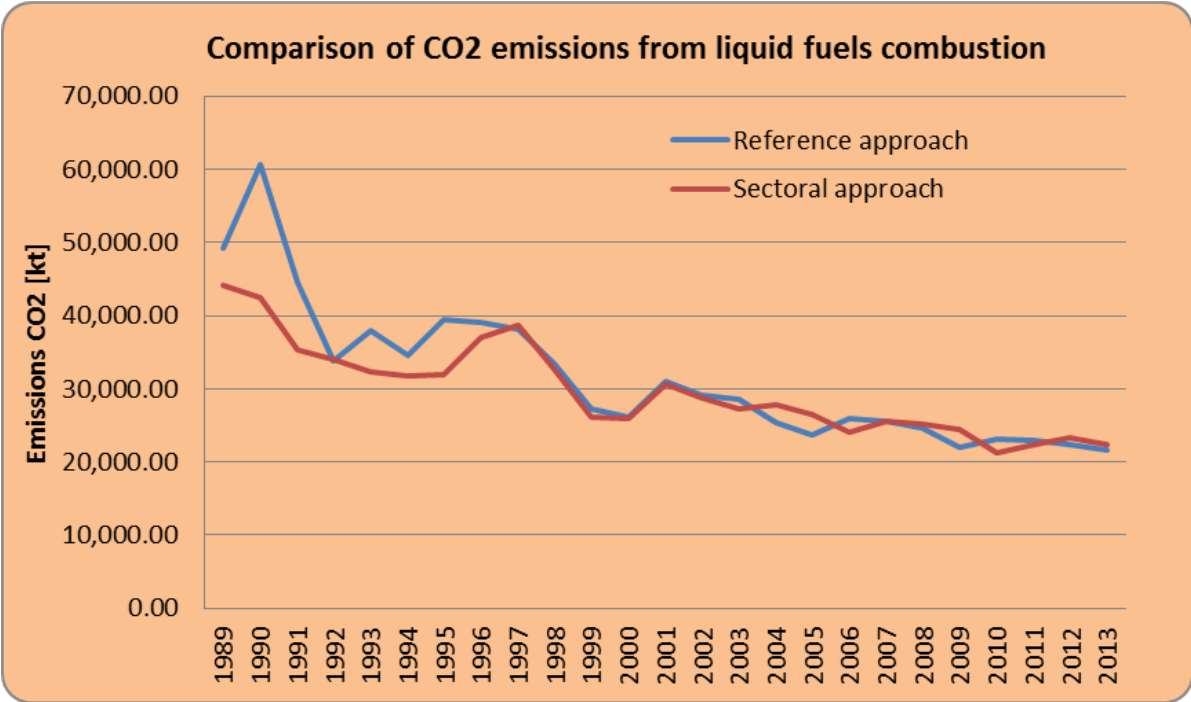


Figure 3.7 Comparison of the sectorial approach with the reference approach – solid fuels

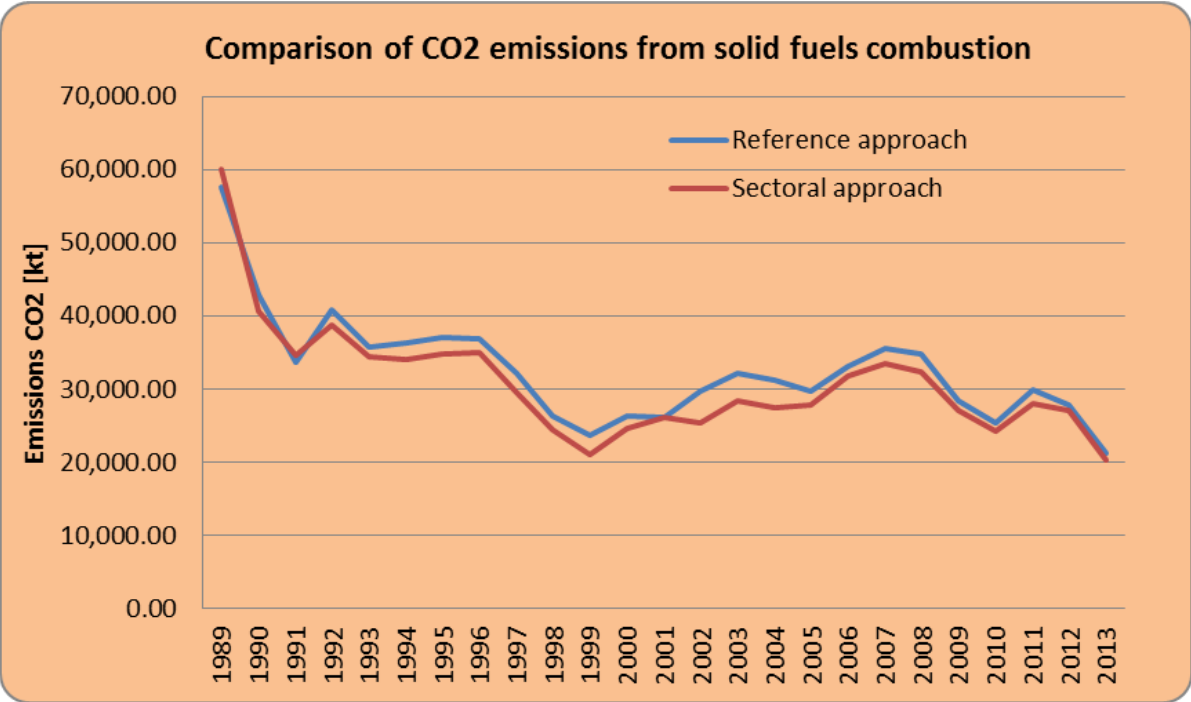
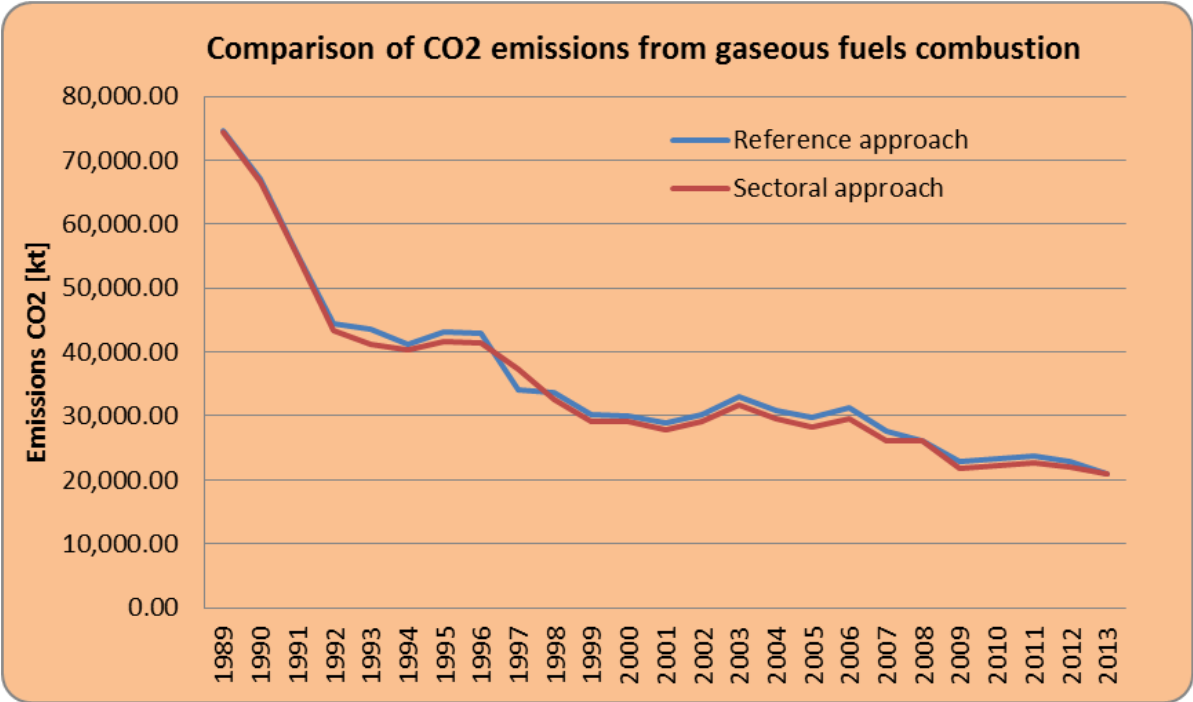


Figure 3.8 Comparison of the sectorial approach with the reference approach – gaseous fuels



Explanation of Differences

A comparison between the RA and the SA indicates differences in both the energy consumption data and CO₂ emissions, -1.09 % in terms of energy consumption and, 0.24 % in terms of CO₂ 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 subtracting the non-energy use from the apparent consumption of the fuels. Thus, the consumption reported through the Energy Balances as being non-energetic in the sectoral activities, were subtracted from the Reference Approach. In addition, the following processes consumption were subtracted from the Reference Approach:

- In 1A1b, Petroleum refining category, the reported quantities of the petroleum coke, on the entire time-serie, were subtracted. 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. the RA-SA difference was affected in the sense of decreasing of this difference.
- 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 CO₂ emissions estimation in the Reference Approach in comparison with the Sectoral Approach.

An explanation for the differences between the two approaches is provided by the Energy Balance, for some of years being reported a significant statistical differences which 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 1990-1996, and most notably in 1990, 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 losses reported (6.1% of total refinery intake in 1995 was reported as refinery losses in comparison with the refinery intake observed reported consumption) and the reported statistical differences. For the fuels reported on the EU-ETS, the national parameter of the NCVs were determined and used: annually 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.

Recalculation performed in Reference Approach

Activity data

- **Liquid Fuels**

- Motor Gasoline: Non-Energy Use in Industry, 2006-2012 period, Energy Balance activity data correction;
- Kerosene Type Jet Fuel: Non-Energy Use in Industry, 2008-2011 period - Energy Balance activity data correction;
- Transport Diesel: Non-Energy Use in Industry Sector, 2006-2012 period - Energy Balance activity data correction;
- Naphta: Non-Energy Use in Industry, 2007–2012 period - Energy Balance activity data correction;
- Other kerosene: Non-Energy Use in Industry, 2007, 2008, 2011, 2012 years - Energy Balance activity data correction;
- LPG - Non-Energy Use in Industry, 2006-2012 period - Energy Balance activity data correction;
- Residual Fuel Oil - Non-Energy Use in Industry, 2006-2012 period - Energy Balance activity data correction;

- Other petroleum products - Non-Energy Use in Industry, 2005-2012 period - Energy Balance activity data correction.

Oxidation factors – the full oxidation was assumed for all reported fuels, as it is provided through the IPCC 2006 GL;

Emission factors – for the fuels not having determined country specific values, the default carbon content provided through the IPCC 2006 GL – Vol. 2.1, Chapter 1, are used.

3.2.2 International Bunkers fuels(CRF 1.D.1)

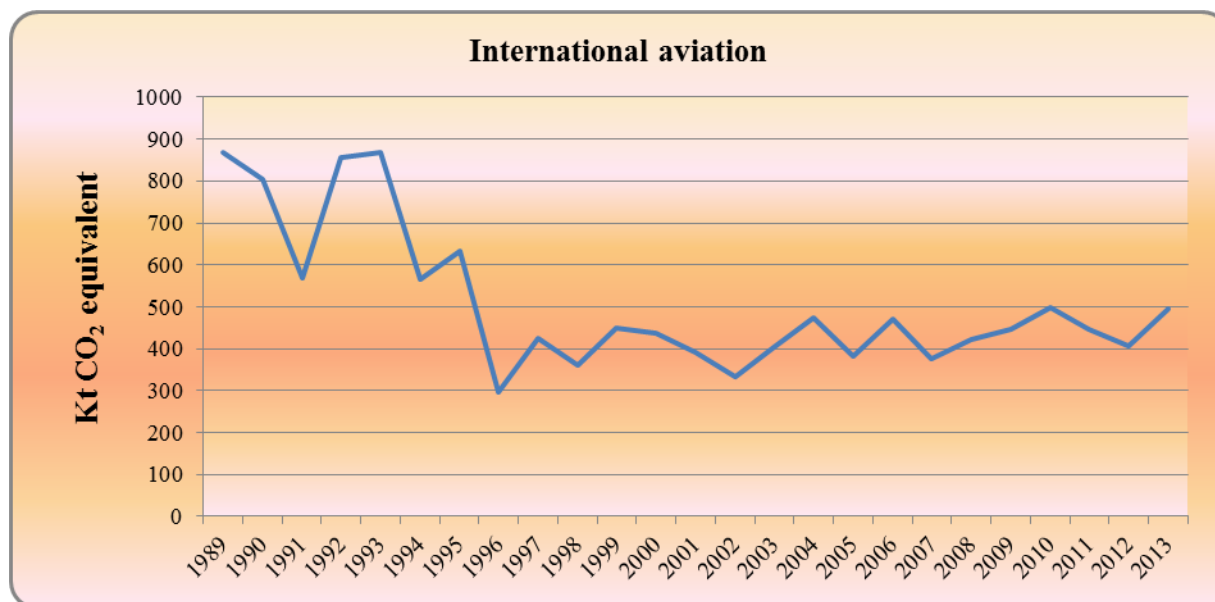
The International Bunkers category comprise data and information on the fuels and the emissions resulting from international air and marine transport of passengers and cargo. These GHG related data and information are also subject to the inventory and they are reported, but the GHG emissions are not 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 1.D.1.a)

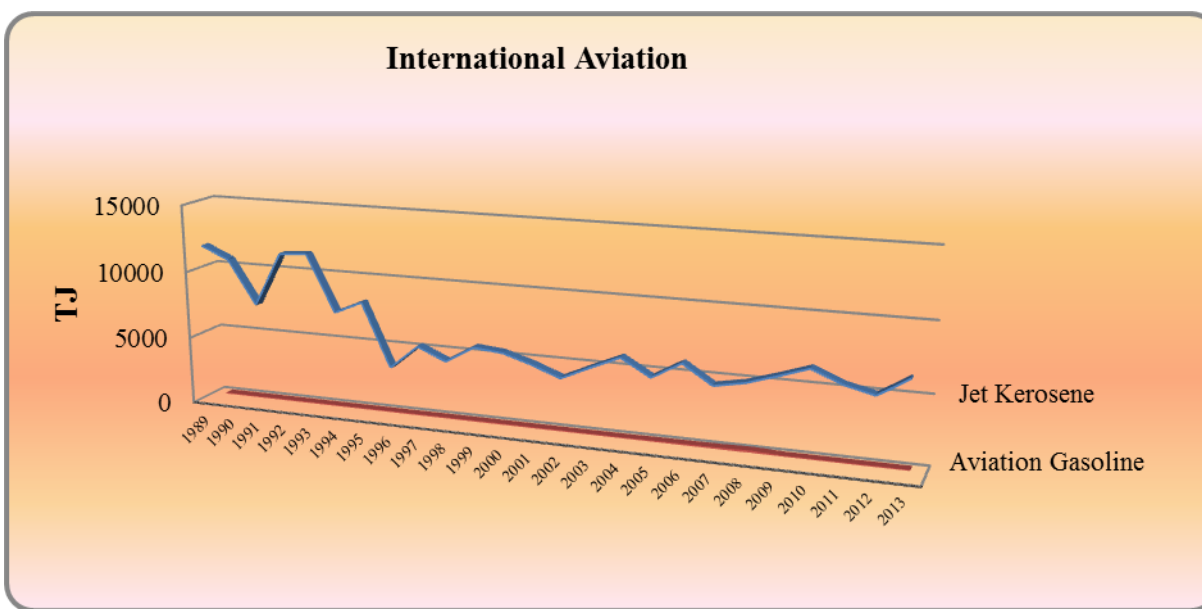
The activity data for International Aviation category were provided through the IEA/Eurostat Questionnaire and values for emissions factors used are provided through the IPCC 2006.

The 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 3.3).

In 2013 the emissions from International Aviation Subsector represent 3.27% of total emissions from the transport sector (15,088.28 kt CO₂ equivalent).

Figure 3.9 GHG emissions from International Aviation Subsector

In 2013 the emissions from the International Aviation subsector have increased by 42.88% compared to the base year 1989 due to the fuel consumption increase.

Figure 3.10 Fuel consumption associated with the International Aviation Subsector, 1989-2013 period

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

The values of CH₄ and N₂O 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 3.3).

3.2.2.2 International Navigation (CRF Sector Marine 1.D.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 2006.

In 2013 the emissions from International Navigation Sub-sector represent 0.86% of total emissions from the transport sector (15,088.28 kt CO₂ equivalent).

Figure 3.11 The GHG emissions from International Navigation Subsector

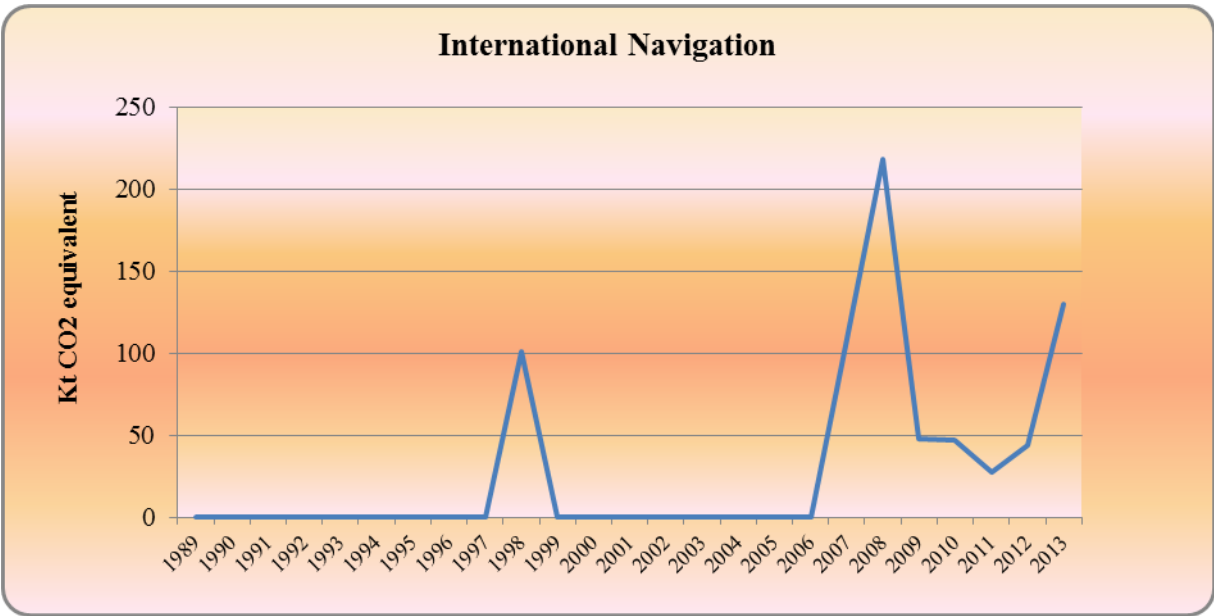
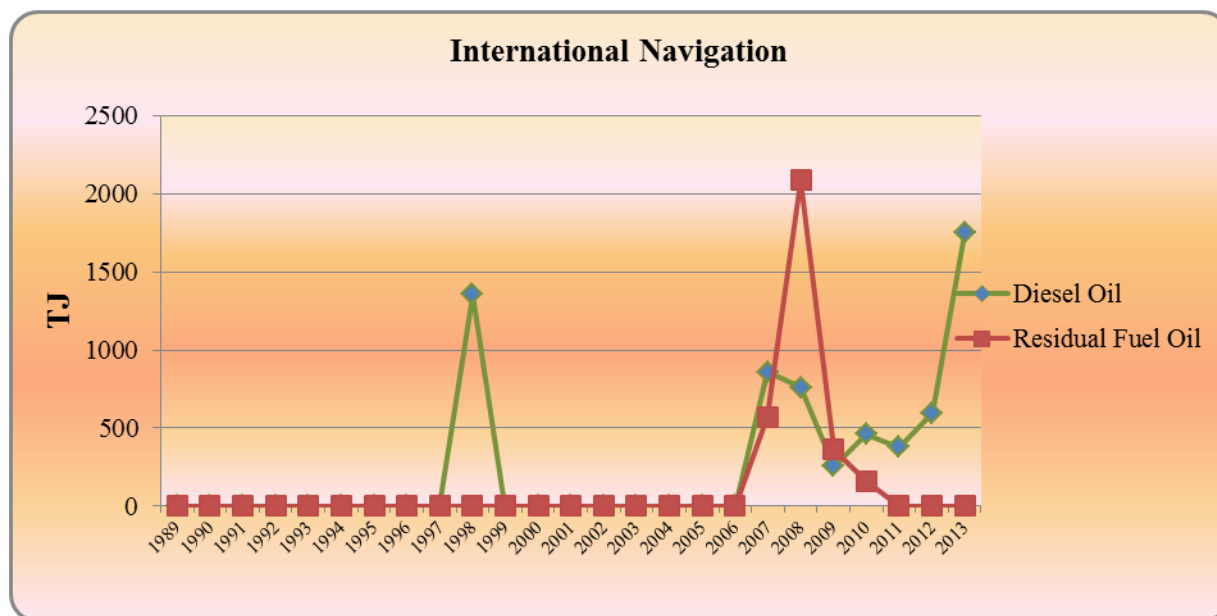


Figure 3.12 Fuel consumption associated with the International Navigation Subsector, 1989- 2013 period



In the period 1989-1997 and 1999-2005 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 2013, the fuel consumption level associated with the International Navigation Sub-sector increased by 192,85% compared with the one associated with 2012.

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

3.2.3 Feedstocks 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 corresponding quantities non-energy use of the products from 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 and consequently from the Reference 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.

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: annually 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.

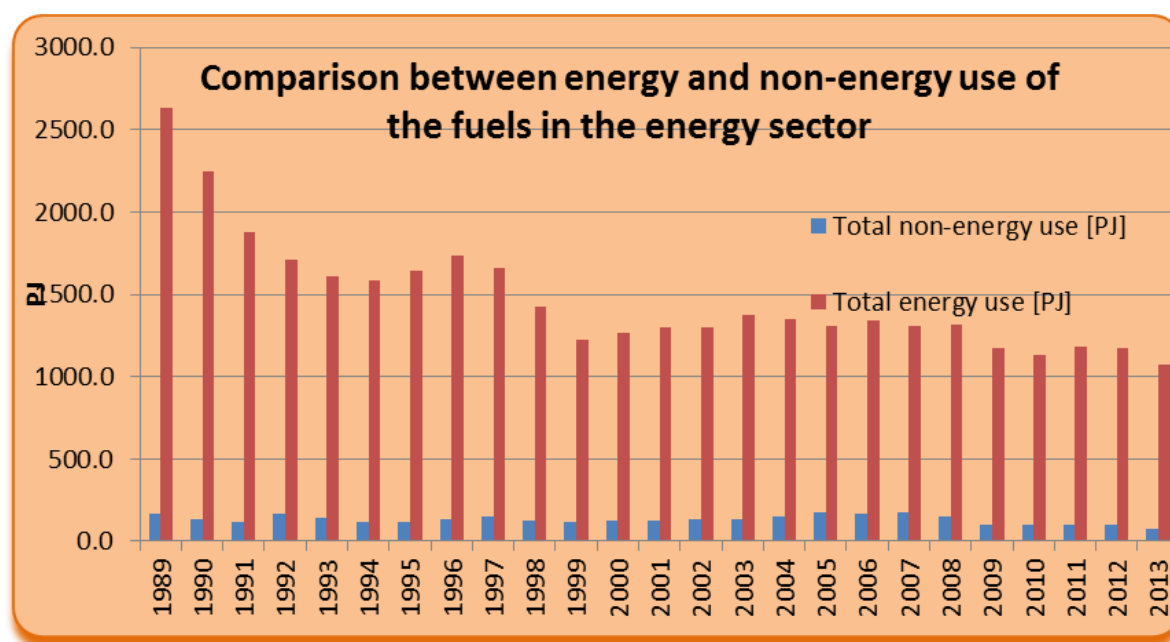
The following type of fuels have been added to the Table1.A(d), “Feedstocks, reductants and other non-energy use of fuels - Other fuels” category: Refinery gas, Motor Gasoline, Paraffin waxes, White spirit.

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	167.8	2,628.63	6%
1990	130	2,250.26	6%
1991	120	1,879.96	6%
1992	166.0	1,712.59	10%
1993	143.3	1,607.76	9%
1994	117.4	1,582.34	7%
1995	118.0	1,639.79	7%
1996	137.5	1,736.35	8%
1997	147.3	1,660.67	9%
1998	127.7	1,428.51	9%
1999	119.1	1,226.25	10%
2000	125.2	1,264.90	10%
2001	127.8	1,297.60	10%
2002	136.0	1,297.94	10%
2003	132.9	1,375.51	10%
2004	153.5	1,346.91	11%
2005	172.0	1,304.87	13%

Year	Non-energy use [PJ]	Apparent energy consumption incl. non-energy use [PJ]	[%]
2006	163.8	1,343.55	12%
2007	173.5	1,304.99	13%
2008	153.2	1,315.01	12%
2009	100.0	1,177.05	8%
2010	96.6	1,129.04	9%
2011	99.4	1,178.47	8%
2012	100.19	1173.20	9%
2013	77.86	1076.07	7%

Figure 3.13 Comparison between the energy and non-energy use of the fuels in the energy sector

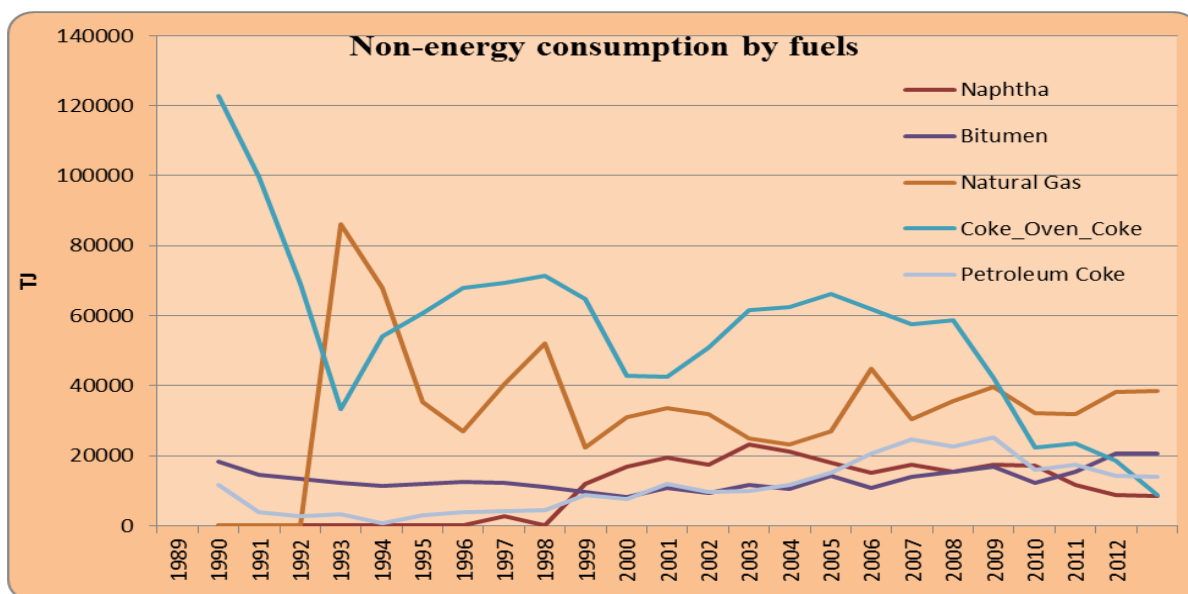


There are some fluctuations of the reported consumption of some of the fuels during the time series – unstable trends in the exports imports, or production.

The non-energy use of fuels is on average 9% of the total apparent energy consumption during the period 1989-2013, and 7% for 2013.

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 3.14 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**

The energy Balance operated some modification in the non-energy use of the fuels and transferred the corresponding quantities in the energy use, transformation sector.

- Motor Gasoline: Non-Energy Use in Industry, 2006-2012 period, Energy Balance activity data correction;
- Kerosene Type Jet Fuel: Non-Energy Use in Industry, 2008-2011 period - Energy Balance activity data correction;
- Transport Diesel: Non-Energy Use in Industry Sector, 2006-2012 period - Energy Balance activity data correction;

- Naphta: Non-Energy Use in Industry, 2007–2012 period - Energy Balance activity data correction;
- Other kerosene: Non-Energy Use in Industry, 2007, 2008, 2011, 2012 years - Energy Balance activity data correction;
- LPG - Non-Energy Use in Industry, 2006-2012 period - Energy Balance activity data correction;
- Residual Fuel Oil - Non-Energy Use in Industry, 2006-2012 period - Energy Balance activity data correction;
- Other petroleum products - Non-Energy Use in Industry, 2005-2012 period - Energy Balance activity data correction.

3.2.4 Fuel combustion (CRF 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.

3.2.4.1 Category description

CO₂ emissions from fuel combustion activities accounted for 76,996.22 kt CO₂ equivalent in 2013.

Within the fuel combustion sector, 38.8% of the CO₂ equivalent emissions correspond to Energy Industries category, 21.4% of the CO₂ equivalent emissions correspond to 1.A.2 Manufacturing Industries and Construction, 23% of the CO₂ equivalent emissions correspond to 1.A.3 Transport, 16.1% of the CO₂ equivalent emissions correspond to 1.A.4 Other Sectors and less than 1% from the CO₂ 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 25,452.53 kt CO₂ equivalent of the emissions in 2013. 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 3.15 Total GHG CO₂ equivalent. emissions associated with the Fuel Combustion Activities by categories

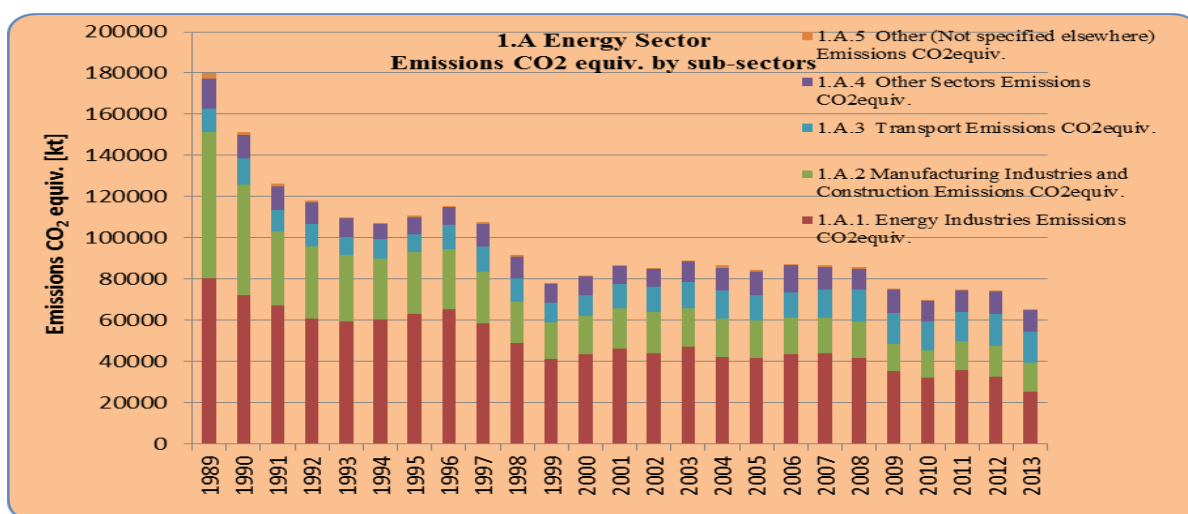
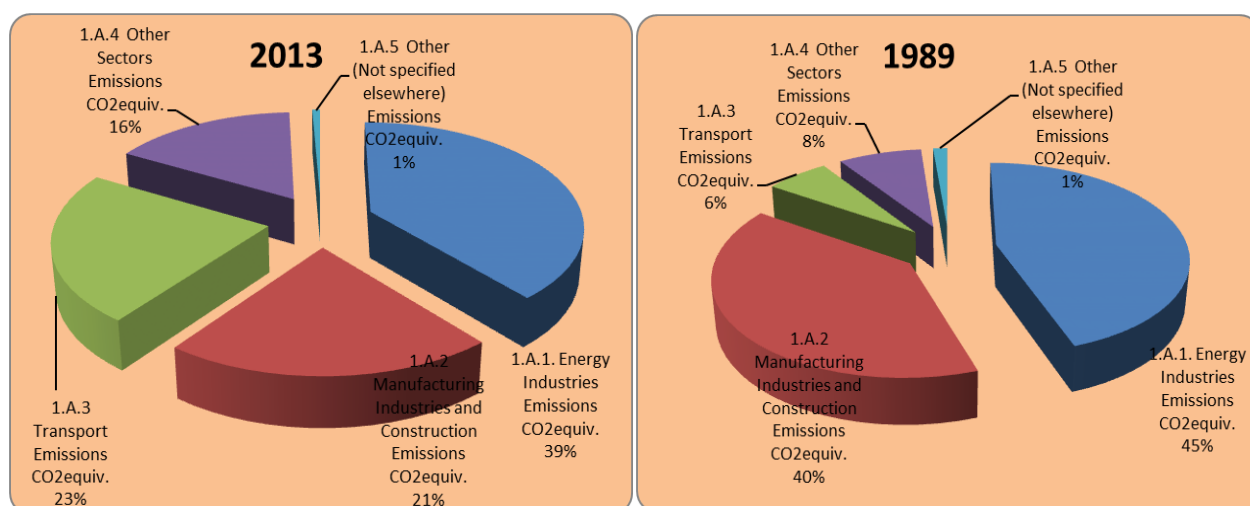


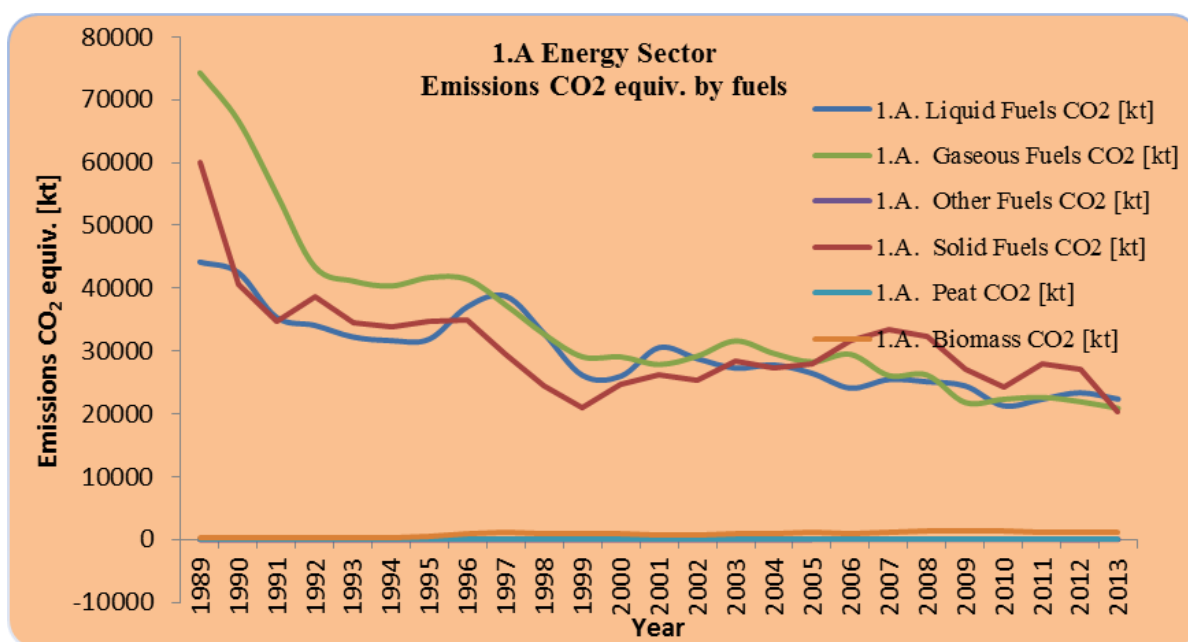
Figure 3.16 Base year and current year comparison in respect to the contribution of Fuel Combustion Activities Subsector categories emissions in total Subsector emissions



In 2013 a decrease of the GHG emissions is observed in all fuel combustion sub-sectors: 1A1 Energy Industries the CO₂eq decreased with 21.8% in comparison with 2012, 1.A.2 Manufacturing Industries and Construction with 6.9%, 1.A.3 Transport with 1.1% and 1.A.4 Other sectors with 3.5 %. 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 2013 in comparison with 2012, with 1.44% .

Manufacturing industry and construction is the sector which changed drastically – compared to 1989, the emissions being decreased from 40% to 21% in 2013. The same, 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 23% in 2012.

Figure 3.17 Total CO₂ emissions [kt] from Fuel combustion by fuel type



In the period 2006-2012 the main contribution to CO₂ emissions was from solid fuels, having a pick in 2007-2008. In 2013 the contribution of the liquid fuel was about 35%, solid 31%, gaseous 32%. It could be observed that, the three main fuels have, each of them, a significant

contribution to the total of the Energy Industry CO₂ 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. In the last year the contribution of the liquid, solid, gaseous fuels was balanced, the non fossil sources in the gross electricity production being of 55%, in comparison with 2012 when this was about 45%.

3.2.4.2 Methodological issues

Stationary Combustion

Methodology

In the development of estimates, it was primarily utilized default EFs obtained from the IPCC 2006 Guidelines.

To achieve the estimations of the CO₂ 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 period 2011-2013 the estimations for the CO₂ emissions were determined using the national emission factors, these values being achieved by using the methodology provided through the same study. For 2013 the country specific emission factors determined from the EU-ETS operator reports for the previous year, 2012, were used.

A) Tier 1 methodology

The IPCC Tier 1 approach (IPCC 2006 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 CO₂, CH₄, N₂O and the indirect GHGs, default emission factors are used.

B) Tier 2 methodology

According to the provisions in the relevant decision trees in the IPCC 2006 GL, giving their status of key categories, the IPCC Tier 2 approach is used to calculate the CO₂ 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 CO₂ gas, country specific emission factors are used.

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, for 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 (kt) for solid and liquid fuels, cubic meters and TJ – tera joules 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 1990-2013. 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 1.A.2.g. 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 analysed 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, CO₂ emissions released from these processes are reported as an information item, as the CO₂ is naturally captured from the air. That is not applicable for the CH₄ and N₂O 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 3.1.

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, annually 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 liquids 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:
 - 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. (IEA Energy Statistics Manual, p. 183, Table A3.12). For all NCVs please consult ANNEX 4.

Greenhouse gas emission factors

CO₂ emission factors

The default CO₂ emission factors according to the IPCC 2006 Guidelines, Volume 2.1, Chapter 2 – Stationary Combustion Table 2.2 – Energy Industries, Table 2.3 - Manufacturing industries and construction, Table 2.4 - Commercial/Institutional, Table 2.5 - Residential and Agriculture/

Forestry/ Fishing/ Fishing farms, are used. For the fuels not having country specific emission factors determined, the full oxidation is assumed, as it is recommended in the IPCC 2006 GL.

The country specific emission factors include the plant specific oxidation factors, which are reported under the EU ETS rules for the available fuels and determines as it is explained above.

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 data reported under the European Emission Trading Scheme

A sum of operators has provided their verified CO₂ 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.

The 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).

General approach for the greenhouse gas emission factors

CO₂ greenhouse 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.

For EU-ETS activity categories, the country specific emission factors associated to each category for the available fuels, are used.

For non EU-ETS activity categories, the country specific emission factors associated to averages of all EU-ETS categories for the available fuels, are used.

For the year 2013, the country specific CO₂ emission factors associated to the 2012 value determinations for the available fuels, are used.

CH₄, N₂O - EFs default are used.

NO_x, CO, NMVOC, SO₂ – default **EMEP** EFs are used.

SO₂ – CS emission factors for solid fuels are used. See Chapter 9 for detailed information.

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).

Table 3.5 Country-Specific CO₂ emission factors for stationary combustion, without oxidation included, from ETS verified reports

EF [t/TJ]	Year						
	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 CO₂ 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 CO₂ 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

Fuel Type	EF CO ₂ t/TJ (including oxidation factor)	EF CO ₂ t/TJ (excluding oxidation factor)	Carbon Content t/TJ
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.

CH₄ emission factors for stationary sources

The default CH₄ emission factors according to the IPCC 2006 Guidelines, Vol. 2.1, Chapter 2 – Stationary Combustion Table 2.2 – Energy Industries, Table 2.3 - Manufacturing industries and construction, Table 2.4 - Commercial/Institutional, Table 2.5 - Residential and Agriculture/ Forestry/ Fishing/ Fishing farms, are used.

N₂O emission factors for stationary sources

The default N₂O emission factors according to the IPCC 2006 Guidelines, Vol. 2.1, Chapter 2 – Stationary Combustion Table 2.2 – Energy Industries, Table 2.3 - Manufacturing industries and construction, Table 2.4 - Commercial/Institutional, Table 2.5 - Residential and Agriculture/ Forestry/ Fishing/ Fishing farms, are used.

3.2.4.3 *Uncertainties and time-series consistency*

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%;
- ❖ Peat, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;
- ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 7%.
- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;

EFs uncertainty

- ***CO₂ 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%;
 - ❖ Peat, CRF categories 1A1, 1A2, 1A4 and 1A5a: 4%;
 - ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 20%.
 - ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 20%;
- ***CH₄ 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%;

- ❖ Peat, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%.
- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;

- ***N₂O 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%;
 - ❖ Peat, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
 - ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%.
 - ❖ Biomass, 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 3.1 in Chapter 3 of the IPCC 2006 Guidelines, Vol. 1, are as follows:

- ***CO₂ gas:***
 - ❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;
 - ❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 5%;
 - ❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;
 - ❖ Peat, CRF categories 1A1, 1A2, 1A4 and 1A5a: 5%;
 - ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 21%.
 - ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 20%;

- ***CH₄ 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%;
 - ❖ Peat, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
 - ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50 %.

- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
- *N₂O 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%;
 - ❖ Peat, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;
 - ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50 %.
 - ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50%;

3.2.4.4 Category-specific QA/QC and verification, if applicable

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 nonconformities 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 3.2.4.5 – 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 this correction are described at the Chapter 3.2.4.5 – 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.

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 3.8 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	<i>Electricity and heat production</i>	90,25	

CRF Category	Main activity	Share of the EU-ETS reporting to the EB [%]	Reporting Plants
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	<i>Manufacturing industry and Construction</i>	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

CRF Category	Main activity	Share of the EU-ETS reporting to the EB [%]	Reporting Plants
			nominal installed thermal power plants > 20 MWt reporting
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: <ul style="list-style-type: none"> ○ Installation for cement clinker production with capacity > 500 tones/day; ○ Installation for lime production with capacity > 50 tones/day; ○ Installation for glass production with capacity >20 tones/day; ○ Installation for ceramics production having a capacity >75 tones/day, ○ and having on sites nominal 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 as 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 as 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 another 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 losing 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, CO₂ EFs - resulted from the ISPE Study and derived from the EU-ETS reports , SO₂ 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 CO₂, CH₄ and N₂O were accounted. Also, there are accounted emissions resulted from indirect GHG gases, NO_x, CO, NMVOC and SO₂.

Consistency

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

3.2.4.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

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;

Emission factors

- ❖ The default carbon content and CO₂, CH₄ and N₂O emission factors were used in accordance with the values provided through the IPCC 2006 GL;
- ❖ For the fuels not having carbon content or CO₂ emission factors country specific determined values, a full oxidation during combustion were assumed, as it is recommended through the IPCC 2006 GL.

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

Table 3.9 The effects of the activity data changes on CO₂, CH₄ and N₂O emission estimates to the sub-sector 1.A 1. - Energy Industries

Year	Changes at AD level [TJ]		Effects of changes on emission estimates for CO ₂ [kt]		Diff [%]	Effects of changes on emission estimates for CH ₄ [kt]		Diff [%]	Effects of changes on emission estimates for N ₂ O [kt]		Diff [%]
	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	
	1989	1,076,987.02	1,076,987.02	80,137.67	80,157.25	0.0	1.45	1.45	0.0	0.76	0.81
1990	1,002,441.33	994,935.39	72,546.02	71,993.97	-0.8	1.56	1.54	-1.4	0.61	0.63	3.9
1991	924,646.05	916,885.68	67,400.10	66,829.70	-0.8	1.35	1.33	-1.7	0.59	0.62	4.3
1992	803,908.53	805,386.57	60,089.69	60,436.49	0.6	1.07	1.08	0.1	0.59	0.63	5.9
1993	788,702.10	789,952.17	59,052.04	59,399.90	0.6	1.08	1.08	0.1	0.57	0.60	5.7
1994	798,301.61	800,064.67	59,724.99	60,210.66	0.8	1.10	1.10	0.2	0.58	0.61	5.7
1995	827,059.27	831,651.32	61,889.83	62,722.24	1.3	1.16	1.23	6.0	0.60	0.64	7.1
1996	864,718.02	867,875.09	64,417.35	65,269.10	1.3	1.24	1.24	0.3	0.61	0.64	5.5
1997	781,124.64	783,655.70	57,656.85	58,361.74	1.2	1.18	1.18	0.2	0.53	0.56	5.2
1998	667,291.72	671,028.71	48,018.15	49,033.89	2.1	0.93	0.93	0.4	0.42	0.44	5.3
1999	558,565.67	559,867.68	40,694.84	41,048.01	0.9	0.79	0.79	0.2	0.36	0.38	5.4
2000	576,035.22	579,498.20	42,614.55	43,304.09	1.6	0.77	0.81	4.9	0.40	0.43	6.9
2001	594,212.99	602,687.36	44,887.58	46,121.57	2.7	0.85	1.01	19.3	0.44	0.49	10.5

Year	Changes at AD level [TJ]		Effects of changes on emission estimates for CO ₂ [kt]		Diff [%]	Effects of changes on emission estimates for CH ₄ [kt]		Diff [%]	Effects of changes on emission estimates for N ₂ O [kt]		Diff [%]
	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	
	2002	578,941.04	581,625.03	43,007.26		43,626.99	1.4		0.79	0.81	
2003	621,155.50	623,665.48	46,333.80	46,842.99	1.1	0.80	0.83	3.5	0.45	0.48	6.7
2004	559,749.96	561,708.93	41,585.68	41,982.18	1.0	0.71	0.73	2.8	0.41	0.43	6.6
2005	551,079.01	553,237.68	41,131.58	41,507.82	0.9	0.68	0.71	4.3	0.41	0.44	7.0
2006	566,907.21	568,945.16	43,191.68	43,484.25	0.7	0.68	0.72	6.2	0.46	0.49	7.5
2007	549,815.13	552,045.95	43,182.42	43,791.85	1.4	0.65	0.65	0.1	0.45	0.48	6.4
2008	532,196.30	533,220.01	41,406.62	41,611.31	0.5	0.61	0.62	1.9	0.45	0.48	6.8
2009	450,870.23	452,801.19	34,918.23	35,102.23	0.5	0.52	0.53	1.9	0.40	0.42	6.9
2010	426,528.12	426,924.08	32,006.81	32,131.73	0.4	0.51	0.51	0.1	0.36	0.39	6.4
2011	469,908.87	469,909.28	35,383.22	35,407.20	0.1	0.57	0.57	0.0	0.43	0.46	6.5
2012	426,849.68	426,849.80	32,390.27	32,429.48	0.1	0.51	0.51	0.0	0.39	0.41	6.5

**Table 3.10 The effects of the activity data changes on CO₂, CH₄ and N₂O emission estimates to the sub-sector 1.A 2. -
Manufacturing Industries and Constructions**

Year	Changes at AD level [TJ]		Effects of changes on emission estimates for CO ₂ [kt]		Diff [%]	Effects of changes on emission estimates for CH ₄ [kt]		Diff [%]	Effects of changes on emission estimates for N ₂ O [kt]		Diff [%]
	NIR 2014	NIR 2015	NIR 2014	NIR 2015		NIR 2014	NIR 2015		NIR 2014	NIR 2015	
	v.2.1. submission	v.1. submission	v.2.1. submission	v.1. submission		v.2.1. submission	v.1. submission		v.2.1. submission	v.1. submission	
1989	1,132,803.17	1,132,803.17	71,558.27	70,923.28	-0.9	6.07	2.82	-53.6	0.38	0.40	4.1
1990	909,756.61	881,216.94	56,226.47	53,689.12	-4.5	4.80	1.92	-59.9	0.27	0.26	-2.6
1991	634,364.33	602,771.36	38,280.62	35,891.78	-6.2	3.07	1.10	-64.2	0.17	0.15	-9.5
1992	578,874.02	578,874.22	35,277.12	35,207.98	-0.2	3.19	1.65	-48.2	0.23	0.23	1.3
1993	532,271.52	532,271.63	32,184.09	32,117.40	-0.2	2.95	1.50	-49.0	0.21	0.21	1.1
1994	500,814.30	500,814.32	29,702.18	29,633.81	-0.2	2.63	1.21	-54.1	0.17	0.17	1.2
1995	513,114.98	513,092.36	30,255.68	30,188.81	-0.2	2.99	1.49	-50.2	0.20	0.20	1.0
1996	488,540.59	488,517.71	28,988.58	28,925.84	-0.2	2.55	1.21	-52.4	0.17	0.17	0.9
1997	394,355.37	418,749.72	23,542.78	24,840.71	5.5	2.18	1.17	-46.0	0.16	0.17	2.8
1998	322,080.47	322,907.48	19,633.18	19,600.47	-0.2	1.76	0.97	-44.8	0.14	0.14	2.0
1999	296,465.33	295,974.61	18,019.51	17,881.82	-0.8	1.66	0.90	-46.0	0.13	0.13	1.5
2000	309,588.21	309,572.13	18,858.30	18,760.16	-0.5	1.80	1.04	-42.6	0.15	0.15	1.5
2001	321,828.03	318,366.38	19,840.48	19,497.05	-1.7	1.83	1.02	-44.1	0.15	0.15	0.2

Year	Changes at AD level [TJ]		Effects of changes on emission estimates for CO ₂ [kt]		Diff [%]	Effects of changes on emission estimates for CH ₄ [kt]		Diff [%]	Effects of changes on emission estimates for N ₂ O [kt]		Diff [%]
	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	
	2002	336,808.81	334,566.68	20,265.28		20,035.63	-1.1		2.16	1.28	
2003	319,516.50	317,245.88	18,803.44	18,569.42	-1.2	2.19	1.33	-39.3	0.18	0.18	1.4
2004	302,383.73	300,176.10	19,023.74	18,773.79	-1.3	1.98	1.25	-36.7	0.17	0.18	2.2
2005	289,691.69	286,512.15	18,341.04	18,069.53	-1.5	1.87	1.16	-37.8	0.16	0.17	2.4
2006	284,896.05	282,254.16	17,925.28	17,680.27	-1.4	1.93	1.29	-33.4	0.18	0.18	2.4
2007	281,985.68	273,862.79	17,727.00	17,055.34	-3.8	2.00	1.26	-36.6	0.19	0.18	-4.4
2008	281,925.51	277,583.61	17,928.72	17,578.59	-2.0	1.89	1.13	-40.3	0.16	0.16	-1.6
2009	206,183.50	210,458.82	12,815.66	13,125.16	2.4	1.47	0.92	-37.2	0.13	0.13	2.1
2010	213,538.16	210,030.13	13,116.97	12,801.36	-2.4	1.70	1.00	-41.1	0.15	0.14	-8.3
2011	230,453.32	226,698.90	14,456.28	14,126.92	-2.3	1.93	1.06	-45.1	0.18	0.15	-15.7
2012	239,004.89	235,560.57	15,271.21	14,967.03	-2.0	2.18	1.21	-44.5	0.21	0.17	-18.8

Table 3.11 The effects of the activity data changes on CO₂, CH₄ and N₂O emission estimates to the sub-sector 1.A 4. - Other Sectors

Year	Changes at AD level [TJ]		Effects of changes on emission estimates for CO ₂ [kt]		Diff [%]	Effects of changes on emission estimates for CH ₄ [kt]		Diff [%]	Effects of changes on emission estimates for N ₂ O [kt]		Diff [%]
	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	
	1989	242,917.87	242,917.87	14,191.37		14,173.02	-0.1		17.74	17.74	
1990	244,828.17	197,799.02	14,434.30	10,953.94	-24.1	17.50	17.03	-2.7	0.18	0.16	-13.8
1991	234,662.40	199,634.37	13,392.11	10,789.26	-19.4	12.61	12.26	-2.8	0.14	0.12	-13.4
1992	173,070.57	173,070.73	9,975.60	9,934.81	-0.4	12.67	12.67	0.0	0.15	0.15	1.2
1993	164,801.92	164,802.04	8,461.04	8,434.93	-0.3	13.44	13.44	0.0	0.17	0.17	0.6
1994	151,640.53	151,640.60	6,852.84	6,852.35	0.0	12.86	12.86	0.0	0.18	0.18	0.2
1995	173,391.84	173,391.91	7,879.79	7,886.34	0.1	14.29	14.29	0.0	0.20	0.20	0.1
1996	215,217.28	215,217.36	7,568.74	7,552.56	-0.2	29.86	29.86	0.0	0.40	0.40	0.2
1997	283,901.09	283,718.30	9,986.80	9,756.24	-2.3	39.42	39.46	0.1	0.54	0.53	-1.0
1998	271,372.02	271,372.07	9,412.66	9,420.00	0.1	35.21	35.21	0.0	0.49	0.49	0.0
1999	240,699.40	240,699.42	7,957.34	7,961.73	0.1	33.06	33.06	0.0	0.45	0.45	0.0
2000	241,675.57	241,675.59	8,215.24	8,220.42	0.1	32.18	32.18	0.0	0.44	0.44	0.0
2001	207,476.50	207,476.52	7,781.44	7,788.12	0.1	22.89	22.89	0.0	0.32	0.32	0.0
2002	208,764.18	208,764.18	7,855.74	7,859.27	0.0	23.43	23.43	0.0	0.32	0.32	0.0

Year	Changes at AD level [TJ]		Effects of changes on emission estimates for CO ₂ [kt]		Diff [%]	Effects of changes on emission estimates for CH ₄ [kt]		Diff [%]	Effects of changes on emission estimates for N ₂ O [kt]		Diff [%]
	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	
	2003	251,950.51	251,950.51	9,274.70		9,281.90	0.1		28.70	28.70	
2004	282,003.07	282,045.47	9,896.52	9,899.46	0.0	34.87	34.87	0.0	0.47	0.47	0.0
2005	289,221.20	289,303.80	10,192.09	10,213.19	0.2	35.53	35.53	0.0	0.48	0.48	0.0
2006	315,712.96	315,712.98	11,951.76	11,959.44	0.1	33.70	33.70	0.0	0.46	0.46	0.0
2007	287,473.18	287,473.17	10,043.22	10,060.99	0.2	35.30	35.30	0.0	0.48	0.48	0.0
2008	296,644.17	296,644.15	8,874.64	8,888.61	0.2	44.67	44.67	0.0	0.60	0.60	0.0
2009	300,622.34	314,681.31	9,092.45	10,110.12	11.2	43.89	44.03	0.3	0.59	0.60	1.4
2010	305,643.27	305,643.34	9,045.52	9,053.77	0.1	45.44	45.44	0.0	0.61	0.61	0.0
2011	290,421.98	290,421.98	9,179.75	9,187.50	0.1	40.80	40.80	0.0	0.55	0.55	0.0
2012	305,236.66	305,236.54	9,689.85	9,695.94	0.1	42.54	42.54	0.0	0.58	0.58	0.0

Table 3.12 The effects of the activity data changes on CO₂, CH₄ and N₂O emission estimates to the sub-sector 1.A 5. - Other (non-specified elsewhere)

Year	Changes at AD level [TJ]		Effects of changes on emission estimates for CO ₂ [kt]		Diff [%]	Effects of changes on emission estimates for CH ₄ [kt]		Diff [%]	Effects of changes on emission estimates for N ₂ O [kt]		Diff [%]
	NIR 2014	NIR 2015	NIR 2014	NIR 2015		NIR 2014	NIR 2015		NIR 2014	NIR 2015	
	v.2.1. submission	v.1. submission	v.2.1. submission	v.1. submission		v.2.1. submission	v.1. submission		v.2.1. submission	v.1. submission	
1989	30,015.39	30,015.39	2,484.72	2,468.35	-0.7	0.15	0.17	12.0	0.03	0.03	4.3
1990	30,232.30	12,972.73	2,517.11	1,232.12	-51.1	0.16	0.13	-21.4	0.03	0.02	-32.4
1991	34,780.60	21,422.45	2,265.16	1,283.36	-43.3	2.24	2.22	-1.0	0.05	0.05	-13.3
1992	11,673.00	11,673.00	990.39	991.39	0.1	0.37	0.37	-0.5	0.02	0.02	5.4
1993	5,814.65	5,814.66	312.10	309.33	-0.9	0.54	0.54	0.6	0.01	0.01	0.5
1994	7,504.84	7,504.84	440.43	437.67	-0.6	0.53	0.54	1.0	0.01	0.01	0.5
1995	8,901.61	8,901.62	558.24	556.59	-0.3	0.83	0.84	0.7	0.01	0.01	0.2
1996	6,844.65	6,844.66	277.08	276.06	-0.4	0.96	0.96	0.3	0.02	0.02	0.2
1997	2,283.30	13,633.68	7.17	845.72	11692.9	0.66	0.70	5.1	0.01	0.02	76.3
1998	10,677.38	10,677.42	698.65	698.33	0.0	0.39	0.40	2.4	0.01	0.01	0.1
1999	3,694.24	3,609.43	109.44	103.19	-5.7	0.67	0.67	0.2	0.01	0.01	-0.5
2000	3,824.37	3,824.39	238.11	238.11	0.0	0.45	0.45	0.5	0.01	0.01	0.0
2001	10,580.71	10,580.73	382.48	382.58	0.0	1.86	1.86	0.2	0.03	0.03	0.0

Year	Changes at AD level [TJ]		Effects of changes on emission estimates for CO ₂ [kt]		Diff [%]	Effects of changes on emission estimates for CH ₄ [kt]		Diff [%]	Effects of changes on emission estimates for N ₂ O [kt]		Diff [%]
	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission		NIR 2014 v.2.1. submission	NIR 2015 v.1. submission	
	2002	9,969.64	9,969.65	268.42		268.32	0.0		1.99	1.99	
2003	11,263.96	11,263.98	377.76	377.89	0.0	1.92	1.93	0.3	0.03	0.03	0.0
2004	14,078.82	22,560.26	680.68	1,307.92	92.1	1.61	1.64	2.1	0.03	0.03	19.1
2005	23,228.52	18,969.26	1,160.39	831.51	-28.3	2.38	2.39	0.1	0.04	0.04	-6.2
2006	14,052.23	14,052.25	502.23	502.65	0.1	2.20	2.21	0.3	0.03	0.03	0.0
2007	18,896.92	18,880.95	950.78	950.81	0.0	1.91	1.85	-3.5	0.03	0.03	-4.8
2008	16,629.06	16,614.04	811.69	811.68	0.0	1.77	1.70	-3.6	0.03	0.03	-4.9
2009	8,597.59	8,582.60	270.73	270.73	0.0	1.56	1.49	-4.6	0.02	0.02	-6.4
2010	8,845.88	8,828.91	267.80	267.81	0.0	1.64	1.56	-4.9	0.02	0.02	-6.9
2011	10,314.14	10,022.13	538.48	538.48	0.0	2.27	0.81	-64.1	0.04	0.01	-66.1
2012	10,283.35	10,249.28	558.37	558.37	0.0	0.98	0.82	-16.5	0.02	0.02	-18.3

3.2.4.6 Category-specific planned improvements, if applicable, including tracking of those identified in 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.

Annually analysis on the EU-ETS reporting in comparison with Large Combustion Plants reporting, in order to check the consistency 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 CO₂ 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.

3.2.5 Fuel combustion, Energy Industry (CRF 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.

Energy Industries, CRF - 1.A.1 is a CO₂ key category by liquid, solid and gaseous fuels, level and trend, excluding and including LULUCF, as result of T1 approach.

Figure 3.18 Total GHG emissions trend for the subsector 1.A.1 Energy industries by category

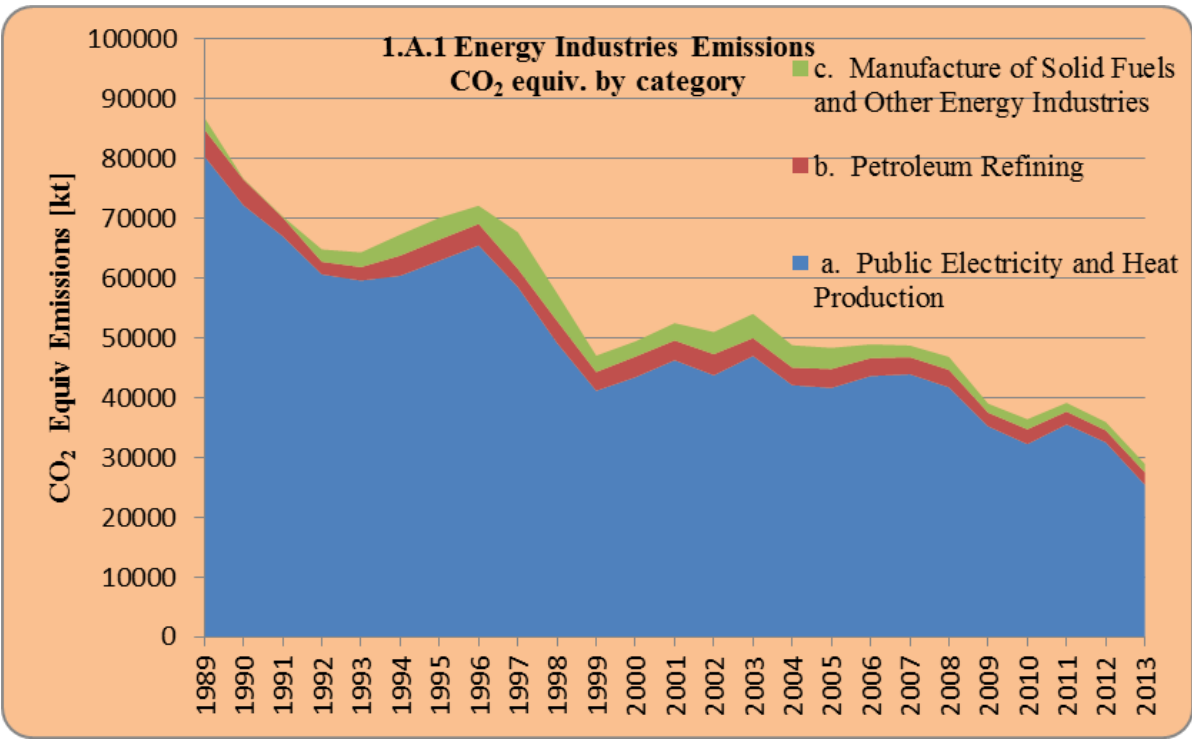
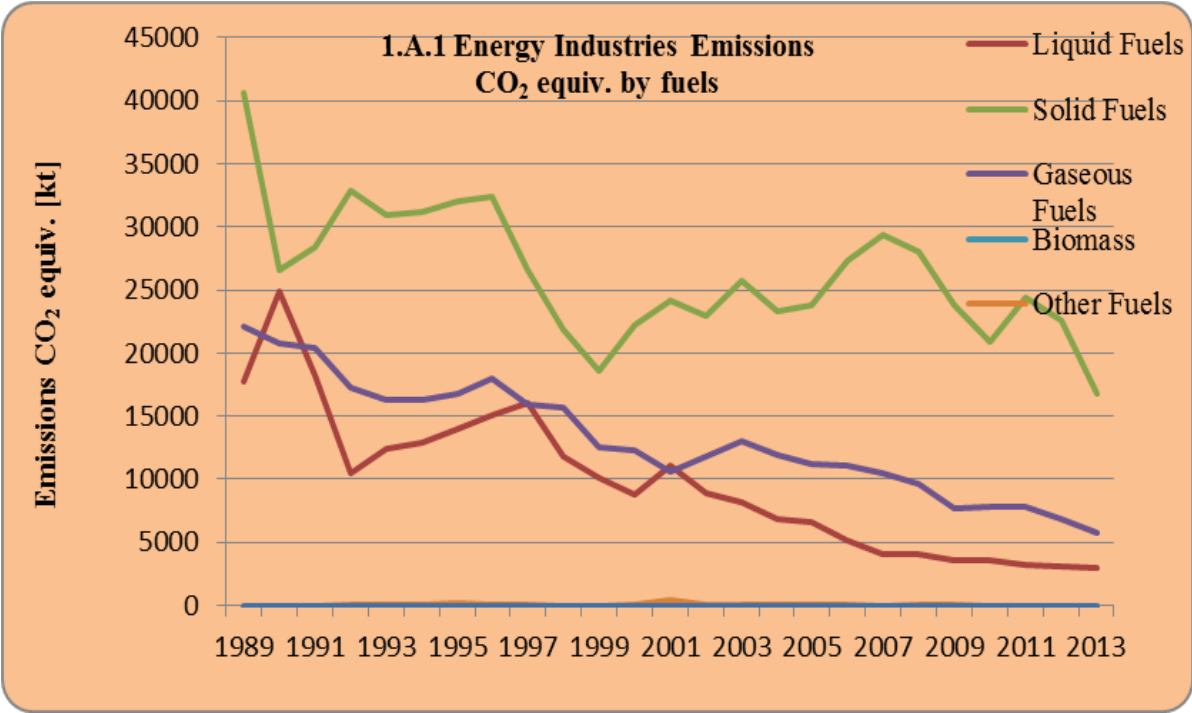


Figure 3.19 GHG emissions trend for the subsector 1.A.1 Energy industries by type of fuels



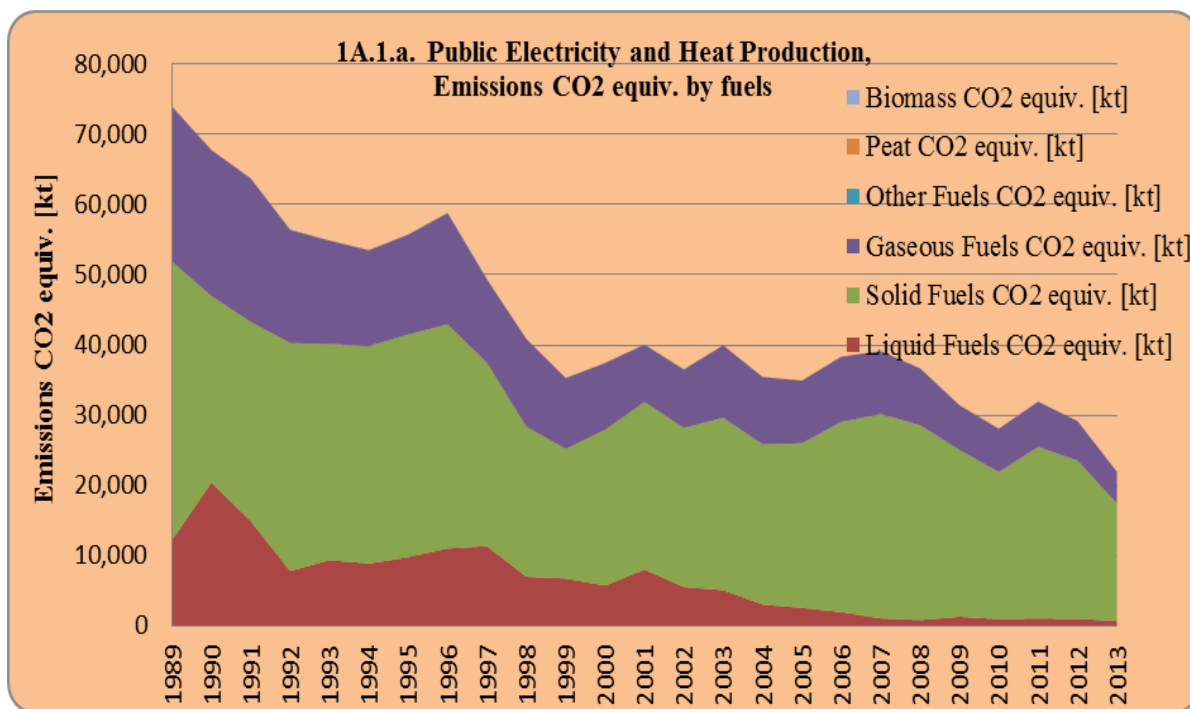
The general trend in CRF category 1.A.1 is a decrease in the emissions, but having a constant contribution to the total of 1A Fuel combustion emissions: 45% in the base year and a 38.8% in last year.

The contribution of this sub-sector to the 1.A. – Fuel combustion is, for the year 2013, about 25,452.53 kt CO₂ equiv. having the main contributor the activity category 1.A.1.a – Electricity and Heat Production with 21958.32 kt CO₂ equiv.

3.2.5.1 Public Electricity and Heat Production (CRF 1.A.1.a)

3.2.5.1.1 Category description

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.4 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.20 GHG emissions from 1.A.1.a Public Electricity and Heat Production

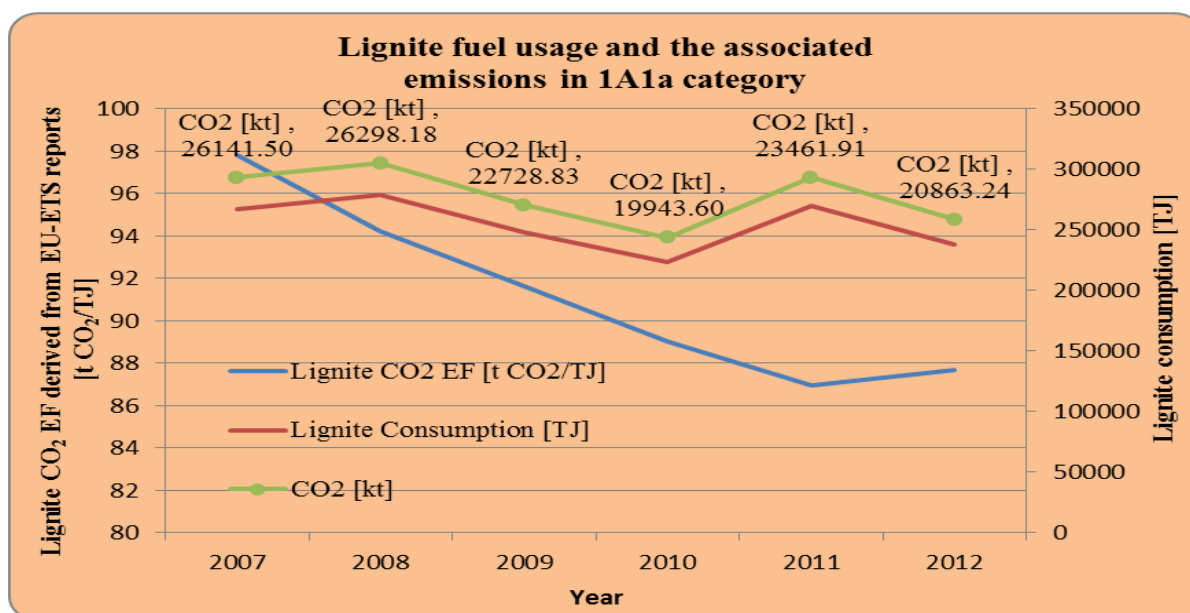
The 1.A.1.a - Electricity and Heat Production activity category covers emissions from fuel combustion in Main Activity Producer Electricity Plants, Main Activity Producer CHP Plants, Main Activity Producer Heat Plants and Own Use in Electricity, CHP and Heat Plants.

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 33.5% for the year 2013. The share of this activity category to the 1.A.1. - Energy Industry is 92% for the base year and 86.3% for the year 2013 (about 21958.3 kt CO₂ 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. Small quantities of GHG emissions are from the combustion of biomass and other fuels (5.2 and 0.7 CO₂ kt equiv.).

The decreasing trend is observed for the all burned fuels, due to the fact that the demand of the energy slightly decreased in the 2013 and for the fact that the supply from non fossil resources has an ascendant trend (hydro, wind, solar and nuclear resources). Particularly, the case of the lignite usage in the 1.A.1.a category, the descent trend of the country specific CO₂ lignite emission factor derived from the EU-ETS reporting period and including the oxidation factor (as

is explained in the 3.2.4.4. chapter - “*Source-specific QA/QC and verification*”), has an influence in the variation of the associated CO₂ emissions, the main cause being the variation of the consumption - see the bellow figure (for 2013 the situation related to the lignite usage in the EU-ETS is not yet analyzed, this activity being scheduled to be undertaken in the following period).

Figure 3.21 CO₂ emissions variation associated with the lignite usage in the 1.A.1.a - Public Electricity and Heat Production



3.2.5.1.2 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.

See the Chapter 3.2.4.2 for more details.

3.2.5.1.3 Uncertainties and time-series consistency

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period. See the chapter 3.2.4.3 for more details.

3.2.5.1.4 Category-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 3.2.4.4 for more details.

3.2.5.1.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

Liquid Fuels

Activity data (AD)

- *Residual Fuel Oil: Own Use in Electricity, CHP and Heat Plants, 2001 year - Energy Balance activity data correction.*

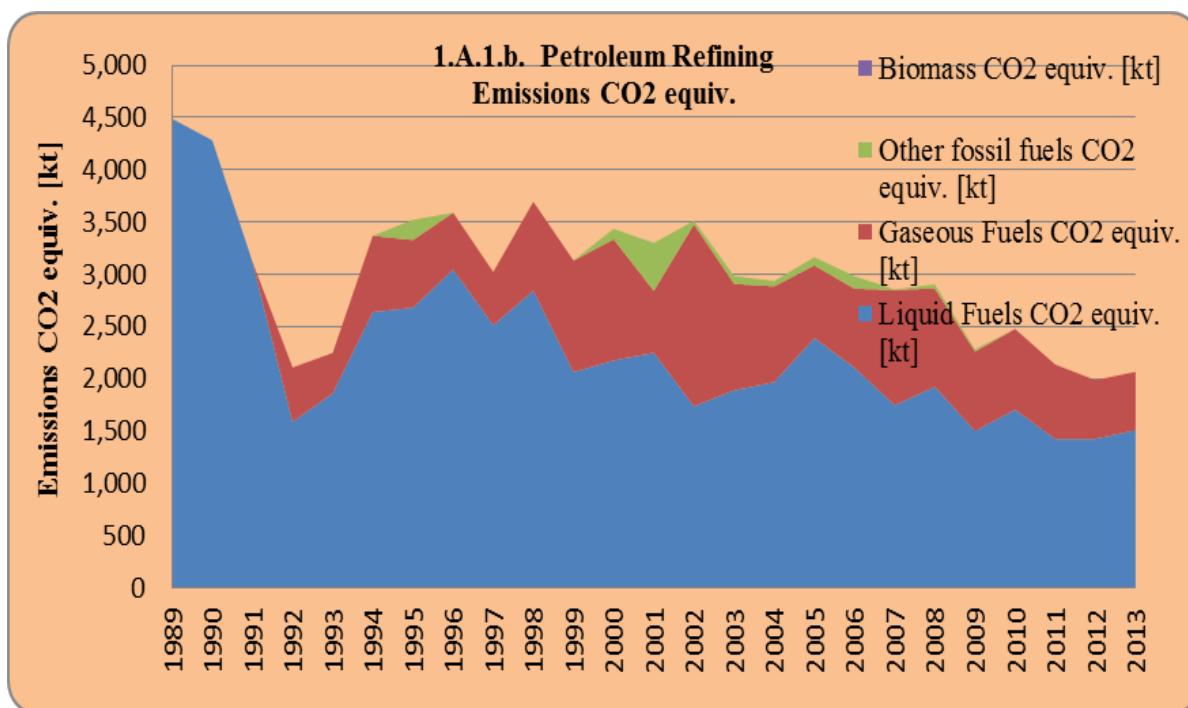
For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.4.5.

3.2.5.1.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

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 CO₂ emissions. See the Chapter 3.2.4.6 for more details.

3.2.5.2 Petroleum Refining (CRF 1.A.1.b)

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.4 Source category - Fuel combustion (CRF Sector 1.A.).

3.2.5.2.1 *Category description***Figure 3.22 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 3.15% for the year 2013. The main fuels reported are liquids which are: Refinery gas, Transport diesel and Residual fuel oil, together with natural gas having a contribution about 2066.55 kt CO₂ equiv. in 2013.

3.2.5.2.2 *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. See the Chapter 3.2.4.2 for more details.

3.2.5.2.3 *Uncertainties and time-series consistency*

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period. See the chapter 3.2.4.3 for more details.

3.2.5.2.4 *Category-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 3.2.4.4 for more details.

3.2.5.2.5 *Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend*

Liquid Fuels

Activity data (AD)

- *Residual fuel oil* on 2005 year Energy Balance activity data correction.

See the Chapter 3.2.4.5 for more details.

3.2.5.2.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

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 CO₂ emissions. See the Chapter 3.2.4.6 for more details.

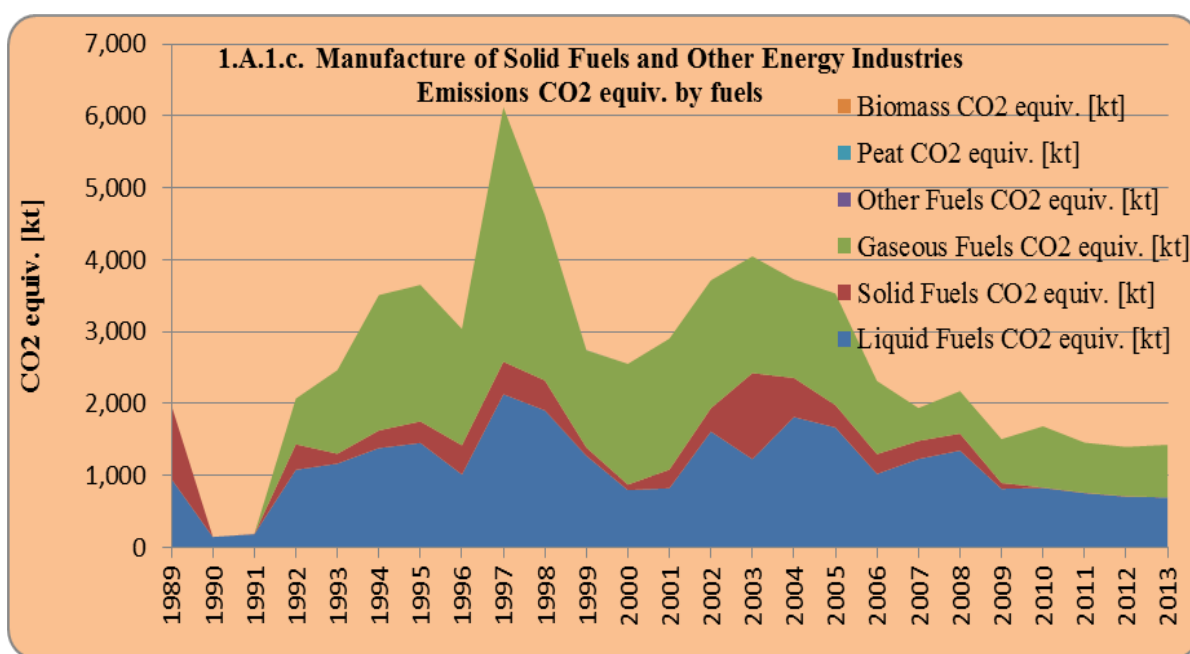
3.2.5.3 Manufacture of Solid Fuels and Other Energy Industries (CRF 1.A.1.c.)

3.2.5.3.1 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).

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.4 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.23 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 preferred. 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.

3.2.5.3.2 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.

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 3.2.4.2 for more details.

3.2.5.3.3 Uncertainties and time-series consistency

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period. See the Chapter 3.2.4.3 for more details.

3.2.5.3.4 Category-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 3.2.4.4 for more details.

3.2.5.3.5 *Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend*

Activity data

Liquid Fuels

- *Transport diesel: 1990, 1991 years - Energy Balance activity data correction;*

For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.4.5.

3.2.5.3.6 *Category-specific planned improvements, if applicable including tracking of those identified in the review process*

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 CO₂ emissions. See the chapter 3.2.4.6 for more details.

3.2.6 *Fuel combustion, Manufacturing Industries and Construction (CRF 1.A.2.)*

CRF 1.A.2. Manufacturing Industries and Construction is a CO₂ key category by solid, liquid, and gaseous fuels, level and trend, excluding and including LULUCF and by other fuels by trend excluding and including LULUCF, as result of T1 approach. See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.4 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.24 Total GHG emissions trend for the subsector 1.A.2. Manufacturing Industries and Constructions by category

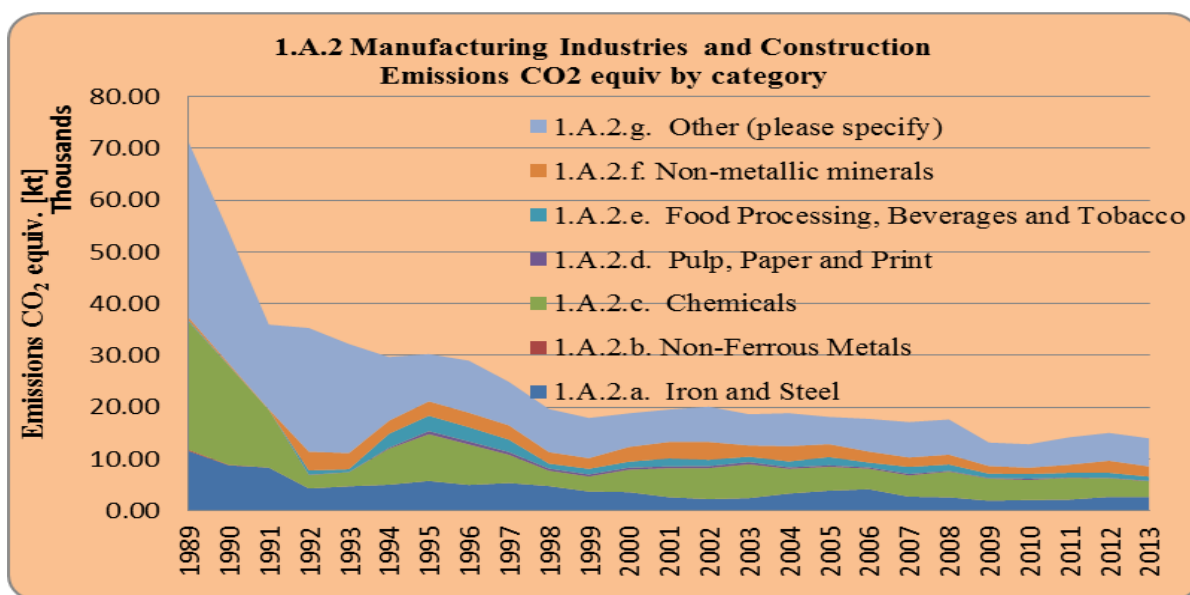
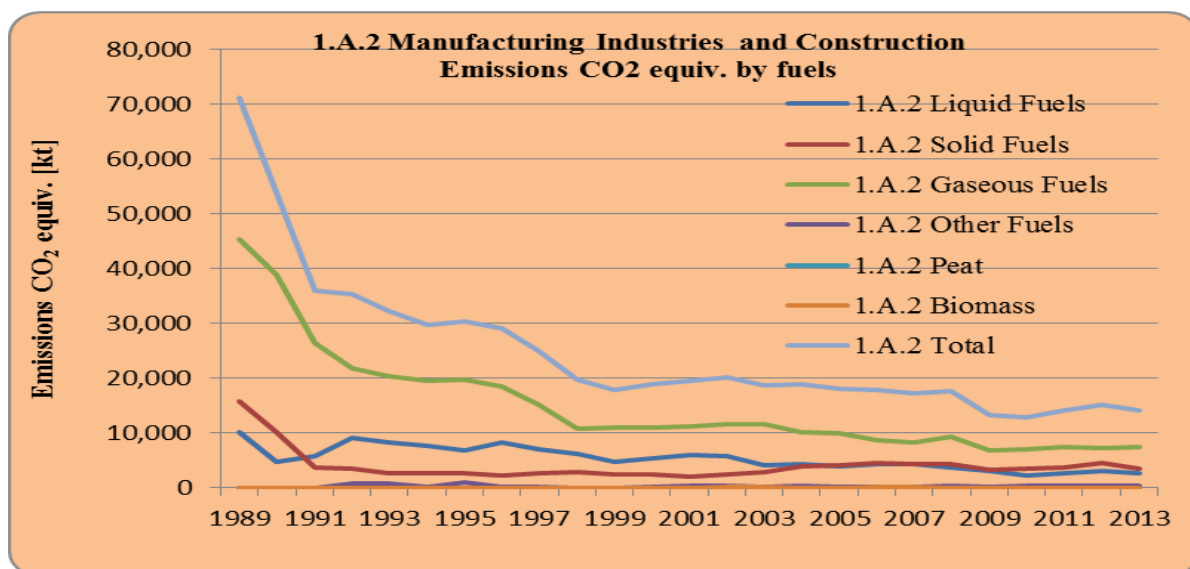


Figure 3.25 GHG emissions trend for the subsector 1.A.2. Manufacturing Industries and Constructions by fuels



The subsector Manufacturing Industries and Construction was responsible in 2013 for 21.4% of the total Energy Sector GHG emissions (about 14,015.27 kt CO₂ equivalents).

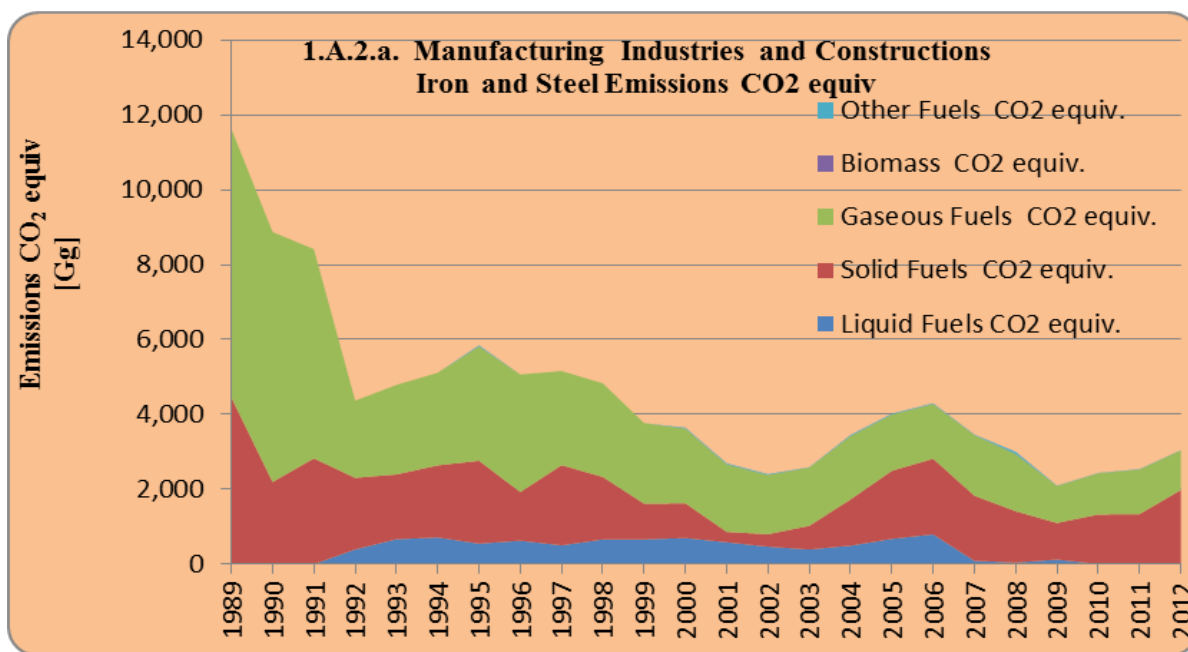
The industries included in this sub-sector are the following:

- ❖ ***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).

3.2.6.1 Iron and Steel (CRF 1.A.2.a)

3.2.6.1.1 Category description

Figure 3.26 GHG emissions from 1.A.2.a – Iron and Steel, by fuels



The share of the total CO₂ equiv. emissions of the 1.A.2.a category to the 1.A.2 sub-sector, is 16.2% from the base year, to 19.37% - current year, 2013. The contribution of this category is about 2,714.83 kt CO₂ equiv., in 2013.

3.2.6.1.2 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.

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 3.2.4.2 for more details.

3.2.6.1.3 Uncertainties and time-series consistency

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period. See the Chapter 3.2.4.3 for more details.

3.2.6.1.4 Category-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 3.2.4.4 for more details.

3.2.6.1.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

No recalculation due to the activity data changes are made. See the Chapter 3.2.4.5 for more details.

3.2.6.1.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

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 CO₂ emissions. See the Chapter 3.2.4.6 for more details.

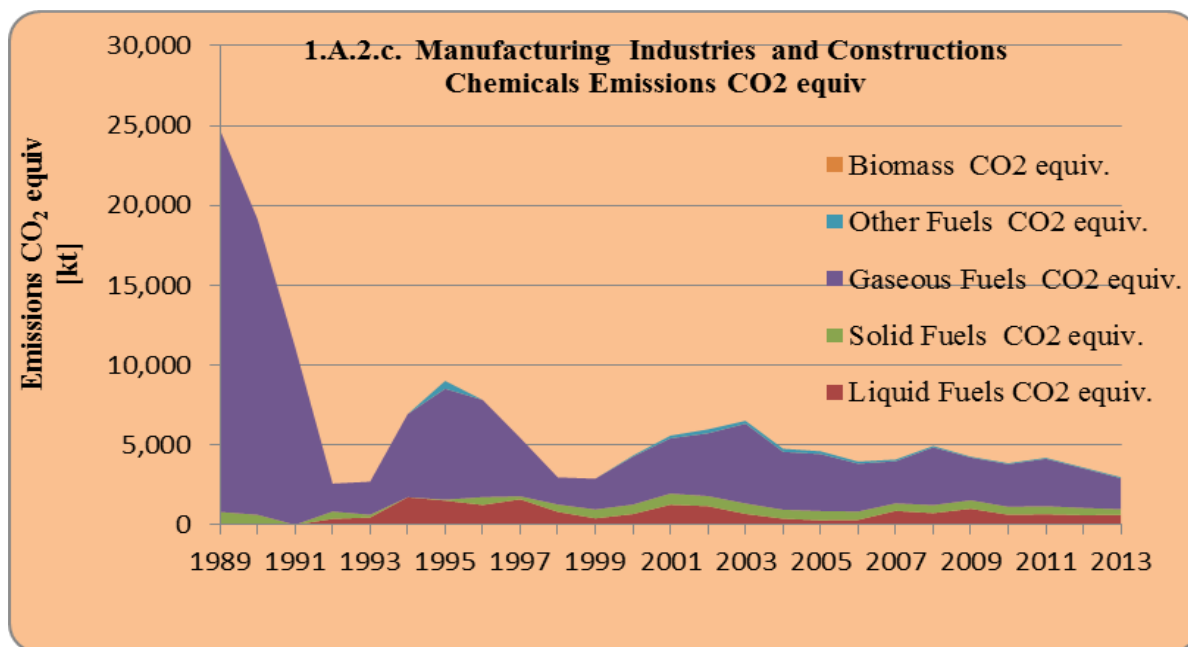
3.2.6.2 Fuel combustion, Manufacturing Industries and Construction, Non-Ferrous metals (CRF 1.A.2.b)

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.

3.2.6.3 Category Fuel combustion, Manufacturing Industries and Construction, Chemicals (CRF 1.A.2.c.)

3.2.6.3.1 Category description

Figure 3.27 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 21.3% - current year, 2013. The contribution of this category is about 2,983.40 kt CO₂ equiv., in 2013.

3.2.6.3.2 *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.

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 3.2.4.2 for more details.

3.2.6.3.3 *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:

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period. See the Chapter 3.2.4.3 for more details.

3.2.6.3.4 *Category-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 3.2.4.4 for more details.

3.2.6.3.5 *Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend*

Liquid Fuels

Activity data

- *Residual fuel oil*: 2005 - Energy Balance activity data correction.

See the Chapter 3.2.4.5 for more details.

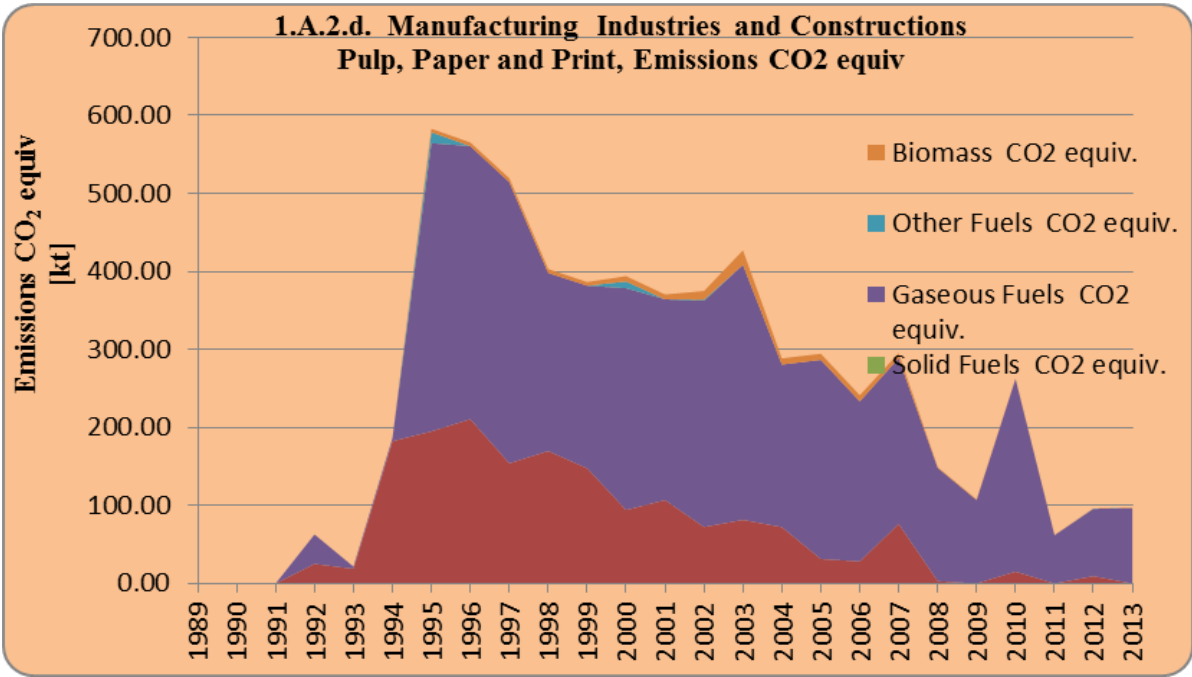
3.2.6.3.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

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 CO₂ emissions. See the Chapter 3.2.4.6 for more details.

3.2.6.4 *Fuel combustion, Manufacturing Industries and Construction, Pulp, Paper and Print (CRF 1.A.2.d.)*

3.2.6.4.1 *Category description*

Figure 3.28 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 0.69% - in the current year, 2013.

The contribution of this category is about 97.06 kt CO₂ equiv., in 2012.

See more details about trends in the Chapters 3.1 – Overview of the sector and 3.2.4 Source category - Fuel combustion (CRF sector 1.A.).

3.2.6.4.2 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.

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 3.2.4.2 for more details.

3.2.6.4.3 Uncertainties and time-series consistency

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period. See the Chapter 3.2.4.3 for more details.

3.2.6.4.4 Category-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 3.2.4.4 for more details.

3.2.6.4.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

No recalculations for the specific activity data change were made in this category. For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.4.5.

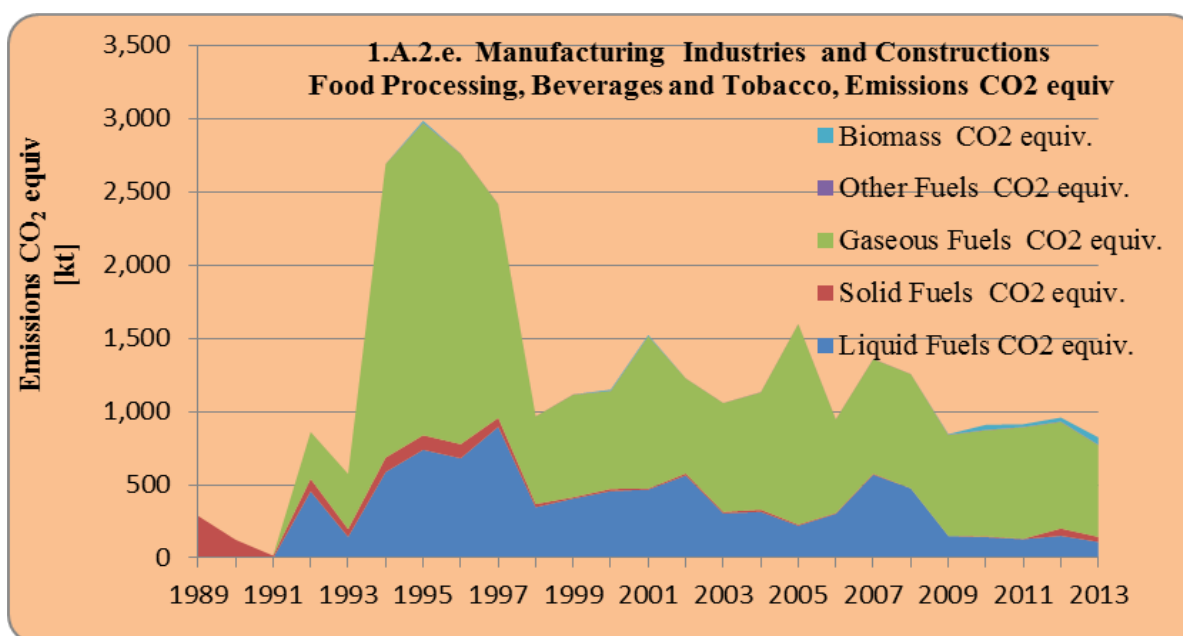
3.2.6.4.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

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 CO₂ emissions. See the Chapter 3.2.4.6 for more details.

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

3.2.6.5.1 *Category description*

Figure 3.29 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 5.87%, current year, 2013. The contribution of this category is about 823 kt CO₂ equiv., in 2013. 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.

3.2.6.5.2 *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.

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 3.2.4.2 for more details.

3.2.6.5.3 *Uncertainties and time-series consistency*

The activity data, EFs and methodology used in estimating GHG emissions are consistent for the entire period. See the Chapter 3.2.4.3 for more details.

3.2.6.5.4 *Category-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 3.2.4.4 for more details.

3.2.6.5.5 *Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend*

No recalculations due to the activity data change were made. For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.4.5.

3.2.6.5.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

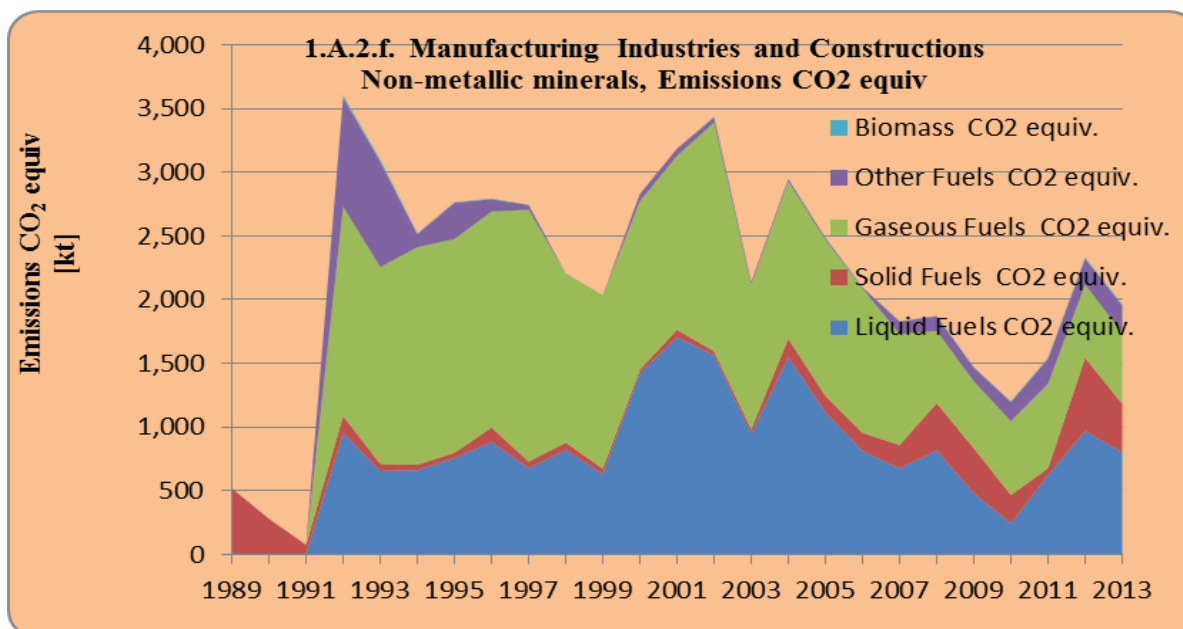
It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a higher tier approach in the estimation of the CO₂ emissions. See the Chapter 3.2.4.6 for more details.

3.2.6.6 *Fuel combustion, Manufacturing Industries and Construction, Other (please specify) (CRF 1.A.2.f.)*

3.2.6.6.1 *Category description*

In this new activity category, 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 1991 - 2000. The share of the total GHG emissions of the 1.A.2.f category to the 1.A.2 sub-sector is about 14%, current year. The contribution of this category is about 1,963.66 kt CO₂ equiv., in 2013.

Figure 3.30 GHG emissions from 1.A.2.f – Other, by fuels



3.2.6.6.2 *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.

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 3.2.4.2 for more details.

3.2.6.6.3 *Uncertainties and time-series consistency*

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period. See the Chapter 3.2.4.3 for more details.

3.2.6.6.4 *Category-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 3.2.4.4 for more details.

3.2.6.6.5 *Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend*

No recalculations were performed due to the activity data changes in the non-metallic minerals activity category. For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.4.5.

3.2.6.6.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

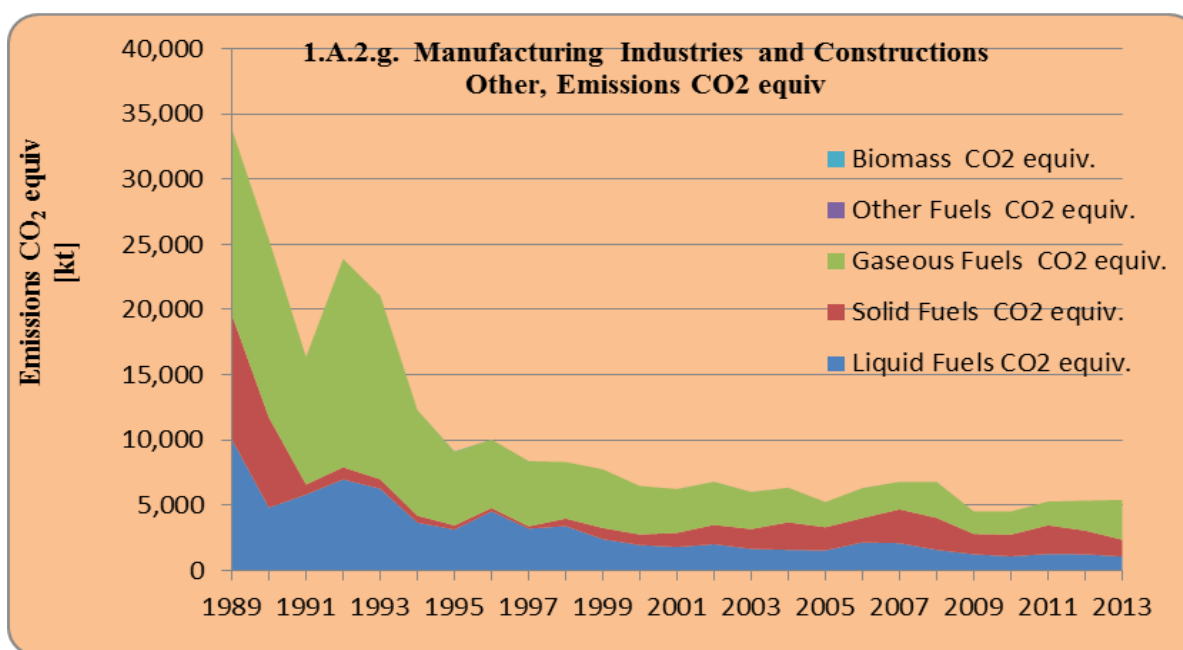
It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a higher tier approach in the estimation of the CO₂ emissions. See the Chapter 3.2.4.6 for more details.

3.2.6.7 *Fuel combustion, Manufacturing Industries and Construction, Other (please specify) (CRF 1.A.2.g.)*

3.2.6.7.1 *Category description*

The usage of the liquid, solid and gaseous fuels is balanced in this category. Small quantities of biomass are used on the period 2000-2010. The share of the total GHG emissions of the 1.A.2.g category to the 1.A.2 sub-sector is about 38.77%, in 2013. The contribution of this category is about 5,433.32 kt CO₂ equiv., in 2013.

Figure 3.31 GHG emissions from 1.A.2.g – Other, by fuels



3.2.6.7.2 *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.

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 3.2.4.2 for more details.

3.2.6.7.3 *Uncertainties and time-series consistency*

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period. See the Chapter 3.2.4.3 for more details.

3.2.6.7.4 *Category-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 3.2.4.4 for more details.

3.2.6.7.5 *Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend*

No recalculations were performed due to the activity data changes in the non-metallic minerals activity category. For more details and effect of the activity data changes on the emissions estimation, see the Chapter 3.2.4.5.

3.2.6.7.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

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 CO₂ emissions. See the Chapter 3.2.4.6 for more details.

3.2.7 *Transport (CRF 1.A.3.)*

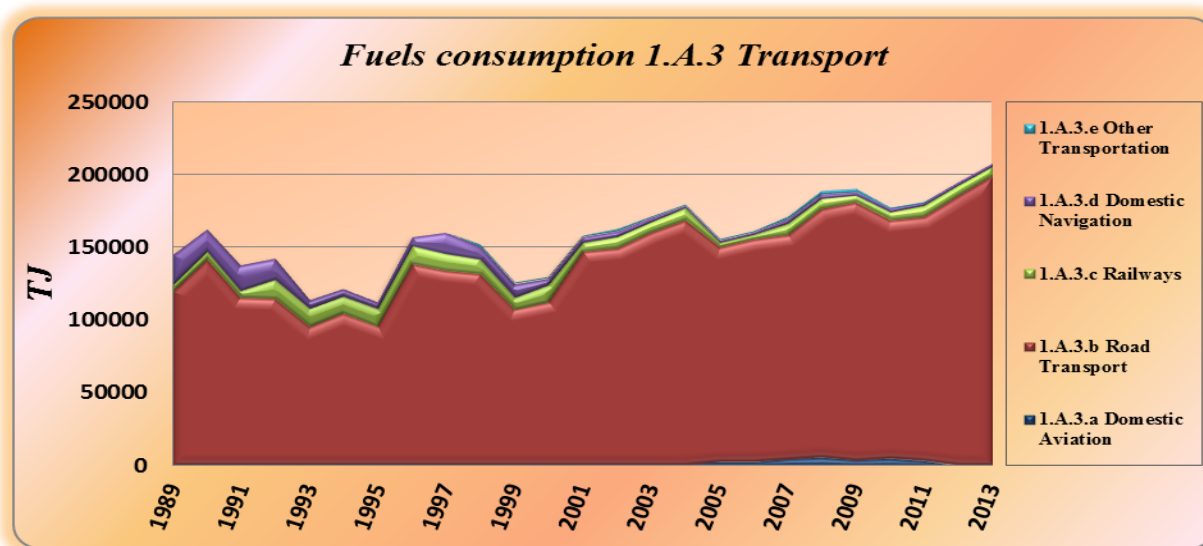
3.2.7.1 *Category description*

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.

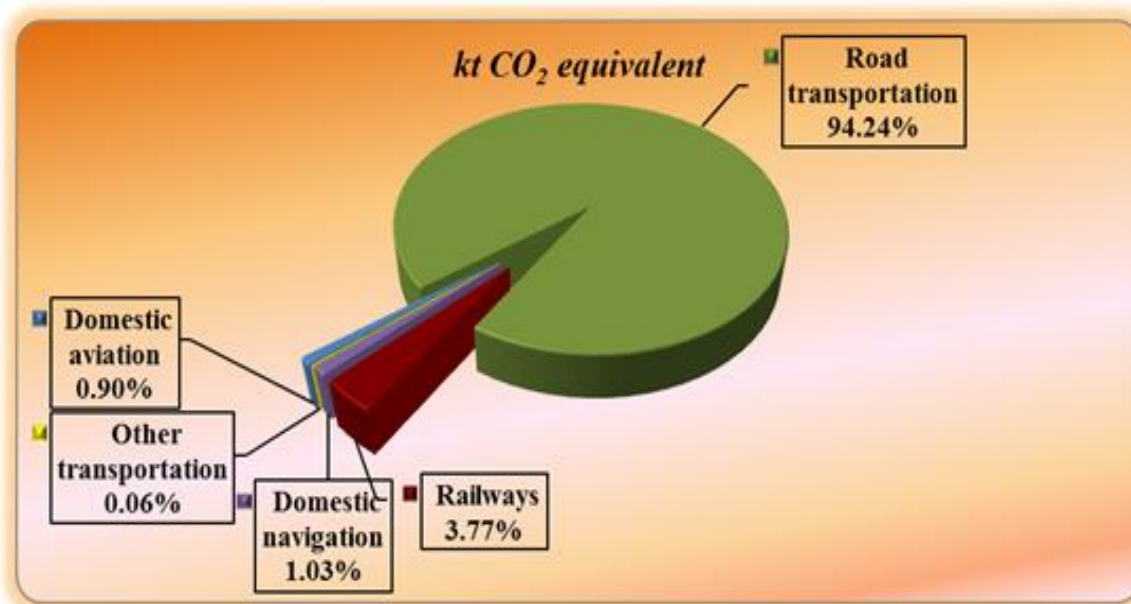
Figure 3.32 Contribution of each category to total fuel consumption in Transport Subsector



In 2013 year, the emissions from transport categories accounted for 15,088.28 kt CO₂ equivalent. The GHG characterized are: CO₂, CH₄, N₂O, NO_x, NMVOC, CO and SO₂.

Within the Energy Sector total emissions, 19.60% represents transport emissions. This sector includes emissions from road transportation, domestic aviation, railways, domestic navigation and other transportation.

Figure 3.33 Transport Subsector emissions by sub-sectors, for 2013



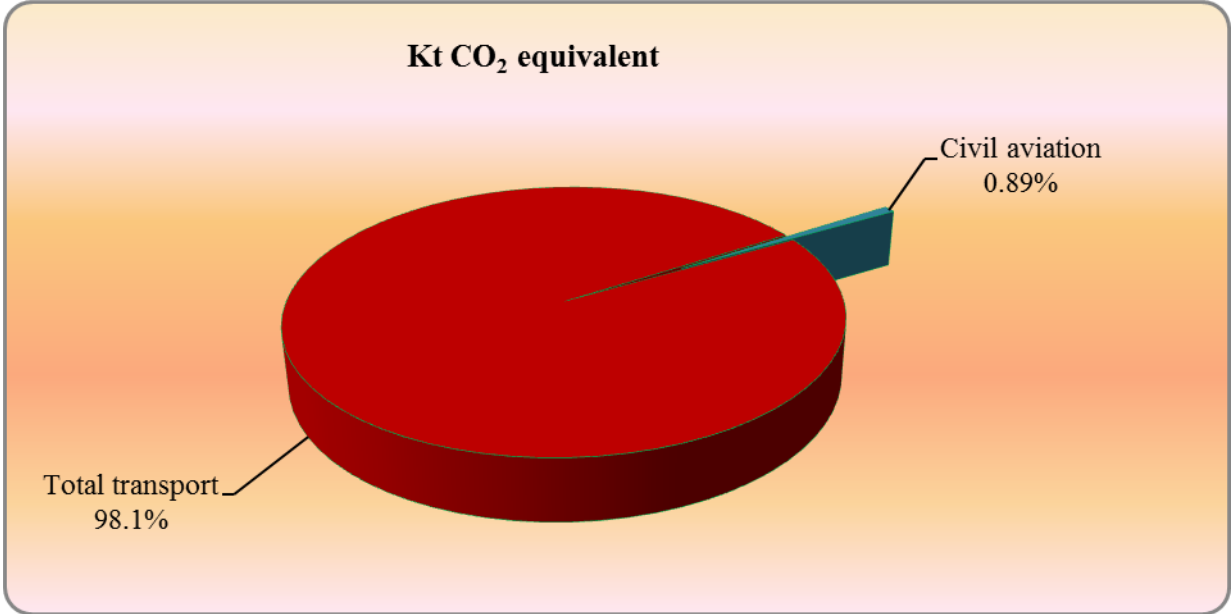
3.2.7.2 Civil Aviation (CRF 1.A.3.a)

3.2.7.2.1 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.

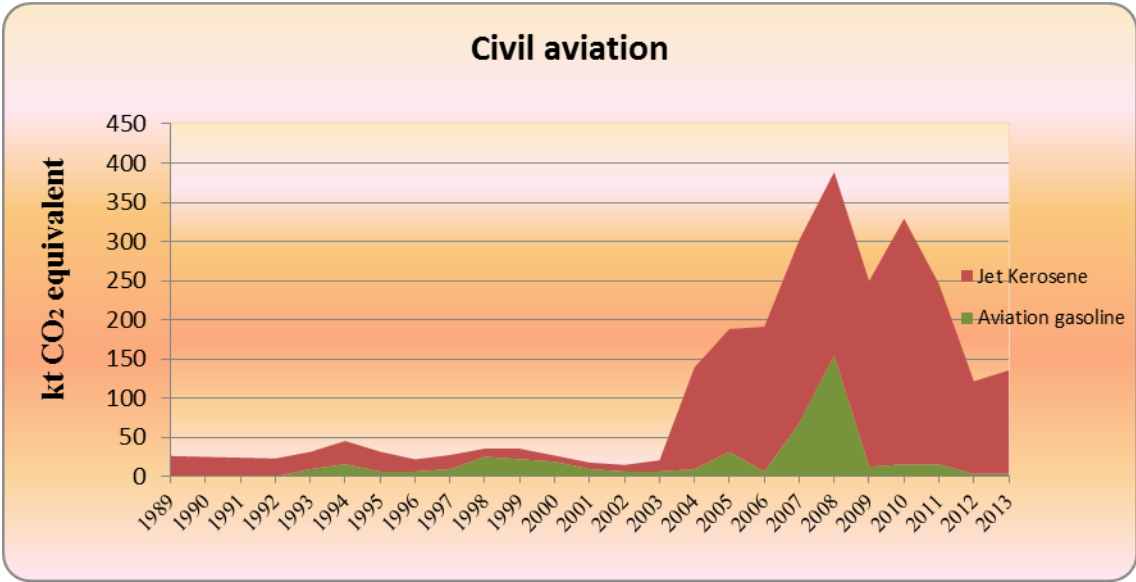
In 2013 year, the civil aviation related emissions represents 0.89% of total emissions from the transport sector (15,088.28 kt CO₂ equivalent).

Figure 3.34 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 2013.

Figure 3.35 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 2005-2013 period increases and decreases of emissions due to fluctuations in the number of flights operated took place.

3.2.7.2.2 Methodological issues

Methodology

The GHG emissions from Civil Aviation category are calculated according to IPCC 2006 provision. For the 1989-2003 period a Tier 1 method was applied as (no LTO data were available); for 2004-2013, 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.

Tier 2 method

The 2 method is applicable for jet kerosene.

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.

Emission factors

Default values of CO₂ emissions factor, according to 2006 IPCC (vol.2, ch 3.6.1.2, table 3.6.4, page 3.64.) for Tier 1 and Tier 2 methods, were used.

CO₂ emission factor	
Fuel	Default (kg/TJ)
Aviation Gasoline	70,000
Jet Kerosene	71,500

For Tier 1 the values of CH₄, N₂O 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	
CH₄	N₂O
0.5	2

For Tier 2 the values of CH₄, N₂O 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.3.3).

The values of CH₄ and N₂O 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 3.3).

The values of NO_x emission factors are default and in according to IPCC 2006 Guidelines.

The values of CO, NMVOC emission factors are default and in according to IPCC 1996 Guidelines.

For the estimation of the SO₂ 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 1989-2013 period IEA/Eurostat Questionnaire data were used.

2004-2006 period, fuelconsumption data were not available, they being collected through extrapolations based on 2007 year fuel consumption data and LTO data on 2004-2007 period; 2007-2011 period it use IEA/Eurostat Questionnaire.

The fuels consumption for domestic 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 3.3).

Figure 3.36 Fuel consumption(Aviation gasoline) for Civil Aviation -1.A.3.a

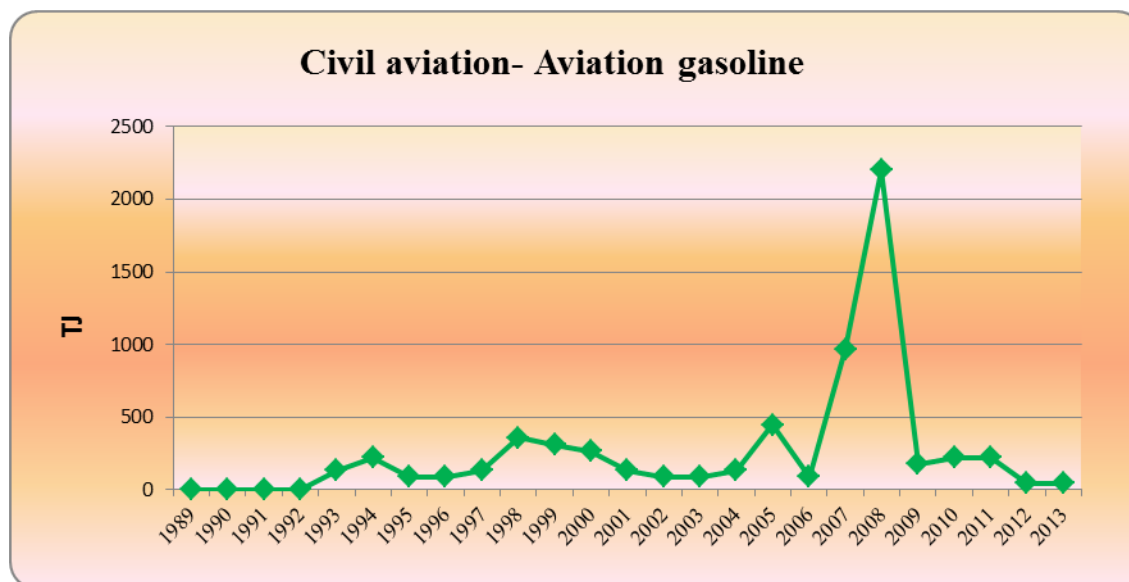
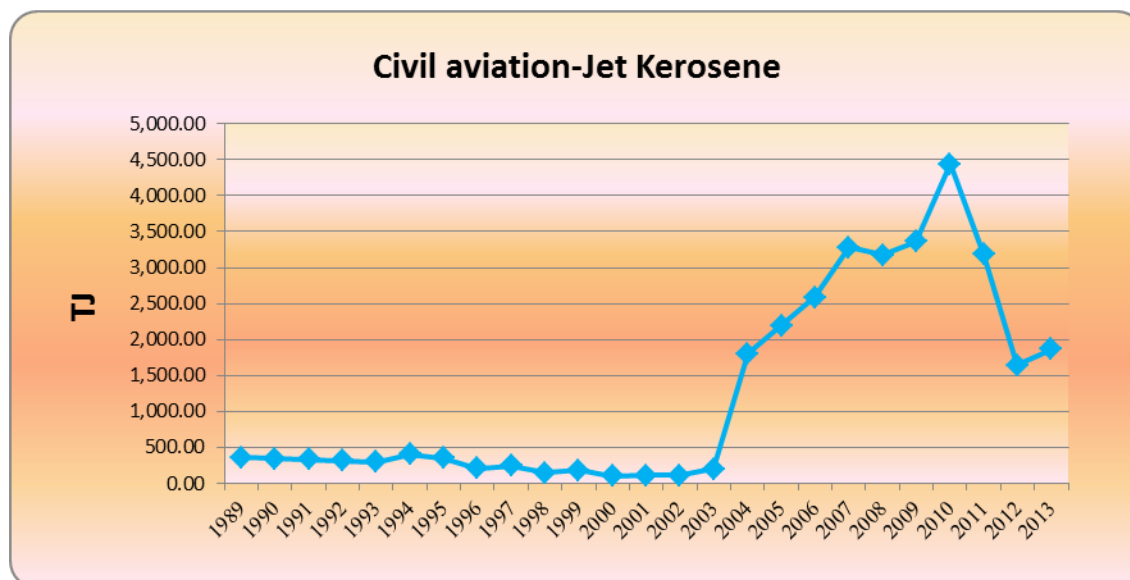


Figure 3.37 Fuel consumption(Jet Kerosene) for Civil Aviation -1.A.3.a

3.2.7.2.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

CO₂

❖ *activity data:*

- aviation gasoline: 5 %;
- jet kerosene: 5 %.

❖ *emission 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

CH₄❖ **activity data:**

- aviation gasoline: 5 %;
- jet kerosene: 5 %.

❖ **emission 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

N₂O❖ **activity data:**

- aviation gasoline: 5 %;
- jet kerosene: 5 %.

❖ **emission 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

3.2.7.2.4 Category-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 3.2.7.2.5 – 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 3.2.7.2.5 – 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 with national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 6.3.

3.2.7.2.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

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

- ✓ recalculations for the 1989 – 2012 period due to changes methodology and update of value emission factors for fuel consumption.

Table 3.13 Effects of data changes on CO₂ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v.2.1.	v. 1	v.2.1.	v. 1	
1989	362.880	362.883	25.687	25.9461	0.999999788
1990	348.550	347.810	24.672	24.8684	0.790501887
1991	334.210	333.503	23.657	23.8455	0.790458384
1992	319.870	319.197	22.642	22.8226	0.790294212
1993	439.140	438.492	30.979	31.1518	0.553188167
1994	634.800	633.927	44.759	44.9917	0.516645448
1995	442.550	441.808	31.256	31.4557	0.633823408
1996	305.610	305.158	21.563	21.6852	0.563227275
1997	383.280	382.757	27.026	27.1667	0.518375778
1998	501.790	501.479	35.239	35.3213	0.232360903
1999	498.930	498.532	35.072	35.1774	0.300131097
2000	375.980	375.755	26.404	26.4657	0.231826888
2001	250.380	250.134	17.618	17.6842	0.372455018
2002	207.330	207.080	14.606	14.6726	0.454600991
2003	289.200	288.776	20.401	20.5139	0.550250555
2004	3,971.340	1,934.577	283.751	138.1219	-105.4350724
2005	5,025.180	2,640.350	358.632	187.7856	-90.97958631
2006	5,515.330	2,674.302	394.213	190.6887	-106.7311063
2007	4,245.800	4,245.804	301.396	300.9022	-0.163980706
2008	5,374.300	5,374.302	387.538	387.0446	-0.127484408
2009	3,536.060	3,536.060	249.467	248.9667	-0.201145816
2010	4,660.490	4,660.490	329.272	328.6096	-0.201699813
2011	3,406.080	3,406.082	245.569	245.0833	-0.198323162

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v.2.1.	v. 1	v.2.1.	v. 1	
2012	1,685.378	1,692.076	121.657	121.4061	-0.206244125

Table 3.14 Effects of data changes on CH₄ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH ₄ [Gg]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v.2.1.	v. 1	v.2.1.	v. 1	
1989	362.88	362.883	0.0002	0.0002	-10.2284
1990	348.55	347.8100076	0.0002	0.0002	-15.0053
1991	334.21	333.5032817	0.0002	0.0002	-19.9388
1992	319.87	319.1965558	0.0002	0.0002	-25.3146
1993	439.14	438.4918299	0.0002	0.0002	8.7782
1994	634.8	633.9266291	0.0003	0.0003	5.3518
1995	442.55	441.8077218	0.0002	0.0002	9.4629
1996	305.61	305.1575989	0.0002	0.0002	-31.0798
1997	383.28	382.7566133	0.0002	0.0002	-4.5051
1998	501.79	501.4790509	0.0003	0.0003	-19.6461
1999	498.93	498.5317373	0.0002	0.0002	19.7644
2000	375.98	375.755143	0.0002	0.0002	-6.4523
2001	250.38	250.1344747	0.0001	0.0001	20.0430
2002	207.33	207.0795183	0.0001	0.0001	3.4187
2003	289.2	288.7764659	0.0001	0.0001	30.7423
2004	3971.34	1,934.58	0.0027	0.0017	-62.3156
2005	5025.18	2,640.35	0.0034	0.0022	-52.7024

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH ₄ [Gg]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v.2.1.	v. 1	v.2.1.	v. 1	
2006	5515.33	2,674.30	0.004	0.0026	-55.3123
2007	4,245.80	4,245.80	0.0039	0.0039	-0.4219
2008	5,374.30	5,374.30	0.0045	0.0045	0.7492
2009	3,536.06	3,536.06	0.004	0.0040	0.2706
2010	4,660.49	4,660.49	0.005	0.0050	0.5678
2011	3,406.08	3,406.08	0.0038	0.0034	-11.7639
2012	1,685.38	1,692.08	0.0017	0.0017	-4.8305

Table 3.15 Effects of data changes on N₂O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N ₂ O [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v.2.1.	v. 1	v.2.1.	v. 1	
1989	362.88	362.883	0.0007	0.0007	3.5502
1990	348.55	347.8100076	0.0007	0.0007	-0.6297
1991	334.21	333.5032817	0.0007	0.0007	-4.9465
1992	319.87	319.1965558	0.0006	0.0006	6.0140
1993	439.14	438.4918299	0.0009	0.0009	-2.6245
1994	634.8	633.9266291	0.0013	0.0013	-2.5355
1995	442.55	441.8077218	0.0009	0.0009	-1.8543
1996	305.61	305.1575989	0.0006	0.0006	1.6901
1997	383.28	382.7566133	0.0008	0.0008	-4.5051
1998	501.79	501.4790509	0.001	0.0010	0.2949
1999	498.93	498.5317373	0.001	0.0010	-0.2945
2000	375.98	375.755143	0.0008	0.0008	-6.4523

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N ₂ O [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v.2.1.	v. 1	v.2.1.	v. 1	
2001	250.38	250.1344747	0.0005	0.0005	0.0538
2002	207.33	207.0795183	0.0004	0.0004	3.4187
2003	289.2	288.7764659	0.0006	0.0006	-3.8866
2004	3971.34	1,934.58	0.008	0.0040	-101.5893
2005	5025.18	2,640.35	0.0015	0.0014	-3.9787
2006	5515.33	2,674.30	0.0008	0.0008	3.4720
2007	4,245.80	4,245.80	0.0027	0.0027	1.2926
2008	5,374.30	5,374.30	0.0055	0.0055	-0.7465
2009	3,536.06	3,536.06	0.0015	0.0015	1.0805
2010	4,660.49	4,660.49	0.0017	0.0017	1.5753
2011	3,406.08	3,406.08	0.0013	0.0013	2.3311
2012	1685.378	1,692.08	0.0007	0.0006	-14.4631

3.2.7.2.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

It is planned further investigations and co-operation with Ministry of Transport in order to have a fully correspondence concerning the quantities of the fuels.

3.2.7.3 *Road Transport (CRF 1.A.3.b)*

3.2.7.3.1 *Category description*

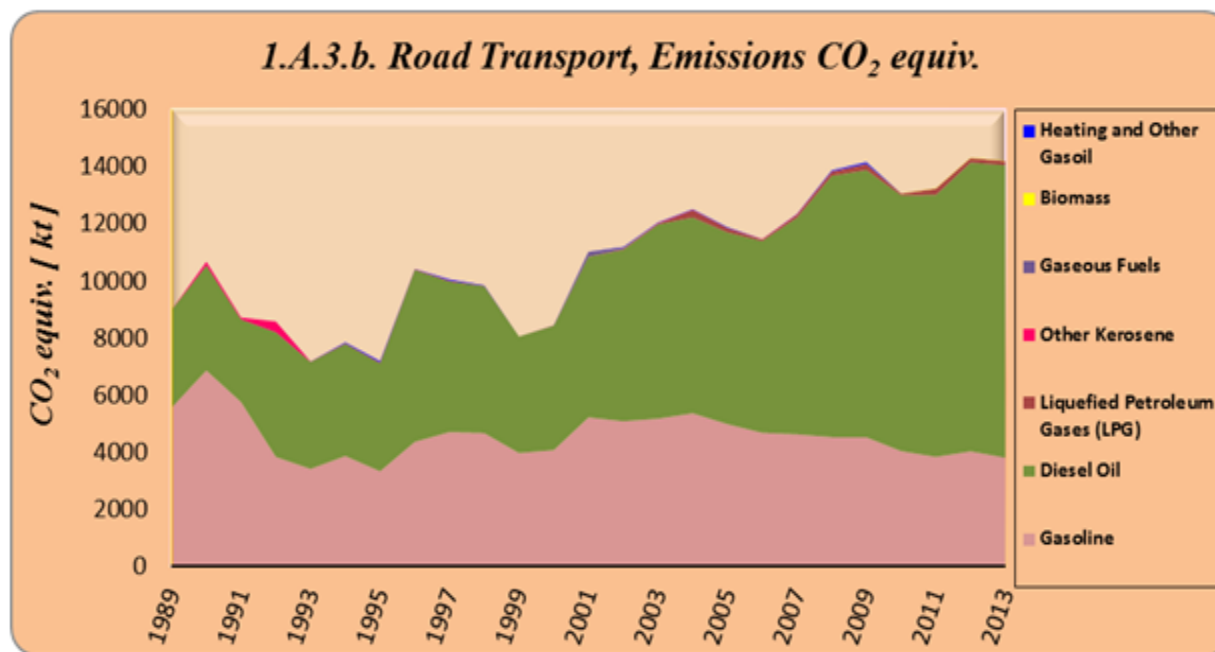
Road Transport category, is a key category, by level, trend, including LULUCF and excluding LULUCF criteria.

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 (CO₂), methane (CH₄) and nitrous oxide (N₂O) 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 (SO₂), particulate matter (PM) and oxides of nitrate (NO_x), 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 3.38 Road transport GHG emissions by fuels

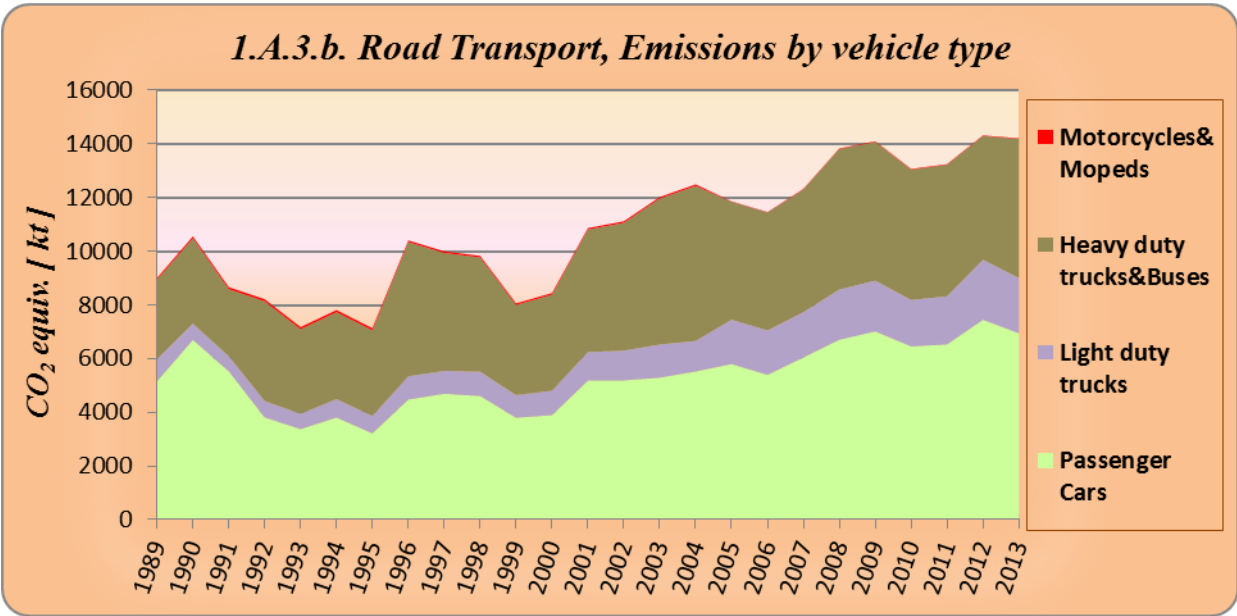


In Road Transport Subsector the emissions trend reflects the changes in period 1989–1999 characterized by a process of transition to a market economy. Roads in Romania had a low level of modernization. Massive development of trade and the industrial revolution led to improving the roads and to achieve 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 CO₂ 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 CO₂ emissions grew constantly to 2010.

Figure 3.39 Road transport GHG emissions by vehicle type



Overall, the GHG emissions from road transport increased by 58,01% compared to base year levels being 8998,90 kt CO₂e in 1989 and reached levels of 14219,07 kt CO₂e in 2013.

The most important contributor to GHG emissions from passenger cars, followed by heavy duty trucks and buses, light duty trucks, motorcycles and mopeds. That as can be seen in 2013, passenger cars represent 48,87%, heavy duty trucks & buses 36,48% of total GHG emissions CO₂e respectively, according to the increase of passenger and freight 14,65% were split between light duty trucks, motorcycles and mopeds.

Figure 3.40 Road transport GHG emissions by vehicle type

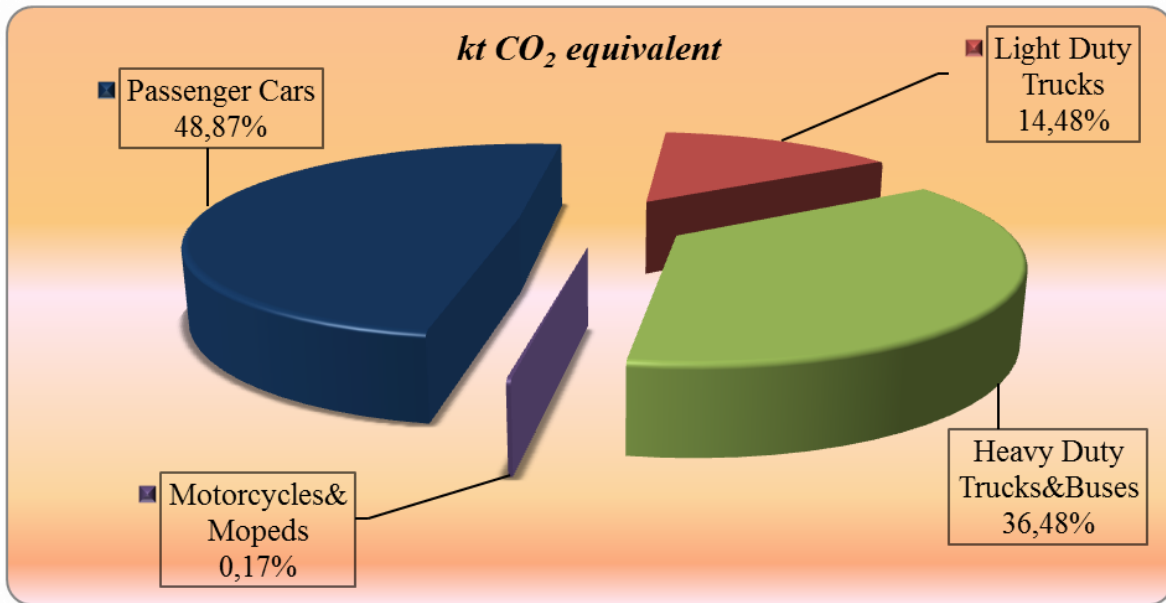
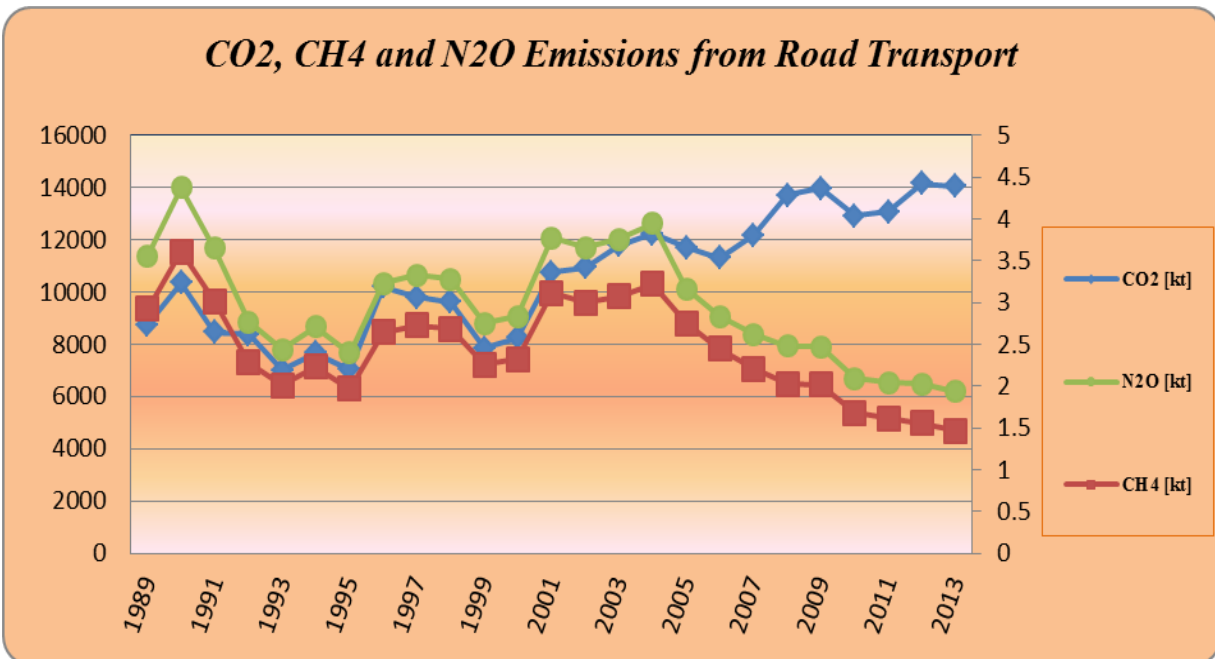


Figure 3.41 CO₂, CH₄, N₂O, [kt] Emissions from Road Transport



Whereas CO₂ emissions are closely linked to fuel consumption, CH₄ and N₂O emissions are impacted and by the technology. N₂O 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, CO₂, N₂O and CH₄ emissions tend to fluctuate for the full period of the inventory.

By far the most important gas emitted from the sector road transport is CO₂. It accounts for 98,76% of the total greenhouse gas emissions of the sector.

In 2013, CH₄ emissions contributed with 0,26 % to the total emissions of the road transport sector (73,14 kt CO₂ eq. in 1989, 36,68 kt CO₂ eq. in 2013). The decreasing trend after 1991 is the result of improved transmission network resulting in substantially lower and reduced emissions from gasoline passenger cars due to catalytic converters.

N₂O emissions contributed with 0,98% to the total emissions of the this sector (187,48 kt CO₂ eq. in 1989, 139,86 kt CO₂ eq. in 2013). The changes in N₂O emissions may mainly be explained by changes in the emission of road transportation due to changes in EFs for diesel and gasoline combustion. The first generation of catalytic converters generates N₂O as undesirable by-product in the exhaust gases, leading to an increase of N₂O emissions until 2004. With new converter materials being used, the emission factors are decreasing after 2005.

There is also an increasing to the years 2000-2005, which is closely linked to the introduction of Euro 1 vehicles. This category it is known for higher N₂O emissions.

CH₄ and N₂O emissions peak growth in 1990-1991 respectively and after the fuel consumption which is also the peak on the 1989-2000 period.

Compliance with emission standards grew raised significantly influence, CH₄ and N₂O thereby leading to low levels of methane and nitrous oxide.

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.

3.2.7.3.2 *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).

For the 1989–2004 period

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 (consumption 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 CO₂, CH₄ and N₂O are calculated based on the amount and type of fuel combusted and its carbon content (for CO₂ gas).

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

CO₂, CH₄, N₂O and for the indirect greenhouse gases

For the period 1989-2004 Tier 1 emission factors (EFs) used, so as to be applicable to countries with older vehicle fleets. The emission factors are given in Table 3-5 to Table 3-11 of EMEP/EEA emission inventory guidebook 2013.

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 estimation of the CO₂, CH₄, N₂O, CO, NO_x 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.

(CO₂ ch. Road transport GB 2013, table 3-11 pag.27; CH₄ ch. Road transport GB 2013, table 3-70 pag.82; N₂O ch. Road transport GB 2013, table 3-7 pag.26; CO, NO_x, ch. Road transport GB 2013, table 3-5 and table 3-6 pags.25-26; NMVOC ch. Gasoline evaporation GB 2013, pag.8-9; SO₂ 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 1990-2013 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, CO₂ emissions released from these processes are reported as an information item, as the CO₂ is naturally captured from the air. That is not applicable for the CH₄ and N₂O emissions, being reported and accounted for, in the total inventory emissions.

The national energy balance is provided by NIS. From biomass, 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 2005-2013 period

Methodology

Model Copert 4, Tier 3 was used for the period 2005-2013, detailed statistics necessary to use higher level methods have allowed.

For period 2005-2013 the emission calculations of road transport have been performed with the use of the version 11 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

For period 2005-2013 have been calculated based on the Tier 3 method (actually Copert 4).

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.

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.

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 calculation.

Activity data

Fuel consumption (liquid, gaseous 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).

The number of vehicles is used in each category and an average mileage for each category based on some average values.

The COPERT software then is run twice - once with the original data to compare the calculated fuel consumption for each fuel with the actual fuel consumption reported by the national statistics. On the second run, the mileage adjustment for the fuel difference, the reason have to do this adjustment several times in order to obtain 0% of the difference calculated and statistics by the fuel.

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 2005-2013 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 3.16 Country specific characteristics for gasoline and diesel oil according Decision no 689/ 2004, update by Decision no. 15/2006

	Sulfur (% m/m)		Hydrocarbons		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)

3.2.7.3.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are:

Table 3.17 Uncertainties for road transport

Road Transport 1.A.3.b.	Uncertainty				Combined uncertainty		
	Activity Data	EF CO ₂	EF N ₂ O	EF CH ₄	EF CO ₂	EF N ₂ O	EF CH ₄
Motor Gasoline	3	5	108	48	0.0583	1.0804	0.4809
Gas Diesel Oil	3	4	50	50	0.0500	0.5009	0.5009
Liquefied Petroleum Gases (LPG)	3	4	50	50	0.0500	0.5009	0.5009
Other Liquid Fuels (Other Kerosene)	3	4	50	50	0.0500	0.5009	0.5009
Gaseous Fuels	3	4	50	50	0.0500	0.5009	0.5009
Biomass	3	20	50	50	0.2022	0.5009	0.5009

Combined uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

3.2.7.3.4 *Category- 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 Domestic Aviation, Railways, Domestic Navigation and Other Transportation, the results of these being mentioned on the Checklists level.

Following these activities there were no nonconformities 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 Commission Implementing Regulation (EU) No 749/2014 166/2005/EC of the European Parliament and of the Council.

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. Further elements are presented within Annex 6.3.

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

3.2.7.3.5 *Category-specific recalculation, if applicable, including changes made in response to the review process and impact on emission trend*

Activity data

Road Transportation from Liquid Fuels (Gasoline, Diesel Oil, LPG and Other Kerosene, Heating and Other Gasoil)

There are recalculations, by Road Transport activity categorie, on the entire time-series 1989-2012, such as follows:

- Recalculation for the period 2005-2012 may be due to updated the model Copert 4 version 9 to version 11;
- Recalculations for 1993–2009 time-series: level of CO₂, CH₄ and N₂O emissions, the fuel consumption of the heating and other gasoil from the Energy Balance was added;
- The recalculations resulted and as a result to the changed methodology from the IPCC 1996 GL to the IPCC 2006 GL.

Emission factors

Road Transportation from Other Liquid Fuels (Heating and Other Gasoil)

Heating and Other Gasoil

- ✓ Recalculations for 1989–2012 time-series: level of CO₂, CH₄ and N₂O emissions, for CO₂, country specific EF and CH₄, N₂O default EF, was changed with a IPCC 2006 Guidelines for National GHG.

Table 3.18 Effects of data changes on CO₂ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1	v. 1	v. 2.1	v. 1	
1989	119,110.48	119,110.48	8,726.39	8,738.27	0.14
1990	141,408.85	141,408.85	10,364.28	10,365.55	0.01
1991	115,372.21	115,372.21	8,457.63	8,458.21	0.01
1992	114,253.11	114,253.11	8,376.17	8,379.88	0.04
1993	95,269.41	95,310.80	7,003.40	7,006.57	0.05
1994	103,822.71	104,195.20	7,625.21	7,653.04	0.36
1995	95,107.42	95,686.86	6,976.75	7,020.02	0.62
1996	138,299.14	138,423.30	10,176.73	10,186.11	0.09
1997	132,777.15	133,315.19	9,771.76	9,811.96	0.41
1998	130,425.27	130,673.59	9,590.47	9,608.98	0.19
1999	106,729.50	106,812.28	7,854.97	7,861.12	0.08
2000	111,843.78	111,885.17	8,238.08	8,241.22	0.04
2001	146,775.65	146,858.43	10,750.08	10,756.42	0.06
2002	148,510.55	148,758.88	10,907.78	10,926.41	0.17
2003	159,603.67	159,852.00	11,753.78	11,772.41	0.16
2004	166,488.45	166,736.78	12,202.59	12,225.07	0.18
2005	158,874.43	147,445.46	11,673.16	11,697.82	0.21
2006	165,171.85	152,873.92	12,160.62	11,296.58	-7.11
2007	168,479.35	154,460.18	12,164.84	12,174.16	0.08
2008	189,512.29	170,771.19	13,661.84	13,695.76	0.25
2009	197,256.59	176,905.58	13,941.07	13,985.69	0.32
2010	180,443.43	163,776.86	13,135.61	12,909.03	-1.72
2011	187,041.64	167,030.11	13,316.84	13,086.38	-1.73

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1	v. 1	v. 2.1	v. 1	
2012	196,379.27	183,573.51	14,028.58	14,147.72	0.85

Table 3.19 Effects of data changes on CH₄ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH ₄ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1	v. 1	v. 2.1	v. 1	
1989	119,110.48	119,110.48	2.92	2.93	0.20
1990	141,408.85	141,408.85	8.84	3.61	-59.15
1991	115,372.21	115,372.21	5.44	3.01	-44.57
1992	114,253.11	114,253.11	17.58	2.28	-87.03
1993	95,269.41	95,310.80	2.39	2.01	-15.99
1994	103,822.71	104,195.20	2.87	2.23	-22.17
1995	95,107.42	95,686.86	2.86	1.97	-31.16
1996	138,299.14	138,423.30	3.28	2.64	-19.44
1997	132,777.15	133,315.19	3.62	2.73	-24.64
1998	130,425.27	130,673.59	2.94	2.68	-8.65
1999	106,729.50	106,812.28	2.25	2.25	0.01
2000	111,843.78	111,885.17	2.58	2.32	-9.90
2001	146,775.65	146,858.43	3.24	3.12	-3.92
2002	148,510.55	148,758.88	3.51	3.00	-14.52
2003	159,603.67	159,852.00	3.84	3.07	-19.93
2004	166,488.45	166,736.78	3.73	3.22	-13.53
2005	158,874.43	147,445.46	3.02	2.75	-8.73
2006	165,171.85	152,873.92	2.94	2.45	-16.68

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH ₄ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1	v. 1	v. 2.1	v. 1	
2007	168,479.35	154,460.18	2.85	2.21	-22.61
2008	189,512.29	170,771.19	2.54	2.03	-20.18
2009	197,256.59	176,905.58	2.27	2.02	-11.14
2010	180,443.43	163,776.86	1.75	1.68	-4.45
2011	187,041.64	167,030.11	1.70	1.61	-5.13
2012	196,379.27	183,573.51	1.62	1.55	-3.96

Table 3.20 Effects of data changes on N₂O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N ₂ O [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1	v. 1	v. 2.1	v. 1	
1989	119,110.48	119,110.48	0.48	0.63	31.20
1990	141,408.85	141,408.85	0.46	0.76	66.72
1991	115,372.21	115,372.21	0.43	0.63	47.05
1992	114,253.11	114,253.11	0.51	0.49	-3.11
1993	95,269.41	95,310.80	0.56	0.43	-23.27
1994	103,822.71	104,195.20	0.54	0.48	-11.33
1995	95,107.42	95,686.86	0.51	0.42	-17.03
1996	138,299.14	138,423.30	0.46	0.59	26.93
1997	132,777.15	133,315.19	0.82	0.60	-27.34
1998	130,425.27	130,673.59	0.84	0.59	-29.74
1999	106,729.50	106,812.28	0.76	0.49	-34.99
2000	111,843.78	111,885.17	0.68	0.51	-25.20
2001	146,775.65	146,858.43	0.56	0.66	17.05

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N ₂ O [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1	v. 1	v. 2.1	v. 1	
2002	148,510.55	148,758.88	0.49	0.66	33.18
2003	159,603.67	159,852.00	0.64	0.69	7.26
2004	166,488.45	166,736.78	0.78	0.72	-6.98
2005	158,874.43	147,445.46	0.71	0.41	-42.53
2006	165,171.85	152,873.92	0.60	0.39	-35.49
2007	168,479.35	154,460.18	0.61	0.41	-32.72
2008	189,512.29	170,771.19	0.51	0.45	-10.47
2009	197,256.59	176,905.58	3.55	0.45	-87.28
2010	180,443.43	163,776.86	1.12	0.41	-63.05
2011	187,041.64	167,030.11	1.81	0.43	-76.14
2012	196,379.27	183,573.51	0.63	0.47	-24.43

3.2.7.3.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

In order to improve the inventory quality:

- implementation requirements and future recommendations consistent with IPCC 2006.

The results will be incorporate in the next NGHGI submission.

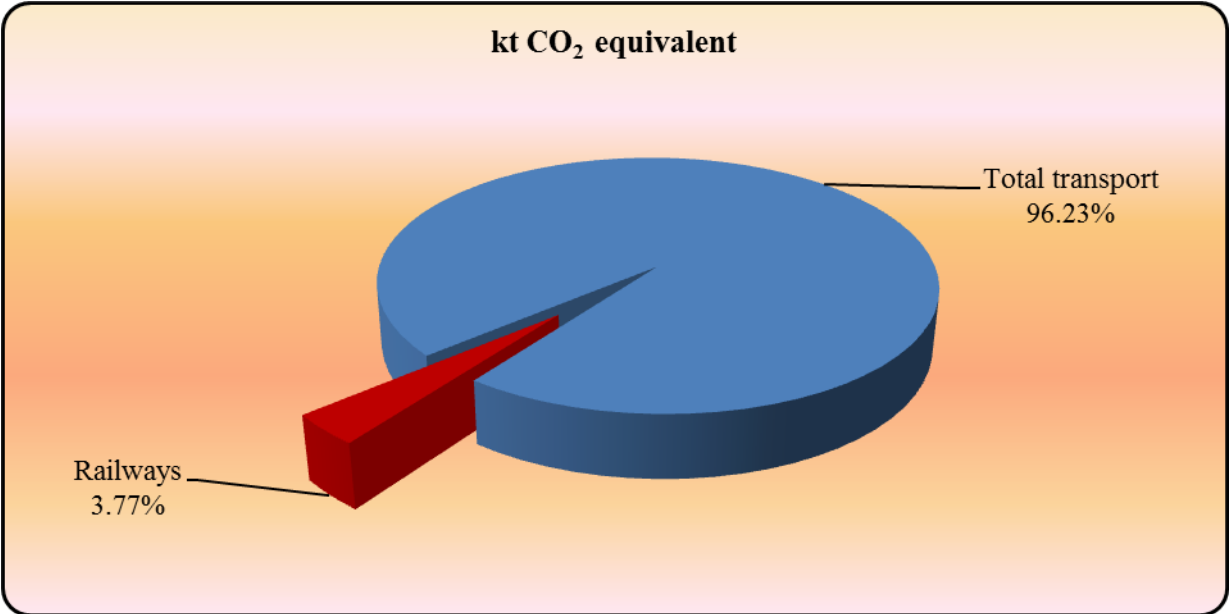
3.2.7.4 *Railways (CRF 1.A.3.c)*

3.2.7.4.1 *Category description*

The Railways Subsector includes emissions from following fuels: Diesel Oil, Gasoline, Residual Fuel Oil, Lignite - Brown coal, Sub-bituminous Coal, Other bituminous Coal, Coking Coal, Other Kerosene.

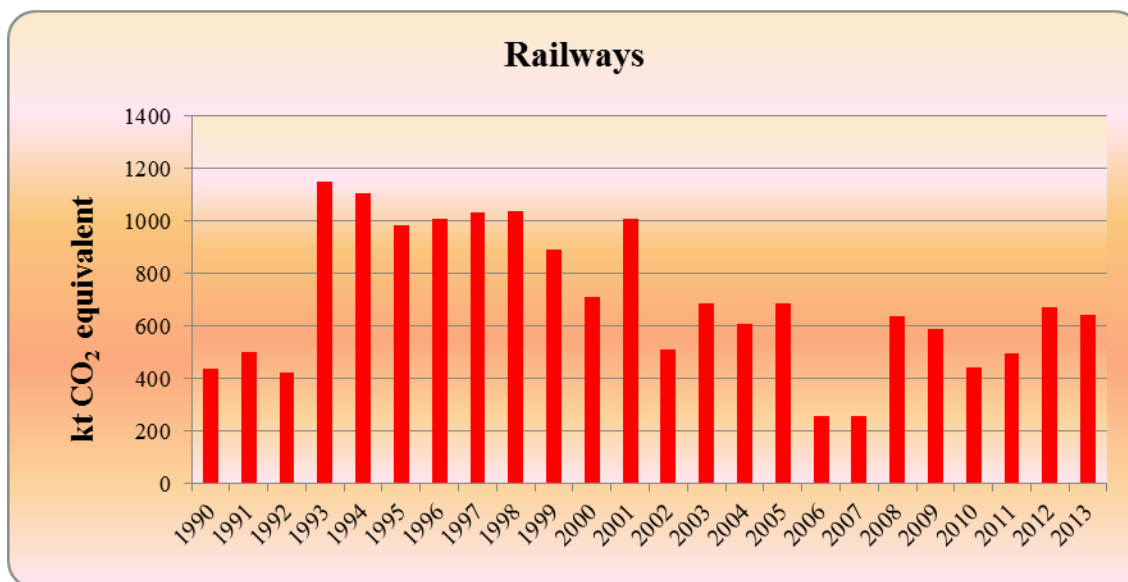
In the 2013 year the emissions from sub-sector Railways represents 3.77% of total emissions from the transport sector (15,088.28 kt CO₂ equivalent).

Figure 3.42 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 2011 year the emissions were increasing that could be explained by the the fuel consumption growth. For 2013 an decrease compared to the 2011 has been observed, due to the domestic trips number decrease.

Figure 3.43 GHG emissions Trend from 1A3c – Railways

3.2.7.4.2 Methodological issues

Methodology

The GHG emissions from Railways category are calculated according to 2006 IPCC and IPCC Good Practice Guidance.

The activity data are provided by IEA/Eurostat Questionnaire and values for emissions factors used are provided by 2006 IPCC Guidelines.

Tier 1 method

The direct GHG emissions are calculated according to IPCC2006 and calculation formula is presented in vol.2, Section 3.3.1.1.

The indirect GHG emissions are calculated according to IPCC1996 and EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009.

Tier 2 method

The CO₂ emissions, are estimated using country-specific and fuel-specific emission factors.

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 is used to calculate the CO₂ emissions from fuel combustion in the sectors.

The CO₂ emissions, are calculated according to 2006 IPCC Guidelines vol.2 (pag.3.33, section 3.3.1.1)

Emission factors

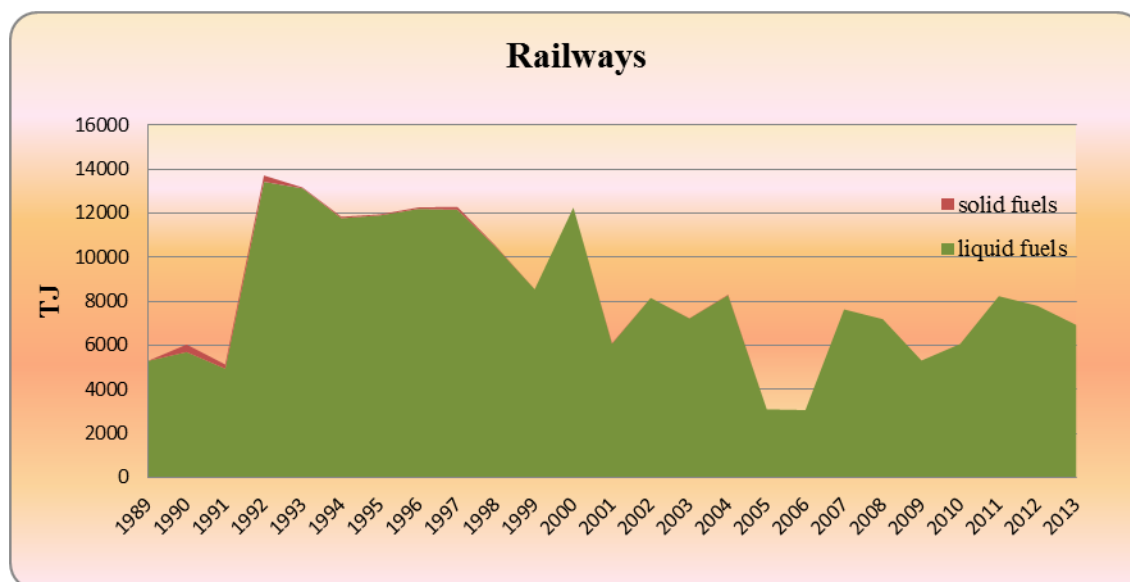
The values of CO₂ Emissions Factor is country specific.

The values of CH₄ and N₂O emission factors are default and in according to IPCC 2006 Guidelines.

Activity data

The activity data for Railways(1.A.3.c) are provided by IEA/Eurostat Questionnaire.

Figure 3.44 Fuel consumption for Railways -1.A.3.c



The solid fuels were used in small quantities until 2004 after which were used liquid fuels and electricity.

3.2.7.4.3 *Uncertainties and time-series consistency*

The uncertainty associated to the GHG emissions estimates are as follows:

CO₂

❖ *activity data:*

- Liquid: 5%
- Solid: 3%

❖ *emission 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

CH₄

❖ *activity data:*

- Liquid: 5%
- Solid: 3%

❖ *emission 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

N₂O❖ ***activity data:***

- Liquid: 5%
- Solid: 3%

❖ ***emission 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

3.2.7.4.4 Category-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 nonconformities 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 nonconformities noted were solved of the 2012 NGHGI; they are described in the Chapter

3.2.7.4.5 – 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 3.2.7.4.5 – 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 with national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 6.3.

3.2.7.4.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

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

- ✓ recalculations for the 1989 – 2012 period due to changes methodology, update of value of Net Calorific Value (NCV) and emission factors for fuel consumption.

Table 3.21 Effects of data changes on CO₂ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1.	v. 1.	v. 2.1.	v. 1.	
1989	5,290.32	5,290.37	383.7832192	390.0305582	1.6018
1990	6,032.73	6,032.78	445.1504504	451.8986538	1.4933
1991	5,126.12	5,127.04	376.2651145	381.8275142	1.4568
1992	13,704.61	13,845.56	1000.763327	1032.032151	3.0298
1993	13,161.23	13,345.52	955.8243335	991.8790545	3.6350
1994	11,830.66	11,914.26	859.8672735	882.8814562	2.6067
1995	11,940.29	12,137.68	867.3467338	903.3929536	3.9901
1996	12,236.03	12,470.37	888.6152677	928.8825567	4.3350

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014 v. 2.1.	NGHGI 2015 v. 1.	NGHGI 2014 v. 2.1.	NGHGI 2015 v. 1.	
	1997	12,283.97	12,473.50	894.087712	
1998	10,491.42	10,718.48	761.9539387	799.8091485	4.7330
1999	8,542.47	8,612.53	619.7517589	637.6899173	2.8130
2000	12,044.65	12,264.65	874.2542283	905.289459	3.4282
2001	6,095.70	6,153.73	442.7864537	456.4639608	2.9964
2002	8,064.38	8,300.19	585.0835778	617.9070119	5.3120
2003	7,224.20	7,353.37	524.3404195	547.2896477	4.1933
2004	8,298.45	8,302.49	602.5927735	612.8744507	1.6776
2005	2,887.79	3,122.74	209.7011144	231.604661	9.4573
2006	2,975.68	3,083.59	215.8829243	228.3357716	5.4537
2007	7,773.64	7,686.18	563.9461218	570.5211688	1.1525
2008	7,145.30	7,188.80	518.578643	528.2119155	1.8238
2009	5,359.23	5,309.92	388.8035224	394.1762877	1.3630
2010	6,032.34	6,059.00	437.6210782	444.0221358	1.4416
2011	8,187.00	8,230.95	587.9323022	600.2396666	2.0504
2012	7,789.06	7,789.68	567.2045765	572.9929577	1.0102

Table 3.22 Effects of data changes on CH₄ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH ₄ [kt]		Differences [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1.	NGHGI 2014 v. 2.1	NGHGI 2014 v. 1.	
	1989	5,290.32	5,290.37	0.0265	
1990	6,032.73	6,032.78	0.0319	0.0239	-33.2374
1991	5,126.12	5,127.04	0.0266	0.0207	-28.6255

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH ₄ [kt]		Differences [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1.	NGHGI 2014 v. 2.1	NGHGI 2014 v. 1.	
	1992	13,704.61	13,845.56	0.0699	
1993	13,161.23	13,345.52	0.0660	0.0600	-10.0297
1994	11,830.66	11,914.26	0.0594	0.0513	-15.7452
1995	11,940.29	12,137.68	0.0599	0.0553	-8.2954
1996	12,236.03	12,470.37	0.0613	0.0569	-7.6748
1997	12,283.97	12,473.50	0.0620	0.0562	-10.2622
1998	10,491.42	10,718.48	0.0526	0.0502	-4.7760
1999	8,542.47	8,612.53	0.0427	0.0375	-13.8087
2000	12,044.65	12,264.65	0.0602	0.0509	-18.3225
2001	6,095.70	6,153.73	0.0306	0.0270	-13.5360
2002	8,064.38	8,300.19	0.0403	0.0383	-5.2859
2003	7,224.20	7,353.37	0.0362	0.0338	-6.9324
2004	8,298.45	8,302.49	0.0416	0.0345	-20.6147
2005	2,887.79	3,122.74	0.0144	0.0134	-7.8202
2006	2,975.68	3,083.59	0.0149	0.0134	-11.1384
2007	7,773.64	7,686.18	0.0389	0.0334	-16.5182
2008	7,145.30	7,188.80	0.0357	0.0299	-19.3956
2009	5,359.23	5,309.92	0.0268	0.0221	-21.2692
2010	6,032.34	6,059.00	0.0302	0.0251	-20.0898
2011	8,187.00	8,230.95	0.0407	0.0342	-19.1147
2012	7,789.06	7,789.68	0.0389	0.0323	-20.4953

Table 3.23 Effects of data changes on N₂O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N ₂ O [kt]		Differences [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1	v. 1.	v. 2.1	v. 1.	
1989	5,290.32	5,290.37	0.0032	0.1505	97.8913
1990	6,032.73	6,032.78	0.0039	0.1623	97.6018
1991	5,126.12	5,127.04	0.0032	0.1407	97.7085
1992	13,704.61	13,845.56	0.0085	0.3831	97.7940
1993	13,161.23	13,345.52	0.0079	0.3756	97.8888
1994	11,830.66	11,914.26	0.0072	0.3352	97.8669
1995	11,940.29	12,137.68	0.0072	0.3393	97.8773
1996	12,236.03	12,470.37	0.0074	0.3479	97.8793
1997	12,283.97	12,473.50	0.0075	0.3467	97.8432
1998	10,491.42	10,718.48	0.0063	0.2993	97.8871
1999	8,542.47	8,612.53	0.0051	0.2441	97.9000
2000	12,044.65	12,264.65	0.0072	0.3422	97.8884
2001	6,095.70	6,153.73	0.0037	0.1737	97.8833
2002	8,064.38	8,300.19	0.0048	0.2311	97.9063
2003	7,224.20	7,353.37	0.0043	0.2067	97.9000
2004	8,298.45	8,302.49	0.0050	0.2366	97.8870
2005	2,887.79	3,122.74	0.0017	0.0815	97.8747
2006	2,975.68	3,083.59	0.0018	0.0862	97.9291
2007	7,773.64	7,686.18	0.0047	0.2175	97.8551
2008	7,145.30	7,188.80	0.0043	0.2038	97.8969
2009	5,359.23	5,309.92	0.0032	0.1514	97.8757
2010	6,032.34	6,059.00	0.0036	0.1726	97.9028
2011	8,187.00	8,230.95	0.0049	0.2354	97.9241
2012	7,789.06	7,789.68	0.0047	0.2220	97.8947

3.2.7.4.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

It is planned further investigations and co-operation with Ministry of Transport in order to have a fully correspondence concerning the quantities of the fuels.

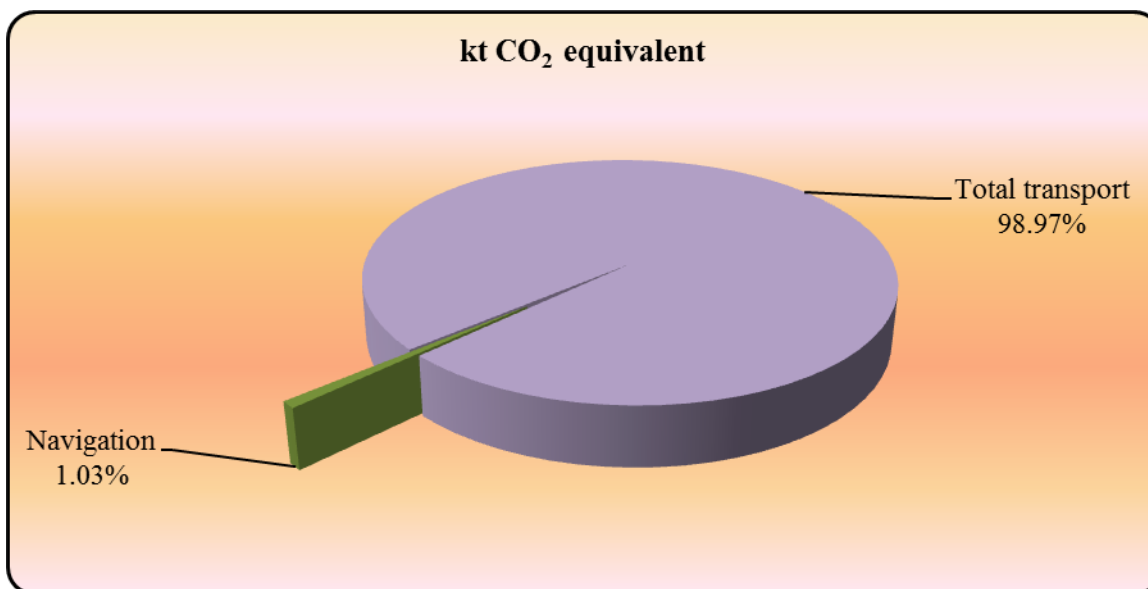
3.2.7.5 *Navigation(CRF 1.A.3.d)*

3.2.7.5.1 *Category description*

The Navigation sub-sector includes emissions from following fuels: Diesel Oil, Gasoline, Residual Fuel Oil, LPG.

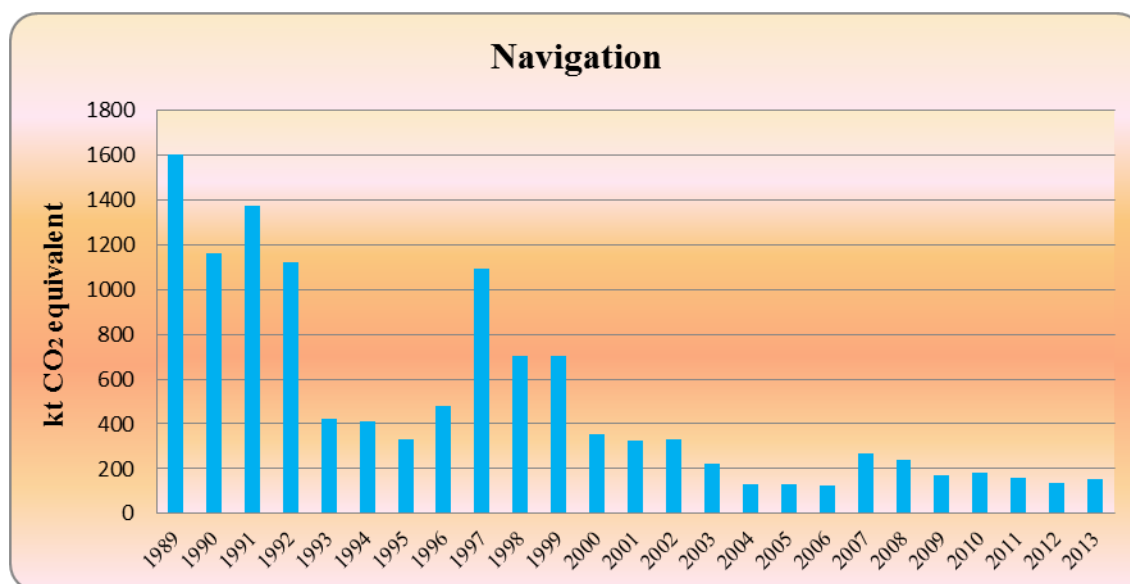
In the 2013 year the emissions from sub-sector Navigation represents 1.03% of total emissions from the transport sector (15,088.28 kt CO₂ equivalent).

Figure 3.45 *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 3.46 GHG emissions from 1A3a – Navigation



3.2.7.5.2 Methodological issues

The GHG emissions from Navigation category are calculated according to 2006 IPCC and IPCC Good Practice Guidance.

The activity data are provided by IEA/Eurostat Questionnaire and values for emissions factors used are provided by 2006 IPCC Guidelines

The Tier1 and Tier 2 method was used and are presented in section 3.2.7.4.2.

Emission Factors

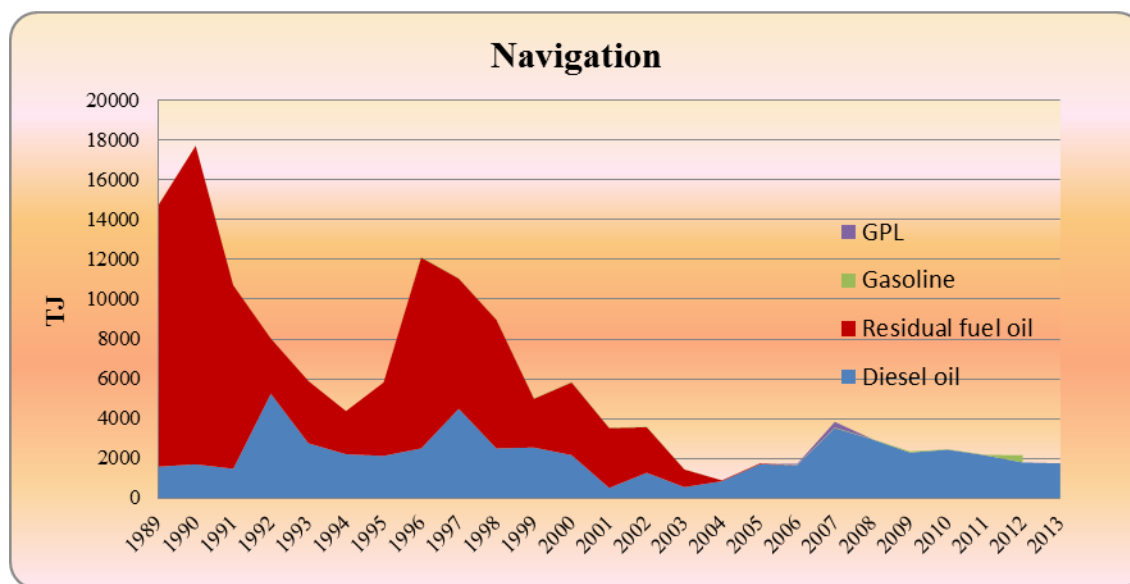
The values of CO₂ Emissions Factor is country specific.

The values of CH₄ and N₂O emission factors are default and in according to IPCC 2006 Guidelines.

Activity Data

The activity data for Navigation (1.A.3.d) are provided by IEA/Eurostat Questionnaire.

Figure 3.47 Fuel consumption 1.A.3.d Navigation 1989-2013



3.2.7.5.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

CO₂

❖ *activity data:*

- Residual Fuel Oil: 5.0 %
- Diesel oil: 5.0%
- Gasoline: 3.0%

❖ *emission factors:*

- Residual Fuel Oil: 3 %
- Diesel oil: 3.0%

- Gasoline:0.8%
- 5.83% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

CH₄

❖ *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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

N₂O

• *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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

3.2.7.5.4 Category-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 nonconformities 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 nonconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 3.2.7.5.5 – 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 3.2.7.5.5 – 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 with national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 6.3.

3.2.7.5.5 *Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend*

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

- ✓ recalculations for the 1989 – 2012 period due to changes methodology, update of value of Net Calorific Value (NCV) and emission factors for fuel consumption.

Table 3.24 Effects of data changes on CO₂ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014 v. 2.1.	NGHGI 2015 v. 1.	NGHGI 2014 v. 2.1.	NGHGI 2015 v. 1.	
	1989	20,435.54	20,435.5463	1,573.4654	
1990	14,850.67	14,850.6952	1,140.7630	1,151.3370	0.9184
1991	17,517.58	17,517.6029	1,348.2021	1,360.3934	0.8962
1992	14,508.13	14,508.1488	1,097.1368	1,109.3798	1.1036
1993	5,535.96	5,535.9739	415.0018	420.0726	1.2071
1994	5,341.22	5,341.2227	402.6236	407.2739	1.1418
1995	4,291.56	4,291.5612	321.8206	325.7423	1.2039
1996	6,199.40	6,199.3997	467.6002	472.9669	1.1347
1997	14,132.22	14,132.2593	1,071.5635	1,083.1594	1.0706
1998	9,068.65	9,068.6734	689.4959	696.7331	1.0387
1999	9,028.14	9,028.1583	686.1735	693.4065	1.0431
2000	4,632.81	4,632.8281	347.9060	352.0747	1.1840
2001	4,189.73	4,189.7523	321.5598	324.5617	0.9249
2002	4,308.83	4,308.8546	327.1049	330.5899	1.0542
2003	2,866.46	2,866.4897	218.9681	221.1309	0.9781
2004	1,745.96	1,745.9708	130.9121	132.5016	1.1996

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1.	v. 1.	v. 2.1.	v. 1.	
2005	1,738.87	1,738.8745	126.3503	128.3844	1.5844
2006	1,697.26	1,697.2650	123.3301	125.3146	1.5836
2007	3,537.17	3,585.3493	256.6139	264.5882	3.0138
2008	2,974.57	3,263.4993	215.7795	236.6164	8.8062
2009	2,306.13	2,306.0807	167.2906	171.1164	2.2358
2010	2,496.66	2,493.3947	181.0400	182.6449	0.8787
2011	2,168.08	2,167.1616	156.5036	158.0096	0.9531
2012	1,818.15	1,817.8570	132.3593	133.6694	0.9801

Table 3.25 Effects of data changes on CH₄ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH ₄ [kt]		Difference [%]
	NGHGI 2013	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1.	v. 1.	v. 2.1.	v. 1.	
1989	20,435.54	20,435.55	0.1022	0.1430	28.5715
1990	14,850.67	14,850.70	0.0743	0.1040	28.5716
1991	17,517.58	17,517.60	0.0876	0.1226	28.5715
1992	14,508.13	14,508.15	0.0725	0.1016	28.5715
1993	5,535.96	5,535.97	0.0277	0.0388	28.5715
1994	5,341.22	5,341.22	0.0267	0.0374	28.5715
1995	4,291.56	4,291.56	0.0215	0.0300	28.5715
1996	6,199.40	6,199.40	0.0310	0.0434	28.5715
1997	14,132.22	14,132.26	0.0707	0.0989	28.5716
1998	9,068.65	9,068.67	0.0453	0.0635	28.5716
1999	9,028.14	9,028.16	0.0451	0.0632	28.5716

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH ₄ [kt]		Difference [%]
	NGHGI 2013	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1.	v. 1.	v. 2.1.	v. 1.	
2000	4,632.81	4,632.83	0.0232	0.0324	28.5717
2001	4,189.73	4,189.75	0.0209	0.0293	28.5719
2002	4,308.83	4,308.85	0.0215	0.0302	28.5718
2003	2,866.46	2,866.49	0.0143	0.0201	28.5721
2004	1,745.96	1,745.97	0.0087	0.0122	28.5720
2005	1,738.87	1,738.87	0.0087	0.0122	28.5715
2006	1,697.26	1,697.26	0.0085	0.0119	28.5715
2007	3,537.17	3,585.35	0.0177	0.0248	28.6140
2008	2,974.57	3263.499321	0.0149	0.0209	28.8691
2009	2,306.13	2306.080731	0.0115	0.0161	28.5700
2010	2,496.66	2,493.39	0.0125	0.0175	28.4780
2011	2,168.08	2,167.16	0.0108	0.0152	28.5410
2012	1,818.15	1,817.86	0.0091	0.0127	28.5599

Table 3.26 Effects of data changes on N₂O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N ₂ O [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1	v. 1.	v. 2.2	v. 1.	
1989	20,435.54	20,435.55	0.0123	0.0409	70.0000
1990	14,850.67	14,850.70	0.0089	0.0297	70.0001
1991	17,517.58	17,517.60	0.0105	0.0350	70.0000
1992	14,508.13	14,508.15	0.0087	0.0290	70.0000
1993	5,535.96	5,535.97	0.0033	0.0111	70.0001
1994	5,341.22	5,341.22	0.0032	0.0107	70.0000

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N ₂ O [kt]		Difference [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1.	NGHGI 2014 v. 2.2	NGHGI 2015 v. 1.	
	1995	4,291.56	4,291.56	0.0026	
1996	6,199.40	6,199.40	0.0037	0.0124	70.0000
1997	14,132.22	14,132.26	0.0085	0.0283	70.0001
1998	9,068.65	9,068.67	0.0054	0.0181	70.0001
1999	9,028.14	9,028.16	0.0054	0.0181	70.0001
2000	4,632.81	4,632.83	0.0028	0.0093	70.0001
2001	4,189.73	4,189.75	0.0025	0.0084	70.0002
2002	4,308.83	4,308.85	0.0026	0.0086	70.0002
2003	2,866.46	2,866.49	0.0017	0.0057	70.0003
2004	1,745.96	1,745.97	0.0010	0.0035	70.0002
2005	1,738.87	1,738.87	0.0010	0.0035	70.0000
2006	1,697.26	1,697.26	0.0010	0.0034	70.0000
2007	3,537.17	3,585.35	0.0021	0.0071	70.0208
2008	2,974.57	3263.499321	0.0018	0.0060	70.1456
2009	2,306.13	2306.080731	0.0014	0.0046	69.9994
2010	2,496.66	2493.394735	0.0015	0.0050	69.9607
2011	2,168.08	2167.161636	0.0013	0.0043	69.9872
2012	1,818.15	1817.856981	0.0011	0.0036	69.9952

3.2.7.5.6 *Category-specific planned improvements, if applicable, including tracking of those identified in 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.

3.2.7.6 Other transportation- (CRF 1.A.3.e)

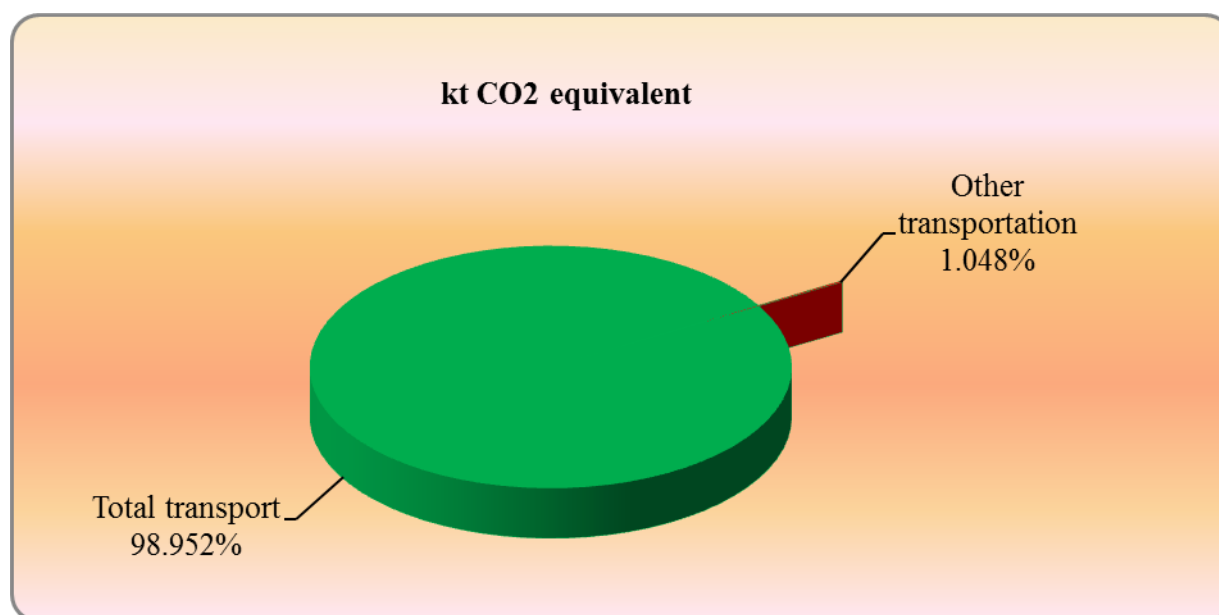
3.2.7.6.1 Category description

This sub-sector includes Pipeline Transport (1A.3.e.i) and Off-road Transport (1.A.3.e.ii).

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).

In the 2013 year the emissions from sub-sector Other Transportation represents 1.048% of total emissions from the transport sector (15,088.28 kt CO₂ equivalent).

Figure 3.48 The contribution of Other transportation emissions in total GHG emissions from Transport subsector



3.2.7.6.2 Methodological issues

The GHG emissions from Other Transportation are calculated according to 2006 IPCC Guidelines and IPCC good practice guidance.

The Tier 1 and Tier 2 method was used and are presented in the section 3.2.7.4.2.

Emission Factors

The CO₂ emission factor is country specific and is presented in section 3.2.7.4.2.

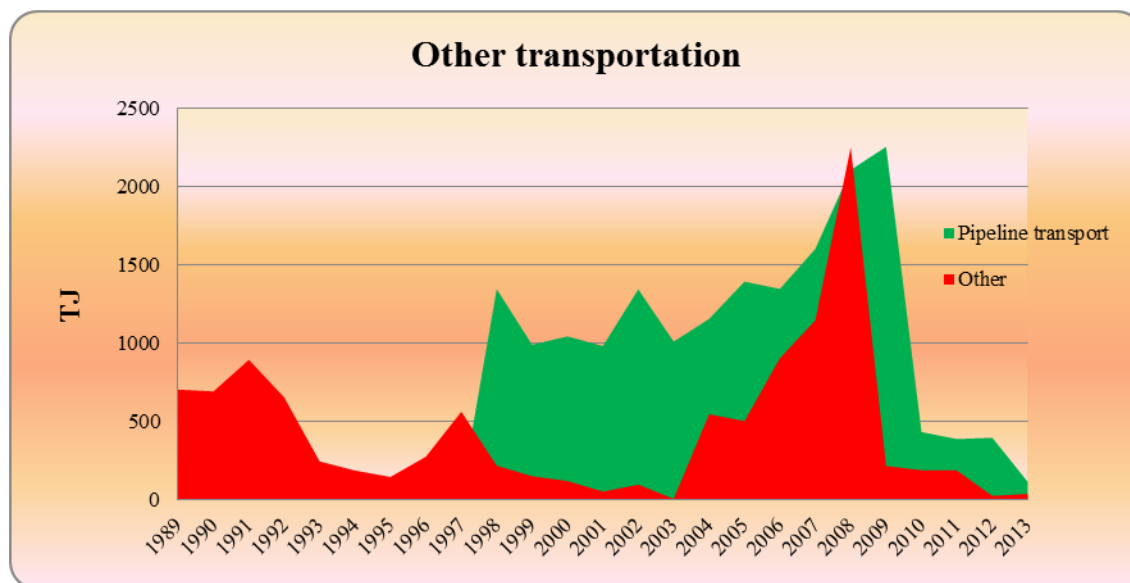
The values of CH₄, N₂O, NO_x, emission factors are default and in accordance with 2006 IPCC Guidelines.

The values of CO, NMVOC, SO₂ emission factors are default and in accordance with 2006 IPCC Guidelines, IPCC 1996 Guidelines and EMEP/EEA guidebook 2009.

Activity Data

The activity data for Other transportation (1.A.3.e) are provided by IEA/Eurostat Questionnaire.

Figure 3.49 Fuel consumption 1.A.3.c Other transportation 1989 -2013



3.2.7.6.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

CO₂

- **activity data:**
 - Liquid: 3.0%
 - Solid: 3.0%
 - Gaseous: 3.0%
 - Biomass: 3.0%
- **emission factors:**
 - Liquid: 3%
 - Solid: 4.0%
 - 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

CH₄

- **activity data:**
 - Liquid: 3.0%
 - Solid: 3.0%
 - Gaseous: 3.0%
 - Biomass: 3.0%
- **emission factors:**
 - Liquid: 50%
 - Solid: 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

N₂O

- ***activity data:***
 - Liquid: 3.0%
 - Solid: 3.0%
 - Gaseous: 3.0%
 - Biomass: 3.0%
- ***emision factors:***
 - Liquid: 50%
 - Solid: 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 Annex6.3.

3.2.7.6.4 Category-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 3.2.7.6.5 – 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 3.2.7.6.5 – 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 with national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 6.3.

3.2.7.6.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

- ✓ recalculations for the 1989 – 2012 period due to changes methodology, update of value of Net Calorific Value (NCV) and emission factors for fuel consumption.

Table 3.27 Effects of data changes on CO₂ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014 v. 2.1.	NGHGI 2015 v. 1.	NGHGI 2014 v. 2.1.	NGHGI 2015 v. 1.	
1989	124.256	710.373	8.810	67.508	86.949
1990	700.242	700.386	10.865	65.686	83.458

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO ₂ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1.	v. 1.	v. 2.1.	v. 1.	
1991	900.302	900.423	9.097	86.398	89.471
1992	798.486	658.566	29.415	44.505	33.907
1993	477.302	293.474	16.962	19.186	11.591
1994	317.288	234.318	12.123	15.905	23.777
1995	392.128	195.133	9.828	13.089	24.913
1996	706.424	495.531	31.473	34.220	8.028
1997	798.478	609.716	26.032	48.585	46.420
1998	1,937.350	1,566.225	98.072	90.375	-8.516
1999	1,315.277	1,145.126	72.693	67.430	-7.806
2000	1,295.747	1,167.090	71.550	65.261	-9.636
2001	1,290.433	1,038.875	70.448	58.390	-20.652
2002	1,745.460	1,443.557	89.527	81.456	-9.908
2003	1,251.937	1,020.550	63.689	58.199	-9.434
2004	1,822.504	1,704.364	111.839	106.319	-5.192
2005	2,080.860	1,898.188	121.330	113.252	-7.133
2006	2,421.796	2,252.559	147.263	140.059	-5.144
2007	2,979.250	2,746.988	179.278	169.795	-5.585
2008	4,586.520	4,353.768	288.136	278.275	-3.544
2009	2,724.654	2,470.514	153.778	140.321	-9.590
2010	685.619	626.435	41.033	37.827	-8.473
2011	636.539	580.623	38.266	35.296	-8.415
2012	472.399	426.792	26.636	24.172	-10.194

Table 3.28 Effects of data changes on CH₄ emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH ₄ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1.	v. 1.	v. 2.1.	v. 1.	
1989	124.256	710.373	0.0024	0.0216	88.820
1990	700.242	700.386	0.0194	0.0213	9.050
1991	900.302	900.423	0.0256	0.0273	5.923
1992	798.486	658.566	0.0125	0.0077	-62.901
1993	477.302	293.474	0.0086	0.0035	-145.091
1994	317.288	234.318	0.0050	0.0025	-99.575
1995	392.128	195.133	0.0077	0.0015	-430.392
1996	706.424	495.531	0.0110	0.0059	-85.763
1997	798.478	609.716	0.0180	0.0153	-17.601
1998	1937.350	1566.225	0.0181	0.0076	-136.556
1999	1315.277	1145.126	0.0106	0.0066	-61.113
2000	1295.747	1167.090	0.0075	0.0026	-189.230
2001	1290.433	1038.875	0.0087	0.0028	-207.029
2002	1745.460	1443.557	0.0140	0.0046	-202.099
2003	1251.937	1020.550	0.0096	0.0019	-418.671
2004	1822.504	1704.364	0.0117	0.0089	-31.425
2005	2080.860	1898.188	0.0180	0.0168	-7.236
2006	2421.796	2252.559	0.0263	0.0315	16.490
2007	2979.250	2746.988	0.0328	0.0382	14.017
2008	4586.520	4353.768	0.0561	0.0751	25.313
2009	2724.654	2470.514	0.0164	0.0082	-98.332
2010	685.619	626.435	0.0065	0.0068	4.356
2011	636.539	580.623	0.0062	0.0067	6.464
2012	472.399	426.792	0.0028	0.0013	-112.182

Table 3.29 Effects of data changes on N₂O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N ₂ O [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v. 2.1.	v. 1.	v. 2.1.	v. 1.	
1989	124.256	710.373	0.0001	0.0027	97.275
1990	700.242	700.386	0.0023	0.0027	14.653
1991	900.302	900.423	0.0032	0.0035	9.384
1992	798.486	658.566	0.0013	0.0009	-37.461
1993	477.302	293.474	0.0009	0.0004	-113.813
1994	317.288	234.318	0.0005	0.0003	-56.095
1995	392.128	195.133	0.0010	0.0002	-302.863
1996	706.424	495.531	0.0011	0.0009	-29.296
1997	798.478	609.716	0.0018	0.0018	-2.437
1998	1937.350	1566.225	0.0012	0.0008	-47.833
1999	1315.277	1145.126	0.0005	0.0008	30.805
2000	1295.747	1167.090	0.0002	0.0003	20.933
2001	1290.433	1038.875	0.0004	0.0003	-50.441
2002	1745.460	1443.557	0.0008	0.0005	-79.279
2003	1251.937	1020.550	0.0007	0.0003	-125.026
2004	1822.504	1704.364	0.0005	0.0024	77.491
2005	2080.860	1898.188	0.0006	0.0018	68.083
2006	2421.796	2252.559	0.0008	0.0031	73.867
2007	2979.250	2746.988	0.0011	0.0039	71.600
2008	4586.520	4353.768	0.0016	0.0074	78.445
2009	2724.654	2470.514	0.0004	0.0010	58.721
2010	685.619	626.435	0.0002	0.0007	74.145
2011	636.539	580.623	0.0002	0.0006	73.989
2012	472.399	426.792	0.0001	0.0001	49.648

3.2.7.6.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

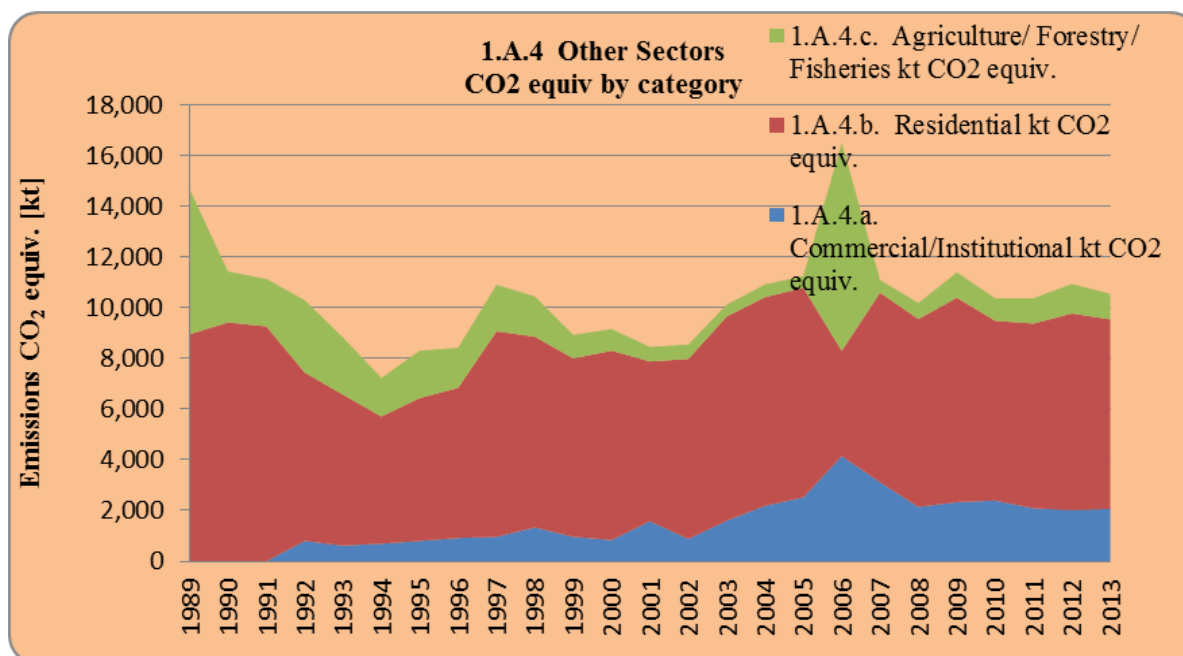
It is planned further co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.

3.2.8 *Fuel combustion, Other Sectors (CRF 1.A.4.)*

3.2.8.1 *Category description*

CRF category 1.A.4. Other sectors, as result of T1 approach is a CO₂ key category by gaseous fuel – level and trend, excluding and including LULUCF, CO₂ key category by solid fuel - trend, excluding and including LULUCF, CO₂ key category by liquid fuels – level, excluding and including LULUCF and is a CH₄ key category by biomass – level and trend, excluding and including LULUCF.

Figure 3.50 GHG emissions from 1.A.4. – Other, by category



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

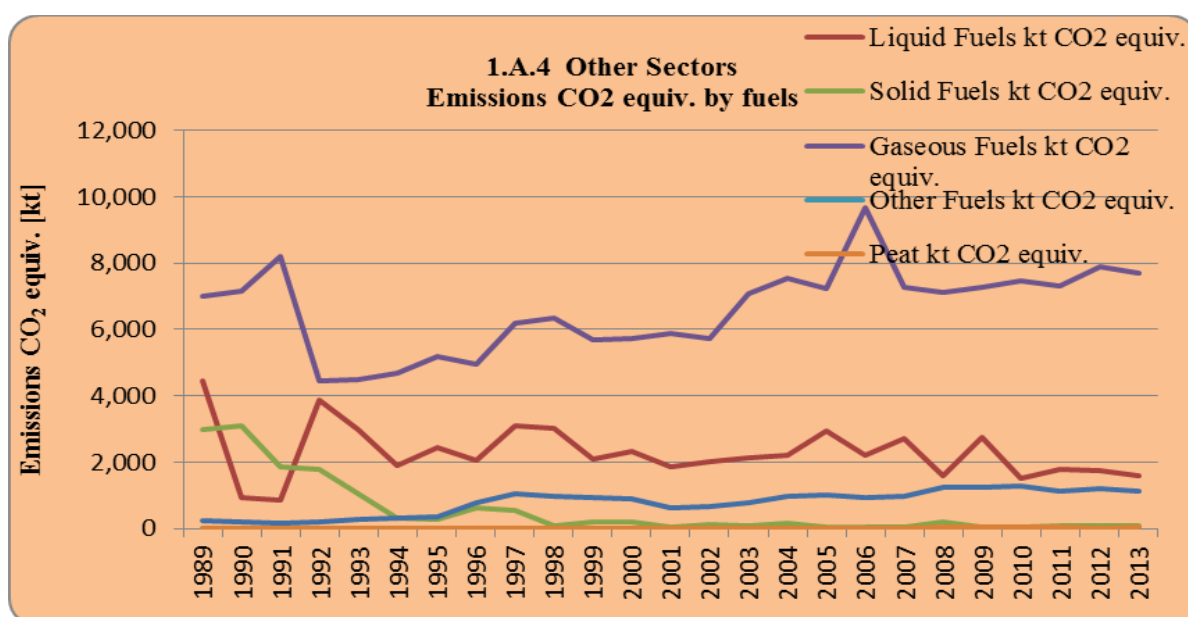
- ❖ Commercial/Institutional;
- ❖ Residential;
- ❖ Agriculture/ Forestry/ Fisheries.

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.

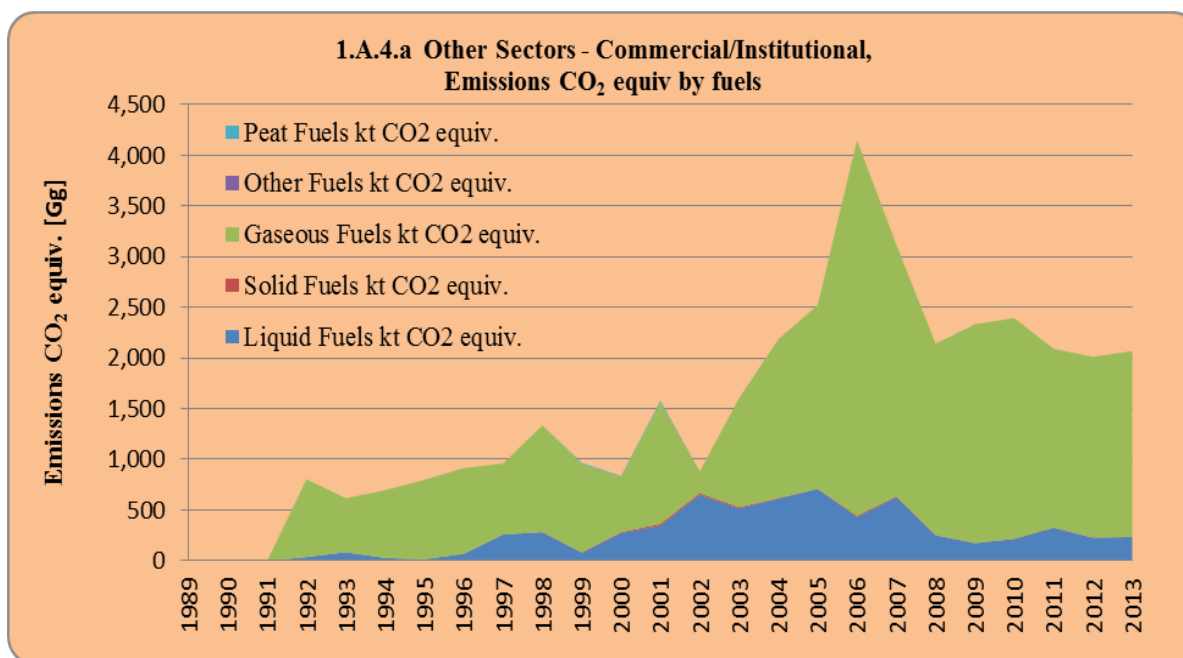
The agriculture/forestry/fishing category includes consumptions recorded in the following activity fields: agriculture, forestry, logging, hunting, fishing, and fuel consumption of the fishing ships.

Figure 3.51 GHG emissions from 1.A.4. – Other, by fuels



3.2.8.2 Fuel combustion, Other Sectors – Commercial/Institutional (CRF 1.A.4.a)

3.2.8.2.1 Category description

Figure 3.52 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 19.6%, current year, 2013.

The reporting of combustion on this category started with the 1992 year. The contribution of this category is about 2,067.31 kt CO₂ equiv., in 2013.

It is observed a main contribution of the natural gas usage as fuel in this activity category, mostly on the period 2003 - 2012.

3.2.8.2.2 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.

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 3.2.4.2 for more details.

3.2.8.2.3 Uncertainties and time-series consistency

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period. See the Chapter 3.2.4.3 for more details.

3.2.8.2.4 Category-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 3.2.4.4 for more details.

3.2.8.2.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

No recalculations were performed due to the activity data changes. For more details and effect of the activity data changes on the emissions estimation, see the chapter 3.2.4.5.

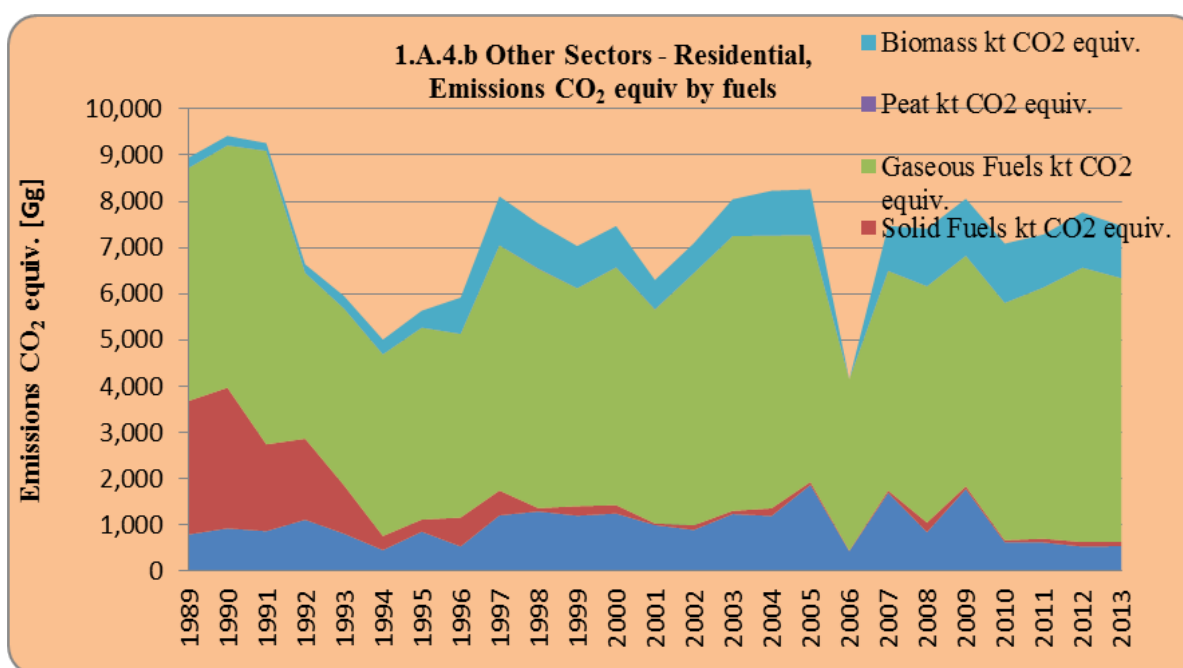
3.2.8.2.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

See the Chapter 3.2.4.6 for more details.

3.2.8.3 Fuel combustion, Other Sectors – Residential (CRF 1.A.4.b)

3.2.8.3.1 Category description

Figure 3.53 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 70.84%, current year, 2013. The contribution of this category is about 7,470.75 kt CO₂ equiv., in 2013.

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 (CH₄ and N₂O accounted).

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 on EU-ETS analyze, Tier 2 methodology is 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 3.2.4.2 for more details.

3.2.8.3.3 *Uncertainties and time-series consistency*

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period. See the chapter 3.2.4.3 for more details.

3.2.8.3.4 *Category-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 3.2.4.4 for more details.

3.2.8.3.5 *Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend*

No recalculations were performed due to the activity data changes. For more details and effect of the activity data changes on the emissions estimation, see the chapter 3.2.4.5.

3.2.8.3.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

See the Chapter 3.2.4.6 for more details.

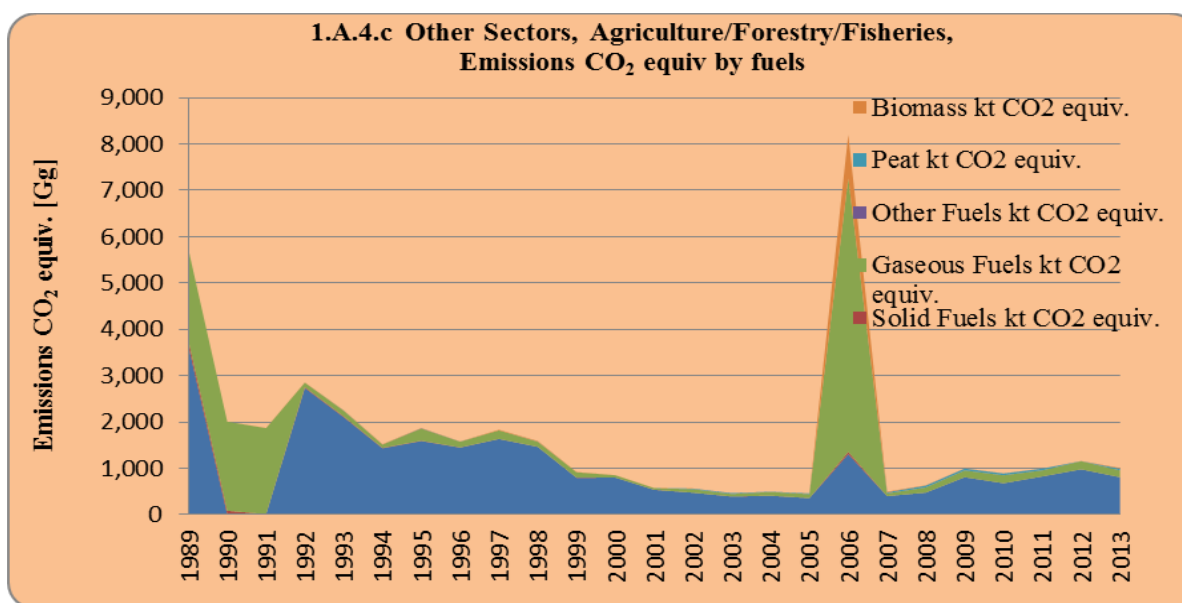
3.2.8.4 *Fuel combustion, Other Sectors – Agriculture/ Forestry/ Fisheries (CRF 1.A.4.c)*

3.2.8.4.1 *Category description*

The information provided by the National Institute for Statistics related to the agriculture category was that no available collected data exist to report stationary data separated from mobile. Also, the consumption data, associated to the fishing activity will be reported starting with the reference year 2013 – this is the first year for which the number of the reporting units is representative for the fishing activity. Data or estimation methodology are not available for the previous years.

See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.4 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.54 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 9.56%, current year, 2013. The contribution of this category is about 1,008.24 kt CO₂ equiv., in 2013.

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 2011 and 2012 years were good years for the agriculture sector.

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 on EU-ETS analyze, Tier 2 methodology is 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 3.2.4.2 for more details.

3.2.8.4.3 Uncertainties and time-series consistency

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period. See the chapter 3.2.4.3 for more details.

3.2.8.4.4 Category-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 3.2.4.4 for more details.

3.2.8.4.5 Category-specific recalculation, if applicable, including changes made in response to the review process and impact on emission trend

No recalculations were performed due to the activity data changes. For more details and effect of the activity data changes on the emissions estimation, see the chapter 3.2.4.5.

3.2.8.4.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

See the chapter 3.2.4.6 for more details.

3.2.9 Fuel combustion, Other Sectors (Not specified elsewhere) - Stationary (CRF 1.A.5.a)

3.2.9.1 Category description

This category accounts the fuel consumption reported through the Energy Balances in the category "Other sectors - Not elsewhere specified (Other)", EUROSTAT/ IEA/ UNECE questionnaires format. According to the Energy Balances IEA Statistics manual, in the above Energy Balances category the military consumption shall be reported.

The National Institute for Statistics clarified that the fuel consumptions reported by military and internal affairs institutions are collected and associated to the NACE Rev. 2 corresponding activities. 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. See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.4 Source category - Fuel combustion (CRF sector 1.A.).

3.2.9.2 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.

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 3.2.4.2 for more details.

3.2.9.3 Uncertainties and time-series consistency

The activity data, EF and methodology used in estimating GHG emissions are consistent for the entire period. See the chapter 3.2.4.3 for more details.

3.2.9.4 Category-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 3.2.4.4 for more details.

3.2.9.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

Liquid Fuels

Activity data

- Residual fuel oil: Non-specified (Other), 2005 year - Energy Balance activity data correction. For more details and effect of the activity data changes on the emission estimations, see the Chapter 3.2.4.5.

3.2.9.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

See the Chapter 3.2.4.6 for more details.

3.3 Fugitive emissions from solid fuels and oil and natural gas and other emissions from energy production (CRF 1.B)

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:

- ❖ CH₄ emissions from Solid Fuels;
- ❖ CH₄, CO₂ and N₂O emissions from Oil and Natural Gas.

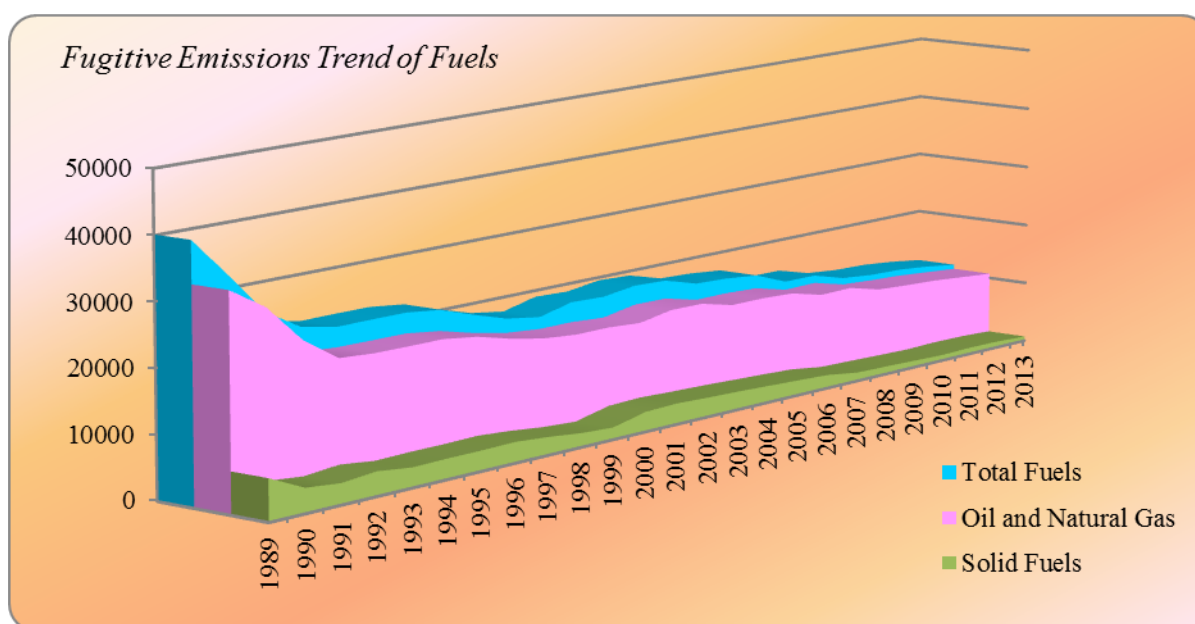
In 2013 GHG emissions from the Fugitive Emissions from Fuels Subsector accounted for 11,450.02 kt CO₂ equivalent, which represent 10.32% of the total national GHG emissions in this year. In the base year, the total GHG emissions from the Fugitive Emissions from Fuels Subsector amounted to 40,173.28 kt CO₂ equivalent, which represent 13.48% of the total national GHG emissions in this year (see in the table below).

Table 3.30 The contribution of Fugitive Emissions from Fuels Subsector emissions to the total GHG in Romania, for 1989–2013 period

Year	Total GHG emissions (excl. LULUCF) [kt CO₂ equiv.]	GHG emissions from Fugitive Emissions [kt CO₂ equiv.]	Contribution of Fugitive Emissions in total GHG emissions [%]
1989	298,018.54	40,173.28	13.48
1990	253,317.98	33,861.81	13.37
1991	207,053.32	27,267.63	13.17
1992	189,445.14	23,880.95	12.61
1993	180,869.15	22,790.63	12.60
1994	176,841.41	22,824.72	12.91
1995	183,698.01	22,788.09	12.41
1996	186,091.91	22,119.64	11.89
1997	174,222.63	20,254.54	11.63
1998	154,624.74	18,550.95	12.00
1999	135,890.86	17,699.26	13.02
2000	141,141.57	18,989.05	13.45
2001	145,667.23	18,776.50	12.89
2002	145,929.94	19,522.10	13.38
2003	151,134.43	19,278.11	12.76
2004	149,948.26	17,737.58	11.83
2005	147,373.53	17,503.44	11.88
2006	148,660.74	16,976.78	11.42
2007	146,874.89	14,880.94	10.13
2008	141,966.63	14,837.28	10.45
2009	124,248.91	13,358.76	10.75
2010	117,705.63	12,838.54	10.91
2011	122,565.56	12,685.15	10.35
2012	120,977.12	12,171.23	10.06

Year	Total GHG emissions (excl. LULUCF) [kt CO ₂ equiv.]	GHG emissions from Fugitive Emissions [kt CO ₂ equiv.]	Contribution of Fugitive Emissions in total GHG emissions [%]
2013	110,929.05	11,450.02	10.32

Figure 3.55 Total GHG emissions from Fugitive Emissions from Fuels Subsector for 1989–2013 period



Mostly GHG emissions are resulting from Oil and Natural Gas category, responsible for 93.89 % of total GHG emissions from Fugitive Emissions subsector, Solid Fuels category contributes with 6.11%.

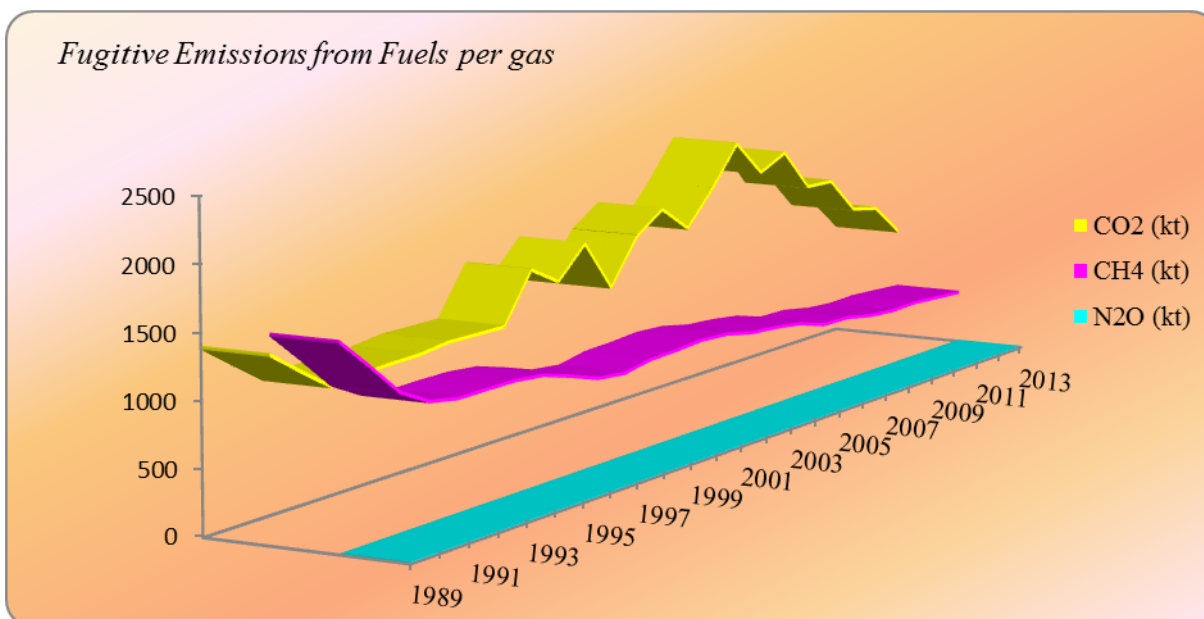
GHG emissions from *Oil and Natural Gas* and *Solid Fuels* are key category sources: by level and trend for CH₄ emissions from Solid Fuels source category, level and trend for CH₄ and CO₂ emissions from *Oil and Natural Gas* source category, from *Oil* sub-source category, level and trend for CH₄ emissions from *Oil and Natural Gas* source category, from *Natural Gas* sub-source category, level and trend for CH₄ from *Venting and Flaring* sub-source category and from *Other* sub-source category (see Table 3.36).

Table 3.31 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 – 2013 period

Year	Total emissions from Fugitive Emissions from Fuels Subsector [kt CO ₂ equiv.]	CH ₄ emissions		CO ₂ emissions		N ₂ O emissions	
		kt CO ₂ equiv.	%	kt CO ₂	%	kt CO ₂ equiv.	%
1989	40,173.28	38,769.33	96.51	1,399.89	3.48	4.07	0.01
1990	33,861.81	32,645.27	96.41	1,213.08	3.58	3.46	0.01
1991	27,267.63	26,229.77	96.19	1,034.90	3.80	2.97	0.01
1992	23,880.95	22,820.08	95.56	1,057.82	4.43	3.05	0.01
1993	22,790.63	21,716.81	95.29	1,070.73	4.70	3.09	0.01
1994	22,824.72	21,747.73	95.28	1,073.89	4.70	3.10	0.01
1995	22,788.09	21,681.31	95.14	1,103.70	4.84	3.08	0.01
1996	22,119.64	21,019.36	95.03	1,097.24	4.96	3.03	0.01
1997	20,254.54	19,158.89	94.59	1,092.67	5.39	2.98	0.01
1998	18,550.95	17,075.63	92.05	1,472.43	7.94	2.90	0.02
1999	17,699.26	16,376.57	92.53	1,319.86	7.46	2.82	0.02
2000	18,989.05	17,429.63	91.79	1,556.63	8.20	2.79	0.01
2001	18,776.50	17,620.92	93.85	1,152.82	6.14	2.76	0.01
2002	19,522.10	18,017.13	92.29	1,501.41	7.69	3.56	0.02
2003	19,278.11	17,617.65	91.39	1,657.00	8.60	3.46	0.02
2004	17,737.58	16,286.74	91.82	1,448.30	8.17	2.54	0.01
2005	17,503.44	15,787.31	90.20	1,713.52	9.79	2.61	0.01
2006	16,976.78	14,951.36	88.07	2,022.75	11.91	2.67	0.02
2007	14,880.94	13,143.34	88.32	1,735.38	11.66	2.22	0.01
2008	14,837.28	12,993.47	87.57	1,841.72	12.41	2.10	0.01
2009	13,358.76	11,849.89	88.71	1,506.89	11.28	1.98	0.01
2010	12,838.54	11,342.02	88.34	1,494.63	11.64	1.89	0.01

Year	Total emissions from Fugitive Emissions from Fuels Subsector [kt CO ₂ equiv.]	CH ₄ emissions		CO ₂ emissions		N ₂ O emissions	
		kt CO ₂ equiv.	%	kt CO ₂	%	kt CO ₂ equiv.	%
2011	12,685.15	11,478.83	90.49	1,204.44	9.49	1.87	0.01
2012	12,171.23	11,016.28	90.51	1,153.18	9.47	1.77	0.01
2013	11,450.02	10,546.98	92.11	901.22	7.87	1.81	0.02

Figure 3.56 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.

3.3.1 *Solid Fuels (CRF 1.B.1)*

3.3.1.1 *Category description*

The source category "Solid Fuels" consists of three sub-source categories:

- ❖ "Coal Mining and Handling", "Solid Fuel Transformation" and "Other".

3.3.1.1.1 *Coal mining and handling (CRF 1.B.1.a)*

- ❖ Emission: CH₄;
- ❖ Key source: Yes.

The sub-source category "Coal Mining and Handling" is a key source of CH₄ 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 1990-2013 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.

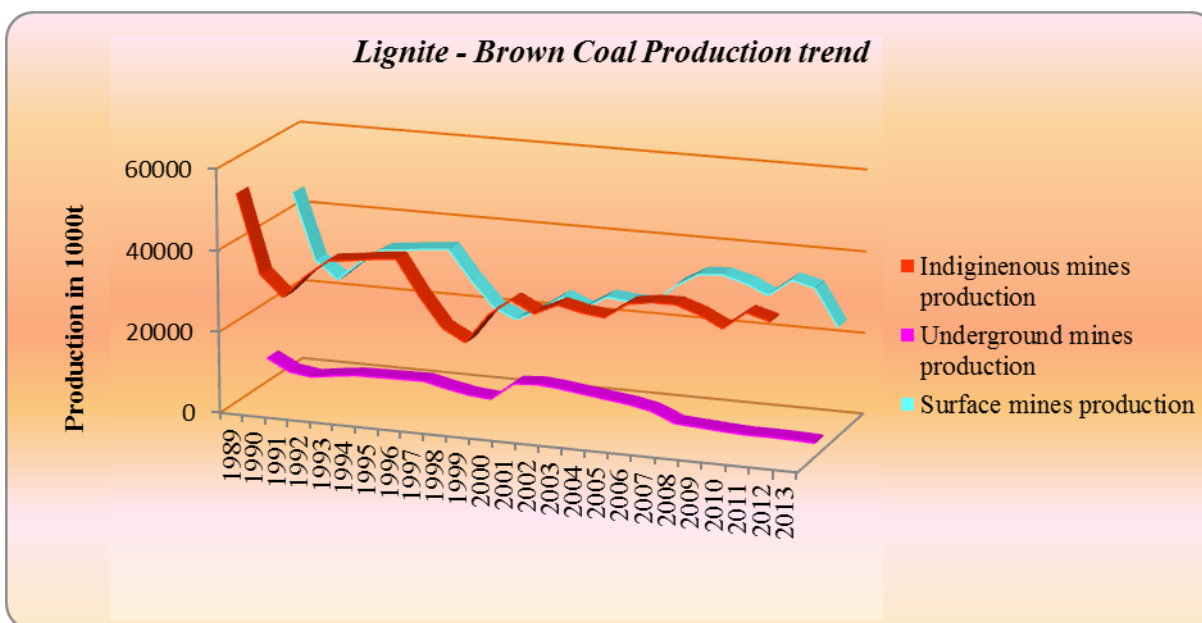
The activity data include:

- ❖ 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 1989-2013 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 3.57 Lignite – Brown Coal Production trend



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 2011–2013 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).

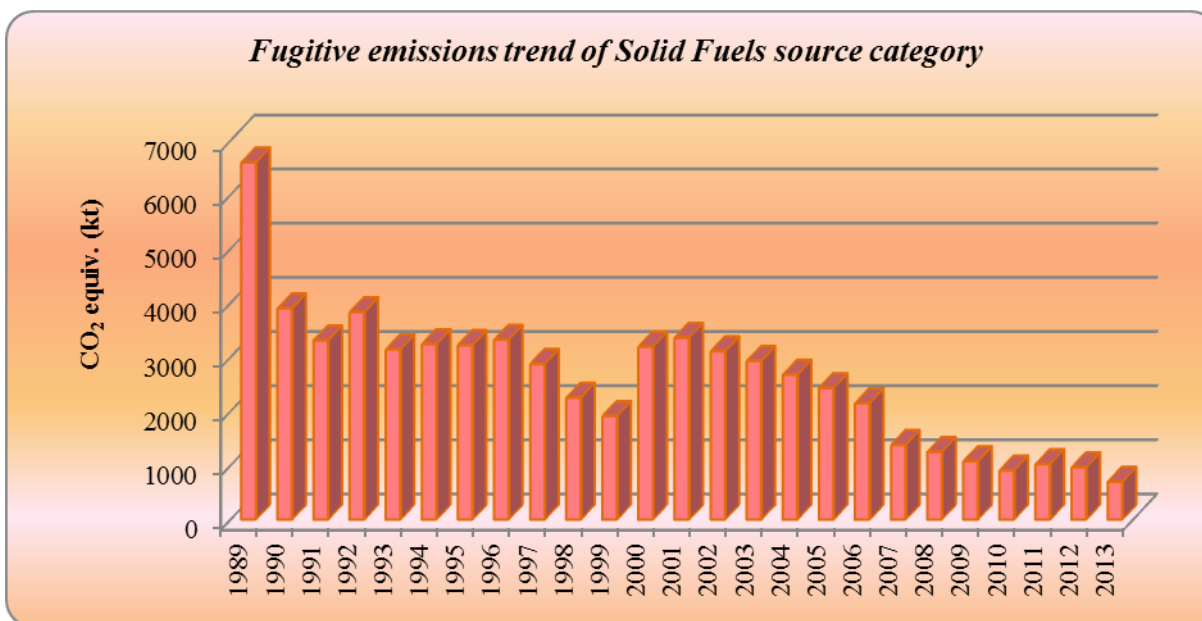
From the 2007-2010 period the emissions started to decrease again after the beginning of global financial crisis which conducted to economic contraction.

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).

In 2013 continued the decrease of coal resources (-1.786 million toe). (Source – Romanian National Institute for Statistics).

The trend of the CH₄ emissions from solid fuels category is shown in the figure below.

Figure 3.58 Fugitive Emissions of CH₄ from Solid Fuels (1.B.1)

3.3.1.2 Methodological issues

3.3.1.2.1 Coal mining and handling (CRF 1.B.1.a)

- ❖ Emission: CH₄;
- ❖ Key source: Yes.

Underground mines category:

- ❖ *Mining activities ((1.B.1.a.i.1);*
- ❖ *Post mining activities (1.B.1.a.i.2.)*
- ❖ *Abandoned Underground Mines (1.B.1.a.i.3.).*

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 *Equation 4.1.1* from 2006 IPCC GL, volume 2, chapter 4.1.3, page 4.9, where:

- ❖ *Default Emission Factor:* from 2006 IPCC GL, volume 2, chapter 4.1.3.2, page 4.12;

- ❖ *The default value of 18 m³/t* (average CH₄ Emission Factor) according to 2006 IPCC GL for “Mining Underground Coal Production” has been used.
- ❖ *The default value of 2.5 m³/t* (average CH₄ Emission Factor) according to 2006 IPCC GL for “Post Mining Underground Coal Production” has been used;
- ❖ *Conversion Factor*: this is the density of CH₄ and converts volume of CH₄ to mass of CH₄. The density is taken at 20°C and 1 atmosphere pressure and has a value of 0.67 Gg/10⁶ m³ (0.00000067 Gg/m³).

Activity Data

1989_BAL_Romania have been used for 1989, and IEA/ Eurostat Questionnaire 2013 - for entire 1990-2013 time series have been used.

- ❖ *Underground Coal Production (Mt)*: IEA/Eurostat Questionnaire 2013 - 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 *Equation 4.1.7*. from 2006 IPCC GL, volume 2, chapter 4.1.4., page 4.18, where:

- ❖ *Default Emission Factor*: from 2006 IPCC GL, volume 2, chapter 4.1.3.2, page 4.18;
- ❖ *The default value of 1.2 m³/t* (average CH₄ Emission Factor) according to 2006 IPCC GL for “Surface Coal Production” has been used;
- ❖ *The default value of 0.1 m³/t* (average CH₄ Emission Factor) according to 2006 IPCC GL for “Post mining Surface Coal Production” has been used;

- ❖ *Conversion Factor*: this is the density of CH₄ and converts volume of CH₄ to mass of CH₄. The density is taken at 20°C and 1 atmosphere pressure and has a value of 0.67 Gg/10⁶ m³ (0.00000067 Gg/m³).

Activity Data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 time series have been used.

- ❖ *Surface Coal Production (Mt)*: IEA/Eurostat Questionnaire 2013 - 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 (see the Figure and the Table below).

Figure 3.59 Underground Mines category and Solid Fuel Transformation sub-source category emissions trend

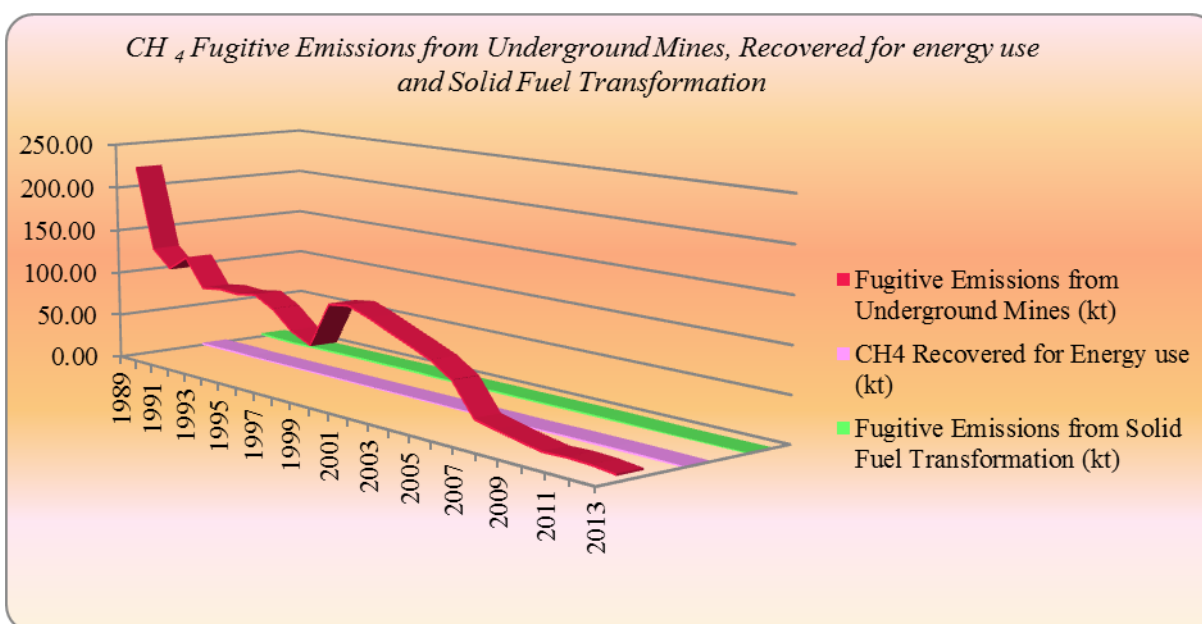


Table 3.32 Fugitive Emissions of CH₄ from Underground Mines and CH₄ Recovered for energy use

Year	Underground mines	
	CH ₄ fugitive emissions (kt)	CH ₄ Recovered for energy use (kt)
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
2013	6.91	0.37

3.3.1.2.2 *Solid Fuel Transformation (CRF 1.B.1.b)*

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors for the Solid Fuels transformation reporting are used.

- ❖ *Default Emission Factor*: EFDB of IPCC - Database on Greenhouse Gas Emission Factors;
- ❖ *The default value of 0.35 kg CH₄/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 2013 - for entire 1990-2013 time series have been used.

- ❖ *Coking Coal Production (Mt)*: IEA/Eurostat Questionnaire 2013 – Transformation Sector (Coking Coal – 100 %).

3.3.1.3 *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:
 - CO₂: 200%;
 - CH₄: 200%;
 - 200.06 % for CO₂ and 200 % for CH₄ associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.
- ❖ ***Solid Fuel Transformation sub-source category***
 - AD: 1%;

- EF:
 - CO₂: 200%;
 - CH₄: 200%;
 - 200 % for CO₂ and 200 % for CH₄ associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

Due to the fact that all activity data were provided through the IEA/Eurostat Questionnaire 2013 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 1989-2013 is consistent.

3.3.1.4 Category-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 *Stationary Combustion* categories, the results of these being mentioned on the Checklists level.

Following these activities there were no nonconformities 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.

3.3.1.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

The implications of all changes made on emission estimates are described in the following table:

Table 3.33 Change made at activity data and their effects on CH₄ emission estimates Sub-sector 1.B 1. - Solid Fuels

Year	Effects of changes on CH ₄ emission estimates [kt]		Difference [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	
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
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

Year	Effects of changes on CH ₄ emission estimates [kt]		Difference [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	
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	40.94	40.94	0.00
2012	38.57	38.57	0.00

3.3.1.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

Creating a data base for the abandoned underground mines, to increase the accuracy in determination of fugitive emissions.

3.3.2 *Oil and natural gas and other emissions from energy production(CRF 1.B.2)*

3.3.2.1 *Category description*

The source category "Oil and Natural Gas" is a key source of CH₄ and CO₂ 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.

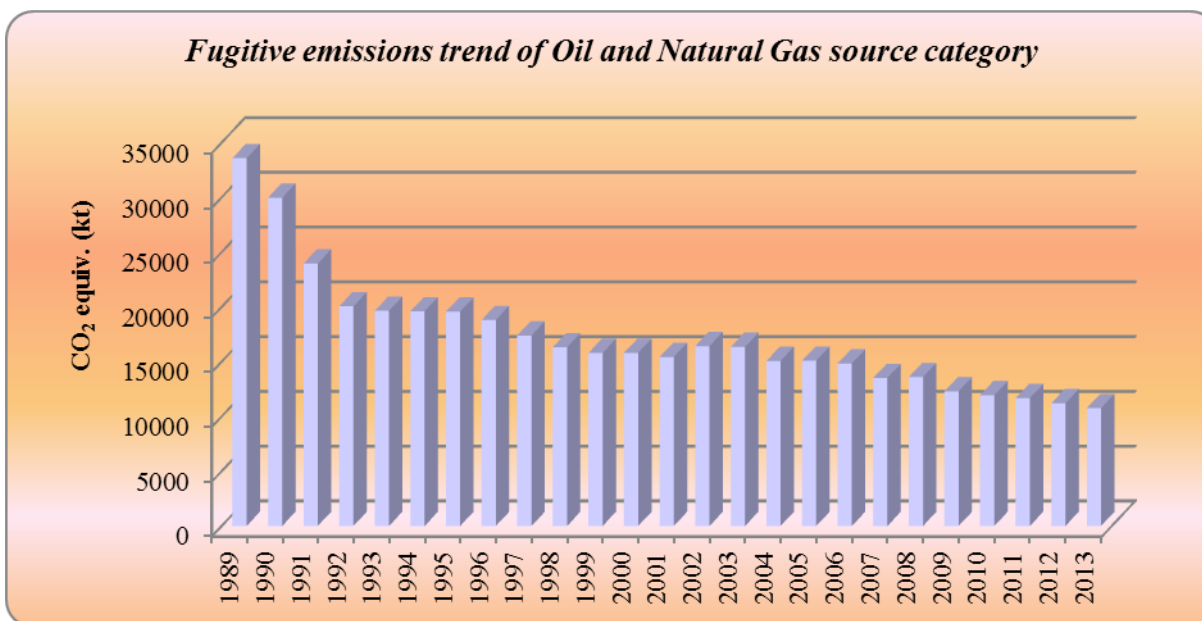
The National Society of Oil, PETROM S.A., has the exclusive right to extract oil from all of the Romanian oil-fields.

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, "covers" 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).

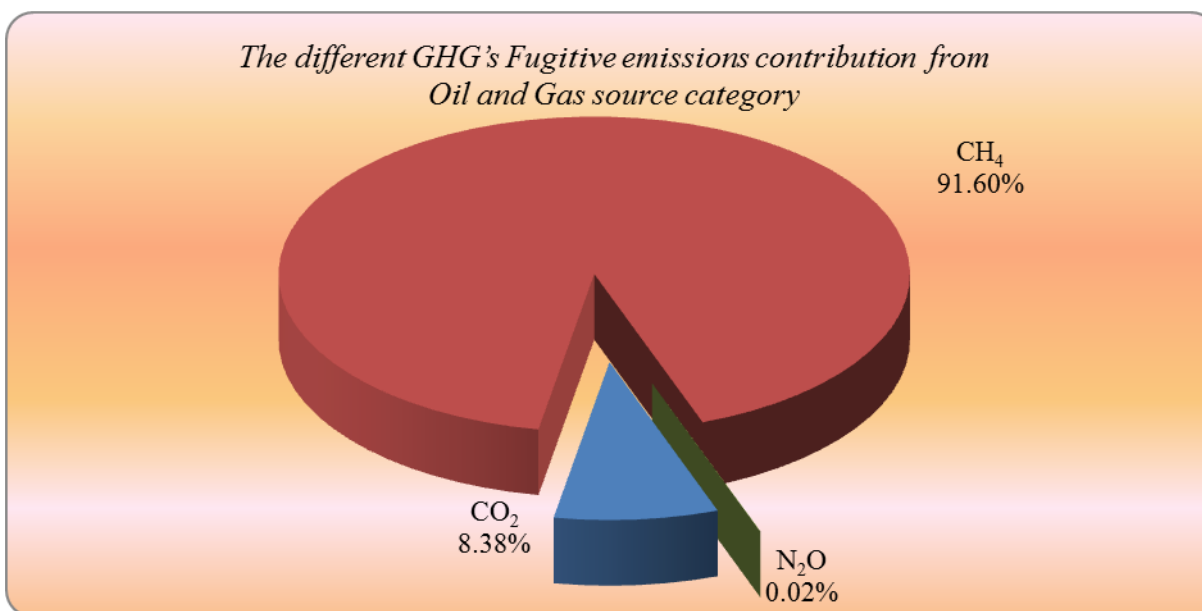
Figure 3.60 Total GHG Oil and Natural Gas source category emissions trend

The emissions trend for the entire period is characterized by a continuous 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 especially 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 rose 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 registered 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%);
 - in 2013 continued decline the natural gas resources (-1.025 million toe), but these were partially offset by the petroleum resources increases (423,000 toe) (Source – Romanian National Institute for Statistics).

Figure 3.61 *The contribution of GHG s Fugitive emission per gas from Oil and Natural Gas source category*



3.3.2.2 Methodological issues

3.3.2.2.1 Oil (CRF 1.B.2.a)

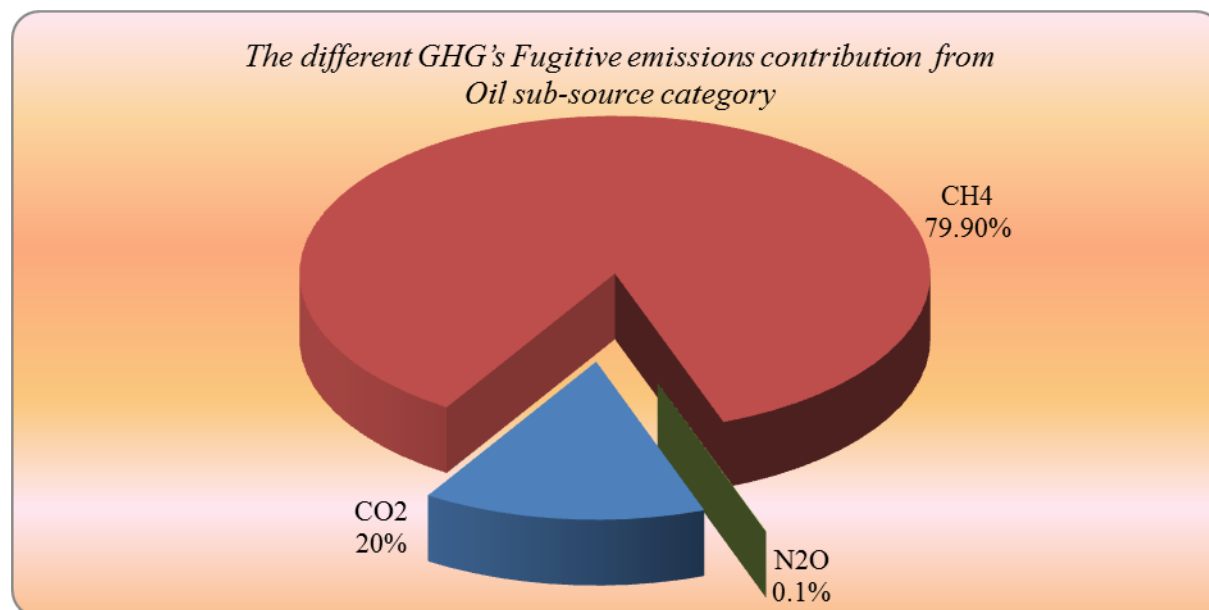
- Emission: CH₄, CO₂, N₂O
- Key source: Yes

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 in the calculations is *Equation 4.2.1* from 2006 IPCC GL, Volume. 2, Chapter 4.2.2.2, page 4.41.

Figure 3.62 *The different GHG's Fugitive emissions contribution from Oil sub-source category*



The most important GHG in the Energy sector is CH₄ emissions and small amounts of CO₂ and N₂O are emitted in Fugitive emissions from Oil sub-source category also.

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/10³m³* (Venting) for CH₄ (average CH₄ Emission Factor) according to 2006 IPCC GL for “Oil production” has been used.
- ❖ *The default value of 0.0021500 Gg/10³m³* (Venting) for CO₂ (average CO₂ Emission Factor) according to 2006 IPCC GL for “Oil production” has been used.
- ❖ *The default value of 0.0000250 Gg/10³m³* (Flaring) for CH₄ (average CH₄ Emission Factor) according to 2006 IPCC GL for “Oil production” has been used.
- ❖ *The default value of 0.0405000 Gg/10³m³* (Flaring) for CO₂ (average CO₂ Emission Factor) according to 2006 IPCC GL for “Oil production” has been used.
- ❖ *The default value of 0.0000064 Gg/10³m³* (Flaring) for N₂O (average N₂O 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 2013 - for entire 1990-2013 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 CO₂, CH₄ and N₂O 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/10³m³* (Exploration) for CH₄ (average CH₄ Emission Factor) according to 2006 IPCC GL for “Oil extraction-well drilling, testing, servicing” has been used.

- ❖ *The default value of 0.080417Gg/10³m³* (Exploration) for CO₂ (average CO₂ Emission Factor) according to 2006 IPCC GL for “Oil extraction-well drilling, testing, servicing” has been used.
- ❖ *The default value of 0.000000584 Gg/10³m³* (Exploration) for N₂O (average N₂O Emission Factor) according to 2006 IPCC GL for “Oil extraction –well testing” has been used.
- ❖ *NCV* - from IEA/Eurostat Questionnaire 2013 - 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 2013 - for entire 1990-2013 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 CO₂, CH₄ and N₂O 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): CH₄ 0,0196000 Gg per 10³ m³

Fugitives (production): CO₂ 0,0024900 Gg per 10³ m³

N₂O – NA

Activity data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 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 2013 - 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/10³m³ (Oil Transport Pipelines) for CH₄ (average CH₄ 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/10³m³ (Oil Transport Pipelines) for CO₂ (average CH₄ 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.

N₂O – N.A.

Activity data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 time series have been used.

From *IEA/Eurostat Questionnaire 2013 Petrol - Indigenous Production + Import + Export:*

❖ Crude Oil, Natural Gas Liquids and Other Hydrocarbons;

NCV- from IEA/Eurostat Questionnaire 2013 - 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 CH₄ (average CH₄ Emission Factor) has been used.

The default value of 135 kg/PJ (Storage Tank) for CH₄ (average CH₄ Emission Factor) has been used.

*The default value of **Combined EF of 880** kg/PJ for CH₄ has been used.*

The country specific value of 93.73 kt/PJ (Petroleum Coke used in refineries as catalytic regenerator) for CO₂ has been used.

EF N₂O– N.A.

Activity data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 time series have been used.

From *IEA/Eurostat Questionnaire 2013* 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.

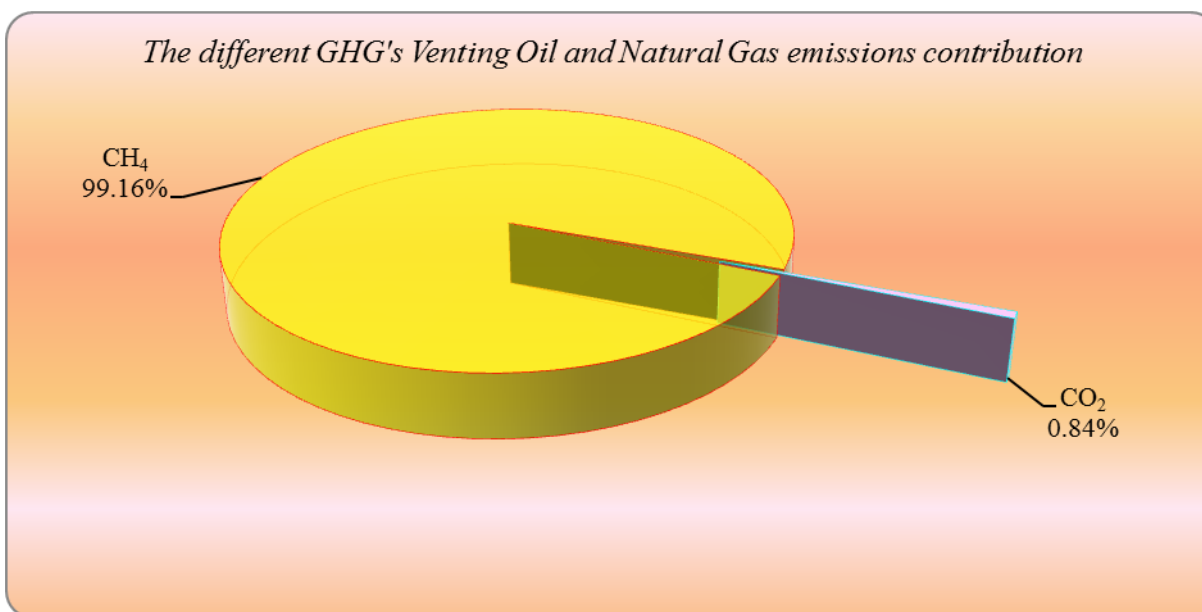
Refined Product Distribution: Gasoline, Diesel, Aviation Fuel, Jet Kerosene

CO_2 – N.A.

CH_4 – N.A.

N_2O – N.A.

Figure 3.63 The different GHG's Venting oil emissions contribution



3.3.2.2.2 Natural Gas (CRF 1.B.2.b)

- Emissions: CH_4 , CO_2 , N_2O
- Key source: Yes

This *sub-source category* comprises 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 4.2.1 Tier 1: Estimating Fugitive Emissions from an industry segment*.

Venting gas

Venting (I.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

N₂O – N.A.

Activity data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 time series have been used.

From *IEA/Eurostat Questionnaire 2013* Indigenous Production:

- ❖ Natural Gas– in both units – $10^6 m^3$ and $TJ (GCV) * 0.9 \rightarrow TJ (NCV)$.

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

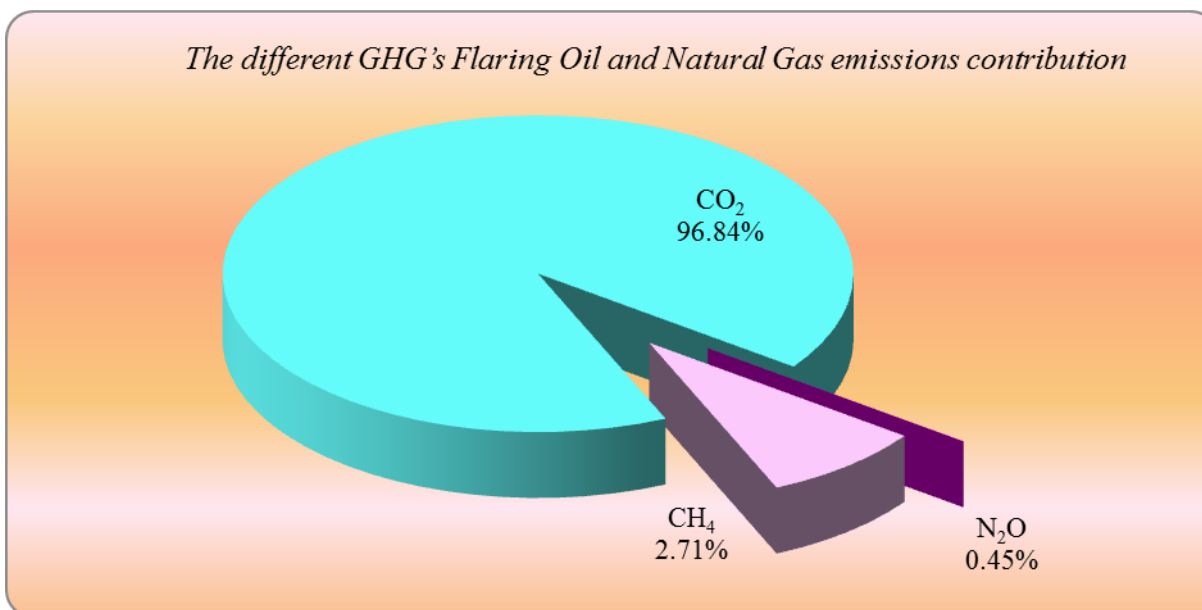
Flaring	lower	upper	average	units
CH ₄	0.000002	0.0000028	0.0000024	Gg per 10 ⁶ m ³
CO ₂	0.003	0.0041	0.00355	Gg per 10 ⁶ m ³
N ₂ O	0.000000033	0.000000045	0.000000039	Gg per 10 ⁶ m ³

Activity data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 time series have been used.

From *IEA/Eurostat Questionnaire 2013* Indigenous Production:

- ❖ Natural Gas– in both units – $10^6 m^3$ and $TJ (GCV) * 0.9 \rightarrow TJ (NCV)$.

Figure 3.64 The different GHG's Flaring Oil and Natural Gas emissions contribution**Production**

Production (1 B 2 b iii 2): 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

- *Default Emission Factors* - 2006 IPCC, Volume 2, chapter 4.2.2.3, Table 4.2.5, page 4. 57

Flaring	lower	upper	average	units
CH ₄	0.00038	0.024	0.01219	Gg per 10 ⁶ m ³
CO ₂	0.000014	0.00018	0.000097	Gg per 10 ⁶ m ³

N_2O – N.A.

Activity data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 time series have been used.

From *IEA/Eurostat Questionnaire 2013* Indigenous Production:

- ❖ Natural Gas– in both units – $10^6 m^3$ and $TJ (GCV) * 0.9 \rightarrow TJ (NCV)$.

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

- *Default Emission Factors* - 2006 IPCC, Volume 2, chapter 4.2.2.3, Table 4.2.5, page 4. 57

	lower	upper	average	units
CH ₄	0.0000166	0.0011	0.000633	Gg per 10 ⁶ m ³
CO ₂	0.00000088	0.000002	0.00000144	Gg per 10 ⁶ m ³

N₂O – N.A.

Activity data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 time series have been used.

From *IEA/Eurostat Questionnaire 2013* Indigenous Production + Import:

❖ Natural Gas– in both units – $10^6 m^3$ and $TJ (GCV) * 0.9 \rightarrow TJ (NCV)$

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 factor

Default Emission Factors - 2006 IPCC, Volume 2, chapter 4.2.2.3, Table 4.2.5, pag. 4.57

CH ₄	0.0018	Gg per 10 ⁶ m ³ per utility sales
CO ₂	0.0000955	Gg per 10 ⁶ m ³

N₂O – N.A.

Activity data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 time series have been used.

From *IEA/Eurostat Questionnaire 2013* Indigenous Production+ Import:

- ❖ Natural Gas – in 10^6 m^3

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 2013 - for entire 1990-2013 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

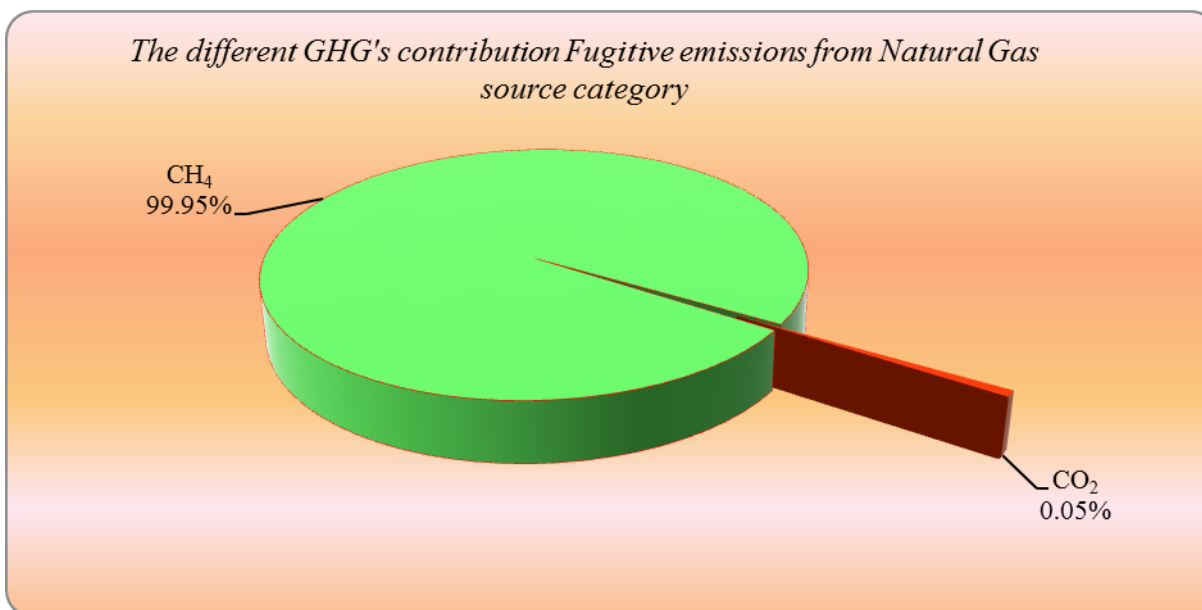
Flaring	lower	upper	average	units
CH ₄	87,000	192,000	139,500	kg/PJ

Activity data

1989_BAL_Romania have been used for 1989, and IEA/Eurostat Questionnaire 2013 - for entire 1990-2013 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 3.65 *The different GHG's Natural Gas sub-source category emissions contribution*



3.3.2.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

❖ ***Oil sub-source category***

- AD: 3%;
- EF:
 - CO₂: 50%;
 - CH₄: 50%;
 - N₂O: 50%.
 - 50.09 % for CO₂, 50.09 % for CH₄ and 50.09% for N₂O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

❖ ***Natural Gas sub-source category***

- AD: 2.24%;
- EF:

- CO₂: 50%;
 - CH₄: 50%;
 - 50.05 % for CO₂ and 50.05 % for CH₄ and 2.24% for N₂O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.
- ❖ ***Venting sub-source category:***
- AD: 2.24%;
 - EF:
 - CO₂: 50%;
 - CH₄: 50%;
 - 50.05 % for CO₂, 50.05 % for CH₄ and 2.24% N₂O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.
- ❖ ***Flaring sub-source category:***
- AD: 3%;
 - EF:
 - CO₂: 50%;
 - CH₄: 50%;
 - 50.09 % for CO₂, 50.09 % for CH₄ and 3% N₂O as resulted after the the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3. 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 1989-2013 is consistent.

3.3.2.4 Category-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 *Stationary Combustion* categories, the results of these being mentioned on the Checklists level.

Following these activities there were no nonconformities 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 nonconformities 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 with national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 6.3.

3.3.2.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

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

❖ *activity data*

- Refining /Storage (1 B 2 a iii 4): new activity data values have been used due to the calculating the CO₂ emissions for the entire time series 1989-2013;
- Transmission and Storage (1B2b iii 4) and Distribution (1B2b iii5): new activity data values have been used due to the calculating the emissions for the entire time series 1989-2013.

❖ *emission factor*

- Refining /Storage (1 B 2 a iii 4): CO₂ country specific emission factor has been used;
- Transmission and Storage (1B2b iii 4) and Distribution (1B2b iii5): emission factors have been updated due to the update of the associated domain in the IPCC 2006.

The implications of all changes made on emission estimates are described in the Tables below.

Table 3.34 Change made at activity data and their effects on CO₂ emission estimates
Oil and Natural Gas category

Year	Effects of changes on CO ₂ emission estimates [kt]		Difference [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	
1989	1,399.87	1,399.89	0.001
1990	1,213.11	1,213.08	-0.003
1991	1,034.95	1,034.90	-0.01
1992	1,057.88	1,057.82	-0.01
1993	1,070.80	1,070.73	-0.01
1994	1,073.97	1,073.89	-0.01

Year	Effects of changes on CO ₂ emission estimates [kt]		Difference [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	
1995	1,068.44	1,103.70	3.30
1996	1,050.22	1,097.24	4.48
1997	1,030.94	1,092.67	5.99
1998	1,001.46	1,472.43	47.03
1999	975.50	1,319.86	35.30
2000	962.01	1,556.63	61.81
2001	952.73	1,152.82	21.00
2002	1,221.83	1,501.41	22.88
2003	1,189.00	1,657.00	39.36
2004	877.26	1,448.30	65.09
2005	901.06	1,713.52	90.17
2006	918.82	2,022.75	120.15
2007	766.89	1,735.38	126.29
2008	723.79	1,841.72	154.45
2009	682.34	1,506.89	120.84
2010	651.84	1,494.63	129.29
2011	646.24	1,204.44	86.38
2012	608.37	1,153.18	89.55

Table 3.35 Change made at activity data and their effects on CH₄ emission estimate
Oil and Natural Gas category

Year	Effects of changes on CH ₄ emission estimates [kt]		Difference [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	
1989	775.63	1,286.90	65.92
1990	817.12	1,149.84	40.72
1991	633.84	916.80	44.64
1992	514.21	759.61	47.72
1993	511.22	743.01	45.34
1994	535.94	740.32	38.14
1995	537.60	738.32	37.34
1996	515.65	708.03	37.31
1997	492.61	651.41	32.24
1998	447.76	593.03	32.44
1999	438.43	578.58	31.97
2000	433.23	569.46	31.44
2001	439.35	570.50	29.85
2002	466.01	596.40	27.98
2003	459.83	587.58	27.78
2004	419.70	544.44	29.72
2005	421.14	534.33	26.88
2006	400.88	512.16	27.76
2007	368.86	470.51	27.56

Year	Effects of changes on CH ₄ emission estimates [kt]		Difference [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	
2008	371.83	469.80	26.35
2009	342.12	430.97	25.97
2010	334.10	417.42	24.94
2011	333.72	418.22	25.32
2012	309.02	402.08	30.11

*Table 3.36 Change made at activity data and their effects on N₂O emission estimates
Oil and Natural Gas category*

Year	Effects of changes on N ₂ O emission estimates [kt]		Difference [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	
1989	0.0136	0,0136	0.00
1990	0.0116	0,0116	0.00
1991	0.0100	0,0100	0.00
1992	0,0102	0,0102	0.00
1993	0.0104	0,0104	0.00
1994	0,0104	0,0104	0.00
1995	0,0103	0,0103	0.00
1996	0.0102	0,0102	0.00
1997	0.0100	0,0100	0.00
1998	0,0097	0,0097	0.00
1999	0,0095	0,0095	0.00
2000	0,0094	0,0094	0.00

Year	Effects of changes on N ₂ O emission estimates [kt]		Difference [%]
	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	
2001	0,0093	0,0093	0.00
2002	0,0119	0,0119	0.00
2003	0,0116	0,0116	0.00
2004	0,0085	0,0085	0.00
2005	0,0088	0,0088	0.00
2006	0,0090	0,0090	0.00
2007	0,0075	0,0075	0.00
2008	0,0070	0,0070	0.00
2009	0,0066	0,0066	0.00
2010	0,0063	0,0063	0.00
2011	0,0063	0,0063	0.00
2012	0,0059	0,0059	0.00

3.3.2.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

No source-specific planned improvements are envisaged.

3.4 CO₂ transport and storage (CRF 1.C)

CO₂ transport and CO₂ storage is not occurring in Romania.

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF Sector 2)

4.1 Overview of 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 (CRF sector 1.A.2).

GHG emissions from Industrial Processes and Product Use are grouped in the following Sub-sectors: Mineral Products (CRF 2.A), Chemical Industry (CRF 2.B), Metal Production (CRF 2.C), Non-energy products from fuels and solvent use (CRF 2.D), Electronics Industry (CRF 2.E), Product uses as substitutes for ODS (CRF 2.F), Other product manufacture and use (CRF 2.G) and Other (CRF 2.H).

The direct GHG emissions reported in this sector are associated with CO₂, CH₄, N₂O, HFCs, PFCs and SF₆.

Table 4.1 Status of emissions estimation within the Industrial Processes Sector

2 INDUSTRIAL PROCESSES AND PRODUCT USE	Emissions estimation status			
	CO ₂	CH ₄	N ₂ O	PFC
IPCC category				
2.A. MINERAL INDUSTRY				
2.A.1. CEMENT PRODUCTION	✓	NA	NA	NA
2.A.2. LIME PRODUCTION	✓	NA	NA	NA
2.A.3. GLASS PRODUCTION	✓	NA	NA	NA
2.A.4. OTHER PROCESS USES OF CARBONATES	✓	NA	NA	NA
2.A.4.a. CERAMICS				
2.A.4.b. OTHER USES OF CARBONATES				
2.A.4.c. NON-METALLURGICAL MAGNESIUM PRODUCTION				
2.A.4.d. OTHER				
2.B. CHEMICAL INDUSTRY				

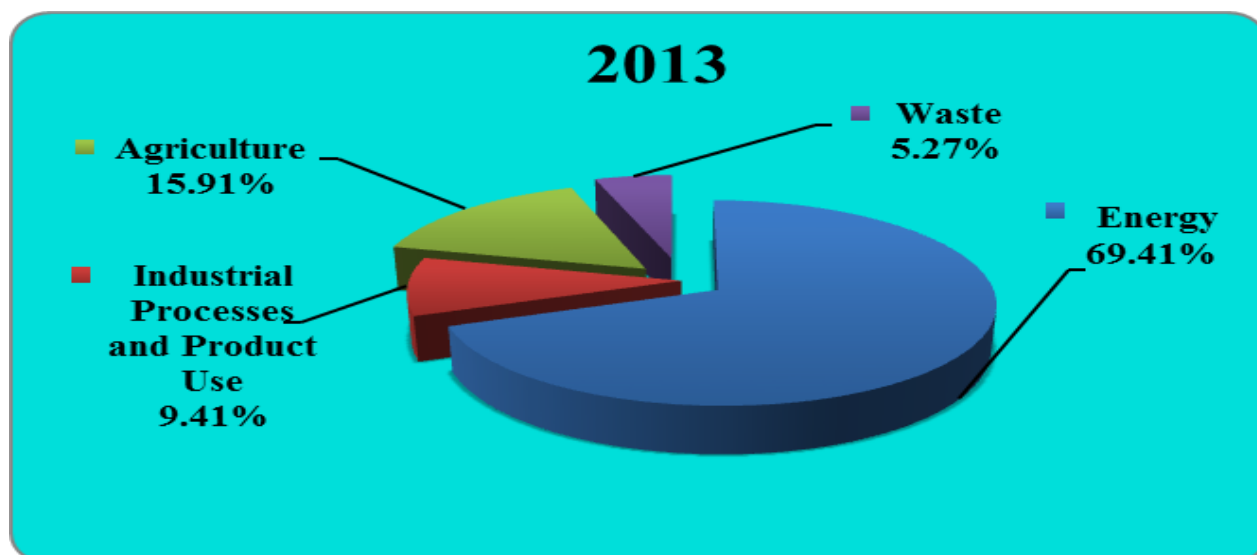
2 INDUSTRIAL PROCESSES AND PRODUCT USE	Emissions estimation status			
	CO ₂	CH ₄	N ₂ O	PFC
2.B.1. AMMONIA PRODUCTION	✓	NE	NE	NA
2.B.2. NITRIC ACID PRODUCTION	NA	NA	✓	NA
2.B.3. ADIPIC ACID PRODUCTION	NO	NO	NO	NO
2.B.4. CAPROLACTAM, GLYOXAL AND GLYOXYLIC ACID PRODUCTION				
2.B.4.a. CAPROLACTAM	NE	NE	✓	NO
2.B.4.b. GLYOXAL				
2.B.4.c. GLYOXYLIC ACID				
2.B.5.a. SILICON CARBIDE PRODUCTION	IE	✓	NA	NA
2.B.5.b. CALCIUM CARBIDE PRODUCTION	✓	NE	NO	NO
2.B.6. TITANIUM DIOXIDE PRODUCTION	IE	NA	NA	NA
2.B.7. SODA ASH PRODUCTION	✓	NA	NA	NA
2.B.8. PETROCHEMICAL AND CARBON BLACK PRODUCTION				
2.B.8.a. METHANOL				
2.B.8.b. ETHYLENE				
2.B.8.c. ETHYLENE DICHLORIDE AND VINYL CHLORIDE MONOMER	✓	✓	NA	NA
2.B.8.d. ETHYLENE OXIDE				
2.B.8.e. ACRYLONITRILE;				
2.B.8.f. CARBON BLACK				
2.B.8.g. OTHER				
2.B.9. FLUOROCHEMICAL PRODUCTION	NO	NO	NO	NO
2.B.10. OTHER	NO	NO	NO	NO
2.C. METAL INDUSTRY				
2.C.1 IRON AND STEEL PRODUCTION				
2.C.1.a. STEEL	✓	NE	NA	NA

2 INDUSTRIAL PROCESSES AND PRODUCT USE	Emissions estimation status			
	CO ₂	CH ₄	N ₂ O	PFC
IPCC category				
2.C.1.b. PIG IRON 2.C.1.c. DIRECT REDUCED IRON 2.C.1.d. SINTER 2.C.1.e. PELLET 2.C.1.f. OTHER				
2.C.2. FERROALLOYS PRODUCTION	✓	✓	NA	NA
2.C.3. ALUMINIUM PRODUCTION	✓	NE	NA	✓
2.C.4. MAGNESIUM PRODUCTION	NO	NO	NO	NO
2.C.5. LEAD PRODUCTION	✓	NA	NA	NA
2.C.6. ZINC PRODUCTION	✓	NA	NA	NA
2.C.7. OTHER	NA	NA	NA	NA
2.D. NON-ENERGY PRODUCTS FROM FUELS AND SOLVENT USE				
2.D.1. LUBRICANT USE	✓	NA	NA	NA
2.D.2. PARAFFIN WAX USE	✓	NA	NA	NA
2.D.3. OTHER	✓	NA	NA	NA
2.E. ELECTRONICS INDUSTRY				
2.E.1. INTEGRATED CIRCUIT OR SEMICONDUCTOR	NO	NO	NO	NO
2.E.2. TFT FLAT PANEL DISPLAY	NO	NO	NO	NO
2.E.3. PHOTOVOLTAICS	NO	NO	NO	NO
2.E.4. HEAT TRANSFER FLUID	NO	NO	NO	NO
2.E.5. OTHER	NO	NO	NO	NO
2.F. PRODUCT USES AS SUBSTITUTES FOR ODS				
2.F.1. REFRIGERATION AND AIR CONDITIONING	NA	NA	NA	✓
2.F.2. FOAM BLOWING AGENTS	NA	NA	NA	✓
2.F.3. FIRE PROTECTION	NA	NA	NA	✓
2.F.4. AEROSOLS	NA	NA	NA	✓

2 INDUSTRIAL PROCESSES AND PRODUCT USE	Emissions estimation status			
	CO ₂	CH ₄	N ₂ O	PFC
IPCC category				
2.F.5. SOLVENTS	NA	NA	NA	✓
2.F.6. OTHER APPLICATIONS	NA	NA	NA	✓
2.G. OTHER PRODUCT MANUFACTURE AND USE				
2.G.1. ELECTRICAL EQUIPMENT	NO	NO	NO	✓
2.G.2. SF ₆ AND PFCs FROM OTHER PRODUCT USE	NO	NO	NO	NO
2.G.3. N ₂ O FROM PRODUCT USES	NO	NO	✓	NO
2.G.4. Other	NO	NO	NO	NO
2.H. Other				
2.H.1. PULP AND PAPER	NE	NE	NE	NO
2.H.2. FOOD AND BEVERAGES INDUSTRY	NE	NE	NE	NO
2.H.3. OTHER	NO	NO	NO	NO

In 2013 the GHG emissions from Industrial Processes and Product Use Sector contributed with 9.41% to the total GHG emissions in Romania.

Figure 4.1 The contribution of Industrial Processes and Product Use Sector to the total GHG emissions in Romania, 2013



Emissions from this sector estimated in 2013 decreased by 73.26% compared with 1989 and decreased by 10.05% compared with 2012.

The decrease from 1989 to 2013 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.

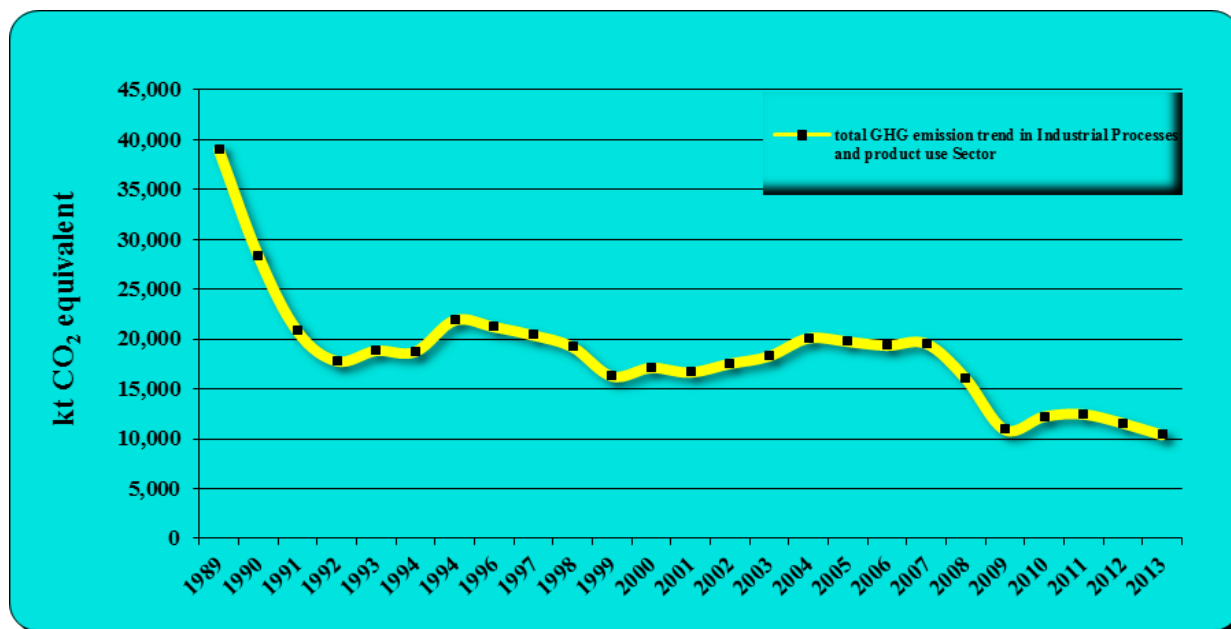
In 2010–2011 the emissions have recorded a increase due to increase of various industry productions.

After 1989 the whole Romania recorded a decrease within the Industrial Processes, because many categories of industrial production have decreased (Chemical Industry, Mineral Industry and Metal Industry):

- 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;
- CO₂ emissions associated with the production of lime calcium show a decreasing trend for the entire time series (1989–2013). Since 1989 until 1993 emissions decrease is due to reduced economic activity. In the next period emission value was kept somewhat constant, with a maximum in 2008. After this year emission values decreased due to the economic crisis;
- the historical evolution of the CO₂ emissions associated with the production the dolomite lime distinguishes three periods:
 - 1989–1997 - a period in which emissions have remained relatively constant around about 60 kt CO₂ due to keeping production structure in industries that use the dolomite lime;
 - 1998–2007 - a period characterized by economic restructuring of the units in industries that use the dolomite lime (changes in the technological flow, abnormal operating periods). One influence was the increased production and economic growth during 2004-2007;
 - 2008–2013 - emissions decreased substantially the economic crisis and the closure of the dolomite lime plant of the largest producer of iron and steel;

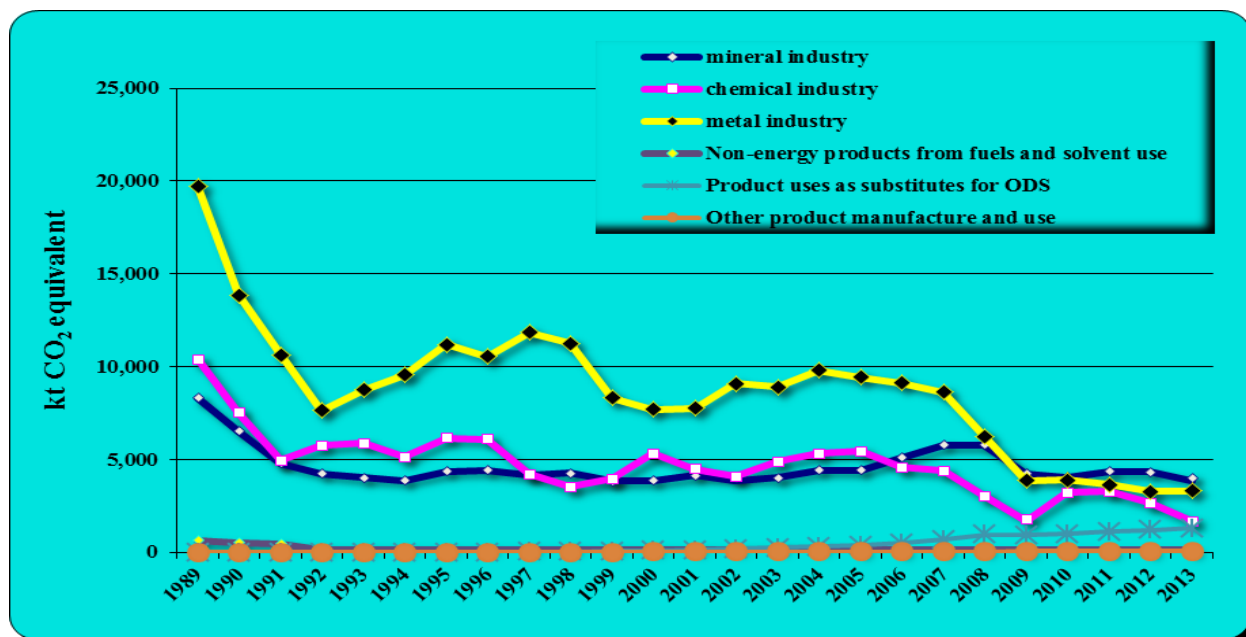
- the CO₂ emissions afferent to the category CRF 2.A.3 – Glass Production presents a decrease trend for the entire period (1989–2013). Starting with the year of 1989 and until 1993 the decrease of the emissions is abrupt and it is owed to the reduction of the economic activity. In the following 3 years a slight growth of the emissions was recorded, followed by an accentuated drop. During the period 2000–2013, the value of the emissions remained somewhat constant, with a minimum value in 2006 of 45 kt CO₂. In the year 2013, the value of the emissions represents 34% of the value of emissions for the year 1989.
- 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;
- in 2010–2011 the emissions rised due to increase of various production activities (ammonia production, nitric acid production, soda ash production and silicon carbide production);
- in 2012–2013 the emissions decreased due to decrease of various production activities (ammonia production, nitric acid production, carbide production);
- 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;
- 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, Aluminium Production and Ferroalloys Production Sub-sectors;
- in 2010–2013 period the emissions trends have recorded an decrease due to decreased of various production activities (iron and steel production and ferroalloys production sub-sectors).

Figure 4.2 Total GHG emissions trend in Industrial Processes and Product Use Sector, for 1989–2013 period



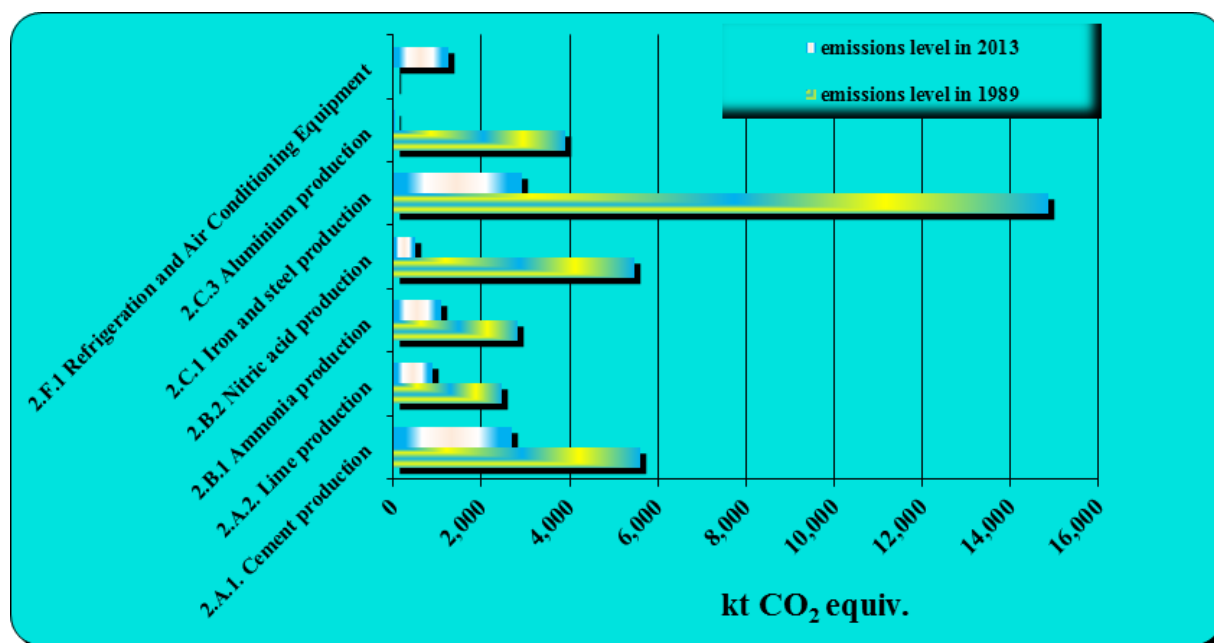
Metal Industry contributes with 31.80% to the total GHG emissions from Industrial Processes and Product Use Sector in 2013. Mineral Industry and Chemical Industry are the two other main contributing Sub-sectors with 38.01% and 15.98%, respectively, of the total GHG emissions in this sector. The contribution of Product uses as ODS substitutes Sub-sector to the overall sector is 12.45%. The contribution of Non-energy product from fuels and solvent use Sub-sector to the overall sector is very low: 1.19%. Other product manufacture and use contributes with 0.58% to the total GHG emissions from Industrial Processes and Product Use Sector.

Figure 4.3 GHG emissions trends in Industrial Processes and Product Use Sector, by sub-sectors, for 1989–2013 period



In the base year, various Industrial Processes and Product Use Sub-sectors contributions were: Mineral Industry 21.30%, Chemical Industry 26.59%, Metal Industry 50.45%, Non-energy product from fuels and solvent use 1.66%, Product uses as ODS substitutes 0.00% and Other product manufacture and use 0.00%.

Figure 4.4 Key categories in Industrial Processes and Product Use Sector in 2013, both by level and trend criteria



The Tier 1 key category analysis performed for 2013 has revealed the following key categories presented in the Table 4.2.

Table 4.2 Key categories in Industrial Processes and Product Use Sector in 2013

Key category	GHG	Criteria	Contribution in total GHG emissions [%]
2.A.1 Cement Production	CO ₂	L,T (Tier 1, excluding and including LULUCF)	2.43%
2.A.2 Lime Production	CO ₂	L (Tier 1, excluding and including LULUCF)	0.81%
2.B.1 Ammonia Production	CO ₂	L (Tier 1, excluding and including LULUCF)	0.97%

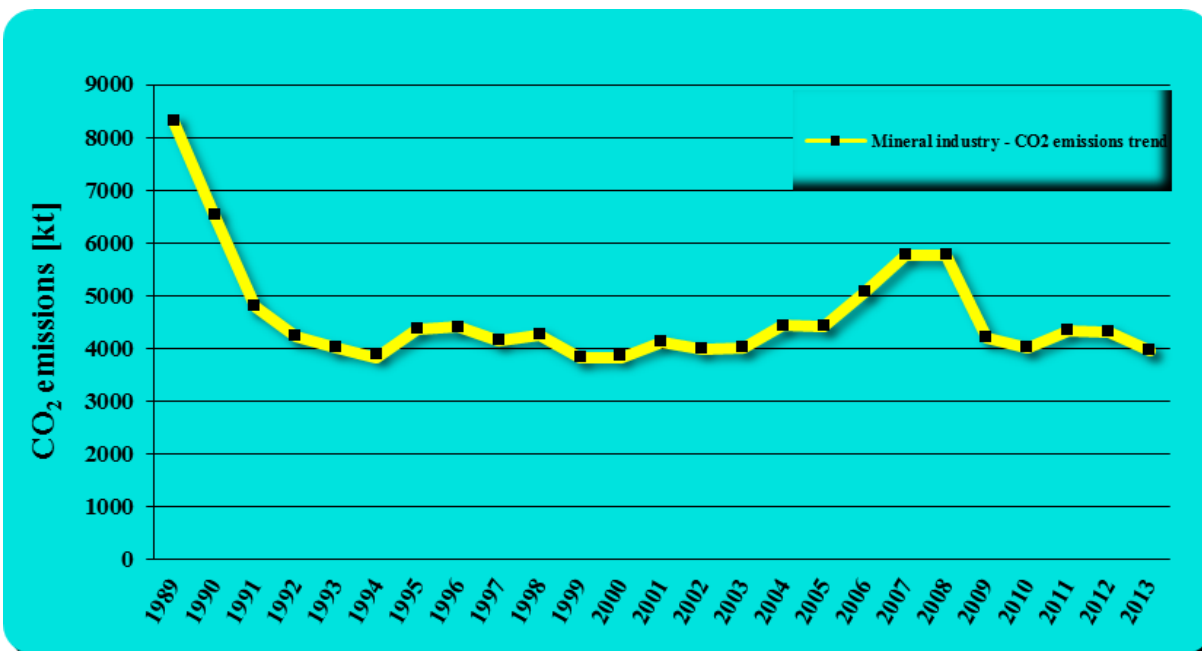
Key category	GHG	Criteria	Contribution in total GHG emissions [%]
2.B.2 Nitric Acid Production	N ₂ O	T (Tier 1, excluding and including LULUCF)	0.46%
2.C.1 Iron and Steel Production	CO ₂	L, T (Tier 1, excluding and including LULUCF)	2.64
2.C.3 Aluminium Production	PFC	T (Tier 1, excluding and including LULUCF)	0.01%
2.F.1 Refrigeration and Air Conditioning Equipment	HFC	L, T (Tier 1, excluding and including LULUCF)	1.14%

4.2 Mineral Industry (CRF 2.A)

4.2.1 Category description

GHG emissions reported include estimates for the following categories: Cement Production (CRF 2.A.1), Lime Production (CRF 2.A.2), Glass Production (CRF 2.A.3), Other Process Uses of Carbonates (CRF 2.A.4).

CO₂ emissions from cement production represent an important key category of the inventory because of its contribution to the total inventory emissions level (in 2013 CO₂ emissions from production of cement contributed with 2.43% to total greenhouse gas emissions). In the base year, these emissions accounted for 1.88% from the total GHG emissions.

Figure 4.5 GHG emissions trend in the Mineral Industry Sub-sector for 1989–2013 period

GHG emissions in the Mineral Industry Sub-sector were decreased during 1989–2011 period due to the decrease recorded after 1989 in Cement Production, Lime Production, Glass Production and Other Process Uses of Carbonates; 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, other process uses of carbonates, soda ash use.

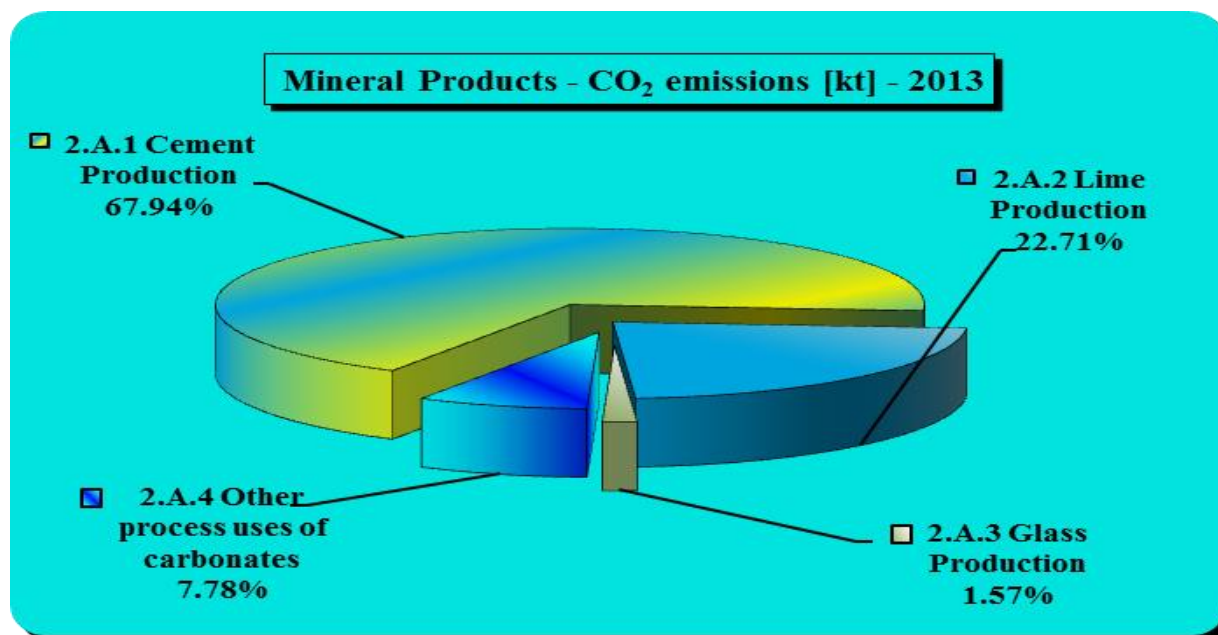
Mineral Industry Sub-sector was responsible for 38.01% of the Industrial Processes and Product Use Sector related GHG emissions in 2013.

Table 4.3 CO₂ emissions in the Mineral Industry Sub-sector, in the year 2013

Sector	CO ₂ emissions [kt]
2.A Mineral Industry	3,966.141
2.A.1 Cement Production	2,694.533

Sector	CO ₂ emissions [kt]
2.A.2 Lime Production	900.626
2.A.3 Glass Production	62.288
2.A.4 Other Process Uses of Carbonates	308.695

Figure 4.6 Structure of the Mineral Industry Sub-sector, in 2013



4.2.2 Methodological issues

4.2.2.1 Cement Production (CRF 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 CO₂ from cement is in line with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC GL) (Tier 2), considering the “Decision Tree for Estimation of CO₂ Emissions from Cement

Production” from 2006 IPCC GL – page 2.9 (Figure 2.1) 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 CO₂ is emitted during the production of clinker (calcination process) when calcium carbonate (CaCO₃) is heated in a cement kiln. During this process calcium carbonate is converted into lime (CaO – Calcium Oxide) and CO₂. Activity data related to the calcinations process were collected directly from the companies:

- clinker production data was provided by each company 1989-2013 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. For the period 1989-2006 the correction factor for discarded amounts of dust varies between 1.00 and 1.13. 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

For 1989-2007 the specific EF was calculated considering the average between the default emission factor from the base year 1989 (0.527 t CO₂/t clinker) and the emission factor from 2008 (the first year with laboratory analyses for plant specific CaO and MgO content in clinker), 0.530 t CO₂/t clinker.

The resulted specific emission factor **for 1989–2007 period** is **0.5285 t CO₂/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).

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 CO₂ 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 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, 0.657 for CaO and 0.015 for MgO for 2012 year).

Starting with 2008 EF for clinker is calculated based on the below presented IPCC formula.

Equation 4.1 Calculation of EF for clinker

$$EF_{clinker} = 0.785 \times CaO_{Content (Weight Fraction) in Clinker} + 1.091 \times MgO_{Content (Weight Fraction) in Clinker}$$

Emissions resulted from discarded cement kiln dust were calculated separately, taking into account its degree of calcinations and added to the CO₂ emissions resulted from calcinations (the production of clinker), using the Equation 2.2 from page 2.9 in according with 2006 IPCC GL methodology.

The correction factor for discarded amounts of dust varies between 1.00 and 1.13 for the period 1989-2007. Starting with 2008 the value of correction factor for discarded amounts of dust is 1 – page 2.12 from 2006 IPCC GL.

The total CO₂ emissions from clinker are estimated using a combined **Tier 2 with country specific method**, by adding the emissions from clinker production and the 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 CO₂ EF for clinker production and CO₂ 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 CO₂ emissions from Clinker Production in the period 1989–2013

Year	Activity data and CO ₂ emissions from Cement Production Sub-sector		
	Clinker production [kt]	Emission factor [tCO ₂ /t clinker]	CO ₂ Emissions [kt]
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
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

Year	Activity data and CO ₂ emissions from Cement Production Sub-sector		
	Clinker production [kt]	Emission factor [tCO ₂ /t clinker]	CO ₂ Emissions [kt]
2013	5,039.75	0.52914	2,694.53

4.2.2.2 Lime Production (CRF 2.A.2)

Methodology

The Lime Production is a key category only considering the level criteria (Tier 1, excluding and including LULUCF).

Total CO₂ emissions from Lime Production were estimated using production data and the emission factors, in line with the 2006 IPCC GL (Tier 2 method), considering the “Decision Tree for Lime Production” from 2006 IPCC GL – page 2.20 (Figure 2.2) and taking into account the information from “Table 2.4 – Basic Parameters for the Calculation of Emission Factors for Lime Production” – page 2.22 in according with 2006 IPCC GL methodology.

Activity data

According to the Tier 2 method from the IPCC 2006 Guidelines, for the category CRF 2.A.2. – Lime Production needs the collection of data and information from economic operators based on questionnaires for the period 1989–2013.

For each type of lime, the following data was requested:

- Identification data (holder of the activity, type of activity performed, address, contact person, telephone/fax, email address);
- Type of lime kiln;
- Production capacity, tonnes/year;
- Production reported to INS (Yes/No);
- Annual quantity of lime produced for each type of lime, tonnes/year;
- Water content in the slaked lime, %;
- Stoichiometric ratio (t CO₂ / t CaO for lime or t CO₂ / t CaO·MgO for dolomite lime);

- Specific average CaO or CaO·MgO content (t CaO/t lime or t CaO·MgO/t lime dolomite);
- The lime dust quantity produced, tonnes;
- Average CaO or CaO·MgO contents in the lime dust, %.

These questionnaires were sent to a total of 30 potential operators lime producers, identified based on their membership in a sector where it is necessary to use / manufacture lime, based on the analysis of the integrated environmental authorizations and their inclusion in the EU-ETS. Thus eight economic operators producing lime as main product and for marketing purposes have been identified, as well as three economic operators from metallurgy, 7 from the sugar industry, two from chemical industry and 10 from the pulp and paper industry.

The following table shows a summary of the number of units that have sent data to each year and for each parameter considered. For the period 1989–2004, a single economic unit reported and it reported only the value of production of quicklime.

Estimating the calcium quicklime quantity produced in the period 1989–2013

Due to differences given by production data reported by the NIS and to the data collected during the project, the estimation of the activity data upon the quantity of calcium quicklime produced during the period 1989–2013 was divided into two periods:

- 2009–2013 for which the annual activity data will be used (calcium quicklime quantity) collected from economic operators based on questionnaires;
- 1989–2008, for which the activity data reported by the NIS will be used, after being adjusted with a correction factor.

The calculation of the correction factor was made taking into account the collected data and the data reported by the NIS. The stages undergone are the following:

- Determining the percentage of the calcium quicklime produced (data collected) from the total lime reported by the NIS for the years 2009–2012. The value of these percentages varies between 68.06% in 2012 and 78.94% in 2011;
- Calculating the average weighted value of this correction factor for the years 2009–2012;
- Applying the correction factor value (75.16%) for the production data related to the calcium quicklime produced and reported by the NIS for the years 1989–2008.

Estimating the quantity of dolomite lime during the period 1989–2013

In order to estimate the quantity of dolomitic lime produced, the NIS data will be used because the data collected from the economic operators are not sufficient (one single operator reported for the period 2001–2007).

Emission factors

In the case of Tier 2 method, the emission factor for each type of lime reflecting the stoichiometric relation between CO₂ and CaO or CaO•MgO adjusted with the content of CaO or CaO•MgO of lime. Also, it is necessary to know the structure of the national production on types of lime. A good practice is considered the development of emission factors considering the CaO or the CaO•MgO of lime.

For the above, we used the Equations 2.9 from Chapter 2 – page 2.23 in according with IPCC 2006 methodology.

Stoichiometric ratio

The default value of the stoichiometric ratio for calcium lime presented in the 2006 IPCC is 0,785 t CO₂/t CaO. This value depends on the chemical composition of the limestone used in the process of obtaining calcium lime. The data reported by the lime producers show values of the parameter stoichiometric ratio which vary between 0.7200 t CO₂/t CaO and 0.9650 t CO₂/t CaO. For each year in the period 2005–2013 the average value was calculated as a weighted average taking into account the quantity of calcium quicklime and the afferent stoichiometric ratio of this parameter; this value of the stoichiometric report for this period is presented in Table 4.6.

Table 4.5 Value of the stoichiometric report for high calcium lime

Year	Stoichiometric report
	t CO₂/t CaO
2005	0.8665

Year	Stoichiometric raport
	t CO ₂ /t CaO
2006	0.9267
2007	0.9171
2008	0.9163
2009	0.9053
2010	0.9126
2011	0.9144
2012	0.9086
2013	0.9055

The value of the stoichiometric ratio report which will be used for the rest of the data series was calculated as a weighted average value. The period selected was the period 2009–2013 because the number of values collected was improved and it was constant. In order to determine the possibility of using the value of 0.9094 of the stoichiometric ratio for the calcium lime, an analysis was performed upon the representativeness of the activity data for which values were reported.

Therefore, during the period 2009–2013, the activity data for which value were reported within the stoichiometric ratio represent between 47% (for 2009) and 52% (for 2013) of the activity data collected.

Therefore, we can conclude that the calculated value of the stoichiometric ratio for calcium lime at this moment we cannot extrapolate to all amount of calcium lime due to the low representativity.

All aspects considered, taking into account that the values collected of the stoichiometric report were provided by producers of commercial calcium lime falling under the EU–ETS; we analyzed the possibility of using these values only for this category of producers. Thus, it is observed that during the period 2009–2013 the representativity level of the stoichiometric report is very high (between 85% and 95%). In these conditions, it is recommended to use the following values.

Table 4.6 Value of the stoichiometric report for high calcium lime

Type of economic units	1989–2008	2009	2010	2011	2012	2013
EU–ETS lime producers	0.9094	0.9053	0.9126	0.9144	0.9086	0.9055
EU–ETS captive lime productions and non-ETS lime production units	0.785	0.785	0.785	0.785	0.785	0.785

No data were completed related to values determined by economic operators for the dolomite lime in the stoichiometric report. It is proposed to use the default value of the dolomite lime stoichiometric report.

The CaO or CaO•MgO content in the lime

The default value of CaO in the high calcium lime presented in IPCC 2006 is 0.95 t CaO / t calcium lime. This value depends on the combustion level of the limestone, the content of impurities and its final destination. The data reported by manufacturers lime parameter values CaO content vary between 0.8200 t CaO / t calcium lime and 0.9638 t / t calcium lime.

For each of the 2005–2013 years the mean (weighted average) of this parameter was calculated and is presented in Table 4.8.

Table 4.7 Average content of CaO in the high calcium lime

Year	CaO content in the high calcium lime
	t CaO/t high calcium lime
2005	0.9366
2006	0.9141
2007	0.9045
2008	0.9124
2009	0.9193

Year	CaO content in the high calcium lime
	t CaO/t high calcium lime
2010	0.9195
2011	0.9126
2012	0.9151
2013	0.9198

The amount of CaO in the calcium lime that will be used for the rest of the data series was calculated as the weighted average. The period selected was 2009–2013 because the number of values collected are improved and remained steady.

To determine the possibility of using the value of 0.9155 of the CaO content in the calcium lime an analysis was performed upon the activity data representation for which values have been reported. Thus, during the 2009–2013 period, the activity data for which values of the stoichiometric report have been provided are between 89% for the 2009 year and 94% for the 2013 year from the activity data collected.

It can be considered that a value of the representativeness of approximately 90% is adequate so that the calculated value of the CaO content can be used as a national value for this parameter. Under these conditions, for estimating CO₂ emissions it is recommended to use the following values.

Table 4.8 Average content of CaO in the high calcium lime

Type of economic units	1989-2008	2009	2010	2011	2012	2013
Lime producers	0.9155	0.9193	0.9195	0.9126	0.9151	0.9198

No data were completed in regard to determinant values by the economic operators for the CaO•MgO content in the dolomite lime. It is suggested that the implicit value of the CaO•MgO of the dolomite lime be use.

The correction factor for lime dust

For the correction factor parameter for lime dust, the calculation is based on the amount of lime dust collected. This parameter was supplied by a single operator. In this situation it is recommended to applied an implicit correction factor of 1.02 to the CO₂ emissions calculated in according with IPCC 2006 – Chapter 2 – page 2.24.

Estimating the CO₂ emission levels for the calcium lime production and for the dolomite lime production

In order to estimate the CO₂ emission levels resulted at the production of calcium lime and dolomite lime, we use the Equation 2.6 from Chapter 2 – IPCC 2006 – page 2.21. Thus, for estimating lime production achieved by EU–ETS commercial lime producers for the 1989–2008 period, we applied the average weighed value from the national production. This average value was calculated as a weighted average value for the 2009–2013 years. In the next table, the values of the production weighs for commercial lime are presented in Table 4.10, as found in EU–ETS units from the total of the lime productions, for the period between 1989–2013. The amount of calcium lime produced in captive or non–ETS units is calculated as the difference from the total calcium lime production.

Table 4.9 The weights value for the comercial lime (under EU–ETS) from the total lime production

Year	1989-2008	2009	2010	2011	2012	2013
Weight, %	53.55	55.84	51.41	52.03	54.42	54.56

Table 4.10 CO₂ emissions from Lime Production in the period 1989–2013

Year	Emissions from Lime Production Sub-sector
	CO₂ emissions [kt]
1989	2,474.837

Year	Emissions from Lime Production Sub-sector
	CO ₂ emissions [kt]
1990	1,897.608
1991	1,454.064
1992	1,215.342
1993	1,089.196
1994	1,017.628
1995	1,104.894
1996	1,091.952
1997	1,054.848
1998	1,252.884
1999	1,122.001
2000	1,136.683
2001	1,275.921
2002	1,249.906
2003	1,252.871
2004	1,332.056
2005	1,173.827
2006	1,300.598
2007	1,523.871
2008	1,394.829
2009	948.042
2010	1,057.252
2011	1,052.643
2012	925.164
2013	900.626

4.2.2.3 Glass Production (CRF 2.A.3)

Methodology

The Glass Production is not a key category. Total CO₂ emissions from Glass production were estimated using production data and the emission factors, in line with the 2006 IPCC GL (Tier 2 method), considering the “The decision tree for estimating CO₂ emissions resulted from glass production” – page 2.29 (Figure 2.3) and the Equation 2.11 – page 2.28 from 2006 IPCC GL methodology.

Estimating the CO₂ emissions associated to the Mineral Industry sub-sector (CRF 2.A) – Glass Production category (CRF 2.A.3) is based on the yearly national production (structured on types of glass) for each year (1989–2013) and correction factors for the quantity of cullet reintroduced in the process.

Activity data

According to Tier 2 method from the IPCC 2006 Guide for the category CRF 2.A.3. – Glass production, was collected data and information from economic operators based on questionnaires for the period 1989–2013.

Each economic operator was requested the following data:

- Identification data (holder of the activity, type of activity performed, address, contact person, telephone/fax, email address);
- Type of melting furnace;
- Production capacity, tons/year;
- Production reported to NIS (Yes/No);
- Type of glass produced;
- Yearly melted glass quantity produced, tonnes/year;
- Quantity of the glass pieces reintroduced into the process (cullet), t;
- Percentage of glass pieces reintroduced into the process (cullet ratio), %.

Based on the analysis of the operators included into the EU–ETS, 6 large glass producers were identified and contacted.

For the three glass categories produced in Romania, we compared between the activities data received from the economic operators with the activity data from the NIS.

Thus the comparative analysis for the quantity of glass produced for plain/float glass, the following are observed:

- For the period 1989–2005 no activity data were reported by economic operators;
- The quantity of glass from the NIS data is higher during the period between 2005 and 2009, due to the high level of data collected and due to the fact that several economic operators were functioning;
- For the period 2010–2013 the data collected are close to the ones presented by the NIS which indicates a good identification of the NIS category. The existing differences are owed to the fact that data collected from the operators are the melted glass quantity and the NIS reports the sold glass quantity.

The comparative analysis performed, for keeping the consistency of the inventory for the period 2003–2013 it is recommended to use NIS data in estimating CO₂ emissions afferent to the plain/float glass production. For the period 1989–2002 the data series are represented by those obtained by extrapolation, on the base of average percentages calculated for the period 2003–2012.

The comparative analysis for the glass quantity produced for glass recipients, the following are observed:

- The glass quantity in the NIS data is higher during the period 1989–2005, due to the level of data collecting and due to the fact that several operators were functioning;
- The glass quantity from the data collected from the economic operators for the period 2006–2013 is higher compared to the ones provided by the NIS, due to the fact that data collected from the operators are the melted glass quantity and data from the NIS represent the glass quantity sold. Also, it is observed for the period 2008–2013 that the quantity provided by the NIS represents 86.3% of the glass quantity value reported by the operators.

From the comparative analysis presented above and for keeping the consistency of the inventory for the period 1989–2007, it is recommended that we use the NIS data adjusted with 86.3%.

For the period 2008–2013 it is recommended to use the activity data collected because they represent the quantity of the melted glass and not the one produced.

The comparative analysis for the glass quantity produced for glass wool shows the following:

- The data provided by the NIS show only one category where mineral wool productions and not only glass wool;
- For the period 1989–2006 there weren't any activity data reported by the economic operators;
- For the period 2008–2012, the glass quantity for the glass wool collected from the economic operators, amounts to 58 % from the value of the mineral wool quantity reported by the NIS.

From the comparative analysis presented above and for keeping the consistency of the inventory for the period 1989–2002 it is recommended to use the data series obtained by extrapolation, on the base of average percentages calculated for the period 2003–2012.

For the period 2003–2008 the activity data for glass wool are calculate as a percentage (58%) from the data provided by NIS for the category mineral wool.

For the period 2009–2013 it is recommended to use the activity data collected because they represent the quantity of melted glass wool.

Emission factors

Emission factors for glass recipients

Though in the level 2 IPCC 2006 method implicit emission factors were used for the glass category produced for recipients, a national factor was calculated. The emissions associated to the technological process were collected from the reports of EU–ETS of the economic operators for the period 2010–2012. The calculated emission factor (average weighted value) is 0.151 t CO₂/t of melted glass. In order to keep the consistency of the inventory, another emission factor was developed, taking into account the quantity of glass pieces reintroduced into the process. Thus, the value to be used is 0.194 t CO₂/t of melted glass, a value which is close to the implicit one.

Emission factor for flat glass

Because in the level 2 IPCC 2006 method, implicit factors are used, for the plain glass category, the implicit value 0.21 t CO₂/t of melted glass will be used.

Emission factor for the glass wool

In the level 2 IPCC 2006 method for the plain glass category, implicit emission factors are used, with the implicit value of 0.25 t CO₂/t melted glass.

Correction factors for the glass recipients

For the glass recipients category the operators provided data afferent to the quantity of the glass pieces reintroduced into the process for the entire period of time analyzed. Thus, the values of the parameter percentage of glass pieces reintroduced into the process will be national values. For the recipients, the average value of the glass percentage reintroduced into the process is 28% and it is lower than the values in Table 1.

Correction factor for the flat glass

For the plain glass category the operators provided data afferent to the quantity of glass pieces reintroduced into the process for the period 2007–2013. The average value of this parameter is 17% and it was calculated as an average weighted value. This value is placed in the interval of the values presented in the Table 1.

For the period 1989–2006 the value of 17% will be used, and for the period 2007–2013 the average values reported by the economic operators will be used.

Correction factor for the glass wool

For the plain glass wool category, the operators used the data afferent to the quantity of glass pieces reintroduced into the process for the years 2008–2013. The average value of this

parameter is 16.91% and it was calculated as a weighted average value. This value is located in the value interval presented in Table 1.

For the period 1989–2006 the value of 16.91%, will be used and for the period 2007–2013 the average values reported by the economic operators will be used.

Table 4.11 CO₂ emissions from Glass Production in the period 1989–2013

Year	Emissions from Glass Production Sub-sector
	CO ₂ emissions [kt]
1989	183.286
1990	149.944
1991	122.666
1992	100.615
1993	80.96
1994	87.591
1995	97.323
1996	104.527
1997	87.511
1998	78.507
1999	45.332
2000	61.846
2001	64.243
2002	63.942
2003	81.571
2004	59.959
2005	46.902
2006	45.281
2007	74.846
2008	77.286
2009	61.475

Year	Emissions from Glass Production Sub-sector
	CO ₂ emissions [kt]
2010	68.34
2011	65.308
2012	62.383
2013	62.288

4.2.2.4 Other Process Uses of Carbonates (CRF 2.A.4)

Methodology

Other Process Uses of Carbonates is not a key category. The method for calculating emissions of CO₂ from Other Process Uses of Carbonates is in line with the 2006 IPCC GL (Tier 2 method), considering the “Decision tree for estimation of CO₂ emissions from other process uses of carbonates” from 2006 IPCC GL – page 2.35 (Figure 2.4) considering four broad source categories: (1) ceramics, (2) other uses of soda ash, (3) non-metallurgical magnesia production, and (4) other uses of carbonates. The method estimates the amount of Other Process Uses of Carbonates in ceramics plants, pulp and paper production, flue gas desulphurisation, water treatment, soap and detergents producers, production of chemicals, for all-time series.

Activity data

The activity data were provided directly by the plants (ceramics plants, pulp and paper production, flue gas desulphurisation, water treatment, soap and detergents producers, production of chemicals).

In order to estimate CO₂ emissions from Other Process Uses of Carbonates 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 (ceramics plants, pulp and paper production, flue gas desulphurisation, water treatment, soap and detergents producers, production of chemicals) in order to complete the needed data. The completed questionnaire has been sent to NEPA where the data are aggregated.

The CO₂ emissions from limestone and dolomite consumption in the iron and steel production are reported under 2.C.1 Iron and steel production category.

It is considered that lime production activity in sugar factories as an activity neutral in terms of emissions and therefore was corrected in Other Process Uses of Carbonates category by subtracting the amount of limestone used in this sector.

Table 4.12 Amount of Other Process Uses of Carbonates and CO₂ emissions in the period 1989–2013

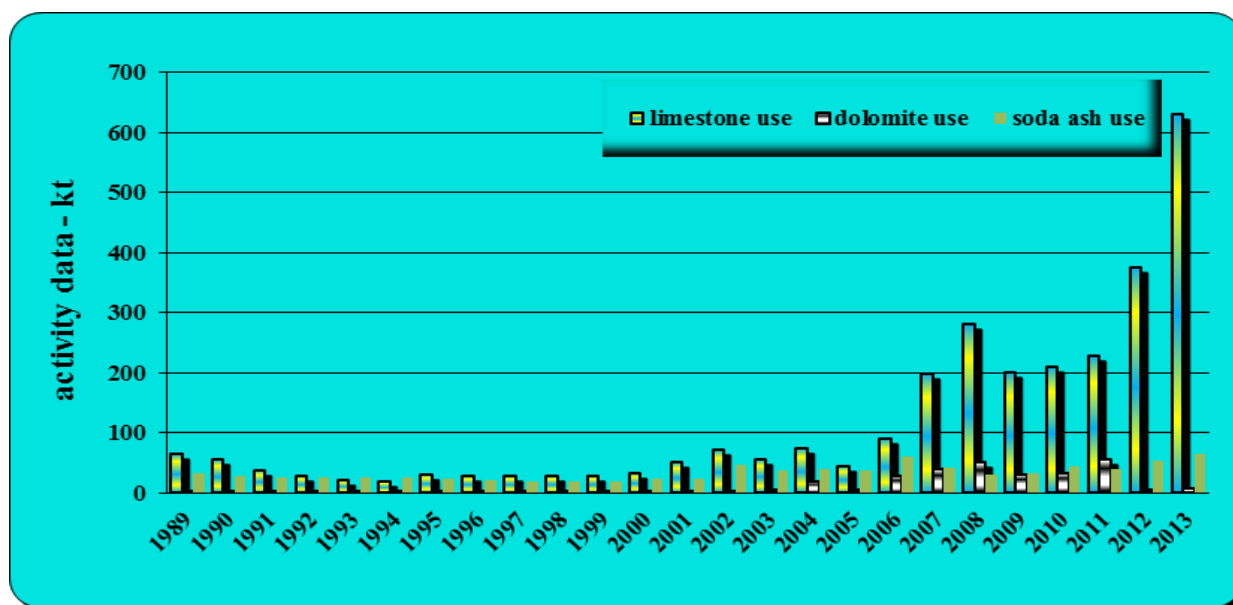
Year	Activity data from Other Process Uses of Carbonates Sub-sector			
	Limestone Use	Dolomite Use	Soda ash use	CO ₂ emission from Other Process Uses of Carbonates
	[kt]			[kt]
1989	65.52	1.89	33.21	43.51
1990	55.10	1.89	28.85	37.12
1991	36.14	1.89	26.42	27.77
1992	28.25	1.89	26.64	24.39
1993	20.87	1.87	25.96	20.85
1994	19.16	1.94	25.75	20.04
1995	31.33	1.93	23.94	24.64
1996	28.74	1.94	20.82	22.21
1997	27.54	1.24	18.47	20.38
1998	26.95	1.22	18.07	19.94
1999	28.29	1.29	18.47	20.72
2000	32.16	3.46	22.38	25.09
2001	51.48	3.20	24.02	34.14
2002	72.36	3.52	45.95	52.59
2003	56.04	3.98	37.24	42.01
2004	73.12	19.84	40.16	58.30
2005	43.71	6.06	36.15	37.12
2006	90.39	28.36	59.96	78.18

Year	Activity data from Other Process Uses of Carbonates Sub-sector			
	Limestone Use	Dolomite Use	Soda ash use	CO ₂ emission from Other Process Uses of Carbonates
	[kt]			[kt]
2007	197.32	39.20	42.22	123.04
2008	281.22	50.92	30.06	160.50
2009	200.41	31.13	31.66	116.17
2010	209.31	32.80	44.38	126.16
2011	227.78	55.28	39.28	142.89
2012	375.27	4.25	53.81	189.48
2013	631.50	7.86	65.27	308.69

Emission factors

The default emission factors 440 kg CO₂/tonne limestone, 477 kg CO₂/tonne dolomite and 415 kg CO₂/tonne soda ash are used.

Figure 4.7 CO₂ emissions from Other Process Uses of Carbonates in the period 1989–2013



4.2.3 *Uncertainties and time series consistency*

4.2.3.1 *Cement Production (CRF 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.2.3.2 *Lime Production (CRF 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.2.3.3 Glass Production (CRF 2.A.3)

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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.2.3.4 Other Process Uses of Carbonates (CRF 2.A.4)

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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.2.4 Category-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 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.

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 – Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend and at the Chapter 10 – Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.2.5 – Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend. 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 CO₂ 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 CO₂ emissions from Lime Production, Glass Production and Other Process Uses of Carbonates, were compared with the emissions reported in monitoring plans of GHG emissions for the EU-ETS installations. Further elements are presented within Annex 6.5.

4.2.5 Category-specific recalculation, if applicable, including changes made in response to the review process and impact on emission trend

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

- *activity data:*
 - Lime Production (CRF 2.A.2);
 - Glass Production (CRF 2.A.3);
 - Other Process Uses of Carbonates (CRF 2.A.4).

- *emission factors:*
 - Lime Production (CRF 2.A.2);
 - Glass Production (CRF 2.A.3).

Table 4.13 The effects of recalculations in Mineral Industry Sub-sector

The effects of recalculations in Mineral Industry Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	10,669.97	8,310.74	-22.11
1990	8,173.33	6,529.97	-20.11
1991	6,074.63	4,805.25	-20.90
1992	5,435.96	4,246.31	-21.88
1993	5,099.42	4,024.43	-21.08
1994	4,983.81	3,896.17	-21.82
1995	5,595.66	4,372.70	-21.86
1996	5,557.04	4,418.73	-20.48
1997	5,471.32	4,167.67	-23.83
1998	5,339.09	4,267.28	-20.07
1999	4,668.86	3,832.83	-17.91
2000	4,777.77	3,879.58	-18.80
2001	5,278.31	4,142.67	-21.52
2002	5,227.52	4,008.53	-23.32
2003	5,173.17	4,026.50	-22.17
2004	5,699.43	4,442.40	-22.06

The effects of recalculations in Mineral Industry Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
2005	5,596.91	4,432.66	-20.80
2006	6,278.11	5,079.63	-19.09
2007	6,977.85	5,775.73	-17.23
2008	6,621.08	5,775.28	-12.77
2009	4,710.40	4,218.76	-10.44
2010	4,608.34	4,029.65	-12.56
2011	4,880.99	4,349.69	-10.89
2012	5,000.96	4,327.27	-13.47
2013		3,966.14	

4.2.5.1 Lime Production (CRF 2.A.2)

Recalculations were made as a result of improved activity data on lime production and emission factors.

Table 4.14 Recalculations of CO₂ emissions in the Lime Production Sub-sector

The effects of recalculations in Lime Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	3,222.27	2,474.84	-23.20
1990	2,389.47	1,897.61	-20.58
1991	1,830.74	1,454.06	-20.58
1992	1,529.98	1,215.34	-20.56
1993	1,371.52	1,089.20	-20.58
1994	1,281.56	1,017.63	-20.59
1995	1,391.29	1,104.89	-20.58

The effects of recalculations in Lime Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1996	1,374.67	1,091.95	-20.57
1997	1,327.99	1,054.85	-20.57
1998	1,477.36	1,252.88	-15.19
1999	1,322.83	1,122.00	-15.18
2000	1,347.42	1,136.68	-15.64
2001	1,620.66	1,275.92	-21.27
2002	1,578.18	1,249.91	-20.80
2003	1,581.22	1,252.87	-20.77
2004	1,685.73	1,332.06	-20.98
2005	1,482.76	1,173.83	-20.83
2006	1,645.31	1,300.60	-20.95
2007	1,940.95	1,523.87	-21.49
2008	1,759.32	1,394.83	-20.72
2009	1,185.85	948.04	-20.05
2010	1,274.52	1,057.25	-17.05
2011	1,260.41	1,052.64	-16.48
2012	1,281.22	925.16	-27.79
2013		900.63	

4.2.5.2 Glass Production (CRF 2.A.3)

The recalculations have been made due to improved activity data on production of glass of the entire time series. The recalculations of the emissions afferent to the category CRF – glass production are based on use of IPCC 2006 emission factors, the activity data corrected and the correction factors for the cullet.

Table 4.15 Recalculations of CO₂ emissions in the Glass Production Sub-sector

The effects of recalculations in Glass Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	219.24	183.29	-16.40
1990	178.53	149.94	-16.01
1991	145.38	122.67	-15.63
1992	119.80	100.62	-16.01
1993	95.95	80.96	-15.62
1994	105.26	87.59	-16.78
1995	118.05	97.32	-17.56
1996	125.61	104.53	-16.78
1997	104.68	87.51	-16.40
1998	93.04	78.51	-15.62
1999	55.25	45.33	-17.94
2000	75.02	61.85	-17.56
2001	77.93	64.24	-17.56
2002	77.93	63.94	-17.94
2003	154.11	81.57	-47.07
2004	88.39	59.96	-32.17
2005	77.34	46.90	-39.36
2006	73.27	45.28	-38.20
2007	69.20	74.85	8.16
2008	73.79	77.29	4.74
2009	55.60	61.48	10.57
2010	58.61	68.34	16.60
2011	59.15	65.31	10.41
2012	57.14	62.38	9.18
2013		62.29	

4.2.5.3 Other Process Uses of Carbonates (CRF 2.A.3)

Recalculation have been made for the entire time series. The CO₂ emissions from limestone and dolomite consumption in the iron and steel production are reported under 2.C.1 Iron and steel production category therefore was corrected in Other Process Uses of Carbonates category by subtracting the amount of limestone used in this sector.

It is considered that lime production activity in sugar factories as an activity neutral in terms of emissions and therefore was corrected in Other Process Uses of Carbonates category by subtracting the amount of limestone used in this sector.

Table 4.16 Recalculations of CO₂ emissions in the Other Process Uses of Carbonates Sub-sector

The effects of recalculations in Other Process Uses of Carbonates Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	1,483.02	43.51	-97.07
1990	1,060.93	37.12	-96.50
1991	821.85	27.77	-96.62
1992	806.85	24.39	-96.98
1993	736.59	20.85	-97.17
1994	753.49	20.04	-97.34
1995	861.05	24.64	-97.14
1996	774.18	22.21	-97.13
1997	950.63	20.38	-97.86
1998	781.54	19.94	-97.45
1999	581.14	20.72	-96.43
2000	636.18	25.09	-96.06
2001	739.18	34.14	-95.38
2002	847.65	52.59	-93.80

The effects of recalculations in Other Process Uses of Carbonates Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
2003	716.37	42.01	-94.14
2004	861.67	58.30	-93.23
2005	799.29	37.12	-95.36
2006	816.62	78.18	-90.43
2007	833.89	123.04	-85.25
2008	564.73	160.50	-71.58
2009	306.35	116.17	-62.08
2010	426.92	126.16	-70.45
2011	398.80	142.89	-64.17
2012	431.01	189.48	-56.04
2013		308.69	

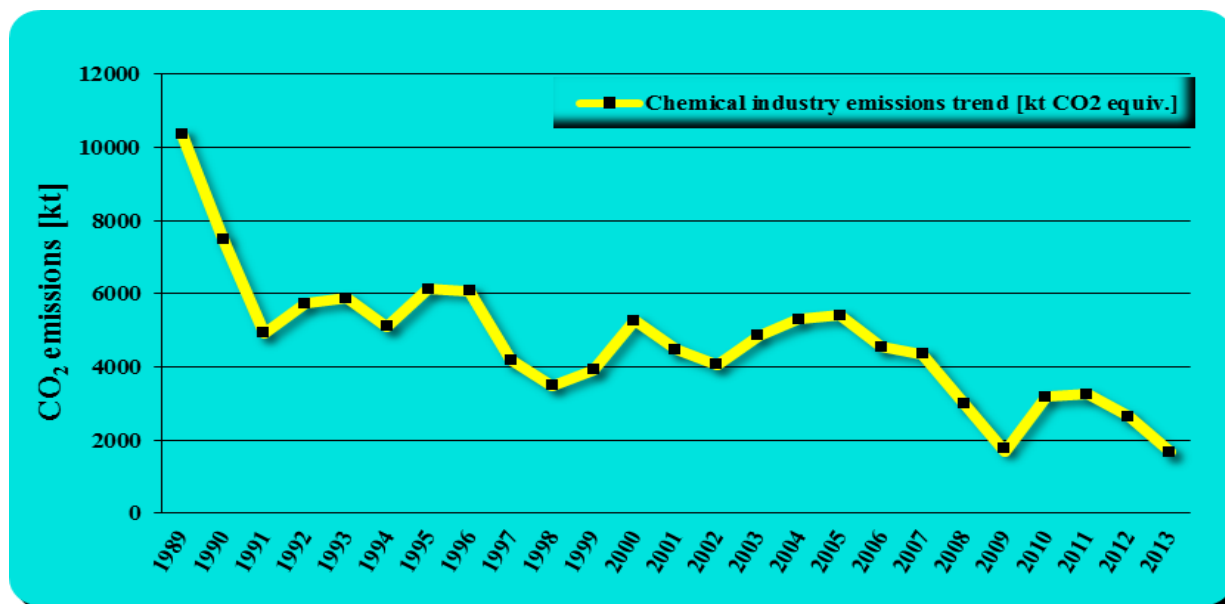
4.2.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

More detailed data will try to be obtained, in respect to the 2006 IPCC GL provisions.

4.3 Chemical Industry (CRF 2.B)

4.3.1 Category description

CRF Sector 2.B includes: Ammonia Production (CRF 2.B.1), Nitric Acid Production (CRF 2.B.2), Adipic Acid Production (CRF 2.B.3), Caprolactam, glyoxal and glyoxylic acid production (CRF 2.B.4), Silicon Carbide Production (CRF 2.B.5.a), Calcium Carbide Production (CRF 2.B.5.b), Titanium dioxide production (CRF 2.B.6), Soda ash production (CRF 2.B.7), Petrochemical and carbon black production (CRF 2.B.8), Fluorochemical production (CRF 2.B.9) and Other (CRF 2.B.10). Chemical Industry Sub-sector was responsible for 15.98% of the total Industrial Processes Sector GHG emissions in 2013.

Figure 4.8 GHG emissions trend in the Chemical Industry Sub-sector for 1989–2013 period

GHG emissions trend in the Chemical Industry Sub-sector for 1989–2013 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 2010–2011 the emissions rised due to increase of various production activities (ammonia production, nitric acid production, soda ash production and silicon carbide production);
- in 2012–2013 the emissions decreased due to decrease of various production activities (ammonia production, nitric acid production, carbide production).

Table 4.17 GHG emissions from the Chemical Industry Sector, in 2013

Sector	CO ₂	CH ₄	N ₂ O
	[kt] - 2013		
2.B Chemical Industry	1,147.58	0.47	1.71
2.B.1 Ammonia Production	1,080.90	0.00	0.00
2.B.2 Nitric Acid Production	0.00	0.00	1.71
2.B.3 Adipic Acid Production	NO	NO	NO
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	NO	NO	NO
2.B.5.a Silicon Carbide Production	IE	0.46	0.00
2.B.5.b Calcium Carbide Production	6.59	NO	NO
2.B.6 Titanium dioxide production	IE	NO	NO
2.B.7 Soda ash production	58.60	NO	NO
2.B.8 Petrochemical and carbon black production	1.49	0.01	NO
2.B.9 Fluorochemical production	NO	NO	NO
2.B.10 Other	NO	NO	NO

4.3.2 Methodological issues

4.3.2.1 Ammonia Production (CRF 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 only considering the level criteria (Tier 1, excluding and including LULUCF).

The CO_2 emissions from ammonia production are estimated according to the Tier 3 methodology. In order to estimate the CO_2 emission levels resulted at the production of ammonia production, we use the Equation 3.3 – page 3.13 from Chapter 3 in line with 2006 IPCC methodology.

Within the chemical industry sector, Ammonia Production is one of the most important GHG emission source. The lowest level of emissions was recorded in 1997, 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 the 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 1989–2013. 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;

- Annual amount of urea production, kg/year.

Emission factors

In order to estimate the CO₂ emissions inside the Ammonia Production Sub-sector it is used the Equation 3.3 – page 3.13 from Chapter 3 in line with 2006 IPCC methodology.

CO₂ emissions

- Unit measurement: kt CO₂ emissions/ year;
- Carbon dioxide is formed by oxidation of carbon from the fuel (natural gas);
- CO₂ emissions estimation is done by calculations using Tier 3 method, in compliance with IPCC.

Methodology

Annual amount of natural gas used as feedstock

- Unit measurement: Nm³/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 CO₂ emissions calculation inside the Industrial Process and Product Use 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 and Product Use Sector, not to Energy Sector.

Carbon content of natural gas used as feedstock

- Unit measurement: kg C / Nm³ natural gas;
- In order to convert Nm³ of natural gas in kg of natural gas, the density of the natural gas was used ($\rho = 0.8779 \text{ kg/m}^3$);

- For accurate calculations, the Carbon content of natural gas used as feedstock is obtained from the operators.

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 – CO₂ (44) and molecular weight of carbon – C (12). Value is 44/12.

Ammonia annual production

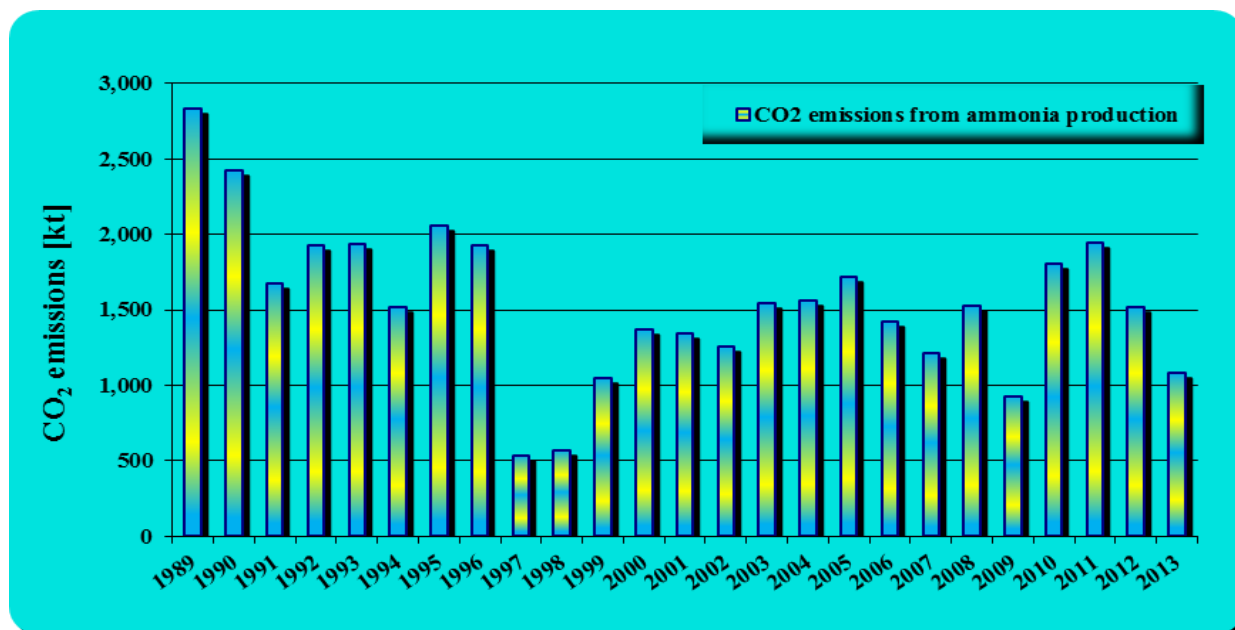
- Unit measurement: t/year (tone Ammonia Production 100%/year);
- Annual production is annually obtained from operators.

Table 4.18 Ammonia Production related to the CO₂ emissions in the period 1989–2013

Year	Activity data and emissions from Ammonia Production Subsector	
	Natural gas consumption [kt]	CO ₂ emissions [kt]
1989	1,947.02	2,831.13
1990	1,510.90	2,423.00
1991	1,064.03	1,673.82
1992	1,261.58	1,924.24
1993	1,237.55	1,934.28
1994	1,147.35	1,522.43
1995	1,397.03	2,059.71
1996	1,287.90	1,927.43
1997	635.41	535.04
1998	305.00	565.46
1999	644.60	1,045.92
2000	945.06	1,371.45
2001	924.56	1,342.37
2002	872.56	1,259.71

Year	Activity data and emissions from Ammonia Production Subsector	
	Natural gas consumption [kt]	CO ₂ emissions [kt]
2003	1,101.06	1,542.76
2004	1,070.13	1,562.17
2005	1,161.78	1,721.95
2006	1,003.98	1,425.77
2007	919.82	1,214.98
2008	1,038.18	1,531.08
2009	747.10	924.97
2010	1,081.52	1,805.43
2011	1,245.43	1,949.67
2012	1,042.46	1,517.12
2013	700.33	1,080.90

Figure 4.9 The trend of CO₂ emissions from Ammonia Production in the period 1989–2013



4.3.2.2 Nitric Acid Production (CRF 2.B.2)

Methodology

The nitric acid production is a key category only considering the trend criteria (Tier 1, excluding and including LULUCF).

The nitrous oxide and nitrogen oxide emissions were estimated according to the “2006 IPCC Guidelines for National Greenhouse Gas Inventories” for each facility and each year of operation between 1989 and 2013, by using, based on the existing activity data, approach level 2 or approach level 3.

Approach level 2 was used for nitric acid production facilities that do not have continuous emission monitoring systems.

Approach level 3 was used for nitric acid production facilities that have Continuous Emissions Monitoring Systems – CEMS.

Emissions have been calculated by multiplying annual Nitric Acid Production (tons HNO₃ 100% by each plant) by a default emission factor, which reflects the process, in line with 2006 IPCC GL and CORINAIR Methodology. According with the Decision Tree for N₂O Emissions from Nitric Acid Production from 2006 IPCC GL – page 3.22 (Figure 3.2), 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.

Activity data

There were seven chemical plants in Romania in 1989, with ten nitric acid production plants. Seven plants are currently in operation in five chemical plants. The seven plants can be grouped in:

- Medium and high pressure operation facilities (six plants)
- Old facilities, erected before 1975, without NSCR (one plant).

According to the “2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 3. Industrial Processes and Product Use”, the relevant, specific parameters used to estimate the nitrous oxide emissions in approach level 2 are as follows:

- Nitrous oxide emissions
- Emission factor
- Nitric acid production
- The destruction factor for the reduction technology
- The reduction technology utilization factor

According to the “2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 3. Industrial Processes and Product Use”, on the establishment of continuous emission monitoring systems (CEMS), the relevant, specific parameters for approach level 3 are as follows:

- Nitrous oxide emissions (continuous measurements);
- Emission factor;
- Nitric acid production.

Emission factors

The emission factors used in the spreadsheets for approach level 2 reflect the nitric acid production process:

a) For medium and high pressure facilities – “dual pressure” (6 facilities):

- The N₂O emission factor is 8 – 10 kg N₂O/t HNO₃, according to the 2006 IPCC Guideline, Table 3.3 and 2000 IPCC GPG, Table 3.8. A **9 kg N₂O/t HNO₃** average value was used to estimate the emissions, in the absence of continuous emission measurements.

b) For old facilities, commissioned before 1975, without a NSCR, operating under low pressure (one facility):

- The N₂O emission factor is 10 – 19 kg N₂O/t HNO₃, according to the 2000 IPCC GPG, Table 3.8. The **14.5 kg N₂O/t HNO₃** average value was used for the emission estimate, in the absence of continuous emission measurements.

In recent years, most nitric acid production facilities have been fitted with emission reduction and monitoring systems, leading to the drop of emissions. The nitric acid productions submitted by economic agents were compared to the productions acquired from the National Institute of Statistics, and it was discovered that the HNO₃ production registered by the National Institute of Statistics is constantly lower than that reported by the economic agents. This can be explained

through the fact that certain economic agents do not report the production values, as they are confidential.

The analysis of the N₂O emission level tend was carried out under the following conditions:

- The HNO₃ production facilities are old, as they were erected between 1963 and 1978;
- The HNO₃ production technologies have not changed in the last 40 years;
- Catalyst repair, maintenance and replacement works were carried out in the facilities;
- Nitrogen oxide reduction systems and emission monitoring systems have been mounted since 2003;
- A facility, shut down its operation in 1990;
- Another facility, shut down its operation in 2008;
- There are currently five chemical plants, where seven HNO₃ production facilities are in operation;
- Six operating HNO₃ production facilities are fitted with nitrogen oxide reduction and emission monitoring systems;
- Upgrading efforts are made in all seven operating HNO₃ production facilities, to reduce nitrogen oxide emissions.

In the Table 4.20 are presented the estimations of the N₂O 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 4.19 Nitric Acid Production related to the N₂O emissions in the period 1989–2013

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 ₂ O Emissions [kt]	N ₂ O Emissions [kt]
1989	1,993.70	1.06	17.28
1990	1,260.98	0.81	10.85

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 ₂ O Emissions [kt]	N ₂ O Emissions [kt]
1991	741.95	0.33	6.47
1992	1,051.09	0.46	9.17
1993	1,024.76	0.45	8.94
1994	884.85	0.14	7.88
1995	1,025.81	0.10	9.17
1996	1,057.15	0.05	9.48
1997	768.56	0.07	6.88
1998	547.69	0.05	4.90
1999	609.55	0.16	5.38
2000	874.12	0.26	7.70
2001	750.72	0.31	6.56
2002	795.35	0.10	7.09
2003	960.24	0.07	8.60
2004	1,059.14	0.45	9.25
2005	1,102.14	0.21	9.79
2006	869.25	0.36	7.60
2007	981.38	0.28	8.66
2008	867.39	0.56	3.07
2009	642.48	0.31	1.97
2010	1,055.38	0.50	3.48
2011	1,076.96	0.68	3.29
2012	983.80	0.55	2.80
2013	949.58	0.23	1.48

HNO₃ production trend

The HNO₃ production trend decreased between 1989 and 2001, following the economic decline; several low-efficiency production capacities were shut down.

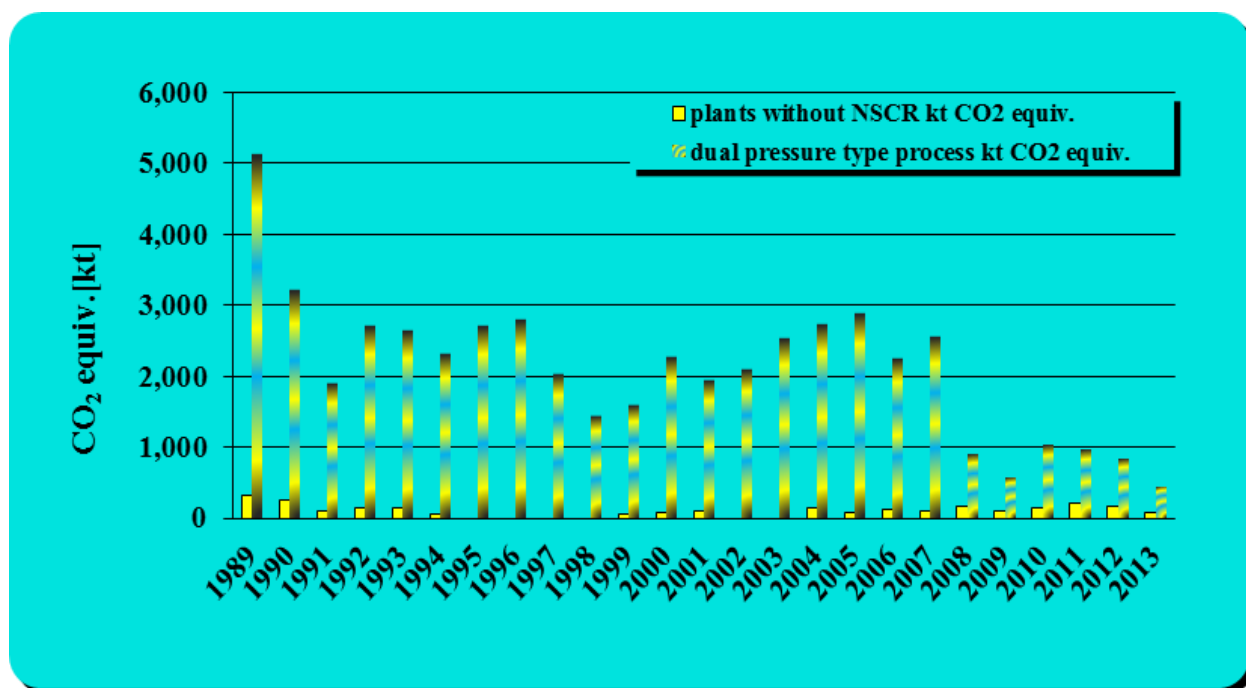
The HNO₃ production trend increased between 2002 and 2013, following the economic recovery; several production capacities were upgraded.

N₂O emission level trend

- The emissions decreased between 1989 and 2001, following the decrease of production.
- The emission level was maintained between 2002 and 2007, simultaneous with the production increase. Explanation: technological improvements, catalyst replacement.
- A drop of emissions was registered between 2008 and 2013, while the production level was maintained. Explanation: the mounting of the N₂O reduction systems.

N₂O emission monitoring systems

N₂O emission monitoring systems use analyzers manufactured by internationally renowned companies, designed according to the U.S. EPA 40 CFR 60875 norms and the 2000/76/EC (WID), 2001/80/EC (LCPD) norms. The type of flow analyzers is the MIR 9000 Multi – Gas InfraRed GFC Analyzer.

Figure 4.10 The trend of CO₂ emissions from Nitric Acid Production, 1989–2013

4.3.2.3 Adipic Acid Production (CRF 2.B.3)

Methodology

The default methodology has been followed for estimating the emissions from Adipic Acid Production, according with the 2006 IPCC Guidelines for National GHG Inventories, 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 with 2002, this activity is suspended.

Emission factors***Table 4.20 The default EFs used to estimate emissions from Adipic Acid Production***

EMISSION FACTORS FOR ADIPIC ACID PRODUCTION (KG/TONNE PRODUCT)
N ₂ O
300

4.3.2.4 Caprolactam, glyoxal and glyoxylic acid production (CRF 2.B.4)***Methodology***

Caprolactam, glyoxal and glyoxylic acid production is not a key category. The method for calculating emissions of N₂O from Caprolactam, Glyoxal and Glyoxylic Acid Production is in line with the 2006 IPCC GL (Tier 1 method), considering the “Decision tree for estimation of N₂O emissions from caprolactam, glyoxal or glyoxylic acid production” from 2006 IPCC GL – page 3.36 (Figure 3.4).

Activity data

The caprolactam production data was provided by the National Institute for Statistics. The N₂O emissions from caprolactam production are estimated for the period 1989–2000.

In 2001 the production of caprolactam was stopped. The glyoxal and glyoxylic acid productions are not occurring.

Emission factors

For confidentiality reasons the presentation of N₂O emission factor used to estimate emission from Caprolactam Production is omitted.

4.3.2.5 Silicon Carbide Production (CRF 2.B.5.a)

Methodology

Total CH₄ emissions from Silicon Carbide Production were estimated using the production data and the 2006 IPCC GL emission factor. According with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, page 3.44 the default value on CH₄ emission factor was used, considering that the Silicon Carbide Sub-sector is not a key source category. The CO₂ 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 CH₄ emission factor used to estimate emission from Silicon Carbide Production is omitted.

4.3.2.6 Calcium Carbide Production (CRF 2.B.5.b)

Methodology

Total CO₂ emissions from Calcium Carbide Production were estimated using the production data and calcium carbide use data and the default emission factor, in line with 2006 IPCC GL. According with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the default values on CO₂ emission factor were used (Table 3.8, page 3.44), 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 2006 IPCC GL in order to estimate CO₂ emission from Calcium Carbide Production were used default emission factors provided in production process of calcium carbide: the 1.09 tonnes CO₂/tonne carbide corresponding to the reduction step and the default emission factor of 1.100 tonnes CO₂/tonne carbide corresponding to the use of product. Emissions from the CaO step are reported as emissions from lime production.

Table 4.21 CO₂ emissions from Calcium Carbide Production in the period 1989–2013

Year	Emissions from Calcium Carbide Production Sub-sector
	CO ₂ emissions [kt]
1989	288.77
1990	224.30
1991	176.57
1992	164.04
1993	162.35
1994	127.13
1995	163.49
1996	177.92
1997	151.61
1998	125.04

Year	Emissions from Calcium Carbide Production Sub-sector
	CO ₂ emissions [kt]
1999	91.15
2000	91.85
2001	90.84
2002	86.71
2003	66.48
2004	94.89
2005	60.88
2006	42.78
2007	21.68
2008	13.19
2009	15.82
2010	18.35
2011	13.61
2012	9.39
2013	6.59

4.3.2.7 Titanium Dioxide Production (CRF 2.B.6)

Methodology

Titanium dioxide production is not a ket category. The method for calculating emissions of CO₂ from Titanium Dioxide Production is in line with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Tier 1 method), considering the “Decision tree for estimation of CO₂ emissions from titanium dioxide production” from 2006 IPCC GL - page 3.49 (Figure 3.9).

Activity data

The amount of titanium slag production data was provided by the National Institute for Statistics.

The CO₂ emissions from titanium slag production are noted as IE because are accounted in Energy Sector (1.A.A.2.a.- Iron and steel – liquid fuels sub-sector).

Emission factors

For confidentiality reasons the presentation of CO₂ emission factor used to estimate emission from Titanium Slag Production is omitted.

4.3.2.8 Soda Ash Production (CRF 2.B.7)

Methodology

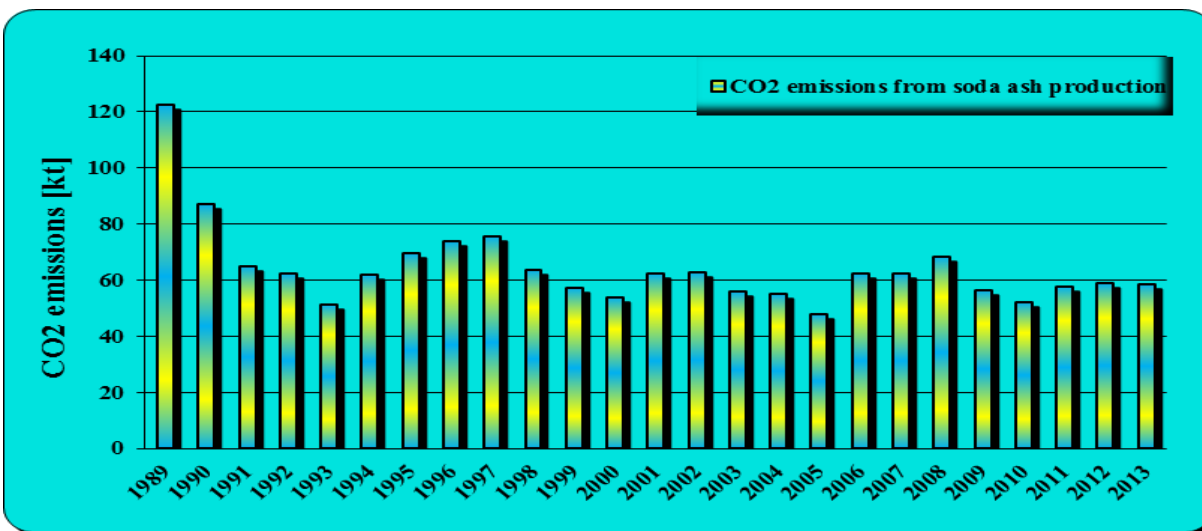
Soda ash production is not a key category. Total CO₂ emissions from Soda Ash Production were estimated using the quantity of trona utilized and the emission factor, in line with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Tier 1 method), considering the “Decision tree for estimation of CO₂ emissions from natural soda ash production from 2006 IPCC GL – page 3.53 (Figure 3.7).

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.

Emission factors

For confidentiality reasons the presentation of CO₂ emission factor used to estimate emission from Soda Ash Production is omitted.

Figure 4.11 CO₂ emissions from Soda Ash Production in the period 1989–2013*Table 4.22 CO₂ emissions from Soda Ash Production in the period 1989–2013*

Year	Emissions from Soda Ash Production Sub-sector
	CO ₂ emissions [kt]
1989	122.57
1990	87.14
1991	64.94
1992	62.32
1993	51.15
1994	61.91
1995	69.49
1996	73.90
1997	75.41
1998	63.70
1999	57.22
2000	53.91
2001	62.22
2002	62.59

Year	Emissions from Soda Ash Production Sub-sector
	CO ₂ emissions [kt]
2003	55.98
2004	54.87
2005	47.70
2006	62.46
2007	62.32
2008	68.11
2009	56.39
2010	51.98
2011	57.49
2012	59.01
2013	58.60

4.3.2.9 Petrochemical and carbon black Production (CRF 2.B.8)

Methodology

Petrochemical and carbon black Production is not a key category. Total CO₂ emissions from from Petrochemical and Carbon Black Production were estimated in line with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Tier 1 method), considering the “Decision tree for estimation of CO₂ emissions from petrochemical industry and carbon black industry from 2006 IPCC GL – page 3.63 (Figure 3.8).

Total CH₄ emissions from from Petrochemical and Carbon Black Production were estimated in line with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Tier 1 method), considering the “Decision tree for estimation of CH₄ emissions from petrochemical industry and carbon black industry” from 2006 IPCC GL – page 3.64 (Figure 3.9).

Activity data

National Statistics provided annually the amounts of these production processes (carbon black, ethylene, methanol, acrylonitrile, ethylene dichloride, ethylene oxide, vinyl chloride monomer, propylene, polystyrene, polyethylene, sulphuric acid, phthalic anhydride, polypropylene, polyvinylchloride, 1, 2 dichloroethane). 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 CO₂ were estimated from those productions.

4.3.2.10 Fluorochemical Production (CRF 2.B.9)***Methodology***

Fluorochemical 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.

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.

4.3.2.11 Other Production (CRF 2.B.10)

Other emissions are not known to be occurring.

4.3.3 Uncertainties and time series consistency

4.3.3.1 Ammonia Production (CRF 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.2 Nitric Acid Production (CRF 2.B.2)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 40 %;
- 40.31 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.3 Adipic Acid Production (CRF 2.B.3)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 15 %;
- EF: 10 %;
- 18.03% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.4 Caprolactam, Glyoxal and Glyoxylic Acid Production (CRF 2.B.4)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 2%;
- EF: 10%;
- 10.20% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.5 Silicon Carbide Production (CRF 2.B.5.a)

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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.6 Calcium Carbide Production (CRF 2.B.5.b)

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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.7 Titanium Dioxide Production (CRF 2.B.6)

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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.8 Soda Ash Production (CRF 2.B.7)

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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.9 Petrochemical and carbon black Production (CRF 2.B.8)

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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.10 Fluorochemical Production (CRF 2.B.9)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 0 %;
- EF: 0 %;
- 0 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.3.11 Other Production (CRF 2.B.10)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 0 %;
- EF: 0 %;
- 0 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.3.4 Category-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 Mineral Industry Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no nonconformities recorded.

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 nonconformities noted are described in the Chapter 4.3.5 – Category–specific recalculations, including changes made in response to the review process and impact on emission trend and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.3.5 – Category–specific recalculations, including changes made in response to the review process and impact on emission trend.

All noted nonconformities 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 *Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend*

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

- methodology, by introducing new categories (soda ash production, caprolactam, glyoxal and glyoxylic acid production, titanium dioxide production):
 - Ammonia Production (CRF 2.B.1)
 - Calcium Carbide Production (CRF 2.B.5.b)
- activity data:
 - Nitric Acid production (CRF 2.B.2)
 - Petrochemical and carbon black Production (CRF 2.B.8)
- emission factors:
 - Nitric Acid production (CRF 2.B.2)
 - Petrochemical and carbon black Production (CRF 2.B.8)

Table 4.23 The effects of recalculations in Chemical Industry Sub-sector

The effects of recalculations in Chemical Industry Sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	11,074.48	10,373.39	-6.33
1990	7,863.83	7,493.61	-4.71
1991	5,234.22	4,919.67	-6.01
1992	6,290.37	5,724.98	-8.99
1993	6,422.36	5,867.73	-8.64
1994	5,738.33	5,102.27	-11.08
1995	6,754.77	6,132.64	-9.21
1996	6,707.73	6,072.85	-9.46
1997	4,655.94	4,179.41	-10.23

The effects of recalculations in Chemical Industry Sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1998	3,331.46	3,489.60	4.75
1999	4,039.31	3,913.01	-3.13
2000	5,547.34	5,274.71	-4.91
2001	4,818.00	4,464.20	-7.34
2002	4,255.10	4,057.23	-4.65
2003	5,233.29	4,855.21	-7.22
2004	5,487.45	5,303.11	-3.36
2005	5,731.84	5,420.25	-5.44
2006	4,759.22	4,547.88	-4.44
2007	4,892.58	4,350.39	-11.08
2008	4,958.80	2,988.30	-39.74
2009	2,218.85	1,757.41	-20.80
2010	3,731.16	3,180.47	-14.76
2011	4,257.36	3,238.58	-23.93
2012	3,704.47	2,632.46	-28.94
2013		1,667.46	

4.3.5.1 Ammonia Production (CRF 2.B.1)

Recalculation have been made for the entire time series.

Recalculations were made as a result of due to the change in the formula CO₂ emissions, taking into account CO₂ emissions going to produce urea.

Table 4.24 Recalculations of CO₂ emissions in the Ammonia Production Sub-sector

The effects of recalculations in Ammonia Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	4,403.96	2,831.13	-35.71
1990	3,438.34	2,423.00	-29.53
1991	2,428.34	1,673.82	-31.07
1992	2,883.47	1,924.24	-33.27
1993	2,825.62	1,934.28	-31.54
1994	2,620.00	1,522.43	-41.89
1995	3,187.29	2,059.71	-35.38
1996	2,948.14	1,927.43	-34.62
1997	1,446.63	535.04	-63.01
1998	696.36	565.46	-18.80
1999	1,480.47	1,045.92	-29.35
2000	2,163.33	1,371.45	-36.60
2001	2,113.41	1,342.37	-36.48
2002	1,998.39	1,259.71	-36.96
2003	2,518.94	1,542.76	-38.75
2004	2,442.19	1,562.17	-36.03
2005	2,666.76	1,721.95	-35.43
2006	2,305.40	1,425.77	-38.16
2007	2,120.93	1,214.98	-42.71
2008	2,380.62	1,531.08	-35.69
2009	1,671.10	924.97	-44.65
2010	2,542.69	1,805.43	-29.00
2011	3,020.38	1,949.67	-35.45
2012	2,727.74	1,517.12	-44.38
2013		1,080.90	

4.3.5.2 Nitric Acid production (CRF 2.B.2)

Recalculation have been made for the entire time series.

The recalculations have been made due to improved activity data and emission factors on production of nitric acid of the entire time series.

Table 4.25 Recalculations of CO₂ emissions [kt] in the Nitric Acid Production Sub-sector

The effects of recalculations in Nitric Acid Production Subsector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	5,464.46	5,467.35	0.05
1990	3,459.66	3,473.39	0.40
1991	2,022.17	2,027.12	0.24
1992	2,786.20	2,871.34	3.06
1993	2,781.99	2,799.53	0.63
1994	2,353.29	2,389.18	1.52
1995	2,689.89	2,762.95	2.72
1996	2,853.65	2,841.11	-0.44
1997	2,098.46	2,068.71	-1.42
1998	1,543.78	1,474.60	-4.48
1999	1,703.53	1,653.22	-2.95
2000	2,350.84	2,374.20	0.99
2001	2,047.10	2,048.57	0.07
2002	2,091.01	2,144.81	2.57
2003	2,567.79	2,583.01	0.59
2004	2,843.58	2,891.76	1.69
2005	2,918.94	2,979.79	2.08
2006	2,334.09	2,371.66	1.61
2007	2,718.55	2,663.88	-2.01

The effects of recalculations in Nitric Acid Production Subsector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
2008	2,529.68	1,081.73	-57.24
2009	516.75	679.32	31.46
2010	1,152.25	1,186.08	2.94
2011	1,209.81	1,182.98	-2.22
2012	953.15	998.76	4.79
2013		508.22	

4.3.5.3 Calcium Carbide Production (CRF 2.B.5.b)

Recalculation have been made for the entire time series.

Recalculations were made as a result of due to the change in the formula CO₂ emissions. The emissions from the CaO step are reported as emissions from lime production and are included in Lime production category.

Table 4.26 Recalculations of CO₂ emissions in the Calcium Carbide Production Sub-sector

The effects of recalculations in Calcium Carbide Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	425.57	288.77	-32.15
1990	322.34	224.30	-30.42
1991	248.01	176.57	-28.81
1992	230.16	164.04	-28.73
1993	226.19	162.35	-28.22
1994	178.05	127.13	-28.60
1995	231.89	163.49	-29.50
1996	258.48	177.92	-31.17
1997	220.77	151.61	-31.33

The effects of recalculations in Calcium Carbide Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1998	180.52	125.04	-30.73
1999	132.19	91.15	-31.05
2000	133.65	91.85	-31.28
2001	131.12	90.84	-30.72
2002	126.99	86.71	-31.72
2003	100.68	66.48	-33.97
2004	142.77	94.89	-33.54
2005	86.72	60.88	-29.80
2006	57.98	42.78	-26.22
2007	21.68	21.68	0.00
2008	13.19	13.19	0.00
2009	15.82	15.82	0.00
2010	18.35	18.35	0.00
2011	13.61	13.61	0.00
2012	9.39	9.39	0.00
2013		6.59	

4.3.5.4 Petrochemical and carbon black Production (CRF 2.B.8)

Recalculation have been made for the entire time series.

The 2006 IPCC GL methodology provides formulas for calculating CO₂ emissions and new emission factors for CH₄.

Table 4.27 Recalculations of CO₂ emissions in the Petrochemical and carbon black Production Sub-sector

The effects of recalculations in Petrochemical and carbon black Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	102.80	880.70	756.75
1990	69.77	624.31	794.79
1991	47.26	440.64	832.36
1992	43.75	321.40	634.57
1993	41.82	343.87	722.23
1994	49.81	439.66	782.63
1995	53.38	448.61	740.38
1996	50.39	430.27	753.88
1997	56.24	488.07	767.86
1998	45.91	375.75	718.52
1999	28.73	371.16	1,192.00
2000	37.73	511.95	1,257.00
2001	31.43	444.42	1,314.14
2002	38.70	503.40	1,200.67
2003	42.02	602.39	1,333.54
2004	47.20	685.47	1,352.35
2005	41.91	589.07	1,305.70
2006	45.53	625.91	1,274.77
2007	31.43	387.53	1,133.13
2008	21.95	278.29	1,168.13
2009	9.17	73.75	704.54
2010	8.11	107.02	1,220.26
2011	1.55	20.52	1,220.24
2012	2.60	34.38	1,220.24

The effects of recalculations in Petrochemical and carbon black Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
2013		1.66	

4.3.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

More detailed data will try to be obtained, in respect to the 2006 IPCC GL provisions.

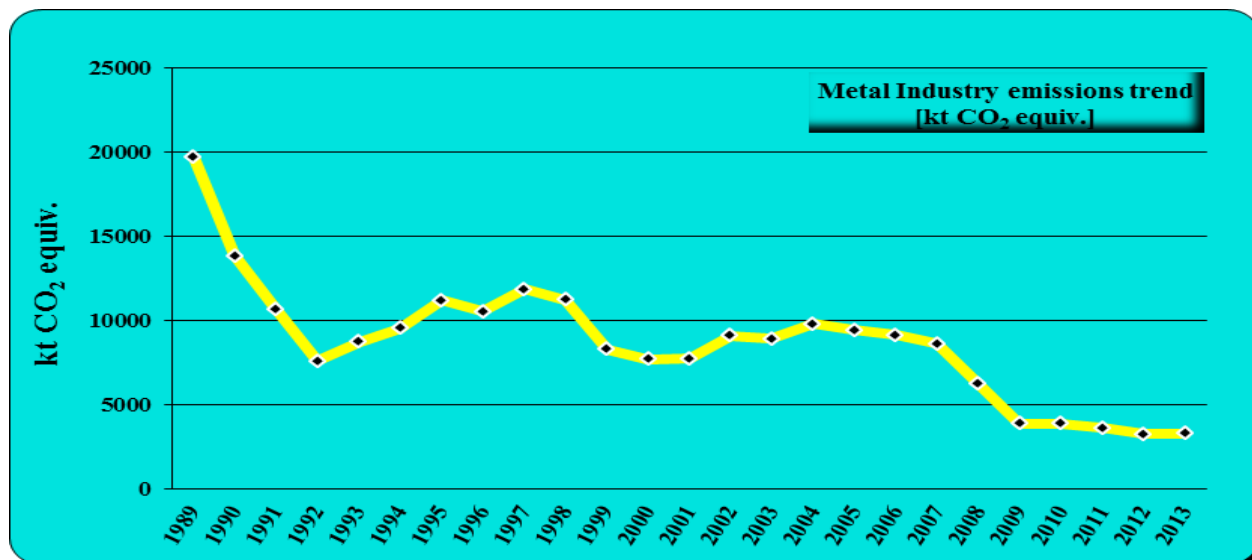
4.4 Metal Industry (CRF 2.C)

4.4.1 Category description

The emission estimates cover sub-categories Iron and Steel Production (CRF 2.C.1), Ferroalloys Production (CRF 2.C.2), Aluminium Production (CRF 2.C.3), Magnesium Production (CRF 2.C.4), Lead Production (CRF 2.C.5), Zinc Production (CRF 2.C.6) and Other (CRF 2.C.7). The use of SF₆ in Aluminium and Magnesium Foundries is not applicable in Romania. Metal Industry Sub-sector is responsible for 31.79% of the total Industrial Processes and Product Use Sector GHG emissions in 2013.

CO₂ emissions from Iron and Steel Production represent an important key category of the inventory because of its contribution to the total inventory level (in 2013 CO₂ emissions from production of iron and steel contributed 2.65% to total greenhouse gas emissions). In the base year, these emissions accounted for 4.99% from the total GHG emissions. The CO₂ emissions from Ferroalloys Production have been included in the inventory.

Aluminium Production results in a smaller quantity of CO₂ 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 1989–2013 period

GHG emissions trend in the Metal Industry Sub-sector for 1989–2013 period due:

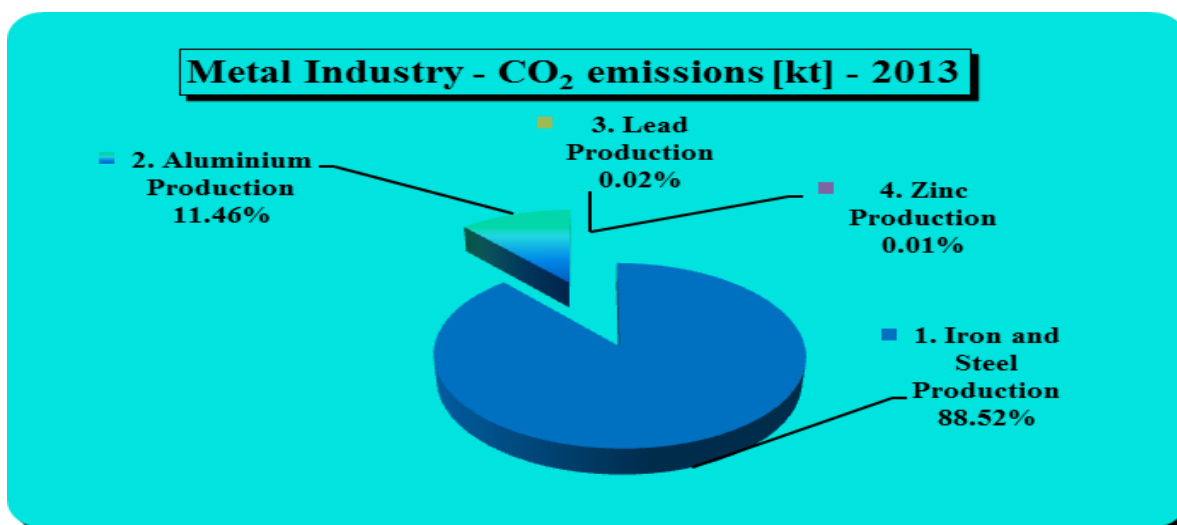
- iron and steel production recorded decreases after 1989;
- ferroalloys production has recorded a decrease after 1989. The lowest level of emissions was recorded in 1999 due to the cease of production;
- the reduction of PFC emissions from production of aluminum due to changes in technology starting with 1997 and 2003;
- after 2008 the trend of emission decreases due to reduction of production level recorded in Iron and Steel Production, Aluminium Production and Ferroalloys Production Sub-sectors;
- in 2010–2013 period the emissions trends have recorded an decrease due to decreased of various production activities (iron and steel production and ferroalloys production sub-sectors).

Table 4.28 GHG emissions from Metal Production Sub-sector, in the year 2013

Sector	CO ₂	CH ₄	PFCs
	CO ₂ equivalent [kt]		
2.C Metal Industry	3,308.156	3.70	6.149

Sector	CO ₂	CH ₄	PFCs
	CO ₂ equivalent [kt]		
2.C.1 Iron and Steel Production	2,933.25	3.70	0.00
2.C.2 Ferroalloys Production	0.00	0.00	0.00
2.C.3 Aluminium Production	373.954	0.00	6.149
2.C.4 Magnesium Production	0.00	0.00	0.00
2.C.5. Lead Production	0.58136	0.00	0.00
2.C.6. Zinc Production	0.37496	0.00	0.00

Figure 4.13 Structure of the Metal Production Sub-sector, in 2013



4.4.2 Methodological issues

4.4.2.1 Iron and Steel Production (CRF 2.C.1)

Methodology

Iron and Steel Production Sub-sector results in a large amount of CO₂ 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).

The method for calculating emissions of CO₂ from Iron and Steel Production is in line with 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Tier 3 method), considering the “Decision tree for estimation of CO₂ emissions from iron and steel production” from 2006 IPCC Guidelines - page 4.20 (Figure 4.7) and taking into account all the information provided by each Iron and Steel Production company.

Because, for Romania, iron and steel production is key category is required using Tier 3 method. The method for calculating emissions of CH₄ from Iron and Steel Production is in line with 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Tier 1 method), considering the “Decision tree for estimation of CH₄ emissions from iron and steel production” from 2006 IPCC Guidelines - page 4.20 (Figure 4.8) and taking into account all the information provided by each Iron and Steel Production company.

Activity data

The data collection was performed based on questionnaires sent to the economic agents identified by the Local Agencies for Environmental Protection.

Questionnaires were made for the three methods for iron and steel production and they were made in accordance with the requirements of the IPCC 2006 methodology (Tier 3 method).

The questionnaire for the assessment of the emissions from iron and steel production on the integrated flow contains requirements for the two subsequent processes: sinter production and iron and steel production in furnaces and basic oxygen furnaces.

The questionnaires include elements for the identification of the economic agent, contact data, and request data from the period between 1989 and 2013.

The data requested for the assessment of the emissions from sinter production and iron and steel production are shown in the tables below.

Table 4.29 Data requested for the sinter production process

Parameter type	Quantity, t or GJ	Average carbon content, tC/t product or tC/GJ
Iron ore	√	√

Parameter type	Quantity, t or GJ	Average carbon content, tC/t product or tC/GJ
Coke breeze	√	√
Limestone	√	√
Dolime	√	√
Other materials with carbon content	√	√
Sinter produced	√	√
Coke gas used in sinter production	√	√
BF gas used in sinter production	√	√

Table 4.30 Data types for the iron and steel production on the integrated flow

Parameter type	Quantity, t or GJ	Average carbon content, tC/t product or tC/GJ
Sinter	√	√
Coal dust	√	√
Coke	√	√
Limestone	√	√
Dolime	√	√
Other materials (ex. Plastics, coke by-product)	√	√
Steel	√	√
Pig iron produced and not transformed in steel	√	√
Coke gas used to BF/BOF	√	√
BF gas transferred outside installation (sold)	√	√
BF gas transferred to sinter plant	√	√

Since the data requirements for the assessment of the emissions from iron and steel production on the BF-OF flow are similar to those for the BF-BOF flow, there was no separate questionnaire and the questionnaire for the integrated flow were used.

The data required for the assessment of the emissions from steelmaking in electric arc furnaces are:

- quantity of scrap iron used in electric furnaces for electric raw steel production, tonnes/year
- average carbon content of the scrap iron (weighted average), %
- quantity of raw steel produced in electric furnaces, tonnes/year
- average carbon content in raw steel (weighted average), %
- electrode consumption, tonnes/an
- average carbon content in electrodes (weighted average), %
- consumption of other carbon content materials, tonnes/year
- average carbon content on other materials (weighted average), %

For assessing the emissions from steelmaking in induction furnaces, the following data were requested:

- quantity of reduction agent used for iron production (metallurgical coke, coal, oil coke, coal dust, other), tonnes/year;
- average carbon content in the reduction agent (weighted average), %;
- quantity of iron used for the making of raw steel in induction furnaces, tonnes/year;
- average carbon content in the iron used for making raw steel in induction furnaces (weighted average), %
- quantity of raw steel made in induction furnaces, tonnes/year;
- average carbon content in the raw steel obtained from iron made in induction furnaces (weighted average), %.

The data requested for the assessment of the emissions from iron/steel production in cupola furnaces are:

- quantity of reduction agent used for iron production (metallurgical coke, coal, oil coke, coal dust, other), tonnes/year;

- average carbon content in the reduction agent (weighted average), %.

Since some of the economic agents do not produce iron and steel with a single technology and since the production structure has changed in the last 25 years, the data were centralized according to technology type.

Emission factors

Estimation of CO₂ Emissions for Iron and Steel Production (CRF 2.C. 1) for 1989–2013 period

From the analysis of data received against the data from energy balance was decided that given the most complete character of the energy balance for quantities of reduction agents used in EAF, cupola and induction furnaces steel/iron making process, the CO₂ emissions released from this reduction agents will be calculated and reported in the energy sector. Emissions from the use of coke and coal dust from BF-BOF steel are calculated and reported under 2.C.1. category, also emissions from electrode consumption in EAF steel making process.

Estimation of CO₂ emissions for the Integrated Flow

In Romania is only one economic unit which produces iron and steel with the integrated flow.

The data reported by this unit include the sinter production sector and the iron production in furnaces and steel production in basic oxygen converters.

The emissions of CO₂ were calculated based on the data provided by the economic agent and considering the structure of the data provided. Since the activity data and the carbon contents of the materials provided in the questionnaire on iron and steel production also cover the activity data for the sinter production sector, and considering that such data were reported and checked at EU–ETS, it was decided to use them as basis for the calculation.

The CO₂ emissions were calculated with the Tier 3 method presented in IPCC 2006 Guide, for the period 1989-2013. Where there were no data, the following assumptions were used:

- For the carbon content in the furnace gas and coke gas, specific values of the economic unit calculated in specific studies were used;

- The quantity of coal dust and coke used for the period 1989-2006, was calculated based on the specific quantities used in 2007;
- The quantities of limestone and dolomite used in process for the period 1989–2011 are estimated based on average value of specific quantity (t limestone/t BOF steel and t dolomite/t BOF steel) used in the period 2012–2013;
- The average carbon contents for coke, coal dust, limestone, dolomite, and steel for the period 1989–2006 are those in the last year for which there are specific analyses, namely 2007.

The table below shows the CO₂ emissions estimated for the period 1989–2013.

Table 4.31 CO₂ emissions estimated for the period 1989–2013

Year	CO₂ emissions [kt CO₂ equivalent]
1989	11,661.95
1990	8,846.24
1991	6,718.28
1992	4,849.35
1993	5,015.37
1994	5,534.77
1995	6,872.59
1996	6,260.62
1997	7,625.33
1998	7,551.99
1999	5,517.22
2000	5,661.09
2001	6,011.36
2002	7,744.43
2003	7,921.69
2004	8,840.00

Year	CO₂ emissions [kt CO₂ equivalent]
2005	8,618.03
2006	8,443.91
2007	7,998.31
2008	5,640.97
2009	3,528.20
2010	3,482.39
2011	3,232.41
2012	2,826.04
2013	2,912.20

Estimation of CO₂ emissions for the Electric Flow

In Romania, there are several economic units which produce steel in electric arc furnaces. The emissions of CO₂ were calculated with the Tier 3 method based on the data provided by the economic units and considering the data structure of the data provided by them.

The emissions from the reduction agents used was not take into account, except the electrode consumption. These emissions are calculated and reported under Energy sector.

For the calculation of the CO₂ emissions for the units which have not reported enough data and for the units that have been shut down and who have not reported, a weighted emission factor was calculated for each year in the period 1989–2013. This emission factor was applied to the difference between the EAF steel production and the quantities provided by NIS (National Institute of Statistics).

The table below shows the CO₂ emissions estimated for the period 1989–2013.

Table 4.32 CO₂ emissions estimated for the period 1989–2013

Year	Total CO₂ emissions EAF [kt CO₂ equivalent]
1989	342.74
1990	195.01
1991	139.80
1992	93.26
1993	108.12
1994	109.64
1995	98.82
1996	84.89
1997	77.82
1998	62.14
1999	39.36
2000	39.29
2001	39.24
2002	34.02
2003	34.45
2004	42.60
2005	45.79
2006	40.59
2007	31.13
2008	23.63
2009	12.85
2010	24.38
2011	26.72
2012	25.75
2013	21.05

Estimation of CO₂ emissions for steel/iron production in Induction Furnaces

In Romania, there are several economic units which produce steel or iron in induction furnaces. The process of iron and steel making in induction furnaces consist mainly in melting the iron and steel scraps. Considering the fact that emissions from the reduction agents used was not take into account (the emissions are calculated and reported under Energy sector category) and this represent almost all the emissions from this type of steel/pig iron production was assume that are no emissions from this category.

Estimation of CO₂ Emissions for Iron Production in Cupola Furnaces

In Romania, there are several economic units which produce iron in cupola furnaces. The process of iron making in cupola furnaces consist mainly in melting the iron ore or scraps steel based on reduction agents (coke, coal, different wastes) consumption.

Considering the fact that emissions from the reduction agents used was not take into account (the emissions are calculated and reported under Energy sector category) and this represent almost all the emissions from this type of steel/pig iron production was assume that are no emissions from this category.

Estimation of CO₂ Emissions for Steel Production with the OH Flow

In Romania, the steel production in Siemens-Martin furnaces took place in two economic units and was ceased in 1999.

However, data have been collected from one of the economic agents, data which are insufficient for the calculation of emissions with the Tier 3 methodology.

Therefore, emissions were calculated by applying the default emission factor from IPCC 2006 (1.72 t CO₂/t steel) to the activity data. For the period 1993-1999, the data for Romania provided by World Steel Statistics were used as activity data, and for the period 1989-1992 the collected data were used as activity data.

The table below shows the CO₂ emissions estimated.

Table 4.33 CO₂ emissions for steel production in OHF

Year	CO₂ emissions [kt CO₂ equivalent]
1989	2,853.33
1990	1,739.96
1991	1,029.03
1992	731.27
1993	1,644.32
1994	1,735.48
1995	1,664.96
1996	1,611.64
1997	1,608.20
1998	1,155.84

Estimation of CO₂ Emissions for Iron and Steel Production (CRF 2.C.1)

CO₂ emissions for Iron and Steel Production during the period 1989–2013, represent the sum of CO₂ emissions for the flows/technologies shown in the previous subchapters.

Table 4.35 shows these emissions, as well as the total corresponding to Iron and Steel Production category (CRF 2.C.1).

Table 4.34 CO₂ emissions from Iron and Steel Production for the 1989–2013 period

Year	CO₂ emissions [kt CO₂ equivalent]					Total CO₂ emissions [kt CO₂ equivalent]
	BOF	EAF	CI	Cupola furnace	OHF	
1989	11,661.95	342.74	0.00	0.00	2,853.33	14,858.01
1990	8,846.24	195.01	0.00	0.00	1,739.96	10,781.22

Year	CO ₂ emissions [kt CO ₂ equivalent]					Total CO ₂ emissions [kt CO ₂ equivalent]
	BOF	EAF	CI	Cupola furnace	OHF	
1991	6,718.28	139.80	0.00	0.00	1,029.03	7,887.11
1992	4,849.35	93.26	0.00	0.00	731.27	5,673.88
1993	5,015.37	108.12	0.00	0.00	1,644.32	6,767.82
1994	5,534.77	109.64	0.00	0.00	1,735.48	7,379.89
1995	6,872.59	98.82	0.00	0.00	1,664.96	8,636.37
1996	6,260.62	84.89	0.00	0.00	1,611.64	7,957.15
1997	7,625.33	77.82	0.00	0.00	1,608.20	9,311.35
1998	7,551.99	62.14	0.00	0.00	1,155.84	8,769.97
1999	5,517.22	39.36	0.00	0.00	557.28	6,113.86
2000	5,661.09	39.29	0.00	0.00	0.00	5,700.37
2001	6,011.36	39.24	0.00	0.00	0.00	6,050.59
2002	7,744.43	34.02	0.00	0.00	0.00	7,778.45
2003	7,921.69	34.45	0.00	0.00	0.00	7,956.14
2004	8,840.00	42.60	0.00	0.00	0.00	8,882.60
2005	8,618.03	45.79	0.00	0.00	0.00	8,663.81
2006	8,443.91	40.59	0.00	0.00	0.00	8,484.51
2007	7,998.31	31.13	0.00	0.00	0.00	8,029.44
2008	5,640.97	23.63	0.00	0.00	0.00	5,664.60
2009	3,528.20	12.85	0.00	0.00	0.00	3,541.04
2010	3,482.39	24.38	0.00	0.00	0.00	3,506.77
2011	3,232.41	26.72	0.00	0.00	0.00	3,259.13
2012	2,826.04	25.75	0.00	0.00	0.00	2,851.79
2013	2,912.20	21.05	0.00	0.00	0.00	2,933.25

Figure 4.14 The trend of CO₂ emissions from Iron and Steel Production (BOF, EAF and OHF) in the period 1989–2013

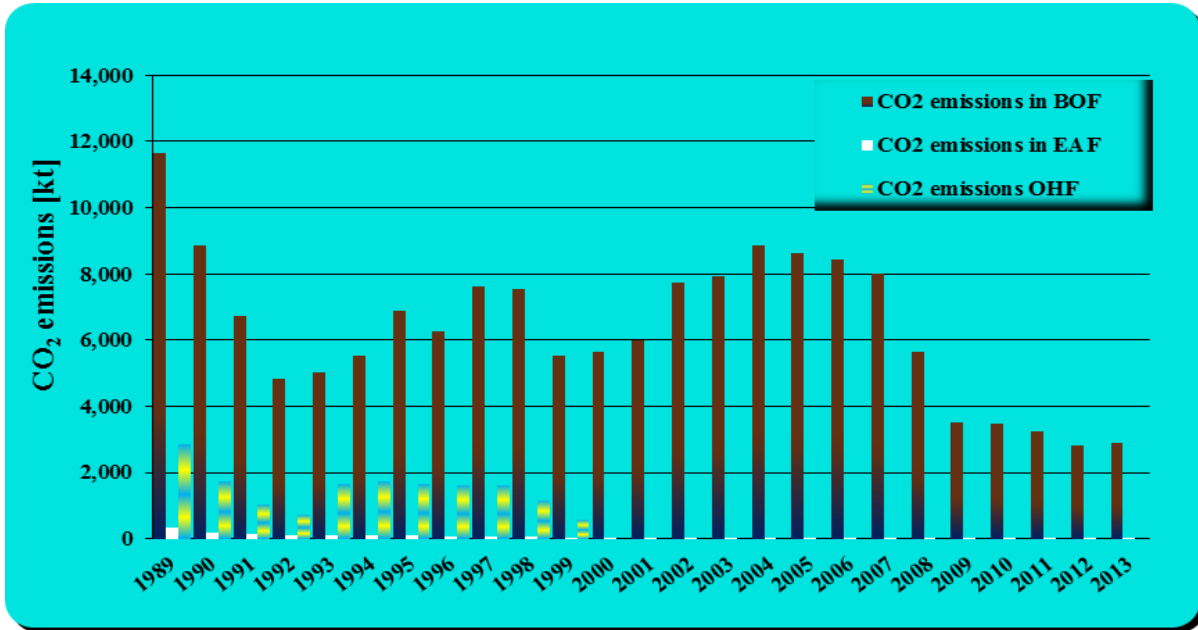
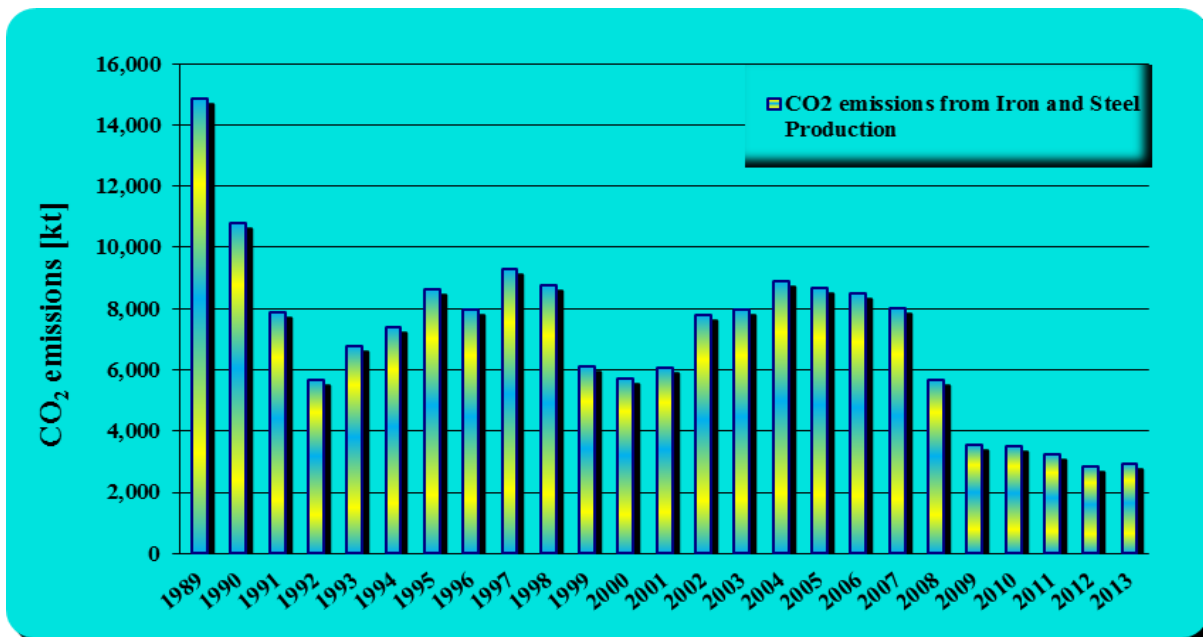


Figure 4.15 The trend of CO₂ emissions from Iron and Steel Production in the 1989–2013 period



Estimation of CH₄ Emissions for Iron and Steel Production (CRF 2.C.1) for the 1989–2013 period

The CH₄ emissions for the period 1989–2013 were estimated based on the Tier 1 methodology in IPCC 2006 (sinter production data x default emission factor).

Table 4.36 shows the CH₄ emissions for category CRF 2.C.1 – Iron and Steel Production.

Table 4.35 CH₄ emissions for Iron and Steel production for the period 1989-2013

Year	Sinter [kt CO₂ equivalent]	Emission factor [kg/t]	CH₄ emissions [kt CO₂ equivalent]
1989	13,626.00	0.07	23.85
1990	11,357.00	0.07	19.88
1991	7,290.00	0.07	12.75
1992	4,761.00	0.07	8.33
1993	3,346.00	0.07	5.85
1994	5,452.00	0.07	9.55
1995	6,671.00	0.07	11.68
1996	5,449.00	0.07	9.53
1997	6,532.00	0.07	11.43
1998	6,514.00	0.07	11.40
1999	4,164.00	0.07	7.28
2000	3,875.00	0.07	6.78
2001	6,185.00	0.07	10.83
2002	6,799.00	0.07	11.90
2003	6,609.00	0.07	11.58
2004	6,601.00	0.07	11.55
2005	6,600.00	0.07	11.55
2006	5,780.00	0.07	10.13
2007	6,359.22	0.07	11.13

Year	Sinter [kt CO₂ equivalent]	Emission factor [kg/t]	CH₄ emissions [kt CO₂ equivalent]
2008	3,445.55	0.07	6.03
2009	1,806.98	0.07	3.15
2010	1,977.60	0.07	3.45
2011	1,841.84	0.07	3.23
2012	1,705.94	0.07	2.98
2013	2,111.45	0.07	3.70

The NMVOC, NO_x, CO, SO₂ emissions are estimated using the default emission factors applied to the first fusion raw Pig Iron Production.

4.4.2.2 Ferroalloys Production (CRF 2.C.2)

The CO₂ and CH₄ emissions within the Production of Ferroalloys Sub-sector are calculated based on the production volume and the emission factors, in line with 2006 IPCC GL. The Ferroalloys Production Sub-sector is not a key source category.

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 CO₂ emissions have increased due to improve the Production of Silicon Manganese.

In 2011–2013 period the Ferroalloys Production and the CO₂ emissions have decreased due to decreasing of the Ferrochromium Production.

Starting with 2002 year there are no emissions of CH₄ because there was no Ferrosilicon 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 CO₂ emission factors used to estimate emission from Ferroalloys Production are omitted.

Table 4.36 CO₂ emission from Ferroalloys Production in the 1989–2013 period

Years	Emissions from Ferroalloys Production Subsector
	CO₂ emissions [kt]
1989	451.72
1990	313.06
1991	233.20
1992	179.21
1993	132.39
1994	208.58
1995	213.79
1996	244.07
1997	142.27
1998	103.83
1999	0.80

Years	Emissions from Ferroalloys Production Subsector
	CO ₂ emissions [kt]
2000	123.07
2001	124.48
2002	118.61
2003	198.92
2004	272.90
2005	165.55
2006	78.65
2007	37.62
2008	19.21
2009	19.99
2010	43.97
2011	32.98
2012	19.11
2013	NO

Table 4.37 CH₄ emission from Ferroalloys Production in the 1989–2013 period

Years	Emissions from Ferroalloys Production Subsector
	CH ₄ emissions [kt]
1989	0.07
1990	0.05
1991	0.03
1992	0.02
1993	0.02
1994	0.03
1995	0.02
1996	0.02

Years	Emissions from Ferroalloys Production Subsector
	CH ₄ emissions [kt]
1997	0.01
1998	0.01
1999	NO
2000	0.01
2001	0.01
2002	NO
2003	NO
2004	NO
2005	NO
2006	NO
2007	NO
2008	NO
2009	NO
2010	NO
2011	NO
2012	NO
2013	NO

4.4.2.3 Aluminium Production (CRF 2.C.3)

Methodology

The Aluminium Production is a key category, only from trend point of view (Tier 1, 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 (CO₂)** 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 **CF₄** and **C₂F₆** 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 **CO₂** 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 **C₂F₆** emissions and also **IPCC GPG 2000 Methodology (Tier 1 Method)** for **CF₄** emissions, considering the type of technology use within the facility.
- **Starting with 2003** the **CO₂** 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 **C₂F₆/CF₄** from **IPCC 2006 Methodology (Tier 2 Method)**.

Activity data

Along the time period (1989–2013), 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 **CO₂** emissions are calculated based on **Aluminium Production** in line with **IPCC 1996 Methodology (Tier 1b Method)**. The calculation of **CO₂** 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 **CF₄ emissions** and **IPCC 1996 Methodology (Tier 1b Method)** for **C₂F₆ emissions**;

- **From 1997 to 2002** the combined technology was used: **SWPB** (Side Worked Pre-baked) and **CWPB** (Center Worked Prebaked) in different percentages. **The CO₂ emissions** are also calculated based on **Aluminium Production** in line with **IPCC 1996 Methodology (Tier 1b Method)**. The calculation of CO₂ 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 **CF₄ emissions** and **IPCC 1996 Methodology (Tier 1b Method)** for **C₂F₆ emissions**;
- **Starting with 2003** the technology was changed to **CWPB** (Centre Worked Pre-baked). **The CO₂ 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 C₂F₆/CF₄ from **IPCC 2006 Methodology**.

Table 4.38 The activity data, PFC and CO₂ emissions from Aluminium Production Sub-sector in the 1989–2013 period

Year	Emissions and activity data from Aluminium Production Sub-sector			
	CF ₄ emissions	C ₂ F ₆ emissions	CO ₂ emissions	Aluminium Production
	[tones]		[kt]	[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

Year	Emissions and activity data from Aluminium Production Sub-sector			
	CF ₄ emissions	C ₂ F ₆ emissions	CO ₂ emissions	Aluminium Production
	[tones]		[kt]	[kt]
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
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
2013	0.70	0.08	373.95	197.25

Emission factors

Along the period 1989–2013 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 **CO₂ emissions** are calculated based on primary Aluminium Production data and the **default EF (1.5 tonnes CO₂/tonne Al)** in line with **IPCC 1996 Methodology (Tier 1b Method)**. The calculation of CO₂ 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 CF₄ emissions and IPCC 1996 Methodology (Tier 1b Method) for C₂F₆ emissions**. **Emissions of CF₄** were estimated by multiplying annual primary Aluminium Production with the default emission factor (**1.7 kg CF₄/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 **C₂F₆ emissions be 1/10 that of CF₄**.
- From **1997 to 2002** period the combined technology was used **SWPB** (Side Worked Pre-baked) and **CWPB** (Center Worked Prebaked) in different percentages. The **CO₂ emissions** are also calculated based on Aluminium Production data and the **default EF (1.5 tonnes CO₂/tonne Al)** in line with **IPCC 1996 Methodology (Tier 1b Method)**. The calculation of CO₂ 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 CF₄ emissions and IPCC 1996 Methodology (Tier 1b Method) for C₂F₆ emissions**; **Emissions of CF₄** were estimated by multiplying annual primary Aluminium Production with the default emission factors (**1.7 kg CF₄/tonne Al – SWPB technology and 0.31 kg CF₄/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 **C₂F₆ emissions be 1/10 that of CF₄**.

- **Starting with 2003** the technology was changed to **CWPB** (Centre Worked Pre-baked).

I. The **CO₂ 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, page 4.45). The **parameters used** in order to estimate the **CO₂ emissions** are: total metal production (aluminium), net prebaked anode consumption, CO₂ molecular mass, ash content in baked anodes, sulphur content in baked anodes, in compliance with the Equation 4.21, page 4.45. At these emissions are added the **emission from decomposition of sodium carbonate** used in electrolysis cell.

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 **CF₄ 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 CF₄ emissions are: Overvoltage coefficients, Anode effect over-voltage, Aluminium Production process current efficiency, total metal production (aluminium), in compliance with the Equation 3.11 from 2000 GPG Methodology.

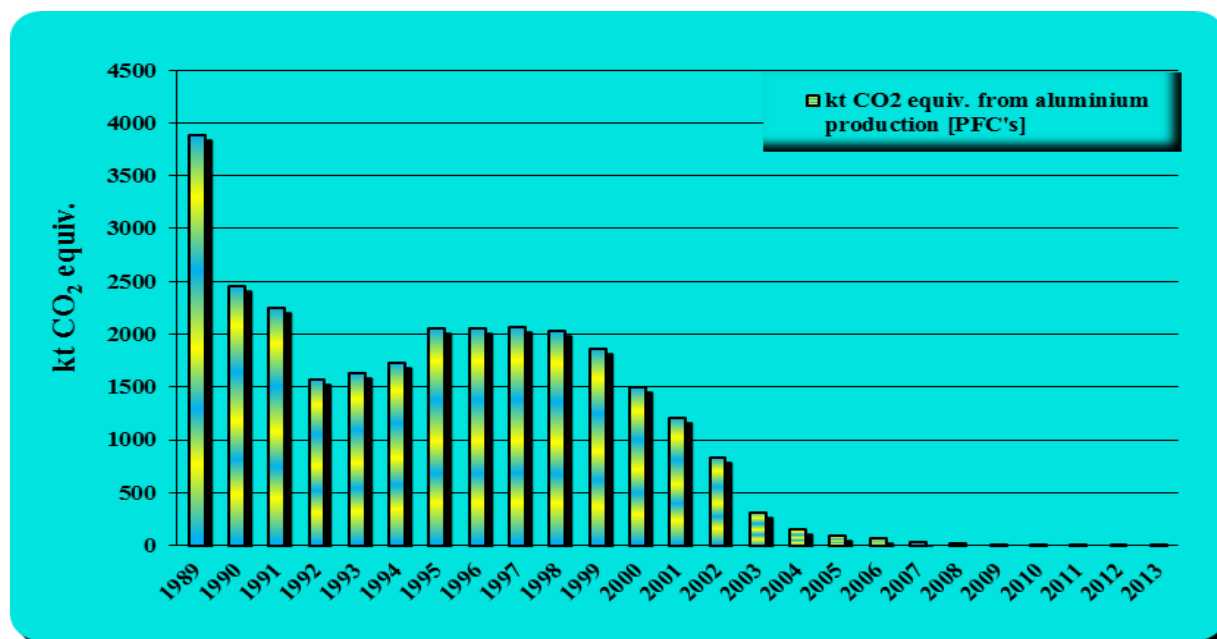
Measurement data are not available to determine smelter-specific Overvoltage coefficients, therefore default coefficients were used (an average parameters from measurements at numerous facilities), compliance with **IPCC 2006 Methodology (Tier 2 Method – Table 4.16 at page 4.54)**: Overvoltage Coefficient = **1.16 [(kg CF₄/tAl) / (mV)]**.

Anode effect overvoltage parameter greatly decreased due to changing production technology leading to lower emission factor for CF₄.

In order to **calculate C₂F₆ emission** there was used the Equation 4.27 at page 4.52 from **2006 IPCC Methodology (Tier 2 Method)**.

The data related with weight fraction of C₂F₆/CF₄, kg C₂F₆/kg CF₄ was in line with **2006 IPCC Methodology (Tier 2 Method – Table 4.16)**: weight fraction is **C₂F₆/CF₄ = 0.121**.

Figure 4.16 *The trend of PFC emissions from Primary Aluminium Production Sub-sector in the 1989–2013 period*



4.4.2.4 Magnesium Production (CRF 2.C.4)

Methodology

Magnesium are not produced in Romania and therefore there are no emissions from manufacturing.

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.

4.4.2.5 Lead production (CRF 2.C.5)

Methodology

The method for calculating emissions of CO₂ from Lead Production is in line with the 2006 IPCC GL (Tier 1), considering the “Decision tree for estimation of CO₂ emissions from lead production” from 2006 IPCC GL – page 4.72 (Figure 4.15).

Activity data

The lead production data was provided by the National Institute for Statistics.

The CO₂ emissions from lead production are estimated for the entire period 1989–2013.

Emission factors

For confidentiality reasons the presentation of CO₂ emission factor used to estimate emission from Lead Production is omitted.

4.4.2.6 Zinc production (CRF 2.C.6)

Methodology

The method for calculating emissions of CO₂ from Zinc Production is in line with the 2006 IPCC GL (Tier 1 method), considering the “Decision tree for estimation of CO₂ emissions from zinc production” from 2006 IPCC GL – page 4.81 (Figure 4.16).

Activity data

The zinc production data was provided by the National Institute for Statistics.

The CO₂ emissions from zinc production are estimated for the entire period 1989–2013.

Emission factors

For confidentiality reasons the presentation of CO₂ emission factor used to estimate emission from Zinc Production is omitted.

4.4.2.7 Other Production (CRF 2.C.7)

Other emissions are not known to be occurring.

4.4.3 Uncertainties and time series consistency

4.4.3.1 Iron and Steel Production (CRF 2.C.1)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 5 %;
- 7.07 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.4.3.2 Ferroalloys Production (CRF 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.4.3.3 Aluminium Production (CRF 2.C.3)

4.4.3.3.1 CO₂ 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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.4.3.3.2 PFC emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 50 %;

- 50.25% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.4.3.4 Magnesium Production (CRF 2.C.4)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 0 %;
- EF: 0 %;
- 0 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.4.3.5 Lead Production (CRF 2.C.5)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 10 %;
- EF: 50 %;
- 50.99 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.4.3.6 Zinc Production (CRF 2.C.6)

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 10 %;
- EF: 50 %;
- 50.99 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.4.4 Category-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 Consumption of Halocarbons and SF₆ 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 4.4.5 – Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend and at the Chapter 10 – Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.4.5 – Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend.

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. 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 CO₂ 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 6.5.

4.4.5 Category-specific recalculation, including changes made in response to the review process and impact on emission trend

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

- methodology, by introducing new categories (lead production, zinc production):
 - Iron and Steel Production (CRF 2.C.1);
 - Ferroalloys Production (CRF 2.C.2);
 - Aluminium Production (CRF 2.C.3).

- *activity data*:
 - Iron and Steel Production (CRF 2.C.1).

- *emission factors*:
 - Iron and Steel Production (CRF 2.C.1);
 - Ferroalloys Production (CRF 2.C.2).

Table 4.39 The effects of recalculations in Metal Industry Sector

The effects of recalculations in Metal Industry Sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	13,721.66	19,685.03	43.46
1990	8,852.98	13,847.78	56.42
1991	6,308.19	10,639.07	68.65
1992	6,677.09	7,617.11	14.08
1993	6,745.94	8,739.85	29.56
1994	7,851.51	9,546.60	21.59
1995	8,959.86	11,188.70	24.88
1996	8,475.97	10,529.68	24.23
1997	8,841.59	11,842.07	33.94

The effects of recalculations in Metal Industry Sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1998	9,128.32	11,239.62	23.13
1999	6,286.39	8,300.18	32.03
2000	6,337.61	7,692.10	21.37
2001	5,650.00	7,761.29	37.37
2002	6,854.72	9,099.15	32.74
2003	5,774.16	8,908.42	54.28
2004	5,979.99	9,787.22	63.67
2005	6,358.10	9,424.77	48.23
2006	7,609.41	9,124.96	19.92
2007	7,855.42	8,627.37	9.83
2008	5,459.11	6,232.22	14.16
2009	3,613.32	3,876.54	7.28
2010	3,374.52	3,884.31	15.11
2011	3,019.02	3,647.97	20.83
2012	2,598.82	3,267.13	25.72
2013		3,318.01	

4.4.5.1 Iron and Steel Production (CRF 2.C.1)

Recalculation have been made for the entire time series.

Recalculations were made as a result of due to the changes in methodology for estimating of CO₂ and CH₄ emissions from iron and steel production, activity data and emission factors.

Table 4.40 Recalculations of CO₂ emissions in the Iron and Steel Production Sub-sector

The effects of recalculations in Iron and steel Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	9,499.64	14,881.86	56.66
1990	6,154.35	10,801.09	75.50
1991	3,886.43	7,899.86	103.27
1992	4,971.36	5,682.21	14.30
1993	5,025.17	6,773.67	34.79
1994	5,957.54	7,389.44	24.03
1995	6,737.91	8,648.05	28.35
1996	6,225.45	7,966.68	27.97
1997	6,646.13	9,322.78	40.27
1998	6,992.31	8,781.37	25.59
1999	4,420.95	6,121.13	38.46
2000	4,644.07	5,707.15	22.89
2001	4,190.49	6,061.42	44.65
2002	5,712.95	7,790.35	36.36
2003	4,936.15	7,967.72	61.42
2004	5,154.35	8,894.15	72.56
2005	5,702.24	8,675.36	52.14
2006	7,061.53	8,494.63	20.29
2007	7,383.41	8,040.56	8.90
2008	5,022.23	5,670.62	12.91
2009	3,287.29	3,544.19	7.81
2010	3,002.98	3,510.22	16.89
2011	2,632.08	3,262.35	23.95
2012	2,184.73	2,854.76	30.67
2013		2,936.95	

4.4.5.2 Ferroalloys production (CRF 2.C.2)

Recalculation have been made for the entire time series.

Recalculations were made as a result of due to the changes of emission factors and the introduction of a method for estimating CH₄ emissions.

Table 4.41 Recalculations of CO₂ emissions in the Ferroalloys Production Sub-sector

The effects of recalculations in Ferroalloys Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	474.15	453.50	-4.35
1990	331.19	314.24	-5.12
1991	248.73	234.03	-5.91
1992	192.81	179.81	-6.74
1993	143.74	132.80	-7.61
1994	225.69	209.28	-7.27
1995	237.53	214.27	-9.79
1996	271.31	244.67	-9.82
1997	163.53	142.51	-12.85
1998	120.61	103.97	-13.80
1999	0.98	0.80	-17.69
2000	141.53	123.28	-12.90
2001	145.59	124.48	-14.50
2002	144.02	118.61	-17.65
2003	241.55	198.92	-17.65
2004	331.39	272.90	-17.65
2005	201.43	165.55	-17.81
2006	95.57	78.65	-17.71
2007	45.68	37.62	-17.65

The effects of recalculations in Ferroalloys Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
2008	21.60	19.21	-11.09
2009	19.99	19.99	0.00
2010	48.95	43.97	-10.17
2011	40.04	32.98	-17.65
2012	23.21	19.11	-17.65
2013		0.00	

4.4.5.3 Aluminium Production (CRF 2.C.3)

Recalculation have been made for the entire time series.

Recalculations were made as a result of due to the change of values of global warming potentials for PFCs.

Table 4.42 Recalculations of CO₂ emissions in the Aluminium Production Sub-sector

The effects of recalculations in Aluminium Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	3,747.87	4,285.07	14.33
1990	2,367.44	2,706.77	14.33
1991	2,173.03	2,484.50	14.33
1992	1,512.92	1,729.77	14.33
1993	1,577.03	1,803.07	14.33
1994	1,668.27	1,907.39	14.33
1995	1,984.43	2,268.86	14.33
1996	1,979.21	2,262.89	14.33
1997	2,031.93	2,318.42	14.10

The effects of recalculations in Aluminium Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1998	2,015.40	2,296.59	13.95
1999	1,864.46	2,121.60	13.79
2000	1,552.01	1,759.23	13.35
2001	1,313.93	1,481.39	12.75
2002	997.75	1,112.88	11.54
2003	596.46	639.50	7.22
2004	494.26	516.01	4.40
2005	454.43	467.89	2.96
2006	452.31	461.37	2.00
2007	426.33	430.32	0.93
2008	415.27	417.80	0.61
2009	306.04	307.19	0.38
2010	322.59	323.88	0.40
2011	346.90	348.69	0.52
2012	390.88	391.93	0.27
2013		380.10	

4.4.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

More detailed data will try to be obtained, in respect to the 2006 IPCC GL provisions.

4.5 Non-energy products from fuels and solvent use (CRF 2.D)

4.5.1 Category description

The emission estimates cover sub-categories Lubricant use (CRF 2.D.1), Paraffin wax use (CRF 2.D.2) and Other (CRF 2.D.3: Solvent use (CRF 2.D.3.a), Road paving with asphalt (CRF

2.D.3.b), Asphalt roofing (CRF 2.D.3.c). Non-energy products from fuels and solvent use Sub-sector is responsible for 1.19% of the total Industrial Processes and Product Use Sector GHG emissions in 2013.

Figure 4.17 CO₂ emissions trend in the Non-energy products from fuels and solvent use Sub-sector for 1989–2013 period

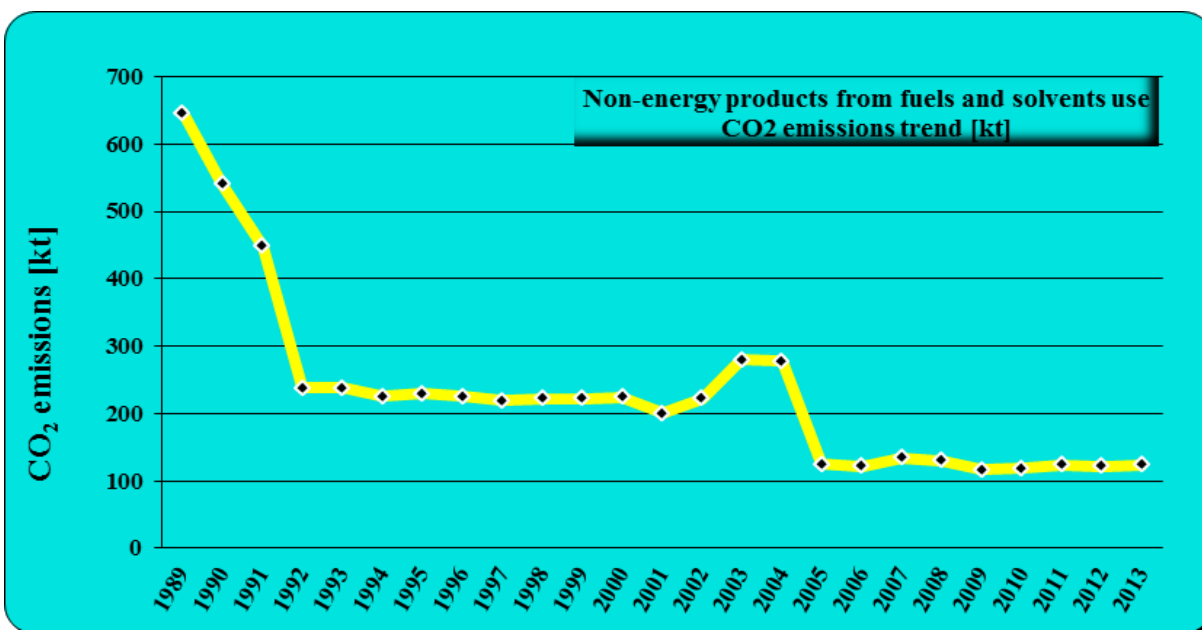


Table 4.43 CO₂ emissions from Non-energy products from fuels and solvent use Sub-sector, in the 2013 year

Sector	CO ₂ emissions
	[kt]
2.D Non-energy products from fuels and solvent use	123.94
2.D.1 Lubricant use	0.05
2.D.2 Paraffin wax use	0.0042
2.D.3 Other	123.89

4.5.2 *Methodological issues*

4.5.2.1 *Lubricant use (CRF 2.D.1)*

Methodology

Lubricants use is not a key source category. The method for calculating emissions of CO₂ from Lubricant use is in line with 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Tier 1 method), considering the “Decision tree for CO₂ from non-energy uses of lubricants” from 2006 IPCC Guidelines – page 5.8 (Figure 5.2).

Activity data

The data on Lubricant use are provided by National statistics, from RO Energy Balance.

Emission factors

CO₂ emissions are calculated according to Equation 5.2 at page 5.7 from 2006 IPCC GL (Tier 1 method) with aggregated default data for the limited parameters available and the ODU factor based on a default composition of oil and greases in total lubricant figures (in TJ units).

The emission factor is composed of a specific carbon content factor (tonne C/TJ) multiplied by the ODU factor. A further multiplication by 44/12 (the mass ratio of CO₂/C) yields the emission factor (expressed as tonne CO₂/TJ). For lubricants the default carbon contents factor is 20.0 kg C/GJ on a Lower Heating Value basis.

4.5.2.2 *Paraffin wax use (CRF 2.D.2)*

Methodology

Paraffin wax use is not a key source category. The method for calculating emissions of CO₂ from Paraffin wax use is in line with 2006 IPCC Guidelines for National Greenhouse Gas Inventories

(Tier 1 method), considering the “Decision tree for CO₂ from non-energy uses of paraffin waxes” from 2006 IPCC Guidelines – page 5.12 (Figure 5.3).

Activity data

The data on Lubricant use are provided by National statistics, from RO Energy Balance.

Emission factors

CO₂ emissions are calculated according to Equation 5.4 at page 5.11 from 2006 IPCC GL (Tier 1 method) with aggregated default data for the limited parameters available.

It can be assumed that 20 percent of paraffin waxes are used in a manner leading to emissions, mainly through the burning of candles, leading to a default ODU factor of 0.2.

4.5.2.3 Solvent Use (CRF 2.D.3.a)

Category description

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 CO₂, which is included in the total greenhouse gas emissions reported to the UNFCCC Secretariat.

Paint Application (CRF 3A), Degreasing and Dry Cleaning (CRF 3B), Chemical Products, Manufacture and Processing (CRF 3C), Other (CRF 3D).

- 3 A source category includes emissions resulted from: domestic use, automobile manufacture and repairing, construction and buildings;
- 3 B source category refers to emissions resulted from metal degreasing, dry cleaning, electronic components manufacturing, other industrial cleaning;

- 3 C 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;
- 3 D 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.

Methodology

Solvents use is not a key source category. 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 4.47).

Table 4.44 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 2015 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

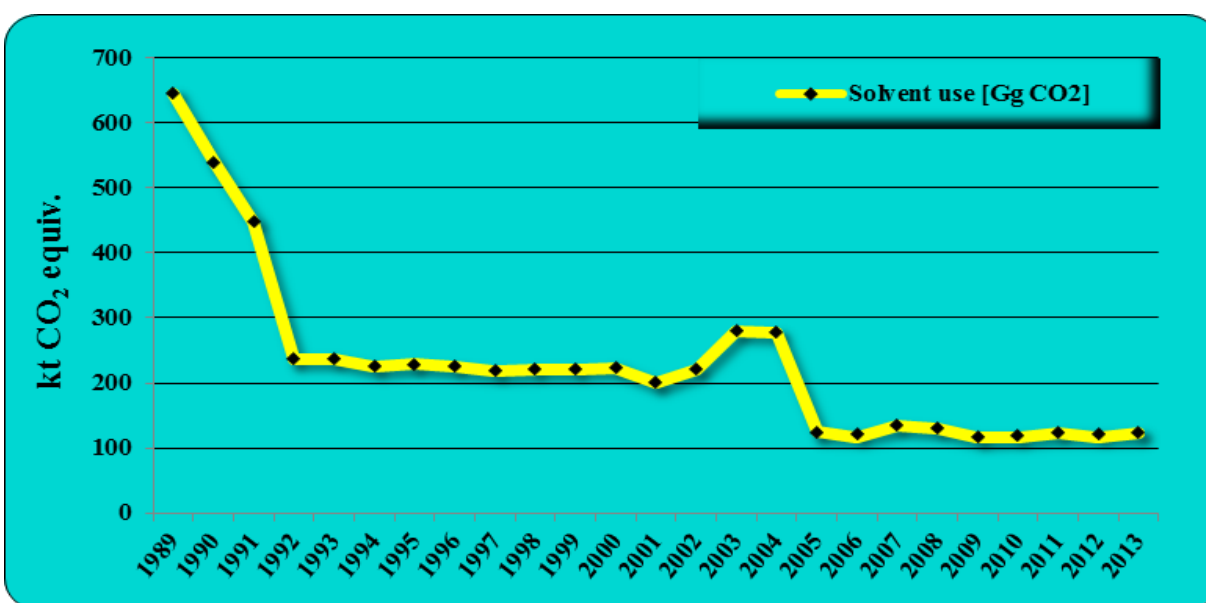
The CO₂ emissions from Solvent Use were calculated from NMVOC emissions of this sector and is calculated using the carbon content conversion factor (0.85) multiplying with (44/12) and multiplying with emissions of the NMVOC.

Table 4.45 CO₂ emissions resulted from Solvent Use in the 1989–2013 period

Solvents Use					
Year	3A	3B	3C	3D	Total
	CO₂ emissions [kt]				
1989	141.19	100.67	0.00	403.92	645.77
1990	111.58	88.20	0.00	340.65	540.43
1991	84.46	70.13	0.00	293.59	448.18
1992	52.05	30.98	0.00	154.59	237.61
1993	51.11	30.98	0.00	155.52	237.61
1994	41.45	30.95	0.00	153.03	225.43
1995	43.95	30.92	0.00	154.59	229.45
1996	39.58	30.89	0.00	154.90	225.37
1997	33.04	30.82	0.00	155.21	219.07
1998	31.48	30.79	0.00	159.57	221.84
1999	30.54	30.76	0.00	161.13	222.44
2000	32.73	30.76	0.00	160.82	224.31
2001	41.45	17.45	0.00	141.50	200.40
2002	45.50	17.77	0.00	158.95	222.22
2003	106.59	21.79	0.00	151.47	279.85
2004	99.76	25.75	0.00	151.82	277.34
2005	22.77	20.33	0.00	81.87	124.98
2006	20.66	19.96	0.00	81.00	121.62
2007	35.37	19.65	0.00	79.63	134.66
2008	25.16	27.29	0.00	78.13	130.58

Solvents Use					
Year	3A	3B	3C	3D	Total
	CO ₂ emissions [kt]				
2009	11.05	24.37	0.00	81.63	117.04
2010	12.39	23.95	0.00	82.73	119.07
2011	14.78	25.62	0.00	83.83	124.23
2012	15.96	24.57	0.00	81.35	121.89
2013	11.19	25.86	0.00	86.85	123.89

Figure 4.18 The trend of CO₂ emissions resulted from Solvent Use Sector, in the 2013 year



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); after 2004 the emissions decreased and are relatively stable from 2005 to 2013.

4.5.3 *Uncertainties and time series consistency*

4.5.3.1 *Lubricant use (CRF 2.D.1)*

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 15 %;
- EF: 50 %;
- 52.20 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989-2013 is consistent.

4.5.3.2 *Paraffin wax use (CRF 2.D.2)*

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 15 %;
- EF: 100 %;
- 101.12% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.5.3.3 Solvent use (CRF 2.D.3.a)

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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.5.4 Category-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 Consumption of Halocarbons and SF₆ Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no nonconformities 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 nonconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 4.5.5 – Category-specific recauculations, if applicable, including changes made in response to

the review process and impact on emission trend and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.5.5 – Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend.

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.

4.5.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

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

- **activity data:**
 - Solvent use (CRF 2.D.3.a)

Recalculation have been made for the entire period.

Recalculations were made as a result of due to the changes in activity data.

Table 4.46 The effects of recalculations in Solvent use Sub-sector

The effects of recalculations in Solvent use Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	645.80	645.77	0.00
1990	540.50	540.43	-0.01
1991	448.20	448.18	-0.01
1992	237.60	237.61	0.01
1993	237.50	237.61	0.05
1994	225.40	225.43	0.01
1995	229.40	229.45	0.02

The effects of recalculations in Solvent use Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1996	225.30	225.37	0.03
1997	219.00	219.07	0.03
1998	221.90	221.84	-0.03
1999	222.40	222.44	0.02
2000	224.30	224.31	0.00
2001	200.50	200.40	-0.05
2002	222.30	222.22	-0.04
2003	279.90	279.85	-0.02
2004	277.40	277.34	-0.02
2005	269.65	124.98	-53.65
2006	208.50	121.62	-41.67
2007	137.82	134.66	-2.29
2008	135.14	130.58	-3.37
2009	122.33	117.04	-4.32
2010	124.74	119.07	-4.55
2011	125.61	124.23	-1.10
2012	127.77	121.89	-4.60
2013		123.89	

4.5.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

More detailed data will try to be obtained, in respect to the 2006 IPCC GL provisions.

4.6 Electronics Industry (CRF 2.E)

4.6.1 Category description

CRF Sector 2.E includes: Integrated circuit or semiconductor (CRF 2.E.1), TFT flat panel display (CRF 2.E.2), Photovoltaics (CRF 2.E.3), Heat transfer fluid (CRF 2.E.4), Other (CRF 2.E.5).

4.6.2 Methodological issues

Methodology

Many modern processes for the manufacture of electronic components use fluorinated chemicals needed for cleaning of reaction chambers, temperature control, plasma etching of complex patterns, etc. This industry emits fluorinated chemical compounds that are gases at room temperature and those which are in liquid form. Such substances include CF_4 , C_2F_6 , C_3F_8 , C_4F_6 , C_5F_8 , CHF_3 , CH_2F_2 , SF_6 and others. Most of the emissions resulting from that small part of the input quantities are fully utilized.

Activity data

In order to collect activity data, a survey of the electronics industry has been conducted using as input data the registration codes (CAEN codes) from the National Trade Register Office. The following codes have been used to identify potential companies in this field:

- 2611 - Manufacture of electronic components;
- 2931 - Manufacture of electrical and electronic equipment for motor vehicles and their engines;
- 2932 - Manufacture of other parts and accessories for motor vehicles and their engines.

Based on the registration codes, 471 companies have been identified. Using the raw data inputs, preliminary direct phone conversations have been carried out to identify the relevance of each

company for the data collection process. During this process, the activity type has been verified in order to validate the scope for the future survey. Based on the conversation, 224 companies have been included in the scope of the survey. For each of these companies, a questionnaire has been prepared by Denkstatt and sent by MMSC to collect (if available) data regarding with the utilization of F-gases. The companies list and the questionnaires are presented in Annex 6 Electronic sector.

The economic entities, which are of interest, are the following:

- Producers of semiconductors;
- Producers of photovoltaic panels;

The survey showed that in Romania there are currently no manufacturers of semiconductors and producers of photovoltaic panels (only 3 assembly companies exist – Siliken, Altius Fotovoltaic and Renovatio Trading). There used to be a manufacturing facility IPRS (Întreprinderea de piese radio și semiconductori) Baneasa, but the production ceased with the transition to market economy and it was subsequently closed down.

NF₃ is only used in the electronics industry for the production of semiconductors and TFT displays as a chamber cleaning gas. We did not find any references in the guidelines for using NF₃ for other purposes. The EU study (http://ec.europa.eu/clima/policies/f-gas/docs/2011_study_en.pdf) does not list Romania as a user of NF₃ - only Germany, Ireland, France, Italy, Austria (7%), Netherlands, Great Britain, Finland, and the Czech Republic are mentioned. Most of the NF₃ emissions may occur from 2.E.1, 2.E.2, 2.E.3 categories and there are no other activities where consumption of NF₃ may occur.

Since no companies returned any data on F-gases consumption, no further data compilation and processing was done.

4.7 Product uses as substitutes for ODS (CRF 2.F)

4.7.1 Category description

Under this F-gases category are considered the following subcategories: Domestic refrigeration (CRF 2.F.1.b), Commercial and industrial refrigeration and air-conditioning (CRF 2.F.1.a,

2.F.1.c, and 2.F.1.f), Transport refrigeration (CRF 2.F.1.d), Mobile air-conditioning (CRF 2.F.1.e), Foam blowing (CRF 2.F.2), Fire protection (CRF 2.F.3), Aerosols/Metered dose inhalers (CRF 2.F.4), Solvents (CRF 2.F.5). Product uses as substitutes for ODS Sub-sector is responsible for 12.45% of the total Industrial Processes and Product Use Sector GHG emissions in 2013.

In 2013 year, the actual emissions from CRF 2F category equal to 1,298.578 kt CO₂eq. are presented in the Table 4.51.

Figure 4.19 GHG emissions trend in the Product uses as substitutes for ODS Sub-sector for 1995–2013 period

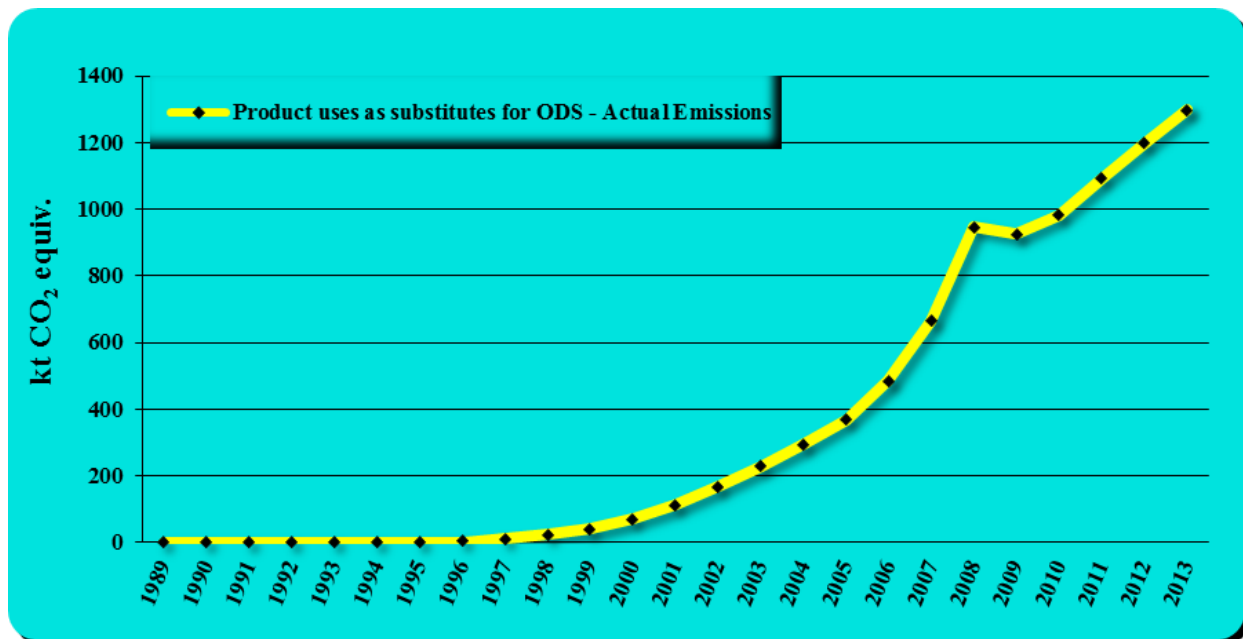
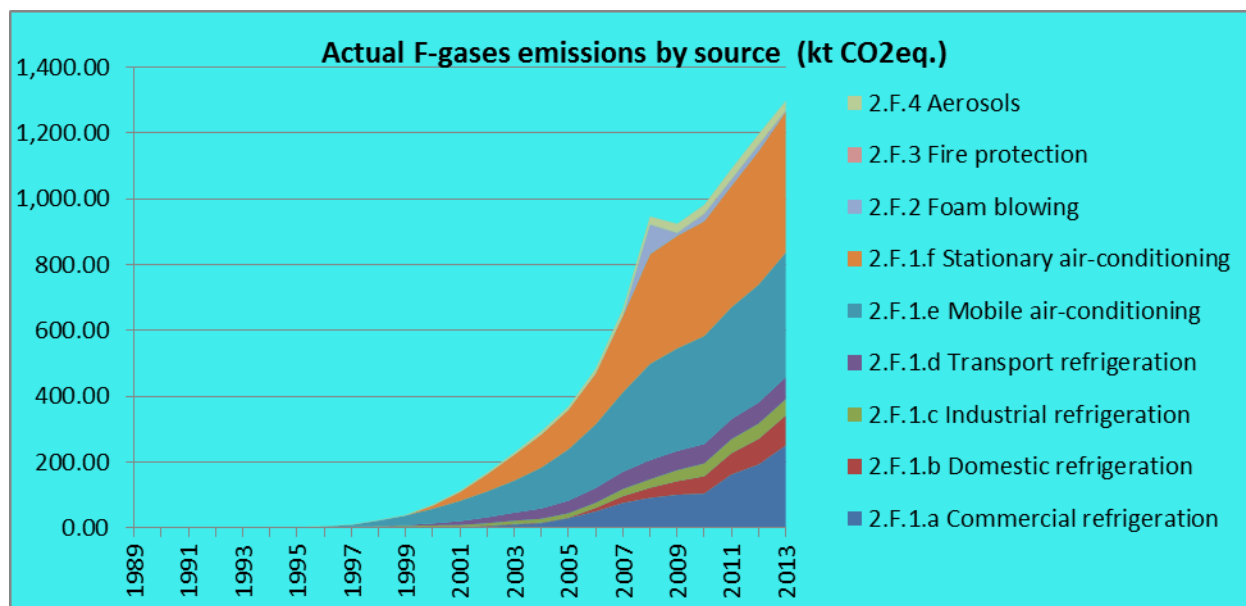


Table 4.47 The Actual emissions in the Product uses as substitutes for ODS Sub-sector for 1989 – 2013 period

Year	Actual emissions (kt CO ₂ eq.)
1989	0.16
1990	0.18

Year	Actual emissions (kt CO₂eq.)
1991	0.29
1992	0.45
1993	0.73
1994	1.20
1995	2.53
1996	4.72
1997	10.36
1998	23.88
1999	39.73
2000	70.82
2001	112.87
2002	168.16
2003	228.75
2004	293.93
2005	368.91
2006	484.20
2007	665.63
2008	946.95
2009	924.42
2010	982.46
2011	1,092.24
2012	1,197.43
2013	1,298.58

There is a stable increasing trend for F-gases emissions, which is valid also for most of the subcategories (Figure 4.20). 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 4.20 Actual F-gases emissions by source for 1989–2013 period

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 method), while the choice of emission factors is mostly based on the default IPCC values or it is based on recent EU studies.

4.7.2 Methodological issues

4.7.2.1 Refrigeration and Air Conditioning Equipment (CRF 2.F.1)

Refrigeration and Air Conditioning Equipment (2.F.1) is a key category from both level and trend point of view (Tier 1, excluding and including LULUCF).

4.7.2.1.1 Commercial Refrigeration (CRF 2.F.1.a)

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.

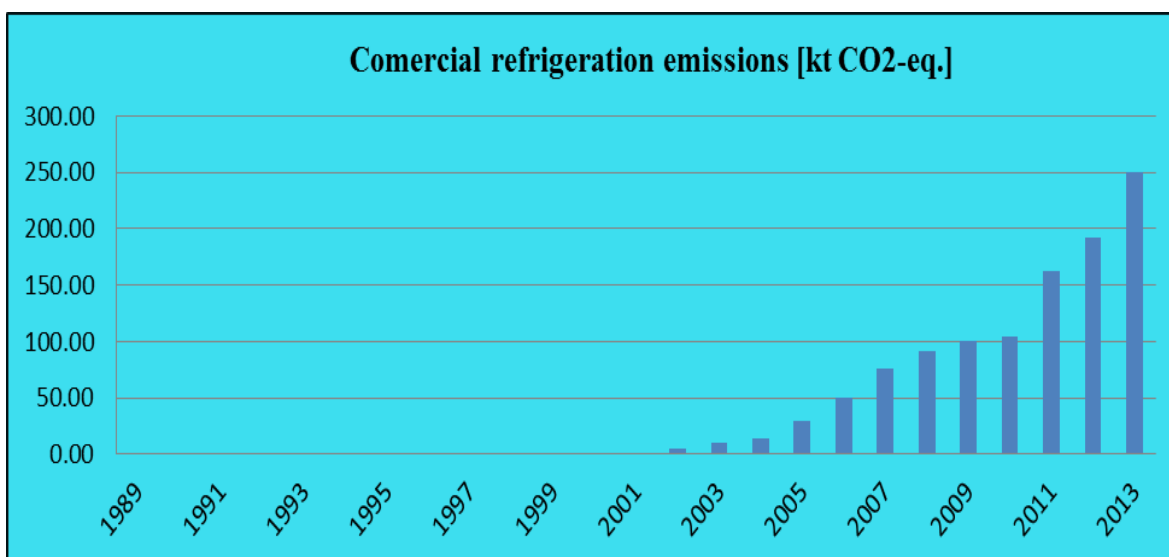
There is also a variety of HFC species, which are used for this sector, but most predominant are R-404A, R-410A, R-407C and HFC-134a.

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 250.29 kt CO₂eq. for 2013 year.

The actual emissions for the period are represented on the Figure 4.21.

Figure 4.21 Actual emissions of the Comercial Refrigeration for 1989–2013 period



The quantity of banked HFCs for this subcategory is estimated at 496 t in 2013 year and is presented in Table 4.48.

Table 4.48 The quantity of banked HFC of the Commercial Refrigeration for 1989–2013 period

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [t HFC]	Operation emissions [t HFC]	Disposal emissions [t HFC]	Actual emissions [kt CO₂eq.]
1989	0	0	0	0	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
1992	0	0	0	0	0	0
1993	0	0	0	0	0	0
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	6	7	0	1	0	4
2003	11	17	0	3	0	10
2004	12	26	0	4	0	14
2005	33	55	0	8	0	29
2006	48	94	0	14	0	50
2007	64	143	0	22	0	76
2008	56	178	0	27	0	91
2009	50	201	0	30	0	100

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [t HFC]	Operation emissions [t HFC]	Disposal emissions [t HFC]	Actual emissions [kt CO ₂ eq.]
2010	41	211	0	32	0	104
2011	127	306	1	46	0	162
2012	111	370	1	56	0	193
2013	182	496	1	74	0	250

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, at page 7.44 from Volume 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.

4.7.2.1.2 Domestic Refrigeration (CRF 2.F.1.b)

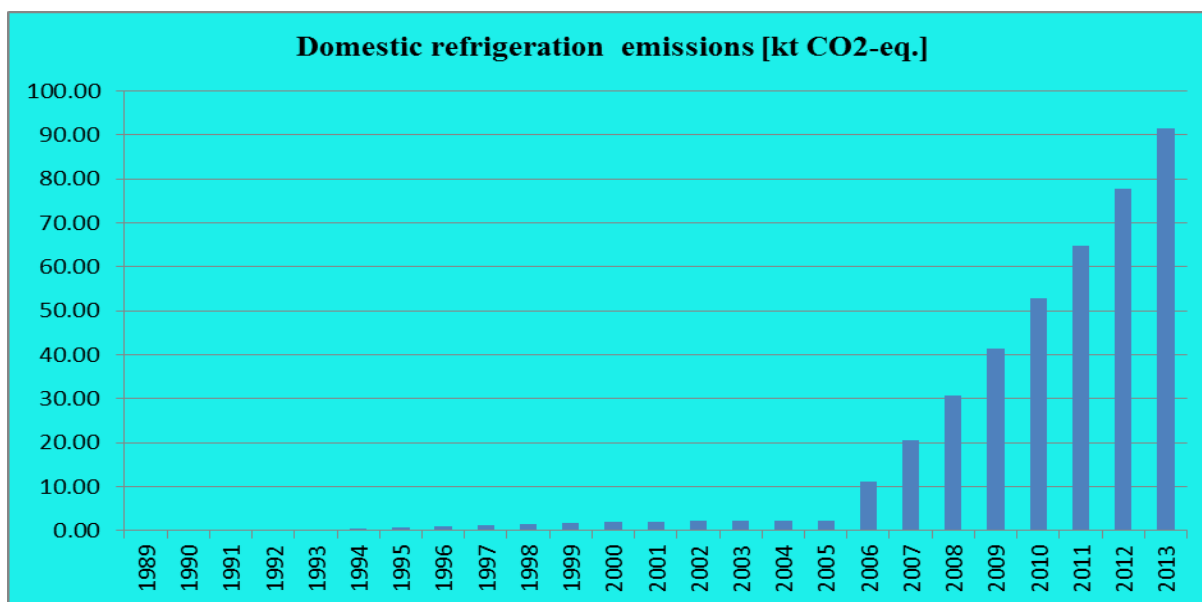
Methodology

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 – 2013 are represented on the Figure 4.22.

Figure 4.22 Actual emissions of the Domestic Refrigeration for 1989–2013 period



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 2013 year from production, operation and decommissioning are equal to 91.6 kt CO₂eq., of which operation emissions are equal to 1.11 Gg.

The detailed results are presented in the Table 4.49.

Table 4.49 The result detailed of the Domestic Refrigeration for 1989–2013 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 [kt CO ₂ eq.]
1989	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1990	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1991	18,181.00	54,428.00	2.00	7.00	7.00	13.00	20.00	0.00	0.05
1992	41,027.00	112,806.00	5.00	14.00	20.00	30.00	60.00	0.00	0.13
1993	69,253.00	174,916.00	8.00	21.00	41.00	50.00	123.00	0.00	0.25
1994	103,852.00	240,959.00	12.00	29.00	70.00	75.00	209.00	0.00	0.41
1995	145,893.00	310,973.00	18.00	37.00	107.00	105.00	321.00	0.00	0.61
1996	196,894.00	385,532.00	24.00	46.00	153.00	142.00	458.00	0.00	0.86
1997	258,996.00	465,793.00	31.00	56.00	208.00	186.00	625.00	0.00	1.16
1998	333,580.00	551,042.00	40.00	66.00	274.00	240.00	821.00	0.00	1.52
1999	323,440.00	490,780.00	39.00	59.00	332.00	233.00	995.00	0.00	1.76
2000	305,233.00	425,453.00	37.00	51.00	382.00	220.00	1,146.00	0.00	1.95
2001	277,187.00	354,929.00	33.00	43.00	423.00	200.00	1,270.00	0.00	2.10
2002	237,472.00	279,335.00	28.00	34.00	456.00	171.00	1,367.00	0.00	2.20
2003	147,929.00	161,146.00	18.00	19.00	474.00	107.00	1,421.00	0.00	2.18
2004	121,632.00	114,059.00	15.00	14.00	486.00	88.00	1,457.00	0.00	2.21
2005	43,075.00	40,087.00	5.00	5.00	489.00	31.00	1,468.00	0.00	2.14
2006	59,806.00	43,971.00	7.00	5.00	487.00	43.00	1,460.00	6,244.00	11.08
2007	67,442.00	59,430.00	8.00	7.00	479.00	49.00	1,438.00	12,940.00	20.63
2008	61,455.00	48,547.00	7.00	6.00	464.00	44.00	1,391.00	20,065.00	30.75
2009	58,843.00	34,436.00	7.00	4.00	439.00	42.00	1,317.00	27,641.00	41.47
2010	68,549.00	50,242.00	8.00	6.00	408.00	49.00	1,224.00	35,672.00	52.83
2011	76,357.00	37,497.00	9.00	4.00	367.00	55.00	1,101.00	44,225.00	64.89
2012	100,423.00	47,576.00	12.00	6.00	318.00	72.00	954.00	53,432.00	77.88
2013	94,024.00	36,663.00	11.28	4.40	258.40	68.00	775.00	63,211.00	91.60

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 4.50.

Table 4.50 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 2003-2013, and for the imports and exports it was for the period 2000–2013. 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 1989–2013.

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 2013, 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 2013 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, has been used the equation below:

Equation 4.2 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.

4.7.2.1.3 Industrial Refrigeration (CRF 2.F.1.c)

Methodology

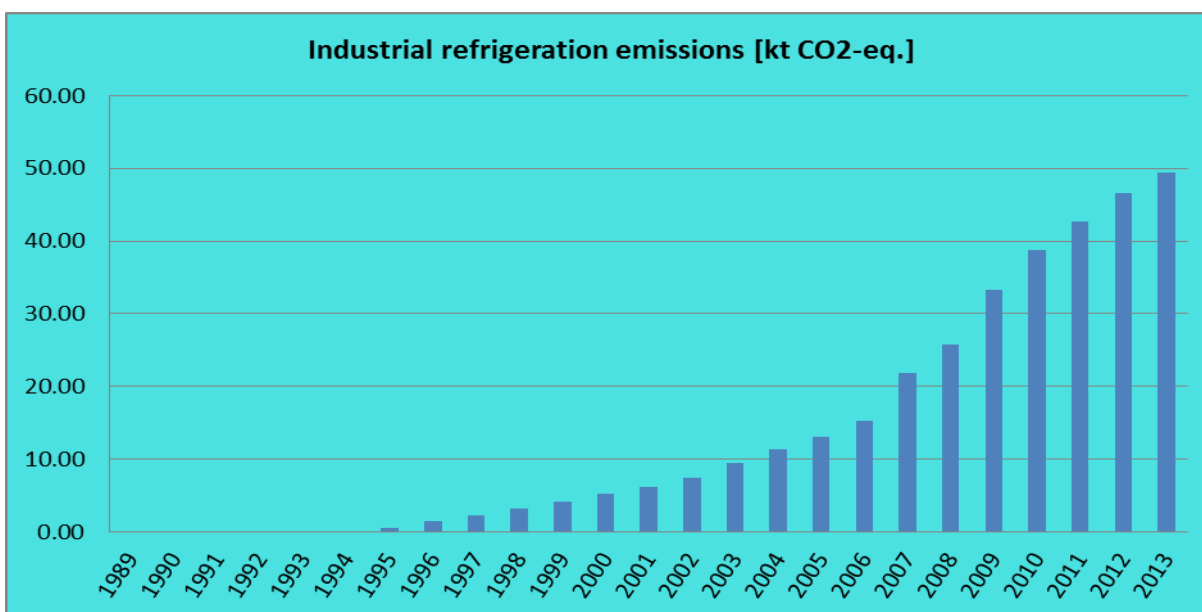
Industrial refrigeration is also an important source of HFC emissions. Similar to commercial refrigeration, after the ban on the CFCs use, imposed by the Montreal Protocol, the main substitute on the market became different types of HFCs. The transition seems to have started as early as 1995 for a limited 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 49.36 kt CO₂eq. for 2013 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 1989–2013 are represented in the Figure 4.23.

Figure 4.23 Actual emissions of the Industrial Refrigeration for 1989–2013 period



The quantity of banked HFCs for this subcategory is estimated at 152 t in 2013 year and is presented in Table 4.51.

Table 4.51 The quantity of banked HFC of the Industrial Refrigeration for 1989–2013 period

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [t HFC]	Operation emissions [t HFC]	Disposal emissions [t HFC]	Actual emissions [kt CO ₂ eq.]
1989	0	0	0	0	0	0.00
1990	0	0	0	0	0	0.00
1991	0	0	0	0	0	0.00
1992	0	0	0	0	0	0.00
1993	0	0	0	0	0	0.00
1994	0	0	0	0	0	0.00
1995	1	1	0	0	0	0.52
1996	2	3	0	0	0	1.40
1997	3	6	0	1	0	2.28
1998	3	8	0	1	0	3.19
1999	3	10	0	1	0	4.15
2000	4	13	0	1	0	5.21
2001	4	16	0	2	0	6.25
2002	5	20	0	2	0	7.38
2003	8	26	0.1	3	0	9.53
2004	8	32	0.1	3	0	11.31
2005	8	37	0.1	4	0	13.12
2006	10	43	0.1	4	0	15.32
2007	21	60	0.2	6	0	21.77
2008	19	72	0.1	7	0	25.80
2009	32	97	0.2	10	0	33.32
2010	28	115	0.2	12	0.18	38.78

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [t HFC]	Operation emissions [t HFC]	Disposal emissions [t HFC]	Actual emissions [kt CO ₂ eq.]
2011	27	130.5	0.2	13	0.32	42.61
2012	27.5	144.4	0.14	14	0.33	46.66
2013	22.4	152	0.07	15	0.35	49.36

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 at page 7.44 from Volume 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.

4.7.2.1.4 *Transport Refrigeration (CRF 2.F.1.d)*

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).

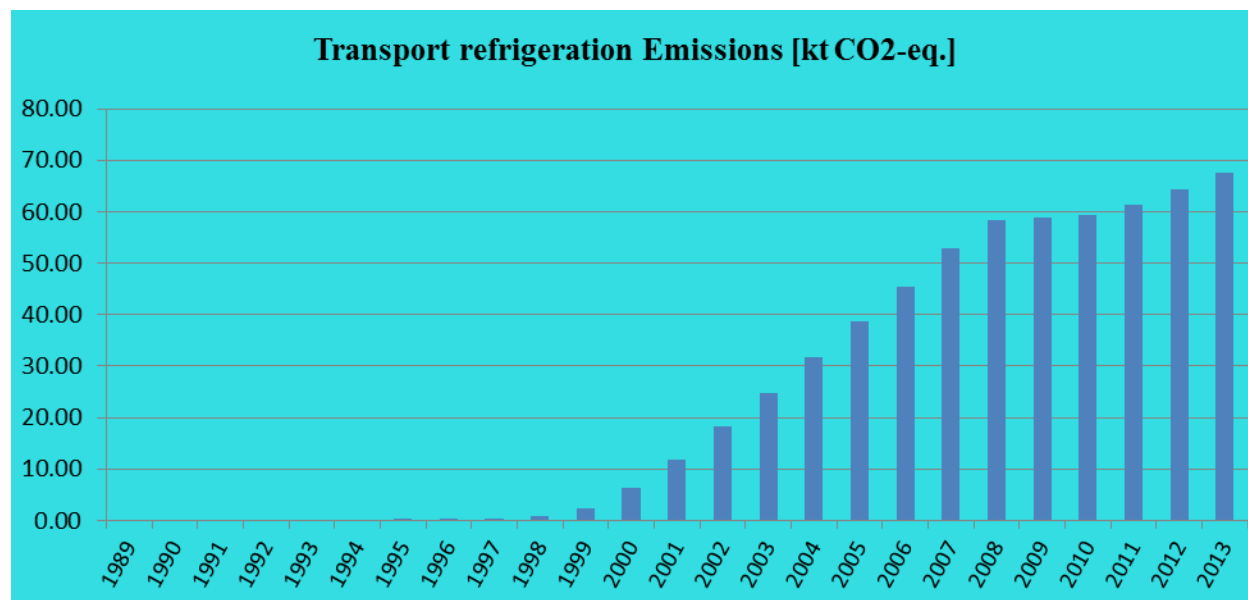
The IPCC guidelines do not provide special guidance regarding different subcategories of transport refrigeration and there is no difference in the proposed ranges by the 2000 IPCC GPG and 2006 IPCC Guidelines.

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 67.49 kt CO₂eq. for 2013 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 1989–2013 are represented on the Figure 4.24.

Figure 4.24 Actual emissions of the Transport Refrigeration for 1989–2013 period

The quantity of banked HFCs for this subcategory is estimated at 94 t in 2013 year and is presented in Table 4.52.

Table 4.52 The quantity of banked HFC of the Transport Refrigeration for 1989–2013 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 [kt CO ₂ eq.]
1989	0	0	0	0	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
1992	0	0	0	0	0	0
1993	0	0	0	0	0	0
1994	0	0	0	0	0	0
1995	20	0	0	9	0	0.01
1996	54	0	0	25	0	0.04

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 [kt CO ₂ eq.]
1997	215	0	0	97	0	0.14
1998	812	1	2	434	0	0.88
1999	1,596	1	4	947	0	2.22
2000	3,174	3	10	2,237	0	6.28
2001	5,221	4	17	3,968	0	11.84
2002	7,271	4	26	5,880	0	18.35
2003	9,376	3	35	7,805	0	24.83
2004	11,476	3	45	9,829	0	31.83
2005	13,591	3	54	11,815	0	38.61
2006	15,762	4	63	13,833	0	45.47
2007	17,903	6	73	15,969	0	52.99
2008	19,890	6	81	17,670	0	58.49
2009	20,291	1	82	17,857	0	58.79
2010	20,522	1	83	18,040	2	59.35
2011	21,559	3	86	18,774	4	61.42
2012	23,001	4	90	19,775	34	64.24
2013	24,400	4	94	20,759	116	67.49

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 through 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 2013 as about 13,000 refrigerated vans and 11,500 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 4.53).

Table 4.53 The total number of Refrigeration trucks with HFC-containing units for 1993–2013 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%

Year	% N1 and N2 trucks with HFC units	% N3 trucks with HFC units
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%
2013	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.

4.7.2.1.5 Mobile Air-Conditioning (CRF 2.F.1.e)

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.

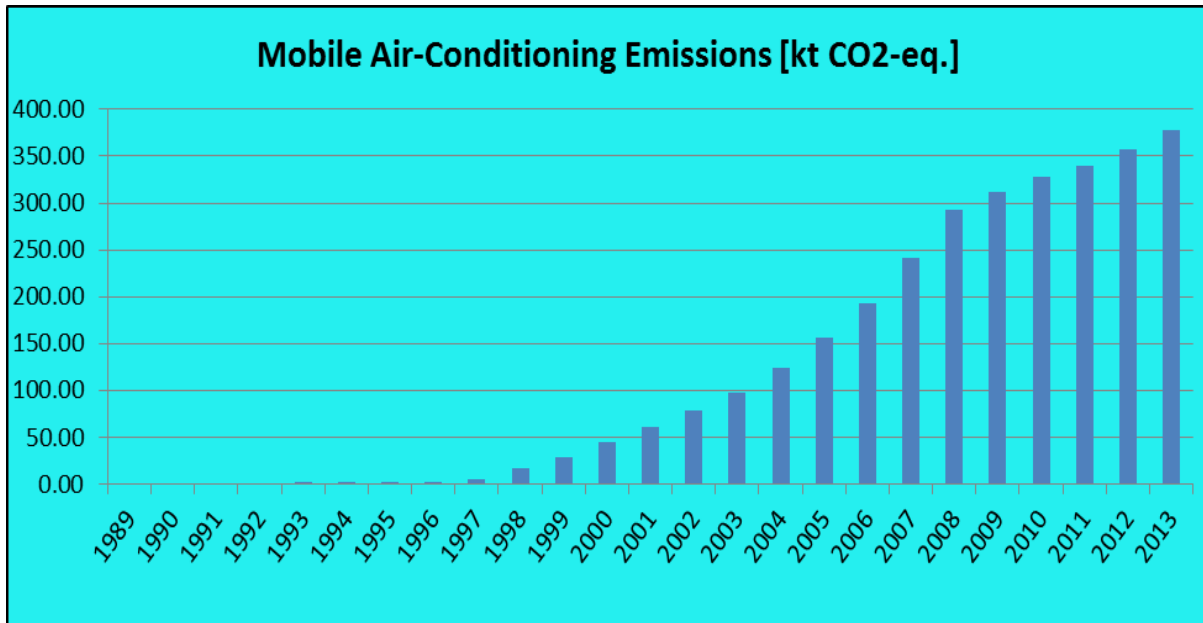
There are three major automobile producers in the country, so the emission estimates also consider initial emissions from mobile air conditioning production.

The aggregated emission estimates for all three subcategories result in total actual emissions of 377.91 kt CO₂eq. for 2013, 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 1989–2013 are represented on the Figure 4.25.

Figure 4.25 Actual emissions of the Mobile Air-Conditioning for 1989–2013 period



The initial emissions are estimated to be around 1.2 t of HFC-134a, while the operation emissions are around 263 t. There is a large quantity of banked HFCs, estimated at 2,463 t in 2013 year and is presented in Table 4.54.

Table 4.54 The quantity of banked HFC of the Mobile Air-Conditioning for 1989–2013 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 [kt CO ₂ eq.]
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	2,258	189	2	0	0	11	31	0	0
1994	5,384	1,012	5	0	1	24	146	0	0
1995	8,577	3,190	8	1	4	39	422	0	1
1996	13,870	8,001	12	2	8	60	967	0	1
1997	20,927	34,535	18	19	34	88	3,737	0	5
1998	30,029	106,180	24	58	103	122	11,317	0	16
1999	41,511	187,876	33	67	182	164	20,194	0	29
2000	55,817	270,570	43	85	269	213	30,695	0	44
2001	66,997	367,000	50	84	368	250	42,588	0	61
2002	80,388	477,597	58	60	470	291	54,383	0	78
2003	68,298	620,959	48	50	589	241	67,609	0	97
2004	92,405	838,813	63	67	762	317	86,190	0	124
2005	170,519	1,116,718	114	74	972	570	108,411	0	156
2006	194,802	1,465,572	128	110	1,223	642	134,412	0	193
2007	224,742	1,926,815	146	142	1,545	730	167,797	0	241
2008	225,569	2,423,527	146	212	1,888	728	203,594	0	292
2009	274,307	2,658,001	175	88	2,018	874	216,804	0	311
2010	323,105	2,870,474	204	34	2,129	1,021	228,299	0	328
2011	309,193	3,014,349	195	19	2,205	977	236,227	0	339
2012	318,853	3,228,814	201	88	2,329	1,003	249,056	0	358
2013	394,971	3,464,389	247	109	2,463	1,236	263,034	0	378

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 1989-2013.

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 4.55 The number of new cars, all cars, trucks and busses with HFC-containing units of MAC for 1993–2013 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%	5%	1%	34%	3%
1994	18%	1%	0%	3%	1%	4%	20%	3%	40%	7%
1995	25%	3%	1%	4%	1%	8%	36%	6%	44%	12%
1996	36%	5%	2%	6%	2%	10%	44%	12%	46%	17%
1997	47%	11%	3%	8%	4%	13%	51%	18%	48%	22%
1998	58%	15%	4%	9%	5%	15%	59%	24%	50%	27%
1999	69%	16%	5%	11%	7%	18%	66%	30%	52%	32%
2000	80%	16%	6%	13%	8%	20%	74%	36%	54%	37%
2001	83%	17%	8%	17%	11%	23%	77%	43%	55%	40%
2002	86%	19%	10%	20%	13%	26%	80%	51%	55%	43%
2003	88%	22%	13%	24%	16%	30%	82%	58%	56%	47%
2004	91%	27%	15%	27%	18%	33%	85%	66%	56%	50%
2005	94%	34%	17%	31%	21%	36%	88%	73%	57%	53%
2006	94%	40%	20%	34%	24%	37%	88%	76%	57%	54%
2007	95%	49%	24%	37%	27%	39%	89%	79%	57%	55%
2008	95%	54%	27%	39%	29%	40%	89%	81%	57%	55%
2009	96%	57%	31%	42%	32%	42%	90%	84%	57%	56%
2010	96%	60%	34%	45%	35%	43%	90%	87%	57%	57%
2011	96%	63%	36%	45%	36%	43%	90%	88%	57%	57%
2012	96%	65%	38%	45%	38%	43%	90%	88%	57%	57%
2013	96%	66%	40%	45%	39%	43%	90%	89%	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 4.3.

Equation 4.3 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 4.56).

Table 4.56 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	11.80	11.94
2002	0.78	0.72	0.90	0.90	1.00	1.00	1.20	1.20	11.60	11.88
2003	0.77	0.70	0.90	0.90	1.00	1.00	1.20	1.20	11.40	11.82
2004	0.75	0.68	0.90	0.90	1.00	1.00	1.20	1.20	11.20	11.76
2005	0.74	0.66	0.90	0.90	1.00	1.00	1.20	1.20	11.00	11.70
2006	0.73	0.65	0.88	0.88	1.00	1.00	1.20	1.20	10.88	11.54
2007	0.71	0.65	0.86	0.86	1.00	1.00	1.20	1.20	10.76	11.38
2008	0.70	0.64	0.84	0.84	1.00	1.00	1.20	1.20	10.64	11.22
2009	0.68	0.63	0.82	0.82	1.00	1.00	1.20	1.20	10.52	11.06
2010	0.67	0.63	0.80	0.80	1.00	1.00	1.20	1.20	10.40	10.90
2011	0.66	0.63	0.80	0.80	1.00	1.00	1.20	1.20	10.40	10.82
2012	0.65	0.63	0.80	0.80	1.00	1.00	1.20	1.20	10.40	10.74
2013	0.64	0.63	0.80	0.80	1.00	1.00	1.20	1.20	10.40	10.66

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.

4.7.2.1.6 Stationary Air-Conditioning (CRF 2.F.1.f)

Methodology

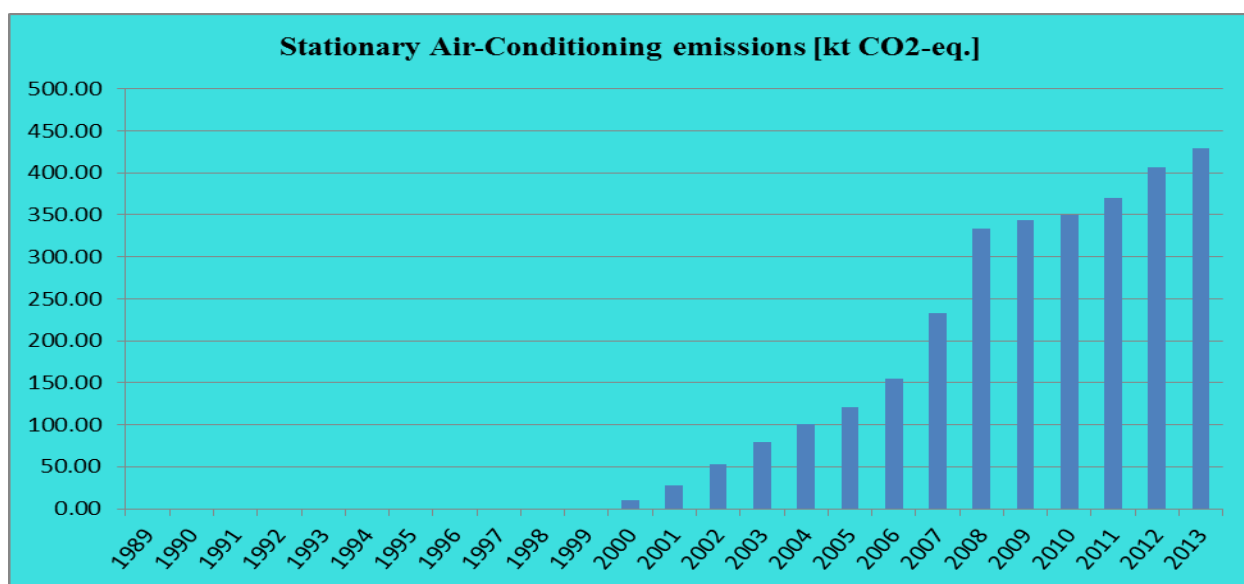
Stationary air-conditioning is one of the fastest growing subsectors from all F-gas emissions, which is due to the rapidly increasing number of air-conditioning units in operation since 2000.

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 4.26.

Figure 4.26 Actual emissions of the Stationary Air-Conditioning for 1989–2013 period



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 2013 year banked quantities are equal to more than 4,000 tons, with additional 429 tons in heat pump units (Table 4.57). Combined with a higher operation emission factor (related to domestic refrigeration), this leads to significant emission equal to 398.58 kt CO₂ eq. from AC equipment and 29.99 kt CO₂ eq. 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 4.57 The quantity of banked HFC of the Domestic Air-Conditioning for 1989–2013 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 [kt CO ₂ eq.]
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	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0
2000	28	63,241	0	109	109	0	4,952	0	10
2001	112	115,162	0	187	292	1	13,572	0	27
2002	251	173,496	0	281	559	2	26,237	0	53
2003	447	188,789	1	300	832	4	39,387	0	79
2004	46	174,358	0	283	1,076	1	50,888	0	101
2005	0	151,391	0	244	1,292	0	61,097	0	120
2006	0	239,787	0	385	1,657	0	78,446	0	155
2007	5,298	532,436	8	820	2,459	48	117,827	0	232
2008	5,835	728,756	9	1,108	3,514	53	170,161	0	334
2009	2,991	129,844	4	202	3,607	27	174,605	0	343
2010	0	122,350	0	191	3,676	0	177,891	0	349
2011	0	199,237	0	309	3,890	0	188,307	0	370
2012	0	250,740	0	383	4,267	0	207,011	0	407
2013	0	118,350	0	184	4,493	0	218,191	0	429

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 4.58.

Table 4.58 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 112,000 AC units and 6,000 heat pumps were placed on the market in 2013 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 2013 year around 168 t of refrigerant have been introduced to the market as contained in AC equipment and 16 t in heat pumps.

To estimate the quantity of banks in a particular year n , the equation 4.4 has been used.

Equation 4.4 The quantity of banks of the Domestic Air-Conditioning

$$\begin{aligned} Banks_n = & Banks_{n-1} + HFC \text{ in new units}_n + HFC \text{ for servicing}_n - \\ & - Emissions \text{ from operation}_{n-1} - Disposal_n \end{aligned}$$

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 4.59.

Table 4.59 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.

4.7.2.2 Foam Blowing (CRF 2.F.2)

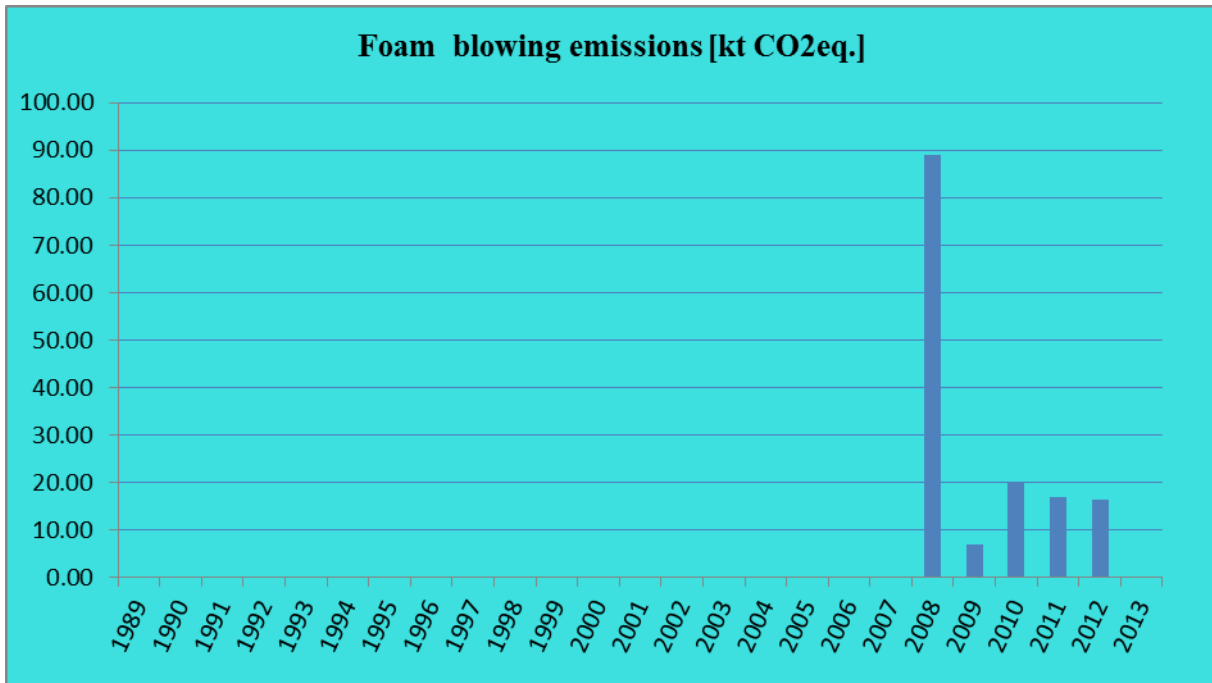
Methodology

Several types of HFCs, CO₂ 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, HFC-365mfc 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 vary 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 2013 year, the actual emissions from foam blowing were 0.12 kt CO₂eq. (see Figure 4.27).

Figure 4.27 Actual emissions of the Foam Blowing for 1989–2013 period

The banked quantities of HFCs are estimated to be around 1.6 t in 2013 year and are shown in Table 4.60.

Table 4.60 The quantity of banked HFC of the Foam Blowing for 1989–2013 period

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFCs]	Operation emissions [kg HFCs]	Actual emissions [kt CO ₂ eq.]
1989	0.0	0.0	0	0	0.0
1990	0.0	0.0	0	0	0.0
1991	0.0	0.0	0	0	0.0
1992	0.0	0.0	0	0	0.0
1993	0.0	0.0	0	0	0.0
1994	0.0	0.0	0	0	0.0
1995	0.0	0.0	0	0	0.0
1996	0.0	0.0	0	0	0.0
1997	0.0	0.0	0	0	0.0
1998	0.0	0.0	0	0	0.0
1999	0.0	0.0	0	0	0.0
2000	0.0	0.0	0	0	0.0
2001	0.0	0.0	0	0	0.0
2002	0.0	0.0	0	0	0.0
2003	0.0	0.0	0	0	0.0
2004	0.0	0.0	0	0	0.0
2005	0.0	0.0	0	0	0.0
2006	0.0	0.0	0	0	0.0
2007	0.0	0.0	0	0	0.0
2008	62.3	0.0	62,299	0	89.09
2009	4.9	0.0	4,875	0	6.97
2010	13.9	0.02	13,874	0.35	19.84
2011	12.2	0.43	11,796	6.50	16.84
2012	12.2	1.09	11,528	16.43	16.45
2013	0.625	1.61	93.73	24.15	0.12

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 mattresses, 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. Three types of HFCs are used in the production – HFC-134a for producing open-cell flexible foam and HFC-227ea and HFC-365mfc 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 of 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 and 2006 IPCC Guidelines. For open-cell flexible foam was applied a 100% loss in the first year, while for closed-cell spray foam is assumed 15% loss for the first year and 1.5% per annum thereafter.

4.7.2.3 Fire Protection (CRF 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 26 t in 2013 year and while its usage in Romania started in 1996 year, the market started to grow significantly after 2006 year (Table 4.61).

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 2013 year are estimated to be about 4.15 kt CO₂eq (Figure 4.28).

Figure 4.28 Actual emissions of the Fire Protection for 1989–2013 period

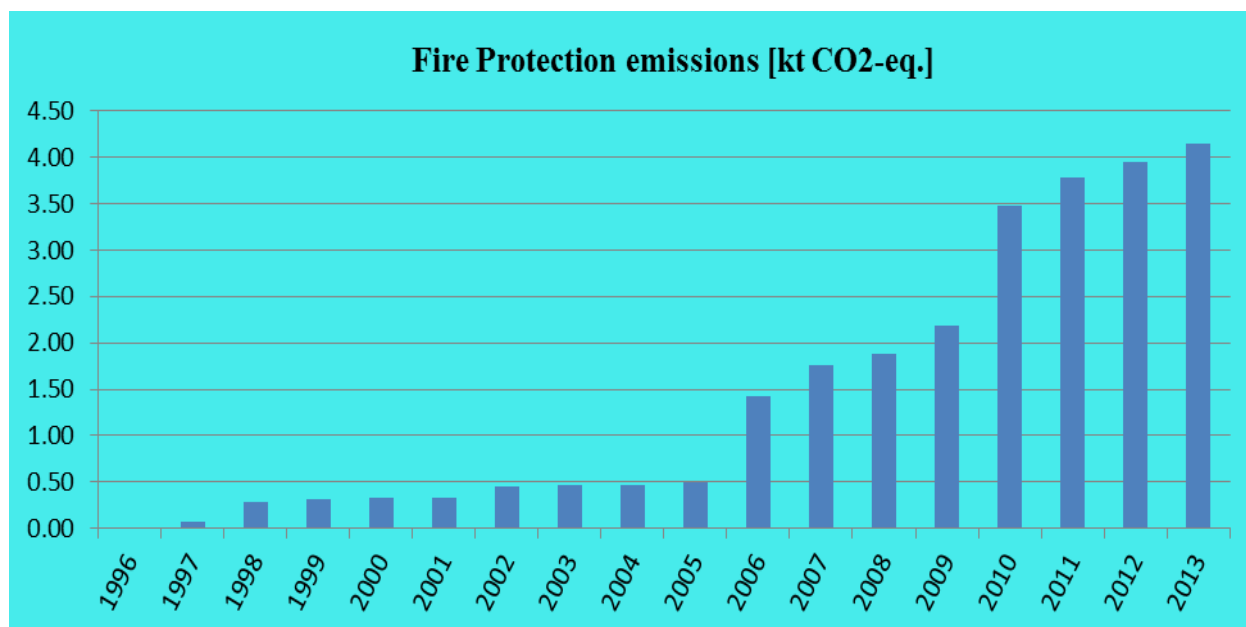


Table 4.61 The quantity of banked HFC of the Fire Protection for 1989–2013 period

Year	HFCs placed on the market [t]	Quantity of banks [t]	Operation emissions [kg HFC]	Actual emissions [kt CO ₂ eq.]
1989	0.00	0.00	0.00	0.00
1990	0.00	0.00	0.00	0.00
1991	0.00	0.00	0.00	0.00
1992	0.00	0.00	0.00	0.00
1993	0.00	0.00	0.00	0.00
1994	0.00	0.00	0.00	0.00
1995	0.00	0.00	0.00	0.00
1996	0.09	0.09	4.55	0.01
1997	0.34	0.43	21.66	0.07
1998	1.37	1.81	90.33	0.29

Year	HFCs placed on the market [t]	Quantity of banks [t]	Operation emissions [kg HFC]	Actual emissions [kt CO₂eq.]
1999	0.19	1.99	99.68	0.32
2000	0.08	2.07	103.61	0.33
2001	0.00	2.07	103.61	0.33
2002	0.78	2.85	142.40	0.46
2003	0.07	2.92	145.87	0.47
2004	0.00	2.92	145.87	0.47
2005	0.19	3.10	155.12	0.50
2006	5.74	8.84	441.89	1.42
2007	2.13	10.97	548.39	1.77
2008	0.68	11.65	582.39	1.88
2009	1.95	13.60	679.78	2.19
2010	8.01	21.60	1,080.20	3.48
2011	1.90	23.50	1,174.95	3.78
2012	1.03	24.53	1,226.25	3.95
2013	1.25	25.78	1,288.74	4.15

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/l².

²http://www2.dupont.com/FE/en_US/assets/downloads/pdf_fm/k17649_FM-200_physical_properties_si.pdf

Emission factors

The 2000 IPCC GPG provide a default emission factor of 5% annually. 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.

4.7.2.4 Aerosols/Metered Dose Inhalers (CRF 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 Federation³, FEA Statistics Report for 2008-2012⁴, Aerosol Europe Market survey of European producers⁵). 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 2013 more than 1.2 mln. MDIs were sold on the market, the emissions from which amount to 29.10 kt CO₂eq.

³ <http://www.aerosol.org/about-fea/members>

⁴ <http://www.aerosol.org/publications-news/publications/statistics/statistics-2>

⁵ http://www.aerosoleurope.de/wp-content/uploads/MarketSurvey_AE0211.pdf

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-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 4.29 Actual emissions of the Aerosols/Metered Dose Inhalers for 1989–2013 period

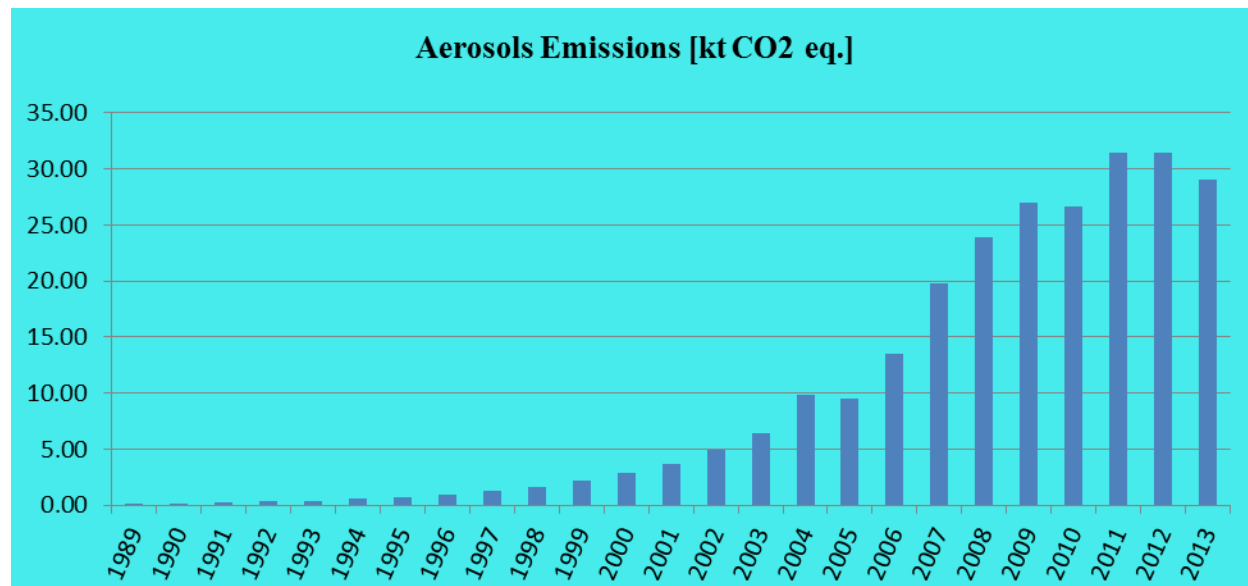


Table 4.62 The quantity of banked HFC of the Aerosols/Metered Dose Inhalers for 1989–2013 period

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC]	Operation emissions [kg HFC]	Actual emissions [kt CO ₂ eq.]
1989	0.11	0.05	54.59	54.59	0.16
1990	0.14	0.07	72.11	54.59	0.18

Year	HFCs placed on the market [t]	Quantity of banks [t]	Initial emissions [kg HFC]	Operation emissions [kg HFC]	Actual emissions [kt CO₂eq.]
1991	0.19	0.10	95.68	72.11	0.24
1992	0.25	0.13	126.47	95.68	0.32
1993	0.33	0.17	166.19	126.47	0.42
1994	0.44	0.22	218.10	166.19	0.55
1995	0.57	0.29	285.74	218.10	0.72
1996	0.75	0.37	374.94	285.74	0.94
1997	0.99	0.49	494.80	374.94	1.24
1998	1.30	0.65	652.28	494.80	1.64
1999	1.72	0.86	858.22	652.28	2.16
2000	2.25	1.13	1,127.38	858.22	2.84
2001	2.96	1.48	1,478.44	1,127.38	3.73
2002	3.88	1.94	1,939.24	1,478.44	4.89
2003	5.09	2.54	2,543.40	1,939.24	6.41
2004	8.75	4.37	4,374.64	2,543.40	9.89
2005	4.56	2.28	2,279.06	4,374.64	9.51
2006	14.35	7.18	7,175.09	2,279.06	13.52
2007	13.33	6.66	6,663.40	7,175.09	19.79
2008	20.03	10.02	10,016.62	6,663.40	23.85
2009	17.71	8.86	8,855.65	10,016.62	26.99
2010	19.60	9.80	9,798.32	8,855.65	26.68
2011	24.41	12.20	12,203.56	9,798.32	31.46
2012	19.56	9.78	9,779.65	12,203.56	31.44
2013	21.14	10.57	10,568.92	9,779.65	29.10

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 2004–2013 – 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 from 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.

4.7.2.5 Solvents (CRF 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 assess 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.

4.7.2.6 Other Applications (CRF 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.

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 SF₆), 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.

4.7.3.1 Commercial Refrigeration (CRF 2.F.1.a)

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%.

4.7.3.2 Domestic Refrigeration (CRF 2.F.1.b)

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%.

4.7.3.3 Industrial Refrigeration (CRF 2.F.1.c)

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%.

4.7.3.4 Transport Refrigeration (CRF 2.F.1.d)

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%.

4.7.3.5 Mobile Air-Conditioning (CRF 2.F.1.e)

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%.

4.7.3.6 Stationary Air-Conditioning (CRF 2.F.1.f)

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%.

4.7.3.7 Foam Blowing (CRF 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%.

4.7.3.8 Fire Protection (CRF 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 than current estimates. The combined uncertainty of this sector is 101%.

4.7.3.9 Aerosols/Metered Dose Inhalers (CRF 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%.

4.7.4 Category-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 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 4.6.5 – Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.6.5 –

Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend .

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 Category-specific recalculation, including changes made in response to the review process and impact on emission trend

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

- a recalculation of the HFC, PFC and SF₆ emission estimates is performed for the full time series following a methodological change (change GWP and EF).

Table 4.63 The effects of recalculations in Product uses as substitutes for ODS Sub-sector

The effects of recalculations in Product uses as substitutes for ODS Sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
1989	0.52	0.16	-69.97
1990	0.55	0.18	-67.06
1991	0.68	0.29	-57.84
1992	0.80	0.45	-44.26
1993	1.11	0.73	-34.63
1994	1.74	1.20	-31.07
1995	3.14	2.53	-19.55
1996	5.55	4.72	-14.89
1997	10.59	10.36	-2.17
1998	22.96	23.88	4.00
1999	37.51	39.73	5.91
2000	70.15	70.82	0.95

The effects of recalculations in Product uses as substitutes for ODS Sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CO₂ emissions [kt]		
2001	111.25	112.87	1.46
2002	157.72	168.16	6.62
2003	209.25	228.75	9.32
2004	269.13	293.93	9.22
2005	335.85	368.91	9.84
2006	442.43	484.20	9.44
2007	602.84	665.63	10.42
2008	852.95	946.95	11.02
2009	840.78	924.42	9.95
2010	903.03	982.46	8.80
2011	984.03	1,092.24	11.00
2012	1,074.12	1,197.43	11.48
2013		1,298.58	

4.7.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

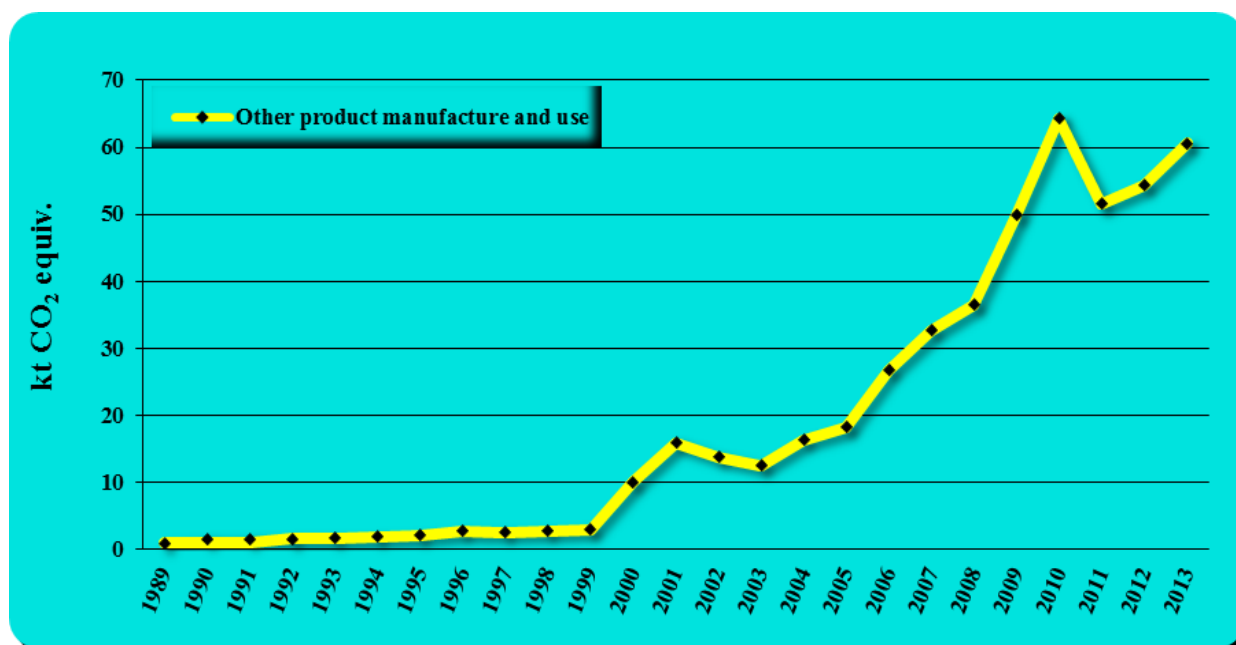
More detailed data will try to be obtained, in respect to the 2006 IPCC GL provisions.

4.8 Other product manufacture and use (CRF 2.G)

4.8.1 Category description

Under this F-gases category are considered the following subcategories: Electrical equipment (CRF 2.G.1), SF₆ and PFCs from other product use (CRF 2.G.2), N₂O from product uses (CRF 2.G.3) and Other (CRF 2.G.4).

Figure 4.30 GHG emissions trend in the Other product manufacture and use Sub-sector for 1995–2013 period



4.8.2 Methodological issues

4.8.2.1 Electrical Equipment (CRF 2.G.1)

Methodology

Electrical Equipment is not a key source category. Sulphur hexafluoride (SF₆) 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, SF₆ 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 SF₆ are contained in closed pressure equipment (around 70% of the total quantity or 73 t in 2013 year), while the rest is banked in sealed pressure equipment (29 t in 2013 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 57.08 kt CO₂eq. in 2013 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 4.31 Actual emissions of the Electrical Equipment for 1989–2013 period

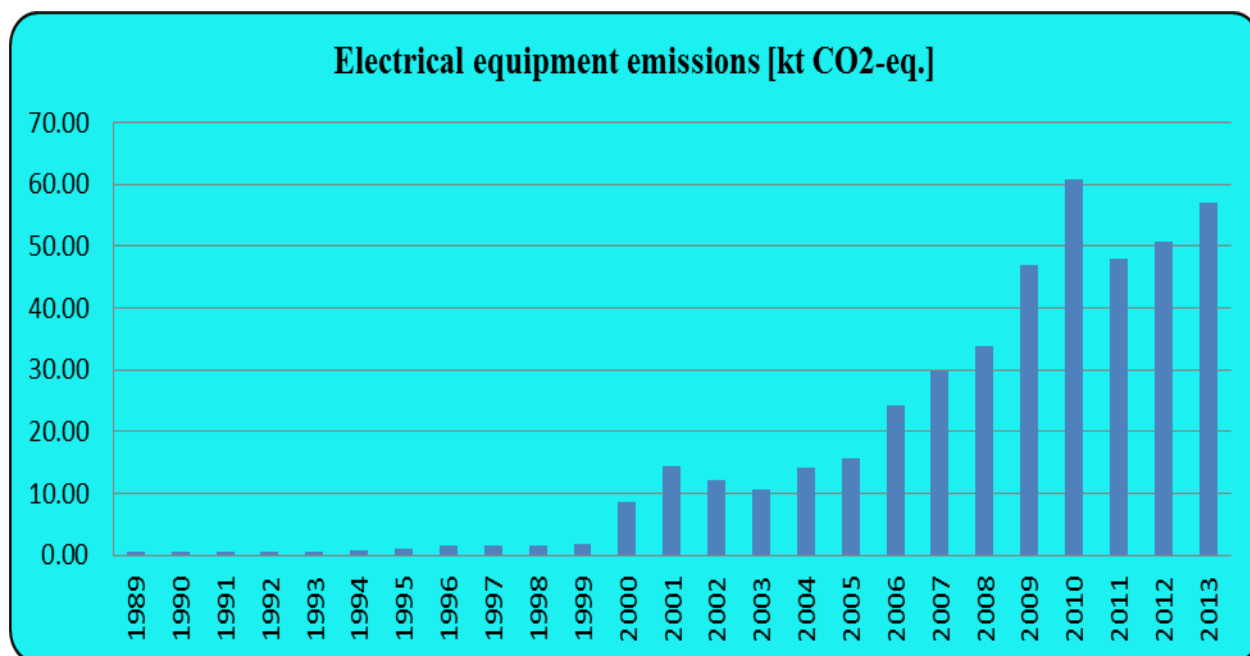


Table 4.64 The quantity of banked HFC of the Electrical Equipment for 1989–2013 period

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 [kt CO ₂ eq.]
1989	0.00	0.80	0.00	20.83	0.00	0.47
1990	0.00	0.80	0.00	20.83	0.00	0.47
1991	0.02	0.82	1.53	21.29	0.00	0.52
1992	0.00	0.82	0.00	21.29	0.00	0.49
1993	0.01	0.84	1.19	21.66	0.00	0.52
1994	0.10	0.93	8.16	24.15	0.00	0.74
1995	0.17	1.10	14.28	28.52	0.00	0.98
1996	0.36	1.47	29.87	37.66	0.00	1.54
1997	0.36	1.82	18.23	43.24	0.00	1.41
1998	0.31	2.14	17.34	48.54	0.00	1.51
1999	0.24	2.38	19.66	54.55	0.00	1.70
2000	3.06	5.44	249.26	130.80	0.00	8.68
2001	4.70	10.14	380.25	247.11	0.00	14.33
2002	2.95	13.10	215.28	312.96	0.22	12.10
2003	1.86	14.96	111.83	347.16	0.22	10.54
2004	3.06	18.02	203.46	409.40	0.90	14.10
2005	2.32	20.34	171.09	461.73	49.20	15.67
2006	6.08	26.41	419.06	589.92	41.93	24.13
2007	7.98	34.39	532.29	752.74	14.70	29.88
2008	9.19	43.58	530.79	915.09	21.15	33.83
2009	13.72	57.30	842.92	1,172.93	22.65	47.03
2010	21.35	78.65	1,105.83	1,511.18	4.45	60.71
2011	8.20	86.85	386.90	1,629.53	33.14	47.83
2012	8.03	94.88	393.46	1,749.88	27.68	50.76
2013	7.28	102.16	524.09	1,910.19	11.68	57.08

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 SF₆ 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 8.5%, given by the 2006 IPCC Guidelines. Regarding the operation emissions, the 2006 IPCC Guidelines provides a default EF of 2.6%. For sealed pressure equipment is used the default emission factor from the 2006 IPCC Guidelines, equal to 0.2% per year.

4.8.2.2 SF_6 and PFCs from other product use (CRF 2.G.2)

Other emissions are not known to be occurring.

4.8.2.3 N_2O from product uses (CRF 2.G.3)

Methodology

Evaporative emissions of nitrous oxide (N_2O) can arise from various types of product use, including:

- Medical applications (anaesthetic use, analgesic use and veterinary use);
- Use as a propellant in aerosol products, primarily in food industry (pressure-packaged whipped cream, etc);
- Oxidising agent and etchant used in semiconductor manufacturing;
- Oxidising agent used, with acetylene, in atomic absorption spectrometry;
- Production of sodium azide, which is used to inflate airbags;
- Fuel oxidant in auto racing; and
- Oxidising agent in blowtorches used by jewelers and others.

The method for calculating emissions of N_2O from Medical applications is in line with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, considering the Equation 8.24 at page 8.36 from 2006 IPCC Guidelines.

Activity data

The data on N_2O used in medical applications were collected from the economic operators (hospitals).

Emission factors

N₂O emissions are calculated according to Equation 8.24 at page 8.36 from 2006 IPCC GL.

It is assumed that none of the administered N₂O is chemically changed by the body, and all is returned to the atmosphere. It is reasonable to assume an emission factor of 1.0.

4.8.2.4 Other (CRF 2.G.4)

Other emissions are not known to be occurring.

4.8.3 Uncertainties and time series consistency

4.8.3.1 Electrical Equipment (CRF 2.F.8)

The activity data was obtained directly from operators, thus its uncertainty should be around 175%. 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 0%. The combined uncertainty is 175 %.

4.8.3.2 N₂O from product uses (CRF 2.G.3)

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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989–2013.

4.8.4 Category-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 Consumption of Halocarbons and SF₆ Sub-sector, the results of these being mentioned on the Checklists level. Following these activities there were no nonconformities 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 nonconformities noted were solved of the 2012 NGHGI; they are described in the Chapter 4.7.5 – Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.7.5 – Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend. All noted nonconformities 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.

4.8.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

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

- **Methodology** (change GWP)
 - Electrical equipment (CRF 2.G.1)
- **Emissions factors.**
 - Electrical equipment (CRF 2.G.1)

A recalculation of the SF₆ emission estimates is performed for the full time series following a methodological change (change GWP) and change of EF.

Table 4.65 The effects of recalculations in Electrical Equipment Sub-sector

The effects of recalculations in Electrical Equipment Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences
	CO₂ emissions [kt]		[%]
1989	0.38	0.47	24.01
1990	0.38	0.47	24.01
1991	0.42	0.52	24.70
1992	0.39	0.49	24.01
1993	0.42	0.52	24.54
1994	0.58	0.74	26.64
1995	0.77	0.98	27.51
1996	1.20	1.54	28.68
1997	1.11	1.41	26.90
1998	1.20	1.51	26.43
1999	1.35	1.70	26.47
2000	6.63	8.68	30.99
2001	10.99	14.33	30.43
2002	9.44	12.10	28.13
2003	8.35	10.54	26.25
2004	11.09	14.10	27.13
2005	12.67	15.67	23.62
2006	19.10	24.13	26.37

The effects of recalculations in Electrical Equipment Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences
	CO₂ emissions [kt]		[%]
2007	23.43	29.88	27.54
2008	26.68	33.83	26.78
2009	36.91	47.03	27.43
2010	47.53	60.71	27.73
2011	38.43	47.83	24.46
2012	40.79	50.76	24.44
2013		57.08	

4.8.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

More detailed data will try to be obtained, in respect to the 2006 IPCC GL provisions.

5 AGRICULTURE (CRF Sector 3)

5.1 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 3). The following source categories are quantified and reported:

- CH₄ emissions from enteric fermentation;
- CH₄ and N₂O emissions from manure management;
- CH₄ emissions from rice cultivation;
- N₂O emissions from agricultural soils;
- CH₄, N₂O, NO_x and CO emissions from field burning of agricultural residues;
- CO₂ emissions from Lime application;
- CO₂ emissions from Urea application.

The direct GHGs reported within this sector are CH₄, N₂O and CO₂ while indirect gases comprise NO_x and CO.

Domestic livestock are the major source of CH₄ emissions from agriculture, both from enteric fermentation and manure management. Manure management also generates N₂O emissions.

Table 5.1 gives an overview of the IPCC categories included in this chapter and provides information on the status of related emissions estimates.

Table 5.1 Status of emissions estimation within the Agriculture Sector

IPCC category	Emissions estimation status		
	CH ₄	N ₂ O	CO ₂
3. A Enteric fermentation			
3.A.1 Cattle	✓	NA	NA
3.A.1.A.1. Dairy cattle	✓	NA	NA
3.A.1.A.2. Non-dairy cattle	✓	NA	NA

IPCC category	Emissions estimation status		
3.A.2 Sheep	✓	NA	NA
3.A.3 Swine	✓	NA	NA
3.A.4 Other livestock			
3.A.4.1 Buffalo	✓	NA	NA
3.A.4.2 Camels	NO	NO	NO
3.A.4.3 Goats	✓	NA	NA
3.A.4.4 Horses	✓	NA	NA
3.A.4.5 Mules and Asses	✓	NA	NA
3.A.4.6 Poultry	✓	NA	NA
3.B Manure management			
3.B.1. CH₄ emissions	✓	NA	NA
3.B.1.1 Cattle	✓	NA	NA
3.B.1.1.A.1. Dairy cattle	✓	NA	NA
3.B.1.1.A.2. Non-dairy cattle	✓	NA	NA
3.B.1.2. Sheep	✓	NA	NA
3.B.1.3. Swine	✓	NA	NA
3.B.1.4 Other livestock	✓	NA	NA
3.B.1.4.1. Buffalo	✓	NA	NA
3.B.1.4.2. Camels	NO	NO	NO
3.B.1.4.3. Goats	✓	NA	NA
3.B.1.4.4. Horses	✓	NA	NA
3.B.1.4.5. Mules and Asses	✓	NA	NA
3.B.1.4.6. Poultry	✓	NA	NA
3.B.2. N₂O and NMVOC emissions	NA	✓	NA
3.B.2.1 Cattle	NA	✓	NA
3B.2.1.A.1. Dairy cattle	NA	✓	NA
3B.2.1.A.2. Non - dairy cattle	NA	✓	NA
3.B.2.2. Sheep	NA	✓	NA
3.B.2.3. Swine	NA	✓	NA

IPCC category	Emissions estimation status		
3.B.2.4. Other livestock	NA	✓	NA
3.B.2.4.1. Buffalo	NA	✓	NA
3.B.2.4.2. Camels	NA	✓	NA
3.B.2.4.3. Goats	NA	✓	NA
3.B.2.4.4. Horses	NA	✓	NA
3.B.2.4.5. Mules and Asses	NA	✓	NA
3.B.2.4.6. Poultry	NA	✓	NA
3.B.2.5. Indirect N₂O Emissions	NA	✓	NA
3.B.2.6. Emissions per MMS	NA	✓	NA
3.C Rice cultivation			
3.C.1 Irrigated	✓	NA	NA
3.C.1.1 Continuously flooded	NO	NA	NA
3.C.1.2 Intermittently flooded	✓	NA	NA
3.C.1.2.1 Single aeration	NO	NA	NA
3.C.1.2.2 Multiple aeration	✓	NA	NA
3.C.2 Rainfed	NO	NA	NA
3.C.3 Deep water	NO	NA	NA
3.C.3.1. Water Depth 50-100 cm	NO	NA	NA
3.C.3.2. Water Depth >100 cm	NO	NA	NA
3.C.4 Other	NO	NA	NA
3.D Agricultural soils			
3.D.1 Direct soil emissions	NA	✓	NA
3.D.1.1. Inorganic N Fertilizers	NA	✓	NA
3.D.1.2. Organic N Fertilizers	NA	✓	NA
3D.1.2.a. Animal Manure Applied to Soils	NA	✓	NA
3.D.1.2.b. Sewage Sludge Applied to Soils	NA	✓	NA
3.D.1.2.c. Other Organic Fertilizers Applied to Soils	NA	✓	NA
3.D.1.3 Urine and Dung Deposited by	NA	✓	NA

IPCC category	Emissions estimation status		
Grazing Animals			
3.D.1.4 Crop Residues	NA	✓	NA
3.D.1.5.Mineralization/Immobilization Associated with Loss/Gain of Soil Organic	NA	✓	NA
3.D.1.6 Cultivation of Organic Soils	NA	✓	NA
3.D.1.7.Other	NA	✓	NA
3.D.2. Indirect N₂O Emissions from Managed Soils	NA	✓	NA
3.D.2.1.Atmospheric Deposition	NA	✓	NA
3.D.2.2. Nitrogen Leaching and Run-off	NA	✓	NA
3.E Prescribed burning of savannas	NO	NO	NO
3.F Field burning of agricultural residues	✓	✓	NA
3.G. Liming	NA	NA	✓
3.H. Urea Application	NA	NA	✓
3.I. Other Carbon-containing Fertilizers	NA	NA	✓

Observations

1) In respect to the IPCC GPG 2006 provisions, N₂O emissions from Daily spread and Pasture range and paddock AWMS are reported under 3D – Agricultural soils (see Chapter 5.5).

Figure 5.1 Total GHG emissions trend in Agriculture for 1989–2013 period

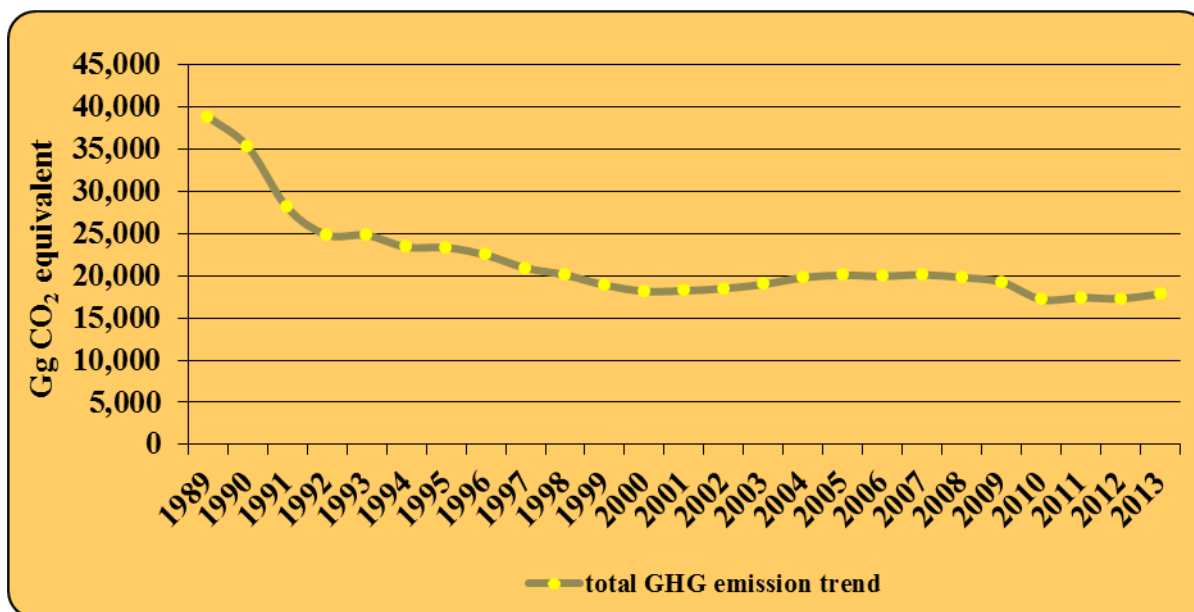
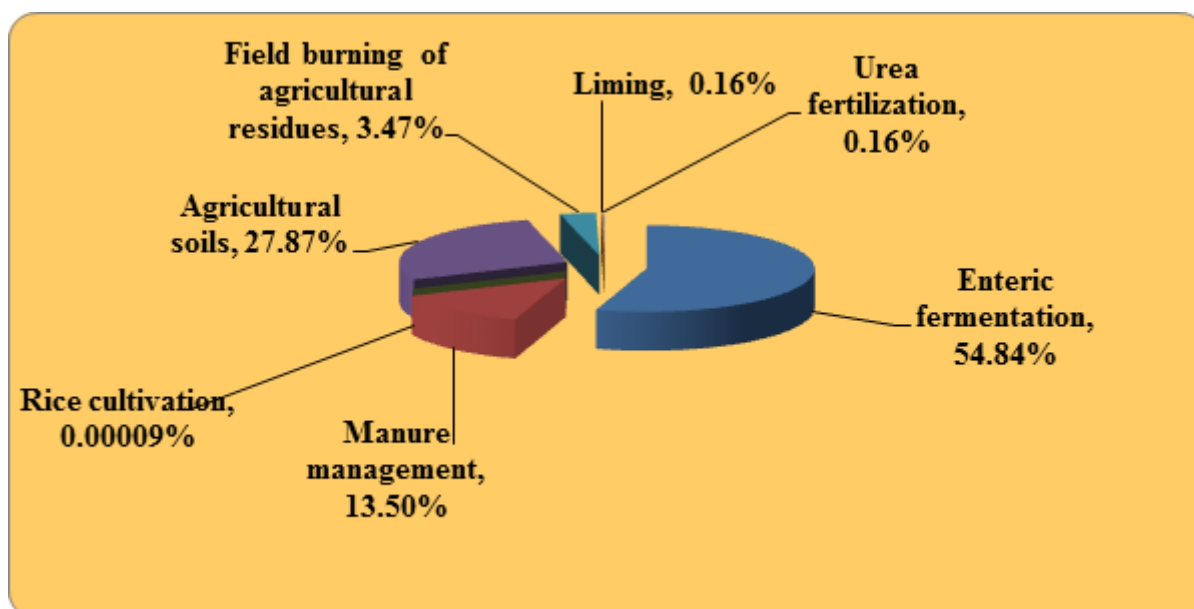


Figure 5.2 Contribution of the sub-sectors in the total GHG emissions from Agriculture, in 2013 year



Another source of methane is represented by anaerobic decomposition of organic material in flooded rice fields.

Microbiological processes in soil lead to N₂O emissions. Two N₂O sources are distinguished:

- ❖ direct soil emissions from agricultural soils (sources: Inorganic N fertilizers, organic N fertilizers, urine and dung deposited by grazing animals, crop residues, mineralization/immobilization associated with loss/ gain of soil organic matter and cultivation of organic soils);
- ❖ indirect soil emissions (atmospheric deposition, leaching and run off).

Burning of agricultural residues is a net source of CH₄, CO, N₂O and NO_x emissions for 1989-2013 period.

Emissions from prescribed burning of savannas do not occur in Romania.

The Agriculture Sector accounted for 15.91% of the total GHG emissions in 2013, reaching 110,929.05 kt CO₂ equivalent (Table 5.2).

Within the GHG emissions from the agriculture sector, the CH₄ emissions have the largest contribution (in 2013, CH₄ emissions contribution is 66.57% to the total Agriculture Sector's CO₂ equivalent emissions), followed by the N₂O emissions (that account for the remaining 31.48%).

Over the period 1989 – 2013, the GHG emissions resulted from Agriculture Sector decreased by 53.82% (Figure 5.1).

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 occurred, 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 2013 there were registered 383,669 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 sheep'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 grown in farms.

Poultry for meat number decreased from 1989 to 1994, after which they slightly increased, the egg poultry decreased sharply in 1994, then began 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 2004-2013 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 2013 were slowly increased some livestock categories for example: cattle, sheep and goats.

The rice cultivation generated in 2013 a significantly reduced emission compared to the base year 1989 due to the decrease of areas (70.96% decrease comparing with the base year).

In case of agricultural soils, the emissions decreased over the period (47.31% decrease in 2013 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 1999 year, the N₂O emissions from Agricultural Soils fluctuates: decreases until 2000, in 2001 increases and then decreases. This is due variation of quantities of synthetic fertilizers, number of animals and of the crop productions.

The Agriculture sector's CH₄ emissions decreased in 2013 with 53.82% compared to basic (see Annex 3.3 - sheet *Distribution of N₂O and CH₄ 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 N₂O emissions from the Agriculture Sector decreased in 2013 with 46.84% comparing with the base year (see Annex 3.3 - sheet *Distribution of N₂O and CH₄ 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.

The crop productions of the N fixing for all plants decreased in 2012 compared with 2011 due to drought.

Table 5.2 Contribution of Agriculture sector in total GHG emissions, in 1989–2013

Year	Total GHG emissions [kt]	GHG emissions from Agriculture [kt]	Contribution of Agriculture in total GHG emissions [%]	Methane emissions from Agriculture [kt]	Contribution of methane emissions in total GHG emissions from Agriculture [%]	Nitrous oxide emissions from Agriculture [kt]	Contribution of nitrous oxide emissions in total GHG emissions from Agriculture [%]
1989	298,018.54	38,218.40	12.82	27,022.63	70.71	10,992.81	28.76

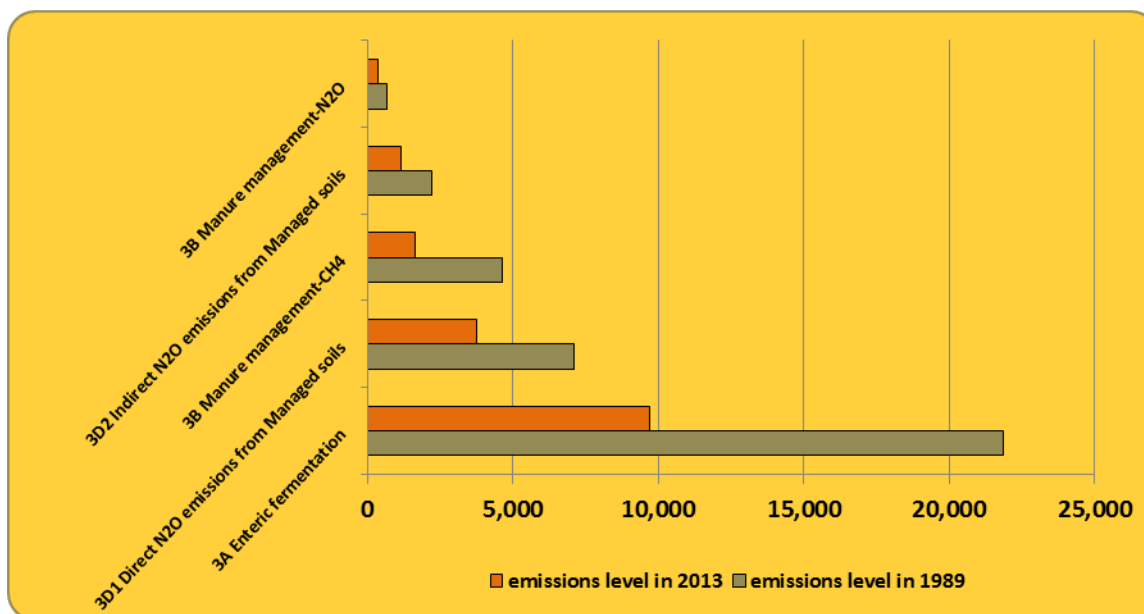
Year	Total GHG emissions [kt]	GHG emissions from Agriculture [kt]	Contribution of Agriculture in total GHG emissions [%]	Methane emissions from Agriculture [kt]	Contribution of methane emissions in total GHG emissions from Agriculture [%]	Nitrous oxide emissions from Agriculture [kt]	Contribution of nitrous oxide emissions in total GHG emissions from Agriculture [%]
1990	253,317.98	34,876.06	13.77	24,293.63	69.66	10,462.38	30.00
1991	207,053.32	27,901.38	13.48	20,232.47	72.51	7,615.98	27.30
1992	189,445.14	24,674.99	13.02	18,051.96	73.16	6,573.46	26.64
1993	180,869.15	24,584.89	13.59	17,389.79	70.73	7,137.67	29.03
1994	176,841.41	23,187.62	13.11	16,285.58	70.23	6,822.41	29.42
1995	183,698.01	23,141.56	12.60	16,033.40	69.28	7,039.58	30.42
1996	186,091.91	22,289.11	11.98	15,801.22	70.89	6,415.66	28.78
1997	174,222.63	20,748.00	11.91	14,166.22	68.28	6,520.00	31.42
1998	154,624.74	19,945.20	12.90	13,910.06	69.74	5,970.08	29.93
1999	135,890.86	18,745.57	13.79	13,102.20	69.89	5,591.07	29.83
2000	141,141.57	18,011.34	12.76	12,837.11	71.27	5,094.12	28.28
2001	145,667.23	18,054.80	12.39	12,231.95	67.75	5,727.31	31.72
2002	145,929.94	18,340.14	12.57	12,836.82	69.99	5,420.11	29.55
2003	151,134.43	18,823.10	12.45	13,192.41	70.09	5,531.85	29.39
2004	149,948.26	19,612.17	13.08	13,014.20	66.36	6,487.60	33.08
2005	147,373.53	19,878.92	13.49	13,404.52	67.43	6,364.35	32.02
2006	148,660.74	19,780.22	13.31	13,875.43	70.15	5,799.15	29.32
2007	146,874.89	19,955.76	13.59	14,391.53	72.12	5,472.07	27.42
2008	141,966.63	19,615.98	13.82	13,688.88	69.78	5,816.76	29.65
2009	124,248.91	19,063.78	15.34	13,332.19	69.93	5,636.73	29.57
2010	117,705.63	16,994.04	14.44	11,565.54	68.06	5,350.40	31.48
2011	122,565.56	17,208.17	14.04	11,491.89	66.78	5,655.46	32.86
2012	120,977.12	17,113.44	14.15	11,928.93	69.71	5,135.49	30.01
2013	110,929.05	17,648.31	15.91	11,747.69	66.57	5,843.47	33.11

Table 5.3 and Figure 5.3 describe Key categories in Agriculture, both from level and trend and

including and excluding LULUCF views.

Table 5.3 Key categories overview – Agriculture, 2013

Key categories	GHG	Criteria	Contribution in total GHG emissions [%]
3.A Enteric fermentation	CH ₄	L,T (Tier 1, excluding and including LULUCF)	8.72
3.D.1 Direct N ₂ O emissions from Managed soils	N ₂ O	L,T (Tier 1, excluding and including LULUCF)	3.38
3.B Manure management	CH ₄	L (Tier 1, excluding and including LULUCF)	1.46
3.D.2 Indirect N ₂ O emissions from Managed soils	N ₂ O	L,T (Tier 1, excluding and including LULUCF)	1.04
3.B Manure management	N ₂ O	L,T (Tier 1, excluding and including LULUCF)	0.68

Figure 5.3 Key Categories in Agriculture, both by level and trend

5.2 Enteric Fermentation (CRF 3.A)

5.2.1 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 CH₄.

Enteric Fermentation:

- ❖ is the main source of CH₄ emissions in the Agriculture sector (in 2013, CH₄ emissions from Enteric Fermentation represented 82.38% of total CH₄ emissions in the Agriculture sector);
- ❖ is the second source in the Agriculture sector (in 2013, CH₄ emissions from Enteric Fermentation as CO₂ equivalent represented 54.82% from Total Agriculture emissions);
- ❖ contributed with 8.72% to Total GHG emissions of Romania.

Compared to 1989, total CH₄ emissions from Enteric Fermentation decreased with 55.69 % in 2013 (Figure 5.4). 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 5.4 Methane emission trend due to the Enteric Fermentation

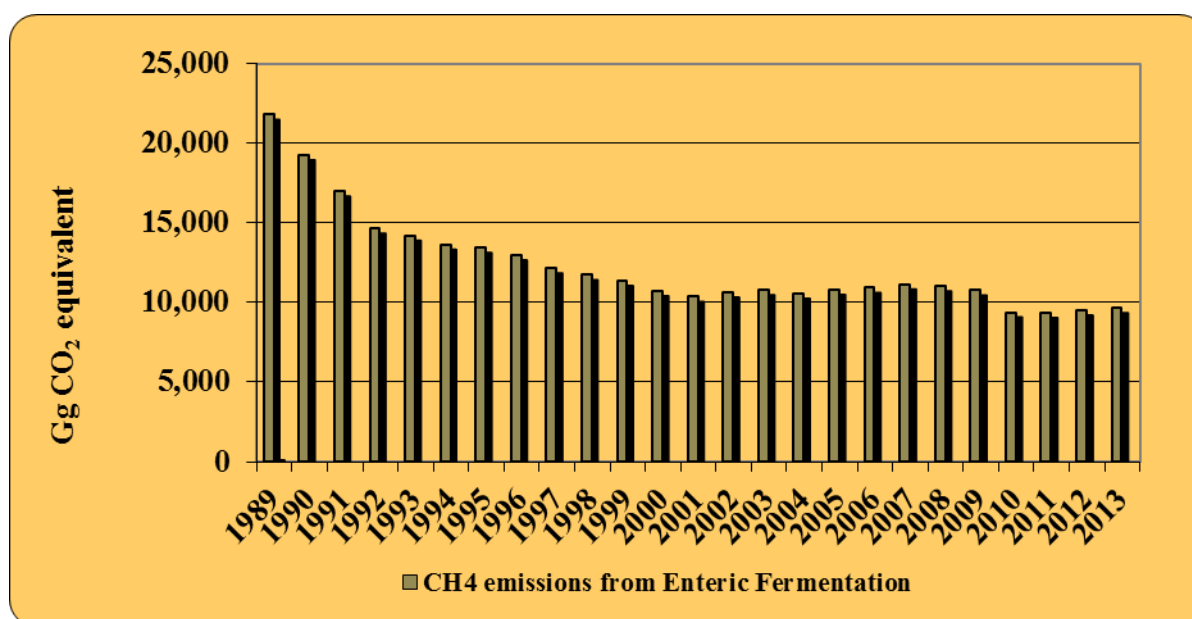


Table 5.4 Observations on source category 3A – “Enteric Fermentation”

Source indicative	Source (livestock) type	Observation	Data source
3.A.1	Cattle	Includes livestock data from nine different <i>cattle</i> categories: <i>dairy cows</i> and <i>non-dairy cattle</i> .	AD: NIS and expert judgment, 1989-2003; NIS, 2004-2013 EF: Country specific, expert judgment

Source indicative	Source (livestock) type	Observation	Data source
3.A.2	Sheep	Includes livestock data from three different sheep: <i>Ewes of milk and fitted, reproducers rams and other sheep</i>	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013; EF: IPCC 2006, IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
3A3	Swine	Includes livestock data from five different swine: <i>pigs under 20 kg, pigs between 20 and 50 kg, pigs fattening, boars, breeding sows</i>	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013 EF: IPCC 2006, IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
3.A.4	Buffalo	Includes livestock data from two different buffalo: buffalo milk and other buffalo	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013; EF: IPCC 2006, IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
3.A.4	Goats	Includes livestock data from two different goats: <i>Female goats for milk and females by first mount and other goats</i>	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013; EF: IPCC 2006, IPCC GPG 2000, IPCC 1996,
3.A.4	Horses		Country specific, expert judgment
3.A.4	Mules and asses		AD: FAO, 2011; EF: IPCC 2006, IPCC GPG 2000, IPCC 1996, Country

Source indicative	Source (livestock) type	Observation	Data source
			specific, expert judgment
3.A.4	Poultry	Includes livestock data from two different <i>poultry: adult poultry for eggs, poultry for meat</i>	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013 EF: IPCC 2006, IPCC GPG 2000, IPCC 1996, Country specific, expert judgment

5.2.2 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 2006 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 10.19, 10.20 and 10.21 in the *IPCC 2006 (pg.10.28 and10.31)*.

Emission factors

According to the provisions in IPCC 2006, to use equation 10.21 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 2006 (Tables 10.12 and 10.13) 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 5.1 Calculation of energy gross intake

$$GE \text{ (kcal/kg)} = 5.72 \cdot PB + 9.5 \cdot GB + 4.79 \cdot CelB + 4.17 \cdot SEN$$

(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 5.5 Calculation of feed digestible energy

Specification	Digestible PB	Digestible GB	Digestible CelB	Digestible SEN
Symbol	x ₁	x ₂	x ₃	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 •e ₁	x ₂ •e ₂	x ₃ •e ₃	x ₄ •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 calorificity 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 calorificity 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 5.6 are presented the milk productions per year, for the period 1989-2013 for dairy cows and, respectively, buffaloes.

For dairy cattle DE (MJ)=154.46 and DE (%) = 67.93.

Table 5.6 Milk production in cows and buffalo in the period 1989-2013 (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

Year	Dairy cattle production (thousand hl)	Milk buffalo production (thousand hl)
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
2013	42,381	210

- ❖ *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 calorificity 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 calorificity 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 calorificity 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 calorificity 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 calorificity 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 calorificity 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 calorificity 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 calorificity 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, calorificity is 4122.97 kcal, equivalent to 17.25 MJ/1 kg ration. For an increase of 35 g, specific to this type of exploitation, 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 2006 and IPCC 1996 - Reference Manual*, because there are no national studies on the rate of conversion of methane from gross energy intake.

For cattle were used the value of 0.065 for all categories, the value which corresponds to the default value for developed countries.

For dairy cattle and sheep, Y_m value is 0.065 for developing countries.

For other categories Y_m values were used from IPCC 1996 - Reference Manual, Table A-4 (Y_m values for 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 5.7.

The gross energy intake is in direct correlation with animal's weight.

Table 5.7 The factors emission (kg CH₄/head/year) used for calculation of methane emissions from enteric fermentation of livestock and data necessary for their calculation, in the 1989-2013 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 (Y _m fraction)
3.A.1	CATTLE			
3.A.1.1	<i>Dairy cattle</i>	96.93	227.37	0.065
3.A.1.2	<i>Non dairy cattle</i>			
	Calves for slaughter younger than 1 year	60.99	143.07	0.065
	Young cattle of breeding under 1 year	49.24	115.5	0.065
	Young cattle of breeding between 1 and 2 years	62.59	146.83	0.065

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 (Y _m fraction)
	Young cattle of slaughter between 1 and 2 years	94.78	222.33	0.065
	Cattle 2 years and over Breeding bulls	103.03	241.68	0.065
	Cattle 2 years and over Heifers for breeding	90.00	211.12	0.065
	Males and females for sacrificed older than 2 years	71.07	166.72	0.065
	Cattle for work	119.27	303.08	0.06
3.A.2	<i>SHEEP</i>			
	Ewes of milk and fitted	18.23	42.78	0.065
	Reproducers rams	21.41	50.23	0.065
	Other sheep	19.29	45.27	0.065
3.A.3	<i>SWINE</i>			
	Pigs under 20 kg	0.69	8.18	0.013
	Pigs between 20 and 50 kg	1.15	13.49	0.013

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 (Y _m fraction)	
	Pigs fattening	1.84	46.86	0.006	
	Boars	1.78	45.32	0.006	
	Breeding sows	1.78	45.34	0.006	
3.A.4.1	<i>BUFFALO</i>				
	Female buffalo	114.99	269.74	0.065	
	Other buffalo	54.93	128.85	0.065	
3.A.4.3	<i>GOATS</i>				
	Female goats for milk and females by first mount	17.34	52.88	0.1 0.05 0,0020.000	
	Other goats	16.15	49.25	0.05	
3.A.4.4	<i>HORSES</i>		37.02	225.79	0.025
3.A.4.5	<i>MULES AND ASSES</i>		29.70	181.18	0.025
3.A.4.6	<i>POULTRY</i>				
	Adult poultry for eggs	0	1.83	0	
	Poultry for meat	0	1.3	0	

In the Table 5.8 are summarized the values energy digestible DE (Mj), the percentage of digestible energy DE (%) and the weight for each subcategory. These values were determined in the context of the implementation of the 2011 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*“.

Table 5.8 The values energy digestible expressed in Mj/day and percent and weight (kg) for livestock, in the 1989-2013 period

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
3.A.1	CATTLE			
3.A.1.1	<i>Dairy cattle</i>	154.46	67.93	650
3.A.1.2	<i>Non dairy cattle</i>			
	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 Heifers for breeding	124.23	58.84	490

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
	Males and females for sacrificed older than 2 years	95.15	57	500
	Cattle for work	173.22	57.15	800
3.A.2	<i>SHEEP</i>			
	Ewes of milk and fitted	19.7	44.57	60
	Reproducers rams	30.07	59.86	77
	Other sheep	20.84	46.04	48
3.A.3	<i>SWINE</i>			
	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
3.A.4.1	<i>BUFFALO</i>			
	Female buffalo	145	53.75	500
	Other buffalo	71.3	55.34	400
3A.4.3	<i>GOATS</i>			
	Female goats for milk and females by first mount	23.91	45.21	48
	Other goats	20.82	42.27	50
3.A.4.4	<i>HORSES</i>	121.84	53.96	500
3.A.4.5	<i>MULES AND</i>	99.2	54.75	300

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
	<i>ASSES</i>			
3.A.4.6	<i>POULTRY</i>			
	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.

2004-2013

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 1989-2013, are presented.

For the all livestock the differences are due to the fact that the values for the year X are allocated by FAO of year X-1, due to methodology used by FAO, and respectively NIS.

Following the implementation of a analysis, differences under 7.33% approximatively have been identified between Eurostat and NGHGI data; the differences are due to specific elements on data manipulation at the National Institute for Statistics (NGHGI and EUROSTAT data provider) and EUROSTAT level.

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 2004-2013. 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 1989-2013 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 2013), 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.

2004-2013

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*).

5.2.3 *Uncertainties and time-series consistency*

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 10 %;
- EF: 20%;
- 22.36% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 5.2.2), 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 1989-2013 is consistent.

5.2.4 *Category-specific QA/QC and verification, if applicable*

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating LULUCF, 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.

5.2.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

Since the last submission was made recalculation at the level of the emission factors for the 1989-2013 period.

5.2.6 Category-specific planned improvements, if applicable, including tracking of those identified in 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.

5.3 Manure Management (CRF 3.B)

5.3.1 Category description

Managing a large number of animals in a confined area creates conditions for CH₄ emissions due to the anaerobic decomposition of manure. A part of the nitrogen from manure is converted to N₂O during storage of manure.

Manure Management:

- ❖ is the three source of CH₄ and the last source of N₂O emissions in the Agriculture sector (in 2013, CH₄ emissions from Manure Management represented 13.79% of total CH₄ emissions while N₂O accounted for 13.03% of total N₂O emissions in the Agriculture sector);
- ❖ is the third source in the Agriculture sector (in 2013, CH₄ and N₂O emissions from Manure Management as CO₂ equivalent represented 13.49% from Total Agriculture emissions);
- ❖ contributed with 2.14% to Total GHG emissions of Romania.

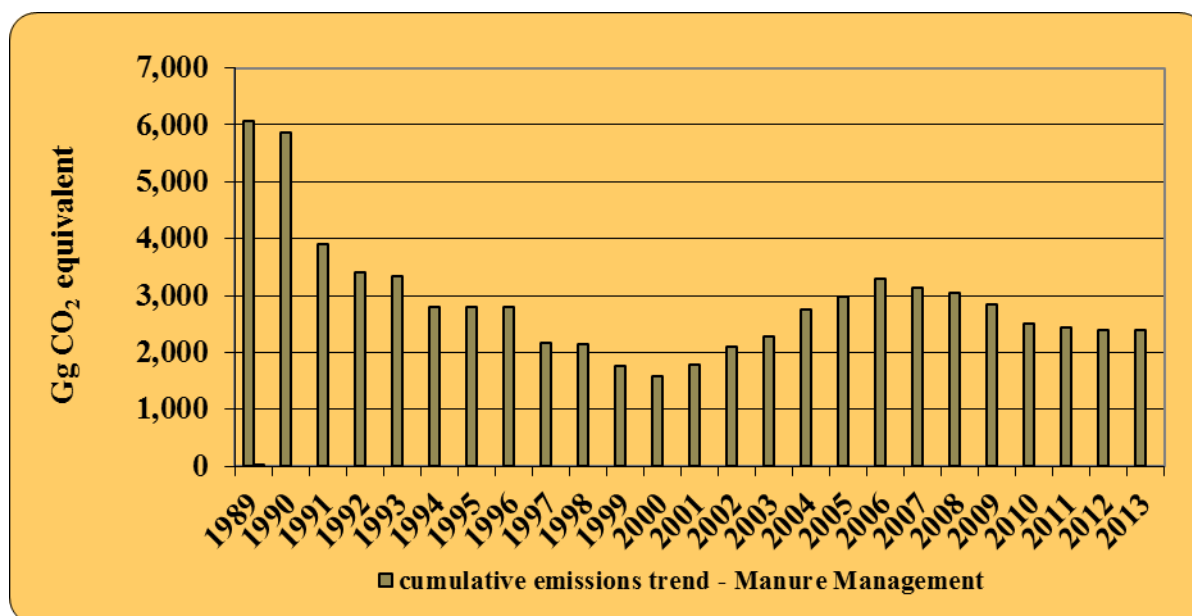
Emissions from manure management are declining since 1989 due to the decrease of the animal population, on the one hand due to lower number of animals, and on the other hand the switchover any part of it from traditional systems, economic in farms organized, in which is practiced different waste management systems (Figure 5.5).

The dynamic of emission of CH₄ 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 3B – “Manure Management” are presented in the Table 5.9. And the of N₂O emission decreased due to the decrease the effective of livestock including per those them found on farms where it practice manure management system.

Figure 5.5 Overall trends of emissions from Manure Management*Table 5.9 Observations on source category 4B – “Manure Management”*

Source indicative	Source type	Observation	Data source
<i>Observations on source category 3B – “Manure Management – CH₄ and N₂O emissions”</i>			
3.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, 2004-2013 EF: Country specific, expert judgment, IPCC 2006
3.B.2	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, 2004-2013; EF: IPCC 2006, expert judgment

Source indicative	Source type	Observation	Data source
<i>Observations on source category 3B – “Manure Management – CH₄ and N₂O emissions”</i>			
3.B.3	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, 2004-2013 EF: IPCC 2006, expert judgment
3.B.4.1	Buffalo	Includes livestock data from two different buffalo:buffalo milk and other buffalo	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013; EF: IPCC 2006, expert judgment
3.B.4.3	Goats	Includes livestock data from two different goats: Female goats for milk and females by first mount and other goats	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013; EF: IPCC 2006, expert judgment
3.B.4.4	Horses		AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013; EF: IPCC 2006, expert judgment
3.B.4.5	Mules and asses		AD: FAO, 2011; EF: IPCC 2006, expert judgment

Source indicative	Source type	Observation	Data source
<i>Observations on source category 3B – “Manure Management – CH₄ and N₂O emissions”</i>			
3.B.4.6	Poultry	Includes livestock data from two different poultry: adult poultry for eggs, poultry for meat	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013 EF: IPCC 2006, expert judgment
3.B.2.1	Cattle	Includes following type of systems of management: - Anaerobic Lagoon - Liquid/Slurry - Daily Spread - Solid storage and dry lot - Pasture/range/paddock - Pit storage - Poultry manure with bedding - Poultry manure without bedding	AD: SY, other correspondence, NIS and expert judgment, IPCC 2006 EF: IPCC 2006, expert judgment
3.B.2.2	Sheep	Includes following type of systems of management: - Anaerobic Lagoon - Liquid/Slurry - Daily Spread - Solid storage and dry lot - Pasture/range/paddock - Pit storage - Poultry manure with bedding - Poultry manure without	AD: SY, other correspondence, NIS and expert judgment, IPCC 2006 EF: IPCC 2006, expert judgment

Source indicative	Source type	Observation	Data source
<i>Observations on source category 3B – “Manure Management – CH₄ and N₂O emissions”</i>			
		bedding	
3.B.2.3	Swine	Includes following type of systems of management: - Anaerobic Lagoon - Liquid/Slurry - Daily Spread - Solid storage and dry lot - Pasture/range/paddock - Pit storage - Poultry manure with bedding - Poultry manure without bedding	AD: SY, other correspondence, NIS and expert judgment, IPCC 2006 EF: IPCC 2006, expert judgment
3.B.2.4.1	Buffalo	Includes following type of systems of management: - Anaerobic Lagoon - Liquid/Slurry - Daily Spread - Solid storage and dry lot - Pasture/range/paddock - Pit storage - Poultry manure with bedding - Poultry manure without bedding	AD: SY, other correspondence, NIS and expert judgment, IPCC 2006 EF: IPCC 2006, expert judgment
3.B.2.4.3	Goats	Includes following type of systems of management: - Anaerobic Lagoon - Liquid/Slurry	AD: SY, other correspondence, NIS and expert judgment, IPCC 2006

Source indicative	Source type	Observation	Data source
<i>Observations on source category 3B – “Manure Management – CH₄ and N₂O emissions”</i>			
		<ul style="list-style-type: none"> - Daily Spread - Solid storage and dry lot - Pasture/range/paddock - Pit storage - Poultry manure with bedding - Poultry manure without bedding 	EF: IPCC 2006, expert judgment
3.B.2.4.4	Horses	<p>Includes following type of systems of management:</p> <ul style="list-style-type: none"> - Anaerobic Lagoon - Liquid/Slurry - Daily Spread - Solid storage and dry lot - Pasture/range/paddock - Pit storage - Poultry manure with bedding - Poultry manure without bedding 	<p>AD: SY, other correspondence, NIS and expert judgment, IPCC 2006</p> <p>EF: IPCC 2006, expert judgment</p>
3.B.2.4.5	Mules and asses	<p>Includes following type of systems of management:</p> <ul style="list-style-type: none"> - Anaerobic Lagoon - Liquid/Slurry - Daily Spread - Solid storage and dry lot - Pasture/range/paddock - Pit storage - Poultry manure with bedding - Poultry manure without bedding 	<p>AD: SY, other correspondence, NIS and expert judgment, IPCC 2006</p> <p>EF: IPCC 2006, expert judgment</p>

Source indicative	Source type	Observation	Data source
<i>Observations on source category 3B – “Manure Management – CH₄ and N₂O emissions”</i>			
		bedding	
3.B.2.4.6	Poultry	Includes following type of systems of management: - Anaerobic Lagoon - Liquid/Slurry - Daily Spread - Solid storage and dry lot - Pasture/range/paddock - Pit storage - Poultry manure with bedding - Poultry manure without bedding	AD: SY, other correspondence, NIS and expert judgment, IPCC 2006 EF: IPCC 2006, expert judgment
<i>Observations on source category 3B – “Manure Management – N₂O indirect emissions”</i>			
3.B.2.5	Includes the following systems AWMS: Anaerobic Lagoon, Liquid/Slurry, Daily Spread, Solid storage and dry lot, Pasture/range/paddock, Pit storage, Poultry manure with bedding, Poultry manure without bedding		AD: SY, other correspondence, NIS and expert judgment, IPCC 2006 EF: IPCC 2006, expert judgment

5.3.2 Methodological issues

CH₄ 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.

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 CH₄ producing capacity for manure produced by an animal within defined population i , m³/kg of VS and MCF - CH₄ conversion factors for each manure management system j by climate region k).

Emissions of methane from manure management were calculated using equations: 10.22 of 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*.

Emission factors

According to the provisions of IPCC 2006, to use equation 10.23 and 10.24 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, UE (urinary energy expressed) and MCF used from 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*.

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 5.2.2 - "Enteric fermentation".

The fractions values of ashes (ASH) used in the VS calculation are default, with those in the IPCC 2006 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 2006 and Reference Manual.

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 B_0 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 almost all the systems described in 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*, with the exception some exemple 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 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*, considering Romania make part of the cold climate.

The values urinary energy expressed as fraction of GE were calculated using the default value for UE (urinary energy) from 2006 *IPCC Guidelines for National Greenhouse Gas Inventories* multiplied with the GE value. Were presented in the table 5.10.

In the Table 5.10 are summarized the values used in the calculation of emissions factors for 1989-2013 period for each livestock and in the Table 5.11 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 5.10 The values used in the calculation of emissions factors from Manure management for 1989-2013

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>i</i> , m ³ /kg of VS (B ₀)	Urinary energy expressed as fraction of GE
3.B.1	<i>CATTLE</i>				
3.B.1.1	<i>Dairy cattle</i>	8	4.09	0.24	9.09
3.B.1.2	<i>Non dairy cattle</i>				
	Calves for slaughter younger than 1 year	8	3.37	0.17	5.72
	Young cattle of breeding under 1 year	8	2.71	0.17	4.62
	Young cattle of breeding between	8	3.55	0.17	5.87

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>i</i> , m ³ /kg of VS (B ₀)	Urinary energy expressed as fraction of GE
	1 and 2 years				
	Young cattle of slaughter between 1 and 2 years	8	3.92	0.17	8.89
	Cattle 2 years and over -Breeding bulls	8	5.90	0.17	9.66
	Cattle 2 years and over - Heifers for breeding	8	4.75	0.17	8.44
	Males and females for sacrificed older than 2 years	8	3.59	0.17	6.66
	Cattle for work	8	7.08	0.17	12.12
3.B.2	<i>SHEEP</i>				
	Ewes of milk and fitted	8	1.26	0.13	1.71
	Reproducers rams	8	1.10	0.13	2.00

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>i</i> , m ³ /kg of VS (B ₀)	Urinary energy expressed as fraction of GE
	Other sheep	8	1.30	0.13	1.81
3.B.3	<i>SWINE</i>				
	Pigs under 20 kg	2	0.08	0.45	0.16
	Pigs between 20 and 50 kg	2	0.10	0.45	0.26
	Pigs fattening	2	0.37	0.45	0.93
	Boars	2	0.36	0.45	0.90
	Breeding sows	2	0.45	0.45	0.90
3.B.4.1	<i>BUFFALO</i>				
	Buffalo milk	8	6.76	0.1	10.78
	Other buffalo	8	3.12	0.1	5.15
3.B.4.3	<i>GOATS</i>				
	Female goats for milk and females by first mount	8	1.55	0.13	2.11
	Other goats	8	1.51	0.13	1.97
3.B.4.4	<i>HORSES</i>				
		8	5.87	0.26	9.03

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>i</i> , m ³ /kg of VS (B ₀)	Urinary energy expressed as fraction of GE
3.B.4.5	<i>MULES AND ASSES</i>	8	4.64	0.26	7.24
3.B.4.6	<i>POULTRY</i>				
	Adult poultry for eggs	8	0.02	0.24	0.03
	Poultry for meat	8	0.02	0.24	0.02

Table 5.11 The values MCF used in calculation of emissions factor for each manure system management for all livestock in the 1989-2013 period

The period 1989-2013	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
	0.66	0.17	0.001	0.02	-	0.01	0.03	0.015	0.015

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 1989-2013 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 1989-2013 period (from 0.3 to 0.58 kg CH₄/head/year) due to the variation in MS level associated to the Solide Storage, Daily spread and Pasture Range/Paddock AWMS.

Emission factors of CH₄ 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 CH₄ emissions from enteric fermentation. Data are presented in Chapter 5.2.2.

N₂O emissions

Direct N₂O emissions

Methodology

Emissions of nitrous oxide from manure management were calculated using the default method, for all species, according to the provisions in 2006 *IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006)*. For these national data are available for annual average N excretion per head of species/category (kg N/animal/yr) (N_{ex}), 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 (EF₃ - the Table 10.21 from 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*).

The direct nitrous oxide emissions from manure management were calculated in according with the equation 10.25 from IPCC 2006 (pg.10.54)

In respect to the IPCC 2006 provisions, Direct and indirect N₂O emissions from Pasture range and paddock AWMS are reported under 3D – Agricultural soils (see Chapter 11., Section 2).

Emission factors

According to the provisions in IPCC 2006, the calculation methodology took into account national the values for annual average N excretion per head of species/category (kg N/animal/yr) (N_{ex}), 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 EF₃ (Table 10 - 21 of IPCC 2006).

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 N₂O emission factors used in the calculation the emissions N₂O from manure management are presented in Table 5.12 depending to manure management system.

Table 5.12 N₂O emission factors [kg N₂O-N/kg N excreted] for animal waste per AWMS

AWMS (source) type	Emission factor EF₃ [kg N₂O-N/kg N excreted]
Anaerobic Lagoon	0
Liquid/Slurry	0.005
Daily Spread	0
Solid storage	0.005
Dry lot	0.02
Pit storage	0.002
Poultry manure wit bedding	0.001
Poultry manure without bedding	0.001

Activity data

They were used the same livestock population numbers as for calculation of CH₄ emissions from enteric fermentation. Data are presented in Chapter 5.2.2.

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 5.2 Nitrogen excretion

$$N_{ex} = \text{the amount of solid manure} \cdot 365 \cdot N\% \text{ from solid manure} / 100 + \text{the amount of liquid manure} \cdot 365 \cdot N\% \text{ from liquid manure} / 100$$

The MS values were established by expert opinion in the context of the above study.

In the Table 5.13 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). The values were implemented through 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“

In poultry the N_{ex} value is considered sum of solid manure with liquid manure. The phases are not separated physiological.

Table 5.13 Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2013 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)
3 B1	<i>CATTLE</i>					
3 B1.1	<i>Dairy cattle</i>	23.5	9	0.4031	0.58	53.63
3 B1.2	<i>Non dairy cattle</i>					

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)
	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
3 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
3 B2	SHEEP					

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)
	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
3 B3	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
3 B4.1	BUFFALO					
	Female buffalo	23.5	9	0.4031	0.58	53.63
	Other buffalo	23.5	9	0.4031	0.58	53.63
3 B.3	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

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)
3 B.4.4	<i>HORSES</i>	16	3.6	0.6	1.55	55.4
3 B.4.5	<i>MULES AND ASSES</i>	11	2.2	0.6	1.55	36.53
3 B.4.6	<i>POULTRY</i>					
	Adult poultry for eggs	0.175	-	1.7	-	1.08
	Poultry for meat	0.18	-	1.84	-	1.2

5.3.3 Uncertainties and time-series consistency

CH₄ emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 10 %;
- EF: 30%;
- 31.62% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 5.2.2), 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 1989-2013 is consistent.

Direct N₂O emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 10 %;
- EF: 30%;
- 31.62% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 5.2.2), 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 1989-2013 is consistent.

5.3.4 Category-specific QA/QC and verification, if applicable

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating LULUCF, 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 6.6.

5.3.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission was made recalculation at the level of the emissions for the 1989-2013 period due to change emission factors defaults in accordance with IPCC 2006.

5.3.6 Category-specific planned improvements, if applicable, including tracking of those identified in 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 CH₄ producing capacity for manure produced by an animal within defined population (B₀);
- ❖ CH₄ conversion factors for each manure management system by climate region (MCF).

5.4 Rice Cultivation (CRF 3.C)

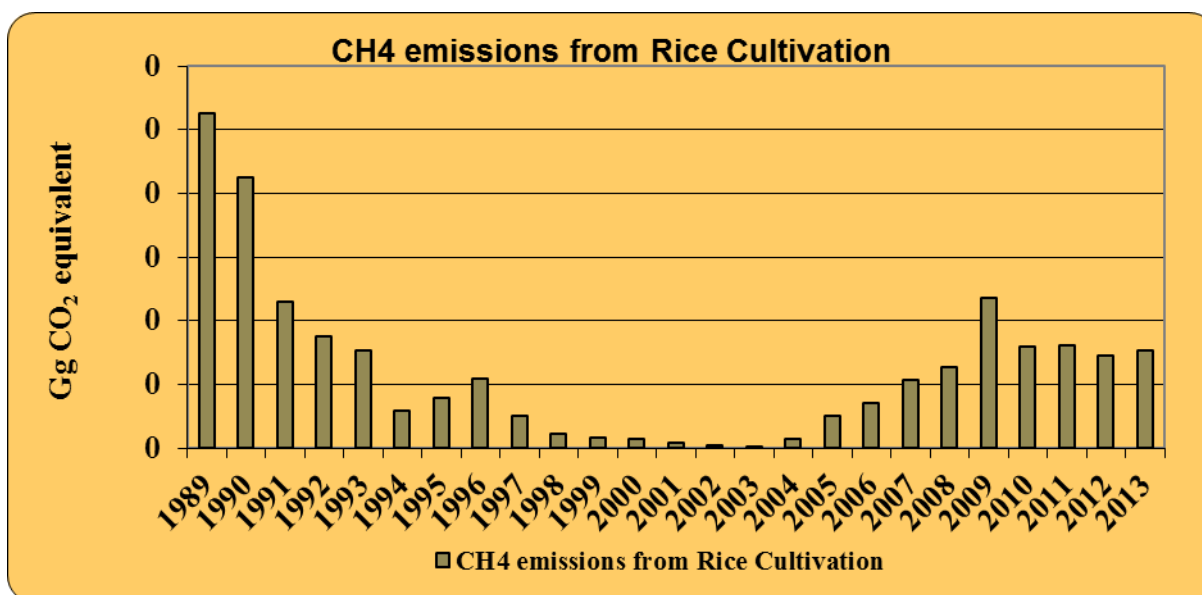
5.4.1 Category description

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 CH₄ emissions in the Agriculture sector (in 2013, CH₄ emissions from Rice Cultivation represented 0.0001% of total CH₄ emissions in the Agriculture sector);
- ❖ is the smallest source in the Agriculture sector (in 2013, CH₄ emissions from Rice Cultivation as CO₂ equivalent represented 0.000086% from Total Agriculture emissions);
- ❖ contributed with 0.000013% to Total GHG emissions of Romania.

Emissions from rice cultivation are declining since 1989 due to the decrease of rice cultivated area (Figure 5.6). The rice area cultivated with is decreased in 21.6 thousands ha in 1991 by 100 ha in 2003. In 2013 the rice area cultivated is 11.9 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 5.6 Methane emission trend due to the Rice Cultivation**Table 5.14 Observations on source category 4C – “Rice Cultivation”**

Source indicative	Source type	Observation	Data source
3.C.1.2	Rice harvested area		AD: SY, NIS, 1989-2013; expert judgment; EF: IPCC 2006

5.4.2 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 5.1 and 5.2 of IPCC 2006 were used (pag.5.45 and 5.48).

Emission factors

Considering the provisions in IPCC 2006 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 $1.30 \text{ kg CH}_4 \text{ ha}^{-1} \text{ day}^{-1}$;
- ❖ a default value of 0.78 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 5.15.

Table 5.15 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

Year	Rice residues productivity [tones d.m./ha]	Scaling factor to account for the type and amount of amendment applied (SF_O)
1998	2.25	1.8
1999	1.78	1.5
2000	1.93	1.5
2001	0.94	1
2002	0.90	1
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
2013	3.43	1.8

Activity data

Total rice cultivated area is provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook 1989-2013.

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 5.16.

Table 5.16 Harvested area data series for 1989-2013

Year	Harvested area [10^8 m²]
1989	4.93
1990	3.99
1991	2.16
1992	1.64
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

Year	Harvested area [10^8 m ²]
2013	1.19

5.4.3 *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 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 1989-2013 is consistent.

5.4.4 *Category-specific QA/QC and verification, if applicable*

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating LULUCF, 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 3.5.

5.4.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Done since last submission have made recalculation at the level all time series 1989-2013 due to of the change of methodologies.

5.4.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

In respect to the IPCC 2006 provisions, more detailed data on rice cultivation techniques used are proposed to be obtained.

5.5 Managed soils (CRF 3.D)

5.5.1 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});
 - organic N applied as fertilizer (F_{ON})
 - urine and dung N deposited on pasture, range and paddock by grazing animals (F_{PRP});
 - N in crop residues (F_{CR});
 - N mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soil (F_{SOM});
 - drainage/management of organic soils (F_{OS}).

Direct soil emissions (3D1)***Direct soil emissions:***

- ❖ is the first source of N₂O emissions in the Agriculture sector (in 2013, N₂O Direct soil emissions represented 64.31% of total N₂O emissions in the Agriculture sector);
- ❖ is the first source in the Agriculture sector (in 2013, N₂O Direct soil emissions as CO₂ equivalent represented 21.22% from Total Agriculture emissions);
- ❖ contributed with 3.39% to Total GHG emissions of Romania.

Emissions from Agricultural Soils are declining since 1989 (Figures 5.7 and 5.8) due to the decrease of the:

- ❖ amount of synthetic fertilizer applied;
- ❖ livestock populations (the details can be found in Chapter 5.1);
- ❖ crop productions level.

In the 1989-1999 period the N-synthetic fertilizer amount is decreasing due to:

- the transition of economy from a centralized state to the market economy. The centralized economy has associated the existence of large/centralized farms with an appropriate technical management. After 1989 year, the large farms has been splitted/disaggregated in the sense that smaller land areas have been restituted to individuals; there was no appropriate N-synthetic fertilizer management at the individuals level;
- the N-synthetic fertilizer price variation-the prices increased while the newly created individuals administrating smaller farms did not had an adequate financial capacity;
- a significant part of land in the small farms had not been temporarily subject to cultivation (due to limited individuals capacity).

In the 1999-2011 period the N-synthetic fertilizer amount is increasing due to:

- re-establishment of large farms, in a significant manner, now in private property; these have associated an optimal technical and financial management aiming to maximize the crop production level.

The amount of N₂O emissions from application of synthetic fertilizers have decreased from 10.45 kt N₂O in 1989, to 5.41 kt N₂O in 2013.

The quantity of synthetic fertilizer has decreased considerably after the 1989 year from 665,300 tonnes/year to 344,000 tonnes/year. This decrease is reflected in the decrease of the nitrogen fraction volatilized into the atmosphere as N₂O. The main cause was a decrease of crop production and the inability of farmers to use the agricultural technology correctly (Table 5.16).

The amount of N₂O emissions from annual amount of animal manure, compost, sewage sludge and other organic N additions applied to soils have decreased from 5.55 kt N₂O in 1989, to 2.36 kt N₂O in 2013.

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 5.7 Overall emissions trend of Agricultural Soils

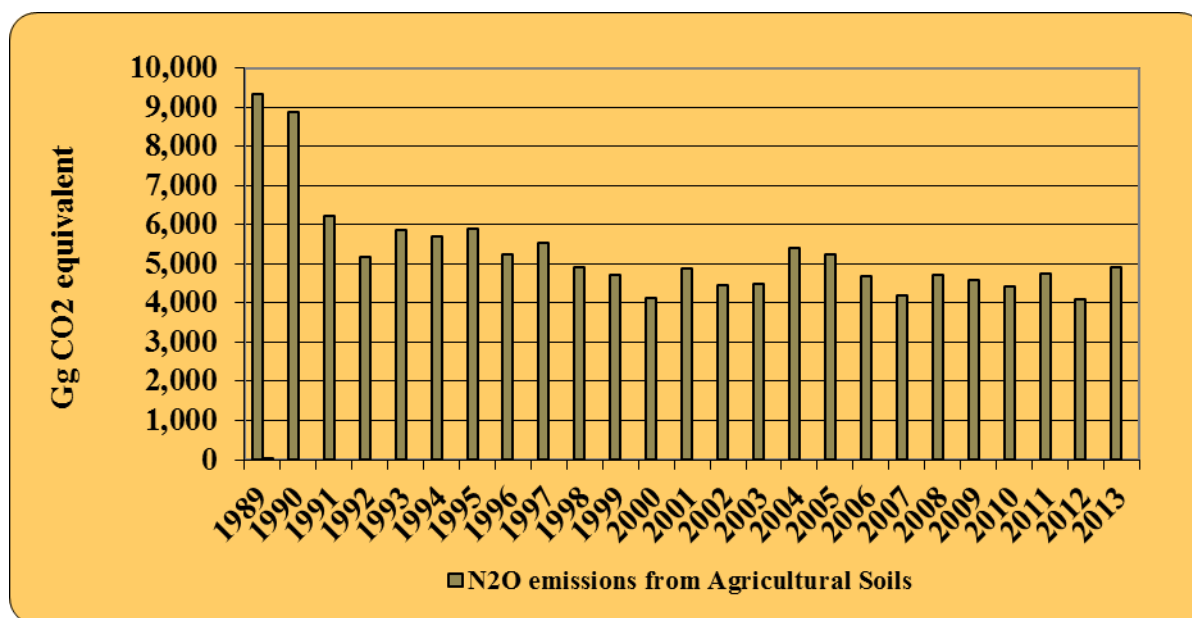
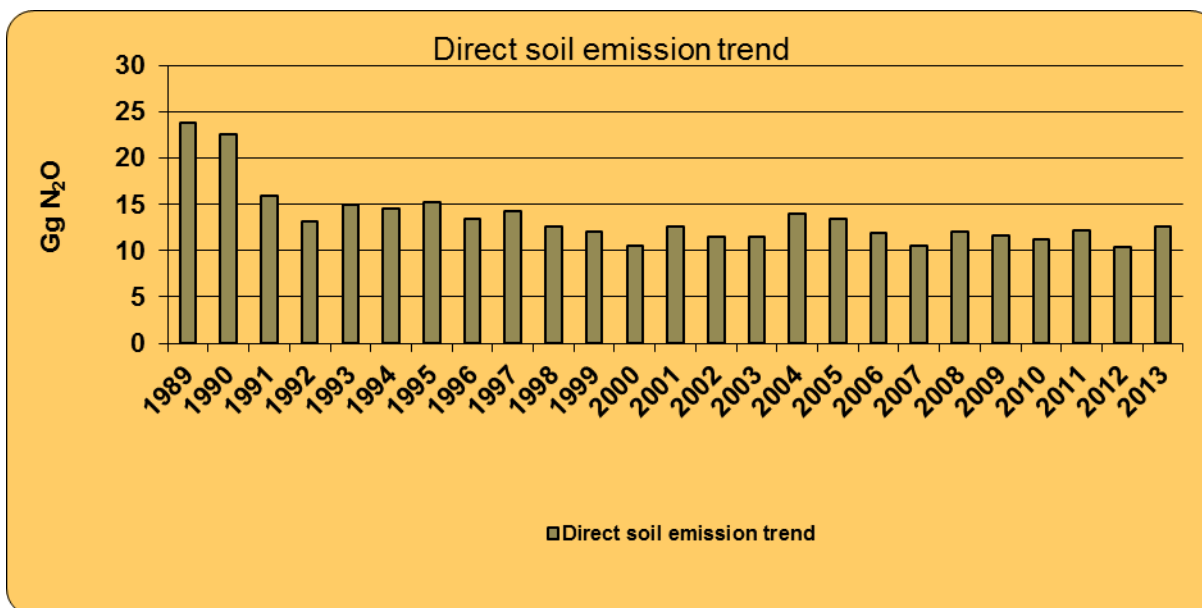


Figure 5.8 Direct N₂O emissions trends – Agricultural Soils**Table 5.17 Observations on source category 3D – “Managed Soils”**

Source indicative	Source (livestock) type	Observation	Data source
3.D.1, 3.D.2	Amount of N synthetic fertilizer used		AD: SY, NIS, 1989-2013; EF: IPCC 2006
3.D.1.2.a, 3.D.1.3, 3.D.2	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,	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2013; The study „ <i>Elaboration of national emission factors /other parameters relevant to NGHGI Sectors Energy, Industrial Process,</i>

Source indicative	Source (livestock) type	Observation	Data source
		swine (pigs under 20 kg, pigs between 20 and 50 kg, pigs fattening, boars, breeding sows) and poultry (adult poultry for eggs, poultry for meat).	<i>Agriculture and Waste, to allow for the higher tier calculation methods“</i> EF: IPCC 2006, Country specific, expert judgment
3.D.1.4	Production crops	Includes following crops: <i>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, pea beans, dry bean, other leguminous for dry bean, soybeans, Annual leguminous, lucerne, clover, other perennial leguminous.</i>	AD: SY, other correspondence, NIS, 1989 -2013; The study „ <i>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“.</i> EF: IPCC 2006

Source indicative	Source (livestock) type	Observation	Data source
	Area crop	<p>Includes following crops: <i>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, pea beans, dry bean, other leguminous for dry bean, soybeans, Annual leguminous, lucerne, clover, other perennial leguminous.</i></p>	<p>AD: NIS, 1989 -2013; EF: IPCC 2006</p>
	Area burnt	<p>Includes following crops: <i>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</i></p>	<p>AD: NIS, 1989 -2013; expert judgment EF: IPCC 2006</p>

Source indicative	Source (livestock) type	Observation	Data source
		<p>- 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, pea beans, dry bean, other leguminous for dry bean, soybeans, Annual leguminous, lucerne, clover, other perennial leguminous.</p>	
3.D.1.6	Area of cultivated organic soils		AD: The Report of National Research Institute for Soil Agrochemical and Environment Protection EF: IPCC 2006

5.5.2 *Methodological issues*

N₂O 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 11.1, 11.3, 11.4, 11.5, 11.6 and 11.7 in IPCC 2006 and the equation 4.22 in IPCC GPG 2000.

Emission factors

The calculation methodology took into account IPCC 2006 default emissions factors (Table 11.1 of IPCC 2006):

- ❖ $EF_1 = 0.01$ (fraction of N-input, kg N₂O-N/kg N);
- ❖ $EF_2 = 8$ (value specific to Middle-Latitude Organic Soils; kg N₂O-N/ha/year);
- ❖ $EF_{3PRP, CPP}$ for cattle = 0.02 (dairy, non dairy and buffalo);
- ❖ $EF_{3PRP, SO}$ for sheep and other animals = 0.01.

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 NH₃ 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 1989-2013.

Data series are presented in Table 5.18.

Default value of **Frac_{GASF}** used is 0.1 (Reference Manual, 1996).

Data used for calculation of annual amount of animal manure, compost, sewage sludge and other organic N additions applied to soils (F_{ON})

For calculation F_{ON} is necessary of the annual amount of animal manure N applied to soils (F_{AM}). Livestock data are presented in Chapter 5.2.2.

Nitrogen excretion per head of animal and fraction of nitrogen excretion produced in different AWMS values used are presented in Chapter 5.3.2.

For the calculation amount of managed manure N available for soil application, feed, fuel or construction (N_{MMS}) were used the parameters presented in Chapter 5.2.2 and 5.3.2.

For parameters annual amount of total sewage N that is applied to soils (F_{SEW}) and annual amount of total compost N applied to soils (F_{OOA}) have been used values 0 because no known the values.

Amount of managed manure nitrogen for livestock category that is lost in the manure management system ($Frac_{LossMS}$) is used the default value from IPCC 2006 (Table 10.23), and the amount of nitrogen from bedding ($N_{bedding}$) is used the value 0, it is not known organic bedding.

For fractions of managed manure used for feed ($Frac_{FEED}$), fraction of managed manure used for fuel ($Frac_{FUEL}$) and fraction of managed manure used for construction ($Frac_{CNST}$) 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 5.18 Activity data series used for calculation of F_{SN} , for 1989-2013

Year	Amount of synthetic fertilizer applied to soil [thousands tonnes/year]
1989	665.3
1990	656.0
1991	275.0
1992	258.0
1993	346.0

Year	Amount of synthetic fertilizer applied to soil [thousands tonnes/year]
1994	313.0
1995	306.0
1996	268.0
1997	262.0
1998	254.0
1999	225.0
2000	239.0
2001	268.0
2002	239.0
2003	252.0
2004	270.0
2005	299.0
2006	252.0
2007	265.0
2008	279.8
2009	296.06
2010	306.0
2011	313.0
2012	289.9
2013	344.0

Data used for calculation of annual amount of nitrogen in crops residues (F_{CR})

Primary data for crop production of nitrogen fixing crop

In the calculation annual amount of nitrogen in crop residues (F_{CR}) has been considered the primary data on Crop production of nitrogen fixing crop and non-N-fixing crop, total annual area harvested of crop and annual area of crop burnt.

Primary data on Crop production of nitrogen fixing crop and non-N-fixing crop which has been

obtained from the NIS through SY 1989-2013 and data base. Crop production of nitrogen fixing crop are presented in Table 5.19.

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*.

Until 2003 NIS the data on crop production of *plant used silage* were collected in accordance with the Regulations, and the data were collected in accordance other Regulations according to the requirements EUROSTAT, renouncing at the name of this indicator, resulting the indicator *annual green fodder total* (the sum plant used silage with annual green fodder).

Table 5.19 The primary data on Crop production of nitrogen fixing crop obtained from the NIS, in the 1989-2013 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
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

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
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	IE	IE	1,923,528	4,655,262
2005	39,096	41,733	80,913	312,781	IE	IE	2,454,958	6,274,555
2006	36,147	34,942	71,574	344,909	IE	IE	3,182,639	6,381,270
2007	17,748	18,014	36,185	136,094	IE	IE	2,222,483	4,166,344
2008	36,917	25,157	62,466	90,579	IE	IE	2,860,655	5,505,795
2009	30,009	22,348	52,918	84,268	IE	IE	2,898,188	5,642,588
2010	39,677	21,059	61,344	149,940	IE	IE	3,041,978	5,799,305
2011	55,076	21,351	76,830	142,636	IE	IE	3,371,352	6,015,839
2012	45,878	16,603	62,934	104,330	IE	IE	3,043,519	4,836,406
2013	54,600	18,900	74,214	149,900	IE	IE	3,346,435	5,480,516

Table 5.19 (continued) The primary data on Crop production of nitrogen fixing crop obtained from the NIS, in the 1989-2013 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

Year	Crop production of nitrogen fixing crop (tonnes/year)		
	Clover in equivalent green fodder	Other perennial forage	Perennial forage
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
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
2013	1,873,522	2,345,173	9,699,211

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 5.19 (NIS) for the calculation F_{CR} are used the data on Crop production of nitrogen fixing crop presented in the Table 5.20.

The values for pea beans, dry bean, soybeans, lucerne and clover were used in the primary data table (Table 5.19).

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.

Table 5.20 The data on Crop production of nitrogen fixing crop obtained through the dedicated study (tonnes/year), in the 1989-2013 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
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

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
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
2013	54,600	18,900	714	149,900	5,480,516	1,873,522	1,003,930	938,069

Primary data for crop production of nitrogen non fixing crop

The primary data on Crop production of nitrogen non-N-fixing crop are provided by NIS through SY 1989-2013 and data base are presented in Table 5.21.

Table 5.21 The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2013 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
2013	23,812	7,296,400	1,542,200	373,800	11,305,100	49,800	54,600	20,897,100

Table 5.21 (continued) The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2013 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

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
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
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
2013	7,320,212	245,027	666,100	2,142,100	4,046	2,966,621	149,900	36

Table 5.21 (continued) The primary data on Crop production of non- nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2013 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

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
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
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
2013	31	0	1,357	172	4,397	6,191	3,289,722	1,029,209

Table 5.21 (continued) The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2013 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
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

Year	Productions of non-N-fixing crops (tonnes/year)							
	Fodder roots	Tomatoes	Eggplant	Dry onion	Dry garlic	Cabbage	Green peppers	Cultivated mushrooms
2013	417,182	749,128	123,278	391,837	62,156	1,156,436	227,690	8,785

Table 5.21 (continued) The primary data on Crop production of non- nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2013 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	IE	IE	1,923,528	6,608,789
2005	229,569	691,760	3,624,612	IE	IE	2,454,958	10,127,514

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
2006	292,579	641,791	4,138,862	IE	IE	3,182,639	10,622,291
2007	209,029	407,973	3,116,801	IE	IE	2,222,483	7,330,212
2008	265,999	562,260	3,819,890	IE	IE	2,860,655	9,273,329
2009	238,748	652,844	3,901,862	IE	IE	2,898,188	9,461,506
2010	241,578	662,863	3,863,617	IE	IE	3,041,978	9,974,033
2011	275,145	645,486	4,176,298	IE	IE	3,371,352	10,661,681
2012	275,145	554,588	3,535,316	IE	IE	3,043,519	8,482,250
2013	242,265	634,786	3,960,990	IE	IE	3,346,435	9,699,211

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 5.21 (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 5.20.

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 5.21).

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*.

The values associated the nitrogen fixing crop used in the calculation F_{CR} are presented in the table 5.22.

Above-ground residues dry matter (AG_{DM}) has calculated with the formula in Table 11.2 in IPCC 2006, pg.11.17 using the default value for *AG_{DMslope}* and *AG_{DMintercept}* in the same table and for the N content of above-ground residues for crop (N_{AG}), N content of below-ground residues for crop (N_{BG}) and ratio of below-ground residues above-ground biomass (R_{BG-BIO}), dry matter has fraction ($Frac_{DM}$) used the default value in Table 11.2 (IPCC 2006).

Data on **Area crops** (ha) and **Area burnt** were presented in Anexe 3.5.

Area burnt was calculated by expert opinion so:

- was estimated percent of area crops divided area crops cereals to total area crops cereals multiplied with 100;
- area burnt was estimated dividing the percent of area crop cereals to 100 and multiplied with total area of cereals;
- total area of cereals was estimated divided the data from Food and Agriculture Organization of the United Nations (FAO) on amount biomass burned to the data from National Institute of Statistics (NIS) on average production.

Table 5.22 The values associated the nitrogen fixing crop used in the calculation F_{CR} (AG_{DM} slope, AG_{DM} intercept, R_{BG-BIO} , N_{AG} , N_{BG} , $Frac_{Remove}$, $Frac_{DM}$, $Frac_{RENEW}$), in the 1989-2013 period

Parameters	<i>The values associated the nitrogen fixing crop in the calculation F_{CR}</i>							
	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
AG_{DM} slope	1.13	1.13	1.13	0.93	0.29	0.3	1.13	0.3
AG_{DM} intercept	0.85	0.85	0.85	1.35	0	0	0.85	0
R_{BG-BIO} (kg d. m.)	0.19	0	0.19	0.19	0.4	0.8	0.4	0.4
N_{AG} (kg d.m.)	0.008	0.01	0.008	0.008	0.027	0.025	0.027	0.027
N_{BG}	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
$Frac_{Remove}$	0.10	0.03	0.10	0	0	0	0	0
$Frac_{DM}$	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.90
$Frac_{RENEW}$	1	1	1	1	0.2	0.5	1	0.5

In the table 5.23 are presented the values associated the nitrogen non fixing crop used in the calculation F_{CR} .

Table 5.23 The values associated the nitrogen non fixing crop used in the calculation F_{CR} (AG_{DM} slope, AG_{DM} intercept, R_{BG-BIO} , N_{AG} , N_{BG} , $Frac_{Remove}$, $Frac_{DM}$, $Frac_{RENEW}$), in the 1989-2013 period

Parameters	<i>The values associated the nitrogen non fixing crop in the calculation F_{CR}</i>							
	Rye	Wheat	Barley and two-row barley	Oats	Maize grains	Sorghum	Rice	Other cereals
AG_{DM} slope	1.09	1.51	0.98	0.91	1.03	0.88	0.95	1.43
AG_{DM} intercept	0.88	0.52	0.59	0.89	0.61	1.33	2.46	0.14
R_{BG-BIO} (kg d. m.)	0	0.24	0.22	0.25	0.22	0	0.16	0
N_{AG} (kg d.m.)	0.005	0.01	0.007	0.007	0.006	0.007	0.007	0.007
N_{BG}	0.011	0.01	0.01	0.01	0.01	0.01	0	0
$Frac_{Remove}$	0	0.25	0	0.20	0.20	0	0	0
$Frac_{DM}$	0.88	0.89	0.89	0.89	0.87	0.89	0.89	0.9
$Frac_{RENEW}$	1	1	1	1	1	1	1	1

Table 5.23 (continued) The values associated the nitrogen non fixing crop used in the calculation F_{CR} (AG_{DM} slope, AG_{DM} intercept, R_{BG-BIO} , N_{AG} , N_{BG} , $Frac_{Remove}$, $Frac_{DM}$, $Frac_{RENEW}$), in the 1989-2013 period

Parameters	<i>The values associated the nitrogen non fixing crop in the calculation F_{CR}</i>							
	Rape	Sunflower	Flax for oil	Other oilseed plants - castor	In fiber-textile plants	Hemp for fiber-Plant textiles	Other textile plants-cotton	Tobacco
AG_{DM} slope	0.93	0.93	0.93	0.93	0	0	0	0
AG_{DM} intercept	1.35	1.35	1.35	1.35	0	0	0	0
R_{BG-BIO} (kg d. m.)	0.19	0.19	0.19	0.19	0	0	0	0
N_{AG} (kg d.m.)	0.008	0.008	0.008	0.008	0	0	0	0
N_{BG}	0.01	0.01	0.01	0.01	0	0	0	0
$Frac_{Remove}$	0.40	0.40	0.10	0	0.30	0.30	0.30	0
$Frac_{DM}$	0.91	0.91	0.91	0.91	0.85	0.85	0.85	0.85
$Frac_{RENEW}$	1	1	1	1	1	1	1	1

Table 5.23 (continued) The values associated the nitrogen non fixing crop used in the calculation F_{CR} (AG_{DM} slope, AG_{DM} intercept, R_{BG-BIO} , N_{AG} , N_{BG} , $Frac_{Remove}$, $Frac_{DM}$, $Frac_{RENEW}$), in the 1989-2013 period

Parameters	<i>The values associated the nitrogen non fixing crop in the calculation F_{CR}</i>								
	Hop	Medicinal aromatic plants/spices grown	Other industrial crops-sorghum for brooms	Potatoes	Sugar beet	Fodder roots	Tomatoes	Eggplant	Dry onion
AG_{DM} slope	0	0	0.88	0.1	1.07	1.07	0.1	0.1	0
AG_{DM} intercept	0	0	1.33	1.06	1.54	1.54	1.06	1.06	0
R_{BG-BIO} (kg d. m.)	0	0	0	0.2	0.2	0.2	0.2	0.2	0
N_{AG} (kg d.m.)	0	0	0.007	0.019	0.016	0.016	0.019	0.019	0
N_{BG}	0	0	0.01	0.01	0.01	0.01	0.01	0.01	0
$Frac_{Remove}$	0	0	0.10	0	0.40	0	0	0	0
$Frac_{DM}$	0.85	0.85	0.89	0.22	0.94	0.94	0.85	0.22	0.85
$Frac_{RENEW}$	1	1	1	1	1	1	1	1	1

Table 5.23 (continued) The values associated the nitrogen non fixing crop used in the calculation F_{CR} (AG_{DM} slope, AG_{DM} intercept, R_{BG-BIO} , N_{AG} , N_{BG} , $Frac_{Remove}$, $Frac_{DM}$, $Frac_{RENEW}$), in the 1989-2013 period

Parameters	The values associated the nitrogen non fixing crop in the calculation F_{CR}								
	Dry garlic	Cabbage	Green peppers	Cultivated mushrooms	Root vegetables – Edible roots	Water melons and melons	Other vegetables	Annual grasses	Other perennial grasses
AG_{DM} slope	0	0	0.1	0	1.07	0	0.1	0.3	0.3
AG_{DM} intercept	0	0	1.06	0	1.54	0	1.06	0	0
R_{BG-BIO} (kg d. m.)	0	0	0.2	0	0.2	0	0.2	0.8	0.8
N_{AG} (kg d.m.)	0	0	0.019	0	0.016	0	0.019	0.015	0.015
N_{BG}	0	0	0.01	0	0.01	0	0.01	0.01	0.01
$Frac_{Remove}$	0	0	0	0	0.10	0	0	0	0
$Frac_{DM}$	0.85	0.85	0.22	0.85	0.94	0.85	0.22	0.90	0.90
$Frac_{RENEW}$	1	1	1	1	1	1	1	1	0.5

Combustion factor (C_f)

The value for combustion factor (C_f) for following plants wheat, rice, maize was used in Volume 4, Chapter 2, table 2.6, pg.2.49. Combustion factor for rye, barley and two-row barley have been taken at wheat, for oats, other cereals have been taken from rice and for other remaining plants have been taken from sugarcane.

$Frac_{Remove}$

In the context implementing of the study, by expert opinion „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“ was estimated for $Frac_{Remove}$ (fraction

construction and feed) for the 1989-2013 period the national values for some plants: *wheat, oats, maize, peas beans, dry bean, other leguminous for dry beans, rape, sunflower, flax for oil, in fiber-textile plants, hemp for fiber-plant textiles, other textile plants-cotton, other industrial crop, sugar beet, root vegetables.*

Frac_{DM}

Were used the default values from the Table 11.2 (IPCC 2006) and the national values based on data presented in national bibliography.

Frac_{Renew}

By expert opinion, fraction of total area under crop that is renewed annually was considered for the annual plants the value 1 and for lucerne was divided 1 to 5 year and for clover, other perennial grasses and other perennial leguminous 1 to 2 year.

Data used for calculation of nitrogen mineralized in mineral soils as a results of loss of soil C through chance in land use or management (F_{SOM})

In Romania activity data on nitrogen mineralized in mineral soils as a results of loss of soil C through chance in land use or management not there is.

Area of organic soils cultivated

After of a collaboration between the Ministry of Environment, Water and Forests and The Forestry Research Institute of Design (ICAS) and in the context implementing the raport of the National Research and Development Institute for Soil Science, Agrochemistry and Environment (ICPA) elaborated in 2014 Histosols of Romania occupy an area cultivated of 6362.61 ha.

Annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock and by grazing animals (Frac_{PRP})

For the calculating (**Frac_{PRP}**) were used the same livestock population numbers as for calculation of CH₄ emissions from enteric fermentation and annual average N excretion per head and fraction of total annual N excretion for each livestock as for calculation of N₂O emissions from manure management. Data are presented in Chapter 5.2.2. and 5.3.2.

5.5.3 *Uncertainties and time-series consistency*

Direct soil emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;
- EF: 300%;
- 300.67% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 in crop residues (kg N/year) (F_{CR}); detailed information is provided in Section 5.2.2 and 5.5.2, 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 1989-2013 is consistent.

5.5.4 Category-specific QA/QC and verification, if applicable

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating LULUCF, 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 nonconformity 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 6.6.

5.5.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission was made recalculation for the 1989-2013 period due to of the change of the methodology.

5.5.6 Category-specific planned improvements, if applicable, including tracking of those identified in 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 ($\text{Frac}_{\text{GASF}}$);
- ❖ fraction that volatilizes as NH_3 and NO_x , specific to animal manure nitrogen used as fertilizer, adjusted for volatilization ($\text{Frac}_{\text{GASM}}$);
- ❖ national values for activity data in totality;

- ❖ fraction of N input that is lost through leaching and runoff ($\text{Frac}_{\text{LEACH}}$).

5.6 Prescribed Burning of Savannas (CRF 3.E)

Prescribed Burning of Savannas does not occur in Romania.

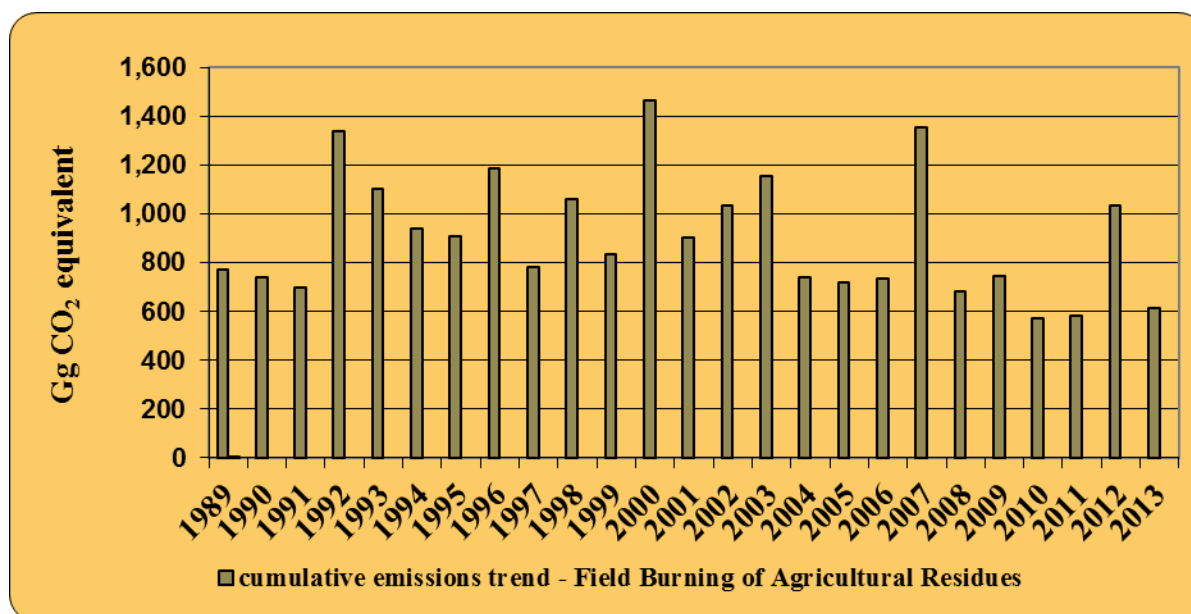
5.7 Field Burning of Agricultural Residues (CRF 3.F)

5.7.1 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, we concluded that this activity happens 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 2013 are lower than emissions in 1989 with 611.87 kt CO₂ equivalent, due to the lower agricultural yields.

Figure 5.9 Cumulative emissions trend - Field Burning of Agricultural Residues**Table 5.24 Observations on source category 4F – “Field Burning of Agricultural Residues”**

Source indicative	Source (livestock) type	Observation	Data source
3.F	Crop productions	Includes data on 6 types of crops productions: rye, wheat, barley and two-row barley, maize grains, sorghum, other cereals	AD: SY, other correspondence NIS, 1989-2013; the study „ <i>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</i> “ EF: IPCC 2006

5.7.2 Methodological issues

Methodology

Due to the fact that CH₄ and N₂O 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 and nitrogen oxides emissions, the equation on page 2.42 of IPCC 2006, Volume 4, Chapter 2, was used.

Emission factors

According to the provisions in IPCC 2006 was used default emission factors for various of burning in table 2.5, pg.2.47, Volume 4, Chapter 2.

Was used default combustion factor from IPCC 2006, table 2.6, Volume 4, Chapter 2. of 0.9 for rye, wheat and 0.8 for barley and two-row barley, maize grains, sorghum, other cereals.

Table 5.25 Default emission ratios for agricultural residue burning of residues calculations

Gas	Default IPCC 1996 emission ratios
Methane (CH ₄)	2.7
Nitrous oxide (N ₂ O)	0.07

Activity data

Data on Area burnt described in Chapter 5.5.2.

5.7.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;

- EF: 50%;
- 53.85% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

N₂O emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;
- EF: 50%;
- 53.85% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

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 6.3.

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 5.5.2), 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 1989-2013 is consistent.

5.7.4 Category-specific QA/QC and verification, if applicable

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by

the sectorial expert administrating LULUCF, 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 nonconformity 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 6.6.

5.7.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission was made recalculation for the 1989-2013 period due to of the change of the methodology.

5.7.6 Category-specific planned improvements, if applicable, including tracking of those identified in 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.

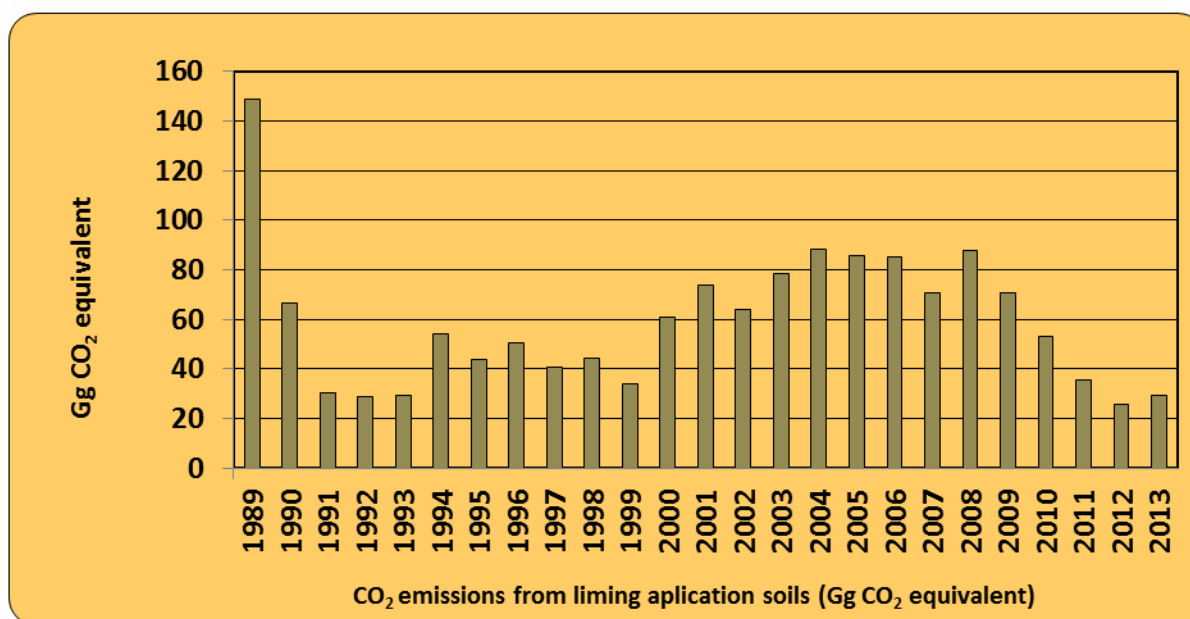
5.8 Liming (CRF 3G)

5.8.1 Category description

Liming is used to reduce soil acidity and improve plant growth in managed systems, partilulary agricultural lands and managed forests. Adding carbonates to soils in the form of lime (calcil limestone CaCO_3 or dolomite $\text{CaMg}(\text{CO}_3)_2$ leads to CO_2 emissions as the carbonate limes dissolve and release bicarbonate (2HCO_3), which evolves into CO_2 and water (H_2O).

The emissions decreasing until 1993 then begin to fluctuate in according with the decreasing and increasing of annual amount of calcic limestone CaCO_3 .

Figure 5.10 CO₂ emissions from liming application soils



5.8.2 Methodological issues

Methodology

Was applied the method of tier 1 applying the equation 11.12 from IPCC 2006, pg.11.27.

Emission factor

Were used default emissions factors from IPCC 2006 of 0.12 for limestone and 0.13 for dolomite.

Activity data

Annual amount of calcic limestone or dolomite have been provided by Ministry of Agriculture and Rural Development.

5.8.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 25 %;
- EF: 40 %;

Uncertainties were taken from IPCC 2006.

- 0.47 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

5.8.4 Category-specific QA/QC and verification, if applicable

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating LULUCF, the results of these being mentioned on the Checklists level.

No nonconformity has been noted following the UNFCCC review of the NGHGI.

5.8.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Recalculation not apply because it is a new category.

5.8.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

Aiming to their incorporation into next inventory submissions, the development of national values for activity data in totality.

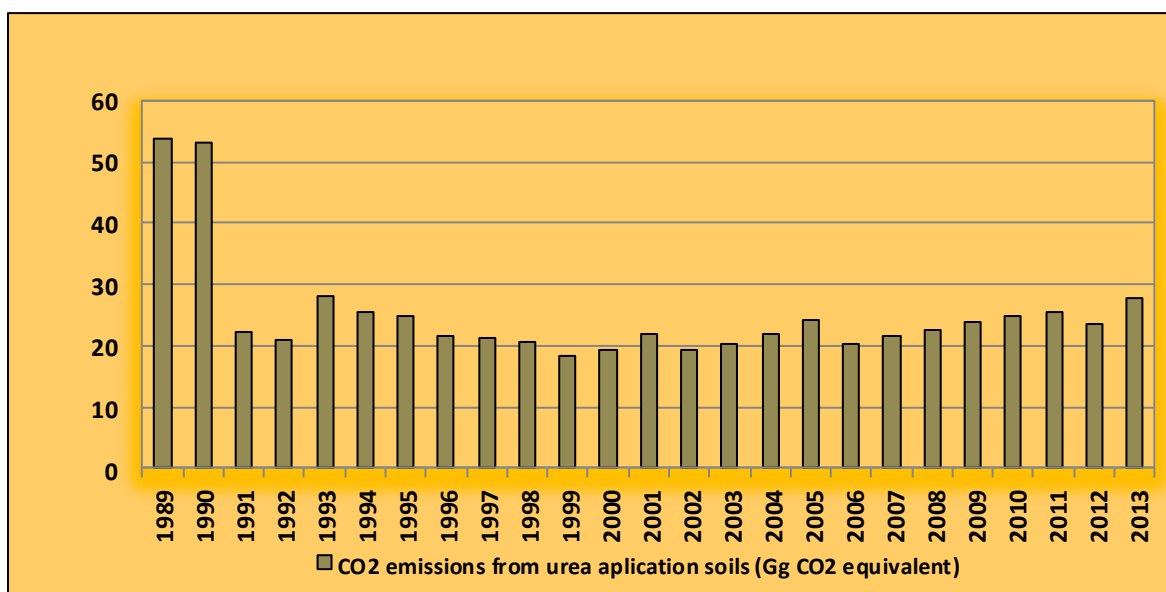
5.9 Urea fertilization (CRF 3H)

5.9.1 Category description

Adding urea to soils during fertilisation leads to a loss of CO₂ that was fixed in the industrial production process. Urea is converted into ammonium (NH₄), hydroxyl in and bicarbonate that is formed evolves into CO₂ and water. This source is included because the CO₂ removal from the atmosphere during urea manufacturing is estimated in the Industrial Processes and Product Use Sector (IPPU Sector).

The emissions were decreased until 1992 then begin to fluctuate in according with the decreasing and increasing of annual amount of urea fertilisation.

Figure 5.11 CO₂ emissions from Urea fertilization



5.9.2 *Methodological issues*

Methodology

Was applied the method of Tier 1 applying the equation 11.13 from IPCC 2006, pg.11.32.

Emission factor

Was used default emissions factor of 0.20 from IPCC 2006.

Activity data

Annual amount of urea fertilization

Was estimated by the expert opinion as 11.06% of annual amount of synthetic fertilizer N applied to soils presented in Chapter 5.5.2.

5.9.3 *Uncertainties and time-series consistency*

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 25 %;
- EF: 40 %;
- 47.17 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 3.1, page 3.2.8 from Chapter 3, Volume 1 of the IPCC 2006.

5.9.4 *Category-specific QA/QC and verification, if applicable*

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by

the sectorial expert administrating LULUCF, the results of these being mentioned on the Checklists level.

No unconformity has been noted following the UNFCCC review of the NGHGI.

5.9.5 Category-specific recalculation, including change made in response to the review process and impact on emission trend

Recalculation not apply because it is a new category.

5.9.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

Aiming to their incorporation into next inventory submissions, the development of national values for activity data in totality.

6 LULUCF (CRF Sector 4)

6.1 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 methodologies presented in *2006 IPCC Guidelines for National Greenhouse Gas Inventory* (IPCC, 2006) and *2013 Supplement to the 2006 Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement)* (IPCC, 2013).

The net GHG emissions for LULUCF in Romania are presented in Table 6.1

Table 6.1 GHGs emissions and removals for the LULUCF Sector in 1989 (BY), 2000, 2010 and 2013

IPCC Subcategories	Emission (“+”) / removal (“-“), in GgCO ₂ eq			
	BY(1989)	2000	2008	2012
4.A.1. Forest land remaining Forest Land (+4G. Harvested Wood Products)	-19650	-23636	-23364	-24489
4.A.2. Land converted to Forest Land	-3785	-3979	-3979	-3979
4.B.1. Cropland remaining Cropland	-2600	-2289	-2269	-2263
4.B.2. Land converted to Cropland	1364	-12	-249	-249
4.C.1. Grassland remaining Grassland	-1484	-1562	-1562	-1562
4.C.2. Land converted to Grassland	3474	1183	921	921
4.D.1. Wetlands remaining Wetlands	0	0	0	0
4.D.2. Land converted to Wetlands	356	358	358	358
4.E.1. Settlements remaining Settlements	0	0	0	0

IPCC Subcategories	Emission ("+") / removal ("-"), in GgCO ₂ eq			
	BY(1989)	2000	2008	2012
4.E.2. Land converted to Settlements	3444	3550	3550	3550
4.F.1. Other land remaining Other Land	0	0	0	0
4.F.2. Land converted to Other Land	873	890	890	890
CH ₄ emissions	0	3	0	1
N ₂ O emissions	879	887	862	862

CO₂ removals have increased in forestland while CO₂ emissions from land converted to settlements have decreased compared to base year (1989). The major GHG is CO₂, with non - CO₂ GHG having insignificant contributions (Table 6.2).

Table 6.2 LULUCF GHG emissions and removals for the period 1989-2013 ("-"CO₂ removals, "+" GHG emissions, in kt)

Reported year	CO ₂	CH ₄	N ₂ O	NO _x , CO, NMVOC	SO ₂
BY (1989)	-18009	0.00	2.83	NA, NE	NA
1990	-22170	0.02	2.94	NA, NE	NA
1991	-24241	0.01	2.93	NA, NE	NA
1992	-25054	0.03	2.93	NA, NE	NA
1993	-26360	0.02	2.92	NA,NE	NA
1994	-25565	0.01	2.91	NA,NE	NA
1995	-24995	0.01	2.90	NA,NE	NA
1996	-23998	0.01	2.89	NA,NE	NA
1997	-24249	0.00	2.88	NA,NE	NA
1998	-26511	0.01	2.88	NA,NE	NA
1999	-25748	0.01	2.87	NA,NE	NA
2000	-25497	0.13	2.86	NA,NE	NA
2001	-26966	0.04	2.85	NA,NE	NA
2002	-24631	0.13	2.84	NA,NE	NA

Reported year	CO ₂	CH ₄	N ₂ O	NO _x , CO, NMVOC	SO ₂
2003	-24568	0.03	2.84	NA,NE	NA
2004	-24272	0.00	2.83	NA,NE	NA
2005	-26319	0.01	2.82	NA,NE	NA
2006	-25662	0.03	2.81	NA,NE	NA
2007	-25181	0.11	2.80	NA,NE	NA
2008	-26147	0.03	2.79	NA,NE	NA
2009	-25911	0.04	2.78	NA,NE	NA
2010	-25703	0.01	2.78	NA,NE	NA
2011	-25978	0.04	2.78	NA,NE	NA
2012	-27158	0.05	2.78	NA,NE	NA
2013	-26822	0.05	2.78	NA,NE	NA

Emission factors are based on country specific data for forestland, while for the other land categories on a both default and country specific factors and parameters.

The GHG emissions estimates include all land categories and GHG (Table 6.3).

Table 6.3 Status of estimating emissions by sources/ removals by sinks in the LULUCF Sector
(for completeness on C pools and GHG sources more information is available within the specific chapters in the NIR, R-reported, shaded cells – not relevant)

GHG source and sink categories	CO ₂	CH ₄	N ₂ O
4.A. Forest Land			
4.A.1. Forest Land remaining Forest Land	R	R	R
Living biomass	R		
Dead Wood	NO		
Litter	NO		
SOMmin	NO		
SOMorg	NO		
4.A.2. Land converted to Forest Land	R	NO	IE, NO

GHG source and sink categories	CO₂	CH₄	N₂O
4.A.2.1. Cropland converted to Forest Land			
Living biomass	R		
Dead Wood	NO		
Litter	R		
SOMmin	R		
SOMorg	NO		
4.A.2.2. Grassland converted to Forest Land			
Living biomass	R		
Dead Wood	NO		
Litter	R		
SOMmin	R		
SOMorg	NO		
4.A.2.3. Wetlands converted to Forest Land			
Living biomass	R		
Dead Wood	NO		
Litter	NO		
SOMmin	NO		
SOMorg	NO		
4.A.2.4. Settlements converted to Forest Land			
Living biomass	NO		
Dead Wood	NO		
Litter	NO		
SOMmin	NO		
SOMorg	NO		
4.A.2.5. Other Land converted to Forest Land			
Living biomass	R		
Dead Wood	NO		
Litter	R		
SOMmin	R		

GHG source and sink categories	CO₂	CH₄	N₂O
SOMorg	NO		
4.B. Cropland			
4.B.1. Cropland remaining Cropland	R	NO	NO
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	R		
4.B.2. Land converted to Cropland	R	NO	R
4.B.2.1. Forest Land converted to Cropland			
Living biomass	NO		
Dead Wood	NO		
Litter	R		
SOMmin	NO		
SOMorg	NO		
4.B.2.2. Grassland converted to Cropland			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
4.B.2.3. Wetlands converted to Cropland			
Living biomass	R		
DOM	NO		
SOMmin	R		
SOMorg	IE		
4.B.2.4. Settlements converted to Cropland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		

GHG source and sink categories	CO₂	CH₄	N₂O
4.B.2.5. Other Land converted to Cropland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.C. Grassland			
4.C.1. Grassland remaining Grassland	NO	NO	NO
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	R		
4.C.2. Land converted to Grassland	R	NO	NO
4.C.2.1. Forest Land converted to Grassland			
Living biomass	NO		
DOM	R		
SOMmin	R		
SOMorg	NO		
4.C.2.2. Cropland converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.C.2.3. Wetlands converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
4.C.2.4. Settlements converted to Grassland			
Living biomass	NO		

GHG source and sink categories	CO₂	CH₄	N₂O
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.C.2.5. Other Land converted to Grassland			
Living biomass	R		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.D. Wetlands			
4.D.1. Wetlands remaining Wetlands	NO	NO	NO
4.D.1.1. Peat extraction remaining peat extraction			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
4.D.1.2. Flooded land remaining flooded land			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
4.D.1.3 Other wetlands remaining other wetlands			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
4.D.2. Land converted to Wetlands	R	NO	NO
4.D.2.1. Land converted to peat extraction			
Living biomass	NO		
DOM	NO		

GHG source and sink categories	CO₂	CH₄	N₂O
SOMmin	NO		
SOMorg	NO		
4.D.2.2. Land converted to flooded land			
4.D.2.2.1. Forest Land converted to flooded land			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
4.D.2.2.2. Cropland converted to flooded land			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.D.2.2.3. Grasslands converted to flooded land			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
4.D.2.2.4. Settlements converted to flooded land			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
4.D.2.3. Other Land converted to flooded land			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.D.2.4. Land converted to other wetlands			

GHG source and sink categories	CO₂	CH₄	N₂O
4.D.2.4.1. Forest Land converted to other wetlands			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
4.D.2.4.2. Cropland converted to other wetlands			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.D.2.4.3. Grasslands converted to other wetlands			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
4.D.2.4.4 Settlements converted to other wetlands			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
4.D.2.4.5 Other Land converted to other wetlands			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.E Settlements			
4.E.1 Settlements remaining Settlements	NO	NE	NE
Living biomass	NO		
DOM	NO		

GHG source and sink categories	CO₂	CH₄	N₂O
SOMmin	NO		
SOMorg	NO		
4.E.2 Land converted to Settlements	R	NE	NE
4.E.2.1 Forest Land converted to Settlements			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
4.E.2.2 Cropland converted to Settlements			
Living biomass	R		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.E.2.3 Grassland converted to Settlements			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.E.2.4 Wetlands converted to Settlements			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.E.2.5. Other Land converted to Settlements			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.F. Other Land			

GHG source and sink categories	CO₂	CH₄	N₂O
4.F.1. Other Land remaining Other Land			
4.F.2. Land converted to Other Land	R	NO	NO
4.F.2.1. Forest Land converted to Other Land			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
4.F.2.2. Cropland converted to Other Land			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.F.2.3. Grassland converted to Other Land			
Living biomass	R		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.F.2.4. Wetlands converted to Other Land			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.F.2.5. Settlements converted to Other Land			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
4.G. Other			
Harvested Wood Products	R		

GHG source and sink categories	CO ₂	CH ₄	N ₂ O
GHG sources			
4 (I) Direct nitrous oxide (N ₂ O) emissions from nitrogen (N) inputs to managed soils			R
4 (II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils		R	R
4 (III) Direct nitrous oxide (N ₂ O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils			R
4 (IV) Indirect nitrous oxide (N ₂ O) emissions from managed soils			R
4 (V) Biomass burning	R	R	R

* R- reported

Key categories in the national GHG inventory are 4.A.1 Forest Land remaining Forest Land, 4.A.2 Land converted to Forest Land, 4.B.1 Cropland remaining Cropland, 4.E.2 Land converted to Settlements and 4.F.2 Land converted to Other Land.

Table 6.4 describes the key categories in the LULUCF Sector, based on level and trend assessment, showing also the change of the annual removals compared to the base year.

Both land sub-categories of Forest Land are key categories for CO₂ in the national GHG inventory, thus higher methodological levels is required.

Table 6.4 Key categories overview – LULUCF, 2013

Key categories	GHG	Criteria
4.A.1 Forest Land remaining Forest Land	CO ₂	L, T

Key categories	GHG	Criteria
4.A.2 Land converted to Forest Land	CO ₂	L, T
4.B.1 Cropland remaining Cropland	CO ₂	L, T
4.B.2 Land Converted to Cropland	CO ₂	T
4.C.1 Grassland Remaining Grassland	CO ₂	L, T
4.C.2 Land Converted to Grassland	CO ₂	L
4.E.2 Land converted to Settlements	CO ₂	L, T
4.F.1 Other Land Remaining Other Land	CO ₂	L, T
4.F.2 Land converted to Other Land	CO ₂	L, T
4(III).Direct N ₂ O emissions from N mineralization/immobilization	N ₂ O	T

6.2 Land-use definitions and classification systems used and their correspondence to the land use, land-use change and forestry categories

The IPCC guidelines specify six land-use categories for the LULUCF sector: Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land. Land use categories definitions are implemented by National Forest Inventory, as follows:

Forest vegetation land, associated to “*Forest land*”. It includes land covered with forest vegetation according to following parameters: canopy cover 10%, minimum area 0.25ha and tree height at maturity of 5m, as well as forest belts wider than 20 m. It comprises deciduous forest, coniferous forest, mixt forests, clear-cut areas and nurseries, as defined by presence of deciduous trees, coniferous trees, deciduous and resinous trees, dead trees, clear-cuts and forest nursery.

Agricultural land class associated to „*Cropland*”. This class includes agricultural lands, i.e. lands covered or temporary uncovered by agricultural crops (major crops and horticultural plants cultures). It includes 3 groups (non-woody crops, woody crops and other wooded land and trees outside forests (which do not meet the forest definition parameters, e.g. forest belts which are narrower than 20m) with 9 categories: orchard, vineyard, shrubs, cultivated land agricultural,

temporary fallow land, deciduous tree, coniferous tree, deciduous and resinous trees and dead trees.

Grassland class associated to „*Grassland*” which includes land whose destination is grazing or mowing hay for livestock production, as well as other wooded land and trees outside forests (which do not meet the forest definition parameters, e.g. forest belts which are narrower than 20m). It includes pastures, hayfields in hilly and mountainous areas and meadows in lowlands.

Water bodies and wet areas, associated to „*Wetlands*”. It includes all lands covered by water (rivers, ponds, dams, swimming pools, etc.) and land affected by humidity (caused by water stagnation, marshy areas, etc.), with the exception of agricultural land. It contains two sections (waters and wetlands) and 11 categories (permanent streams, temporary streams, lakes, dams, floating vegetation, hydrophilic vegetation (stubble etc), harbors, temporarily flooded areas, bogs, channels and piers.

Buildings/constructions/infrastructure in urban, rural and infrastructure across the country, associated to „*Settlements*”. It has 3 groups (urban/rural, buildings and infrastructure) and includes: fenced and constructed areas, sealed lands (e.g. car parks, roundabouts, platforms), urban/rural lawns, playgrounds in green areas, beach lawn and other areas with lawn, dwellings, industrial and administration buildings (e.g. banks, churches, railway stations, restaurants), warehouses, huts, ruins, greenhouses, graveyards, dirt roads, trails, rail roads and roads (street, sidewalk, square), bridges and dams.

"*Other land*” class includes following categories: rocky areas, excavations, stone quarries (active, closed), stony debris, gravel/sand/earth pits, drilling perimeters and locally degraded lands.

Unmanaged forests - Following comprehensive assessment by NFI all forests are assumed managed, either through a forest management plan or under wood collection so under anthropogenic impact, thus all forest are assumed managed land. Also, current assumption is that all grasslands are assumed managed, while wetlands unmanaged.

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.

Land use matrix is developed based on only two existing land assessments in 1980 and 2005 (for current process on developing data please see more info under next title). Land conversions are interpolated and extrapolated back/forward linearly starting from the change between two moments in time. Complete matrix can be found in CRF Table 4.1.

The advantage of the new land classification and area estimation method is that it provides sampling error for the area estimates for each land class in the primary classification, land sub-category and category. From that aggregated estimates for the inventory would be provided by Tier 2 (which was implemented in the previous submissions).

6.3 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

For the purpose of the national GHG inventory a new reporting system is being put in place starting 2014. This new approach intends to make use of any spatial explicit information existing in the country, either for land classification or for classification quality check. It strives to assess consistently in time within the national territory the land according harmonized classifications. This information is already incorporated in the submission 2015 and expected to be updated while analysis progresses. Improved reporting of land categories is based on multiple data sources:

- a. National Forest Inventory statistical sampling grid that covers entire country territory (1st cycle 2008-2012, 2nd cycle for 2013-2016)(details for <http://roifn.ro/site/>);
- b. Military topographic maps for 1970 (edition I), 1980 (edition II), and 1990 (edition III), (1:25000, assessed at 2x2km grid of the NFI grid);
- c. Ortophotoplans for 2003-2005 (edition I), 2007-2011 (edition II), 2010-2013 (edition III), and 2013-2015 (edition IV) (1:5.000, assessed at 0.5 x 0.5 km).

Harmonization and consistency of the legend of the maps was ensured at the most disaggregated division, and finally aggregated up to IPCC land use categories.

The work of historical reconstruction of data is expected to last 2 more years (to be included in 2017 submission), including QAQC. QAQC would be achieved by ancillary data (Landsat, various available GIS maps and field checks for share of deforested areas and conversions to forest, e.g. orchards and vineyards after incorporating LPIS data).

Table 6.5 Land use matrix for 1989 – 2013 (kHa)

Year	1989	1995	2000	2005	2010	2013
Land sub-category						
4a1	6672.2	6706.1	6753.9	6801.6	6849.4	6878.0
4a2.1	57.1	60.1	60.1	60.1	60.1	60.1
4a2.2	246.6	259.6	259.6	259.6	259.6	259.6
4a2.3	24.0	25.2	25.2	25.2	25.2	25.2
4a2.4	12.7	13.4	13.4	13.4	13.4	13.4
4a2.5	10.6	11.1	11.1	11.1	11.1	11.1
4b1	5850.4	5468.9	5192.8	4916.6	4640.5	4474.9
4b2.1	85.3	74.0	58.9	43.9	29.7	29.7
4b2.2	660.2	694.9	694.9	694.9	694.9	694.9
4b2.3	71.2	74.9	74.9	74.9	74.9	74.9
4b2.4	131.8	138.7	138.7	138.7	138.7	138.7
4b2.5	5.6	21.7	36.7	51.8	66.0	66.0
4c1	4498.5	4543.4	4658.6	4773.7	4888.9	4958.0
4c2.1	137.4	116.3	90.4	64.5	41.2	41.2
4c2.2	1467.7	1545.0	1545.0	1545.0	1545.0	1545.0
4c2.3	62.0	65.2	65.2	65.2	65.2	65.2
4c2.4	97.2	102.4	102.4	102.4	102.4	102.4
4c2.5	9.2	38.0	63.9	89.8	113.1	113.1
4d1	1325.0	1377.8	1440.3	1502.8	1565.3	1602.8
4d2.1	NO	NO	NO	NO	NO	NO
4d2.2	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
4d2.3.1	23.2	24.5	24.5	24.5	24.5	24.5
4d2.3.2	183.2	192.8	192.8	192.8	192.8	192.8
4d2.3.3	192.4	202.5	202.5	202.5	202.5	202.5
4d2.3.4	12.0	12.6	12.6	12.6	12.6	12.6

Year	1989	1995	2000	2005	2010	2013
Land sub-category						
4d2.3.5	12.0	12.6	12.6	12.6	12.6	12.6
4e1	1217.7	1275.2	1346.2	1417.2	1788.2	1530.8
4e2.1	59.2	62.3	62.3	62.3	62.3	62.3
4e2.2	279.7	294.5	294.5	294.5	294.5	294.5
4e2.3	176.1	185.4	185.4	185.4	185.4	185.4
4e2.4	9.9	10.4	10.4	10.4	10.4	10.4
4e2.5	1.4	1.5	1.5	1.5	1.5	1.5
4f1	133.5	108.1	87.8	67.5	47.2	35.0
4f2.1	25.4	26.7	26.7	26.7	26.7	26.7
4f2.2	15.5	16.3	16.3	16.3	16.3	16.3
4f2.3	54.9	57.8	57.8	57.8	57.8	57.8
4f2.4	14.8	15.6	15.6	15.6	15.6	15.6
4f2.5	2.8	3.0	3.0	3.0	3.0	3.0
Total area	23838.3	23838.3	23838.3	23838.3	23838.3	23838.3

6.4 Forest Land (CRF 4.A)

6.4.1 Category description

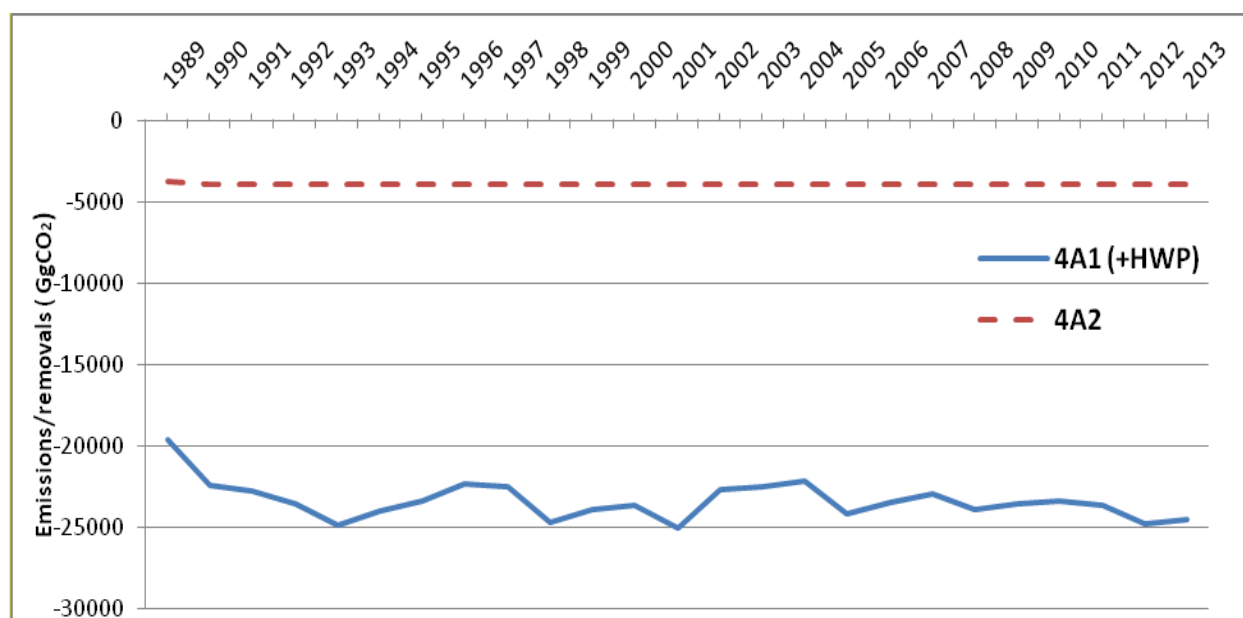
At the end of 2013, forest land area in Romania was about 7228.3 kha, which represents about 28% of the country area. The total area of forest land has increased by about 1% since 1990. The deciduous forests comprise 74% of forest area, while the Coniferous comprise 26%. In the deciduous forest, beech 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 (4%) and other species (pine, larch, etc. - 4%). According to current data Romanian forests grow more than is harvested from them, with a growing / harvesting ratio of about 2.

According to current NFI1 data, the stand age class structure reflects an unbalanced distribution of age classes, with a surplus in in 2nd age class (23% of total forest land) above 3rd and 4th age classes (19% each) and a deficit in classes I (13%). 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 extremely rare 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. Major windblown volume of about 6mil. mc, i.e. 25-30% of regular annual cut, happen in the years 1997, 1998 and 2003. Under the current data availability there is a change of annual removals estimate only given by the annual harvest variation (i.e. total volume harvested, share on species).

Figure 6.1 Emissions for 4.A.1 - Forest Land remaining Forest Land and 4.A.2 - Land converted to Forest Land (kt CO₂)



6.4.2 Methodological issues

Methods currently implemented allow fully consistent reporting of activity data and C stock change factors/C pools for Forest Land remaining Forest Land (CRF 4.A.1) and Land converted to Forest Land (CRF 4.A.2).

6.4.2.1 Forest Land remaining Forest Land (CRF 4A1)

Estimation of CO₂ removals have been following default, i.e. “gain-loss” method. The method involves estimating the C stock change for all C pools as multiplication of forest area (the activity data) and country specific parameters (used to derive the C stock change factors).

Actual and updated data was used as much as possible for the estimations of national GHG inventory, while improvements are underway as new data becomes available from the second NFI cycle. Generally, a Tier 2 applies.

6.4.2.1.1 Change of C stocks in living biomass

Estimation of C stock change uses equation 2.7 (IPCC, 2006).

Equation 6.1 Estimation of C stock change uses

$$\Delta CFF_{LB} = (\Delta CFF_G - \Delta CFF_L)$$

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 C stock change factors.
- ΔCFF_L = annual decrease in carbon stocks due to biomass loss, tonnes C yr⁻¹. These estimates are derived from statistics on removals of biomass from forest (i.e. wood harvest) and other losses (i.e. forest fires).

Activity data

Activity data is provided by the land-use change matrix (the area, see Annex 6.7.1).

The area and the structure of the forest land by species/groups of species are obtained from the NFI (for mid-year 2010). Same proportions are applied throughout the time series since 1990.

Table 6.6 Activity data on area of species/ groups of species used for calculation of the “increase” in carbon stocks due to living biomass growth (kha)

Year/ Parameter	Total area	Distribution on species/groups of species				
		Coniferous	Beech	Oaks	Various Hardwood	Various Softwood
1989	6672.2	2027.1	1992.3	1206.1	1018.2	333.2
1990	6658.4	2025.0	1990.3	1202.0	1013.9	331.8
1991	6667.9	2028.6	1999.2	1200.4	1012.9	331.5
1992	6677.5	2027.4	2006.3	1203.2	1013.6	331.7
1993	6687.0	2021.1	2020.0	1201.5	1016.5	332.7
1994	6696.6	2021.8	2017.6	1209.1	1019.2	333.6
1995	6706.1	2014.5	2037.8	1199.4	1024.1	335.1
1996	6715.7	2005.2	2052.9	1199.9	1026.4	335.9
1997	6725.2	2008.1	2055.9	1201.7	1027.8	336.4
1998	6734.8	2004.8	2064.4	1202.0	1030.8	337.3
1999	6744.3	1994.6	2073.6	1203.4	1037.8	339.6
2000	6753.9	1990.3	2078.0	1200.0	1047.5	342.8
2001	6763.4	1988.7	2090.5	1200.1	1046.3	342.4
2002	6773.0	1987.7	2098.2	1198.2	1050.2	343.3
2003	6782.5	1989.3	2114.7	1197.2	1041.8	344.1
2004	6792.1	1979.6	2136.8	1193.8	1045.3	341.2
2005	6801.6	1996.2	2151.4	1184.5	1040.1	334.1
2006	6811.2	2018.1	2179.7	1168.0	1013.9	336.2

Year/ Parameter	Total area	Distribution on species/groups of species				
		Coniferous	Beech	Oaks	Various Hardwood	Various Softwood
2007	6820.7	2029.8	2174.6	1162.4	1023.0	335.6
2008	6830.3	2047.7	2176.7	1148.6	1027.0	334.9
2009	6839.8	2071.8	2193.6	1131.0	1019.9	328.2
2010	6849.4	2063.3	2172.1	1148.4	1024.7	345.5
2011	6858.9	2066.2	2175.2	1150.0	1026.2	346.0
2012	6868.5	2069.2	2178.2	1151.7	1027.6	346.5
2013	6878.0	2072.1	2181.3	1153.3	1029.1	347.0

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, i.e. set to zero, applies). Thus, the average annual increment in biomass (G_{TOTAL}) is calculated with the equation 2.10 from 2006 Guidelines (IPCC, 2006), as follows:

Equation 6.2 The average annual increment in biomass (G_{TOTAL})

$$G_{TOTAL, i} = I_v * D * (1 + R)$$

where:

- $G_{TOTAL, i}$ = average annual biomass increment above and belowground for strata i , tonnes d.m. $ha^{-1}yr^{-1}$. Currently, there are considered only six strata given on species/groups of species;
- I_v = average annual increment of the growing stock on species/group of species, $m^3ha^{-1}yr^{-1}$;
- R = ratio of below-ground biomass to above-ground biomass (set to zero under Tier 1);
- 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 entire period. This data is based on forest inventory drawn from the forest management plans for the national forest fund. Forest management plans are renewed every 10 (4) years and include specific estimates at the forest stands in terms of area, volume, species composition, current growth, etc. Growth values were calculated by summing the corresponding updated forest management plans data in force for the year 1984 (no other estimate was available meantime). New NFI increment data is available from first cycle, although it is not yet used being mostly because of apparently incomplete harvesting statistics (meantime a NFI based methodology is prepared to extract such data).

Table 6.7 Parameter values used to estimate annual increment of living biomass

Species / groups of species	I_v [m ³ /ha/yr]	D [tone d.m./m ³]	R [dimensionless]
Coniferous	6.4	0.4	0
Beech	4.4	0.644	0
Oaks	4.7	0.644	0
Various hardwood	4.7	0.6	0
Various softwood	7.4	0.41	0

- ❖ 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 and conversion factor ($BCEF_f$) 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 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", ICPIIL Manuscript, 1984. 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 1984 (along with the Forest Fund Inventory). These values represent the best estimates for the breakdown used in forestry statistics and applied therefore in the national GHG inventory;

- ❖ **C fraction** (CF) is assumed to be 0.47 of the dry biomass is generally applied.

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).

Collecting firewood from forests by people is not a significant practice in Romanian forests, and if any the estimates of dead wood from NFI account for it.

Unlawful cutting of trees is accounted for separately using field check data collected by forest administrators. This data is summarized regionally by forest authority offices and reported by the ministry. The volume of unauthorized harvested trees is finally estimated based on the official yield tables.

Wood resulted following disturbances 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). Recent assessment showed that for large disturbances (> 2 mil. mc) a small volume of max 10% may remain untouched in the forest.

For forest fires CO₂, CH₄, N₂O emissions are calculated using country-specific activity data and default emission factors and are reported in CRF Table 4 (V) "Emissions from biomass burning". 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 to assess changes in dead wood or litter pools.

Annual decrease of carbon stock due to biomass loss (ΔL_{FF})***Equation 6.3 Annual decrease of carbon stock due to biomass loss***

$$\Delta L_{FF} = L_{fellings} + L_{other losses}$$

where:

- $L_{fellings}$ = 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 6.4 Annual carbon loss due to wood harvesting

$$L_{fellings} = H \times D \times (1+R) \times CF$$

where:

- H = annual volume of wood extracted [m^3 /year];
- R – is from national sources.

Parameters D and CF have the same meaning as in the other equations. 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). Currently, 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, with non-explicit contribution of wood sources (regular management, natural disturbances, deforestation) or wood faith on commercial wood (for industrialization) and firewood (Table 6.8). 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 theoretically intensive forest management in Romania there is no standing dead wood in the forests. It is considered as part of the harvest and probably most of it used as firewood. This way, the forest growth, standing volume and harvested volume are fully consistent within Romanian forestry.

Table 6.8 Activity data for harvested wood volume during 1989-2013 (thousands cubic meters/year)

Year	Distribution on species/groups of species					Unauthorized cut	Total harvest
	Coniferous	Beech	Oaks	Various Hardwood	Various Softwood		
1989	6516	6636	1842	2268	2004	83	19266
1990	5813	4958	2045	2071	1762	121	16649
1991	4956	4644	1919	2089	1769	187	15377
1992	4418	4629	1739	2109	1524	282	14419
1993	4564	4073	1629	1872	1452	148	13590
1994	4285	4037	1651	1741	1228	146	12942
1994	4973	4215	1551	1774	1300	122	13813
1996	5751	4266	1658	1876	1252	129	14803
1997	5836	4263	1489	1757	1164	137	14509
1998	5195	3635	1276	1491	1045	122	12642
1999	5564	4115	1358	1588	1093	130	13718
2000	5346	4509	1333	1731	1366	143	14285
2001	4915	4260	1288	1673	1274	141	13410
2002	7166	4439	1495	1805	1478	102	16383
2003	7139	4748	1532	1823	1450	81	16692
2004	6357	5412	1694	2030	1589	71	17082
2004	6061	4794	1586	1852	1378	86	15671
2006	5765	4997	1632	1915	1375	64	15684
2007	7491	5182	1485	1668	1412	176	17238

Year	Distribution on species/groups of species					Unauthorized cut	Total harvest
	Coniferous	Beech	Oaks	Various Hardwood	Various Softwood		
2008	6766	5208	1653	1760	1318	174	16705
2009	6635	5489	1403	1845	1148	180	16520
2010	6635	5489	1403	1845	1155	238	16527
2011	6635	5489	1403	1845	1315	266	16687
2013	6635	5489	1403	1845	1433	331.4	16805

Other annual carbon losses (unauthorized logging)

Equation 6.5 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 [m³/year].

Other parameters have the same meaning as the previous equation.

Unauthorized logging statistics refer to entire aboveground volume of the stands/trees. Once the NFI data becomes available this will be implicitly included in the biomass loss estimate.

6.4.2.1.2 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 (2006)). This assumption is consistent 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 (including a couple of measured data and modeling exercise).

6.4.2.1.3 *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 94.3 kha. Such areas are located in mountainous areas included under protected areas of the national forest fund and there are no involved in conversions. 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 systems were actually settled before 1990. Nevertheless for a conservative approach, entire area of 94.3kha is assumed as subject of drainage (still subject of investigation). IPCC 2006 default CO₂ emission factor for cool temperate forests of 0.68tC/year/ha (Table 4.6) and N₂O emission factor for mineral soils of 0.1 kg N₂O-N ha⁻¹ (for temperate nutrient poor forest soils, Table 11.1) were applied to drained area under forest management. All emissions estimates have been reported under 4.A.1 Forest Land remaining Forest Land - in Table 4(III).

6.4.2.2 *Land converted to Forest Land (CRF 4.A.2)*

Activity data

In Romania conversions to forest land occur by:

- i) artificial afforestation (which is later considered as afforestation/reforestation activity (A/R) under the Kyoto Protocol) where is classified as 4.A.2.1 Cropland converted to Forest Land and 4.A.2.2 Grassland converted to Forest Land;

- ii) natural expansion of forest reported under mostly as conversion from Cropland, Grasslands and Wetlands. Such natural expansion of forest vegetation is included in the forest management plans, then also considered under forest management activity (FM) under the Kyoto Protocol (which explains why FM area is higher than area reported under 4.A.1 and AR is smaller than 4.A.2).

The activity data for conversions to forest land is detailed in the land area matrix (see Table 6.5). GHG inventory emission/removals estimates were prepared assuming an annual afforested area ratio of 20% by Populus 40% Robinia and 40% Oak and other broadleaved species. This share corresponds to the 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 (as direct human induced)

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 Management and Planning 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 Management and Planning 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 240 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 the 3 main types of plantations. Equations of the C stocks/biomass were obtained with non-linear processing following Richard-Chapman models functions. Data is shown in Table 6.9 below.

Table 6.9 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	1,4
4	2,4	2,6	2,0
6	2,4	3,0	2,4
7	2,4	3,3	2,9
8	2,3	3,7	3,4
9	2,3	4,0	4,0
10	2,2	4,3	4,4
11	2,1	4,4	4,9
12	2,0	4,6	4,3

Plantation age (years)	Poplar & Willow	Robinia	Oak
13	1,9	4,6	4,7
14	1,8	4,6	4,9
14	1,7	4,4	6,0
16	1,6	4,3	6,1
17	1,4	4,0	6,0
18	1,4	3,8	4,9
19	1,3	3,4	4,8
20	1,3	3,1	4,6
21	1,2	2,8	4,3
22	1,1	2,4	4,1
23	1,1	2,2	4,8
24	1,0	1,9	4,4
24	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 4.A.2 Land converted to Forest Land. Average net annual removals in all pools in JI project was 7.4 tCO₂/year since the project beginning.

Based on detailed information from the JI project, while also confirmed by 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 non-direct human induced)

As far as such areas occur by natural expansion and are sooner or later included in the forest fund they are assumed to behave as plantations. Structure of areas being under conversion to forestland by natural expansion of forest vegetation is not yet known although it can be derived from NFI, for which reason the same share of species is used as for artificial plantations. For estimation of annual C stock change the same approach as for direct human induced was used to report WL and OTL converted to FL (this approach is conservative as long as biomass in natural expansion is expected to be higher than in plantations, at least over the first age class).

Annual change of C stocks in the dead organic matter

Data available from the JI project is used to report estimates of C stock change in litter pool (which is an annually increasing sink) while dead wood pool is negligible (from same projects mentioned above 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 $\sim 0.1 \text{ tC ha}^{-1}\text{yr}^{-1}$ 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 6.10 Annual change in litter pool

Age (years)	Annual change in Litter pool (tC/ha/an)
1	0,04
2	0,04
3	0,08
4	0,13
5	0,18
6	0,21

Age (years)	Annual change in Litter pool (tC/ha/an)
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 6.11), 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 6.11 National reference C stocks in mineral soils on land use categories (tC/ha) and annual C stock change (tC ha⁻¹yr⁻¹) in conversions from to, assuming 20 years transition period

Land categories / C stock		from					
		FL	CL	GL	WL	SL	OTL
To	FL	84	+1.84	+1.74	+1.74	+2.64	+2.2

Land categories / C stock		from					
		FL	CL	GL	WL	SL	OTL
	CL	-1.84	48	-0.1	-0.1	+0.8	+0.34
	GL	-1.74	+0.1	40	0	+0.9	+0.44
	WL	-1.74	+0.1	0	40	+0.9	+0.44
	SL	-2.64	-0.8	-0.9	-0.9	32	-0.44
	OTL	-2.2	-0.34	-0.44	-0.44	+0.44	41

Based on Table 6.11 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 40 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 artificial plantations.

6.4.3 *Uncertainties and time-series consistency*

Uncertainty assessment attached to the new approach for land assessment and NFI sampling errors for C pools is due to be provided with the new estimates.

For 4.A.2, 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 $\pm 10\%$ (for 94% confidence interval of the mean).

6.4.4 Category-specific QA/QC verification, if applicable

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. Land classification and area estimation follows NFI procedures for data processing and quality control. In fact specific components are developed for classification and control of non-forest land, including field assessments for the conversions (especially regarding the conversions from/to forests). A first version of the manual for land classification and associated QAQC manual for new land assessment system, including the schedule for implementation, was prepared in 2014 and it is subject for further development.

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:

- Methods are established and followed step by step to avoid handling errors, especially by the implementation of complex excel spreadsheets.
- Verification of land use classification by repeated assessment of sensitive cases (especially looking to forest conversions and forest/non forest wood areas) and comparison against other data sources. 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 reported by other EU countries.
- Graphic check of the smoothness of the time series for each land category and emissions of each individual C pool, check and fix any outlier and provide the explanation in the text for any extreme value.
- Archiving of hard copies, or digital as appropriate, of the original data on the land categories (i.e. statistical reports, databases with digital maps and aerial photography).
- 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. The list is completed and verified by different employees of Forest Research Management and Planning Institute Bucharest.

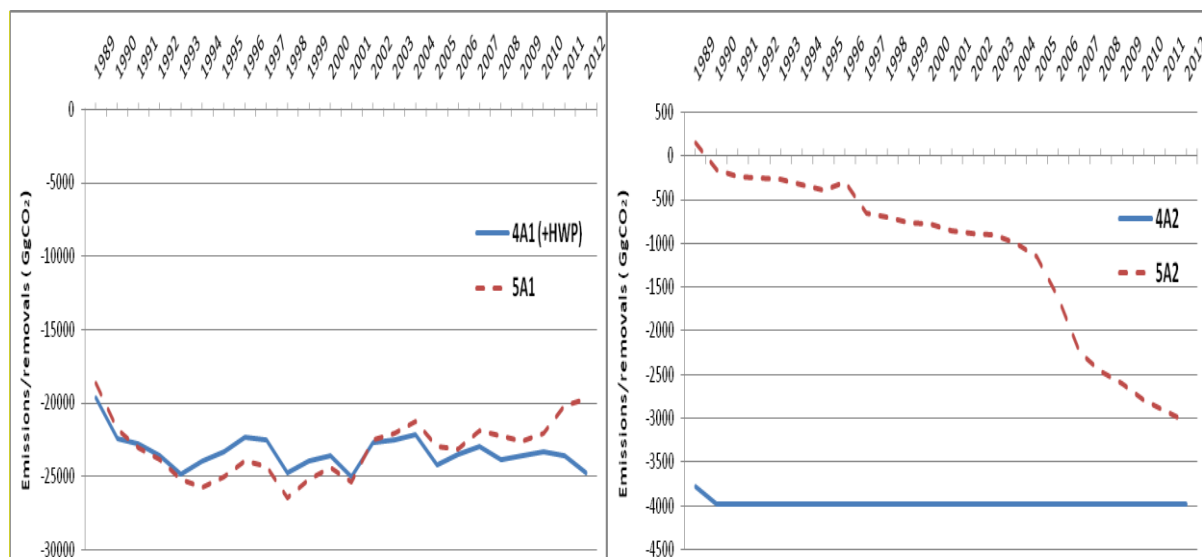
- The project contractor on LULUCF sector, namely Forest Research
- Management and Planning Institute Bucharest, implements steps to ensure that the staff involved has gradually increasing understanding of the national GHG inventory reporting requirements. This included short training sessions on the 2006 Guidelines and 2013 Wetlands supplement and relevant UNFCCC decisions (e.g. 24/CP19).

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 actual 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 (e.g. Blujdea et. al, 2014).

6.4.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

Activity data was recalculated for entire time series due to change of land use assessment system. New data also starts in 1970. Recalculations are expected for the following two years until the time series will be finalized. This cause change of both AD and net emission/removals (Figure 6.2).

Figure 6.2 Recalculation of Forest Land remaining Forest Land and Conversions to Forest Land



The reasons for recalculation were:

- ✓ New data from 1st NFI cycle for reporting living biomass for the category “Forest Land remaining Forest Land”. National Forest Inventory 2008 - 2013 annual increment is higher than values from forest inventory 1984, which are still used in the current submission (see Table 6.7). Once data from 2nd NFI becomes available the stock change method is planned with the second NFI cycle (meantime methodological work is underway).
- ✓ Harvest statistics remained unchanged.
- ✓ New estimates of CO₂ and N₂O emissions from drained organic soils.
- ✓ The current submission includes emissions/removals updated estimates of CO₂ removals by the JI project according to the most recent estimation as part the project verification for 2008-2013 (JI is included under AR, with individual estimates of area and emission/removals in the CRF tables). Estimates associated to JI are only reported for 2013 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.

6.4.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

First, activity data is subject to major improvement starting year 2014. Improvement is ongoing on land use assessment system for all land categories and C stock change in biomass. The shift consists in the use of all relevant land spatial databases available in the country, as mentioned under chapter 6.3. Development of the entire time series since 1970 for land matrix is expected to finish in 2016, including quality assurance and quality control. The project is financed on annual basis by the Ministry of Environment, Forests and Waters and implemented by Forest Research Management and Planning Institute with various partners.

Second, C stock change data is also under improvement. With the availability of data from second NFI cycle it is endeavoured a shift to stock change method to estimate the change in living biomass. Although new annual increment data is available from NFI1, harvest data is still only available from the National Statistics (which seems much underestimated). For this reason current gain-loss method would be replaced by stock change entirely based on NFI data, likely starting submission in 2017.

New approach will also ensure implementation of all requirements from 2/CM7 (e.g. plantations replacing natural forests) and 2006 Guidelines (e.g. use of different biomass growth rates for forests naturally re-growing on abandoned lands and for forest plantations).

6.5 Cropland (CRF 4.B)

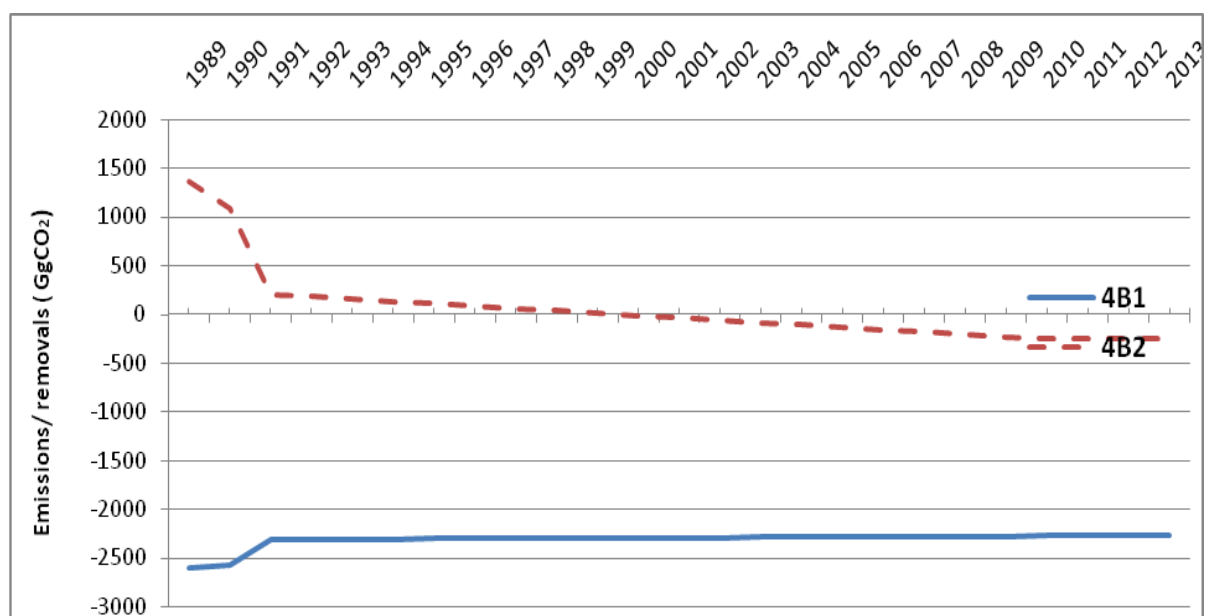
6.5.1 Category description

Cropland covers about 30% of the total country territory. Conversions to Cropland represents some 105kha/year for 25 years, with largest contribution of conversions from Grasslands.

In 2005 about 95% is arable land, 3% is occupied by orchards and 2% is covered with vineyards. 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. They are managed as part of the agricultural land – mainly arable, or transport infrastructure.

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. Revegetation occupies a very small area (less than 0.2% of total area of land included under 4.B.1 Cropland remaining Cropland category). While area of 4B1 was steadily decreasing since the base year, the annual CO₂ removals generally also decreases (Figure 6.3).

Figure 6.3 Removals and emissions for 4B1 - Cropland remaining Cropland (kt CO₂) and 4B2 - Land converted to Cropland (kt CO₂)



GHG removals and emissions trend in Cropland remaining Cropland is under the influence of two main components: area of permanent woody crops (orchards, vineyards) and land classified as “revegetation” (corresponding to activity under the Kyoto Protocol). Tree plantations classified as revegetated areas “behave” as forest plantations with regard to change in each C pools, and same data and approach is used as for Land converted to Forest Land (4.A.2) and AR. 4.B.1 - Cropland remaining Cropland is a key category based on level & trend assessment.

6.5.1.1 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 6.1.1.

6.5.2 Methodological issues

Activity data (i.e. area) for the lands divisions included in this category is provided by the land use change matrix, for both 4.B.1 Cropland remaining Cropland and 4.B.2 Land converted to Cropland subcategories. Estimation of carbon stock changes corresponds to Tier 1, estimating annual rates of growth and loss for national level data on the major type of crops.

6.5.2.1 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 and their subcategories: perennial crops (orchards and vineyards); revegetation and non-woody agricultural land (arable).

A. Woody perennial crops (vineyards and orchards)

Woody perennial species occupy about 5% of the Cropland area. For the estimation of *annual* removals and emissions “gain-loss method” following Equation 2.7 of IPCC’s 2006 Guidelines on lands with woody perennial crops (vineyards and orchards) was applied:

Equation 6.6 Annual C stock change on lands with woody perennial crops

$$C_{stock\ change} = C_{stock\ annual\ increase} - C_{stock\ annual\ decrease}$$

Equation 6.7 Annual C stock increase on lands with woody perennial crops

$$C_{stock\ increase} = A_{CLP} * C_{biomass\ stock\ increment}$$

where:

- A_{CLP} – total national 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 area increase).
- $C_{biomass\ stock\ increment}$ – annual growth of carbon stock in the living biomass [=0.3 tC ha⁻¹ year⁻¹], for <14 years plantations (Perennial Woody – Hungary’s national GHG inventory 2014).

When there is a decrease of area of permanent woody crops between successive years that is considered as a conversion to other land use (category or within the cropland), in which case a C stock decrease is calculated in *Equation 6.7* above, as following:

Equation 6.8 Annual C stock decrease on lands with woody perennial crops

$$C_{stock\ decrease} = (A_{CLP\ previous\ year} - A_{CLP\ current\ year}) * C_{standing\ C\ stock}$$

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 – according to Hungary’s national Inventory Report 2014).

Estimates also include conversions between arable and woody perennial crops, assuming a C stock for annual crops of 4.7 tC/ha.

B. Lands which are subject to revegetation

These lands are included in the category 4.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). Such lands once covered by trees remain this way indefinitely in time and practically never convert back to arable lands.

Calculation of C stocks changes in all C pools is identical to that for artificial afforestation reported in the subcategory 4.A.2 – Land converted to Forestland, but averaged with equal weight across the 3 main types of plantations. Average C stock change in biomass in such planted tree patches are ~3 tC/ha/yr for 25 years (one cycle of tree plantations), which is quite realistic under fertilization and irrigation benefit from neighbor agricultural crops.

C. Land in conversion to agricultural land

Agricultural land here is represented mainly by arable land or management cycles which include arable land. Current data shows there are conversions from all land use categories to cropland, largest area being the conversions from grasslands. Conversion also occur from Settlements and Other land (i.e. industrial dumps and ecologization, reclamation of river deposits and islands along Danube and other rivers).

Estimates are calculated using equation 2.15 from 2006 Guidelines. Initial C stock changes in biomass are calculated under Tier 1 ($\Delta C_{\text{conversions}}$), assuming a biomass C stock of 91.34tC/ha for forests, 6.1 t dm/ha for grasslands the default value for the warm temperate dry eco-region (Table 6.4 of 2006 Guidelines) and 4.7t C/ha for annual crops (Table 5.9 of 2006 Guidelines). Entire amount of C stock in biomass in land use category before conversion is assumed to be lost in the moment of conversion to cropland (e.g. usually the technology implies deep soil preparation and removals of any pre-existing vegetation).

6.5.2.2 Change of C stock in dead organic matter and soil

Carbon stock change in ***mineral soils*** on land category 4.B.1 – Cropland remaining Cropland is currently estimated only for areas under revegetation which cumulates some 15 kha in 2013 (when counted since 1990). 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 1.84 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 increases for the first 24 years since tree plantation as for forest plantations, then it is assumed no change in DOM.

6.5.2.3 Change of C stock in soil organic matter pool

Following Tier 1 approach, there is no change estimated in soils organic matter pools for lands under annual crops (4.B.1), as soil management technologies did not change significantly (this issues is under current investigation). Current approach is that there no change in soil organic matter C pool since there is no management change (reference soil C stock and values of C stock change factors did not changed in time practically).

For the category 4.B.2 – Land converted to Cropland, there are available the average values of C stocks in soils under (Table 6.11), 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 $1.74 \text{ tC yr}^{-1}\text{ha}^{-1}$. In conversions from grassland and wetlands, there is a decrease of $0.1 \text{ tC yr}^{-1}\text{ha}^{-1}$, while increase is expected in conversions from settlements ($+0.8 \text{ tC}$) and other lands ($+0.34\text{tC}$).

N_2O emissions from organic soils under cropland remaining cropland (area of 6.39 kha) are reported under Cultivation of Histosols. For organic soils area, CO_2 emissions under LULUCF are estimated for the entire time series using 2006 Guideline default emission factor for Cropland under ‘warm temperate dry’ zone of 10 tC/ha/yr . This adds annually an amount of 16 kt CO_2 emissions.

Following a ERT question in 2014 Romania improved data on organic soil area under various land use categories. Analysis was done in the framework of Romanian GHG inventory reporting contract 88/2014 between Ministry of Environment and Climate Change and Forest Research Management and Planning Institute Bucharest (as main contractor).

Definition of organic soils. Analysis includes histic soil types, like „gleiosols” and „distric and eutric histosols”. Definition used is consistent with FAO/IPCC definition.

Methodology to estimate organic soils area relies on Romanian soil database (SIGSTAR-200) and land use and cover information (LCCS-09) managed by Institutul Național de Cercetare-Dezvoltare pentru Pedologie, Agrochimie și Protecția Mediului (National Institute for Research and Development for Soil Science, Agrochemistry and Environment, ICPA București) (<http://www.icpa.ro/>). Core of database is the Soil Map of Romania (1:200000), whose original version was achieved between 1963-1994 and updated with newest available information, whenever that was available ever since. It is organized as a GIS database called SIGSTAR-200 (Geographic Information System of Soil Resources, as described by Vintilă și colab., 2004, at <http://www.icpa.ro/proiecte/SIGSTAR-200.pdf>). For land use information for non-forest land use categories (Cropland, Grassland, Wetlands) another database owned by ICPA as well, called LCCS 09 (1:50000) provides information from photo-interpretation of recent aerial photography. Area is extracted by GIS analysis.

Results. Area of cultivation of organic soils under cropland as 6.387 kha of arable soils and 5.036 kha of grassland (grass covered considered as undisturbed soils). Cultivation refers to soil processing by technological means. Experts of MADR confirmed that in Romania grasslands are not subject of soil disturbance by machineries processing.

6.5.3 Uncertainties and time-series consistency

With ongoing project to derive new activity data for all land categories the uncertainty is not yet estimated. Estimates for the uncertainty of the activity data would be derived as soon as data processing will be finalized. The advantage of the new land classification and area estimation method is that it provides sampling error for the area estimates for each land category and subcategory.

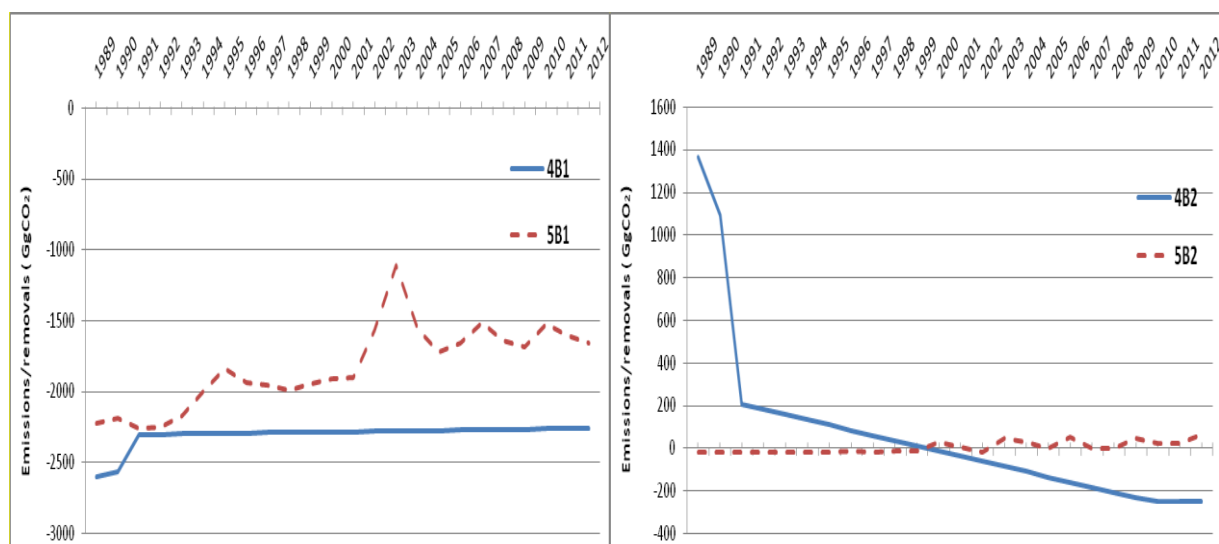
6.5.4 Category-specific QA/QC and verification, if applicable

General QA/QC rules are mentioned in the section 6.4.4 subcategory, under Forest Land (5.A).

6.5.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Activity data was recalculated for entire time series due to change of land use assessment system. New available data starts in 1970 (to better consider emissions and removals for non-forest land in the base year). Recalculations might be substantial for the following two years, until complete historical time series will be finalized (expected in 2016). For this year AD is some 20 to 50 % smaller and net emission/removals also smaller by 100 to 20% along the time series 1989-2012, Figure 6.4).

Figure 6.4 Recalculation of Cropland remaining Cropland and Land converted to Cropland inventory (kt CO₂)



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.

6.5.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

For the estimation of C stock changes in soils of land “remaining croplands” there is an improvement plan available, related to the development of national system to respond accounting requirements set in decision 529/2013UE. According to this decision a reporting to European Commission on the national estimating system for cropland management and grazing land management is due annually for 2016-2018 while provide preliminary estimates before 2022 and final estimates in the final deadline in 2022.

6.6 Grassland (CRF 4.C)

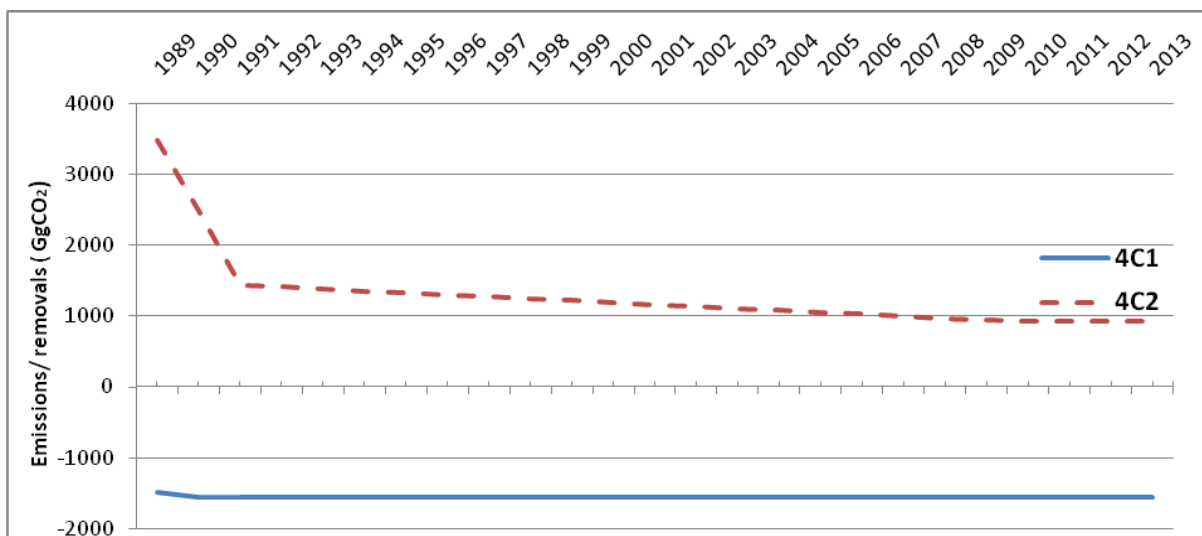
6.6.1 Category description

Grassland remaining Grassland area occupies 25% of the total country area, of which 1 % is represented by conversions among them.

Lands in conversion to grassland is around 70 kha/year over 25 years. Main transition is from Cropland and Wetlands.

Figure 6.5 Emissions/removals for 4.C.1 – Grassland remaining grassland and 4.C.2 - Land converted to Grassland (kt CO₂)

Figure 6.5 Emissions/removals for 4.C.1 – Grassland remaining grassland and 4.C.2 - Land converted to Grassland (kt CO₂)



6.6.1.1 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 in section 6.2. From GHG inventory perspective, it is assumed there is no difference between hayfield and pasture.

6.6.2 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 4.C.1 – Grassland remaining Grassland and 4.C.2 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.

6.6.2.1 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.* A default biomass value for the warm temperate dry eco-region (Table 6.4 of 2006 Guidelines) of 6.1tC/ha was used in calculations. Estimates are calculated using equation 2.15 from 2006 Guidelines. Initial C stock changes in biomass are calculated under Tier 1 ($\Delta C_{\text{conversions}}$), assuming a biomass C stock of 91.34tC/ha for forests and 4.7t C/ha for annual crops (Table 5.9 of 2006 Guidelines).

6.6.2.2 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, related to the development of national system to respond accounting requirements set in decision 529/2013UE. Current approach is that there no change in soil organic matter C pool since there is no management change (reference soil C stock and values of C stock change factors would practically no change in time).

For land in conversion to Grassland and reference C stocks from Table 6.11 are used for the calculation of emissions and removals under various conversions to grassland (assuming 20 years transition period).

6.6.3 Uncertainties and time-series consistency

With ongoing project to derive new activity data for all land categories the uncertainty is not yet estimated. Estimates for the uncertainty of the activity data would be derived as soon as data processing will be finalized. The advantage of the new method is that it provides sampling error for the area estimates.

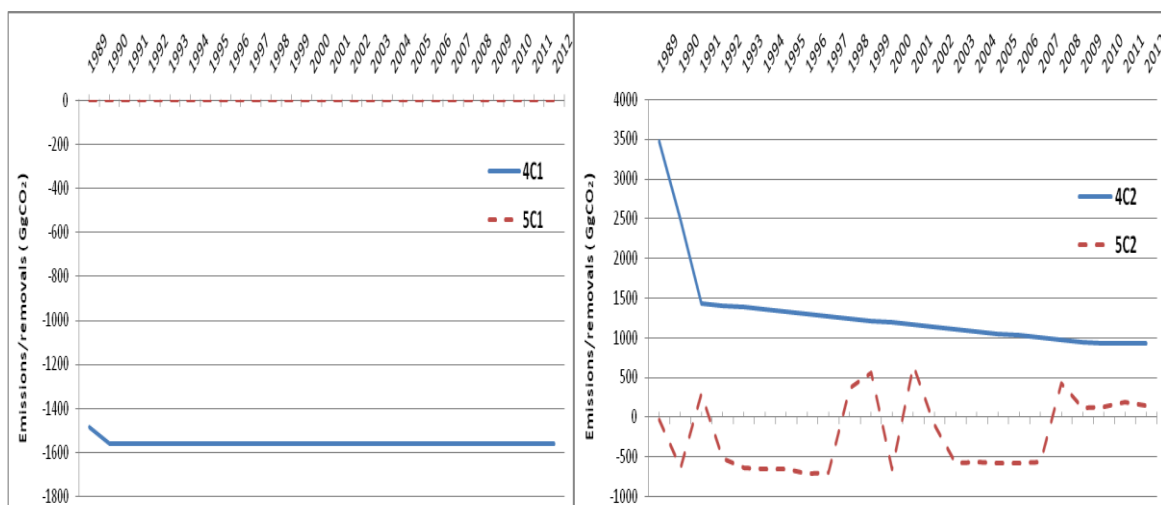
6.6.4 Category-specific QA/QC and verification, if applicable

General QA/QC rules are mentioned in the under Forest Land (4.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.

6.6.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Activity data was recalculated for entire time series due to change of land use assessment system. New data also starts in 1970. Recalculations are expected for the following two years until the time series will be finalized. This has caused changes of AD between around 24% and net emission/removals (Figure 6.6).

Figure 6.6 Recalculation of Grassland remaining Grassland and Land converted to Grassland (kt CO₂)



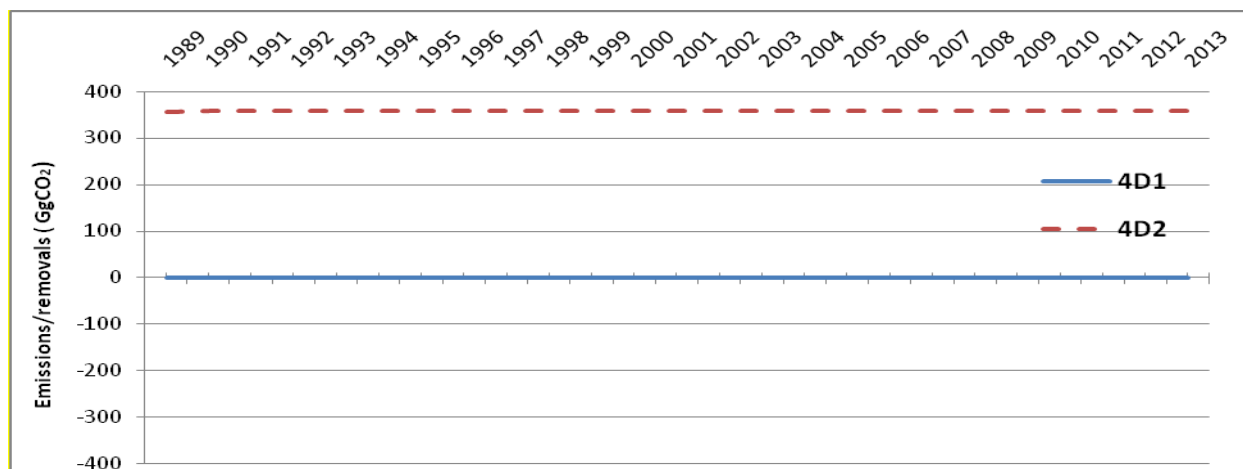
6.6.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

For the estimation of C stock changes in soils of land “remaining grasslands” there is an improvement plan available, related to the development of national system to respond accounting requirements set in decision 529/2013UE. According to this decision a reporting to European Commission on the national estimating system for cropland management and grazingland management is due annually for 2016-2018 while provide preliminary estimates before 2022 and final estimates in the final deadline in 2022.

6.7 Wetlands (CRF 4.D)

6.7.1 Category description

Wetlands area is about 3.4% of total land area. Absolute area is about 664 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 4(II).

Figure 6.7 Emissions for 4D2 - Land converted to Wetlands (kt CO₂)

6.7.1.1 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 this section 6.2.

6.7.2 Methodological issues

6.7.2.1 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 144 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 14 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").

6.7.2.2 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 is computed by same approach as in 4.E.2 Land converted to Settlements. Soils emissions under various conversions to wetlands are computed based on reference C stocks provided in Table 6.11 (assuming a 20 years transition).

6.7.3 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%.

6.7.4 Category-specific QA/QC and verification, if applicable

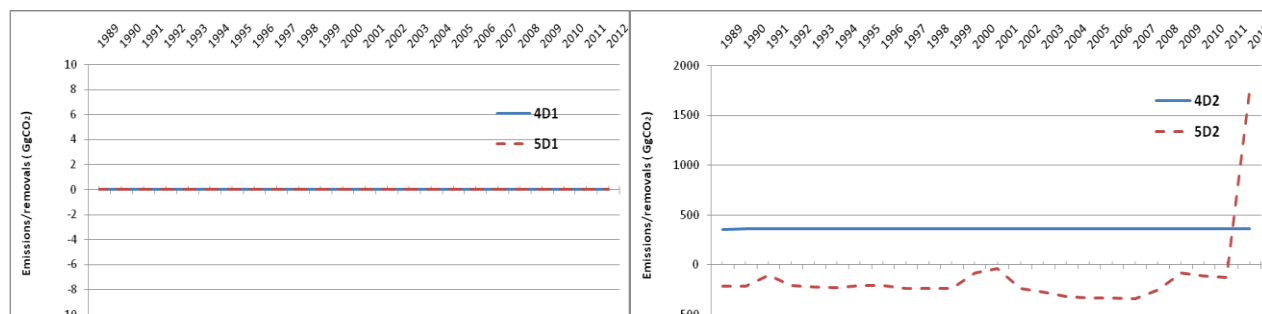
General QA/QC rules are mentioned in the 6.4.4 subcategory, under Forest Land (4.A).

6.7.5 Category-specific recalculations, including changes made in response to the review process and impact emission trend

With 2013 submission there were only a few recalculations in the Wetlands category, details can be seen in Chapter 10 - Recalculations and improvements.

Activity data was recalculated for entire time series due to change of land use assessment system. New data also starts in 1970. Recalculations are expected for the following two years until the time series will be finalized.

Figure 6.8 Recalculation of Grassland remaining Grassland and Land converted to Grassland (kt CO₂)



6.7.6 *Category-specific planned improvements, if applicable, including tracking of those identified in the review process*

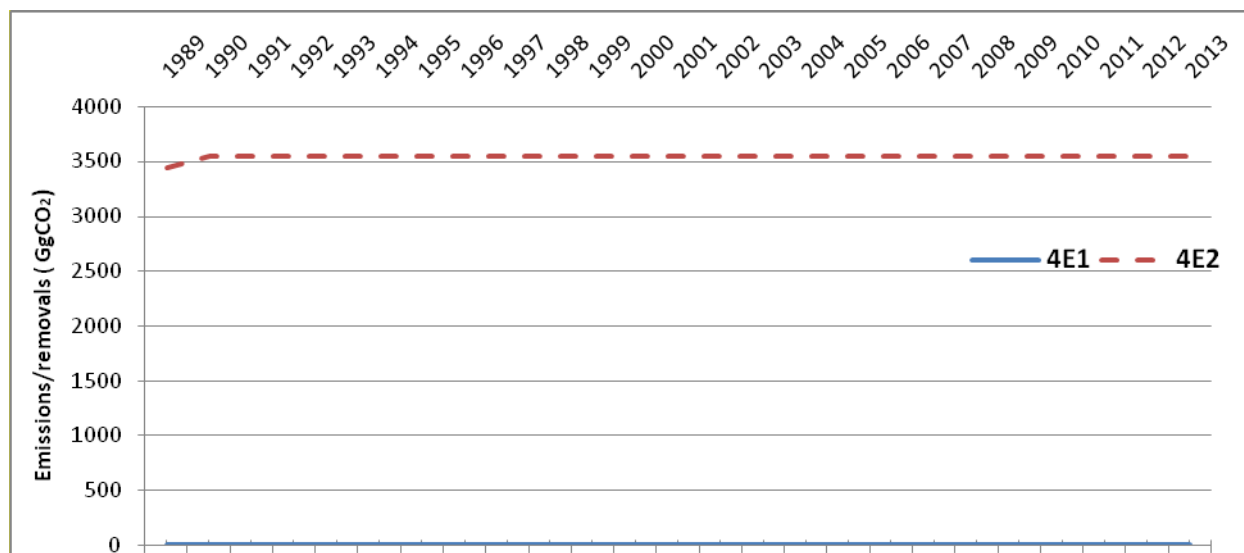
Improvements cover preparation to shift to post-2013 reporting requirements spelled out in GL 2006 and previsions of Wetland supplement 2013.

6.8 Settlements (CRF 4.E)

6.8.1 Category description

Area of settlements is about 4% 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 2013 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 6.9 Emissions for 4.E.2 - Land converted to Settlements (kt CO₂)

6.8.1.1 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 6.2.

Area of forest leaving national forest fund to settlements is subject to national legislation on licensing land for constructions which generally requires the removals 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 (license issuance).

6.8.2 Methodological issues

6.8.2.1 Changes of C stock in living biomass and dead organic matter and in soils

GHG emissions associated with the 4.E.1 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 4.A.1 – Forest Land remaining Forest Land. Below 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.

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 m³ha⁻¹ (applied for 1990-2007) and 314 m³ha⁻¹ according to latest NFI (applied for 2008-on). Estimation also considered a weighted average of the wood density of 420 kg/m³, 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 (a country specific value). 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 2008-2013 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 0.74 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/m³. 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 CO₂ 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. CO₂ emissions from soils under conversion to settlements were computed based on C stock data in Table 6.11 and it associated with emissions no matter of origin land category.

6.8.3 *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%.

6.8.4 *Category-specific QA/QC and verification, if applicable*

General QA/QC rules are mentioned in the 6.4.4 subcategory, under Forest Land (4.A).

6.8.5 *Category-specific recalculations, including changes made in response to the review process and impact on emission trend*

Activity data was recalculated for entire time series due to change of land use assessment system. New data also starts in 1970. Recalculations are expected for the following two years until the time series will be finalized. With 2013 submission there were only a few recalculations in the Settlements category, details can be seen in Chapter 10 - Recalculations and improvements.

6.8.6 *Category-specific planned improvements, if applicable, including tracking of those identified in 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 2015). Reference C stock in the soils under settlements could be reanalyzed as well as the transition period to this category.

6.9 Other land (CRF 4.F)

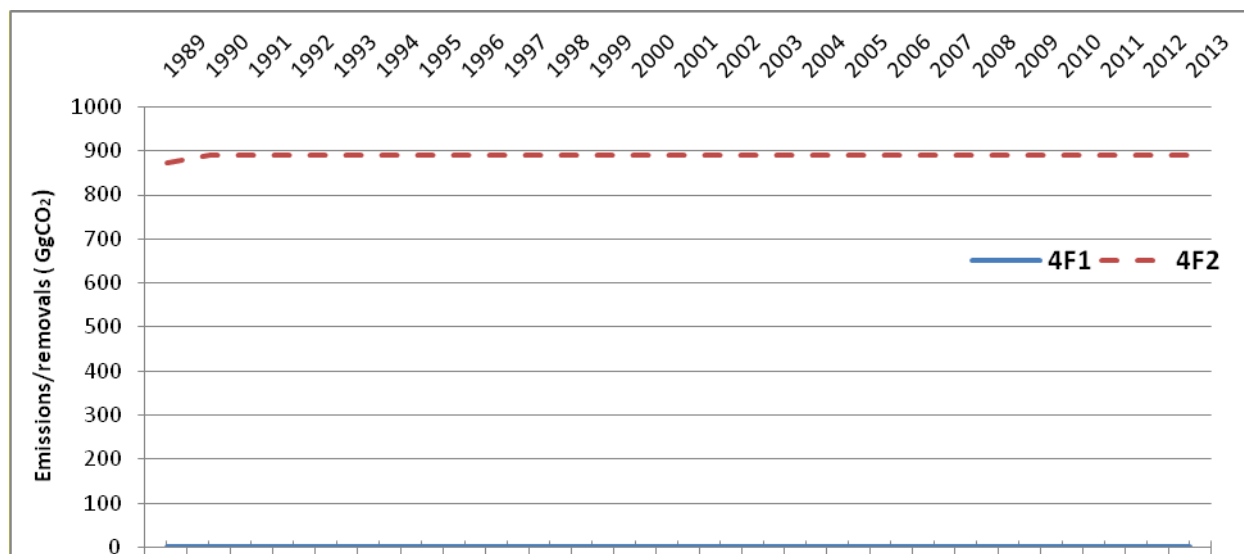
6.9.1 *Category description*

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 $\pm 0.01\%$. Thus, one of the features is the conversion to "Other Lands" of some 40kha 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 6.10 Emissions for 5.F.2 - Land converted to Other land (kt CO₂)



6.9.1.1 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 6.2.

6.9.2 Methodological issues

6.9.2.1 Changes of C stock in living biomass and dead organic matter and in soils

For category 4.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 (4.F.2.1), CO₂ emissions from living biomass removals 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 6.8.2.1.

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 4.E.2 – Land converted to Settlements.

Soils C stock changes are estimated based on C stock data in Table 6.11 and it is associated with emissions no matter of origin of the land category.

6.9.3 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%.

6.9.4 Category specific QA/Qc and verification, if applicable

General QA/QC rules are mentioned in the 6.4.4 subcategory, under Forest Land (4.A).

6.9.5 Category specific recalculations, including changes made in response to the review process and impact on emission trend

With 2013 submission there were only a few recalculations in the Other Land category, details can be seen in Chapter 10 - Recalculations and improvements. Activity data was recalculated for entire time series due to change of land use assessment system. New data also starts in 1970. Recalculations are expected for the following two years until the time series will be finalized.

6.9.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

No specific improvements are envisaged.

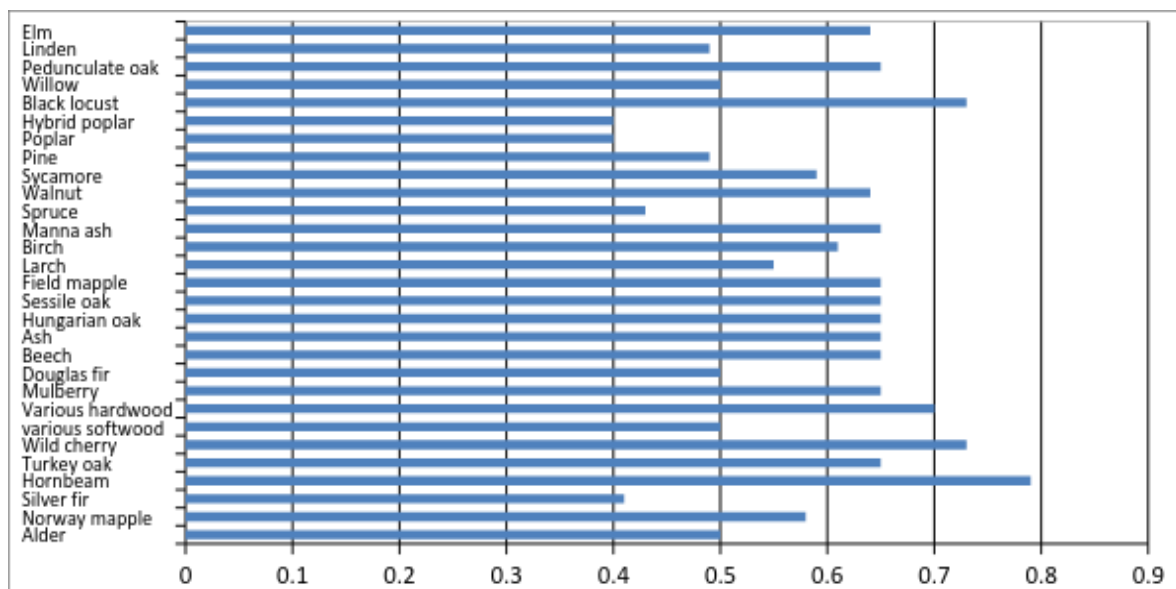
6.10 Harvested wood products (CRF 4G)

6.10.1 Category description

In Romania, HWP reservoir size is estimated to about 10.mil. tC in 2013.

6.10.2 Methodological issues

parameters needed for estimation of emissions/removals associated to HWP, it was necessary to consult the literature regarding wood density and carbon content of Romanian tree species (Rîșcuță, 1979; Petrovici and Popa, 1997). When aggregated on species and groups of species we took into account the share of tree species in wood harvest (Figure 6.11).

Figure 6.11 Oven dry density of wood (g·cm⁻³) species harvested in Romania

Further on, the coefficients from Table 12.4 of 2006 Guidelines (Default factors to convert from product units to carbon) were adapted to the conditions of our country, resulting the following factors for conversion to carbon:

Table 6.12 Factors for conversion to carbon

Item	Value
1. Solid wood	0,285
1.1 Sawnwood	0,268
1.2 Wood panels	0,294
2. Paper and paperboard	0,45
3. Wood charcoal	0,765
4. Bark	1,120

1.1 The Half-live time parameter. According to the 2006 Guidelines, the half-live time parameters are: 30 years - solid wood (decay rate $k=0,023$) and 2 years- paper products

(decay rate $k=0,347$).

- 1.2 Consulting international databases (FAO). When determining CO₂ emissions, we resorted to consulting the FAO database (available at the following address: <http://faostat.fao.org>). Based on FAO classification, we retrieved data regarding the production, import and export of the following wood products: roundwood, sawnwood, wood-based panels, paper and paperboard, wood pulp and recovered paper, industrial roundwood, chips and particles, wood charcoal and wood residues. In case of chips and particles boards, data were transformed from the fiberboard and particleboard category (import-export), using conversion factors inferred from literature (Bularca,1996)
- 1.3 Estimating data for the period between 1900 and 1960. Due to the fact that FAO only supplies data beginning with 1961, we resorted to estimate production, import and export of wood products between 1900 and 1960 by equation 12.6, which takes into account the production, imports and exports values for 1961 and U (the exchange rate in Europe, which amounts to 0.0151).
The variables (1.A, 1.B, 2.A, 2.B,3,4,5) were determined in conformity with the provisions of the *IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Agriculture, Forestry and Other Land Use, chapter 12 Harvested Wood Products 2006*. Calculation runs through all of the mentioned stages, and also by using the *Inventory Software ver 2.12*, available at <http://www.ipcc-nggip.iges.or.jp/software/index.html>.
- 1.4 Calculating variable 1.A (i.e. Annual change in carbon stock in “products in use”). It was calculated using formulas 12.1 and 12.2, for each product category (solid wood or paper products), inflow, k (decay rate), and the carbon stock at the beginning of the year ($C_{(i)}$).
- 1.5 Calculating variable 2.A (Annual change in carbon stock in "products in use" where wood came from harvest in the reporting country (includes exports)). It was calculated using formulas 12.1 and 12.3, accounting for the product category (solid wood or paper products), inflow, k (decay rate) and the stock of carbon at the beginning of the year ($C_{(i)}$).
- 1.6 Calculating variable 1.B (Annual Change in stock of HWP in SWDS from consumption) and 2.B (annual Change in stock of HWP in SWDS produced from domestic harvest).
When calculating the 1.B and 2.B variables, we took into account the Waste Sector Tier 1 estimates, as laid out in the IPCC Guidelines (2006).

6.10.3 Uncertainties and time series consistency

Estimation of C stock change in HWP is under further refining. Estimate of uncertainty is going to be done with future submissions.

6.10.4 Category-specific QA/QC and verification, if applicable

Comparable order of magnitude of currently submitted estimates with those submitted by Romania in the past (TAR for forest management reference level).

6.10.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

Current submission is the first when Romania submits estimates for HWP.

6.10.6 Category-specific planned improvements, if applicable (e.g. methodologies, activity data, emission factors, etc.), including those in response to the review process

Current approach is to build capacity to cover HWP, to better understand the estimation methodologies and requirements, as well as available data.

6.11 Nitrous oxide emissions from runoff associated to land conversions

6.11.1 Description of sources of indirect emissions in GHG inventory

Under land use change, N₂O emissions from leaching and run-offs are considered negligible, thus reported as not occurring (NO) in CRF tables. Organic soils area is very small, thus leaching there is also negligible.

6.11.2 Methodological issues

Default factors from Tier 1 and Equation 11.10 is tested. Amount of N₂O emissions from runoff/leaching is negligible.

6.11.3 Uncertainties and time-series consistency

Not applicable.

6.11.4 Category-specific QA/QC and verification, if applicable

Not applicable.

6.11.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

Not applicable.

6.11.6 Category-specific planned improvements, if applicable (e.g. methodologies, activity data, emission factors, etc.), including tracking of those identified in the review process

Further research have to be implemented in order to estimate such sources and emissions. Potential GHG source may be erosion of agricultural soils.

6.12 GHG emission from LULUCF sources

6.12.1 Direct N₂O emissions from N fertilization of Forest Land and Other (CRF Table 4(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 4(I).

6.12.2 Non-CO₂ emissions from drainage of soils and wetlands (CRF Table 4(II))

An area of 94.3 kha is reported as drained organic soils under forestland with CO₂ emissions reported under 4.A.1/FM and N₂O emissions in Table 4(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.

6.12.3 N₂O emissions from disturbance associated with land-use conversion to cropland (CRF Table 4(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 214 kha in 1990 with some 64 % of total area as drainage of organic soils. In 2013 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 N₂O emissions by humus decomposition. According the land use matrix, from total cumulated area under conversion to arable land, in 2013, 43% were conversions from grasslands, 38 % from wetlands and 10 % from other land (they are all reported under 4.B.2 Land converted to Cropland). N₂O emissions are estimated assuming 20 years transition period.

N₂O 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 840KgC/ha/yr. IPCC default values were used: C/N ratio (~14) and emission factor for N (~0.0124 kg N₂O-N/kg N). Thus IEF is constant around 0.01 kg N₂O-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 flooding and classified as wetlands but not associated with mineral soils).

6.12.4 Biomass Burning (CRF Table 4(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, CO₂, N₂O and CH₄ are all reported in CRF Table 4(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 (4.A.1 – Forest Land remaining Forest Land) and lands under conversion to forests (4.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 4.A.2 and AR estimation assumes that both DOM and standing living biomass pool are entirely burned. DOM estimate is 0.74 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-CO₂ emissions by some +4% in Table 4(V) and (KP-II)4, because of larger C stock in DOM+LB in AR than in DOM in FM (since only litter fires was previously assumed).

Table 6.13 Forest fires area

Year	Total affected area (ha)
1989	93
1990	444
1991	277
1992	729
1993	418
1994	312
1994	208
1996	227
1997	68
1998	137
1999	379
2000	3607
2001	1020
2002	3490
2003	762
2004	124
2004	212
2006	946
2007	2924
2008	844
2009	974
2010	206
2011	3047
2012	1228
2013	1295
Average area	1178

GHG emissions from forest fires are computed based on Eq. 3.2.19 of the IPCC GPG 2003.

Equation 6.9 GHG emissions from forest fires

$$L_{forest\ fires} = S_{forest\ fires} \times M_f$$

where:

- $L_{forest\ fires}$ = total amount of C annually emitted (tC yr⁻¹);
- $S_{forest\ fires}$ = annually affected area (ha yr⁻¹);
- M_f = amount of C in „dead wood lying on the soil surface” [MgC ha⁻¹].

For 4.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/m³ (same input data as for the estimation of DOM related emissions in land converted to settlements 4.E.2). Carbon content was 0.4 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 CO₂ and non-CO₂ emissions from forest fires, IPCC default factors are used in the formulas 3.2.19 of IPCC GPG 2003.

Equation 6.10 Calculation of absolute CO₂ and non-CO₂ emissions from forest fires

$$\text{Emission of CO}_2 \text{ [Gg yr}^{-1}\text{]} = (\text{C emitted}) \text{ [tC yr}^{-1}\text{]} \times (44/12)/1000,$$

$$\text{Emission of CH}_4 \text{ [Gg yr}^{-1}\text{]} = (\text{C emitted}) \text{ [tC yr}^{-1}\text{]} \times (\text{emission ratio}) \times (16/12)/1000,$$

$$\text{Emission of CO} \text{ [Gg yr}^{-1}\text{]} = (\text{C emitted}) \text{ [tC yr}^{-1}\text{]} \times (\text{emission ratio}) \times (28/12)/1000,$$

$$\text{Emission of N}_2\text{O} \text{ [Gg yr}^{-1}\text{]} = (\text{C emitted}) \text{ [tC yr}^{-1}\text{]} \times (\text{N/C ratio}) \times (\text{emission ratio}) \times (44/28)/1000,$$

$$\text{Emission of NO}_x \text{ [Gg yr}^{-1}\text{]} = (\text{C emitted}) \times [\text{N/C ratio}] \times (\text{emission ratio}) \times (46/14)/1000,$$

where:

- $(C\ emitted) = L_{forest\ fires}$, respectively total amount of C annually emitted (tC/year),
- $N/C\ ratio$ = ratio of nitrogen/carbon in the burnt dead mass, N/C ratio was 1/24,
- $(emission\ ratio)$ = default values of direct and indirect GHG emission factors from forest fires. According Table 3A.1.14 of IPCC GPG 2003 these values are: CH₄ – 0.012; CO – 0.06; N₂O – 0.007 and NO_x – 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.

6.12.5 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 2013 submission following data provided by the Ministry of Agriculture, also because highlighted by the ERT's reports.

6.12.6 Recalculations of non CO₂ emissions from sources

For 4(IV) CO₂ 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 2013, some amount of lime was disaggregated to dolomite because of improved data.

Both for AR and FM activities, an error in calculation formula for CH₄ and N₂O was corrected in 2014 submission. Error consisted in wrong entering of CO₂ amount instead of C amount in equation; corrected estimates are 3.666 less now.

Split of forest fires emissions between 4.A.1 and 4.A.2 resulted in slight change in emissions of about 4% for the respective year for all the greenhouse gases.

7 WASTE (CRF Sector 5)

7.1 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:

- CH₄ and CO₂ emissions from Solid Waste Disposal;
- CH₄ and N₂O emissions from Wastewater Treatment and Discharge;
- CO₂ and N₂O emissions from Waste Incineration.

Starting with 2013 submission NMVOC emissions from Solid Waste Disposal on Land were estimated.

Table 7.1 Status of the direct GHG emissions estimation in the Waste Sector

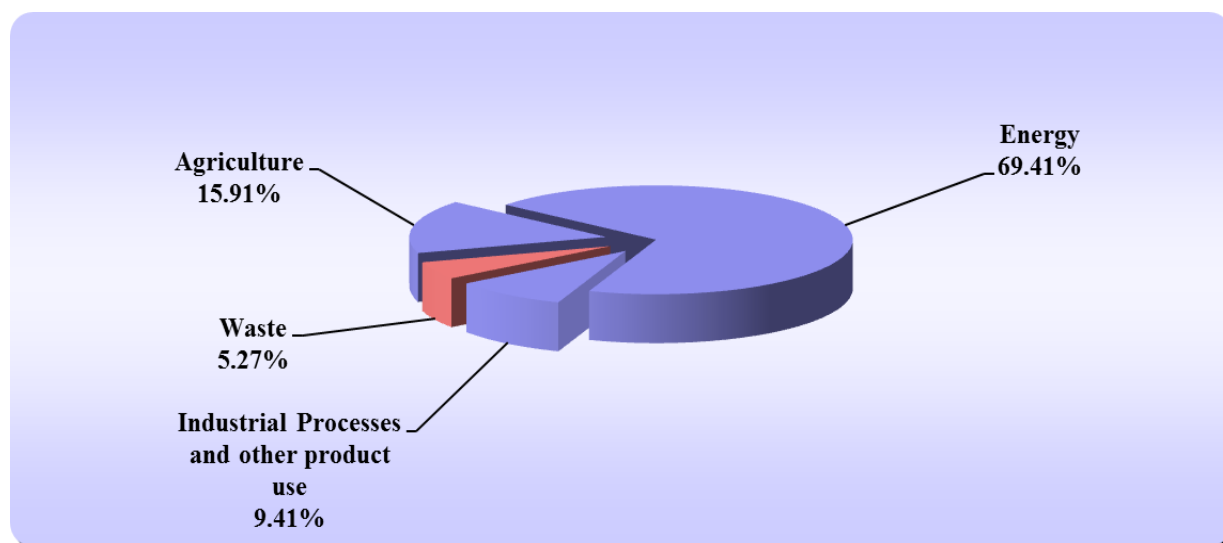
IPCC category	Emissions estimation status		
	CO ₂	CH ₄	N ₂ O
5.A Solid Waste Disposal			
5.A.1 Managed Waste Disposal	✓	✓	NA
5.A.2 Unmanaged Waste Disposal	✓	✓	NA
5.A.2.1 deep (>5m)	✓	✓	NA
5.A.2.2 shallow (<5 m)	✓	✓	NA
5.A.3 Other	NA	NA	NA
5.B Biological Treatment of Solid Waste			
5.B.1 Composting	NA	NA	NA
5.B.1 Anaerobic Digestion at Biogas Facilities	NA	NA	NA
5.C Incineration and open burning of waste			

IPCC category	Emissions estimation status		
	CO ₂	CH ₄	N ₂ O
5.C. 1 Waste incineration	✓	NE	✓
5.C.1.1 Biogenic	NE	NE	✓
5.C.1.1.a Municipal Solid Waste	NA	NA	NA
5.C.1.1.b Other-Biogenic Waste other than Municipal Solid Waste	NE	NE	✓
5.C.1.2 Non-biogenic	✓	NE	✓
5.C.1.2.a Municipal Solid Waste	NA	NA	NA
5.C.1.2.b Other			
Hazardous waste	✓	NE	✓
Clinical waste	✓	NE	✓
5.C.2 Open Burning Waste	NA	NA	NA
5.C.2.1 Biogenic	NA	NA	NA
5.C.2.2 Non- Biogenic	NA	NA	NA
5.D Wastewater Treatment and Discharge			
5.D.1 Domestic Wastewater	NA	✓	✓
5.D.2 Industrial Wastewater	NA	✓	✓
5.D.3 Other (please specify)	NA	NA	NA
6.E Other	NA	NA	NA

* CH₄ emissions from industrial sludge are reported under 6.B.1.a – Industrial wastewater.

In 2013 GHG emissions from the Waste Sector accounted for 5,848.33 kt CO₂ equivalent, which represent 5.27 % of the total national GHG emissions in this year (Figure 7.1).

**Figure 7.1 The contribution of Waste Sector to the total GHG emissions
in Romania, 2013**



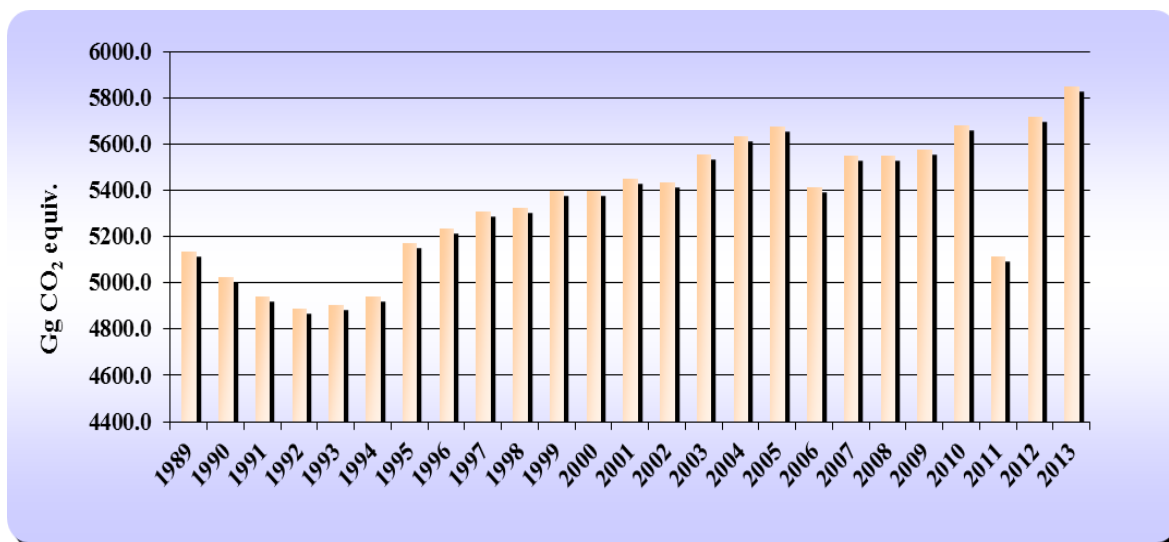
In the base year (1989), the total GHG emissions from the waste sector amounted to 5,135.66 kt CO₂ equivalent, which accounted for 1.73% of the total national GHG emissions in this year. Compared with the other sectors, emissions from the waste sector showed a significant increase from the base year, with 13.88 %, due to increasing of incineration activities and waste generation rate in parallel with increasing of living standards (Table 7.2, Figure 7.2).

**Table 7.2 The contribution of Waste Sector to the total GHG emissions in Romania,
for 1989–2013 period**

Year	Total GHG emissions (excl. LULUCF) [kt CO ₂ equiv.]	GHG emissions from Waste [kt CO ₂ equiv.]	Contribution of Waste in total GHG emissions [%]
1989	298,018.54	5,135.66	1.72
1990	253,317.98	5,023.36	1.98
1991	207,053.32	4,941.02	2.39
1992	189,445.14	4,884.24	2.58
1993	180,869.15	4,903.42	2.71

Year	Total GHG emissions (excl. LULUCF) [kt CO₂ equiv.]	GHG emissions from Waste [kt CO₂ equiv.]	Contribution of Waste in total GHG emissions [%]
1994	176,841.41	4,940.19	2.79
1995	183,698.01	5,170.62	2.81
1996	186,091.91	5,235.30	2.81
1997	174,222.63	5,309.15	3.05
1998	154,624.74	5,324.41	3.44
1999	135,890.86	5,395.89	3.97
2000	141,141.57	5,393.96	3.82
2001	145,667.23	5,450.31	3.74
2002	145,929.94	5,434.36	3.72
2003	151,134.43	5,552.46	3.67
2004	149,948.26	5,634.86	3.76
2005	147,373.53	5,675.69	3.85
2006	148,660.74	5,410.39	3.64
2007	146,874.89	5,545.78	3.78
2008	141,966.63	5,550.96	3.91
2009	124,248.91	5,574.66	4.49
2010	117,705.63	5,678.43	4.82
2011	122,565.56	5,110.58	4.17
2012*	120,977.12	5,714.54	4.72
2013	110,929.05	5,848.33	5.27

* Preliminary data

Figure 7.2 Total GHG emissions trend from Waste Sector for 1989–2013 period

The most important contribution to GHG emissions from Waste Sector, in 2012 year, has Solid Waste Disposal Subsector, contributing with 56.55 % in the total (Figure 7.3); Incineration and Open Burning of Waste Subsector accounts for only 0.16 % and Wastewater Treatment and Discharge Subsector contribute with 43.29 %. Wastewater Treatment and Discharge and Solid Waste Disposal Subsectors are key category sources both by level and trend (Table 7.3 and Figure 7.4).

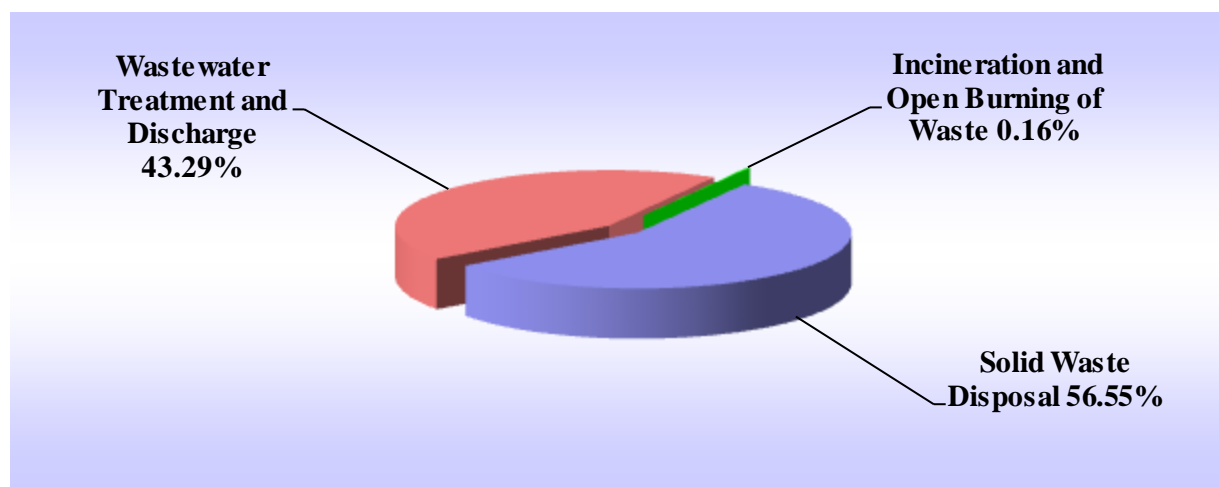
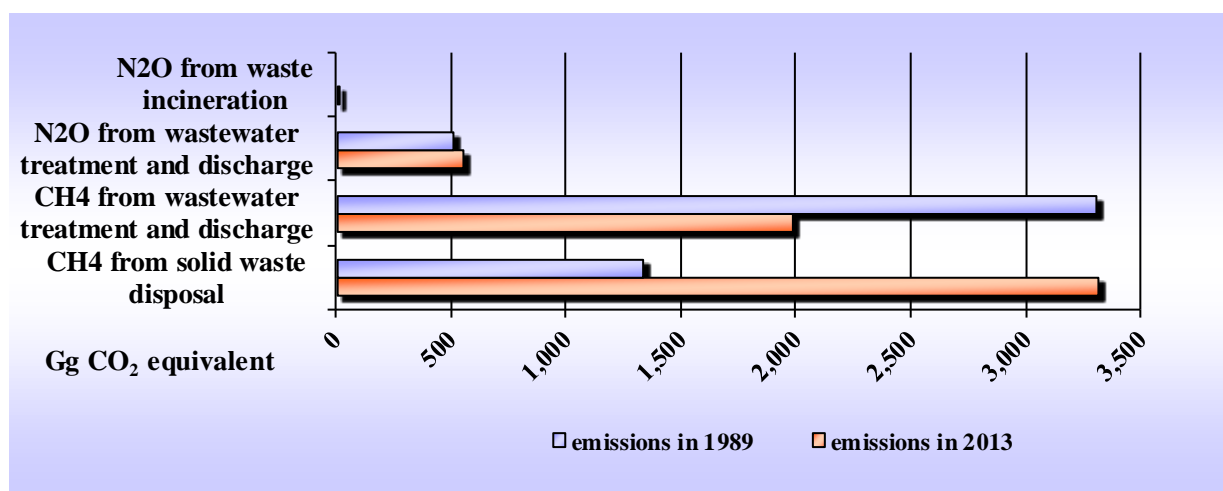
Figure 7.3 Contribution of the sub-sectors in the total GHG emissions from Waste Sector in 2013

Table 7.3 Key categories in Waste Sector based on the level and trend assessment in 2013

Key category	Direct GHG	Criteria for identification	Contribution of key category in total GHG emissions [%] - (excluding LULUCF)
5.A Solid waste disposal	CH ₄	L,T	2.98
5.D Wastewater Treatment and Discharge	CH ₄	L,T	2.04
	N ₂ O	T	0.55

Figure 7.4 Key categories in Waste Sector both by level and trend criteria, in 2013

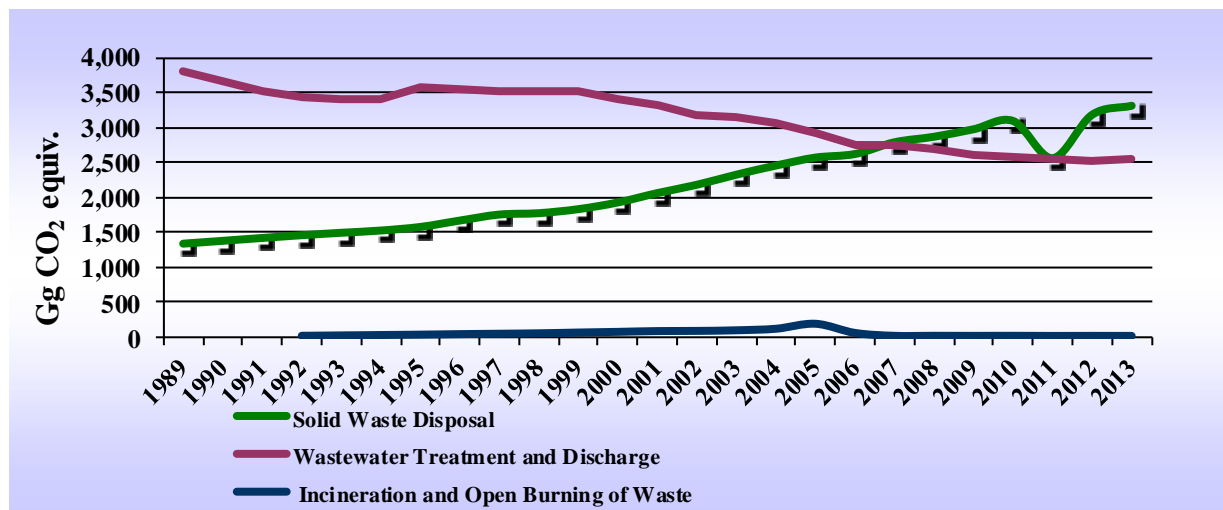
Methane represents the major greenhouse gas from Waste sector with a contribution of 18.41 % to the total methane emissions in Romania, in 2013. In the same year, nitrous protoxide has a contribution of 9.19 % to the total N₂O emissions in our country. Only CO₂ emissions from Waste Incineration category are reported, these representing 0.01 % of total net CO₂ 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 category (SWD) increased significantly in 2013 year comparing with the level in the base year, with a percentage of 148.52 % (Figure 7.5). This increase is due to the increasing trend of waste generation rate following the relatively increased trend of population consumption. Emissions from wastewater treatment and discharge decreased with 33.46 % in 2013 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.

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. Assessing the N₂O emissions resulting from waste incineration", finished in 2013, in Waste Incineration category were described also the N₂O emissions, the various type of incinerated waste and in this context the GHG emissions trend decrease in 2013 year comparing with the level in 1992 year, with a percentage of 17.42 % (Figure 7.5).

In Waste Incineration Subsector the emissions trend has remained almost constant in 2013 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 7.5 GHG emissions trend from Waste Sector, by sub-sectors for 1989–2013 period

7.2 Solid Waste Disposal (CRF 5.A)

7.2.1 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 is responsible for CH₄ and CO₂ generation. To estimate CH₄ emissions from Solid Waste Disposal 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 2013, the data regarding recovered/deposited MSW categories will be finalized later this year after statistical survey. Concerning the amounts 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 temporarily deposited 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 generated by extractive industry, power and manufacturing was around 213 million tons, most of them (over 90%) are waste resulting from extractive activities (mining) and do not contain a biodegradable component. Rest of 21.3 million tons is managed in different ways (reusing, elimination through incineration), the part that is deposited is treated to reduce the biodegradable organic C.

In Table 7.4 are presented the percentages of municipal solid waste categories which have been recovered and stored in 2011.

Table 7.4 Percentages of recovered and deposited MSW from the total amount of collected MSW, in 2011 (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	47.68	53.67

Municipal Solid Waste categories	Recovered from total collected MSW (%)	Deposited from total collected MSW (%)
activities		

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 48 sites in 2013 year (Table 7.5). In accordance with European regulations, the unmanaged SWDS are subject to a transition period, storage activity being stopped gradually until 2017.

Table 7.5 Number of Solid waste Disposal Sites (Source Waste Directorate of NEPA)

Type of SWDS/Year	2006	2007	2008	2009	2010	2011	2012	2013
Managed	20	20	20	26	27	31	33	34
Unmanaged deep	90	92	87	87	40	70	49	48
Unmanaged shallow	130	109	96	14	35			

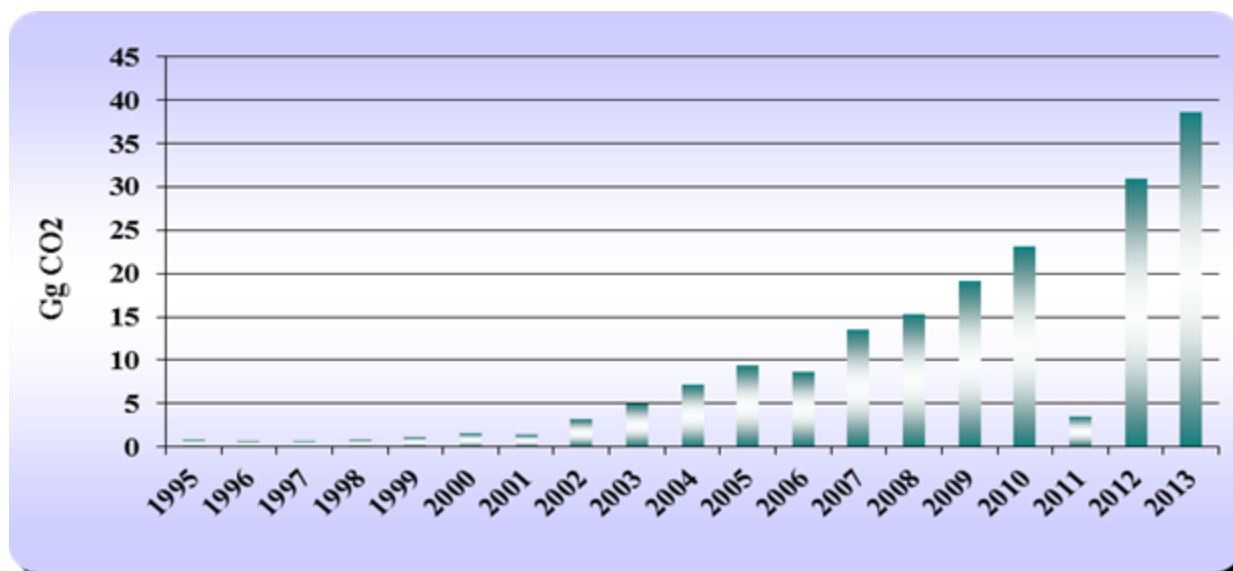
A large amount of recyclable materials (paper, cardboard, glass, plastics, metals) are not recovered but are finally stored together with other municipal wastes. The percentage of biodegradable waste in deposited waste is 63 % for 2011 year.

CH₄ emissions from SWDS

The methane emissions from Solid Waste Disposal Sites to managed landfills were estimated for the period 1995-2013, 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 CH₄ recovered in 2011 which register a value of 42.59 kt and determine in 2011 a lower level of CH₄ emissions from managed solid waste disposal sites of about 15.47 kt. In 2013 year, the amount of CH₄ recovery register a sharp decrease comparing with 2012 year (16.91 kt in 2012 to 12.77 kt in 2013 year), determining a higher level of CH₄ emissions from managed solid waste disposal sites of about 38.60 kt. The decrease associated to the amount of CH₄ recovery is due to the rearrangement of certain waste disposal sites that have stopped the recovery of methane created during the development works (Figure 7.6).

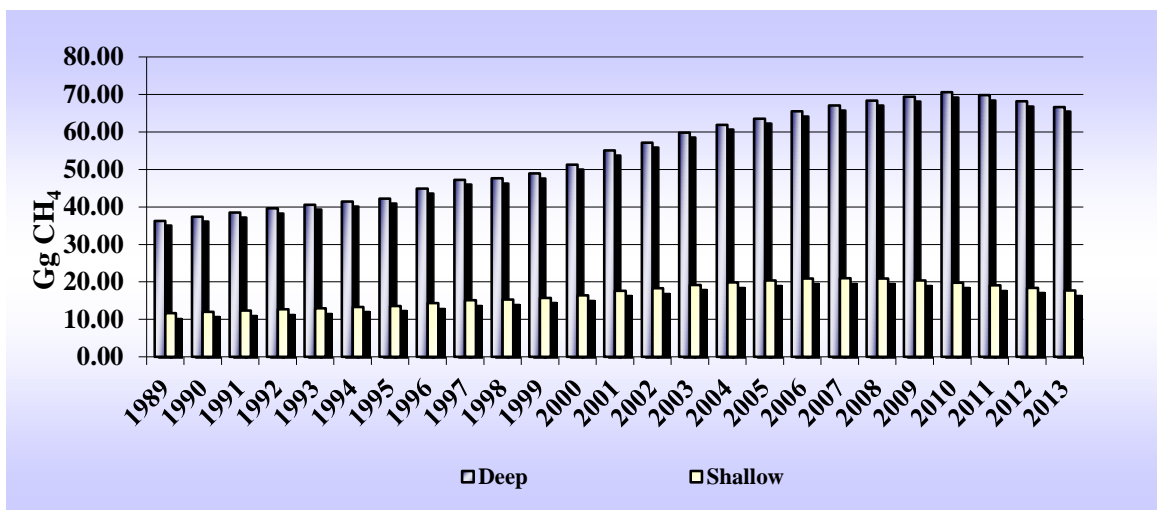
Figure 7.6 CH₄ emissions trend from waste disposed to managed sites for 1995–2013 period



During 1950-2009, CH₄ 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 CH₄ emissions had a decreasing trend due to the decrease of the amounts of waste stored in unmanaged landfills.

Figure 7.7 CH₄ emissions trend from waste disposed to unmanaged sites for 1989–2013 period



7.2.2 Methodological issues

Methodology

Given the key category status both by level and trend, CH₄ emissions from managed and unmanaged SWDS were estimated by applying First Order Decay Model, in accordance with IPCC 2006. 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 1950-2013 period, according to the IPCC 2006 provisions, to achieve an acceptably accurate result.

In order to estimate CH₄ emissions from managed and unmanaged sites, were taken into account also the amount of sewage sludge deposited to SWDS.

Emission factors***Municipal solid waste***

Except Degradable Organic Carbon (DOC), country specific emissions factors and parameters were not available to estimate CH₄ 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 2003-2013 (see the Table 7.6).

Given the statistical survey on waste for 2014 has not yet finalised, for this year it was considered the same value as in 2013.

Table 7.6 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	7.53	9.00	23.08	0.57	0.08	
1977	7.64	9.14	23.44	0.58	0.08	
1978	7.72	9.22	23.66	0.59	0.08	
1979	7.83	9.36	24.01	0.60	0.09	
1980	7.95	9.51	24.39	0.61	0.09	
1981	8.09	9.67	24.81	0.62	0.09	
1982	6.35	7.59	19.48	0.48	0.07	

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	7.06	8.44	21.64	0.54	0.08	
1998	9.62	11.49	29.48	0.73	0.10	
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	12.58	15.04	38.58	0.96	0.14	
2002	14.21	16.98	43.57	1.08	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	7.49	6.15	47.67	1.46	0.12	
2012	8.73	6.91	38.62	1.35	0.11	
2013*	8.73	6.91	38.62	1.35	0.11	

* Preliminary data

In order to calculate the CH₄ emissions from municipal solid waste, default values associated with the other parameters, provided through IPCC 2006, taking into account the national circumstances, were used (Table 7.7).

Table 7.7 Other parameters used to calculate the emission factors (SWDS) for municipal solid waste disposed to SWDS

Type of site	MCF	DOC _F	F	k	OX
MSW disposed to managed SWDS	1.00	0.55	0.50	0.05	0.1
MSW disposed to unmanaged-deep	0.80	0.55	0.50	0.05	0.00
MSW disposed to unmanaged-shallow	0.40	0.55	0.50	0.05	0.00
Source	IPCC 2006				

Activity data

Municipal solid waste

For 2003-2013 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 2013 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 7.8).

Table 7.8 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	1,005.35	
1956	NO	1,562.08	1,000.62	
1957	NO	1,629.21	1,043.62	
1958	NO	1,651.55	1,057.93	
1959	NO	1,670.59	1,070.13	
1960	NO	1,703.69	1,091.33	
1961	NO	1,724.23	1,104.49	
1962	NO	1,738.34	1,113.53	
1963	NO	1,757.34	1,125.70	
1964	NO	1,771.71	1,134.91	
1965	NO	1,786.60	1,144.44	
1966	NO	1,870.61	1,198.26	
1967	NO	1,890.37	1,210.91	
1968	NO	1,892.51	1,212.28	
1969	NO	1,925.74	1,233.57	
1970	NO	1,954.03	1,251.69	

Year	Amount of waste in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1971	NO	1,981.17	1,269.08	<p>Study</p> <p><i>“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”</i></p>
1972	NO	2,006.88	1,285.55	
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	
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	3,465.26	595.98	164.69	
2013*	3,492.98	600.74	166.01	

* Preliminary data (final data for 2011 will be 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. Assessing the N₂O 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.

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 2013 year, was considered the preliminary value for sewage sludge landfilled, data provided by NIS.

The Table 7.9 shows the activity data for the period 1950-2013.

Table 7.9 Total annual sewage sludge disposed to Solid Waste Disposal Sites (1950–2013 period)

Year	Total amount of sewage sludge in Gg disposed to			Source	
	managed sites	unmanaged deep sites	unmanaged shallow sites		
1950	NO	9.32	21.74	Study " <i>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. Assessing the N₂O emissions resulting from waste incineration</i> "	
1951	NO	9.45	22.04		
1952	NO	9.58	22.34		
1953	NO	9.71	22.65		
1954	NO	9.84	22.96		
1955	NO	9.97	23.27		
1956	NO	10.11	23.59		
1957	NO	10.25	23.92		
1958	NO	10.39	24.24		
1959	NO	10.53	24.58		
1960	NO	10.53	24.58		
1961	NO	11.56	26.98		
1962	NO	11.56	26.98		
1963	NO	11.56	26.98		
1964	NO	11.57	26.99		
1965	NO	11.57	26.99		Study " <i>Determining the quantities of industrial waste with biodegradable contents and the</i>
1966	NO	11.57	26.99		

Year	Total amount of sewage sludge in Gg disposed to			Source	
	managed sites	unmanaged deep sites	unmanaged shallow sites		
1967	NO	10.54	24.60	<i>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. Assessing the N₂O emissions resulting from waste incineration"</i>	
1968	NO	10.55	24.61		
1969	NO	11.58	27.01		
1970	NO	11.58	27.02		
1971	NO	11.58	27.02		
1972	NO	11.58	27.03		
1973	NO	11.59	27.04		
1974	NO	11.59	27.05		
1975	NO	11.60	27.06		
1976	NO	11.60	27.07		
1977	NO	11.61	27.09		
1978	NO	11.62	27.10		
1979	NO	11.88	27.73		
1980	NO	15.05	35.12		<i>Study "Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in</i>
1981	NO	15.05	35.12		
1982	NO	15.25	35.59		
1983	NO	15.29	35.68		
1984	NO	15.29	35.69		

Year	Total amount of sewage sludge in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1985	NO	15.35	35.81	<i>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"</i>
1986	NO	15.35	35.83	
1987	NO	15.38	35.88	
1988	NO	21.80	50.87	
1989	NO	21.78	50.82	
1990	NO	21.73	50.70	
1991	NO	23.24	54.22	
1992	NO	23.21	54.15	
1993	NO	23.18	54.10	
1994	NO	23.13	53.96	
1995	72.23	33.97	49.07	
1996	12.57	33.96	49.05	
1997	11.38	33.95	49.04	
1998	11.15	38.49	55.60	
1999	13.27	38.51	55.62	
2000	123.39	38.65	55.82	
2001	26.48	38.40	55.46	
2002	184.71	38.51	55.63	

Year	Total amount of sewage sludge in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
2003	169.26	37.52	54.19	
2004	306.89	32.53	46.98	
2005	443.50	31.13	44.96	
2006	438.66	36.35	52.51	
2007	572.07	4.99	5.91	
2008	1186.75	6.17	6.81	
2009	308.48	4.20	0.68	
2010	271.61	2.05	1.80	
2011	692.50	2.06	1.54	
2012	93.11	1.08	0.81	
2013*	93.11	1.08	0.81	

* Preliminary data (final data for 2012 will be provided after statistical survey of the end of this year)

CH₄ 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 CH₄ 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 2013 the quantity of methane recovered from landfill register a significant decrease, determining a large difference between the CH₄ recovered in 2011 and 2012. The differences between 2010 and 2011 year are due to the CH₄ recovery data reported by an important operator for 2011 year. For 2012 year the share of methane recovery decreased because certain waste disposal sites stopped the recovery of methane due to the rearrangement of landfill; therefore, the methane emissions increased again in 2013 year. (Table 7.10).

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 7.10 The amounts of CH₄ recovered from managed SWDS (Source: operators of landfills)

Year	Amount of CH ₄ recovered (kt)	Year	Amount of CH ₄ recovered (kt)
1989	NA	2002	4.72
1990	NA	2003	6.40
1991	NA	2004	7.76
1992	NA	2005	8.91
1993	NA	2006	13.61

Year	Amount of CH ₄ recovered (kt)	Year	Amount of CH ₄ recovered (kt)
1994	NA	2007	13.09
1995	NA	2008	15.91
1996	0.43	2009	15.99
1997	0.83	2010	16.37
1998	1.23	2011	42.59
1999	1.60	2012	16.91
2000	1.97	2013	12.39
2001	3.27		

CO₂ emissions from solid waste disposal on land

CO₂ 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 CH₄, solid waste disposal sites can also produce substantial amounts of CO₂. Decomposition of organic material derived from biomass sources (e.g., crops, forests) which are reground on an annual basis is the primary source of CO₂ released from waste. Hence, these CO₂ 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, CO₂ and a range of carboxylic acids. These acids are then converted to acetic acid which, together with hydrogen and CO₂, forms the major substrate for growth of methanogenic bacteria.

Landfill gas consists of approximately 50 per cent CO₂ and 50 per cent CH₄ by volume.

However, the percentage of CO₂ 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 CO₂ dissolves in water within the site.”

Taking into account these issues and considering the expert judgement, according to which CO₂ represent about 40% from landfill gas, there were estimated CO₂ emissions from SWDS, using CH₄ 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, CO₂ emissions from waste with fossil carbon content are insignificant and were not included in total emissions from Waste Sector.

Table 7.11 Percentage of direct and indirect Greenhouse Gas emissions from waste category 5A
(Source: International Solid Waste Association – “Landfill Operational Guideline, 2nd Edition”)

Year	Greenhouse Gas			
	CH ₄		CO ₂	
	kt	%	kt	%
1989	53.24	50	42.59	40
1990	54.86	50	43.89	40
1991	56.51	50	45.21	40
1992	58.09	50	46.47	40
1993	59.48	50	47.58	40
1994	60.77	50	48.61	40
1995	62.83	50	50.26	40
1996	66.48	50	53.18	40
1997	69.93	50	55.94	40
1998	70.72	50	56.58	40
1999	73.03	50	58.42	40
2000	76.87	50	61.50	40

Year	Greenhouse Gas			
	CH ₄		CO ₂	
	kt	%	kt	%
2001	82.24	50	65.79	40
2002	87.01	50	69.61	40
2003	92.81	50	74.25	40
2004	98.01	50	78.41	40
2005	102.60	50	82.08	40
2006	104.65	50	83.72	40
2007	111.38	50	89.10	40
2008	114.53	50	91.62	40
2009	118.82	50	95.06	40
2010	123.56	50	98.85	40
2011	102.24	50	81.80	40
2012	127.15	50	101.72	40
2013*	132.30	50	105.84	40

* Preliminary data

7.2.3 Uncertainties and time-series consistency

Accuracy in CH₄ and CO₂ 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 6.3.

The uncertainties associated to CH₄ emissions estimates on managed and unmanaged SWDS are presented in Table 7.12.

Table 7.12 Uncertainties associated with CH₄ emissions estimates from managed and unmanaged SWDS

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
CH ₄ from managed and 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 3.1 in Chapter 3, Volume 1 of the IPCC 2006. 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 1989-2013 is consistent.

7.2.4 Category-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 Wastewater Handling category, the results of these being mentioned on the Checklists level.

Following these activities there were no nonconformities 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 2003-2013 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.

7.2.5 Category-specific recalculation, if applicable, including changes made in response to the review process and impact on emission trend

Changes made due to the beginning of use of IPCC 2006.

Table 7.13 Changes made made parameters and their effects on emission estimates

The effects of recalculations in Solid waste disposal sub- sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CH₄ emissions [kt]		
1989	59.10	53.24	-9.92
1990	60.89	54.86	-9.91
1991	62.57	56.51	-9.69
1992	64.01	58.09	-9.26
1993	65.39	59.48	-9.04
1994	66.69	60.77	-8.88
1995	72.35	62.83	-13.17
1996	75.64	66.48	-12.11
1997	76.59	69.93	-8.69
1998	78.57	70.72	-9.98

The effects of recalculations in Solid waste disposal sub- sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	CH₄ emissions [kt]		
1999	83.44	73.03	-12.47
2000	90.72	76.87	-15.27
2001	95.69	82.24	-14.05
2002	103.11	87.01	-15.61
2003	108.25	92.81	-14.26
2004	113.05	98.01	-13.30
2005	119.32	102.60	-14.01
2006	121.88	104.65	-14.14
2007	128.57	111.38	-13.37
2008	133.77	114.53	-14.38
2009	138.47	118.82	-14.19
2010	140.36	123.56	-11.97
2011	118.42	102.24	-13.66
2012	141.23	127.15	-9.97

7.2.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

In order to improve the next submission, we will try to obtain more detailed data in respect to IPCC 2006.

7.3 Biological Treatment of Solid Waste (CRF 5.B)

At the end of 2013, at a national level, about 70 plants and platforms were authorized for composting biodegradable municipal waste and about 50 plants and composting platforms were in various stages of completion and regulators in terms of the environment protection.

Therefore, we will consider investigating the scale of biological treatment for estimation of emissions in the future submissions.

7.4 Waste Incineration and Open Burning of Waste (CRF 5.C)

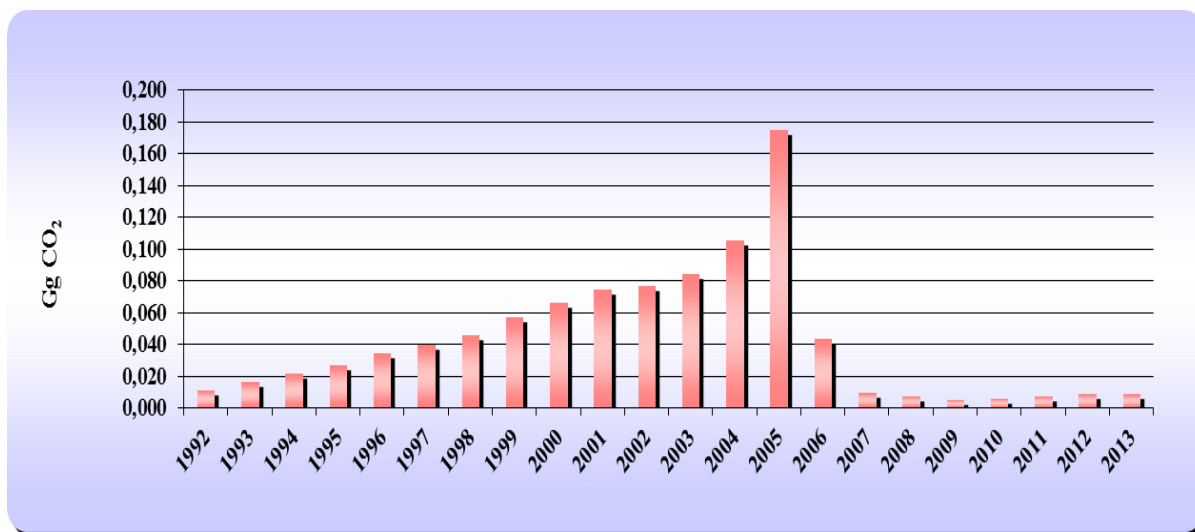
7.4.1 Category description

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 CO₂ and N₂O 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. Assessing the N₂O emissions resulting from waste incineration" finalized in 2013, were estimated the N₂O 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 CO₂ emissions from incinerated waste were calculated starting with 1992, because since this year we have activity data. There is no data regarding open burning of waste.

Figure 7.8 CO₂ emissions trend from waste incineration, for 1992–2013 period

The CO₂ emissions from waste incineration were calculated for hazardous and clinical waste.

In the estimation of CO₂ 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, as follows:

- based on data reported in questionnaires was determined the share of incinerators without heat recovery from the total incinerators for every year of the period 1997-2012 for which there were reports;
- based on these percentages, given that data are collected from a representative sample area, was estimated following percentages, that have been applied to estimate the total quantity of waste incinerated in national incinerators without heat recovery:
 - 1992-1996 period: retrospective estimation of the percentage for last year 's historical survey (1997);

- 1997-2002 period: according to the questionnaire;
- 2003-2009 period: was maintained a constant percentage of 97.58 % corresponding for 2002;
- 2010-2013 period: was used a percentage of 7.95 % which is the arithmetic average of the values for the years 2009-2010.

Figure 7.9 CO₂ emissions trend from clinical waste incineration, for 1996–2013 period

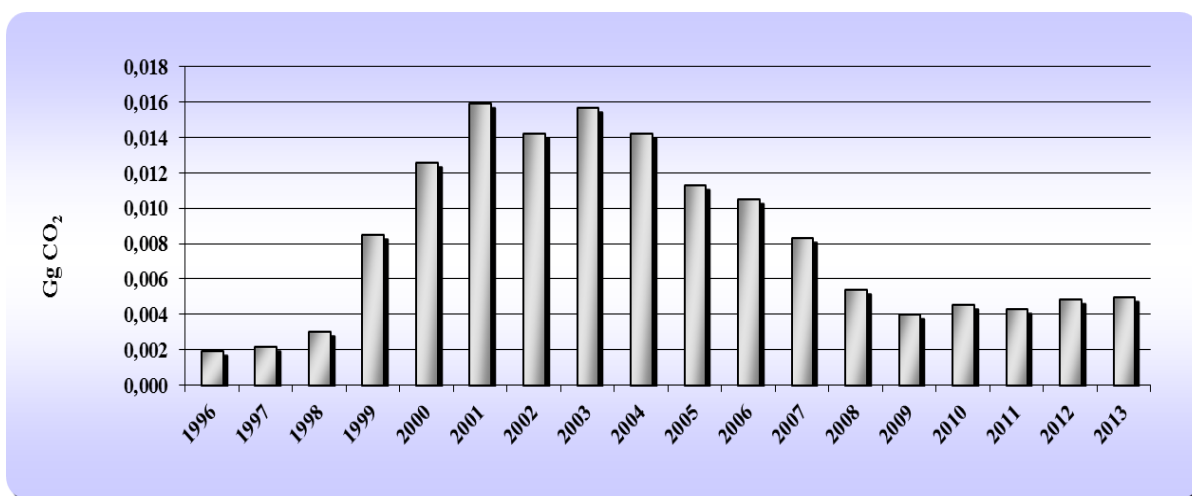


Figure 7.10 CO₂ emissions trend from hazardous waste incineration, for 1992–2013 period

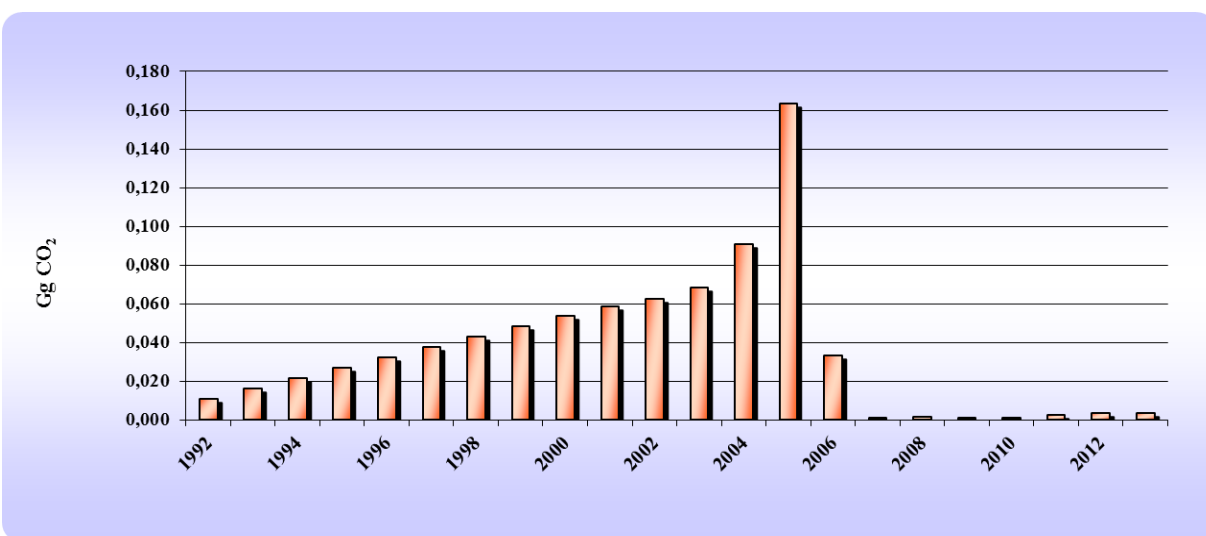
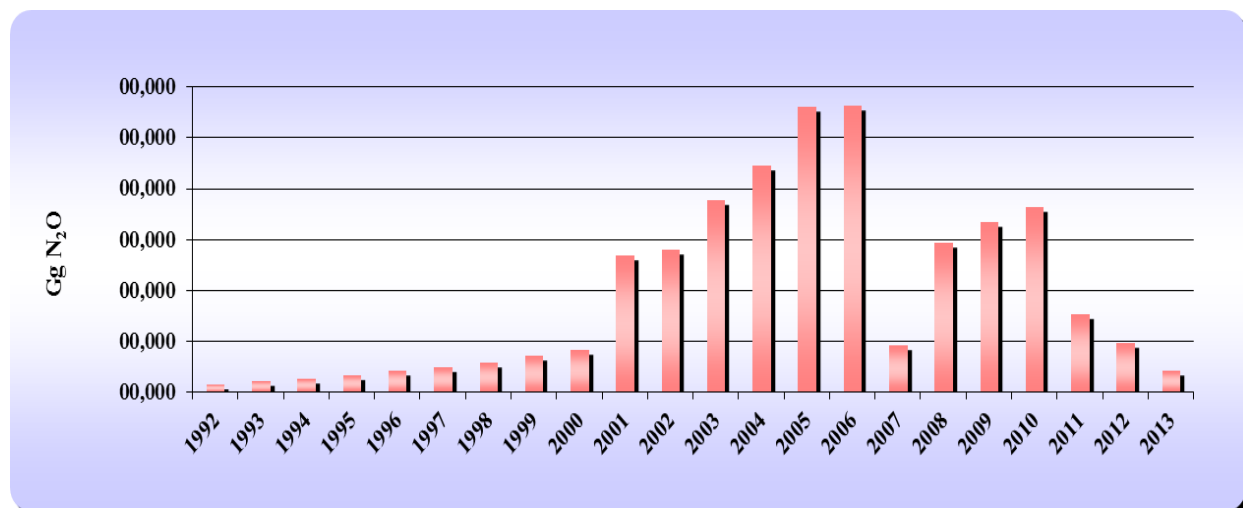


Figure 7.11 N₂O emissions trend from waste incineration, for 1992–2013 period

The N₂O emissions from waste incineration were calculated for hazardous, clinical and biogenic waste.

For estimation of N₂O emissions from clinical waste incineration were used the amounts of waste incinerated provided by National Institute for Public Health. For N₂O emissions from hazardous and biogenic waste we used the data provided by 2013 study.

The amounts of hazardous and biogenic waste incinerated without heat recovery 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), performed by ISPE in 2013; there were determined the types/quantities of incinerated waste and the parameters specific to the incineration thereof, for 1989-2012 and the N₂O emissions resulting from waste incineration were assessed, 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.

In 2007, quantity of industrial waste incinerated was much smaller than in previous years because many incinerators were closed, and the existing ones incinerated medical waste, that are reported at clinical waste incineration.

Figure 7.12 N₂O emissions trend from clinical waste incineration, for 1996–2013 period

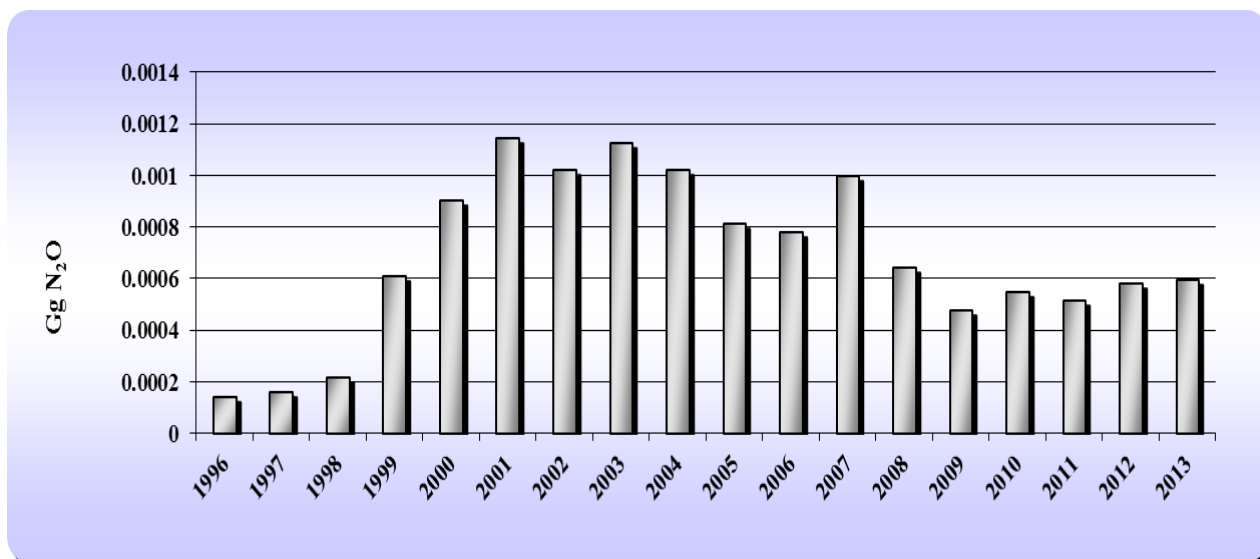


Figure 7.13 N₂O emissions trend from hazardous waste incineration, for 1992–2013 period

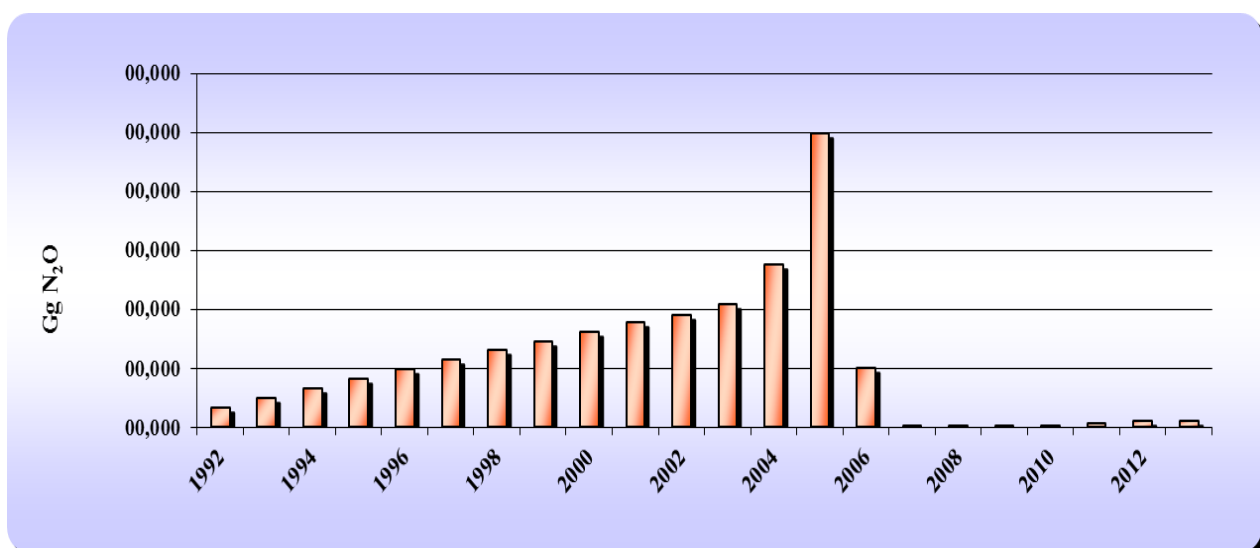
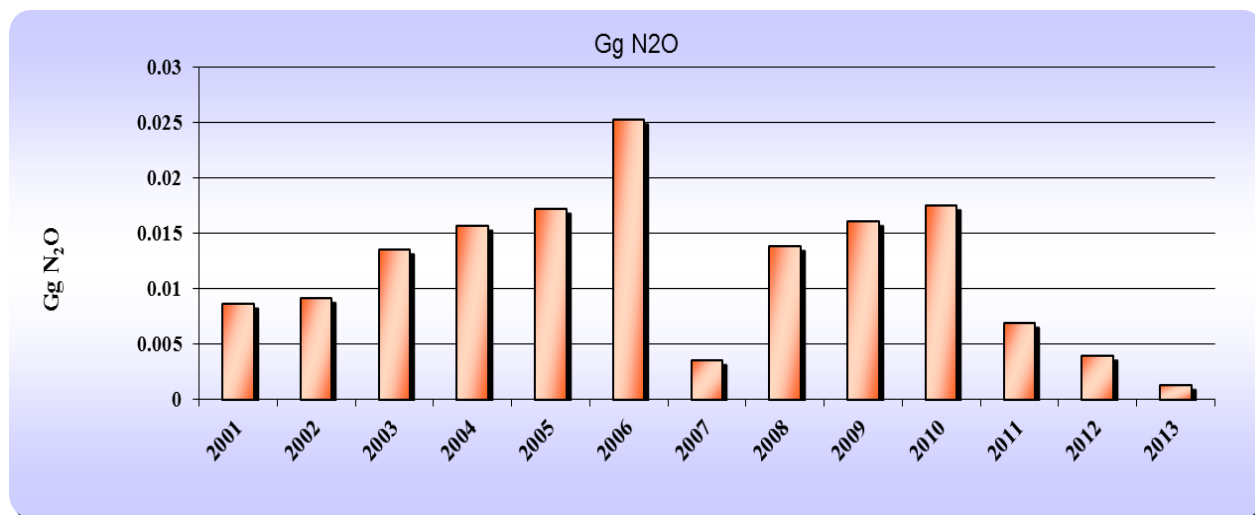


Figure 7.14 N₂O emissions trend from biogenic waste incineration, for 2001–2013 period



7.4.2 Methodological issues

Methodology

To calculate carbon dioxide emissions from waste incineration, the equation 5.1 from page 5.7 of IPCC 2006.

To calculate nitrous oxide emissions from waste incineration, the, Equation 5.5 from IPCC 2006 was used.

Emissions factor

Default emission factors according to the provisions in IPCC 2006 have been used. The emissions factors are presented in Table 7.14 and Table 7.15.

Table 7.14 Default data for estimation of CO₂ emissions from waste incineration (Source: IPCC 2006. table 5.2)

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 7.15 Default data for estimation of N₂O emissions from waste incineration (Source: IPCC 2006)

Type of incinerated waste	N₂O emission factors, in gN₂O/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 7.16).

Table 7.16 Amounts of clinical waste generated and incinerated (Source: ISPB and ICIM)

Year	Clinical waste generated	Clinical waste incinerated
	Unit [kt/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
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
2013	7.94	5.94

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 2003-2013 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 7.17 Amounts of hazardous, clinical and biogenic waste incinerated

Year	Hazardous waste		Clinical waste		Biogenic	
	Incinerated waste[kt/yr]	Source	Incinerated waste[kt/yr]	Source	Incinerated waste[kt/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			

Year	Hazardous waste		Clinical waste		Biogenic	
	Incinerated waste[kt/yr]	Source	Incinerated waste[kt/yr]	Source	Incinerated waste[kt/yr]	Source
2011	1.50		5.13		32.95	
2012	2.17		5.81		20.67	
2013	2.17		5.94		9.06	

* Preliminary data (final data for 2010 will be provided after statistical survey of the end of this year)

7.4.3 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 6.3.

In the table below are presented the uncertainties associated to CO₂ emissions from waste incineration.

Table 7.18 Uncertainties for estimation of CO₂ 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 ₂ O from waste incineration	N ₂ O	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 equation 3.1 in Chapter 3, Volume 1 of the IPCC 2006.

7.4.4 Category-specific QA/QC and verification, if applicable

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.

7.4.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

There have been no recalculation for this category.

Starting 2014 submission, the N₂O 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.

7.4.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

In order to improve the next submission, we will try to estimate CH₄ emissions in accordance with IPCC 2006.

7.5 Wastewater Treatment and Discharge (CRF 5.D)

7.5.1 Category description

This sector includes methane emissions from industrial and wastewater handling and nitrous oxide emissions from domestic.

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 2013, from a total volume of 2,071.78 million m³/year wastewater evacuated, 99.19% was wastewater which requiring treatment. From this, 58.28 % was represented wastewater sufficient (appropriate) treated, 19.98% untreated wastewater and 20.92% insufficient treated wastewater (Table 7.19).

Table 7.19 Wastewater evacuated into Romania, in 2013 (Source: National Administration “Romanian Waters”)

Wastewater category	Volume (mil. mc)	Percentage (%)
Total wastewater evacuated	2,071.78	-
Total domestic wastewater evacuated	1,044.70	50.43
Total industrial wastewater evacuated	1,010.61	48.78
Domestic wastewater treated	864.76	41.74
Industrial wastewater treated	763.87	36.87
Total wastewater requiring treatment	2,054.94	99.19
Sufficient treated wastewater	1,207.49	58.28
Insufficient treated wastewater	433.50	20.92

Wastewater category	Volume (mil. mc)	Percentage (%)
Untreated wastewater	413.95	19.98

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 1,010.61 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 2013 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.

CH₄ emissions from wastewater

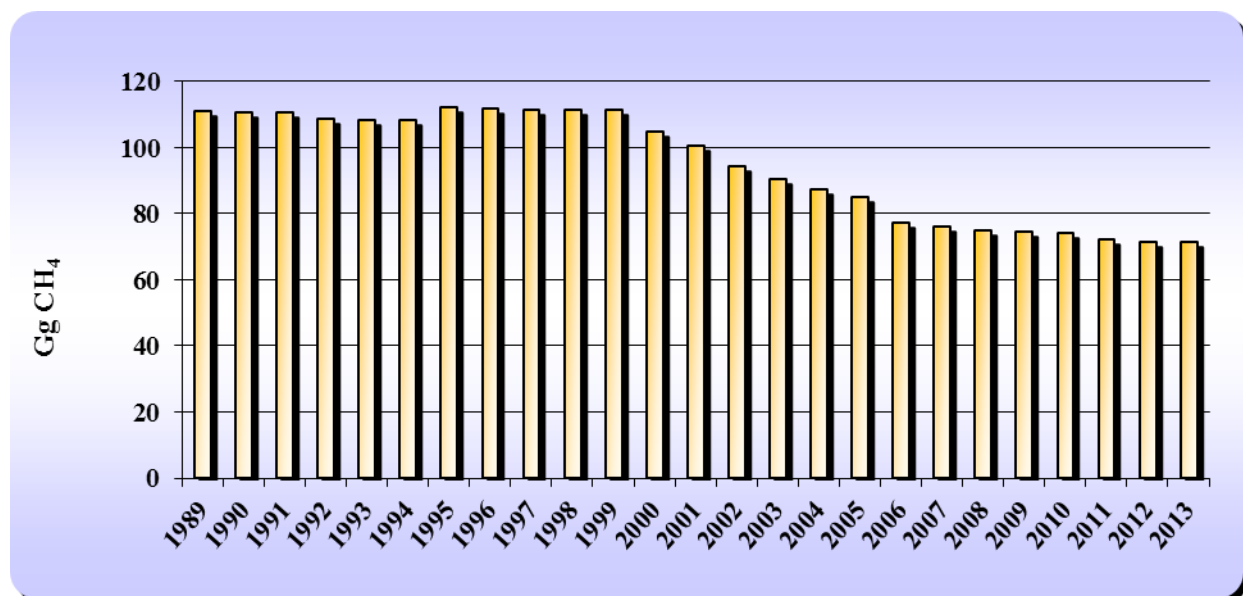
CH₄ emissions from domestic and commercial wastewater and sludge (CRF 5.D. 1)

In estimation of CH₄ 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 7.15). The methane emissions level of 2013 compared to base year (1989) is in decreasing with 35.54 %.

Figure 7.15 CH₄ emissions trend from domestic/commercial wastewater and sludge treatment for 1989–2013 period



CH₄ emissions from industrial wastewater (CRF 5.D2)

Depending on the industry of origin, industrial wastewaters have a different composition.

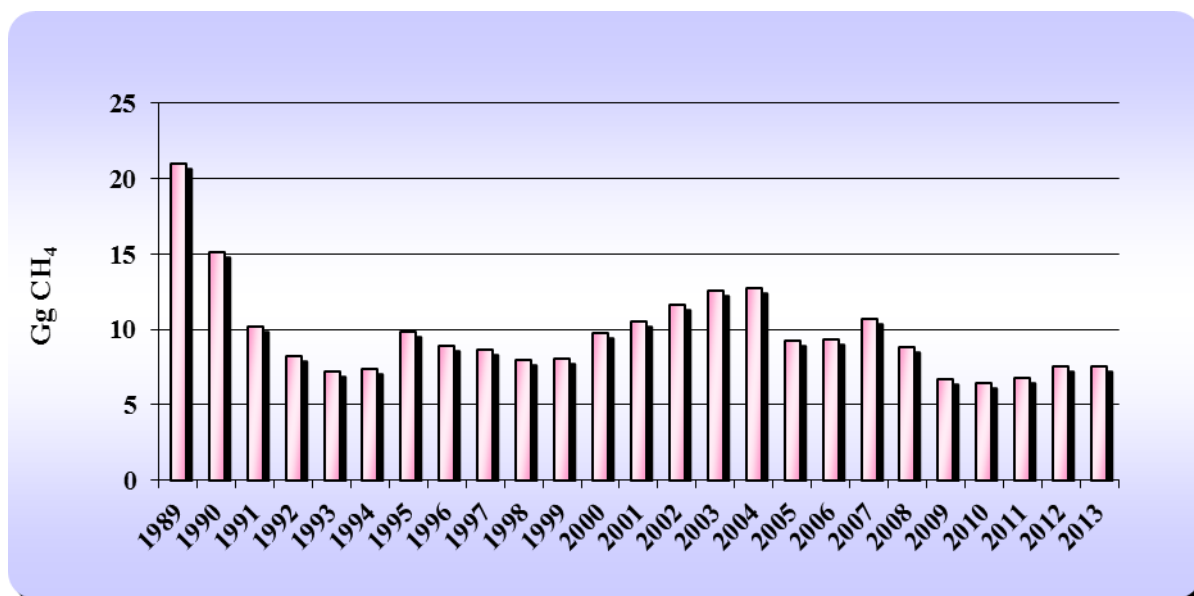
The sensitive issues of industrial wastewater treatment are associated with time-varying flows, extreme temperatures and excessive quantities of the following substances: petroleum products, organic oils, fats; acids and bases; materials in suspension; organic and inorganic substances; explosives and 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 7.16).

Since 2007, CH₄ 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 7.16 CH₄ emissions trend from industrial wastewater handling for 1989–2013 period



Compared with the base year (1989), CH₄ emissions from industrial wastewater treatment decreased with 63.80 %.

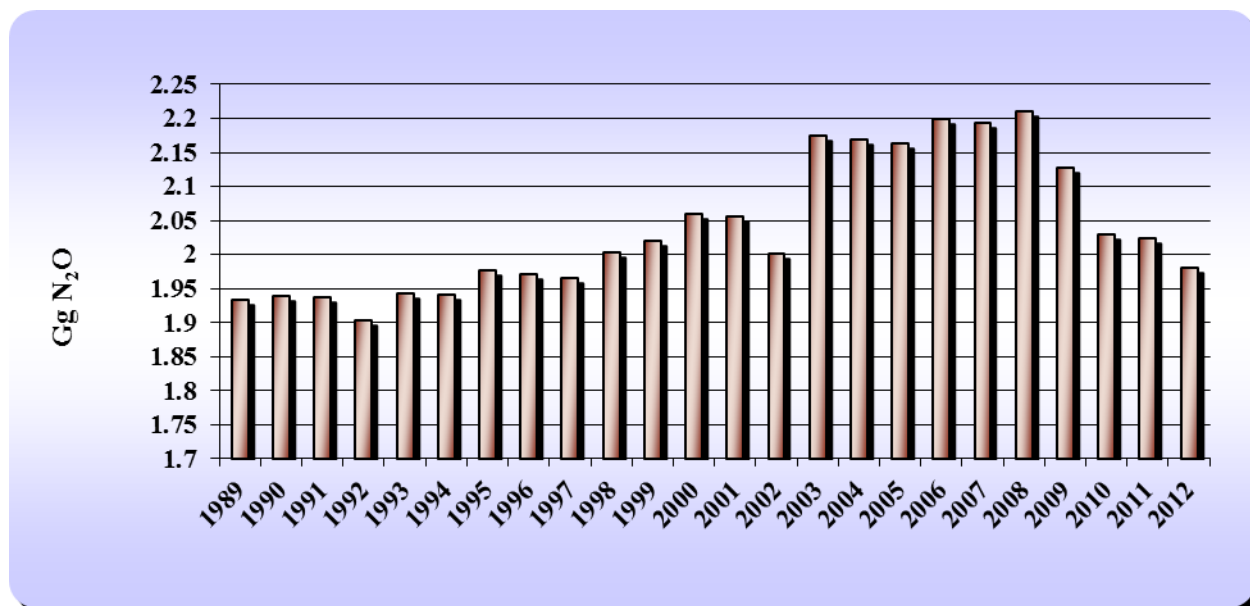
Table 7.20 Explanations on methane emissions estimates

Period	Methane emissions from industrial wastewater treatment - Explanations
1989-1996	Values between 21.01–8.96 kt These values are decreasing following decreasing industrial production.
1997-2004	Values between 8.65–12.77 kt

Period	Methane emissions from industrial wastewater treatment - Explanations
	These values are relatively higher than previous period due to: <ul style="list-style-type: none"> • progress in Romanian economy, increase of the production • increasing of fraction of wastewater treated anaerobically.
2005-2013	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 CH₄ emissions from domestic/commercial wastewater (Figure 7.10).

For estimate N₂O emissions from domestic wastewater 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, N₂O 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 N₂O emissions recorded in 2002, compared with 2001 year, is due to the severe loss of population number. Additional, the increasing trend of N₂O 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 7.17 and Table 7.28).

Figure 7.17 N₂O emissions trend from domestic wastewater for 1989–2013 period

7.5.2 Methodological issues

CH₄ emissions from domestic and commercial wastewater (CRF 5.D.1)

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 CH₄ emissions from domestic and commercial wastewater, we taking into account the decisions tree from IPCC 2006, page 6.10 and we used equation 6.1 page 6.11.

Were estimated CH₄ emissions both from the population connected to sewerage with treatment and population unconnected to sewerage.

The following steps were considered:

For calculation of Total Organic Wastewater were used equation 6.3 from IPCC 2006

Emission factor

To calculate Emission Factor we used the equation 6.2 from IPCC 2006.

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 7.21.

Table 7.21 Calculation of Emission Factors domestic/commercial wastewater, for 1989-2013 period

Parameter	B_{oi} (kg CH ₄ /kg BOD)	MCF_j	EFs
Population connected to sewerage with treatment	0.60	0.9	0.03
Population connected to sewerage without treatment	0.60	0.0	0.00
Centralized, aerobic treatment plant	0.6	0.2	0.12
Population unconnected to sewerage	0.60	0.5	0.30
Source:	IPCC 2006	Expert opinion	-

Activity data

To estimate methane emissions from domestic/commercial wastewater, data provided by 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”.

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, the urban population and the population in rural areas were obtained from the National Institute for Statistics (NIS). The fraction of total population connected to sewerage with treatment is obtained from different sources (Table 7.22).

The data regarding population unconnected to sewerage were obtained by making the difference between total population and population connected to sewerage.

Table 7.22 The sources of activity data used in methane emissions estimates from domestic/commercial wastewater treatment

Activity Data	Source
Total population [1000 persons]	<i>National Institute for Statistics</i>
Total population connected to sewerage with treatment [1000 persons] - $P_{tot\ tr}$	<i>1989 -2005 period: $P_{tot\ tr} = P_{urb\ tr} + P_{rur\ tr}$; 2006 – 2013 : National Institute for Statistics</i>
Total population unconnected to sewerage [1000 persons] – $P_{tot\ uncon}$	<i>1989 -2005 period: $P_{tot\ uncon} = P_{urb\ uncon} + P_{rur\ uncon}$ 2006 – 2013 : $P_{tot\ uncon} = P_{tot} - P_{tot\ tr}$</i>
Total population [1000 persons]	<i>National Institute for Statistics</i>

To calculate Total Organic Wastewater we used the parameters provided by the study (Table 7.23).

Table 7.23 Parameters used to estimate Total organic industrial wastewater (Source:IPCC GPG 2000, table 5-4)

Parameters	Years				
	1989-1999	2000-2005	2006	2007	2008-2013
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 degradable organic component for year 2006 is a single national value and was provided by the National Institute for Statistics (NIS). The other value of degradable organic component is assumed by expert Prof. Dr. Vladimir Rojanschi and is provided through the study finished 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”).

The biochemical oxygen demand was provided by NIS.

The fraction of BOD removed as sludge for 1989-2007 was provided by expert Prof. Dr. Vladimir Rojanschi and for 2008-2013 period was provided by NIS. The other value of BOD is assumed by expert judgement and is provided through the study finalized in 2011.

CH₄ 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.

N₂O emissions from domestic wastewater

Direct emissions of N₂O from domestic wastewater are minor and only occur in advanced centralised treatment plants. As the proportion of advanced treatment plants is small, it will be reported only indirect N₂O emissions.

Methodology

To estimate N₂O emissions from domestic wastewater, we used the equations 6.7 and 6.8 from IPCC 2006.

Default parameters according to IPCC 2006 have been used. Fraction of nitrogen in protein (0.16 kg N/kg protein), the factor for non- consumed protein discharged to wastewater (1.4), the factor for industrial and commercial co-discharged protein into the sewer system (1.25), nitrogen removed with sludge (0 kg N₂O- N/kg N), emission factor (0.005 kg N₂O – N/kg N).

Activity data

In estimation of N₂O emissions from domestic wastewater was taking into account the total population of our country. The number of population was provided by National Institute for Statistics for 1989-2013 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 7.24.

Table 7.24 Values of Protein Consumption for Romania in period 1989-2013

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	39.931	
2011	40.150	
2012	38.946	
2013*	39.566	<i>Preliminary data</i>

CH₄ emissions from industrial wastewater and sludge (CRF 5.D.2)

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 2006, figure 6.3, 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 CH₄ 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 CH₄ emissions from industrial wastewater according to the IPCC 2006.

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 6.4 from IPCC 2006.

The following steps were considered:

1. Calculation of Total Organic Wastewater for each of the three industrial branches, using equation 6.6 from IPCC 2006.
2. Calculation of Total Industrial Organic Wastewater for pulp, paper and petroleum refining, by summing TOW obtained for each industry in step 1.

Estimation of CH₄ emissions on the one hand for pulp, paper, petroleum refining and on the other hand separately for anaerobic and aerobic treatment in beer industry.

Methane is recovered only in beer industry which treating their wastewater in anaerobic conditions.

Emission factor

The emission estimation method and system was determined according to figure 6.1. Romanian industrial wastewater are collected and treated by aerobic and/or anaerobic methods. Formula 6.5 was used to calculate the emission factor for each industrial sector, by using the methane maximum production capacity and the methane correction factor specific to the industrial branch. Formula 6.4 was used to estimate emissions corrected for potential removed sludge or for the recovered CH₄ and the summation of the results. 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 7.25 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	0.020	0.250	0.018	0.004
1999	0.103	0.897	0.800	0.020	0.250	0.018	0.004
2000	0.107	0.893	0.800	0.020	0.250	0.019	0.004
2001	0.124	0.876	0.800	0.020	0.250	0.022	0.004
2002	0.149	0.851	0.800	0.020	0.250	0.026	0.004
2003	0.144	0.856	0.800	0.020	0.250	0.025	0.004
2004	0.144	0.856	0.800	0.020	0.250	0.025	0.004

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
2005	0.155	0.845	0.800	0.020	0.250	0.027	0.004
2006	0.191	0.809	0.800	0.020	0.250	0.033	0.004
2007	0.212	0.788	0.800	0.020	0.250	0.037	0.004
2008	0.408	0.592	0.800	0.020	0.250	0.071	0.003
2009	0.447	0.553	0.800	0.020	0.250	0.078	0.003
2010	0.469	0.531	0.800	0.020	0.250	0.082	0.003
2011	0.462	0.538	0.800	0.020	0.250	0.081	0.003
2012	0.449	0.551	0.800	0.020	0.250	0.078	0.003
2013	0.347	0.653	0.800	0.020	0.250	0.061	0.003
Pulp, paper and petroleum refinery							

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
1989-1997	0.000	1.000	0.800	0.050	0.250	0.000	0.013
1998-2013	0.000	1.000	0.800	0.020	0.250	0.000	0.005
Source	Expert judgement based on data provided by economic operators		IPCC 2006		IPCC 2006, page 6.21	Calculated	

For Maximum methane producing capacity (Boi) were not found national values, in this case has been used the default value of 0.25 kg CH₄/kg COD (Chemical Oxygen Demand) from IPCC 2006.

Activity data

The activity data as regard industrial production of sectors taking into account have been provided by National Institute for Statistics (Table 7.26).

Table 7.26 Industrial production of the industrial sectors with the greatest potential for methane emissions (source: NIS - Statistical Yearbook 2013)

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
2013	1,751,900	372,000	*	9,366,000

* Confidential data

As regards Degradable Organic Component and Wastewater generated, we used the default values from IPCC 2006 (Table 7. 27).

Table 7.27 Parameters used to estimate Total organic industrial wastewater (Source:IPCC 2006, table 6.8)

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.

CH₄ recovery

Data on methane recovered from industrial wastewater treatment are available. Considering information that we have at this time, the methane is recovered by most important 4 operators of breweries (Table 7.28).

Table 7.28 The amounts of CH₄ 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
2013	1.34

CH₄ emissions from industrial sludge

CH₄ emissions from industrial sludge are reported IE because the emissions are included at the industrial wastewater level.

7.5.3 Uncertainties and time-series consistency

CH₄ 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 6.3.

The uncertainties associated with CH₄ emissions from industrial wastewater are presented in the next table:

Table 7.29 Uncertainties for estimation of CH₄ 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 equation 3.1 in Chapter 3, Volume 1 of the IPCC 2006.

CH₄ 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 6.3.

In the table below are presented the uncertainties associated CH₄ emissions from domestic/commercial wastewater treatment.

Table 7.30 Uncertainties for estimation of CH₄ 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 according to Chapter 3, Volume 1 of the IPCC 2006.

N₂O from domestic 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 6.3. In the table below are presented the uncertainties associated to N₂O emissions from human sewage.

Table 7.31 Uncertainties for estimation of N₂O emissions from domestic wastewater

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
N ₂ O from wastewater handling	N ₂ O	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 Chapter 3, Volume 1 of the IPCC 2006.

7.5.4 Category-specific QA/QC and verification, if applicable

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 nonconformities 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 7.32).

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 7.32 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

Year	Total number of population (1000 persons)		Difference (persons)
	NGHGI 2013 (Source NIS) 1 July	EUROSTAT 1 January	
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
2012	21,355.849	21,355.849	0.000
2013	21,305.097	21,305.097	0.000

7.5.5 *Category-specific recalculation, including changes made in response to the review process and impact on emission trend*

In the previous submissions, emissions for wastewater and sludge removed from wastewater have been calculated separately. In the current submission the distinction has been removed.

Table 7.33 Effects of activity data on emission estimates from domestic and commercial wastewater

Year	Changes at AD level		Effects of changes on emission estimates for CH ₄		Difference [%]
	NGHGI	NGHGI	[kt]		
	2014	2015	NGHGI	NGHGI	
	v.2.1.	v. 1	v.2.1.	v. 1	
1989	401.381	507.019	109.649	111.012	1.2431
1990	401.142	508.227	109.318	110.733	1.2948
1991	400.968	507.753	109.315	110.721	1.2861
1992	393.986	499.078	107.382	108.769	1.2920
1993	393.148	498.34	107.097	108.493	1.3034
1994	392.567	497.801	106.904	108.304	1.3104
1995	394.502	496.713	111.573	112.378	0.7214
1996	393.255	495.107	111.224	112.026	0.7208
1997	392.045	493.756	110.864	111.667	0.7239
1998	391.461	492.811	110.720	111.517	0.7201
1999	390.785	491.831	110.542	111.335	0.7178
2000	372.581	491.331	105.889	104.919	-0.9166
2001	363.835	490.744	101.367	100.614	-0.7429
2002	348.346	477.306	95.093	94.615	-0.5028
2003	340.144	475.965	90.591	90.401	-0.2092
2004	330.589	474.65	86.732	87.529	0.9184

Year	Changes at AD level		Effects of changes on emission estimates for CH ₄ [kt]		Difference [%]
	NGHGI 2014	NGHGI 2015	NGHGI 2014	NGHGI 2015	
	v.2.1.	v. 1	v.2.1.	v. 1	
2005	325.05	473.56	83.792	85.218	1.7019
2006	320.865	472.70	82.053	77.379	-5.6960
2007	324.59	471.67	82.716	76.386	-7.6524
2008	319.53	470.95	82.110	75.120	-8.5132
2009	318.74	470.19	81.826	74.831	-8.5484
2010	319.05	470.02	81.245	74.152	-8.7294
2011	334.30	468.96	81.336	72.484	-10.8838
2012	332.837	467.69	80.736	71.616	-11.2959

7.5.6 Category-specific planned improvements, if applicable, including tracking of those identified in the review process

In order to improve the next submissions, we will try to include the parameters/emission factors associated on sludge that result from industrial wastewater treatment.

7.6 Other (CRF 5.E)

This category is not occurring in Romania.

7.7 Memo items (CRF 5.F)

This category is not occurring in Romania.

8 OTHER (CRF Sector 6)

There are no additional GHG emissions, removals or activities characterized.

9 Indirect CO₂ and nitrous oxide emissions

9.1 Sources of indirect emissions in GHG inventory

9.1.1 ENERGY SECTOR (CRF Sector 1)

9.1.1.1 STATIONARY COMBUSTION

9.1.1.1.1 Description of sources of indirect emissions Stationary Combustion

The activity categories where the fuels are combusted in the stationary combustion, sources for the precursors gases, are as follows:

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

The reported precursor gases which results from these activities are NO_x, CO, NMVOC and SO₂.

9.1.1.1.2 Methodological issues

Activity Data

The activity data required for calculation of the precursor emissions from stationary combustion is based on the National Energy Balances, which provide information about the indigenous consumption, by subsector, for all types of fuels: solid, liquid, gaseous, peat, other and biomass fuels.

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.

The considered energetic consumption of the fuels is the same analysed for the direct GHG gas emission estimations see the Energy sector– stationary combustion chapter 3.2.4.1.

NO_x, CO, NMVOC, SO₂ 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 9.1 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 9.2 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**

CO [kg/TJ]	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Other Biomass and Wastes
Manufacturing Industries and Construction	931*	25*	40*	1596*	4000**	4000**
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 9.3 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 NO_x , CO, NMVOC emission factors are in accordance with the IPCC 1996 Guidelines.

For the 2005–2013 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.

SO₂ Emission Factors

For the estimation of the SO₂ emissions, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook—2009 (bellow table), were analyzed.

Table 9.4 Default Emission Factors For SO₂ 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	900	900	0.5	0.5	140	140	38.4

EF SO ₂ [g/GJ]	Hard Coal	Brown Coal	Natural Gas	Derived Gases	Heavy Fuel Oil	Other Liquid Fuels	Biomass
combustion							

In order to have consistency in estimation of SO₂ 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 SO₂ country specific emission factor was determined and used for the 1989–2004 time-series.

For the 2005–2013 period, the SO₂ 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 1.A.1.c activity category, 1.A.2, 1.A.4 subsectors, 1.A.5.a activity category, for the estimation of the SO₂ emissions, the emission factors provided by the National Inventory of Air Pollutants under the CLRTAP, were used.

Table 9.5 Country Specific SO₂ 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

9.1.1.1.3 *Uncertainties and time-series consistency*

The values for the uncertainty of the activity data were collected/elaborated in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium.

Based on the above background information, the results of the uncertainties associated to the used activity data, 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%;
- ❖ Peat, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;
- ❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 7%.
- ❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%;

EFs uncertainty – averages of the ranges provided through the EMEP/EEA emission inventory guidebook 2013, were used.

- ***NO_x, CO gases:***
 - ❖ 1A1, 1A2,: 40%;
 - ❖ 1A4 and 1A5a: 125%;

- ***NM VOC gas:***
 - ❖ 1A1, 1A2, 1A4 and 1A5a: 125%;

- ***SO₂ gas:***
 - ❖ 1A1: 5%;
 - ❖ 1A2: 20%;
 - ❖ 1A4 and 1A5a: 40%.

Aggregated uncertainty

The overall uncertainties, as result of the aggregation of AD and EF related uncertainties, according to the equation 3.1 in Chapter 3 of the IPCC 2006 Guidelines, Vol. 1, are as follows:

- ***NO_x, CO gases:***
 - Liquid fuels, CRF categories 1A1, 1A2: 40%;
 - Solid fuels, CRF categories 1A1, 1A2: 40%;
 - Gaseous fuels, CRF categories 1A1, 1A2: 40%;
 - Peat, CRF categories 1A1, 1A2: 40%;
 - Other fuels, CRF categories 1A1, 1A2: 41%.
 - Biomass, CRF categories 1A1, 1A2: 40%;

 - Liquid fuels, CRF categories 1A4 and 1A5a: 125%;
 - Solid fuels, CRF categories 1A4 and 1A5a: 125%;
 - Gaseous fuels, CRF categories 1A4 and 1A5a: 125%;
 - Peat, CRF categories 1A4 and 1A5a: 125%;
 - Other fuels, CRF categories 1A4 and 1A5a: 125%.
 - Biomass, CRF categories 1A4 and 1A5a: 125%;

- ***NM VOC gas:***
 - Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 125%;
 - Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 125%;
 - Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 125%;
 - Peat, CRF categories 1A1, 1A2, 1A4 and 1A5a: 125%;
 - Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 125%.
 - Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 125%;

- ***SO₂ gas:***
 - Liquid fuels, CRF categories 1A1: 6%;

- Solid fuels, CRF categories 1A1: 6%;
- Gaseous fuels, CRF categories 1A1: 6%;
- Peat, CRF categories 1A1: 6%;
- Other fuels, CRF categories 1A1: 9%.
- Biomass, CRF categories 1A1: 6%;

- Liquid fuels, CRF categories 1A2,: 20%;
- Solid fuels, CRF categories 1A2: 20%;
- Gaseous fuels, CRF categories 1A2: 20%;
- Peat, CRF categories 1A2: 20%;
- Other fuels, CRF categories 1A2: 21%.
- Biomass, CRF categories 1A2: 20%;

- Liquid fuels, CRF categories 1A4 and 1A5a: 40%;
- Solid fuels, CRF categories 1A4 and 1A5a: 40%;
- Gaseous fuels, CRF categories 1A4 and 1A5a: 40%;
- Peat, CRF categories 1A4 and 1A5a: 40%;
- Other fuels, CRF categories 1A4 and 1A5a: 41%.
- Biomass, CRF categories 1A4 and 1A5a: 40%;

9.1.1.1.4 *Category-specific QA/QC and verification, if applicable*

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.

See the corresponding Energy sector chapter 3.2.4.4 - Category-specific QA/QC and verification, if applicable for the considerations related to the Activity data checks, Calculations checks, Transparency, Accuracy, Completeness, Consistency.

9.1.1.1.5 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

Activity Data

See the recalculations of the activity data, by some Energy stationary combustion activity categories, chapter 3.2.4.5.

9.1.1.1.6 Category-specific planned improvements, including tracking of those identified in the review process

It is planned continue to use the country specific IPPC Directive reported data for the NO_x and SO₂ emissions.

9.1.1.2 CIVIL AVIATION (1.A.3.a)

9.1.1.2.1 Description of sources of indirect emissions in GHG inventory

The sources of indirect emissions are provided from international and domestic civil aviation, including take-offs and landings. Comprises civil commercial use of airplanes, including: scheduled and charter traffic for passengers and freight, air taxiing, and general aviation.

The activity and emission values for the precursors (NO_x, CO, NMVOC and SO₂) are found in the CRF Reporter GHG inventory [1. Energy] [1.AA Fuel Combustion - Sectoral approach] [1.A.3 Transport] [1.A.3.a Domestic Aviation].

The emission factors are default and *provided* in the Revised 1996 IPCC Guidelines and IPCC 2006.

9.1.1.2.2 *Methodological issues*

This section provides the estimation methods for emissions of precursors (NO_x, CO, NMVOC and SO₂) from combustion of aviation fuel. The NO_x, CO, NMVOC and SO₂ emissions from the specified sources were calculated by multiplying the fuel consumption converted to net calorific value by the default emission factors.

9.1.1.2.3 *Uncertainties and time-series consistency*

NO_x, CO, NMVOC, SO₂ emissions

- *activity data*: jet fuels: 5 %.
- *emission factors*: Jet fuels: 150%.
- 1.5% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.1.2.4 *Category-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 Road Transport Subsector.

9.1.1.2.5 *Category-specific recalculations, including changes made in response to the review process and impact on emission trend*

Recalculations for the 1989 – 2012 period due to changes methodology, update of value emission factors for fuel consumption.

9.1.1.2.6 Category-specific planned improvements, including tracking of those identified in the review process

No source-specific planned improvements are envisaged.

9.1.1.3 ROAD TRANSPORT (1.A.3.b)

NO_x, CO, NMVOC, and SO₂ emissions

9.1.1.3.1 Description of sources of indirect emissions in GHG inventory

This section provides the estimation methods for emissions of precursors and other substances (NO_x, CO, NMVOC, and SO₂) from fuel combustion of vehicles.

9.1.1.3.2 Methodological issues

NO_x, CO, SO₂ and NMVOC

- *Estimation Method*

Exhaust emissions from road transport are reported according to the four different NFR codes listed: 1.A.3.b.i passenger cars, 1.A.3.b.ii light duty trucks, 1.A.3.b.iii heavy duty trucks and buses, 1.A.3.b.iv mopeds and motorcycles.

NO_x, CO, SO₂ and NMVOC emissions from the specified mobile sources were calculated by multiplying the distance traveled per year for each vehicle type by fuel consumed and own emission factor.

- *Emission factors for period 1989-2004*

For exhaust emissions of precursors NO_x, CO, NMVOC are used emission factors 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). Tier 1 emission factors of Copert 4 will give somewhat higher emission values as is the

case of Romania than 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.

The maximum values for the emission factors used correspond to uncontrolled vehicle technology.

Table 9.6 Emission Factors for Tier 1 method of Copert 4

Category	Fuel	CO (g/kg fuel)	NMVOC (g/kg fuel)	NOx (g/kg fuel)
Passenger Cars	Gasoline	269.5	34.42	29.89
Passenger Cars	Diesel	8.19	1.88	13.88
Passenger Cars	LPG	117	25.66	34.3
Light-Duty Vehicles	Gasoline	238.3	26.08	25.46
Light-Duty Vehicles	Diesel	11.71	1.96	18.43
Heavy-Duty Vehicles	Diesel	10.57	3.77	38.29
Two-Wheel Vehicles	Gasoline	664.5	364.8	10.73

CO, NOx, ch. Road transport GB 2013, table 3-5 and table 3-6 pag.25-26; NMVOC ch. Gasoline evaporation GB 2013, pag.8-9; SO₂ IPCC 1996, Vol.III, pag.1.44 Guidelines table 1-12 Default Values of Sulphur Content in gasoline(road), diesel(road) and jet kerosene).

The emissions of sulphur oxides (SO₂) are directly related to the sulphur content of the fuel:

Equation 9.1 The Emission Factor for SO₂

$$EF_{SO_2} [kg/TJ] = 2 \times (s/100) \times 1/Q \times 10^6 \times (100 - r/100) \times (100 - n/100)$$

where:

- EF = Emission Factor (kg/TJ);

- $2 = \text{SO}_2/\text{S}$ [kg/kg];
- $s = \text{Sulphur content in fuel}$ [%];
- $r = \text{Retention of sulphur in ash}$ [%];
- $Q = \text{Net calorific value}$ [TJ/kt];
- $n = \text{Efficiency of abatement technology and/or reduction efficiency}$ [%].

Table 9.7 Default values of sulphur content (s) in fuel

Fuel (IPCC grouping)	Default value [%]
Diesel (road)	0.3
Gasoline (road)	0.1
Jet kerosene	0.05

- *Emission factors for period 2005-2013*

Model Copert 4, Tier 3 was used for the period 2005-2013, detailed statistics necessary to use higher level methods have allowed.

For period 2005-2013 the emission calculations of road transport have been performed with the use of the version 11 of the European COPERT 4 software, model methodology corresponding to Tier 3, according to the IPCC GPG 2000 and IPCC 2006.

9.1.1.3.3 *Uncertainties and time-series consistency*

Table 9.8 Uncertainties for road transport

Road Transport 1.A.3.b.	Uncertainty					Combined uncertainty			
	Activity Data	EF CO	EF SO ₂	EF NMVOC	EF NO _x	EF CO	EF SO ₂	EF NMVOC	EF NO _x
Motor Gasoline	3	50	50	50	50	0.5009	0.5009	0.5009	0.5009
Gas Diesel Oil	3	50	50	50	50	0.5009	0.5009	0.5009	0.5009

Road Transport 1.A.3.b.	Uncertainty					Combined uncertainty			
	Activity Data	EF CO	EF SO ₂	EF NMVOC	EF NO _x	EF CO	EF SO ₂	EF NMVOC	EF NO _x
Liquefied Petroleum Gases (LPG)	3	50	50	50	50	0.5009	0.5009	0.5009	0.5009
Other Liquid Fuels (Other Kerosene)	3	50	50	50	50	0.5009	0.5009	0.5009	0.5009
Gaseous Fuels	3	50	50	50	50	0.5009	0.5009	0.5009	0.5009
Biomass	3	50	50	50	50	0.5009	0.5009	0.5009	0.5009

9.1.1.3.4 Category-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 Domestic Aviation, Railways, Domestic Navigation and Other Transportation, the results of these being mentioned on the Checklists level.

9.1.1.3.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Recalculations for the 1989 – 2012 period due to changes methodology, update of value emission factors for fuel consumption.

9.1.1.3.6 *Category-specific planned improvements, including tracking of those identified in the review process*

No source-specific planned improvements are envisaged.

9.1.1.4 *RAILWAYS (1.A.3.c.)*

9.1.1.4.1 *Description of sources of indirect emissions in GHG inventory*

The sources of indirect emissions are provided from railway transport for both freight and passenger traffic routes.

The activity data and emission values for the precursors (NO_x, CO, NMVOC and SO₂) are found in the CRF Reporter GHG inventory [1. Energy][1.AA Fuel Combustion - Sectoral approach] [1.A.3 Transport] [1.A.3.c Railways].

The emission factors are default and *provided* provided in the *Revised 1996 IPCC Guidelines* and EMEP/EEA emission inventory guidebook 2013.

9.1.1.4.2 *Methodological issues*

This section provides the estimation methods for emissions of precursors (NO_x, CO, NMVOC and SO₂) caused by combustion of railway fuel. The NO_x, CO, NMVOC and SO₂ emissions from the specified sources were calculated by multiplying fuel consumption converted to net calorific value by the default emission factors provided in the *Revised 1996 IPCC Guidelines* and EMEP/EEA emission inventory guidebook 2013.

9.1.1.4.3 *Uncertainties and time-series consistency*

NO_x, CO, NMVOC, SO₂ emissions

- *activity data*: Liquid: 5%

Solid: 3%

- *emission factors*: Fuel consumption: 150%.
- 1.5008% liquid and 1.5003% solid associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.1.4.4 *Category-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 Road Transport Subsector.

9.1.1.4.5 *Category-specific recalculations, including changes made in response to the review process and impact on emission trend*

Recalculations for the 1989 – 2012 period due to changes methodology, update of value emission factors for fuel consumption.

9.1.1.4.6 *9.1.3.6. Category-specific planned improvements, including tracking of those identified in the review process*

No source-specific planned improvements are envisaged.

9.1.1.5 *NAVIGATION(1.A.3.d.)*

9.1.1.5.1 *Description of sources of indirect emissions in GHG inventory*

The sources of indirect emissions are provided from fuels used to propel water-borne vessels, including hovercraft and hydrofoils, but excluding fishing vessels.

The activity data and emission values for the precursors (NO_x, CO, NMVOC and SO₂) are found in the CRF Reporter GHG inventory [1. Energy][1.AA Fuel Combustion - Sectoral approach] [1.A.3 Transport] [1.A.3.d Domestic Navigation].

The emission factors are default and *provided* provided in the *Revised 1996 IPCC Guidelines* and EMEP/EEA emission inventory guidebook 2013.

9.1.1.5.2 *Methodological issues*

This section provides the estimation methods for emissions of precursors (NO_x, CO, NMVOC and SO₂) caused by combustion of railway fuel. The NO_x, CO, NMVOC and SO₂ emissions from the specified sources were calculated by multiplying fuel consumption converted to net calorific value by the default emission factors.

9.1.1.5.3 *Uncertainties and time-series consistency*

NO_x, CO, NMVOC, SO₂ emissions

- *activity data*: Residual Fuel Oil: 5.0 %

Diesel oil: 5.0%

Gasoline: 3.0%

- *emission factors*: Fuel consumption: 150%.

- 1.5008% residual fuel and diesel oil, 1.5003% gasoline, associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.1.5.4 *Category-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 Road Transport Subsector.

9.1.1.5.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Recalculations for the 1989 – 2012 period due to changes methodology, update of value emission factors for fuel consumption.

9.1.1.5.6 Category-specific planned improvements, including tracking of those identified in the review process

No source-specific planned improvements are envisaged.

9.1.1.6 OTHER TRANSPORTATION (1.A.3.e.)

9.1.1.6.1 Description of sources of indirect emissions in GHG inventory

The sources of indirect emissions are provided from combustion emissions from all remaining transport activities including pipeline transportation, ground activities in airports and harbours, and off-road activities.

The activity data and emission values for the precursors (NO_x, CO, NMVOC and SO₂) are found in the CRF CRF Reporter GHG inventory [1. Energy] [1.AA Fuel Combustion - Sectoral approach] [1.A.3 Transport] [1.A.3.e Other Transportation (please specify)].

The emission factors are default and provided provided in the Revised 1996 IPCC Guidelines and EMEP/EEA emission inventory guidebook 2013.

9.1.1.6.2 Methodological issues

This section provides the estimation methods for emissions of precursors (NO_x, CO, NMVOC and SO₂) caused by combustion of railway fuel. The NO_x, CO, NMVOC and SO₂ emissions from the specified sources were calculated by multiplying fuel consumption converted to net calorific value by the default emission factors .

9.1.1.6.3 *Uncertainties and time-series consistency*

NO_x, CO, NMVOC, SO₂ emissions

- *activity data*: Liquid: 3.0%

Solid: 3.0%

Gaseous: 3.0%

Biomass: 3.0%

- *emission factors*: Fuel consumption: 150%.

- 1.5% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.1.6.4 *Category-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 Road Transport Subsector.

9.1.1.6.5 *Category-specific recalculations, including changes made in response to the review process and impact on emission trend*

Recalculations for the 1989 – 2012 period due to changes methodology, update of value emission factors for fuel consumption.

9.1.1.6.6 *Category-specific planned improvements, including tracking of those identified in the review process*

No source-specific planned improvements are envisaged.

9.1.1.7 Fugitive Emissions from Fuels (1.B)

Emissions from Oil Production (1.B.2.a)

9.1.1.7.1 Description of sources of indirect emissions in GHG inventory

The sources of indirect Fugitive emissions from oil production 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 to treating or extraction facilities, activities at extraction and upgrading facilities, associated gas re-injection systems and produced water disposal systems.

Activity data

According with the methodological provisions, activity data level used for emissions of precursors (NO_x, CO, NMVOC and SO₂) from *Oil production (1.B.2.a)* is the “crude oil throughput” of the Domestic RO Energy Balance 2013.

Emission Factor

The default emission factors from Revised 1996 IPCC Guidelines and from EMEP/EEA Emission Inventory Guidebook 2013 have been used.

9.1.1.7.2 Methodological issues

This section provides the estimation methods for emissions of precursors (NO_x, CO, NMVOC and SO₂) from *Production and upgrading Oil*.

The NO_x, CO, NMVOC and SO₂ emissions from the specified sources were calculated by multiplying the fuel consumption with the default emission factors.

9.1.1.7.3 *Uncertainties and time-series consistency*

NO_x, CO, NMVOC, SO₂ emissions

- *activity data*: 7 %.

- *emission factors*: 125%.

- 125,20% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA Emission Inventory Guidebook 2013.

9.1.1.7.4 *Category-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 Fuel Combustion Subsector.

9.1.1.7.5 *Category-specific recalculations, including changes made in response to the review process and impact on emission trend*

No recalculations were performed.

9.1.1.7.6 *Category-specific planned improvements, including tracking of those identified in the review process*

No source-specific planned improvements are envisaged.

9.1.2 INDUSTRIAL PROCESSES AND PRODUCT USE SECTOR (CRF Sector 2)

9.1.2.1 MINERAL INDUSTRY (CRF 2.A)

9.1.2.1.1 Description of sources of indirect emissions in GHG inventory

GHG emissions reported include estimates for the Cement Production (CRF 2.A.1) category.

9.1.2.1.2 Methodological issues

9.1.2.1.2.1 Cement Production (CRF 2.A.1)

Methodology

The method for calculating emissions of SO₂ from cement is in line with the 1996 IPCC Revised Guidelines for National Greenhouse Gas Inventories - page 2.7.

Activity data

The AD necessary to estimate emissions from this source category are provided by the National Institute for Statistics (Cement Production). The data set in case of Cement Production is complete.

Emission factors

SO₂ emissions from cement production are estimated using the below equation.

Equation 9.2 The SO₂ emissions from cement production

$$SO_2 [Gg] = \text{Quantity of Cement Produced (t)} \times \text{Emission Factor} \times 10^{-6}$$

The default emission factor of 0.3 kg SO₂/tonne cement is used.

Table 9.9 Cement Production data and SO₂ emissions from Cement Production in the period 1989–2013

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 [kt]
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

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 [kt]
2011	8,087.00	0.30	2.43
2012	8,223.00	0.30	2.47
2013	7,451.00	0.30	2.24

9.1.2.1.3 *Uncertainties and time-series consistency*

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 2 %;
- EF: 40 %;
- 40.05 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.2.1.4 *Category-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 nonconformities 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.

9.1.2.1.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations were made relative to previous submission.

9.1.2.1.6 Category-specific planned improvements, including tracking of those identified in the review process

No source-specific planned improvements are envisaged.

9.1.2.2 CHEMICAL INDUSTRY (CRF 2.B)

9.1.2.2.1 Description of sources of indirect emissions in GHG inventory

The Chemical Industry subsector (CRF 2.B) includes the following categories: Ammonia Production (CRF 2.B.1), Nitric Acid Production (CRF 2.B.2), Adipic Acid Production (CRF 2.B.3) and Petrochemical and carbon black production (CRF 2.B.8).

9.1.2.2.2 Methodological issues

9.1.2.2.2.1 Ammonia Production (CRF 2.B.1)

Methodology

The CO and SO₂ emissions from Ammonia Production are estimated according to the 1996 IPCC Revised Guidelines for National Greenhouse Gas Inventories.

Activity data

The AD necessary to estimate emissions from this source category are provided by the economic agents.

Emission factors

CO emissions from ammonia production are estimated using the below equation.

Equation 9.3 CO emissions from ammonia production

$$CO [Gg] = \text{Quantity of Ammonia Produced (t)} \times \text{Emission Factor} \times 10^{-6}$$

SO₂ emissions from ammonia production are estimated using the below equation.

Equation 9.4 SO₂ emissions from ammonia production

$$SO_2 [Gg] = \text{Quantity of Ammonia Produced (t)} \times \text{Emission Factor} \times 10^{-6}$$

The default emission factors of 7.9 kg CO/ tonne of product and 0.03 kg SO₂/ tonne of product are used (1996 IPCC Revised Guidelines for National Greenhouse Gas Inventories Workbook - page 2.13).

Table 9.10 Ammonia Production data and CO and SO₂ emissions from Ammonia Production in the period 1989–2013

Year	Total annual production [t/an]	Emission Factor (kg CO/t ammonia produced)	Emission Factor (kg SO₂ /t ammonia produced)	CO emissions kt	SO₂ emissions kt
1989	2,360,290.00	7.9	0.03	18.646	0.071
1990	1,757,965.00	7.9	0.03	13.888	0.053
1991	1,185,525.00	7.9	0.03	9.366	0.036
1992	1,575,576.00	7.9	0.03	12.447	0.047
1993	1,466,671.00	7.9	0.03	11.587	0.044

Year	Total annual production [t/an]	Emission Factor (kg CO/t ammonia produced)	Emission Factor (kg SO₂/t ammonia produced)	CO emissions kt	SO₂ emissions kt
1994	1,568,150.00	7.9	0.03	12.388	0.047
1995	1,641,398.00	7.9	0.03	12.967	0.049
1996	1,652,878.00	7.9	0.03	13.058	0.050
1997	836,927.00	7.9	0.03	6.612	0.025
1998	459,482.00	7.9	0.03	3.630	0.014
1999	824,867.00	7.9	0.03	6.516	0.025
2000	1,245,068.00	7.9	0.03	9.836	0.037
2001	1,149,376.00	7.9	0.03	9.080	0.034
2002	1,131,526.00	7.9	0.03	8.939	0.034
2003	1,435,176.00	7.9	0.03	11.338	0.043
2004	1,426,105.00	7.9	0.03	11.266	0.043
2005	1,601,724.00	7.9	0.03	12.654	0.048
2006	1,370,461.00	7.9	0.03	10.827	0.041
2007	1,365,890.00	7.9	0.03	10.791	0.041
2008	1,273,413.10	7.9	0.03	10.060	0.038
2009	1,022,020.99	7.9	0.03	8.074	0.031
2010	1,379,884.00	7.9	0.03	10.901	0.041
2011	1,542,980.00	7.9	0.03	12.190	0.046
2012	1,525,120.00	7.9	0.03	12.048	0.046
2013	1,123,463.00	7.9	0.03	8.875	0.034

9.1.2.2.2.2 Nitric Acid Production (CRF 2.B.2)

Methodology

The nitrogen oxide emissions were estimated according to the “2006 IPCC Guidelines for National Greenhouse Gas Inventories” for each facility and each year of operation between 1989 and 2013, by using, based on the existing activity data, approach level 2 or approach level 3.

Approach level 2 was used for nitric acid production facilities that do not have continuous emission monitoring systems.

Approach level 3 was used for nitric acid production facilities that have Continuous Emissions Monitoring Systems – CEMS.

Emissions have been calculated by multiplying annual Nitric Acid Production (tons HNO₃ 100% by each plant) by a default emission factor, which reflects the process, in line with CORINAIR Methodology.

Activity data

There were seven chemical plants in Romania in 1989, with ten nitric acid production plants. Seven plants are currently in operation in five chemical plants. The seven plants can be grouped in:

- Medium and high pressure operation facilities (six plants);
- Old facilities, erected before 1975, without NSCR (one plant).

The AD necessary to estimate emissions from this source category are provided by the economic agents.

Emission factors

The emission factors used in the spreadsheets for approach level 2 reflect the nitric acid production process:

- a) For medium and high pressure facilities – “dual pressure” (6 facilities):

- The NO_x emission factor is 5 – 12 kg NO_x /t HNO₃, according to the 2013/EMEP/EEA Emissions inventory guidebook, chap. 3.3.2.2. The **7.5 kg NO_x/t HNO₃** average value was used for the emission estimate, in the absence of continuous emission measurements.
- b) For old facilities, commissioned before 1975, without a NSCR, operating under low pressure (one facility):
- The NO_x emission factor is **12 kg NO_x /t HNO₃**, according to the 2013/EMEP/EEA Emissions inventory guidebook.

The analysis of the NO_x emission level trend was carried out under the following conditions:

- The HNO₃ production facilities are old, as they were erected between 1963 and 1978;
- The HNO₃ production technologies have not changed in the last 40 years;
- Catalyst repair, maintenance and replacement works were carried out in the facilities;
- Nitrogen oxide reduction systems and emission monitoring systems have been mounted since 2003;
- A facility, shut down its operation in 1990;
- Another facility, shut down its operation in 2008. A NO_x reduction system operated between 1997 and 2008;
- There are currently five chemical plants, where seven HNO₃ production facilities are in operation;
- Six operating HNO₃ production facilities are fitted with nitrogen oxide reduction and emission monitoring systems;
- Upgrading efforts are made in all seven operating HNO₃ production facilities, to reduce nitrogen oxide emissions.

NO_x emission level trend

- The emissions decreased between 1989 and 2001, following the decrease of production.
- A drop of emissions was registered between 2008 and 2013, while the production level was maintained or even increased. Explanation: the mounting of the NO_x reduction systems.

NO_x emission monitoring systems

NO_x emission monitoring systems use analyzers manufactured by internationally renowned companies, designed according to the U.S. EPA 40 CFR 60875 norms and the 2000/76/EC (WID), 2001/80/EC (LCPD) norms. The type of flow analyzers is the MIR 9000 Multi – Gas InfraRed GFC Analyzer.

Table 9.11 Nitric Acid Production related to the NO_x emissions in the period 1989–2013

Year	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)
		NO _x emissions [kt]	NO _x emissions [kt]
1989	1,993.70	0.88	14.40
1990	1,260.98	0.67	9.04
1991	741.95	0.27	5.39
1992	1,051.09	0.38	7.64
1993	1,024.76	0.37	7.45
1994	884.85	0.12	6.56
1995	1,025.81	0.09	7.64
1996	1,057.15	0.04	7.90
1997	768.56	0.05	4.87
1998	547.69	0.04	3.82
1999	609.55	0.13	4.01
2000	874.12	0.22	5.42
2001	750.72	0.26	4.84
2002	795.35	0.09	5.27

Year	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)
		NO _x emissions [kt]	NO _x emissions [kt]
2003	960.24	0.06	3.41
2004	1,059.14	0.37	1.87
2005	1,102.14	0.17	2.75
2006	869.25	0.30	2.01
2007	981.38	0.23	2.26
2008	867.39	0.46	1.71
2009	642.48	0.25	1.90
2010	1,055.38	0.41	3.28
2011	1,076.96	0.56	2.72
2012	983.80	0.46	1.47
2013	949.58	0.19	0.62

9.1.2.2.2.3 Adipic Acid Production (CRF 2.B.3)

Methodology

The NO_x, NMVOC and CO emissions from Adipic Acid Production are estimated according to the 1996 IPCC Revised Guidelines for National Greenhouse Gas Inventories - page 2.19.

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 with 2002, this activity is suspended.

Emission factors

Table 9.12 The default EFs used to estimate emissions from Adipic Acid Production

EMISSION FACTORS FOR ADIPIC ACID PRODUCTION (KG/TONNE PRODUCT)		
NO_x	NMVOC	CO
8.1	43.3	34.4

Table 9.13 Adipic Acid Production related to the NO_x, NMVOC and CO emissions in the period 1989–2001

Year	Amount of Adipic Acid Produced	NO_x emissions kt	NMVOC emissions kt	CO emissions kt
1989	7,287.00	0.06	0.32	0.25
1990	6,169.00	0.05	0.27	0.21
1991	5,252.00	0.04	0.23	0.18
1992	3,729.00	0.03	0.16	0.13
1993	5,879.00	0.05	0.25	0.20
1994	5,776.00	0.05	0.25	0.20
1995	6,369.00	0.05	0.28	0.22
1996	6,420.00	0.05	0.28	0.22
1997	8,966.00	0.07	0.39	0.31
1998	9,312.00	0.08	0.40	0.32
1999	7,461.00	0.06	0.32	0.26
2000	9,258.00	0.07	0.40	0.32

Year	Amount of Adipic Acid Produced	NO_x emissions kt	NMVOC emissions kt	CO emissions kt
2001	5,322.00	0.04	0.23	0.18

9.1.2.2.2.4 Petrochemical and carbon black Production (CRF 2.B.8)

Methodology

Emissions of NO_x, CO, NMVOC, and SO₂ were estimated in line with the 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, ethylene, methanol, acrylonitrile, ethylene dichloride, ethylene oxide, vinyl chloride monomer, propylene, polystyrene, polyethylene, sulphuric acid, phthalic anhydride, polypropylene, polyvinylchloride, 1, 2 dichloroethane). Carbon black and sulphuric acid are not produced anymore.

Emission factors

For confidentiality reasons the presentation of emission factors used to estimate emission from those productions are omitted.

Emissions of NO_x, CO, NMVOC, and SO₂ were estimated from those productions.

Table 9.14 The NO_x, CO, NMVOC and SO₂ emissions for Petrochemical and carbon black Production Sub-sector

Year	NO_x emissions kt	CO emissions kt	NMVOC emissions kt	SO₂ emissions kt
1989	0.03	0.77	6.81	29.76
1990	0.02	0.58	5.32	19.62
1991	0.02	0.47	4.42	13.18
1992	0.01	0.27	3.32	10.09
1993	0.01	0.27	3.67	9.31
1994	0.01	0.19	3.92	8.65
1995	0.01	0.22	4.82	8.42
1996	0.01	0.26	4.63	7.47
1997	0.01	0.21	5.01	5.82
1998	0.01	0.18	4.45	4.06
1999	0.00	0.12	4.78	4.13
2000	0.01	0.15	5.01	3.21
2001	0.01	0.16	5.51	1.06
2002	0.00	0.08	5.50	1.04
2003	0.00	0.02	6.11	1.14
2004	NO	NO	6.56	0.49
2005	NO	NO	6.74	0.19
2006	NO	NO	5.17	NO
2007	NO	NO	2.90	NO
2008	NO	NO	2.92	NO
2009	NO	NO	1.54	NO
2010	NO	NO	1.31	NO
2011	NO	NO	1.62	0.04
2012	NO	NO	1.23	NO
2013	NO	NO	1.59	NO

9.1.2.2.3 *Uncertainties and time-series consistency*

9.1.2.2.3.1 *Ammonia Production (CRF 2.B.1)*

CO emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 125 %;
- 125.10 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

SO₂ emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 40 %;
- 40.31 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.2.2.3.2 *Nitric Acid Production (CRF 2.B.2)*

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 125 %;
- 125.10 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.2.2.3.3 *Adipic Acid Production (CRF 2.B.3)*

CO, NO_x and NMVOC emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 15 %;
- EF: 125 %;
- 125.90 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.2.2.3.4 *Petrochemical and carbon black Production (CRF 2.B.8)*

CO, NO_x and NMVOC emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 125 %;
- 125.90 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

SO₂ emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 40 %;
- 40.31 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.2.2.4 *Category-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 nonconformities recorded.

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.

9.1.2.2.5 *Category-specific recalculations, including changes made in response to the review process and impact on emission trend*

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

- *activity data:*
 - Nitric Acid production (CRF 2.B.2);
 - Petrochemical and carbon black Production (CRF 2.B.8).
- *emission factors:*
 - Nitric Acid production (CRF 2.B.2).

9.1.2.2.5.1 *Nitric Acid production (CRF 2.B.2)*

Recalculations have been made for the entire time series.

The recalculations have been made due to improved activity data and emission factors on production of nitric acid of the entire time series.

Table 9.15 Recalculations of NO_x emissions in the Nitric Acid Production Sub-sector

The effects of recalculations in Nitric Acid Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	NO_x emissions [kt]		
1989	14.68	15.28	4.08
1990	9.30	9.71	4.44
1991	5.43	5.67	4.28
1992	7.49	8.03	7.21
1993	7.48	7.83	4.68
1994	6.33	6.68	5.61
1995	7.23	7.73	6.85
1996	7.67	7.94	3.57
1997	4.78	4.92	3.01
1998	3.88	3.86	-0.68
1999	4.10	4.14	1.07
2000	5.32	5.64	6.01
2001	4.88	5.10	4.63
2002	4.98	5.35	7.57
2003	2.07	3.47	67.96
2004	2.67	2.25	-15.84
2005	3.19	2.92	-8.28
2006	2.08	2.30	10.71
2007	2.54	2.49	-2.02
2008	3.24	2.18	-32.91
2009	1.94	2.16	11.41
2010	4.12	3.70	-10.31
2011	3.88	3.28	-15.56
2012	2.79	1.93	-30.99
2013		0.81	

9.1.2.2.5.2 Petrochemical and carbon black Production (CRF 2.B.8)

Recalculations were made as a result of improved activity data on Petrochemical and carbon black Production.

Table 9.16 Recalculations of NMVOC emissions in the Petrochemical and carbon black Production Sub-sector

The effects of recalculations in Petrochemical and carbon black Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	NMVOC emissions [kt]		
1989	3.54	6.81	92.05
1990	2.66	5.32	100.02
1991	2.11	4.42	109.61
1992	1.26	3.32	163.63
1993	1.26	3.67	191.79
1994	0.96	3.92	308.46
1995	1.11	4.82	336.06
1996	1.26	4.63	266.39
1997	1.05	5.01	379.21
1998	0.93	4.45	376.15
1999	0.71	4.78	569.66
2000	0.84	5.01	493.91
2001	1.39	5.51	296.04
2002	1.18	5.50	366.07
2003	1.99	6.11	206.46
2004	2.39	6.56	174.21
2005	2.47	6.74	172.78
2006	2.61	5.17	98.09

The effects of recalculations in Petrochemical and carbon black Production Sub-sector			
Years	NGHGI 2014 v. 2.1	NGHGI 2015 v. 1	Differences [%]
	NMVOC emissions [kt]		
2007	2.90	2.90	0.00
2008	2.92	2.92	0.00
2009	1.54	1.54	0.00
2010	1.31	1.31	0.00
2011	1.62	1.62	0.00
2012	1.23	1.23	0.00
2013		1.59	

9.1.2.2.6 *Category-specific planned improvements, including tracking of those identified in the review process*

No source-specific planned improvements are envisaged.

9.1.2.3 METAL INDUSTRY (CRF 2.C)

9.1.2.3.1 *Description of sources of indirect emissions in GHG inventory*

The emission estimates cover sub-categories Iron and Steel Production (CRF 2.C.1) and Aluminium Production (CRF 2.C.3).

9.1.2.3.2 *Methodological issues*

9.1.2.3.2.1 *Iron and Steel Production (CRF 2.C.1)*

Methodology

The NMVOC, NO_x, CO and SO₂ emissions for the period 1989-2013 were estimated based on the Tier 1 methodology in IPCC 1996 (activity data x default emission factor).

Activity data

The data collection was performed based on questionnaires sent to the economic agents identified by the Local Agencies for Environmental Protection.

Emission factors

The default emission factors of 0.112 kg CO/ tonne of product, 0.02 kg NMVOC/ tonne of product, 0.076 kg NO_x/ tonne of product and 0.03 kg SO₂/ tonne of product are used (1996 IPCC Revised Guidelines for National Greenhouse Gas Inventories - page 2.29).

Table 9.17 NMVOC emissions for category CRF 2.C.1 – Iron and Steel Production

Year	Iron production, t	Emission factor, kg/t	NMVOC emissions, t
1989	8,495,130	0.02	170
1990	5,916,270	0.02	118
1991	4,231,800	0.02	85
1992	3,001,320	0.02	60
1993	3,118,790	0.02	62
1994	3,421,210	0.02	68
1995	4,118,570	0.02	82

Year	Iron production, t	Emission factor, kg/t	NM VOC emissions, t
1996	3,905,790	0.02	78
1997	4,445,200	0.02	89
1998	4,463,690	0.02	89
1999	2,943,280	0.02	59
2000	3,041,540	0.02	61
2001	3,221,860	0.02	64
2002	3,969,800	0.02	79
2003	4,084,940	0.02	82
2004	4,246,500	0.02	85
2005	4,117,920	0.02	82
2006	3,984,650	0.02	80
2007	3,946,680	0.02	79
2008	3,238,790	0.02	65
2009	1,568,860	0.02	31
2010	1,721,750	0.02	34
2011	1,581,250	0.02	32
2012	1,468,160	0.02	29
2013	1,603,843	0,02	32

Table 9.18 NOx emissions for category CRF 2.C.1 – Iron and Steel Production

Year	Iron production, t	Emission factor, kg/t	NOx emissions, t
1989	8,495,130	0.076	646
1990	5,916,270	0.076	450
1991	4,231,800	0.076	322
1992	3,001,320	0.076	228
1993	3,118,790	0.076	237
1994	3,421,210	0.076	260

Year	Iron production, t	Emission factor, kg/t	NOx emissions, t
1995	4,118,570	0.076	313
1996	3,905,790	0.076	297
1997	4,445,200	0.076	338
1998	4,463,690	0.076	339
1999	2,943,280	0.076	224
2000	3,041,540	0.076	231
2001	3,221,860	0.076	245
2002	3,969,800	0.076	302
2003	4,084,940	0.076	310
2004	4,246,500	0.076	323
2005	4,117,920	0.076	313
2006	3,984,650	0.076	303
2007	3,946,680	0.076	300
2008	3,238,790	0.076	246
2009	1,568,860	0.076	119
2010	1,721,750	0.076	131
2011	1,581,250	0.076	120
2012	1,468,160	0.076	112
2013	1,603,843	0.076	122

Table 9.19 CO emissions for category CRF 2.C.1 – Iron and Steel Production

Year	Iron production, t	Emission factor, kg/t	CO emissions, t
1989	8,495,130	0.112	951
1990	5,916,270	0.112	663
1991	4,231,800	0.112	474
1992	3,001,320	0.112	336
1993	3,118,790	0.112	349

Year	Iron production, t	Emission factor, kg/t	CO emissions, t
1994	3,421,210	0.112	383
1995	4,118,570	0.112	461
1996	3,905,790	0.112	437
1997	4,445,200	0.112	498
1998	4,463,690	0.112	500
1999	2,943,280	0.112	330
2000	3,041,540	0.112	341
2001	3,221,860	0.112	361
2002	3,969,800	0.112	445
2003	4,084,940	0.112	458
2004	4,246,500	0.112	476
2005	4,117,920	0.112	461
2006	3,984,650	0.112	446
2007	3,946,680	0.112	442
2008	3,238,790	0.112	363
2009	1,568,860	0.112	176
2010	1,721,750	0.112	193
2011	1,581,250	0.112	177
2012	1,468,160	0.112	164
2013	1,603,843	0.112	180

Table 9.20 SO₂ emissions for category CRF 2.C.1 – Iron and Steel Production

Year	Iron production, t	Emission factor, kg/t	SO ₂ emissions, t
1989	8,495,130	0.03	255
1990	5,916,270	0.03	177
1991	4,231,800	0.03	127
1992	3,001,320	0.03	90

Year	Iron production, t	Emission factor, kg/t	SO ₂ emissions, t
1993	3,118,790	0.03	94
1994	3,421,210	0.03	103
1995	4,118,570	0.03	124
1996	3,905,790	0.03	117
1997	4,445,200	0.03	133
1998	4,463,690	0.03	134
1999	2,943,280	0.03	88
2000	3,041,540	0.03	91
2001	3,221,860	0.03	97
2002	3,969,800	0.03	119
2003	4,084,940	0.03	123
2004	4,246,500	0.03	127
2005	4,117,920	0.03	124
2006	3,984,650	0.03	120
2007	3,946,680	0.03	118
2008	3,238,790	0.03	97
2009	1,568,860	0.03	47
2010	1,721,750	0.03	52
2011	1,581,250	0.03	47
2012	1,468,160	0.03	44
2013	1,603,843	0.03	48

9.1.2.3.2.2 Aluminium Production (CRF 2.C.3)

Methodology

The CO₂, SO₂ emissions are estimated according to the 1996 IPCC Revised Guidelines for National Greenhouse Gas Inventories - page 2.33 and are estimated related to primary Aluminium Production.

Activity data

Primary Aluminium Production is carried out in one facility in Romania, where the pre-baked process is used.

Emission factors

The default emission factors of 400 kg CO/ tonne of product and 0.9 kg SO₂/ tonne of product are used (1996 IPCC Revised Guidelines for National Greenhouse Gas Inventories - page 2.33, Table 2-18).

Table 9.21 Emission factors for CO and SO₂ from primary Aluminium Production

Gas	Process	Emission Factor [kg/tonne primary Al produced]
CO	Anode baking	400
SO ₂	Anode baking	0.9

Table 9.22 The CO and SO₂ emissions from primary Aluminium Production

Year	SO₂ emissions kt	CO emissions kt
1989	0.239	106.217
1990	0.151	67.095
1991	0.139	61.585
1992	0.096	42.877
1993	0.101	44.694
1994	0.106	47.280
1995	0.127	56.240
1996	0.126	56.092

Year	SO₂ emissions kt	CO emissions kt
1997	0.147	65.482
1998	0.157	69.885
1999	0.157	69.632
2000	0.156	69.308
2001	0.162	71.928
2002	0.168	74.636
2003	0.178	79.219
2004	0.194	86.103
2005	0.215	95.604
2006	0.230	102.330
2007	0.236	105.002
2008	0.239	106.095
2009	0.181	80.222
2010	0.186	82.688
2011	0.202	89.802
2012	0.182	80.830
2013	0.178	78.898

9.1.2.3.3 *Uncertainties and time-series consistency*

9.1.2.3.3.1 *Iron and Steel Production (CRF 2.C.1)*

CO, NMVOC and NO_x emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 125 %;

- 125.10 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

SO₂ emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 40 %;
- 40.31 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.2.3.3.2 Aluminium Production (CRF 2.C.3)

CO emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 125 %;
- 125.10 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

SO₂ emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 5 %;
- EF: 40 %;

- 40.31 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.2.3.4 Category-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 SF₆ Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no nonconformities 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.

9.1.2.3.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations were made relative to previous submission.

9.1.2.3.6 Category-specific planned improvements, including tracking of those identified in the review process

No source-specific planned improvements are envisaged.

9.1.2.4 NON-ENERGY PRODUCTS FROM FUELS AND SOLVENT USE (CRF 2.D)

9.1.2.4.1 Description of sources of indirect emissions in GHG inventory

The emission estimates cover sub-categories Road paving with asphalt (CRF 2.D.3.b) and Asphalt roofing (CRF 2.D.3.c).

9.1.2.4.2 Methodological issues

9.1.2.4.2.1 Road Paving with Asphalt (CRF 2.D.3.b)

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.

Table 9.23 The NMVOC emissions from Road Paving with Asphalt Sector

Year	Activity data	NMVOC emissions
	kt	kt
1989	NE	NE
1990	NE	NE
1991	NE	NE
1992	NE	NE
1993	NE	NE
1994	NE	NE
1995	NE	NE
1996	NE	NE
1997	NE	NE
1998	192.333	0.003
1999	171.577	0.003
2000	223.196	0.004
2001	155.441	0.002
2002	155.89	0.002
2003	190.258	0.003
2004	952.121	0.015
2005	676.403	0.011
2006	949.411	0.015
2007	C	0.038
2008	C	0.009
2009	C	0.022
2010	C	0.026
2011	C	0.025
2012	C	0.029
2013	C	0.032

*9.1.2.4.2.2 Asphalt Roofing Production (CRF 2.D.3.c)****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 9.24 Emission factors for NMVOC, CO from Asphalt Roofing Production Sector

EMISSIONS FACTORS FOR ASPHALT ROOFING PRODUCTION–SATURATION	
PROCES [kg/tonne product]	
NMVOC	0.0475
CO	0.0095

EMISIONS FACTORS FOR ASPHALT BLOWING PROCESS – no control [kg/tonne product]	
NMVOC	2.4

Table 9.25 The CO and NMVOC emissions from Asphalt Roofing Production Sector

Year	Activity data kt	CO emissions kt	NMVOC emissions kt
1989	NE	NE	NE
1990	NE	NE	NE
1991	NE	NE	NE
1992	NE	NE	NE
1993	NE	NE	NE
1994	NE	NE	NE
1995	NE	NE	NE
1996	NE	NE	NE
1997	NE	NE	NE
1998	NE	NE	NE
1999	NE	NE	NE
2000	NE	NE	NE
2001	NE	NE	NE
2002	NE	NE	NE
2003	NE	NE	NE
2004	NE	NE	NE
2005	12.144	0.00	0.03
2006	8.79	0.00	0.02
2007	C	0.00	0.01
2008	C	0.00	0.01
2009	C	0.00	0.01
2010	C	0.00	0.01

Year	Activity data kt	CO emissions kt	NMVOC emissions kt
2011	C	0.00	0.24
2012	C	0.00	0.09
2013	C	0.00	0.00

9.1.2.4.3 *Uncertainties and time-series consistency*

9.1.2.4.3.1 *Road Paving with Asphalt (CRF 2.D.3.b)*

NMVOC emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 300 %;
- EF: 125 %;
- 325 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.2.4.3.2 *Asphalt Roofing Production (CRF 2.D.3.c)*

CO and NMVOC emissions

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 300 %;
- EF: 125 %;
- 325 % associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.2.4.4 Category-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 SF₆ Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no nonconformities 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.

9.1.2.4.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations were made relative to previous submission.

9.1.2.4.6 Category-specific planned improvements, including tracking of those identified in the review process

No source-specific planned improvements are envisaged.

9.1.2.5 OTHER PRODUCTION (CRF 2.H)

9.1.2.5.1 Description of sources of indirect emissions in GHG inventory

This sector includes NO_x, CO, NMVOC and SO₂ emission resulted from the Pulp and Paper Production (CRF 2.H.1), Food and beverages Industry (CRF 2.H.2). The activity data necessary to estimate these emissions are provided in the Statistical Yearbook.

9.1.2.5.2 *Methodological issues*

Methodology

According with 2006 IPCC Guidelines 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 (CRF 2.H.1) Sub-sector the Pulp Production was broken down by kraft and acid sulphite processes.

In the Food and Beverages Industry (CRF 2.H.2) Sub-sector the emission was estimated based on the total annual production of the particular food and drink manufacturing process.

The emissions of NO_x, CO, NMVOC, and SO₂ within the Production of Pulp and Paper and Food and Beverages Industry 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 (CRF 2.H.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 Beverages Industry (CRF 2.H.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 NO_x, CO, NMVOC, SO₂ emission factors used to estimate emission from the Production of Pulp and Paper and Food and Beverages Industry Sub-sector are omitted.

9.1.2.5.3 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 1989–2013.

9.1.2.5.4 Category-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 SF₆ 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.

9.1.2.5.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations were made relative to previous submission.

9.1.2.5.6 *Category-specific planned improvements, including tracking of those identified in the review process*

No source-specific planned improvements are envisaged.

9.1.3 *AGRICULTURE SECTOR (CRF Sector 3)*

9.1.3.1 *MANURE MANAGEMENT (3B)*

Indirect N₂O emissions from Manure management (3B 2.5)

9.1.3.1.1 *Description of sources of indirect emissions in GHG inventory*

N₂O Indirect emissions result from N volatilization in forms of ammonia and NO_x and N losses due to leaching and runoff from manure management systems. The fraction of excreted organic nitrogen that is mineralized to ammonia nitrogen during manure collection and storage depends primarily on time, and to a lesser degree temperature. Simple forms of organic nitrogen such as urea and uric acid are rapidly mineralized to ammonia nitrogen, which is highly volatile and easily diffused into the surrounding air. Nitrogen losses begin at the point of excretion in houses and other animal production areas and continue through on-site management in storage and treatment systems.

9.1.3.1.2 *Methodological issues*

Methodology

Emissions of indirect nitrous oxide from manure management were calculated using the default method of 1 Tier, for all species, according to the provisions in IPCC 2006.

The emissions were calculated in accordance with the equations 10.26 and 10.27.

Emission factors

In accordance with IPCC 2006 for the calculating indirect N₂O emissions was used the value default emissions factor from IPCC, respectively EF₄ (Table 11.3 - of IPCC 2006).

Activity data

They were used the same livestock population numbers as for calculation of CH₄ emissions from enteric fermentation. Data are presented in Chapter 5.2.2.

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] and MS were established by expert opinion being explained in the section direct N₂O emissions.

The values for percent of managed manure nitrogen for livestock that volatilises as NH₃ and NO_x in the manure management were used from IPCC 2006, the Table 10.22.

9.1.3.1.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 10 %;
- EF: 2.6%;
- 10.33% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation in Chapter 3, Volume 1 of the IPCC 2006.

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 5.2.2), 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 1989-2013 is consistent.

9.1.3.1.4 Category-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating LULUCF, the results of these being mentioned on the Checklists level.

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 6.6.

9.1.3.1.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Due to of the new methodology IPCC 2006 it is a new category input.

9.1.3.1.6 Category-specific planned improvements, including tracking of those identified in 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:

- ❖ percent of managed manure nitrogen for livestock category T that volatilizes as NH_3 and NO_x in the manure management system S, % ($\text{Frac}_{\text{GasMS}}$)

9.1.3.2 NON METHANE VOLATILE ORGANIC COMPOUNDS (NMVOC)

NMVOC emissions are not estimated in Romania.

9.1.3.3 MANAGED SOILS (3D)

Indirect N₂O emissions from Managed soils (3D2)

9.1.3.3.1 Description of sources of indirect emissions in GHG inventory

Emissions of N₂O also take place through two indirect pathways:

- ❖ The first of these pathways is the volatilisation of N as NH₃ and oxides of N (NO_x), and the deposition of these gases and their products NH₄⁺ and NO₃⁻ onto soils and the surface of lakes and other waters. The sources of N as NH₃ and NO_x are not confined to agricultural fertilisers and manures, but also include fossil fuel combustion, biomass burning, and processes in the chemical industry. Thus, these processes cause N₂O emissions in an exactly analogous way to those resulting from deposition of agriculturally derived NH₃ and NO_x, following the application of synthetic and organic N fertilisers and /or urine and dung deposition from grazing animals.
- ❖ The second pathway is the leaching and runoff from land of N from synthetic and organic fertiliser additions, crop residues, mineralisation of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition from grazing animals.

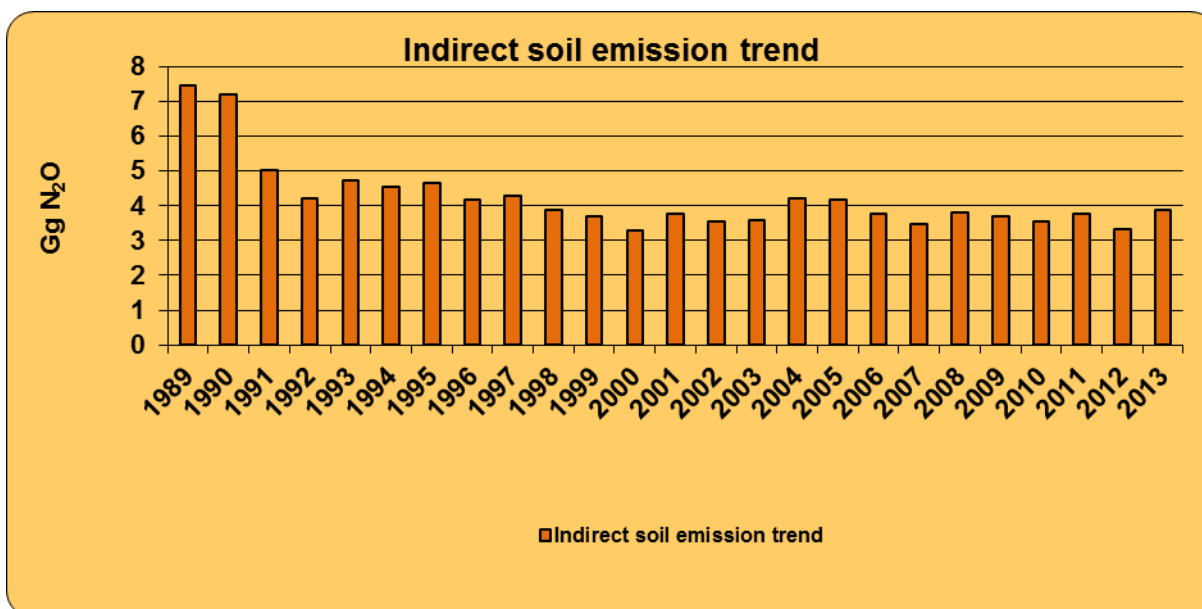
Microbial processes of nitrification and denitrification in agricultural soils produce indirect nitrous oxide emissions.

Indirect soils emissions result from the following nitrogen input to soils:

- synthetic fertilizers (F_{SN});
- organic N applied as fertilizer (F_{ON})
- urine and dung N deposited on pasture, range and paddock by grazing animals (F_{PRP});
- N in crop residues (F_{CR});
- N mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soil (F_{SOM});
- drainage/management of organic soils (F_{OS}).

- ❖ the second source of N₂O emissions in the Agriculture sector (in 2013, N₂O Indirect soil emissions represented 19.85 % of total N₂O emissions in the Agriculture sector);
- ❖ is fourth source in the Agriculture sector (in 2013, N₂O Indirect soil emissions as CO₂ equivalent represented 6.57 % from Total Agriculture emissions);
- ❖ contributed with 1.05 % to Total GHG emissions of Romania.

Figure 9.1 Indirect N₂O emissions trends – Agricultural Soils



9.1.3.3.2 Methodological issues

Methodology

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 11.9 and 11.10 from IPCC 2006 were used.

Emission factors

The calculation methodology took into account IPCC 2006 default emissions factors (Table 11.3 from IPCC 2006):

- ❖ $EF_4 = 0.010$ [kg N₂O-N/kg NH₃-N and NO_x-N volatilised];
- ❖ $EF_5 = 0.0075$ [kg N₂O-N/kg N leaching/runoff].

Activity data

A default IPCC 2006 value of 0.3 from Table 11.3, 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 11.3 (IPCC 2006).

The all activity data are presented in the relevant Direct soil emissions section and Chapter 5.3.2.

9.1.3.3.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;
- EF: 1.93%;
- 20.09% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation in Chapter 3, Volume 1 of the IPCC 2006.

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 1989-2013 is consistent.

9.1.3.3.4 *Category-specific QA/QC and verification*

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating LULUCF, 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 nonconformity 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 6.6.

9.1.3.3.5 *Category-specific recalculations, including changes made in response to the review process and impact on emission trend*

Since the last submission was made recalculation for the 1989-2013 period due to of the change of the methodology.

9.1.3.3.6 *Category-specific planned improvements, including tracking of those identified in 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 ($\text{Frac}_{\text{GASF}}$);
- ❖ fraction that volatilizes as NH_3 and NO_x , specific to animal manure nitrogen used as fertilizer, adjusted for volatilization ($\text{Frac}_{\text{GASM}}$);
- ❖ national values for activity data in totality;

- ❖ fraction of N input that is lost through leaching and runoff ($Frac_{LEACH}$).

9.1.3.4 FIELD BURNING OF AGRICULTURAL RESIDUES (3F)

NO_x and CO emissions

9.1.3.4.1 Description of sources of indirect emissions in GHG inventory

Burning of agricultural crop residues is a significant source of emissions and of carbon monoxide 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, we concluded that this 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*“.

9.1.3.4.2 Methodological issues

Methodology

For calculation of carbon monoxide, nitrous oxide emissions, the equation on page 2.42 of IPCC 2006, Volume 4, Chapter 2, was used.

Emission factors

According to the provisions in IPCC 2006 was used default emission factors for various of burning in table 2.5, pg.2.47, Volume 4, Chapter 2.

Was used default combustion factor from IPCC 2006, table 2.6, Volume 4, Chapter 2. of 0.9 for rye, wheat and 0.8 for barley and two-row barley, maize grains, sorghum, other cereals.

Table 9.26 Default emission factors for various types of burning

Gas	Default IPCC 2006 emission ratios
Carbon monoxide (CO)	92
Nitrogen oxides (NO _x)	2.5

Activity data

Data on Area burnt described in Chapter 5.5.2.

9.1.3.4.3 Uncertainties and time-series consistency

The uncertainty associated to the GHG emissions estimates are as follows:

- AD: 20 %;
- EF: 200%;
- 200.9% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation from Chapter 5, of the EMEP/EEA emission inventory guidebook 2013.

9.1.3.4.4 Category-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating LULUCF, the results of these being mentioned on the Checklists level.

9.1.3.4.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission was made recalculation for the 1989-2013 period due to of the change of the methodology.

9.1.3.4.6 Category-specific planned improvements, including tracking of those identified in the review process

No source-specific planned improvements are envisaged.

9.1.3.5 NMVOC

NMVOC emissions from Field burning of Agricultural residues are not estimated in Romania.

9.1.4 WASTE SECTOR (CRF Sector 5)

9.1.4.1 NMVOC emissions from solid waste disposal on land

9.1.4.1.1 Methodological issues

Methodology

By expert judgement, 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, NMVOC emissions from SWDS were considered to 0.7% from landfill gas and were estimated using CH₄ emissions.

Activity data

The AD are presented in the relevant Section 7.2.2 from Chapter 7.

Emission factors

The EF is presented in the relevant Section 7.2.2 from Chapter 7.

The NMVOC emissions were updated based on revised methane emissions for the entire time series.

Table 9.27 Percentage of direct and indirect Greenhouse Gas emissions from waste category 5A
(Source: International Solid Waste Association – “Landfill Operational Guideline, 2nd Edition”)

Year	Greenhouse Gas			
	CH ₄		NMVOC	
	kt	%	kt	%
1989	53.24	50	0.75	0.7
1990	54.86	50	0.77	0.7
1991	56.51	50	0.79	0.7
1992	58.09	50	0.81	0.7
1993	59.48	50	0.83	0.7
1994	60.77	50	0.85	0.7
1995	62.83	50	0.88	0.7
1996	66.48	50	0.93	0.7
1997	69.93	50	0.98	0.7
1998	70.72	50	0.99	0.7
1999	73.03	50	1.02	0.7
2000	76.87	50	1.08	0.7
2001	82.24	50	1.15	0.7
2002	87.01	50	1.22	0.7

Year	Greenhouse Gas			
	CH ₄		NMVOC	
	kt	%	kt	%
2003	92.81	50	1.30	0.7
2004	98.01	50	1.37	0.7
2005	102.60	50	1.44	0.7
2006	104.65	50	1.47	0.7
2007	111.38	50	1.56	0.7
2008	114.53	50	1.60	0.7
2009	118.82	50	1.66	0.7
2010	123.56	50	1.73	0.7
2011	102.24	50	1.43	0.7
2012	127.15	50	1.78	0.7
2013*	132.30	50	1.85	0.7

9.1.4.1.2 *Uncertainties and time-series consistency*

The *uncertainties are presented in the relevant Section 7.2.3. from Chapter 7.*

9.2 Indirect CO₂ and nitrous oxide emissions

Under paragraph 29 of the UNFCCC Inventory Reporting Guidelines, Romania did not choose to report indirect CO₂ emissions from the atmospheric oxidation of CH₄, CO and NMVOCs, or indirect N₂O emissions arising from sources other than those in the agriculture and LULUCF sectors.

10 Recalculations and improvements

This chapter presents the changes in GHG emissions/removals between the version 2.1 of the 2014 Greenhouse Gas Inventory submission and 2015 Greenhouse Gas Inventory submission. Since the 2014 version 2.1 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 2014 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 2014 NGHGI, are presented in Table 10.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS Please tick where the latest NIR includes major changes in methodological descriptions compared to the previous year NIR	RECALCULATIONS Please tick where this is also reflected in recalculations compared to the previous year CRF	REFERENCE 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	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters 3.2.4 and 3.2.5. from the NIR.
2. Manufacturing industries and construction	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
			about each category is provided in chapters 3.2.4 and 3.2.6. from the NIR.
3. Transport	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters 3.2.7 from the NIR (Aviation, Railways, Navigation, Other Transportation). The major changes in methodological descriptions are associated to the Road Transport Subsector and to all gases; they are included in the NIR section 3.2.7.3.2.
4. Other sector	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
			3.2.4 and 3.2.8 from the NIR.
5. Other	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters 3.2.4 and 3.2.9 from the NIR.
B. Fugitive emissions from fuels			Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters 3.3 from the NIR.
1. Solid fuels			No changes associated to the emission factor or the activity data. The IPCC 2006 was implemented starting with 2012 inventory submissions.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
2. Oil and natural gas and other emissions from energy production			The IPCC 2006 was implemented starting with 2012 inventory submissions. Information about changes associated to the emission factor or updating of activity data is provided in chapters 3.3.2.5 from the NIR.
C. CO ₂ transport and storage			
2. Industrial processes and product use			
A. Mineral industry	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters 4.2.5 from the NIR.
B. Chemical industry	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor,

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
			updating of activity data. Detailed information about each category is provided in chapters 4.3.5 from the NIR.
C. Metal industry	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters 4.4.5 from the NIR.
D. Non-energy products from fuels and solvent use	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters 4.5.5 from the NIR.
E. Electronic industry			
F. Product uses as substitutes	√	√	Changes due to the beginning of use of IPCC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
for ODS			2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters 4.7.5 from the NIR.
G. Other product manufacture and use	√	√	Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data. Detailed information about each category is provided in chapters 4.8.5 from the NIR.
H. Other			
3. Agriculture			
A. Enteric fermentation	√		The major changes in methodological descriptions are associated to the Enteric fermentation Sector; they are included in the NIR section 5.2.2.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
B. Manure management	√		The major changes in methodological descriptions are associated to the Manure management Sector; they are included in the NIR section 5.3.2.
C. Rice cultivation	√		The major changes in methodological descriptions are associated to the Rice cultivation Sector; they are included in the NIR section 5.4.2.
D. Agricultural soils	√		The major changes in methodological descriptions are associated to the Agricultural soils Sector; they are included in the NIR section 5.5.2.
E. Prescribed burning of savannahs			
F. Field burning of agricultural	√		The major changes in methodological

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
residues			descriptions are associated to the Field burning Sector; they are included in the NIR section 5.7.2.
G. Liming			Based on applying reporting requirements (including also the use of IPCC 2006) the category is part of the GHG Inventory starting with the 2015 submission
H. Urea application			Based on applying reporting requirements (including also the use of IPCC 2006) the category is part of the GHG Inventory starting with the 2015 submission
I. Other carbon containing fertilisers			
J. Other			
4. Land use, land-use change			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
and forestry			
A. Forest land	√	√	Activity data was recalculated for entire time series due to change of land use assessment system. Time series also starts in 1970 (NIR section 6.4.5)
B. Cropland	√	√	Activity data was recalculated for entire time series due to change of land use assessment system. Time series also starts in 1970 (NIR section 6.5.5)
C. Grassland	√	√	Activity data was recalculated for entire time series due to change of land use assessment system. Time series also starts in 1970 (NIR section 6.6.5)
D. Wetlands	√	√	Activity data was recalculated for entire time series due to change of land use assessment

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
			system. Time series also starts in 1970 (NIR section 6.7.5)
E. Settlements	√	√	Activity data was recalculated for entire time series due to change of land use assessment system. Time series also starts in 1970 (NIR section 6.8.5)
F. Other land	√	√	Activity data was recalculated for entire time series due to change of land use assessment system. Time series also starts in 1970 (NIR section 6.9.5)
G. Harvested wood products	√	√	Current submission is the first when Romania submits estimates for HWP
H. Other	√	√	Activity data was recalculated for entire time series due to change of land use assessment system. Time series also starts in 1970 (NIR

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
			section 6.4.5)
5. Waste			
A. Solid waste disposal	√	√	Changes due to the beginning of use of IPCC 2006, updating of activity data. Detailed information about each category is provided in chapters 7.2.5 from the NIR.
B. Biological treatment of solid waste			
C. Incineration and open burning of waste			
D. Wastewater treatment and discharge	√	√	Changes due to the beginning of use of IPCC 2006, updating of activity data. Detailed information about each category is provided in chapters 7.5.5 from the NIR.
E. Other			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological 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
6. Other (as specified in Summary 1.A)			
KP LULUCF			
Article 3.3 activities			
Afforestation/reforestation			
Deforestation			
Article 3.4 activities			
Forest management		√	Recalculations only affect forest management estimates where area subject to forest management increased by 10% following rigorous implementation of forest definition by new land assessment method.
Cropland management (if elected)			
Grazing land management (if			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
		Please tick where the latest NIR includes major changes in methodological descriptions compared to the previous year NIR	Please tick where this is also reflected in recalculations compared to the previous year CRF
elected)			
Revegetation (if elected)			
Wetland drainage and rewetting (if elected)			
NIR Chapter	DESCRIPTION		REFERENCE
	Please tick where the latest NIR includes major changes in descriptions compared to the previous year NIR		If ticked please provide some more 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 in response to the review process and for KP-LULUCF activities

10.1.1 GHG Inventory

Recalculations by categories

The inventory contains improvements in the following sectors:

Energy

➤ **Energy sector – stationary combustion**

There are recalculations, by some Energy stationary combustion activity categories, on the entire 1989-2012 time-series, such as follows:

Activity Data

- Energy Balances corrections.

Emission factors

- The default carbon content and CO₂, CH₄ and N₂O emission factors were used in accordance with the values provided through the IPCC 2006 GL;
- For the fuels not having carbon content or CO₂ emission factors country specific determined values, a full oxidation during combustion were assumed, as it is recommended through the IPCC 2006 GL.

For the specific categories, the following recalculations due to the Energy Balances corrections were performed:

➤ **Public Electricity and Heat Production (1.A.1.a)**

Liquid Fuels

Activity data

- *Residual Fuel Oil*: Own Use in Electricity, CHP and Heat Plants, 2001 year - Energy Balance activity data correction.

➤ **Petroleum Refineries (1.A.1.b)**

Liquid Fuels

Activity data

- *Residual fuel oil* on 2005 year Energy Balance activity data correction.

➤ **Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c)**

Liquid fuels

Activity data

- *Transport diesel*: 1990, 1991 years - Energy Balance activity data correction;

➤ **Manufacturing Industries and Construction, Chemicals (1.A.2.c)**

Liquid Fuels

Activity data

- *Residual fuel oil*: 2005 - Energy Balance activity data correction.

Energy Transport

➤ **Civil aviation/Liquid fuels (1.A.3.a)**

- recalculations for the 1989 – 2012 period due to changes methodology, update of value emission factors for fuel consumption.

➤ **Road Transportation/Liquid fuels (1.A.3.b)**

Motor Gasoline

- recalculation for the period 2005-2012 may be due to updated the model Copert 4 version 9 to version 11;
- the recalculations resulted and as a result to the changed methodology from the IPCC 1996 GL to the IPCC 2006 GL.

Diesel Oil

- recalculation for the period 2005-2012 may be due to updated the model Copert 4 version 9 to version 11;

- the recalculations resulted and as a result to the changed methodology from the IPCC 1996 GL to the IPCC 2006 GL.

LPG

- recalculation for the period 2005-2012 may be due to updated the model Copert 4 version 9 to version 11;
- the recalculations resulted and as a result to the changed methodology from the IPCC 1996 GL to the IPCC 2006 GL.

Heating and Other Gasoil

- recalculations for 1993–2009 time-series: level of CO₂, CH₄ and N₂O emissions, the fuel consumption of the Heating and Other Gasoil from the Energy Balance was added;

Railways (1.A.3.c)

- recalculations for the 1989 – 2012 period due to changes methodology, update of value of Net Calorific Value (NCV) and emission factors for fuel consumption.

Navigation (1A.3.d)

➤ **Navigation/Liquid fuels (1.A.3.d)**

- recalculations for the 1989 – 2012 period due to changes methodology, update of value of Net Calorific Value (NCV) and emission factors for fuel consumption.

➤ **Other Transportation (please specify) (1.A.3.e)**

- recalculations for the 1989 – 2012 period due to changes methodology, update of value of Net Calorific Value (NCV) and emission factors for fuel consumption.

➤ **Other (Not specified elsewhere), Stationary (1.A.5.a)**

Liquid Fuels

Activity data

- Residual fuel oil: Non-specified (Other), 2005 year - Energy Balance activity data correction. For more details and effect of the activity data changes on the emission estimations, see the Chapter 3.2.4.5.

➤ **Reference Approach (1.AB)**

Liquid Fuels

Activity data

- Motor Gasoline: Non-Energy Use in Industry, 2006-2012 period, Energy Balance activity data correction;
- Kerosene Type Jet Fuel: Non-Energy Use in Industry, 2008-2011 period - Energy Balance activity data correction;
- Transport Diesel: Non-Energy Use in Industry Sector, 2006-2012 period - Energy Balance activity data correction;
- Naphta: Non-Energy Use in Industry, 2007–2012 period - Energy Balance activity data correction;
- Other kerosene: Non-Energy Use in Industry, 2007, 2008, 2011, 2012 years - Energy Balance activity data correction;
- LPG - Non-Energy Use in Industry, 2006-2012 period - Energy Balance activity data correction;
- Residual Fuel Oil - Non-Energy Use in Industry, 2006-2012 period - Energy Balance activity data correction;
- Other pertroleum products - Non-Energy Use in Industry, 2005-2012 period - Energy Balance activity data correction.

Oxidation factors

- the full oxidation was assumed for all reported fuels, as it is provided through the IPCC 2006 GL;

Emission factors

- for the fuels not having determined country specific values, the default carbon content provided through the IPCC 2006 GL – Vol. 2.1, Chapter 1, are used.

➤ **Feedstocks and non-energy use of fuels (1.AD)**

Liquid Fuels

Activity data

The energy Balance operated some modification in the non-energy use of the fuels and transferred the corresponding quantities in the energy use, transformation sector.

- Motor Gasoline: Non-Energy Use in Industry, 2006-2012 period, Energy Balance activity data correction;
- Kerosene Type Jet Fuel: Non-Energy Use in Industry, 2008-2011 period - Energy Balance activity data correction;
- Transport Diesel: Non-Energy Use in Industry Sector, 2006-2012 period - Energy Balance activity data correction;
- Naphta: Non-Energy Use in Industry, 2007–2012 period - Energy Balance activity data correction;
- Other kerosene: Non-Energy Use in Industry, 2007, 2008, 2011, 2012 years - Energy Balance activity data correction;
- LPG - Non-Energy Use in Industry, 2006-2012 period - Energy Balance activity data correction;
- Residual Fuel Oil - Non-Energy Use in Industry, 2006-2012 period - Energy Balance activity data correction;
- Other petroleum products - Non-Energy Use in Industry, 2005-2012 period - Energy Balance activity data correction.

➤ **Fugitive Emissions from Oil and Natural Gas (1.B.2.)**

Oil

- recalculation in the Refining /Storage (1 B 2 a iii 4): have been updated due to the calculating the CO₂ emissions;

Natural Gas

- recalculation in the Transmission and Storage (1B2b iii 4) and Distribution (1B2b iii5): the activity data values and emission factors have been updated due to the update of the associated domain in the IPCC 2006.

International Transport –Bunkers (1.D.1)➤ **Aviation (1.D.1.a)**

- recalculations for the 1989 – 2012 period due to changes methodology, update of value emission factors for fuel consumption.

➤ **Marine (1.D.1.b)**

- recalculations for the 1989 – 2012 period due to changes methodology, update of value of Net Calorific Value (NCV) and emission factors for fuel consumption.

Industrial Processes and Product Use

- Changes due to the beginning of use of IPCC 2006, changes associated to the emission factor, updating of activity data;
- Recalculations for all-time series 1989-2012 were made as a result of improved activity data on lime production and emission factors (2.A.2);
- The recalculations have been made due to improved activity data on production of glass of the entire time series. The recalculations of the emissions afferent to the glass production are based on use of IPCC 2006 emission factors, the activity data corrected and the correction factors for the cullet (2.A.3);
- Recalculation have been made for all-time series 1989-2012. The CO₂ emissions from limestone and dolomite consumption in the iron and steel production are reported under 2.C.1 Iron and steel production category therefore was corrected in Other Process Uses of Carbonates category by subtracting the amount of limestone used in this sector. It is considered that lime production activity in sugar factories as an activity neutral in terms of emissions and therefore was corrected in Other Process Uses of Carbonates category by subtracting the amount of limestone used in this sector (2.A.4);
- Recalculation have been made for all-time series 1989-2012. Recalculations were made as a result of due to the change in the formula CO₂ emissions, taking into account CO₂ emissions going to produce urea. Ammonia Production (IPCC category 2.B.1);
- Recalculation have been made for all-time series 1989-2012. The recalculations have been made due to improved activity data and emission factors on production of nitric acid of the entire time series (2.B.2);

- Recalculation have been made for all-time series 1989-2012. Recalculations were made as a result of due to the change in the formula CO₂ emissions. The emissions from the CaO step are reported as emissions from lime production and are included in Lime production category (2.B.5.b fost 2.B.4.2);
- Recalculation have been made all-time series 1989-2012. The 2006 IPCC GL methodology provides formulas for calculating CO₂ emissions and new emission factors for CH₄ (2.B.8);
- Recalculation have been made for all-time series 1989-2012. Recalculations were made as a result of due to the changes in methodology for estimating of CO₂ and CH₄ emissions from iron and steel production, activity data and emission factors (2.C.1);
- Recalculation have been made for all-time series 1989-2012. Recalculations were made as a result of due to the changes of emission factors and the introduction of a method for estimating CH₄ emissions (2.C.2);
- Recalculation have been made for all-time series 1989-2012. Recalculations were made as a result of due to the change of values of global warming potentials for PFCs (2.C.3);
- Recalculation have been made for all-time series 1989-2012. Recalculations were made as a result of due to the changes in activity data for solvent use (2.D.3.a);
- Recalculation of the HFC, PFC and SF₆ emission estimates is performed for the full time series following a methodological change (change GWP and EF) (2.F.1-2.F.4);
- Recalculation of the HFC emission estimates is performed for the 2010-2012 period. Recalculations were made as a result of improved activity data (2.F.2);
- Recalculation of the SF₆ emission estimates is performed for the full time series following a methodological change (change GWP) and change of EF (2.G.1).

Agriculture

➤ **Enteric fermentation (3A)**

Method:

- Tier 2 calculation methods were used for all livestock for estimating CH₄ emissions and 1989-2013 period in according with IPCC 2006.

Emission factor:

- Update of the emission factor according to the new methodology IPCC 2006.

➤ **Manure management (3.B.1)**

Method:

- Tier 2 calculation methods were used for all livestock for estimating CH₄ emissions and 1989-2013 period in according with IPCC 2006.

Emission factor:

- Update of the emission factor according to the new methodology IPCC 2006.

➤ **Manure management (3.B.2)**

Emission factor:

- Update of the emission factor according to the new methodology IPCC 2006.

➤ **Rice cultivation (3.C)**

Multiple aeration (3.C.1.2.2)

Activity data:

- New information/data on cultivation period were considered by opinion expert.

Methods:

- Tier 1 calculation method began to be used for estimating CH₄ emissions in 1989-2013 period in according with IPCC 2006.

➤ **Managed soils (3.D)**

Direct N₂O emissions (3.D.1.2)

Activity data:

- New information/data activity were considered due to the change of the methodology.

A combination of national and default values for the fractions associated with the crop productions in the context of using a Tier 1 method was used for 1989-2013 period in IPCC 2006.

Methods:

- Tier 1 calculation method began to be used for estimating Direct N₂O emissions in 1989-2013 period in according with IPCC 2006.

Emission factor:

- Update of the emission factor according to the new methodology IPCC 2006.

Indirect N₂O emissions (3.D.2)**Atmospheric deposition (3.D.2.1)****Methods:**

- Tier 1 calculation method began to be used in according with IPCC 2006.

Nitrogen Leaching and Run-off (3.D.2.2)**Methods:**

- Tier 1 calculation method began to be used in according with IPCC 2006.

Emission factor:

- Update of the emission factor according to the new methodology IPCC 2006.

➤ Field burning of Agricultural Residues (3.F)**Activity data:**

- New information/data activity were considered due to the change of the methodology.

Methods:

- Tier 1 calculation method began to be used in according with IPCC 2006.

Emission factor:

- Update of the emission factor according to the new methodology IPCC 2006.

LULUCF

Activity data was recalculated for entire time series for all land use categories due to change of land use assessment system. For the purpose of the national GHG inventory a new reporting system is being put in place starting 2014 (estimates included in submission 2015, for the first time). The system relies on National Forest Inventory grid to cover entire country territory, all land use categories with a time series which starts in 1970 (see Land representation sub-chapter under LULUCF). Recalculations are still expected for the 2017 until the new time series will be finalized. Recalculations affect more emissions or removals from land conversions. Overall

recalculation effect for the annual LULUCF sink is on average -2% smaller than previous estimates.

A new methodology was also implied to determine the total organic soils area under cultivation all non-forest land categories (detailed under Cropland).

The change of C stock in living biomass was determined based on the data and information from two research projects:

- 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 Management and Planning 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 Management and Planning 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.
- 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 240 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 the 3 main types of plantations. Equations of the C stocks/biomass were obtained with non-linear processing following Richard-Chapman models functions.

The data collected allows a Tier 3 estimation of C stock change in living biomass for AR land under 4.A.2 Land converted to Forest Land. Average net annual removals in all pools in JI project was 7.4tCO₂/year since the project beginning.

Based on detailed information from the JI project, while also confirmed by 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.

Data available from the JI project is used to report estimates of C stock change in litter pool (which is an annually increasing sink) while dead wood pool is negligible (from same projects mentioned above 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⁻¹yr⁻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.

Activity data was recalculated for entire time series due to change of land use assessment system. New data also starts in 1970. Recalculations are expected for the following two years until the time series will be finalized. This cause change of both AD and net emission/removals.

The reasons for recalculation were:

- New data from 1st NFI cycle for reporting living biomass for the category "Forest Land remaining Forest Land". National Forest Inventory 2008 - 2013 annual increment is higher than values from forest inventory 1984, which are still used in the current submission. Once data from 2nd NFI becomes available the stock change method is planned with the second NFI cycle (meantime methodological work is underway).
- Harvest statistics remained unchanged.
- New estimates of CO₂ and N₂O emissions from drained organic soils.
- The current submission includes emissions/removals updated estimates of CO₂ removals by the JI project according to the most recent estimation as part the project verification for 2008-2013 (JI is included under AR, with individual estimates of area and emission/removals in the CRF tables). Estimates associated to JI are only reported for 2013 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.

Waste

➤ **Managed Waste Disposal on Land (5.A.1)**

- CH₄ emissions were recalculated for 2012 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 2012 was updated based on annual statistical survey made by Waste directorate of NEPA.

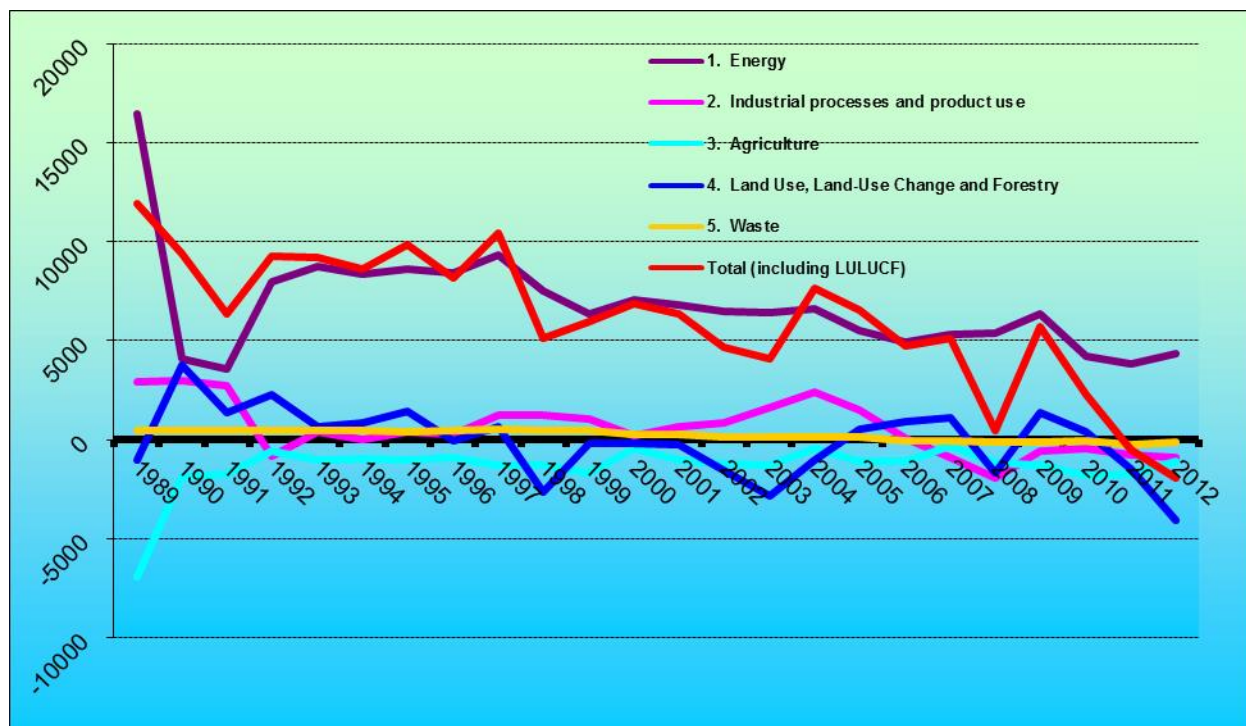
➤ **Unmanaged Waste Disposal on Land (5.A.2)**

- CH₄ emissions were recalculated for 2012 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 2012 was updated based on annual statistical survey made by Waste directorate of NEPA.

➤ **Wastewater treatment and discharge (5.D)**

- the CH₄ emissions from domestic and commercial wastewater were recalculated for 1989-2013 recalculation have been made. In previous submissions, emissions for wastewater and sludge removed from wastewater have been calculated separately. IPCC 2006 have removed this distinction.

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 2014 version 2.1 report



Recalculations by gases

CO₂ recalculations were carried out in the following sectors:

- Domestic Aviation (1.A.3.a);
- Road Transport (1.A.3.b);
- Railways (1.A.3.c);
- Domestic Navigation (1.A.3.d);
- Other Transportation (1.A.3.e);
- Refining/Storage (1.B.2.A);
- Transmission/Storage (1.B.2.B);
- Distribution (1.B.2.B);
- International Transport –Bunkers (1.D.1);
- Lime production (2.A.2);
- Glass Production (2.A.3);

- Other Process Uses of Carbonates (2.A.4);
- Ammonia Production (2.B.1);
- Carbide Production (2.B.5.b);
- Petrochemical and Carbon Black Production (2.B.8);
- Iron and Steel Production (2.C.1);
- Solvent Use (2.D.3.a);
- Forest Land (4.A);
- Cropland (4.B);
- Grassland (4.C);
- Wetlands (4.D);
- Settlements (4.E);
- Other Lands (4.F);
- Other (4G)

CH₄/N₂O recalculations were carried out in the following sectors:

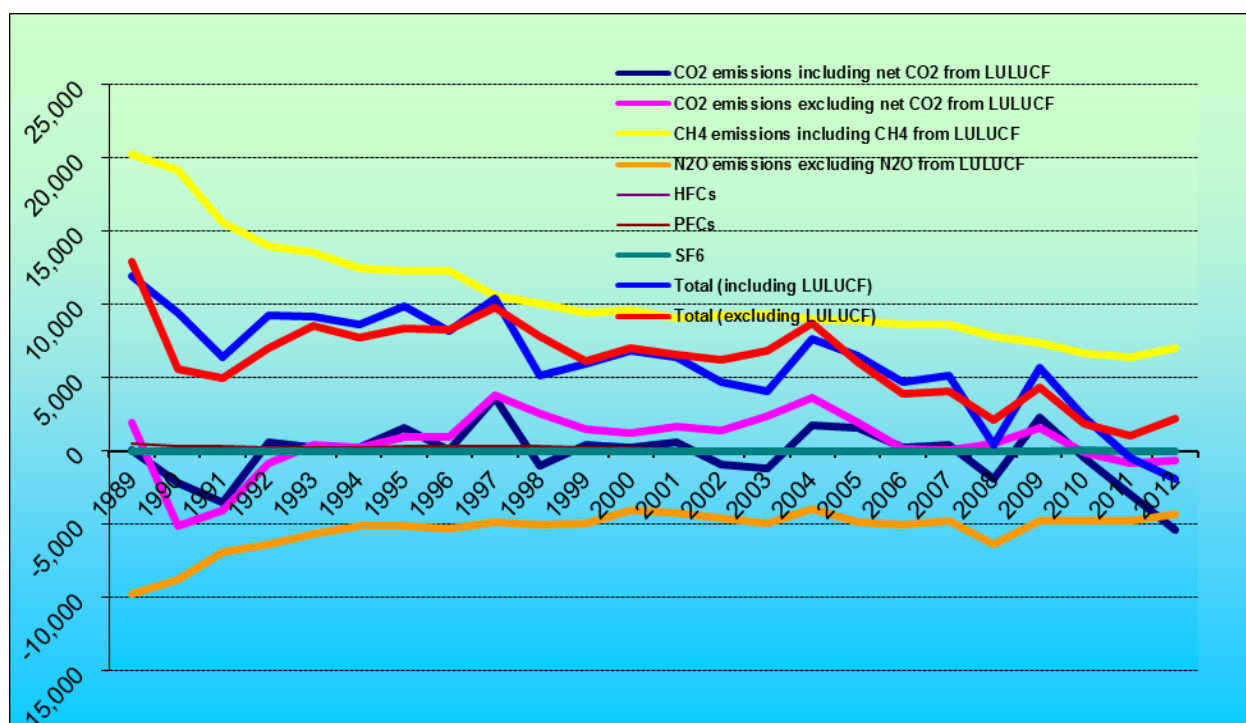
- Domestic Aviation (1.A.3.a);
- Road Transport (1.A.3.b);
- Railways (1.A.3.c);
- Domestic Navigation (1.A.3.d);
- Other Transportation (1.A.3.e);
- Transmission/Storage (1.B.2.B);
- Distribution (1.B.2.B);
- International Transport –Bunkers (1.D.1);
- Nitric Acid Production (2.B.2);
- Petrochemical and Carbon Black Production (2.B.8);
- Iron and Steel Production (2.C.1);
- Ferroalloys Production (2.C.2);
- Enteric fermentation (3A);
- Manure management -CH₄ (3.B.1);
- Manure management -N₂O (3.B.2);

- Rice cultivation-CH₄ (3.C);
- Managed soils – N₂O (3.D);
- Forest Land (4.A);
- Cropland (4.B);
- Grassland (4.C);
- Wetlands (4.D);
- Settlements (4.E);
- Solid Waste Disposal (5.A);
- Wastewater Handling (5.D.1.).

HFC/PFC/SF₆ recalculations were carried out in the following sectors:

- Aluminium Production (2.C.3);
- Refrigeration and Air-Conditioning (2.F.1);
- Foam blowing (2.F.2);
- Fire Protection (2.F.3);
- Aerosols / Metered dose inhalers (2.F.4);
- Electrical Equipment (2.G.1).

Figure 10.2 Category total emissions/removals change, for all gases, and for the entire time series, in comparison to the figures in the 2014 version 2.1 submission



10.1.2 KP-LULUCF inventory

Recalculations by categories

Recalculations only affect forest management estimates where area subject to forest management increased by 10% following rigorous implementation of forest definition by new land assessment method.

Recalculations by gases

CO₂ recalculations were carried out in the following sectors:

- Forest Management (KP.B.1);

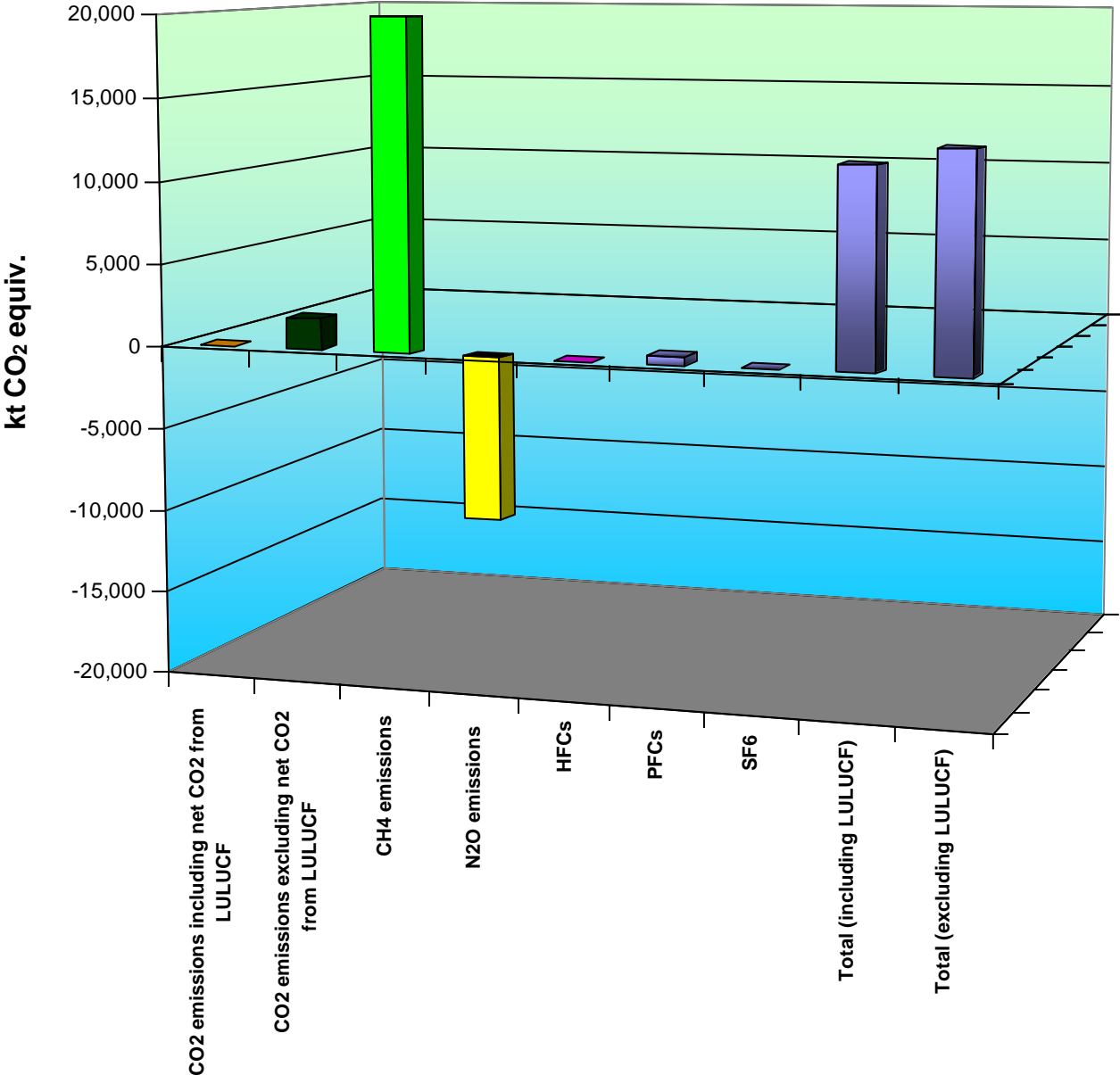
10.2 Implications for emissions levels, including on KP-LULUCF emissions levels

10.2.1 GHG inventory

Emissions changes due to recalculations, for 1989 are as follows:

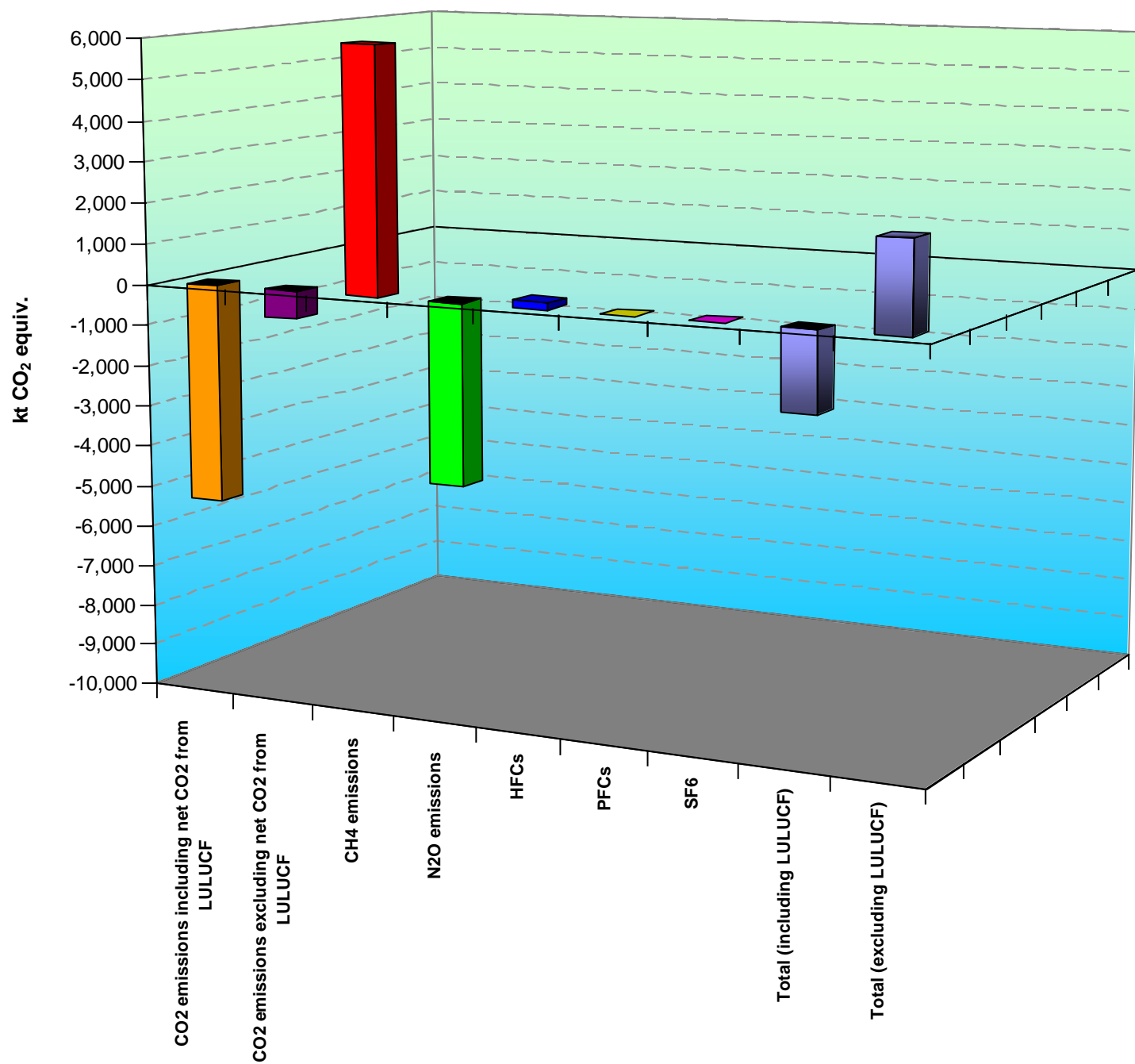
- CO₂ including LULUCF (0.02%), CO₂ excluding LULUCF (0.92%);
- CH₄ (43.46%);
- N₂O including LULUCF (-31.67%); N₂O excluding LULUCF (-34.61%);
- HFC (10.00%);
- PFC (16.04%)
- SF₆ (24.01%);
- Total GHG including LULUCF (4.41%);
- Total GHG excluding LULUCF (4.54%).

Figure 10.3 Effects of recalculations (presented in the 2015 submission) for 1989, by gas



Emissions changes due to recalculations, for 2012, are as follows:

- CO₂ including LULUCF (-8.48%), CO₂ excluding LULUCF (-0.81%);
- CH₄ including LULUCF (31.62%), CH₄ excluding LULUCF (31.73%);
- N₂O including LULUCF (-32.26%); N₂O excluding LULUCF (-37.59%);
- HFC (15.88%);
- PFC (16.42%);
- SF₆ (24.44%);
- Total GHG including LULUCF (-1.95%);
- Total GHG excluding LULUCF (1.84%).

Figure 10.4 Effects of recalculations (presented in the 2015 submission) for 2012, by gas

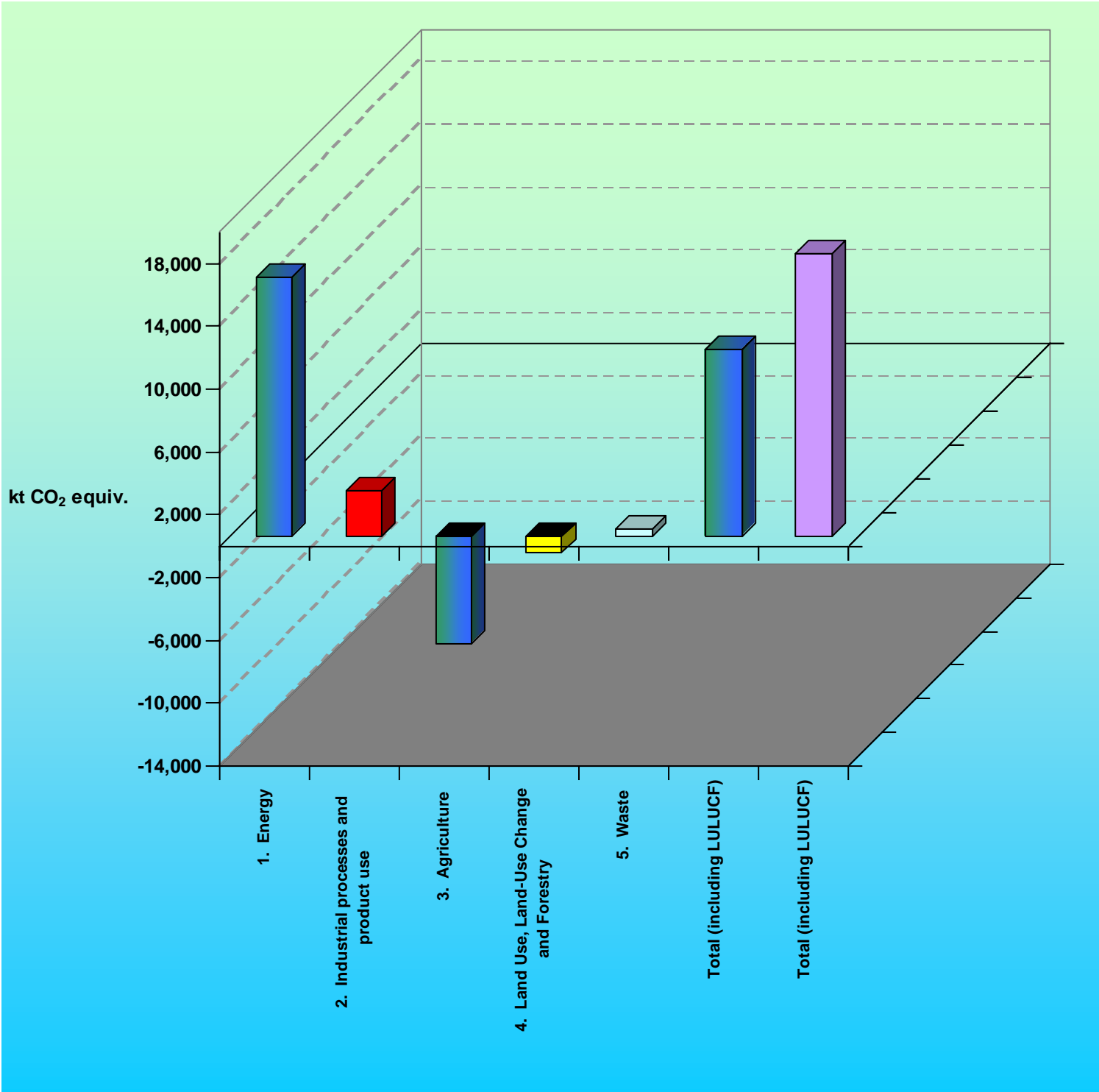
Impacts on 1989 emissions levels

Total emissions in 1989 including LULUCF have increased with 4.41% compared to the 2014 version 2.1 submission.

Table 10.2 Recalculation of total emissions/removals, by sector, for all gases, for 1989

Differences for 1989 estimates	Differences		2015 v. 1	2014 v. 2.1
	kt CO ₂ eq.	%	kt CO ₂ eq.	kt CO ₂ eq.
1. Energy	16,463.56	8.09	220,008.16	203,544.60
2. Industrial Processes and Product Use	2,903.79	8.04	39,016.24	35,466.64
3. Agriculture	-6,900.55	-16.93	33,858.48	40,759.03
4. Land Use, Land-Use Change and Forestry	-1,051.61	6.89	-16,315.63	-15,264.02
5. Waste	479.10	10.29	5,135.66	4,656.56
Total (including LULUCF)	11,894.29	4.41	281,702.91	269,808.62

Figure 10.5 Changes of 1989 emissions/removals, in respect to the 2015 figures

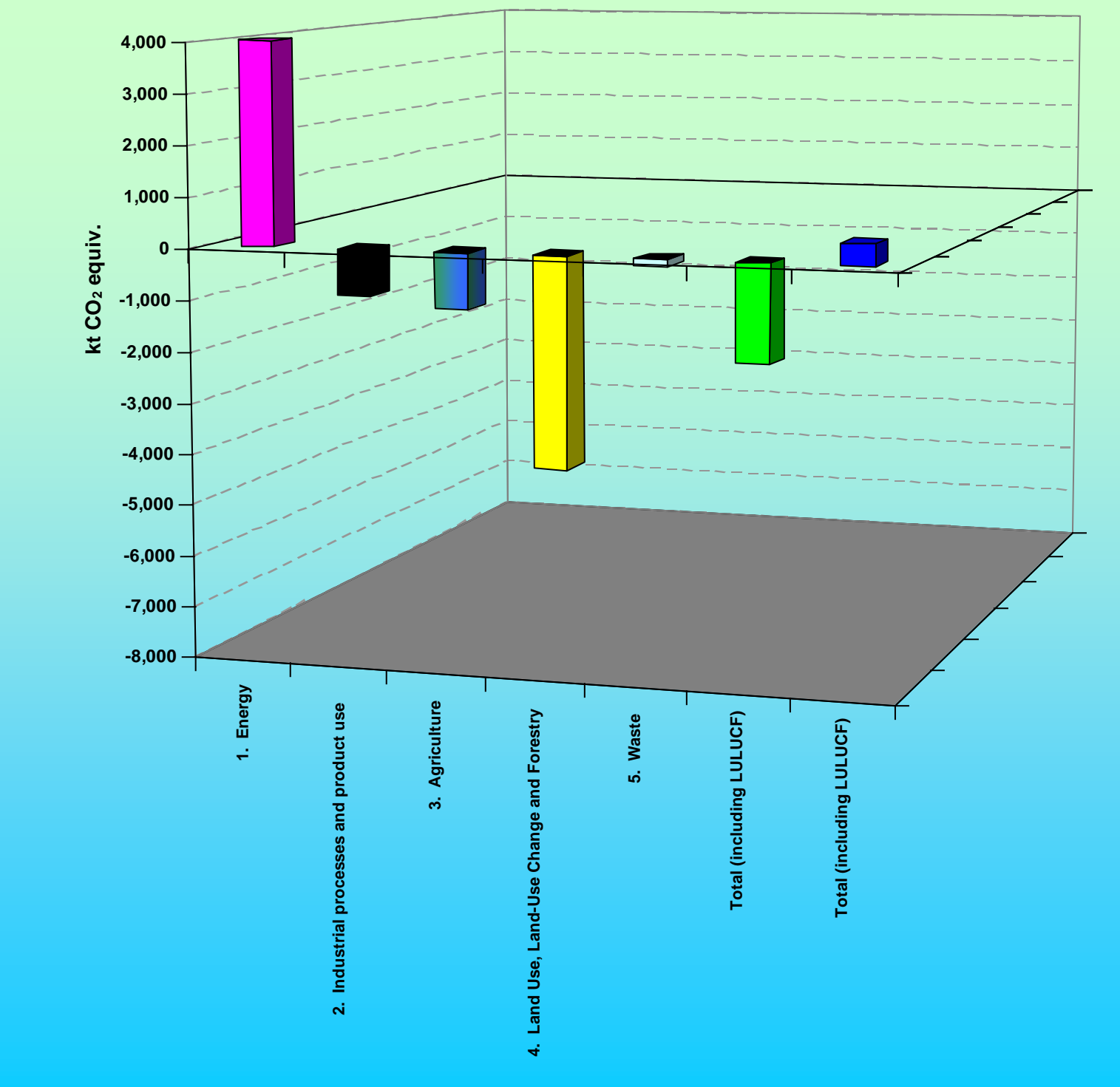


Total emissions in 2012, including LULUCF have decreased by 1.95% compared to the 2014 submission Version 2.1.

Table 10.3 Recalculation of total emissions/removals, by sector, for all gases, for 2012

Differences for 2012 estimates	Differences		2015 v.1	2014 v.2.1
	kt CO ₂ eq.	%	kt CO ₂ eq.	kt CO ₂ eq.
1. Energy	4,326.23	5.26	86,548.74	82,222.51
2. Industrial Processes and Product Use	-905.47	-7.24	11,600.67	12,506.13
3. Agriculture	-1,097.65	-6.03	17,113.17	18,210.82
4. Land Use, Land-Use Change and Forestry	-4,102.48	20.00	-24,618.69	-20,516.21
5. Waste	-135.04	-2.31	5,714.54	5,849.58
Total (including LULUCF)	-1,914.40	-1.95	96,358.43	98,272.83

Figure 10.6 Changes of 2011 emissions/removals, in respect to the 2015 figures



10.2.2 KP-LULUCF inventory

Emissions changes due to recalculations, as follows:

- Recalculations only affect forest management estimates where area subject to forest management increased by 10% following rigorous implementation of forest definition by new land assessment method.

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 Planned improvements, including in response to the review process and 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	<i>Activity Data:</i>

No.	Category subject to improvement	Description of improvement
	(CRF 1.A)	<p>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. ISPE Study provided an analysis regarding the share of EU-ETS reporting to the Energy Balance. A further analysis on the EU-ETS reporting, 2012, 2013, 2014 years it is planned to be conducted in order to take into consideration the ETS emissions, as Tier 3 approach, on the activity category where these operators have to report.</p> <p><i>Emission Factors:</i></p> <p>Further to the recommendation of the ispe Study regarding the annually usage of the National Emission Factors, and following the procedure provided by this document (or, as an object of further Study), it is planned the determination of the emission factors resulting from the EU-ETS annually operators reporting.</p>
2	Public Electricity And Heat Production (CRF 1.A.1.a)	<p>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 CO₂ emissions. See the chapter 3.2.4.6 for more details.</p>

No.	Category subject to improvement	Description of improvement
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 higher tier approach in the estimation of the CO ₂ emissions. See the chapter 3.2.4.6 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 higher tier approach in the estimation of the CO ₂ emissions. See the chapter 3.2.4.6 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 higher tier approach in the estimation of the CO ₂ emissions. See the chapter 3.2.4.6 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 higher tier approach in the estimation of the CO ₂ emissions. See the chapter 3.2.4.6 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 higher tier approach in the estimation of the CO ₂ emissions.

No.	Category subject to improvement	Description of improvement
		See the chapter 3.2.4.6 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 higher tier approach in the estimation of the CO ₂ emissions. See the chapter 3.2.4.6 for more details.
9	Fuel combustion, Manufacturing Industries and Construction, Non-metallic minerals (CRF 1.A.2.g.)	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 3.2.4.6 for more details.
10	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 higher tier approach in the estimation of the CO ₂ emissions. <i>See the chapter 3.2.4.6 for more details.</i>
11	Transport- Civil aviation (CRF 1.A.3.a)	<i>It is planned further co-operation with Ministry of Transport in order to have a fully correspondence concerning the quantities of the fuels.</i>
12	Transport – Railways (CRF 1.A.3.c)	It is planned further co-operation with Ministry of Transport 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 Ministry of Transport in order to have a fully

No.	Category subject to improvement	Description of improvement
		correspondence concerning the quantities of the fuels.
14	Transport - Other Transportation (CRF 1.A.3.e)	It is planned further co-operation Ministry of Transport 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 3.2.4.6 for more details.
16	Fuel combustion, Other Sectors – Residential (CRF 1.A.4.b)	See the chapter 3.2.4.6 for more details.
17	Fuel combustion, Other Sectors – Agriculture / Forestry / Fisheries (CRF 1.A.4.c)	See the chapter 3.2.4.6 for more details.
18	Fuel combustion, Other (Not specified elsewhere) – Stationary (CRF 1.A.5.a)	See the chapter 3.2.4.6 for more details.
Industrial Processes		
1	All categories	Will need investment of resources to address changes to be compliant with IPCC 2006.
Agriculture		
1	Source category Enteric Fermentation (CRF source category 3.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 3.B)	<i>Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters</i>

No.	Category subject to improvement	Description of improvement
		<p><i>relevant to significant species, are envisaged:</i></p> <p><i>ash content of the manure (ASH);</i></p> <p><i>maximum CH₄ producing capacity for manure produced by an animal within defined population (B₀);</i></p> <p><i>CH₄ conversion factors for each manure management system by climate region (MCF).</i></p>
3	Source category Rice Cultivation (CRF source category 3.C)	In respect to the IPCC 2006 provisions, more detailed data on rice cultivation techniques used are proposed to be obtained.
4	Source category Agricultural soils (CRF source category 3.D)	<p>Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species, are envisaged:</p> <p>fraction that volatilizes as NH₃ and NO_x, specific to synthetic fertilizers nitrogen adjusted for volatilization (Frac_{GASF});</p> <p>fraction that volatilizes as NH₃ and NO_x, specific to animal manure nitrogen used as fertilizer, adjusted for volatilization (Frac_{GASM});</p> <p>national values for activity data in totality;</p> <p>fraction of N input that is lost through leaching and runoff (Frac_{LEACH}).</p>
5	Source category Field Burning of Agricultural Residues (CRF source category 3.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.
6	Source category Liming	Aiming to their incorporation into next

No.	Category subject to improvement	Description of improvement
	(CRF source category 3.G)	inventory submissions, the development of national values for activity data in totality.
7	Source category Urea application (CRF source category 3.H)	Aiming to their incorporation into next inventory submissions, the development of national values for activity data in totality.
Waste		
1	Source category Solid Waste Disposal (CRF sector 5.A)	In order to improve the next submission, we will try to obtain more detailed data in respect to IPCC 2006.
2	Source category Waste Incineration and Open Burning of Waste (CRF sector 5.C)	In order to improve the next submission, we will try to obtain more detailed data in respect to IPCC 2006..
3	Source category Wastewater Treatment and Discharge (CRF sector 5.D)	In order to improve the next submissions, we will include the parameters/emission factors associated on sludge that result from industrial wastewater treatment.
LULUCF		
1	Forest Land (CRF sector 4.A.)	First, activity data is subject to major improvement starting year 2014. Improvement is ongoing on land use assessment system for all land categories and C stock change in biomass. The shift consists in the use of all relevant land spatial databases available in the country, as mentioned under chapter 1.3. Development of the entire time series since 1970 for land matrix is expected to finish in 2016, including quality assurance and quality control. The project is financed on annual basis by the Ministry of Environment, Forests and Waters and

No.	Category subject to improvement	Description of improvement
		<p>implemented by Forest Research Management and Planning Institute with various partners.</p> <p>Second, C stock change data is also under improvement. With the availability of data from second NFI cycle it is endeavoured a shift to stock change method to estimate the change in living biomass. Although new annual increment data is available from NFI1, harvest data is still only available from the National Statistics (which seems much underestimated). For this reason current gain-loss method would be replaced by stock change entirely based on NFI data, likely starting submission in 2017.</p> <p>New approach will also ensure implementation of all requirements from 2/CM7 (e.g. plantations replacing natural forests) and 2006 Guidelines (e.g. use of different biomass growth rates for forests naturally re-growing on abandoned lands and for forest plantations).</p>
2	Cropland (CRF sector 4.B.)	<p>For the estimation of C stock changes in soils of land “remaining croplands” there is an improvement plan available, related to the development of national system to respond accounting requirements set in decision 529/2013UE. According to this decision a reporting to European Commission on the national estimating system for cropland management and grazing land management is due annually for 2016-2018 while provide</p>

No.	Category subject to improvement	Description of improvement
		preliminary estimates before 2022 and final estimates in the final deadline in 2022.
3	Grassland (CRF sector 4.C.)	For the estimation of C stock changes in soils of land “remaining grasslands” there is an improvement plan available, related to the development of national system to respond accounting requirements set in decision 529/2013UE. According to this decision a reporting to European Commission on the national estimating system for cropland management and grazingland management is due annually for 2016-2018 while provide preliminary estimates before 2022 and final estimates in the final deadline in 2022.
4	Wetlands (CRF sector 4D)	Improvements cover preparation to shift to post-2013 reporting requirements spelled out in GL 2006 and provisions of Wetland supplement 2013.
5	Settlements (CRF sector 4E)	Improvements under this land category are related to the targets assumed for the other land categories and expected under the same schedule (submission of 2015). Reference C stock in the soils under settlements could be reanalyzed as well as the transition period to this category.
6	Harvested Wood Products (HWP) (CRF sector 4G)	Current approach is to build capacity to cover HWP, to better understand the estimation methodologies and requirements, as well as available data.

In response to the review process, recalculations were carried out as follows:

Activity data was recalculated for entire time series for all land use categories due to change of land use assessment system. For the purpose of the national GHG inventory a new reporting system is being put in place starting 2014 (estimates included in submission 2015, for the first time). The system relies on National Forest Inventory grid to cover entire country territory, all land use categories with a time series which starts in 1970 (see Land representation sub-chapter under LULUCF). Recalculations are still expected for the 2017 until the new time series will be finalized. Recalculations affect more emissions or removals from land conversions. Overall recalculation effect for the annual LULUCF sink is on average -2% smaller than previous estimates.

A new methodology was also implied to determine the total organic soils area under cultivation all non-forest land categories (detailed under Cropland).

The change of C stock in living biomass was determined based on the data and information from two research projects:

- 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 Management and Planning 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 Management and Planning 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.
- 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 240 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 the 3 main types of plantations. Equations of the C stocks/biomass were obtained with non-linear processing following Richard-Chapman models functions.

The data collected allows a Tier 3 estimation of C stock change in living biomass for AR land under 4.A.2 Land converted to Forest Land. Average net annual removals in all pools in JI project was 7.4tCO₂/year since the project beginning.

Based on detailed information from the JI project, while also confirmed by 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.

Data available from the JI project is used to report estimates of C stock change in litter pool (which is an annually increasing sink) while dead wood pool is negligible (from same projects mentioned above 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⁻¹yr⁻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.

Activity data was recalculated for entire time series due to change of land use assessment system. New data also starts in 1970. Recalculations are expected for the following two years until the time series will be finalized. This cause change of both AD and net emission/removals.

The reasons for recalculation were:

- New data from 1st NFI cycle for reporting living biomass for the category "Forest Land remaining Forest Land". National Forest Inventory 2008 - 2013 annual increment is higher than values from forest inventory 1984, which are still used in the current submission. Once data from 2nd NFI becomes available the stock change method is planned with the second NFI cycle (meantime methodological work is underway).
- Harvest statistics remained unchanged.
- New estimates of CO₂ and N₂O emissions from drained organic soils.

- The current submission includes emissions/removals updated estimates of CO₂ removals by the JI project according to the most recent estimation as part the project verification for 2008-2013 (JI is included under AR, with individual estimates of area and emission/removals in the CRF tables). Estimates associated to JI are only reported for 2013 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.

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	Recalculations only affect forest management estimates where area subject to forest management increased by 10% following rigorous implementation of forest definition by new land assessment method.

In response to the review process, recalculations were carried out as follows:

- recalculations only affect forest management estimates where area subject to forest management increased by 10% following rigorous implementation of forest definition by new land assessment method.

The implementation by Romania of recommendations and adjustments following the inventory review under UNFCCC, KP and Decision no. 406/2009/EC is described in Annex 6.10.

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11 Supplementary information to be submitted for the first annual GHG inventory according to decision 2/CMP8 (according to Table 2.4.1)

11.1 Information on methods and approaches to estimate emissions and removals

Identification of elected activities. Romania reports GHG emissions and CO₂ removals on afforestation/reforestation and deforestation (ARD), forest management (FM) and revegetation (Rv). The accounting will be done at the end of the commitment period (in the year 2022).

Forest management and Re-vegetation activities accounted in the first commitment period under the Kyoto Protocol continues to be accounted during the second commitment period. The land area reported and changes in land area subject to the various activities in the inventory year reported KP-LULUCF NIR-2 table.

How land activities are identified and tracked in time. Romania implements a spatially explicit statistical method for land classification and identification (Approach 3, Reporting Method 1) for area of forest management and deforestation, while for afforestation/reforestation and revegetation it implements forest authority historical records (Approach 3, Reporting method 2). Romania does not apply CEFC provision and does not count removal of natural forests by plantations.

11.2 Specific information for activities under Article 3, paragraphs 3 and 4

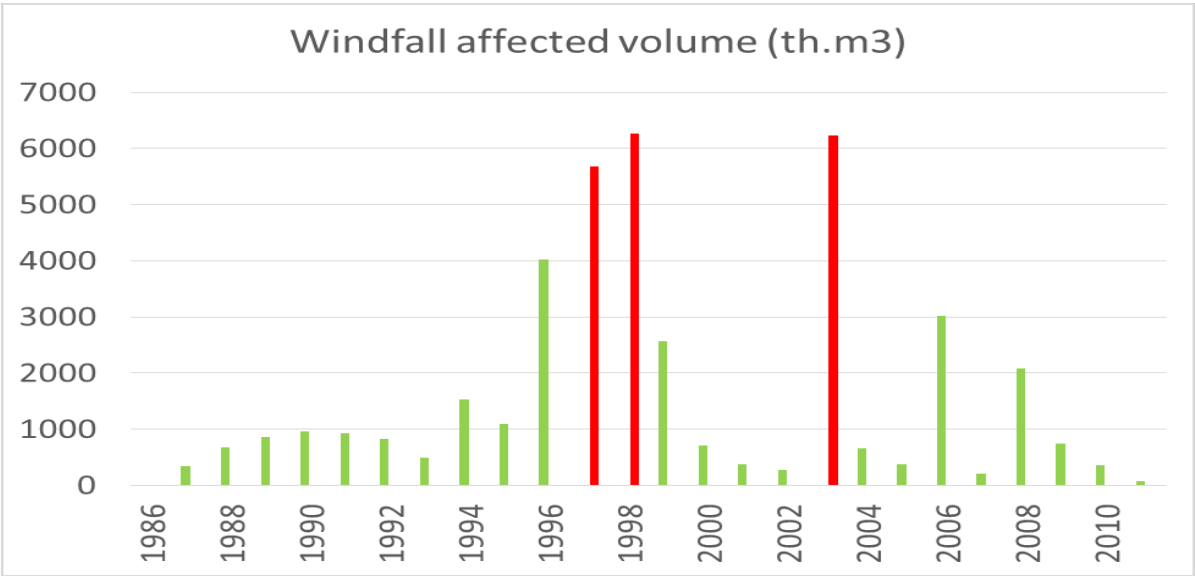
11.2.1 Definition of the forest and any other criteria

Area under forest management matches the area of forests, as defined by the forest parameters (canopy cover 10%, minimum area 0.25ha and tree height at maturity of 5m, as well as forest belts wider than 20 m).

11.2.2 Application of provision to exclude emissions from natural disturbance

Two types of disturbances are quantitatively relevant for forestland in Romania: wildfires and windfalls. Such events associated in the past with extreme intensity, e.g. over 1986-2010 there were 3 major windfalls (> 5.6mil.m3/year affected, which is more than 32% of total annual regular harvest).

Figure 11.1 Windfall blown down wood volume in Romania



For this reason Romania intends to apply the provisions to exclude emissions from natural disturbances for the accounting for afforestation and reforestation under Article 3, paragraph 3, of the Kyoto Protocol and for forest management under Article 3, paragraph 4, of the Kyoto Protocol, during the second commitment period. Assumption in the FMRL is that volume affected by disturbance was fully subject to salvage logging, an approach consistent between national GHG inventory and Forest Management (FM) activity estimates (i.e. fully included in the annual wood harvest reported by the National Statistics and included in the gain-loss). This assumption is now slightly revised, as resulted from a survey of professional foresters, in the sense that some 10 % of affected standing volume of large windfalls may not be actually harvested (e.g. left untouched in scattered forest small areas and because of inaccessibility).

A windfall is assumed large when annual estimated affected volume was above 5 mil. m³ (see previous figure). This is also supported by low level of damage, according forestry statistics more than 90% of affected area is graded as slightly damaged (e.g. low volume on large areas), which makes economically unattractive harvesting. Conservatively, estimates are now established for the background level, although investigations on actual biomass left in forests continue and the assumption will be also incorporated into FMRL's technical correction.

- 1) **background level.** Values (GgCO₂/yr) for the background levels for FM and AR are shown in the following table:

Table 11.1 Values for the the background levels for FM and AR

Parameter	FM value	AR value
Background level	66	0.20
Margin	61	0.22
Background level plus margin	188	0.64
Background group for windstorms/ Background group for wildfires Years excluded (outliers)	1986-2009/ 1986-2009/ 1997, 1998, 2002	-/ 1990-2009/ 1990, 1992, 2000, 2002

- 2) **information how background level was estimated**

Forest Management activity

GHG emissions from forest wildfire. Cumulative net emission from these sources is negligible, representing less than 1 % (~10GgCO₂eq/year, reported by national GHG inventory) of the annual net CO₂ removals. Associated GHG emissions are calculated using Equation 2.27 and default factors (combustion factor, emission factors for CH₄, N₂O) from IPCC 2006. Activity data is the annual area of the event (following annual survey and report by Forest Authority).

Combustible amount is given by average DOM amount in Romanian (from NFI 2010). Calibration period covers 1986 - 2010. Forest area changes of +5% from 1970 to 2009 was taken into account in the margin estimation. Background level and margin estimates include emissions of CO₂, CH₄ and N₂O.

For *windfalls* annual estimates of standing volume affected are available for a historical period starting 1986 to 2010. Estimation of CO₂ emission associated to background level assumed:

- a) from affected area/standing volume 90% is resinous species and 10% are broadleaved;
- b) 10% of affected standing stock volume of large windfalls (max 1.7mil.m3 is not subject to harvest/salvage logging (which remains untouched in the forests), because of inaccessibility or lack of capacity/resources to collect entire wood;
- c) 90% rest of the affected volume is harvested. Traditionally, “salvage logging” from disturbance events receive highest priority to harvesting, which ensures rather constant harvest across time.
- d) entire affected volume is transferred to DOM pool in the calendar year of the event;
- e) decay of such additional DOM input occurs following decomposition function with half-time of 5 years. Thus, CO₂ emission associated to disturbance event occurs over following next 10 years, e.g. at the end of 10th year some 88% (or 91% in 12th year) of original biomass/carbon is lost and assumed emitted to atmosphere.

Afforestation/reforestation activity

For afforestation/reforestation *forest fires* are only relevant. A background level was established assuming the same share of burnt area as AR to FM total area (i.e. 0,042%). Because of the size of trees in young plantations entire living biomass is assumed completely affected by fires, along with litter and dead wood pools (total of 12.4tC/ha, as estimated from an afforestation project monitored for emissions reduction transaction purpose).

- 3) expectation of net credits or debits:** In theory salvage logging always follow any disturbance in Romania, although there is some doubt that entire volume affected is actually collected especially after windfalls. Exclusion from accounting of disturbance related emissions will be first supported by an in-depth analysis of the actual rate of

salvage logging. New NFI data would allow better sampling of windfalls events, and better data.

Technical correction of the FMRL would ensure consistency between FMRL and FM estimates. Technical correction should consider actual changes in DOM and SOM caused by historical disturbances (for blown down volume) as well as any abandonment of forest area affected. In the FMRL, DOM and SOM changes were both assumed as “no change”, while also assumed that entire affected standing volume affected was subject to salvage logging (slightly revised now and subject to further checks).

4) information how the margin is established, if needed. Frequency distributions for CO₂/CO₂eq emission estimates from disturbance events are not normal, which means a larger number of disturbances are classified as extreme when the normal distribution assumption is used (since it underestimates the 97.5% bound of the distribution). This is more relevant for AR where there is no baseline, and inclusion/exclusion of high emissions is sensitive to 97.5% value. In any case, distribution type is not relevant for FM when exclusion occurs for FMRL too. Margin value was nevertheless estimated as the value corresponding to 97.5% on normal distribution of area-specific emissions for each of FM and AR time series of emissions from disturbances (following KP_supplement 2013 guidance).

11.2.3 Forest Management specific information

11.2.3.1 Forest Management specific information

Currently, Romania’s reference level relies on projection achieved by a collaboration with Joint Research Center of the European Commission. Forest Inventory 1985 and other forest statistics provided the historical activity data for the greenhouse gas inventory. Romania included in its submission the estimated age-class distribution as modelled by EFISCEN (European Forest Information Scenario Model, from the European Forest Institute) and assumed that wood resulted from disturbance is entirely subject to salvage logging.

Under a ‘business as usual’ scenario, Romania anticipates a slow decrease in CO₂ removals from forest management for the period 2012–2020.

Forest Management Reference Level in the “Report of the technical assessment of the forest management reference level submission of Romania” submitted in 2011

(<http://unfccc.int/resource/docs/2011/tar/rou01.pdf>) is -15.444 kt CO₂ equivalent (assuming instantaneous oxidation) and -15.793 kt CO₂ equivalent (applying first-order decay function for HWP). It was recalculated in comparison to the “Submission of information on forest management reference levels by Romania”

(http://unfccc.int/files/meetings/ad_hoc_working_groups/kp/application/pdf/awgkp_romania_2011.pdf).

A technical correction is necessary, in order to ensure methodological consistency and use of updated forestry data for the estimation of emissions and removals of forestland, for ensuring a consistent FMRL and for the estimation of FM accounting amount over the 2nd commitment period.

For accounting purpose a technical correction is needed to the reference level established by TAR. Correction is caused by the change of the methodological elements: new increment data from NFI, possible adjustment of historical harvest data based on NFI data, different age structure estimated by NFI than simulated by EFISCEN model (based on old national data) and inclusion of dead organic matter pool in order to account for emissions from natural disturbance over calibration period 1990-2009. It may include a change from projected to historical data based on NFI, with a change from current ‘gain-loss’ to ‘stock-change’ for annual estimation over the CP2. Technical correction is expected at the latest in 2017 submission.

11.2.3.2 Harvested wood products in FMRL.

Emissions from harvested wood products originating from forests prior to the start of the second commitment period have been calculated in the FMRL using the stock change approach defined in IPCC 2006 (data used were associated with years starting with 1900).

11.2.4 Supplementary information to be reported in the annual GHG inventory according to decision 2/CMP8 (according to Table 2.4.1)

11.3 Land-related information

Information on geographical location and identification of land. National boundary applies for all activities. Nevertheless, more explicit sub-national boundary can apply for AR and RV.

11.3.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

Afforestation and Reforestation

Artificial plantations of forest trees on lands which are expected to meet forest definitions thresholds are reported as AR. Currently, data provided by National Statistics is used, but the system improves to provide better data by statistical sampling associated to NFI combined with spatial information from afforestation projects (publically funded, in GIS). NFI implements field checks able to differentiate between natural expansion of forest vegetation and AR (e.g. presence of tree lines and soil disturbance) and remote sensing checks (re-assessments), also by their combination. Noteworthy, Romania implements an afforestation/ reforestation JI under Kyoto protocol. The emissions reduction associated to this project are highlighted in the Table 4(KP-D)A1.1. in a separate line.

Forest management

Forest management applies to all forests in Romania, including forests under management plans, forest currently without management plans and forests under direct anthropogenic impact by wood harvesting. All forest are considered managed. All these types of activities on land are shown by NFI data.

Deforestation

The area of deforestation is derived from statistical sampling grid of NFI. According current preliminary assessment, annual area of deforestation between 1990 and 2005 is some 8.9kha/year. This seems overestimated for which reason the time series would include additional assessments to be included in the following submission.

11.3.1.1 Methodology used to develop the land transition matrix

Methodology for the preparation of the land use change matrix is described in the LULUCF section 6.2 and 6.3. There were two matrices developed: one that starts in 1970, developed for the inventory purpose (which covers GHG inventory 1989-2013) and another one that starts in 1990 developed for the Kyoto Protocol reporting and accounting purpose. The two are fully consistent, the difference is that Convention's one implements 20 years transition period, and also by that some lands are associated to particular KP activity under KP matrix (i.e. lands under conversions to forestland which resulted from natural expansion of forest are reported under FM). Since 1989 is the base year for Romania, pre-1990 data was needed to provide a net GHG emission/removals estimate for the Revegetation activity in 1989, which includes the time series from 1970. The complete matrix used for estimation of emission/removals on KP eligible lands is available in NIR-2.

11.3.1.2 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. According to national forest code, 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 statistical report (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

Deforested lands are identified by statistical sampling method implemented with NFI grid.

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.

11.3.1.3 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.

Information on how lands subject to activities are identified. According to the Romanian legislation, "**afforestation/reforestation**" means “conversion of non-forest land through forest plantations”, which implies direct anthropogenic intervention on land. 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. This lands are included under 4.A.2 conversions to forest lands.

Once a piece of non-forest land starts the procedure of afforestation in an afforestation project, the work 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 4.A.2 area reported as AR. Further on, area of natural expansion of forest become automatically subject to management planning, for which reason these areas are included under FM area and not under AR, what explains larger area under FM than 4.A.1.

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". For the purpose of the GHG inventory the new system implements more strict definition that any permanent change from forest to another land use is deforestation.

"**Forest management**" (FM) applies to all forests in the country, i.e. all forest are managed. The management of majority of the forests 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 – 4.A.1", plus part of the

areas reported under 4.A.2 Land converted to Forest land resulted as natural expansion of forest vegetation.

"**Revegetation**" is identified with areas created by planting of trees (thus directly human induced). Such tree planting areas do not meet the forest definition parameters (at least one, usually minimum area). Re-vegetation is currently associated to tree planting reported in statistical report SILV 4, derived from 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 "4.B.1 - Cropland remaining Cropland".

Current submission is consistent with previous submission under first commitment period of the Kyoto Protocol, in the sense that emissions were not underestimated and sink was not overestimated. Improvement of land assessment system is underway.

11.3.1.4 Natural disturbances

No natural disturbances **were** recorded in the year 2013.

11.3.1.5 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

The ranking of priority is given in this order: Deforestation – Afforestation – Revegetation - Forest management. 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 11.1 and is identified by project documentations and NFI based on these indicators (planted trees on line or grids).

11.3.2 Information on methods and approaches to estimate emissions and removals

Description of methodologies used methods used for calculating the reference level and the associated background level of emissions from natural disturbances. Implementation of 2006 Guidelines has affected insignificantly the estimates for KP activities. All emissions are estimated, none is considered as insignificant in the sense of para 37 of the Annex to decision 24/CP19.

11.3.2.1 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 in some 4 years since planting (sampled data is available from Romanian JI and national FORLUC project mentioned under AFOLU sector chapter), thus C stock change is estimated and reported. Instead, DW cannot 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 trees barely 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 and conservatively assume that DW is not a net source 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, as follows:

Quantitative data

As explained in the chapter 6.4.2.1, 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, in which case “not a source” applies (key category NR is reported in NIR-2 and NE in sectoral table 4.A.1 Cropland remaining Cropland).

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. Validation exercise 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 4 years till 140) 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 when comparing 2010 to 1990 (e.g. Olofsson et al., 2011 in Environ. Res. Lett. 6 (2011) 044202). 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 1990-2013.

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 (mid-year 2010). In order to derive time series for 1990-2013,

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). This work is ongoing, as long as the NFI final results were released and 2nd NFI cycle started.

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. CBM and Yasso07 runs were achieved and under ongoing improvements in order to support better the reporting.

11.3.2.2 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.

11.3.2.3 Changes in data and methods since the previous submission (recalculations)

All changes are caused by the change in activity data, for forest and forest management activity. Emission and C stock change factors are not changed at all.

11.3.2.3.1 Information that demonstrates methodological consistency between the reference level and reporting for forest management

In order to avoid expectance of net debits and credits, during the second commitment period, the consistency of parameters used for FMRL and estimates over the CP2 has to be ensured for, i.e. area accounted for, the treatment of harvested wood products, and the accounting of any emissions from natural disturbances.

11.3.2.3.2 Technical corrections

A technical correction is planned in the light of new data available from NFI (for 2008-on).

11.4 Activity-specific information

11.4.1 Methods for carbon stock change and GHG emission and removal estimates

11.4.1.1 Description of the methodologies and the underlying assumptions used

Afforestation/reforestation

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. Further on 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 4, section 4.A.2 - Land converted to Forest Land (item B. Artificial plantations). Currently there are no areas of afforestation which have been subject to harvest (mainly because large planting schemes and slow growing long cycles planted species). The AR is a key category under KP.

Deforestation

Emissions are calculated using Tier 2 methods and input data as described under the chapter 6.8.1.1. All carbon pools are reported and D is not a key activity under KP.

Forest management

FM area is consistent with forest area reported under 4.A.1 – Forest Land remaining Forest Land, plus the conversions to forests resulted by natural expansion of forest vegetation (excluding artificial plantations from 4.A.2 which are reported as AR).

Emissions/removals from FM activity have been calculated, using the same assumptions, formulas and parameters as used for the estimation of the GHG inventory (see section 6.4.2. of the NIR). C pools reported are aboveground and belowground biomass. Change in soil organic matter, dead wood and litter are reported under Ch.6. The FM is a key category under KP.

Revegetation

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 2013 KP supplement (IPCC, 2013).

Actual revegetation data is drawn from statistics back till 1974, while for 1970-1974 data is linearly extrapolated. For GHG inventory purpose, this activity is entirely included with 4B1 Cropland where such emissions are reported in the national GHG inventory (following current NFI assessment this assumption, first by splitting this area between croplands and grasslands).

This activity is subject of “net-net accounting” (i.e. the difference between the annual sinks in 1989 and 2013 on land which are subject to revegetation in each year).

C pools are estimated exactly as in the case of 4.A.2 land converted to forestland (artificial plantations) under assumption that plantations differ only by their legal status (land classification). Revegetation on revegetation areas 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 revegetation land after 25 years since the establishment. DW change was always assumed as 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.

11.4.1.2 Uncertainty estimates

New sound estimates were under development since new sampling based activity data estimates are under preparation.

As highlighted in the section 6.4.3, the uncertainty reported under 4.A.2 Land converted to Forest Land was estimated for the artificial plantations aged less than 10 years on some 6 kha included under the JI project. The uncertainty of the cumulated C stock was $\pm 9\%$ (for 95% confidence interval). The area the uncertainty was less than 1%.

11.4.1.3 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 6 of the NIR.

11.4.1.4 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. Under current method, which determines the land use change periodically, interpolation is used between successive moments in time.

11.5 Article 3.3

11.5.1 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 land, which is observed by the approval of documentation for funding. Otherwise it is “reforestation after wood harvesting” under national forestry regime (and included under forest management).

According to current sampling based land assessment system D was forest at 1 January 1990 and it is not forest anymore in 2013.

Tree plantations under Revegetation is identified exactly under same manner as AR, reported under different headings of statistical report SILV 4.

11.5.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

The forest disturbance alone cannot trigger land conversions from forestland, i.e. land is subject to further forest management. 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 (including tree harvest based on permit), to apply the forest management plans specifications and regenerate it within a given timeframe (maximum 2 years); for the latter, following legal procedure with the issuance of the approval, a new land use category is assigned to that land, and the forestry regime is no longer applicable.

11.5.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

A basic requirement of the forest regime is that an area has to be afforested in maximum 2 years, without reference to a minimum area. In practice, such lands can regenerate either by plantations (usually followed by state forests) or by assisted natural regeneration (in private forests), or by mixed ways. Its implementation is observed by public authority responsible for forestry. These areas cannot be confounded with deforested areas as far as they are subject to continuous planning and management (i.e. planting/ gap filling, maintenance, etc).

11.6 Article 3.4

11.6.1 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 or subject to forest regime in any case.

Revegetation activity occurs on non-forest lands. They result by tree planting (also publically funded at the time of their establishment since 1970 on).

11.6.2 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 and can be associated with forest belts. 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 GHG estimations).

11.6.3 Information relating to Forest Management

Forest management activity refers to forest for which a management plan has been set up (some 90% of forests) while rest are subject to wood harvesting permission. First category are managed according to management plans, they are continuously surveyed for disturbances; forest operations and harvesting are subject to 10 years cycle 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.

11.7 Other information

11.7.1 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 CO₂ removals from the category 4.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 are still achieved according to 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.

11.8 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/removals amount is subject to an independent verification. First verification was performed in 2007 and second one in 2013 (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 4(KP-I) A1.1. This approach is consistent with KP supplement 2013). CO₂ removals 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-CO₂ emissions in pre-2008, 2008-2012 and 2013-2017. Meanwhile activity data is reported according to the annual afforestation area in the project.

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 MgCO₂eq 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 removals estimate was $\pm 14\%$;
- net removals for the Kyoto I commitment period (2008-2013) coinciding with the 2nd project verification period is also available, as follows:
 - Claimed verified amount for 2nd verification was 229641 tCO₂ with an uncertainty of $\pm 8.5\%$. Largest contribution is given by removals of living biomass, DOM and SOM pools of 240361 MgCO₂;
 - JI project's non-CO₂ 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, ICERs, AAUs and RMUs for the year 2014 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 31.12.2014 as well as information on transfers of the units in 2014 to and from other Parties of the Kyoto Protocol (Table 12.1). Neither AAUs, nor RMUs have been issued in the Romanian Registry in 2014.

Table 12.1 Information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Romanian registry at 31.12.2014

Annual Submission Item	Reporting
15/CMP.1 annex I.E paragraph 11: Standard Electronic Format (SEF)	12.2. The Standard Electronic Format report for 2014 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 2014
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications	No CDM notifications occurred in 2014
15/CMP.1 annex I.E paragraph 15: List of non-replacement	No non-replacement occurred in 2014

Annual Submission Item	Reporting
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist as at 31 December 2014
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://www.mmediu.ro/categorie/eu-ets-rueges/5
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)

The calculation of the commitment period reserve will be finalized along with the finalization and submission of the of the Romania's Report to facilitate the calculation of the assigned amount pursuant to Article 3, paragraphs 7bis, 8 and 8bis, of the Kyoto Protocol for the second

commitment period and to demonstrate its capacity to account for its emissions and assigned amounts.

12.6 KP-LULUCF accounting

The elements on the KP-LULUCF accounting will be finalized along with the finalization and submission of the Romania's Report to facilitate the calculation of the assigned amount pursuant to Article 3, paragraphs 7bis, 8 and 8bis, of the Kyoto Protocol for the second commitment period and to demonstrate its capacity to account for its emissions and assigned amounts.

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 in the National System performed before the submission of the version 1 of the 2014 NGHGI are presented in Annex 6.8.

Changes implemented after submitting the version 1 of the 2014 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;
- update of the legal acts approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the Greenhouse Gas levels and the Quality Assurance/Quality Control Procedure;
- the change of the title of the national entity with overall responsibility for the national inventory from the Ministry of Environment and Climate Change to the Ministry of Environment, Waters and Forests;
- the QA/QC and verification activities have been enhanced as a result of the implementation of the studies:
 - “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation

- methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology”;
- “Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology”;
 - “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.
- 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 study “Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”.
 - following the government reorganization, 12 posts are available in the National System for Estimating the GHG Emissions Unit–Climate Change General Directorate in the MEWF, 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 agreed under the KP 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.

Further elements, including on the implementation of studies in Table 13.1 and in Tables of Annex 6.8 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.

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 2015 NGHGI

- ***improving the accuracy***
 - applying higher/higher Tier methods for the Lime production, Glass production and Ammonia production categories based on IPCC 2006 methodology ;
 - applying higher Tier methods for the Iron and steel production category based on the IPCC 2006 methodology;
 - applying higher/higher Tier methods in the LULUCF Sector.

- improving the completeness, consistency and transparency of the LULUCF Sector based on the implementation of study 3 in Table 13.1.

Elements pertaining to the studies administration

The studies in Table 13.1 above and in Tables in Annex 6.8 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, MEWF is the coordinator of funds distribution for studies in the field of environment and climate change.

MEWF 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. MEWF 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 MEWF which use the results in the inventory preparation and hence the interest of MEWF 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, MEWF 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 MEWF;

- the funding is provided by the MEWF;
 - 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 MEWF as the main beneficiary of these studies;
 - during the implementation phase, the contractor is required to provide MEWF, after the generation of the results, the proper documentation on the scope, methods, assumptions, key parameter values and data sources; further on, MEWF 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 MEWF 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 MEWF 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 MEWF to monitor closely their development and avoiding in this way the deviation from the initial scope of the studies.

- *within the reception phase*

MEWF is making the payments for the contractor only after MEWF'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 MEWF'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, MEWF 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 2014.

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	Romania has nominated in 2014 as National Administrator on Miss Alexandra ULMEANU Tel.: (021). 408.95.50 Fax.: (021). 408.95.50 e-mail: alexandra.ulmeanu@mmediu.ro
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 A. Versions of the CSEUR released after 6.1.7.1. (the production version at the time Last Chapter 14 introduces changes in the structure of the database. These 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.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.1.7.1. of the national registry were limited and only affected EU ETS functionality.

Reporting Item	Description
	<p>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 B). Annex H testing was carried out in February 2015 and the report is provided as part of this submission.</p> <p>Annex 6.2.4 testing was carried out in February 2014 and the successful test report has been attached.</p> <p>No other change in the registry's conformance to the technical standards occurred for the reported period.</p>
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.
15/CMP.1 annex II.E paragraph 32.(j)	Changes introduced since version 6.1.7.1. of the

Reporting Item	Description
Change regarding test results	<p>national registry were limited and only affected EU ETS functionality.</p> <p>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 B.</p> <p>Annex H testing was carried out in February 2015 and the test report is provided as part of this submission.</p>

15 INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

No changes occurred compared to the previous inventory submission.

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 Commission Implementing Regulation (EU) no. 749/2014, the levels of GHG emissions during 1989-2012 were far below the reduction commitment taken within the Kyoto Protocol.

This reduction of emissions was mainly the consequence of the decline of the economic activities, the upgrading of technologies and energy efficiency projects promoted as a result of the approximative process of .the European *acquis communautaire*.

The GHG emissions reduction achieved have allowed our country to participate from the early stage at the implementation of the AIJ and JI mechanism in order to upgrade and refurbish the old technologies and improve energy efficiency. An important role in the reduction of GHG emissions was played by the participation since 2007 at the application of the Emission Trading Scheme.

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.

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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