Ministry of Environment
and Climate Change

Romania's Greenhouse Gas Inventory
1989-2011

National Inventory Report

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AD	Activity Data
AGB	Above Ground Biomass
AR	Afforestation/Reforestation
ASH	ASH content of the manure
AWMS	Animal Waste Management Systems
B_0	Maximum methane (CH4) producing capacity for manure produced by animal within defined population
BEF	Biomass Expansion Factor
BGB	Below Ground Biomass
BOD	Biochemical Oxygen Demand
BOF	Basic Oxygen Furnace
C	Carbon
C^{nat}	National Oxidation Factor expressed in Carbon content
C_2F_6	Hexafluoroethane
$CaCO_3$	Calcium Carbonate (limestone)
CaO	Calcium Oxide (lime)
CaO*MgO	Dolomitic lime
CAP	Agricultural Production Cooperatives
Cel B	Gross Pulp
CF_4	Tetrafluoromethane
CH_4	Methane
CHP	Co-generation Heat Plants
CIV	Identity Card Vehicle
CKD	Cement Kiln Dust
CLRTAP	Convention on Long-range Transboundary Air Pollution
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand

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

FLRFL	Forest Land Remaining Forest Land
FM	Forest Management
FORLUC	Forest Land Use
GB	Gross Fat
GD	Governmental Decision
GE	Gross Energy Intake
G	Grams
Gg	Giga gram
GHG	Greenhouse Gas
GPG	Good Practice Guidance
GWP	Global Warming Potential
Ha	Hectares
HCFC	Fluorinated Gases
HFC_s	Hydro-fluorocarbons
ICAS	Forest Research and Management Planning Institute
ICIM	National Research and Development Institute for Environmental Protection
ICPA	National Institute of Research and Development in Soil Science, Agro-chemistry and Environment
ICPIL	Research and Design Institute of Wood Industry
IE	Included elsewhere
IEA	International Energy Agency
INSEMEX Petrosani	National Institute for Research and Development in Mine Safety and Protection to Explosion
IPCC 1996	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories -1996
IPCC GPG 2000	IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories -2000
IPCC GPG 2003	IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry -2003
IPCC	Intergovernmental Panel on Climate Change

IPPC	Integrating Pollution Prevention and Control
ISPB	Public Health Institute of Bucharest
ISPE	Institute for Studies and Power Engineering
IT	Information Technologies
ITRSV	Territorial Inspectorates on Forestry and Hunting Regime
JI	Joint Implementation
KP	Kyoto Protocol
KCA	Key Category Analysis
Kcal	Kilocalorie
Kg	Kilograms
Kj	Kilojoule
L	Level
L	liquid
LB	Loss in Biomass
LT	Litter
LTO	Landing/Taking Off
LULUCF	Land Use, Land Use Change and Forestry
M	meter
M^3	meter cubic
mm	milimeter
MADR	Ministry of Agriculture and Rural Development
MAI	Ministry of Administration and Interior
MCF	Methane Conversion Factor
MECC	Ministry of Environment and Climate Change
MEF	Ministry of Environment and Forests
$MgCO_3$	Magnesium Carbonate
MgO	Magnesium Oxide
MJ	Megajoule
MoEO	Ministry of Environment Order
MS	Fraction of minimal species/category manure handled using manure system

MSW	Municipal Solid Waste
N	Nitrogen
N.A. ”Romanian Waters”	National Administration ”Romanian Waters”
N_2O	Nitrous Oxide
NACE	National Classification of Economic Activities
NCV_s	Net Calorific Values
NEPA	National Environmental Protection Agency
N_{ex}	Available for annual average N excretion per head of species/category
NFI	National Forest Inventory
NGHGI	National Greenhouse Gas Inventory
NH_3	Ammonia
NIM	National Institute of Meteorology
NIR	National Inventory Report
NIS	National Institute for Statistics
NMVOC	Non-methane Volatile Organic Compound
NO	Not occured
NOx	Nitrogen Oxides
NS	National System for the estimation of anthropogenic emissions by sources and removals by skins of all greenhouse gases not controlled by the Montreal Protocol
NSCR	Non Selective Catalytic Reduction
NTPA - 011	Romanian Standard regarding wastewater treatment
PB	Gross Protein
PFC_s	Per-fluorocarbons
QA/QC	Quality Assurance/Quality Control
RAR	Romanian Automobile Register
Rev	Re-vegetation
RNP	Public National Forest Administration
S	Solid

Saturday paper	Problems and Further Questions from the ERT formulated in the course of the review of the submitted greenhouse gas inventories
SEF	Standard Electronic Files
SEN	Nitrogenous substances extractable
SF_6	Sulfur Hexafluoride
SILV 4	Statistical Report Forest regeneration works performed in the forestry fund, degraded lands and other lands outside the forest fund
SNAP	Selected Nomenclature for Air Pollution
SNFI 1984	Synthesis of National Forest Inventory, 1988
SO_2	Sulfur Dioxide
SOC	Soil Organic Carbon
SRC	Selective Catalytic Reduction
SWDS	Solid Waste Disposal Sites
SWPB	Side Worked Pre-baked
SY	Statistical Yearbook
T	Trend
t	tones
TOS	Total Organic Sludge
TOW	Total Organic Wastewater
UN	Nutritive Units
UNFCCC	United Nations Framework Convention on Climate Change
VFAFF	Forest Vegetation outside of the National Forest Fund
VS	Volatile Solid excretion per day on a dry-matter weight basis
WA	Weighted arithmetic average
WS_x	Fraction of wastewater treated anaerobically
Y_m	Methane conversion rate as the fraction of gross energy in feed converted to methane
YR	Year
%	Percent

Notation Keys	IE	Included elsewhere
	NA	Not Applicable
	NE	Not Estimated
	NO	Not occurring
	C	Confidential

ES EXECUTIVE SUMMARY

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

ES.1.1 Background information on climate change

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

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

ES.1.2 Background information on greenhouse gas inventories

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

In compliance with the reporting requirements, this is the eighteenth version of the National Inventory Report (NIR) submitted by Romania, covering the national inventories of GHG emissions/removals for the period 1989-2011.

This report documents Romania's National Inventory of anthropogenic emissions/removals of direct GHGs: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and indirect GHGs: NO_x, CO, NMVOC and SO_2.

This report includes descriptions of methods, data sources, key categories, quality assurance and quality control (QA/QC) activities carried out and a trend analysis. The NIR also comprises a full quantitative assessment of the uncertainty; the uncertainty analysis is presented both on the sub-sectorial level and in the Annex 7.

Following the paragraph 15 in the Decision under paragraph 2 of section X concerning the request for reinstatement, decision of the Enforcement Branch of the Compliance Committe (CC-2011-1-15/Romania/EB/13 July 2012), Romania included in the current NGHGI, as Annex 8.6, the Fourth progress report on the implementation of the Plan of Romania under paragraph 1 of section XV of Decision 27/CMP. 1.

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

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

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

ES.2.1 GHG inventory

For the trends analysis, the GHG emissions resulted from each sector were converted into CO_2 equivalent using the Global Warming Potential values provided by IPCC in the Second Assessment Report (the GWP values are presented in the Annex 6 of the NIR). The evolution of the total GHG emissions is presented in the next chart.

The GHG emissions trend reflects the main trends in the economic development of the country. The period is characterized by a process of transition to a market economy, restructuring of the economy, bringing into operation of the first reactor at the Cernavoda nuclear power plant (1996). The emissions have started to increase after 1999 as a consequence of the economy revitalization; in 2009, the emissions decreased significantly comparing to the level in 2008 while in 2010 they continued to decrease, due to the economic crisis. In 2011, the emissions started to increase again, following the increase of economic activities level.

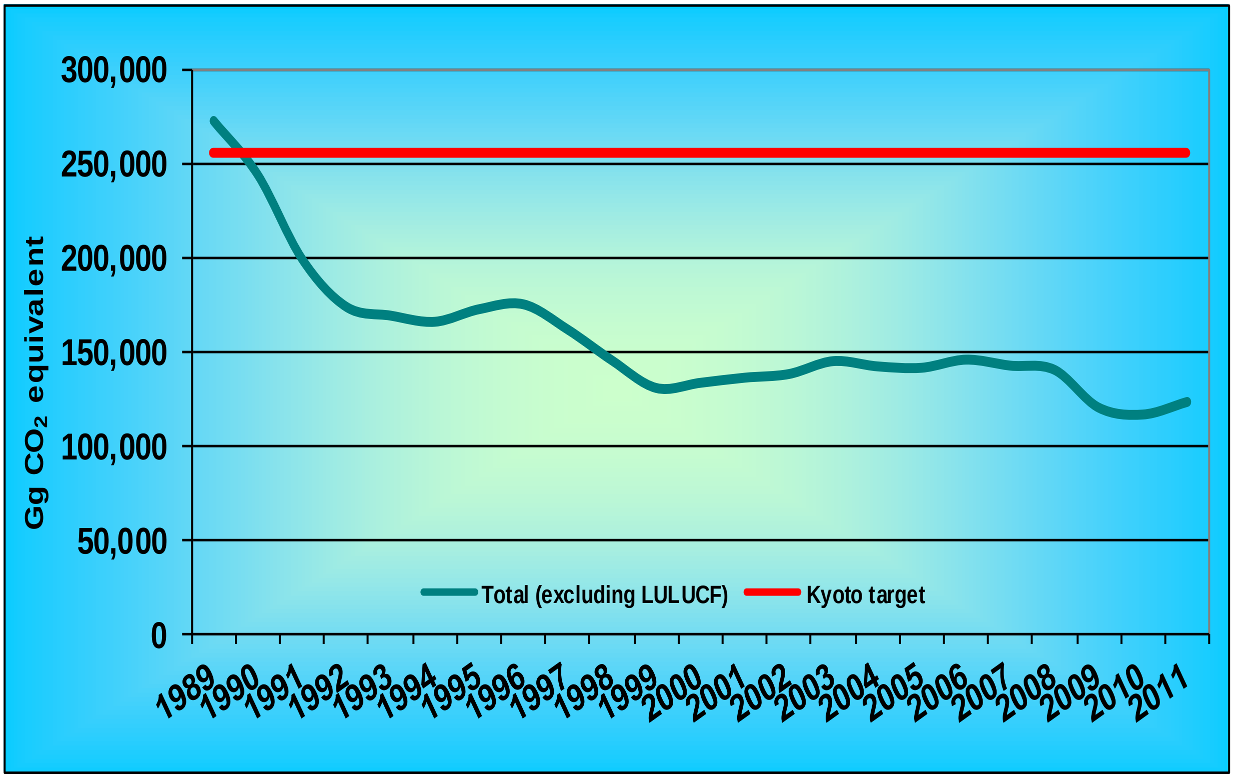
The largest contributor to the total national GHG emissions is CO_2, followed by CH_4 and N_2O. The share of each direct GHG in total emissions in 1989 and, respectively 2011, and the average share of each direct GHG in total emissions for 1989-2011 period are presented in the Table ES.1.

The total GHG emissions excluding LULUCF, in CO_2 equivalent, during 1989-2011 period, are presented in the Figure ES.1.

Table ES 1 Share of each direct GHG in total emissions in 1989, 2010, respectively 1989-2011 period

GHG	1989 (%)	2011 (%)	Average share for 1989-2011 period (%)
CO_2	71.53%	71.30%	70.95%
CH_4	17.03%	18.05%	18.38%
N_2O	10.21%	10.28%	9.85%
HFCs	0.0000%	0.0036%	0.0021%
PFCs	1.23%	0.01%	0.60%
SF_6	0.00000%	0.00006%	0.00008%

Figure ES 1 The total GHG emissions in CO_2 equivalent during 1989-2011 period



According to the figure above, there is a great probability for Romania to meet the Kyoto Protocol commitments on the limitation of the GHG emissions in the 2008-2012 commitment period. In 2011, the GHG emissions without LULUCF have decreased with 54.86% comparing with the base year level.

ES.2.2 KP-LULUCF activities

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

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

ES.3.1 GHG inventory

The present NGHGI for 1989–2011 was compiled according to the recommendations for GHG inventories set out in the Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of Decision 14/CP. 11 (FCCC/SBSTA/2006/9) and in the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol, using the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1996) as well as the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC GPG 2000) and Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC GPG 2003).

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

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

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

GHG emissions inventories have been reported since the 2005 submission using the CRF Reporter software, delivered by the UNFCCC Secretariat. This version of NIR refers to figures in CRF table's generated using CRF Reporter version 3.6.2.

ES.3.2 KP LULUCF activities

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

ES.4 Other information

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

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

PART 1 ANNUAL INVENTORY SUBMISSION

1 INTRODUCTION

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

1.1.1. Background information on climate change

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

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

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

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

Effects on agriculture

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

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

Effects on silviculture

Out of the national area, approximately 27% represent the area covered by forests; the forests are unevenly spread on the country's territory (approximately 51.9% in the mountain area, 37.2% in the hilly area and 10.9% in the plain area). In 2011 year, the forest fund area accounted for approximately 6 400 thousand ha; associated to that, an additional area was destined to forest crop, production and management. In the lower and hilly forested areas, a considerable drop of the forests productivity is foreseen after 2040, due to the increase of the temperatures and to the decrease of the precipitations volume.

Effects on the water management

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

Effects on the human establishments

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

1.1.2. Background information on greenhouse gas inventories

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

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

For this submission, Romania prepared: the CRF Reporter database and the CRF Tables containing emissions/removals estimates and background data for 1989-2011 period and the National Inventory Report.

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

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

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

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

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

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

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

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

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

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

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

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

The system is based on Article 5 of the Kyoto Protocol and complies with the provisions of the subsequent decisions of the CMPs of the Kyoto Protocol and with the provisions of the Decision 280/2004/EC of the European Parliament and of the Council and of the Decision 166/2005/EC of the European Commission concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol.

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

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

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

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

- includes all institutional, legal and procedural arrangements made as a Party included in Annex I for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and for reporting and archiving inventory information;

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

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

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

Institutional arrangements

The elements characterizing the institutional arrangements comprise:

- according to the Governmental Decision no. 1570/2007 as ulteriorly modified and completed, the single national entity with overall responsibility for the national inventory, including with the responsibilities of administrating the NS and of preparation and management of the NGHGI, is NEPA, organization under the subordination of MECC;

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

- ❖ central and territorial public authorities, research and development institutes and other public organizations under the authority, in the subordination or in the coordination of central public authorities, owners and professional associations, economic operators and other relevant organizations have the obligation of providing to MECC the necessary activity data, emission factors and associated uncertainty data;
- ❖ the main activity data supplier is the National Institute for Statistics through the yearly-published documents as the National Statistical Yearbook and the Energy Balance and other documents;
- ❖ the characteristics of the institutional arrangements include:
  - ➢ centralized approach – MECC maintain a large degree of control and decision making authority over the inventory preparation process;
  - ➢ in-sourced approach, in majority – the major part of the inventory is prepared by MECC (governmental agency);
  - ➢ single agency – the single national entity is housed within a single governmental organization;
  - ➢ separate approach – the NGHGI related work is not integrated with other air pollutant inventories work; however, cross checking activities are periodically implemented.
- ❖ the institutional arrangements currently used in Romania are presented in the Figure 1.1;
- ❖ in 2011, the NGHGI Land Use, Land-Use Change and Forestry (LULUCF) Sector, both under the UNFCCC and KP, was administrated by the Forest Research and Management

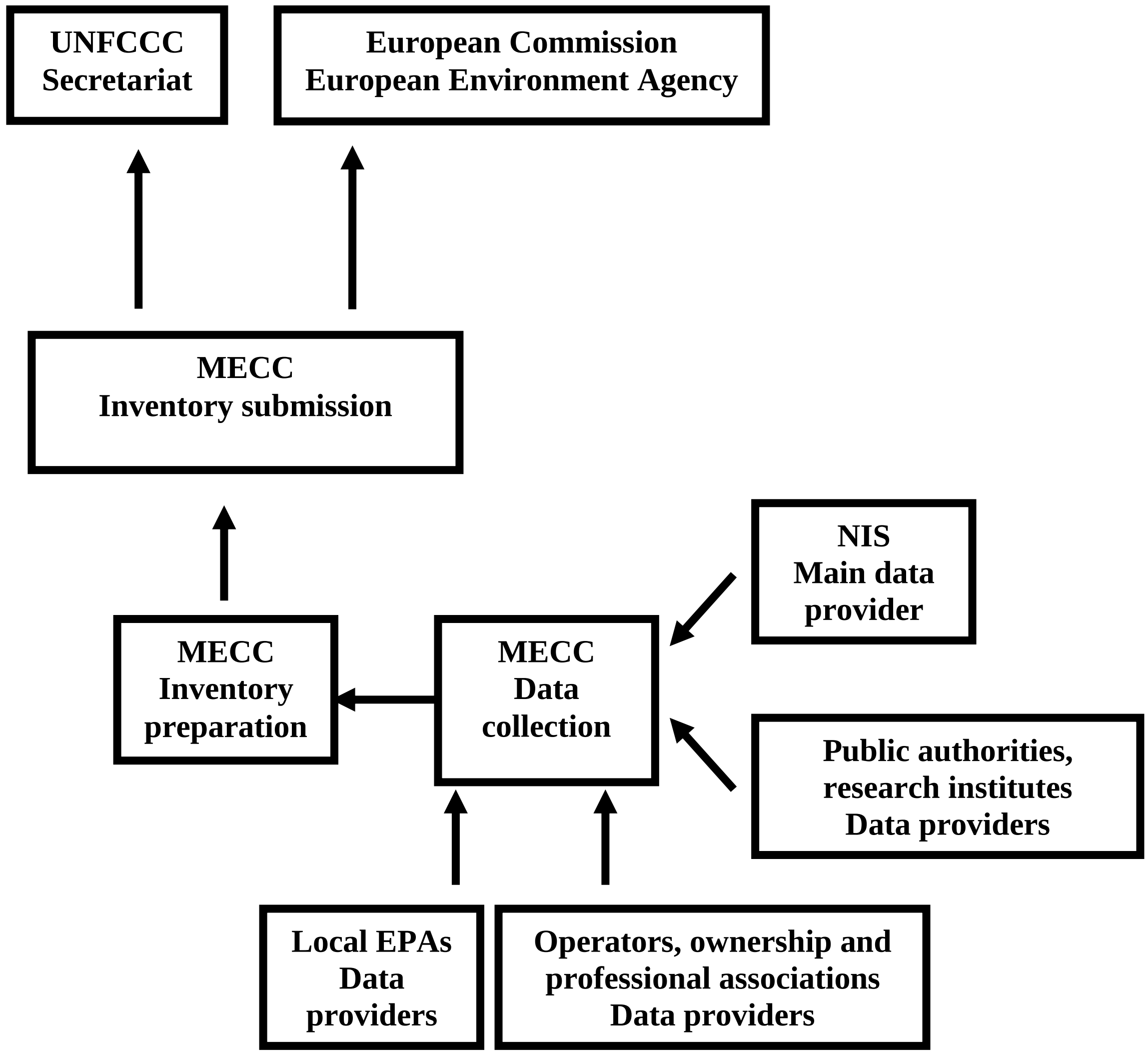
Planning Institute (ICAS), based on a contract with Ministry of Environment and Forests, in the context of the study "NGHGI LULUCF both under the UNFCCC and KP obligations";

- in 2012-2014 period, the NGHGI LULUCF Sector, both under the UNFCCC and KP, is administrated by ICAS, based on the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS; ICAS also contributed by developing the studies "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;
- 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 "Support for the implementation of the European Union requirements on the monitoring and reporting of the carbon dioxide (CO_2) and other greenhouse gas emissions" study was carried out in 2011 by the Institute for Studies and Power Engineering (ISPE); specific elements comprise:
  - package 1 activities – improving NS:
    - evaluation of NS and of the relevant technical assistance projects previously implemented;
    - establishing the measures necessary for improving the institutional capacity and structure for implementing the NS- the contractor identified the institutional, legal and procedural measures for assuring the compliance of the NGHGI with the applicable standards, including solutions for improving the sectorial databases;
    - elaboration of draft legal proposals for an efficient administration of the NGHGI. The GD no. 1570/2007 was updated accordingly;
    - general training session for improving the expertise of the personnel working in the climate change field, at the central administration and subsequent level.

- package 2 activities – developing the institutional capacity for reporting the GHG emissions/removals:
    - evaluation of the Romanian capacity to report the GHG emissions according to the European Union requirements;
    - improving the reporting capacity of the authorities in Romania;
    - specific training session for improving the expertise of NEPA team on the attributions/responsibilities of administrating the NS/NGHGI.
- package 3 activities-establishing the programs and measures necessary for determining the emission factors and other national relevant parameters.

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

Figure 1.1 Current national inventory system description



Legal and procedural arrangements

The legal and procedural framework specific to the NS include:

- GD no. 48/2013 on the organization and functioning of the Ministry of Environment and Climate Change and for modifying some environment protection and climate change domain related legal acts; it modified also the GD no. 1570/2007;
- GD no. 668/2012 for modifying and completing the GD no. 1570/2007 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals of CO_2 by sinks, regulated through the KP;

- Ministry of Environment Order (MoEO) no. 1376/2008 for approving the Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review;
- MoEO no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI;
- NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels;
- NEPA's President Decision no. 417/2012 on abrogating the NEPA's President Decision no. 119/2012 (on abrogating the QA/QC Procedure approved through the Decision no. 24/2009 and on approving a updated QA/QC Procedure related to the NGHGI) and on approving a updated QA/QC Procedure related to the NGHGI;
- Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS, on administrating the NGHGI LULUCF Sector both under the UNFCCC and KP;
- Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior, on the preparation of Road transport category estimates based on COPERT 4 model.

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

Specific elements include:

- following the governmental approval of taking over the NEPA climate change related structure, personnel, atributions and responsibilities, starting with 1 April 2013, 14 people (out of 16 available posts) in the National System for Estimating the GHG Emissions Unit– Climate Change General Directorate in the MECC have exclusively the responsibilities of administrating the NS/NGHGI.

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

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

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

- general training session for improving the expertise of the personnel working in the climate change field, at the central administration and subsequent level, including personnel from NGHGI data/information providers/potential providers, was held in 2011 in the context of the "Support for the implementation of the European Union requirements on the monitoring and reporting of the carbon dioxide (CO_2) and other greenhouse gas emissions" study;
- training of NEPA team dedicated to the administration of the NS and the NGHGI and of other partners in the NS on key category analysis and uncertainty analysis related issues was also performed in 2012 by the Environment Agency of Austria and University of Graz consortium in the general framework of implementation of the study "Environmental Integrated Informational System" (by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium); additional training on the use of the key category analysis and, respectively, uncertainty analysis related software developed by the Environment Agency of Austria and University of Graz consortium, have been provided to NEPA team by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium in 2013.

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

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

No.	Activity	Period/ Deadline	Persons subject to training	Responsible persons	Documents to be considered
1.	Improving the technical knowledge based on international and national documents related to the National System for Estimating the Greenhouse Gas Emissions/Removals (NS) and the Greenhouse Gas Inventory (NGHGI)	1 September 2011-10 March 2012	All new Sectorial Experts (SEs)	GHG Inventory coordinator	Governmental Decision (GD) no. 1570/2007, Ministry of Environment Order (MoEO) no. 1376/2008 for approving the Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review; MoEO no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI; NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels; NEPA's President Decision no. 24/2009 for approving the QA/QC Procedure related to the NGHGI, National Inventory Report-Romanian version-NGHGI 2009, NGHGI 2011, 2010, 2009, Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11
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
					(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 Use, Land-Use Change and Forestry (LULUCF) Sectors	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
5.	Implementing together with the more senior staff, based on a sectorial approach, all activities pertaining to the NS and NGHGI administration, including the activities related to NGHGI preparation plan and NGHGI improvement plan	1 September 2011-10 May 2012	All new SEs	GHG Inventory coordinator, QA/QC coordinator, older SEs	All documents at point 1, as well as other relevant documents

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

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

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

Specific elements comprise:

- as a Party to the UNFCCC, KP and as a Member State of the European Union, Romania annually submits the GHGI;
- 2013 version 3.1 submission of the NGHGI constitutes the eighteenth complete submission of the NGHGI of Romania;
- Romania submits the NGHGI within the relevant deadline: 15 January and 15 March, to the European Commission and to the European Environment Agency, and 15 April, to the UNFCCC Secretariat;
- the NGHGI is prepared in accordance with Article 5 and Article 7, paragraphs 1 and 2, of the KP, and with relevant decisions of the COP and/or COP/MOP. Beginning with 2010, Romania reports supplementary information required under Article 7, paragraph 1, of the KP within the NGHGI.

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

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

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

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

1.2.2. Overview of inventory planning

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

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

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

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

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

- national entity:
    - name: Ministry of Environment and Climate Change;
    - address: Bd. Libertăţii no. 12, Sector 5, Bucharest;

   - telephone/ fax: +40-21-2071141.
- designated representative with overall responsibility:
   - name: Sorin Deaconu;
   - telephone/fax: +40-21-2071141;
   - e-mail: sorin.deaconu@anpm.ro.

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

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

- the roles of, and cooperation between, government organizations and other entities involved in the inventory preparation, are established within the GD no. 1570/2007 as ulteriorly modified and completed;
- every person part of MECC team managing the NS/NGHGI has assigned specific/clear attributions/responsibilities comprising (through individual Job fiche):
   - sector management;
   - implementation of other sector relevant activities:
      - key category analysis;
      - uncertainty analysis;
      - QA/QC;
      - data/information archiving;
      - coordinating the team/activities relevant to the NS/NGHGI administration;
      - coordinating the QA/QC activities;
      - managing the archiving system.

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

Specific elements comprise:

- ❖ QA/QC plan is part of the QA/QC Programme and of the NEPA's President Decision no. 417/2012 on abrogating the NEPA's President Decision no. 119/2012 (on abrogating the QA/QC Procedure approved through the Decision no. 24/2009 and on approving a updated QA/QC Procedure related to the NGHGI) and on approving a updated QA/QC Procedure related to the NGHGI;
- ❖ QA/QC plan is intended to ensure the fulfillment of the NGHGI principles in Romania. Main objectives of the plan include:
  - ➢ applying greater QC effort for key categories and for those categories where data and methodological changes have occurred recently;
  - ➢ periodically checking the validity of all information as changes in reporting, methods of collection or frequency of data collection occur;
  - ➢ conducting the general procedures outlined in QC procedures (Tier 1) on all parts of the inventory over a complete exercise.

Detailed specific elements are presented within Section 1.6.

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

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

- ❖ defined within the GD no. 1570/2007 as ulteriorly modified and completed and within the MoEO no. 1373/2008;
- ❖ NGHGI verification and evaluation is performed at MECC level;

- ❖ MECC personnel with the atributions and responsibilities of preparing the NGHGI considers the observations and comments received, and as appropriate updates the NGHGI, aiming to its improvement, as soon as possible considering the relevant reporting guidelines.

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

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

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

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

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

The main activity data supplier is the National Institute for Statistics (NIS) through the yearly-published documents like the National Statistical Yearbook and the Energy Balance.

In 2011 the Forest Research and Management Planning Institute administrated the NGHGI LULUCF Sector, both under the UNFCCC and the KP, based on a contract with MEF, in the context of the implementation of the study “NGHGI LULUCF both under the UNFCCC and KP obligations”; the main activities implemented comprise also:

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

During the period 2012-2014, ICAS is continuing the implementation of activities on administrating the LULUCF Sector, both under the UNFCCC and the KP, based on the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS; ICAS also contributed by developing 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.

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.

On an undetermined period, the preparation of Road transport category estimates based on COPERT 4 model is administered also based on the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian

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

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

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

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

Specific elements comprise:

- key category analysis (KCA) is performed according to the provisions in Chapter 7 of IPCC GPG 2000 and Chapter 5 of IPCC GPG 2003, both following the Tier 1 and Tier 2 approach;
- KCA was conducted both considering the exclusion and inclusion of the LULUCF sector and, also, both level and trend criteria;
- all IPCC sectors and categories, sources and sinks (as suggested in Table 7.1 of IPCC GPG 2000 and in Table 5.4.1 of IPCC GPG 2003), and gases were analyzed;
- KCA was conducted for every year of the characterized period;
- KCA was implemented using an integrated software application developed in 2012 by the Environment Agency of Austria-University of Graz consortium, in the context of the study “Environmental Integrated Informational System”, implemented by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium; the application allow for:
    - automatic data import from the CRF Reporter application, through the use of CRF tables;
    - integrate both key category and uncertainty analysis performed following both Tier 1 and Tier 2 approach;

  - automatic export of results, data and information, within the relevant reporting templates.
- results are presented in NIR, within:
  - Chapter 1, at general level;
  - Annex 1, using also the guidance and/or template associated with the Tables 7A1-7A3 in IPCC GPG 2000, Tables 5.4.5, 5.4.7 and 5.4.8 of IPCC GPG 2003 and KP-LULUCF CRF Table NIR. 3.
- KCA is used for prioritize efforts for improving the quality of the NGHGI-the relevant implemented and future studies refers mainly to the use of higher Tier methods on key categories.

Further elements are presented in Section 1.5.

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

Specific elements comprise:

- emissions from KP Annex A Sectors are estimated following the IPCC 1996, as elaborated by IPCC GPG 2000;
- emissions/removals from LULUCF Sector are estimated following the IPCC GPG 2003;
- estimation methods selection is based on NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels;
- mainly due to NEPA's work, to the implementation in 2011 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" and 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, 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 the implementation in 2011 of the study "NGHGI LULUCF both under the UNFCCC and KP obligations", to the implementation of the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS and to the implementation of the study "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations", 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, both under the UNFCCC and KP; additionally, the implementation of the study "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" enabled further development of emission/removal factors.
- CORINAIR methodology was applied in case of the NGHGI Solvent and Other Product Use Sector.

Further specific elements are presented in Section 1.4.

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

Specific elements include:

- steps of data collection:
    - identification of data requirements;
    - identification of potential data suppliers;
    - preparation of specific templates;
    - submitting the requests and templates to the potential suppliers of data;
    - data collection;

  - ➢ data verification: activity data received are examined (time series discrepancies, large changes in values from the previous to the current inventory year), and double-checked against similar databases.

- ❖ the main activity data provider is the National Institute for Statistics;
- ❖ sources of emission factors/increment rates are: national studies, IPCC 1996, IPCC GPG 2000, IPCC GPG 2003, national research institutes and plants, in a limited number;
- ❖ data processing is performed according to the GD no. 1570/2007 and to the MoEO no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI. Primary data processing is mostly carried out by MECC;
- ❖ emission factors (EFs) selection is performed according to the provisions in the NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels;
- ❖ due to NEPA's work, to the implementation in 2011 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" and 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, 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 the implementation in 2011 of the study "NGHGI LULUCF both under the UNFCCC and KP obligations", to the implementation of the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS and to the implementation of the study "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations", 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; additionally, the implementation of

the study “Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations” enabled further development of emission/removal factors.

- 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.

Further elements are presented within the Section 1.3.2.

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

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

- based both on Tier 1 and Tier 2 method according to the provisions in Chapter 6 of the IPCC GPG 2000, in the Chapter 5 of the IPCC GPG 2003;
- performed for 2011, 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”, “NGHGI LULUCF both under the 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” studies), study on Romanian uncertainty information and data performed in 2012 by the Environment Agency of Austria-University of Graz consortium (uncertainty data have been collected through interviews, based on the collaboration between “Environmental Integrated Informational System” study contractor, Environment Agency of Austria-University of Graz consortium, data providers and NEPA), and default AD and EFs uncertainty sources;

- ❖ except the Forest Land remaining Forest Land category, the disaggregation of the inventory into categories is equivalent to the key category analysis splitting;
- ❖ was implemented using an integrated software application developed in 2012 by the Environment Agency of Austria-University of Graz consortium, in the context of the study "Environmental Integrated Informational System", implemented by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium; the application allow for:
  - o automatic data import from the CRF Reporter application, through the use of CRF tables;
  - o integrate both key category and uncertainty analysis performed following both Tier 1 and Tier 2 approach;
  - o automatic export of results, data and information, within the relevant reporting templates.
- ❖ results are presented within the NIR, in:
  - ➢ Uncertainties and time series consistency sub-sectorial sections;
  - ➢ in Annex 7.
- ❖ uncertainty analysis results are used for prioritize efforts for improving the quality of the NGHGI-in the implementation of progresses, highest priority is attributed to categories having associated high uncertainty level.

Further elements are provided within the Section 1.7.

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

The elements associated to the implementation of recalculations comprise:

- ❖ based on IPCC GPG 2000 and on IPCC GPG 2003, Romania implemented significant recalculations in order to account for better AD and/or EFs, mainly based on NEPA's 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", 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, on the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS and on the study "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations";

- the recalculations resulted in significant increase of the accuracy, completeness and consistency of data series;
- the recalculations are presented in NIR in:
  - Source-specific recalculations, including changes made in response to the review process sub-sectorial sections, including the quantified impact;
  - Chapter 10 Recalculations.

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

Specific elements on the compilation of the national inventory include:

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

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

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

- the QA/QC Programme and the QA/QC Procedure comprise information on:
  - the national authority responsible for the coordination of QA/QC activities;
  - the objectives envisaged within the QA/QC framework;
  - the QA/QC Plan;
  - the QC procedures;
  - the QA procedures.
- according to the GD no. 1570/2007 as ulteriorly modified and completed establishing the national system and to those in the NEPA's President Decision no. 417/2012 on abrogating the NEPA's President Decision no. 119/2012 (on abrogating the QA/QC Procedure approved through the Decision no. 24/2009 and on approving a updated QA/QC Procedure related to the NGHGI) and on approving a updated QA/QC Procedure related to the NGHGI, MECC represents the competent authority responsible with the implementation of the QA/QC activities;
- the QA/QC coordinator is designated by MECC;
- QC activities were implemented:
  - by every sectorial expert during all phases of inventory preparation;
  - by NGHGI improvement studies ("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" and "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations") contractors;
  - documented within sectorial QC lists consistently used across the dedicated NS/NGHGI dedicated team;
  - greater effort was applied to key categories.
- QA activities:
  - NGHGI was subject to the annual internal review under EU-Monitoring Mechanism;

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

Further relevant information is presented under Section 1.6.

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

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

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

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

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

More relevant detailed elements are provided within Section 1.3.2.

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

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

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

Relevant elements comprise:

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

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

1.3. Inventory preparation

1.3.1. GHG inventory and KP-LULUCF inventory

The present NIR was compiled according to the recommendations for inventories set out in the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol and includes detailed information on the inventories for all years from the base year to the year 2011, in order to ensure the transparency of the inventory. The emissions are estimated using the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1996), as well as the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC GPG 2000) and IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC GPG 2003).

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

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

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

Data collection

Data collection process comprises the following steps:

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

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

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

Due to NEPA's work, to the implementation in 2011 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" and 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, 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.

Also, due to the implementation in 2011 of the study "NGHGI LULUCF both under the UNFCCC and KP obligations", to the implementation of the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS and to the implementation of the study "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations", 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; additionally, the implementation of the study "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" enabled further development of emission/removal factors.

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 NEPA.

Activities were carried out mostly at NEPA, and at ISPE and ICAS, as contractors of studies “Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”, “NGHGI LULUCF both under the 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 respect to the LULUCF Sector, studies implemented in 2011 and 2012; specific activities comprise:

- primary data processing:
- check the completeness of all data and information for all years and categories within the analyzed period;
- complete the datasets, using also default IPCC interpolation/extrapolation and/or alternative techniques;
- check the accuracy and consistency of datasets;
- values transformation in order to reach the measurement unit adequate within the method used;
- data aggregation/disaggregation considering the IPCC classification;
- calculation and/or adjustment of different parameters considering the available data.
- selection of the emission factors and of the methods;
- application of methods;

- emissions/removals estimates, using the most recent data;
- internal review (errors are rectified);
- preparation of the national inventory report.

Activities previously presented are also implemented within the collaboration between:

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

Data archive

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

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

- assumptions and criteria for selection of AD and EF;
- EF used, including references to the IPCC documents for default factors or to published references or other documentation for emission factors used in higher tier methods;
- AD or sufficient information to enable activity data to be traced to the referenced source;
- information on the uncertainty associated with AD and EF;
- rationale for choice of methods;
- methods used, including those used to estimate uncertainty;
- changes in data inputs or methods from previous years;
- identification of individuals providing expert judgment for uncertainty estimates and their qualifications to do so;

- details of electronic databases or software used in production of the inventory, including versions, operating manuals, hardware requirements and any other information required to enable their later use;
- worksheets and interim calculations for category estimates and aggregated estimates and any recalculations of previous estimates;
- final inventory report and any analysis of trends from previous years;
- QA/QC plans and outcomes of QA/QC procedures.

All inventory information, as far as needed to reconstruct and interpret inventory data and to describe the national system and its functions, is accessible at a single location at the NEPA'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 NEPA's server with daily frequency during the generation of the official submission and weekly in rest of cases.

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

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

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

Programme (attached as Annex 6.1.2) and within the QA/QC Procedure related to the NGHGI, approved by the NEPA's President Decision no. 417/2012.

Further information is provided within Section 1.6.

1.4. Brief general description of methodologies and data sources used

1.4.1. GHG inventory

Estimation methods selection is done according to the provisions in the NEPA's President Decision no. 23/2009 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels.
The emissions from KP Annex A Sectors are estimated following the IPCC 1996, as elaborated by IPCC GPG 2000. Emissions/removals from LULUCF Sector are estimated using IPCC GPG 2003. CORINAIR methodology was applied in case of the NGHGI Solvent and Other Product Use Sector.
The main data sources used for activity data are presented within the following table.

Table 1.3 Main activity data sources

Sector	Data sources
Energy	National Institute for Statistics - Energy Balance Energy producers Ministry of Economy Romanian Civil Aviation Authority Transgaz SA National Authority on Regulating in Energy National Agency for Mineral Resources
Industrial Processes	National Institute for Statistics- Statistical Yearbook and other data sources Industrial operators through 42 Local/Regional Environmental Protection Agencies Direct information from industrial operators
Solvent and other product use	National Institute for Statistics Industrial operators through 42 Local/Regional Environmental Protection Agencies
Agriculture	National Institute for Statistics
LULUCF	National Institute for Statistics through Statistical Yearbook Ministry of Agriculture, Forests and Rural Development (MADR)-Forests General Directorate (2007-2008); Ministry of Environment and Forests-Forests General Directorate (2009-2011) 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 work and the implementation by ISPE and ICAS, in 2011 and 2012, of the studies "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation", "NGHGI LULUCF both under the 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", and,
- 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, and, respectively, no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS, on administrating the LULUCF Sector, both under the UNFCCC and the KP.

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

Due to NEPA's work, to the implementation in 2011 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" and to the implementation of the Protocol of collaboration no. 3136/MMP/9.07.2012, 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 the implementation in 2011 of the study "NGHGI LULUCF both under the UNFCCC and KP obligations", of the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 and of the study "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations", 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, both under the UNFCCC and KP; additionally, the implementation of the study "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" enabled further development of emission/removal factors.

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

1.4.2. KP-LULUCF activities

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

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

1.5.1. GHG inventory

The key category analysis has been performed according to the provisions in Chapter 7 of IPCC GPG 2000 and Chapter 5 of IPCC GPG 2003, both following the Tier 1 and Tier 2 approach.

Separate key category analysis were conducted taking into account both the exclusion and inclusion of the LULUCF sector and also both level and trend criteria; all IPCC sectors and categories, sources and sinks (as suggested in Table 7.1 of IPCC GPG 2000 and in Table 5.4.1 of IPCC GPG 2003), and gases were analyzed. KCA was conducted for every year of the characterized period.

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

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

Taking into account the Tier 1 analysis and the exclusion of the LULUCF sector, in 2011:

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

Taking into account the Tier 1 analysis and the inclusion of the LULUCF sector, in 2011:

- ❖ 29 categories are considered as key ones, both by level and trend;
- ❖ 48 categories are considered as key ones, only by level;
- ❖ 41 categories are considered as key ones, only by trend.

Taking into account the Tier 2 analysis and the exclusion of the LULUCF sector, in 2011:

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

Taking into account the Tier 2 analysis and the inclusion of the LULUCF sector, in 2011:

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

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

- ❖ Oil-CO_2 emissions (IPCC category 1.B.2.a);
- ❖ Solvent and Other Product Use-CO_2 emissions (IPCC category 3);
- ❖ Land converted to Grassland-CO_2 emissions (IPCC category 5.C.2);

- Residential-biomass fuels-N_2O emissions (IPCC category 1.A.4.b);
- Other AWMS-N_2O emissions (IPCC category 4.B.14);
- Refrigeration and Air Conditioning Equipment-HFCs emissions (IPCC category 2.F.1);
- Foam Blowing-HFCs emissions (IPCC category 2.F.2);
- Other-HFCs emissions (IPCC category 2.F.9).

All identified key categories are presented in Table 1.4.

Table 1.4 Key categories associated with the 2013 NGHGI

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2011) Estimate Ex,t
1 A 1 a solid	Public Electricity and Heat Production	CO_2	24378
1 A 3 b diesel oil	Road Transportation	CO_2	9093
1 A 1 a gaseous	Public Electricity and Heat Production	CO_2	6443
1 A 4 b gaseous	Residential	CO_2	5421
4 D 1	Direct Soil Emissions	N_2O	5349
1 A 3 b gasoline	Road Transportation	CO_2	4002
4 A 3	Sheep	CH_4	3557
1 B 2 b	Natural gas	CH_4	3427
4 A 1	Cattle	CH_4	3178
2 A 1	Cement Production	CO_2	3089
2 B 1	Ammonia Production	CO_2	3020
1 A 2 c gaseous	Chemicals	CO_2	2964

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2011) Estimate Ex,t
4 D 3	Indirect Emissions	N_2O	2892
2 C 1	Iron and Steel Production	CO_2	2632
1 A 2 f gaseous	Other	CO_2	2485
1 A 2 a solid	Iron and Steel	CO_2	2483
6 A	SOLID WASTE DISPOSAL ON LAND	CH_4	2476
1 B 2 a	Oil	CH_4	2428
6 B	WASTEWATER HANDLING	CH_4	2253
1 A 1 b liquid	Petroleum refining	CO_2	2210
1 A 2 f solid	Other	CO_2	2121
1 A 2 f liquid	Other	CO_2	1963
1 A 4 a gaseous	Commercial/Institutional	CO_2	1757
2 A 2	Lime Production	CO_2	1260
2 B 2	Nitric Acid Production	N_2O	1210

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2011) Estimate Ex,t
1 A 2 a gaseous	Iron and Steel	CO_2	1191
1 B 2 c Venting	Venting	CH_4	1166
1 A 1 a liquid	Public Electricity and Heat Production	CO_2	1114
1 B 1 a	Coal Mining	CH_4	879
1 A 1 b gaseous	Petroleum refining	CO_2	861
5 F 2	Land converted to Other land	CO_2	835
4 D 2	Pasture, Range and Paddock Manure	N_2O	831
1 A 4 b biomass	Residential	CH_4	830
1 A 4 c liquid	Agriculture/Forestry/Fisheries	CO_2	826
4 B 13	Solid Storage and Dry Lot	N_2O	772
1 A 1 c liquid	Manufacture of Solid fuels and Other Energy Industries	CO_2	762
1 A 2 e gaseous	Food Processing, Beverages and Tobacco	CO_2	761
1 A 2 c liquid	Chemicals	CO_2	734

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2011) Estimate Ex,t
1 A 1 c gaseous	Manufacture of Solid fuels and Other Energy Industries	CO_2	696
6 B	WASTEWATER HANDLING	N_2O	627
1 A 4 b liquid	Residential	CO_2	614
1 A 3 c liquid	Railways	CO_2	593
1 A 5 a liquid	Stationary	CO_2	542
1 A 2 c solid	Chemicals	CO_2	477
4 A 6	Horses	CH_4	464
4 A 4	Goats	CH_4	445
4 B 14	Other AWMS	N_2O	416
1 B 2 a	Oil	CO_2	412
5 E 2	Land converted to Settlements	CO_2	410
2 A 3	Limestone and Dolomite Use	CO_2	408
4 B 8	Swine	CH_4	399

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year (2011) Estimate Ex,t
1 A 3 a jet kerosene	Civil Aviation	CO_2	350
2 F 1	Refrigeration and Air Conditioning Equipment	HFCs	282
2 F 9	Other	HFCs	206
1 A 4 b biomass	Residential	N_2O	200
1 A 4 c gaseous	Agriculture/Forestry/Fisheries	CO_2	163
3	SOLVENT AND OTHER PRODUCT USE	CO_2	131
5 C 2	Land converted to grassland	CO_2	126
1 A 4 b solid	Residential	CO_2	118
2 F 2	Foam Blowing	HFCs	71
2 C 3	Aluminium production	PFCs	23
1 A 1 c solid	Manufacture of Solid fuels and Other Energy Industries	CO_2	11
5 A 2	Land converted to forest land	CO_2	5
5 B 1	Cropland remaining cropland	CO_2	-20292

The results of the key category analysis for 1989 and 2010 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) – 2012-2013 – May 2012 (attached as Annex 6.1.3).

1.5.2. KP-LULUCF activities

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

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

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

1.6.1. QA/QC procedures

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

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

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

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

For this purpose, NEPA 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, NEPA designated a QA/QC coordinator.

The overall objective of the QA/QC Programme is to develop the NGHGI in line with the requirements of the IPCC 1996, IPCC GPG 2000 and IPCC GPG 2003 and with the provisions of the Decision 280/2004/EC of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

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

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

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

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

- ❖ confirming that the national statistical institute and other agencies supplying activity data to NEPA 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 in 2011 and 2012, through the NGHGI improvement studies ("Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation", "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" and "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations") contractors.

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 Decision 280/2004/EC of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission, which provides for a QA activity after the first submission of data on 15th of January and a final QA for all 27 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, NEPA involve third party reviewers at the QA activities level according to the provisions in IPCC-GPG, depending on the availability of resources. In this scope, NEPA is developing the specific procedural arrangements. MECC through its international contacts and bilateral agreements supports NEPA in identifying 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 in 2011, according to the relevant provisions in IPCC GPG 2000, in the context of elaboration 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".

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

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

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

The results of QA checks (excepting those of checks performed under Decisions 280/2004/EC, 166/2005/EC and 406/2009/EC and, respectively, by ERT) are documented in the annual QA checklists for inventory preparation. For this purpose, QA checklists are used consistently throughout the years by all inventory experts involved in the inventory compilation.

1.6.2. Verification activities

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

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

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

1.6.3. Treatment of confidentiality issues

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

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

- automated data validation within the Excel model-validation is implemented on the consideration of any activity data value provided through the Energy Balance and concerning an inventory specific activity, and on the range of the determined country-specific emission factors as defined within the relevant IPCC methodologies; the model is directly linked to the International Energy Agency and Eurostat versions of the Energy Balance provided by the National Institute for Statistics and to the determination of the country-specific or default emission factors spreadsheets (Energy Sector-Stationary Combustion Subsector and Reference Approach);
- manual checks on all spreadsheets part of the model presented at the previous point (Energy Sector-Stationary Combustion Subsector and Reference Approach);
- manual checks on all spreadsheets on renewable fuel combustion; the spreadsheets are directly linked to the International Energy Agency and Eurostat versions of the Energy Balance and to the default emission factors spreadsheets (Energy Sector-Stationary Combustion Subsector and Reference Approach);
- manual checks on all spreadsheets on Fugitive Emissions Subsector; the spreadsheets are directly linked to the International Energy Agency and Eurostat versions of the Energy Balance and to the used emission factors spreadsheets (Energy Sector-Fugitive Emissions Subsector);

- ❖ implementing an analysis on the share of European Union-Emission Trading Scheme to Energy Balance fuel consumption data, in respect to equivalent activity categories (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- ❖ checks specific to country-specific emission factors determination, based on background data reported under the European Union Emission Trading Scheme and validated through the reports of Ministry of Economy accredited verifiers (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- ❖ checks on the correlation between energy demand and energy resources data in the Energy Balance (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- ❖ checks of the outliers on the fuel mix and on the energy consumption data changes, and of double accounting potential cases, together with the Industrial Processes Sector experts (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- ❖ check on the potential double accounting cases through the use of carbon balance (Industrial Processes Sector);
- ❖ implement cross-sectoral checks for emissions from categories calculated using tier 1 default emission factors that do not specifically account for the sources of carbon (Industrial Processes Sector);
- ❖ implementing an analysis on the share of European Union-Emission Trading Scheme to National Greenhouse Gas Inventory data, in respect to equivalent activity categories (Industrial Processes Sector);
- ❖ comparison of activity data on the CH_4 recovery for valorizing from solid waste disposal on land facilities and on the waste incineration with corresponding data in the Energy Sector (Waste Sector-Solid Waste Disposal on Land and Waste Incineration Subsectors);
- ❖ check the potential occurrence of double accounting cases between the Agriculture and Land Use, Land-Use Change and Forestry Sectors (Agriculture and Land Use, Land-Use Change and Forestry Sectors);
- ❖ implementation of a comparative analysis of country-specific emission factors and associated uncertainties with equivalent international data, mostly from the countries having similar national circumstances (technologies, the same fuels sources) (Energy Sector except the Fugitive Emissions Subsector);

- comparison of the Enteric Fermentation and Manure Management Subsectors country-specific emission factors data and information with equivalent international data and information, especially in respect with elements available within countries with similar technical conditions (livestock characteristics, Animal Manure Management Systems characteristics) (Agriculture Sector-Enteric Fermentation and Manure Management Subsectors);
- comparison between Agriculture and Waste Sectors data in the National Greenhouse Gas Inventory and at the level of Food and Agriculture Organization and Eurostat.

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

- increased number of NEPA NS/NGHGI dedicated staff;
- training of NEPA and data providers representatives through several training instruments;
- using a cross-checking QC approach within NEPA;
- applying on a significantly larger scale sector-specific QC, QA and verification activities;
- their implementation also in the context of development in 2011 and 2012 of the NGHGI improvement studies: “Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”, “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” and “Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations”;
- continuous consideration of QA, third party support (collaborations with Austria and Netherlands, implementation of the NGHGI improvement related studies, EU internal reviews, review under Article 8 of the KP).

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

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

1.7.1. GHG inventory

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

The uncertainty calculation was performed for 2011, 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", "NGHGI LULUCF both under the 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" studies), study on Romanian uncertainty information and data performed in 2012 by the Environment Agency of Austria-University of Graz consortium (uncertainty data have been collected through interviews, based on the collaboration between "Environmental Integrated Informational System" study contractor, Environment Agency of Austria-University of Graz consortium, data providers and NEPA), and default AD and EFs uncertainty values.

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

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

- automatic data import from the CRF Reporter application, through the use of CRF Tables;
- integrate both key category and uncertainty analysis performed following both Tier 1 and Tier 2 approach;

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

Considering the version 2 of the 2012 NGHGI and the Tier 1 method:

- the total NGHGI uncertainty for 2010 excluding LULUCF was 18.09%, while including LULUCF was 14.87%;
- the uncertainty introduced into the trend in total national emissions, for 2010, was 1.9% when considering excluding LULUCF criteria and 2.24%, including LULUCF.

Considering the 2013 NGHGI and the Tier 1 method:

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

Based on data and information associated with the 2013 NGHGI, a important contribution of LULUCF Sector at the uncertainty data presented in paragraph above can be observed.
Uncertainty data associated with the 2013 NGHGI is the result of a significant update of the version 2 of the 2012 NGHGI related data, based on the study on Romanian uncertainty information and data performed in 2012 by the Environment Agency of Austria-University of Graz consortium.

Based on version 2 of the 2012 NGHGI, it can be concluded that most of the total NGHGI uncertainty and uncertainty introduced into the trend in total national emissions related values significantly decreased within the version 2 of the 2012 NGHGI comparing with the version 3 of the 2011 NGHGI due to the implementation in 2011 of the studies which conducted to a significant increase of the NGHGI quality, through the collection/processing/development of more accurate and complete data, and to the inclusion within the 2012 version 2 NGHGI of these elements.

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

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

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

1.8. *General assessment of the completeness*

1.8.1. GHG inventory

The inventory covers all sectors and all gases in the period 1989-2011 and is complete in terms of geographical coverage. Emissions are presented by sector, by sub-sector and by gas.

There are still some gaps in the inventory, such as the estimation of emissions from asphalt roofing and road paving with asphalt, due to the lack of national/default method and emission factors.

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

1.8.2. KP-LULUCF

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

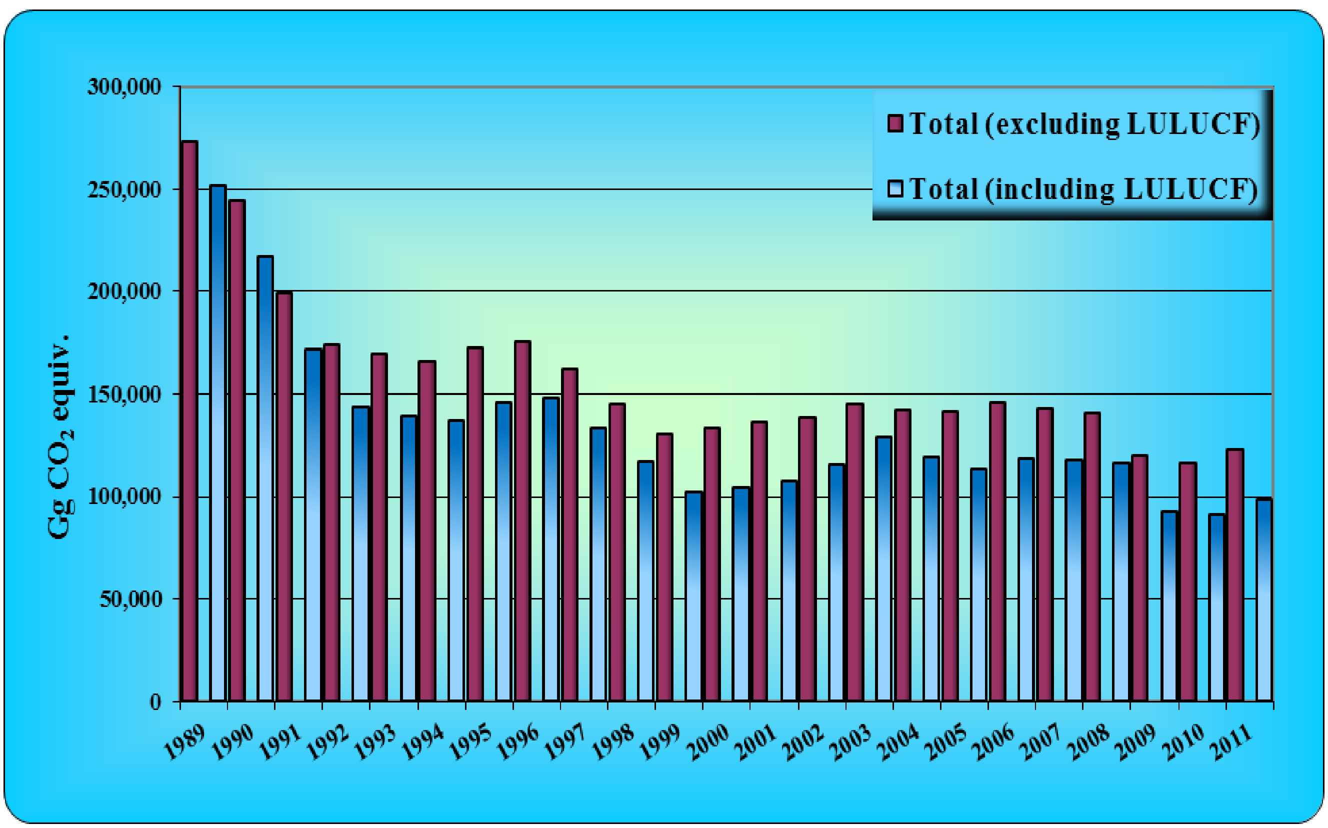
2 TRENDS IN GREENHOUSE GAS EMISSIONS

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

The total GHG emissions in 2011, excluding removals by sinks, amounted to 123,345.54 Gg CO_2 equivalents. According to the provisions of the Kyoto Protocol, Romania has committed itself to reduce the GHG emissions by 8% in 2008-2012 considering the base year (1989) levels.

The total GHGs emissions (without considering sinks) decreased with 54.86 % in 2011 in comparison to 1989 while the net GHG emissions/removals (taking into account the CO_2 removals) decreased with 61.05 %. 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 2011 comparing with 2008.

2.2 Description and interpretation of emissions trends by gas

All GHG emissions, except HFCs and SF_6, decreased comparing with the base year. The shares of GHG emissions have not significantly changed during the period. The largest contributor to total GHG emissions is CO_2, followed by CH_4 and N_2O. In the base year, the shares of GHG emissions were: 71.53% CO_2, 17.03% CH_4, 10.21% N_2O, 1.23% PFCs. In 2011, the shares of GHG emissions were: 71.30% CO_2, 18.05% CH_4, 10.28% N_2O, 0.01% PFCs. The F gases started to be used as substitutes for ODS in refrigerating and air conditioning systems since 1995. In 2011, the contribution of these gases to the total GHG emissions is negligible: 0.3572% HFCs and 0.00584% SF_6. Next table presents the trend of the aggregated emissions, split by gas.

Table 2.1 Trends by gas [Gg CO_2 equivalent]

Year	CO_2 including LULUCF	CO_2 excluding LULUCF	CH_4 excluding LULUCF	N_2O excluding LULUCF	HFCs	PFCs	SF_6
1989	173,936.58	195,449.25	46,540.15	27,893.98	NA,NE,NO	3349.56	NA,NE,NO
1990	148,202.98	175,558.40	42,806.27	23,923.07	NA,NE,NO	2115.83	NA,NE,NO
1991	116,074.56	144,054.02	35,753.92	17,761.83	NA,NE,NO	1942.09	NA,NE,NO
1992	94,463.06	125,128.26	31,413.45	16,156.61	NA,NE,NO	1352.13	NA,NE,NO
1993	90,530.41	120,472.95	30,420.97	17,060.96	NA,NE,NO	1409.43	NA,NE,NO
1994	89,723.19	118,378.34	30,440.02	15,784.94	NA,NE,NO	1490.97	NA,NE,NO
1995	96,765.12	123,957.69	30,568.21	16,395.94	95.04	1773.69	0.06
1996	100,146.75	127,334.73	30,121.62	16,079.31	97.64	1769.07	0.06
1997	87,517.90	116,148.66	28,663.94	15,245.29	123.94	1786.59	0.02
1998	74,276.81	102,580.61	26,693.07	14,307.56	154.37	1753.54	0.01
1999	60689.28	89,365.92	25,861.07	13,796.09	151.42	1603.62	0.05
2000	63,169.82	92,390.27	26,397.54	13,282.36	163.43	1292.37	0.00
2001	66,191.92	95,209.39	26,410.49	13,378.22	216.79	1044.49	0.00
2002	74,657.66	97,027.25	27,191.13	13,041.31	239.47	717.86	0.01
2003	86,875.27	103,274.73	27,281.29	13,956.81	292.50	261.51	17.83
2004	78,196.05	101,140.88	26,377.81	14,258.94	367.96	132.60	22.64
2005	71,326.95	99,392.02	26,334.77	15,215.04	487.21	81.90	49.56
2006	77,027.64	104,893.43	25,999.77	14,223.03	641.10	55.03	67.76
2007	77,698.92	102,920.86	24,949.18	13,910.54	840.45	24.23	58.39
2008	75,765.83	100,080.80	25,088.20	14,373.27	890.27	15.34	16.33
2009	55,098.50	83,356.44	24,057.26	12,163.21	703.10	7.00	7.38
2010	55,086.60	80,920.70	22,584.36	12,408.07	695.05	7.93	5.09
2011	62,640.87	87,949.27	22,258.13	12,679.45	440.55	10.92	7.21

Carbon dioxide (CO_2) – the most significant anthropogenic greenhouse gas is the carbon dioxide. The decrease of CO_2 emissions (from 195,449.25 Gg in 1989 to 87,949.27 Gg in 2011) is caused by the decline of the amount of fossil fuels burnt in the energy sector (especially in the public electricity and heat production, and manufacturing industries and constructions sectors) as a consequence of activity decline.

Methane (CH_4) – the methane emissions, related mainly to the Fugitive emissions from fossil fuels extraction and distribution and to the livestock, decreased in 2011 by 52.17% compared with the levels in 1989. The decrease of CH_4 emissions in Agriculture is due to the decrease of the livestock level.

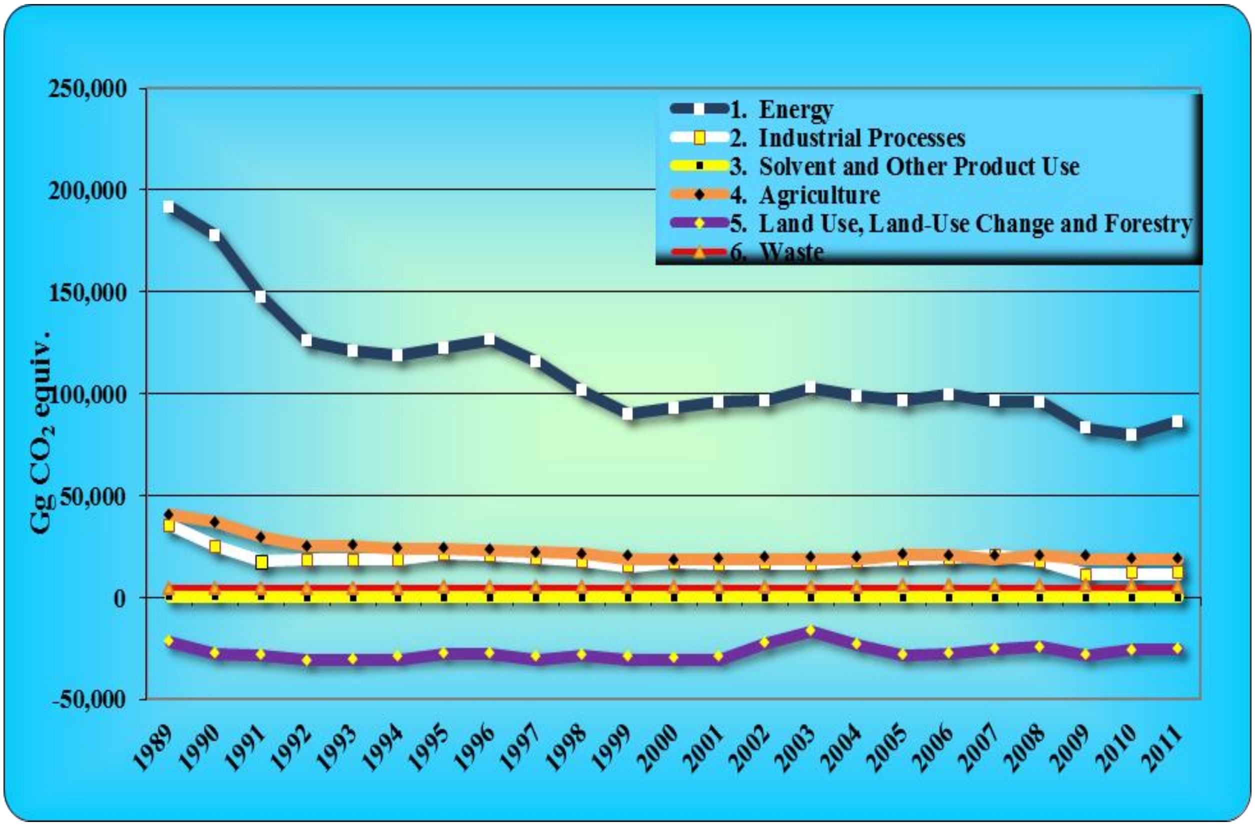
Nitrous oxide (N_2O) – the N_2O emissions are mainly generated within the Agricultural Soils activities in the Agriculture sector and within the Chemical industry activities in the Industrial Processes sector. The decline of these activities (decline of livestock, decline of N synthetic fertilizer applied on soils amounts, decrease of the crop productions level) is reflected in the N_2O emissions trend. The N_2O emissions in 2011 decreased with 54.54% in comparison with the level in the base year.

Fluorocarbons and SF_6 (HFCs, PFCs, SF_6) – the F-gases started to be used as substitutes for ODS in refrigerating and air conditioning systems since 1995; therefore the emissions resulted as a consequence of the use of these substances and are estimated beginning with the same year. The PFCs emissions generated in the production of the primary aluminium are reported for the entire analyzed period (1989-2011) and have decreased with 99.67% in 2011 comparing with the level in 1989).

2.3 Description and interpretation of emissions trends by category

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

Figure 2.2 Trends by sector



Energy represents the most important sector in Romania. The Energy sector accounted for 69.98% of the total national GHG emissions in 2011. The GHG emissions resulted from the Energy sector decreased with 55.00% compared with the base year.

Industrial Processes contributes to total GHG emissions with 10.21%. A significant decrease of GHG emissions was registered in this sector (64.40% decreases in 2011 compared to the level in 1989) due to the decline or the termination of certain production activities.

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

The GHG emissions level decreased in 2011 by 80.55% in comparison with the level recorded in 1989.

Agriculture GHG emissions have also decreased. The GHG emissions in 2011 are 53.50% 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.

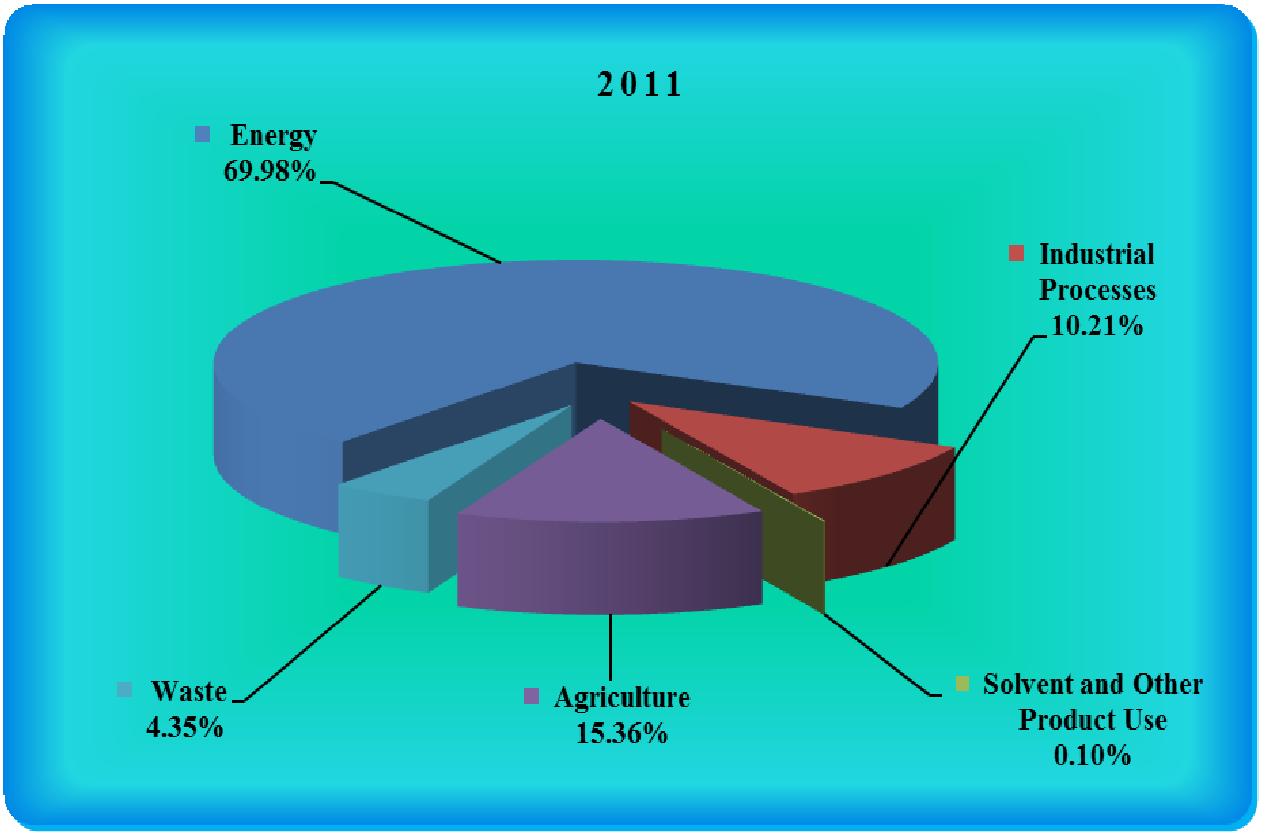
In 2011, 15.36 % of the total GHG emissions resulted from the agriculture sector.

LULUCF The net GHG removals/emissions level is 17.63 % higher in 2011 in comparison with the level in the base year. The Romanian land use sector acts as a net sink, at an average uptake of 25,304.94 Gg/year, being relatively stable over the last 22 years.

Waste sector emissions have increased in 2011 with 14.91% in comparison with the level in 1989. The contribution of the waste sector to the total GHG emissions in 2011 is 4.35%.

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

Figure 2.3 Sectorial GHG emissions in 2011 [%]



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

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

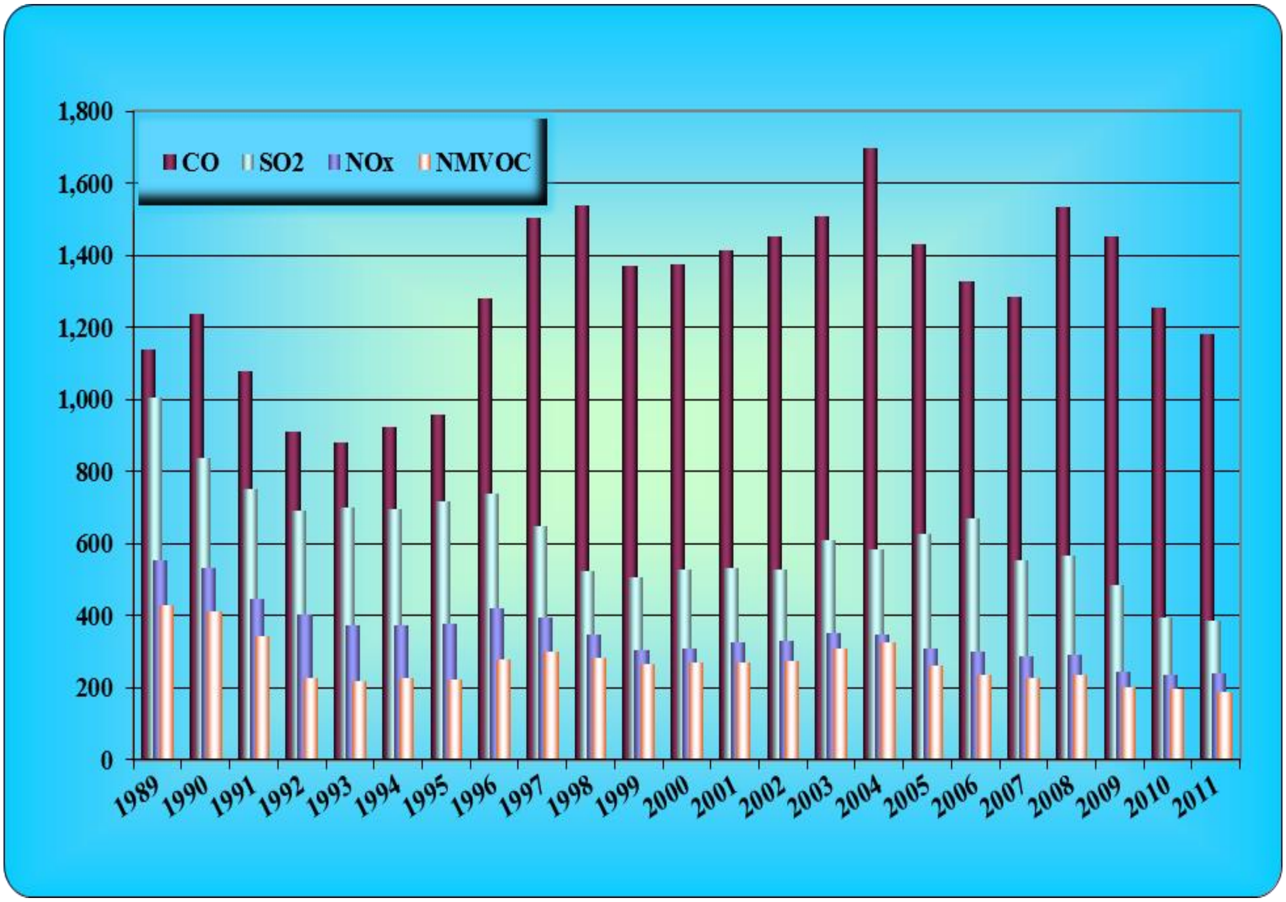
The NO_x, NMVOC and SO_2 emissions evolution follows the general direct GHG emissions trend. The SO_2 emissions decrease is caused by the decline of the fuels burnt for energy and the decrease of sulphur content in fuels.

The indirect GHG emissions trends are presented in Figure 2.4.

Table 2.2 Indirect GHG emissions levels [Gg]

Year	NO_x	CO	NMVOC	SO_2
1989	554.86	1,139.11	427.58	1,006.57
1990	532.92	1,237.88	412.00	839.03
1991	445.16	1,078.88	343.46	750.61
1992	400.62	909.17	224.26	691.02
1993	373.17	878.36	215.95	700.77
1994	372.21	924.21	225.47	693.07
1995	376.53	956.39	223.27	715.44
1996	419.38	1,278.79	278.73	739.00
1997	395.36	1,505.77	298.40	646.91
1998	344.63	1,538.53	282.38	522.71
1999	301.72	1,370.86	263.11	507.36
2000	307.13	1,372.94	268.22	528.60
2001	323.36	1,411.69	270.03	532.84
2002	329.86	1,451.46	272.26	528.90
2003	351.02	1,506.83	308.19	610.00
2004	346.05	1,695.40	322.95	583.44
2005	306.80	1,431.89	262.53	627.19
2006	299.74	1,326.04	235.37	670.88
2007	285.78	1,284.74	224.06	555.01
2008	291.42	1,534.04	235.78	565.09
2009	243.51	1,453.97	200.24	483.66
2010	234.23	1,254.68	196.70	393.57
2011	237.38	1,180.95	189.27	383.88

Figure 2.4 Indirect GHG emissions trends [Gg]



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

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

3 ENERGY (CRF Sector 1)

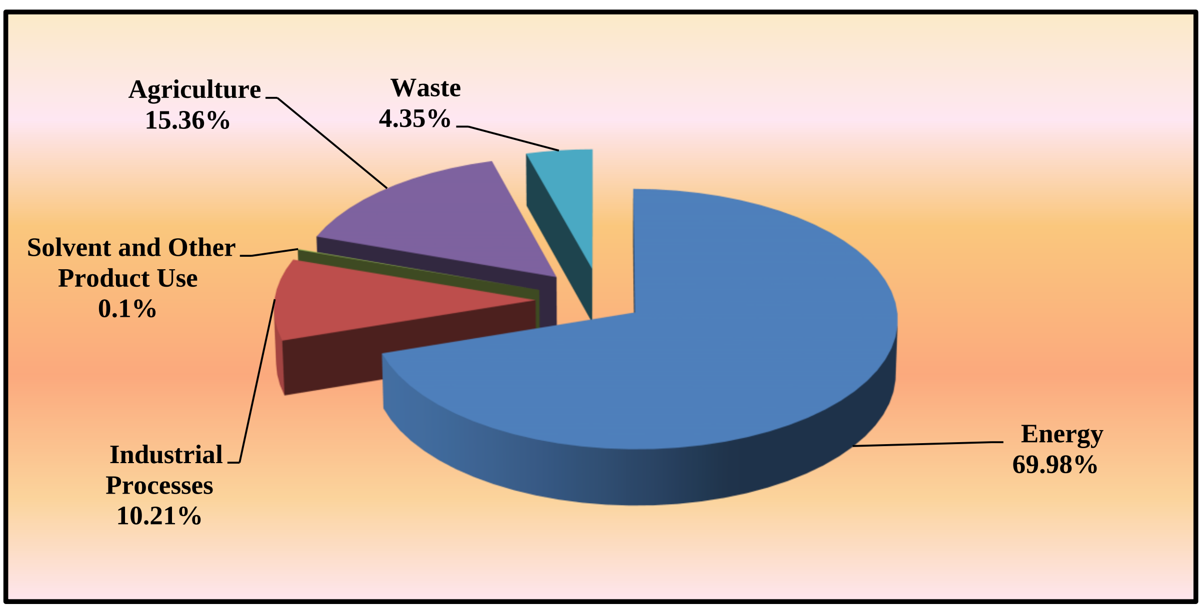
3.1 Overview of the sector

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

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

Compared to the other GHG emissions sectors (Industrial Processes, Agriculture, LULUCF, Waste), the Energy sector represents the largest source of anthropogenic GHG emissions in Romania. In 2011, the Energy sector was responsible for about 69.98% of the total GHG emissions 123,345.54 Gg CO_2 equivalents.

Figure 3.1 The contribution of Energy Sector to the total GHG emissions in Romania, 2011



Emission trends

In 2011, emissions from the Energy sector have decreased by 54.99% (86,320.46) Gg CO_2 equivalent compared to 191,809.14 Gg CO_2 equivalent in 1989, base year.

Figure 3.2 Total GHG emissions from Energy Sector

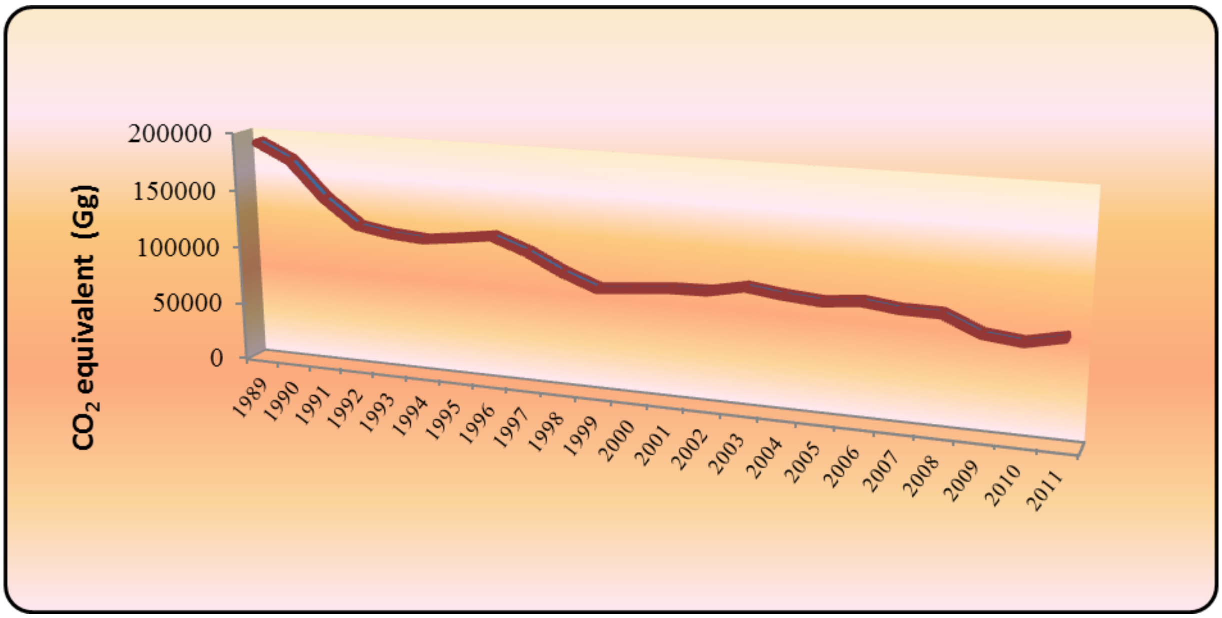
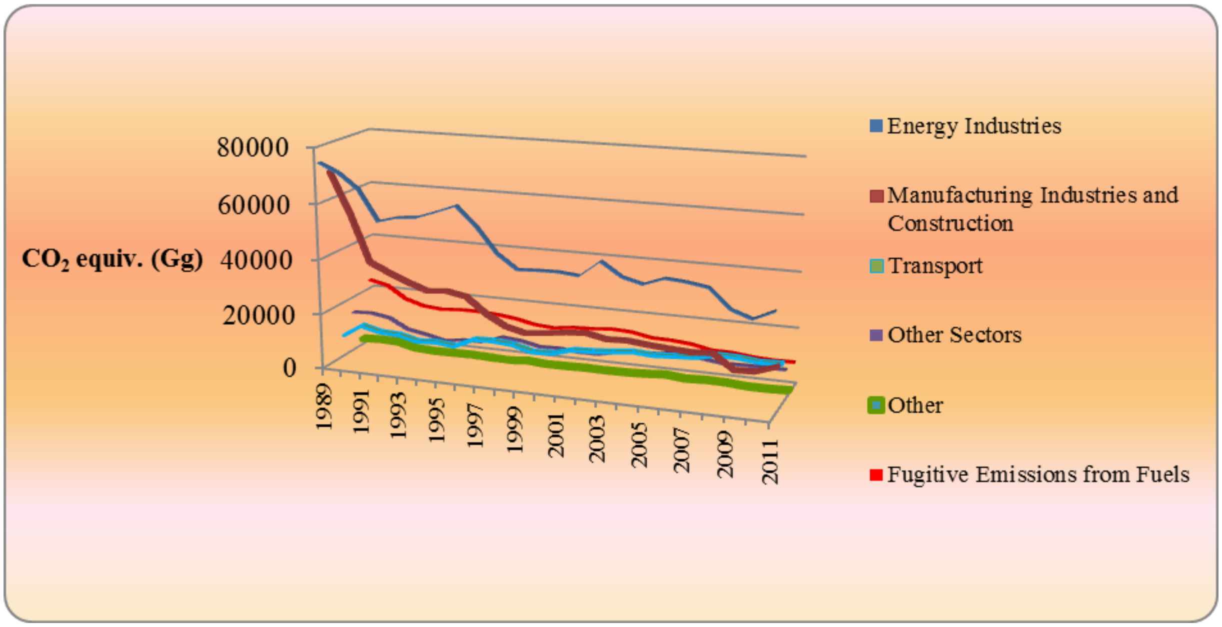


Table 3.1 GHG emissions and their trends for the years 1989-2011 - Energy Sector

Year	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1989	169,024.41	1,065.56	1.32	191,809.14
1990	156,430.43	998.83	1.17	177,768.20
1991	130,562.83	787.04	1.02	147,408.26
1992	111,074.42	685.13	0.99	125,769.01
1993	106,802.29	655.93	1.00	120,888.33
1994	104,043.12	683.92	0.98	118,709.29
1995	107,565.66	686.98	1.06	122,320.62

Year	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1996	111,666.92	684.53	1.27	126,435.38
1997	101,748.48	652.61	1.32	115,861.25
1998	88,767.41	577.70	1.13	101,250.83
1999	78,154.66	552.49	1.05	90,082.38
2000	80,011.63	597.61	1.07	92,894.36
2001	82,838.66	603.00	1.00	95,810.37
2002	83,265.86	620.51	1.03	96,617.33
2003	89,620.93	612.46	1.19	102,850.19
2004	86,650.12	567.92	1.24	98,959.43
2005	84,340.73	561.57	1.51	96,602.11
2006	88,145.53	527.79	1.55	99,709.24
2007	85,842.41	466.45	1.57	96,123.48
2008	85,491.60	473.51	1.71	95,965.23
2009	73,238.56	435.47	1.59	82,877.82
2010	70,267.42	422.21	1.58	79,624.01
2011	76,903.63	423.79	1.67	86,320.46

Figure 3.3 The energy sector emission trend for the period 1989-2011



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.

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

Table 3.2 Shares of GHG emission categories within the Energy sector, in 2011

Energy sector-categories	**Percentages for 2011**
Energy industries	42.43%
Manufacturing Industries and Construction	18.26%
Transports	16.89%
Other sectors	11.82%
Other	0.70%
Fugitive emissions	9.91%

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

Figure 3.4 The different GHG's contribution to the 2011 Energy emissions

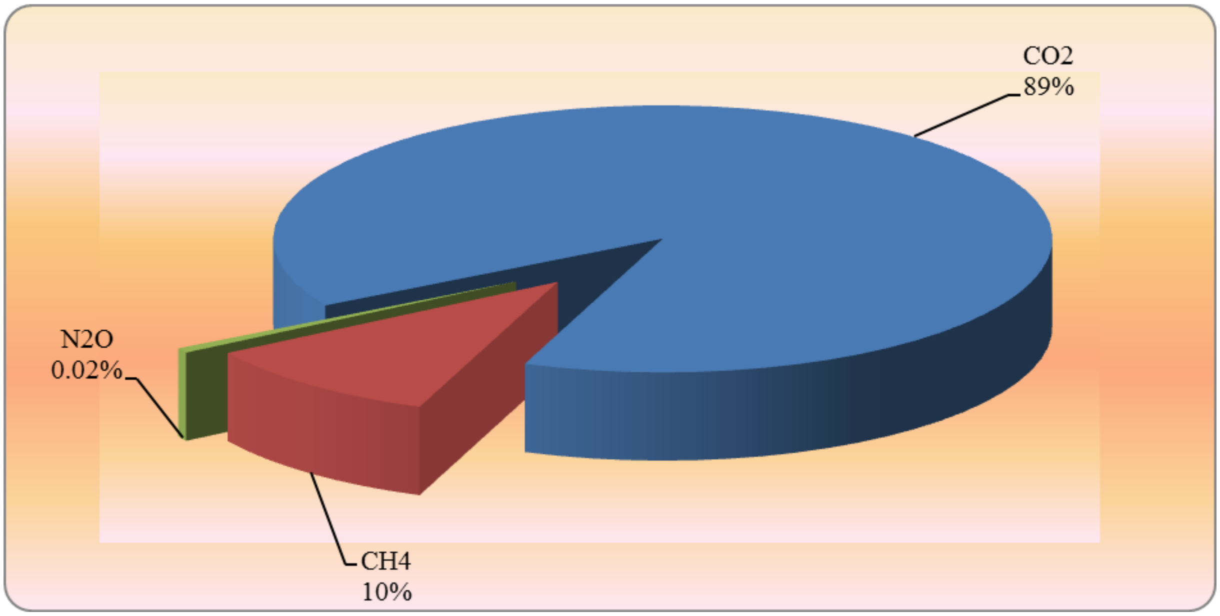


Table 3.3 Status of emissions estimation within the Energy Sector for 2011

IPCC category-Energy Sector	**Emissions estimation status**		
	CO_2	**CH_4**	**N_2O**
1AA Fuel Combustion – Sectorial Approach			
1.A.1. Energy Industries			
1.A.1.a. Public Electricity and Heat Production	✓	✓	✓
1.A.1.b. Petroleum Refining	✓	✓	✓
1.A.1.c. Manufacture of solid fuels and other energy industries	✓	✓	✓
1.A.2. Manufacturing Industries and Construction	✓	✓	✓
1.A.2.a. Iron and steel	✓	✓	✓
1.A.2.b. Non ferrous metals	✓, NO, IE	✓, NO, IE	✓,NO, IE
1.A.2.c. Chemicals	✓	✓	✓
1.A.2.d. Pulp paper and print	✓	✓	✓

IPCC category-Energy Sector	Emissions estimation status		
	CO_2	CH_4	N_2O
1.A.2.e. Food processing, beverages and tobacco	✓	✓	✓
1.A.2.f. Other (as specified in table 1.A(a)s2)	✓	✓	✓
1.A.3. Transport			
1.A.3.a. Civil Aviation	✓	✓	✓
1.A.3.b. Road Transportation	✓	✓	✓
1.A.3.c. Railways	✓	✓	✓
1.A.3.d. Navigation	✓	✓	✓
1.A.3.e. Other Transportation - pipeline	✓	✓	✓
1.A.4. Other Sectors	✓	✓	✓
1.A.4.a. Commercial/institutional	✓	✓	✓
1.A.4.b. Residential	✓	✓	✓
1.A.4.c. Agriculture/Forestry/Fisheries	✓	✓	✓
1.A.5. Other	✓	✓	✓
1.A.5.a.Stationary	✓	✓	✓
1.A.5.b.Mobile	✓	✓	✓
1B Fugitive Emissions from Fuels			
1.B.1.Solid Fuels			
1.B.1.a. Coal Mining and handling	NA	✓	NA
1.B.1.a.i. Underground mines	NA	✓	NA
1.B.1.a.i.1. Post - Mining Underground activites	NA	✓	NA
1.B.1.a.i.1. Surface mines	NA	✓	NA
1.B.1.a.i.1. Post - Mining Surface activites	NA	✓	NA
1.B.1.b. Solid fuel transformation	NA	NO	NA
1.B.1.c. Other	NA	NA	NA
1.B.2. Oil and Natural Gas			
1.B.2.a. Oil	✓	✓	✓
1.B.2.a.i. Venting oil	✓	✓	NA

IPCC category-Energy Sector	Emissions estimation status		
	CO_2	CH_4	N_2O
1.B.2.a.ii. Flaring oil	✓	✓	✓
1.B.2.a.iii.1. Exploration	✓	✓	NA
1.B.2.a.iii.2. Production and upgrading	✓	✓	NA
1.B.2.a.iii.3. Transport	✓	✓	NA
1.B.2.a.iii.4. Refining and storage	NA	✓	NA
1.B.2.a.iii.5. Distribution of oil products	NA	NA	NA
1.B.2.a.iii.6. Other	NO	NO	NO
1.B.2.b. Natural Gas	✓	✓	✓
1.B.2.b.i. Venting gas	✓	✓	NA
1.B.2.b.ii. Flaring gas	✓	✓	✓
1.B.2.b.iii.1. Exploration	IE[1)]	IE[1)]	NA
1.B.2.b.iii.2. Production/Processing	NA	✓	NA
1.B.2.b.iii.3. Transmission	✓	✓	NA
1.B.2.b.iii.4. Distribution and storage	✓	✓	NA
1.B.2.b.iii.5. Other Leakage	NE	✓	NA
1.B.2.b.iii.5.1. at industrial plants and power station	NE	✓	NA
1.B.2.b.5.iii.2. in the residential and commercial sectors	NE	✓	NA
1.B.2.d.iii.6. Other	✓	IE, NA	NA
1.C. Memo items			
1.C.1. International Bunkers			
1.C.1.a. Aviation	✓	✓	✓
1.C.1.b. Marine	✓	✓	✓
1.C.2. Multilateral Operations	NE	NE	NE
1.C.3. CO_2 Emissions from Biomass	✓	NA	NA
1.A.B. Fuel Combustion – Reference Approach	✓		

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

3.1.1 Key sources

Table 3.4 Key categories overview - Energy 2011

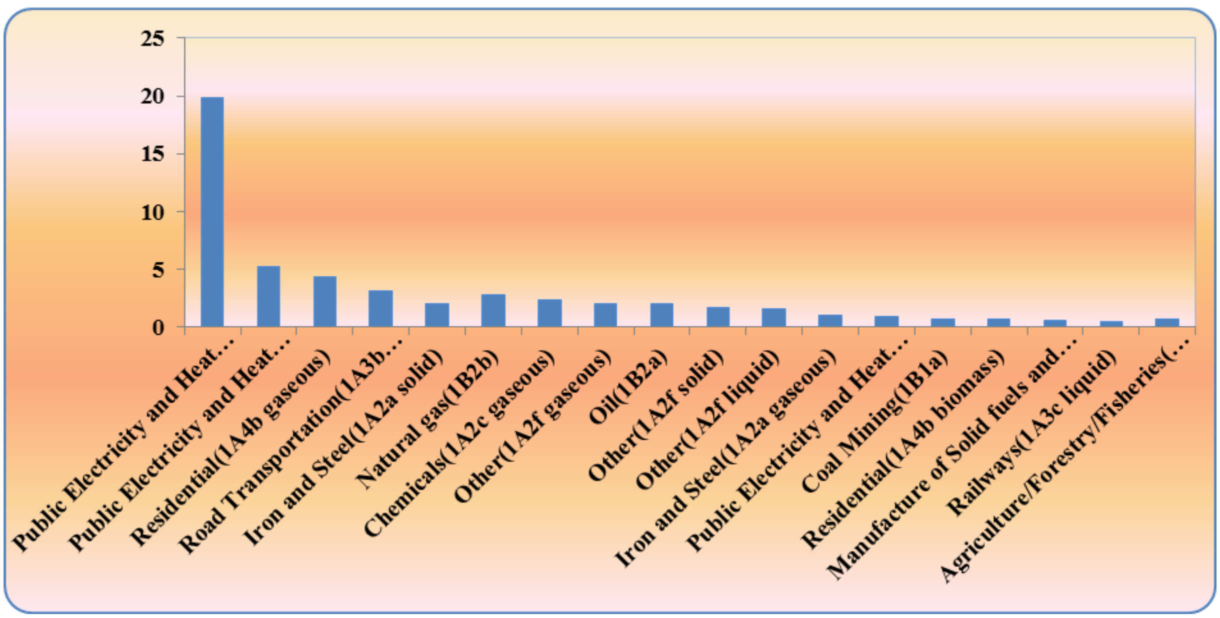
Key categories		GHG	Criteria	Contribution in total GHG emissions [%]
1 A 1 a solid	Public Electricity and Heat Production	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(L,T excluding; L,T including LULUCF)	19.80
1 A 3 b diesel oil	Road Transportation	CO_2	Tier 1(L excluding; L including LULUCF), Tier 2(L excluding; L including LULUCF)	7.40
1 A 1 a gaseous	Public Electricity and Heat Production	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(L,T excluding; T includind LULUCF)	5.20
1 A 4 b gaseous	Residential	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(L,T excluding; T including LULUCF)	4.40
1 A 3 b gasoline	Road Transportation	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(L,T excluding; L,T including LULUCF)	3.20
1 A 2 a solid	Iron and Steel	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(L excluding)	2.00
1 B 2 b	Natural gas	CH_4	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(L,T excluding; L,T including LULUCF)	2.80
1 A 2 c gaseous	Chemicals	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(T excluding; T including LULUCF)	2.40

Key categories		GHG	Criteria	Contribution in total GHG emissions [%]
1 A 2 f gaseous	Other	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(T excluding; T including LULUCF)	2.00
1 B 2 a	Oil	CH_4	Tier 1(L excluding; L including LULUCF), Tier 2(L,T excluding; L including LULUCF)	2.00
1 A 2 f solid	Other	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(T excluding; T including LULUCF)	1.70
1 A 1 b liquid	Petroleum refining	CO_2	Tier 1(L excluding; L including LULUCF)	1.80
1 A 4 a gaseous	Commercial/Institutional	CO_2	Tier 1(L excluding; L including LULUCF)	1.40
1 A 2 f liquid	Other	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(T excluding; T including LULUCF)	1.60
1 A 2 a gaseous	Iron and Steel	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(T excluding; T including LULUCF)	1.00
1 B 2 c Venting	Venting	CH_4	Tier 1(L excluding; L including LULUCF), Tier 2(L excluding; L,T including LULUCF)	0.90
1 A 1 a liquid	Public Electricity and Heat Production	CO_2	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(T excluding; T including LULUCF)	0.90
1 B 1 a	Coal Mining	CH_4	Tier 1(L ,T excluding; L,T including LULUCF), Tier 2(L,T excluding; L,T including LULUCF)	0.70
1 A 1 b gaseous	Petroleum refining	CO_2	Tier 1(L excluding; L including LULUCF)	0.70

Key categories		GHG	Criteria	Contribution in total GHG emissions [%]
1 A 4 b biomass	Residential	CH_4	Tier 1(L ,T excluding; L, T including LULUCF), Tier 2(L,T excluding; L, T including LULUCF)	0.70
1 A 2 e gaseous	Food Processing, Beverages and Tobacco	CO_2	Tier 1(L excluding; L including LULUCF)	0.70
1 A 2 c liquid	Chemicals	CO_2	Tier 1(L excluding; L including LULUCF)	0.60
1 A 1 c liquid	Manufacture of Solid fuels and Other Energy Industries	CO_2	Tier 1(L ,T excluding; L,T including LULUCF)	0.60
1 A 1 c gaseous	Manufacture of Solid fuels and Other Energy Industries	CO_2	Tier 1(L excluding; L including LULUCF)	0.60
1 A 4 b liquid	Residential	CO_2	Tier 1(L ,T excluding; L,T including LULUCF)	0.50
1 A 3 c liquid	Railways	CO_2	Tier 1(L ,T excluding; L,T including LULUCF)	0.50
1 A 2 c solid	Chemicals	CO_2	Tier 1(L excluding; L including LULUCF)	0.40
1 A 4 b biomass	Residential	N_2O	Tier 2(T excluding; T includind LULUCF)	-
1 A 4 c liquid	Agriculture/Forestry/Fisheries	CO_2	Tier 1(L ,T excluding; L,T including LULUCF)	0.70
1 A 4 b solid	Residential	CO_2	Tier 1(T excluding; T including LULUCF), Tier 2(T includingLULUCF)	-
1 A 4 c gaseous	Agriculture/Forestry/Fisheries	CO_2	Tier 1(T excluding; T including LULUCF)	-
1 A 5 a liquid	Stationary	CO_2	Tier 1(L excluding; L including LULUCF)	0.40
1 A 1 c solid	Manufacture of Solid fuels and Other Energy Industries	CO_2	Tier 1(T excluding; T including LULUCF)	-

Key categories		GHG	Criteria	Contribution in total GHG emissions [%]
1 A 3 a jet kerosene	Civil Aviation	CO_2	Tier 1(T excluding; T including LULUCF)	-
1 B 2 a	Oil	CO_2	Tier 2(L excluding; L includind LULUCF)	-

Figure 3.5 Key categories, both by level and trend criteria, overview – Energy Sector, 2011



3.2 Fuel combustion (CRF 1.A)

3.2.1 Comparison of the sectorial approach with the reference approach

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

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

- Reference Approach;
- Sectorial Approach.

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

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

The Reference Approach (RA) is a method for estimating CO_2 combustion emissions using a simplified methodology. For the purpose of the RA the apparent consumption of each fuel is calculated. The conversion factor used to calculate the apparent energy consumption for solid fuels was obtained calculating the weighted average NCV from the NCVs of production, imports and exports. The elements on NCVs used within the Reference Approach are included in Annex 2.

The Sectoral Approach is a more detailed methodology (a bottom-up method), using the fuel consumption for each of the Subsectors:

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

Methodology

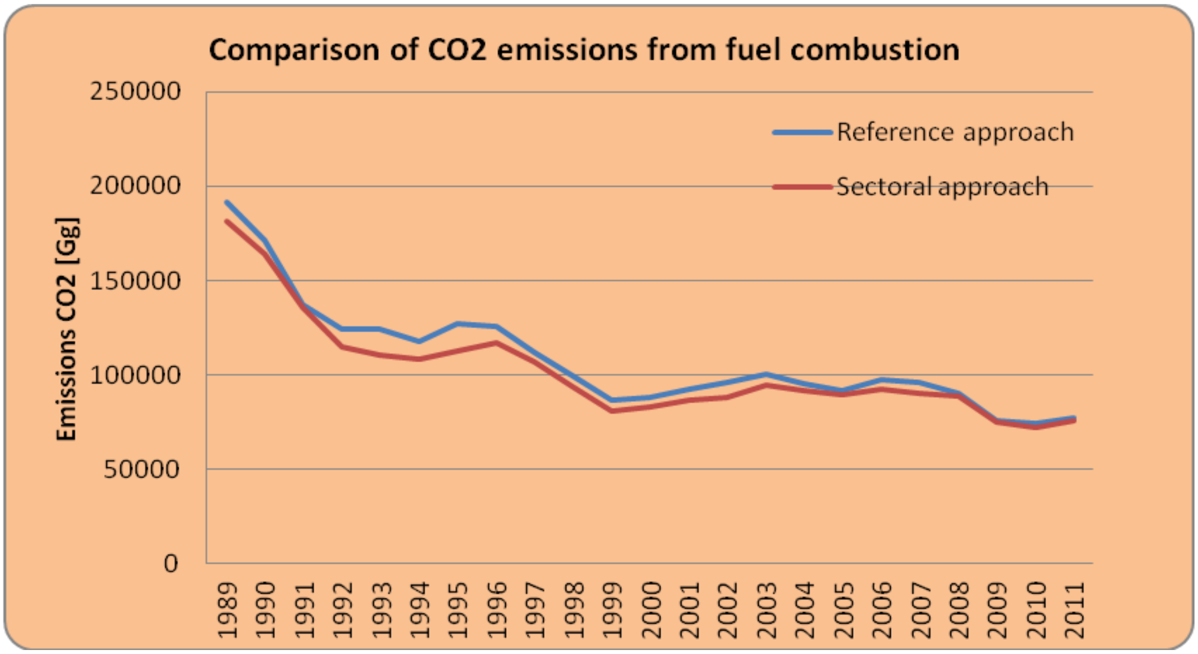
The applied methodologies are in accordance with the IPCC Worksheets provisions. For the fuels having associated determined country-specific emission factors (CS EFs) Tier 2 method is applied. For the fuels having associated default emission factors, Tier 1 method is applied.

According to the information provided by the NIS, some operators, reporting under the EU ETS for the years 2007–2010, had reported quantities of industrial waste co-incinerated in cement installations as biomass and not as industrial waste. In order to avoid the potential underestimation of emissions in the inventory, from these emissions was subtracted the percentage representing real biomass, and the CO_2 emissions were accounted under the energy sector – corresponding activity category (1A2f). In order not influence the RA-SA difference, the consumption and the corresponding CO_2 emissions were also added in the Reference Approach, as production of industrial wastes and corresponding emissions.

Regarding the ERT observation that the energy consumption values for several oil products are consistently higher in the IEA data than in the CRF tables (for lubricants, around 20 per cent higher; for bitumen, around 11 per cent; for residual fuel oil and gasoline around 1 to 2 per cent, respectively), Romania, as declared before, uses the National Statistics Institute activity data provided through the Energy Balance an reported also to EUROSTAT and IEA. Also, as conversion factor, the NCVs reported through the Energy Balance and assumed for the entire time series, is used. For the above type of fuels, for the Reference Approach estimations, it was taken into account the fraction of carbon stored in products which was subtracted from the carbon content. Therefore, the IEA data and CRF table must be the same. Further investigation will performed and corresponding results will be included in the next submission.

Results of the Reference Approach

Figure 3.6 Comparisonof the sectorial approach with the reference approach



The following tables compare the energy consumption and the emissions according to both approaches in terms of all fuels, liquid fuels, solid fuels, gaseous fuels, other fuels.

Table 3.5 Comparison of the sectorial approach with the reference approach (all fuels)

Year	Energy consumption [PJ]		Difference [%]	CO_2 emissions [Gg]		Difference [%]
	Reference approach	Sectorial approach		Reference approach	Sectorial approach	
1989	2,614.29	2,474.24	5.66	180,481.17	167,624.54	7.67
1990	2,372.64	2,302.72	3.04	162,152.15	155,217.32	4.47
1991	1,918.13	1,919.27	-0.06	131,240.21	129,527.88	1.32
1992	1,678.89	1,605.40	4.58	121,162.25	110,016.54	10.13
1993	1,668.93	1,535.74	8.67	119,522.76	105,731.49	13.04
1994	1,579.10	1,503.01	5.06	112,355.30	102,969.15	9.12
1995	1,702.41	1,555.42	9.45	120,865.98	106,497.22	13.49
1996	1,673.46	1,605.02	4.26	119,434.72	110,616.71	7.97
1997	1,455.58	1,461.00	-0.37	105,546.80	100,717.54	4.79
1998	1,327.21	1,289.21	2.95	93,992.26	87,765.95	7.09
1999	1,160.05	1,121.91	3.40	82,521.35	77,179.16	6.92
2000	1,170.77	1,143.61	2.37	84,185.44	79,049.62	6.50
2001	1,217.16	1,178.74	3.26	87,856.91	81,885.93	7.29
2002	1,249.84	1,188.49	5.16	90,463.36	82,044.03	10.26
2003	1,316.34	1,271.00	3.57	94,850.21	88,431.94	7.26
2004	1,229.32	1,226.96	0.19	89,173.13	85,772.86	3.96
2005	1,172.84	1,192.08	-1.61	85,842.14	83,439.67	2.88
2006	1,255.62	1,235.60	1.62	92,023.59	87,226.71	5.50
2007	1,205.44	1,183.82	1.83	90,752.41	85,075.53	6.67
2008	1,155.37	1,181.32	-2.20	86,987.24	84,767.81	2.62
2009	992.61	1,020.85	-2.77	73,787.36	72,556.22	1.70
2010	982.92	994.67	-1.18	72,056.78	69,615.58	3.51
2011	1,068.88	1,077.40	-0.79	78,792.78	76,257.39	3.32

Table 3.6 Comparison of the sectorial approach with the reference approach (liquid fuels)

Year	Energy consumption [PJ]		Difference [%]	CO_2 emissions [Gg]		Difference [%]
	Reference approach	Sectorial approach		Reference approach	Sectorial approach	
1989	682.57	562.20	21.41	49,535.09	41,178.80	20.29
1990	726.99	672.91	8.04	53,238.43	49,523.78	7.50
1991	578.22	561.57	2.96	42,686.15	41,537.66	2.76
1992	459.95	452.20	1.71	33,753.73	33,321.07	1.30
1993	510.56	431.34	18.37	37,595.54	31,838.21	18.08
1994	468.36	426.57	9.80	34,264.46	31,239.71	9.68
1995	533.10	432.25	23.33	39,047.29	31,545.74	23.78
1996	526.34	496.96	5.91	38,817.91	36,645.78	5.93
1997	512.65	520.48	-1.51	37,787.57	38,205.05	-1.09
1998	456.38	450.76	1.25	33,849.51	32,846.27	3.05
1999	376.10	356.78	5.42	28,029.09	26,168.77	7.11
2000	361.11	359.78	0.37	26,952.13	26,326.65	2.38
2001	423.55	419.74	0.91	31,539.28	30,649.49	2.90
2002	398.81	397.12	0.43	29,774.88	28,825.61	3.29
2003	392.97	380.56	3.26	29,232.42	27,487.60	6.35
2004	352.60	383.49	-8.05	26,410.36	27,829.52	-5.10
2005	331.38	384.54	-13.83	25,004.39	27,995.63	-10.68
2006	352.79	362.29	-2.62	26,880.39	26,462.37	1.58
2007	341.75	365.78	-6.57	25,952.78	26,395.38	-1.68
2008	326.51	361.30	-9.63	24,707.51	26,186.38	-5.65
2009	287.37	331.11	-13.21	21,765.90	23,855.05	-8.76
2010	292.55	314.93	-7.11	22,017.38	22,613.33	-2.64
2011	306.69	326.95	-6.20	22,700.98	23,598.12	-3.80

Table 3.7 Comparison of the sectorial approach with the reference approach (solid fuels)

Year	Energy consumption [PJ]		Difference [%]	CO_2 emissions [Gg]		Difference [%]
	Reference approach	Sectorial approach		Reference approach	Sectorial approach	
1989	587.21	567.54	3.47	56,716.86	52,141.40	8.78
1990	438.24	422.40	3.75	42,253.58	38,965.93	8.44
1991	343.56	361.34	-4.92	33,545.93	32,926.43	1.88
1992	406.65	356.46	14.08	39,064.39	32,349.43	20.76
1993	363.54	349.81	3.92	35,248.52	31,911.10	10.46
1994	367.51	344.52	6.67	35,709.60	31,237.28	14.32
1995	375.50	356.54	5.32	36,562.28	32,249.82	13.37
1996	373.00	357.12	4.45	36,326.19	32,420.33	12.05
1997	326.66	299.81	8.95	31,769.98	27,070.56	17.36
1998	265.94	246.90	7.71	25,915.42	22,227.44	16.59
1999	239.98	238.72	0.53	23,316.29	21,917.94	6.38
2000	266.54	254.49	4.74	25,889.71	23,387.58	10.70
2001	264.14	250.38	5.50	25,645.00	23,012.03	11.44
2002	300.61	258.35	16.36	29,247.50	23,639.35	23.72
2003	326.08	315.28	3.43	31,682.34	29,077.68	8.96
2004	316.30	303.87	4.09	30,720.83	28,030.96	9.60
2005	299.87	292.80	2.42	29,174.21	26,921.56	8.37
2006	335.36	337.48	-0.63	32,593.83	31,095.12	4.82
2007	359.55	337.23	6.62	35,650.76	32,290.49	10.41
2008	355.07	343.72	3.30	34,494.55	31,986.11	7.84
2009	292.23	290.12	0.72	27,972.15	26,541.75	5.39
2010	267.59	271.15	-1.31	25,305.87	24,269.18	4.27
2011	332.17	336.42	-1.26	30,818.71	29,576.22	4.20

Table 3.8 Comparison of the sectorial approach with the reference approach (gaseous fuels)

Year	Energy consumption [PJ]		Difference [%]	CO_2 emissions [Gg]		Difference [%]
	Reference approach	Sectorial approach		Reference approach	Sectorial approach	
1989	1,344.51	1,344.51	-0.00	74,229.22	74,304.34	-0.10
1990	1,207.41	1,207.41	-	66,660.15	66,727.60	-0.10
1991	996.36	996.36	-	55,008.13	55,063.80	-0.10
1992	887.38	785.71	1.98	47,422.46	43,422.10	9.21
1993	853.10	744.77	5.40	45,858.39	41,159.85	11.42
1994	777.03	730.42	1.55	42,255.92	40,366.52	4.68
1995	805.55	754.90	3.13	43,981.54	41,719.71	5.42
1996	813.01	749.21	3.09	44,145.75	41,405.36	6.62
1997	667.31	639.52	-3.82	35,890.64	35,343.07	1.55
1998	627.38	591.55	2.25	34,227.33	32,692.24	4.70
1999	574.89	526.42	3.33	31,175.97	29,092.44	7.16
2000	572.75	526.50	2.39	31,007.85	29,096.91	6.57
2001	551.81	504.57	3.07	29,886.64	27,884.65	7.18
2002	570.61	528.75	3.21	31,049.79	29,221.24	6.26
2003	616.69	572.33	3.71	33,626.00	31,629.77	6.31
2004	583.53	536.40	3.77	31,726.24	29,644.36	7.02
2005	582.94	512.08	5.06	31,365.11	28,300.25	10.83
2006	594.47	533.83	5.67	32,266.56	29,502.32	9.37
2007	534.32	478.22	4.31	28,704.44	26,172.20	9.68
2008	509.09	473.08	-0.75	27,430.77	26,323.70	4.21
2009	442.98	397.64	3.33	23,871.07	21,991.57	8.55
2010	451.69	405.56	3.50	24,482.48	22,478.87	8.91
2011	464.95	410.58	3.90	24,986.17	22,795.13	9.61

Table 3.9 Comparison of the sectorial approach with the reference approach (other fuels industrial wastes)

Year	Energy consumption [PJ]		Difference [%]	CO_2 emissions [Gg]		Difference [%]
	Reference approach	Sectorial approach		Reference approach	Sectorial approach	
1989	NO	NA,NO	NO	NO	NA,NO	NO
1990	NO	NA,NO	NO	NO	NA,NO	NO
1991	NO	NA,NO	NO	NO	NA,NO	NO
1992	11.04	11.04	-	921.67	923.94	-0.25
1993	9.82	9.82	-	820.30	822.32	-0.25
1994	1.50	1.50	-0.00	125.33	125.64	-0.25
1995	15.27	11.73	30.15	1,274.87	981.95	29.83
1996	1.74	1.74	-	144.87	145.23	-0.25
1997	1.18	1.18	-	98.61	98.86	-0.25
1998	NO	NA,NO	NO	NO	NA,NO	NO
1999	NO	NA,NO	NO	NO	NA,NO	NO
2000	4.02	2.85	41.14	335.75	238.48	40.79
2001	9.41	4.06	131.90	785.98	339.76	131.33
2002	4.69	4.28	9.59	391.20	357.84	9.32
2003	3.71	2.83	30.95	309.45	236.89	30.63
2004	3.78	3.20	18.08	315.71	268.02	17.79
2005	3.57	2.66	34.61	298.43	222.24	34.28
2006	3.39	1.99	69.86	282.81	166.91	69.44
2007	5.32	2.58	105.94	444.43	217.46	104.37
2008	4.24	3.21	32.13	354.41	271.62	30.48
2009	2.13	1.98	7.56	178.24	167.85	6.19
2010	3.01	3.03	-0.66	251.06	254.20	-1.24
2011	3.44	3.45	-0.32	286.92	287.94	-0.35

Explanation of Differences

A comparison between the RA and the SA indicates differences in both the energy consumption data and CO_2 emissions, -1.34% in terms of energy consumption and, 1.69 % in terms of CO_2 emissions for 2011.

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

Due to the fact that recalculations were performed in the Sectoral Approach in regards of the subtraction of the non-energy use from iron and steel production - petroleum coke; chemicals - refinery gas and naphtha; other (manufacturing industries and construction) - naphtha, refinery gas, residual fuel oil, white spirit, petroleum coke and other petroleum products, transport - diesel, the RA-SA difference was affected in the sense of decreasing of this difference.

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

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

The highest differences between the two approaches are observed in the period 1992-1996, and most notably in 1993 and in 1995.

The analysis showed that the main reason for this are the differences in liquid fuels consumption resulting from the significant amounts of refinery loses reported (5.5% of total refinery intake in 1995 was reported as refinery losses) and the reported statistical differences.

Recalculation performed in Reference Approach

- ***Liquid Fuels* - Activity data**
  - Transport Diesel: NCV of Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
  - for the following type of fuels, correction on the Stock Changes associated with the 2009 year was conducted: *Natural Gas Liquids, Gas/Diesel Oil (Transport Diesel), Residual Fuel Oil*;
  - for the following type of fuels, the Energy Balance provides correction on the Stock Changes, for 2010 year: *Crude Oil, Natural Gas Liquids, LPG, Motor Gasoline, Kerosene Type Jet Fuel, Gas/Diesel Oil (Transport Diesel), Heating and Other Gas Oil, Residual Fuel Oil, Lubricants, Petroleum Coke, Other Products*;
  - *Paraffin Wax* fuel, the Energy Balance provides correction on the Imports, for 2010 year;
  - *Additives Oxygenates*: the fuel was added, as secondary fuel (aggregated with the Refinery Feedstock's fuel), for the entire time-series reported through the Energy Balance;
  - *Other Hydrocarbons*: the fuel was added as primary fuel (as Orimulsion), for the entire time-series reported through the Energy Balance;
  - *Petroleum Coke* reported as Non-energy use in the industry sector was analyzed: the carbon stored in the Petroleum Coke has been subtracted from the carbon content of this fuel, for the entire time-series reported through the Energy Balance.

- ***Solid Fuels* - Activity Data**
  - *Coking Coal:* 2010 year - correction of the Stock Changes provided through the Energy Balance;

- *Peat:* 2003–2005 period - correction of the Indigenous production provided through the Energy Balance; 2004, 2005 years - correction of the Imports provided through the Energy Balance; 2010 year - correction of the Stock Changes provided through the Energy Balance;
- *BKB & Patent Fuels*: the Other Solid Fuel – Patent Fuels was deleted and the values were moved under *BKB & Patent Fuels;*
- *Coke Oven Coke:* 2003 year - correction of the Imports provided through the Energy Balance.
- *Coke Oven Coke:* 1989 – 2010 period – the non-energy use of the fuel in blast furnace, Iron and Steel Production activity, from the Reference Approach was subtracted.

- ***Solid Fuels* - CO_2 emission factors**
  - *Coking Coal:* correction of the CO_2 EF (country specific EF was changed with a default EF);
  - *Coke Oven Coke:* 1989–2010 period - correction of the CO_2 EF (default EF was changed with a country specific EF).
- ***Gaseous Fuels* - Activity data**
  - *Natural gas:* 2005–2010 period - correction of the Stock Changes provided through the Energy Balance.
- ***Other Fuels - Activity data***
  - *Industrial Wastes*: 1995, 1998, 1999, 2000–2002, 2006, 2007 years - corrections of the Indigenous Production provided through the Energy Balance were made; 1995, 2000–2002, 2006, 2007 - corrections of the Stock Changes provided through the Energy Balance were made.
- ***Other Fuels* - CO_2 emission factors**
  - *Industrial Wastes*: country specific EFs were determinate, for the entire time-series.

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

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

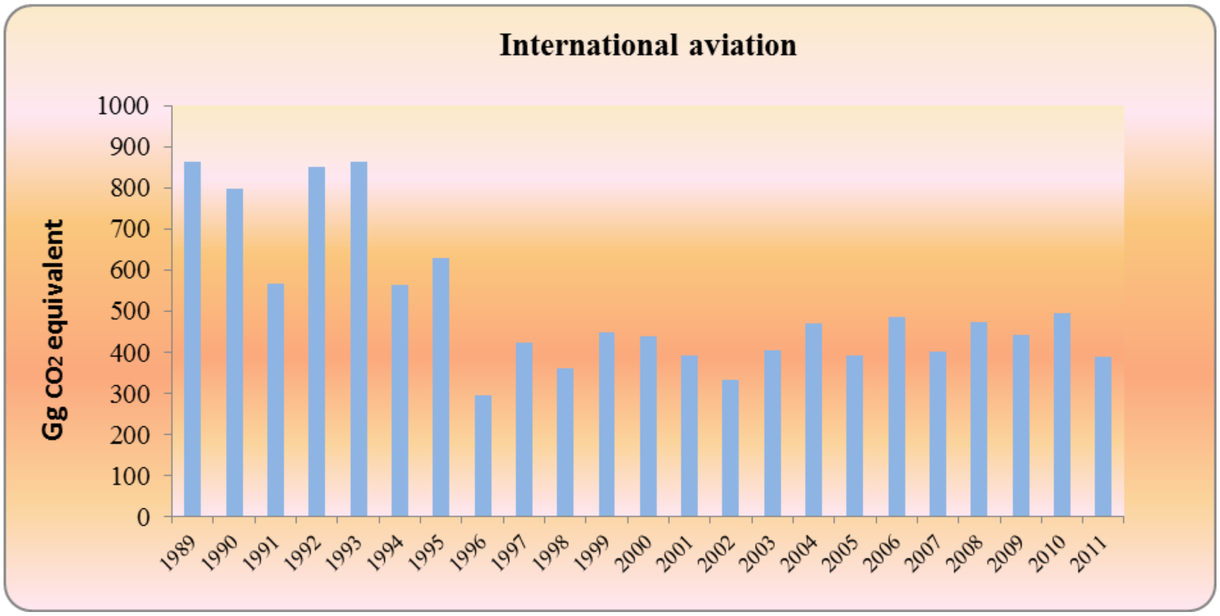
3.2.2.1 International Aviation (CRF Sector 1.C.1.A)

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

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

In 2011 the emissions from International Aviation Subsector represent 2.68% of total emissions from the transport sector (14,577.72 Gg CO_2 equivalent).

Figure 3.7 GHG emissions from International Aviation Subsector



In the 1989-2011 period increases and decreases of emissions due to fluctuations in the number of flights.

In 2011 year, fuel consumption level in International Aviation Subsector decreased by 22.97% compared with the one associated with 2010.

Figure 3.8 Fuel consumption associated with the International Aviation Subsector, 1989-2011 period

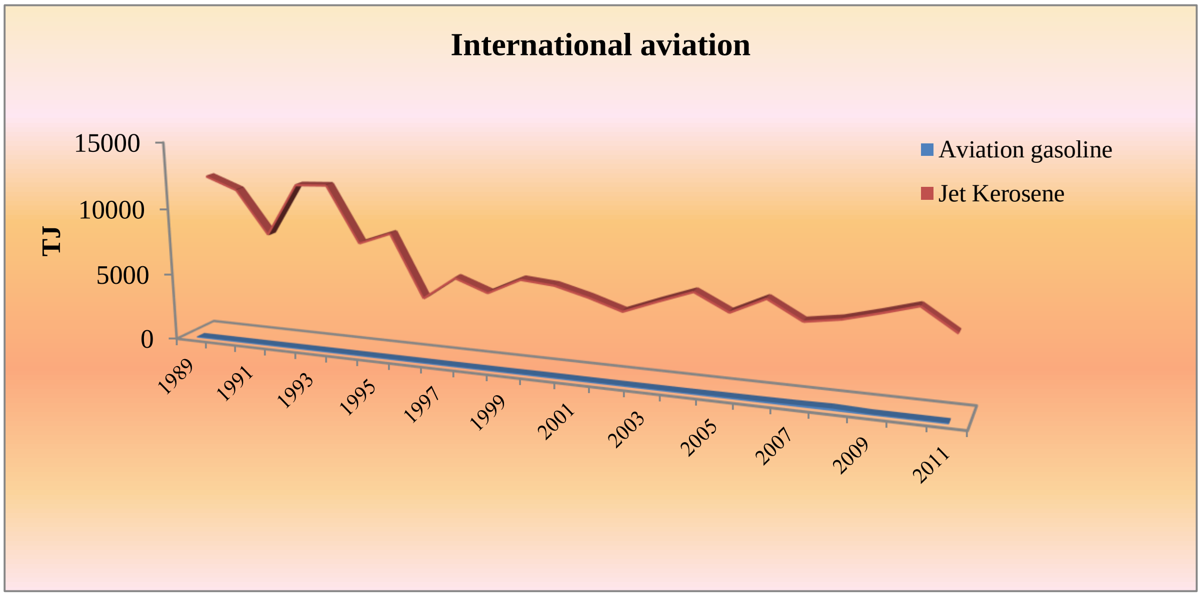


Table 3.10 Fuel consumption (Aviation gasoline and Jet Kerosene), emission factor and CO_2 emissions data

	Aviation Gasoline		**EF CO_2**	**CO_2 emission**	**Jet Kerosene**		**EF CO_2**	**CO_2 emission**
Year	**TJ**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**TJ**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**
1989	4.92E-05	44,534	70,000	3.38E-06	11950.61	48,778	71,500	854.4686
1990	0.001024	44,534	70,000	7.03E-05	11072.61	48,778	71,500	791.6913
1991	0.006042	44,534	70,000	0.000415	7853.258	48,778	71,500	561.5079
1992	0.021267	44,534	70,000	0.001459	11804.28	48,778	71,500	844.0057
1993	0.056412	44,534	70,000	0.00387	11950.61	48,778	71,500	854.4686
1994	0.125136	44,534	70,000	0.008585	7804.48	48,778	71,500	558.0203
1995	0.24536	44,534	70,000	0.016833	8731.262	48,778	71,500	624.2852

	Aviation Gasoline		EF CO_2	CO_2 emission	Jet Kerosene		EF CO_2	CO_2 emission
1996	0.439549	44,534	70,000	0.030156	4097.352	48,778	71,500	292.9607
1997	0.734961	44,534	70,000	0.050423	5853.36	48,778	71,500	418.5152
1998	1.163867	44,534	70,000	0.079849	4975.356	48,778	71,500	355.738
1999	0.91994	44,534	70,000	0.063114	6194.806	48,778	71,500	442.9286
2000	10.32965	44,534	70,000	0.708686	5999.694	48,778	71,500	428.9781
2001	5.697436	44,534	70,000	0.390884	5365.58	48,778	71,500	383.639
2002	3.312099	44,534	70,000	0.227233	4585.132	48,778	71,500	327.8369
2003	4.027407	44,534	70,000	0.276308	5560.692	48,778	71,500	397.5895
2004	3.621294	44,534	70,000	0.248446	6487.474	48,778	71,500	463.8544
2005	19.94225	44,534	70,000	1.368178	5268.024	48,778	71,500	376.6637
2006	28.08332	44,534	70,000	1.926713	6487.474	48,778	71,500	463.8544
2007	43.977	43,977	70,000	3.07839	5137.65	48,930	71,500	366.2008
2008	87.924	43,962	70,000	6.15468	5546.502	47,406	71,500	408.0524
2009	NO	43,960	70,000	NO	6226.29	49,415	71,500	439.441
2010	NO	43,960	70,000	NO	6957.081	49,341	71,500	491.7554
2011	NO	43,960	70000	NO	5358.747	48,277	71,500	387.1266

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

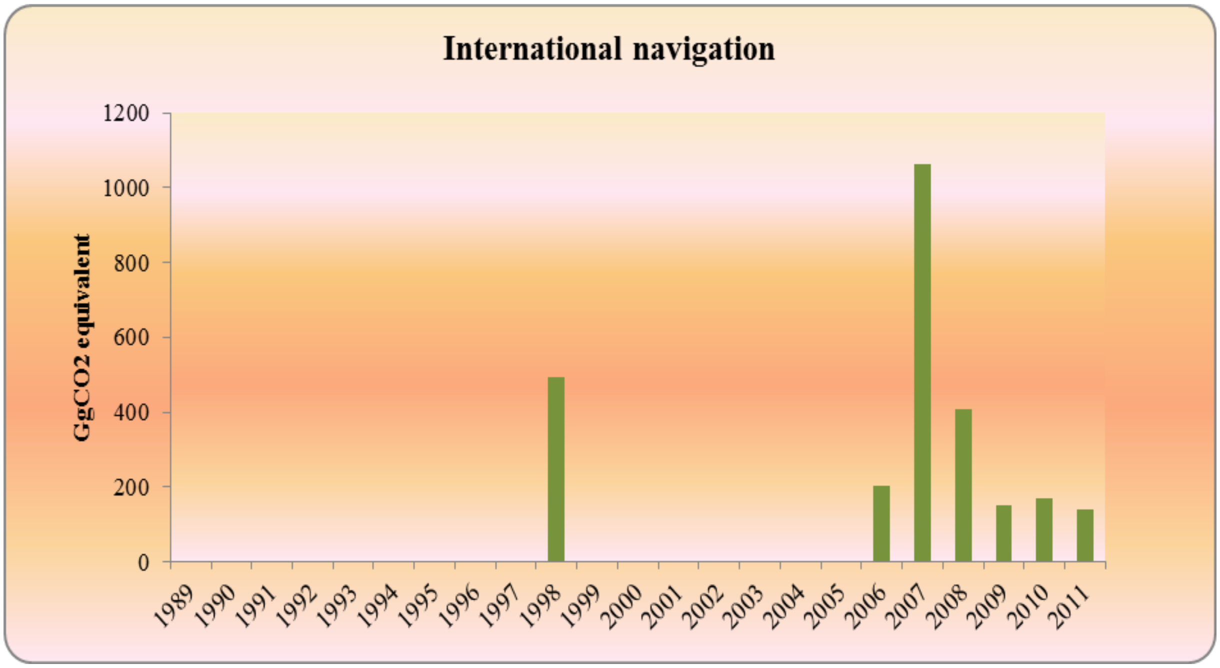
The values of CH_4 and N_2O emissions for Domestic and International Aviation were calculated for each cycle type of aircraft flight (kg fuel/ LTO) using the IPCC 2006 methodology vol 2, chapter 3 Table 3.6.9, page 3.70 (see Annex 3.1).

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

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

In 2011 the emissions from International Navigation Sub-sector represent 0.95% of total emissions from the transport sector (14,577.72 Gg CO_2 equivalent).

Figure 3.9 The GHG emissions trend



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

In 2011, the fuel consumption level associated with the International Navigation Sub-sector decreased by 18.18% compared with the one associated with 2010.

Figure 3.10 Fuel consumption associated with the International Navigation Subsector, 1989-2011 period

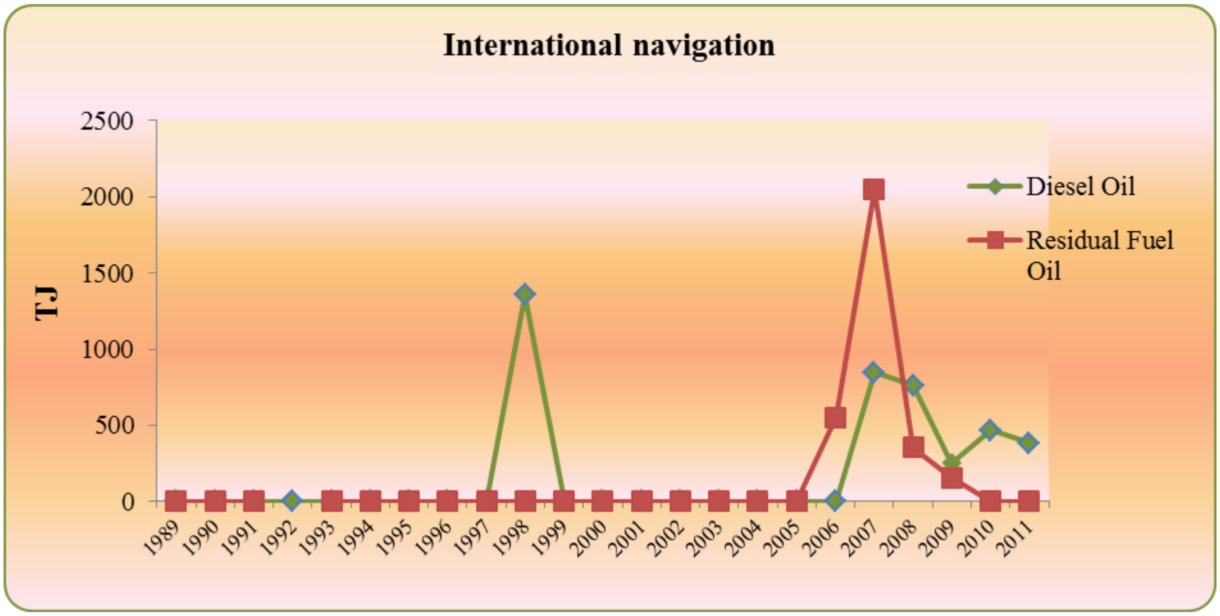


Table 3.11 Fuel consumption (Residual Fuel Oil), emission factors and emissions data

	Residual Fuel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion(TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	40,000	78.15	NO	5	NO	0.6	NO
1990	NO	39,350	78.15	NO	5	NO	0.6	NO
1991	NO	39,350	78.15	NO	5	NO	0.6	NO
1992	NO	39,350	78.15	NO	5	NO	0.6	NO
1993	NO	39,350	78.15	NO	5	NO	0.6	NO
1994	NO	39,350	78.15	NO	5	NO	0.6	NO
1995	NO	39,350	78.15	NO	5	NO	0.6	NO
1996	NO	39,350	78.15	NO	5	NO	0.6	NO

	Residual Fuel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
1997	NO	39,350	78.15	NO	5	NO	0.6	NO
1998	NO	39,350	78.15	NO	5	NO	0.6	NO
1999	NO	39,350	78.15	NO	5	NO	0.6	NO
2000	NO	39,350	78.15	NO	5	NO	0.6	NO
2001	NO	39,350	78.15	NO	5	NO	0.6	NO
2002	NO	39,350	78.15	NO	5	NO	0.6	NO
2003	NO	39,350	78.15	NO	5	NO	0.6	NO
2004	NO	39,350	78.15	NO	5	NO	0.6	NO
2005	NO	39,350	78.15	NO	5	NO	0.6	NO
2006	550.9	39,350	78.15	42.6245	5	550.9	0.6	0.33054
2007	2046.2	39,350	78.15	158.3196	5	2046.2	0.6	1.22772
2008	354.15	39,350	78.15	27.40146	5	354.15	0.6	0.21249
2009	157.4	39,350	78.15	12.17843	5	157.4	0.6	0.09444
2010	NO	39,350	78.15	NO	5	NO	0.6	NO
2011	NO	39,350	79.49	NO	5	NO	0.6	NO

Table 3.12 Fuel consumption (Diesel Oil), emission factors and emissions data

	Diesel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion(TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	42,600	73.29	NO	5	NO	0.6	NO
1990	NO	42,435	73.29	NO	5	NO	0.6	NO
1991	NO	42,435	73.29	NO	5	NO	0.6	NO
1992	NO	42,435	73.29	NO	5	NO	0.6	NO
1993	NO	42,435	73.29	NO	5	NO	0.6	NO

	Diesel Oil		**EF CO_2**	**CO_2 emission**	**EF CH_4**	**CH_4 emission**	**EF N_2O**	**N_2O emission**
1994	NO	42,435	73.29	NO	5	NO	0.6	NO
1995	NO	42,435	73.29	NO	5	NO	0.6	NO
1996	NO	42,435	73.29	NO	5	NO	0.6	NO
1997	NO	42,435	73.29	NO	5	NO	0.6	NO
1998	1357.92	42,435	73.29	98.52125	5	6.7896	0.6	0.8148
1999	NO	42,435	73.29	NO	5	NO	0.6	NO
2000	NO	42,435	73.29	NO	5	NO	0.6	NO
2001	NO	42,435	73.29	NO	5	NO	0.6	NO
2002	NO	42,435	73.29	NO	5	NO	0.6	NO
2003	NO	42,435	73.29	NO	5	NO	0.6	NO
2004	NO	42,435	73.29	NO	5	NO	0.6	NO
2005	NO	42,435	73.29	NO	5	NO	0.6	NO
2006	NO	42,435	73.29	NO	5	NO	0.6	NO
2007	848.7	42,435	73.29	61.57578	5	4.2435	0.6	0.5092
2008	763.83	42,435	73.29	55.4182	5	3.81915	0.6	0.4583
2009	254.61	42,435	73.29	18.47273	5	1.27305	0.6	0.1528
2010	466.785	42,435	73.29	33.86668	5	2.333925	0.6	0.2801
2011	381.915	42,435	72.92	27.7091	5	1.909575	0.6	0.2291

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

3.2.3 Feedstock and non-energy use of fuels

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

In response of ERT recommendation, "Romania further investigate and elaborate on the non-energy use of fuels reported in the energy balance, which is not reported in the energy sector, and assess whether the country specific carbon storage factors are appropriate", Romania investigated the non-energy use of fuels reported in the energy balance; consequently, Romania subtracted the non-energy use from the Sectoral Approach and the fraction of the carbon stored in the products in the Reference Approach.

Methodology

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

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

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

Table 3.13 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	178.10	2,792.38	6.38
1990	138.50	2,511.15	5.52
1991	124.32	2,042.45	6.09
1992	158.25	1,837.14	8.61
1993	149.02	1,817.95	8.20
1994	124.60	1,703.70	7.31
1995	125.91	1,828.33	6.89
1996	144.57	1,818.03	7.95
1997	155.09	1,610.67	9.63
1998	130.14	1,457.35	8.93
1999	117.13	1,277.17	9.17
2000	123.07	1,293.84	9.51
2001	126.00	1,343.16	9.38
2002	138.86	1,388.70	10.00
2003	132.69	1,449.04	9.16
2004	153.56	1,382.87	11.10
2005	175.49	1,348.33	13.02
2006	168.31	1,423.93	11.82
2007	182.72	1,388.16	13.16
2008	168.68	1,324.05	12.74
2009	122.36	1,114.97	10.97
2010	120.12	1,103.04	10.89
2011	99.18	1,168.06	8.49

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 9.3% of the total apparent energy consumption during the period 1989-2011, and a 8.5% for 2011.

Table 3.14 Apparent consumption of non-energy fuels

Non-energy cons. [TJ]	Lubricants	Bitumen	Naphtha	LPG	Natural Gas as Feedstock	Coal Oil and Tars	Refinery gas	Motor Gasoline	Kerosene Type Jet Fuel
1989	14,742.00	18,369.00	NO	NO	NO	10,088.65	5,295.07	NO	NO
1990	11,934.00	14,556.24	NO	NO	NO	8,068.75	2,069.89	NO	NO
1991	11,021.40	13,325.64	NO	NO	NO	4,201.98	914.60	NO	NO
1992	8,424.00	12,341.16	NO	NO	86,135.40	8,371.76	NO	NO	NO
1993	4,633.20	11,286.36	NO	NO	68,090.40	5,572.48	NO	NO	NO
1994	3,439.80	11,884.08	43.95	NO	35,304.30	6,842.52	NO	NO	NO
1995	4,001.40	12,657.60	NO	NO	27,005.40	7,986.54	NO	NO	NO
1996	6,353.10	12,270.84	2,637.00	NO	40,623.30	7,251.59	722.06	NO	NO
1997	6,212.70	10,969.92	87.90	NO	52,216.20	8,068.58	NO	NO	NO
1998	6,142.50	9,774.48	12,086.25	NO	22,488.30	7,200.56	NO	NO	NO
1999	5,440.50	8,297.76	16,876.80	NO	30,918.60	4,075.81	NO	NO	NO
2000	5,545.80	10,864.44	19,513.80	NO	33,658.20	3,667.05	NO	NO	NO
2001	2,913.30	9,458.04	17,580.00	NO	31,753.80	3,762.71	8,905.35	NO	NO
2002	4,036.50	11,813.76	23,205.60	NO	24,867.90	5,156.08	14,200.42	NO	NO
2003	3,474.90	10,477.68	21,096.00	NO	23,102.10	4,208.90	16,656.44	NO	NO
2004	4,212.00	14,239.80	17,887.65	NO	26,889.30	4,800.99	14,970.61	NO	NO
2005	3,615.30	10,899.60	15,118.80	NO	44,919.00	4,815.62	6,787.74	NO	NO
2006	2,742.48	13,888.20	17,360.25	481.40	30,390.30	4,449.93	6,787.74	4,569.81	NO
2007	2,742.48	15,470.40	15,295.64	962.72	35,491.50	4,685.60	962.80	7,426.62	NO
2008	2,250.24	16,841.64	20,305.82	914.58	39,542.40	3,170.86	NO	5,019.41	237.03
2009	1,230.60	12,376.32	27,205.05	1,155.43	32,098.50	547.71	NO	1,044.05	642.40
2010	2,531.52	15,400.08	22,370.55	1,299.67	31,921.20	212.91	NO	1,044.24	641.43

Non-energy cons. [TJ]	Lubricants	Bitumen	Naphtha	LPG	Natural Gas as Feedstock	Coal Oil and Tars	Refinery gas	Motor Gasoline	Kerosene Type Jet Fuel
2011	3,340.20	20,568.60	7,603.35	1,492.22	38,358.90	203.16	NO	261.06	193.11

Table 3.14 (continued) Apparent consumption of non-energy fuels

Non-energy cons. [TJ]	Other Kerosene	Gas-Diesel Oil	Petrol. Coke	Residual Fuel Oil	Other Products	Paraffin waxes	White spirit	Lignite/ Brown Coal	Other Bituminous Coal	Coke_Oven_ Coke
1989	NO	NO	12,032.00	NO	NO	NO	NO	NO	NO	122,866.81
1990	NO	NO	4,186.06	NO	NO	NO	NO	NO	NO	99,757.90
1991	NO	NO	3,019.46	NO	NO	NO	NO	NO	23,785.18	68,967.78
1992	NO	NO	3,637.07	NO	NO	467.90	NO	NO	187.25	33,393.37
1993	NO	NO	686.24	590.25	836.02	62.39	571.35	52.54	414.36	54,154.03
1994	NO	NO	3,259.64	393.50	396.01	93.58	791.10	224.69	346.01	60,669.40
1995	NO	NO	3,980.19	629.60	308.01	62.39	791.10	83.42	431.91	67,976.11
1996	NO	NO	4,117.44	NO	748.02	218.35	703.20	NO	370.80	69,273.99
1997	NO	NO	4,254.69	NO	1,056.02	62.39	527.40	NO	354.48	71,278.11
1998	NO	NO	4,083.13	1,810.10	704.02	187.16	835.05	NO	NO	64,829.49
1999	NO	1,529.46	4,460.56	236.10	220.01	436.70	1,098.75	NO	NO	42,812.05
2000	NO	NO	6,210.47	NO	220.01	311.93	571.35	NO	NO	42,507.76
2001	NO	382.37	8,303.50	78.70	308.01	187.16	219.75	NO	NO	51,052.32
2002	42.99	NO	7,754.51	NO	NO	155.97	263.70	NO	NO	61,559.55
2003	42.99	NO	7,308.46	NO	176.00	124.77	263.70	NO	NO	62,417.79
2004	NO	NO	9,813.23	NO	132.00	187.16	219.75	NO	NO	66,267.81
2005	NO	NO	12,969.94	NO	6,732.15	249.54	NO	NO	NO	61,969.50
2006	NO	1,996.80	13,999.30	1,180.50	2,728.06	218.35	131.85	NO	NO	57,512.97

Non-energy cons. [TJ]	Other Kerosene	Gas-Diesel Oil	Petrol. Coke	Residual Fuel Oil	Other Products	Paraffin waxes	White spirit	Lignite/ Brown Coal	Other Bituminous Coal	Coke_Oven_ Coke
2007	1,161.30	1,104.61	13,553.24	2,400.35	8,582.15	94.27	NO	NO	NO	58,778.73
2008	1,160.81	1,359.52	14,310.61	4,407.20	10,029.95	94.60	NO	NO	NO	42,244.74
2009	NO	2,634.07	7,618.37	3,423.45	3,098.90	126.13	43.95	NO	NO	22,325.23
2010	NO	6,585.18	9,126.46	2,715.15	1,821.63	126.13	NO	NO	NO	23,363.82
2011	902.41	4,928.26	9,676.27	3,935.00	132.56	31.53	87.90	NO	NO	7,462.71

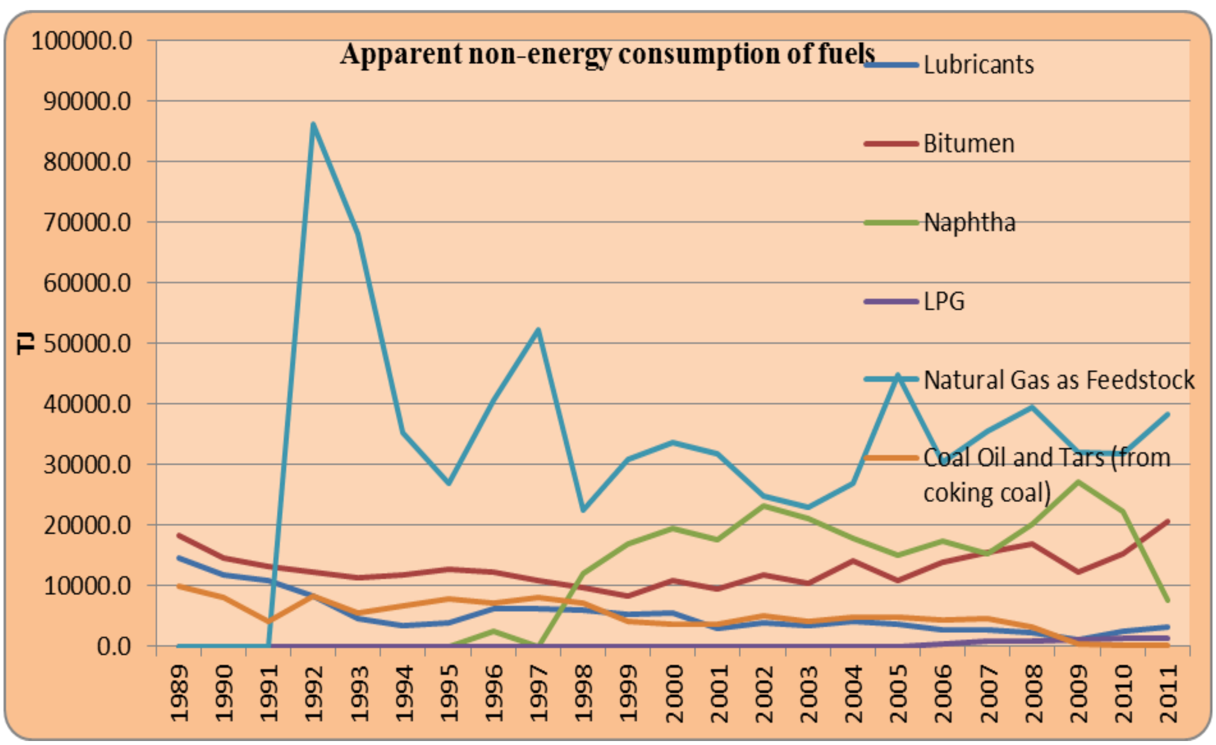
The most significant fuels used as feedstock are natural gas, bitumen, naphtha and lubricants. Also, the Coke_Oven_Coke used as reduction agent in Blast Furnace, the associated emissions being accounted in Industrial Processes sector, represents an important non-energy use quantity. For coal oil and tars the assumption suggested in the methodology (5.91 % from the coking coal consumption is assumed to be stored in products) was applied.

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

- ***Liquid Fuels*** **- Activity data**
  - *Petroleum Coke*: recalculations for the 1990–2010 period due to the correction of the Energy Balance, as non-energy use of the fuel;
  - *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- ***Liquid Fuels*** **- CO_2 emissions**
  - Associated CO_2 emissions, for the entire time series, for the all non-energy use of the fuels, were recalculated.
- ***Gaseous Fuels*** **- CO_2 emissions**
  - Associated CO_2 emissions, for the entire time series, for the *Natural Gas as Feedstock*, were recalculated.

- ***Solid Fuels* – Activity data**
  - *Coke Oven Coke:* 1989 – 2010 period – the non-energy use of the fuel in blast furnace, Iron and Steel Production activity, was calculated.
- ***Solid Fuels* - CO_2 emission factors**
  - *Coal Oil and Tars (from Coking Coal):* correction of the CO_2 EF (country specific EF was changed with a default EF);
- ***Solid Fuels* - CO_2 emissions**
  - Associated CO_2 emissions, for the entire time series, for the following fuels, were recalculated:
    - *Lignite/Brown Coal;*
    - *Coal Oil and Tars (from coking coal);*
    - *Other Bituminous Coal;*
    - *Coke Oven Coke.*

Figure 3.11 Apparent non-energy consumption of fuels



3.2.4 CO_2 capture from flue gases and subsequent CO_2 storage

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

3.2.5 Country-specific issues

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

For the stationary combustion the Eurostat energy balances prepared by the Romanian National Institute for Statistics were the most significant source of information and they were used for estimating the emissions for the years 1990-2011. The National Statistics have not prepared balances in the Eurostat format for the years before 1990, so the Romanian Energy balances transmitted by International Energy Agency (IEA), were used for the year 1989.

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

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

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

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

3.2.6.1 Source category description

CO_2 emissions from fuel combustion activities accounted for 77,767.49 Gg CO_2 equivalent in 2011.

Within the fuel combustion sector, 47.1% of the CO_2 equivalent emissions correspond to Energy Industries category, 20.3% of the CO_2 equivalent emissions correspond to 1.A.2 Manufacturing Industries and Construction, 18.7% of the CO_2 equivalent emissions correspond to 1.A.3 Transport, 13.1% of the CO_2 equivalent emissions correspond to 1.A.4 Other Sectors and less than 1% from the CO_2 equivalent emissions correspond to 1.A.5 Other (Not specified elsewhere). It is observed that Energy Industries are the main source of GHG emissions from fuel combustion with 47.1% of the emissions in 2011. 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 3.12 Total GHG CO_2 equivalent. emissions associated with the Fuel Combustion Activities by categories

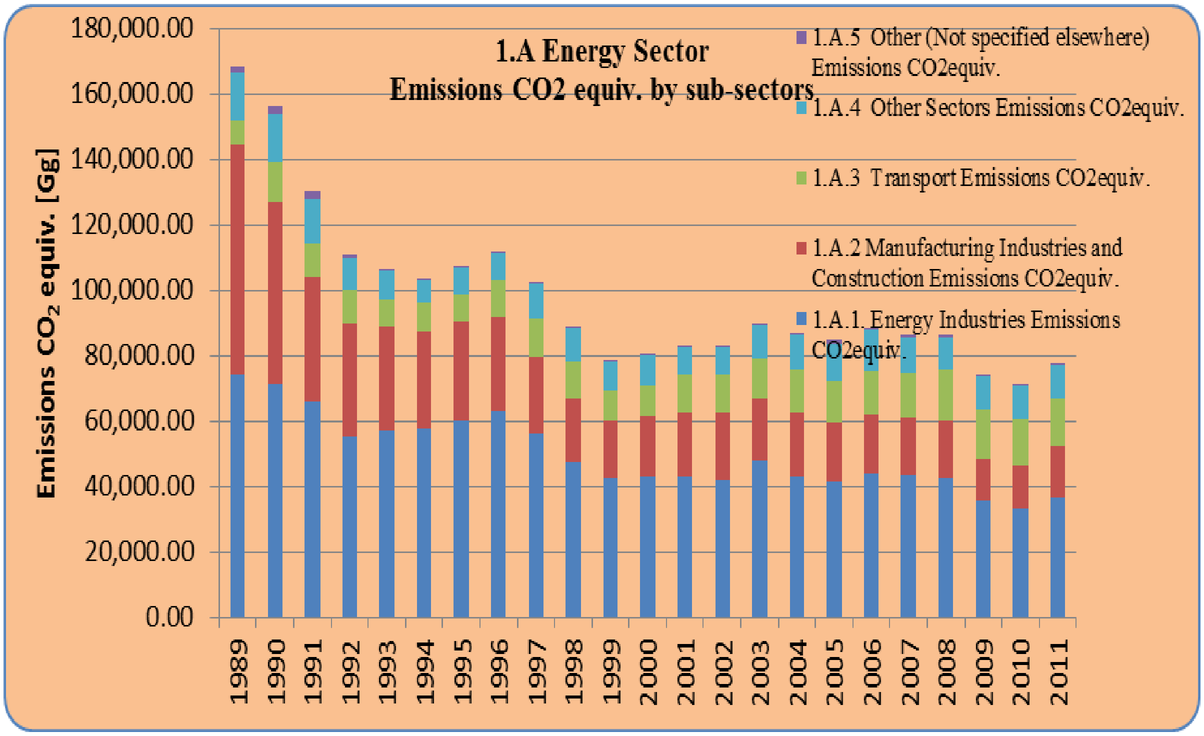
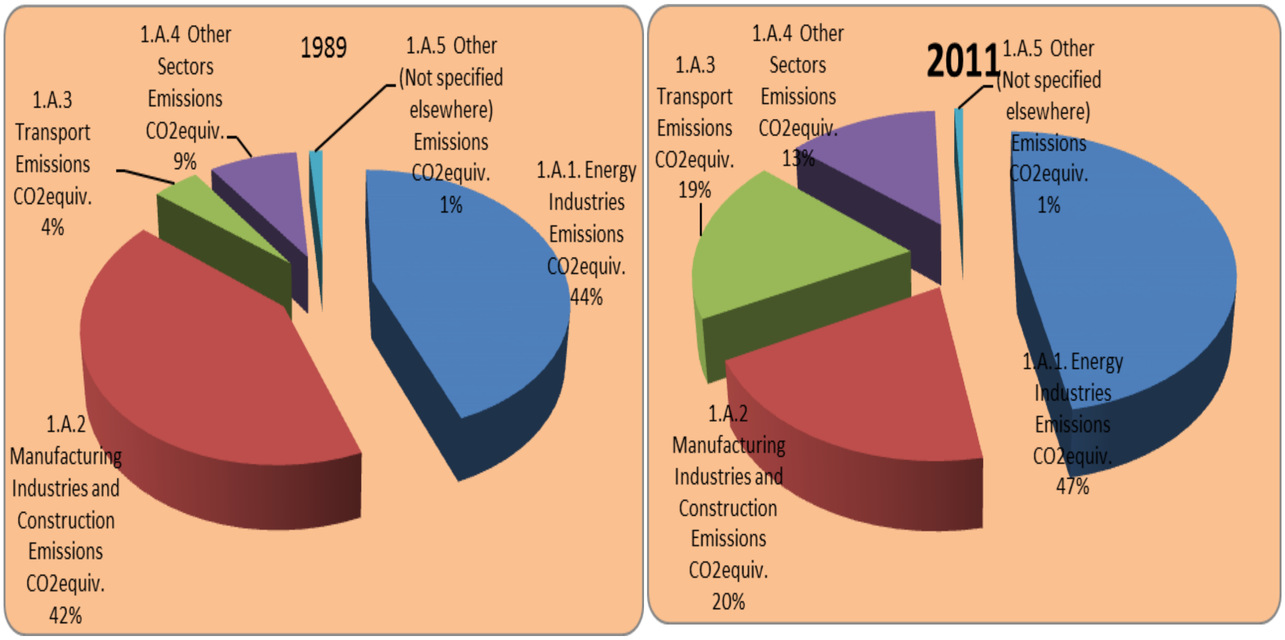


Figure 3.13 Base year and current year comparison in respect to the contribution of Fuel Combustion Activities Subsector categories emissions in total Subsector emissions

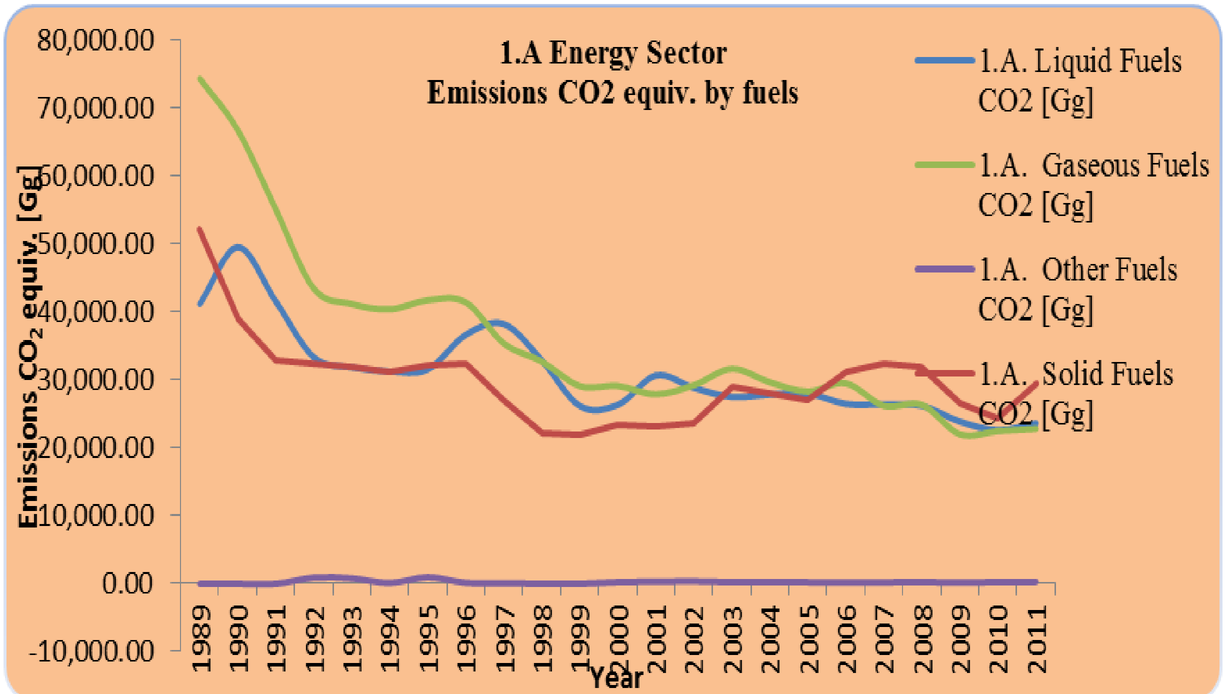


In 2011 a slight increase of the CO_2 equivalent is observed in 1.A.1 Energy Industry with 10.4%, 1.A.2 Manufacturing Industries and Construction with with 19.3% and in 1.A.3 Transport with 1.94%. The demand for energy from fossil fuels is higher than in precedent year due to the fact that 2011 was a very dry year.

On the other hand, in 1.A.4 Other Sectors, due to the reducing of the salaries/consumption in the economic crisis context, the CO_2 equivalent is stationary, a substantial increase being observed in the 1.A.5 Other (Not specified elsewhere) sub-sector, arround 92%.

Manufacturing industry and construction is the sector, which changed drastically – compared to 1989 the emissions decreased from 42% to 20.3%. In the same time the transport sub-sector has a substantial modification in the contribution to the emissions, rising from 4% in the base year up to 18.7% in 2010.

Figure 3.14 Total CO_2 emissions [Gg] from Fuel combustion by fuel type



Starting to 2003 the main contribution to CO_2 emissions was from solid fuel, having a pick in 2007-2008. In 2011 the contribution of the liquid fuel was about 31%, solid 39%, gaseous 30%. It could be observed that, the three main fuels have, each of them, a significant contribution to the total of the Energy Industry CO_2 emissions. Only within the period of 2005–2007, the trend is an increase in the percentage of solid fuels, mostly due to the energy industries growth and a decrease in liquid and gaseous fuels share.

Table 3.15 CO_2 emissions in 1.A. Fuel Combustion

CO_2 [Gg]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	167,624.54	41,178.80	52,141.40	74,304.34	2,986.70	NA,NO
1990	155,217.32	49,523.78	38,965.93	66,727.60	2,760.24	NA,NO
1991	129,527.88	41,537.66	32,926.43	55,063.80	3,246.99	NA,NO
1992	110,016.54	33,321.07	32,349.43	43,422.10	3,683.49	923.94

CO_2 [Gg]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1993	105,731.49	31,838.21	31,911.10	41,159.85	4,879.23	822.32
1994	102,969.15	31,239.71	31,237.28	40,366.52	5,634.79	125.64
1995	106,497.22	31,545.74	32,249.82	41,719.71	6,327.21	981.95
1996	110,616.71	36,645.78	32,420.33	41,405.36	11,953.69	145.23
1997	100,717.54	38,205.05	27,070.56	35,343.07	15,573.86	98.86
1998	87,765.95	32,846.27	22,227.44	32,692.24	13,997.17	NA,NO
1999	77,179.16	26,168.77	21,917.94	29,092.44	13,207.06	NA,NO
2000	79,049.62	26,326.65	23,387.58	29,096.91	12,973.91	238.48
2001	81,885.93	30,649.49	23,012.03	27,884.65	10,007.16	339.76
2002	82,044.03	28,825.61	23,639.35	29,221.24	11,027.00	357.84
2003	88,431.94	27,487.60	29,077.68	31,629.77	13,330.88	236.89
2004	85,772.86	27,829.52	28,030.96	29,644.36	14,616.54	268.02
2005	83,439.67	27,995.63	26,921.56	28,300.25	14,979.20	222.24
2006	87,226.71	26,462.37	31,095.12	29,502.32	14,690.93	166.91
2007	85,075.53	26,395.38	32,290.49	26,172.20	15,365.61	217.46
2008	84,767.81	26,186.38	31,986.11	26,323.70	18,227.60	271.62
2009	72,556.22	23,855.05	26,541.75	21,991.57	18,175.26	167.85
2010	69,615.58	22,613.33	24,269.18	22,478.87	18,976.71	254.20
2011	76,257.39	23,598.12	29,576.22	22,795.13	16,908.88	287.94
Decrease 1989 - 2011 [%]	54.51	42.69	43.28	69.32	-466.14	_
Decrease 1990 - 2011 [%]	50.87	52.35	24.10	65.84	-512.59	_
Decrease 2010 - 2011 [%]	-9.54	-4.35	-21.87	-1.41	10.90	-13.27

Table 3.16 CH_4 emissions in 1.A. Fuel Combustion

CH_4 [Gg]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	26.0598	3.1138	9.9779	5.1263	7.8419	NA,NO
1990	25.7386	3.8464	10.0976	4.5324	7.2622	NA,NO
1991	20.8010	3.1846	5.9537	3.5040	8.1586	NA,NO
1992	17.7204	2.5597	4.9787	2.6830	7.1678	0.3311
1993	19.0395	2.2911	3.5351	2.5478	10.3709	0.2947
1994	18.3998	2.3042	1.4487	2.4771	12.1248	0.0450
1995	20.4475	2.2629	1.3682	2.5629	13.5887	0.6649
1996	36.1347	2.6817	2.3203	2.4438	28.6369	0.0521
1997	45.0545	2.9313	2.0219	2.0461	38.0198	0.0354
1998	39.9509	2.6824	0.7293	1.8276	34.7115	NA,NO
1999	37.5791	2.1359	1.0441	1.7282	32.6710	NA,NO
2000	36.6508	2.1809	0.9941	1.7393	31.4375	0.2990
2001	29.3135	2.5961	0.5249	1.8855	24.0006	0.3065
2002	30.2178	2.5614	0.8093	1.8290	24.8261	0.1920
2003	35.5025	2.5548	0.8295	1.9246	30.0474	0.1462
2004	41.1886	2.6635	1.1671	1.8237	35.3812	0.1530
2005	43.2667	3.4800	0.9106	1.7524	37.0301	0.0937
2006	41.0111	3.0832	0.9598	1.8697	35.0186	0.0798
2007	42.0988	2.9080	0.9562	1.6182	36.5657	0.0507
2008	51.0677	2.5874	1.4772	1.6664	45.2737	0.0630
2009	49.4887	2.4589	0.8930	1.4176	44.6972	0.0220
2010	51.0722	2.1753	0.8549	1.4562	46.5469	0.0389
2011	47.3674	2.1379	1.1788	1.4766	42.5377	0.0364
Decrease 1989 - 2011 [%]	-81.76	31.34	88.19	71.20	-442.44	–

CH_4 [Gg]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 1990 - 2011 [%]	-84.03	44.42	88.33	67.42	-485.74	–
Decrease 2010 - 2011 [%]	7.25	1.72	-37.89	-1.40	8.61	6.33

Table 3.17 N_2O emissions in 1.A. Fuel Combustion

N_2O [Gg]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	1.3022	0.3010	0.7602	0.1345	0.1067	NA,NO
1990	1.1572	0.3664	0.5693	0.1207	0.1008	NA,NO
1991	1.0148	0.3112	0.4848	0.0996	0.1191	NA,NO
1992	0.9798	0.2520	0.4729	0.0786	0.1322	0.0442
1993	0.9945	0.2389	0.4675	0.0745	0.1744	0.0393
1994	0.9695	0.2329	0.4561	0.0730	0.2014	0.0060
1995	1.0490	0.2303	0.4702	0.0755	0.2261	0.0469
1996	1.2587	0.2770	0.4728	0.0749	0.4270	0.0069
1997	1.3059	0.2869	0.3932	0.0640	0.5571	0.0047
1998	1.1246	0.2445	0.3210	0.0592	0.4999	NA,NO
1999	1.0402	0.1943	0.3216	0.0526	0.4717	NA,NO
2000	1.0644	0.1927	0.3443	0.0526	0.4634	0.0114
2001	0.9867	0.2244	0.3382	0.0505	0.3574	0.0162
2002	1.0228	0.2108	0.3452	0.0529	0.3968	0.0171
2003	1.1740	0.2012	0.4282	0.0572	0.4761	0.0113
2004	1.2268	0.2275	0.4108	0.0536	0.5220	0.0128
2005	1.6904	0.6997	0.3940	0.0512	0.5350	0.0106
2006	1.5397	0.4970	0.4567	0.0534	0.5247	0.0080

N_2O [Gg]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2007	1.5589	0.4897	0.4583	0.0478	0.5563	0.0068
2008	1.7027	0.5135	0.4723	0.0473	0.6612	0.0084
2009	1.5881	0.4794	0.4033	0.0398	0.6627	0.0029
2010	1.5746	0.4524	0.3796	0.0406	0.6969	0.0052
2011	1.6625	0.4646	0.4710	0.0411	0.6810	0.0049
Decrease 1989 - 2011 [%]	-27.67	-54.38	38.04	69.46	-538.44	–
Decrease 1990 - 2011 [%]	-43.67	-26.79	17.26	65.99	-575.82	–
Decrease 2010 - 2011 [%]	-5.58	-2.71	-24.07	-1.24	2.28	6.33

3.2.6.2 Methodological issues

Stationary Combustion

Methodology

In the development of estimates, it was primarily utilized default EFs obtained from the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and, in some cases (where the other two IPCC sources don't provide values), the IPCC 2006 Guidelines.

To achieve the estimations of the CO_2 emissions on the national circumstances, a study, "Elaboration/documentation of national emission factors/other parameters relevant to National Greenhouse Gas Inventory (NGHGI) Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher tier calculation methods implementation", has determined the national emission factors based on EU-ETS operators reporting on the period of 1989–2010; for 2011 the estimations for the CO_2 emissions were determined using the national emission factors, based on the methodology of the same study.

A) Tier 1 methodology

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

Equation 3.1 CO_2 emission estimation Tier 1 methodology Stationary Combustion

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

where:

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

B) Tier 2 methodology

According to the provisions in the relevant decision trees in the IPCC GPG 2000, giving their status of key categories, both by level and trend criteria, the IPCC Tier 2 approach (Revised 1996 IPCC Guidelines) is used to calculate the CO_2 emissions from fuel combustion in the sectors CRF 1.A.1, CRF 1.A.2., CRF 1.A.4 and CRF 1.A.5.
For the CO_2 gas, Country Specific Emission Factors are used.
The formula used in the calculations is the following:

Equation 3.2 CO_2 emission estimation Tier 1 methodology Stationary Combustion

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

where:

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

- EF(fuel) = default (IPCC)

Activity Data

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

Solid, liquid and gaseous fuels

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

Following the recommendations of the international experts, the energy balances prepared by the Romanian National Institute for Statistics in the Eurostat format, were used for estimating the emissions for the years 1990-2011. The National statistics have not prepared balances in the Eurostat format for the years before 1990, so the IEA Energy balances were used for the year 1989.

Other Fuels – Industrial Wastes

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

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

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

Biomass

In order to estimate the emissions from biomass combustion activities a separated spreadsheet was completed, using the energetic quantities provided by Energy Balance.
A wide range of biomass sources can be used to produce bioenergy in a variety of forms. In Romania different types of biomass, solid, liquid and gaseous, are consumed in the energy sector. Solid biofuels comprises the following:

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

All these types are combusted to produce heat and/or power. However, CO_2 emissions released from these processes are reported as an information item, as the CO_2 is naturally captured from the air. That is not applicable for the CH_4 and N_2O emissions, being reported and accounted for, in the total inventory emissions.
The correspondence between the energy balance categories and CRF categories can be reviewed in the ANNEX 2.
The national energy balance is provided by NIS and presented in ANNEX 4. The net calorific values (NCVs) used for converting mass or volume units of the fuel quantities into energy units [TJ] are provided by NIS and presented in ANNEX 4.

Choice of NCV

The corresponding Net Calorific Values (NCVs) from the Energy balances were used in order to convert the fuel consumption reported in natural units to energy units.

For solid fuels the balances provide NCVs 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. (Revised 1996 IPCC GL: Reference manual, Ch. 1, p. 1.24, Table 1-4; IEA Energy Statistics Manual, p. 183, Table A3.12)

For all NCVs please consult ANNEX 4.

Emission factors

CO_2 emission factors

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

Equation 3.3 CO_2 emission factors for stationary sources

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

where:

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

Oxidation factors

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

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

Table 3.18 Default Emission factors for CO_2 for different fuels

Fuel	Carbon Content t/TJ	EF CO_2 t/TJ (excluding oxidation factor)	EF CO_2 t/TJ (including oxidation factor)
LIQUID FOSSIL			
Primary fuels			
Crude oil	20.0	73.333	72.60
Orimulsion	22.0	80.667	79.86
Natural Gas Liquids	17.2	63.067	62.44
Secondary fuels/products			
Gasoline*	18.9	69.300	68.61
Jet Kerosene	19.5	71.500	70.79
Other Kerosene	19.6	71.867	71.15
Shale Oil	20.0	73.333	72.60
Gas/Diesel Oil*	20.2	74.067	73.33
Residual Fuel Oil*	21.1	77.367	76.59
LPG	17.2	63.067	62.44

Fuel	Carbon Content t/TJ	EF CO_2 t/TJ (excluding oxidation factor)	EF CO_2 t/TJ (including oxidation factor)
Ethane	16.8	61.600	60.98
Naphtha	20.0	73.333	72.60
Bitumen	22.0	80.667	79.86
Lubricants	20.0	73.333	72.60
Petroleum Coke*	27.5	100.833	99.83
Refinery Feedstock’s	20.0	73.333	72.60
Refinery Gas*	18.2	66.733	66.07
Other Oil	20.0	73.333	72.60
SOLID FOSSIL			
Primary Fuels			
Anthracite	26.8	98.267	96.30
Coking Coal	25.8	94.600	92.71
Other Bituminous Coal*	25.8	94.600	92.71
Sub-bituminous Coal	26.2	96.067	94.15
Lignite*	27.6	101.200	99.18
Oil Shale	29.1	106.700	104.57
Peat	28.9	105.967	104.91
Secondary Fuels/Products		0.000	
BKB & Patent Fuel	25.8	94.600	92.71
Coke Oven / Gas Coke	29.5	108.167	106.00
Coke Oven Gas	13.0	47.667	47.43
Blast Furnace Gas	66.0	242.000	240.79
GASEOUS FOSSIL		0.000	
Natural Gas (Dry)*	15.3	56.100	55.82
BIOMASS			
Solid Biomass	29.9	109.633	107.44
Liquid Biomass	20.0	73.333	72.60

Fuel	Carbon Content t/TJ	EF CO_2 t/TJ (excluding oxidation factor)	EF CO_2 t/TJ (including oxidation factor)
Gas Biomass	30.6	112.200	111.64

*The above 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.

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

Emission data reported under the European Emission Trading Scheme

A sum of operators has provided their verified CO_2 emission reports required under the EU ETS for the years 2007-2011.

Data from the verified ETS reports were analyzed in order to use a Tier 2 methodology for emission calculations. The number of plants, using a plant specific methodologies, made possible to achieve country specific EFs for a sum of solid and liquid fuels and natural gas (listed above). Also, the contry specific emission factor for the industrial wastes ETS reporting, was derived. These emission factors (without oxidation fraction included) are derived from the verified ETS reports as a weighted average from all operators which have declared that they have used plant-specific emission factors (Tiers 3 according to the Methodology for monitoring GHG emissions of operators participating in the ETS).

Table 3.19 Country-Specific CO_2 emission factors for stationary combustion, without oxidation included, from ETS verified reports

EF [t/TJ]	**Year**					
Type of Fuel	**2007**	**2008**	**2009**	**2010**	**2007-2010 WA EFs**	**2011**
Lignite	102.14	98.87	97.70	96.55	98.96	94.49
Natural gas	55.20	55.58	55.49	55.78	55.49	55.52
Refinery gas	55.12	54.05	57.99	57.42	56.10	57.42
Other bituminous coal	93.24	94.34	95.20	94.88	94.55	91.80
Coke_Oven_Coke	92.92	84.33	92.89	92.65	91.22	95.16
Transport diesel	74.00	72.35	74.04	72.75	73.29	72.92
Residual fuel oil	78.58	76.81	77.97	79.69	78.15	79.49
Heating and other gasoil	74.46	77.87	74.45	73.66	74.19	73.31
Petroleum Coke	0.00	94.34	91.85	94.02	93.63	98.50
Industrial Wastes	-	-	-	-	-	83.50

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

Table 3.20 Country-Specific CO_2 emission factors for stationary combustion, oxidation included, from ETS verified reports

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

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 3.21 Country-specific emission factors 2007-2010 period weighted averages

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

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

CH_4 emission factors for stationary sources

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

Table 3.22 Emission factors for CH_4 for different fuels

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

N_2O emission factors for stationary sources

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

Table 3.23 Emission factors for N_2O for different fuels

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

EF N_2O [Kg/TJ]	**Coal**	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Other Biomass and Wastes**
Agriculture/Forestry/Fishing	1.4	0.1	0.6	4	1	4

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

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

Table 3.24 NO_x emission factors for different fuels

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

Table 3.25 CO emission factors for different fuels

CO [kg/TJ]	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Other Biomass and Wastes
Public electricity and heat production	113*	39*	5*	258*	1000**	1000**
Petroleum Refineries	20**	39*	5*	1000**	1000**	1000**
Manufacture of Solid Fuels and Other Energy Industries	525*	20**	15**	1000**	1000**	1000**
Manufacturing Industries and Construction	931*	25*	40*	1596*	4000**	4000**
Commercial/Institutional	931*	25*	40*	1600*	7000**	5000**
Residential	4600*	31*	46*	5300*	7000**	5000**
Agriculture/Forestry/Fishing	931*	25*	40*	1600*	7000**	5000**

Table 3.26 NMVOC emission factors for different fuels

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

Notes:

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

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

For the 2005–2011 period, the NO_x emissions under CLRTAP reporting (based on measured emissions reported by the Large Combustion Plants), in the 1A1a and 1A1b activity categories, were used.

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

SO_2 Emission Factors

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

Table 3.27 Default Emission Factors For SO_2 Emissions

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

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

For the 2005–2011 period, the SO_2 emissions estimation, the reporting under CLRTAP (based on measured emissions reported by the Large Combustion Plants), in the 1A1a and 1A1b activity actegories, were used.

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

Table 3.28 Country Specific SO_2 emission factors – 1.A.1.a, solid fuel

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

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

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

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

AD uncertainty

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

EFs uncertainty

- ***CO_2 gas:***

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

- ***CH_4 gas:***

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

- ***N_2O gas:***

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

Aggregated uncertainty

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

- ***CO_2 gas:***

❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3.105%;
❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 5.00%;
❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 3.041%;
❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 20.224%;
❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 21.190%.

- ***CH_4 gas:***

❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.09 %;
❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.09%;
❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.09%;
❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.09%;
❖ Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.49 %.

- ***N_2O gas:***

❖ Liquid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.09%;
❖ Solid fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.09%;
❖ Gaseous fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.09%;
❖ Biomass, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.09%;

- Other fuels, CRF categories 1A1, 1A2, 1A4 and 1A5a: 50.49 %.

3.2.6.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *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 Decision 280/2004/EC 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; they are described in the Chapter 3.2.6.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.2.6.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

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

Specific to the stationary combustion, for the calculation of the emissions from CRF category 1A, it was developed an Excel spreadsheet model, which was linked directly to the Eurostat format energy balances provided by the NIS. Wherever it was possible, automated data validation was implemented within the model, but many manual checks were performed, too.
Furthermore the background data for the emission factors calculations under the ETS, were used for further QA/QC checks.
In response to the ERT recommendation, there is presented in the bellow table an analysis resulting from the ISPE Study regarding the share of the EU-ETS fuel combustion to the Energy Balance reporting, within the corresponding activity category.

Table 3.29 Share of the EU-ETS installations to the National Energy Balance, 2008 year

<table>
<tr><th>CRF Category</th><th>Main activity</th><th>Share of the EU-ETS reporting to the EB [%]</th><th>Reporting Plants</th></tr>
<tr><td>1A1a</td><td>Electricity and heat production</td><td>90,25</td><td></td></tr>
<tr><td>1A1 a - i</td><td>Electricity production</td><td rowspan="2">99,66</td><td rowspan="3">Nominal installed thermal power plants > 20 MWt reporting</td></tr>
<tr><td>1A1 a – ii</td><td>Electricity and heat production</td></tr>
<tr><td>1A1 a - iii</td><td>Heat production</td><td>73,47</td></tr>
<tr><td>1A1 b</td><td>Petroleum refining</td><td rowspan="2">74,15</td><td>Emissions from fuel combustion only</td></tr>
<tr><td>1A1 c</td><td>Manufacture of solid fuels and other industries</td><td>Nominal installed thermal power plants > 20 MWt reporting</td></tr>
</table>

CRF Category	Main activity	Share of the EU-ETS reporting to the EB [%]	Reporting Plants
1A2	***Manufacturing industry and Construction***	**60,60**	
1A2 a	Iron and Steel	53,92	Fuel combustion for the installations having production capacity greater than >2,5 tones/h and nominal installed thermal power plants > 20 MWt reporting
1A2 b	Non-ferrous metals (aluminum)		Nominal installed thermal power plants > 20 MWt reporting
1A2 c	Chemical	74,44	Nominal installed thermal power plants > 20 MWt reporting
1A2 d	Pulp, Paper and Print	90,43	Fuel combustion for the installations having production capacity greater than >20 tones/day and nominal installed thermal power plants > 20 MWt reporting
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: - 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

CRF Category	Main activity	Share of the EU-ETS reporting to the EB [%]	Reporting Plants
			>75 tones/day, - and having on sites nnominal installed thermal power plant > 20 MWt.

Activity data checks

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

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

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

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

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

Calculations checks

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

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

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

Following the above activities the unconformities has been noted and solved; actually, further to the quality 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);

- emission factors (default according to the IPCC methodology, CO_2 EFs - resulted from the ISPE Study, SO_2 emission factors – resulted from the reporting of the Large Combustion Plants);
- all the results are summed in a global calculation sheet for Stationary Fuel Combustion, linked with the spreadsheets of the model (having results for all greenhouse gases emissions from solid, liquid and gaseous fuels on the entire time-series), other fuel – industrial wastes sheet, biomass sheets (having results for emissions accounted from solid and gaseous biomass combustion; liquid biofuels are not reported to the activity categories corresponding with the Stationary Combustion).

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

Accuracy

The accuracy of the emissions estimation results from automatic character of the calculation.

Completeness

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

Consistency

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

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

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

Activity Data

There are recalculations, by some Energy stationary combustion activity categories, on the entire 1989-2010 time-series, such as follows:

- Energy Balance correction;
- Avoiding double counting activity data with Industrial Processes Sector from the usage of the Coke Oven Coke as reduction agent in Blast Furnace: due to the fact that in the Iron and Steel Production - 2.C.1. IP activity category, the mass balance approach to estimate CO_2 emissions is used, the Blast furnace Gas was subtracted as fuel in the Energy sector, from the activity categories were it is reported; the associated emissions are reported under 2.C.1. activity category, 1992 - 2010 period.
- The non-energy use of the fuel data, was subtracted.

Emission factors

The CO_2 emission factors for some solid fuels were reconsidered, such as:

- Coking Coal fuel - country specific EF was changed with a default EF;
- Coke oven coke fuel - default EF was changed with a country specific EF.

The country specific CO_2 emission factor for *Industrial Wastes*, was determinated and used for the entire reported time-series.

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

SO_2 country specific emission factors

In order to have consistency in estimation of the NO_x and SO_2 emissions with the air monitoring department, for the solid fuel combusted in the 1.A.1.a. – Electricity and Heat Production activity category, the SO_2 emissions reported under CLRTAP by the Large Combustion Plants, on the 2005–2011 period, were used.

In the rest of the sector activity categories, for indirect gases, the emission factors provided by the National Inventory of Air Pollutants under the CLRTAP, were used.

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

Table 3.30 The effects of the activity data changes on CO_2 emissions estimation to the sub-sector 1.A 1. - Energy Industry

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CO_2 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	1,014,364.74	1,014,364.74	74,101.90	74,118.64	(0.02)
1990	986,234.47	986,243.32	70,977.85	70,978.50	(0.00)
1991	906,854.93	906,864.08	65,711.89	65,712.61	(0.00)
1992	750,379.36	747,919.61	55,517.34	54,874.48	1.16
1993	766,543.04	764,780.54	57,212.39	56,797.85	0.72
1994	780,342.14	774,029.34	58,944.54	57,431.75	2.57
1995	808,382.96	806,046.01	60,467.78	59,903.14	0.93
1996	848,517.80	845,365.75	63,394.36	62,600.24	1.25
1997	767,719.84	761,960.39	57,290.02	55,859.49	2.50
1998	664,947.78	658,992.13	48,642.42	47,210.33	2.94
1999	579,753.59	575,152.03	43,039.98	42,219.43	1.91
2000	580,664.62	576,513.62	43,623.53	42,621.32	2.30
2001	578,113.51	571,759.13	44,230.97	42,755.56	3.34
2002	576,617.47	569,435.57	43,835.67	42,089.00	3.98
2003	641,400.01	636,878.36	48,843.71	47,764.67	2.21
2004	581,108.67	576,114.42	44,274.90	43,067.69	2.73
2005	556,214.36	552,492.21	42,104.02	41,203.20	2.14
2006	577,711.85	574,996.05	44,558.75	43,904.12	1.47
2007	555,286.16	551,729.30	44,171.19	43,312.25	1.94
2008	542,103.66	540,584.46	42,523.12	42,155.77	0.86
2009	459,972.22	459,045.96	35,751.61	35,526.92	0.63
2010	440,095.41	439,283.65	33,227.81	33,037.88	0.57

Table 3.31 The effects of the activity data changes on CH_4 emissions estimation to the sub-sector 1.A 1. - Energy Industry

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CH_4 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	1,014,364.74	1,014,364.74	1.38	1.38	(0.00)
1990	986,234.47	986,243.32	1.54	1.54	(0.00)
1991	906,854.93	906,864.08	1.32	1.32	(0.00)
1992	750,379.36	747,919.61	1.02	1.01	0.24
1993	766,543.04	764,780.54	1.05	1.05	0.17
1994	780,342.14	774,029.34	1.08	1.07	0.58
1995	808,382.96	806,046.01	1.13	1.13	0.21
1996	848,517.80	845,365.75	1.22	1.21	0.26
1997	767,719.84	761,960.39	1.16	1.16	0.49
1998	664,947.78	658,992.13	0.93	0.93	0.64
1999	579,753.59	575,152.03	0.82	0.81	0.99
2000	580,664.62	576,513.62	0.78	0.78	0.53
2001	578,113.51	571,759.13	0.83	0.83	0.86
2002	576,617.47	569,435.57	0.79	0.78	0.91
2003	641,400.01	636,878.36	0.83	0.83	0.54
2004	581,108.67	576,114.42	0.74	0.73	0.68
2005	556,214.36	552,492.21	0.71	0.70	0.53
2006	577,711.85	574,996.05	0.72	0.71	0.38
2007	555,286.16	551,729.30	0.67	0.67	0.53
2008	542,103.66	540,584.46	0.65	0.64	0.23
2009	459,972.22	459,045.96	0.55	0.55	0.17
2010	440,095.41	439,283.65	0.55	0.55	0.15

Table 3.32 The effects of the activity data changes on N_2O emissions estimation to the sub-sector 1.A 1. - Energy Industry

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for N_2O [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	1,014,364.74	1,014,364.74	0.67	0.67	0.00
1990	986,234.47	986,243.32	0.59	0.59	0.00
1991	906,854.93	906,864.08	0.57	0.57	0.00
1992	750,379.36	747,919.61	0.51	0.51	0.05
1993	766,543.04	764,780.54	0.54	0.54	0.03
1994	780,342.14	774,029.34	0.54	0.54	0.12
1995	808,382.96	806,046.01	0.57	0.57	0.04
1996	848,517.80	845,365.75	0.58	0.58	0.05
1997	767,719.84	761,960.39	0.50	0.50	0.11
1998	664,947.78	658,992.13	0.40	0.40	0.15
1999	579,753.59	575,152.03	0.38	0.38	0.34
2000	580,664.62	576,513.62	0.40	0.40	0.10
2001	578,113.51	571,759.13	0.41	0.41	0.21
2002	576,617.47	569,435.57	0.40	0.40	0.18
2003	641,400.01	636,878.36	0.47	0.47	0.10
2004	581,108.67	576,114.42	0.42	0.42	0.12
2005	556,214.36	552,492.21	0.40	0.40	0.09
2006	577,711.85	574,996.05	0.45	0.45	0.06
2007	555,286.16	551,729.30	0.45	0.45	0.07
2008	542,103.66	540,584.46	0.45	0.45	0.03
2009	459,972.22	459,045.96	0.39	0.39	0.02
2010	440,095.41	439,283.65	0.37	0.37	0.04

Table 3.33 The effects of the activity data changes on CO_2 emissions estimation to the sub-sector 1.A 2. - Manufacturing Industries and Constructions

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CO_2 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	1,172,439.57	1,114,939.57	84,412.53	69,841.84	17.26
1990	944,651.69	902,499.28	65,515.54	55,539.73	15.23
1991	660,825.10	631,571.89	45,058.59	38,043.74	15.57
1992	601,674.11	573,991.27	40,887.52	34,831.51	14.81
1993	553,107.81	529,812.11	37,557.33	31,976.06	14.86
1994	521,335.81	498,830.91	34,293.41	29,525.16	13.90
1995	541,020.78	512,024.93	37,088.05	30,142.83	18.73
1996	518,219.29	487,158.08	35,307.58	28,870.54	18.23
1997	418,567.94	392,804.17	28,991.62	23,399.63	19.29
1998	359,175.19	321,129.99	25,696.15	19,529.62	24.00
1999	330,971.96	294,451.19	22,927.22	17,843.75	22.17
2000	346,577.81	307,574.34	23,961.37	18,653.82	22.15
2001	360,083.42	319,882.27	25,292.19	19,643.91	22.33
2002	384,241.48	336,368.34	26,899.70	20,194.96	24.92
2003	367,631.77	319,184.63	25,972.58	18,755.91	27.79
2004	359,124.20	303,472.20	26,805.44	19,068.47	28.86
2005	351,610.67	289,407.87	26,392.32	18,305.17	30.64
2006	350,921.70	283,459.26	26,150.64	17,780.41	32.01
2007	341,418.64	278,400.03	25,287.20	17,361.25	31.34
2008	335,431.07	281,259.48	24,739.96	17,855.46	27.83
2009	245,229.35	205,949.93	17,076.27	12,775.16	25.19
2010	257,674.57	213,892.20	18,482.61	13,128.88	28.97

Table 3.34 The effects of the activity data changes on CH_4 emissions estimation to the sub-sector 1.A 2. - Manufacturing Industries and Constructions

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CH_4 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	1,172,439.57	1,114,939.57	6.18	5.89	4.65
1990	944,651.69	902,499.28	4.93	4.73	4.02
1991	660,825.10	631,571.89	3.18	3.05	4.31
1992	601,674.11	573,991.27	3.28	3.15	3.89
1993	553,107.81	529,812.11	3.05	2.94	3.56
1994	521,335.81	498,830.91	2.72	2.62	3.60
1995	541,020.78	512,024.93	3.12	2.99	4.11
1996	518,219.29	487,158.08	2.67	2.54	4.90
1997	418,567.94	392,804.17	2.28	2.17	4.88
1998	359,175.19	321,129.99	1.88	1.75	7.02
1999	330,971.96	294,451.19	1.76	1.64	6.54
2000	346,577.81	307,574.34	1.91	1.79	6.35
2001	360,083.42	319,882.27	1.93	1.81	6.37
2002	384,241.48	336,368.34	2.30	2.15	6.36
2003	367,631.77	319,184.63	2.33	2.18	6.67
2004	359,124.20	303,472.20	2.17	1.98	8.95
2005	351,610.67	289,407.87	2.09	1.86	10.94
2006	350,921.70	283,459.26	2.16	1.92	11.22
2007	341,418.64	278,400.03	2.16	1.93	10.71
2008	335,431.07	281,259.48	2.03	1.85	8.75
2009	245,229.35	205,949.93	1.54	1.42	7.85
2010	257,674.57	213,892.20	1.88	1.65	12.08

Table 3.35 The effects of the activity data changes on N_2O emissions estimation to the sub-sector 1.A 2. - Manufacturing Industries and Constructions

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for N_2O [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	1,172,439.57	1,114,939.57	0.36	0.36	1.58
1990	944,651.69	902,499.28	0.27	0.26	2.37
1991	660,825.10	631,571.89	0.17	0.16	2.65
1992	601,674.11	573,991.27	0.23	0.23	1.99
1993	553,107.81	529,812.11	0.21	0.21	1.74
1994	521,335.81	498,830.91	0.17	0.17	2.75
1995	541,020.78	512,024.93	0.21	0.20	2.79
1996	518,219.29	487,158.08	0.18	0.17	4.08
1997	418,567.94	392,804.17	0.17	0.16	3.34
1998	359,175.19	321,129.99	0.15	0.14	9.07
1999	330,971.96	294,451.19	0.14	0.12	10.75
2000	346,577.81	307,574.34	0.16	0.14	11.13
2001	360,083.42	319,882.27	0.16	0.14	10.84
2002	384,241.48	336,368.34	0.20	0.18	10.34
2003	367,631.77	319,184.63	0.20	0.18	9.73
2004	359,124.20	303,472.20	0.19	0.17	10.21
2005	351,610.67	289,407.87	0.18	0.16	11.36
2006	350,921.70	283,459.26	0.20	0.18	11.34
2007	341,418.64	278,400.03	0.20	0.18	10.78
2008	335,431.07	281,259.48	0.18	0.16	12.63
2009	245,229.35	205,949.93	0.14	0.12	11.92
2010	257,674.57	213,892.20	0.18	0.14	18.72

Table 3.36 The effects of the activity data changes on CO_2 emissions estimation to the sub-sector 1.A 4. - Other Sectors

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CO_2 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	240,681.71	240,681.71	13,968.97	13,968.97	0.00
1990	243,565.98	243,621.43	14,308.35	14,312.44	-0.03
1991	233,727.53	233,768.83	13,298.89	13,301.94	-0.02
1992	169,951.62	169,994.22	9,674.97	9,678.11	-0.03
1993	164,183.84	164,216.89	8,400.51	8,402.55	-0.02
1994	151,428.96	151,450.86	6,833.43	6,834.65	-0.02
1995	173,190.85	173,214.95	7,866.84	7,865.32	0.02
1996	214,916.98	214,939.23	7,538.70	7,540.34	-0.02
1997	283,296.45	283,331.95	9,934.01	9,936.63	-0.03
1998	271,087.80	271,109.75	9,390.47	9,392.09	-0.02
1999	240,478.50	240,490.55	7,939.95	7,940.83	-0.01
2000	241,392.35	241,404.35	8,193.62	8,194.45	-0.01
2001	207,302.40	207,310.60	7,767.08	7,767.57	-0.01
2002	208,389.67	208,511.34	7,824.71	7,837.37	-0.16
2003	251,504.50	251,677.36	9,235.96	9,253.14	-0.19
2004	281,875.03	281,942.66	9,879.11	9,885.42	-0.06
2005	288,890.68	289,036.72	10,161.99	10,177.09	-0.15
2006	315,498.38	315,627.57	11,930.46	11,942.92	-0.10
2007	287,166.79	287,230.11	10,018.40	10,024.46	-0.06
2008	296,645.78	296,651.08	8,874.66	8,875.05	0.00
2009	300,572.08	300,581.33	9,088.29	9,088.98	-0.01
2010	305,667.34	305,676.94	9,047.04	9,047.75	-0.01

Table 3.37 The effects of the activity data changes on CH_4 emissions estimation to the sub-sector 1.A 4. - Other Sectors

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CH_4 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	240,681.71	240,681.71	17.03	17.03	0.00
1990	243,565.98	243,621.43	17.11	17.11	0.00
1991	233,727.53	233,768.83	12.32	12.32	0.00
1992	169,951.62	169,994.22	11.76	11.76	0.00
1993	164,183.84	164,216.89	13.26	13.26	0.00
1994	151,428.96	151,450.86	12.80	12.80	0.00
1995	173,190.85	173,214.95	14.28	14.28	0.00
1996	214,916.98	214,939.23	29.77	29.77	0.00
1997	283,296.45	283,331.95	39.33	39.33	0.00
1998	271,087.80	271,109.75	35.20	35.20	0.00
1999	240,478.50	240,490.55	33.05	33.05	0.00
2000	241,392.35	241,404.35	32.17	32.17	0.00
2001	207,302.40	207,310.60	22.87	22.87	0.00
2002	208,389.67	208,511.34	23.40	23.43	-0.15
2003	251,504.50	251,677.36	28.64	28.69	-0.18
2004	281,875.03	281,942.66	34.82	34.84	-0.05
2005	288,890.68	289,036.72	35.48	35.52	-0.12
2006	315,498.38	315,627.57	33.69	33.69	0.00
2007	287,166.79	287,230.11	35.29	35.29	0.00
2008	296,645.78	296,651.08	44.67	44.67	0.00
2009	300,572.08	300,581.33	43.89	43.89	0.00
2010	305,667.34	305,676.94	45.44	45.44	0.00

Table 3.38 The effects of the activity data changes on N_2O emissions estimation to the sub-sector 1.A 4. - Other Sectors

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for N_2O [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	240,681.71	240,681.71	0.19	0.19	0.00
1990	243,565.98	243,621.43	0.18	0.18	-0.02
1991	233,727.53	233,768.83	0.14	0.14	-0.02
1992	169,951.62	169,994.22	0.14	0.14	-0.02
1993	164,183.84	164,216.89	0.17	0.17	-0.01
1994	151,428.96	151,450.86	0.18	0.18	-0.01
1995	173,190.85	173,214.95	0.20	0.20	-0.01
1996	214,916.98	214,939.23	0.39	0.39	0.00
1997	283,296.45	283,331.95	0.54	0.54	0.00
1998	271,087.80	271,109.75	0.49	0.49	0.00
1999	240,478.50	240,490.55	0.45	0.45	0.00
2000	241,392.35	241,404.35	0.44	0.44	0.00
2001	207,302.40	207,310.60	0.31	0.31	0.00
2002	208,389.67	208,511.34	0.32	0.32	-0.05
2003	251,504.50	251,677.36	0.39	0.39	-0.06
2004	281,875.03	281,942.66	0.47	0.47	-0.02
2005	288,890.68	289,036.72	0.48	0.48	-0.04
2006	315,498.38	315,627.57	0.46	0.46	-0.04
2007	287,166.79	287,230.11	0.48	0.48	-0.02
2008	296,645.78	296,651.08	0.60	0.60	0.00
2009	300,572.08	300,581.33	0.59	0.59	0.00
2010	305,667.34	305,676.94	0.61	0.61	0.00

Table 3.39 The effects of the activity data changes on CO_2 emissions estimation to the sub-sector 1.A 5. - Other (non-specified elsewhere)

Year	**Changes at AD level [TJ]**		**Effects of changes on emissions estimation for CO_2 [Gg]**		**Difference [%]**
	NGHGI 2012 v. 3.1	**NGHGI 2013 v. 1.4**	**NGHGI 2012 v. 3.1**	**NGHGI 2013 v. 1.4**	
1989	26,821.12	26,821.12	2,174.84	2,174.84	0.00
1990	30,070.21	30,090.56	2,500.77	2,502.28	-0.06
1991	34,805.15	34,820.90	2,267.37	2,268.54	-0.05
1992	8,360.32	8,360.32	671.29	671.29	0.00
1993	5,768.31	5,772.01	307.56	307.83	-0.09
1994	7,368.37	7,371.47	429.14	429.37	-0.05
1995	8,824.51	8,829.36	617.71	552.25	10.60
1996	6,831.17	6,835.07	275.73	276.01	-0.10
1997	2,281.87	2,281.87	7.03	7.03	0.00
1998	10,675.99	10,686.89	698.40	699.20	-0.12
1999	3,695.23	3,696.98	109.51	109.64	-0.12
2000	3,957.78	3,828.68	294.64	238.42	19.08
2001	10,670.60	10,587.70	429.45	383.00	10.82
2002	10,086.41	9,976.09	294.59	268.90	8.72
2003	11,267.09	11,272.64	390.68	378.40	3.14
2004	14,083.78	14,092.58	692.96	681.69	1.63
2005	24,277.36	24,285.76	1,239.09	1,236.68	0.19
2006	15,086.29	14,986.59	584.36	570.08	2.44
2007	18,777.89	18,743.48	943.15	939.43	0.39
2008	16,692.97	16,706.07	816.38	817.34	-0.12
2009	8,599.41	8,603.71	270.87	271.19	-0.12
2010	8,883.85	8,888.20	270.59	270.90	-0.12

Table 3.40 The effects of the activity data changes on CH_4 emissions estimation to the sub-sector 1.A 5. - Other (non-specified elsewhere)

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for CH_4 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	26,821.12	26,821.12	0.12	0.12	26,821.12
1990	30,070.21	30,090.56	0.16	0.16	30,070.21
1991	34,805.15	34,820.90	2.24	2.24	34,805.15
1992	8,360.32	8,360.32	0.34	0.34	8,360.32
1993	5,768.31	5,772.01	0.54	0.54	5,768.31
1994	7,368.37	7,371.47	0.53	0.53	7,368.37
1995	8,824.51	8,829.36	0.83	0.83	8,824.51
1996	6,831.17	6,835.07	0.96	0.96	6,831.17
1997	2,281.87	2,281.87	0.66	0.66	2,281.87
1998	10,675.99	10,686.89	0.39	0.39	10,675.99
1999	3,695.23	3,696.98	0.67	0.67	3,695.23
2000	3,957.78	3,828.68	0.45	0.45	3,957.78
2001	10,670.60	10,587.70	1.86	1.86	10,670.60
2002	10,086.41	9,976.09	1.99	1.99	10,086.41
2003	11,267.09	11,272.64	1.92	1.92	11,267.09
2004	14,083.78	14,092.58	1.61	1.61	14,083.78
2005	24,277.36	24,285.76	2.39	2.39	24,277.36
2006	15,086.29	14,986.59	2.21	2.21	15,086.29
2007	18,777.89	18,743.48	1.91	1.91	18,777.89
2008	16,692.97	16,706.07	1.77	1.77	16,692.97
2009	8,599.41	8,603.71	1.56	1.56	8,599.41
2010	8,883.85	8,888.20	1.64	1.64	8,883.85

Table 3.41 The effects of the activity data changes on N_2O emissions estimation to the sub-sector 1.A 5. - Other (non-specified elsewhere)

Year	Changes at AD level [TJ]		Effects of changes on emissions estimation for N_2O [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	26,821.12	26,821.12	0.02	0.02	0.00
1990	30,070.21	30,090.56	0.03	0.03	-0.04
1991	34,805.15	34,820.90	0.05	0.05	-0.02
1992	8,360.32	8,360.32	0.01	0.01	0.00
1993	5,768.31	5,772.01	0.01	0.01	-0.02
1994	7,368.37	7,371.47	0.01	0.01	-0.02
1995	8,824.51	8,829.36	0.01	0.01	-0.02
1996	6,831.17	6,835.07	0.02	0.02	-0.02
1997	2,281.87	2,281.87	0.01	0.01	0.00
1998	10,675.99	10,686.89	0.01	0.01	-0.06
1999	3,695.23	3,696.98	0.01	0.01	-0.01
2000	3,957.78	3,828.68	0.01	0.01	1.04
2001	10,670.60	10,587.70	0.03	0.03	0.18
2002	10,086.41	9,976.09	0.03	0.03	0.55
2003	11,267.09	11,272.64	0.03	0.03	-0.01
2004	14,083.78	14,092.58	0.03	0.03	-0.02
2005	24,277.36	24,285.76	0.04	0.04	-0.01
2006	15,086.29	14,986.59	0.03	0.03	0.43
2007	18,777.89	18,743.48	0.03	0.03	0.18
2008	16,692.97	16,706.07	0.03	0.03	-0.03
2009	8,599.41	8,603.71	0.02	0.02	-0.01
2010	8,883.85	8,888.20	0.02	0.02	-0.01

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

Activity Data

Further investigations and co-operation with Romanian authorities administrating the EU-ETS and National 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 under EU-ETS and, respectively, to NIS.

The assumptions on NCVs associated to the Energy Balance, fuels consumption, on a sum of years where these values are missing, will be submitted to the provider of the documents, in order to be approved and included in the future in the Energy Balance.

A further analysis 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.

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

Emission Factors

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

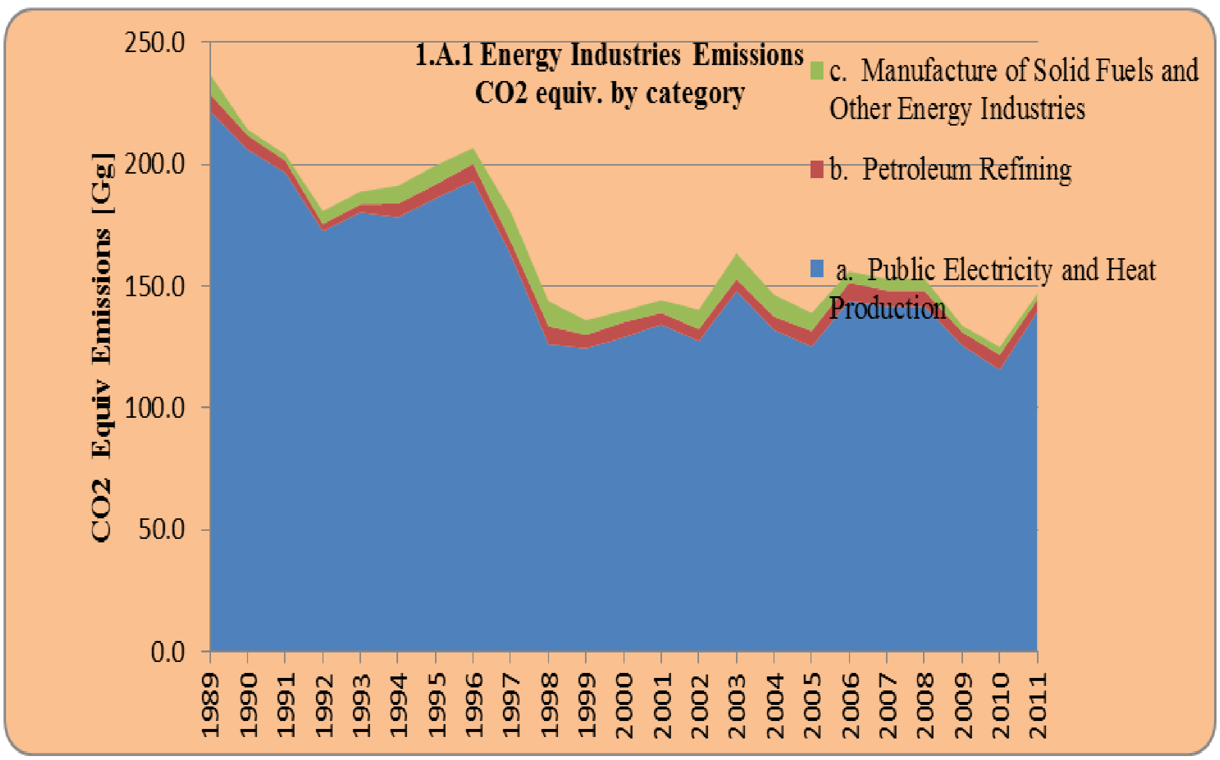
In response of ERT recommendation, "Romania further investigate and elaborate on the non-energy use of fuels reported in the energy balance, which is not reported in the energy sector, and assess whether the country specific carbon storage factors are appropriate", Romania will assess the appropriateness of the country-specific carbon storage factors; consequently, the conclusions will be included in the 2014 submissions.

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

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

- Conventional electricity, CHP and heat producer plants;
- Petroleum refining plants;
- Solid fuel transformation plants;
- Oil and gas extraction and coal mining;
- And the own consumption of the energy sector.

Figure 3.15 Total GHG emissions trend for the subsector 1.A.1 Energy industries by category



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: 44% in the base year and a 47% in last year.

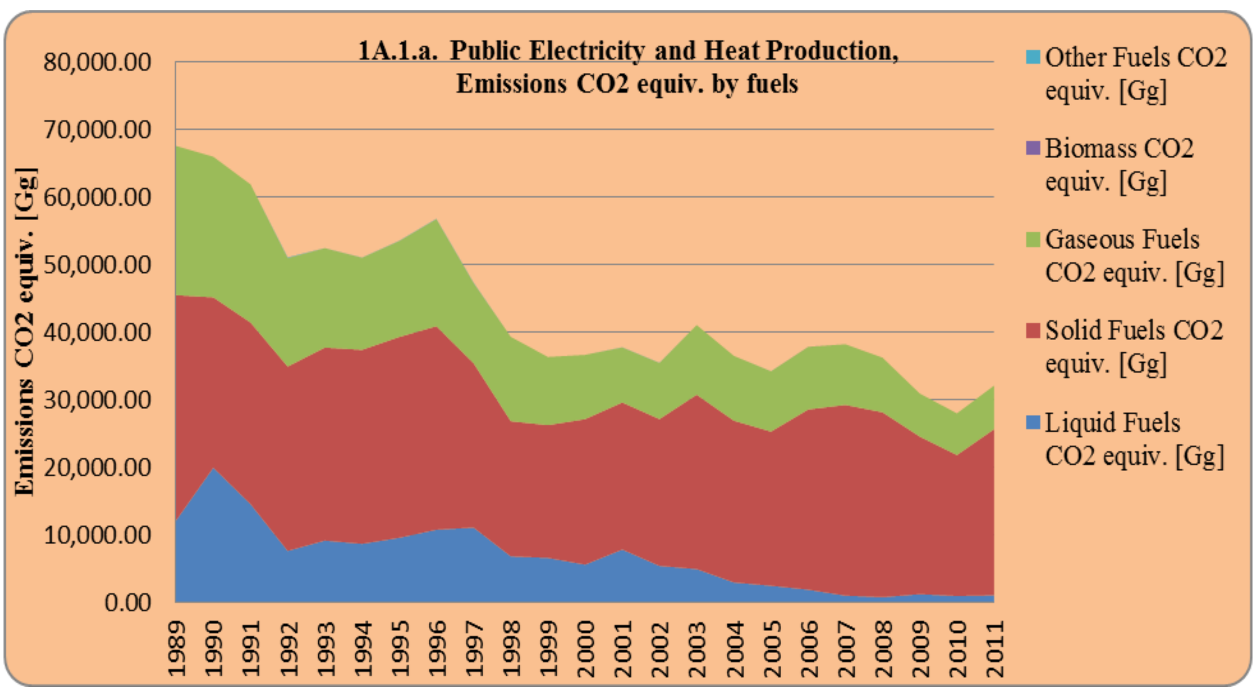
The contribution of this sub-sector to the 1.A. – Fuel combustion is, for the year 2011, about 36,621.90 Gg CO_2 equiv. having the main contributor the activity category 1.A.1.a – Electricity and Heat Production.

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

3.2.7.1.1 Source category description

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

Figure 3.16 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 40.1% in the base year and 41.25% for the year 2011. The share of this activity category to the 1.A.1. - Energy Industry is 90.9% for the base year and 87.6% for the year 2011 (about 32078.6 Gg CO_2 equiv.). The most quantity of combusted fuel in this activity is from solid fuel, 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. Also, the decreasing trend is observed for the gaseous fuel, too. An increasing of the consumption of the liquid - 10% and solid fuels – 18%, in 2011 in comparison with 2010 is observed.

Table 3.42 CO_2 emissions in 1.A.1.a. Public Electricity and Heat Production

CO_2 [Gg]	1A.aFuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	67,383.87	12,159.19	33,170.23	22,054.46	NO	NO
1990	65,806.81	19,931.91	25,086.29	20,788.61	NO	NO
1991	61,719.55	14,562.09	26,740.36	20,417.11	NO	NO
1992	50,646.85	7,651.30	26,854.83	16,054.59	22.51	86.13
1993	52,017.75	9,176.02	28,124.26	14,701.74	0.22	15.74
1994	50,491.13	8,694.57	28,146.45	13,625.00	7.73	25.11
1995	52,827.31	9,579.55	29,017.96	14,197.49	7.62	32.31
1996	55,875.93	10,780.73	29,213.75	15,832.05	30.02	49.39
1997	46,607.30	11,092.10	23,588.89	11,862.86	10.08	63.45
1998	38,334.63	6,845.82	19,016.11	12,472.71	0.34	NO

CO_2 [Gg]	1A.aFuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1999	35,935.86	6,617.87	19,246.52	10,071.48	20.94	NO
2000	36,010.06	5,628.63	20,872.81	9,505.35	33.38	3.26
2001	36,709.47	7,851.72	20,695.20	8,142.21	24.30	20.34
2002	34,528.56	5,438.33	20,754.13	8,311.57	31.25	24.53
2003	40,237.49	4,967.93	24,954.01	10,307.93	24.75	7.62
2004	35,739.82	2,998.44	23,160.56	9,575.38	23.52	5.44
2005	33,613.05	2,518.94	22,169.25	8,919.08	30.46	5.78
2006	37,439.09	1,935.51	26,228.22	9,275.36	79.18	NO
2007	37,454.68	1,050.65	27,437.40	8,966.64	89.32	NO
2008	35,875.96	822.99	26,973.86	8,077.35	60.87	1.76
2009	30,737.77	1,276.26	23,089.98	6,371.53	62.16	NO
2010	27,728.15	1,004.98	20,561.43	6,161.73	146.83	NO
2011	31,939.19	1,114.38	24,378.21	6,442.67	200.93	3.92
Decrease 1989 - 2011	52.60	90.84	26.51	70.79	_	_
Decrease 1990 - 2011	51.47	94.41	2.82	69.01	_	_
Decrease 2010 – 2011	-15.19	-10.89	-18.56	-4.56	-36.84	_

Table 3.43 CH_4 emissions in CRF 1.A.1.a. Public Electricity and Heat Production

CH_4 [Gg]	1A.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	1.223241626	0.46752	0.356655326	0.3991	NO	NO
1990	1.412364208	0.7663806	0.269822308	0.3762	NO	NO
1991	1.21684512	0.55991115	0.28749477	0.3694	NO	NO
1992	0.906312001	0.290262698	0.288648203	0.2905	0.0060	0.0309
1993	0.92298219	0.349786908	0.301473282	0.2660	0.0001	0.0056
1994	0.891287889	0.331832908	0.301846181	0.2465	0.0021	0.0090
1995	0.947878469	0.366341508	0.311019161	0.2569	0.0020	0.0116
1996	1.038102712	0.412986859	0.312901353	0.2865	0.0080	0.0177
1997	0.917421163	0.424554397	0.252773166	0.2147	0.0027	0.0227
1998	0.692481017	0.262655783	0.204046734	0.2257	0.0001	NO
1999	0.647449492	0.253073337	0.206526955	0.1822	0.0056	NO
2000	0.621460711	0.214814287	0.224541024	0.1720	0.0089	0.0012
2001	0.681931243	0.298595606	0.222205637	0.1473	0.0065	0.0073
2002	0.597603129	0.207538913	0.222509716	0.1504	0.0084	0.0088
2003	0.654519294	0.191314875	0.267326619	0.1865	0.0066	0.0027
2004	0.544857617	0.115276634	0.248068383	0.1733	0.0063	0.0020
2005	0.505806366	0.096762706	0.23742656	0.1614	0.0082	0.0021
2006	0.543844574	0.074005157	0.280795617	0.1678	0.0212	NO
2007	0.511475275	0.039336328	0.281413047	0.1638	0.0269	NO

CH_4 [Gg]	1A.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2008	0.481819369	0.030501133	0.286270836	0.1452	0.0193	0.0006
2009	0.434283168	0.048782249	0.251676419	0.1152	0.0186	NO
2010	0.412853509	0.031902085	0.230451624	0.1112	0.0393	NO
2011	0.486161885	0.035265475	0.27962221	0.1160	0.0538	0.0014
Decrease 1989 - 2011	60.26	92.46	21.60	70.92	_	_
Decrease 1990 - 2011	65.58	95.40	-3.63	69.15	_	_
Decrease 2010 – 2011	-17.76	-10.54	-21.34	-4.38	-36.84	_

Table 3.44 N_2O emissions in 1.A.1.a. Public Electricity and Heat Production

N_2O [Gg]	1A.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.6327	0.0935	0.4993	0.0399	NO	NO
1990	0.5686	0.1533	0.3778	0.0376	NO	NO
1991	0.5514	0.1120	0.4025	0.0369	NO	NO
1992	0.4950	0.0577	0.4033	0.0291	0.0008	0.0041
1993	0.5186	0.0697	0.4216	0.0266	0.0000	0.0008
1994	0.5141	0.0662	0.4218	0.0247	0.0003	0.0012
1995	0.5354	0.0731	0.4348	0.0257	0.0003	0.0015
1996	0.5520	0.0824	0.4375	0.0286	0.0011	0.0024

N_2O [Gg]	1A.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1997	0.4625	0.0847	0.3529	0.0215	0.0004	0.0030
1998	0.3592	0.0524	0.2842	0.0226	0.0000	NO
1999	0.3573	0.0505	0.2879	0.0182	0.0007	NO
2000	0.3734	0.0428	0.3120	0.0172	0.0012	0.0002
2001	0.3861	0.0594	0.3101	0.0147	0.0009	0.0010
2002	0.3698	0.0414	0.3111	0.0150	0.0011	0.0012
2003	0.4321	0.0382	0.3740	0.0187	0.0009	0.0004
2004	0.3884	0.0230	0.3469	0.0173	0.0008	0.0003
2005	0.3690	0.0193	0.3321	0.0161	0.0011	0.0003
2006	0.4274	0.0148	0.3931	0.0168	0.0028	NO
2007	0.4216	0.0078	0.3940	0.0164	0.0035	NO
2008	0.4238	0.0060	0.4008	0.0145	0.0025	0.0001
2009	0.3760	0.0097	0.3523	0.0115	0.0024	NO
2010	0.3448	0.0059	0.3226	0.0111	0.0052	NO
2011	0.4168	0.0064	0.3915	0.0116	0.0072	0.0002
Decrease 1989 - 2011	34.12	93.15	21.60	70.92	_	_
Decrease 1990 - 2011	26.69	95.82	-3.63	69.15	_	_
Decrease 2010 – 2011	-20.88	-9.52	-21.34	-4.38	-36.84	_

3.2.7.1.2 Methodological issues

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

CO_2 gas

For the 1989–2006 period

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

For the 2007-2010 period

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

CH_4, N_2O - EFs default are used.

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

SO_2 – CS emission factors for solid fuels are used.

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

3.2.7.1.3 Uncertainties and time-series consistency

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

***CO_2* gas**

- Liquid Fuels - 3.105%;
- Solid Fuels – 5.00%;
- Gaseous Fuels - 3.041%;
- Biomass - 20.224%;
- Other (Industrial Wastes) - 21.190%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09 %;
- Solid Fuels - 50.09%;
- Gaseous Fuels - 50.09%;
- Biomass - 50.09%;
- Other (Industrial Wastes) - 50.49 %.

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

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

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

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

❖ ***Liquid Fuels* - Activity data (AD)**

- *Residual Fuel Oil:* 2001 year – the non-energy use of the fuel data, was subtracted;
- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.
- *Motor Gasoline*: 2010 year – Energy Balance correction.

❖ ***Solid Fuels* - Activity data (AD)**

- *Lignite*: 2009, 2010 years - activity data correction provided through the Energy Balance;
- *Blast Furnace Gas – avoiding double counting activity data with Industrial Processes Sector*: due to the fact that in the Iron and Steel Production - 2.C.1. IP activity category, the mass balance approach to estimate CO_2 emissions is used, the fuel Blast furnace Gas was subtracted; the associated emissions are reported under 2.C.1. activity category, 1992 – 2010 period.

❖ ***Solid Fuels* - CO_2 emission factors (EFs)**

- *Coking Coal*: 1992–1995 period – correction of the CO_2 EF (country specific EF was changed with a default EF).

❖ ***Solid Fuels* - SO_2 emissions**

- The SO_2 emissions reported under CLRTAP by the Large Combustion Plants, on the 2005 – 2011 period, were used.

❖ ***Other Fuels* - CO_2 emission factors**

- *Industrial Wastes*: the entire reported time-series - country specific CO_2 EF was determinate and used.

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

3.2.7.1.6 Source-specific planned improvements, if applicable

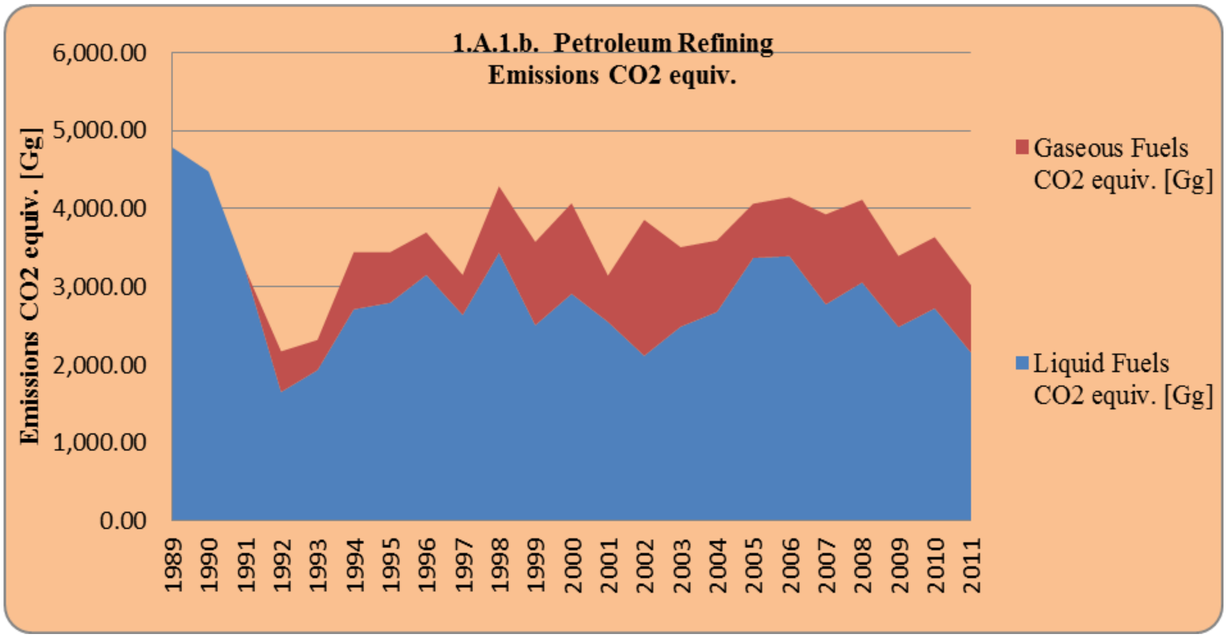
It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.
See the Chapter 3.2.6.6 for more details.

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

Category 1.A.1.b Petroleum refining covers emissions from fuel combustion in petroleum refineries and is a key category by liquid fuels and gaseous fuels, level, including and excluding LULUCF.
1.A.1.b Petroleum refining is not a key category as result of T2 approach.
See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF Sector 1.A.).

3.2.7.2.1 Source category description

Figure 3.17 GHG emissions from CRF 1.A.1.b Petroleum refining



The share in total GHG emissions 1.A – fuel Combustion of this activity is 6.4% for the year 1989 and 8.4% for the year 2011. The main fuels reported are liquids which are: Refinery gas, Transport diesel and Residual fuel oil, together with natural gas having a contribution about 3076.9 Gg in 2011.

Table 3.45 CO_2 emissions in CRF 1.A.1.b Petroleum refining

CO_2 [Gg]	1A.1.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	4,780.44	4,780.44	NO	NO	NO	NO
1990	4,472.52	4,472.52	NO	NO	NO	NO
1991	3,234.32	3,234.32	NO	NO	NO	NO
1992	2,170.12	1,650.90	NO	519.22	NO	NO

CO_2 [Gg]	1A.1.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1993	2,316.14	1,929.87	NO	386.27	NO	NO
1994	3,435.73	2,707.06	NO	728.67	NO	NO
1995	3,437.08	2,790.43	NO	646.65	NO	NO
1996	3,689.32	3,146.87	NO	542.45	NO	NO
1997	3,145.38	2,635.56	NO	509.82	NO	NO
1998	4,280.86	3,429.88	NO	850.98	NO	NO
1999	3,569.92	2,504.08	NO	1,065.85	NO	NO
2000	4,064.61	2,906.15	NO	1,158.46	NO	NO
2001	3,138.70	2,547.31	NO	591.39	NO	NO
2002	3,852.62	2,113.66	NO	1,738.96	NO	NO
2003	3,503.42	2,485.71	NO	1,017.70	NO	NO
2004	3,588.17	2,672.78	NO	915.39	NO	NO
2005	4,058.16	3,364.60	NO	693.56	NO	NO
2006	4,141.11	3,386.08	NO	755.03	NO	NO
2007	3,921.25	2,769.80	NO	1,151.45	NO	NO
2008	4,109.13	3,051.02	NO	1,058.11	NO	NO
2009	3,389.69	2,480.84	NO	908.85	NO	NO
2010	3,630.33	2,719.80	NO	910.53	NO	NO
2011	3,071.77	2,210.34	NO	861.43	NO	NO
Decrease 1989 - 2011	35.74	53.76	_	_	_	_
Decrease 1990 - 2011	31.32	50.58	_	_	_	_
Decrease 2010 - 2011	15.39	18.73	_	5.39	_	_

Table 3.46 CH_4 emissions in CRF 1.A.1.b Petroleum refining

CH_4 [Gg]	1A.1.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.1085	0.1085	NO	NO	NO	NO
1990	0.0960	0.0960	NO	NO	NO	NO
1991	0.0756	0.0756	NO	NO	NO	NO
1992	0.0468	0.0374	NO	0.0094	NO	NO
1993	0.0516	0.0446	NO	0.0070	NO	NO
1994	0.0834	0.0702	NO	0.0132	NO	NO
1995	0.0837	0.0720	NO	0.0117	NO	NO
1996	0.0988	0.0890	NO	0.0098	NO	NO
1997	0.0800	0.0708	NO	0.0092	NO	NO
1998	0.1075	0.0921	NO	0.0154	NO	NO
1999	0.0838	0.0645	NO	0.0193	NO	NO
2000	0.0940	0.0730	NO	0.0210	NO	NO
2001	0.0727	0.0620	NO	0.0107	NO	NO
2002	0.0814	0.0499	NO	0.0315	NO	NO
2003	0.0770	0.0585	NO	0.0184	NO	NO
2004	0.0822	0.0656	NO	0.0166	NO	NO
2005	0.0957	0.0831	NO	0.0125	NO	NO
2006	0.1045	0.0908	NO	0.0137	NO	NO
2007	0.0957	0.0747	NO	0.0210	NO	NO
2008	0.0957	0.0767	NO	0.0190	NO	NO
2009	0.0797	0.0632	NO	0.0164	NO	NO
2010	0.0890	0.0725	NO	0.0164	NO	NO
2011	0.0737	0.0582	NO	0.0155	NO	NO
Decrease 1989 - 2011	32.0582	46.3574	–	–	–	–
Decrease 1990 - 2011	23.1918	39.3570	–	–	–	–

CH_4 [Gg]	1A.1.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 2010 - 2011	17.1278	19.7501	_	5.54977264	_	_

Table 3.47 N_2O emissions in CRF 1.A.1.b Petroleum refining

N_2O [Gg]	1A.1.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.0153	0.0153	NO	NO	NO	NO
1990	0.0127	0.0127	NO	NO	NO	NO
1991	0.0110	0.0110	NO	NO	NO	NO
1992	0.0062	0.0053	NO	0.0009	NO	NO
1993	0.0071	0.0064	NO	0.0007	NO	NO
1994	0.0125	0.0111	NO	0.0013	NO	NO
1995	0.0126	0.0114	NO	0.0012	NO	NO
1996	0.0161	0.0151	NO	0.0010	NO	NO
1997	0.0125	0.0116	NO	0.0009	NO	NO
1998	0.0168	0.0153	NO	0.0015	NO	NO
1999	0.0123	0.0104	NO	0.0019	NO	NO
2000	0.0137	0.0116	NO	0.0021	NO	NO
2001	0.0105	0.0095	NO	0.0011	NO	NO
2002	0.0106	0.0075	NO	0.0031	NO	NO
2003	0.0107	0.0088	NO	0.0018	NO	NO
2004	0.0120	0.0103	NO	0.0017	NO	NO
2005	0.0144	0.0132	NO	0.0013	NO	NO
2006	0.0168	0.0154	NO	0.0014	NO	NO
2007	0.0148	0.0127	NO	0.0021	NO	NO
2008	0.0145	0.0126	NO	0.0019	NO	NO
2009	0.0121	0.0104	NO	0.0016	NO	NO

N_2O [Gg]	1A.1.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2010	0.0140	0.0123	NO	0.0016	NO	NO
2011	0.0114	0.0099	NO	0.0016	NO	NO
Decrease 1989 - 2011	25.2825	35.4456	–	–	–	–
Decrease 1990 - 2011	10.2021	22.4164	–	–	–	–
Decrease 2010 - 2011	18.4218	20.1353	–	5.54977264	–	–

3.2.7.2.2 Methodological issues

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

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

CO_2 gas

For the 1989–2006 period

- ❖ **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 - 2011 period

- ❖ **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2011 period, on each EU-ETS reported activity category, oxidation included, are used.

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

CH_4, N_2O - default EFs are used.

NO_x, CO, NMVOC, SO_2 – Default EMEP EFs are used.

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

3.2.7.2.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%;
- Solid Fuels – 5.00%;
- Gaseous Fuels - 3.041%;
- Biomass - 20.224%;
- Other (Industrial Wastes) - 21.190%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09%;
- Solid Fuels - 50.09%;
- Gaseous Fuels - 50.09%;
- Biomass - 50.09%;
- Other (Industrial Wastes) - 50.49%.

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

See the chapter 3.2.6.3 for more details.

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

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

See the Chapter 3.2.6.4 for more details.

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

- ***Liquid Fuels***
  - **Activity data**
    - *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series (2005-2010 reported period), was used.

3.2.7.2.6 Source-specific planned improvements, if applicable

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

See the Chapter 3.2.6.6 for more details.

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

3.2.7.3.1 Source category description

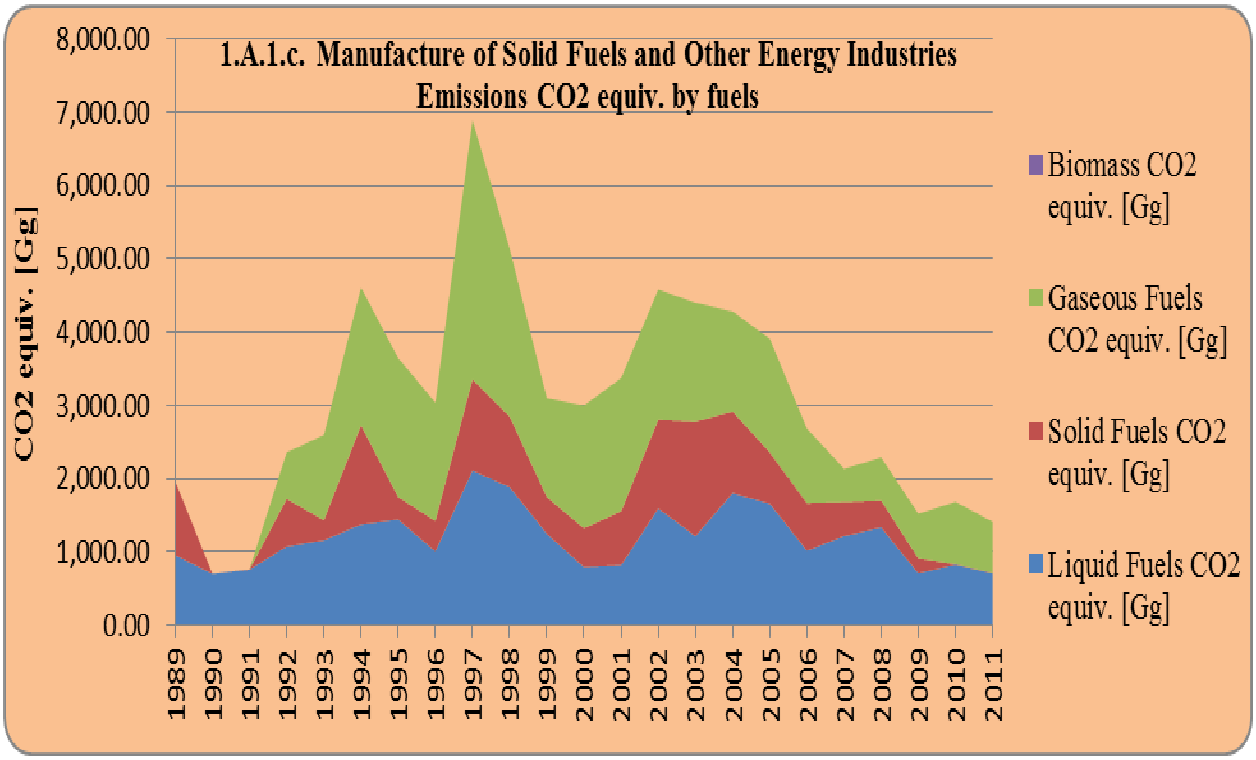
Category 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries covers emissions from fuel combustion in Coal Mines, Patent Fuel Plants (Energy), Coke Ovens (Energy) and BKB Plants (Energy) and is a key category by liquid fuels - level and trend, solid fuels – trend and gaseous fuels - level,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

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

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

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

Figure 3.18 GHG emissions from 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries



The share in total GHG emissions - sector 1A, is 2.6% for the year 2011, starting to a share of 4.0% in the base year, 1989. The emissions from this activity decreased by 25% 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 natural gas.

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

Table 3.48 CO_2 emissions in CRF 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

CO_2 [Gg]	1A.1c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	1,954.32	952.63	1,001.70	NO	NO	NO
1990	699.17	699.17	NO	NO	NO	NO
1991	758.74	756.21	2.52	NO	NO	NO
1992	2,057.51	1,071.56	647.21	635.16	NO	NO
1993	2,463.96	1,157.07	271.58	1,161.00	NO	NO
1994	3,504.89	1,369.80	1,352.43	1,880.67	NO	NO
1995	3,638.75	1,436.31	306.74	1,895.69	NO	NO
1996	3,034.99	1,004.82	412.57	1,617.60	NO	NO
1997	6,106.81	2,103.45	1,245.28	3,536.32	NO	NO
1998	4,594.85	1,878.71	960.46	2,290.46	NO	NO
1999	2,713.64	1,243.36	500.24	1,351.45	NO	NO
2000	2,546.65	789.50	529.01	1,676.74	0.896	NO
2001	2,907.38	817.19	733.45	1,818.10	3.472	NO
2002	3,707.81	1,587.71	1,208.74	1,776.76	2.576	NO
2003	4,023.76	1,210.57	1,558.79	1,620.88	2.240	NO
2004	3,739.70	1,796.27	1,112.20	1,367.46	1.120	NO
2005	3,531.99	1,651.83	701.47	1,550.95	0.560	NO
2006	2,323.92	1,014.68	646.60	1,014.92	0.224	NO
2007	1,936.32	1,212.24	463.74	456.58	0.112	NO
2008	2,170.67	1,330.18	365.20	588.95	NO	NO
2009	1,399.46	705.21	203.25	608.51	0.896	NO
2010	1,679.41	824.98	5.65	848.77	0.112	NO
2011	1,463.68	762.48	5.45	695.74	NO	NO
Decrease 1989 - 2011	25.106	19.960	99.455	–	–	–

CO_2 [Gg]	1A.1c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 1990 - 2011	-109.345	-9.055	–	–	–	–
Decrease 2010 - 2011	12.846	7.576	3.535	18.029	–	–

Table 3.49 CH_4 emissions in CRF 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

CH_4 [Gg]	1A.1c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.04963	0.03884	0.01079	NO	NO	NO
1990	0.02854	0.02854	NO	NO	NO	NO
1991	0.03091	0.03088	0.00003	NO	NO	NO
1992	0.06128	0.04433	0.00669	0.01149	NO	NO
1993	0.07199	0.04790	0.00360	0.02101	NO	NO
1994	0.09514	0.05668	0.00899	0.03403	NO	NO
1995	0.09825	0.05971	0.00423	0.03430	NO	NO
1996	0.07646	0.04161	0.00558	0.02927	NO	NO
1997	0.15908	0.08761	0.01072	0.06399	NO	NO
1998	0.12691	0.07918	0.00851	0.04145	NO	NO
1999	0.07723	0.05094	0.00342	0.02445	NO	NO
2000	0.06390	0.03251	0.00268	0.03034	0.00024	NO
2001	0.07201	0.03321	0.00689	0.03290	0.00093	NO
2002	0.10532	0.06578	0.01030	0.03215	0.00069	NO
2003	0.09579	0.05035	0.01703	0.02933	0.00060	NO
2004	0.10637	0.07235	0.01120	0.02474	0.00030	NO
2005	0.10031	0.06539	0.00825	0.02806	0.00015	NO
2006	0.06431	0.03978	0.00757	0.01836	0.00006	NO
2007	0.06232	0.04834	0.00642	0.00834	0.00003	NO

CH_4 [Gg]	1A.1c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2008	0.06628	0.05054	0.00563	0.01058	NO	NO
2009	0.03748	0.02454	0.00219	0.01100	0.00024	NO
2010	0.04472	0.02932	0.00006	0.01531	0.00003	NO
2011	0.03874	0.02615	0.00006	0.01253	NO	NO
Decrease 1989 - 2011	21.933	32.680	99.418	–	–	–
Decrease 1990 - 2011	-35.746	8.381	–	–	–	–
Decrease 2010 - 2011	13.370	10.802	1.222	18.166	–	–

Table 3.50 N_2O emissions in CRF 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

N_2O [Gg]	1A.1c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.02287	0.00777	0.01510	NO	NO	NO
1990	0.00571	0.00571	NO	NO	NO	NO
1991	0.00621	0.00618	0.00004	NO	NO	NO
1992	0.01291	0.00887	0.00302	0.00115	NO	NO
1993	0.01199	0.00958	0.00036	0.00210	NO	NO
1994	0.01641	0.01134	0.00213	0.00340	NO	NO
1995	0.01868	0.01194	0.00331	0.00343	NO	NO
1996	0.01579	0.00832	0.00454	0.00293	NO	NO
1997	0.02772	0.01752	0.00412	0.00640	NO	NO
1998	0.02410	0.01584	0.00434	0.00414	NO	NO
1999	0.01369	0.01019	0.00122	0.00245	NO	NO
2000	0.01071	0.00650	0.00133	0.00303	0.00003	NO
2001	0.01150	0.00662	0.00166	0.00329	0.00012	NO

N_2O [Gg]	1A.1c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2002	0.01779	0.01314	0.00170	0.00321	0.00009	NO
2003	0.02767	0.01007	0.01474	0.00293	0.00008	NO
2004	0.02156	0.01435	0.00491	0.00247	0.00004	NO
2005	0.01673	0.01293	0.00113	0.00281	0.00002	NO
2006	0.01041	0.00783	0.00089	0.00184	0.00001	NO
2007	0.01100	0.00955	0.00069	0.00083	0.00000	NO
2008	0.01159	0.00982	0.00076	0.00106	NO	NO
2009	0.00605	0.00461	0.00036	0.00110	0.00003	NO
2010	0.00719	0.00556	0.00009	0.00153	0.00000	NO
2011	0.00622	0.00488	0.00009	0.00125	NO	NO
Decrease 1989 - 2011	72.782	37.142	99.418	–	–	–
Decrease 1990 - 2011	-9.039	14.453	–	–	–	–
Decrease 2010 - 2011	13.420	12.247	1.222	18.166	–	–

3.2.7.3.2 Methodological issues

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

CO_2 gas

<u>For the 1989–2006 period</u>

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

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

F<u>or the 2007 - 2011 period</u>

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

CH_4, N_2O - default EFs are used.

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

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

3.2.7.3.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%;
- Solid Fuels – 5.00%;

- Gaseous Fuels - 3.041%;
- Biomass - 20.224%;
- Other (Industrial Wastes) - 21.190%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09%;
- Solid Fuels - 50.09%;
- Gaseous Fuels - 50.09%;
- Biomass - 50.09%;
- Other (Industrial Wastes) - 50.49%.

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

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

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

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

- ***Liquid Fuels*** **- Activity data**
  - *Motor Gasoline*: 2010 year – Energy Balance correction;
  - *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.
    The non-energy use data associated with the following fuels was subtracted:
  - *Transport Diesel:* 1999, 2001 years;

- *Residual Fuel Oil:* 1999 year.

❖ ***Solid Fuels - Activity* data**

- *Coking Coal*: 2007, 2010 years - activity data correction provided through the Energy Balance;
- *Blast Furnace Gas – avoiding double counting activity data with Industrial Processes Sector*: due to the fact that in the Iron and Steel Production - 2.C.1. IP activity category, the mass balance approach to estimate CO_2 emissions is used, the fuel Blast furnace Gas was subtracted; the associated emissions are reported under 2.C.1. activity category, 1992 – 1994, 1997 - 2009 periods.

❖ ***Solid Fuels* - CO_2 emission factors**

- *Coking Coal*: 1989, 1991 years, 1994-2003 period – correction of the CO_2 EF (country specific EF was changed with a default EF).

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

3.2.7.3.6 Source-specific planned improvements, if applicable

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

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

Figure 3.19 Total GHG emissions trend for the subsector 1.A.2. Manufacturing Industries and Constructions by category

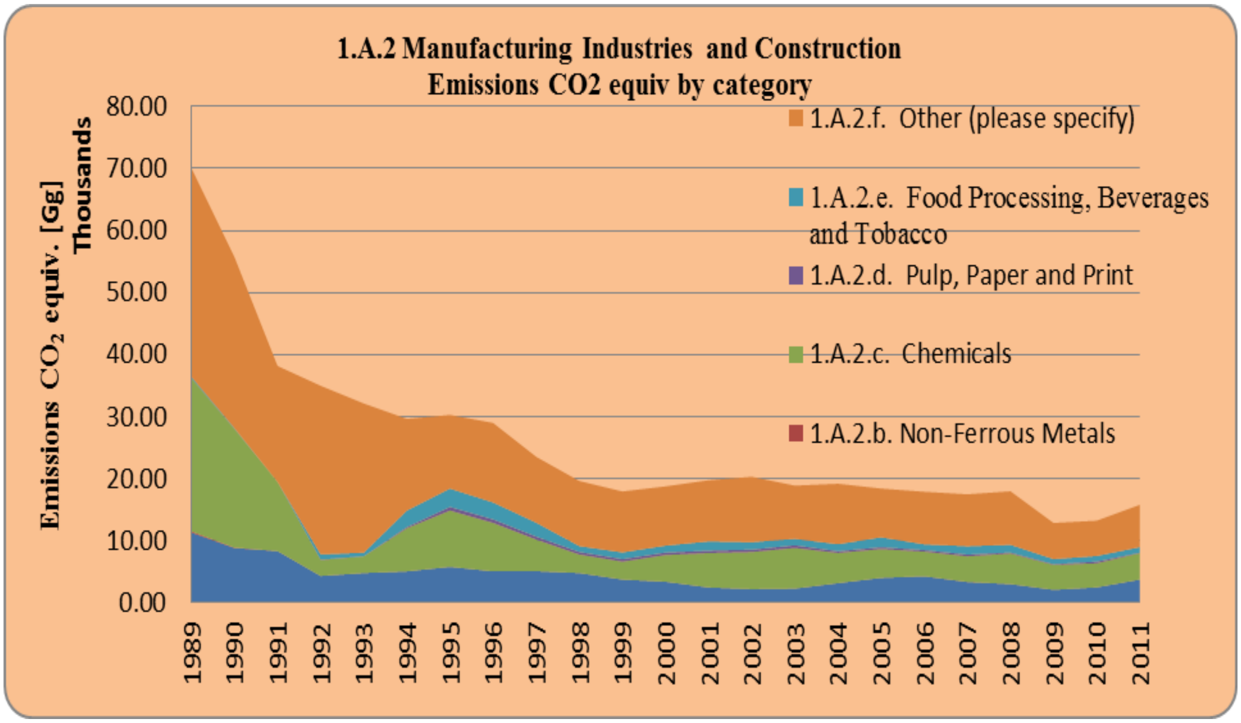
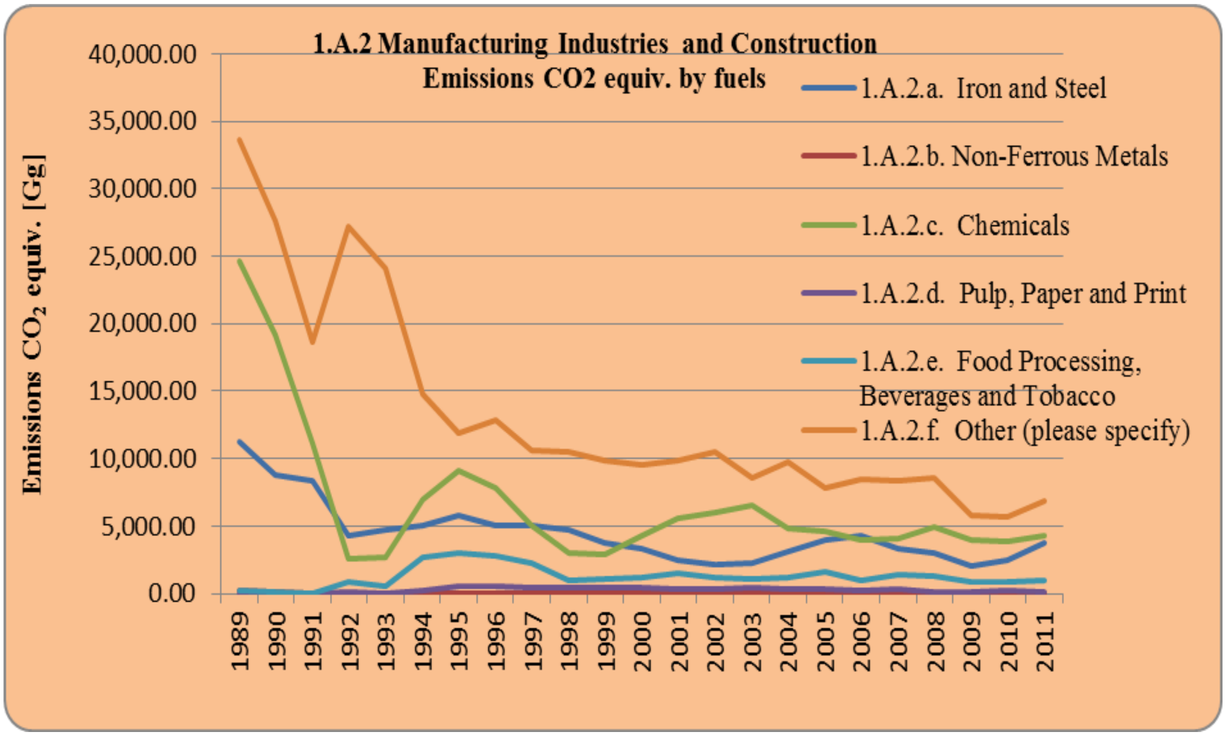


Figure 3.20 GHG emissions trend for the subsector 1.A.2. Manufacturing Industries and Constructions by fuels



The subsector Manufacturing Industries and Construction was responsible in 2011 for 20.3% of the total Energy Sector GHG emissions (about 15,761.24Gg CO_2 equivalents).

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

- ***Energy Use in the Petrochemical Sector***
- ***Energy Use in Transformation Sector**, **autoproducers:***
  - Auto producer Electricity Plants
  - Auto producer CHP Plants
  - Auto producer Heat Plants.
- ***Energy Sector - Blast Furnaces (Energy)***
- ***Industry Sector:***
  - Iron and Steel;

- Chemical (including Petrochemical);
- Non-Ferrous Metals;
- Non-Metallic Minerals;
- Transport Equipment;
- Machinery;
- Mining and Quarrying;
- Food, Beverages and Tobacco;
- Paper, Pulp and Printing;
- Wood and Wood Products;
- Construction;
- Textiles and Leather.
- Non-specified (Industry).

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

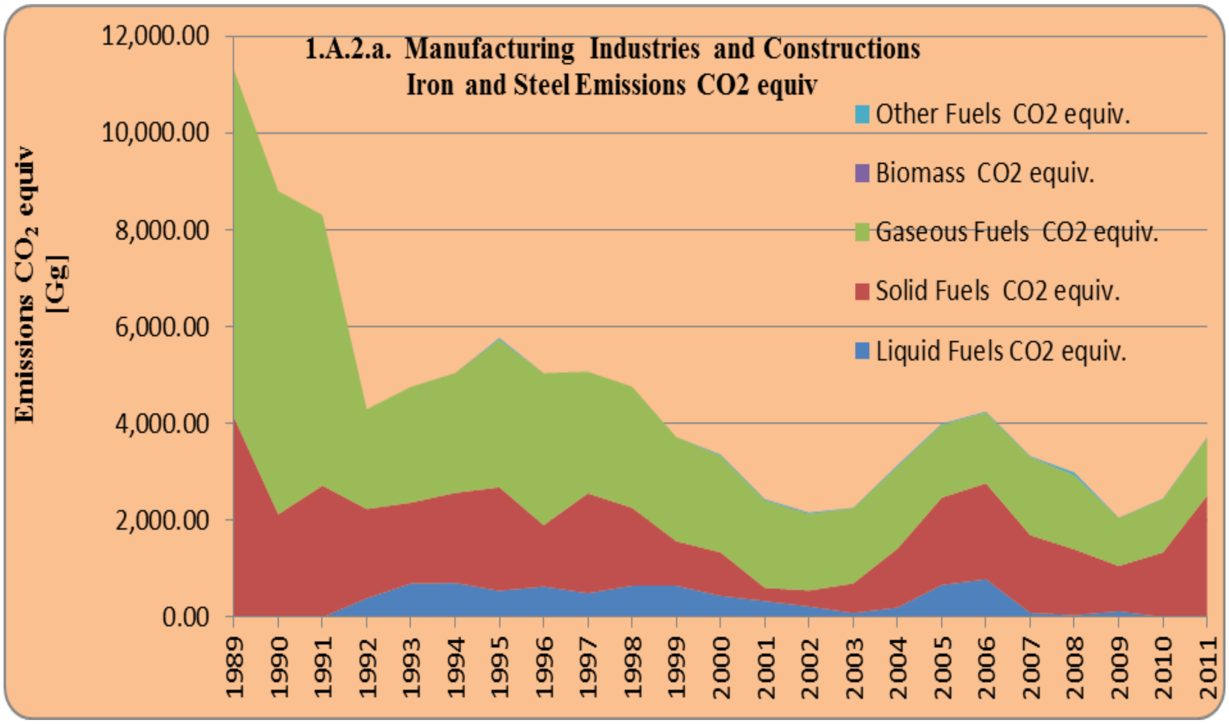
3.2.8.1.1 Source category description

CRF 1.A.2.a - Iron and Steel is a key category by solid and gaseous fuels, level and trend, including and excluding LULUCF, as result of T1 approach.

CRF 1.A.2.a - Iron and Steel is a key category by solid fuels - level and gaseous fuels - trend, excluding LULUCF, and by gaseous fuels - trend, including LULUCF, as result of T2 approach.

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

Figure 3.21 GHG emissions from 1.A.2.a – Iron and Steel, by fuels



The share of the total CO_2 equiv. emissions of the 1.A.2.a category to the 1.A.2 sub-sector, is 16.12% from the base year, to 23.57% - current year, 2011. The contribution of this category is about 3,714.73 Gg CO_2 equiv., in 2011.

Table 3.51 CO_2 emissions in 1.A.2.a – Iron and Steel

CO_2 [Gg]	1A.2.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	11,257.90	NO	4,100.61	7,157.29	NO	NO
1990	8,773.36	NO	2,112.56	6,660.80	NO	NO
1991	8,276.33	NO	2,700.28	5,576.05	1.12	NO
1992	4,278.06	387.84	1,832.73	2,057.49	13.78	NO
1993	4,738.95	693.31	1,661.27	2,384.37	12.43	NO
1994	5,021.53	705.88	1,848.26	2,467.38	20.61	NO

CO_2 [Gg]	1A.2.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1995	5,743.80	541.97	2,127.94	3,042.41	23.86	31.47
1996	5,022.85	629.18	1,263.12	3,130.55	22.96	NO
1997	5,049.95	494.39	2,049.68	2,505.88	9.86	NO
1998	4,743.67	647.19	1,600.75	2,495.74	0.22	NO
1999	3,707.78	647.36	912.41	2,148.01	1.68	NO
2000	3,346.52	439.67	891.00	1,990.74	0.67	25.11
2001	2,430.89	333.13	270.53	1,801.04	0.34	26.20
2002	2,151.32	219.47	328.83	1,577.91	2.69	25.11
2003	2,252.86	84.74	606.86	1,553.39	0.67	7.87
2004	3,125.18	198.80	1,206.70	1,690.22	NO	29.46
2005	3,977.36	663.89	1,791.86	1,498.92	NO	22.68
2006	4,227.00	780.73	1,967.55	1,459.88	1.01	18.83
2007	3,309.40	89.98	1,591.37	1,612.31	0.67	15.74
2008	2,972.98	42.42	1,347.67	1,522.96	NO	59.93
2009	2,044.47	122.94	926.65	986.50	NO	8.37
2010	2,434.37	6.34	1,319.71	1,099.54	NO	8.79
2011	3,694.66	9.58	2,483.44	1,190.62	0.22	11.02
Decrease 1989 - 2011	67.18	_	39.44	83.36	_	_
Decrease 1990 - 2011	57.89	_	-17.56	82.12	_	_
Decrease 2010 - 2011	-51.77	-51.05	-88.18	-8.28	_	-25.41

Table 3.52 CH_4 emissions in CRF 1.A.2.a. – Iron and Steel

CH_4 [Gg]	1A.2.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	1.0920	NO	0.4445	0.6475	NO	NO
1990	0.8309	NO	0.2282	0.6026	NO	NO
1991	0.7978	NO	0.2930	0.5045	0.0003	NO
1992	0.3983	0.0100	0.1984	0.1861	0.0037	NO
1993	0.4150	0.0161	0.1798	0.2157	0.0033	NO
1994	0.4464	0.0179	0.1997	0.2232	0.0055	NO
1995	0.5368	0.0138	0.2300	0.2753	0.0064	0.0113
1996	0.4404	0.0156	0.1354	0.2832	0.0062	NO
1997	0.4643	0.0127	0.2222	0.2267	0.0026	NO
1998	0.4155	0.0166	0.1730	0.2258	0.0001	NO
1999	0.3102	0.0166	0.0988	0.1943	0.0005	NO
2000	0.2979	0.0124	0.0963	0.1801	0.0002	0.0090
2001	0.2109	0.0097	0.0288	0.1629	0.0001	0.0094
2002	0.1939	0.0067	0.0348	0.1428	0.0007	0.0090
2003	0.2127	0.0035	0.0657	0.1405	0.0002	0.0028
2004	0.3000	0.0063	0.1302	0.1529	NO	0.0106
2005	0.3530	0.0170	0.1923	0.1356	NO	0.0081
2006	0.3708	0.0200	0.2117	0.1321	0.0003	0.0068
2007	0.3258	0.0022	0.1704	0.1473	0.0002	0.0056
2008	0.3117	0.0013	0.1521	0.1368	NO	0.0215
2009	0.1946	0.0031	0.0993	0.0892	NO	0.0030
2010	0.2442	0.0002	0.1417	0.0992	NO	0.0032
2011	0.3736	0.0002	0.2621	0.1072	0.0001	0.0040
Decrease 1989 - 2010	65.79	–	41.03	83.44	–	–
Decrease 1990 - 2010	55.04	–	-14.83	82.21	–	–

CH_4 [Gg]	1A.2.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 2009 - 2010	-53.01	-55.33	-85.01	-8.10	_	-25.71

Table 3.53 N_2O emissions in CRF 1.A.2.a. – Iron and Steel

N_2O [Gg]	1A.2.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.05930	NO	0.04635	0.01295	NO	NO
1990	0.03381	NO	0.02175	0.01205	NO	NO
1991	0.04143	NO	0.03130	0.01009	0.00004	NO
1992	0.02712	0.00301	0.01990	0.00372	0.00049	NO
1993	0.02766	0.00483	0.01807	0.00431	0.00044	NO
1994	0.02939	0.00538	0.01881	0.00446	0.00074	NO
1995	0.03398	0.00414	0.02197	0.00551	0.00085	0.00150
1996	0.02065	0.00469	0.00948	0.00566	0.00082	NO
1997	0.03163	0.00382	0.02292	0.00453	0.00035	NO
1998	0.02607	0.00499	0.01656	0.00452	0.00001	NO
1999	0.01888	0.00499	0.00995	0.00389	0.00006	NO
2000	0.01759	0.00372	0.00905	0.00360	0.00002	0.00120
2001	0.00882	0.00290	0.00140	0.00326	0.00001	0.00125
2002	0.00736	0.00200	0.00121	0.00286	0.00010	0.00120
2003	0.01085	0.00104	0.00660	0.00281	0.00002	0.00038
2004	0.02170	0.00190	0.01534	0.00306	NO	0.00141
2005	0.03250	0.00510	0.02361	0.00271	NO	0.00108
2006	0.03562	0.00599	0.02605	0.00264	0.00004	0.00090
2007	0.02530	0.00067	0.02091	0.00295	0.00002	0.00075
2008	0.02611	0.00031	0.02020	0.00274	NO	0.00286
2009	0.01664	0.00094	0.01352	0.00178	NO	0.00040
2010	0.02228	0.00005	0.01983	0.00198	NO	0.00042

N_2O [Gg]	1A.2.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2011	0.03944	0.00007	0.03669	0.00214	0.00001	0.00053
Decrease 1989 - 2011	33.49	_	20.84	83.44	_	_
Decrease 1990 - 2011	-16.68	_	-68.68	82.21	_	_
Decrease 2010 - 2011	-77.02	-55.33	-85.01	-8.10	_	-25.71

3.2.8.1.2 Methodological issues

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

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

CO_2 gas

For the 1989–2006 period

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

For the 2007-2011 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2011 period, on each EU-ETS reported activity category, oxidation included, are used.

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

CH_4, N_2O - default EFs are used.

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

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

3.2.8.1.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%;
- Solid Fuels – 5.00%;
- Gaseous Fuels - 3.041%;
- Biomass - 20.224%;
- Other (Industrial Wastes) - 21.190%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09%;

- Solid Fuels - 50.09%;
- Gaseous Fuels - 50.09%;
- Biomass - 50.09%;
- Other (Industrial Wastes) - 50.49%.

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

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

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

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

- ***Liquid Fuels* - Activity data**
  - *Petroleum Coke*: 2000–2010 period – the non-energy use of the fuel data was subtracted;
  - *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.
- ***Solid Fuels* - Activity data**
  - *Blast Furnace Gas – avoiding double counting activity data with Industrial Processes Sector*: due to the fact that in the Iron and Steel Production - 2.C.1. IP activity category, the mass balance approach to estimate CO_2 emissions is used, the fuel Blast furnace Gas was subtracted; the associated emissions are reported under 2.C.1. activity category, 1990 – 2010 period;
  - *Coking Coal*: 2009 year - activity data correction provided through the Energy Balance.

❖ ***Solid Fuels* - CO_2 emission factors**

- *Coking Coal*: 1992–1996 period, 2000 year, 2004–2010 period – correction of the CO_2 EF (country specific EF was changed with a default EF);
- *Coke Oven Coke*: 1989–2010 period – correction of the CO_2 EF (default EF was changed with a country specific EF).

❖ ***Other Fuels* - CO_2 emission factors**

- *Industrial Wastes*: the entire reported time-series - country specific CO_2 emission factor was determinated and used.

3.2.8.1.6 Source-specific planned improvements, if applicable

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

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

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

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

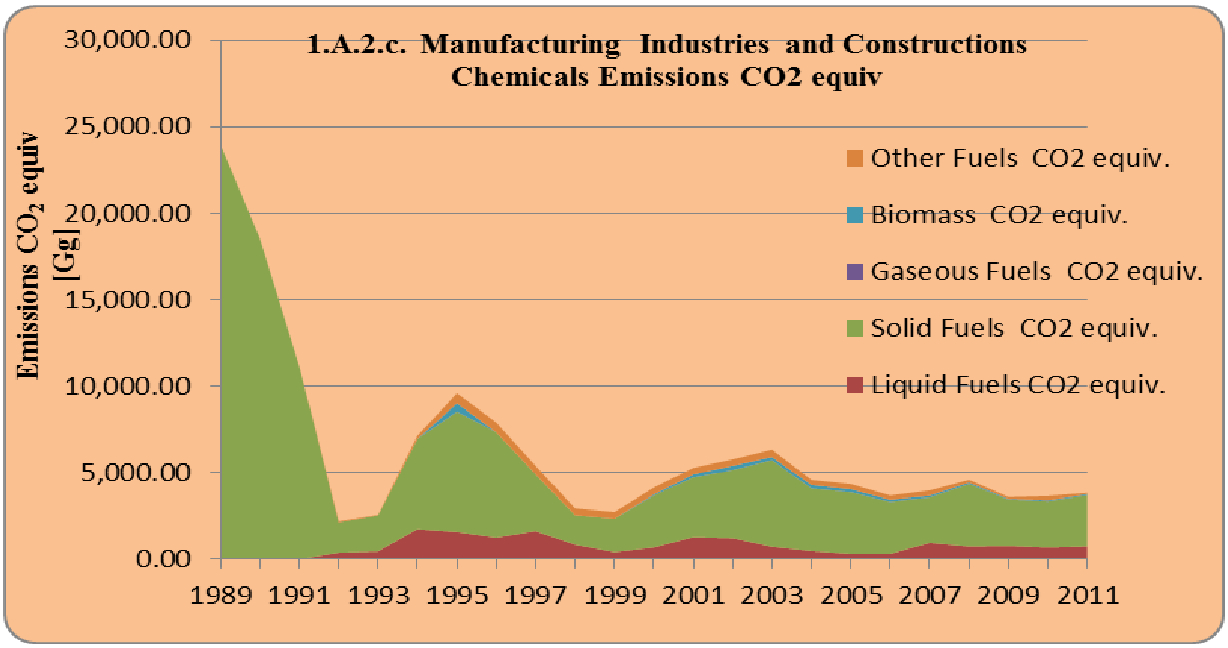
3.2.8.3.1 Source description

CRF category 1.A.2.c. – Chemicals is a key category by liquid and solid fuels – level and gaseous fuels - level and trend, excluding and including LULUCF, as result of T1 approach.

CRF category 1.A.2.c. – Chemicals is a key category by gaseous fuels - trend, excluding and including LULUCF, as result of T2 approach.

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

Figure 3.22 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 - 35% to 27% - current year, 2011. The contribution of this category is about 4,255.31Gg CO_2 equiv., in 2011.

Table 3.54 CO_2 emissions in 1.A.2.c. – Chemicals

CO_2 [Gg]	1A.2.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	24,610.20	NO	718.84	23,891.35	NO	NO
1990	19,093.19	NO	594.06	18,499.14	NO	NO

CO_2 [Gg]	1A.2.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1991	11,134.96	NO	5.29	11,129.67	1.120	NO
1992	2,550.77	374.37	434.15	1,742.24	52.640	NO
1993	2,686.04	453.21	161.76	2,071.07	40.544	NO
1994	6,928.70	1,731.80	4.54	5,192.36	27.776	NO
1995	9,040.93	1,559.48	62.08	6,933.71	39.424	485.659
1996	7,787.96	1,240.54	472.10	6,075.32	62.384	NO
1997	5,071.33	1,612.29	174.51	3,284.54	91.056	NO
1998	2,980.75	831.61	452.35	1,696.78	37.632	NO
1999	2,876.11	404.84	548.87	1,922.40	2.576	NO
2000	4,289.53	669.19	557.91	2,995.21	3.920	67.215
2001	5,532.01	1,266.68	644.64	3,451.86	2.912	168.834
2002	5,977.07	1,205.02	606.83	3,923.48	2.464	241.741
2003	6,526.34	715.05	644.78	4,989.13	5.376	177.372
2004	4,838.76	466.76	560.20	3,613.66	3.584	198.131
2005	4,620.06	303.23	582.06	3,561.34	0.448	173.438
2006	3,949.30	305.24	519.07	2,992.57	NO	132.422
2007	4,107.42	931.98	434.45	2,637.28	2.576	103.711
2008	4,909.46	726.16	486.43	3,605.12	1.344	91.741
2009	3,998.18	760.18	512.89	2,676.73	1.229	48.382
2010	3,874.58	666.97	485.21	2,657.95	9.866	64.453
2011	4,238.05	733.97	477.37	2,964.25	9.766	62.458
Decrease 1989 - 2011	82.779	–	33.592	87.593	–	–
Decrease 1990 - 2011	77.803	–	19.642	83.976	–	–
Decrease 2010 - 2011	-9.381	-10.046	1.616	-11.524	1.008	3.096

Table 3.55 CH_4 emissions in 1.A.2.c. – Chemicals

CH_4 [Gg]	1A.2.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	2.2403	NO	0.0787	2.1615	NO	NO
1990	1.7387	NO	0.0650	1.6737	NO	NO
1991	1.0078	NO	0.0005	1.0069	0.0003	NO
1992	0.2360	0.0166	0.0476	0.1576	0.0141	NO
1993	0.2304	0.0144	0.0177	0.1874	0.0109	NO
1994	0.5589	0.0812	0.0005	0.4698	0.0074	NO
1995	0.9188	0.1003	0.0065	0.6273	0.0106	0.1741
1996	0.6710	0.0530	0.0516	0.5497	0.0167	NO
1997	0.4226	0.0821	0.0190	0.2972	0.0244	NO
1998	0.2622	0.0517	0.0469	0.1535	0.0101	NO
1999	0.2440	0.0133	0.0561	0.1739	0.0007	NO
2000	0.3789	0.0249	0.0579	0.2710	0.0011	0.0241
2001	0.5007	0.0604	0.0667	0.3123	0.0008	0.0605
2002	0.5864	0.0815	0.0626	0.3550	0.0007	0.0866
2003	0.6379	0.0547	0.0669	0.4514	0.0014	0.0636
2004	0.4869	0.0301	0.0579	0.3269	0.0010	0.0710
2005	0.4574	0.0134	0.0595	0.3222	0.0001	0.0622
2006	0.3799	0.0086	0.0531	0.2707	NO	0.0475
2007	0.3868	0.0633	0.0447	0.2410	0.0007	0.0372
2008	0.4659	0.0574	0.0513	0.3239	0.0004	0.0329
2009	0.3751	0.0579	0.0555	0.2420	0.0023	0.0173
2010	0.4040	0.0526	0.0534	0.2398	0.0352	0.0231
2011	0.4679	0.0592	0.0536	0.2670	0.0657	0.0224
Decrease 1989 - 2011	79.115	–	31.945	87.650	–	–
Decrease 1990 - 2011	73.089	–	17.552	84.050	–	–

CH_4 [Gg]	1A.2.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 2010 - 2011	-15.817	-12.664	-0.369	-11.338	-86.803	2.857

Table 3.56 N_2O emissions in 1.A.2.c. – Chemicals

N_2O [Gg]	1A.2.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.0543	NO	0.0110	0.0432	NO	NO
1990	0.0426	NO	0.0091	0.0335	NO	NO
1991	0.0203	NO	0.0001	0.0201	0.0000	NO
1992	0.0140	0.0023	0.0067	0.0032	0.0019	NO
1993	0.0112	0.0035	0.0025	0.0037	0.0014	NO
1994	0.0207	0.0103	0.0000	0.0094	0.0010	NO
1995	0.0438	0.0065	0.0001	0.0125	0.0014	0.0232
1996	0.0277	0.0079	0.0065	0.0110	0.0022	NO
1997	0.0206	0.0087	0.0027	0.0059	0.0033	NO
1998	0.0140	0.0036	0.0059	0.0031	0.0013	NO
1999	0.0137	0.0029	0.0073	0.0035	0.0001	NO
2000	0.0213	0.0044	0.0081	0.0054	0.0001	0.0032
2001	0.0309	0.0071	0.0093	0.0062	0.0001	0.0081
2002	0.0322	0.0047	0.0088	0.0071	0.0001	0.0116
2003	0.0292	0.0021	0.0094	0.0090	0.0002	0.0085
2004	0.0262	0.0020	0.0081	0.0065	0.0001	0.0095
2005	0.0250	0.0019	0.0083	0.0064	0.0000	0.0083
2006	0.0216	0.0024	0.0074	0.0054	NO	0.0063
2007	0.0199	0.0038	0.0063	0.0048	0.0001	0.0050
2008	0.0198	0.0017	0.0072	0.0065	0.0000	0.0044
2009	0.0172	0.0020	0.0078	0.0048	0.0002	0.0023
2010	0.0205	0.0016	0.0075	0.0048	0.0036	0.0031

N_2O [Gg]	1A.2.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2011	0.0240	0.0015	0.0075	0.0053	0.0066	0.0030
Decrease 1989 - 2011	55.794	–	31.945	87.650	–	–
Decrease 1990 - 2011	43.665	–	17.552	84.050	–	–
Decrease 2010 - 2011	-17.057	1.589	-0.369	-11.338	-84.615	2.857

3.2.8.3.2 Methodological issues

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

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

CO_2 gas

For the 1989–2006 period

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

For the 2007 - 2011 period

- ❖ **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2011 period, on each EU-ETS reported activity category, oxidation included, are used.

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

CH_4, N_2O - default EFs are used.

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

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

3.2.8.3.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%;
- Solid Fuels – 5.00%;
- Gaseous Fuels - 3.041%;
- Biomass - 20.224%;
- Other (Industrial Wastes) - 21.190%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09%;
- Solid Fuels - 50.09%;
- Gaseous Fuels - 50.09 %;
- Biomass - 50.09%;
- Other (Industrial Wastes) - 50.49%.

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

See the Chapter 3.2.6.3 for more details.

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

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

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

- ***Liquid Fuels*** **- Activity data**
  - *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.
  - The non-energy use data associated with the following fuels was subtracted:
    - *Refinery Gas*: 1992–1994 period, 1999 year, 2004–2010 period;
    - *Residual Fuel Oil*: 1993–1995, 1998-1999, 2006–2008 periods;
    - *Naphtha*: 1994 year, 1996–2010 period;
    - *Transport Diesel*: 2001 year;
    - *Other Kerosene*: 2002, 2003 years;

- *White Spirit &SPB*: 2006 year.

❖ ***Solid Fuels* - CO_2 emission factors**

- *Coke Oven Coke*: 1989, 1990, 1992, 1993 years, 1996-2008 period - correction of the CO_2 EF (default EF was changed with a country specific EF).

❖ ***Other Fuels* - CO_2 emission factors**

- *Industrial Wastes*: the entire reported time-series - country specific CO_2 emission factor was determinate and used.

❖ ***Other Fuels* - CO_2 emission factors**

- *Industrial Wastes*: the entire reported time-series - country specific CO_2 emission factor was determinate and used.

3.2.8.3.6 Source-specific planned improvements, if applicable

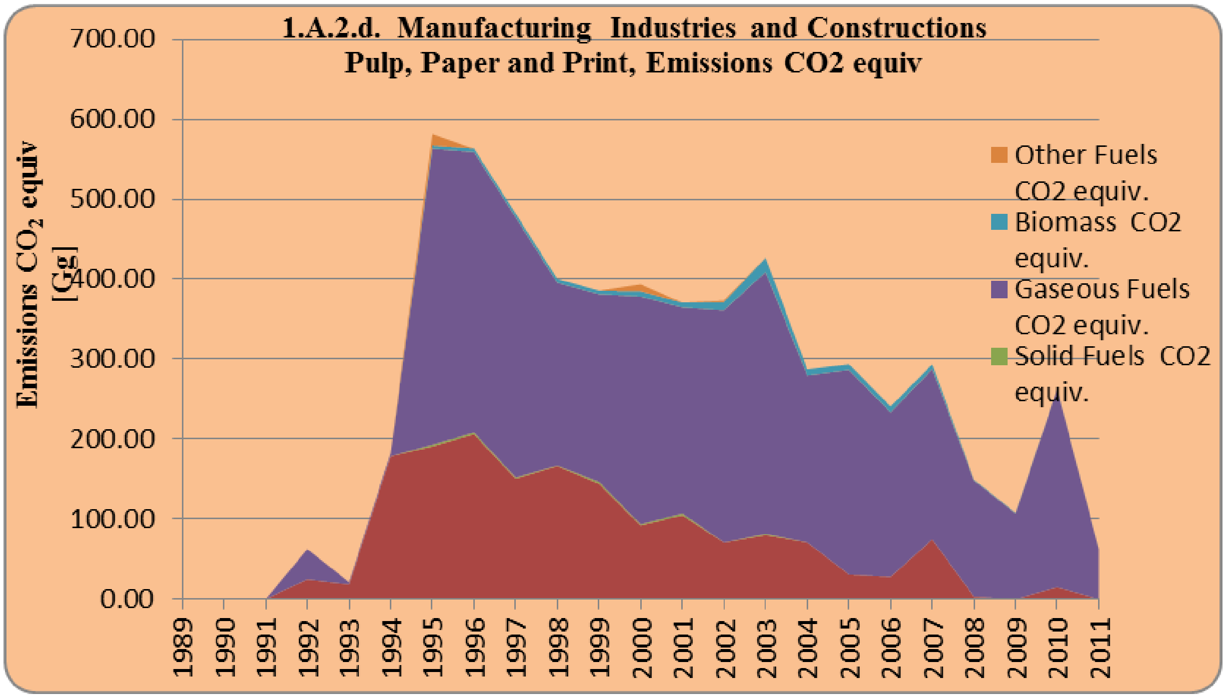
It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.
See the Chapter 3.2.6.6 for more details.

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

3.2.8.4.1 Source description

1.A.2.d - Fuel combustion, Manufacturing Industries and Construction, Pulp, Paper and Print is not a key category as result of t1 or T2 approach.

Figure 3.23 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 0.38% - in the current year, 2011. The contribution of this category is about 62.18 Gg CO_2 equiv., in 2011.

Activity category 1.A.2.d - *Pulp, Paper and Print,* is not a key category, as result, both, T1 and T2 approach.

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

Table 3.57 CO_2 emissions in 1.A.2.d. - Pulp, Paper and Print

CO_2 [Gg]	1A.2.d Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.72	NO	0.72	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	62.43	24.67	NO	37.75	0.11	NO
1993	21.27	18.48	NO	2.79	NO	NO
1994	182.11	178.14	NO	3.98	NO	NO
1995	575.21	190.35	2.13	369.16	263.31	13.5603
1996	557.40	205.47	2.17	349.76	262.53	NO
1997	476.01	150.27	1.49	324.25	283.81	NO
1998	394.52	165.68	0.75	228.10	287.06	NO
1999	380.28	144.06	2.25	233.97	265.89	NO
2000	385.85	91.82	1.41	284.16	396.59	8.4542
2001	363.99	104.43	2.35	257.20	354.14	NO
2002	362.02	70.62	NO	289.73	628.43	1.6741
2003	408.04	79.92	1.54	326.58	1,070.83	NO
2004	278.94	70.79	NO	208.16	453.94	NO
2005	285.81	30.70	NO	255.11	443.52	NO
2006	232.94	27.82	NO	205.12	445.20	NO
2007	286.85	74.42	NO	212.43	367.02	NO
2008	148.15	3.12	NO	145.03	56.00	NO
2009	106.92	NO	NO	106.92	43.34	NO
2010	261.50	14.72	NO	246.77	17.36	NO
2011	61.86	NO	NO	61.86	10.42	NO
Decrease 1989 - 2011	-8,511.53	–	–	–	–	–

CO_2 [Gg]	1A.2.d Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 1990 - 2011	–	–	–	–	–	–
Decrease 2010 - 2011	76.34	–	–	74.93	40.00	–

Table 3.58 CH_4 emissions in 1.A.2.d. - Pulp, Paper and Print

CH_4 [Gg]	1A.2.d Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.00007	NO	0.00007	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	0.00409	0.00065	NO	0.00342	0.00003	NO
1993	0.00073	0.00048	NO	0.00025	NO	NO
1994	0.00493	0.00457	NO	0.00036	NO	NO
1995	0.11389	0.00488	0.00023	0.03340	0.07053	0.00486
1996	0.10747	0.00527	0.00023	0.03164	0.07032	NO
1997	0.10937	0.00386	0.00015	0.02934	0.07602	NO
1998	0.10185	0.00425	0.00008	0.02064	0.07689	NO
1999	0.09633	0.00372	0.00023	0.02117	0.07122	NO
2000	0.13748	0.00237	0.00014	0.02571	0.10623	0.00303
2001	0.12106	0.00268	0.00025	0.02327	0.09486	NO
2002	0.19695	0.00181	NO	0.02621	0.16833	0.00060
2003	0.31876	0.00223	0.00016	0.02955	0.28683	NO
2004	0.14225	0.00183	NO	0.01883	0.12159	NO
2005	0.14267	0.00079	NO	0.02308	0.11880	NO
2006	0.13855	0.00074	NO	0.01856	0.11925	NO

CH_4 [Gg]	1A.2.d Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2007	0.11969	0.00197	NO	0.01941	0.09831	NO
2008	0.02812	0.00008	NO	0.01303	0.01500	NO
2009	0.02128	NO	NO	0.00967	0.01161	NO
2010	0.02747	0.00056	NO	0.02226	0.00465	NO
2011	0.00836	NO	NO	0.00557	0.00279	NO
Decrease 1989 - 2011	-11,443.56	–	–	–	–	–
Decrease 1990 - 2011	–	–	–	–	–	–
Decrease 2010 - 2011	69.56	–	–	74.97	40.00	–

Table 3.59 N_2O emissions in 1.A.2.d. - Pulp, Paper and Print

N_2O [Gg]	1A.2.d Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.00001	NO	0.00001	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	0.00027	0.00019	NO	0.00007	0.00000	NO
1993	0.00015	0.00014	NO	0.00001	NO	NO
1994	0.00138	0.00137	NO	0.00001	NO	NO
1995	0.01222	0.00146	0.00003	0.00067	0.00940	0.00065
1996	0.01162	0.00158	0.00003	0.00063	0.00938	NO
1997	0.01190	0.00116	0.00002	0.00059	0.01014	NO
1998	0.01195	0.00128	0.00001	0.00041	0.01025	NO
1999	0.01107	0.00111	0.00003	0.00042	0.00950	NO
2000	0.01581	0.00071	0.00002	0.00051	0.01416	0.00040

N_2O [Gg]	1A.2.d Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2001	0.01395	0.00081	0.00003	0.00047	0.01265	NO
2002	0.02359	0.00054	NO	0.00052	0.02244	0.00008
2003	0.03946	0.00060	0.00002	0.00059	0.03824	NO
2004	0.01714	0.00055	NO	0.00038	0.01621	NO
2005	0.01654	0.00024	NO	0.00046	0.01584	NO
2006	0.01649	0.00022	NO	0.00037	0.01590	NO
2007	0.01409	0.00059	NO	0.00039	0.01311	NO
2008	0.00229	0.00003	NO	0.00026	0.00200	NO
2009	0.00174	NO	NO	0.00019	0.00155	NO
2010	0.00117	0.00010	NO	0.00045	0.00062	NO
2011	0.00048	NO	NO	0.00011	0.00037	NO
Decrease 1989 - 2011	-4,667.36	–	–	–	–	–
Decrease 1990 - 2011	–	–	–	–	–	–
Decrease 2010 - 2011	58.52	–	–	74.97	40.00	–

3.2.8.4.2 Methodological issues

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

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

CO_2 gas

<u>For the 1989–2006 period</u>

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

<u>For the 2007-2011 period</u>

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

CH_4, N_2O - default EFs are used.

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

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

3.2.8.4.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%;
- Solid Fuels – 5.00%;
- Gaseous Fuels - 3.041%;
- Biomass - 20.224%;
- Other (Industrial Wastes) - 21.190%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09 %
- Solid Fuels - 50.09 %
- Gaseous Fuels - 50.09 %
- Biomass - 50.09%
- Other (Industrial Wastes) - 50.49 %

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

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

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

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

- ***Liquid Fuels*** **- Activity data**
  - *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.
- ***Other Fuels*** **- Activity data**
  - *Industrial Wastes:* 2000, 2002 years - correction of the activity data provided through the Energy Balance.
- ***Other Fuels*** **- CO_2 emission factors**
  - *Industrial Wastes:* 1995, 2000, 2002 years - country specific CO_2 emission factor was determinated and used.

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

3.2.8.4.6 Source-specific planned improvements, if applicable

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

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

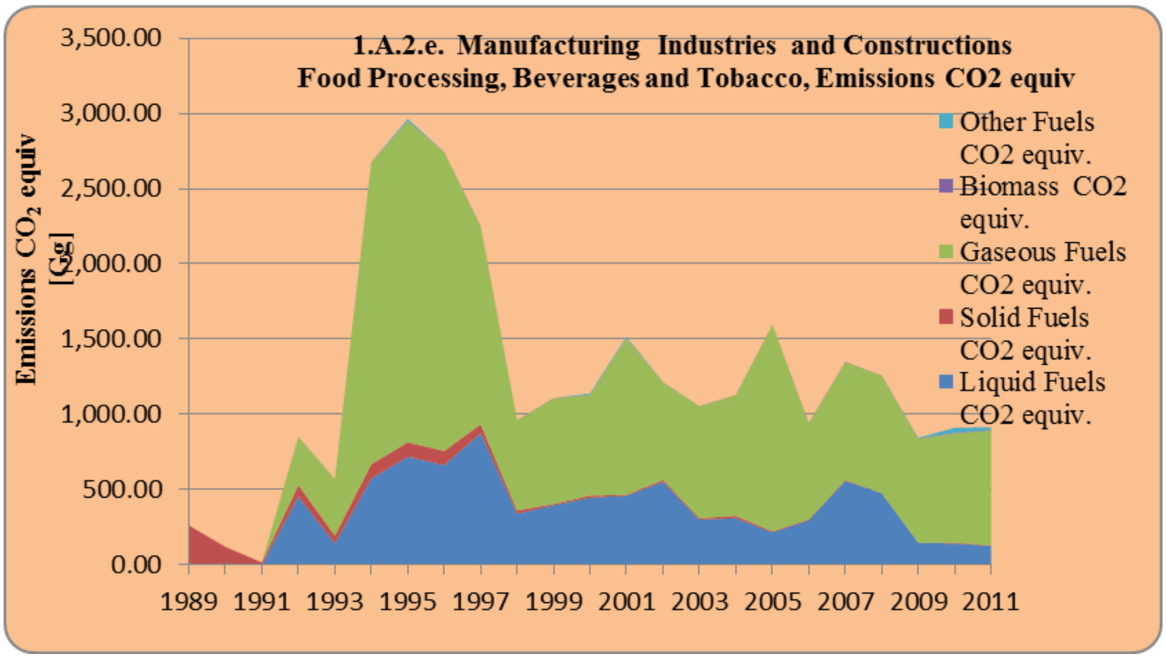
3.2.8.5.1 Source description

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

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

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

Figure 3.24 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 0.37% - base year to the 5.8%, current year, 2011. The contribution of this category is about 914.21 Gg CO_2 equiv., in 2011. 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.

Table 3.60 CO_2 emissions in 1.A.2.e. - Food Processing, Beverages and Tobacco

CO_2 [Gg]	1A.2.e Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	259.45	NO	259.45	NO	NO	NO
1990	118.05	NO	118.05	NO	NO	NO
1991	15.71	NO	15.71	NO	NO	NO
1992	847.55	452.52	75.46	319.57	20.83	NO
1993	568.80	141.99	50.34	376.47	27.78	NO
1994	2,667.84	571.16	94.65	2,002.03	66.75	NO
1995	2,953.69	716.62	94.24	2,129.36	85.01	13.4766
1996	2,734.26	661.07	92.80	1,980.39	88.59	NO
1997	2,242.00	872.55	57.94	1,311.51	102.37	NO
1998	957.04	338.53	20.70	597.81	59.47	NO
1999	1,102.80	394.62	8.71	699.47	99.34	NO
2000	1,134.24	444.35	13.86	667.24	83.55	8.7891
2001	1,510.61	457.44	6.62	1,038.59	49.84	7.9520
2002	1,210.95	549.99	12.76	647.95	46.14	0.2511
2003	1,050.37	299.01	9.61	741.75	65.86	NO
2004	1,123.60	309.46	14.58	799.55	99.46	NO
2005	1,590.16	215.29	7.21	1,367.66	77.06	NO
2006	938.55	296.09	4.80	637.65	109.54	NO
2007	1,342.88	556.38	4.86	781.65	95.13	NO
2008	1,254.34	475.38	NO	778.96	60.93	NO
2009	839.42	147.59	NO	688.40	137.76	3.4319
2010	904.16	141.38	4.89	723.91	139.52	33.9844
2011	907.74	125.99	2.51	761.20	119.01	18.0359
Decrease 1989 - 2011	-249.86	_	99.03	_	_	_
Decrease	-668.92	_	97.87	_	_	_

CO_2 [Gg]	1A.2.e Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1990 - 2011						
Decrease 2010 - 2011	-0.40	10.88	48.65	-5.15	14.70	46.93

Table 3.61 CH_4 emissions in 1.A.2.e. - Food Processing, Beverages and Tobacco

CH_4 [Gg]	1A.2.e Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.0277	NO	0.0277	NO	NO	NO
1990	0.0127	NO	0.0127	NO	NO	NO
1991	0.0016	NO	0.0016	NO	NO	NO
1992	0.0548	0.0122	0.0082	0.0289	0.0056	NO
1993	0.0505	0.0037	0.0053	0.0341	0.0074	NO
1994	0.2240	0.0151	0.0099	0.1811	0.0179	NO
1995	0.2492	0.0188	0.0101	0.1926	0.0228	0.0048
1996	0.2301	0.0173	0.0099	0.1792	0.0237	NO
1997	0.1755	0.0232	0.0062	0.1187	0.0274	NO
1998	0.0814	0.0092	0.0023	0.0541	0.0159	NO
1999	0.1012	0.0104	0.0009	0.0633	0.0266	NO
2000	0.0995	0.0121	0.0015	0.0604	0.0224	0.0032
2001	0.1244	0.0135	0.0007	0.0940	0.0134	0.0029
2002	0.0886	0.0162	0.0014	0.0586	0.0124	0.0001
2003	0.0959	0.0101	0.0011	0.0671	0.0176	NO
2004	0.1096	0.0090	0.0016	0.0723	0.0266	NO
2005	0.1522	0.0070	0.0008	0.1237	0.0206	NO
2006	0.0983	0.0108	0.0005	0.0577	0.0293	NO
2007	0.1262	0.0159	0.0005	0.0714	0.0383	NO
2008	0.0996	0.0133	NO	0.0700	0.0163	NO

CH_4 [Gg]	1A.2.e Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2009	0.1048	0.0044	NO	0.0622	0.0369	0.0012
2010	0.1439	0.0049	0.0005	0.0653	0.0610	0.0122
2011	0.1466	0.0039	0.0003	0.0686	0.0674	0.0065
Decrease 1989 - 2011	-429.51	_	99.05	_	_	_
Decrease 1990 - 2011	-1,053.38	_	97.93	_	_	_
Decrease 2010 - 2011	-1.86	19.34	50.00	-4.98	-10.37	46.80

Table 3.62 N_2O emissions in 1.A.2.e. - Food Processing, Beverages and Tobacco

N_2O [Gg]	1A.2.e Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.0039	NO	0.0039	NO	NO	NO
1990	0.0018	NO	0.0018	NO	NO	NO
1991	0.0002	NO	0.0002	NO	NO	NO
1992	0.0061	0.0037	0.0011	0.0006	0.0007	NO
1993	0.0035	0.0011	0.0007	0.0007	0.0010	NO
1994	0.0119	0.0045	0.0014	0.0036	0.0024	NO
1995	0.0146	0.0057	0.0014	0.0039	0.0030	0.0006
1996	0.0133	0.0052	0.0014	0.0036	0.0032	NO
1997	0.0138	0.0069	0.0009	0.0024	0.0037	NO
1998	0.0062	0.0027	0.0003	0.0011	0.0021	NO
1999	0.0081	0.0031	0.0001	0.0013	0.0035	NO
2000	0.0083	0.0035	0.0002	0.0012	0.0030	0.0004
2001	0.0077	0.0035	0.0001	0.0019	0.0018	0.0004
2002	0.0073	0.0042	0.0002	0.0012	0.0016	0.0000

N_2O [Gg]	1A.2.e Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2003	0.0060	0.0021	0.0001	0.0013	0.0024	NO
2004	0.0076	0.0024	0.0002	0.0014	0.0036	NO
2005	0.0069	0.0016	0.0001	0.0025	0.0028	NO
2006	0.0072	0.0020	0.0001	0.0012	0.0039	NO
2007	0.0105	0.0044	0.0001	0.0014	0.0047	NO
2008	0.0074	0.0038	NO	0.0014	0.0022	NO
2009	0.0074	0.0011	NO	0.0012	0.0049	0.0002
2010	0.0113	0.0010	0.0001	0.0013	0.0073	0.0016
2011	0.0110	0.0009	0.0000	0.0014	0.0078	0.0009
Decrease 1989 - 2011	-182.88	–	99.05	–	–	–
Decrease 1990 - 2011	-516.18	–	97.93	–	–	–
Decrease 2010 - 2011	3.26	8.16	50.00	-4.98	-6.05	46.80

3.2.8.5.2 Methodological issues

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

CO_2 gas

For the 1989–2006 period

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

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

For the 2007–2010 period

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

CH_4, N_2O - default EFs are used.

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

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

3.2.8.5.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%;

- Solid Fuels – 5.00%;
- Gaseous Fuels - 3.041%;
- Biomass - 20.224%;
- Other (Industrial Wastes) - 21.190%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09%;
- Solid Fuels - 50.09%;
- Gaseous Fuels - 50.09%;
- Biomass - 50.09%;
- Other (Industrial Wastes) - 50.49%.

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

See the Chapter 3.2.6.3 for more details.

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

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

See the Chapter 3.2.6.4 for more details.

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

- ***Liquid Fuels*** **- Activity data**
  - *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
  - *Naphtha*: 2000, 2005 years - the non-energy use data was subtracted.

❖ ***Solid Fuels* - CO_2 emission factors**

- *Coke Oven Coke*: 1989, 1990, 1992–2007 period, 2010 year, correction of the CO_2 EF (default EF was changed with a country specific EF).

❖ ***Other Fuels* - CO_2 emission factors**

- *Industrial Wastes:* 1995, 2000-2002 period, 2009, 2010 years - country specific CO_2 emission factor was determinate and used.

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

3.2.8.5.6 Source-specific planned improvements, if applicable

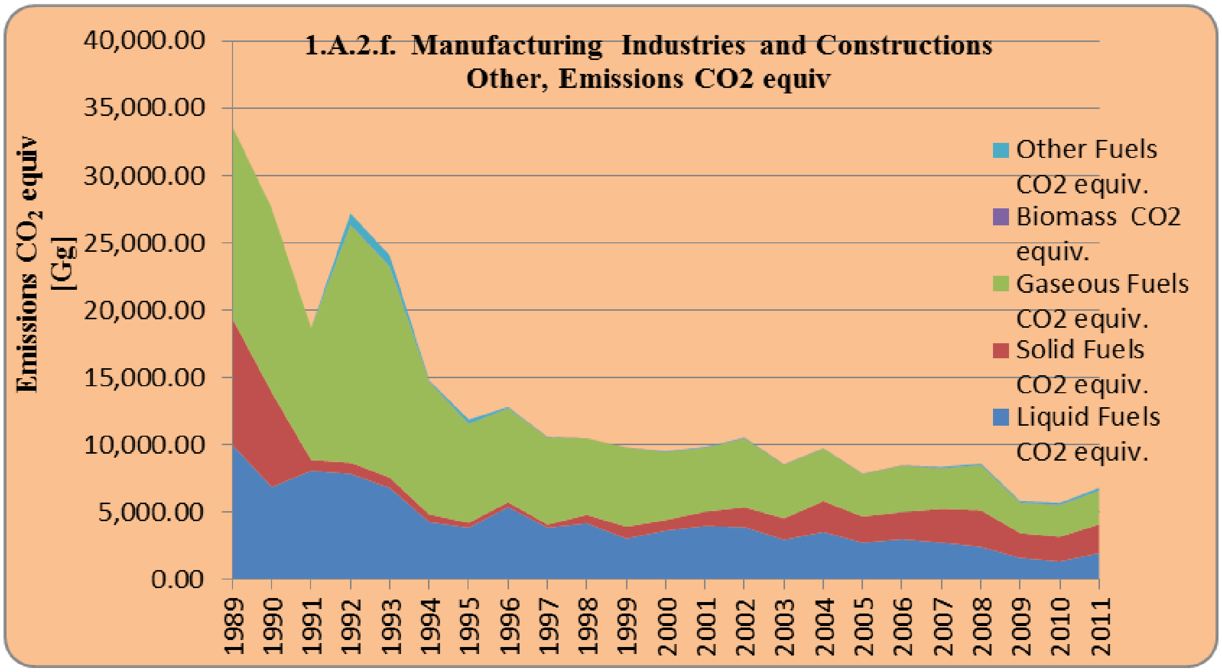
It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.
See the Chapter 3.2.6.6 for more details.

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

3.2.8.6.1 Source description

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

Figure 3.25 GHG emissions from 1.A.2.f – Other, by fuels



In this activity all type of fuels are consumed in a different proportion. Predominant is the usage of the liquid and gaseous fuels. It is observed a main contribution of the natural gas usage as fuel in this activity category, mostly on the period 1989 - 2003. In the last four years the gaseous, liquid and solid fuels have a comparable share to the category emissions.

The share of the total GHG emissions of the 1.A.2.f category to the 1.A.2 sub-sector is about 48% - base year to the 43%, current year, 2011. The contribution of this category is about 6,814.80 Gg CO_2 equiv., in 2011.

Table 3.63 CO_2 emissions in 1.A.2.f. – Other

CO_2 [Gg]	1A.2.f Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	33,524.38	9,990.04	9,323.71	14,210.62	65.63	NO
1990	27,480.61	6,860.73	6,984.73	13,635.15	61.26	NO
1991	18,616.75	8,052.06	805.72	9,758.97	230.83	NO

CO_2 [Gg]	1A.2.f Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1992	27,092.71	7,828.24	830.03	17,596.63	996.46	837.81
1993	23,961.00	6,789.99	763.31	15,601.12	1,018.98	806.58
1994	14,724.97	4,262.92	556.64	9,804.88	1,100.06	100.53
1995	11,829.20	3,846.18	361.40	7,313.17	953.57	308.45
1996	12,768.06	5,366.64	363.16	6,942.42	914.14	95.84
1997	10,560.35	3,848.73	227.95	6,448.27	1,018.53	35.41
1998	10,453.63	4,171.04	621.00	5,661.60	744.58	NO
1999	9,776.78	3,044.44	877.41	5,854.93	724.19	NO
2000	9,497.68	3,625.40	783.73	5,029.12	854.34	59.43
2001	9,806.41	3,970.09	1,056.99	4,720.15	722.06	59.18
2002	10,493.61	3,892.57	1,464.06	5,092.19	1,236.33	44.78
2003	8,518.30	2,953.93	1,571.59	3,967.75	1,164.46	25.03
2004	9,701.99	3,521.87	2,277.36	3,885.43	981.90	17.33
2005	7,831.78	2,734.31	1,929.20	3,152.29	727.89	15.99
2006	8,432.62	2,997.81	2,000.00	3,425.35	1,159.20	9.46
2007	8,311.69	2,745.39	2,482.99	2,985.30	1,256.11	98.01
2008	8,570.53	2,423.31	2,703.11	3,325.92	976.16	118.19
2009	5,786.17	1,605.57	1,833.83	2,239.11	906.72	107.67
2010	5,654.27	1,346.71	1,817.86	2,342.74	1,157.61	146.97
2011	6,760.81	1,962.90	2,120.65	2,484.77	1,121.57	192.50
Decrease 1989-2011	79.83	80.35	77.26	82.51	-1,608.87	_
Decrease 1990-2011	75.40	71.39	69.64	81.78	-1,730.71	_
Decrease 2010-2011	-19.57	-45.76	-16.66	-6.06	3.11	-30.98

Table 3.64 CH_4 emissions in 1.A.2.f. – Other

CH_4 [Gg]	1A.2.f Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	2.5107	0.2612	0.9463	1.2857	0.0176	NO
1990	2.1395	0.1783	0.7111	1.2336	0.0164	NO
1991	1.2402	0.2088	0.0866	0.8829	0.0618	NO
1992	2.4557	0.2100	0.0865	1.5920	0.2669	0.3003
1993	2.2415	0.1895	0.0784	1.4115	0.2729	0.2891
1994	1.3876	0.1125	0.0573	0.8871	0.2947	0.0360
1995	1.1686	0.1032	0.0378	0.6616	0.2554	0.1106
1996	1.0888	0.1433	0.0382	0.6281	0.2449	0.0344
1997	0.9941	0.1013	0.0238	0.5834	0.2728	0.0127
1998	0.8840	0.1091	0.0632	0.5122	0.1994	NO
1999	0.8925	0.0800	0.0888	0.5297	0.1940	NO
2000	0.8775	0.0931	0.0793	0.4550	0.2288	0.0213
2001	0.8494	0.1010	0.1068	0.4270	0.1934	0.0212
2002	1.0852	0.0992	0.1485	0.4607	0.3607	0.0161
2003	0.9132	0.0747	0.1587	0.3590	0.3119	0.0090
2004	0.9378	0.0869	0.2302	0.3515	0.2630	0.0062
2005	0.7531	0.0725	0.1947	0.2852	0.1950	0.0057
2006	0.9306	0.1050	0.2018	0.3099	0.3105	0.0034
2007	0.9707	0.0789	0.2540	0.2727	0.3572	0.0079
2008	0.9493	0.0703	0.2870	0.2988	0.2851	0.0080
2009	0.7264	0.0553	0.1998	0.2024	0.2685	0.0005
2010	0.8292	0.0501	0.2030	0.2113	0.3643	0.0005
2011	0.9854	0.0598	0.2396	0.2238	0.4601	0.0021
Decrease 1989-2011	60.75	77.10	74.68	82.59	-2,516.89	_
Decrease	53.94	66.47	66.30	81.86	-2,703.47	_

CH_4 [Gg]	1A.2.f Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1990-2011						
Decrease 2010-2011	-18.83	-19.28	-18.02	-5.89	-26.29	-373.33

Table 3.65 N_2O emissions in 1.A.2.f. – Other

N_2O [Gg]	1A.2.f Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.2387	0.0782	0.1325	0.0257	0.0023	NO
1990	0.1797	0.0533	0.0996	0.0247	0.0022	NO
1991	0.1006	0.0626	0.0121	0.0177	0.0082	NO
1992	0.1779	0.0600	0.0105	0.0318	0.0356	0.0400
1993	0.1647	0.0516	0.0099	0.0282	0.0364	0.0385
1994	0.1023	0.0329	0.0076	0.0177	0.0393	0.0048
1995	0.0955	0.0291	0.0044	0.0132	0.0341	0.0147
1996	0.0960	0.0415	0.0047	0.0126	0.0326	0.0046
1997	0.0820	0.0295	0.0028	0.0117	0.0364	0.0017
1998	0.0778	0.0323	0.0086	0.0102	0.0266	NO
1999	0.0720	0.0232	0.0124	0.0106	0.0259	NO
2000	0.0804	0.0269	0.0111	0.0091	0.0305	0.0028
2001	0.0813	0.0293	0.0149	0.0085	0.0258	0.0028
2002	0.1072	0.0281	0.0207	0.0092	0.0471	0.0021
2003	0.0934	0.0213	0.0221	0.0072	0.0416	0.0012
2004	0.0999	0.0249	0.0322	0.0070	0.0351	0.0008
2005	0.0793	0.0196	0.0272	0.0057	0.0260	0.0008
2006	0.0961	0.0199	0.0282	0.0062	0.0414	0.0005
2007	0.1089	0.0200	0.0355	0.0055	0.0469	0.0011
2008	0.1013	0.0169	0.0402	0.0060	0.0372	0.0011

N_2O [Gg]	1A.2.f Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2009	0.0777	0.0106	0.0280	0.0040	0.0349	0.0001
2010	0.0882	0.0087	0.0284	0.0042	0.0467	0.0001
2011	0.1074	0.0132	0.0335	0.0045	0.0559	0.0003
Decrease 1989-2011	55.00	83.17	74.68	82.59	-2,286.52	_
Decrease 1990-2011	40.24	75.32	66.30	81.86	-2,456.67	_
Decrease 2010-2011	-21.84	-51.11	-18.02	-5.89	-19.69	-373.33

3.2.8.6.2 Methodological issues

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

CO_2 gas

For the 1989–2006 period

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

For the 2007 - 2011 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007–2011 period, on each EU-ETS reported activity category, oxidation included, are used.

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

CH_4, N_2O - default EFs are used.

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

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

3.2.8.6.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%;
- Solid Fuels – 5.00%;
- Gaseous Fuels - 3.041%;
- Biomass - 20.224%;
- Other (Industrial Wastes) - 21.190%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09%;
- Solid Fuels - 50.09%;
- Gaseous Fuels - 50.09%;
- Biomass - 50.09%;
- Other (Industrial Wastes) - 50.49%.

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

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

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

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

- ***Liquid Fuels*** **- Activity data**
  - *Petroleum Coke:* 2000–2010 period, the non-energy use data associated with the Non Metallic Minerals activity was subtracted; 1990–1999 period, the non-energy use data associated with the Non-specified (Industry) activity was subtracted;
  - *Paraffin Wax*: 2010 year, the non-energy use data was subtracted;
  - *Other Products*: 1993–2000 period, 2003–2006 period, the non-energy use data associated with the Non-specified (industry) activity was subtracted;
  - *White Spirit & SPB:* 1993–2004 period, 2009 year, the non-energy use data associated with the Non-specified (Industry) activity was subtracted;

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- *Transport Diesel:* 2007–2010 period, the non-energy use data associated with the Non-specified (Industry) activity was subtracted.

❖ ***Solid Fuels* - Activity data**

- *Lignite**:*** 2006, 2008, 2009 years – correction provided through the Energy Balance;
- *Blast Furnace Gas – avoiding double counting activity data with Industrial Processes Sector*: due to the fact that in the Iron and Steel Production - 2.C.1. IP activity category, the mass balance approach to estimate CO_2 emissions is used, the fuel Blast furnace Gas was subtracted; the associated emissions are reported under 2.C.1. activity category, 1992 - 2010 period.

❖ ***Solid Fuels* - CO_2 emission factors**

- *Coking Coal:*1995–1998 period – correction of the CO_2 EF (country specific EF was changed with a default EF);
- *Coke Oven Coke*: 1989-2010 period - correction of the CO_2 EF (default EF was changed with a becomes country specific EF).

❖ ***Other Fuels* - Activity data**

- *Industrial Wastes:* 2000, 2001 years, 2004–2008 period **- c**orrection of the activity data provided through the Energy Balance.

❖ ***Other Fuels - CO_2 emission factors***

- Industrial Wastes: 1992–1997 period, 2000–2010 period - country specific CO_2 EF was determinate and used.

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

3.2.8.6.6 Source-specific planned improvements, if applicable

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

See the Chapter 3.2.6.6 for more details.

3.2.9 Transport (CRF sector 1.A.3.)

3.2.9.1 Source category description

The IPCC source category for transport covers all types of mobile sources including also the range of characteristics that affect the emission factors and consequently the emissions. Those are compiled in five categories, according to the source.

The direct GHG emissions originating from transport are carbon dioxide, methane and nitrous oxide ; for the estimation of each the most appropriate method has been chosen based on the type of emission, transport category and data availability.

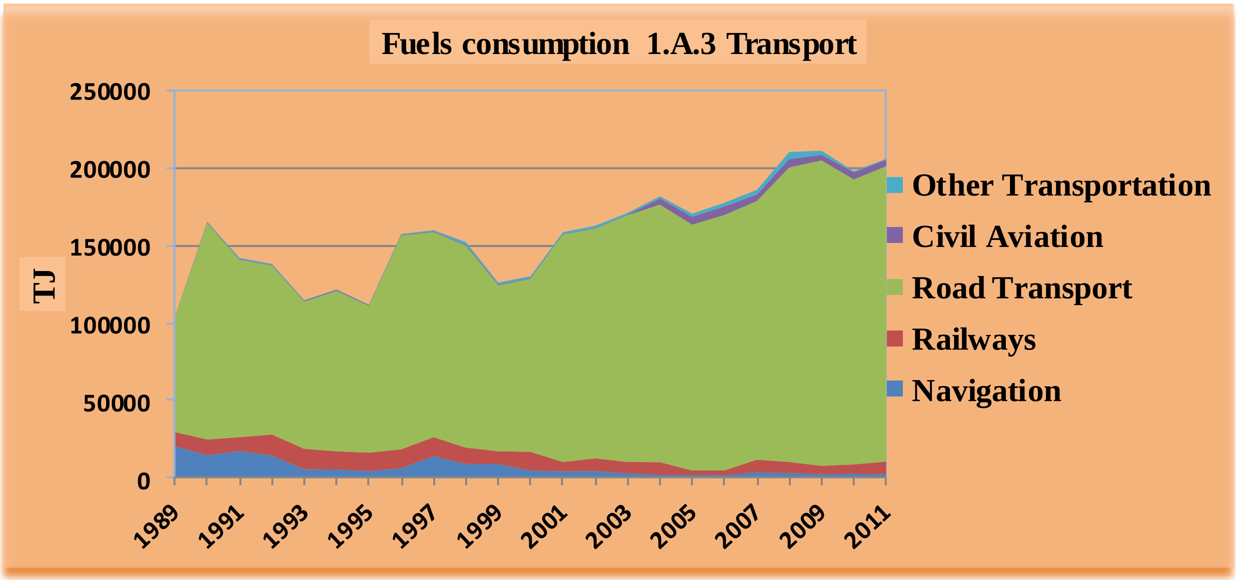
Emission trends over the years depend significantly on the amount of fuel consumed. The fuel quantities used in the Transport Subsector and associated with the 1989–2011 period are presented in Table 3.67.

Table 3.66 Fuels Consumption associated with Transport Subsector, for 1989-2011 period

Year/Fuel consumption by category	a. Civil Aviation[TJ]	b. Road Transportation [TJ]	c. Railways [TJ]	d. Navigation [TJ]	e. Other Transport [TJ]
1989	362.88	74,150.88	9,106.20	20,357.52	125.66
1990	348.55	139,704.12	10,127.76	14,579.75	700.28
1991	334.21	114,602.19	8,832.68	17,335.84	900.34
1992	319.87	109,147.81	13,592.83	14,320.28	798.51
1993	439.14	95,186.25	13,171.02	5,480.39	477.35
1994	634.80	103,656.88	11,789.60	5,277.79	317.32
1995	442.55	94,852.48	11,903.53	4,248.04	392.16
1996	305.61	138,153.70	12,197.05	6,124.52	706.60
1997	383.28	132,540.22	12,245.17	13,936.38	798.58

Year/Fuel consumption by category	a. Civil Aviation[TJ]	b. Road Transportation [TJ]	c. Railways [TJ]	d. Navigation [TJ]	e. Other Transport [TJ]
1998	501.79	130,402.05	10,498.68	8,934.71	1,937.43
1999	498.93	107,149.15	8,269.52	8,811.71	1,315.38
2000	375.98	111,811.27	12,134.34	4,583.50	1,295.76
2001	250.38	146,921.98	6,045.87	4,105.05	1,290.51
2002	207.33	148,410.49	8,224.25	4,247.28	1,745.49
2003	289.20	159,425.00	7,358.30	2,819.42	1,252.00
2004	3,971.34	166,397.04	8,310.07	1,728.22	1,440.97
2005	5,025.18	158,866.60	2,915.74	1,739.17	2,081.02
2006	5,515.33	165,085.09	3,001.74	1,697.53	2,422.06
2007	4,245.80	167,150.47	8,110.79	3,489.58	2,983.13
2008	5,374.30	190,298.32	7,194.79	2,973.79	4,593.69
2009	3,536.06	197,399.53	5,329.21	2,291.25	2,724.64
2010	4,660.49	184,134.51	6,067.57	2,515.59	685.62
2011	4,130.24	190,913.26	8,216.50	2,180.32	617.27

Figure 3.26 Contribution of each category to total fuel consumption in Transport Subsector

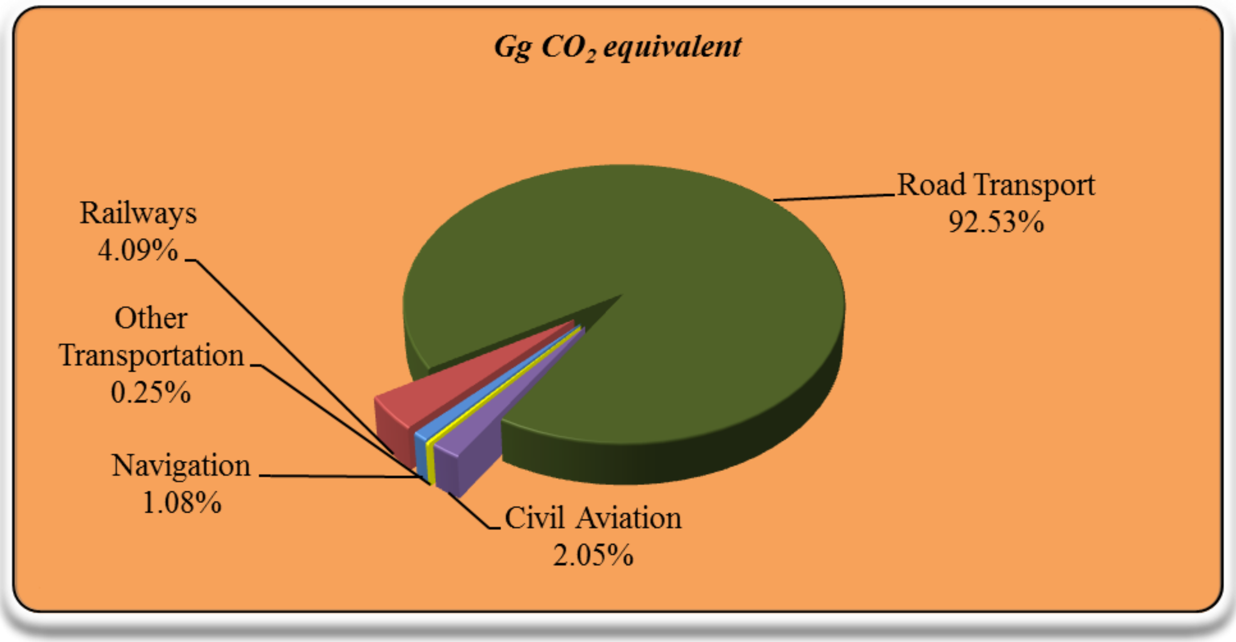


In 2011 year, the emissions from transport categories accounted for 14,577.72 Gg CO_2 equivalent.

The GHG characterized are: CO_2, CH_4, N_2O, NO_x, NMVOC, CO and SO_2.

Within the Energy Sector total emissions, 16.89% represents transport emissions. This sector includes emissions from road transportation, civil aviation, railways, navigation and pipeline transportation (figure 3.27).

Figure 3.27 Transport Subsector emissions by sub-sectors, for 2011



3.2.9.2 Source category Civil Aviation (CRF sector 1.A.3.a)

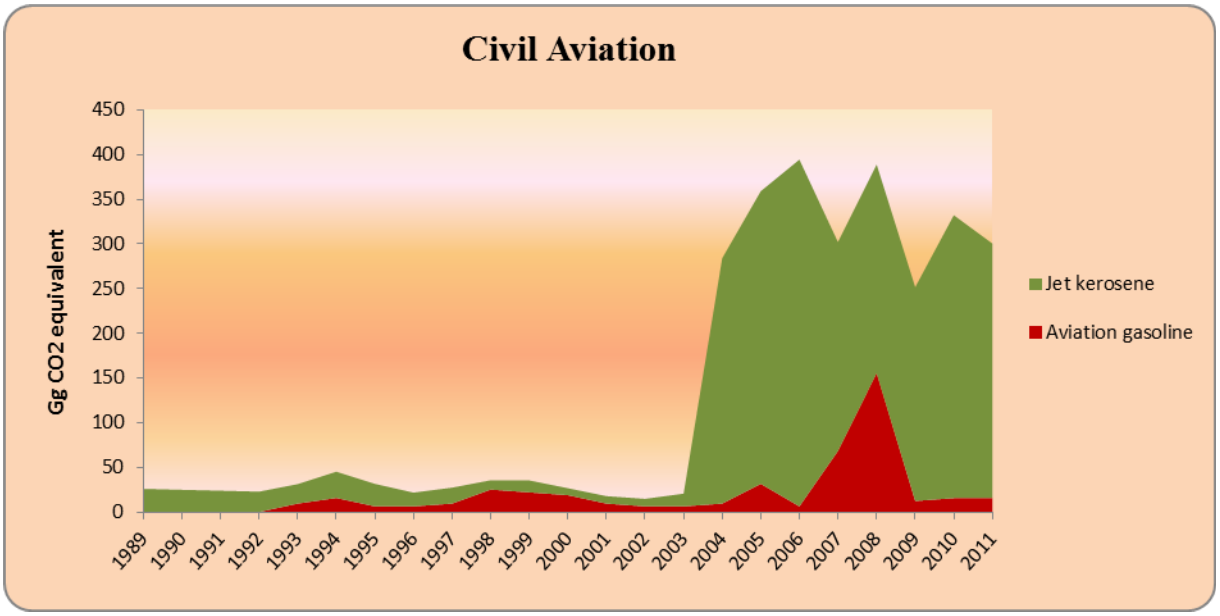
3.2.9.2.1 Source category description

Emissions from Aviation Subsector originate from the combustion of jet kerosene and aviation gasoline. Aircraft emit carbon dioxide, methane and nitrous oxide, as well as carbon monoxide, non-methane volatile organic compounds, sulphur dioxide, and nitrogen oxides.

In 2011 year, the civil aviation related emissions represents 2.04% of total emissions from the transport sector (14,577.72 Gg CO_2 equivalent).

Greenhouse gas emissions from aviation are low in comparison to emissions from the transport sector but show an increase from 1989 to 2011(Figure 3.28).

Figure 3.28 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 2005-2011 period increases and decreases of emissions due to fluctuations in the number of flights operated took place.

3.2.9.2.2 Methodological issues

Methodology

The GHG emissions from Civil Aviation category are calculated according to IPCC 1996 and IPCC 2006 provision. For the 1990-2003 period a Tier 1 method was applied as (no LTO data were available); for 2004-2011, a Tier 2 method was used.

Tier 1 method

The Tier 1 method is based on an aggregate quantity of fuel consumption data for aviation (LTO and cruise) multiplied by average emission factors.The direct greenhouse gas emissions are calculated according to Equation 3.6.1 in IPCC 2006-Volume 2, , chapter 3.6.1.1, page 3.59:

Equation 3.4 The direct calculation of greenhouse gas emissions

$$Emissions = Fuel\ Consumption * Emission\ Factor$$

The direct and indirect GHG emissions are calculated according to IPCC 1996 (CH_4 pag.1.34, Ch1.4.2.1 N_2O pag.1.36, Ch.1.4.2.2, NO_x pag.1.37,Ch.1.4.2.3,CO pag.1.39,Ch.1.4.2.4,NMVOC pag.1.41Ch 1.4.2.5,SO_2 pag.1.43,Ch1.4.2.6)

Equation 3.5 The indirect calculation of greenhouse gas emissions

$$Emissions(CH_4, N_2O, NOx, CO, NMVOCSO_2) = \sum (EFab \times Activityab)$$

where:

EF = Emission Factor (kg/TJ);

Activity = Energy Input (TJ);

a = Fuel type; and

b = Sector-activity.

Tier 2 method

Tier 2 method splits the calculation of emissions from aviation into the following steps:

1. Estimate the domestic and international fuel consumption totals for aviation.
2. Estimate LTO fuel consumption for domestic and international operations.
3. Estimate the cruise fuel consumption for domestic and international aviation.
4. Estimate emissions from LTO and cruise phases for domestic and international aviation.

Tier 2 approach uses Equations 3.6.2 to 3.6.5 (page 3.59, Chapter 3.6.1.1, vol.2, 2006 IPCC GL) to estimate emissions:

Equation 3.6 The calculation of emissions from aviation for step 1

Total Emissions = LTO Emissions + Cruise Emissions

where:

Equation 3.7 The calculation of emissions from aviation for step 2

LTO Emissions = Number of LTOs • Emission Factor LTO

Equation 3.8 The calculation of emissions from aviation for step 3

LTO Fuel Consumption = Number of LTOs • Fuel Consumption per LTO

Equation 3.9 The calculation of emissions from aviation for step 4

Cruise Emissions = (Total Fuel Consumption – LTO Fuel Consumption)
• Emission Factor Cruise

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

Emission factors

Default values of CO_2 emissions factor, according to 2006 IPCC GL (vol.2, ch 3.6.1.2,table 3.6.4, page 3.64.) for Tier 1 and Tier 2 methods, were used.

CO_2 emission factor	
Fuel	**Default (kg/TJ)**
Aviation Gasoline	70,000
Jet Kerosene	71,500

For Tier 1 the values of CH_4, N_2O emissions factor for domestic and international aviation are default according to 2006 IPCC methodology, Table 3.6.5,pag 3.6.4, chapter 3, vol 2.

Default emission factor (kg/TJ) for all fuels	
CH_4	N_2O
0.5	2

For Tier 2 the values of CH_4, N_2O emissions factor for Domestic and International Aviation are default according to 2006 IPCC methodology, Table 3.6.9, page 3.70, Chapter 3, vol 2.(see annex.3).

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

For the estimation of the SO_2 emissions were used the values of the Sulphur content provided by the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009 and in according to 1996 IPCC Guidelines. Determination of values emission factors and emissions were in according to 1996 IPCC Guidelines.

Activity Data

Fuel consumption data are provided through the Romanian Civil Aeronautical Authority and IEA/Eurostat Questionnaire, elaborated by NIS.

In respect to aviation gasoline data, for 1989-2006 period Romanian Civil Aeronautical Authority data were used; for 2007-2011 period IEA/Eurostat Questionnaire data were used.

In respect to jet kerosene : 1989-2003 period it use Domestic Energy Balance and for 2004-2011 period it use IEA/Eurostat Questionnaire;

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

Figure 3.29 Fuel consumption(Aviation gasoline) for Civil Aviation -1.A.3.a

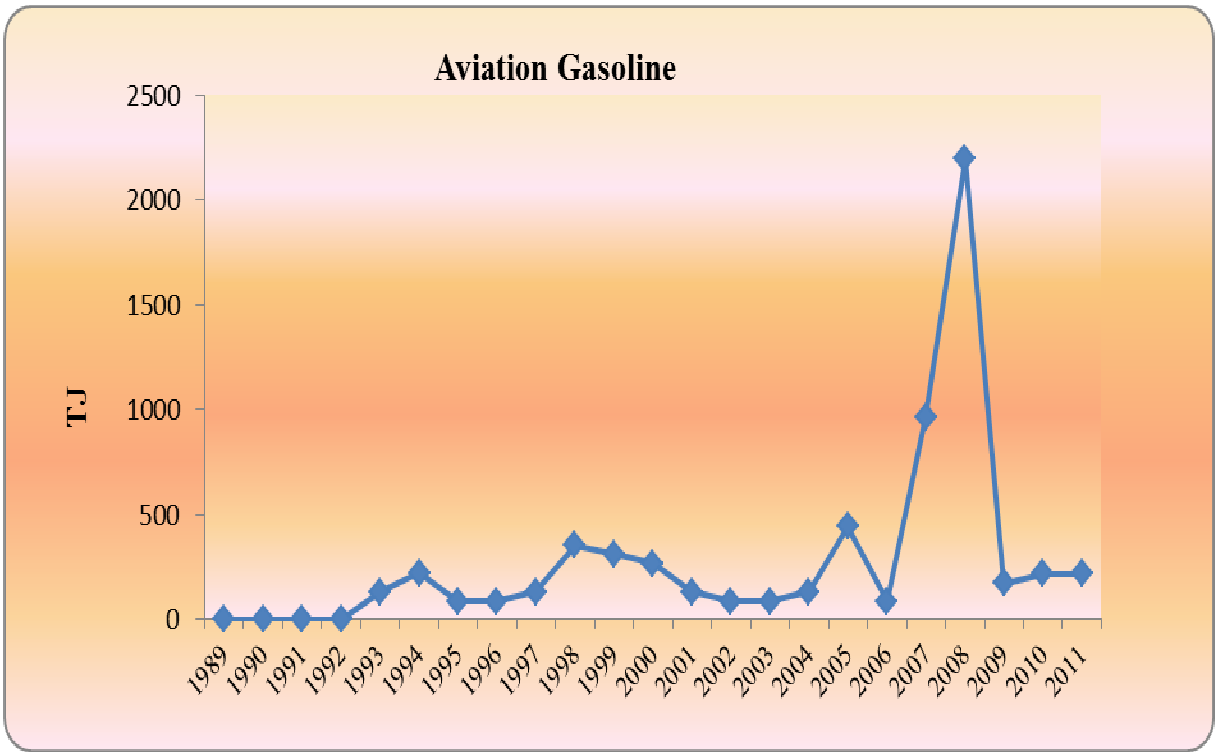


Figure 3.30 Fuel consumption(Jet Kerosene) for Civil Aviation -1.A.3.a

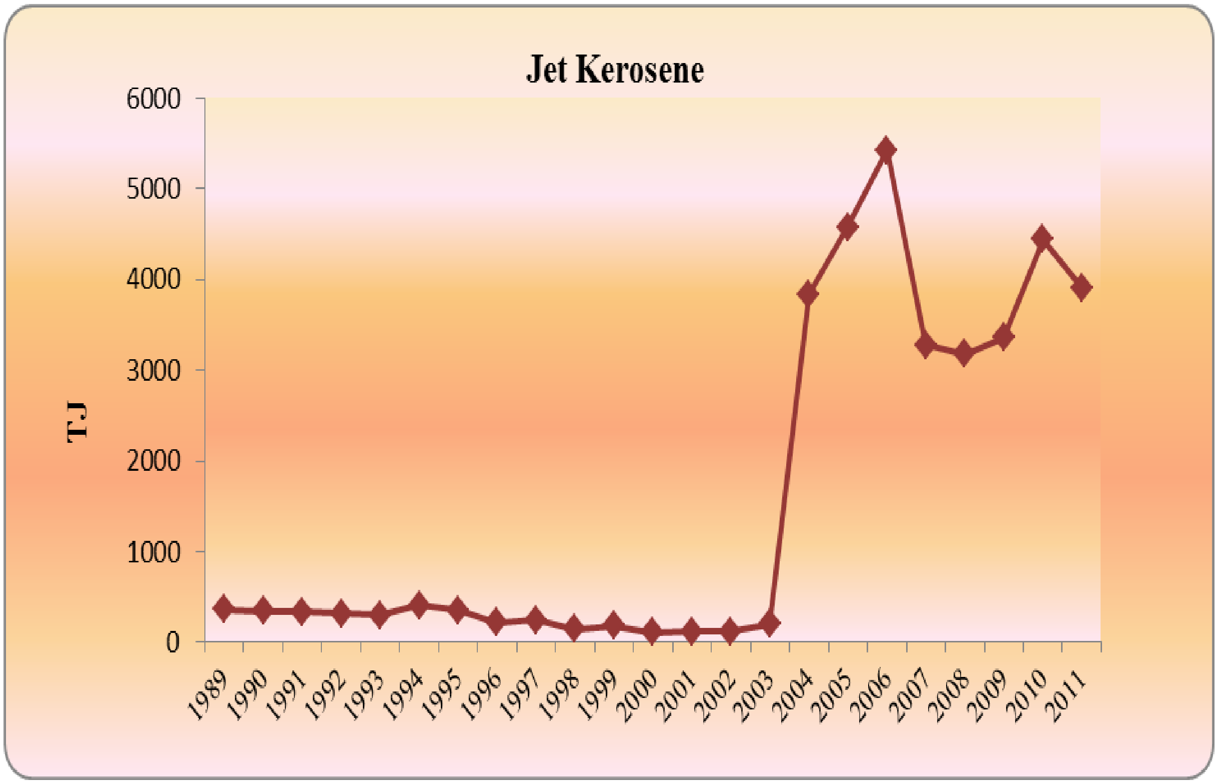


Table 3.67 Fuel consumption (Aviation gasoline and Jet Kerosene), emission factor and CO_2 emissions data

	Aviation Gasoline		EF CO_2	CO_2 emission	Jet Kerosene		EF CO_2	CO_2 emission
Year	**TJ**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**TJ**	**NCV(KJ/kg)**	**kg/TJ**	**Gg**
1989	0.0000008	44,534	70,000	0.0000001	362.88	48,778	71,500	25.69
1990	0.00002	44,534	70,000	0.0000016	348.55	48,778	71,500	24.67
1991	0.00017	44,534	70,000	0.0000119	334.21	48,778	71,500	23.66
1992	0.00071	44,534	70,000	0.0000489	319.87	48,778	71,500	22.64
1993	133.60	44,534	70,000	9.35	305.54	48,778	71,500	21.63
1994	222.67	44,534	70,000	15.59	412.13	48,778	71,500	29.17
1995	89.07	44,534	70,000	6.23	353.49	48,778	71,500	25.02

	Aviation Gasoline		**EF CO_2**	**CO_2 emission**	**Jet Kerosene**		**EF CO_2**	**CO_2 emission**
1996	89.07	44,534	70,000	6.23	216.55	48,778	71,500	15.33
1997	133.60	44,534	70,000	9.35	249.68	48,778	71,500	17.67
1998	356.27	44,534	70,000	24.94	145.51	48,778	71,500	10.30
1999	311.74	44,534	70,000	21.82	187.19	48,778	71,500	13.25
2000	267.20	44,534	70,000	18.70	108.78	48,778	71,500	7.70
2001	133.60	44,534	70,000	9.35	116.78	48,778	71,500	8.27
2002	89.07	44,534	70,000	6.23	118.26	48,778	71,500	8.37
2003	89.07	44,534	70,000	6.23	200.13	48,778	71,500	14.17
2004	133.60	44,534	70,000	9.35	3,837.74	48,778	71,500	274.40
2005	445.34	44,534	70,000	31.17	4,579.84	48,778	71,500	327.46
2006	89.07	44,534	70,000	6.23	5,426.27	48,778	71,500	387.98
2007	967.49	43,977	70,000	67.72	3,278.31	48,930	71,500	233.67
2008	2,198.10	43,962	70,000	153.87	3,176.20	47,406	71,500	233.67
2009	175.84	43,960	70,000	12.31	3,360.22	49,415	71,500	237.16
2010	219.80	43,960	70,000	15.39	4,440.69	49,341	71,500	313.89
2011	219.80	43,960	70000	15.39	3,910.44	48,277	71,500	282.50

3.2.9.2.3 Uncertainties and time-series consistency

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

CO_2

❖ ***activity data***

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

- ***emision* factors:**
  - Aviation gasoline: 5%;
  - Jet Kerosene: 5%.
  - 7.07% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4

- ***activity data***
  - aviation gasoline: 5 %;
  - jet kerosene: 5 %.
- ***emision factors***
  - Aviation gasoline: 150%
  - Jet Kerosene: 150%
  - 150% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC

N_2O

- ***activity data***
  - aviation gasoline: 5 %;
  - jet kerosene: 5 %.
- ***emision factors:***
  - Aviation gasoline: 150%
  - Jet Kerosene: 150%
  - 150% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

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

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Road Transport Subsector the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 2013 NGHGI; they are described in the Chapter 3.2.9.2.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.2.9.2.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

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

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

- activity data

Jet Kerosene

Recalculation for the 2004-2006 period, due to update of values (were made extrapolations reported to year 2007); CO_2, CH_4 and N_2O emissions levels have been consequently updated emissions.

- emission factors

Aviation Gasoline

Recalculation for 1993-2010 period at CO_2 emissions, due to a transcription error of the CO_2 emissions values from the spreadsheet in the CRF Reporter application.

Jet Kerosene

Recalculation for 2007-2010 period at N_2O emissions level, due to a transcription error of the N_2O emissions values from the spreadsheet in the CRF Reporter application.

Table 3.68 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	362.88	362.88	25.69	25.69	0.00
1990	348.55	348.55	24.67	24.67	0.00
1991	334.21	334.21	23.66	23.66	0.00
1992	319.87	319.87	22.64	22.64	0.00

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
1993	439.14	439.14	30.89	30.98	0.30
1994	634.80	634.80	44.60	44.76	0.35
1995	442.55	442.55	31.19	31.26	0.20
1996	305.61	305.61	21.50	21.56	0.29
1997	383.28	383.28	26.93	27.03	0.35
1998	501.79	501.79	34.99	35.24	0.71
1999	498.93	498.93	34.85	35.07	0.62
2000	375.98	375.98	26.22	26.40	0.71
2001	250.38	250.38	17.52	17.62	0.53
2002	207.33	207.33	14.54	14.61	0.43
2003	289.20	289.20	20.34	20.40	0.31
2004	323.26	3,971.34	22.68	283.75	92.01
2005	648.16	5,025.18	45.22	358.63	87.39
2006	255.37	5,515.33	17.94	394.21	95.45
2007	4,245.80	4,245.80	300.72	301.40	0.22
2008	5,374.30	5,374.30	386.00	387.54	0.40
2009	3,536.06	3,536.06	249.34	249.47	0.05
2010	4,660.49	4,660.49	329.12	329.27	0.05

Table 3.69 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	362.8830	362.8830	0.0002	0.0002	0.00
1990	348.5460	348.5460	0.0002	0.0002	0.00
1991	334.2092	334.2092	0.0002	0.0002	0.00

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
1992	319.8727	319.8727	0.0002	0.0002	0.00
1993	439.1370	439.1370	0.0002	0.0002	0.00
1994	634.7969	634.7969	0.0003	0.0003	0.00
1995	442.5541	442.5541	0.0002	0.0002	0.00
1996	305.6149	305.6149	0.0002	0.0002	0.00
1997	383.2838	383.2838	0.0002	0.0002	0.00
1998	501.7863	501.7863	0.0003	0.0003	0.00
1999	498.9270	498.9270	0.0002	0.0002	0.00
2000	375.9848	375.9848	0.0002	0.0002	0.00
2001	250.3811	250.3811	0.0001	0.0001	0.00
2002	207.3292	207.3292	0.0001	0.0001	0.00
2003	289.1991	289.1991	0.0001	0.0001	0.00
2004	323.2646	3,971.3445	0.0002	0.0027	93.96
2005	648.1634	5,025.1776	0.0003	0.0004	19.80
2006	255.3703	5,515.3343	0.0001	0.0002	41.55
2007	4,245.8040	4,245.8040	0.0039	0.0007	-497.08
2008	5,374.3020	5,374.3020	0.0045	0.0013	-260.37
2009	3,536.0600	3,536.0600	0.0040	0.0002	-1,565.56
2010	4,660.4900	4,660.4900	0.0050	0.0003	-1,492.72

Table 3.70 Effects of data changes on N_2O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	362.88	362.88	0.0007	0.0007	0.00
1990	348.55	348.55	0.0007	0.0007	0.00

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
1991	334.21	334.21	0.0007	0.0007	0.00
1992	319.87	319.87	0.0006	0.0006	0.00
1993	439.14	439.14	0.0009	0.0009	0.00
1994	634.80	634.80	0.0013	0.0013	0.00
1995	442.55	442.55	0.0009	0.0009	0.00
1996	305.61	305.61	0.0006	0.0006	0.00
1997	383.28	383.28	0.0008	0.0008	0.00
1998	501.79	501.79	0.0010	0.0010	0.00
1999	498.93	498.93	0.0010	0.0010	0.00
2000	375.98	375.98	0.0008	0.0008	0.00
2001	250.38	250.38	0.0005	0.0005	0.00
2002	207.33	207.33	0.0004	0.0004	0.00
2003	289.20	289.20	0.0006	0.0006	0.00
2004	323.26	3,971.34	0.0006	0.0006	0.00
2005	648.16	5,025.18	0.0013	0.0013	0.00
2006	255.37	5,515.33	0.0005	0.0005	0.00
2007	4,245.80	4,245.80	0.0020	0.0019	-5.26
2008	5,374.30	5,374.30	0.0046	0.0044	-4.55
2009	3,536.06	3,536.06	0.0071	0.0071	0.00
2010	4,660.49	4,660.49	0.0093	0.0093	0.00

3.2.9.3 Road Transport (CRFcategory 1.A.3.b)

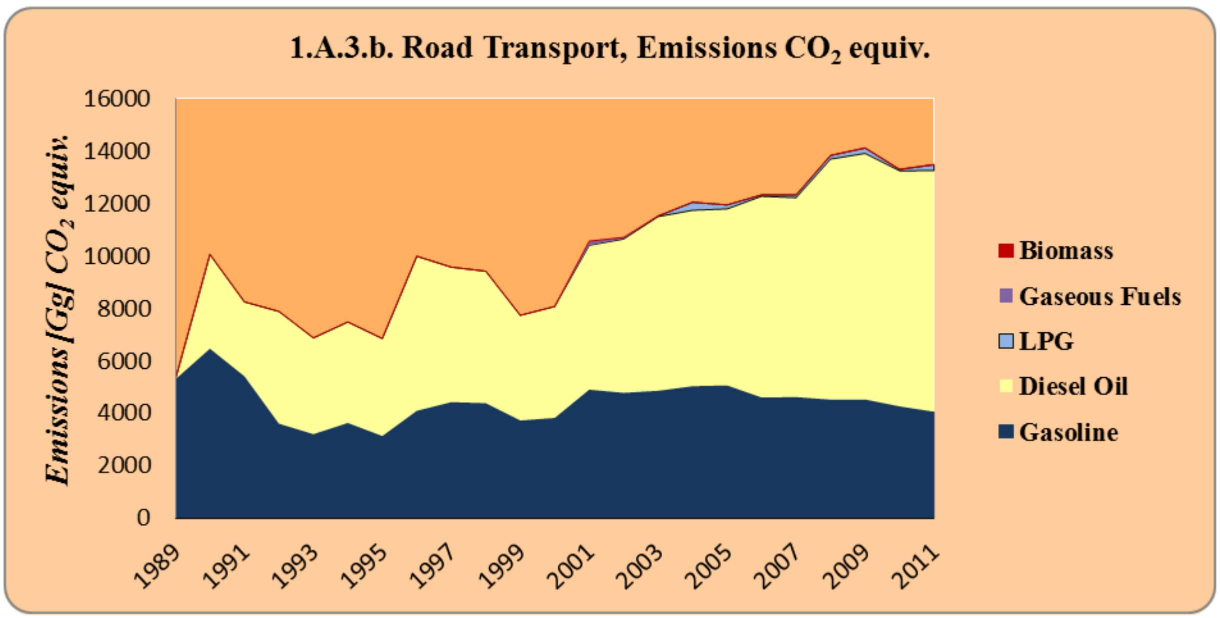
3.2.9.3.1 Source category description

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

Road Transport category includes emissions from all types of vehicles, light-duty vehicles such as automobiles and light trucks, and heavy-duty vehicles such as tractor trailers and buses; on-road motorcycles (including mopeds, scooters, and three-wheelers) related emissions are also included. Road transport emits significant amounts of carbon dioxide, methane and nitrous oxide, as well as NO_x, CO, NMVOC and SO_2.

Exhaust emissions from road transport arise from the engines internal combustion of fuels such as gasoline, diesel, liquefied petroleum gas and natural gas (Figure 3.31).

Figure 3.31 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.

The share of road freight transport increased starting with 2000 at the expense of rail transport. On the whole, increasing emissions trend from the Road Transport Sub–sector (Figure 3.32) is due to the increasing trend of the number of vehicles and volume of goods transported, especially starting with 2000 (Tables 3.71-3.73).

Figure 3.32 CO_2, CH_4, N_2O, [Gg CO_2 equiv.] Emissions from Road Transport

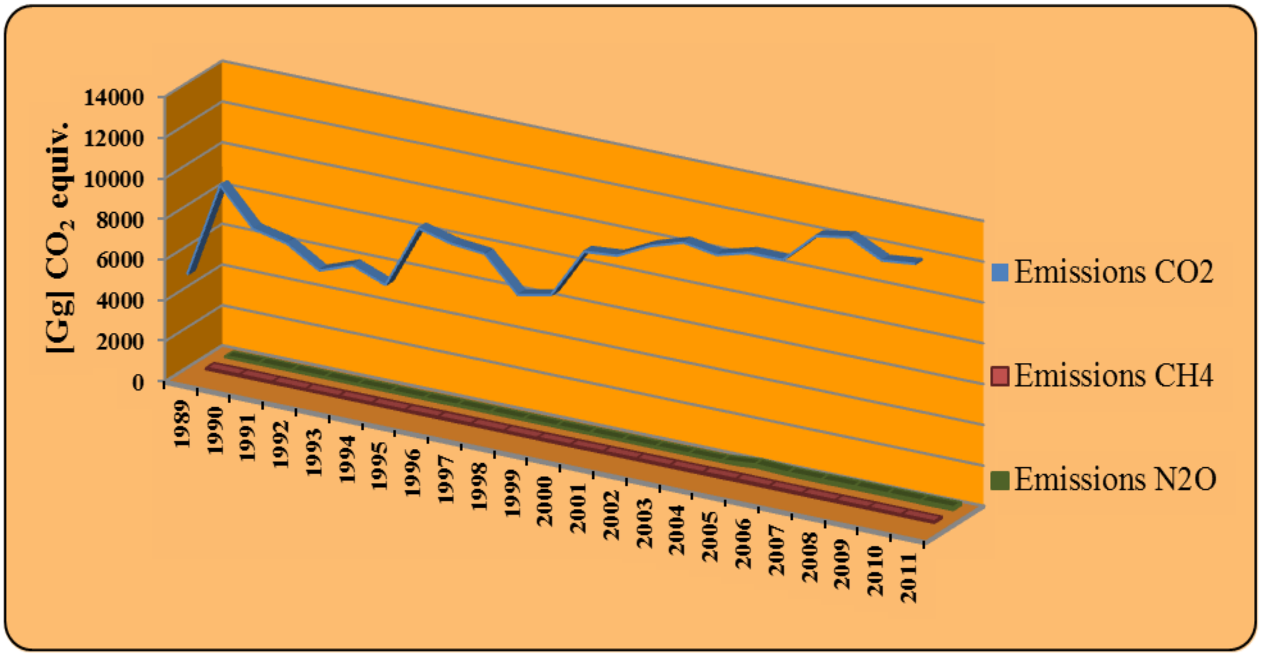


Table 3.71 CO_2 emissions in Road Transport category

Year/CO_2 emissions level [Gg]	1A.3.b Road Transport	Liquid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	5,257.58	5,257.58	NO, NA	NO, NA	NA, NA
1990	9,986.78	9,986.78	NO, NA	NO, NA	NA, NA
1991	8,189.84	8,189.84	NO, NA	NO, NA	NA, NA
1992	7,835.79	7,835.79	NO, NA	NO, NA	NA, NA
1993	6,832.07	6,832.07	NO, NA	NO, NA	NA, NA
1994	7,436.80	7,436.80	NO, NA	NO, NA	NA, NA
1995	6,809.45	6,809.45	NO, NA	NO, NA	NA, NA
1996	9,928.95	9,928.95	NO, NA	NO, NA	NA, NA
1997	9,514.06	9,514.06	NO, NA	NO, NA	NA, NA
1998	9,359.80	9,359.80	NO, NA	NO, NA	NA, NA

Year/CO_2 emissions level [Gg]	1A.3.b Road Transport	Liquid Fuels	Gaseous Fuels	Biomass	Other Fuels
1999	7,687.96	7,687.96	NO, NA	NO, NA	NA, NA
2000	8,023.94	8,023.94	NO, NA	NO, NA	NA, NA
2001	10,497.82	10,342.79	155.03	NO, NA	NA, NA
2002	10,641.85	10,591.17	50.68	NO, NA	NA, NA
2003	11,455.66	11,455.66	NO, NA	NO, NA	NA, NA
2004	11,969.01	11,969.01	NO, NA	NO, NA	NA, NA
2005	11,701.52	11,701.52	NO, NA	NO, NA	NA, NA
2006	12,148.38	12,148.38	NO, NA	NO, NA	NA, NA
2007	12,149.54	12,149.54	NO, NA	125.38	NA, NA
2008	13,652.72	13,652.72	NO, NA	332.22	NA, NA
2009	13,938.09	13,938.09	NO, NA	504.59	NA, NA
2010	13,137.25	13,137.25	NO, NA	357.84	NA, NA
2011	13,316.76	13,316.76	NO, NA	659.10	NA, NA
Decrease 1989 - 2011	-153.29	-153.29	_	_	_
Decrease 2010 - 2011	-1.37	-1.37	_	-84.19	_

Table 3.72 CH_4 emissions in Road Transport category

Year/CH_4 emissions level [Gg]	1A.3.b Road Transport	Liquid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	1.48	1.48	NO, NA	NO, NA	NA, NA
1990	2.06	2.06	NO, NA	NO, NA	NA, NA
1991	1.71	1.71	NO, NA	NO, NA	NA, NA
1992	1.30	1.30	NO, NA	NO, NA	NA, NA

Year/CH_4 emissions level [Gg]	1A.3.b Road Transport	Liquid Fuels	Gaseous Fuels	Biomass	Other Fuels
1993	1.15	1.15	NO, NA	NO, NA	NA, NA
1994	1.28	1.28	NO, NA	NO, NA	NA, NA
1995	1.13	1.13	NO, NA	NO, NA	NA, NA
1996	1.55	1.55	NO, NA	NO, NA	NA, NA
1997	1.59	1.59	NO, NA	NO, NA	NA, NA
1998	1.57	1.57	NO, NA	NO, NA	NA, NA
1999	1.32	1.32	NO, NA	NO, NA	NA, NA
2000	1.36	1.36	NO, NA	NO, NA	NA, NA
2001	1.89	1.75	0.14	NO, NA	NA, NA
2002	1.79	1.74	0.05	NO, NA	NA, NA
2003	1.82	1.82	NO, NA	NO, NA	NA, NA
2004	1.97	1.97	NO, NA	NO, NA	NA, NA
2005	2.76	2.76	NO, NA	NO, NA	NA, NA
2006	2.43	2.43	NO, NA	NO, NA	NA, NA
2007	2.20	2.19	NO, NA	0.01	NA, NA
2008	2.02	1.99	NO, NA	0.03	NA, NA
2009	2.01	1.97	NO, NA	0.04	NA, NA
2010	1.74	1.71	NO, NA	0.03	NA, NA
2011	1.67	1.62	NO, NA	0.05	NA, NA
Decrease 1989 - 2011	-12.81	-9.21	_	_	_
Decrease 2010 - 2011	3.74	5.23	_	-84.19	_

Table 3.73 N_2O emissions in Road Transport category

Year/ N_2O emissions level [Gg]	1A.3.b Road Transport	Liquid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.04	0.04	NO, NA	NO, NA	NA, NA
1990	0.08	0.08	NO, NA	NO, NA	NA, NA
1991	0.07	0.07	NO, NA	NO, NA	NA, NA
1992	0.07	0.07	NO, NA	NO, NA	NA, NA
1993	0.06	0.06	NO, NA	NO, NA	NA, NA
1994	0.06	0.06	NO, NA	NO, NA	NA, NA
1995	0.06	0.06	NO, NA	NO, NA	NA, NA
1996	0.08	0.08	NO, NA	NO, NA	NA, NA
1997	0.08	0.08	NO, NA	NO, NA	NA, NA
1998	0.08	0.08	NO, NA	NO, NA	NA, NA
1999	0.06	0.06	NO, NA	NO, NA	NA, NA
2000	0.07	0.07	NO, NA	NO, NA	NA, NA
2001	0.09	0.09	0.00	NO, NA	NA, NA
2002	0.09	0.09	0.00	NO, NA	NA, NA
2003	0.10	0.10	NO, NA	NO, NA	NA, NA
2004	0.12	0.12	NO, NA	NO, NA	NA, NA
2005	0.41	0.41	NO, NA	NO, NA	NA, NA
2006	0.41	0.41	NO, NA	NO, NA	NA, NA
2007	0.41	0.40	NO, NA	0.01	NA, NA
2008	0.45	0.43	NO, NA	0.02	NA, NA
2009	0.45	0.42	NO, NA	0.03	NA, NA
2010	0.42	0.40	NO, NA	0.02	NA, NA
2011	0.44	0.41	NO, NA	0.04	NA, NA
Decrease 1989 - 2011	-892.03	-812.06	–	–	–

Year/ N_2O emissions level [Gg]	1A.3.b Road Transport	Liquid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 2010 - 2011	-5.14	-1.33	–	-84.19	–

3.2.9.3.2 Methodological issues

Methodology

In the development of estimates, it was primarily utilized default EFs available in IPCC 1996, IPCC GPG 2000 and, in some cases (where the previous documents do not comprise values), in the IPCC 2006.
To achieve the estimations of the CO_2 emissions on the national circumstances, a study, "Elaboration/documentation of national emission factors/other parameters relevant to National Greenhouse Gas Inventory (NGHGI) Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher tier calculation methods implementation", has determined the national emission factors based on EU-ETS operators reporting on the period of 1989 – 2010; for 2011 the estimations for the CO_2 emissions were determined using the national emission factors, based on the methodology of the same study.

For the 1989–2004 period

A) Tier 1 methodology

The IPCC Tier 1 approach, included in IPCC 1996, is used to estimate giving tha lack of detailed Tier 2 related data.
For the gases: CO_2(for LPG fuel), CH_4, N_2O and the indirect GHGs, default emission factors are used (for all fuels consumtion).
The formula used in the calculations is the following:

Equation 3.10 CO_2, CH_4 and N_2O emissions estimation-Tier 1 methodology

$$E = \Sigma(F * EF_{ab})$$

where:

- E = Emissions(Gg);
- F = Fuel Consumption(TJ);
- EF = Default Emission Factor (IPCC)(Gg);
- a = Fuel type;
- b = Sector-activity.

B) Tier 2 methodology

According to the provisions in the relevant decision trees in the IPCC GPG 2000, giving their status of key categories, both by level and trend criteria, the IPCC Tier 2 approach in the IPCC 1996 is used to estimate the CO_2 emissions from fuel combustion in the Road Tranport category.
For the CO_2 gas (for fuels diesel oil, gasoline and natural gas), Country Specific Emission Factors are used.
The formula used in the calculations is the following:

Equation 3.11 CO_2 emission estimation-Tier 2 methodology

$$E = \Sigma(F * EF_{ab})$$

where:

- E = Emissions(Gg)
- F = Fuel Consumption(TJ)
- EF = Country Specific Emission Factor (Gg)
- a = Fuel type; and
- b = Sector-activity

Emission factors

CO_2 gas

For period 1989-2004 the emission CO_2 gas, Country Specific Emission Factors including the oxidation factor are used.

The CO_2 emissions, are calculated according to 1996 IPCC Guidelines (ch 1.5.2.2, pag.1.50).

Country-Specific Emission Factors

In a similar way, country-specific emission factors were calculated as a weighted average for all the years (2007–2010 period). The following country-specific emission factors were used for the calculations of the emissions for the time-series 1989-2004 and in the subsector in CRF 1.A.3.b The country-specific emission factors are listed in the following (Table 3.74).

Table 3.74 Country-specific CO_2 emission factors for stationary combustion, without oxidation factors included, derived from EU-ETS verified reports

EF [t/TJ]	**Year**					
Type of Fuel	**2007**	**2008**	**2009**	**2010**	**2007-2010 WA EFs**	**2011**
Lignite	102.14	98.87	97.70	96.55	98.96	94.49
Natural gas	55.20	55.58	55.49	55.78	55.49	55.52
Refinery gas	55.12	54.05	57.99	57.42	56.10	57.42
Other bituminous coal	93.24	94.34	95.20	94.88	94.55	91.80
Coke_Oven_Coke	92.92	84.33	92.89	92.65	91.22	95.16
Transport diesel	74.00	72.35	74.04	72.75	73.29	72.92
Residual fuel oil	78.58	76.81	77.97	79.69	78.15	79.49
Heating and other gasoil	74.46	77.87	74.45	73.66	74.19	73.31
Petroleum Coke	0.00	94.34	91.85	94.02	93.63	98.50

EF [t/TJ]	**Year**					
Type of Fuel	**2007**	**2008**	**2009**	**2010**	**2007-2010 WA EFs**	**2011**
Industrial Wastes	-	-	-	-	-	83.50

The oxidation factor is referenced in the IPCC 1996 Guidelines, vol. II, ch. 1, table 1-4.

Type of fuel	**Oxidation factors (fraction)**
Coal	0.98
Oil and Oil Products	0.99
Gas	0.995
Peat for electricity generation	0.99

CH_4, N_2O and for the indirect greenhouse gases

For the gases CH_4, N_2O and for the indirect greenhouse gases default emission factors are used. (CH_4 ch.1.4.2.1, pag.1.34, N_2O ch.1.4.2.2, pag.1.36, NOx ch.1.4.2.3, pag.1.37, emisiile de CO ch.1.4.2.4, pag .1.39, NMVOC ch 1.4.2.5, pag.1.41, SO_2 ch1.4.2.6, pag.1.43).

The values of CH_4 EFs Default accordind to 1996 IPCC Guidelines (ch.1, pag. 1.35, Table 1-7).

	Coal	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**and Wastes**
Energy Industries	1	1	3	30	200	30
Manufacturing Industries and Construction	10	5	2	30	200	30
Commercial/Institutional	10	5	10	300	200	300
Residential	300	5	10	300	200	300
Agriculture/Forestry/Fishing	300	5	10	300	200	300

	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	and Wastes
Aviation			0.5			
Road			Gasoline diesel 20 5			
Railways	10		5			
Navigation	10		5			

The values of N_2O emissions is default according to 1996 IPCC Guidelines (ch.1, pag. 1.36, Table 1-8).

	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	and Wastes
Energy Industries	1.4	0.1	0.6	4	4	4
Manufacturing Industries and Construction	1.4	0.1	0.6	4	4	4
Commercial/Institutional	1.4	0.1	0.6	4	1	4
Residentia`l	1.4	0.1	0.6	4	1	4
Agriculture/Forestry/Fishing	1.4	0.1	0.6	4	1	4
Aviation			2			
Road		0.1	Gasoline Diesel 0.6 0.6			
Railways	1.4		0.6			

	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	and Wastes
Navigation	1.4		0.6			

The values of NOx, CO, NMVOC EFs are Default and in according to IPCC 1996 Guidelines.
For the estimation of the SO_2 emissions were used the values of the Sulphur content provided by the site EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009 and in according to 1996 IPCC Guidelines.

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 1990-2011 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.

Biomass

In order to estimate the emissions from biomass combustion activities in road transport, data on energetic quantities provided through the Energy Balance were used.
Liquid biomass used comprise biogasoline, biodiesel and other bioliquids.
All these types are combusted to produce heat and/or power. However, CO_2 emissions released from these processes are reported as an information item, as the CO_2 is naturally captured from the air. That is not applicable for the CH_4 and N_2O emissions, being reported and accounted for, in the total inventory emissions.
The national energy balance is provided by NIS. The net calorific values (NCVs) used for converting mass or volume units of the fuel quantities into energy units [TJ] are provided by NIS.

Choice of NCV

The corresponding Net Calorific Values (NCVs) from the Energy balances were used in order to convert the fuel consumption reported in natural units to energy units.

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.

For the 2005-2011 period

Methodology

For period 2005-2011 the emission calculations of road transport have been performed with the use of the version 9 of the European COPERT 4 software, model methodology corresponding to Tier 3, according to the IPCC GPG 2000 and IPCC 2006.
In the Tier 3 method, exhaust emissions are calculated using a combination of firm technical data (emission factors) and activity data (total vehicle km).
In the model emissions were calculated through the input of detailed data on average daily trip distance, the relative humidity per month, minimum and maximum temperatures per month, consumption and fuel specifications, vehicle fleet categorized in sectors, subsectors and technology (standard), vehicle stock and annual mileage, speed and driving shares.

Emission Factors

In the Tier 3 approach, total exhaust emissions from road transport are calculated as the sum of hot emissions (when the engine is at its normal operating temperature) and emissions during transient thermal engine operation (termed cold-start emissions).

The distinction between emissions during the hot stabilised phase and the transient warming-up phase is necessary because of the substantial difference in vehicle emission performance during these two conditions. Concentrations of some pollutants during the warming-up period are many times higher than during hot operation, and a different methodological approach is required to estimate the additional emissions during this period. To summarise, total emissions can be calculated by means of the following equation.

Equation 3.12 The calculation of the total exhaust emissions from road transport

$$E_{TOTAL} = E_{HOT} + E_{COLD}$$

where:

- E_{TOTAL} = total emissions (g) of any pollutant for the spatial and temporal resolution of the application;
- E_{HOT} = emissions (g) during stabilised (hot) engine operation;
- E_{COLD} = emissions (g) during transient thermal engine operation (cold start).

Vehicle emissions are heavily dependent on the engine operation conditions. Different driving situations impose different engine operation conditions, and therefore a distinct emission performance. In this respect, a distinction is made between urban, rural and highway driving.
As will be demonstrated later, different activity data and emission factors are attributed to each driving situation. Cold-start emissions are attributed mainly to urban driving (and secondarily to rural driving), as it is expected that a limited number of trips start at highway conditions. Therefore, as far as driving conditions are concerned, total emissions can be calculated by means of the equation.

Equation 3.13 The calculation of the total emissions from road transport

$$E_{TOTAL} = E_{URBAN} + E_{RURAL} + E_{HIGHWAY}$$

where:

- E_{URBAN}, E_{RURAL} and $E_{HIGHWAY}$ are the total emissions (g) of any pollutant for the respective driving situations.

Total emissions are calculated by combining activity data for each vehicle category with appropriate emission factors. The emission factors vary according to the input data (driving situations, climatic conditions). Also, information on fuel consumption and fuel specification is required to maintain a fuel balance between the figures provided by the user and the calculations.

Activity data

Fuel consumption (liquid, gaseous, LPG and biofuels) is obtained from Romanian Energy Balance IEA/Eurostat/UNECE format data and converted into energy units using the NCV. According to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the net (or lower) calorific value (NCV) should be used as the conversion factor for each fuel.

The other data, necessary for implementation of model COPERT have been provided by national institutions: Romanian National Institute for Statistics (NIS), Romanian Automobile Registry (RAR), Directorate for Driving Licenses and Registration Certificates (DDLRCV), National Institute of Meteorology (NIM).

A degree of expert judgment was necessitating as well.

The following input data is compiled for the emission calculations with the use of COPERT 4:

Activity data: fleet data, circulation data

Input data for Population, Annual Mileage (km/year), Mean fleet mileage (km), Speed (Km/h) and the mileage percentage driven by each vehicle technology per driving mode (urban, rural, highway), data collected by monitoring traffic systems (video cameras located on the public roads from the endowment Romanian Police) and through field surveys (made by partners from RAR) (see Annex 2.2).

Minimum and maximum temperatures and relative humidity

National Institute of Meteorology provided us data on maximum and minimum temperatures and relative humidity for each month of the period 2005-2011 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, according of Table 3.75.

Table 3.75 Country specific characteristics for gasoline and diesel oil according Decision no 689/ 2004, update by Decision no. 15/2006

	Sulfur (% m/m)		Hidrocarbons		Benzene (% v/v)	E100 (% v/v)	E150 (% v/v)	Oxygen Content (%m/m)
			aromatics (% v/v)	olefins (% v/v)				
< 1 january 2005								
Leaded gasoline	-	0.08	42	-	3	-	-	-
Unleaded gasoline	**Sulfur (mg/kg)**							
	min	max						
	-	150	42	-	3	-	-	-
Unleaded Gasoline								
≥ 1 january 2005	-	150	42	18	1	46	75	2.7
≥ 1 january 2007	-	50	35	18	1	46	75	2.7
≥ 1 january 2009	-	10	35	18	1	46	75	2.7
Diesel oil								
	Sulfur (mg/kg)		**PAH (% m/m)**		**Density (kg/m^3)**	**T95% C^0**	**Cetane number**	
			max.				**min.**	

	Sulfur (% m/m)		Hidrocarbons	Benzene	E100	E150	Oxygen
< 1 january 2007	-	350	11	845	360	51	
≥ 1 january 2007	-	50	11	845	360	51	
≥ 1 january 2009	-	10	11	845	360	51	

Vehicle fleet

The data on fleet detailed on technology , necessary for implementation of model COPERT 4 have been provided by Romanian Auto Register (RAR).

Romanian Auto Register (RAR) is the technical body appointed by the Ministry of Transport as the competent authority in the field of road vehicles, road safety and environmental protection.

Individual approval is a legal requirement for vehicle registration and the procedure where by RAR shows that a vehicle meets individual constructive conditions and technical state under the regulations. Successful completion of individual approval procedure is materialized by issuing Identity Card Vehicle (CIV) that are registered on the technical data and vehicle identification. Database on registered fleet, detailed technical categories is thus achieved.

Data on fleet in circulation is provided by Directorate on Driving Licenses and Vehicles Registration Certificates (DDLVRC) data compiled and processed by registered fleet RAR (see Annex 2.2)

3.2.9.3.3 Uncertainties and time- series consistency for road transport

The uncertainty associated to the GHG emissions estimates are as follows in Table 3.76.

Table 3.76 Uncertainties for road transport

Road Transport 1.A.3.b.	Uncertainty				Combined uncertainty		
	Activity Data	EF CO_2	EF N_2O	EF CH_4	EF CO_2	EF N_2O	EF CH_4
Motor Gasoline	3	5	108	48	5.83	108.04	48.09

Gas Diesel Oil	3	4	50	50	5.00	50.09	50.09
Liquefied Petroleum Gases (LPG)	3	4	50	50	5.00	50.09	50.09
Gaseous Fuels	3	4	50	50	5.00	50.09	50.09
Biomass	3	20	50	50	20.22	50.09	50.09

Combined uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in ch. 6 of the IPCC GPG 2000.

3.2.9.3.4 Source- specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Civil Aviation, Railways, Navigation and Other Transportation, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 2013 NGHGI; they are described in the Chapter 3.2.9.3.5 – 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 3.2.9.3.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

To the Road Transport, for the calculation of the emissions from CRF category 1.A.3.b, it was developed an Excel spreadsheet model, which was linked directly to the Eurostat format energy balances provided by the NIS. Wherever it was possible, automated data validation was implemented within the model, but many manual checks were performed, too.

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

The activity data series were compared with Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared with national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

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

3.2.9.3.5 Source- specific recalculation, if applicable, including changes made in response to the review process

Activity data

There are recalculations, by Road Transport activity categorie, on the entire 1989-2010 time-series, such as follows:

- Due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used;
- The share for the motor gasoline of the transport activities in the total domestic Energy Balance, to the Romanian Energy Balance IEA/Eurostat/UNECE format;
- The non-energy use of the fuel was subtracted from the corresponding activity category consumption for the diesel oil
- Implementation of higher tier method and incorporation of model COPERT 4 into the national road transport inventory (for time-series 2005-2010).

- The fleet data taken from the Romanian Automobile Registry (RAR) used COPERT 4 model.

Were made recalculations following recommendations made by experts of ERT.

Emission factors

Road Transportation from Liquid Fuels (Gasoline, Diesel Oil and LPG)

Road Transportation/ Liquid fuels

Motor Gasoline

- ✓ Recalculations for the 1989–2004 period: CO_2 emission factors (EFs) were changed with the country specific (CS);
- ✓ Recalculations for the 1989–2004 period: CH_4 and N_2O emissions were used default EFs from 1996 IPCC GL;

Diesel Oil

- ✓ Recalculations for the 1989–2004 period: CO_2 emission factors (EFs) were changed with the country specific (CS) ;
- ✓ Recalculations for the 1989–2004 period: CH_4 and N_2O emissions were used default EFs from 1996 IPCC GL;

LPG

- ✓ Recalculations for the 1989–2004 period: CO_2 CH_4 and N_2O emission factors (EFs) were derived as average from COPERT III model usage in the 2012 mars transmission;

Road Transportation/ Gaseous Fuels

Gaseous Fuels

- ✓ Recalculations for the 1989–2010 period: for CO_2 emission factors (EFs) were changed with the country specific (CS);

- ✓ Recalculations for the 1989–2010 period: for CH_4 and N_2O emissions factors (EFs) were used default EFs from 1996 IPCC GL;

Road Transportation/ Biomass

Biomass

- ✓ Recalculations for the 1989–2010 period: for CO_2, CH_4 and N_2O emissions were used default EFs from 1996 IPCC GL;

Table 3.77 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	63,800.63	74,150.88	4,574.31	5,257.58	13.00
1990	91,192.67	139,704.12	10,827.09	9,986.78	-8.41
1991	76,721.67	114,602.19	9,356.52	8,189.84	-14.25
1992	97,738.83	109,147.81	8,597.62	7,835.79	-9.72
1993	94,426.05	95,186.25	8,081.78	6,832.07	-18.29
1994	104,523.88	103,656.88	8,753.12	7,436.80	-17.70
1995	103,212.44	94,852.48	8,441.91	6,809.45	-23.97
1996	141,677.89	138,153.70	11,579.65	9,928.95	-16.63
1997	133,423.62	132,540.22	11,077.29	9,514.06	-16.43
1998	134,268.48	130,402.05	10,630.72	9,359.80	-13.58
1999	103,634.19	107,149.15	8,276.81	7,687.96	-7.66
2000	113,679.08	111,811.27	9,463.21	8,023.94	-17.94
2001	148,389.44	146,921.98	11,244.70	10,497.82	-7.11
2002	157,354.01	148,410.49	12,148.50	10,641.85	-14.16

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
2003	159,319.31	159,425.00	12,289.08	11,455.66	-7.28
2004	194,951.08	166,397.04	13,017.70	11,969.01	-8.76
2005	160,542.06	158,866.60	11,731.41	11,701.52	-0.26
2006	166,901.10	165,085.09	12,266.50	12,148.38	-0.97
2007	167,505.22	167,150.47	12,307.88	12,149.54	-1.30
2008	193,672.90	190,298.32	14,168.37	13,652.72	-3.78
2009	195,836.71	197,399.53	14,389.72	13,938.09	-3.24
2010	183,027.29	184,134.51	13,498.11	13,137.25	-2.75

Table 3.78 Effects of data changes on N_2O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	63,800.63	74,150.88	0.04	0.04	14.18
1990	91,192.67	139,704.12	0.39	0.08	-364.10
1991	76,721.67	114,602.19	0.39	0.07	-463.02
1992	97,738.83	109,147.81	0.31	0.07	-370.31
1993	94,426.05	95,186.25	0.32	0.06	-458.71
1994	104,523.88	103,656.88	0.41	0.06	-552.97
1995	103,212.44	94,852.48	0.41	0.06	-620.10
1996	141,677.89	138,153.70	0.50	0.08	-508.45
1997	133,423.62	132,540.22	0.45	0.08	-471.04
1998	134,268.48	130,402.05	0.42	0.08	-437.11
1999	103,634.19	107,149.15	0.36	0.06	-460.16
2000	113,679.08	111,811.27	0.43	0.07	-535.25

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
2001	148,389.44	146,921.98	0.49	0.09	-467.48
2002	157,354.01	148,410.49	0.54	0.09	-503.91
2003	159,319.31	159,425.00	0.58	0.10	-498.58
2004	194,951.08	166,397.04	0.60	0.12	-406.66
2005	160,542.06	158,866.60	0.77	0.41	-88.20
2006	166,901.10	165,085.09	0.73	0.41	-77.82
2007	167,505.22	167,150.47	0.86	0.41	-110.80
2008	193,672.90	190,298.32	1.15	0.45	-152.95
2009	195,836.71	197,399.53	1.12	0.45	-148.07
2010	183,027.29	184,134.51	1.62	0.42	-286.15

Table 3.79 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	63,800.63	74,150.88	0.65	1.48	56.39
1990	91,192.67	139,704.12	4.66	2.06	-126.90
1991	76,721.67	114,602.19	3.02	1.71	-76.77
1992	97,738.83	109,147.81	2.63	1.30	-101.51
1993	94,426.05	95,186.25	1.99	1.15	-73.16
1994	104,523.88	103,656.88	2.66	1.28	-107.96
1995	103,212.44	94,852.48	2.33	1.13	-105.96
1996	141,677.89	138,153.70	3.36	1.55	-116.72
1997	133,423.62	132,540.22	3.41	1.59	-114.17
1998	134,268.48	130,402.05	3.61	1.57	-129.19

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
1999	103,634.19	107,149.15	2.43	1.32	-84.23
2000	113,679.08	111,811.27	3.60	1.36	-164.11
2001	148,389.44	146,921.98	3.86	1.89	-104.35
2002	157,354.01	148,410.49	2.89	1.79	-61.24
2003	159,319.31	159,425.00	3.40	1.82	-86.22
2004	194,951.08	166,397.04	3.76	1.97	-91.07
2005	160,542.06	158,866.60	2.85	2.76	-3.14
2006	166,901.10	165,085.09	2.45	2.43	-0.87
2007	167,505.22	167,150.47	2.82	2.20	-27.94
2008	193,672.90	190,298.32	2.33	2.02	-15.53
2009	195,836.71	197,399.53	2.44	2.01	-21.34
2010	183,027.29	184,134.51	6.10	1.74	-251.16

3.2.9.3.6 Source- specific planned improvements

In order to improve the inventory quality, the investigation of the country-specific values associated to parameters used in the Copert IV model is planned, as follows:

- ability to separately report in Copert 4 biofuel consumption data (biogasoline, biodiesel);
- the availability of fleet data for each year of the period 1989-2004.

The results will be incorporate in the next NGHGI submission.

3.2.9.4 Source category Railways (CRF sector 1.A.3.c)

3.2.9.4.1 Source category description

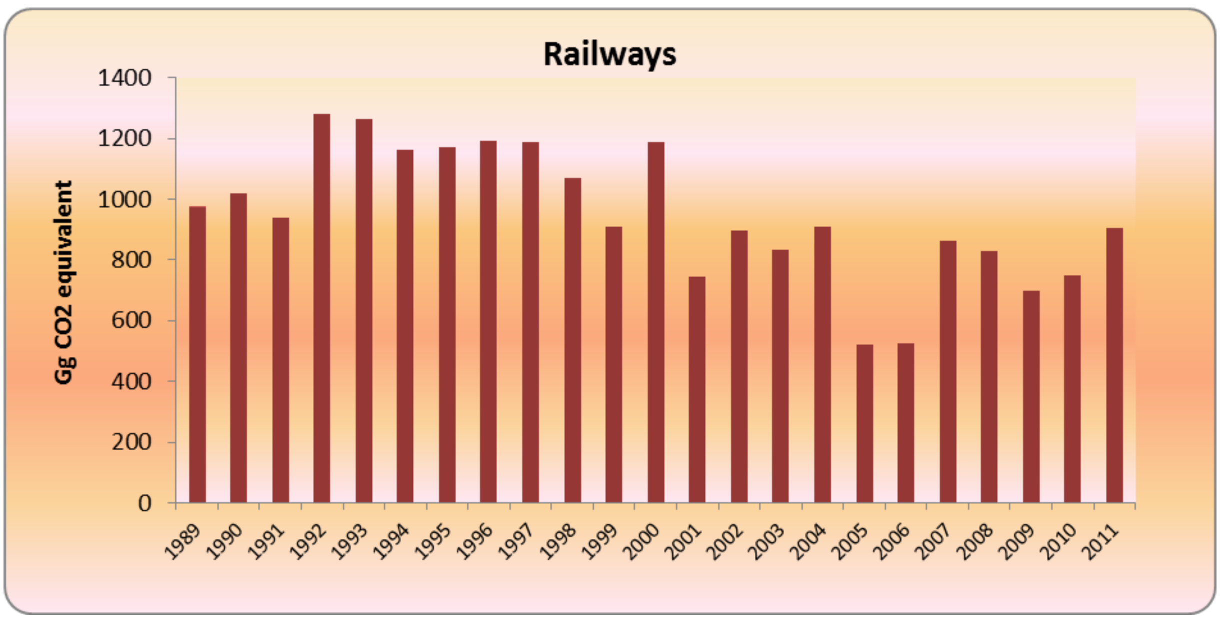
The Railways Subsector includes emissions from following fuels: Diesel Oil,Gasoline, Residual Fuel Oil,Lignite -Brown coal, Sub-bitouminous Coal, Other bitouminous Coal, Coking Coal.

In 2011 year, the railways related emissions represents 4.06% of total emissions from the transport sector (14,577.72 Gg CO_2 equivalent).

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 year the emissions were decreasing that could be explained by the global economically crisis. For 2010–2011 an increase compared to the 2009 has been observed, due to the domestic trips number increase (Figure 3.33).

Figure 3.33 GHG emissions Trend from 1A3c – Railways



3.2.9.4.2 Methodological issues

Methodology

The GHG emissions from Railwais category are calculated according to1996 IPCC and IPCC Good Practice Guidance.

The activity data are provided by IEA/Eurostat Questionnaire and values for emissions factors used are provided by 1996 IPCC Guidelines.

Tier 1 method

The indirect GHG emissions are calculated according to IPCC 1996 and calculation formula is presented in Section 3.2.9.3.2.

Tier 2 method

According to the provisions in the relevant decision trees in the IPCC GPG 2000, giving their status of key categories, both by level and trend criteria, the IPCC Tier 2 approach (Revised 1996 IPCC Guidelines) is used to calculate the CO_2 emissions from fuel combustion in the sectors.
The CO_2 emissions, are calculated according to 1996 IPCC Guidelines (pag.1.30,ch 1.4.1.2)

Equation 3.14 The GHG direct emissions from Railways category

*Emission= ∑ Fuel Consumption*EFCountry Specific/Default*Oxidation Factor*

The oxidation factor is referenced in the IPCC 1996 Guidelines, Vol. II, Ch. 1, Table 1-4.

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

Emission factors

The values of CO_2 Emissions Factor is country specific.

Table 3.80 The values of CO_2 country specific emission factor

2011			
Fuel Type	**EF O_x included**	**EF without O_x**	**EF C**
Lignite	86.96	94.49	25.77
Natural gas	55.52	55.52	15.14
Refinery gas	57.42	57.42	15.66
Other bituminous coal	91.08	91.80	25.04
Coke_Oven_Coke	95.16	95.16	25.95
Transport diesel	73.29	73.29	19.89
Residual fuel oil	79.49	79.49	21.68
Heating and other gasoil	73.29	73.31	19.99
Petroleum Coke	98.50	98.50	26.86
Motor Gasoline		71.62	19.54
Industrial Wastes	83.50	83.50	22.77

The values of CH_4,N_2O NOx, CO, NMVOC emission factors are default and in according to IPCC 1996 Guidelines.

The values of CH_4 Emission Factor default accordind to 1996 IPCC Guidelines (tabel 1-7, ch.1, page 1.35).

Table 3.81 The values of CH_4 emission factors for different fuels

	Coal	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Other Biomass and Wastes**
Energy Industries	1	1	3	30	200	30

	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Other Biomass and Wastes
Manufacturing Industries and Construction	10	5	2	30	200	30
Commercial/Institutional	10	5	10	300	200	300
Residential	300	5	10	300	200	300
Agriculture/Forestry/Fishing	300	5	10	300	200	300
Aviation			0.5			
Road			Gasoline diesel 20 5			
Railways	10		5			
Navigation	10		5			

The values of N_2O emissions is default according to 1996 IPCC Guidelines (tabel 1-8, ch.1, page1.36).

Table 3.82 The values of N_2O emission factors for different fuels

	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Wastes
Energy Industries	1.4	0.1	0.6	4	4	4
Manufacturing Industries and Construction	1.4	0.1	0.6	4	4	4
Commercial/Institutional	1.4	0.1	0.6	4	1	4
Residential	1.4	0.1	0.6	4	1	4

	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Wastes
Agriculture/Forestry/Fishing	1.4	0.1	0.6	4	1	4
Aviation			2			
Road		0.1	Gasoline Diesel 0.6 0.6			
Railways	1.4		0.6			
Navigation	1.4		0.6			

For the estimation of the SO_2 emissions were used the values of the Sulphur content provided by the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009 and in according to 1996 IPCC Guidelines. Determination of values emission factor and emissions were in according to 1996 IPCC Guidelines.

Activity data

The activity data for Railways(1.A.3.c) are provided by IEA/Eurostat Questionnaire instead of domestic Romanian Energy balance.

Figure 3.34 Fuel consumptionfor Railwais -1.A.3.c

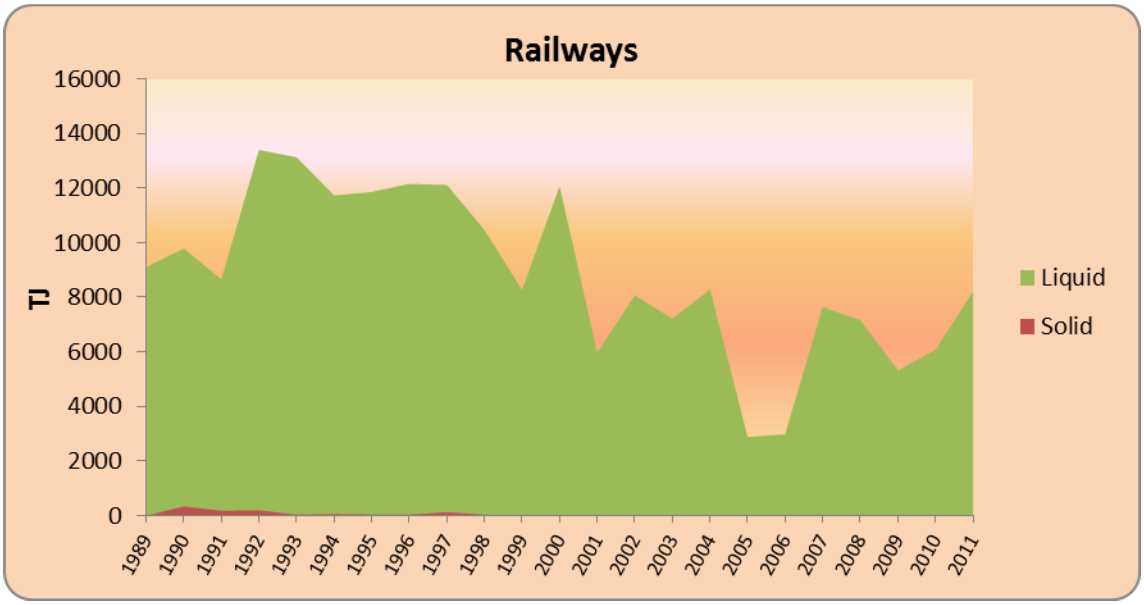


Table 3.83 Fuel consumption (Diesel Oil), emission factors and emissions data

	Diesel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion (TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	9,104.54	42,435	73.29	660.56	5	0.046	0.6	0.005
1990	9,786.83	42,435	73.29	710.06	5	0.049	0.6	0.006
1991	8,616.62	42,435	73.29	625.16	5	0.043	0.6	0.005
1992	13,367.03	42,435	73.29	969.82	5	0.067	0.6	0.008
1993	13,112.42	42,435	73.29	951.35	5	0.066	0.6	0.008
1994	11,712.06	42,435	73.29	849.75	5	0.059	0.6	0.007
1995	11,839.37	42,435	73.29	858.98	5	0.059	0.6	0.007
1996	12,136.41	42,435	73.29	880.53	5	0.061	0.6	0.007
1997	12,093.98	42,435	73.29	877.45	5	0.060	0.6	0.007

	Diesel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
1998	10,439.01	42,435	73.29	757.38	5	0.052	0.6	0.006
1999	8,247.43	42,435	73.29	598.38	5	0.041	0.6	0.005
2000	11,966.67	42,435	73.29	868.22	5	0.060	0.6	0.007
2001	5,957.20	42,435	73.29	432.21	5	0.030	0.6	0.004
2002	8,062.65	42,435	73.29	584.97	5	0.040	0.6	0.005
2003	7,213.95	42,435	73.29	523.39	5	0.036	0.6	0.004
2004	8,274.83	42,435	73.29	600.36	5	0.041	0.6	0.005
2005	2,843.15	42,435	73.29	206.28	5	0.014	0.6	0.002
2006	2,970.45	42,435	73.29	215.52	5	0.015	0.6	0.002
2007	7,635.43	42,435	73.29	553.97	5	0.038	0.6	0.005
2008	7,086.07	42,435	73.29	514.12	5	0.035	0.6	0.004
2009	5,309.43	42,435	73.29	385.22	5	0.027	0.6	0.003
2010	6,052.49	42,435	73.29	439.13	5	0.030	0.6	0.004
2011	8,189.96	42,435	72.92	591.27	5	0.041	0.6	0.005

Table 3.84 Fuel consumption (Residual Fuel Oil), emission factors and emissions data

	Residual Fuel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion(TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	40,000	78.15	NO	5	NO	0.6	NO
1990	NO	39,350	78.15	NO	5	NO	0.6	NO
1991	NO	39,350	78.15	NO	5	NO	0.6	NO
1992	NO	39,350	78.15	NO	5	NO	0.6	NO
1993	NO	39,350	78.15	NO	5	NO	0.6	NO

	Residual Fuel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
1994	NO	39,350	78.15	NO	5	NO	0.6	NO
1995	NO	39,350	78.15	NO	5	NO	0.6	NO
1996	NO	39,350	78.15	NO	5	NO	0.6	NO
1997	NO	39,350	78.15	NO	5	NO	0.6	NO
1998	NO	39,350	78.15	NO	5	NO	0.6	NO
1999	NO	39,350	78.15	NO	5	NO	0.6	NO
2000	78.70	39,350	78.15	6.089	5	0.00039	0.6	0.000042
2001	NO	39,350	78.15	NO	5	NO	0.6	NO
2002	NO	39,350	78.15	NO	5	NO	0.6	NO
2003	NO	39,350	78.15	NO	5	NO	0.6	NO
2004	NO	39,350	78.15	0.000	5	NO	0.6	NO
2005	39.35	39,350	78.15	3.045	5	0.00020	0.6	0.000024
2006	NO	39,350	78.15	NO	5	NO	0.6	NO
2007	NO	39,350	78.15	NO	5	NO	0.6	NO
2008	39.35	39,350	78.15	3.045	5	0.00020	0.6	0.000024
2009	NO	39,350	78.15	NO	5	NO	0.6	NO
2010	NO	39,350	78.15	NO	5	NO	0.6	NO
2011	NO	39,350	79.49	NO	5	NO	0.6	NO

Table 3.85 Fuel consumption (Gasoline), emission factors and emissions data

	Gasoline		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion(TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	1.65	44,000	71.62	0.12	5	0.000008	0.6	0.000001
1990	1.65	43,522	71.62	0.12	5	0.000008	0.6	0.000001

	Gasoline		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
1991	34.09	43,522	71.62	2.42	5	0.000170	0.6	0.000020
1992	28.54	43,522	71.62	2.02	5	0.000143	0.6	0.000017
1993	19.02	43,522	71.62	1.35	5	0.000095	0.6	0.000011
1994	16.90	43,522	71.62	1.20	5	0.000085	0.6	0.000010
1995	18.45	43,522	71.62	1.31	5	0.000092	0.6	0.000011
1996	18.74	43,522	71.62	1.33	5	0.000094	0.6	0.000011
1997	20.64	43,522	71.62	1.46	5	0.000103	0.6	0.000012
1998	22.12	43,522	71.62	1.57	5	0.000111	0.6	0.000013
1999	22.02	43,522	71.62	1.56	5	0.000110	0.6	0.000013
2000	18.71	43,522	71.62	1.33	5	0.000094	0.6	0.000011
2001	5.56	43,522	71.62	0.39	5	0.000028	0.6	0.000003
2002	7.13	43,522	71.62	0.51	5	0.000036	0.6	0.000004
2003	7.08	43,522	71.62	0.50	5	0.000035	0.6	0.000004
2004	6.93	43,522	71.62	0.49	5	0.000035	0.6	0.000004
2005	4.91	43,522	71.62	0.35	5	0.000025	0.6	0.000003
2006	6.35	43,522	71.62	0.45	5	0.000032	0.6	0.000004
2007	7.21	43,686	71.62	0.51	5	0.000036	0.6	0.000004
2008	33.80	43,647	71.62	2.40	5	0.000169	0.6	0.000020
2009	17.14	43,502	71.62	1.22	5	0.000086	0.6	0.000010
2010	15.09	43,510	71.62	1.07	5	0.000075	0.6	0.000009
2011	26.54	43,510	71.62	1.88	5	0.000133	0.6	0.000016

Table 3.86 Fuel consumption (Lignite-BrownCoal), emission factors and emissions data

	Lignite-BrownCoal		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion(TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	7,243	98.96	NO	10	NO	1.4	NO
1990	NO	7,583	98.96	NO	10	NO	1.4	NO
1991	60.49	7,562	98.96	5.99	10	0.0006	1.4	0.000085
1992	56.54	7,067	98.96	5.59	10	0.00057	1.4	0.000079
1993	15.01	7,506	98.96	1.49	10	0.00015	1.4	0.000021
1994	37.45	7,490	98.96	3.71	10	0.00037	1.4	0.000052
1995	22.75	7,583	98.96	2.25	10	0.00023	1.4	0.000032
1996	15.35	7,676	98.96	1.52	10	0.00015	1.4	0.000022
1997	30.05	7,513	98.96	2.97	10	0.0003	1.4	0.000042
1998	NO	7,616	98.96	NO	10	NO	1.4	NO
1999	NO	7,947	98.96	NO	10	NO	1.4	NO
2000	NO	7,879	98.96	NO	10	NO	1.4	NO
2001	NO	7,197	98.96	NO	10	NO	1.4	NO
2002	NO	8,385	98.96	NO	10	NO	1.4	NO
2003	8.49	8,487	98.96	0.84	10	8.5E-05	1.4	0.000012
2004	NO	8,284	98.96	NO	10	NO	1.4	NO
2005	NO	7,801	98.96	NO	10	NO	1.4	NO
2006	NO	7,784	98.96	NO	10	NO	1.4	NO
2007	NO	8,047	98.96	NO	10	NO	1.4	NO
2008	NO	8,132	98.96	NO	10	NO	1.4	NO
2009	NO	8,093	98.96	NO	10	NO	1.4	NO
2010	NO	7,942	98.96	NO	10	NO	1.4	NO

	Lignite-BrownCoal		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
2011	NO	8,233	98.96	NO	10	NO	1.4	NO

Table 3.87 Fuel consumption (Sub-Bitouminous Coal), emission factors and emissions data

	Sub-bituminous Coal		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion(TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	22,737	94.15	NO	10	NO	1.4	NO
1990	NO	22,737	94.15	NO	10	NO	1.4	NO
1991	NO	22,737	94.15	NO	10	NO	1.4	NO
1992	NO	22,737	94.15	NO	10	NO	1.4	NO
1993	NO	22,737	94.15	NO	10	NO	1.4	NO
1994	NO	22,737	94.15	NO	10	NO	1.4	NO
1995	22.74	22,737	94.15	2.14	10	0.00023	1.4	3.2E-05
1996	NO	23,045	94.15	NO	10	NO	1.4	NO
1997	72.64	24,214	94.15	6.84	10	0.00073	1.4	0.0001
1998	37.32	18,662	94.15	3.51	10	0.00037	1.4	5.2E-05
1999	NO	18,713	94.15	NO	10	NO	1.4	NO
2000	NO	18,713	94.15	NO	10	NO	1.4	NO
2001	NO	18,713	94.15	NO	10	NO	1.4	NO
2002	NO	18,713	94.15	NO	10	NO	1.4	NO
2003	NO	18,713	94.15	NO	10	NO	1.4	NO
2004	24.21	24,214	94.15	2.28	10	0.000242	1.4	3.4E-05
2005	NO	24,433	94.15	NO	10	NO	1.4	NO
2006	NO	24,497	94.15	NO	10	NO	1.4	NO

	Sub-bituminous Coal		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
2007	NO	24,592	94.15	NO	10	NO	1.4	NO
2008	NO	24,572	94.15	NO	10	NO	1.4	NO
2009	NO	24,562	94.15	NO	10	NO	1.4	NO
2010	NO	24,585	94.15	NO	10	NO	1.4	NO
2011	NO	24,585	94.15	NO	10	NO	1.4	NO

Table 3.88 Fuel consumption (Other-Bitouminous Coal), emission factors and emissions data

	Other Bituminous Coal		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion (TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/ TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	18,384	94.55	NO	10	NO	1.4	NO
1990	339.27	24,233	94.55	32.08	10	0.003393	1.4	0.000475
1991	121.48	24,295	94.55	11.49	10	0.001215	1.4	0.00017
1992	140.44	15,604	94.55	13.28	10	0.001404	1.4	0.000197
1993	24.37	24,374	94.55	2.30	10	0.000244	1.4	3.41E-05
1994	23.07	23,067	94.55	2.18	10	0.000231	1.4	3.23E-05
1995	NO	25,407	94.55	NO	10	NO	1.4	NO
1996	NO	24,720	94.55	NO	10	NO	1.4	NO
1997	NO	25,320	94.55	NO	10	NO	1.4	NO
1998	NO	27,284	94.55	NO	10	NO	1.4	NO
1999	NO	25,535	94.55	NO	10	NO	1.4	NO
2000	NO	24,618	94.55	NO	10	NO	1.4	NO
2001	24.88	24,881	94.55	2.35	10	0.000249	1.4	3.48E-05
2002	NO	24,826	94.55	NO	10	NO	1.4	NO

	Other Bituminous Coal		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
2003	NO	25,951	94.55	NO	10	NO	1.4	NO
2004	NO	25,951	94.55	NO	10	NO	1.4	NO
2005	NO	25,951	94.55	NO	10	NO	1.4	NO
2006	NO	25,951	94.55	NO	10	NO	1.4	NO
2007	NO	25,951	94.55	NO	10	NO	1.4	NO
2008	NO	25,951	94.55	NO	10	NO	1.4	NO
2009	NO	25,951	94.55	NO	10	NO	1.4	NO
2010	NO	25,951	94.55	NO	10	NO	1.4	NO
2011	NO	25,951	94.55	NO	10	NO	1.4	NO

Table 3.89 Fuel consumption (Coking Coal), emission factors and emissions data

	Coking coal		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion(TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	21,114	91.22	NO	10	NO	1.4	NO
1990	NO	26,865	91.22	NO	10	NO	1.4	NO
1991	NO	27,106	91.22	NO	10	NO	1.4	NO
1992	NO	27,147	91.22	NO	10	NO	1.4	NO
1993	NO	27,228	91.22	NO	10	NO	1.4	NO
1994	NO	26,776	91.22	NO	10	NO	1.4	NO
1995	NO	26,776	91.22	NO	10	NO	1.4	NO
1996	26.3079582	26,308	91.22	2.39987	10	0.000263	1.4	3.68311E-05
1997	27.4475568	27,448	91.22	2.50382	10	0.000274	1.4	3.84266E-05
1998	NO	27,410	91.22	NO	10	0	1.4	NO

	Coking coal		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
1999	NO	27,432	91.22	NO	10	0	1.4	NO
2000	NO	27,491	91.22	NO	10	0	1.4	NO
2001	NO	27,478	91.22	NO	10	0	1.4	NO
2002	NO	27,487	91.22	NO	10	0	1.4	NO
2003	NO	27,486	91.22	NO	10	0	1.4	NO
2004	NO	27,500	91.22	NO	10	0	1.4	NO
2005	NO	27,500	91.22	NO	10	0	1.4	NO
2006	NO	27,500	91.22	NO	10	0	1.4	NO
2007	NO	27,500	91.22	NO	10	0	1.4	NO
2008	NO	27,500	91.22	NO	10	0	1.4	NO
2009	NO	27,500	91.22	NO	10	0	1.4	NO
2010	NO	27,500	91.22	NO	10	0	1.4	NO
2011	NO	27,500	91.22	NO	10	0	1.4	NO

3.2.9.4.3 Uncertainties and time-series consistency

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

CO_2

- ***activity data***
  - Liquid: 5%
  - Solid: 3%
- ***emision* factors**
  - Liquid: 3%
  - Solid: 2%

- 5.83% liquid and 3.61% solid associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4

❖ ***activity data***
- Liquid: 5%
- Solid: 3%

❖ ***emision* factors**
- Liquid: 50%
- Solid: 50%
- 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000

N_2O

❖ ***activity data***
- Liquid: 5%
- Solid: 3%

❖ ***emision* factors**
- Liquid: 50%
- Solid: 50%
- 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000

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

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

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Road Transport Subsector the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 2013 NGHGI; they are described in the Chapter 3.2.9.4.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.2.9.4.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

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

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

Railways/ Liquid fuels 1.A.3c.

Diesel Oil

- activity data
  - recalculations for the 1989 – 2010 period at AD: the non-energy use of the fuel was subtracted;
- emission factors
  - recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed AD and CO_2 country specific emission factor were updated;
  - recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed AD.

Motor Gasoline

- activity data
  - recalculations for the 1989 – 2010 period at activity data: the share of the transport activities in the total domestic Energy Balance, to the Romanian Energy Balance IEA/Eurostat/UNECE format, was applied;
- emission factors
  - recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed activity data and CO_2 country specific emission factor were updated;
  - recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed activity data.

Residual Oil

- activity data
  - recalculations for the 1989 – 2010 period at AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic Romanian Energy Balance is used;
- emission factors
  - recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed activity data and CO_2 country specific emission factor were updated;

- ✓ recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed activity data.

Railways/ Solid fuels 1.A.3.c.

Lignit, Sub-bitouminous Coal, Other bitouminous coal, Coking coal

- ❖ activity data
  - ✓ recalculations for the 1989 – 2010 period at AD due to the change of the source of the activity data: EUROSTAT instead of domestic Romanian Energy Balance is used;
- ❖ emission factors
  - ✓ recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed activity data and CO_2 country specific emission factor were updated;
  - ✓ recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed activity data.

The **Biomass fuel** started to be caracterized Other transport (please specify)/Other non-specified/Biomass1.A3.e.

Table 3.90 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	11,294.58	9,106.20	819.46	660.68	-24.03
1990	12,322.40	10,127.76	894.03	742.26	-20.45
1991	10,366.87	8,832.68	752.15	645.05	-16.60
1992	13,381.49	13,592.83	970.88	990.74	2.01
1993	13,133.27	13,171.02	952.90	956.50	0.38

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
1994	11,727.79	11,789.60	850.91	856.84	0.69
1995	11,895.43	11,903.54	863.27	864.71	0.17
1996	12,157.34	12,197.05	882.10	885.80	0.42
1997	12,116.18	12,245.17	879.12	891.28	1.36
1998	10,456.00	10,498.68	758.65	762.49	0.50
1999	8,538.56	8,269.52	619.50	599.94	-3.26
2000	12,126.36	12,134.34	882.09	882.57	0.05
2001	6,154.60	6,045.87	448.53	440.70	-1.77
2002	8,237.54	8,224.25	601.79	600.72	-0.18
2003	7,659.11	7,358.30	560.86	537.44	-4.36
2004	8,303.88	8,310.07	602.93	603.54	0.10
2005	2,919.97	2,915.74	212.81	212.47	-0.16
2006	3,001.93	3,001.74	218.47	218.43	-0.02
2007	8,114.91	8,110.79	601.00	600.68	-0.05
2008	7,196.85	7,194.79	523.22	523.07	-0.03
2009	5,355.26	5,329.21	388.61	386.69	-0.50
2010	6,074.64	6,067.57	440.73	440.20	-0.12

Table 3.91 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Differences [%]
	NGHGI 2012 v. 3.1.	NGHGI 2013 v. 1.3	NGHGI 2012 v. 3.1.	NGHGI 2013 v. 1.3	
1989	11,294.58	9,106.20	0.0565	0.0455	-24.18
1990	12,322.40	10,127.76	0.0616	0.0491	-25.46
1991	10,366.87	8,832.6819	0.0518	0.0439	-18.00
1992	13,381.49	13,592.83	0.0775	0.0677	-14.48
1993	13,133.27	13,171.024	0.0657	0.0659	0.30
1994	11,727.79	11,789.60	0.0587	0.0591	0.68
1995	11,895.43	11,903.54	0.0596	0.0596	0.00
1996	12,157.34	12,197.05	0.0609	0.0610	0.16
1997	12,116.18	12,245.17	0.0608	0.0610	0.33
1998	10,456.00	10,498.68	0.0523	0.0524	0.19
1999	8,538.56	8,269.52	0.0427	0.0414	-3.14
2000	12,126.36	12,134.34	0.0814	0.0814	0.00
2001	6,154.60	6,045.87	0.0478	0.0473	-1.06
2002	8,237.54	8,224.25	0.0867	0.0867	0.00
2003	7,659.11	7,358.30	0.0764	0.0748	-2.14
2004	8,303.8750	8,310.07	0.0427	0.0426	-0.23

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Differences [%]
2005	2,919.9660	2,915.74	0.0230	0.0229	-0.44
2006	3,001.93	3,001.74	0.0225	0.0224	-0.45
2007	8,114.91	8,110.79	0.1788	0.1787	-0.06
2008	7,196.85	7,194.79	0.0464	0.0465	0.22
2009	5,355.26	5,329.21	0.0276	0.0274	-0.73
2010	6,074.64	6,067.57	0.0303	0.0303	0.00

Table 3.92 Effects of data changes on N_2Oemissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Differences [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	11,294.58	9,106.20	0.0068	0.0055	-23.64
1990	12,322.40	10,127.76	0.0074	0.0093	20.43
1991	10,366.87	8,832.68	0.0062	0.0070	11.43
1992	13,381.49	13,592.83	0.0093	0.0100	7.00
1993	13,133.27	13,171.02	0.0079	0.0083	4.82
1994	11,727.79	11,789.60	0.0070	0.0076	7.89
1995	11,895.43	11,903.54	0.0071	0.0076	6.58
1996	12,157.34	12,197.05	0.0073	0.0077	5.19

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Differences [%]
1997	12,116.18	12,245.17	0.0073	0.0086	15.12
1998	10,456.00	10,498.68	0.0063	0.0067	5.97
1999	8,538.56	8,269.52	0.0051	0.0050	-2.00
2000	12,126.36	12,134.34	0.0075	0.0075	0.00
2001	6,154.60	6,045.87	0.0039	0.0041	4.88
2002	8,237.54	8,224.25	0.0055	0.0055	0.00
2003	7,659.11	7,358.30	0.0050	0.0049	-2.04
2004	8,303.88	8,310.07	0.0050	0.0052	3.85
2005	2,919.97	2,915.74	0.0019	0.0018	-5.56
2006	3,001.93	3,001.74	0.0019	0.0019	0.00
2007	8,114.91	8,110.79	0.0065	0.0065	0.00
2008	7,196.85	7,194.79	0.0044	0.0044	0.00
2009	5,355.26	5,329.21	0.0032	0.0032	0.00
2010	6,074.64	6,067.57	0.0036	0.0036	0.00

3.2.9.4.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

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

3.2.9.5 Source category Navigation(CRF sector 1.A.3.d)

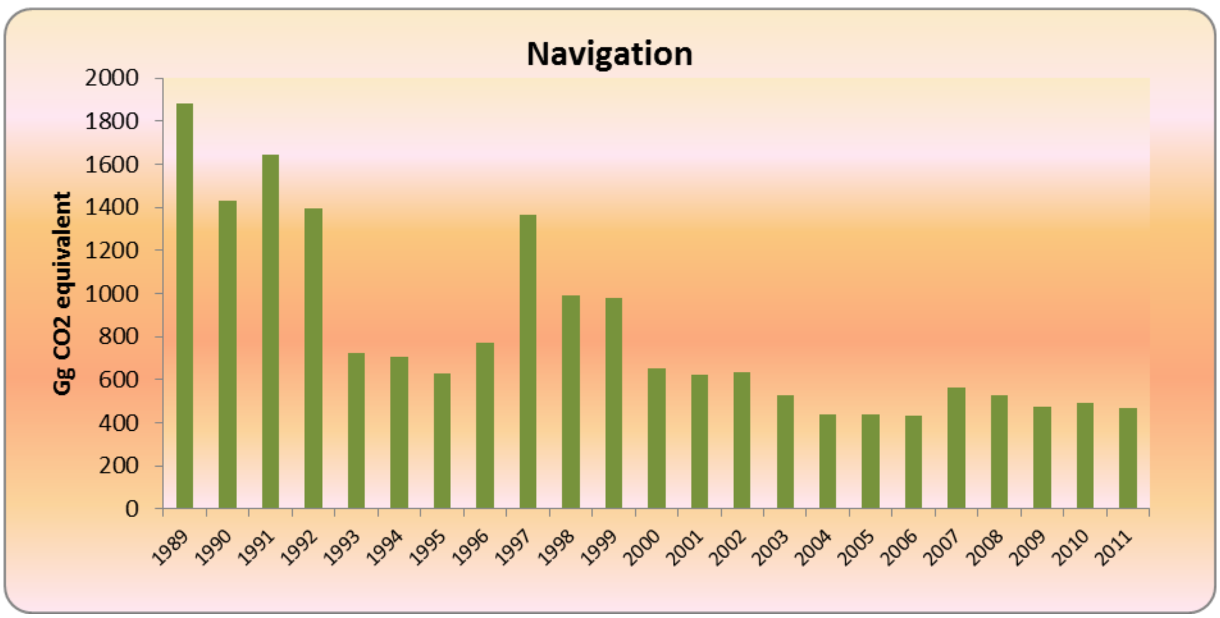
3.2.9.5.1 Source category description

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

The emissions from sub-sector Navigation represents 1.08% of total emissions from the transport sector (14,577.72Gg CO_2 equivalent).

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 3.35).

Figure 3.35 GHG emissions from 1A3a – Navigation



3.2.9.5.2 Methodological issues

The GHG emissions from Navigation are calculated according to1996 IPCC Guidelines and IPCC good practice guidance.

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

Emission Factors

The CO_2 emission factor is country specific and is presented in section 3.2.9.4.2
The values of CH_4,N_2O NOx, CO, NMVOC,SO_2 emission factors are default and in according to IPCC 1996 Guidelines and is presented in section 3.2.9.4.2

Activity Data

The activity data for Navigation(1.A.3.d) are provided by IEA/Eurostat Questionnaire instead of domestic Romanian Energy balance.

Figure 3.36 Fuel consumption 1.A.3.d Navigation 1989-2011

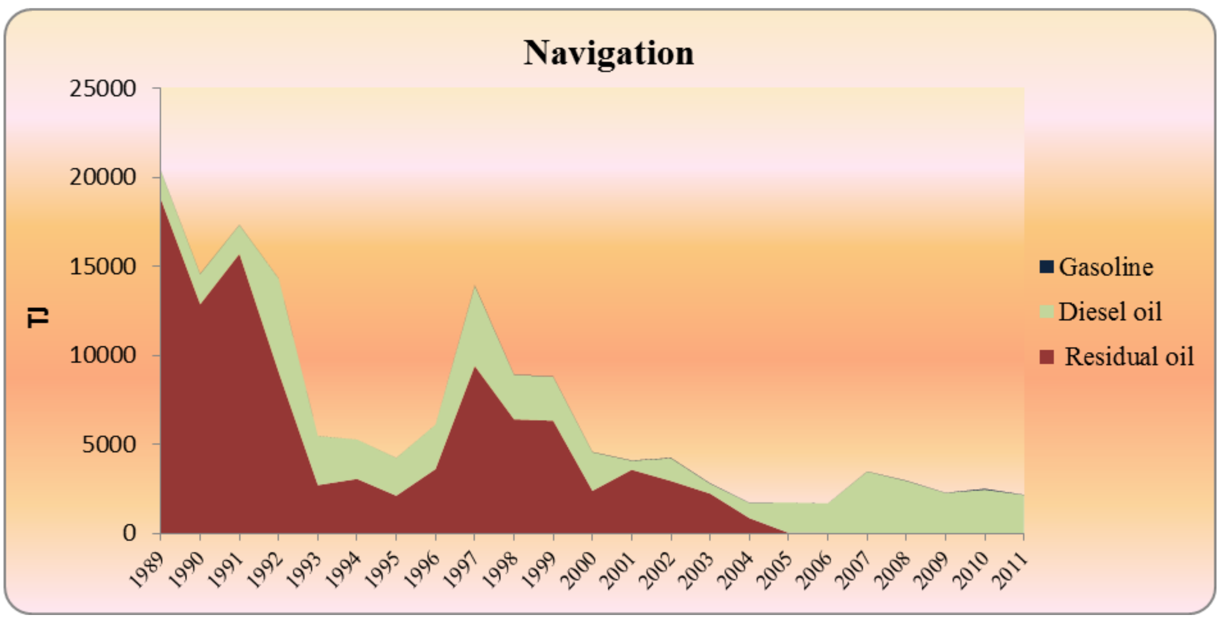


Table 3.93 Fuel consumption (Residual Fuel Oil), emission factors and emissions data

	Residual Fuel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumption (TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	0	40,000	78.15	0	5	0	0.6	0
1990	0	39,350	78.15	0	5	0	0.6	0
1991	0	39,350	78.15	0	5	0	0.6	0
1992	0	39,350	78.15	0	5	0	0.6	0
1993	0	39,350	78.15	0	5	0	0.6	0
1994	0	39,350	78.15	0	5	0	0.6	0
1995	0	39,350	78.15	0	5	0	0.6	0
1996	0	39,350	78.15	0	5	0	0.6	0
1997	0	39,350	78.15	0	5	0	0.6	0
1998	0	39,350	78.15	0	5	0	0.6	0
1999	0	39,350	78.15	0	5	0	0.6	0
2000	78.7	39,350	78.15	6.089	5	0.00039	0.6	4.72E-05
2001	0	39,350	78.15	0	5	0	0.6	0
2002	0	39,350	78.15	0	5	0	0.6	0
2003	0	39,350	78.15	0	5	0	0.6	0
2004	0	39,350	78.15	0	5	0	0.6	0
2005	39.35	39,350	78.15	3.045	5	0.0002	0.6	2.36E-05
2006	0	39,350	78.15	0	5	0	0.6	0
2007	0	39,350	78.15	0	5	0	0.6	0
2008	39.35	39,350	78.15	3.045	5	0.0002	0.6	2.36E-05
2009	0	39,350	78.15	0	5	0	0.6	0
2010	0	39,350	78.15	0	5	0	0.6	0
2011	0	39,350	79.49	0	5	0	0.6	0

Table 3.94 Fuel consumption (Diesel Oil), emission factors and emissions data

	Diesel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumption (TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	1,586.00	42,600	73.29	115.07	5	0.008	0.6	0.0010
1990	1,698.25	42,435	73.29	123.21	5	0.008	0.6	0.0010
1991	1,623.42	42,435	73.29	117.78	5	0.008	0.6	0.0010
1992	5,261.94	42,435	73.29	381.77	5	0.026	0.6	0.0032
1993	2,758.28	42,435	73.29	200.12	5	0.014	0.6	0.0017
1994	2,206.62	42,435	73.29	160.10	5	0.011	0.6	0.0013
1995	2,121.75	42,435	73.29	153.94	5	0.011	0.6	0.0013
1996	2,503.67	42,435	73.29	181.65	5	0.013	0.6	0.0015
1997	4,498.11	42,435	73.29	326.35	5	0.022	0.6	0.0027
1998	2,503.67	42,435	73.29	181.65	5	0.013	0.6	0.0015
1999	2,461.92	42,435	73.29	178.62	5	0.012	0.6	0.0015
2000	2,164.19	42,435	73.29	157.02	5	0.011	0.6	0.0013
2001	499.91	42,435	73.29	36.27	5	0.003	0.6	0.0003
2002	1,273.05	42,435	73.29	92.36	5	0.006	0.6	0.0008
2003	551.66	42,435	73.29	40.02	5	0.003	0.6	0.0003
2004	848.70	42,435	73.29	61.58	5	0.004	0.6	0.0005
2005	1,697.40	42,435	73.29	123.15	5	0.008	0.6	0.0010
2006	1,654.97	42,435	73.29	120.07	5	0.008	0.6	0.0010
2007	3,478.36	42,435	73.29	252.37	5	0.017	0.6	0.0021
2008	2,952.53	42,435	73.29	214.21	5	0.015	0.6	0.0018
2009	2,275.47	42,435	73.29	165.09	5	0.011	0.6	0.0014
2010	2,454.86	42,435	73.29	178.11	5	0.012	0.6	0.0015
2011	2,164.19	42,435	72.92	156.24	5	0.011	0.6	0.0013

Table 3.95 Fuel consumption (Gasoline), emission factors and emissions data

	Gasoline		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumption (TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	11.52	44,000	71.62	0.817	5	0.000058	0.6	0.0000069
1990	14.05	43,522	71.62	0.996	5	0.000070	0.6	0.0000084
1991	11.76	43,522	71.62	0.834	5	0.000059	0.6	0.0000071
1992	7.84	43,522	71.62	0.556	5	0.000039	0.6	0.0000047
1993	6.97	43,522	71.62	0.494	5	0.000035	0.6	0.0000042
1994	1.87	43,522	71.62	0.133	5	0.000009	0.6	0.0000011
1995	1.39	43,522	71.62	0.099	5	0.000007	0.6	0.0000008
1996	0.65	43,522	71.62	0.046	5	0.000003	0.6	0.0000004
1997	33.62	43,522	71.62	2.384	5	0.000168	0.6	0.0000202
1998	16.99	43,522	71.62	1.205	5	0.000085	0.6	0.0000102
1999	14.44	43,522	71.62	1.024	5	0.000072	0.6	0.0000087
2000	18.97	43,522	71.62	1.345	5	0.000095	0.6	0.0000114
2001	24.29	43,522	71.62	1.722	5	0.000121	0.6	0.0000146
2002	22.98	43,522	71.62	1.630	5	0.000115	0.6	0.0000138
2003	24.81	43,522	71.62	1.759	5	0.000124	0.6	0.0000149
2004	13.82	43,522	71.62	0.980	5	0.000069	0.6	0.0000083
2005	2.42	43,522	71.62	0.172	5	0.000012	0.6	0.0000015
2006	3.22	43,522	71.62	0.228	5	0.000016	0.6	0.0000019
2007	11.22	43,686	71.62	0.796	5	0.000056	0.6	0.0000067
2008	21.27	43,647	71.62	1.508	5	0.000106	0.6	0.0000128
2009	15.78	43,502	71.62	1.119	5	0.000079	0.6	0.0000095
2010	60.74	43,510	71.62	4.307	5	0.000304	0.6	0.0000364
2011	16.14	43,510	71.62	1.144	5	0.000081	0.6	0.0000097

3.2.9.5.3 Uncertainties and time-series consistency

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

CO_2

- ***activity data***
  - Residual Fuel Oil:0 %
  - Diesel oil: 0%
  - Gasoline:3%
- ***emision* factors**
  - Residual Fuel Oil:3 %
  - Diesel oil: 30%
  - Gasoline:0.8%
  - 3% Residual Fuel Oil,Diesel Oil and 3.61% Gasoline associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4

- ***activity data***
  - Residual Fuel Oil:0 %
  - Diesel oil: 0%
  - Gasoline:3%
- ***emision* factors**
  - Residual Fuel Oil:50 %
  - Diesel oil: 50%
  - Gasoline:50%
  - 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

N_2O

❖ ***activity data***

- Residual Fuel Oil:0 %
- Diesel oil: 0%
- Gasoline:3%

❖ ***emision* factors**

- Residual Fuel Oil:50 %
- Diesel oil: 50%
- Gasoline:50%
- 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

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

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Road Transport Subsector the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 2013 NGHGI; they are described in the Chapter 3.2.9.5.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.2.9.5.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

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

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

Residual Oil

- ❖ activity data
  - ✓ recalculations for the 1989 – 2009 period at AD due to the change of the source of the activity data: EUROSTAT instead of domestic Romanian Energy Balance is used;
  - ✓ change of values AD for 2007-2009 period with notation key „NO” due to changed AD
- ❖ emission factors
  - ✓ recalculations for the 1989 – 2009 period at CO_2 emissions level due to changed activity data and CO_2 country specific emission factor were updated;
  - ✓ recalculation for the 2007-2009 period at CO_2 emissions level: change of values with notation key ,”NO” due to changed AD;
  - ✓ recalculations for the 1989 – 2009 period at CH_4 and N_2O emissions level due to changed activity data;
  - ✓ recalculation for the 2007-2009 period at CH_4 and N_2O emissions levels: change of values with notation key ,”NO” due to changed AD.

Diesel oil

- ❖ activity data
  - ✓ recalculations for the 1989 – 2010 period: the non-energy use of the fuel was subtracted;
- ❖ emission factors
  - ✓ recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed AD and CO_2 country specific emission factor were updated;
  - ✓ recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed AD.

Motor Gasoline

- ❖ activity data
  - ✓ recalculations for the 1989 – 2010 period at activity data: the share of the transport activities in the total domestic Energy Balance, to the Romanian Energy Balance IEA/Eurostat/UNECE format, was applied;
  - ✓ for the 1989-1992 period notation key "NA" for AD was changed with activity data were taken from IEA/Eurostat Questionnaire 2011 - Petrol – Motor gasoline;
- ❖ emission factors
  - ✓ recalculations for the 1989 – 2010 period at CO_2 emissions due to changed activity data and CO_2 country specific emission factor were updated;
  - ✓ for the 1989-1992 period notation key "NA" for CO_2 emissions level was changed with values due to changed AD;
  - ✓ recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed AD;
  - ✓ for the 1989-1992 period notation key "NA" for CH_4 and N_2O emissions level was changed with values due to changed AD.

Table 3.96 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	3,376.93	20,357.52	259.11	1,567.39	83.47
1990	2,436.55	14,579.75	185.94	1,119.80	83.40
1991	3,307.34	17,335.84	253.54	1,333.42	80.99
1992	7,103.22	14,320.28	524.20	1,082.59	51.58
1993	3,353.44	5,480.39	246.14	410.69	40.07
1994	2,919.98	5,277.79	215.28	397.71	45.87
1995	2,635.78	4,248.04	193.70	318.45	39.17
1996	3,281.86	6,124.52	241.84	461.80	47.63
1997	6,698.77	13,936.38	496.55	1,056.40	53.00
1998	4,514.93	8,934.71	337.24	679.12	50.34
1999	5,259.94	8,811.71	394.66	669.83	41.08
2000	3,156.49	4,583.50	233.73	344.08	32.07
2001	518.02	4,105.05	37.57	315.05	88.07
2002	1,333.33	4,247.28	96.96	322.34	69.92
2003	560.26	2,819.42	40.64	215.33	81.13
2004	867.23	1,728.22	62.96	129.54	51.40

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
2005	1,722.13	1,739.17	125.05	126.37	1.04
2006	1,673.12	1,697.53	121.46	123.35	1.53
2007	3,652.29	3,489.58	265.78	253.16	-4.98
2008	3,564.97	2,973.79	261.48	215.72	-21.21
2009	2,296.27	2,291.25	166.60	166.21	-0.23
2010	2,476.91	2,515.59	179.69	182.41	1.50

Table 3.97 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	3,376.93	20,357.52	0.017	0.102	83.41
1990	2,436.55	14,579.75	0.012	0.073	83.29
1991	3,307.34	17,335.84	0.017	0.087	80.92
1992	7,103.22	14,320.28	0.009	0.072	87.15
1993	3,353.44	5,480.39	0.013	0.027	52.55
1994	2,919.98	5,277.79	0.006	0.026	78.37
1995	2,635.78	4,248.04	0.004	0.021	79.87
1996	3,281.86	6,124.52	0.005	0.031	85.02

Year	**Changes at AD level (TJ)**		**Effects of changes on emission estimates for CH_4 [Gg]**		**Difference [%]**
1997	6,698.77	13,936.38	0.050	0.070	28.83
1998	4,514.93	8,934.71	0.020	0.045	54.78
1999	5,259.94	8,811.71	0.038	0.044	13.98
2000	3,156.49	4,583.50	0.049	0.023	-112.89
2001	518.02	4,105.05	0.041	0.021	-97.73
2002	1,333.33	4,247.28	0.044	0.021	-106.05
2003	560.26	2,819.42	0.039	0.014	-179.49
2004	867.23	1,728.22	0.035	0.009	-300.95
2005	1,722.13	1,739.17	0.004	0.009	50.37
2006	1,673.12	1,697.53	0.005	0.008	39.95
2007	3,652.29	3,489.58	0.017	0.017	3.69
2008	3,564.97	2,973.79	0.018	0.015	-23.11
2009	2,296.27	2,291.25	0.010	0.011	10.10
2010	2,476.91	2,515.59	0.063	0.013	-403.04

Table 3.98 Effects of data changes onN_2O emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	3,376.93	20,357.52	0.002	0.0122	83.41
1990	2,436.55	14,579.75	0.001	0.0087	83.29
1991	3,307.34	17,335.84	0.002	0.0104	80.93
1992	7,103.22	14,320.28	0.004	0.0086	50.40
1993	3,353.44	5,480.39	0.014	0.0033	-327.55
1994	2,919.98	5,277.79	0.004	0.0032	-36.66
1995	2,635.78	4,248.04	0.004	0.0025	-42.53
1996	3,281.86	6,124.52	0.003	0.0037	23.56
1997	6,698.77	13,936.38	0.050	0.0084	-502.43
1998	4,514.93	8,934.71	0.015	0.0054	-177.84
1999	5,259.94	8,811.71	0.032	0.0053	-512.46
2000	3,156.49	4,583.50	0.055	0.0028	-1,883.16
2001	518.02	4,105.05	0.049	0.0025	-1,889.61
2002	1,333.33	4,247.29	0.053	0.0025	-1,979.83
2003	560.26	2,819.42	0.048	0.0017	-2,713.77
2004	867.23	1,728.22	0.042	0.0010	-3,952.36
2005	1,722.13	1,739.17	0.006	0.0010	-481.42
2006	1,673.12	1,697.53	0.007	0.0010	-588.81
2007	3,652.29	3,489.58	0.021	0.0021	-919.15
2008	3,564.97	2,973.79	0.021	0.0018	-1,052.35
2009	2,296.27	2,291.25	0.014	0.0014	-897.89
2010	2,476.91	2,515.59	0.077	0.0015	-5,028.69

3.2.9.5.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

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

3.2.9.6 Source category - Other transportation- (CRF sector 1.A.3.e)

3.2.9.6.1 Source category description

This sub-sector includes emissions from following fuels: Diesel Oil,Gasoline, Natural Gas, Wood/ Wood Wastes.

This category includes combustion emissions from all remaining transport activities including pipeline transportation(the operation of pump stations and maintenance of pipelines), ground activities in airports and harbours, and off –road activities not otherwise reported under 1 A 4 c Agriculture or 1 A 2.Manufacturing Industries and Construction, and emissions from the combustion of the fuels Wood/Wood Waste used in Railwais sub –sector.

The emissions from sub-sector Other transportation represents 0.25% of total emissions from the transport sector (14,577.72 Gg CO_2 equivalent).

3.2.9.6.2 Methodological issues

The GHG emissions from Other Transportation are calculated according to1996 IPCC Guidelines and IPCC good practice guidance.

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

Emission Factors

The CO_2 emission factor is country specific and is presented in section 3.2.9.4.2.

The values of CH_4,N_2O NOx, CO, NMVOC,SO_2 emission factors are default and in according to IPCC 1996 Guidelines and is presented in section 3.2.9.4.2.

Activity Data

The activity data for Navigation(1.A.3.e) are provided by IEA/Eurostat Questionnaire instead of domestic Romanian Energy balance.

Figure 3.37 Fuel consumption 1.A.3.c Navigation 1989 -2011

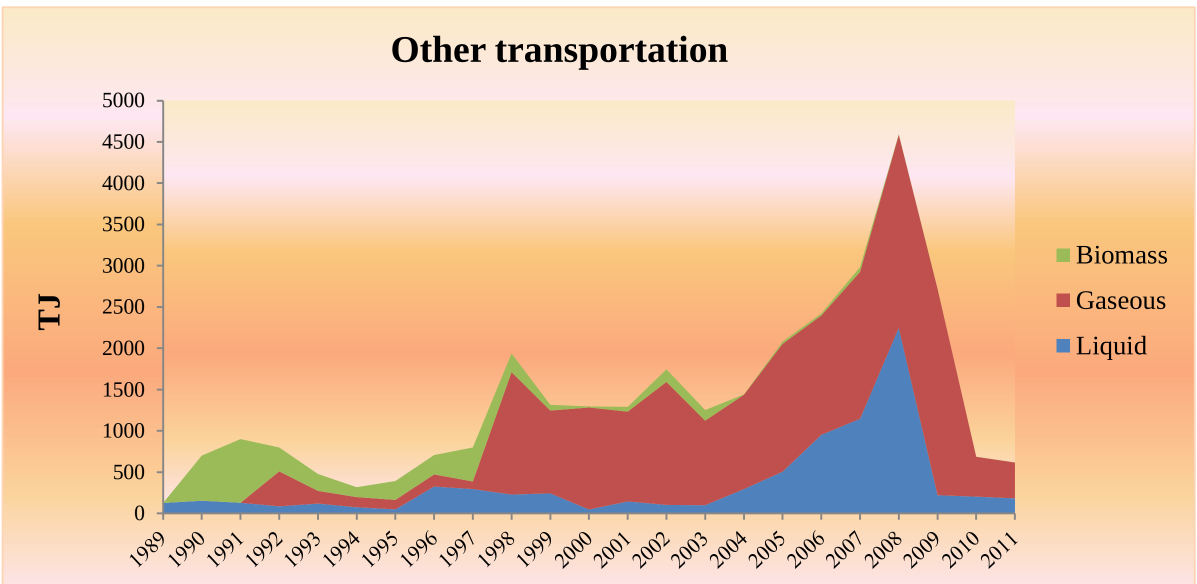


Table 3.99 Fuel consumption (Diesel Oil), emission factors and emissions data

	Diesel Oil		EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion(TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	42,600	73.29	NO	5	NO	0.6	NO
1990	NO	42,435	73.29	NO	5	NO	0.6	NO
1991	NO	42,435	73.29	NO	5	NO	0.6	NO
1992	NO	42,435	73.29	NO	5	NO	0.6	NO
1993	42.44	42,435	73.29	3.08	5	0.00021	0.6	0.00003
1994	42.44	42,435	73.29	3.08	5	0.00021	0.6	0.00003
1995	42.44	42,435	73.29	3.08	5	0.00021	0.6	0.00003
1996	212.18	42,435	73.29	15.39	5	0.00106	0.6	0.00013
1997	42.44	42,435	73.29	3.08	5	0.00021	0.6	0.00003
1998	42.44	42,435	73.29	3.08	5	0.00021	0.6	0.00003
1999	84.87	42,435	73.29	6.16	5	0.00042	0.6	0.00005
2000	NO	42,435	73.29	NO	5	NO	0.6	NO
2001	84.87	42,435	73.29	6.16	5	0.00042	0.6	0.00005
2002	NO	42,435	73.29	NO	5	NO	0.6	0.00
2003	84.87	42,435	73.29	6.16	5	0.00042	0.6	0.00005
2004	127.31	42,435	73.29	9.24	5	0.00064	0.6	0.00008
2005	NO	42,435	73.29	NO	5	NO	0.6	NO
2006	NO	42,435	73.29	NO	5	NO	0.6	NO
2007	NO	42,435	73.29	NO	5	NO	0.6	NO
2008	NO	42,435	73.29	NO	5	NO	0.6	NO
2009	NO	42,435	73.29	NO	5	NO	0.6	NO
2010	NO	42,435	73.29	NO	5	NO	0.6	NO
2011	NO	42,435	73.29	NO	5	NO	0.6	NO

Table 3.100 Fuel consumption (Gasoline), emission factors and emissions data

	Gasoline		EF CO_2	CO_2 emission	EF CH_4		CH_4 emission	EF CH_4	N_2O emission
					kg/TJ				
Year	**Fuel consumption(TJ)**	**NCV (KJ/kg)**	**kg/TJ**	**Gg**	**Pipeline**	**Off road**	**Gg**	**kg/ TJ**	**Gg**
1989	125.66	44,000	71.62	8.91	5	20	0.0024	0.6	0.00008
1990	153.28	43,522	71.62	10.87	5	20	0.0030	0.6	0.00009
1991	128.34	43,522	71.62	9.10	5	20	0.0025	0.6	0.00008
1992	85.51	43,522	71.62	6.06	5	20	0.0017	0.6	0.00005
1993	76.02	43,522	71.62	5.39	5	20	0.0015	0.6	0.00005
1994	31.59	43,522	71.62	2.24	5	20	0.0006	0.6	0.00002
1995	5.52	43,522	71.62	0.39	5	20	0.0001	0.6	0.00000
1996	112.72	43,522	71.62	7.99	5	20	0.0022	0.6	0.00007
1997	252.34	43,522	71.62	17.89	5	20	0.0050	0.6	0.00015
1998	185.39	43,522	71.62	13.15	5	20	0.0036	0.6	0.00011
1999	157.51	43,522	71.62	11.17	5	20	0.0031	0.6	0.00010
2000	46.56	43,522	71.62	3.30	5	20	0.0009	0.6	0.00003
2001	59.64	43,522	71.62	4.23	5	20	0.0011	0.6	0.00004
2002	102.49	43,522	71.62	7.27	5	20	0.0020	0.6	0.00006
2003	14.13	43,522	71.62	1.00	5	20	0.0002	0.6	0.00001
2004	166.67	43,522	71.62	11.82	5	20	0.0033	0.6	0.00010
2005	462.58	43,522	71.62	32.80	5	20	0.0093	0.6	0.00028
2006	952.06	43,522	71.62	67.50	5	20	0.0183	0.6	0.00057
2007	1,103.70	43,686	71.62	78.26	5	20	0.0221	0.6	0.00066
2008	2,206.25	43,647	71.62	156.43	5	20	0.0441	0.6	0.00132
2009	177.21	43,502	71.62	12.56	5	20	0.0035	0.6	0.00011
2010	202.62	43,510	71.62	14.37	5	20	0.0041	0.6	0.00012
2011	182.27	43,510	71.62	12.92	5	20	0.0036	0.6	0.00011

Table 3.101 Fuel consumption (Natural Gas), emission factors and emissions data

	Natural Gas	EF CO_2	CO_2 emission	EF CH_4	CH_4 emission	EF N_2O	N_2O emission
Year	**Fuel consumtion (TJ)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	55.49	NO	5	NO	0.1	0
1990	NO	55.49	NO	5	NO	0.1	0
1991	NO	55.49	NO	5	NO	0.1	0
1992	423.00	55.49	23.35	5	0.0021	0.1	0.00004
1993	153.90	55.49	8.50	5	0.0008	0.1	0.00002
1994	123.30	55.49	6.81	5	0.0006	0.1	0.00001
1995	115.20	55.49	6.36	5	0.0006	0.1	0.00001
1996	146.70	55.49	8.10	5	0.0007	0.1	0.00001
1997	91.80	55.49	5.07	5	0.0005	0.1	0.00001
1998	1,482.60	55.49	81.85	5	0.0074	0.1	0.00015
1999	1,003.00	55.49	55.37	5	0.0050	0.1	0.00010
2000	1,236.20	55.49	68.25	5	0.0062	0.1	0.00012
2001	1,088.00	55.49	60.07	5	0.0054	0.1	0.00011
2002	1,490.00	55.49	82.26	5	0.0075	0.1	0.00015
2003	1,024.00	55.49	56.53	5	0.0051	0.1	0.00010
2004	1,143.00	55.49	63.10	5	0.0057	0.1	0.00011
2005	1,548.00	55.49	85.46	5	0.0077	0.1	0.00015
2006	1,445.00	55.49	79.78	5	0.0072	0.1	0.00014
2007	1,779.00	55.49	98.22	5	0.0089	0.1	0.00018
2008	2,339.00	55.49	129.13	5	0.0117	0.1	0.00023
2009	2,502.00	55.49	138.13	5	0.0125	0.1	0.00025
2010	483.00	55.49	26.67	5	0.0024	0.1	0.00005
2011	434.00	55.52	23.98	5	0.0022	0.1	0.00004

Table 3.102 Fuel consumption (Wood/Wood Wastes), emission factors and emissions data

	Wood/Wood Wastes	**EF CO_2**	**CO_2 emission**	**EF CH_4**	**CH_4 emission**	**EF N_2O**	**N_2O emission**
Year	**Fuel consumtion(TJ)**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**	**kg/TJ**	**Gg**
1989	NO	107.44	NO	30	NO	4	NO
1990	547.00	107.44	58.77	30	0.0164	4	0.00219
1991	772.00	107.44	82.94	30	0.0232	4	0.00309
1992	290.00	107.44	31.16	30	0.0087	4	0.00116
1993	205.00	107.44	22.03	30	0.0062	4	0.00082
1994	120.00	107.44	12.89	30	0.0036	4	0.00048
1995	229.00	107.44	24.60	30	0.0069	4	0.00092
1996	235.00	107.44	25.25	30	0.0071	4	0.00094
1997	412.00	107.44	44.27	30	0.0124	4	0.00165
1998	227.00	107.44	24.39	30	0.0068	4	0.00091
1999	70.00	107.44	7.52	30	0.0021	4	0.00028
2000	13.00	107.44	1.40	30	0.0004	4	0.00005
2001	58.00	107.44	6.23	30	0.0017	4	0.00023
2002	153.00	107.44	16.44	30	0.0046	4	0.00061
2003	129.00	107.44	13.86	30	0.0039	4	0.00052
2004	4.00	107.44	0.43	30	0.0001	4	0.00002
2005	28.00	107.44	3.01	30	0.0008	4	0.00011
2006	25.00	107.44	2.69	30	0.0008	4	0.00010
2007	58.00	107.44	6.23	30	0.0017	4	0.00023
2008	6.00	107.44	0.64	30	0.0002	4	0.00002
2009	3.00	107.44	0.32	30	0.0001	4	0.00001
2010	0.00	107.44	0.00	30	0.00	4	0.00
2011	1.00	107.44	0.11	30	0.00003	4	0.000004

3.2.9.6.3 Uncertainties and time-series consistency

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

CO_2

❖ ***activity data***

- Liquid: 0%
- Gaseous: 0%
- Biomass: 3%

❖ ***emision* factors**

- Liquid: 3%
- Gaseous:2 %
- Biomass: 20%
- 3% liquid ,2% gaseous and 20.22% biomass associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4

❖ ***activity data***

- Liquid: 0%
- Gaseous: 0%
- Biomass: 3%

❖ ***emision* factors**

- Liquid: 50%
- Gaseous:50 %
- Biomass: 50%
- 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

N_2O

- ***activity data*:**
  - Liquid: 0%
  - Gaseous: 0%
  - Biomass: 3%
- ***emision* factors:**
  - Liquid: 50%
  - Gaseous:50 %
  - Biomass: 50%
  - 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

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

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Road Transport Subsector the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 2013 NGHGI; they are described in the Chapter 3.2.9.6.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.2.9.6.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

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

Other Transportation (please specify)/Other non-specified/Liquid fuels 1.A.3.e.

- activity data
  - ✓ for the 1989 – 1992 period at AD: The notation key "NA" was changed with values, because available data were found in IEA/Eurostat Questionnaire 2011.
- emission factors
  - ✓ recalculations for the 1989 – 2010 at CO_2 emissions level due to the change of the source of the AD and EF;
  - ✓ for the 1989 – 1992 period at CO_2 emissions level. The notation key "NA" was changed with values, because changed AD and country specific EF;
  - ✓ recalculations for the 1989 – 2010 at CH_4 and N_2O emissions level: the notation key "NA" was changed with values, because changed AD, and was used new EF.

Diesel Oil

- activity data
  - ✓ recalculations for the 1989 – 2009 period at AD due to the change of the source of the AD;
  - ✓ for Pipeline Transport for this period change AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic Romanian Energy Balance is used;
  - ✓ for Non-Specified, Off Road Transport use AD from EUROSTAT;
- emission factors
  - ✓ recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed AD and CO_2 country specific emission factor were updated;
  - ✓ for the 1989-2010 period notation key "NA" for CH_4 and N_2O emissions level was changed with values due to changed AD.

Motor Gasoline

- activity data
  - ✓ recalculations for the 1989 – 2009 period at AD due to the change of the source of the AD;
  - ✓ for Pipeline Transport for this period change AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic Romanian Energy Balance is used.
  - ✓ for Off Road use AD from EUROSTAT
- emission factors
  - ✓ recalculations for the 1989 – 2010 period at CO_2 emissions due to changed AD and CO_2 country emission factor;
  - ✓ For the 1989-2010 period notation key "NA" for CH_4 and N_2O emissions was changed with values due to changed AD.

Other Transportation (please specify)/Other non-specified/Gaseous fuels 1.A.3.e

❖ activity data

- ✓ for Pipeline Transport and Non-specified for this period change AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic Romanian Energy Balance is used. (Change of values AD for 1989-1991 period with notation key „NO" due to changed AD);

❖ emission factors

- ✓ recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed AD and CO_2 emission factor (Change of values CO_2 emissions for 1989-1991 period with notation key „NO" due to changed AD);
- ✓ recalculations for the 1992 – 2010 period at CH_4 and N_2O emissions level due to changed AD.

Other Transportation (please specify)/Other non-specified/Biomass 1.A.3.e

❖ activity data

- ✓ recalculations for the 1990 – 2010 period at AD due to the change of the source of the AD;

❖ emission factors

- ✓ for Pipeline Transport and Railwais (wood/wood) the notation key "NO" was changed with values, because available data were found in IEA/Eurostat Questionnaire 2011;
- ✓ recalculations for the 1990 – 2010 at CO_2, CH_4 and N_2O emissions levels: The notation key "NO" was changed with values, because changed AD ,and was used new EF.

Table 3.103 Effects of data changes on CO_2 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CO_2 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	133.62	125.66	7.35	8.91	17.50
1990	128.96	700.28	7.09	10.87	34.76
1991	920.66	900.34	50.63	9.10	-456.37
1992	370.08	798.51	20.35	29.42	30.82
1993	19.81	477.35	1.12	16.97	93.40
1994	1.58	317.32	0.11	12.13	99.09
1995	1.26	392.16	0.09	9.83	99.08
1996	1.70	706.60	0.12	31.49	99.62
1997	1.58	798.58	0.11	26.04	99.58
1998	1,301.54	1,937.43	71.60	98.08	27.00
1999	885.39	1,315.38	48.72	72.70	32.98
2000	1,043.81	1,295.76	57.44	71.55	19.72
2001	996.55	1,290.51	54.83	70.45	22.18
2002	865.17	1,745.49	47.61	89.53	46.82
2003	932.91	1,252.00	51.33	63.69	19.41
2004	530.04	1,440.97	29.17	84.16	65.34
2005	874.17	2,081.02	48.10	121.34	60.36
2006	966.63	2,422.06	53.19	147.28	63.89
2007	802.24	2,983.13	44.12	179.55	75.43
2008	860.93	4,593.69	47.35	288.65	83.60
2009	351.13	2,724.64	19.31	153.78	87.44
2010	439.09	685.62	24.15	41.03	41.14

Table 3.104 Effects of data changes on CH_4 emissions level

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for CH_4 [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	133.62	125.66	NO	0.0024	100
1990	128.96	700.28	NO	0.0030	100
1991	920.66	900.34	NO	0.0025	100
1992	370.08	798.51	NO	0.0080	100
1993	19.81	477.35	NO	0.0080	100
1994	1.58	317.32	NO	0.0039	100
1995	1.26	392.16	NO	0.0068	100
1996	1.70	706.60	NO	0.0103	100
1997	1.58	798.58	NO	0.0113	100
1998	1,301.54	1,937.43	NO	0.0181	100
1999	885.39	1,315.38	NO	0.0106	100
2000	1,043.81	1,295.76	NO	0.0075	100
2001	996.55	1,290.51	NO	0.0087	100
2002	865.17	1,745.49	NO	0.0140	100
2003	932.91	1,252.00	NO	0.0096	100
2004	530.04	1,440.97	NO	0.0098	100
2005	874.17	2,081.02	NO	0.0180	100
2006	966.63	2,422.06	NO	0.0263	100
2007	802.24	2,983.13	NO	0.0329	100
2008	860.93	4,593.69	NO	0.0562	100
2009	351.13	2,724.64	NO	0.0164	100
2010	439.09	685.62	NO	0.0065	100

Table 3.105 ***Effects of data changes on N_2O emissions level***

Year	Changes at AD level (TJ)		Effects of changes on emission estimates for N_2O [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	133.62	125.66	NO	0.00008	100
1990	128.96	700.28	NO	0.00009	100
1991	920.66	900.34	NO	0.00008	100
1992	370.08	798.51	NO	0.00065	100
1993	19.81	477.35	NO	0.00082	100
1994	1.58	317.32	NO	0.00039	100
1995	1.26	392.16	NO	0.00083	100
1996	1.70	706.60	NO	0.00105	100
1997	1.58	798.58	NO	0.00094	100
1998	1,301.54	1,937.43	NO	0.00119	100
1999	885.39	1,315.38	NO	0.00053	100
2000	1,043.81	1,295.76	NO	0.00020	100
2001	996.55	1,290.51	NO	0.00043	100
2002	865.17	1,745.49	NO	0.00082	100
2003	932.91	1,252.00	NO	0.00068	100
2004	530.04	1,440.97	NO	0.00031	100
2005	874.17	2,081.02	NO	0.00057	100
2006	966.63	2,422.06	NO	0.00082	100
2007	802.24	2,983.13	NO	0.00110	100
2008	860.93	4,593.69	NO	0.00161	100
2009	351.13	2,724.64	NO	0.00039	100
2010	439.09	685.62	NO	0.00017	100

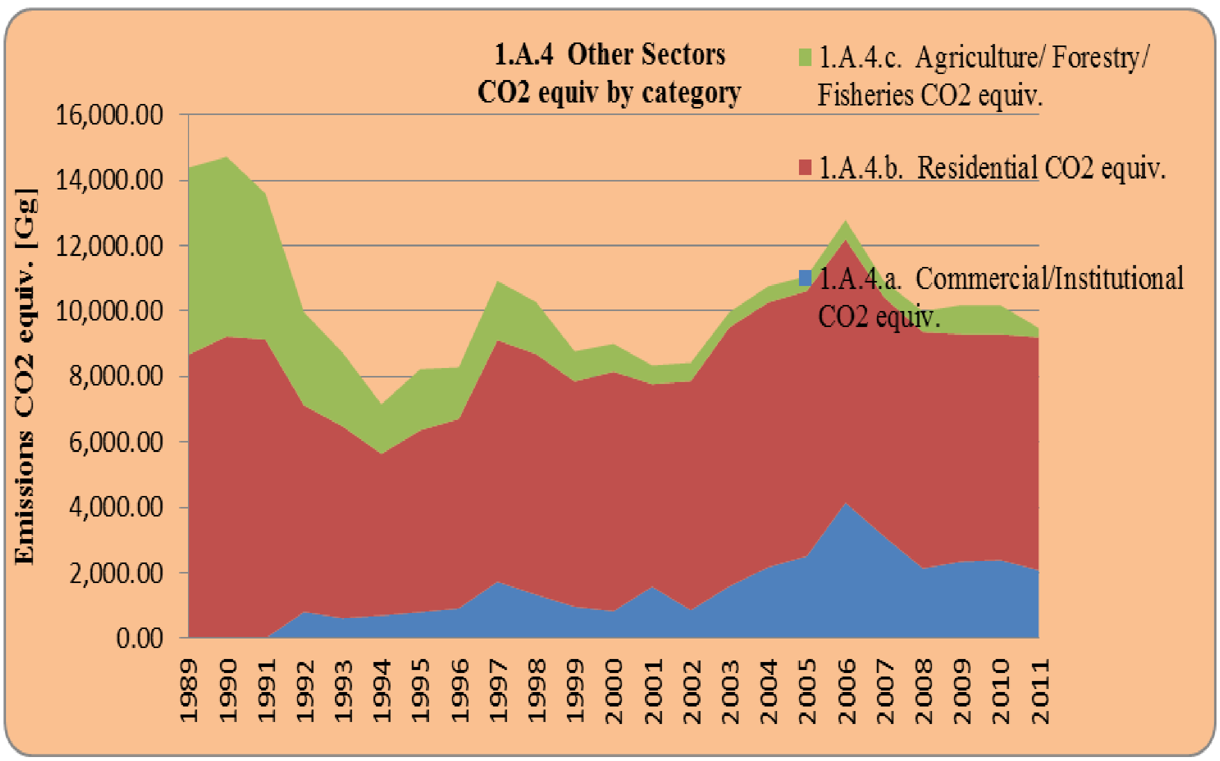
3.2.9.6.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

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

3.2.10 Fuel combustion, Other Sectors (CRF sub-sector 1.A.4.)

3.2.10.1 Source description

Figure 3.38 GHG emissions from 1.A.4. – Other, by category



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

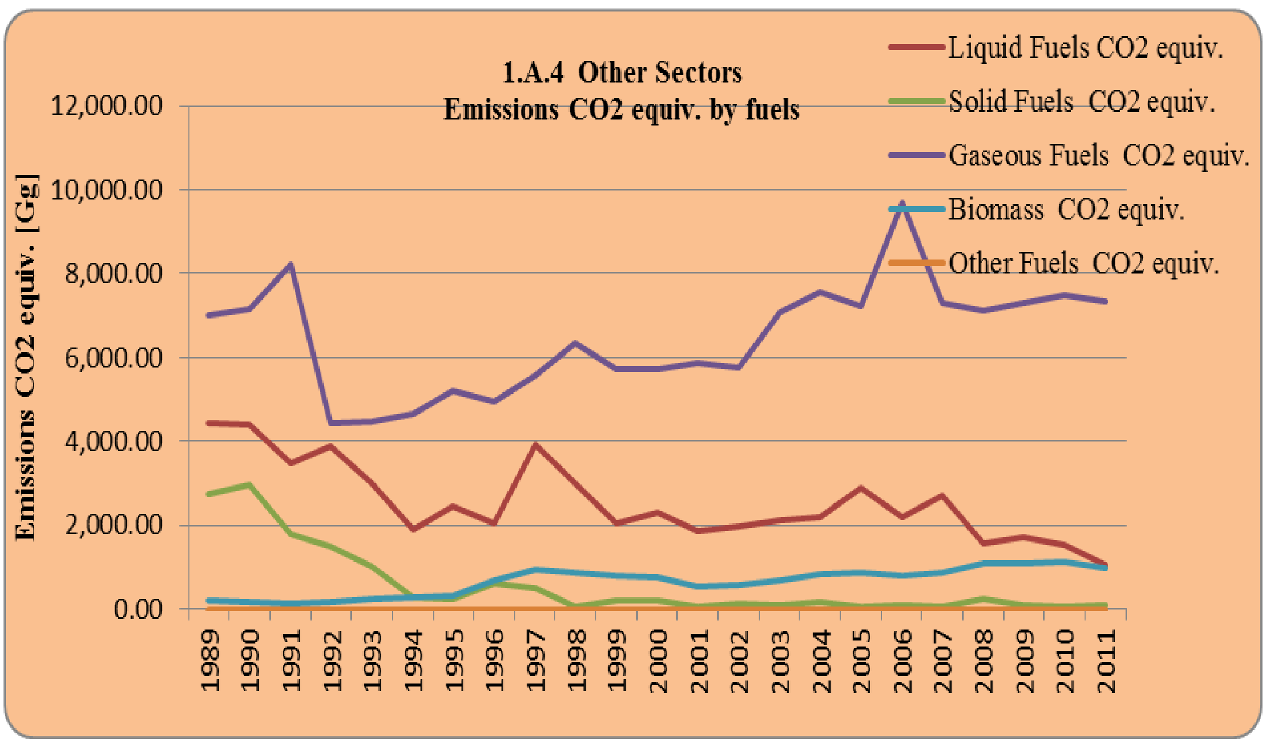
- Commercial/Institutional
- Residential
- Agriculture/ Forestry/ Fisheries

The commercial/institutional category includes fuel consumptions declared by the economic agents in various activities, including: commerce, financial activities, banking and insurance, hotels and restaurants, real-estate transactions, rentals and services, public administration and defense, education, health and social assistance, other collective, social and personal services.

The residential category includes the quantities: the deliveries for open flame consumption for heating and cooking purposes, including energy consumption for residential space by the owners and the administration of the economic agents; the deliveries to population to produce heat and hot water in central heating and quantities of coal received by the miners as direct allowances (payment) from the mining companies; the heat delivered to the population for heating and hot water, both from the public and from auto producer sectors.

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

Figure 3.39 GHG emissions from 1.A.4. – Other, by fuels



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

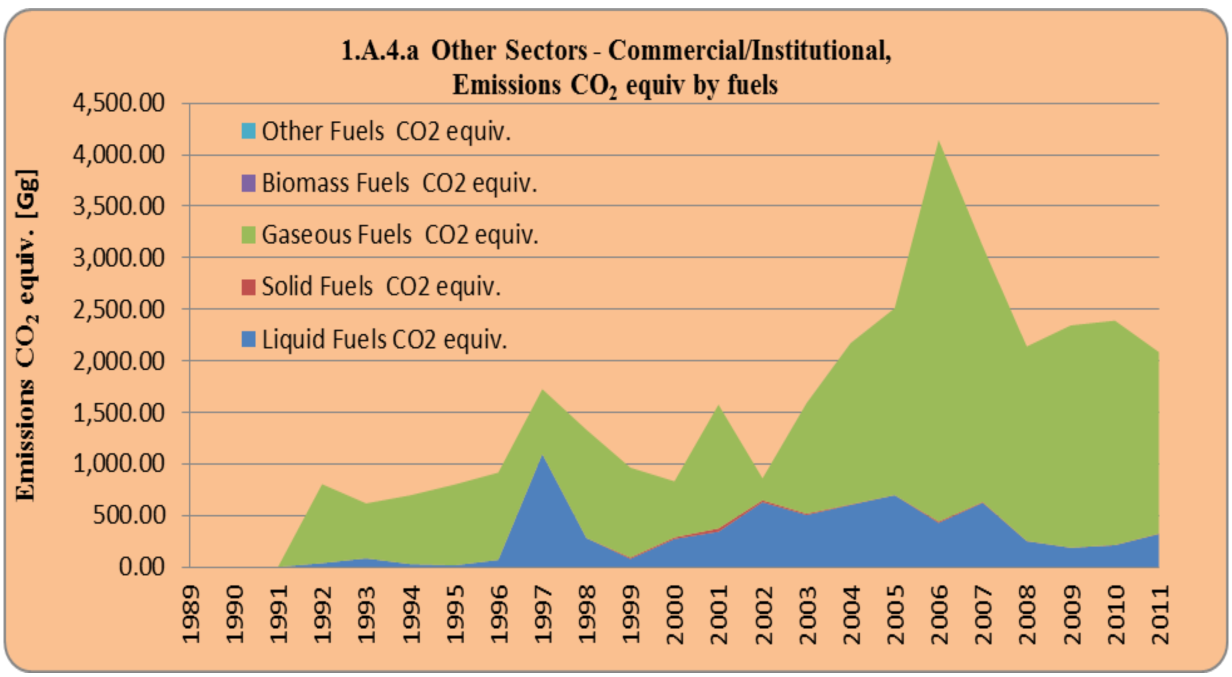
3.2.10.2.1 Source description

CRF category 1.A.4.a - Commercial/Institutional is a key category by gaseous fuel - level, excluding and including LULUCF, as result of T1 approach.

CRF category 1.A.4.a - Commercial/Institutional is not a key category as result of T2 approach.

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

Figure 3.40 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 20.43%, current year, 2011.

The reporting of combustion on this category started with the 1992 year. The contribution of this category is about 2,085.01 Gg CO_2 equiv., in 2011.

It is observed a main contribution of the natural gas usage as fuel in this activity category, mostly on the period 2003 - 2011.

Table 3.106 CO_2 emissions in 1.A.4.a. - Commercial/Institutional

CO_2 [Gg]	1A.4.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	801.59	37.40	NO	764.18	NO	NO
1993	615.02	84.16	NO	530.86	NO	NO
1994	693.76	28.05	NO	665.70	NO	NO
1995	796.98	15.59	NO	781.39	NO	NO
1996	913.14	68.58	NO	844.56	NO	NO
1997	1,720.43	1,092.18	NO	628.25	NO	NO
1998	1,328.01	279.97	NO	1,048.04	NO	NO
1999	961.62	79.12	12.38	870.13	NO	NO
2000	828.83	270.84	15.14	542.85	NO	NO
2001	1,570.28	341.02	31.01	1,198.25	NO	NO
2002	856.70	626.17	18.29	212.23	NO	NO
2003	1,585.46	503.41	11.56	1,069.48	NO	1.0045
2004	2,166.84	600.36	4.63	1,561.10	NO	0.7533
2005	2,504.03	693.89	1.54	1,808.60	NO	NO
2006	4,132.21	426.84	12.13	3,693.24	NO	NO
2007	3,103.83	621.76	6.24	2,475.82	NO	NO
2008	2,134.34	250.41	1.53	1,882.39	NO	NO
2009	2,338.22	186.29	0.73	2,151.20	NO	NO
2010	2,384.41	211.17	2.06	2,171.19	NO	NO
2011	2,079.09	318.95	2.95	1,757.20	NO	NO

CO_2 [Gg]	1A.4.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 1989 - 2011	–	–	–	–	–	–
Decrease 1990 - 2011	–	–	–	–	–	–
Decrease 2010 - 2011	12.80	-51.04	-42.94	19.07	–	–

Table 3.107 CH_4 emissions in 1.A.4.a. - Commercial/Institutional

CH_4 [Gg]	1A.4.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	0.0744	0.0052	NO	0.0691	NO	NO
1993	0.0598	0.0118	NO	0.0480	NO	NO
1994	0.0641	0.0039	NO	0.0602	NO	NO
1995	0.0729	0.0022	NO	0.0707	NO	NO
1996	0.0860	0.0096	NO	0.0764	NO	NO
1997	0.1155	0.0587	NO	0.0568	NO	NO
1998	0.1324	0.0376	NO	0.0948	NO	NO
1999	0.0905	0.0106	0.0012	0.0787	NO	NO
2000	0.0844	0.0338	0.0015	0.0491	NO	NO
2001	0.1568	0.0453	0.0031	0.1084	NO	NO
2002	0.1046	0.0836	0.0018	0.0192	NO	NO
2003	0.1652	0.0636	0.0012	0.0968	NO	0.0036
2004	0.2155	0.0711	0.0005	0.1412	NO	0.0027
2005	0.2458	0.0820	0.0002	0.1636	NO	NO
2006	0.3889	0.0535	0.0012	0.3341	NO	NO

CH_4 [Gg]	1A.4.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2007	0.2964	0.0696	0.0006	0.2262	NO	NO
2008	0.2000	0.0307	0.0002	0.1691	NO	NO
2009	0.2175	0.0230	0.0001	0.1945	NO	NO
2010	0.2217	0.0256	0.0002	0.1959	NO	NO
2011	0.1997	0.0411	0.0003	0.1583	NO	NO
Decrease 1989 - 2011	–	–	–	–	–	–
Decrease 1990 - 2011	–	–	–	–	–	–
Decrease 2010 - 2011	9.92	-60.67	-37.64	19.20	–	–

Table 3.108 N_2O emissions in 1.A.4.a. - Commercial/Institutional

N_2O [Gg]	1A.4.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	0.0017	0.0003	NO	0.0014	NO	NO
1993	0.0017	0.0007	NO	0.0010	NO	NO
1994	0.0014	0.0002	NO	0.0012	NO	NO
1995	0.0015	0.0001	NO	0.0014	NO	NO
1996	0.0021	0.0006	NO	0.0015	NO	NO
1997	0.0101	0.0089	NO	0.0011	NO	NO
1998	0.0041	0.0022	NO	0.0019	NO	NO
1999	0.0024	0.0006	0.0002	0.0016	NO	NO
2000	0.0030	0.0018	0.0002	0.0010	NO	NO
2001	0.0052	0.0026	0.0004	0.0022	NO	NO

N_2O [Gg]	1A.4.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2002	0.0056	0.0049	0.0003	0.0004	NO	NO
2003	0.0057	0.0035	0.0002	0.0019	NO	0.0000
2004	0.0066	0.0036	0.0001	0.0028	NO	0.0000
2005	0.0075	0.0042	0.0000	0.0033	NO	NO
2006	0.0098	0.0029	0.0002	0.0067	NO	NO
2007	0.0079	0.0033	0.0001	0.0045	NO	NO
2008	0.0050	0.0016	0.0000	0.0034	NO	NO
2009	0.0052	0.0013	0.0000	0.0039	NO	NO
2010	0.0053	0.0014	0.0000	0.0039	NO	NO
2011	0.0056	0.0024	0.0000	0.0032	NO	NO
Decrease 1989 - 2011	–	–	–	–	–	–
Decrease 1990 - 2011	–	–	–	–	–	–
Decrease 2010 - 2011	-4.89	-73.86	-37.64	19.20	–	–

3.2.10.2.2 Methodological issues

Since the resources for solid fuels in the Romanian economy are mainly from the internal exploitations, the weighted arithmetic averages for the emission factors calculated based on all the EU-ETS activities reporting, are used in the 1.A.4 – Other Sectors.

For the liquid and gaseous fuels, being a mix between import and exports supply, result the same quality of this kind of fuels in the entire economy. Based on the recommendation of the ISPE Study, have been used the weighted arithmetic averages for the Emission Factors calculated based on the all the EU-ETS activities reporting.

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

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

CO_2 gas

For the 1989 – 2006 period

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

For the 2007 - 2011 period

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

CH_4, N_2O - default EFs are used.

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

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

3.2.10.2.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%
- Solid Fuels – 5.00%
- Gaseous Fuels - 3.041%
- Biomass - 20.224%
- Other (Industrial Wastes) - 21.190%

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09 %
- Solid Fuels - 50.09 %
- Gaseous Fuels - 50.09 %
- Biomass - 50.09%
- Other (Industrial Wastes) - 50.49 %

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

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

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

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

❖ ***Liquid Fuels* - Activity data**

- *White Spirit & SPB:* 2000 year, the non-energy use data was subtracted.

❖ ***Solid Fuels* - Activity data**

- *Lignite*: 2006, 2007 years - correction of the consumption data provided through the Energy Balance.

❖ ***Other Fuels* - CO_2 emission factors**

- *Industrial Wastes:* 2003, 2004 years - country specific CO_2 EF was determinated and used.

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

3.2.10.2.6 Source-specific planned improvements, if applicable

See the Chapter 3.2.6.6 for more details.

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

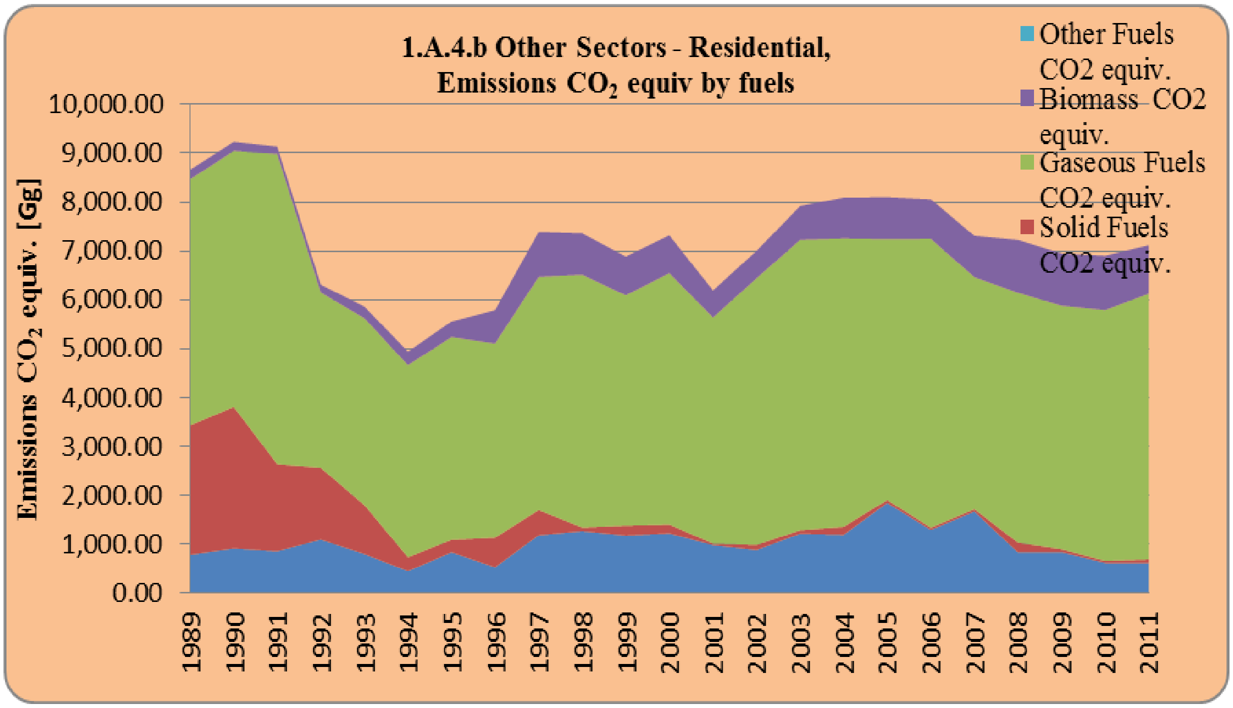
3.2.10.3.1 Source description

CRF category 1.A.4.b - Residential is a key category by liquid and gaseous fuels – level and trend, solid – trend, excluding and including LULUCF, as result of T1 approach.

CRF category 1.A.4.b - Residential is a key category by solid fuels – trend and gaseous fuels – level and trend, excluding LULUCF, and by gaseous fuels – trend, including LULUCF, as result of T2 approach.

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

Figure 3.41 GHG emissions from 1.A.4.b – Residential, by fuels



The share of the total GHG emissions of the 1.A.4.b category to the 1.A.4 sub-sector is about 60% - base year to the 70%, current year, 2011. The contribution of this category is about 7,118.38 Gg CO_2 equiv., in 2011. 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 contribution to the emissions (CH_4 and N_2O accounted).

Table 3.109 CO_2 emissions in 1.A.4.b. – Residential

CO_2 [Gg]	1A.4.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	8,280.80	782.26	2,471.95	5,026.59	2,921.07	NO
1990	8,842.64	912.13	2,705.67	5,224.84	2,698.98	NO
1991	8,851.60	853.82	1,666.25	6,331.53	2,181.42	NO
1992	6,043.05	1,092.53	1,373.57	3,576.95	2,400.27	NO
1993	5,548.83	798.20	937.42	3,813.21	3,507.62	NO

CO_2 [Gg]	1A.4.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1994	4,635.21	447.88	267.98	3,919.35	4,130.22	NO
1995	5,212.33	835.09	234.96	4,142.28	4,707.70	NO
1996	5,056.13	526.96	568.43	3,960.74	10,143.50	NO
1997	6,422.49	1,180.03	481.48	4,760.98	13,645.97	NO
1998	6,492.60	1,262.36	69.30	5,160.93	12,564.61	NO
1999	6,066.85	1,174.96	189.80	4,702.09	11,769.74	NO
2000	6,517.16	1,217.29	170.37	5,129.50	11,505.20	NO
2001	5,626.20	980.98	29.53	4,615.70	8,210.27	NO
2002	6,419.94	880.73	97.46	5,441.75	8,328.54	NO
2003	7,205.15	1,213.47	65.52	5,926.16	10,284.06	NO
2004	7,227.30	1,190.18	151.85	5,885.27	12,475.90	NO
2005	7,219.90	1,840.17	56.35	5,323.38	12,812.24	NO
2006	7,226.63	1,290.21	41.69	5,894.72	12,055.57	NO
2007	6,445.69	1,665.18	43.55	4,736.95	12,572.45	NO
2008	6,116.62	832.67	185.07	5,098.89	16,053.07	NO
2009	5,863.59	839.29	53.21	4,971.09	15,917.89	NO
2010	5,775.36	619.51	37.34	5,118.52	16,535.12	NO
2011	6,104.91	613.72	70.60	5,420.59	14,755.44	NO
Decrease 1989 - 2011	26.28	21.55	97.14	-7.84	-405.14	–
Decrease 1990 - 2011	30.96	32.72	97.39	-3.75	-446.71	–
Decrease 2010 - 2011	-5.71	0.93	-89.09	-5.90	10.76	–

Table 3.110 CH_4 emissions in 1.A.4.b. – Residential

CH_4 [Gg]	1A.4.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	16.0889	0.0750	7.7348	0.4548	7.8243	NO
1990	16.2615	0.0888	8.4706	0.4727	7.2294	NO
1991	11.6774	0.0798	5.1817	0.5728	5.8431	NO
1992	11.1095	0.1150	4.2416	0.3236	6.4293	NO
1993	12.7084	0.0770	2.8910	0.3450	9.3954	NO
1994	12.2957	0.0399	0.8381	0.3546	11.0631	NO
1995	13.8067	0.0818	0.7402	0.3748	12.6099	NO
1996	29.3209	0.0457	1.7468	0.3583	27.1701	NO
1997	38.5826	0.1186	1.4815	0.4307	36.5517	NO
1998	34.4637	0.1299	0.2117	0.4669	33.6552	NO
1999	32.6533	0.1146	0.5872	0.4254	31.5261	NO
2000	31.9336	0.1224	0.5296	0.4641	30.8175	NO
2001	22.5854	0.0870	0.0890	0.4176	21.9918	NO
2002	23.1685	0.0711	0.2964	0.4923	22.3086	NO
2003	28.3890	0.1080	0.1982	0.5362	27.5466	NO
2004	34.5213	0.1119	0.4593	0.5325	33.4176	NO
2005	35.1370	0.1664	0.1705	0.4816	34.3185	NO
2006	33.0783	0.1272	0.1261	0.5333	32.2917	NO
2007	34.4044	0.1598	0.1356	0.4328	33.6762	NO
2008	44.1294	0.0822	0.5897	0.4582	42.9993	NO
2009	43.3302	0.0694	0.1741	0.4494	42.6372	NO
2010	44.9276	0.0500	0.1253	0.4617	44.2905	NO
2011	40.3045	0.0499	0.2430	0.4882	39.5235	NO
Decrease 1989 - 2011	-150.51	33.55	96.86	-7.35	-405.14	_
Decrease	-147.85	43.83	97.13	-3.27	-446.71	_

CH_4 [Gg]	1A.4.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1990 – 2011						
Decrease 2010 - 2011	10.29	0.35	-93.91	-5.72	10.76	–

Table 3.111 N_2O emissions in 1.A.4.b. – Residential

N_2O [Gg]	1A.4.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.15217	0.00265	0.03610	0.00910	0.10432	NO
1990	0.14861	0.00324	0.03953	0.00945	0.09639	NO
1991	0.11621	0.00266	0.02418	0.01146	0.07791	NO
1992	0.11709	0.00510	0.01979	0.00647	0.08572	NO
1993	0.14851	0.00285	0.01349	0.00690	0.12527	NO
1994	0.15969	0.00118	0.00391	0.00709	0.14751	NO
1995	0.18219	0.00311	0.00345	0.00750	0.16813	NO
1996	0.37883	0.00124	0.00815	0.00717	0.36227	NO
1997	0.50763	0.00475	0.00691	0.00861	0.48736	NO
1998	0.46447	0.00541	0.00099	0.00934	0.44874	NO
1999	0.43589	0.00429	0.00274	0.00851	0.42035	NO
2000	0.42754	0.00489	0.00247	0.00928	0.41090	NO
2001	0.30456	0.00257	0.00042	0.00835	0.29322	NO
2002	0.31016	0.00149	0.00138	0.00985	0.29745	NO
2003	0.38218	0.00325	0.00092	0.01072	0.36729	NO
2004	0.46216	0.00380	0.00214	0.01065	0.44557	NO
2005	0.47332	0.00532	0.00080	0.00963	0.45758	NO
2006	0.44677	0.00496	0.00059	0.01067	0.43056	NO
2007	0.46421	0.00590	0.00063	0.00866	0.44902	NO
2008	0.58840	0.00316	0.00275	0.00916	0.57332	NO

N_2O [Gg]	1A.4.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2009	0.57989	0.00160	0.00081	0.00899	0.56850	NO
2010	0.60141	0.00105	0.00058	0.00923	0.59054	NO
2011	0.53895	0.00108	0.00113	0.00976	0.52698	NO
Decrease 1989 - 2011	-254.18	59.45	96.86	-7.35	-405.14	–
Decrease 1990 - 2011	-262.66	66.76	97.13	-3.27	-446.71	–
Decrease 2010 - 2011	10.38	-2.67	-93.91	-5.72	10.76	–

3.2.10.3.2 Methodological issues

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

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

CO_2 gas

For the 1989 – 2006 period

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

For the 2007 - 2011 period

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

CH_4, N_2O - default EFs are used.

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

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

3.2.10.3.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%
- Solid Fuels – 5.00%
- Gaseous Fuels - 3.041%
- Biomass - 20.224%
- Other (Industrial Wastes) - 21.190%

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09 %
- Solid Fuels - 50.09 %
- Gaseous Fuels - 50.09 %
- Biomass - 50.09%
- Other (Industrial Wastes) - 50.49 %

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

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

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

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

- ***Solid Fuels*** **- CO_2 emission factors**
  - *Coking Coal:* 2002 year - correction of the CO_2 EF (country specific EF was changed with a default EF);

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

3.2.10.3.6 Source-specific planned improvements, if applicable

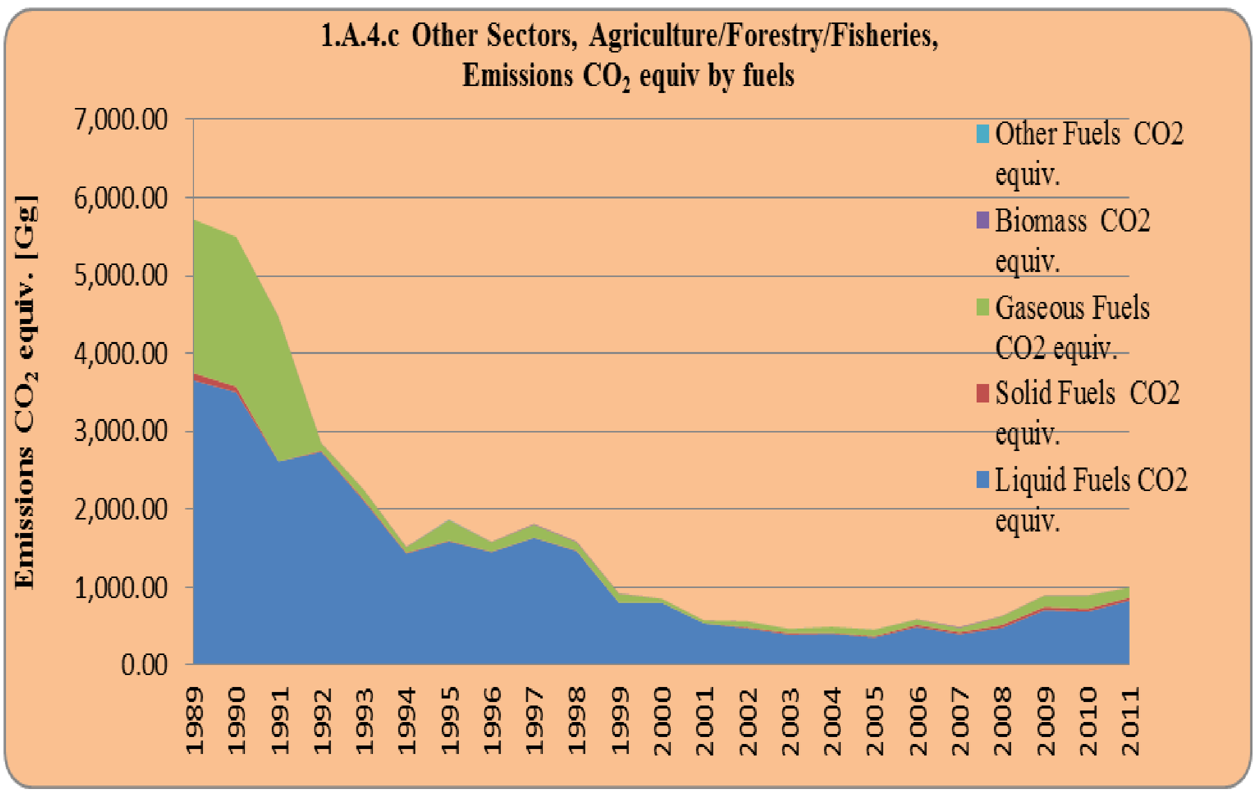
See the Chapter 3.2.6.6 for more details.

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

3.2.10.4.1 Source description

CRF category 1.A.4.c. - Agriculture/ Forestry/ Fisheries is a key category by liquid fuels – level and trend and gaseous fuels – trend, excluding and including LULUCF, as result of T1 approach.
CRF category 1.A.4.c. - Agriculture/ Forestry/ Fisheries is not a key category, as result of T2 approach.
See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.42 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 39.8% - base year to the 9.8 %, current year, 2011. The contribution of this category is about 999.76 Gg CO_2 equiv., in 2011. It is observed a main contribution of the liquid fuel combustion in this activity category, on the entire time-series.

Table 3.112 CO_2 emissions in 1.A.4.c. - Agriculture/Forestry/Fisheries

CO_2 [Gg]	1A.4.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	5,688.17	3,634.20	89.94	1,964.03	NO	NO
1990	5,469.79	3,483.32	67.40	1,919.07	NO	NO
1991	4,450.34	2,599.86	NO	1,850.48	47.04	NO
1992	2,833.47	2,724.98	13.54	94.95	58.35	NO
1993	2,238.70	2,098.59	17.66	122.46	55.10	NO
1994	1,505.68	1,425.84	10.16	69.68	79.41	NO
1995	1,856.01	1,581.88	8.01	262.02	44.35	4.102
1996	1,571.07	1,443.86	5.79	121.41	52.42	NO
1997	1,793.70	1,626.13	2.24	165.33	144.59	NO
1998	1,571.49	1,457.21	7.04	107.24	140.34	NO
1999	912.37	794.29	0.79	117.28	67.65	NO
2000	848.45	798.16	0.92	49.29	15.34	0.084
2001	571.08	535.14	0.71	35.07	19.15	0.167
2002	560.72	472.99	11.99	75.75	19.04	NO
2003	462.54	390.92	19.06	52.47	8.06	0.084
2004	491.28	403.57	8.00	79.63	7.28	0.084
2005	453.16	353.64	15.53	83.91	12.77	0.084
2006	584.08	487.81	27.34	68.69	28.45	0.251
2007	474.95	395.24	22.13	57.58	175.17	NO
2008	624.09	476.33	36.89	110.88	62.83	NO
2009	887.16	703.84	38.73	144.60	46.82	NO

CO_2 [Gg]	1A.4.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2010	887.97	682.38	35.04	170.55	31.92	NO
2011	991.38	825.52	35.04	130.81	22.29	NO
Decrease 1989 - 2011	82.57	77.28	61.04	93.34	–	–
Decrease 1990 – 2011	81.88	76.30	48.01	93.18	–	–
Decrease 2010 - 2011	-11.65	-20.98	0.00	23.30	30.18	–

Table 3.113 CH_4 emissions in 1.A.4.c. - Agriculture/Forestry/Fisheries

CH_4 [Gg]	1A.4.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.944	0.493	0.274	0.178	NO	NO
1990	0.852	0.472	0.206	0.174	NO	NO
1991	0.646	0.353	NO	0.167	0.126	NO
1992	0.576	0.370	0.042	0.009	0.156	NO
1993	0.497	0.285	0.053	0.011	0.148	NO
1994	0.444	0.193	0.031	0.006	0.213	NO
1995	0.396	0.215	0.025	0.024	0.119	0.015
1996	0.364	0.196	0.017	0.011	0.140	NO
1997	0.630	0.221	0.007	0.015	0.387	NO
1998	0.603	0.197	0.020	0.010	0.376	NO
1999	0.302	0.108	0.002	0.011	0.181	NO
2000	0.157	0.108	0.003	0.004	0.041	0.000
2001	0.130	0.072	0.002	0.003	0.051	0.001
2002	0.156	0.064	0.034	0.007	0.051	NO
2003	0.134	0.053	0.055	0.005	0.022	0.000

CH_4 [Gg]	1A.4.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2004	0.105	0.055	0.023	0.007	0.020	0.000
2005	0.134	0.048	0.045	0.008	0.034	0.000
2006	0.227	0.066	0.078	0.006	0.076	0.001
2007	0.591	0.053	0.063	0.005	0.469	NO
2008	0.343	0.059	0.105	0.010	0.168	NO
2009	0.339	0.090	0.111	0.013	0.125	NO
2010	0.290	0.089	0.100	0.015	0.086	NO
2011	0.282	0.110	0.100	0.012	0.060	NO
Decrease 1989 - 2011	70.15	77.63	63.41	93.37	–	–
Decrease 1990 - 2011	66.89	76.66	51.25	93.21	–	–
Decrease 2010 - 2011	2.89	-23.55	0.00	23.43	30.18	–

Table 3.114 N_2O emissions in 1.A.4.c. - Agriculture/Forestry/Fisheries

N_2O [Gg]	1A.4.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.03440	0.02957	0.00128	0.00355	NO	NO
1990	0.03277	0.02834	0.00096	0.00347	NO	NO
1991	0.02618	0.02115	NO	0.00335	0.00168	NO
1992	0.02463	0.02218	0.00019	0.00017	0.00208	NO
1993	0.01952	0.01708	0.00025	0.00022	0.00197	NO
1994	0.01471	0.01160	0.00015	0.00013	0.00284	NO
1995	0.01524	0.01287	0.00011	0.00047	0.00158	0.00020
1996	0.01393	0.01176	0.00008	0.00022	0.00187	NO
1997	0.01873	0.01323	0.00003	0.00030	0.00516	NO

N_2O [Gg]	1A.4.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1998	0.01711	0.01181	0.00010	0.00019	0.00501	NO
1999	0.00911	0.00647	0.00001	0.00021	0.00242	NO
2000	0.00714	0.00648	0.00001	0.00009	0.00055	0.00000
2001	0.00510	0.00434	0.00001	0.00006	0.00068	0.00001
2002	0.00483	0.00385	0.00016	0.00014	0.00068	NO
2003	0.00382	0.00318	0.00026	0.00009	0.00029	0.00000
2004	0.00378	0.00327	0.00011	0.00014	0.00026	0.00000
2005	0.00368	0.00286	0.00021	0.00015	0.00046	0.00000
2006	0.00542	0.00390	0.00037	0.00012	0.00102	0.00001
2007	0.00979	0.00313	0.00030	0.00011	0.00626	NO
2008	0.00618	0.00324	0.00049	0.00020	0.00224	NO
2009	0.00752	0.00507	0.00052	0.00026	0.00167	NO
2010	0.00705	0.00513	0.00047	0.00031	0.00114	NO
2011	0.00795	0.00645	0.00047	0.00024	0.00080	NO
Decrease 1989 - 2011	76.89	78.18	63.41	93.37	–	–
Decrease 1990 - 2011	75.74	77.23	51.25	93.21	–	–
Decrease 2010 – 2011	-12.81	-25.70	0.00	23.43	30.18	–

3.2.10.4.2 Methodological issues

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

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

CO_2 gas

For the 1989 – 2006 period

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

For the 2007 - 2011 period

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

CH_4, N_2O - default EFs are used.

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

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

3.2.10.4.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%
- Solid Fuels – 5.00%
- Gaseous Fuels - 3.041%
- Biomass - 20.224%
- Other (Industrial Wastes) - 21.190%

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09 %
- Solid Fuels - 50.09 %
- Gaseous Fuels - 50.09 %
- Biomass - 50.09%
- Other (Industrial Wastes) - 50.49 %

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

See the chapter 3.2.6.3 for more details.

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

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

See the chapter 3.2.6.4 for more details.

3.2.10.4.5 Source specific recalculation, if applicable, including changes made in response to the review process

- ***Liquid Fuels* - Activity data**
  - *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- ***Solid Fuels* - Activity data**
  - *Peat:* 2002–2005 period – correction of the consumption data provided through the Energy Balance.
- ***Solid Fuels* - CO_2 emission factors**
  - *Coke Oven Coke:* 1993–1995 period **-** correction of the CO2 EF (default EF was changed with a country specific EF)
- ***Other Fuels* - CO_2 emission factors**
  - *Industrial Wastes:* 1995 year, 2000-2006 period - country specific CO_2 EF was determinate and used.

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

3.2.10.4.6 Source specific planned imporvments, if applicable 1.A.4.c. Agriculture/ Forestry/ Fisheries

See the chapter 3.2.6.6 for more details.

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

3.2.11.1 Source description

CRF sector 1.A.5.a - Stationary is a key category by liquid fules - level, including and excluding LULUCF, as result of T1 approach.

CRF sector 1.A.5.a - Stationary is not a key category, as result of T2 approach.

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

This activity category analyzes the fuels burned in the stationary installations not specified to the above sub-sectors. Mainly are combusted liquid fuels and secondly some solid fuels.

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.

Table 3.115 CO_2 emissions in 1.A.5.a. - Other (Not specified elsewhere) – Stationary

CO_2 [Gg]	1A.5.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	2,174.84	1,359.79	815.06	NO	NO	NO
1990	2,502.28	1,311.70	1,190.58	NO	NO	NO
1991	2,268.54	1,295.71	972.82	NO	785.4560	NO
1992	671.29	105.83	565.46	NO	103.4880	NO
1993	307.83	262.42	45.42	NO	196.7840	NO
1994	429.37	381.08	48.29	NO	193.3120	NO
1995	552.25	429.37	29.97	NO	181.2160	92.9130
1996	276.01	253.49	22.52	NO	354.4800	NO
1997	7.03	NO	7.03	NO	247.2960	NO
1998	699.20	688.93	10.27	NO	138.5440	NO
1999	109.64	109.64	NO	NO	247.5200	NO
2000	238.42	172.30	NO	NO	78.6240	66.1272
2001	383.00	325.91	NO	NO	614.4320	57.0871
2002	268.90	247.48	1.66	NO	713.1040	19.7545
2003	378.40	360.49	NO	NO	690.7040	17.9129
2004	681.69	596.02	68.85	NO	569.4080	16.8248
2005	1,236.68	1,193.07	39.34	NO	871.2480	4.2690
2006	570.08	564.13	NO	NO	809.8720	5.9431
2007	939.43	939.43	NO	NO	675.4496	NO

CO_2 [Gg]	1A.5.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2008	817.34	817.34	NO	NO	623.5390	NO
2009	271.19	271.19	NO	NO	553.5390	NO
2010	270.90	270.90	NO	NO	580.5282	NO
2011	542.18	542.18	NO	NO	311.3992	NO
Decrease 1989 - 2011	75.07	60.13	–	–	–	–
Decrease 1990 - 2011	78.33	58.67	–	–	–	–
Decrease 2010 - 2011	-100.14	-100.14	–	–	46.36	–

Table 3.116 CH_4 emissions in 1.A.5.a. - Other (Not specified elsewhere) – Stationary

CH_4 [Gg]	1A.5.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.1207	0.0369	0.0838	NO	NO	NO
1990	0.1587	0.0357	0.1230	NO	NO	NO
1991	2.2403	0.0354	0.1009	NO	2.1039	NO
1992	0.3412	0.0053	0.0587	NO	0.2772	NO
1993	0.5389	0.0073	0.0046	NO	0.5271	NO
1994	0.5330	0.0103	0.0049	NO	0.5178	NO
1995	0.8332	0.0117	0.0030	NO	0.4854	0.3330
1996	0.9588	0.0070	0.0023	NO	0.9495	NO
1997	0.6631	NO	0.0007	NO	0.6624	NO
1998	0.3908	0.0187	0.0011	NO	0.3711	NO
1999	0.6660	0.0030	NO	NO	0.6630	NO
2000	0.4523	0.0047	NO	NO	0.2106	0.2370
2001	1.8592	0.0088	NO	NO	1.6458	0.2046
2002	1.9878	0.0067	0.0002	NO	1.9101	0.0708

CH_4 [Gg]	1A.5.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2003	1.9241	0.0098	NO	NO	1.8501	0.0642
2004	1.6088	0.0162	0.0071	NO	1.5252	0.0603
2005	2.3852	0.0321	0.0041	NO	2.3337	0.0153
2006	2.2060	0.0154	NO	NO	2.1693	0.0213
2007	1.9123	0.0254	NO	NO	1.8869	NO
2008	1.7653	0.0223	NO	NO	1.7430	NO
2009	1.5628	0.0073	NO	NO	1.5555	NO
2010	1.6449	0.0074	NO	NO	1.6375	NO
2011	2.2663	0.0149	NO	NO	2.2514	NO
Decrease 1989 - 2011	-1,777.32	59.67	–	–	–	–
Decrease 1990 - 2011	-1,328.05	58.39	–	–	–	–
Decrease 2010 - 2011	-37.78	-101.15	–	–	-37.49	–

Table 3.117 N_2O emissions in 1.A.5.a. - Other (Not specified elsewhere) – Stationary

N_2O [Gg]	1A.5.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	0.0228	0.0111	0.0117	NO	NO	NO
1990	0.0279	0.0107	0.0172	NO	NO	NO
1991	0.0528	0.0106	0.0141	NO	0.0281	NO
1992	0.0125	0.0006	0.0082	NO	0.0037	NO
1993	0.0098	0.0021	0.0006	NO	0.0070	NO
1994	0.0107	0.0031	0.0007	NO	0.0069	NO
1995	0.0148	0.0035	0.0004	NO	0.0065	0.0044
1996	0.0150	0.0020	0.0003	NO	0.0127	NO
1997	0.0089	NO	0.0001	NO	0.0088	NO

N_2O [Gg]	1A.5.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1998	0.0107	0.0056	0.0001	NO	0.0049	NO
1999	0.0097	0.0009	NO	NO	0.0088	NO
2000	0.0074	0.0014	NO	NO	0.0028	0.0032
2001	0.0273	0.0027	NO	NO	0.0219	0.0027
2002	0.0284	0.0020	0.0000	NO	0.0255	0.0009
2003	0.0285	0.0029	NO	NO	0.0247	0.0009
2004	0.0270	0.0049	0.0010	NO	0.0203	0.0008
2005	0.0415	0.0096	0.0006	NO	0.0311	0.0002
2006	0.0338	0.0046	NO	NO	0.0289	0.0003
2007	0.0333	0.0076	NO	NO	0.0257	NO
2008	0.0304	0.0067	NO	NO	0.0237	NO
2009	0.0234	0.0022	NO	NO	0.0212	NO
2010	0.0246	0.0022	NO	NO	0.0224	NO
2011	0.0442	0.0045	NO	NO	0.0398	NO
Decrease 1989 - 2011	-93.91	59.67	–	–	–	–
Decrease 1990 - 2011	-58.65	58.12	–	–	–	–
Decrease 2010 - 2011	-79.60	-101.15	–	–	-77.46	–

3.2.11.2 Methodological issues

Since the resources for solid fuels in the Romanian economy are mainly from the internal exploitations, the weighted arithmetic averages for the emission factors calculated based on all the EU-ETS activities reporting, are used in the 1.A.4 – Other Sectors.

For the liquid and gaseous fuels, being a mix between import and exports supply, result the same quality of this kind of fuels in the entire economy.

Based on the recommendation of the ISPE Study, have been used the weighted arithmetic averages for the Emission Factors calculated based on the all the EU-ETS activities reporting.
Tier 1 Methodology and Default emission factors for the fuels without analyze on EU-ETS reporting are used.
For the fuels reported in this activity category having determined Country Specific Emission Factors on EU-ETS reporting, Tier 2 methodology is used.

CO_2 gas

For the 1989 – 2006 period

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

For the 2007 - 2011 period

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

CH_4, N_2O - default EFs are used.

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

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

3.2.11.3 Uncertainties and time-series consistency

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

CO_2 gas

- Liquid Fuels - 3.105%;
- Solid Fuels – 5.00%;
- Gaseous Fuels - 3.041%;
- Biomass - 20.224%;
- Other (Industrial Wastes) - 21.190%.

CH_4 gas, N_2O gas

- Liquid Fuels - 50.09%;
- Solid Fuels - 50.09%;
- Gaseous Fuels - 50.09%;
- Biomass - 50.09%;
- Other (Industrial Wastes) - 50.49%.

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

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

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

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

❖ ***Liquid Fuels* - Activity data**

- *White Spirit & SPB:* 2000, 2011 years, the non-energy use data was subtracted
- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.

❖ ***Solid Fuels* - Activity data**

- *Lignite:* 2002, 2006, 2007 years – correction of the consumption data provided through the Energy Balance.

❖ ***Other Fuels* - CO_2 emission factors**

- *Industrial Wastes:* 1995 year, 2000-2006 period - country specific CO_2 emission factor was determinate and used.

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

3.2.11.6 Source-specific planned improvements, if applicable

See the Chapter 3.2.6.6 for more details.

3.3 Fugitive emissions from Solid Fuels and Oil and Natural Gas (CRF 1.B)

3.3.1 Overview of the subsector

This chapter provides information on the estimation of the greenhouse gas emissions associated with the Fugitive Emissions from Fuels Subsector.

The following direct GHG emissions and source categories are quantified and reported:

- CH_4 emissions from Solid Fuels;
- CH_4, CO_2 and N_2O emissions from Oil and Natural Gas.

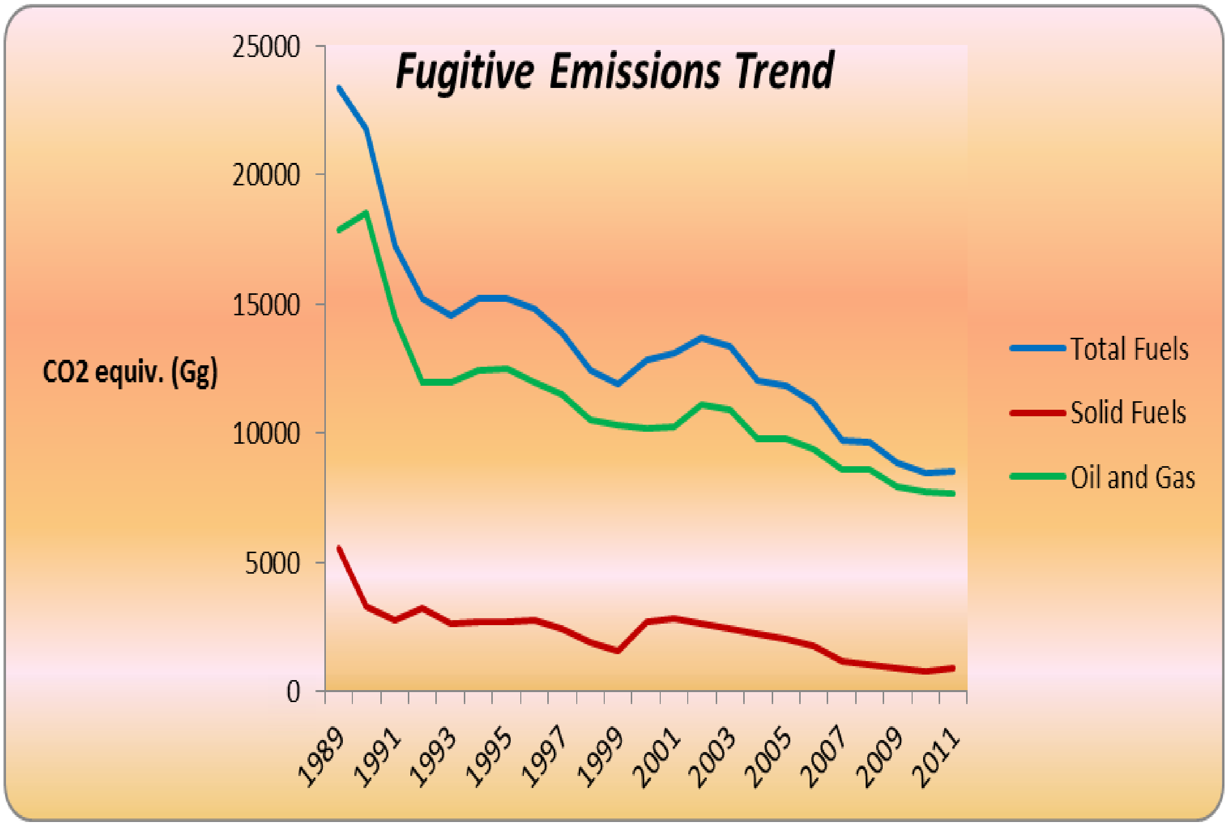
In 2011 GHG emissions from the Fugitive Emissions from Fuels. Subsector accounted for 8552.97 Gg CO_2 equivalent, which represent 6.93% of the total national GHG emissions in this year. In the base year, the total GHG emissions from the Fugitive Emissions from Fuels Subsector amounted to 23,233.65Gg CO_2 equivalent, which represent 8.50% of the total national GHG emissions in this year (Table 3.118).

Table 3.118 The contribution of Fugitive Emissions from Fuels Subsector emissions to the total GHG in Romania, for 1989–2011 period

Year	Total GHG emissions (excl. LULUCF) [Gg CO_2 equiv.]	GHG emissions from Fugitive Emissions [Gg CO_2 equiv.]	Contribution of Fugitive Emissions in total GHG emissions [%]
1989	273,232.94	23,233.65	8.50
1990	244,403.58	21,651.63	8.86
1991	199,511.85	17,128.97	8.59
1992	174,050.45	15,076.62	8.66
1993	169,364.31	14,448.71	8.53
1994	166,094.28	15,053.20	9.06
1995	172,790.63	15,068.82	8.72
1996	175,402.43	14,669.64	8.36

Year	Total GHG emissions (excl. LULUCF) [Gg CO_2 equiv.]	GHG emissions from Fugitive Emissions [Gg CO_2 equiv.]	Contribution of Fugitive Emissions in total GHG emissions [%]
1997	161,968.44	13,792.74	8.52
1998	145,489.16	12,297.29	8.45
1999	130,778.15	11,791.60	9.02
2000	133,525.98	12,745.10	9.55
2001	136,259.37	13,002.96	9.54
2002	138,217.02	13,621.65	9.86
2003	145,084.67	13,308.76	9.17
2004	142,300.84	11,941.30	8.39
2005	141,560.49	11,788.08	8.33
2006	145,880.11	11,144.00	7.64
2007	142,703.65	9,680.62	6.78
2008	140,464.22	9,597.17	6.83
2009	120,294.40	8,790.05	7.31
2010	116,621.20	8,447.77	7.24
2011	123,345.54	8,552.97	6.93

Figure 3.43 Total GHG emissions from Fugitive Emissions from Fuels Subsector for 1989–2011 period



Mostly GHG emissions are resulting from Oil and Natural Gas category, responsible for 89.72% of total GHG emissions from Fugitive Emissions subsector, Solid Fuels category contributes with 10.28%.

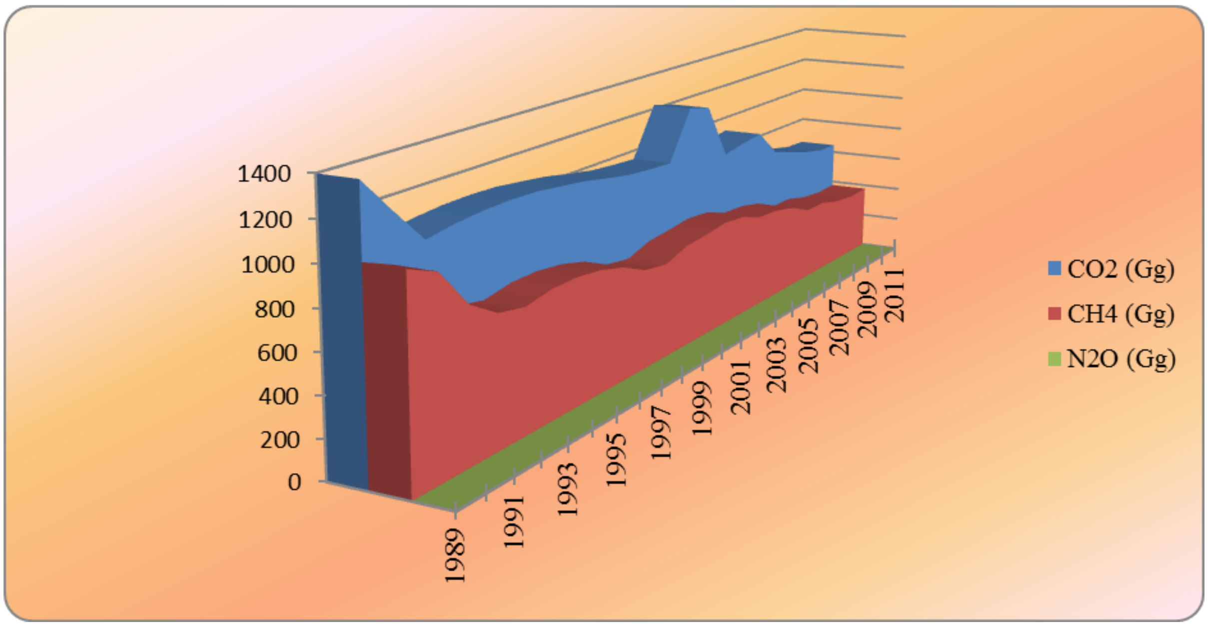
GHG emissions from Oil and Natural Gas and Solid Fuels categories are key category sources: by level for CH_4 emissions from *Venting* subcategory and CO_2 emissions from *Oil* subcategory and level and trend for CH_4 emissions from *Coal Mining and Handling* subcategory and *Oil and Natural Gas* category (see Table 3.4).

Table 3.119 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 – 2011 period

Year	Total emissions from Fugitive Emissions from Fuels Subsector [Gg CO_2 equiv.]	CH_4 emissions		CO_2 emissions		N_2O emissions	
		Gg CO_2 equiv.	%	Gg CO_2	%	Gg CO_2 equiv.	%
1989	23,233.65	21,829.55	93.99	1,399.94	6.03	4.23	0.018
1990	21,651.63	20,434.92	94.41	1,213.18	5.60	3.60	0.017
1991	17,128.97	16,090.94	93.99	1,035.01	6.04	3.09	0.018
1992	15,076.62	14,015.57	93.02	1,057.95	7.02	3.17	0.021
1993	14,448.71	13,374.70	92.63	1,070.86	7.41	3.21	0.022
1994	15,053.20	13,976.01	92.90	1,074.03	7.13	3.22	0.021
1995	15,068.82	13,997.17	92.95	1,068.50	7.09	3.21	0.021
1996	14,669.64	13,616.27	92.88	1,050.28	7.16	3.16	0.022
1997	13,792.74	12,758.69	92.56	1,030.99	7.47	3.10	0.022
1998	12,297.29	11,292.82	91.90	1,001.52	8.14	3.01	0.025
1999	11,791.60	10,813.16	91.77	975.55	8.27	2.94	0.025
2000	12,745.10	11,780.18	92.49	962.06	7.55	2.90	0.023
2001	13,002.96	12,047.37	92.70	952.77	7.33	2.87	0.022
2002	13,621.65	12,396.12	91.06	1,221.88	8.97	3.70	0.027
2003	13,308.76	12,116.16	91.09	1,189.03	8.93	3.60	0.027
2004	11,941.30	11,061.40	92.67	877.29	7.35	2.64	0.022
2005	11,788.08	10,884.30	92.37	901.09	7.64	2.72	0.023
2006	11,144.00	10,222.40	91.76	918.85	8.25	2.78	0.025
2007	9,680.62	8,911.42	92.09	766.91	7.92	2.31	0.024
2008	9,597.17	8,871.19	92.46	723.81	7.54	2.18	0.023
2009	8,790.05	8,105.65	92.24	682.36	7.76	2.06	0.023
2010	8,447.77	7,793.97	92.28	651.85	7.72	1.97	0.023

Year	Total emissions from Fugitive Emissions from Fuels Subsector [Gg CO_2 equiv.]	CH_4 emissions		CO_2 emissions		N_2O emissions	
		Gg CO_2 equiv.	%	Gg CO_2	%	Gg CO_2 equiv.	%
2011	8,552.97	7,904.78	92.42	646.24	7.56	1.95	0.023

Figure 3.44 GHG emissions from Fugitive Emissions from Fuels Subsector, per gas



The inventory preparation, including identification of key categories, preparation of uncertainty estimates and implementation of QA/ QC procedures, have been performed according to IPCC GPG 2000.

3.3.2 Source category Solid Fuels (CRF sector 1.B.1)

3.3.2.1 Source category description

The source category "Solid Fuels" consists of three subcategories:

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

3.3.2.1.1 Coal mining and handling subcategory

The source category "Coal Mining and Handling" is a key source of CH_4 emissions in terms of both emissions level and trend.

This subcategory 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 1990-2011 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 1989-2011 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 3.45 Lignite – Brown Coal Production trend

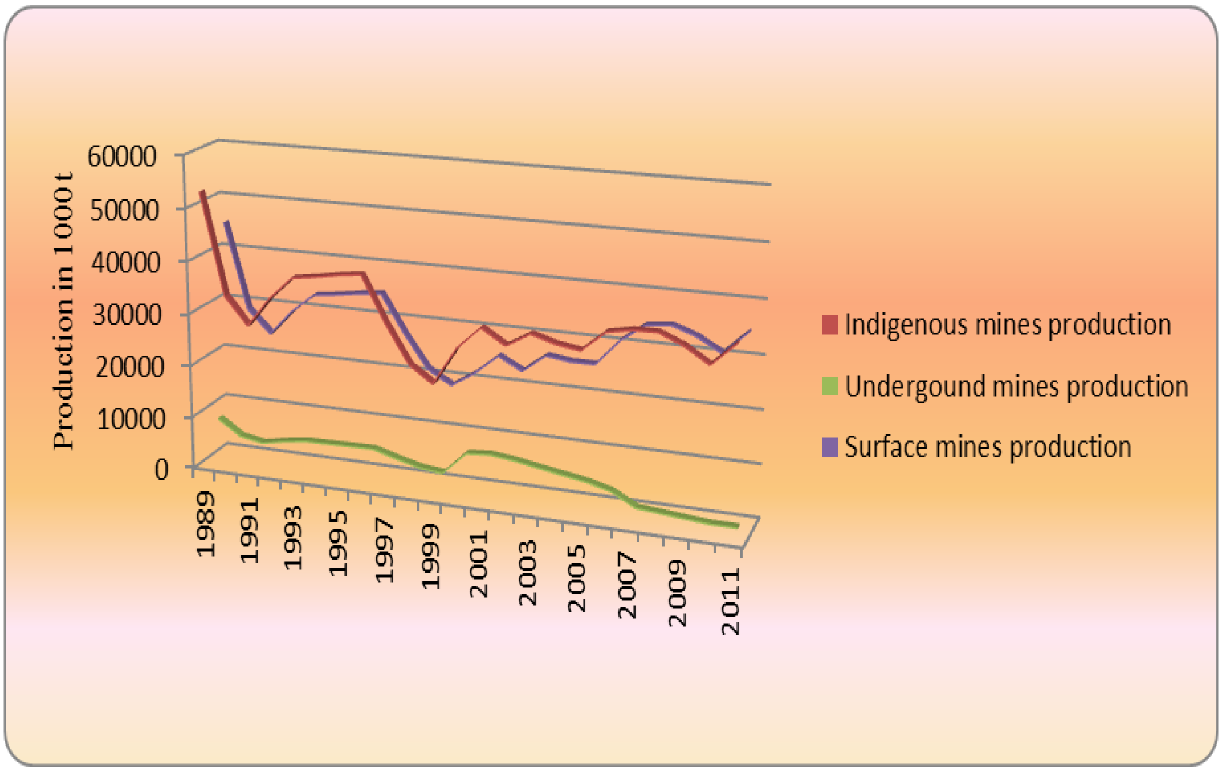
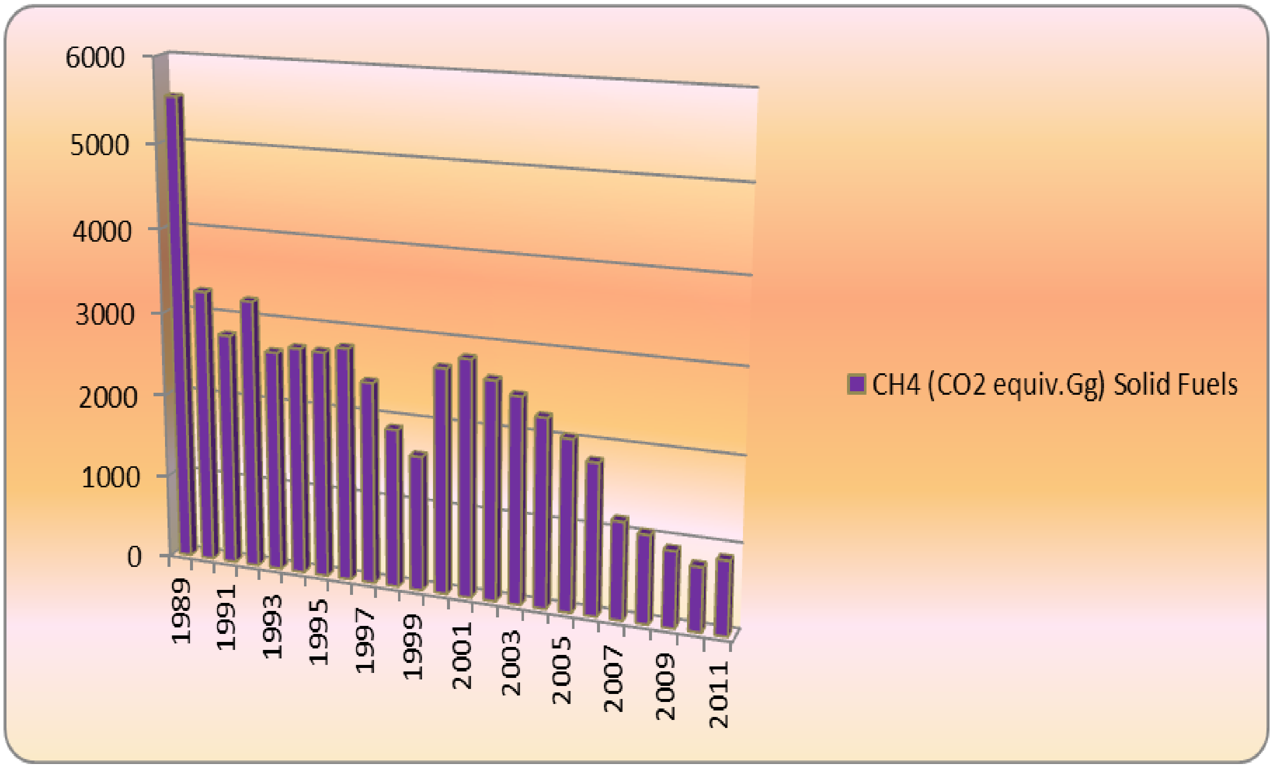


Figure 3.46 Fugitive Emissions of CH_4 from Solid Fuels (1.B.1)



The emissions of methane are the most important in respect to the solid fuels fugitive emissions. The emissions trend reflects the changes in this period characterized by a process of transition to a market economy; the trend can be split in three parts: the period 1989–1999, the period 2000–2007 years and the period 2008–2011.

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 2007-2008 period the emissions started to decrease again after the begining of global financial crisis which conducted to economic contraction.

In 2011 there was an increase in coal resources (excluding coke) compared to 2010, along with the decrease of oil, hydro energy and natural gas resources.

Table 3.125 shows the activity data and CH_4 emissions from Solid Fuels category.

3.3.2.2 Methodological issues

3.3.2.2.1 Coal mining and handling category

- Emission: CH_4;
- Key source: Yes.

Underground mines subcategory:

- *Mining activities ((1.B.1.a.i.1);*
- *Post mining activities (1.B.1.a.i.2.)*

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

The formula used in the calculations is the following:

Equation 3.15 Emissions of CH_4 in Underground mines sub-source category

$$\textbf{CH}_4\textbf{ emissions } (Gg) = [EF\ (m^3\ CH_4/\text{tonne of coal mined}) \times \text{Conversion Factor}\ (Gg/10^6\ m^3) \times \text{Underground Coal Production}\ (Mt)] \times 1000$$

where:

- *Default Emission Factor*: from 2006 IPCC GL, volume 2, chapter 4.1.3.2, page 4.12 (the same as 1996 IPCC GL);
- *The default value of 18 m^3/t* (average CH_4 Emission Factor) according to 2006 IPCC GL for “Mining Underground Coal Production” has been used.

- *The default value of 2.5 m^3/t* (average CH_4 Emission Factor) according to 2006 IPCC GL for "Post Mining Underground Coal Production" has been used;
- *Conversion Factor*: this is the density of CH_4 and converts volume of CH_4 to mass of CH_4. The density is taken at 20°C and 1 atmosphere pressure and has a value of 0.67 $Gg/10^6\ m^3$ (0.00000067 Gg/m^3);
- *Underground Coal Production (Mt):* IEA/Eurostat Questionnaire 2011 - Indigenous Production (Anthracite – 100 %, Coking Coal – 100 %, Other Bituminous Coal - 100 %, Sub-bituminous Coal - 100 %, Lignite/Brown Coal - 15 %).
- *Activity Data* 1989_BAL_Romania have been used for 1989, and IEA/ Eurostat Questionnaire 2011 - for entire 1990-2011 time series have been used.

Surface mines sub-source category:

- *Mining activities (1.B.1.a.ii.1)*
- *Post mining activities (1.B.1.a.ii.2.)*

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

The formula used in the calculations is the following:

Equation 3.16 Emissions of CH_4 in Surface mines sub-source category

$$\mathbf{CH_4\ emissions}\ (Gg) = [EF\ (m^3\ CH_4/\text{tonne of coal mined}) \times \text{Conversion Factor}\ (Gg/10^6\ m^3) \times \text{Surface Coal Production}\ (Mt)] \times 1000$$

where:

- *Default Emission Factor*: from 2006 IPCC GL, volume 2, chapter 4.1.3.2, page 4.18 (the same as 1996 IPCC GL);
- *The default value of 1.2 m^3/t* (average CH_4 Emission Factor) according to 2006 IPCC GL for "Surface Coal Production" has been used.
- *The default value of 0.1 m^3/t* (average CH_4 Emission Factor) according to 2006 IPCC GL for "Post mining Surface Coal Production" has been used.

- *Conversion Factor*: this is the density of CH_4 and converts volume of CH_4 to mass of CH_4. The density is taken at 20°C and 1 atmosphere pressure and has a value of 0.67 $Gg/10^6\ m^3$ ($0.00000067\ Gg/m^3$);
- *Surface Coal Production (Mt):* IEA/Eurostat Questionnaire 2011 - Indigenous Production (Lignite/Brown Coal - 85 %).
- *Activity Data* 1989_BAL_Romania have been used for 1989 , and IEA/Eurostat Questionnaire 2011 - for entire 1990-2011 time series have been used.

According to the information supplied by the Ministry of Economy, Trade and Business Environment (MECMA), the National Coal Company and National Institute for Research and Development in Mine Safety (INSEMEX), there are provided values regarding the recovery of the methane in the mining activities. The recovered methane is reported in the Petrosani Mining Basin, the mines named Lupeni and Vulcan (Figure 3.47 and Table 3.120).

Figure 3.47 Underground Mines subcategory and Solid Fuel Transformation category emissions trend

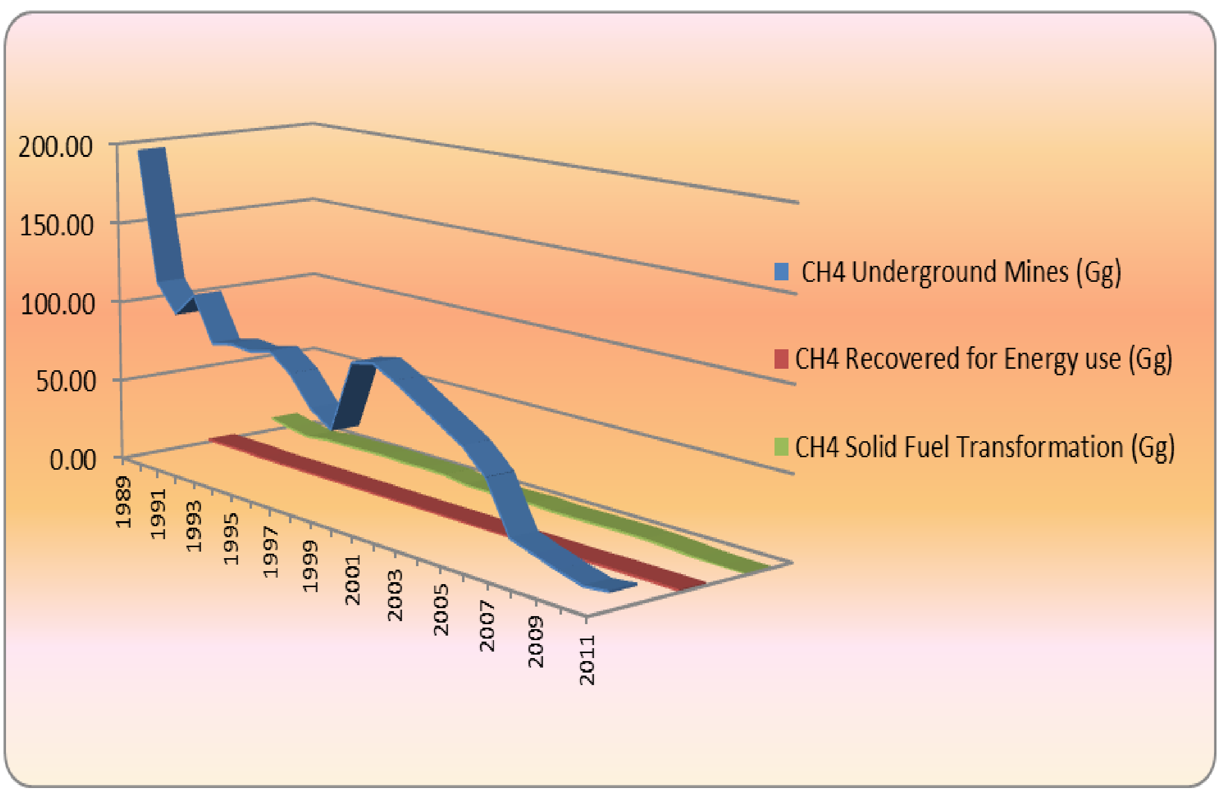


Table 3.120 Fugitive Emissions of CH_4 from Underground Mines and CH_4 Recovered for energy use

Year	**Underground mines**	
	CH_4 fugitive emissions (Gg)	**CH_4 Recovered for energy use (Gg)**
1989	221.92	1.36
1990	129.32	1.25
1991	110.31	1.25
1992	126.31	0.58
1993	95.61	0.58
1994	98.89	0.58
1995	97.54	0.58
1996	101.13	0.58
1997	89.52	0.58
1998	70.01	0.45
1999	59.50	0.45
2000	108.33	0.45
2001	111.64	0.45
2002	103.38	0.45
2003	93.53	0.19
2004	83.90	0.53
2005	73.94	0.59
2006	58.30	0.50
2007	24.83	0.58
2008	19.42	0.91
2009	14.24	0.95
2010	9.83	1.02
2011	11.67	0.93

3.3.2.2.2 Solid Fuel Transformation category

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

The formula used in the calculations is the following:

Equation 3.17 Emissions of CH_4 in Solid Fuel Transformation sub- source category

CH_4 emissions *(Gg) = [EF (m^3 CH_4/tonne of coal mined) x Coking Coal Production (Mt)] x 1000*

where:

- *Default Emission Factor*: EFDB of IPCC - Database on Greenhouse Gas Emission Factors;
- *The default value of 0.35 kg CH_4/t* according to EFDB of IPCC - Database on Greenhouse Gas Emission Factors has been used.
- *Coking Coal Production (Mt):* IEA/Eurostat Questionnaire 2011 – Transformation Sector (Coking Coal – 100 %,).
- *Activity Data* 1989_BAL_Romania have been used for 1989 , and IEA/ Eurostat Questionnaire 2011 - for entire 1990-2011 time series have been used.

Figure 3.47 shows CH_4 of Solid Fuel Transformation category emissions trend.

Table 3.125 and Figure 3.46 shows the activity data and CH_4 emissions trend of Solid Fuels category.

3.3.2.3 Uncertainties and time-series consistency

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

- ***Coal Mining and Handling category***:
  - AD: 5%;
  - EF:
    - CO_2: 200%;

- CH_4: 200%;
- 200.06 % for CO_2 and 200 % for CH_4 associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

❖ ***Solid Fuel Transformation category***:

- AD: 1%;
- EF:
- CO_2: 200%;
- CH_4: 200%;
- 200 % for CO_2 and 200 % for CH_4 values associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Due to the fact that all activity data were provided through the IEA/Eurostat Questionnaire 2011 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 1989-2011 is consistent.

3.3.2.4 Source-specific QA/QC and verification

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. 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.

The unconformities noted and solved as part of the version 2 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.

Recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

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 8.1.

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

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

❖ activity data

- ❖ Solid Fuel Transformation category: AD value for 2010 was changed due to the update of the associated domain in IEA/Eurostat Questionnaire, for 2011 and Coking Coal.

❖ emissions

- Coal Mining and Handing subcategory: CH_4 and CH_4 recovered emissions have been updated in order that CH recovered emissions are correctly considered.

The implications of all changes made on emission estimates are described in Table 3.121.

Table 3.121 Change made at activity data and their effects on CH_4 emission estimates Sub-sector 1.B 1. - Solid Fuels

Year	Effects of changes on CH_4 emission estimates [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	265,24	263,88	-0,52
1990	157,22	155,97	-0,80
1991	133,64	132,39	-0,94
1992	153,77	153,19	-0,38
1993	126,25	125,67	-0,46
1994	130,17	129,58	-0,45
1995	129,51	128,93	-0,45
1996	133,33	132,74	-0,44
1997	115,53	114,95	-0,51
1998	90,44	89,99	-0,50
1999	76,93	76,48	-0,59
2000	128,18	127,73	-0,35
2001	134,78	134,34	-0,33
2002	124,73	124,29	-0,36
2003	117,32	117,13	-0,16
2004	107,56	107,03	-0,49
2005	97,74	97,16	-0,60
2006	86,40	85,90	-0,58

Year	Effects of changes on CH_4 emission estimates [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
2007	55,80	55,22	-1,04
2008	50,85	49,94	-1,82
2009	43,98	43,03	-2,21
2010	37,28	36,26	-2,81

3.3.2.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

It is necessary to realize a new data base for mining sector to increase the accuracy in determination of fugitive emissions.

3.3.3 Source category Oil and Natural Gas - (CRF 1.B.2)

3.3.3.1 Source category description

The source category "Oil and Natural Gas" is a key source of CH_4 and CO_2 emissions in terms of both emissions level and trend.

This source category comprises fugitive emissions from all oil and gas activities. The primary sources of these emissions may include fugitive equipment leaks, evaporation losses, and venting, flaring and accidental releases.

The oil-pools deposits are limited on the terms in which were not identified new oil-pools deposits having an important potentially. Oil reserves in Romania have an estimated potential of about 74 million tones.

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

The most important companies of the fuel distribution in Romania are: OMV (PETROM), LUKOIL, ROMPETROL and MOL. In 2006, in Romania there were a total of 2,140 gas-stations.

According to the estimations of the 2007, the Romania's natural gas pools reseves are limited and they were estimated at about 185 billions cubic metters taking into account of the domestic production decline.

According to the Romanian National Energy Regulatory Agency (ANRE) for repports of 2010, the domestic production of the natural gas was dominated by ROMGAZ S.A. with about 53.4 %, followed by OMV PETROM with 44.44 %; this production of the oil, ”coveres” of about 82.84 % of the total consumption, the rest being covered by import.

The National Society for Natural Gas Transportation TRANSGAZ S.A. has technical infrastructure so that it allows to ensure the transportation of the natural gas to the consumming areas as of 12,960 km of the transporting pipelines and, as well as, of the feeding points, includding also over 554 km of pipelines for the international transit of the gas, having diameters of 1000 mm and 2000 mm.

The information regarding the methane gas distribution is monitorized by the Romanian National Energy Regulatory Agency (ANRE).

Figure 3.48 Total GHG Oil and Natural Gas category emissions trend

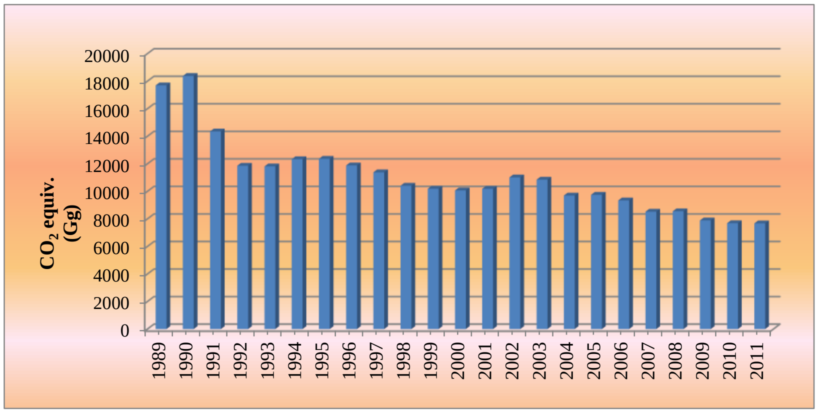
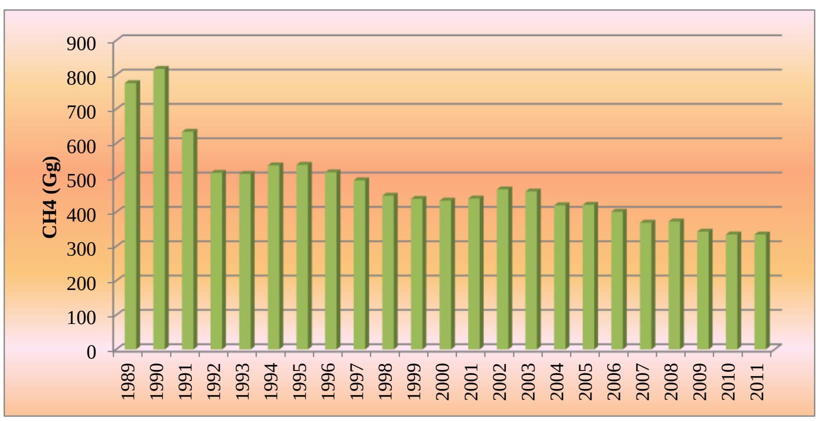


Figure 3.49 CH_4 Oil and Natural Gas category emissions trend



The emissions trend for the entire period is characterized by a continuos decrease, which is due to a number of factors:

- the decline of economic activities and energy consumption;
- the economy being in transition, some energy intensive industries reduced their activities, this being reflected in the GHG emissions reduction especialy during 1989–1999 period;
- the decrease of the natural gas national reserves;
- increase of energy efficiency at the end consumer by changing the old technologies with new technologies, decreasing energy consumption in large cities due to drastic decline in thermal energy demand from industrial consumers, but also because disconnection of households from the public centralized heat supply system, combined with the increasing trend of using individual apartment heating systems;
- in 2006, the available energy resources rised over the level in the previous year. The increase was based mainly on the increased import of energy carriers (+3.1%), offsetting the small decrease of the primary energy production due to diminished crude oil (-8.1%),
- natural gas and hydroelectric power production,compared to 2005 (Source – Romanian National Institute for Statistics);
- the increase of natural gas resources in 2006 was driven by the significant increase in imports (+14.3 %);
- the decrease of crude oil and hydropower resources in 2011 was compensated by the increase of natural gas available for use;
- imports of natural gas have increased in 2011 over the level in the previous year, representing 35.7% of the total imports of energy products; meanwhile a decreased level was registred in case of imports of crude oil, which represent 47.1% of the total imports of energy products (Source – Romanian National Institute for Statistics) (Figure 3.48 and Figure 3.49).

The Table 3.126 and the Table 3.127 shows CH_4 activity data and emissions of Oil and Natural Gas category.

3.3.3.2 Methodological issues

3.3.3.2.1 Oil subcategory

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

This *subcategory* 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.

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

According with the methodological provisions, activity data level used in 1 B 2 a ii Flaring Oil category is the sum of Eurostat/IEA data on the following parameters values:

- Crude oil- indigenous production (1000t)- divided- density value of crude oil (kg/m3);
- Natural Gas Liquids - indigenous production (1000t)- divided- density value of natural gas liquids (kg/m3).

Other Hydrocarbons - indigenous production (1000t) -divided- density value of other hydrocarbons (kg/m3).

As long as, the density values for each fuel type are different and the activity data values are not unitary as content on the time series analyzed period, the implied emission factors of CO_2, CH_4 and N_2O are different.

Exploration (1.B.2.a.iii.1)- Fugitive emissions (excluding venting and flaring) from oil drilling, drill stem, and well completions

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 the following:

Equation 4.2.1 TIER 1: Estimating Fugitive Emissions from an Industry Segment.

Equation 3.18 Estimating Fugitive Emissions from an Industry Segment

$$E_{\text{gas, industry segment}} = A_{\text{industry segment}} * EF_{\text{gas, industry segment}}$$

$$E_{gas} = \sum_{\text{industry segment}} E_{\text{gas,industry segment}}$$

where:

- $E_{\text{gas, industry segment}}$ = Annual emissions (Gg)
- $EF_{\text{gas, industry segment}}$ = emission factor (Gg unit of activity)
- $A_{\text{industry segment}}$ = activity value (units of activity)

Emission [CO_2] = *[(Production of crude oil [kt] / density [$Gg/10^3\ m^3$])*EF CO_2 [$Gg/10^3\ m^3$]*1000*
*+[(Production of natural gas liquid [kt] / density [$Gg/10^3\ m^3$])*EF CO_2 [$Gg/10^3\ m^3$]*1000*
*+[(Production of other hydrocarbons [kt] / density [$Gg/10^3\ m^3$])*EF CO_2 [$Gg/10^3\ m^3$]*1000*
Emission [CH_4] = *[(Production of crude oil [kt] / density [$Gg/10^3\ m^3$])*EF CH_4 [$Gg/10^3\ m^3$]*1000*
*+[(Production of Natural gas liquid [kt] / density [$Gg/10^3\ m^3$])*EF CH_4 [$Gg/10^3\ m^3$]*1000*
*+[(Production of other hydrocarbons [kt] / density [$Gg/10^3\ m^3$])*EF CH_4 [$Gg/10^3\ m^3$]*1000*
Emission [N_2O] = *[(Production of crude oil [kt] / density [$Gg/10^3\ m^3$])*EF N_2O [$Gg/10^3\ m^3$]*1000*
*+[(Production of Natural gas liquid [kt] /density [$Gg/10^3\ m^3$])*EF N_2O [$Gg/10^3\ m^3$]*1000*
*+[(Production of other hydrocarbons [kt] / density [$Gg/10^3\ m^3$])*EF N_2O [$Gg/10^3\ m^3$]*1000*

where:

- *Default Emission Factor*: "Default weighted total" from 2006 IPCC GL, volume 2, chapter 4.2.2.3., page 4.55, table 4.2.5.
- *The default value of 0.0103500 $Gg/10^3m^3$* (Venting) for CH_4 (average CH_4 Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.
- *The default value of 0.0021500 $Gg/10^3m^3$* (Venting) for CO_2 (average CO_2 Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.
- *The default value of 0.0000250 $Gg/10^3m^3$* (Flaring) for CH_4 (average CH_4 Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.

- *The default value of 0.0405000 $Gg/10^3m^3$* (Flaring) for CO_2 (average CO_2 Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.
- *The default value of 0.0000064 $Gg/10^3m^3$* (Flaring) for N_2O (average N_2O Emission Factor) according to 2006 IPCC GL for "Oil production" has been used.
- *The default value of 0.001702 $Gg/10^3m^3$* (Exploration) for CH_4 (average CH_4 Emission Factor) according to 2006 IPCC GL for "Oil extraction-well drilling, testing, servicing" has been used.
- *The default value of 0.080417$Gg/10^3m^3$* (Exploration) for CO_2 (average CO_2 Emission Factor) according to 2006 IPCC GL for "Oil extraction-well drilling, testing, servicing" has been used.
- *The default value of 0.000000584 $Gg/10^3m^3$* (Exploration) for N_2O (average N_2O Emission Factor) according to 2006 IPCC GL for "Oil extraction –well testing" has been used.

***Density*:**

Crude Oil = 881 [kg/m^3] or 0.881 [$Gg/10^3$ m^3]

(http://hypertextbook.com/facts/2007/ArtemGindin.shtml)

Natural Gas Liquids = 450 [kg/m^3] or 0. 450 [$Gg/10^3$ m^3]

(http://www.engineeringtoolbox.com/liquefied-natural-gas-lng-d_1092.html)

Other Hydrocarbons = 550 [kg/m^3] or 0.550 [$Gg/10^3$ m^3]

(http://pubs.acs.org/doi/abs/10.1021/je60058a030)

NCV - from IEA/Eurostat Questionnaire 2011 - Petrol – Crude oil, Natural Gas Liquids and Other Hydrocarbons) in [kJ/kg]

Activity Data (oil production): from *IEA/Eurostat Questionnaire 2011 Petrol* - Indigenous Production: Crude Oil [*1000 t*], Natural Gas Liquids [*1000 t*], Other Hydrocarbons [*1000 t*]

Activity Data 1989_BAL_Romania have been used for 1989 , and IEA/Eurostat Questionnaire 2011 - for entire 1990-2011 time series have been used.

According with the methodological provisions, activity data level used in 1 B 2 a iii 3 Exploration Oil category is the sum of Eurostat/IEA data on the following parameters values:

- Crude oil- indigenous production (1000t) divided by density value of crude oil (kg/m3);
- Natural Gas Liquids - indigenous production (1000t) divided by density value of natural gas liquids (kg/m3);

- Other Hydrocarbons - indigenous production (1000t) divided by density value of Other hydrocarbons (kg/m3).

As long as, the density values for each fuel type are different and the activity data values are not unitary as content on the time series analyzed period, the implied emission factors of CO_2, CH_4 and N_2O are different.

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;
- Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors the reporting are used.

Activity data

Crude oil [1000t] - Indigenous Production [IEA/Eurostat Questionnaire 2011 - Petrol - Crude Oil] - fugitive emissions from atmospheric distillation

Residual Fuel Oil [1000t] - Refinery Gross Output [IEA/Eurostat Questionnaire 2011 - Petrol - Residual Fuel Oil] - fugitive emissions from vacuum distillation

Bitumen [1000t] - Refinery Gross Output [IEA/Eurostat Questionnaire 2011 - Petrol - Bitumen] - fugitive emissions from vacuum distillation

Density

Crude Oil **=** 881 [kg/m^3] or 0.881 [Gg/10^3 m^3]
(http://hypertextbook.com/facts/2007/ArtemGindin.shtml)

Residual Fuel Oil = 950 [kg/m^3] or 0. 950 [Gg/10^3 m^3]

(Fuel oil defines oils that make up the distillation residue. It comprises all residual fuel oils, including those obtained by blending. Its kinematic viscosity is above 10 cSt at 80oC. The flash point is always above 50oC and the density is always higher than 0.90 kg/l)

Bitumen = the same as crude oil = 881 [kg/m^3] or 0.881 [Gg/10^3 m^3]

(http://pubs.acs.org/doi/abs/10.1021/je60058a030)

NCV - from IEA/Eurostat Questionnaire 2011 - Petrol – Crude oil, Natural Gas Liquids and Other Hydrocarbons) in [kJ/kg]

2006 IPCC, volume 2, chapter 4.2.2.3, Table 4.2.5

Emission factor for Oil production: "Default weighted total" from 2006 IPCC, volume 2, chapter 4.2.2.3, Table 4.2.5

Fugitives (production): CH_4 0,0196000 Gg per 10^3 m^3

Fugitives (production): CO_2 0,0024900 Gg per 10^3 m^3

N_2O – NA

Methodology

Emission [CO_2] *= [(Production of crude oil [kt] / density [Gg/10^3 m^3])*EF CO_2 [Gg/10^3 m^3]*1000 +[(Production of RFO [kt] / density [Gg/10^3 m^3])*EF CO_2 [Gg/10^3 m^3]*1000 +[(Production of bitumen [kt] / density [Gg/10^3 m^3])*EF CO_2 [Gg/10^3 m^3]*1000*

Emission [CH_4] *= [(Production of crude oil [kt] / density [Gg/10^3 m^3])*EF CH_4 [Gg/10^3 m^3]*1000 +[(Production of RFO [kt] / density [Gg/10^3 m^3])*EF CH_4 [Gg/10^3 m^3]*1000 +[(Production of bitumen [kt] / density [Gg/10^3 m^3])*EF CH_4 [Gg/10^3 m^3]* 1000*

Emission N_2O – N.A.

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.

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

Activity data

From *IEA/Eurostat Questionnaire 2011 Petrol - Indigenous Production + Import + Export:*
Crude Oil [*1000 t*]
Natural Gas Liquids [*1000 t*]
Other Hydrocarbons [*1000 t*]

Density
Crude Oil = 881 [kg/m^3] or 0.881 [$Gg/10^3\ m^3$]
(http://hypertextbook.com/facts/2007/ArtemGindin.shtml)
Natural Gas Liquids = 450 [kg/m^3] or 0. 450 [$Gg/10^3\ m^3$]
(http://www.engineeringtoolbox.com/liquefied-natural-gas-lng-d_1092.html)
Other Hydrocarbons = 550 [kg/m^3] or 0.550 [$Gg/10^3\ m^3$]
(http://pubs.acs.org/doi/abs/10.1021/je60058a030)
NCV - from IEA/Eurostat Questionnaire 2011 - Petrol – Crude oil, Natural Gas Liquids and Other Hydrocarbons) in [kJ/kg]
The default value of 0,0000054 $Gg/10^3m^3$ (Oil Transport Pipelines) for CH_4 (average CH_4 Emission Factor) according to 2006 IPCC, volume 2, chapter 4.2.2.3, page 4.46, Tabel 4.2.5., page 4.61 (GPG 2000 IPCC, Table 2.16, page 2.87) has been used.
The default value of 0,00000049 $Gg/10^3m^3$ (Oil Transport Pipelines) for CO_2 (average CH_4 Emission Factor) according to 2006 IPCC, volume 2, chapter 4.2.2.3, page 4.46, Tabel 4.2.5., page 4.61 (GPG 2000 IPCC, Table 2.16, page 2.87) has been used.
N_2O – N.A.

Methodology

Emission [CO_2] *= [(Production of crude oil [kt] / density [$Gg/10^3\ m^3$])*EF CO_2 [$Gg/10^3\ m^3$]/1000 +[(Production of Natural gas liquid [kt] / density [$Gg/10^3\ m^3$])*EF CO_2 [$Gg/10^3$*

*m^3]/1000 +[(Production of other hydrocarbons [kt] / density [Gg/10^3 m^3])*EF CO_2 [Gg/10^3 m^3]/1000*

Emission [CH_4] *= [(Production of crude oil [kt] / density [Gg/10^3 m^3])*EF CH_4 [Gg/10^3 m^3]/1000 +[(Production of Natural gas liquid [kt] / density [Gg/10^3 m^3])*EF CH_4 [Gg/10^3 m^3]/1000 +[(Production of other hydrocarbons [kt] / density [Gg/10^3 m^3])*EF CH_4 [Gg/10^3 m^3]*1000*

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

Activity data

Crude oil [1000t] - Refinery Intake (Observed) [IEA/Eurostat Questionnaire 2011 - Petrol - Crude Oil]

Natural Gas Liquids [1000t] - Refinery Intake (Observed) [IEA/Eurostat Questionnaire 2011 - Petrol - Natural Gas Liquids]

Other Hydrocarbons [1000t] - Refinery Intake (Observed) [IEA/Eurostat Questionnaire 2011 - Petrol - Other Hydrocarbons]

Default Emission factor for Refining and Storage Tank: Revised 1996 IPCC, ch 1 Energy 21-40 RB Table 1-58, page 121

The default value of 745 kg/PJ (Refinery) for CH_4 (average CH_4 Emission Factor) has been used.

The default value of 135 kg/PJ (Storage Tank) for CH_4 (average CH_4 Emission Factor) has been used.

The default value of ***Combined EF*** **of 880** kg/PJ for CH_4 has been used.

Methodology

Emission [CH_4] *= ∑(Refinery Intake (Observed) of crude oil, natural gas liquids, other hydrocarbons [PJ]) * EF CH_4 (kg/PJ) / 10^6)*

Emission CO_2 – N.D.

Emission N_2O– N.A.

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

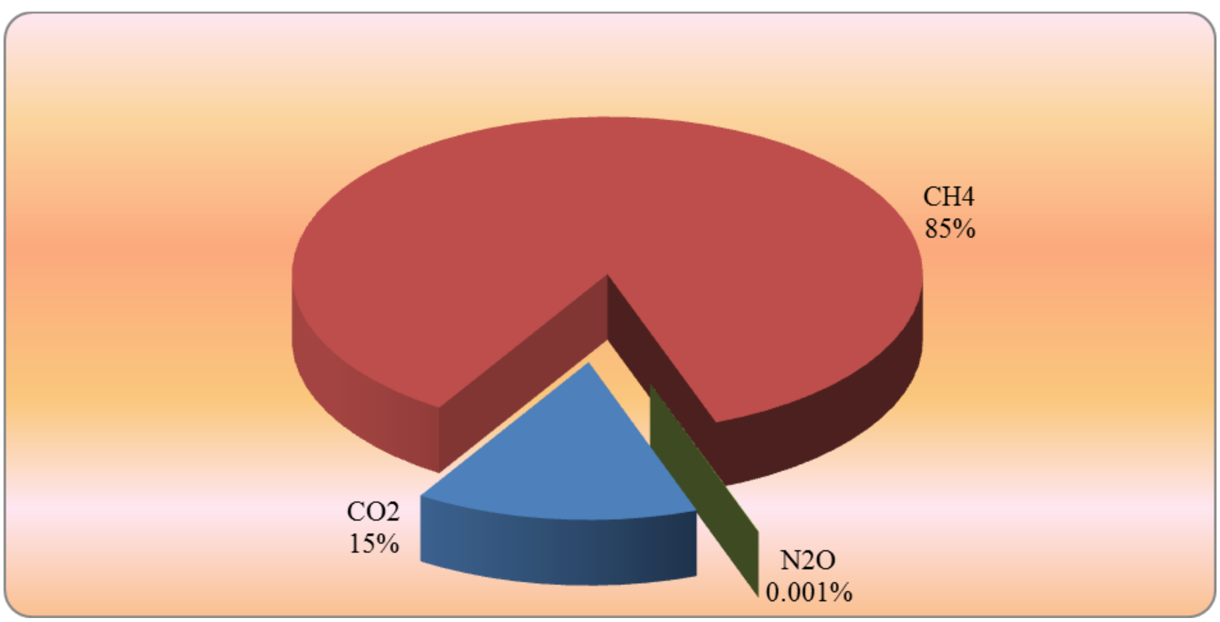
Refined Product Distribution: Gasoline, Diesel, Aviation Fuel, Jet Kerosene

EF CO_2 – N.A.

EF CH_4 – N.A.

EF N_2O – N.A.

Figure 3.50 The different GHG's Oil subcategory Fugitive emissions contribution



The most important GHG in the Energy sector is CO_2 emissions and small amounts of CH_4 and N_2O are emitted in Fugitive emissions from Oil subcategory also.

Figure 3.51 The different GHG's Venting oil emissions contribution

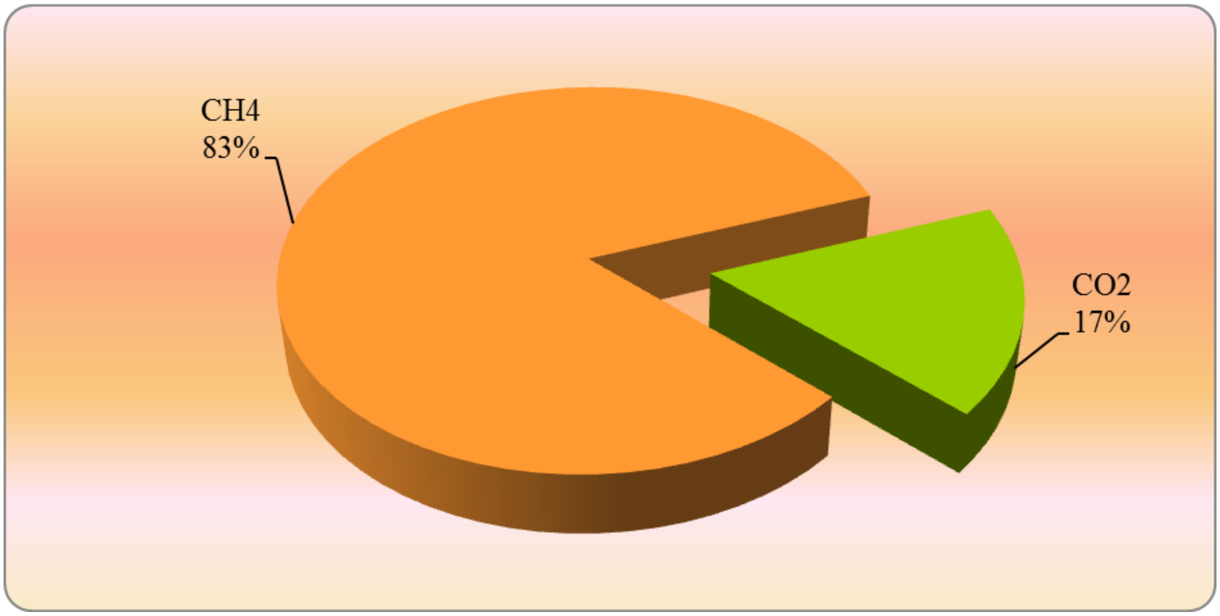
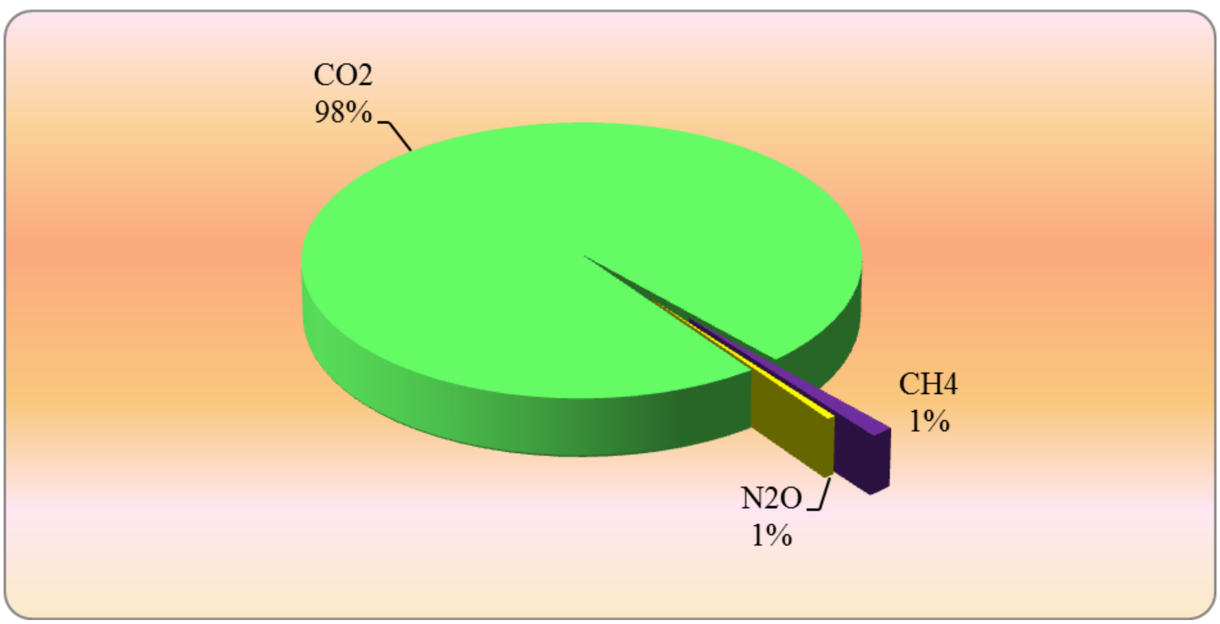


Figure 3.52 The different GHG's Flaring oil emissions contribution



3.3.3.2.2 Natural Gas subcategory

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

This *subcategory* ccomprises emission from venting, flaring and all other fugitive sources associated with the exploration, production, processing, transmission, storage and distribution of natural gas (including both associated and non-associated gas).

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

The formula used in the calculations is presented under equation 3.9.

Venting (1.B. 2. b. i.):

- Emissions from venting of natural gas and waste gas/vapour streams at gas facilities

Activity data*:*

- Natural Gas Indigenous Production [IEA/Eurostat Questionnaire 2011 – Natural Gas] – in both units – *10^6 m^3 and TJ (GCV) * 0.9 → TJ (NCV);*
- Production [10^6 m^3] * NCV = Production [TJ] / 1000 = Production [PJ]
- *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

Methodology

Emission $[CO_2][Gg] = [(Production\ of\ Natural\ Gas\ [10^6\ m^3] * EF\ CO_2\ [Gg/10^6\ m^3]$

Emission $[CH_4][Gg = [(Production\ of\ Natural\ Gas\ [10^6\ m^3] * EF\ CH_4\ [Gg/10^6\ m^3]$

Emission N_2O *– N.A.*

Flaring (1 B 2 b ii): Emissions from flaring of natural gas and waste gas/vapour streams at gas facilities.

Activity data

Natural Gas Indigenous Production [IEA/Eurostat Questionnaire 2011 – Natural Gas] – in both units – $10^6\ m^3$ and TJ (GCV) * 0.9 → TJ (NCV)

Production [$10^6\ m^3$] * NCV = Production [TJ] / 1000 = Production [PJ]

Default Emission Factors - 2006 IPCC, Volume 2, chapter 4.2.2.3, Table 4.2.5, pag 4.56

Flaring	lower	upper	average	units
CH_4	0.000002	0.0000028	0.0000024	Gg per $10^6\ m^3$
CO_2	0.003	0.0041	0.00355	Gg per $10^6\ m^3$
N_2O	0.000000033	0.000000045	0.000000039	Gg per $10^6\ m^3$

Methodology

Emission $[CO_2]$ *[Gg]* = $[(Production\ of\ Natural\ Gas\ [10^6\ m^3] * EF\ CO_2\ [Gg/10^6\ m^3]$

Emission $[CH_4]$*[Gg]*= $[(Production\ of\ Natural\ Gas\ [10^6\ m^3] * EF\ CH_4\ [Gg/10^6\ m^3]$

Emission $[N_2O]$ *[Gg]* = $[(Production\ of\ Natural\ Gas\ [10^6\ m^3] * EF\ N_2O\ [Gg/10^6\ m^3]$

Processing (1 B 2 b iii 3)

- Fugitive emissions (excluding venting and flaring) from gas processing facilities (Revised 1996 IPCC: 1B2b ii Natural Gas - Production/ Processing)

Activity data

- Natural Gas Indigenous Production [IEA/Eurostat Questionnaire 2011 – Natural Gas] – in both units – 10^6 m^3 and TJ (GCV) * 0.9 → TJ (NCV);
- Production [10^6 m^3] * NCV = Production [TJ] / 1000 = Production [PJ]
- Emission factors - GPG 2000 IPCC, Table 2.16, page 2.86

Flaring	**lower**	**upper**	**average**	**units**
CH_4	0.0026	0.0029	0.00275	Gg per 10^6 m^3
CO_2	-	-	0.000095	Gg per 10^6 m^3

Methodology

- *Emission [CO_2] [Gg] = [(Production of Natural Gas [10^6 m^3] * EF CO_2 [Gg/10^6 m^3]*
- *Emission [CH_4] [Gg] = [(Production of Natural Gas [10^6 m^3] * EF CH_4 [Gg/10^6 m^3]*

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 (Sector 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.

Activity data

- Use the length of pipeline of natural gas transit through the country and domestic transmission in km as activity data
- Conversion factor - 0.67 Gg CH_4 /million m3

Emission factors - GPG 2000 IPCC, Table 2.18, page 2.91		
CH_4	2000	m^3/km/yr
Emission factors - GPG 2000 IPCC, Table 2.16, page 2.86		
CO_2	0.000016	Gg/year/km transmission pipeline

Methodology

- *Emission [CO_2] = [(length of gas network [km] * EF CO_2 [Gg/year/km])]*
- *Emission [CH_4] = [(length of gas transmission network [km] * EF CH_4 [m^3/km/yr]) * Conversion factor] /10^6 = Emission [Gg]*
- *Emission N_2O – N.A.*

Distribution (1B2b iii5)

- Fugitive emissions (excluding venting and flaring) from the distribution of natural gas to end users.

Activity data

- Indigenous Production + Import [IEA/Eurostat Questionnaire 2011 – Natural Gas] – in 10^6 m^3;
- Use the length of pipeline of natural gas for domestic distribution in km as activity data;
- Conversion factor - 0.67 Gg CH_4 /million m^3

Emission factors

Emission factors - GPG 2000 IPCC, Table 2.18, page 2.91		
CH_4	1000	m^3/km/yr
Emission factors - 2006 IPCC, volume 2, chapter 4.2.2.3, page 4.46, Tabel 4.2.5., page 4.57		
CO_2	*0.0000955*	*Gg per 10^6 m^3*

Methodology

- *Emission [CO_2] = [(Production + Import of Natural Gas [10^6 m^3] * EF CO_2 [Gg/10^6 m^3] = Emission [Gg]*
- *Emission [CH_4] = [(length of gas distribution network [km] * EF CH_4 [m^3/km/yr]) * Conversion factor /10^6 = Emission [Gg]*
- *Emission N_2O – N.A.*

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

Activity data

Natural Gas from IEA/Eurostat Questionnaire 2011 – 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)

Production [10^6 m^3] * NCV = Production [TJ] / 1000 = Production [PJ]

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

Methodology

***Emission[CH_4]** [Gg]= [(Natural Gas from Industrial plants and power stations [PJ]) * EF CH_4 [kg/PJ]] / 10^6*

Residential and commercial sectors

Activity data

Natural Gas from IEA/Eurostat Questionnaire 2011–Natural Gas - sheet "2ii_TFC_EnergyUse" row 24 (Other sectors) – in both units – 10^6 m^3 and TJ (GCV) * 0.9 → TJ (NCV)

Production [10^6 m^3] * NCV = Production [TJ] / 1000 = Production [PJ]

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

Methodology

Emission [CH_4] *[Gg] = [(Natural Gas from in residential and commercial sectors [PJ]) * EF CH_4 [kg/PJ]] / 10^6*

Figure 3.53 The different GHG's Natural Gas subcategory emissions contribution

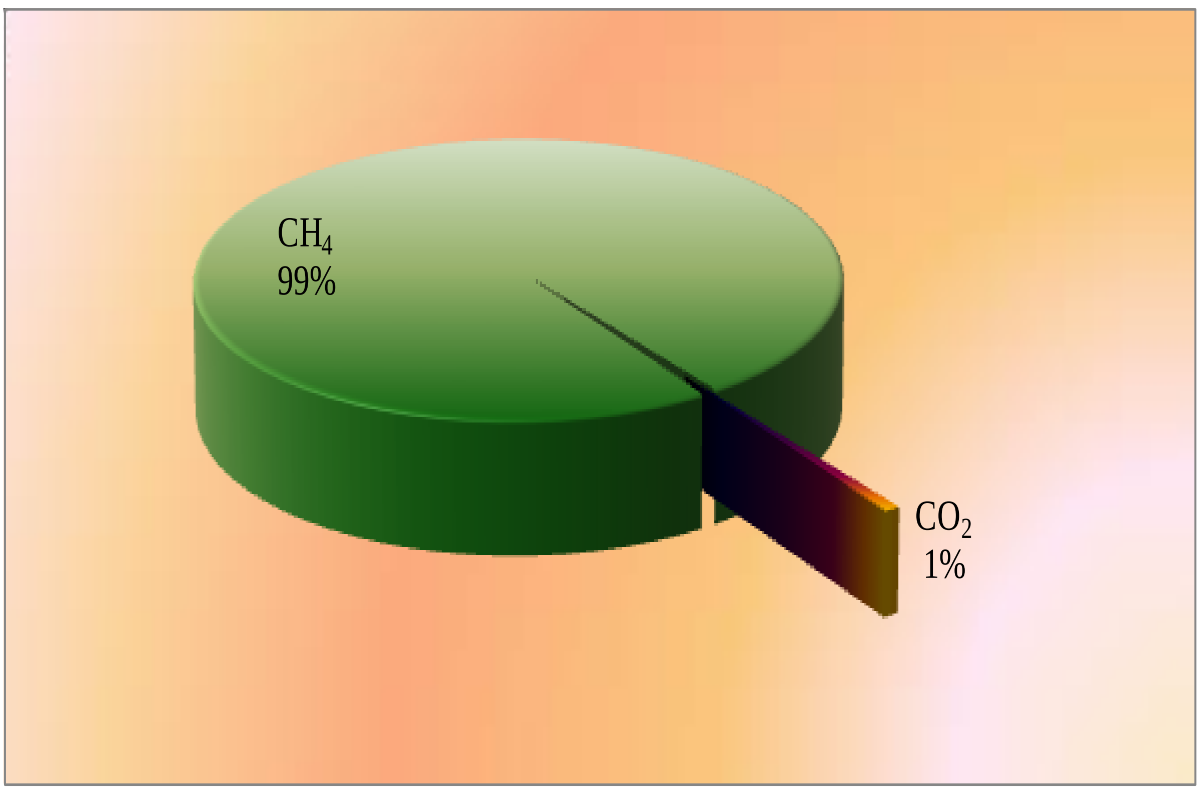


Figure 3.54 The different GHG's Venting gas emissions contribution

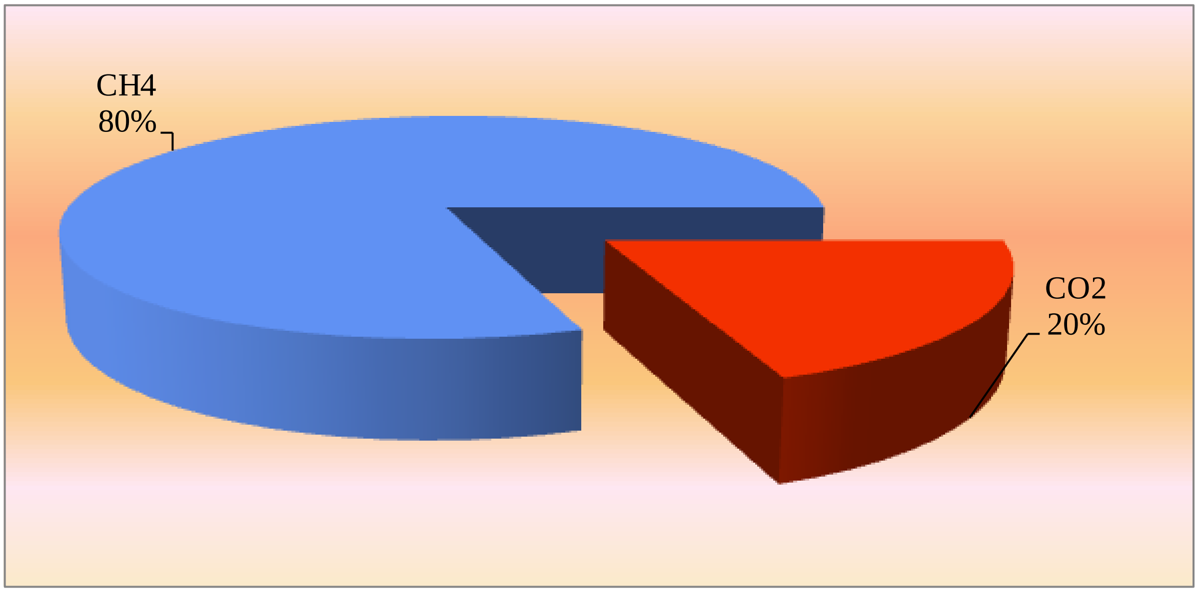
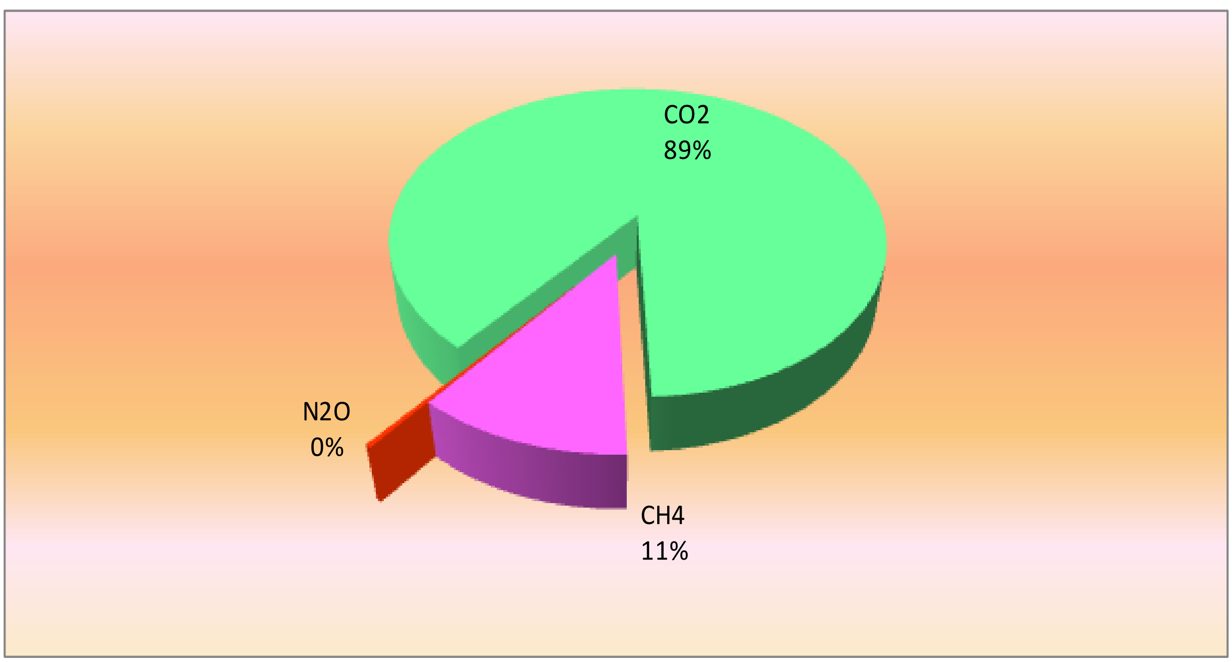


Figure 3.55 The different GHG's Flaring gas emissions contribution



3.3.3.3 *Uncertainties and time-series consistency*

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

- ***Oil subcategory***
  - AD: 3%;
  - EF:
    - CO_2: 50%;
    - CH_4: 500%;
    - N_2O: 50%.
    - 50.09 % for CO_2, 50 % for CH_4 and 50% for N_2O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.
- **Natural Gas subcategory**
  - AD: 2.2%;
  - EF:
    - CO_2: 50%;
    - CH_4: 50%;
    - 50.05 % for CO_2 and 50 % for CH_4 associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.
- **Venting subcategory**
  - AD: 2.2%;
  - EF:
    - CO_2: 50%;
    - CH_4: 50%;
    - 50.05 % for CO_2, 50 % for CH_4 and 2% N_2O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.
- **Flaring subcategory:**
  - AD: 3%;

- EF:
    - CO_2: 50%;
    - CH_4: 50%;
    - 50.09 % for CO_2, 50 % for CH_4 and 3% N_2O associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Due to the fact that all activity data were provided through the IEA/Eurostat Questionnaire 2011 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 1989-2011 is consistent.

3.3.3.4 Source-specific QA/QC and verification

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

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 version 2 of the 2012 NGHGI; they are described in the Chapter 3.3.3.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 3.3.3.5 – Source-specific recalculations, including changes made in response to the review process.

The activity data series were also compared to those on Eurostat, the data being reported at the same level of aggregation and the figures comparable; additionally, national emission factors values were compared witht national emission factors values specific to Bulgaria, considering that similar energy activities are implemented. Further elements are presented within Annex 8.1.

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

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

- ❖ activity data
  - Transmission subcategory: updated activity data (pipeline length) values were provided by the National Company of Natural Gas Transport “TRANSGAZ”;
  - Distribution subcategory: due to a transcription error of the activity data (pipeline length) from the spreadsheet in the CRF, for 2010.
- ❖ emissions
  - Transmission subcategory: due to a transcription error of the CO_2 emission values and CH_4 emission values from the spreadsheet in the CRF, for entire times series;
  - Other Leakage subcategory: the notation key "NA" was changed with the notation key "NE" because no estimation method and emission factor for CO_2 are available in the IPCC good practice guidance/IPCC 1996 and on national level.

The implications of all changes made on emission estimates are described in Tables 3.122 - 3.124.

Table 3.122 Change made at activity data and their effects on CO_2 emission estimates Oil and Natural Gas category

Year	**Effects of changes on CO_2 emission estimates [Gg]**		**Difference [%]**
	NGHGI 2012 v. 3.1	**NGHGI 2013 v. 1.4**	
1989	1.399,94	1.399,87	-0,005
1990	1.213,18	1.213,11	-0,005
1991	1.035,01	1.034,95	-0,006
1992	1.057,94	1.057,88	-0,006
1993	1.070,86	1.070,80	-0,006
1994	1.074,03	1.073,97	-0,006
1995	1.068,50	1.068,44	-0,006
1996	1.050,27	1.050,22	-0,006
1997	1.031,00	1.030,94	-0,005
1998	1.001,51	1.001,46	-0,005
1999	975,55	975,50	-0,005
2000	962,06	962,01	-0,005
2001	952,77	952,73	-0,005
2002	1.221,88	1.221,83	-0,003
2003	1.189,04	1.189,00	-0,003
2004	877,29	877,26	-0,004
2005	901,09	901,06	-0,003
2006	918,85	918,82	-0,002

Year	Effects of changes on CO_2 emission estimates [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
2007	766,91	766,89	-0,002
2008	723,81	723,79	-0,002
2009	682,36	682,34	-0,002
2010	651,85	651,84	-0,002

Table 3.123 Change made at activity data and their effects on CH_4 emission estimate

Oil and Natural Gas category

Year	Effects of changes on CH_4 emission estimates [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	805,26	775,63	-3,82
1990	859,15	817,12	-5,14
1991	674,60	633,84	-6,43
1992	553,75	514,21	-7,69
1993	549,45	511,22	-7,48
1994	572,84	535,94	-6,88
1995	573,19	537,60	-6,62
1996	549,72	515,65	-6,61
1997	525,13	492,61	-6,60
1998	478,83	447,76	-6,94
1999	467,95	438,43	-6,73

Year	Effects of changes on CH_4 emission estimates [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
2000	461,59	433,23	-6,55
2001	465,99	439,35	-6,06
2002	491,19	466,01	-5,40
2003	483,52	459,83	-5,15
2004	441,61	419,70	-5,22
2005	441,22	421,14	-4,77
2006	419,32	400,88	-4,60
2007	384,82	369,13	-4,25
2008	387,73	372,50	-4,09
2009	358,39	342,95	-4,50
2010	348,85	334,88	-4,17

Table 3.124 Change made at activity data and their effects on N_2O emission estimates Oil and Natural Gas category

Year	Effects of changes on N_2O emission estimates [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	0,014	0,014	0
1990	0,012	0,012	0
1991	0,010	0,010	0
1992	0,010	0,010	0

Year	Effects of changes on N_2O emission estimates [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1993	0,010	0,010	0
1994	0,010	0,010	0
1995	0,010	0,010	0
1996	0,010	0,010	0
1997	0,010	0,010	0
1998	0,010	0,010	0
1999	0,009	0,009	0
2000	0,009	0,009	0
2001	0,009	0,009	0
2002	0,012	0,012	0
2003	0,012	0,012	0
2004	0,009	0,009	0
2005	0,009	0,009	0
2006	0,009	0,009	0
2007	0,007	0,007	0
2008	0,007	0,007	0
2009	0,007	0,007	0
2010	0,006	0,006	0

3.3.3.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

It is necessary to realize a new data base for the length of distribution pipelines of natural gas from Romanian National Energy Regulatory Agency (ANRE), increase the accuracy of fugitive emissions determination.

Table 3.125 Activity Data and CH_4 emissions from Solid Fuels category

Year	1.B.1.a Coal Mining and Handling						1.B.1.b Solid Fuels Transformation		TOTAL CH_4 emissions from Solid Fuels category
	i.Underground mines			ii. Surface Mines					
	AD	Mining, CH_4	Post-Mining, CH_4	AD	Mining, CH_4	Post-Mining, CH_4	AD	Emissions, CH_4	
	kt	Gg	Gg	kt	Gg	Gg	kt	Gg	Gg
1989	16.26	194.69	27.23	45.09	36.25	3.02	7.67	2.68	**263.88**
1990	9.51	113.40	15.92	28.68	23.06	1.92	4.79	1.68	**155.97**
1991	8.12	96.71	13.61	24.29	19.53	1.63	2.62	0.92	**132.39**
1992	9.24	110.84	15.47	29.13	23.42	1.95	4.30	1.51	**153.19**
1993	7.00	83.88	11.73	32.75	26.33	2.19	4.39	1.54	**125.67**
1994	7.24	86.76	12.13	33.30	26.78	2.23	4.81	1.68	**129.58**
1995	7.14	85.58	11.97	33.98	27.32	2.28	5.13	1.79	**128.93**
1996	7.40	88.72	12.40	34.46	27.71	2.31	4.57	1.60	**132.74**
1997	6.56	78.54	10.99	27.25	21.91	1.83	4.83	1.69	**114.95**
1998	5.13	61.42	8.59	21.10	16.97	1.41	4.58	1.60	**89.99**
1999	4.36	52.19	7.31	18.52	14.89	1.24	2.43	0.85	**76.48**
2000	7.92	95.07	13.27	21.37	17.18	1.43	2.25	0.79	**127.73**
2001	8.16	97.97	13.67	25.13	20.20	1.68	2.30	0.81	**134.34**
2002	7.56	90.71	12.66	22.86	18.38	1.53	2.87	1.00	**124.29**
2003	6.82	82.10	11.43	26.24	21.10	1.76	2.14	0.75	**117.13**
2004	6.15	73.60	10.30	25.65	20.62	1.72	2.27	0.80	**107.03**
2005	5.43	64.85	9.09	25.68	20.65	1.72	2.43	0.85	**97.16**
2006	4.28	51.13	7.17	30.64	24.64	2.05	2.6	0.91	**85.90**
2007	1.85	21.74	3.10	33.93	27.28	2.27	2.39	0.84	**55.22**
2008	1.48	16.94	2.48	34.38	27.64	2.30	1.656	0.58	**49.94**
2009	1.11	12.39	1.85	32.86	26.42	2.20	0.496	0.17	**43.03**
2010	0.79	8.51	1.32	30.34	24.39	2.03	0.003	0.001	**36.26**
2011	0.85	10.25	1.42	34.66	27.87	2.32	NO	NO	**41.87**

Table 3.126 Activity Data from Oil and Natural Gas category

Year	1.B.2.a. Oil				1.B.2.b. Natural Gas							1.B.2.c. Venting and Flaring			
										v. Other Leakage		1.B.2.c.1 Venting		1.B2.c.2Flaring	
	i. Exploration	ii. Production	iii. Transport	iv. Refining /Storage	ii. Production / Processing	iii. Transmission		iv. Distribution		at industrial plants and power station	in residential and commercial sectors	i. Oil	ii. Gas	i. Oil	ii. Gas
	PJ	PJ	PJ	PJ	PJ	PJ	km	10^6 m^3	km	PJ	PJ	PJ	PJ	PJ	PJ
1989	372.84	405.11	372.84	1,240.93	1,115.46	1,365.39	8,891	52,382	8,387	909.94	126.49	372.84	1,115.46	372.84	1,115.46
1990	322.25	666.58	974.88	961.75	1,065.81	1,341.57	9,007	35,667	9,974	779.98	143.63	322.25	1,065.81	322.25	1,065.81
1991	276.00	495.16	617.31	617.39	933.07	1,107.06	9,046	29,433	11,561	532.08	164.50	276.00	933.07	276.00	933.07
1992	279.41	433.44	546.51	533.35	819.29	985.98	9,047	26,234	13,148	276.39	89.19	279.41	819.29	279.41	819.29
1993	283.61	430.07	591.72	544.16	779.68	947.89	9,100	25,230	14,735	273.71	89.80	283.61	779.68	283.61	779.68
1994	285.53	418.61	615.62	604.18	689.59	863.36	9,169	23,152	16,322	398.55	93.58	285.53	689.59	285.53	689.59
1995	284.72	402.67	636.53	626.50	672.01	895.05	9,228	24,001	17,909	430.91	104.26	284.72	672.01	284.72	672.01
1996	280.63	376.17	571.42	550.96	640.30	903.35	9,416	24,275	19,496	413.99	99.05	280.63	640.30	280.63	640.30
1997	276.59	357.45	530.35	510.32	553.96	741.46	9,630	19,972	21,083	386.29	111.68	276.59	553.96	276.59	553.96
1998	268.56	341.24	511.35	514.15	518.68	697.09	9,783	18,740	22,670	264.90	126.99	268.56	518.68	268.56	518.68
1999	261.46	328.51	436.08	411.49	520.67	638.77	9,992	17,180	24,257	266.12	114.39	261.46	520.67	261.46	520.67
2000	257.83	310.97	451.15	440.37	510.24	636.39	9,955	17,120	25,844	282.70	115.03	257.83	510.24	257.83	510.24
2001	255.61	321.46	480.81	477.43	501.50	608.88	10,276	16,447	27,431	283.84	117.60	255.61	501.50	255.61	501.50
2002	299.31	308.95	557.74	548.69	493.06	638.67	10,430	17,216	29,018	305.81	115.20	299.31	493.06	299.31	493.06
2003	291.20	298.29	503.11	498.79	485.14	682.24	10,604	18,350	30,605	301.11	141.70	291.20	485.14	291.20	485.14
2004	234.10	290.46	531.23	532.81	482.76	674.03	10,968	18,094	32,192	271.53	151.31	234.10	482.76	234.10	482.76
2005	234.52	284.62	587.53	584.64	451.31	646.24	11,361	17,379	33,779	285.87	145.08	234.52	451.31	234.52	451.31
2006	230.83	253.91	583.39	572.94	444.66	667.54	11,632	17,955	35,366	235.93	194.15	230.83	444.66	230.83	444.66
2007	200.93	236.88	547.65	541.92	429.51	609.31	11,920	16,374	37,151	230.34	147.61	200.93	429.51	200.93	429.51
2008	193.39	238.98	535.87	534.28	418.33	582.60	11,968	15,801	38,144	254.17	141.61	193.39	418.33	193.39	418.33
2009	183.78	218.68	463.95	461.80	415.82	490.16	12,063	13,258	40,325	194.91	145.99	183.78	415.82	183.78	415.82
2010	175.27	202.19	415.23	414.65	400.94	485.41	12,327	13,134	41,714	206.48	149.55	175.27	400.94	175.27	400.94
2011	172.87	195.91	397.57	400.99	403.18	517.80	12,408	13,993	43,301	215.93	146.27	172.87	403.18	172.87	403.18

Table 3.127 CH_4 Fugitive emissions from Oil and Natural Gas category

Year	1.B.2.a. Oil				1.B.2.b. Natural Gas					1.B.2.c. Venting and Flaring				TOTAL CH_4 Fugitive emissions from Oil and Natural Gas Category
								v. Other Leakage		1.B.2.c.1. Venting		1.B.2.c.2.Flaring		
	i. Exploration	ii. Production	iii. Transport	iv. Refining /Storage	ii. Production/ Processing	iii. Transmission	iv. Distribution	at industrial plants and power station	in residential and commercial sectors	i. Oil	ii. Gas	i. Oil	ii. Gas	
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg
1989	17.72	221.68	0.06	1.09	117.68	13.69	6.46	254.33	17.65	107.76	16.78	0.26	0.47	**775.63**
1990	15.32	358.5	0.15	0.85	77.92	13.87	7.68	218.00	20.04	93.15	11.11	0.23	0.31	**817.12**
1991	13.12	267.4	0.09	0.54	68.22	13.93	8.9	148.71	22.95	79.78	9.72	0.19	0.27	**633.84**
1992	13.58	234.87	0.08	0.47	59.9	13.93	10.12	77.25	12.44	82.59	8.54	0.2	0.24	**514.21**
1993	13.79	233.01	0.09	0.48	57.03	14.01	11.35	76.50	12.53	83.88	8.13	0.2	0.23	**511.22**
1994	13.91	227.1	0.09	0.53	50.91	14.12	12.57	111.39	13.05	84.6	7.26	0.2	0.2	**535.94**
1995	13.86	218.72	0.1	0.55	49.62	14.21	13.79	120.44	14.54	84.29	7.07	0.2	0.2	**537.60**
1996	13.66	204.76	0.09	0.48	47.43	14.50	15.01	115.71	13.82	83.04	6.76	0.2	0.19	**515.65**
1997	13.48	194.67	0.08	0.45	41.15	14.83	16.23	107.97	15.58	81.94	5.87	0.2	0.16	**492.61**
1998	13.11	185.77	0.08	0.45	38.51	15.07	17.46	74.04	17.71	79.73	5.49	0.19	0.15	**447.76**
1999	12.77	178.79	0.07	0.36	38.57	15.39	18.68	74.38	15.96	77.63	5.5	0.19	0.15	**438.43**
2000	12.6	169.7	0.07	0.39	37.81	15.33	19.9	79.01	16.05	76.64	5.39	0.19	0.15	**433.23**
2001	12.47	174.9	0.07	0.42	37.31	15.83	21.12	79.33	16.40	75.84	5.32	0.18	0.15	**439.35**
2002	16.21	168.09	0.09	0.48	36.97	16.06	22.34	85.47	16.07	98.56	5.27	0.24	0.15	**466.01**
2003	15.77	162.49	0.08	0.44	35.83	16.33	23.57	84.16	19.77	95.92	5.11	0.23	0.14	**459.83**
2004	11.47	158.2	0.08	0.47	35.65	16.89	24.79	75.89	21.11	69.76	5.08	0.17	0.14	**419.70**
2005	11.83	154.73	0.09	0.51	33.33	17.50	26.01	79.90	20.24	71.94	4.75	0.17	0.13	**421.14**
2006	12.11	138.54	0.09	0.5	32.84	17.91	27.23	65.94	27.08	73.63	4.68	0.18	0.13	**400.88**
2007	10.04	129.08	0.08	0.48	31.69	18.36	28.61	64.38	20.59	61.04	4.52	0.15	0.13	**369.13**
2008	9.44	130.48	0.08	0.47	31.26	18.43	29.37	71.04	19.76	57.43	4.46	0.14	0.13	**372.50**
2009	8.9	119.4	0.07	0.41	30.94	18.58	31.05	54.48	20.37	54.1	4.41	0.13	0.12	**342.95**
2010	8.5	110.23	0.06	0.36	29.85	18.98	32.12	57.71	20.86	51.7	4.26	0.12	0.12	**334.88**
2011	8.43	106.76	0.06	0.35	29.98	19.11	33.34	60.35	20.40	51.25	4.27	0.12	0.12	**334.55**

4 INDUSTRIAL PROCESSES (CRF Sector 2)

4.1 Overview of the sector

Only the process related emissions are considered in this sector; emissions due to fuel combustion in manufacturing industries are allocated in the Fuel Combustion-Manufacturing Industries and Construction (IPCC category 1A2).

GHG emissions from Industrial Processes are grouped in the following Sub-sectors: Mineral Products (CRF 2.A), Chemical Industry (CRF 2.B), Metal Production (CRF 2.C), Other Production (CRF 2.D) and Consumption of Halocarbons and SF_6 (CRF 2.F).

The direct GHG emissions reported in this sector are associated with CO_2, CH_4, N_2O, HFCs, PFCs and SF_6.

Table 4.1 Status of emissions estimation within the Industrial Processes Sector

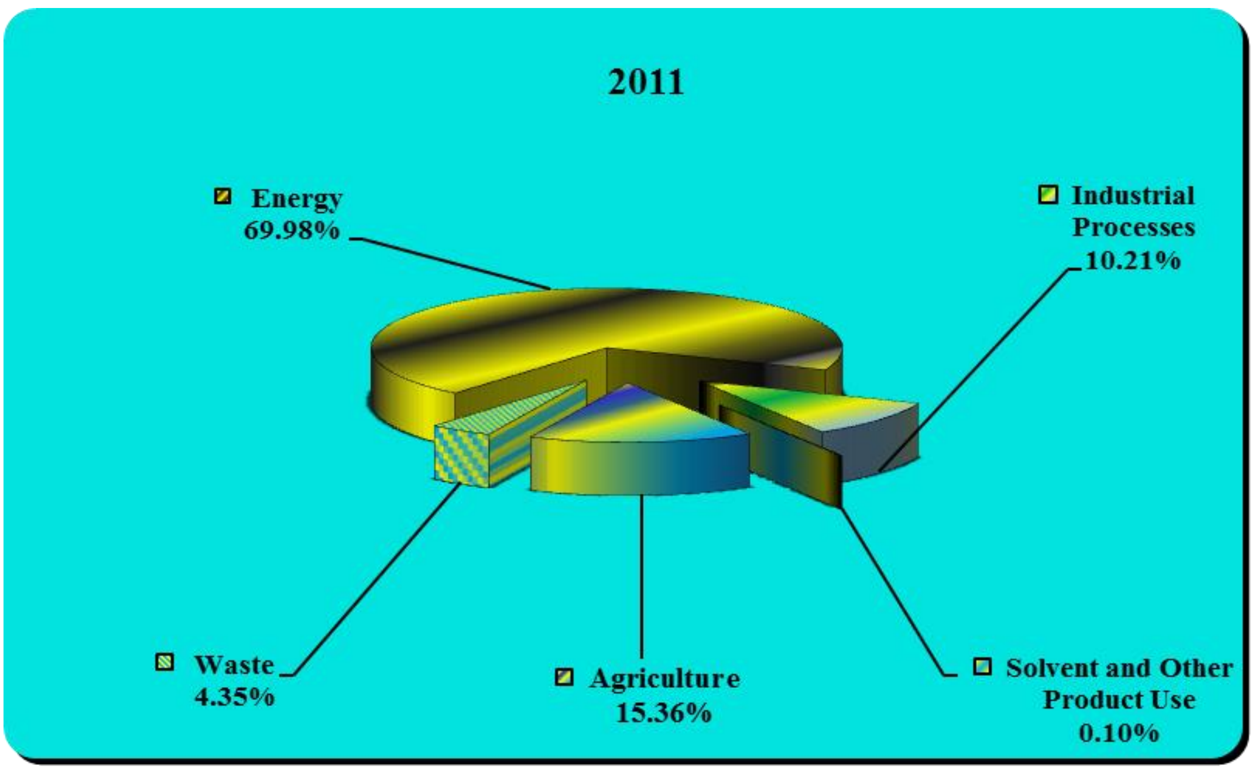
2 INDUSTRIAL PROCESSES	**Emissions estimation status**			
IPCC category	**CO_2**	**CH_4**	**N_2O**	**PFC**
2.A MINERAL PRODUCTS				
2.A.1 CEMENT PRODUCTION	✓	NA	NA	NA
2.A.2 LIME PRODUCTION	✓	NA	NA	NA
2.A.3 LIMESTONE AND DOLOMITE USE	✓	NA	NA	NA
2.A.4 SODA ASH PRODUCTION AND USE	✓	NA	NA	NA
2.A.5 ASPHALT ROOFING	NE	NA	NA	NA
2.A.6 ROAD PAVING WITH ASPHALT	NE	NA	NA	NA
2.A.7 OTHER (GLASS PRODUCTION)	✓	NE	NE	NA
2.B CHEMICAL INDUSTRY				
2.B.1 AMMONIA PRODUCTION	✓	NE	NE	NA
2.B.2 NITRIC ACID PRODUCTION	NA	NA	✓	NA

2 INDUSTRIAL PROCESSES	Emissions estimation status			
IPCC category	**CO_2**	**CH_4**	**N_2O**	**PFC**
2.B.3 ADIPIC ACID PRODUCTION	NO	NO	NO	NO
2.B.4.1 SILICON CARBIDE PRODUCTION	IE	✓	NA	NA
2.B.4.2 CALCIUM CARBIDE PRODUCTION	NO	NO	NO	NO
2.B.5 OTHER	NE	✓	NE	NA
2.C METAL PRODUCTION				
2.C.1 IRON AND STEEL PRODUCTION	✓	NE	NA	NA
2.C.2 FERROALLOYS PRODUCTION	✓	NE	NA	NA
2.C.3 ALUMINIUM PRODUCTION	✓	NE	NA	✓
2.C.4 SF_6 USED IN ALUMINIUM AND MAGNESIUM FOUNDRIES	NO	NO	NO	NO
2.C.5 OTHER	NA	NA	NA	NA
2.D OTHER PRODUCTION				
2.D.1 PULP AND PAPER	NA	NA	NA	NA
2.D.2 FOOD AND DRINK	NE	NA	NA	NA
2.E PRODUCTION OF HALOCARBONS AND SULPHUR HEXAFLUORIDE				
2.E.1 BY-PRODUCT EMISSIONS	NO	NO	NO	NO
2.E.2 FUGITIVE EMISSIONS	NO	NO	NO	NO
2.E.3 OTHER	NO	NO	NO	NO
2.F CONSUMPTION OF HALOCARBONS AND SULPHUR HEXAFLUORIDE				
2.F.1 REFRIGERATION AND AIR CONDITIONING EQUIPMENT	NA	NA	NA	✓
2.F.2 FOAM BLOWING	NA	NA	NA	✓
2.F.3 FIRE EXTINGUISHERS	NA	NA	NA	✓
2.F.4 AEROSOLS	NA	NA	NA	✓
2.F.5 SOLVENTS	NA	NA	NA	✓

2 INDUSTRIAL PROCESSES	Emissions estimation status			
IPCC category	**CO_2**	**CH_4**	**N_2O**	**PFC**
2.F.6 OTHER Please specify.	NA	NA	NA	✓
2.G OTHER	NA	NA	NA	NA

In 2011 the GHG emissions from Industrial Processes Sector contributed with 10.21% to the total GHG emissions in Romania.

Figure 4.1 The contribution of Industrial Processes Sector to the total GHG emissions in Romania, 2011



Emissions from this sector estimated in 2011 decreased by 64.40% compared with 1989 and increased with 1.58% compared with 2010.

The decrease from 1989 to 2011 is the result of the restructuration and privatization in various activity sectors.

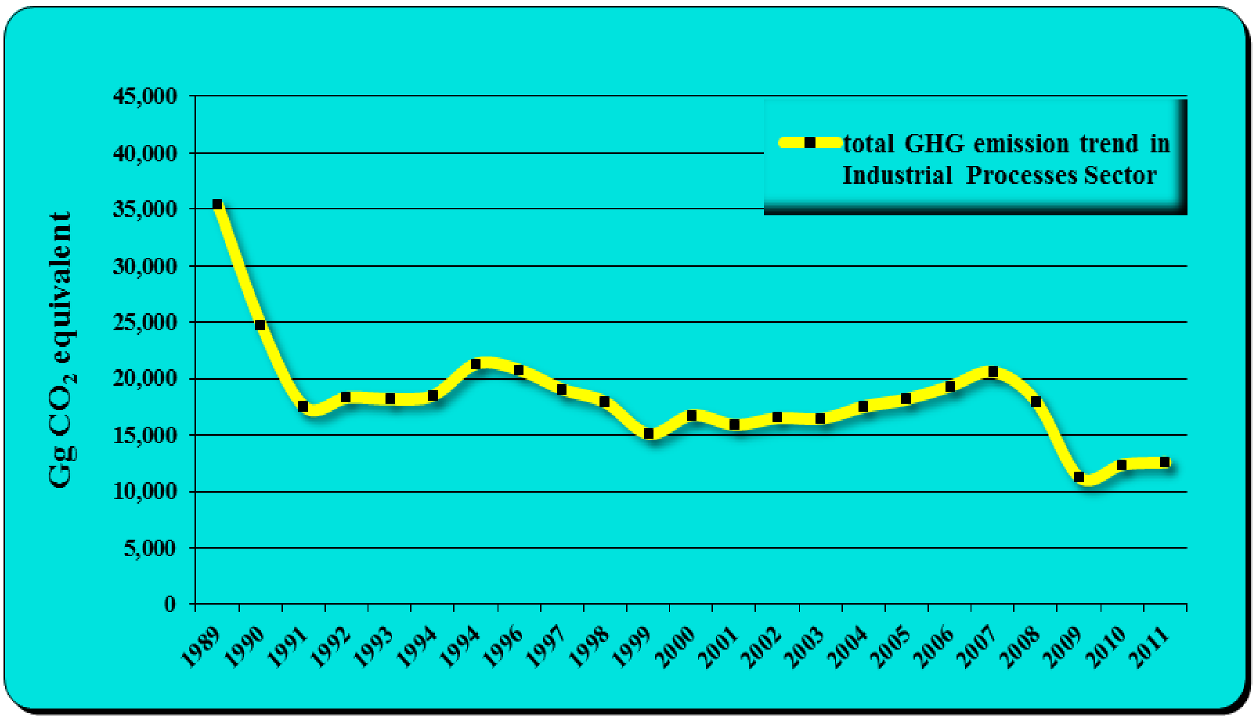
Starting with 2008 the emissions mainly decreased due to the reduction of various productions. In 2009 the emissions had also decreased due to the economic crisis reflected in many activity areas. In 2011 the emissions have recorded a increase due to increase of various industry productions.

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

- cement production, lime production, limestone and dolomite consumption, soda ash production and use, glass production recorded a decrease after 1989;
- starting with 2004 the cement production has recorded a minor increase;
- in 2008 a minor decrease was recorded in consumption of limestone and dolomite level;
- the lowest level of emissions from ammonia production was recorded in 1998, due to the activity data whose level decreased by almost a half compared to the previous and next year. This happened as one producing plant has stopped its activity since 1998 and another plant has been closed in 1998 and reopened in the next year;
- nitric acid production recorded a decrease after 1989. Starting with 2010 the nitric acid production level has recorded an increased;
- adipic acid production stopped at the end of 2001. Starting with 2002, the activity was suspended;
- calcium carbide production recorded a decrease after 1989 and the activity was suspended starting with 2007;
- iron and steel production recorded a decrease after 1989;
- ferroalloys production has recorded a decrease after 1989. The lowest level of emissions from ferroalloys production was recorded in 1999, due to the activity data whose level has decreased. This happened because ferroalloys production has stopped in 1999. In the next year (2000) the production was started again;
- the reduction of PFC emissions from production of aluminium due to changes in technologies, starting with 2003;
- in 2008 the trend of emission decreased due to reduction of production recorded for iron and steel production and ferroalloys production sub-sectors;

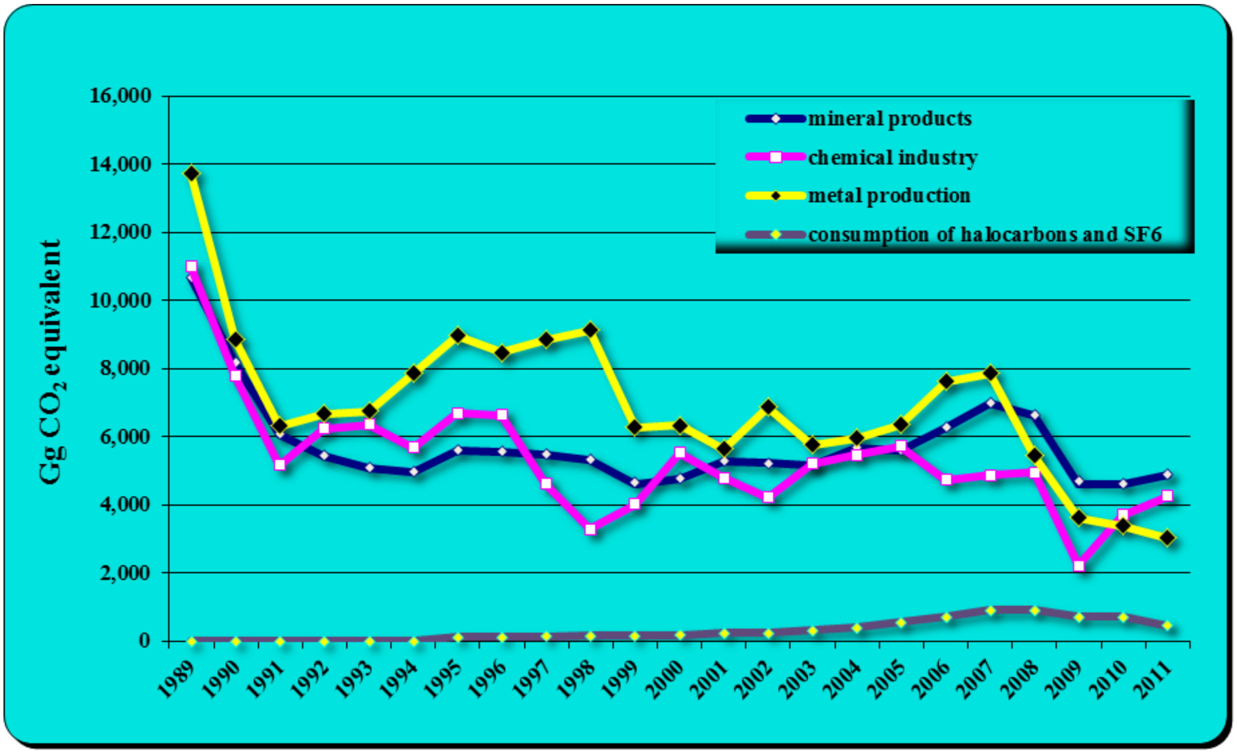
- for 2009 year a significant decrease of emissions level was recorded due to the economic crisis within many activity industries;
- in 2011 year the emissions have recorded an increase due to increase of various production activities level (soda ash production, glass production, cement production).

Figure 4.2 Total GHG emissions trend in Industrial Processes Sector, for 1989–2011 period



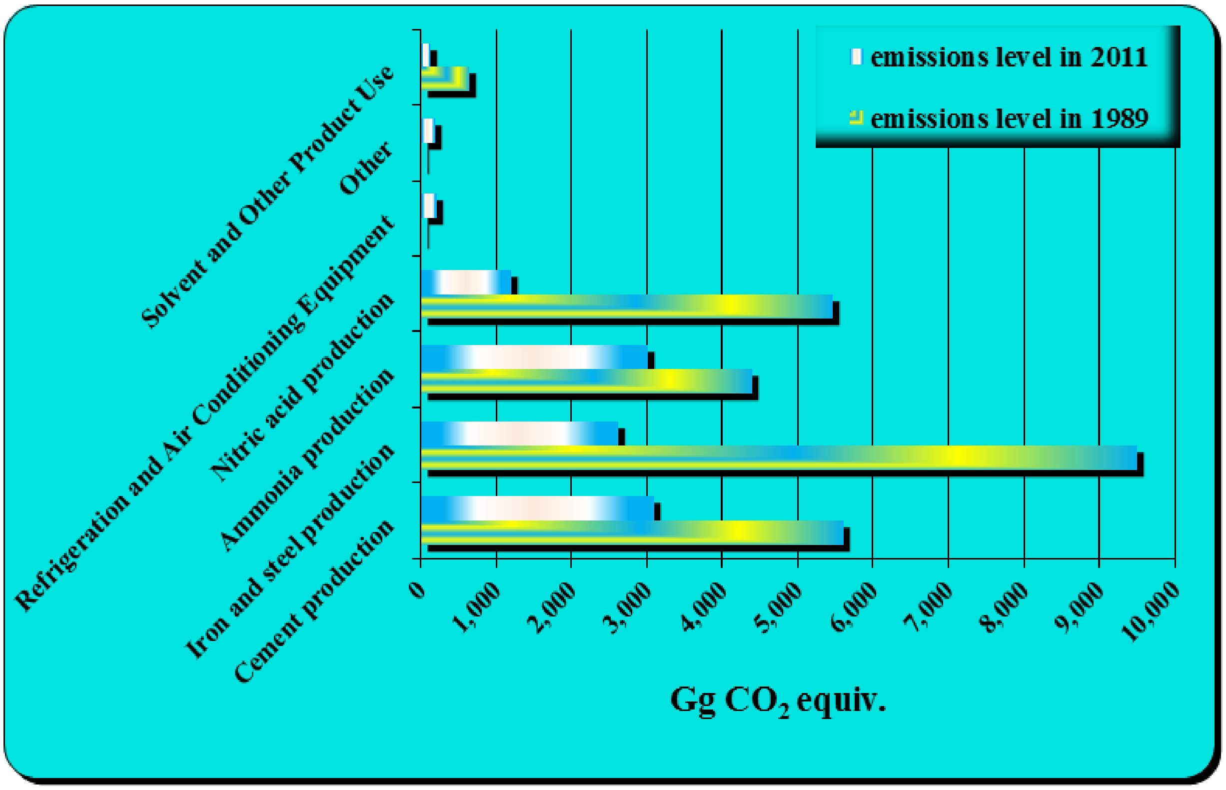
Metal Production contributes with 23.98% to the total GHG emissions from Industrial Processes Sector in 2011. Mineral Products and Chemical Industry are the two other main contributing Sub-sectors with 38.76% and 33.70%, respectively, of the total GHG emissions in this sector. The contribution of Consumption of Halocarbons and SF_6 Sub-sector to the overall sector is very low: 3.56%.

Figure 4.3 GHG emissions trends in Industrial Processes Sector, by sub-sectors, for 1989–2011 period



In the base year, various Industrial Processes Sub-sectors contributions were: Mineral Products 30.16%, Chemical Industry 31.05%, and Metal Production 38.79%, Consumption of Halocarbons and SF_6 0.00%.

Figure 4.4 Key categories in Industrial Processes Sector in 2011, both by level and trend criteria



The Tier 1 and Tier 2 key category analysis performed for 2011 has revealed the following key categories presented in the Table 4.2.

Table 4.2 Key categories in Industrial Processes Sector in 2011

Key category	GHG	Criteria	Contribution in total GHG emissions [%]
2.A.1 Cement Production	CO_2	L,T (Tier 1, excluding and including LULUCF)	2.5%
2.A.2 Lime Production	CO_2	L (Tier 1, excluding LULUCF) L,T (Tier 1, including LULUCF)	1.0%
2.A.3 Limestone and Dolomite Use	CO_2	T (Tier 1 including and excluding LULUCF)	0.3%
2.B.1 Ammonia Production	CO_2	L, T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	2.4%
2.B.2 Nitric Acid Production	N_2O	L, T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	1.0%
2.C.1 Iron and Steel Production	CO_2	L, T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	2.1%
2.C.2 Ferroalloys Production	CO_2	T (Tier 2, excluding LULUCF)	0.0%
2.C.3 Aluminium Production	PFC	T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	0.0%
2.F.1 Refrigeration and Air Conditioning Equipment	HFC	T (Tier 1 excluding LULUCF); L, T (Tier 2, excluding and including LULUCF).	0.2%
2.F.2 Foam Blowing	HFC	T (Tier 2, excluding and including LULUCF)	0.0%
2.F.9 Other	HFC	L, T (Tier 2, excluding and including LULUCF)	0.2%
3 Solvent and Other Product Use	CO_2	L, T (Tier 2, excluding and including LULUCF)	0.1%

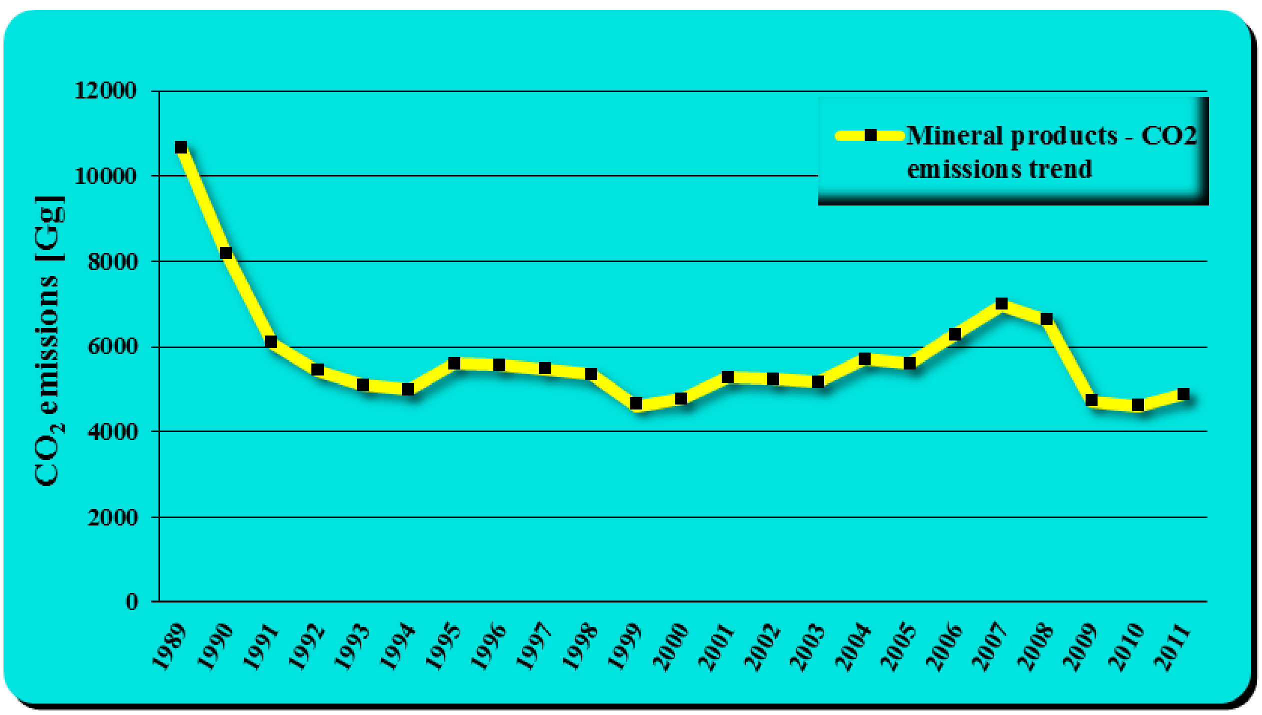
4.2 Source category Mineral Products (CRF Sector 2.A)

4.2.1 Source category description

GHG emissions reported include estimates for the following categories: Cement Production (IPCC category 2.A.1), Lime Production (IPCC category 2A2), Limestone and Dolomite Use (IPCC category 2A3), Soda Ash Production and Use (IPCC category 2A4), Asphalt Roofing (IPCC category 2A5), Road Paving with Asphalt (IPCC category 2A6) and Other: Glass Production (IPCC category 2A7).

CO_2 emissions from cement production represent an important key category of the inventory because of its contribution to the total inventory emissions level (in 2011 CO_2 emissions from production of cement contributed with 2.50% to total greenhouse gas emissions). In the base year, these emissions accounted for 2.05% from the total GHG emissions.

Figure 4.5 GHG emissions trend in the Mineral Products Sub-sector for 1989–2011 period [Gg CO_2]



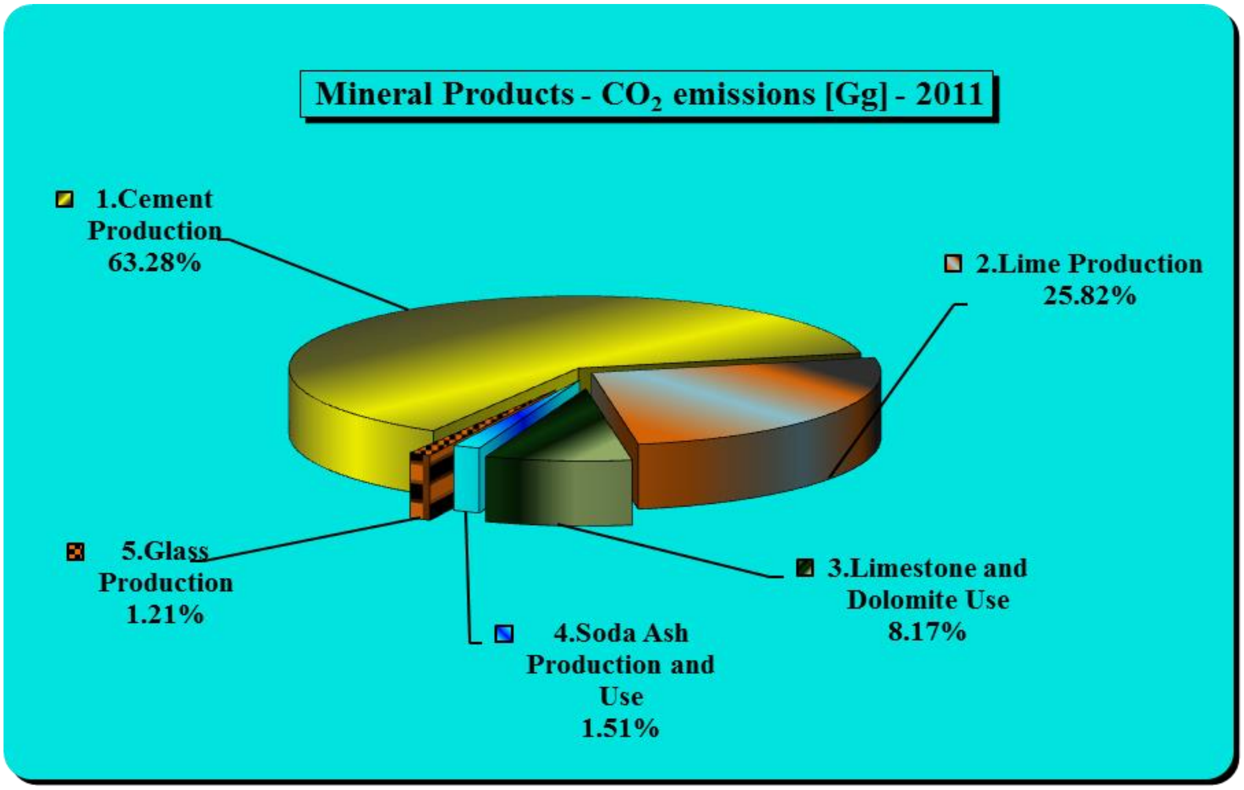
GHG emissions in the Mineral Products Sub-sector were decreased during 1989–2011 period due to the decrease recorded after 1989 in Cement Production, Lime Production, Limestone and Dolomite Consumption, Soda Ash Production and Use, and Glass Production; the emissions were relatively stable during 1993–2007 period. Starting with 2004 the Cement Production has recorded a minor increase. In 2009 a significant decrease of emissions level was recorded in cement, lime, limestone and dolomite, soda ash and glass industries due to the economic crisis. In 2011 the emissions rised due to increase of Cement Production, Glass Production and Soda Ash Production.

Mineral Products Sub-sector was responsible for 38.76% of the Industrial Processes Sector related GHG emissions in 2011.

Table 4.3 CO_2 emissions in the Mineral Products Sub-sector, in the year 2011

Sector	**CO_2 emissions [Gg]**
2.A Mineral Products	4,880.99
2.A.1 Cement Production	3,088.84
2.A.2 Lime Production	1,260.41
2.A.3 Limestone and Dolomite Use	398.80
2.A.4 Soda Ash Production and Use	73.80
2.A.7.1 Glass Production	59.15

Figure 4.6 Structure of the Mineral Products Sub-sector, in 2011



4.2.2 Methodological issues

Cement Production (IPCC category 2.A.1)

Methodology

The Cement Production is a key category from both level and trend point of view (Tier 1, excluding and including LULUCF). The method for calculating emissions of CO_2 from cement is in line with the IPCC GPG 2000 (Tier 2), considering the “Decision Tree for Estimation of CO_2 Emissions from Cement Production” from IPCC GPG 2000 - page 3.11 and taking into account all the parameters described below.

Activity data

The AD necessary to estimate emissions from this source category are provided by the economic agents (clinker production data) and the National Institute for Statistics (Cement Production). Process specific CO_2 is emitted during the production of clinker (calcination process) when calcium carbonate ($CaCO_3$) is heated in a cement kiln. During this process calcium carbonate is converted into lime (CaO - Calcium Oxide) and CO_2. Activity data related to the calcinations process were collected directly from the companies:

- clinker production data was provided by each company 1989-2011 period;
- plant specific content of CaO (%) in clinker was provided by each company (according with laboratory analyses) starting with 2008 year;
- plant specific content of MgO (%) in clinker was provided by each company (according with laboratory analyses) starting with 2008 year;
- cement kiln dust (CKD) is completely recycled in the kiln. Two plants reported **a** correction factor for discarded amounts of dust: one of them for the period 1989-2003 and other plant for 2006 year. Starting with 2007 year there was no reported correction factor for discarded amounts of dust.

Emission factors

The CO_2 EF has also been estimated considering the provisions in the “Decision Tree for Estimation of CO_2 Emissions from Cement Production” from IPCC GPG 2000 - page 3.11 and taking into account all the information provided by each cement company.

In 31 March 2005, a working meeting was held between the NEPA, National Institute for Research and Development in Environmental Protection and the representatives of cement industry, two methodologies for estimating CO_2 emissions from cement production being compared:

- IPCC Good Practice Guidence and Uncertainty Management in National Greenhouse Gas Inventories (IPCC GPG 2000);
- Cement CO_2 protocol, developed within the World Business Council for Sustainable Development (WBCSD), an instrument used by cement manufacturers throughout the world.

Concluding, according to the IPCC GPG 2000, CO_2 emissions from decarbonation of raw materials (from process) are calculated based on clinker production by multiplication with a factor of 510 kg CO_2/t clinker, enabling its correction if there are available input data with a higher precision. Also, it was agreed, based on cement CO_2 protocol, the correction of this factor to **525 kg/t clinker** due to $MgCO_3$ availability in raw material.

For 1989-2007 the default CO_2 emission factor (EF) **0.525 t CO_2/t clinker** was improved. The new specific EF was calculated considering the average between the base year 1989 implied EF (0.527 t CO_2/t clinker) and 2008 EF (the first year with laboratory analyses for plant specific CaO and MgO content in clinker), 0.530 t CO_2/t clinker. The resulted specific emission factor for 1989-2007 period is 0.5285 t CO_2/t clinker.

A value of the IEF has been calculated by dividing the emissions by clinker production data for 1989; the value differs comparing to the previously presented EF value considering the CKD correction factor value (provided by operators on a plant basis).

An average EF value has been calculated as arithmetic mean between the IEF value for 1989 and EF value for 2008 (please see the description below). The value is used for every year of 1989-2007 period and is different comparing to the IEF values when the CKD correction factor value is not 1.

Starting with 2008, analyses have been made for CaO and MgO content and can be considered as representative in order to be used for calculating CO_2 emissions or plant specific clinker EF (plant specific content of CaO and MgO - % in clinker was provided by each company - according with laboratory analyses). We can't provide the CaO and MgO content values per each company because there data are confidential. We can provide the average values related with the plant specific content of CaO and MgO -% in clinker (0.651 for CaO and 0.017 for MgO for 2008 year, 0.656 for CaO and 0.015 for MgO for 2009 year, 0.655 for CaO and 0.015 for MgO for 2010 year, 0.656 for CaO and 0.015 for MgO for 2011 year). A weighted average related with the plant specific EF's for clinker production is presented in the Table 4.4.

CO_2 emissions from clinker are estimated using a combined **Tier 2** with **country specific method**, according to the formula 4.1.

Equation 4.1 Calculation of CO_2 emissions from clinker

$$Emissions_{Clinker\ Production} = EF_{clinker} \times Clinker\ Production$$

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

Equation 4.2 Calculation of EF for clinker

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

For 1989-2007 period the CO_2 emission factor use for clinker was 0.5285 t CO_2/t clinker (average between the base year 1989 implied EF and 2008 EF (the first year with laboratory analyses for plant specific CaO and MgO content in clinker).

Equation 4.3 Calculation of CO_2 emissions from CKD (cement kiln dust)

$$Emissions_{CKD} = EF_{CKD} \times amount\ of\ CKD \times CKD_{Correction\ Factor}$$

Emissions resulted from discarded cement kiln dust were calculated separately taking into account its degree of calcinations and added to the CO_2 emissions resulted from calcinations (the production of clinker). The correction factor for discarded amounts of dust varies between 1.00 and 1.13 along all-time series and due to the small amount of CKD the default EF as clinker production 0.525 t CO_2 / t clinker was used starting with 2007.

Starting with 2008 emissions resulted from discarded cement kiln dust were calculated separately taking into account its degree of calcinations and added to the CO_2 emissions resulted from calcinations (the production of clinker). The value of correction factor for discarded amounts of dust is 1.

Equation 4.4 Calculation of CO_2 emissions

$$Emissions = Emissions\ from\ Clinker\ Production + Emissions\ from\ CKD$$

Emissions were calculated distinctly, for every plant; the activity and, respectively, emissions data were added and reported for the entire subsector.

Starting with 2008 the figures related with clinker production, plant specific CO_2 EF for clinker production and CO_2 emissions from clinker production were compared with the data reported in monitoring plans associated with GHG emissions for the **EU-ETS cement production installations**. The data are similar.

Table 4.4 Clinker Production data and CO_2 emissions from Clinker Production in the period 1989–2011

Year	Activity data and CO_2 emissions from Cement Production Sub-sector		
	Clinker production [kt]	Emission factor [tCO_2/t clinker]	CO_2 Emissions [Gg]
1989	10,571.00	0.5285	5,609.10
1990	8,379.00	0.5285	4,445.30
1991	6,037.00	0.5285	3,200.75
1992	5,488.00	0.5285	2,905.96
1993	5,349.00	0.5285	2,833.43
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

SO_2 emissions from cement production are estimated using the following formula:

Equation 4.5 Calculation emissions of SO_2 from cement

$$SO_2\ [Gg] = Quantity\ of\ Cement\ Produced\ (t) \times Emission\ Factor \times 10^{-6}$$

The default emission factor of 0.3 kg SO_2/tonne cement is used.

Table 4.5 Cement Production data and SO_2 emissions from Cement Production in the period 1989–2011

Year	Activity data and SO_2 emissions from Cement Production Sub-sector		
	Cement production [kt]	Emission factor [kg SO_2 /t cement]	SO_2 Emissions [Gg]
1989	12,225.00	0.30	3.67
1990	9,468.00	0.30	2.84
1991	6,692.00	0.30	2.01
1992	6,271.00	0.30	1.88
1993	6,158.00	0.30	1.85
1994	5,998.00	0.30	1.80
1995	6,842.00	0.30	2.05
1996	6,956.00	0.30	2.09
1997	6,553.00	0.30	1.97
1998	6,577.00	0.30	1.97
1999	5,580.00	0.30	1.67
2000	6,058.00	0.30	1.82
2001	5,668.00	0.30	1.70
2002	5,680.00	0.30	1.70
2003	5,992.00	0.30	1.80
2004	6,239.00	0.30	1.87
2005	7,043.00	0.30	2.11
2006	8,253.00	0.30	2.48
2007	10,060.00	0.30	3.02
2008	10,660.00	0.30	3.20
2009	7,902.00	0.30	2.37
2010	6,992.00	0.30	2.10
2011	8,087.00	0.30	2.43

The data on the amount of cement produced is provided by the National Institute for Statistics. The data set in case of Cement Production is complete.

Lime Production (IPCC category 2.A.2)

Methodology

The Lime Production is a key category only considering the level criteria (Tier 1, excluding LULUCF and from both level and trend point of view (Tier 1, including LULUCF).

Total CO_2 emissions from Lime Production were estimated using production data and the emission factors, in line with the Good Practice Guidance - IPCC GPG 2000, considering the "Decision Tree for Lime Production" from IPCC GPG 2000 - page 3.21 and taking into account the information from "Table 3.4 - Basic Parameters for the Calculation of Emission Factors for Lime Production "– page 3.22 (IPCC GPG 2000).

Activity data

The ADs necessary to estimate emissions from this source category (quicklime and dolomite lime) are provided by the National Statistics. Starting with 2007 the data related with Lime Production are confidential.

Following consultation between experts in the National Environmental Protection Agency and in National Institute for Statistics, Romania corrected estimates of CO_2 emissions from Lime Production through the use of revised activity data (AD) in that calculation: dolomitic lime production (calcined/sintered dolomite and agglomerated dolomite).

Anteriorly emission estimation was based on AD mentioned above and on crude dolomite production.

For 1989 year and for the 1998 to 2000 period there is no data information on the production of calcined/sintered dolomite and agglomerated dolomite.

For these years an average percentage of dolomitic lime production excluding crude dolomite amount in total dolomitic lime production amount for years for which data on dolomitic lime production excluding crude dolomite amount is available was obtained and applied for 1989 and 1998–2000 years to total dolomitic lime production.

Emission factors

The CO_2 EF's are estimated considering the Equations 3.4, 3.5A, 3.5B, from IPCC GPG 2000, page 3.20. taking into account the default values from "Table 3.4 - Basic Parameters for the Calculation of Emission Factors for Lime Production" – page 3.22 (IPCC GPG 2000).

EF_1 = Stoichiometric Ratio ($_{CO2\ /\ CaO)}$ • CaO $_{Content}$

EF_2 = Stoichiometric Ratio ($_{CO2\ /\ CaO\cdot MgO)\ \bullet\ (CaO\cdot MgO)\ Content}$

Where: EF_1 = emission factor for quicklime

Where: EF_2 = emission factor for dolomitic quicklime

For confidentiality reasons the presentation of CO_2 emission factor used to estimate emission from Lime Production is omitted.

Table 4.6 CO_2 emissions from Lime Production in the period 1989–2011

Year	**Emissions from Lime Production Sub-sector**
	CO_2 emissions [Gg]
1989	3,222.27
1990	2,389.47
1991	1,830.74
1992	1,529.98
1993	1,371.52
1994	1,281.56
1995	1,391.29
1996	1,374.67
1997	1,327.99
1998	1,477.36
1999	1,322.83
2000	1,347.42
2001	1,620.66
2002	1,578.18
2003	1,581.22
2004	1,685.73
2005	1,482.76
2006	1,645.31
2007	1,940.95
2008	1,759.32
2009	1,185.85
2010	1,274.52
2011	1,260.41

Limestone and Dolomite Use (IPCC category 2.A.3)

Methodology

Limestone and Dolomite Use is a key category only considering the trend criteria (Tier 1 including and excluding LULUCF). The IPCC methodology has been followed for estimating the CO_2 emissions from Limestone and Dolomite Used. According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the CO_2 emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.6 and Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual, page 2.10. The method estimates the amount of Limestone and Dolomite Used in the Iron and Steel Production, Pulp and Paper Production, sugar mills production, ceramics plants, for all-time series.

Activity data

The activity data were provided directly by the plants (iron and steel producers, pulp and paper producers, sugar mills producers, ceramics producers).

In order to estimate CO_2 emissions from Limestone and Dolomite Used Sub-sector it was made a questionnaire which it was sent to the Local Environmental Protection Agencies. Each agency manages all economic agents which are in its responsibility (iron and steel producers, pulp and paper producers, sugar mills producers, ceramics producers) in order to complete the needed data. The completed questionnaire has been sent to NEPA where the data are aggregated.

Considering the Iron and Steel Production data there was estimated the amount of lime used for each technological process and then it was aggregated all the amount of lime used. For avoiding the double counting with Lime Production category, the total amount of lime used in the two integrated iron and steel plants, was subtracted from the total consumption of limestone provided by economic agents.

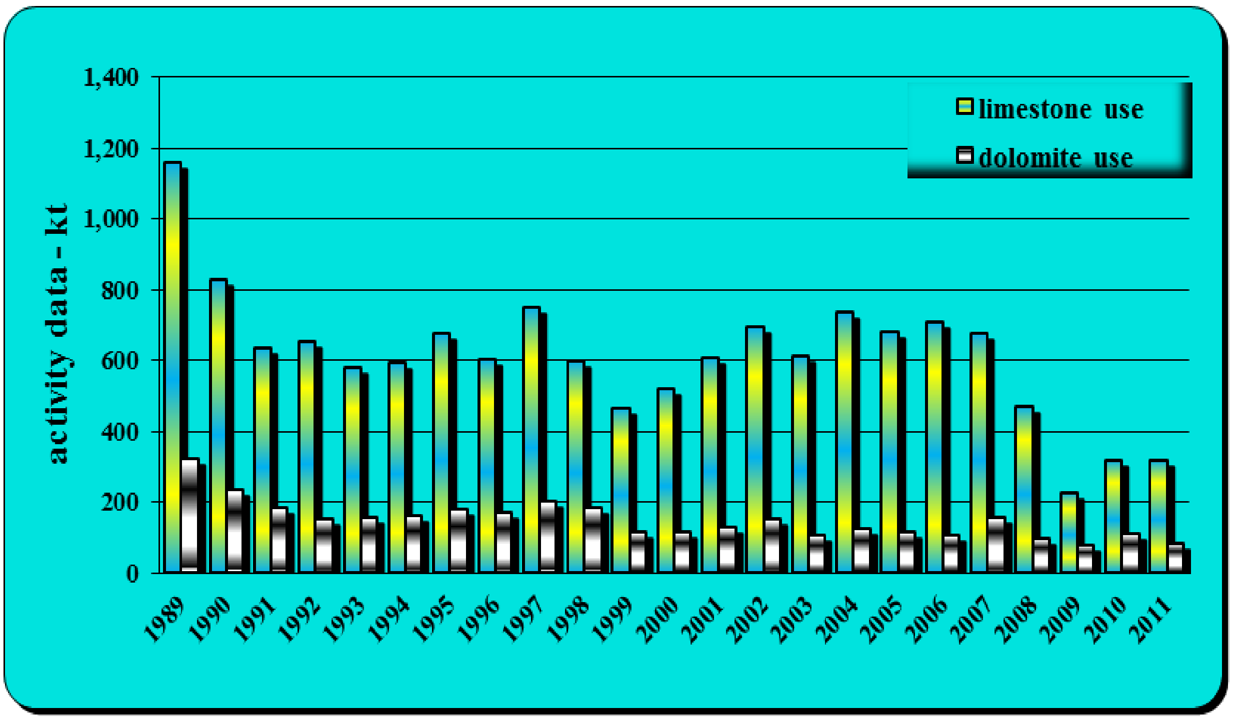
Table 4.7 Amount of Limestone and Dolomite used and CO_2 emissions in the period 1989–2011

Year	Activity data from Limestone and Dolomite Use Sub-sector			
	Limestone Use	Dolomite Use	Total Limestone and Dolomite Consumption	CO_2 emission from Limestone and Dolomite Consumption
	[kt]			[Gg]
1989	2,633.01	680.28	3,313.29	1,483.02
1990	1,880.17	489.84	2,370.01	1,060.93
1991	1,448.95	386.41	1,835.36	821.85
1992	1,482.95	323.59	1,806.53	806.85
1993	1,316.30	330.03	1,646.33	736.59
1994	1,348.53	335.71	1,684.25	753.49
1995	1,542.57	382.23	1,924.80	861.05
1996	1,375.21	354.48	1,729.68	774.18
1997	1,703.77	421.32	2,125.09	950.63
1998	1,359.84	384.09	1,743.93	781.54
1999	1,059.28	241.20	1,300.48	581.14
2000	1,182.70	242.75	1,425.46	636.18
2001	1,384.10	272.90	1,657.00	739.18
2002	1,580.51	319.13	1,899.64	847.65
2003	1,390.25	219.40	1,609.65	716.37
2004	1,671.11	264.95	1,936.06	861.67
2005	1,548.25	247.50	1,795.76	799.29
2006	1,615.57	221.73	1,837.30	816.62
2007	1,535.29	332.00	1,867.29	833.89
2008	1,065.28	201.27	1,266.55	564.73
2009	513.37	168.70	682.06	306.35
2010	722.11	228.91	951.02	426.92
2011	719.53	172.34	891.86	398.80

Emission factors

The default emission factors 477 kg CO_2/tonne dolomite and 440 kg CO_2/tonne limestone are used.

Figure 4.7 Amount of Limestone and Dolomite Used, related with Iron and Steel Production, Pulp and Paper Production, sugar mills production, ceramics plants in the period 1989–2011



Soda Ash Production and Use (IPCC category 2.A.4)

Methodology

According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the CO_2 emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.8 and Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual, pages 2.12–2.13.

Total CO_2 emissions from Soda Ash Production were estimated using the quantity of trona utilized and the emission factor, in line with the IPCC 1996. CO_2 emission from Soda Ash Use were estimated using the data provided directly from economic agents which use Soda Ash in their activities and the default emission factor, line with the IPCC 1996.

Activity data

Soda Ash Production data are annually provided by the National Statistics. Starting with 2007 the data related with Soda Ash Production are confidential. Data on Soda Ash Use were provided directly from economic agents who use soda ash in theirs activities (the soda ash consumption data has been provided by pulp and paper producers, chemicals producers, flue gas desulphurization, water treatment, and soap and detergents producers). In order to estimate CO_2 emissions from Soda Ash Use Sub-sector it was made a questionnaire which it was sent to the Local Environmental Protection Agencies. Each agency manages all economic agents which are in its responsibility (pulp and paper producers, chemicals producers, flue gas desulphurization, water treatment, and soap and detergents producers) in order to complete the needed data. The completed questionnaire has been sent to NEPA where the data are aggregated.

Emission factors

The default emission factors for Soda Ash Use 415 kg CO_2 / tonne of Soda Ash Use is used.
For confidentiality reasons the presentation of CO_2 emission factor used to estimate emission from Soda Ash Production is omitted.

Figure 4.8 CO_2 emissions from Soda Ash Production and Use in the period 1989–2011

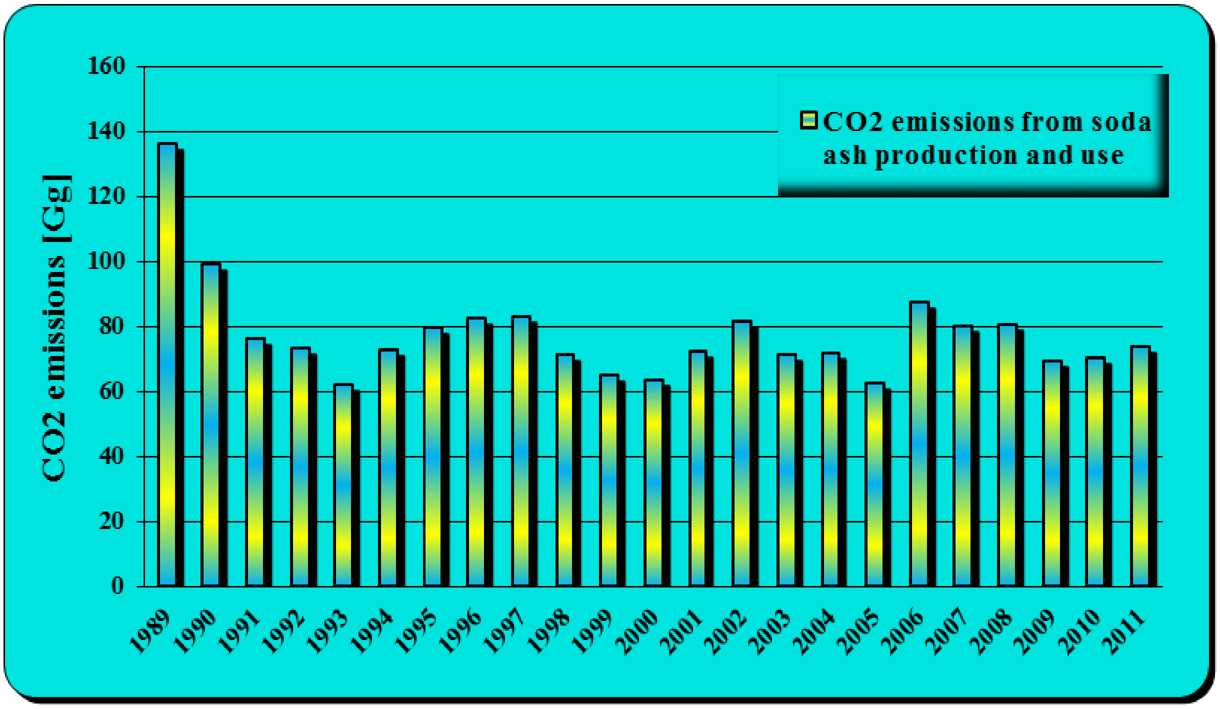


Table 4.8 CO_2 emissions from Soda Ash Production and Use in the period 1989–2011

Year	**Emissions from Soda Ash Production and Use Sub-sector**
	CO_2 emissions [Gg]
1989	136.35
1990	99.11
1991	75.90
1992	73.38
1993	61.92
1994	72.59
1995	79.43
1996	82.54
1997	83.08
1998	71.20
1999	64.88
2000	63.20
2001	72.18
2002	81.66
2003	71.43
2004	71.54
2005	62.71
2006	87.34
2007	79.84
2008	80.58
2009	69.53
2010	70.40
2011	73.80

Asphalt Roofing Production (IPCC category 2.A.5)

Methodology

The default 1996 IPCC methodology for estimation the emissions from Asphalt Roofing Production Sub-sector has been used. According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the NMVOC emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.9, Tables 2–2 and 2–3.

Activity data

The data on Asphalt Roofing Production Sub-sector are provided by National statistics. These data are available starting with 2005 year. The data taking into account in order to estimate CO and NMVOC emissions are: petroleum bitumen for materials insulation, petroleum bitumen for pipelines insulation, products based on bitumen – waterproofing, bitumen oil for industry, asphalt board. Starting with 2007 the data related with Asphalt Roofing Production are confidential.

Emission factors

The default IPCC emission factors were used in order to estimate NMVOC and CO emissions.

Table 4.9 Emission factors for NMVOC, CO from Asphalt Roofing Production Sector

EMISIONS FACTORS FOR ASPHALT ROOFING PRODUCTION–SATURATION PROCES [Kg/tone product]	
NMVOC	**0.0475**
CO	**0.0095**
EMISIONS FACTORS FOR ASPHALT BLOWING PROCESS – no control [Kg/tone product]	
NMVOC	**2.4**

Road Paving with Asphalt (IPCC category 2.A.6)

Methodology

The default CORINAIR emission inventory guidebook for estimation the emissions from Road Paving with Asphalt Sub-sector has been used.

Activity data

The data on Road Paving with Asphalt Sub-sector are provided by National statistics. These data are available starting with 1998 year. The activity data taking into account in order to estimate NMVOC emissions are: natural bitumen and asphaltic rocks, bituminous mixtures based on natural or artificial aggregate and bitumen or natural asphalt, petroleum bitumen road. Starting with 2007 the data related with Road Paving with Asphalt are confidential.

Emission factors

The default CORINAIR emission inventory guidebook EF was used in order to estimate NMVOC emissions: 0.016 kg NMVOC/ tone material used.

Others: Glass Production (IPCC category 2.A.7.1)

Methodology

CO_2 emissions are estimated for container glass, flat glass and glass wool. Total emissions from Glass Production were estimated using production data and the emission factors, in line with CORINAIR methodology. According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the CO_2 emissions, therefore it was followed the CORINAIR and IPCC 2006 methodologies.

Activity data

Source of the data activity is the National Institute for Statistics. Starting with 2007 the data related with container glass, glass wool and flat glass production are confidential.

For the period **1989–2007** there is no data information on the production of glass wool and flat glass.

For the period **1989–2007** the productions of flat glass and glass wool were calculated by extrapolation.

Therefore we calculated an average percentage for the period 2008–2011 for each type of glass: container glass, flat glass and glass wool. The average percentage was applied to the production of container glass for the period 1989–2007 to calculate the production of flat glass and glass wool.

Emission factors

The emission factor was collected from the Emission Inventory Guidebook 2006 as being specific to the Netherlands.

For confidentiality reasons the presentation of CO_2 and NMVOC emission factors used to estimate emission from container glass, flat glass and glass wool production are omitted.

Table 4.10 CO_2 emissions from Container Glass and Flat Glass Production in the period 1989–2011

Year	**Emissions from Glass Production Sub-sector**
	CO_2 emissions [Gg]
1989	219.24
1990	178.53
1991	145.38
1992	119.80
1993	95.95
1994	105.26
1995	118.05
1996	125.61
1997	104.68
1998	93.04
1999	55.25
2000	75.02
2001	77.93
2002	77.93
2003	154.11
2004	88.39
2005	77.34
2006	73.27
2007	69.20
2008	73.79
2009	55.60
2010	58.61
2011	59.15

4.2.3 Uncertainties and time series consistency

Cement Production (IPCC category 2.A.1)

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

- AD: 2%;
- EF: 2%;
- 2.83% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Lime Production (IPCC category 2.A.2)

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

- AD: 5%;
- EF: 2%;
- 5.39% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Limestone and dolomite use (IPCC category 2.A.3)

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

- AD: 3%;
- EF: 2%;
- 3.61% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Soda Ash Production and Use (IPCC category 2.A.4)

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

- AD: 5 %;
- EF: 20 %;
- 20.62% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Glass Production (IPCC category 2.A.7.1)

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

- AD: 5%;
- EF: 20%;

- 20.62% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

4.2.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Chemical Industry, Metal Production and Other Production Sub-sectors, the results of these being mentioned on the Checklists level.

Following these activities there were unconformities recorded.

Recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 version 2 of the 2012 NGHGI; they are described in the Chapter 4.2.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.2.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

Starting with 2008 year the data used in order to estimate CO_2 emissions from clinker production were compared with the data reported in monitoring plans of GHG emissions for the EU-ETS **cement production installations**. The data are similar.

The CO_2 emissions from Lime Production, Limestone and Dolomite Use, Soda Ash Use and Glass Production, were compared with the emissions reported in monitoring plans of GHG emissions for the EU-ETS installations. Further elements are presented within Annex 8.3.

4.2.5 Source specific recalculation, including changes made in response to the review process

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

- activity data:
    - Limestone and Dolomite Use (IPCC category 2.A.3);
    - Glass Production (IPCC category 2.A.7.1).

Table 4.11 The effects of recalculations in Mineral Industry Sub-sector

The effects of recalculations in Mineral Industry Sub-sector			
Years	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	Difference [%]
	CO_2 equivalent [Gg]		
1989	10,787.48	10,669.97	-1.09
1990	8,241.09	8,173.33	-0.82
1991	6,118.79	6,074.63	-0.72
1992	5,467.71	5,435.96	-0.58
1993	5,152.35	5,099.42	-1.03
1994	5,034.89	4,983.81	-1.01
1995	5,657.49	5,595.66	-1.09
1996	5,603.80	5,557.04	-0.83
1997	5,545.07	5,471.32	-1.33
1998	5,423.33	5,339.09	-1.55
1999	4,738.05	4,668.86	-1.46
2000	4,843.15	4,777.77	-1.35
2001	5,349.27	5,278.31	-1.33
2002	5,325.25	5,227.52	-1.84
2003	5,215.92	5,173.17	-0.82
2004	5,792.66	5,699.43	-1.61
2005	5,687.03	5,596.91	-1.58
2006	6,364.30	6,278.11	-1.35
2007	7,046.39	6,977.85	-0.97
2008	6,674.51	6,621.08	-0.80
2009	4,729.28	4,710.40	-0.40
2010	4,632.57	4,608.34	-0.52

Limestone and Dolomite Use (IPCC category 2.A.3)

Recalculation have been made for the entire time series. Considering the Iron and Steel Production data there was estimated the amount of lime used for each technological process and then it was aggregated all the amount of lime used. For avoiding the double counting with lime production category, the total amount of lime used in the two integrated iron and steel plants, was subtracted from the total consumption of limestone provided by economic agents.

Table 4.12 Recalculations of CO_2 emissions [Gg] in the Limestone and Dolomite Use sub-sector

The effects of recalculations in Limestone and Dolomite Use Sub-sector			
Years	**NGHGI 2012 v. 3.1**	**NGHGI 2013 v. 1.4**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	1,710.01	1,483.02	-13.27
1990	1,221.26	1,060.93	-13.13
1991	941.69	821.85	-12.73
1992	896.69	806.85	-10.02
1993	828.53	736.59	-11.10
1994	856.08	753.49	-11.98
1995	981.08	861.05	-12.23
1996	885.45	774.18	-12.57
1997	1,080.36	950.63	-12.01
1998	913.12	781.54	-14.41
1999	672.42	581.14	-13.57
2000	736.23	636.18	-13.59
2001	845.57	739.18	-12.58
2002	973.81	847.65	-12.96
2003	848.97	716.37	-15.62
2004	998.09	861.67	-13.67
2005	931.41	799.29	-14.18
2006	945.98	816.62	-13.67
2007	946.08	833.89	-11.86
2008	668.24	564.73	-15.49
2009	363.88	306.35	-15.81
2010	493.91	426.92	-13.56

Glass Production (IPCC category 2.A.7.1)

The recalculations have been made due to improved activity data on production of glass being considered and other flat glass and mineral wool for the entire time series**.**

For the period 1989–2007 there is no data information on the production of glass wool and all flat glass. Therefore we calculated an average percentage for the period 2008–2011 for each type of glass: container glass, flat glass and glass wool. The average percentage was applied to the production of container glass for the period 1989–2007 to calculate the production of flat glass and glass wool for this period.

Table 4.13 Recalculations of CO_2 emissions [Gg] in the Glass Production Sub-sector

The effects of recalculations in Glass Production Sub-sector			
Years	**NGHGI 2012 v. 3.1**	**NGHGI 2013 v. 1.4**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	109.75	219.24	99.76
1990	85.95	178.53	107.71
1991	69.70	145.38	108.58
1992	61.70	119.80	94.16
1993	56.95	95.95	68.49
1994	53.75	105.26	95.83
1995	59.85	118.05	97.24
1996	61.10	125.61	105.58
1997	48.70	104.68	114.94
1998	45.70	93.04	103.60
1999	33.15	55.25	66.65
2000	40.35	75.02	85.92
2001	42.50	77.93	83.35
2002	49.50	77.93	57.42
2003	64.25	154.11	139.85
2004	45.20	88.39	95.56
2005	35.35	77.34	118.79
2006	30.10	73.27	143.43
2007	25.55	69.20	170.85
2008	23.70	73.79	211.34
2009	16.95	55.60	228.02
2010	15.85	58.61	269.78

4.2.6 Source specific planned improvements, including those in response to the review process

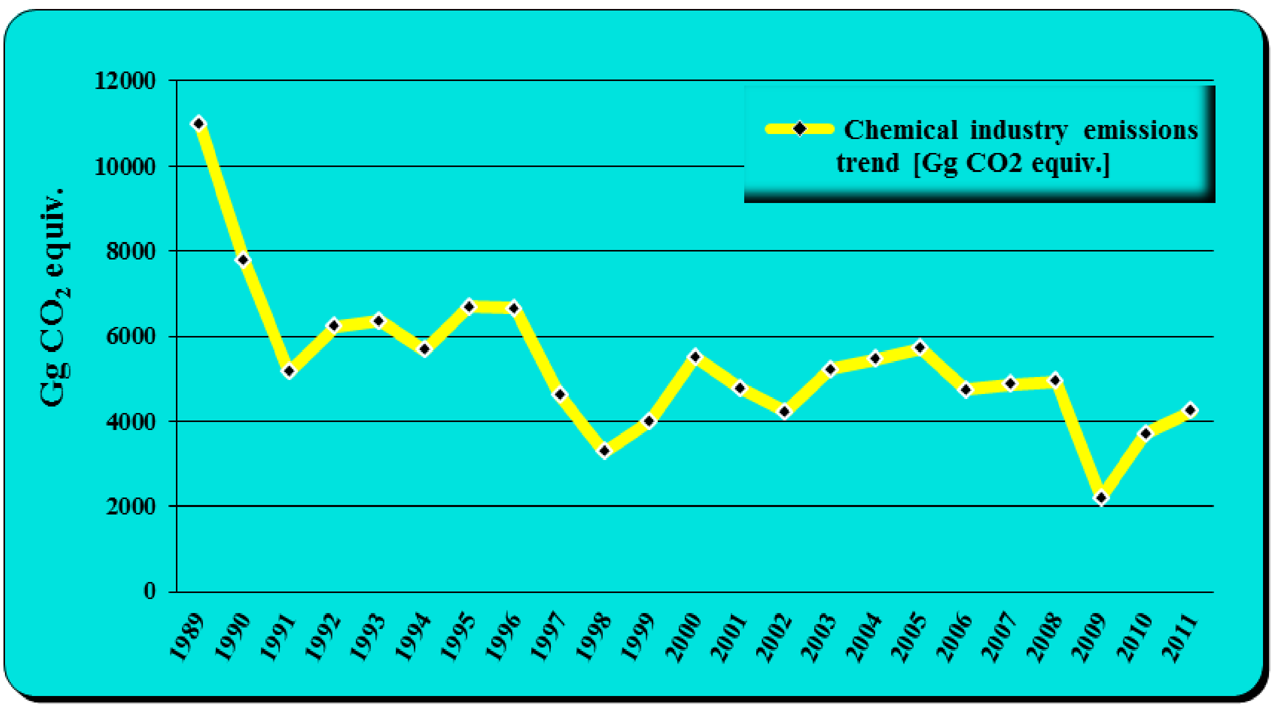
More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

4.3 Source category Chemical Industry (CRF Sector 2.B)

4.3.1 Source category Description

CRF Sector 2.B includes: Ammonia Production (IPCC category 2B.1), Nitric Acid Production (IPCC category 2B.2), Adipic Acid Production (IPCC category 2B.3) -until 2001, Silicon Carbide Production (IPCC category 2B.4.1) Calcium Carbide Production (IPCC category 2B.4.2) and Other Productions (IPCC category 2B.5): carbon black, methanol, ethylene, etc. Chemical Industry Sub-sector was responsible for 33.70% of the total Industrial Processes Sector GHG emissions in 2011.

Figure 4.9 GHG emissions trend in the Chemical Industry Sub-sector for 1989–2011 period [Gg CO_2 equiv.]



GHG emissions trend in the Chemical Industry Sub-sector for 1989–2011 period due:

- lowest level of emissions from the ammonia production was recorded in 1998 (production decreased by almost 50% compared to the previous and the next year) due to closing of a producing plant in 1998 and closing of another plant in 1998 and reopening it the next year;
- nitric acid production decreased after 1989;
- adipic acid production had stopped at the end of 2001;
- carbide production had recorded a decrease after 1989 and it was stopped starting with 2007;
- for 2009 a significant decrease of emissions level was recorded due to the economic crisis;
- in 2011 the emissions rised due to increase of various production activities (ammonia production, nitric acid production, silicon carbide production).

Table 4.14 GHG emissions from the Chemical Industry Sector, in 2011 (Gg)

Sector	**CO_2**	**CH_4**	**N_2O**
	[Gg]		
2.B Chemical Industry	3,020.38	0.65	3.90
2.B.1 Ammonia Production	3,020.38	0.00	0.00
2.B.2 Nitric Acid Production	0.00	0.00	3.90
2.B.3 Adipic Acid Production	NO	NO	NO
2.B.4.1 Silicon Carbide Production	IE	0.57	0.00
2.B.4.2 Calcium Carbide Production	NO	NO	NO
2.B.5 Others (ethylene, carbon black, methanol, sulphuric acid)	0.00	0.07	0.00

4.3.2 Methodological issues

Ammonia Production (IPCC category 2.B.1)

All the issues related with the Ammonia Production category have been implemented following the elaboration of the study “Elaboration/documentation of national emission factors/other parameters relevant to National Greenhouse Gas Inventory (NGHGI) Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher tier calculation methods implementation”. In all the Romania Ammonia Production installations the **Kellogg process** (see the Annex 3.2) is used. This type of technology is based on steam reforming of methane. There are some aspects related with upgrading the installations and the chemical solutions used to absorb carbon dioxide from synthesis gas of ammonia. All the solutions used in absorption of carbon dioxide contain the potassium carbonate-K_2CO_3. Carbon dioxide is resulted from the regeneration process of the absorption solution.

Typically, carbon dioxide resulting from the production process is used to manufacture of urea. If urea production plant is not functioning, carbon dioxide is released into the atmosphere.

Methodology

The Ammonia Production is a key category from both level and trend point of view (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF).

The CO_2 emissions from ammonia production are estimated according to the Tier 1a methodology. According with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories - Industrial Processes, the relevant parameters used for estimation the **CO_2** emissions in line with 1a method are:

- The annual amount of natural gas used as feedstock in Ammonia Production process, m^3/an;
- Carbon content of natural gas used as feedstock in Ammonia Production process, kg carbon/m^3 gas;
- The conversion factor of CO_2;
- CO_2 emissions.

Other relevant parameter than is not used in calculation of CO_2 emissions in line with 1a level is annual Ammonia Production.

Although emissions from Ammonia Production are decreasing along the time series, this source category results in a large amount of CO_2 emissions.

Within the chemical industry sector, Ammonia Production is one of the most important GHG emission source. The lowest level of emissions was recorded in 1998, due to the activity data decreased by almost a half compared to the previous and next year. This happened as one producing plant has stopped its activity since 1998 and another plant has been closed in 1998 and reopened in the next year.

Activity data

In order to estimate de CO_2 emissions have been taking into account the data provided directly from Ammonia Production plant considering the information from the questionnaires completed by all seven economic agents ammonia produces for all-time series 1989–2011. For each installation there were request the next parameters:

- Annual ammonia production, tonne/year;
- The annual amount of natural gas used as feedstock in Ammonia Production process, m^3/year ;
- Carbon content of natural gas used as feedstock in Ammonia Production process, kg carbon/m^3 gas;
- Annual amount of CO_2 resulted from Ammonia Production process with is used in urea production, kg/year;
- Annul amount of urea production, kg/year.

Emission factors

The formula use in order to estimate the CO_2 emissions inside the Ammonia Production Sub-sector – the emissions estimated according with Tier 1a – IPCC 1996 is:

Equation 4.6 CO_2 emission estimation in Ammonia Production Tier 1.a

$$E_{CO2} = C_{natural\ gas} * CC_{natural\ gas} * 44/12$$

where:

E_{CO2} = CO_2 emissions;

$C_{natural\ gas}$ = the annual amount of natural gas used as feedstock in Ammonia Production process

$CC_{natural\ gas}$ = Carbon content of natural gas used as feedstock in Ammonia Production process

44/12 = the conversion factor of CO_2

CO_2 emissions

- Unit measurement: Gg CO_2 emissions/ year;
- Carbon dioxide is formed by oxidation of carbon from the fuel (natural gas);
- CO_2 emissions estimation is done by calculations using Tier 1a compliance with IPCC

Methodology

Annual amount of natural gas used as feedstock

- Unit measurement: Nm^3/year;
- Amount of natural gas is proportional to the production of ammonia 100% expressed in t / year;
- For accurate calculations, the amount of natural gas used as raw material is obtained from the operators;
- The amount of *natural gas use as fuel* is excluded from the CO_2 emissions calculation inside the Industrial Process Sector because this type of energetic gas is considering in Energy sector. The amount of *natural gas used as feedstock* is considering only within Industrial Process Sector, not to Energy sector.

Carbon content of natural gas used as feedstock

- Unit measurement: kg C / Nm^3 natural gas;
- In order to convert Nm^3 of natural gas in kg of natural gas, the density of the natural gas was used (ρ= 0.8779 kg/m^3);

- For accurate calculations, the Carbon content of natural gas used as feedstock is obtained from the operators;
- It is assumed that all carbon is transformed into carbon dioxide and then is emitted into the atmosphere.

Conversion factor of carbon in carbon dioxide

- Unit measurement: dimensionless;
- Conversion factor of carbon in carbon dioxide is stoichiometric ratio between molecular weight of carbon dioxide - CO_2 (44) and molecular weight of carbon - C (12). Value is 44/12.

Ammonia annual production

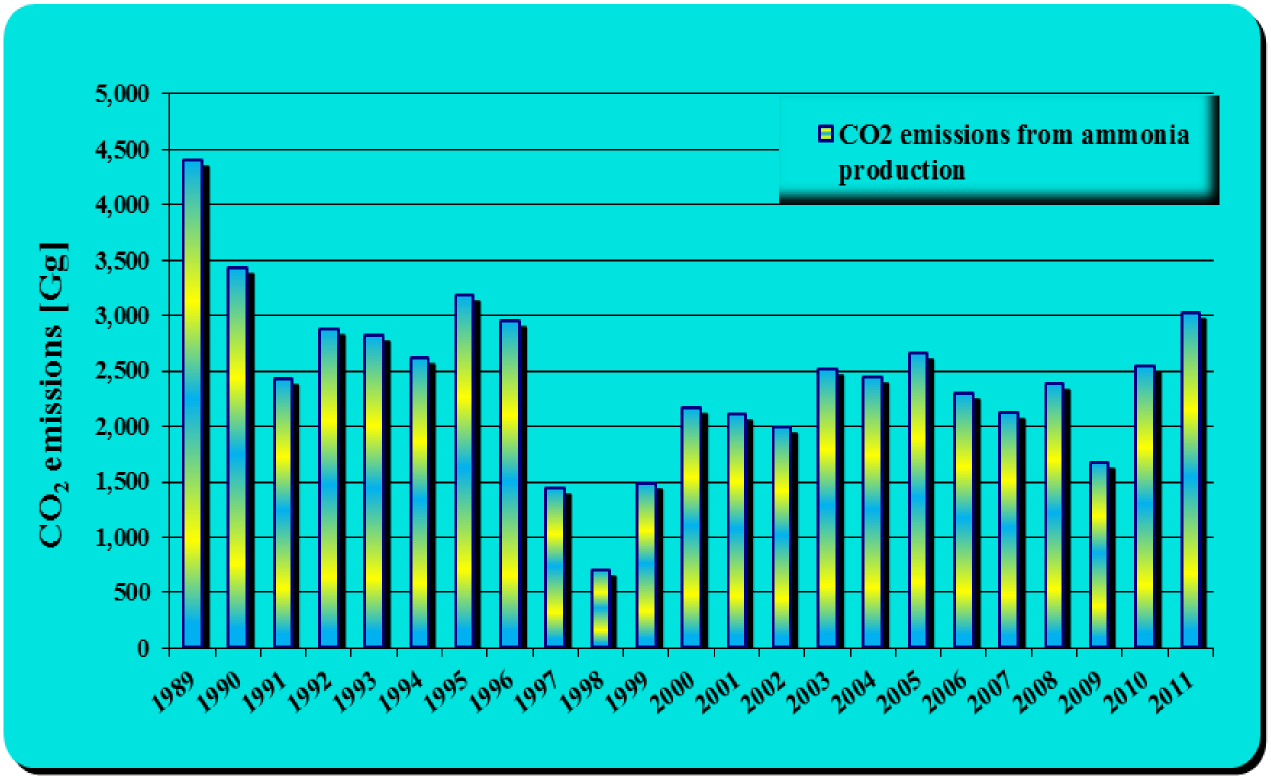
- Unit measurement: t/year (tone Ammonia Production 100%/year);
- Annual production is annually obtained from operators.

The CO and SO_2 emissions from Ammonia Production are estimated according to the revised methodology (default 7.9 kg CO/ tonne of product and 0.03 kg SO_2/ tonne of product).

Table 4.15 Ammonia Production related to the CO_2 emissions in the period 1989–2011

Year	Activity data and emissions from Ammonia Production Sub-sector	
	Natural gas consumption [kt]	CO_2 emissions [Gg]
1989	1,947.02	4,403.96
1990	1,510.90	3,438.34
1991	1,064.03	2,428.34
1992	1,261.58	2,883.47
1993	1,237.55	2,825.62
1994	1,147.35	2,620.00
1995	1,397.03	3,187.29
1996	1,287.90	2,948.14
1997	635.41	1,446.63
1998	305.00	696.36
1999	644.60	1,480.47
2000	945.06	2,163.33
2001	924.56	2,113.41
2002	872.56	1,998.39
2003	1,101.06	2,518.94
2004	1,070.13	2,442.19
2005	1,161.78	2,666.76
2006	1,003.98	2,305.40
2007	919.82	2,120.93
2008	1,038.18	2,380.62
2009	747.10	1,671.10
2010	1,081.52	2,542.69
2011	1,245.43	3,020.38

Figure 4.10 The trend of CO_2 emissions from Ammonia Production in the period 1989–2011



Nitric Acid Production (IPCC category 2.B.2)

Methodology

The nitric acid production is a key category, from both level and trend point of view (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF). Nitric Acid Production results in N_2O and NO_x emissions. Emissions have been calculated by multiplying annual Nitric Acid Production (tons HNO_3 100% by each plant) by a default emission factor, which reflects the process, in line with IPCC GPG 2000 and CORINAIR Methodology. According with the Decision Tree for N_2O Emissions from Adipic Acid and Nitric Acid Production from IPCC GPG 2000 – pg. 3.32, in order to use of a higher Tier calculation method it is need to collect the information regarding emissions and destruction data directly from plants, but the data on plant specific emissions there are not sufficiently documented and explained by operators, therefore the data emissions could not be used in this report 2013.

Activity data

Specific questionnaires have been sent to the local EPA in order to collect information on Nitric Acid Production from economic agents. Based on this survey, 7 manufacturers of Nitric Acid have been identified. From these 7 factories, one stopped its production in 1990 and other factory has stopped its activity during the 2006–2008 periods.

In order to estimate the N_2O and NO_x emissions, within the questionnaires the economic agents had been asked about the data related with the abatement techniques are used for NO_x or N_2O emissions reduction. In 2010 and 2011 years the production data are higher than the previous period because the national Nitric Acid Production increased significant.

Emission factors

The emission factors used reflects the production process:

- dual pressure type process (ammonia oxidation takes place at medium pressure and absorption takes place at high pressure) - this is the case of 6 factories. According to IPCC Good Practice Guidance, N_2O emission factor for European designed dual pressure plants is in the range from 8 to 10 kg N_2O /tonne nitric acid. The mean of this range (9 kg N_2O /tonne nitric acid) has been used to estimate N_2O emissions. The NOx emission factor used is according to CORINAIR methodology: 7.5 kg NOx/tonne nitric acid for medium pressure plants;
- plants without NSCR – this is the case of only one factory. According to IPCC Good Practice Guidance, N_2O emission factor for this plant is in the range from 10 to 19 kg N_2O /tonne nitric acid. The mean of this range (14.5 kg N_2O /tonne nitric acid) has been used to estimate N_2O emissions. An emission factor of 12 kg NO_x/tonne nitric acid has been used to estimate NO_x emissions from this factory.

The emissions have been estimated, considering the process type and the NO_x abatement technology installed at each plant:

- extended absorption for NO_x – used at one factory (it was used since 1997);
- selective catalytic reduction (SCR) for NO_x – used at one single plant since 2003;
- selective catalytic reduction (SCR) for N_2O - used at two plants starting with 2009.

These abatement techniques are used both for NO_x and N_2O reduction emissions.

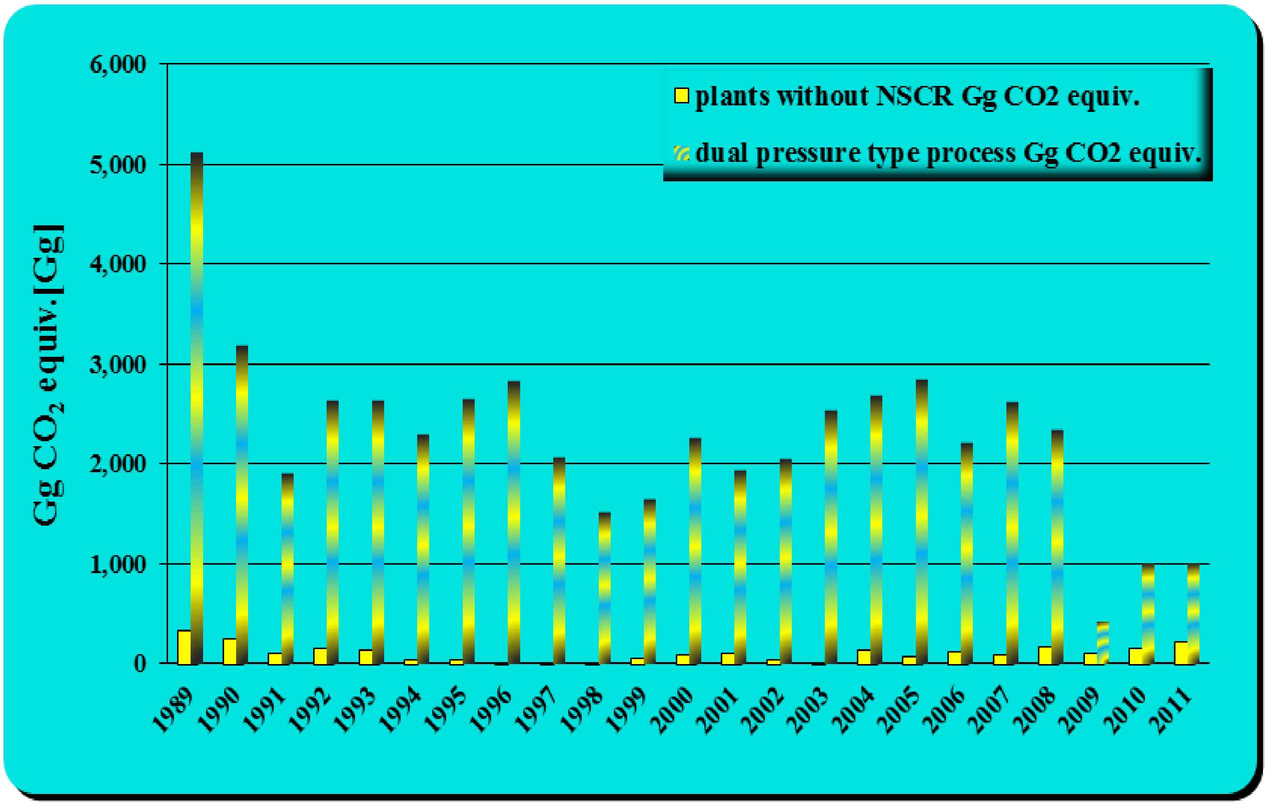
In the Table 4.16 are presented the estimations of the N2O and NOx emissions by type of technology, but from reason of confidentiality the nitric acid production is not split between both proceses (plants without NSCR and dual pressure type process - ammonia oxidation takes place at medium pressure and absorption takes place at high pressure).

Table 4.16 Nitric Acid Production related to the N_2O and NO_x emissions in the period 1989–2011

Years	Activity data and emissions from Nitric Acid Production Sub-sector				
	Nitric acid production [kt]	plants without NSCR		dual pressure type process (ammonia oxidation takes place at medium pressure and absorption takes place at high pressure)	
		N_2O emissions [Gg]	NO_x emissions Gg]	N_2O emissions [Gg]	NO_x Emissions [Gg]
1989	1,913.76	1.06	0.88	16.56	13.80
1990	1,205.92	0.81	0.67	10.35	8.63
1991	710.92	0.33	0.27	6.19	5.16
1992	979.13	0.46	0.38	8.52	7.10
1993	978.06	0.45	0.37	8.52	7.10
1994	837.50	0.14	0.12	7.45	6.21
1995	959.74	0.10	0.09	8.57	7.14
1996	1,020.64	0.05	0.04	9.15	7.63
1997	749.26	0.07	0.06	6.70	4.72
1998	550.47	0.07	0.06	4.91	3.83
1999	603.48	0.17	0.14	5.33	3.96
2000	831.48	0.26	0.22	7.32	5.10
2001	720.62	0.31	0.26	6.29	4.62
2002	745.11	0.10	0.09	6.64	4.89

Years	Activity data and emissions from Nitric Acid Production Sub-sector				
	Nitric acid production [kt]	plants without NSCR		dual pressure type process (ammonia oxidation takes place at medium pressure and absorption takes place at high pressure)	
		N_2O emissions [Gg]	NO_x emissions Gg]	N_2O emissions [Gg]	NO_x Emissions [Gg]
2003	917.50	0.07	0.06	8.22	2.01
2004	1,000.14	0.45	0.37	8.72	2.30
2005	1,037.32	0.21	0.17	9.21	3.01
2006	821.55	0.36	0.30	7.17	1.79
2007	962.52	0.28	0.23	8.49	2.31
2008	883.12	0.56	0.46	7.60	2.78
2009	589.89	0.31	0.25	1.36	1.68
2010	1,055.32	0.50	0.41	3.22	3.71
2011	1,076.97	0.68	0.56	3.23	3.33

Figure 4.11 The trend of CO_2 emissions from Nitric Acid Production, 1989–2011 [Gg CO_2 equivalent]



Adipic Acid Production (IPCC category 2.B.3)

Methodology

The default methodology has been followed for estimating the emissions from Adipic Acid Production, according with the Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.17-2.18, considering that the Adipic Acid Production Sub-sector is not a key source category.

Activity data

Emissions are estimated based on national statistics for the period 1989–1997, after this year no reports on Adipic Acid Production are made. Based on response from the local Environment Protection Agencies that were requested to provide information on this activity (1998–2001), only one producer has been identified. The facility stopped its activity at the end of 2001. Starting 2002, this activity is suspended.

Emission factors

Table 4.17 The default EFs used to estimate emissions from Adipic Acid Production

EMISSION FACTORS FOR ADIPIC ACID PRODUCTION (KG/TONNE PRODUCT)			
N_2O	NO_x	NMVOC	CO
300	8.1	43.3	34.4

Silicon Carbide Production (IPCC category 2.B.4.1)

Methodology

Total CH_4 emissions from Silicon Carbide Production were estimated using the production data and the IPCC 1996 emission factor. According with Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.20 the default value on CH_4 emission factor was used, considering that the Silicon Carbide Sub-sector is not a key source category.

The CO_2 emissions from Silicon Carbide Production are noted as IE because the emissions related with coke consumption are accounted in Energy Sector.

Activity data

National Statistics provided annually the amount of Silicon Carbide Production starting with 2003 year. In 2007 the production was stopped and was reopened in 2008. The data related with Silicon Carbide Productions are confidential starting with 2008.

Emission factors

For confidentiality reasons the presentation of CH_4 emission factor used to estimate emission from Silicon Carbide Production is omitted.

Calcium Carbide Production (IPCC category 2.B.4.2)

Methodology

Total CO_2 emissions from Calcium Carbide Production were estimated using the production data and the default emission factor, in line with IPCC 1996. According with Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.19 the default values on CO_2 emission factor were used (Table 2-8), considering that the Calcium Carbide Sub-sector is not a key source category.

Activity data

National Institute for Statistics provided annually the amount of Calcium Carbide Production. Starting with 2007 the production was stopped.

Emission factors

According with Revised 1996 IPCC in order to estimate CO_2 emission from Calcium Carbide Production default emission factors provided in production process of calcium carbide were used

(CaO step and reduction step): 0.76 tonnes CO_2/tonne carbide and 1.09 tonnes CO_2/tonne carbide, the resulted EF is 1.85 tonnes CO_2/tonne carbide.

Table 4.18 CO_2 emissions from Calcium Carbide Production in the period 1989–2011

Year	**Emissions from Calcium Carbide Production Sub-sector**
	CO_2 emissions [Gg]
1989	333.00
1990	238.65
1991	173.90
1992	160.95
1993	155.40
1994	123.95
1995	166.50
1996	196.10
1997	168.35
1998	135.05
1999	99.90
2000	101.75
2001	98.05
2002	98.05
2003	83.25
2004	116.55
2005	62.90
2006	37.00
2007	NO
2008	NO
2009	NO
2010	NO
2011	NO

Other Production: carbon black, ethylene, methanol, propylene, polystyrene, polyethylene, sulphuric acid, phthalic anhydride, polypropylena, polyvinylchloride, 1, 2 dichloroethane, coke (IPCC category 2.B.5)

Methodology

Total emissions from Other Production were estimated using the production data and the emission factors, in line with IPCC 1996. According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.21-2.25 and Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual, pages 2.22-2.25.

Activity data

National Statistics provided annually the amounts of these production processes. Carbon black and sulphuric acid are not produce anymore.

Emission factors

For confidentiality reasons the presentation of emission factors used to estimate emission from those productions are omitted.
Emissions of CH_4, NO_x, CO, NMVOC, and SO_2 were estimated from those productions.

4.3.3 Uncertainties and time series consistency

Ammonia Production (IPCC category 2.B.1)

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

- AD: 5 %;
- EF: 10 %;

- 11.18% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Nitric Acid Production (IPCC category 2.B.2)

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

- AD: 5 %;
- EF: 40 %;
- 40% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Adipic Acid Production (IPCC category 2.B.3)

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

- AD: 15 %;
- EF: 10 %;
- 18% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Silicon Carbide Production (IPCC category 2.B.4.1)

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

- AD: 5 %;
- EF: 0 %;
- 5% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Calcium Carbide Production (IPCC category 2.B.4.2)

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

- AD: 5 %;
- EF: 2 %;
- 5.39% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Other Production (IPCC category 2.B.5)

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

- AD: 5 %;
- EF: 10 %;
- 11% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

4.3.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Mineral Industry Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

Recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

The unconformities noted are described in the Chapter 4.3.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.3.5 – Source-specific recalculations, including changes made in response to the review process. All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

4.3.5 Source specific recalculation, including changes made in response to the review process

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

- Other - Coke Production (IPCC category 2.B.5).

Other - Coke Production (IPCC category 2.B.5)

Emissions from coke production are characterized for the first time, for the 1989–2011 period: CH_4 emissions are estimated while CO_2, N_2O, HFC, PFC and SF_6 are characterized using the NA notation key.

Table 4.19 The effects of recalculations in Chemical Industry Sub-sector

The effects of recalculations in Chemical Industry Sub-sector			
Year	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	Differences [%]
	CO_2 equivalent [Gg]		
1989	10,920.27	10,981.91	0.56
1990	7,738.51	7,780.14	0.54
1991	5,133.01	5,160.11	0.53
1992	6,190.69	6,221.17	0.49
1993	6,324.26	6,351.57	0.43
1994	5,653.94	5,684.23	0.54
1995	6,653.85	6,689.38	0.53
1996	6,612.24	6,645.34	0.50
1997	4,568.70	4,603.51	0.76
1998	3,253.11	3,285.99	1.01
1999	3,989.01	4,007.02	0.45
2000	5,498.51	5,515.44	0.31
2001	4,770.09	4,784.93	0.31
2002	4,206.56	4,226.15	0.47
2003	5,198.65	5,215.85	0.33
2004	5,443.64	5,461.22	0.32
2005	5,688.16	5,708.02	0.35
2006	4,719.44	4,738.24	0.40
2007	4,853.61	4,870.90	0.36
2008	4,933.66	4,945.61	0.24
2009	2,199.45	2,203.03	0.16
2010	3,712.81	3,712.81	0.00

4.3.6 Source specific planned improvements, including those in response to the review process.

More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

4.4 Source category Metal Production (CRF Sector 2.C)

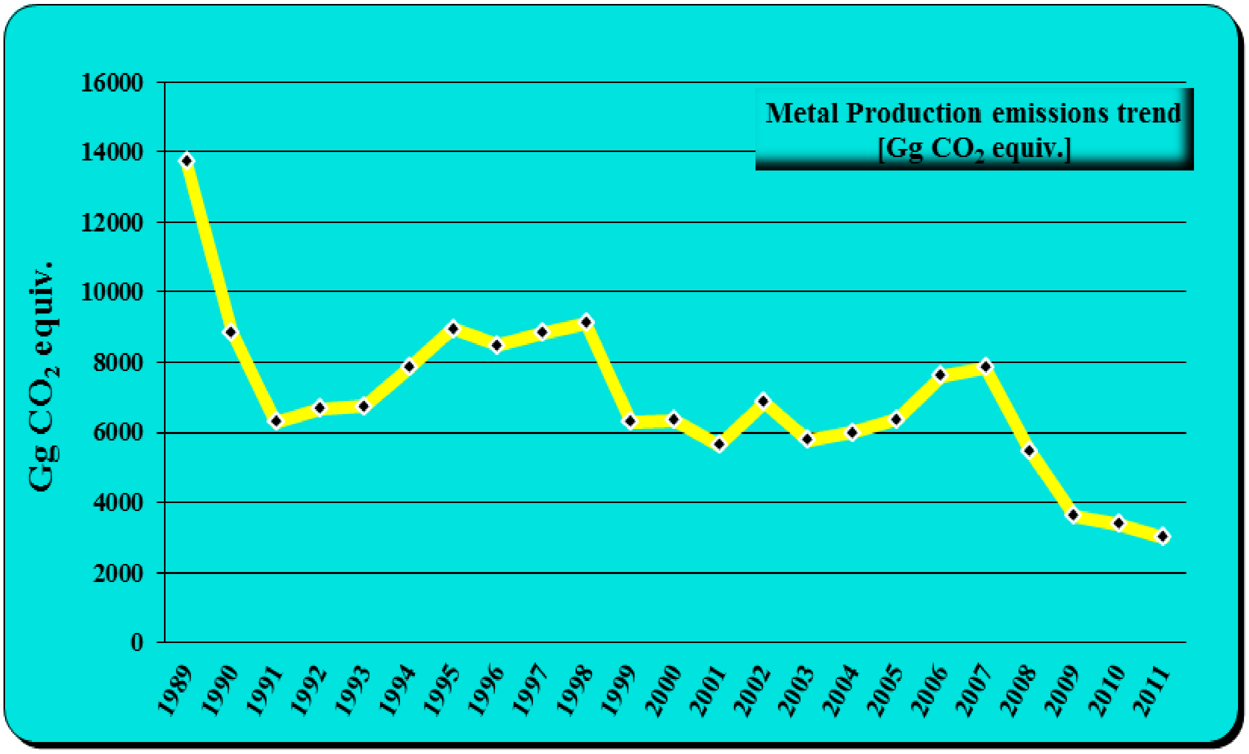
4.4.1 Source category description

The emission estimates cover sub-categories 2C.1 Iron and Steel Production, 2C.2 Ferroalloys Production and 2C.3 Aluminium Production. The use of SF_6 in Aluminium and Magnesium Foundries (2C.4 sub-category) is not applicable in Romania. Metal Production Industry Sub-sector is responsible for 23.98% of the total Industrial Processes Sector GHG emissions in 2011.

CO_2 emissions from Iron and Steel Production represent an important key category of the inventory because of its contribution to the total inventory level (in 2011 CO_2 emissions from production of iron and steel contributed 2.13% to total greenhouse gas emissions). In the base year, these emissions accounted for 3.48% from the total GHG emissions.

The CO_2 emissions from Ferroalloys Production have been included in the inventory. Aluminium Production results in a smaller quantity of CO_2 emissions and also PFCs emissions. PFCs emissions from Aluminium Production represent a significant source of emissions due to high GWP values.

Figure 4.12 GHG emissions trend in the Metal Production Sub-sector for 1989–2011 period [Gg CO_2 equiv.]



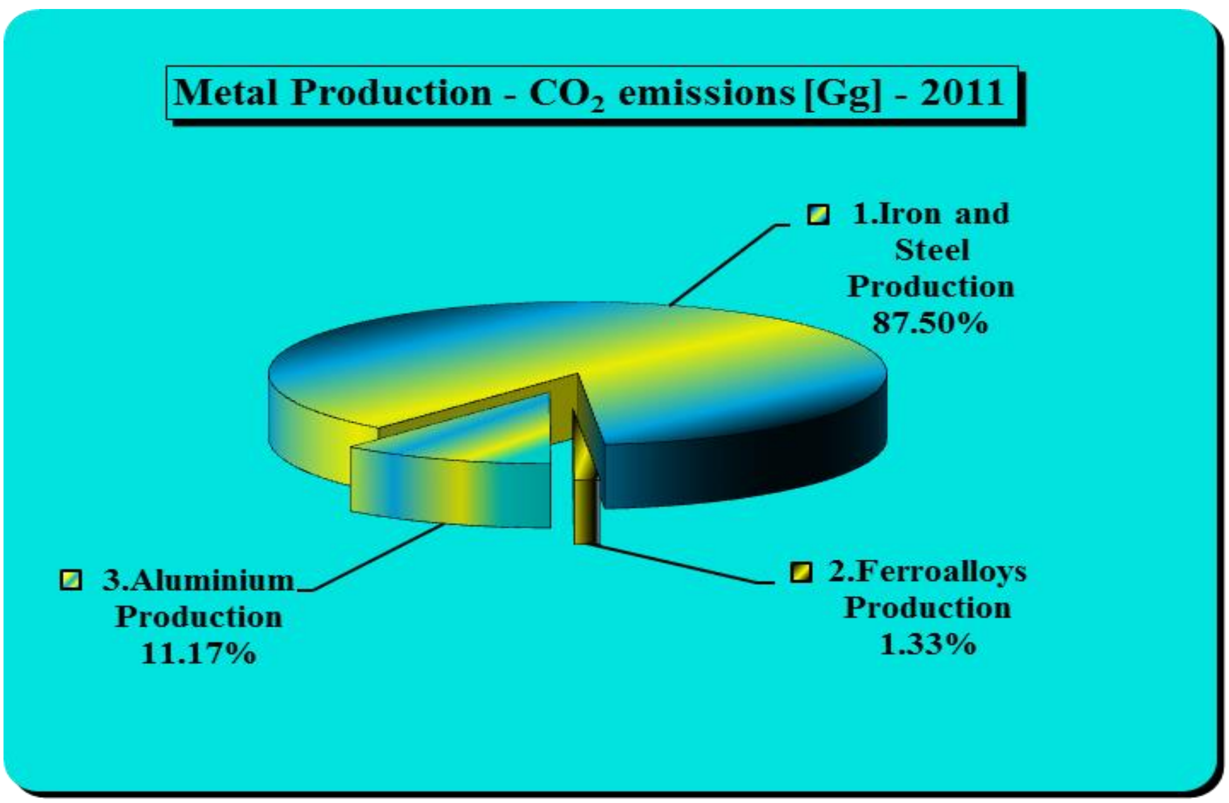
GHG emissions trend in the Metal Products Sub-sector for 1989–2011 period due:

- iron and steel production recorded decreases after 1989;
- ferroalloys production has recorded a decrease after 1989. The lowest level of emissions was recorded in 1999 due to the cease of production. In 2000 the production started again;
- the reduction of PFC emissions from production of aluminum due to changes in technology starting with 1997 and 2003;
- after 2008 the trend of emission decreases due to reduction of production level recorded in Iron and Steel Production and Ferroalloys Production Sub-sectors;
- in 2010 and 2011 the emissions trends have recorded an increased due to increase of various production activities (Iron and Steel Production, Ferroalloys Production and Aluminium Production Sub-sectors.

Table 4.20 GHG emissions from Metal Production sub-sector, in the year 2011 [Gg CO_2 equiv.]

Sector	CO_2	PFCs
	CO_2 equivalent [Gg]	
2.C Metal Production	**3,008.10**	**10.92**
2.C.1 Iron and Steel Production	**2,632.08**	**0.00**
2.C.2 Ferroalloys Production	**40.04**	**0.00**
2.C.3 Aluminium Production	**335.98**	**10.92**

Figure 4.13 Structure of the Metal Production Sub-sector, in 2011



4.4.2 Methodological issues

Iron and Steel Production (IPCC category 2.C.1)

Methodology

Iron and Steel Production Sub-sector results in a large amount of CO_2 emissions, and it represents a key category within the Industrial Processes Sub-sector, from both level and trend point of view (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF).

The method for calculating emissions of CO_2 from Iron and Steel Production is in line with Good Practice Guidance 2000 (Tier 2 method), considering the "Decision Tree for Iron and Steel Industry" from IPCC GPG 2000 - page 3.27 and taking into account all the information provided by each Iron and Steel Production company.

IPCC Good Practice Guidance 2000 is more detailed in terms of CO_2 emissions and deal with aspects related methodologies, reporting and documentation, and insurance / quality control emissions inventory. This guide presents two methods for calculating emissions. Choice of calculation method depends on national circumstances.

Tier 1 method is a simplified method of calculation, based on the amount of reducing agent (coke, coke petroleum, coal, coal dust, etc.) used in the processes of development. This method does not distinguish between the production of iron and steel production, and does not consider any kind of technological flux.

Tier 2 method is similar to method Type 1, but also includes carbon remained in the metal product. The method is based on tracking carbon content in production processes and the different calculation methods for iron and steel. It is considered good practice estimating emissions based on data provided by the operators, due to substantial differences between the technologies.

Because, for Romania, iron and steel production is key category is required using this method.

Activity data

The recommended Tier 2 method, according to the IPCC Good Practice Guidance, is to base the calculations on the amount of reducing agent (coke oven coke) used in blast furnaces for the production of iron. Other information needed to use the Tier 2 method is the amount of pig iron produced as well as the amount used for steel production and produced steel (BOF and EAF), and the carbon content of all those parts. All these information have been collected at plant level.
The coke from coal is used to reduce the iron. Steel is also produced from ferrous scrap using a basic oxygen furnace (BOF) and electric arc furnace (EAF).
For 1989–2006 period the data related sinter consumption were provided by Ministry of Economy due to inconsistence in data provided by economic agents.
Starting with 2007 the data regarding sinter consumption were provided by economic agents and checked again with the data obtained from Ministry of Economy. The differences in AD generated by these two different data sources are negligible.
The coke consumption to reduce the iron has been subtracted from the Energy Sector consumption being considered within Iron and Steel Production category–Industrial Process Sector.

Emission factors

CO_2 emissions are calculated as the sum of emissions from the production of iron and emissions from steel production.

CO_2 emissions from Pig Iron Production

Emissions from the production of iron is calculated as the sum of emissions from reducing agents used in the production of iron and the difference between CO_2 emissions for carbon in ore and for carbon in iron resulting (3.6.A in IPCC GPG 2000), according to the formula:

Equation 4.7 Calculation of CO_2 emissions from Pig Iron Production

$$Emissions_{pig\ iron} = Emission\ Factor_{reducing\ agent} \times Mass\ of\ Reducing\ Agent + (Mass\ of\ Carbon\ in\ the\ ore - Mass\ of\ Carbon\ in\ the\ Crude\ Iron) \times 44/12$$

where:

- EF reducing agent (coke oven coke) = 3.1 tone CO_2 /tone reducing agent (default value);
- Mass of reducing agent: plant level data;
- Carbon content in ore in 2011: 0.35% (country specific value);
- Carbon content in iron in 2011: average 4.66% (country specific value);

Reducing agents are: coke, coal, petroleum coke, etc. In the Table 21 are the default values of emission factors for the most commonly used reducing agents.

Table 4.21 CO_2 emission factors for the reduction agents

Nr. Crt.	Name reducing agent	Emission factor t CO_2 /t reducing agent
1.	coke from coal	3.1

Amount of carbon in ore or iron crude is obtained by multiplying the carbon content of ore or pig iron with the quantities used, respectively produced. Carbon content of ore is very small (close to zero), and the carbon content of pig iron is approximately equal to 4%. Thus the second term of the above equation is always negative.

In the calculation of emissions for iron and in accordance with “Decision Tree for Iron and Steel Industry” from IPCC GPG 2000 - page 3.27, CO_2 emissions from blast furnace gas are included in this chapter, and therefore they should not be included in the Energy chapter.

CO_2 emissions from limestone use in the manufacture of pig iron relates to emissions from limestone and dolomite use in industrial processes category 2.A.3.

CO_2 emissions from Steel Production

Emissions from steel production are calculated as (3.6.B in IPCC GPG 2000), using Tier 2 approach:

Equation 4.8 Calculation of CO_2 emissions from Steel Production

$$Emissions_{crude\ steel} = (Mass\ of\ Carbon\ in\ the\ Crude\ Iron\ used\ for\ Crude\ Steel\ Production - Mass\ of\ Carbon\ in\ the\ Crude\ Steel) \times 44/12 + Emission\ Factor_{EAF} \times Mass\ of\ Steel\ Produced\ in\ EAF$$

where:

- Carbon content in crude iron used for crude steel in 2011: average 4.66% (country specific value);
- Carbon content in crude steel in 2011: average 0.10 % (country specific value);
- EF EAF=0.005 t/t (default value);
- Mass of steel produced in EAF: plant level data;
- Crude iron used for crude steel production: plant level data.

CO_2 emissions from steel production are the sum of emissions from conversion of pig iron into crude steel and emissions from electrode consumption in the production of steel in electric arc furnace.

The first part of the equation is based on the difference between the carbon content of iron and carbon content of steel. Amount of carbon in pig iron and crude steel is obtained by multiplying the carbon content of pig iron or crude steel with the quantities used, respectively and produced.

EAF emission factor refers to the amount of CO_2 emitted due to electrode consumption during production of steel in electric arc furnace (EAF). A rough estimate is **1 - 1.5 kg carbon / t steel**.

If no data are available nationally and at the operator may be used emission factors presented in the guide reducing agents (see Table 22).

On CO_2 emission factor associated with the consumption of electrodes in the manufacture of steel in electric arc furnaces is considered good practice to use emission factors from the economic operators. If these data are not available for Tier 2 method can be applied a factor of **5 kg CO_2 / t steel produced** in the EAF.

In Table 23 are presented the carbon content in crude iron and carbon content in steel (%). For the 1989-2006 period was calculated an average for carbon content of iron, respectively of steel, and this value was used for the entire time series (1989-2006) (country specific values). For the 2007-2011 period it was used country specific values.

Table 4.22 The carbon content in crude iron and carbon content in steel. in the period 1989–2011

Years	**Carbon content in crude iron**	**Carbon content in steel**
	%	
1989	3.6	0.7
1990	3.6	0.7
1991	3.6	0.7
1992	3.6	0.7
1993	3.6	0.7
1994	3.6	0.7
1995	3.6	0.7
1996	3.6	0.7
1997	3.6	0.7
1998	3.6	0.7
1999	3.6	0.7
2000	3.6	0.7
2001	3.6	0.7
2002	3.6	0.7
2003	3.6	0.7
2004	3.6	0.7
2005	3.6	0.7
2006	3.6	0.7
2007	3.6	0.3
2008	2.48	0.34
2009	3.37	0.28
2010	3.11	0.26
2011	4.66	0.10

Figure 4.14 The trend of CO_2 emissions from Iron and Steel Production (BOF and EAF) in the period 1989–2011

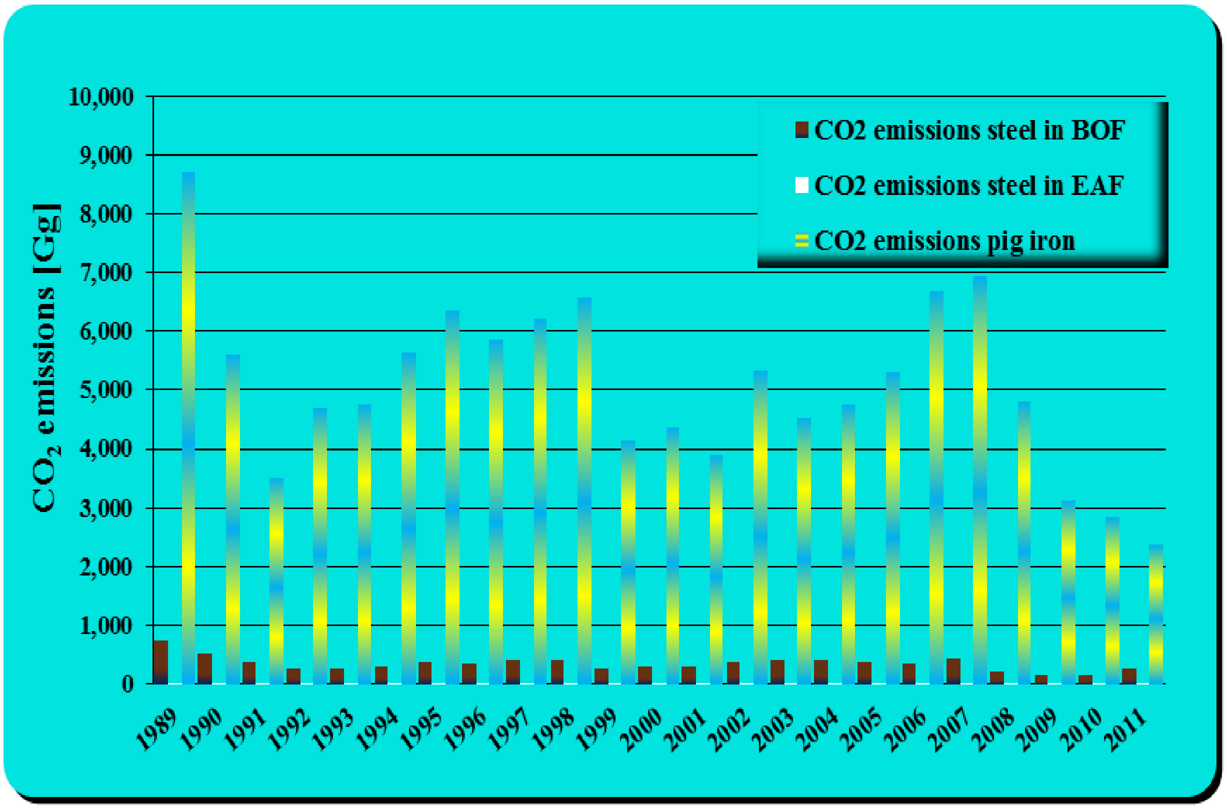


Figure 4.15 The trend of CO_2 emissions from Iron and Steel Production in the period 1989–2011

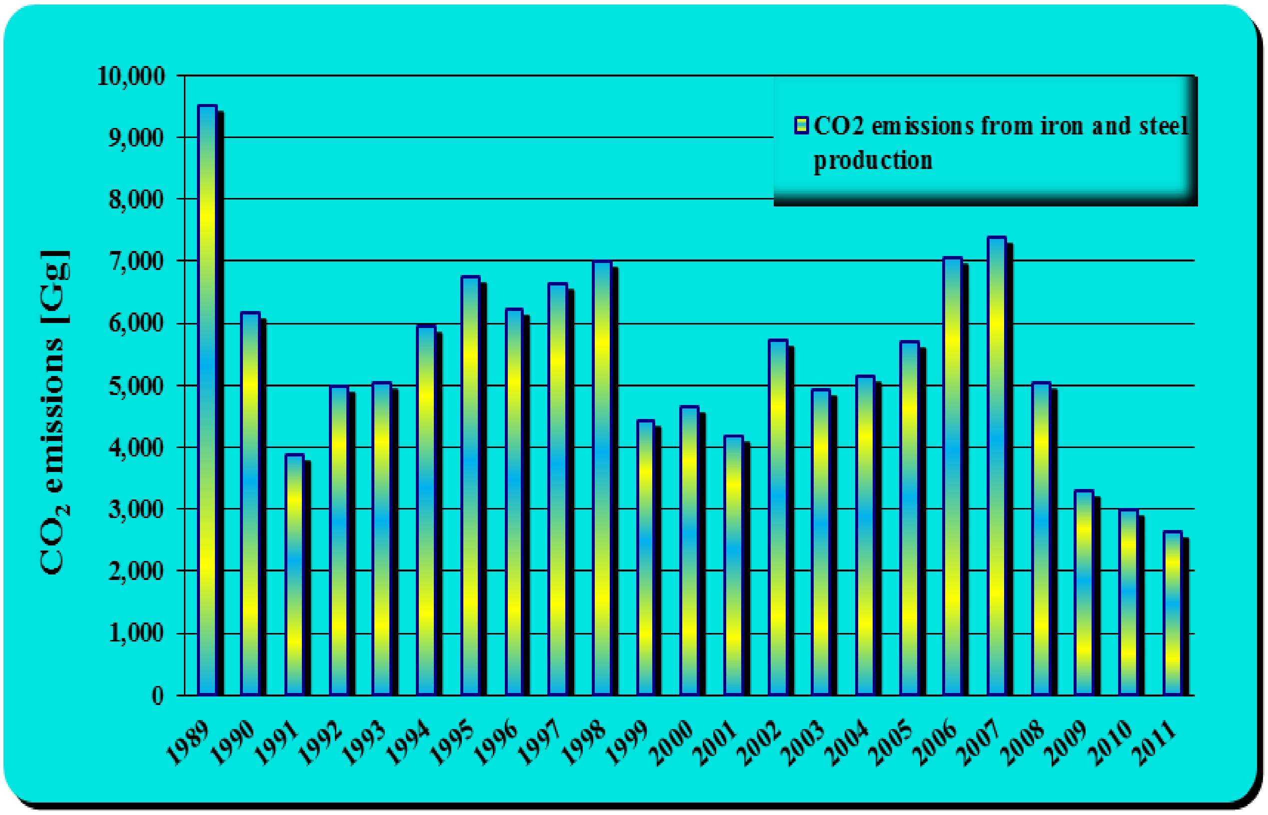


Table 4.23 CO_2 emissions from Iron and Steel Production subsector in the period 1989–2011

Years	CO_2 emissions from Iron and Steel Production Subsector		
	CO_2 emissions from pig iron production	CO_2 emissions from steel production in BOF	CO_2 emissions from steel production in EAF
	Gg		
1989	8,719.85	750.69	29.10
1990	5,605.06	530.93	18.36
1991	3,500.28	373.18	12.97
1992	4,701.86	259.15	10.35
1993	4,741.68	273.32	10.17
1994	5,646.62	299.71	11.21
1995	6,354.19	372.99	10.73
1996	5,858.30	357.73	9.42
1997	6,228.28	408.57	9.28
1998	6,564.85	419.89	7.56
1999	4,142.28	273.77	4.91
2000	4,353.91	284.83	5.33
2001	3,883.01	302.02	5.46
2002	5,323.73	384.77	4.45
2003	4,537.24	393.40	5.51
2004	4,746.19	400.62	7.53
2005	5,313.69	379.79	8.76
2006	6,690.69	361.55	9.28
2007	6,927.68	446.16	9.58
2008	4,808.09	205.52	8.63
2009	3,117.84	164.22	5.23
2010	2,834.93	159.32	8.72
2011	2,361.31	261.00	9.77

Table 4.24 The input data used to calculate emissions from Iron and Steel Industry in the period 1989–2011

Year	**Activity data from Iron and Steel Production Sub-sector**				
	steel production (BOF)	**steel production (EAF)**	**pig iron production**	**sinter**	**coke**
	[kt]				
1989	7,458.02	5,819.46	8,495.13	13,626.00	3,174.58
1990	5,274.49	3,671.84	5,916.27	11,357.00	2,060.00
1991	3,874.85	2,594.80	4,231.80	7,290.00	1,309.32
1992	2,827.47	2,070.69	3,001.32	4,761.00	1,644.53
1993	2,938.24	2,034.81	3,118.79	3,346.00	1,662.37
1994	3,274.90	2,242.51	3,421.21	5,452.00	1,967.17
1995	4,085.96	2,145.64	4,118.57	6,671.00	2,225.11
1996	3,846.69	1,883.99	3,905.79	5,449.00	2,056.08
1997	4,551.02	1,856.74	4,445.20	6,532.00	2,198.40
1998	4,688.11	1,512.28	4,463.69	6,514.00	2,307.76
1999	3,223.52	981.51	2,943.28	4,164.00	1,461.55
2000	3,445.78	1,066.00	3,041.54	3,875.00	1,534.00
2001	3,677.20	1,092.49	3,221.86	6,185.00	1,389.77
2002	4,507.26	889.75	3,969.80	6,979.00	1,886.37
2003	4,542.23	1,102.35	4,084.94	6,609.00	1,637.57
2004	4,676.31	1,506.46	4,246.50	6,601.00	1,711.85
2005	4,508.78	1,751.62	4,117.92	6,600.00	1,889.44
2006	4,369.39	1,856.83	3,984.65	5,780.00	2,327.96
2007	4,355.95	1,915.29	3,946.68	6,359.22	2,402.79
2008	3,343.00	1,725.86	3,238.79	3,445.55	1,646.00
2009	1,789.84	1,045.67	1,568.86	1,806.98	1,068.29
2010	1,989.57	1,745.00	1,721.75	1,977.60	977.83
2011	1,854.48	1,953.92	1,581.25	1,841.84	841.32

The NMVOC, NO_x, CO, SO_2 emissions are estimated using the default emission factors applied to the first fusion raw Pig Iron Production.

Table 4.25 Emission factors for NMVOC, NOx, CO, SO_2 from Iron and Steel Production

The NMVOC, NOx, CO, SO_2 emission factors for Iron and Steel category			
g NMVOC/tonne produce	**g NOx/tonne produce**	**g CO/tonne produce**	**g SO_2/tonne produce**
20	76	112	30

Ferroalloys Production (IPCC category 2.C.2)

Methodology

The CO_2 emissions within the Production of Ferroalloys Sub-sector are calculated based on the production volume and the emission factors, in line with IPCC 1996. The Ferroalloys Production Sub-sector is a key source category only considering the trend criteria (Tier 2, excluding LULUCF).

In order to estimate the emission the production data are take into account in a disaggregate manner, by type of products (Ferromanganese Production, Ferrosilicon Production, Silicon Manganese Production, Ferrochromium Production).

During de time series the ferroalloys production have decreased therefore there were just Silicon Manganese and Ferrochromium Production, for 2007 and 2008 and only Ferrochromium Production for 2009.

In 2010 year the Ferroalloys Production and the CO_2 emissions have increased due to improve the Production of Silicon Manganese.

In 2011 year the Ferroalloys Production and the CO_2 emissions have decreased due to decreasing of the Ferrochromium Production.

Activity data

The National Statistics reports the Ferroalloys Production for the period 1992–2008, in a disaggregate manner, by type of products. National Institute for Statistics did not provide any data for the periods 1989–1991. The activity data for the beginning of the time series (1989–1991) were provided by Ministry of Economy.

The lowest level of emissions was recorded in 1999. This happened because ferroalloys producing plant stopped its activity in 1999 and reopened in the next year.

Starting with 2007 the data related with Ferroalloys Production are confidential.

Emission factors

For confidentiality reasons the presentation of CO_2 emission factors used to estimate emission from Ferroalloys Production are omitted.

Table 4.26 CO_2 emission from Ferroalloys Production in the period 1989–2011

Year	Emissions from Ferroalloys Production Sub-sector
	CO_2 emissions[Gg]
1989	474.15
1990	331.19
1991	248.73
1992	192.81
1993	143.74
1994	225.69
1995	237.53
1996	271.31
1997	163.53
1998	120.61
1999	0.98
2000	141.53
2001	145.59
2002	144.02
2003	241.55
2004	331.39
2005	201.43
2006	95.57
2007	45.68
2008	21.60
2009	19.99
2010	48.95
2011	40.04

Aluminium Production (IPCC category 2.C.3)

Methodology

The Aluminium Production is a key category, only from trend point of view (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF).

Primary Aluminium Production is carried out in one facility in Romania, where the pre-baked process is used.

The most significant emissions process resulted are:

- **Carbon dioxide (CO_2)** emissions resulted from the consumption of carbon anodes in the reaction to convert aluminum oxide to aluminum metal. At these emissions are added the emission from decomposition of sodium carbonate (ash) used in electrolysis cell;
- **Perfluorocarbons (PFCs)** emissions of **CF_4** and **C_2F_6** during anode effects;

The PFC process emissions calculation taking into account the technology use within the facility along the time period 1989–2011:

- From **1989 to 1996**, the technology used was **SWPB** (Side Worked Pre-baked);
- From **1997 to 2002** the combined technology was used **(SWPB and CWPB)** in different percentages;
- **Starting with 2003**, the technology was changed to **CWPB** (Centre Worked Pre-baked).
- For the period **1989–2002 the CO_2** emissions within the production of primary aluminium are calculated based on the production volume in line with **IPCC 1996 Methodology (Tier 1b)** and the **PFC emissions** from aluminium production are calculated in line with **IPCC 1996 Methodology (Tier 1b Method) for C_2F_6** emissions and also **IPCC GPG 2000 Methodology (Tier 1 Method) for CF_4 emissions**, considering the type of technology use within the facility.
- **Starting with 2003 the CO_2** emissions within the production of primary aluminium are calculated in line with **IPCC 2006 Methodology (Tier 3 Method)** and the PFC **emissions** are calculated based on **GPG 2000 Methodology (Tier 2 Method)** using the technology specific over voltage coefficient and weight fraction C_2F_6/CF_4 from **IPCC 2006 Methodology (Tier 2 Method)**.

Activity data

Along the time period (1989–2011), the emissions processes within the Production of Primary Aluminium are calculated used the specific operating facility data in order to respect the IPCC Methodology as following:

- For the period **1989–1996** the technology used was **SWPB** (Side Worked Pre-baked). In this period the **CO_2 emissions** are calculated based on **Aluminium Production** in line with **IPCC 1996 Methodology (Tier 1b Method).** The calculation of CO_2 emissions does not include the emissions from anode baking. The **PFC emissions** are calculated based also on **Aluminium Production** and taking into account the **technology use** within the facility, in line with **IPCC GPG 2000 Methodology (Tier 1 Method) for CF_4 emissions and IPCC 1996 Methodology (Tier 1b Method) for C_2F_6** emissions;
- **From 1997 to 2002** the combined technology was used: **SWPB** (Side Worked Pre-baked) and **CWPB** (Center Worked Prebaked) in different percentages. **The CO_2 emissions** are also calculated based on **Aluminium Production** in line with **IPCC 1996 Methodology (Tier 1b Method).** The calculation of CO_2 emissions does not include the emissions from anode baking. The **PFC emissions** for this period were estimated based on **Aluminium Production** and taking into account a weighted average of the two **constants related technologies** applied SWPB and CWPB, in line with **IPCC GPG 2000 Methodology (Tier 1 Method) for CF_4 emissions and IPCC 1996 Methodology (Tier 1b Method) for C_2F_6** emissions;
- **Starting with 2003** the technology was changed to **CWPB** (Centre Worked Pre-baked). **The CO_2 emissions** within the Production of Primary Aluminium are calculated in line with **IPCC 2006 Methodology (Tier 3 Method –** Equation 4.21**)** taking into account the **specific operating facility data**. At these emissions are added the emission from **decomposition of sodium carbonate** used in electrolysis cell. The **PFC emissions** are calculated based on **GPG 2000 Methodology (Tier 2 Method –** Equation 3.11**)**, considering **the plant specific** data and using the technology specific over voltage coefficient and weight fraction C_2F_6/CF_4 from **IPCC 2006 Methodology**.

Table 4.27 The activity data, PFC and CO_2 emissions from Aluminium Production Sub-sector in the period 1989–2011

Year	Emissions and activity data from Aluminium Production Sub-sector			
	CF_4 emissions	C_2F_6 emissions	CO_2 emissions	Aluminium Production
	[tones]		[Gg]	[kt]
1989	451.42	45.14	398.31	265.54
1990	285.15	28.52	251.61	167.74
1991	261.74	26.17	230.94	153.96
1992	182.23	18.22	160.79	107.19
1993	189.95	19.00	167.60	111.74
1994	200.94	20.09	177.30	118.20
1995	239.02	23.90	210.90	140.60
1996	238.39	23.84	210.35	140.23
1997	240.75	24.08	245.56	163.70
1998	236.30	23.63	262.07	174.71
1999	216.08	21.61	261.12	174.08
2000	174.14	17.41	259.91	173.27
2001	140.73	14.07	269.73	179.82
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

Emission factors

Along the period 1989–2011 the emissions processes within the production of primary aluminium are calculated used the specific operating facility data in order to respect the IPCC Methodology as following:

- For the period **1989–1996** the technology used was **SWPB** (Side Worked Pre-baked). For this period the **CO_2 emissions** are calculated based on primary Aluminium Production data and the **default EF (1.5 tonnes CO_2/tonne Al)** in line with **IPCC 1996 Methodology (Tier 1b Method).** The calculation of CO_2 emissions does not include the emissions from anode baking. The **PFC emissions** are calculated based also on Aluminium Production and taking into account the technology use within the facility, in line with **IPCC GPG 2000 Methodology (Tier 1 Method) for CF_4 emissions and IPCC 1996 Methodology (Tier 1b Method) for C_2F_6** emissions. **Emissions of CF_4** were estimated by multiplying annual primary Aluminium Production with the default emission factor **(1.7 kg CF_4/tonne Al)** provided by **IPCC GPG 2000 Methodology (Tier 1 Method)** and considering the technologies in this period, **SWPB** (Side Worked Pre-baked). Compliance with **IPCC 1996 Methodology (Tier 1b Method)** it is recommended that the default rate for **C_2F_6 emissions be 1/10 that of CF_4.**
- From **1997 to 2002** period the combined technology was used **SWPB** (Side Worked Pre-baked) and **CWPB** (Center Worked Prebaked) in different percentages. The **CO_2 emissions** are also calculated based on Aluminium Production data and the **default EF (1.5 tonnes CO_2/tonne Al)** in line with **IPCC 1996 Methodology (Tier 1b Method)**.The calculation of CO_2 emissions does not include the emissions from anode baking. The **PFC emissions** for this period were estimated based on Aluminium Production and taking into account a **weighted average** of the two constants related technologies applied **SWPB and CWPB**, in line with **IPCC GPG 2000 Methodology (Tier 1 Method) for CF_4 emissions and IPCC 1996 Methodology (Tier 1b Method) for C_2F_6** emissions; **Emissions of CF_4** were estimated by multiplying annual primary Aluminium Production with the default emission factors **(1.7 kg CF_4/tonne Al – SWPB technology and 0.31 kg CF_4/tonne Al – CWPB technology)** provided by **IPCC GPG 2000 Methodology (Tier 1 Method**) and considering the **percentage of each technology** for every period years (SWPB and CWPB). Compliance

with **IPCC 1996 Methodology** it is recommended that the default rate for **C_2F_6 emissions be 1/10 that of CF_4.**

- **Starting with 2003** the technology was changed to **CWPB** (Centre Worked Pre-baked).

  I. The **CO_2 emissions** within the production of primary aluminium are calculated in line with **IPCC 2006 Methodology,** considering the specific operating facility data **(Tier 3 Method**– Equation 4.21**).** The **parameters used** in order to estimate the **CO_2 emissions** are: total metal production (aluminium), net prebaked anode consumption , CO_2 molecular mass, ash content in baked anodes, sulphur content in baked anodes, compliance with the below equation. At these emissions are added the **emission from decomposition of sodium carbonate** used in electrolysis cell.

Equation 4.9 CO_2 emissions from prebaked anode consumption

(Tier 3 Method – IPCC 2006 Methodology)

$$E_{CO2} = NAC * MP * \frac{100 - Sa - Ash_a}{100} * \frac{44}{12}$$

where:

- E_{CO2} = CO_2 emissions from prebaked anode consumption, tonnes CO_2
- MP = total metal production, tonnes Al (plant specific data);
- NAC = net prebaked anode consumption per tonne of aluminium, tonnes C/ tonne Al (plant specific data);
- Sa = sulphur content in baked anodes, wt % (plant specific data);
- Ash_a = ash content in baked anodes, wt % (plant specific data);
- 44/12 = CO_2 molecular mass: carbon atomic mass ratio, dimensionless.

II. The PFC emissions are calculated based on **GPG 2000 Methodology (Tier 2 Method)** and **IPCC 2006 Methodology (Tier 2 Method)**, using **Overvoltage Method** and considering the plant specific data and also average parameters from measurements at numerous facilities.

In order to calculate **CF_4 emission** there was used **IPCC GPG 2000 Methodology (Tier 2 Method**–Equation 3.11) and default parameter obtain from measurements at numerous facilities compliance with **IPCC 2006 Methodology (Tier 2 Method).**

The parameters used in order to estimate the CF_4 emissions are: Overvoltage coefficients, Anode effect over-voltage, Aluminium Production process current efficiency, total metal production (aluminium), compliance with the below equation.

Equation 4.10 CF_4 emissions by Overvoltage Method
(Tier 2 Method – GPG 2000 Methodology)

$$EF\ (kg\ CF_4\ per\ tonne\ of\ Al) = Over\text{-}Voltage\ Coefficient * AEO / CE$$

$$E_{CF4} = EF_{CF4} * MP$$

where:

- EF (kg CF_4 per tonne of Al) = Emission factor for CF_4 using Overvoltage Method
- AEO = Anode effect over-voltage in mV/cell day (plant specific data);
- CE = Aluminium Production process current efficiency expressed in percent (plant specific data);
- E_{CF4} = CF_4 emissions from using Overvoltage Method;
- MP = total metal production, tonnes Al (plant specific data).

Measurement data are not available to determine smelter-specific Overvoltage coefficients, therefore default coefficients were used (an average parameters from measurements at numerous facilities), compliance with **IPCC 2006 Methodology (Tier 2 Method–Table 4.16)**: Overvoltage Coefficient = **1.16 [(kg CF_4/tAl) / (mV)]**

Anode effect overvoltage parameter greatly decreased due to changing production technology leading to lower emission factor for CF_4.

In order to **calculate C_2F_6 emission** there was used **IPCC 2006 Methodology (Tier 2 Method–**Equation 4.27).

Equation 4.11 C_2F_6 emissions by Overvoltage Method (Tier 2 Method - IPCC 2006 Methodology)

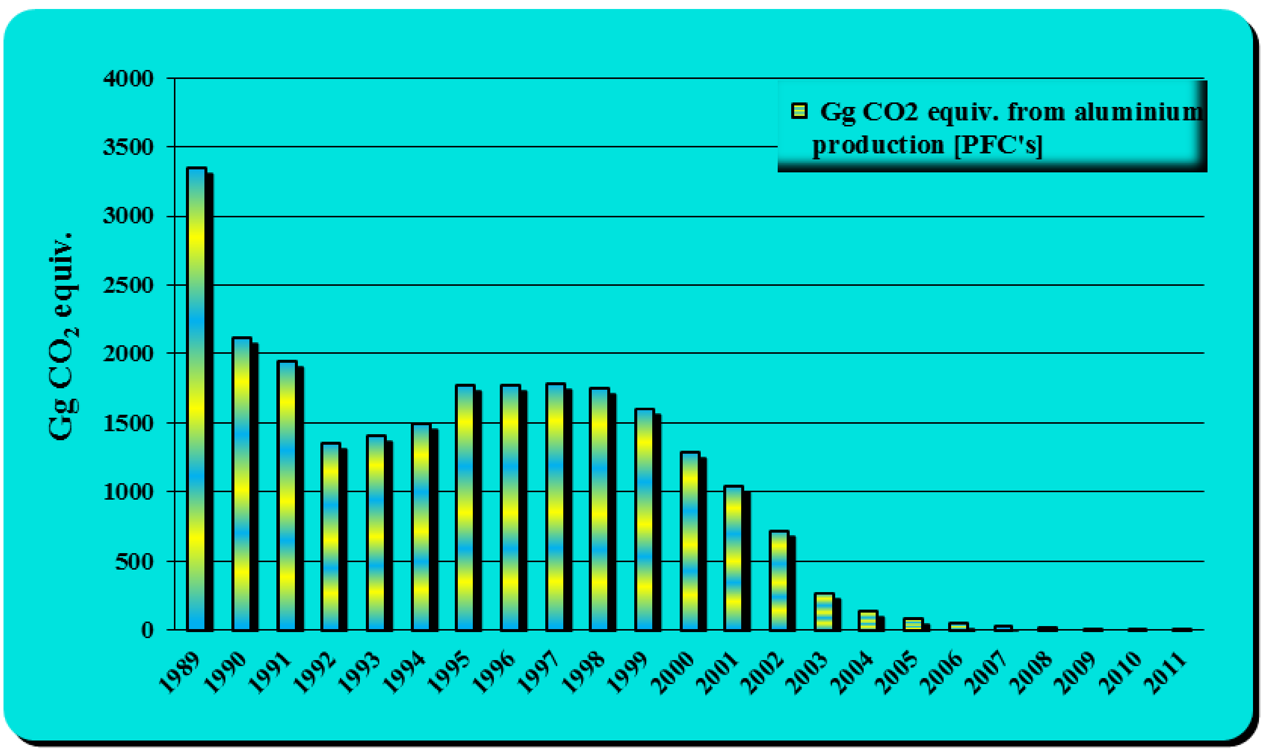
$$EC_2F_6 = ECF_4 \cdot FC_2F_6 / CF_4$$

where:

- E_{C2F6} = emissions of C_2F_6 from Aluminium Production, kg C_2F_6
- $F_{C2F6/CF4}$ = weight fraction of C_2F_6/CF_4, kg C_2F_6/kg CF_4

The data related with weight fraction of C_2F_6/CF_4, kg C_2F_6/kg CF_4 was in line with **IPCC 2006 Methodology (Tier 2 Method – Table 4.16):** weight fraction **C_2F_6/CF_4 = 0.121**

Figure 4.16 The trend of PFC emissions [GgCO$_2$ equiv] from Primary Aluminium Production Sub-sector in the period 1989–2011



The **CO, SO_2 emissions** are also estimated related to primary Aluminium Production.

Table 4.28 Emission factors for CO and SO_2 from primary Aluminium Production

Gas	Process	Emission Factor [Kg/tonne primary Al produced]
CO	**Anode baking**	**400**
SO_2	**Anode baking**	**0.9**

SF_6 used in Aluminium and Magnesium Foundries (IPCC category 2.C.4)

Methodology

The default IPCC methodology for estimation the emissions from this sub-sector cannot be applied because this activity is not applicable in the country.

Activity data

This activity is not applicable in the country.

Emission factors

The default IPCC emission factors cannot be used because this activity is not applicable in the country.

4.4.3 Uncertainties and time series consistency

Iron and Steel Production (IPCC category 2.C.1)

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

- AD: 1 %;
- EF: 10 %;

- 10.05% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Ferroalloys Production (IPCC category 2.C.2)

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

- AD: 5 %;
- EF: 30 %;
- 30.41% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

Aluminium Production (IPCC category 2.C.3)

Time series is consistent. Due to the data are provided directly from economic agent the emissions have been calculated using higher method in line with **IPCC Methodology** just only staring with 2003 year; for the first period 1989–2002 because the plant specific information data have not been not available, the emissions were calculated based on **Tier 1 method–IPCC Methodology**. There is the same source of activity data for the entire time series 1989–2011.

CO_2 emissions

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

- AD: 5 %;
- EF: 20 %;
- 20.62% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

PFC emissions

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

- AD: 5 %;
- EF: 50 %;
- 50% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

4.4.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed.

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Consumption of Halocarbons and SF_6 Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

Recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 version 2 of the 2012 NGHGI; they are described in the Chapter 4.4.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.4.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

AD on primary Aluminium Production obtained from economic agent has been checked against the data obtained from the National Statistics. The differences in AD generated by these two different data sources are negligible (there are some small differences in the first part of the time series, when statistical data are a little bit higher, but the data from plant are consider to be more reliable).

Both the operator, the data/information provider, and the National Environmental Protection Agency (NEPA), the inventory compiler, performs Quality Control checks as outlined within the IPCC GPG 2000 in relation to every inventory submission.

Considering that the latest available plant-specific data/information, provided by the operator, data used in emission estimation, and the quality control activities described above, the data series are considered to be consistent, according with the provisions in the IPCC GPG 2000.

AD on Iron and Steel Production obtained from local Environmental Protection Agencies has been checked against the data obtained from National Statistics and Ministry of Economy. The differences in AD generated by these three different data sources are negligible.

The CO_2 emissions from Iron and Steel Production were compared with the emissions reported in monitoring plans of GHG emissions for the EU-ETS installations. Further elements are presented within Annex 8.3.

4.4.5 Source specific recalculation, including changes made in response to the review process.

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

- activity data:
    - Iron and Steel Production (IPCC category 2.C.1).

Table 4.29 The effects of recalculations in Metal Production Sub-sector

The effects of recalculations in Metal Production Sub-sector			
Years	**NGHGI 2012 v. 3.1**	**NGHGI 2013 v. 1.4**	**Differences [%]**
	CO_2 equivalent [Gg]		
1989	17,783.73	13,721.66	-22.84
1990	11,411.35	8,852.98	-22.42
1991	7,870.39	6,308.19	-19.85
1992	7,728.63	6,677.09	-13.61
1993	7,861.89	6,745.94	-14.19
1994	8,973.13	7,851.51	-12.50
1995	9,987.10	8,959.86	-10.29
1996	9,520.97	8,475.97	-10.98
1997	9,907.17	8,841.59	-10.76
1998	9,828.54	9,128.32	-7.12
1999	6,489.02	6,286.39	-3.12
2000	6,341.54	6,337.61	-0.06
2001	5,653.99	5,650.00	-0.07
2002	6,858.21	6,854.72	-0.05
2003	5,778.96	5,774.16	-0.08
2004	5,984.79	5,979.99	-0.08
2005	6,366.14	6,358.10	-0.13
2006	7,616.29	7,609.41	-0.09
2007	7,862.02	7,855.42	-0.08
2008	5,462.50	5,459.11	-0.06
2009	3,619.86	3,613.32	-0.18
2010	3,406.57	3,374.52	-0.94

Iron and Steel Production Sub-sector (IPCC category 2.C.1.)

Recalculations for all time series 1989-2010 at pig iron production (2.C.1.2) have been made due to keeping the amount of coke used in blast furnaces, all other solid fuels are found in the Energy Sector in 1.A.A.2.A Iron and Steel category.

Table 4.30 Recalculations of CO_2 [Gg] emissions in the Iron and Steel Production Sub- sector

The effects of recalculations in Iron and Steel Production Sub-sector			
Years	**NGHGI 2012 v. 3.1**	**NGHGI 2013 v. 1.4**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	13,561.71	9,499.64	-29.95
1990	8,712.73	6,154.35	-29.36
1991	5,448.62	3,886.43	-28.67
1992	6,022.90	4,971.36	-17.46
1993	6,141.11	5,025.17	-18.17
1994	7,079.16	5,957.54	-15.84
1995	7,765.15	6,737.91	-13.23
1996	7,270.45	6,225.45	-14.37
1997	7,711.71	6,646.13	-13.82
1998	7,692.53	6,992.31	-9.10
1999	4,623.58	4,420.95	-4.38
2000	4,648.01	4,644.07	-0.08
2001	4,194.47	4,190.49	-0.09
2002	5,716.44	5,712.95	-0.06
2003	4,940.95	4,936.15	-0.10
2004	5,159.14	5,154.35	-0.09
2005	5,710.29	5,702.24	-0.14
2006	7,068.41	7,061.53	-0.10
2007	7,390.01	7,383.41	-0.09
2008	5,025.62	5,022.23	-0.07
2009	3,293.82	3,287.29	-0.20
2010	3,035.03	3,002.98	-1.06

4.4.6 Source specific planned improvements, including those in response to the review process.

More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

4.5 Source category Other Production (CRF Sector 2.D)

4.5.1 Source category description

This sector includes NOx, CO, NMVOC and SO_2 emission resulted from the Pulp and Paper Production (IPCC category 2.D.1), alcoholic beverages Production and Food Production (IPCC category 2.D.2). The activity data necessary to estimate these emissions are provided in the Statistical Yearbook.

4.5.2 Methodological issues

Methodology

According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook and Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual

In the Pulp and Paper Production (IPCC category 2.D.1) Sub-sector the Pulp Production was broken down by kraft and acid sulphite processes.

In the Food and Drink Production (IPCC category 2.D.2) Sub-sector the emission was estimated based on the total annual production of the particular food and drink manufacturing process.

The emissions of NOx, CO, NMVOC, and SO_2 within the Production of Pulp and Paper and Food and Drink Sub–sector are calculated based on the production volume and the emission factors, in line with the IPCC 1996.

Activity data

In the Pulp and Paper Production (IPCC category 2.D.1) Sub-sector, the emission was estimated based on the total annual production of dried pulp, provided by National Statistics. Starting with 2009 the activity data are NO inside this category.

In the Food and Drink Production (IPCC category 2.D.2) Sub-sector the AD were provided by the National Statistics. The data set in case of Bread Production is not complete; the data for 1989–2000 are missing. A linear extrapolation was used to estimate Bread Production in order to complete the time series.

The NMVOC emissions resulted from: Beer/Whine/Meat/fish and poultry/Sugar/Margarine and solid cooking fast/Cakes, biscuits and breakfast cereals/Bread production.

Emission factors

For confidentiality reasons the presentation of NOx, CO, NMVOC, SO_2 emission factors used to estimate emission from the Production of Pulp and Paper and Food and Drink Sub-sector are omitted.

4.5.3 Uncertainties and time series consistency

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods were used for the entire time series 1989–2011.

4.5.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Consumption of Halocarbons and SF_6 Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 version 2 of the 2012 NGHGI; they are described in the Chapter 4.5.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.5.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

4.5.5 Source specific recalculation, including changes made in response to the review process

No recalculations were made relative to previous submission.

4.5.6 Source specific planned improvements, including those in response to the review process.

More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

4.6 Source category Production of Halocarbons and SF_6 (CRF Sector 2.E)

4.6.1 Source category description

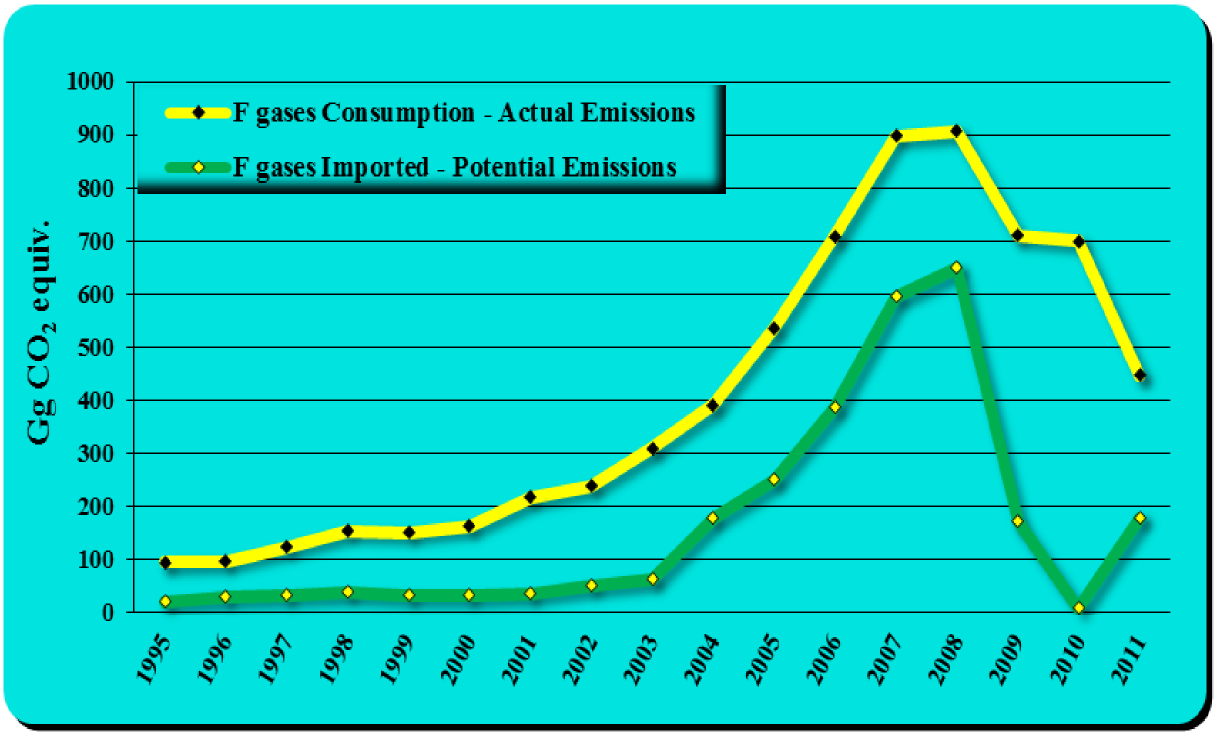
F-gases are not produced in Romania and therefore there are no fugitive emissions from manufacturing. Additionally, there is no production of other fluorinated gases (HCFC) that could lead to by-product F-gas emissions.

4.7 Source category Consumption of Halocarbons and SF_6 (CRF Sector 2.F)

4.7.1 Source category Description

Both potential and actual emissions were estimated. Potential emissions were estimated using Tier 1a method. Actual emissions were estimated based on the cluster method combined with Tier 2 method according to the IPCC methodology.

Figure 4.17 The trend of CO_2 emissions [Gg CO_2 equiv.] Consumption of Halocarbons and SF_6 Sub-sector in the period 1995–2011



4.7.2 Methodological issues

Methodology

Refrigeration and Air Conditioning Equipment (2.F.1) is a key category only consider the trend criteria (Tier 1, excluding LULUCF) and from both level and trend point of view (Tier 2, excluding and including LULUCF); Foam Blowing (2.F.2) is a key category only considering the trend criteria (Tier 2, excluding and including LULUCF); Other (2.F.9) is a key category, from both level and trend point of view (Tier 2, excluding and including LULUCF).

Actual emissions were estimated based on the cluster method for 2F1, 2F2, 2F3, 2F4 categories (related with HFC) and using Tier 2 method according to the IPCC methodology for the same categories (related with PFC and SF_6).

There was also use Tier 2 method for 2F5, 2F6, 2F7, 2F8, 2F9 (related with HFC, PFC and SF_6). Tier 2 method use the information from specific questionnaires provided by economic agents.

In order to estimate consumption of HFCs, PFCs and SF_6 in the period 1995–2011 two sets of questionnaires have been sent to:

- trading companies, to identify the amounts of F gases imported/exported (in order to estimate the potential emissions);
- Local Environment Protection Agencies, to identify manufacturing and service companies as possible sources of handling or consumption of these compounds (in order to obtain the data need to estimate the emissions on Tier 2 method).

Potential emissions were estimated using Tier 1a method considering the amounts of F gases imported.

Table 4.31 Actual and potential emissions from Consumption of Halocarbons and SF_6 Sub-sector in the period 1995–2011

Year	**Emissions from Consumption of halocarbons and SF_6 Sub-sector**
	CO_2 equivalent [Gg]
1989	0.00
1990	0.00
1991	0.00
1992	0.00
1993	0.00
1994	0.00
1995	95.26
1996	97.91
1997	124.18
1998	154.59
1999	151.74
2000	163.71
2001	217.08
2002	239.48
2003	310.33
2004	391.09
2005	536.85
2006	708.87
2007	898.88
2008	906.60
2009	710.48
2010	700.23
2011	447.76

Activity data

The results of the questionnaires were:

- F-gases are not produced in the country;
- export is not applicable;
- there were identified one big importers in the country , for 2011;
- the use of F-gases started in 1995.

For estimated **actual emissions** based on the **cluster method** for 2F1, 2F2, 2F3, 2F4 categories (related with HFC) the next data were considered related with 1995–2008 period: total actual HFC emissions (1), total GDP (2), HFC emissions as a fraction of GDP (3). The data were collected from UNFCCC Secretariat site (National Inventory Submissions 2010, Inventory Review Reports 2010) and United Nations Statistics Database (the data on GDP). We used the GDP as the only driver. In cluster only data from EIT (economies in transition) Parties were used. We also still excluded the countries that had adjustments and those that had no emissions, for each of the subcategories and years. Data use for estimate emissions level in 2009 are already estimated Romania's emissions level in 2008 and Romania's GDP variation between the 2009 and 2008. For the 2010 and 2011 the same formula as 2009 was applied.

For the 2010 year Romania's GDP was 158.43 billion $ and for 2011 year is 55.37 billion $.

For estimated **actual emissions** based on Tier 2 method according to the IPCC methodology (related with PFC and SF_6) and 2F5, 2F6, 2F7, 2F8, 2F9 (related with HFC, PFC and SF_6) the data from questionnaires were used (amount of fluid): filled into new manufactured products, in operating systems , remaining in products at decommissioning.

For estimated the **potential emissions** based on Tier 1a method according to the IPCC methodology the data from questionnaires were used: the amount of F gases imported.

Emission factors

Potential emissions

Potential emissions were estimated using Tier 1a method, based on formula:

Equation 4.12 Calculation of potential emissions

Potential Emissions = Production + Imports – Exports - Destruction

where:

- production = not applicable;
- imports = imported HFC/PFC in bulk (HFC-134a, HFC-32, HFC-125, HFC-143a were identified in 2011);
- exports - not applicable;
- destruction - not estimated.

Potential emissions are equaled with the amount of substance imported in bulk.

Actual emissions

For 2F1, 2F2, 2F3, 2F4 categories (related with HFC) – 1995 – 2008 period.

For estimated **actual emissions** based on the **cluster** method the fraction between HFC emissions and GDP was calculated for every Party in the cluster; the average of the intensity of HFC emissions of all countries in the cluster was calculated and then, this value was multiplied with Romania's GDP in order to estimate the emissions for the year and subcategory. This is the way used for the 1995–2008 period.

For the 2009 year we used the Romania's GDP data for 2009 and 2008 in order to establish the variation; then we calculated the emissions level in 2009 based on the already estimated Romania's emissions level in 2008 and Romania's GDP variation between the 2009 and 2008. For the 2010 the same formula as 2009 was applied.

For 2F1, 2F2, 2F3, 2F4 categories (related with PFC and SF_6) and 2F5, 2F6, 2F7, 2F8, 2F9 (related with HFC, PFC and SF_6) – 1995–2010 period.

The determination of **actual emissions** from use F-gases is based on the data from questionnaires (amount of fluid). The emission factors used to estimate actual emissions (initial emissions, lifetime time emissions and end-of-life emissions) are the recommended emission factors from IPCC GPG, considering IPCC Tier 2 method.

Table 4.32 ***Implied emission factors use to estimate the emissions related to Consumption of Halocarbons and SF_6***

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	IMPLIED EMISSION FACTORS		
	Product manufacturing factor	**Product life factor**	**Disposal loss factor**
1. Refrigeration[(1)]	**(% per annum)**		
Air Conditioning Equipment			
Domestic Refrigeration	0.60	0.30	70.00
Commercial Refrigeration	1.75	20.00	70.00
Transport Refrigeration	0.60	32.50	70.00
Industrial Refrigeration	1.75	16.00	80.00
Stationary Air-Conditioning	0.60	3.00	70.00
Mobile Air-Conditioning	0.50	15.00	70.00
2. Foam Blowing[(1)]			
Hard Foam			
Soft Foam			
3. Fire Extinguishers / *(please specify chemical)*[(1)]	65-40		
4. Aerosols [(1)]			
5. Solvents [(1)]	50.00		
6. Other applications using ODS[(2)] substitutes [(1)]			
7. Semiconductors [(1)]			
8. Electric Equipment[(1)]	0.06		
9. Other ***(please specify)***[(1)]			
Other non-specified	50.00		

In 2011, the sub-sector 2F Consumption of Halocarbons and SF_6 includes the following source categories and the following F-gases:

Table 4.33 Source categories and the F-gases in Consumption of Halocarbons and SF_6 Sub-sector

Source category	Sub-sector	HFCs/PFCs/SF_6
2.F.1 Refrigeration and air conditioning equipment	Domestic refrigeration	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2.F.1 Refrigeration and air conditioning equipment	Commercial refrigeration	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2.F.1 Refrigeration and air conditioning equipment	Industrial refrigeration	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2.F.1 Refrigeration and air conditioning equipment	Transport refrigeration	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2.F.1 Refrigeration and air conditioning equipment	Stationary air conditioning	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2.F.1 Refrigeration and air conditioning equipment	Mobile air conditioning	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2.F.2 Foam Blowing	Foam Blowing	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2.F.3 Fire extinguishers	Fire extinguishers	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2.F.4 Aerosols/Metered Dose Inhalers	Aerosols/Metered Dose Inhalers	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2.F.5 Solvents	Solvents	IPCC Tier 2 method – HFC, PFC, SF_6
2.F.6 Other applications using ODS substitutes	Other applications using ODS substitutes	IPCC Tier 2 method – HFC, PFC, SF_6
2.F.7 Semiconductors	Semiconductors	IPCC Tier 2 method – HFC, PFC, SF_6
2.F.8 Electrical equipment's	Electrical equipment's	IPCC Tier 2 method – HFC, PFC, SF_6
2.F.9 Other non-specified	Other	IPCC Tier 2 method – HFC, PFC, SF_6

For the 1995–2011 period the HFC emissions related with 2F1, 2F2, 2F3, 2F4 categories have been noted as IE and included in aggregate manner under “Unspecified mix of HFC” inside the CRF tables due to using the cluster method. For the same period the PFC and SF_6 related with 2F1, 2F2, 2F3, 2F4 categories have been noted as NO or figures were presented (data from questionnaires).

For the 1995–2011 period the HFC, PFC and SF_6 emissions related with 2F5, 2F6, 2F7, 2F8, and 2F9 categories have been noted as NO or figures were presented (data from questionnaires).

For the 1989–1994 period the NO notation key were used for all the F-gases use.

4.7.3 Uncertainties and time series consistency

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

- AD: 300 %;
- EF: 0 %;
- 300% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

4.7.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Metal Production Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

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

280/2004/EC 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 version 2 of the 2012 NGHGI; they are described in the Chapter 4.7.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 4.7.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

4.7.5 Source specific recalculation, including changes made in response to the review process

There are no recalculations related with this submission.

4.7.6 Source specific planned improvements, including those in response to the review process

Improve the emission estimation within this category.

More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

5 SOLVENT AND OTHER PRODUCT USE (CRF Sector 3)

5.1 Overview of the sector

The Solvent and Other Product Use is a key category from both level and trend point of view (Tier 2, excluding and including LULUCF).

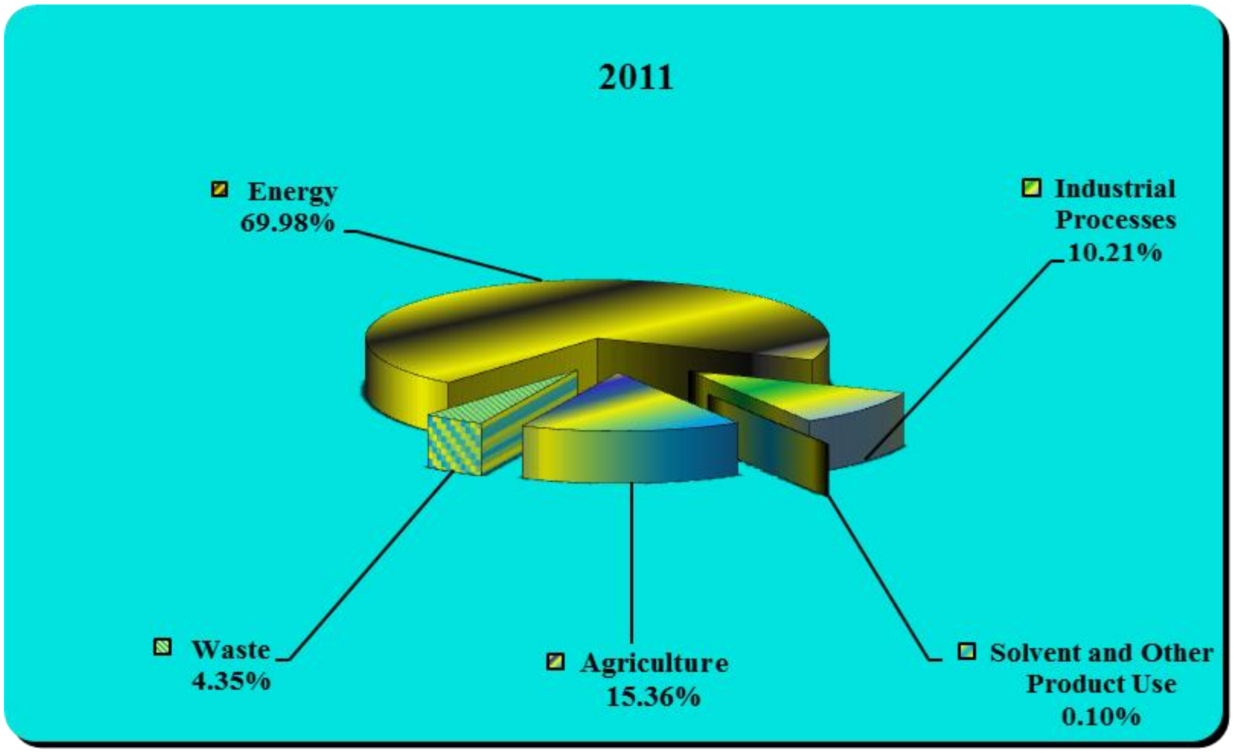
Solvents are chemical compounds, which are used to dissolve substances as paint, glues, ink, rubber, plastic, and pesticides or for cleaning purposes (degreasing). After application of these substances or other procedures of solvent use most of the solvent is released into air. The use of solvents leads to emissions of non-methane volatile organic compounds (NMVOC), which is regarded as an indirect greenhouse gas. The NMVOC emissions will over a period of time in the atmosphere oxidize to CO_2, which is included in the total greenhouse gas emissions reported to the UNFCCC Secretariat.

5.2 Source category

Paint Application (IPCC category 3A), Degreasing and Dry Cleaning (IPCC category 3B), Chemical Products, Manufacture and Processing (IPCC category 3C), Other (IPCC category 3D).

In 2011 the GHG emissions from Solvent and Other Product Use Sector contributed to 0.10% of the total GHG emissions in Romania.

Figure 5.1 The contribution of Solvent and Other Product Use Sector to the total GHG emissions in Romania, 2011



5.2.1 Source category description

- 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.

5.2.2 Methodological issues

Methodology

IPCC guidelines do not provide methodology to determine NMVOC emissions, which is the main source of emissions in this sector. Due to this reason, the NMVOC emissions resulted from Solvents and Other Product Use are estimated based on CORINAIR methodology, using the correspondence between IPCC categories and SNAP codes (Table 5.1).

Table 5.1 Correspondence between IPCC categories and SNAP codes

IPCC categories	SNAP codes
3.A Paint application	0601 Paint application
3.B Degreasing and Dry Cleaning	0602 Degreasing, dry cleaning and electronics
3.C Chemical Products, Manufacture and Processing	0603 Chemical products manufacturing and processing
3.D Other	0604 Other use of solvents & related activities

Activity data

For 2013 submission the AD used to calculate emissions are provided by the National Statistics and economic agents but the main data source is National Statistics.

Emission factors

CO_2 emissions from Solvent Use were calculated from NMVOC emissions of this sector. The following equation has been applied:

Equation 5.1 Calculation of CO_2 emissions from Solvent Use

$$CO_2 \text{ emissions} = 0,85 \times (44/12) \times \text{emissions of NMVOC}$$

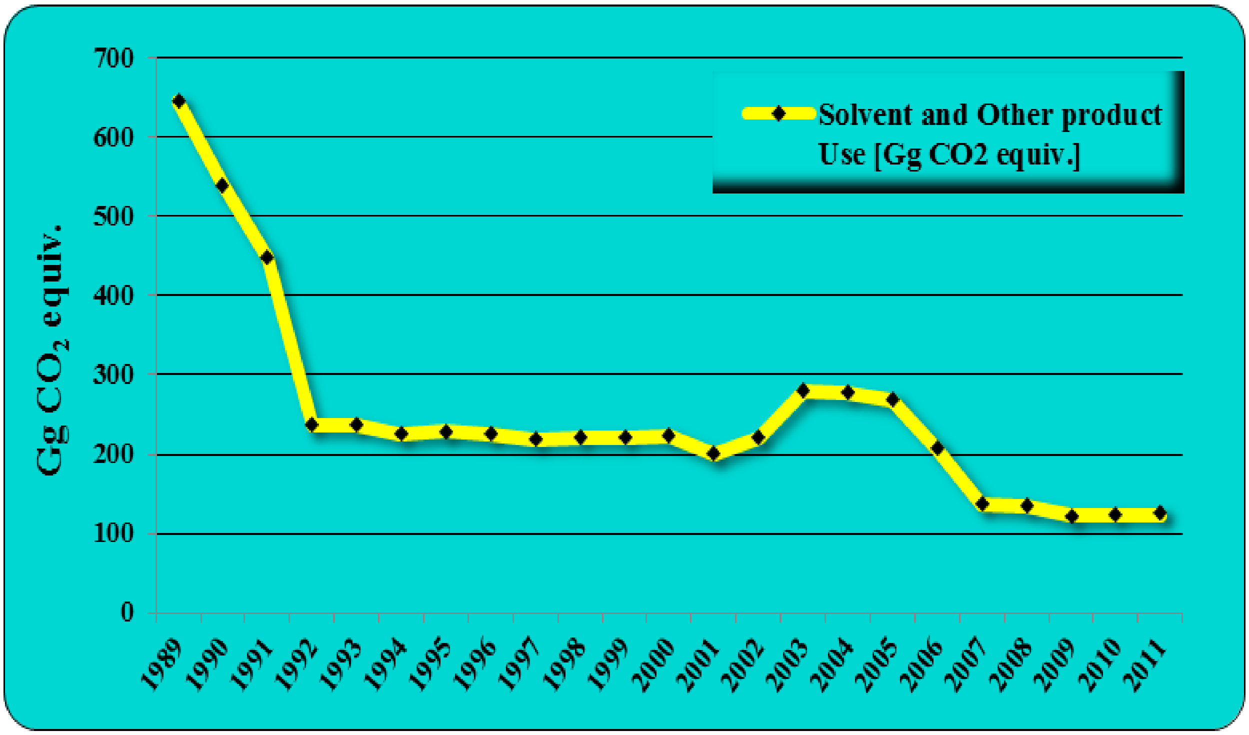
where:

- 0.85 is carbon content conversion factor.

Table 5.2 CO_2 emissions resulted from Solvent and Other Product Use in the period 1989–2011

Solvents and Other Product Use					
Year	**3A**	**3B**	**3C**	**3D**	**Total**
	CO_2 emissions [Gg]				
1989	141.20	100.70	0.00	403.90	**645.80**
1990	111.60	88.20	0.00	340.70	**540.50**
1991	84.50	70.10	0.00	293.60	**448.20**
1992	52.00	31.00	0.00	154.60	**237.60**
1993	51.10	30.90	0.00	155.50	**237.50**
1994	41.50	30.90	0.00	153.00	**225.40**
1995	43.90	30.90	0.00	154.60	**229.40**
1996	39.60	30.80	0.00	154.90	**225.30**
1997	33.00	30.80	0.00	155.20	**219.00**
1998	31.50	30.80	0.00	159.60	**221.90**
1999	30.50	30.80	0.00	161.10	**222.40**
2000	32.70	30.80	0.00	160.80	**224.30**
2001	41.50	17.50	0.00	141.50	**200.50**
2002	45.50	17.80	0.00	159.00	**222.30**
2003	106.60	21.80	0.00	151.50	**279.90**
2004	99.80	25.80	0.00	151.80	**277.40**
2005	95.14	16.85	0.00	157.66	**269.65**
2006	162.42	16.82	0.00	29.26	**208.50**
2007	35.37	20.18	0.00	82.26	**137.82**
2008	25.16	28.19	0.00	81.79	**135.14**
2009	11.05	25.43	0.00	85.85	**122.33**
2010	12.39	25.09	0.00	87.26	**124.74**
2011	10.17	26.82	0.00	88.62	**125.61**

Figure 5.2 The trend of CO_2 emissions resulted from Solvent and Other Product Use Sector, in the year 2011



The trend of emissions resulted from this sector follow the general emission trend: emissions have been seriously decreased after 1989, then the emissions are relatively stable from 1992 to 2002 and after 2002, emissions are started to increase, as an increase in economic activities (automobile manufacture, construction and buildings).

5.2.3 Uncertainties and time series consistency

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

- AD: 300 %;

- EF: 20 %;

- 300.67% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Time series is consistent: emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2011.

5.2.4 Source specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Chemical Industry Sub-sector, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 version 2 of the 2012 NGHGI; they are described in the Chapter 5.2.5 – Source-specific recalculations, including changes made in response to the review process and at the Chapter 10 - Recalculations and improvements levels; the quantitative effects of their solving are described at the Chapter 5.2.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

5.2.5 Source specific recalculation, including changes made in response to the review process

There are no recalculations related with this submission.

5.2.6 Source specific planned improvement, including those in response to the review process.

More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

6 AGRICULTURE (CRF Sector 4)

6.1 Overview of sector

This chapter provides information on the estimation of the greenhouse gas emissions from the Agriculture Sector (being associated with the Common Reporting Format Table 4). The following source categories are quantified and reported:

- CH_4 emissions from enteric fermentation;
- CH_4 and N_2O emissions from manure management;
- CH_4 emissions from rice cultivation;
- N_2O emissions from agricultural soils;
- CH_4, N_2O, NO_x and CO emissions from field burning of agricultural residues.

The direct GHGs reported within this sector are CH_4 and N_2O while indirect gases comprise NO_x and CO.

Domestic livestock are the major source of CH_4 emissions from agriculture, both from enteric fermentation and manure management. Manure management also generates N_2O emissions.

Table 6.1 gives an overview of the IPCC categories included in this chapter and provides information on the status of related emissions estimates.

Table 6.1 Status of emissions estimation within the Agriculture Sector

IPCC category	Emissions estimation status	
	CH_4	N_2O
4.A Enteric fermentation		
4.A.1 Cattle	✓	NA
4.A.1.a Dairy cattle	✓	NA
4.A.1.b Non-dairy cattle	✓	NA

IPCC category	Emissions estimation status	
4.A.2 Buffalo	✓	NA
4.A.3 Sheep	✓	NA
4.A.4 Goats	✓	NA
4.A.5 Camels and lamas	NO	NO
4.A.6 Horses	✓	NA
4.A.7 Mules and asses	✓	NA
4.A.8 Swine	✓	NA
4.A.9 Poultry	✓	NA
4.A.10 Other livestock	NA	NA
4.B Manure management		
4.B.1 Cattle	✓	✓
4.B.1.a Dairy cattle	✓	✓
4.B.1.b Non-dairy cattle	✓	✓
4.B.2 Buffalo	✓	✓
4.B.3 Sheep	✓	✓
4.B.4 Goats	✓	✓
4.B.5 Camels and lamas	NO	NO
4.B.6 Horses	✓	✓
4.B.7 Mules and asses	✓	✓
4.B.8 Swine	✓	✓
4.B.9 Poultry	✓	✓
4.B.10 Other livestock	NA	NA
4.B.11 Anaerobic lagoon	NA	✓
4.B.12 Liquid/Slurry	NA	✓
4.B.13 Daily spread	NA	IE[1)]
4.B.14 Solid storage	NA	✓
4.B.15 Dry lot	NA	✓
4.B.16 Pasture/range/paddock	NA	IE[1)]
4.B.17 Pit storage	NA	✓

IPCC category	Emissions estimation status	
4.B.18 Poultry manure wit bedding	NA	✓
4.B.19 Poultry manure without bedding	NA	✓
4.C Rice cultivation		
4.C.1 Irrigated	✓	NA
4.C.1.1 Continuously flooded	NO	NA
4.C.1.2 Intermittently flooded	✓	NA
4.C.1.2.1 Single aeration	NO	NA
4.C.1.2.2 Multiple aeration	✓	NA
4.C.2 Rainfed	NO	NA
4.C.3 Deep water	NO	NA
4.C.4 Other	NO	NA
4.D Agricultural soils		
4.D.1 Direct soil emissions	NA	✓ , NO
4.D.1.1 Synthetic fertilizers	NA	✓
4.D.1.2 Animal manure applied to soils	NA	✓
4.D.1.3 N-fixing crops	NA	✓
4.D.1.4 Crop residue	NA	✓
4.D.1.5 Cultivation of Histosols	NA	✓
4.D.1.6 Other direct emissions	NA	NA
4.D.2 Pasture range and paddock manure	NA	✓
4.D.3 Indirect emissions	NE	✓
4.D.3.1 Atmospheric Deposition	NA	✓

IPCC category	Emissions estimation status	
4.D.3.2 Nitrogen Leaching and Run-off	NA	✓
4.D.4 Other	NA	NA
4.E Prescribed burning of savannas	NO	NO
4.F Field burning of agricultural residues	✓	✓

Observations

1) In respect to the IPCC GPG 2000 provisions, N_2O emissions from Daily spread and Pasture range and paddock AWMS are reported under 4D – Agricultural soils (see Chapter 6.5).

Figure 6.1 Total GHG emissions trend in Agriculture for 1989–2011 period

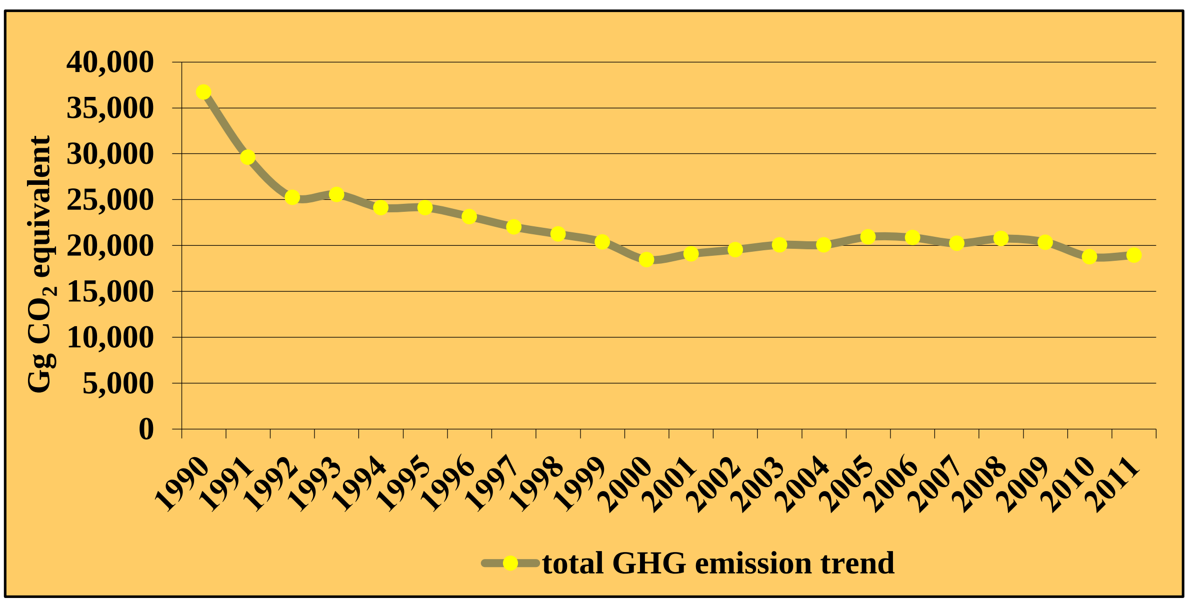
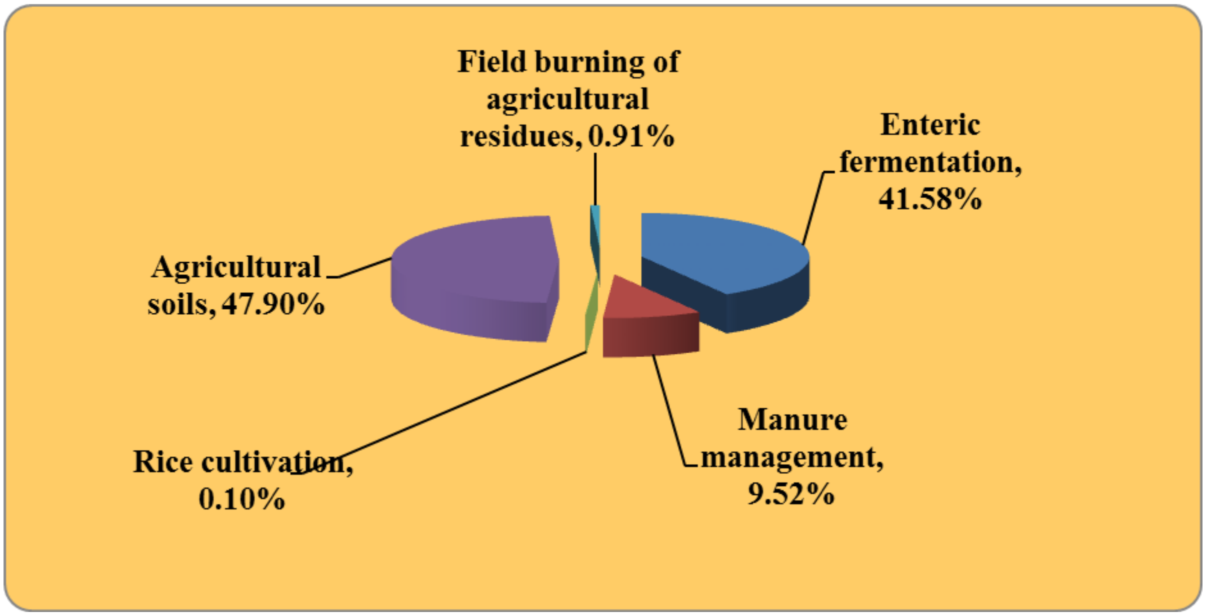


Figure 6.2 Contribution of the sub-sectors in the total GHG emissions from Agriculture, in 2011 year



Another source of methane is represented by anaerobic decomposition of organic material in flooded rice fields.

Microbiological processes in soil lead to N_2O emissions. Three N_2O sources are distinguished:

- direct soil emissions from agricultural soils (sources: synthetic fertilizers, animal waste applied to soil, biological nitrogen fixation, crop residue);
- direct soil emissions from animal production (from grazing animals);
- indirect soil emissions (atmospheric deposition, leaching and run off).

Cultivation of histosoils do not occur in Romania.

Burning of agricultural residues is a net source of CH_4, CO, N_2O and NO_x emissions for 1989-2011 period.

Emissions from prescribed burning of savannas do not occur in Romania.

The Agriculture Sector accounted for 15.36% of the total GHG emissions in 2011, reaching 18,941.46 Gg CO_2 equivalent (Table 6.2).

Within the GHG emissions from the agriculture sector, the N_2O emissions have the largest contribution (in 2011, N_2O emissions contribution is 54.51% to the total Agriculture Sector's CO_2 equivalent emissions), followed by the CH_4 emissions (that account for the remaining 45.49%).

Over the period 1989 – 2011, the GHG emissions resulted from Agriculture Sector decreased by 53.50% (Figure 6.1).

The number of animals decreased in this period whatever of the species and type of operation. After a slight recovery of national livestock situation, another dramatic regression occured, result of economic situation extremely difficult Romania passed in the period 1997-2000. After the period 2001-2002 and in present, for the livestock species of interest there are recorded fluctuations in the livestock number influenced by the economic context, the emergence of various associative forms that have acquired economic power and by the interest shown by farmers for increasing the genetic value of the animals.

After 1989 the livestock from most Agricultural Production Cooperatives (C.A.P.) were attributed to rural population they being sacrificed in large numbers for meat. On the other hand, in most rural areas, a significant number of farmers have lost the interest in animal husbandry.

In case of emissions resulted from enteric fermentation and manure management, the descending trend reflects the decrease in animal population over the period. The number of all cattle categories decreased in the analyzed period.

Buffalo population was subject to the same reduction, the animals being privately owned both in subsistence farms and individual households. The lack of interest for these species is also due to the lack of associated governmental incentives.

After 1989 swine number decreased, from 1,023,000 heads breeding sows in 1989, to 335,000 heads in 2003; the number recorded a slight increase in years with high economic growth, 2004-2007, then decreased again, registering in 2010 355,000 heads; in 2011 there were registered 380,000 heads Annex 3.3 *(*sheet - *Data obtained through the study).*

The reducing of the swine number was due to (Dinu I. - *Swiniculture,* Ed. Coral Sanivet, Bucharest, 2002, pages. 28-29):

- the overgrowth of prices from upstream area, prices associated to the energy, to materials and services, while the price of meat has registered insignificant increases;

- ❖ significant mistakes in the restructuring and the liquidation of companies owned in majority by state;
- ❖ the liquidation almost entirely of the forms of financial farmers's support;
- ❖ the import of meat and meat products made an unfair competition to the local producers, on the internal market.

The sheeps's growth is characterized in some regions through extensivity, using primitive or slightly improved races and through the practice of transhumance.

After 1990, during the C.A.P, the sheep number have decreased continuously.

After 2004, the livestock begin to grow slowly, due to investors's foreign in exploiting this species and , also due to the increased interest for sheep's milk products.

In the 1989-2003 period, goats were represented, especially through White Goat of Banat and Carpathian races.

The horses number has increased from 1989, constant until 2003, because has changed the orientation in the horses's growth of traction, are abandons the species heavier of horses, less viable considering the economic criteria, and are used intermediary horses with mixed aptitude, wich moves and are easy maintenance (Creta V, Morar M., Culea C.- *General and special animal husbandry,* E.D.P., Bucharest, 1995).

From 2007 to present, horse number is decreasing due to the biological disappearance of population employed in agriculture and due to, the increased mechanization degree in agriculture.

On the other, the number of horses used to sport purposes and, in the people therapy and development increased.

The number of mules and asses varied over the period with maximum 8,000 heads. Mules and asses are found only in households, not being growth in farms.

Poultry for meat number decreased from 1989 to 1994, after which they slightly increased, the egg poultry decreased sharply in 1994, then begin to grow, due to the foreign investments. The sector is developed in Romania and there is in present concerns of development of the modern technologies exploitation of these categories.

For the 2004-2011 period, sheep, goats livestock and poultry for meat number is only growing slightly; for the rest of species, their downward trend of 1989-2003 period continued.

Comparatively with the 2010 year, in 2011 were slowly increased some livestock categories for exemple: calves for slaughter, young cattle breeding- cattle unde 1 year and sheep.

The rice cultivation generated in 2011 a significantly reduced emission compared to the base year 1989 due to the decrease of areas (69.15% decrease comparing with the base year).

In case of agricultural soils, the emissions decreased over the period (50.63% decrease in 2011 comparing with 1989), due to the decrease of the amount of the synthetic fertilizer applied, of the livestock populations and of the crop productions level.

Starting with the 2000 year, the N_2O emissions from Agricultural Soils fluctuates: increases until 2005 and then decreases. This is due variation of quantities of synthetic fertilizers, number of animals and of the crop productions.

The Agriculture sector's CH_4 emissions decreased in 2011 with 53.50% compared to basic (see Annex 3.3 - sheet *Distribution of N_2O and CH_4 emission*). Because the methane emissions are mainly resulted in domestic livestock, the decrease of their level is due to the decline of the domestic livestock.

The N_2O emissions from the Agriculture Sector decreased in 2011 with 50.23% comparing with the base year (see Annex 3.3 - sheet *Distribution of N_2O and CH_4 emission*). The reasons for this decrease are:

- the decrease of the amount of chemical fertilizers applied to soils;
- the decline of the domestic livestock (the details are presented above);
- the decrease of the crop productions level.

In the general context of the transition of the economy to a market based approach, the activity data level decreased substantially in the last years of the characterized period in comparison to the base year.

The livestock number decreased in the last years of the characterized period in comparison to 1989 mainly due to:

- the import of animals;
- the draught which affected the crop production levels and the crop production prices;
- state incentives in some periods;
- closing of the old/opening new facilities due to the restructuration of the economy.

The crop productions level decreased in the late years of the analyzed period in comparison to 1989 mainly due to the change in agricultural land property regime and to the transition to the market economy. Reasons for the inter-annual changes in crop production levels include:

- existence of draught periods;
- existence if state incentives for some periods;
- changes in the land property regime, including the disaggregation of large farms before 1990 and crystallization of new large farms in the late years.

The livestock number was decreased in the 2010 year comparative with the 2009 year due to:

- the deficiency precipitation that which led to decreased of production needed for feeding;
- the increases of price per food.

Table 6.2 Contribution of Agriculture sector in total GHG emissions, in 1989–2011

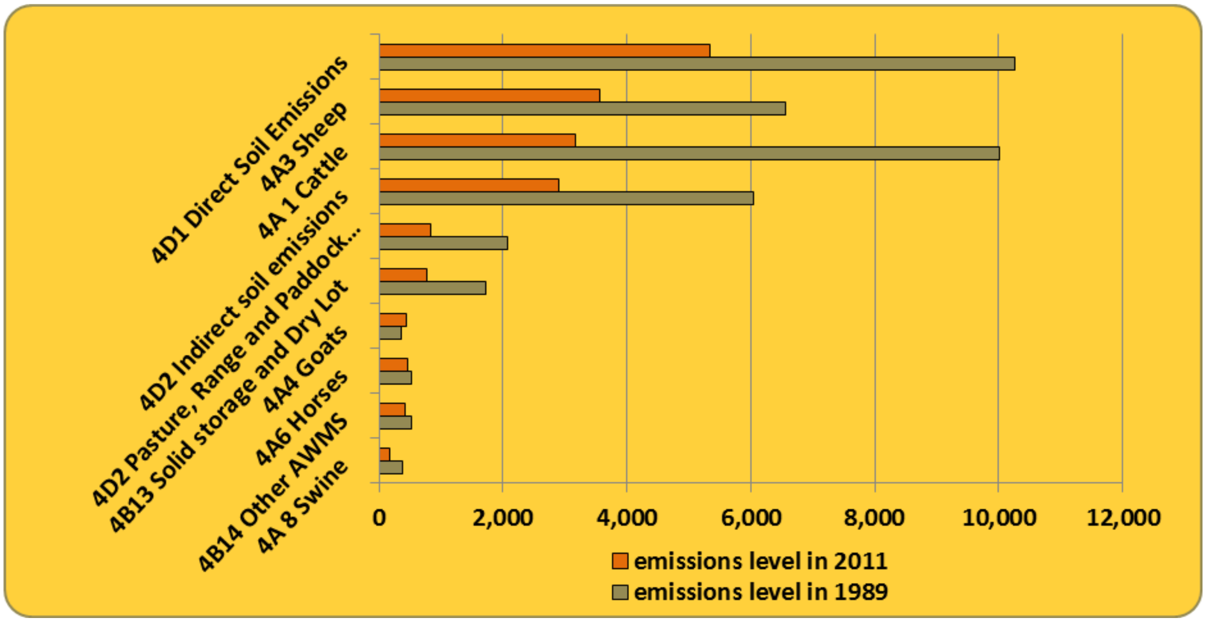
Year	Total GHG emissions [Gg CO_2 equivalent]	GHG emissions from Agriculture [Gg CO_2 equivalent]	Contribution of Agriculture in total GHG emissions [%]	Methane emissions from Agriculture [Gg CO_2 equivalent]	Contribution of methane emissions in total GHG emissions from Agriculture [%]	Nitrous oxide emissions from Agriculture [Gg CO_2 equivalent]	Contribution of nitrous oxide emissions in total GHG emissions from Agriculture [%]
1989	273,232.94	40,734.14	14.91	19,989.60	49.07	20,744.54	50.93
1990	244,403.58	36,708.34	15.02	17,781.78	48.44	18,926.56	51.56
1991	199,511.85	29,601.60	14.84	15,268.27	51.58	14,333.33	48.42
1992	174,050.45	25,251.76	14.51	13,125.02	51.98	12,126.74	48.02
1993	169,364.31	25,563.86	15.09	12,745.19	49.86	12,818.66	50.14
1994	166,094.28	24,130.83	14.53	12,141.50	50.32	11,989.32	49.68
1995	172,790.63	24,135.56	13.97	11,963.21	49.57	12,172.35	50.43
1996	175,402.43	23,153.24	13.20	11,529.01	49.79	11,624.23	50.21
1997	161,968.44	22,027.13	13.60	10,731.41	48.72	11,295.72	51.28
1998	145,489.16	21,241.10	14.60	10,314.84	48.56	10,926.27	51.44
1999	130,778.15	20,380.37	15.58	9,933.75	48.74	10,446.63	51.26
2000	133,525.98	18,455.10	13.82	9,356.50	50.70	9,098.59	49.30
2001	136,259.37	19,096.83	14.02	9,206.91	48.21	9,889.92	51.79
2002	138,217.02	19,552.24	14.15	9,542.76	48.81	10,009.48	51.19
2003	145,084.67	20,073.19	13.84	9,725.66	48.45	10,347.53	51.55
2004	142,300.84	20,070.58	14.10	9,710.25	48.38	10,360.32	51.62
2005	141,560.49	20,949.57	14.80	9,792.49	46.74	11,157.08	53.26
2006	145,880.11	20,862.19	14.30	10,134.93	48.58	10,727.26	51.42
2007	142,703.65	20,236.92	14.18	10,210.62	50.46	10,026.30	49.54
2008	140,464.22	20,753.53	14.77	10,125.15	48.79	10,628.38	51.21
2009	120,319.93	20,353.84	16.92	9,861.40	48.45	10,492.44	51.55
2010	116,621.20	18,760.94	16.09	8,624.13	45.97	10,136.81	54.03
2011	123,345.54	18,941.46	15.36	8,616.63	45.49	10,324.83	54.51

Table 6.3 and Figure 6.3 describe Key categories in Agriculture, both from level and trend and including and excluding LULUCF views.

Table 6.3 Key categories overview – Agriculture, 2011

Key categories	GHG	Criteria	Contribution in total GHG emissions [%]
4.D.1 Direct Soil Emissions	N_2O	L,T (Tier 1, excluding and including LULUCF); Tier 2, excluding and including LULUCF)	**4.3**
4.A.3 Sheep	CH_4	L,T (Tier 1, excluding and including LULUCF; Tier 2, excluding LULUCF); L (Tier 2, including LULUCF)	**2.9**
4.A.1 Cattle	CH_4	L,T (Tier 1, excluding and including LULUCF; Tier 2, excluding and including LULUCF)	**2.6**
4.D.2 Indirect soil emissions	N_2O	L (Tier 1, excluding and including LULUCF), L,T (Tier 2, excluding and including LULUCF)	**2.3**
4.D.2 Pasture, Range and Paddock Manure	N_2O	L (Tier 1, excluding LULUCF and including LULUCF); L,T (Tier 2, excluding and including LULUCF)	**0.7**
4.B.13 Solid storage and Dry Lot	N_2O	L (Tier 1, excluding and including LULUCF), L (Tier 2, excluding LULUCF); L,T (Tier 2 including LULUCF)	**0.6**
4.A.4 Goats	CH_4	T (Tier 1 including LULUCF), L,T (Tier 1 excluding LULUCF); T (Tier 2, excluding LULUCF)	**0.4**
4.A.6 Horses	CH_4	L,T (Tier 1, excluding LULUCF); L (Tier 1 including LULUCF), T (Tier 2 excluding LULUCF)	**0.4**
4.B.14 Other AWMS	N_2O	L,T (Tier 2, excluding and including LULUCF)	**0.3**
4.A.8 Swine	CH_4	L (Tier 2, excluding LULUCF)	**0.3**

Figure 6.3 Key Categories in Agriculture, both by level and trend



6.2 Source category Enteric Fermentation (CRF source category 4.A)

6.2.1 Source category description

Methane is produced by herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. Although ruminants are the largest source, both ruminant and non-ruminant animals produce CH_4.

Enteric Fermentation:

- is the main source of CH_4 emissions in the Agriculture sector (in 2011, CH_4 emissions from Enteric Fermentation represented 91.40% of total CH_4 emissions in the Agriculture sector);
- is the second source in the Agriculture sector (in 2011, CH_4 emissions from Enteric Fermentation as CO_2 equivalent represented 41.58% from Total Agriculture emissions);
- contributed with 6.38% to Total GHG emissions of Romania.

Compared to 1989, total CH_4 emissions from Enteric Fermentation decreased with 56.23% in 2011 (Figure 6.4). The decreasing trend is in direct correlation with the dynamics of livestock.

The livestock number for all species of economic interest, except goats, due to increased interest in recent years for this species, declined; the interest for goats's products is a consequence of the consumers's taste refineries, especially for urban consumers, and of the requirements for milk and goat meat for export.

The administration of goat livestock is based also on valuable genetic biological material import, especially from breeds specialized in milk production.

Figure 6.4 Methane emission trend due to the Enteric Fermentation

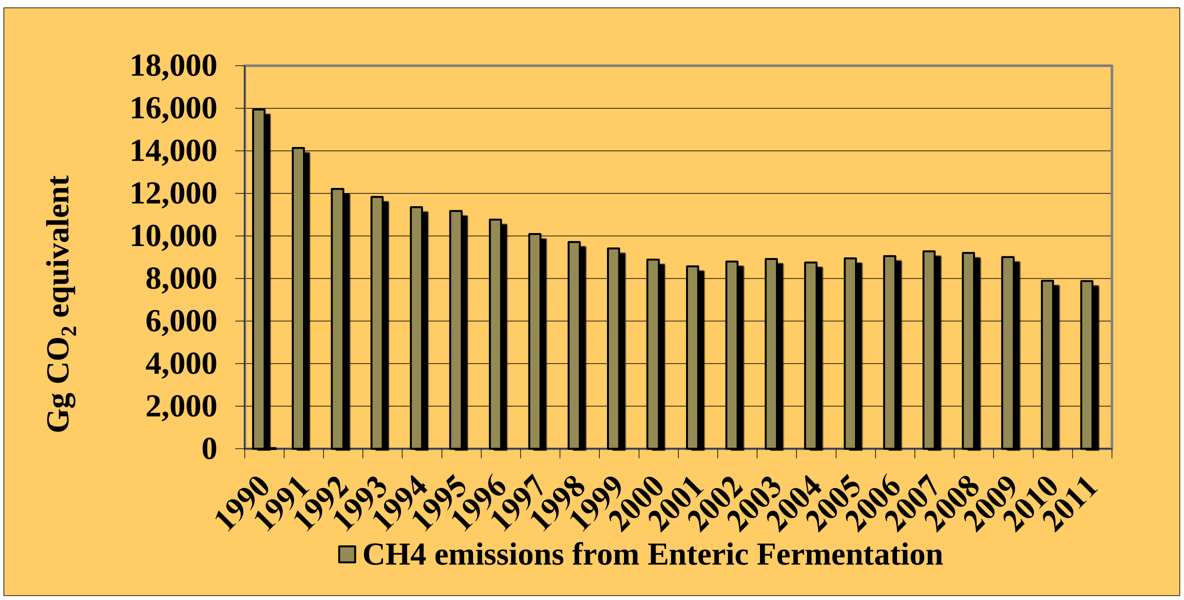


Table 6.4 Observations on source category 4A – "Enteric Fermentation"

Source indicative	Source (livestock) type	Observation	Data source
4.A.1	Cattle	Includes livestock data from nine different *cattle* categories: *dairy cows* and *non-dairy cattle*.	AD: NIS and expert judgment, 1989-2003; NIS, 2004-2011 EF: Country specific, expert judgment
4.A.2	Buffalo	Includes livestock data from two different *buffalo*:buffalo milk and other buffalo	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2011; EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.A.3	Sheep	Includes livestock data from three different sheep: *Ewes of milk and fitted*, *reproducers rams* and *other sheep*	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2011; EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.A.4	Goats	Includes livestock data from two different *goats*: *Female goats for milk* and *females by first mount* and *other goats*	
4.A.6	Horses		
4.A.7	Mules and asses		AD: FAO, 2011; EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.A.8	Swine	Includes livestock data from five different *swine*: *pigs under 20 kg*, *pigs between 20 and 50 kg*, *pigs fattening*, *boars*, *breeding sows*	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2011 EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.A.9	Poultry	Includes livestock data from two different *poultry*: *adult poultry for eggs*, *poultry for meat*	

6.2.2 Methodological issues

Methodology

The amount of methane emitted from enteric fermentation is driven primarily by the number of animals, the type of digestive system, and the type and amount of feed consumed.

Emissions of methane from enteric fermentation were calculated using a Tier 2 method, for all species, according to the provisions in the IPCC GPG 2000 decision tree. There are national data available for every species and subcategory for to estimate the methane emission according with the level 2 method.

Emissions of methane from enteric fermentation were calculated using equations 4.12, 4.13 and 4.14 in the *IPCC GPG 2000.*

Equation 6.1 Emissions from a livestock category

$$Emissions = EF \bullet population/(10^6 kg/Gg)$$

where:

- Emissions = methane emissions from enteric fermentation, Gg CH_4/year;
- EF = emission factor for the specific population, kg/head/year;
- Population = the number of animals, head.

Equation 6.2 Total emissions from livestock

$$Total\ CH_4\ Emissions = \Sigma_i E_i$$

where:

- Total Emissions = total methane emissions from enteric fermentation, Gg CH_4/year;
- index *i* = sums all livestock categories and sub-categories;
- E_i = is the emissions for the *i* the livestock categories and sub-categories.

Equation 6.3 Emission factor development

$$EF = (GE \cdot Y_m \cdot 365\ days/yr) / (55.65\ MJ/kg\ CH_4)$$

where:

- EF = emission factor, kg CH_4/head/yr;
- GE = gross energy intake, MJ/head/day;
- Y_m = methane conversion rate which is the fraction of gross energy in feed converted to methane.

Emission factors

According to the provisions in IPCC GPG 2000, to use equation 4.14 have been considered national values for gross energy intake (GE) and default values for developed countries for methane conversion rate which is the fraction of gross energy in feed converted to methane (Y_m), default values provided through *IPCC GPG 2000* (Tables 4.8 and 4.9) and IPCC 1996-Reference Manual (Table A-4).

The calculation of gross energy intake an estimation method depending on the species and the category exploited, respectively based on an average ration, both in summer and in winter, was used

This rations can ensure the necessary of maintenance (allows normal animal organism functioning on basal metabolism level, assuring vital functions), and, respectively, for production in cattle, buffalo, sheep, goats and horses productions. For poultry and swine was proceeded similarly, taking into account mixed fodder prescriptions specific of categories of exploitation, according to nutritional requirements and standards in force.

The values of gross energy ingested were established correlating the nutritional requirements of each species and exploitation category with the food intake brought of through the rations and average prescriptions which were considered for ensuring the production level part of official statistics (elaborated by NIS).

For calculation of gross energy caloricity for each prescription or ration were took into account the following:

- 1g gross protein = 5.72 kcal;

- 1 g gross fat = 9.5 kcal;
- 1 g gross pulp = 4.79;
- 1 g SEN (unnitrous substances extractable) = 4.17 kcal.

The Calculation formula of energy gross is:

Equation 6.4 Calculation of energy gross intake

$$GE\ (kcal/kg) = 5.72 \bullet PB + 9.5 \bullet GB + 4.79 \bullet CelB + 4.17 \bullet SEN$$

(I.Stoica, Nutrition and feedingstuffs, 1997, pg.131)

where:

- GE = gross energy intake (kcal/kg);
- PB = gross protein;
- GB = gross fat;
- CelB = gross pulp;
- SEN = unnitrous substances extractable

Rations were made up according of equation above, the protein gross values, gross fat, gross pulp and unnitrous substances extractable were used from the tables with chemical composition of the feeding (I.Stoica, *Nutrition and feedingstuffs*, 1997, pages 513-517). In these tables value of these nutritional principles is expressed as percentage (for 100 grams of exemple), so in the calculation of rations and prescriptions these values were multiplied with 10 for to express caloricity for 1 kg. The total value of ration, expressed in kcal it was divided to 239, to obtain equivalent in MJ (Mega Jouli).

The equivalence relations are the following:

- 1J = 1/41855Kcal, where J = joule and Kcal = kilocalorie;
- 1KJ = 0,239 Kcal, where KJ = Kilojoule and Kcal = kilocalorie;
- 1MJ = 239 Kcal, where MJ = Megajoule and Kcal = kilocalorie

The values of protein gross, gross fat, gross pulp and unnitrous substances extractable were multiply with the specific caloricity of each nutritive principle (5,72 kcal for 1 g of gross protein, and so on).

Then was calculated the sum of caloricity of each nutritive principle in order to obtain the caloricity of fodder. This value is multiplied by the number of pounds of fodder which is specified in ration.

Digestible energy (DE) is used to express the nutritional value of fodder and of rations, mainly for grazing animals. For calculating digestible energy are used mathematical equations considering the nutritive digestible content of nutrients, which multiply with the coefficients of specific digestibility each forage and each species (I.Stoica- *Nutrition and feedingstuffs*, 1997, pages 518-522), then are propagated with the energy equivalents for digestible energy, which are different per species, in the table below (Popa O, Milos M, Halga P, Bunicelul El., EDP., 1980, pages 101- *Livestock feeding*).

Table 6.5 Calculation of feed digestible energy

Specification	**Digestible PB**	**Digestible GB**	**Digestible CelB**	**Digestible SEN**
Symbol	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	$x_1 \bullet e_1$	$x_2 \bullet e_2$	$x_3 \bullet e_3$	$x_4 \bullet e_4$

The categories and subcategories for which were the calculated rations are given below:

- For ***calves for slaughter younger than 1 year***, with an average weight of 250 kg and average daily gain of 1000 g/day, it was considered a ration that may contain 3 kg mountain hay, 10 kg pickled corn, mixture of farm 3 kg, ration which corresponds to an energy intake of 143.07 MJ, DE (MJ) = 81.23 and DE (%)= 56.77.
- For ***young cattle of breeding under 1 year***, with an average weight of 250 kg and average daily gain of 600 g/day can be given a ration consisting of : 2 kg hill hay, 10 kg corn silage, 2.3 kg mixture of farm, meaning GE = 115.5 MJ, DE = 65.8 MJ and DE (%) =56.97.

- For ***young cattle of breeding between 1 and 2 years,*** with an average weight of 350 kg and average daily gain of 600 g/day, can be given a ration of type: 2 kg hill hay, 10 kg corn silage, 2 kg clover hay and 2.3 kg mixture of farm, with a GE = 146.83 MJ, DE = 81.49 MJ and DE (%) = 55.49.
- For ***young cattle of slaughter between 1 and 2 years*** was considered a subcategory**,** with an average weight of 400 kg and average daily gain of 1100 g/day. The ration contains 6 kg Hay Mountain, 2 kg clover hay, 10 kg pickled corn and 3 kg mixture of farm. The ration total caloricity is 531,36.58 kcal, equivalent to 222.33 MJ, DE = 152.63 MJ, DE (%) = 68.65.
- ***Cattle 2 years and over- Breeding bulls*** (815 kg average weight) ingest a ration of 8 kg hill hay lucerne, 11 kg pickled corn, 4 kg feed carrots, 3.3 kg mixture of farm, ration, with a caloricity average GE = 241.68 MJ, DE = 132.94MJ, DE (%) = 55
- For **cattle 2 years and over** - ***heifers*** with an average weight of 490 kg, ration used is composed of 3 kg hill hay, 4 kg lucerne hay, 13 kg pickled corn, 10 kg fodder beet, 1 kg mixture of farm, GE = 211.12 MJ, DE = 124.23 MJ, DE (%) = 58.84.
- A ration for ***dairy cattle*** with a mass of 650 kg/animal and a production of about 10-12 l milk/day (including calves consumption), containing 3 kg hay hill, 17,5 kg pickled corn, 4 kg hay of lucerne, 15 kg fodder beet and 2 kg mixture of farm, has an caloricity 54343.57 total kcal, equivalent to 227,37 MJ. Were worked with average caloricity between seasons summer-winter, capable ensures a production of about 10-12 l milk/head/day. The production of milk can vary within very large limits depending on geographic region, of race, the type of holding, level of education and training of farmers.

In zootechnics, feeding dairy cattle is differentiated according to milk production, but the ration is adjusted from 5 to 5 l production/head/day, supplementing the daily energy requirements by 0.5 UN/l milk (or 0.45 UN/l milk).

In the Table 6.6 are presented the milk productions per year, for the period 1989-2011 for dairy cows and, respectively, buffaloes.

For dairy cattle DE (MJ)=154.46 and DE (%) = 67.93.

Table 6.6 Milk production in cows and buffalo in the period 1989-2011 (NIS)

Year	Dairy cattle production (thousand hl)	Milk buffalo production (thousand hl)
1989	40,477	717
1990	39,698	613
1991	41,326	497
1992	40,659	420
1993	43,097	410
1994	49,235	397
1995	52,431	399
1996	53,085	392
1997	52,212	369
1998	50,544	358
1999	48,901	348
2000	48,191	327
2001	49,717	319
2002	51,472	328
2003	53,869	330
2004	55,107	337
2005	54,976	357
2006	57,981	326
2007	54,517	358
2008	52,761	327
2009	5,026	304
2010	42,585	239
2011	43,728	218

- ***Males and females for sacrificed older than 2 years*** with an average weight of 500 kg, and average daily gain of 600 g/day, ingest a ratio of 3 kg mountain hay, 15 kg pickled corn, 3 kg mixture of farm, providing an caloricity average 166.72 MJ, DE = 95.15 MJ, DE (%) = 57.
- ***Cattle for work*** (800 kg average weight) ingest a ration of 10 kg hill hay, 5 kg coarse (oat straw), 15 kg fodder beet, 2 kg mixture of farm, ration with average caloricity 303.08 MJ, DE = 173.22 MJ, DE (%) = 57.15.
- The ratio ***buffalo female*** (500 kg average weight) considered is composed: 4 kg hill hay, 6 kg coarse chopped (oat straw), 20 kg succulents (corn silage), 1 kg concentrates, ration with an average caloricity 269.74 MJ, DE = 145 MJ, DE (%) = 53.75. Average milk production is 4.2 l/head/day, including calves consumption.
- The category ***other buffalo*** (400 kg average weight) has a ration composed of: 1 kg legumes hay, 1 kg hill hay, 2 kg coarse (oat straw), 6.8 kg corn silage, 4 kg root (fodder beet) and 1 kg mixture of farm. GE = 128.85 MJ, DE = 71.3 MJ, DE (%) = 55.34.
- For subcategory ***ewes of milk and fitted***, with an average weight of 60 kg and milk production 1.3 l/head/day were used ration: 1.6 kg clover hay, 0.4 kg oat straw, 2.5 kg fodder beet and 0.36 kg mixed fodder. The total caloricity of the ration is 42.78 MJ/head/day, DE = 19.7 MJ, DE(%) = 44.57.
- For subcategory ***reproducers rams*** (77 kg average weight) was used a ration composed of 2.5 kg hay hill, 2 kg succulents (corn silage) and 0.4 kg mixed fodder. GE = 50.23 MJ, DE = 30.07 MJ, DE (%) = 59.86.
- The ***other sheep*** subcategory (48 kg average weight) ingest a ration of 1.6 kg clover hay, 0.4 kg oat straw, 2.5 kg fodder beet and 0.516 kg mixed fodder, resulting GE = 45.27 MJ, DE = 20.84 MJ, DE (%) = 46.04.
- For ***female goats for milk and females by first mount*** (48 kg average weight and 1.8 l/head/day milk production) the ration contains: 2 kg clover of hay, 2.5 kg beet, 0.5 kg mixed fodder, 0.5 kg oat straw. The caloricity total is 52.88 MJ/head/day, DE = 23.91 MJ, DE(%) = 45.21.
- The ration for ***other goats*** (50 kg average weight) is: 0.27 mixed fodder, 2 kg clover of hay, 2.5 kg fodder beet, 0.5 kg oat straw, obtaining GE = 49.25 MJ, DE = 20.82 MJ, DE (%) = 42.27.

- For ***pigs under 20 kg,*** GE = 8.18 MJ, DE = 6.7 MJ, DE (%) = 82.88, use are the ration 0-1, 0-2. Was chose a weight (14 kg).
- For ***pigs between 20 and 50 kg,*** GE = 13.49 MJ, DE = 11.70 MJ, DE (%) = 86.75, was used are the ration 0-3. Was chose an average weight (35kg).
- ***Pigs fattening*** (110 kg average weight) has GE = 46.86 MJ, DE = 40.66 MJ, DE(%) = 86.77, was used the ration 0-7.
- The was used ration 0-5 to ***boars*** (270 kg average weight), with a caloricity 15.62 Mj/1 kg ration (animal consume an average 2.9 kg mixed fodder/head/day), GE = 45.32 MJ, DE = 39.3 MJ, DE(%) = 86.72.
- For the ***sows of breeding*** (125 kg average weight) were used the ration 0-6 for ***breeding sows*** weight exceeding 110 kg, the ration with a total caloricity 16.19 MJ/1 kg ration (the animal consume in average 2.8 kg mixed fodder/head/day), so GE = 45.34 MJ, DE = 37.7 MJ, DE(%) = 83.14.
- For **horses** (500 kg average weight) the ration is: 10 kg hill hay, 7 kg fodder beet and 3.3 kg mixed fodder. The caloricity of ration is 53965.7 kcal, equivalent to 225.79 MJ , DE = 121.84 MJ, DE(%) = 53.96.
- For the category ***mules and asses*** (300 kg average weight) the ration is: 5 kg hay hill, 5 kg oat straw, 10 kg fodder beet, resulting a caloricity of GE = 181.18 MJ, DE = 99.2 MJ and DE (%) = 53.96.
- For the ***adult poultry for eggs*** (1.9 kg average weight) was used the ration 21-5, contains maize, barley, soy grits, sunflower meal, meat meal, oil, 10% premix hill and P.V.M A 6, resulting a caloricity 1872.38 kcal/1kg ration, respective 7.83 MJ/1 kg ration. An animal consumes on average 120 g of prescription/head/day), that is 1.83 MJ/head/day. DE = 1.5 MJ, DE (%) = 81.96.
- For ***poultry for meat*** (1.8 kg average weight) the rations contain maize, barley, wheat, soy grits, sunflower meal, meat meal, oil and animal protein/plant. For ration 1 kg, caloricity is 4122.97 kcal, equivalent to 17.25 MJ/1 kg ration. For an increase of 35 g, specific to this type of exploatation, average amount ingested is 75g/head/day, equivalent to 1.3 MJ, DE = 1.086 MJ, DE (%) = 83.53.

For values of methane conversion rate (Y_m) were used default values from *IPCC GPG 2000*, because there are no national studies on the rate of conversion of methane from gross energy intake (Table 4.8).

For cattle were used the value of 0.06 for all categories, the value which corresponds to the default value for developed countries.

For dairy cattle, Y_m value is 0.06 for developing countries.

For other categories Y_m values were used from IPCC 1996 -Reference Manual, Table A-4 (Y_m values for sheep, goats, horses and mules and asses are similar for developed countries and developing countries.

For swine was used value of Y_m of 0.6% (0.006), because GE value from our ration is similar to that given in Reference Manual (38 MJ/day for developed countries). For categories where GE value is close to 13 MJ/day (pigs under 20 kg, pigs between 20 and 50 kg) was worked with the value 1.3% (0.013) (Reference Manual, Table A-4).

The emission factors used for livestock are presented in Table 6.7.

The gross energy intake is in direct correlation with animal's weight.

Table 6.7 The factors emission (kg CH_4/head/year) used for calculation of methane emissions from enteric fermentation of livestock and data necessary for their calculation, in the 1989-2011 period

Source indicative	**Livestock (source) type**	**Emission Factors [kg CH_4/head/year]**	**Gross energy intake (GE) (Mj/head/day)**	**Methane conversion rate which is the fraction of gross energy in feed converted to methane (Ym fraction)**
4.A.1	**CATTLE**			
4.A.1.a	***Dairy cattle***	89.47	227.37	0.06
4.A.1.b	***Non dairy cattle***			
	Calves for slaughter younger than 1 year	56.30	143.07	0.06
	Young cattle of breeding under 1 year	45.45	115.5	0.06
	Young cattle of breeding between 1 and 2 years	57.78	146.83	0.06
	Young cattle of slaughter between 1 and 2 years	87.49	222.33	0.06
	Cattle 2 years and over Breeding bulls	95.10	241.68	0.06
	Cattle 2 years and over Heifers	83.08	211.12	0.06
	Males and females for sacrificed older than 2 years	65.60	166.72	0.06
	Cattle for work	119.27	303.08	0.06
4.A.2	***BUFFALO***			
	Female buffalo	106.15	269.74	0.06
	Other buffalo	50.70	128.85	0.06
4.A.3	***SHEEP***			
	Ewes of milk and fitted	19.64	42.78	0.07

Table 6.7 (continued) The factors emission (kg CH_4/head/year) used for calculation of methane emissions from enteric fermentation of livestock and data necessary for their calculation, in the 1989-2011 period

Source indicative	Livestock (source) type	Emission Factors [kg CH_4/head/year]	Gross energy intake (GE) (Mj/head/day)	Methane conversion rate which is the fraction of gross energy in feed converted to methane (Ym fraction)
4.A.3	***SHEEP***			
	Reproducers rams	23.06	50.23	0.07
	Other sheep	20.78	45.27	0.07
4.A.4	***GOATS***			
	Female goats for milk and females by first mount	17.34	52.88	0.05
	Other Goats	16.15	49.25	0.05
4.A.6	***HORSES***	37.02	225.79	0.025
4.A.7	***MULES AND ASSES***	29.70	181.18	0.025
4.A.8	***SWINE***			
	Pigs under 20 kg	0.69	8.18	0.013
	Pigs between 20 and 50 kg	1.15	13.49	0.013
	Pigs fattening	1.84	46.86	0.006
	Boars	1.78	45.32	0.006
	Breeding sows	1.78	45.34	0.006
4.A.9	***POULTRY***			
	Adult poultry for eggs	0	1.83	0
	Poultry for meat	0	1.3	0

In the Table 6.8 are summarized the values energy digestible DE (Mj), the percentage of digestible energy DE (%) and the weight for each subcategory.

Table 6.8 The values energy digestible expressed in Mj/day and percent and weight (kg) for livestock, in the 1989-2011 period

Source indicative	**Livestock (source) type**	**Energy digestible DE (Mj/day)**	**Percentage of digestible energy DE(%)**	**Animal weight (kg)**
4.A.1	***CATTLE***			
4.A.1.a	***Dairy cattle***	154.46	67.93	650
4.A.1.b	***Non dairy cattle***			
	Calves for slaughter younger than 1 year	81.23	56.77	250
	Young cattle of breeding under 1 year	65.8	56.97	250
	Young cattle of breeding between 1 and 2 years	81.49	55.49	350
	Young cattle of slaughter between 1 and 2 years	152.63	68.65	400
	Cattle 2 years and over Breeding bulls	132.94	55	815
	Cattle 2 years and over Heifers	124.23	58.84	490
	Males and females for sacrificed older than 2 years	95.15	57	500
	Cattle for work	173.22	57.15	800
4.A.2	***BUFFALO***			
	Female buffalo	145	53.75	500

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
	Other buffalo	71.3	55.34	400
4.A.3	***SHEEP***			
	Ewes of milk and fitted	19.7	44.57	60

Table 6.8 (continued) The values energy digestible expressed in Mj/day and percent and weight (kg) for livestock, in the 1989-2011 period

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
4.A.3	***SHEEP***			
	Reproducers rams	30.07	59.86	77
	Other sheep	20.84	46.04	48
4.A.4	***GOATS***			
	Female goats for milk and females by first mount	23.91	45.21	48
	Other Goats	20.82	42.27	50
4.A.6	***HORSES***	121.84	53.96	500
4.A.7	***MULES AND ASSES***	99.2	54.75	300
4.A.8	***SWINE***			
	Pigs under 20 kg	6.7	82.88	14
	Pigs between 20 and 50 kg	11.7	86.75	35
	Pigs fattening	40.66	86.77	110
	Boars	39.3	86.72	270
	Breeding sows	37.7	83.14	125
4.A.9	***POULTRY***			
	Adult poultry for eggs	1.5	81.96	1.9

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
	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.

2004-2011

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 1989-2011, are presented.

Livestock data primary obtained through the dedicated study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*"

1989-2003

The data from the NIS by 2003, presents livestock aggregate per larger categories (the aggregation criterion is the operation production), was necessary an extrapolation in the past (1989-2003), of the subcategories of animals which appear in the Annex 3.3 (sheet - *Data obtained through the study*) and for which are official data for 2004-2011.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 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 1989-2011 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 2011), 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.

2004-2011

In the Annex 3.3 (sheet - *Data obtained through 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 study*) are used in according with the Annex 3.3 (sheet – *Primary data*).

Sheep

The values for *ewes of milk and fitted* were taken from the Annex 3.3 (sheet – *Primary data*), from the category *Sheep ewes and ewe mounted- total (3+4).* Remaining subcategories were taken from the same table.

Goats

The values for *female goats for milk and females by first mount* were taken from primary data table from *goats which have littered and goats fitted (9+10).* Other goats were taken from the table by primary data.

Poultry

For *adult poultry for eggs* the values were taken from the Annex 3.3 (sheet – *Primary data*. The values for *poultry for meat* represent the difference between *total poultry* and *adult poultry for eggs*.

The values for *horses* and *mules and asses* were taken from the Annex 3.3 (sheet – *Primary data*).

6.2.3 Uncertainties and time-series consistency

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

- AD: 10 %;
- EF: 20%;
- 22.4% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“* and were obtained using the same method (the use of one methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; detailed information is provided in Section 6.2.2), emission factors were obtained using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2011 is consistent.

6.2.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Rice Cultivation, Agricultural Soils and Filed Burning of Agricultural Residues categories, the results of these being mentioned on the Checklists level.

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 version 2 of the 2012 NGHGI; they are described in the Chapter 6.2.5 – 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 6.2.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level; the major part of unconformities have been solved as part of 2012 NGHGI submissions, the rest being envisaged as planned improvement. The solved unconformities are presented as specified in the paragraph above, in the context of version 1 of the 2012 NGHGI.The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.2.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.2.6 Source-specific planned improvements, including those in response to the review process

Aiming to their incorporation into next inventory submissions, the development of national values for the methane conversion rate (Y_m), for significant categories, is envisaged.

6.3 Source category Manure Management (CRF source category 4.B)

6.3.1 Source category description

Managing a large number of animals in a confined area creates conditions for CH_4 emissions due to the anaerobic decomposition of manure. A part of the nitrogen from manure is converted to N_2O during storage of manure.

Manure Management:

- is the second source of CH_4 and the three source of N_2O emissions in the Agriculture sector (in 2011, CH_4 emissions from Manure Management represented 6.90% of total CH_4 emissions while N_2O accounted for 11.70% of total N_2O emissions in the Agriculture sector);

- is the fourth source in the Agriculture sector (in 2011, CH_4 and N_2O emissions from Manure Management as CO_2 equivalent represented 9.52% from Total Agriculture emissions);
- contributed with 1.46% to Total GHG emissions of Romania.

Emissions from manure management are declining since 1989 due to the decrease of the animal population, on the one hand due to lower number of animals, and on the other hand the switchover any part of it from traditional systems, economic in farms organized, in which is practiced different waste management systems (Figure 6.5).

The dynamic of emission of CH_4 from manure management reflect the livestock described situation in Romania.

The years 1997-2000 have been of Romania unfavorable, in terms economically, which is found both decrease the number of animals and implicitly the emissions.

After 2000, livestock will return with higher share, steps first taken by farmers of especially hens and the emissions increased to 2006, then again begin to fall.

The observations on source category 4B – "Manure Management" are presented in the Table 6.9.

And the of N_2O emission decreased due to the decrease the effective of livestock including per those them found on farms where it practice manure management system.

Figure 6.5 Overall trends of emissions from Manure Management

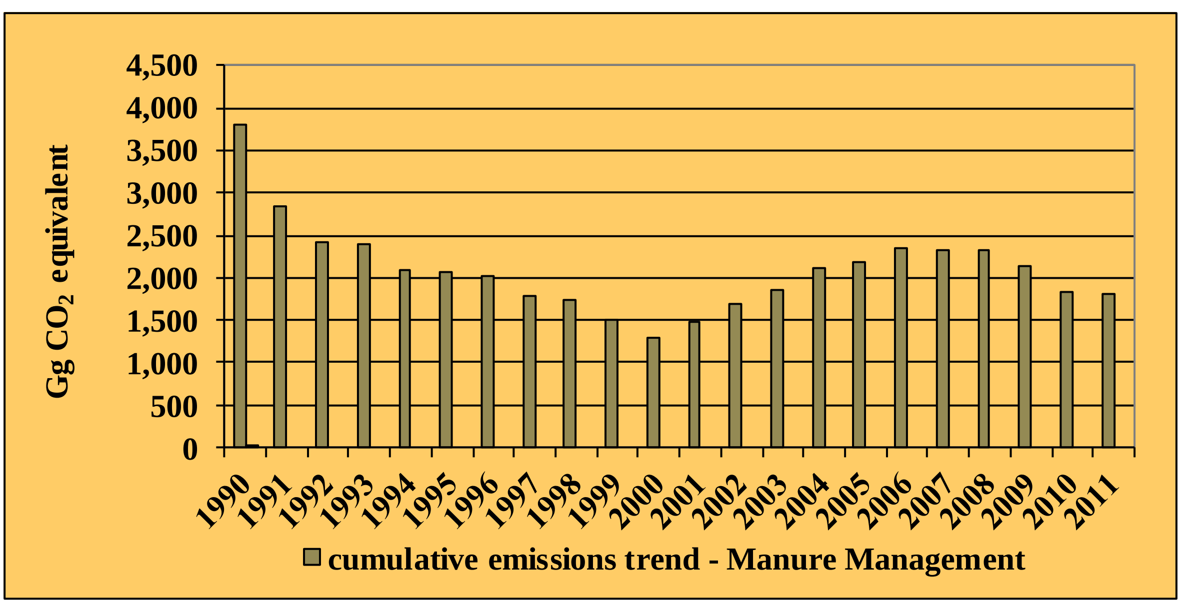


Table 6.9 Observations on source category 4B – "Manure Management"

Source indicative	Source type	Observation	Data source
Observations on source category 4B – "Manure Management – CH_4 and N_2O emissions"			
4.B.1	Cattle	Includes livestock data from nine different cattle categories: dairy cows and non-dairy cattle	AD: NIS and expert judgment, 1989-2003; NIS, 2004-2011 EF: Country specific, expert judgment
4.B.2	Buffalo	Includes livestock data from two different buffalo:buffalo milk and other buffalo	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2011; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.3	Sheep	Includes livestock data from three different sheep: Ewes of milk and fitted, reproducers rams and other sheep	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2011; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.4	Goats	Includes livestock data from two different goats: Female goats for milk and females by first mount and other goats	
4.B.6	Horses		
4.B.7	Mules and asses		AD: FAO, 2011; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.8	Swine	Includes livestock data from five different swine: pigs under 20 kg, pigs between 20 and 50 kg, pigs fattening, boars, breeding sows	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2011 EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.9	Poultry	Includes livestock data from two different poultry: adult poultry for eggs, poultry for meat	

Table 6.9 (continued) Observations on source category 4B – "Manure Management"

Source indicative	Source type	Observation	Data source
Observations on source category 4B – "Manure Management – N_2O emissions"			
4.B.1.1	Anaerobic Lagoon		AD: IPCC GPG 2000, IPCC 1996; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4.B.1.2	Liquid/Slurry		
4.B.1.3	Daily Spread		
4.B.1.4	Solid storage		
4.B.1.5	Dry lot		
4.B.1.6	Pasture/range/paddock		
4.B.1.7	Pit storage		
4.B.1.8	Poultry manure wit bedding		
4.B.1.9	Poultry manure without bedding		

6.3.2 Methodological issues

CH_4 emissions

Methodology

The amount of methane emitted from manure management is driven primarily by the number of animals, the type of digestive system, and the type and amount of feed consumed.

Emissions of methane from manure management were calculated using a Tier 2 method, for all species, according to the provisions in the IPCC good practice guidance decision tree: dairy cows and sheep are significant species and national data and information to allow for the use of Tier 2 method for the other livestock were available.

For these are available national data (GE, DE, VS, MS) for each category and subcategory to estimate methane emissions in according the method 2 using and default values (Bo – maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS and MCF - CH_4 conversion factors for each manure management system *j* by climate region k).

Emissions of methane from manure management were calculated using equations: 4.15, 4.16, 4.17 of *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000.*

Equation 6.5 CH_4 emission from manure management

$$CH_4 \text{ Emissions}_{(mm)} = \text{Emission Factor} \cdot \text{Population} \;/\; (10^6 \text{ kg/Gg})$$

where:

- CH_4 Emissions$_{(mm)}$ = CH_4 emissions from manure management, for a defined population Gg/year;
- Emission Factor = emission factor for the defined livestock population, kg/head/year;
- Population = the number of head in the defined livestock population.

Equation 6.6 Volatile solid excretion rates

$$VS = GE \cdot (1 \text{ kg-dm}/18.45 \text{ MJ}) \cdot (1 - DE/100) \cdot (1 - ASH/100)$$

where:

- VS = volatile solid excretion per day on a dry-matter weight basis, kg-dm/day;
- GE = Estimated daily average feed intake in MJ/day;
- DE = Digestible energy of the feed in percent;
- ASH = Ash content of the manure in percent.

Equation 6.7 Emission factor from manure management

$$EF_i = VS_i \cdot 365 \text{ days/year} \cdot B_{oi} \cdot 0.67 \text{ kg/m}^3 \cdot \Sigma_{(jk)} MCF_{jk} \cdot MS_{ijk}$$

where:

- EF_i = annual emission factor for defined livestock population *i*, in kg;
- VS_i = daily VS excreted for an animal within defined population *i*, in kg;
- B_o = maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS;
- MCF_{jk} = CH_4 conversion factors for each manure management system j by climate region *k*;
- MS_{ijk} = fraction of animal species/category *i*'s manure handled using manure system *j* in climate region k (fraction).

Emission factors

According to the provisions of IPCC GPG 2000, to use equation 4.15, 4.16, 4.17 have been considered national values for gross energy intake, MJ/head/day (GE), digestible energy (DE), excretion rates (VS), fraction of animal species/category *i*'s manure handled using manure system (MS) and the default values for ASH, Bo and MCF used from *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000 and Manual Reference.*

The GE, DE, VS and MS values for all livestock were calculated in the context of implementing in 2011 the study `*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*`.

The gross energy intake (GE) and digestible energy (DE) calculation was presented detail in section 6.2.2 - "Enteric fermentation".

The fractions values of ashes (ASH) used in the VS calculation are default, with those in the IPCC and Reference Manual. For cattle were used for all categories 8%, for swine were chose the specific value of countries developed (2%), because the digestibility calculated (82-88%) is close to that date for developed countries (75%).

For other categories of animals, was choosing the default value from cattle.

The coefficient B_0 does not have specific national values, so its value has been used according IPCC 2000 and Reference Manual (Appendix B).

Were took the values of Eastern European region, respectively 0.24 for dairy cattle and 0.17 for other category of cattle, 0.1 for buffalo, 0.29 for swine (value for developing countries, because the value VS calculated is close of the value VS in Manual Reference for countries developing - 0.34).

For sheep, horses, goats and mules and asses it was chose the values Bo specific of developing countries, because this species are grown extensively or household. Not practice intensive growth, industrial to any of the species mentioned.

For poultry were chose the values for countries developing, because the VS value is close of the value these country.

In regarding manure management systems, in Romania were used all the systems described in *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000,* with the exception of the system "dry lot", which implies the letting for drying manure in refuge and their spread per field after a long time. The distribution of these types of manure management systems were made according expert opinion.

The conversion factors of methane for each manure system management (MCF), according to region, were taken from *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000,* considering Romania make part of the cold climate.

In the Table 6.10 are summarized the values used in the calculation of emissions factors for 1989-2011 period for each livestock and in the Table 6.11 are summarized the MCF (CH_4 conversion factors for each manure management system *j* by climate region *k*) values for each manure system management. Mention that MCF values are the same for each livestock and each year depending manure system management.

Table 6.10 The values used in the calculation of emissions factors from Manure management for 1989-2011

Source indicative	**Livestock (source) type**	**Ash content of the manure in percent (%) (ASH)**	**Volatile solid excretion per day on a dry-matter weight basis, kg-dm/day (VS)**	**Maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS (B_0)**
4.B.1	**CATTLE**			
4.B.1.a	***Dairy cattle***	8	3.63	0.24
4.B.1.b	***Non dairy cattle***			
	Calves for slaughter younger than 1 year	8	3.08	0.17
	Young cattle of breeding under 1 year	8	2.47	0.17
	Young cattle of breeding between 1 and 2 years	8	3.25	0.17
	Young cattle of slaughter between 1 and 2 years	8	3.47	0.17
	Cattle 2 years and over - Breeding bulls	8	5.42	0.17
	Cattle 2 years and over - Heifers	8	4.33	0.17
	Males and females for sacrificed older than 2 years	8	3.57	0.17
	Cattle for work	8	6.47	0.17

Table 6.10 (continued) The values used in the calculation of emissions factors from Manure management for 1989-2011

Source indicative	**Livestock (source) type**	**Ash content of the manure in percent (%) (ASH)**	**Volatile solid excretion per day on a dry-matter weight basis, kg-dm/day (VS)**	**Maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS (B_0)**
4.B.2	***BUFFALO***			
	Female buffalo	8	6.22	0.1
	Other buffalo	8	2.86	0.1
4.B.3	***SHEEP***			
	Ewes of milk and fitted	8	1.18	0.13
	Reproducers rams	8	1.00	0.13
	Other sheep	8	1.21	0.13
4.B.4	***GOATS***			
	Female goats for milk and females by first mount	8	1.44	0.13
	Other Goats	8	1.41	0.13
4.B.6	***HORSES***	8	5.18	0.26
4.B.7	***MULES AND ASSES***	8	4.08	0.26
4.B.8	***SWINE***			
	Pigs under 20 kg	2	0.07	0.29
	Pigs between 20 and 50 kg	2	0.09	0.29
	Pigs fattening	2	0.32	0.29

Table 6.10 (continued) The values used in the calculation of emissions factors from Manure management for 1989-2011

Source indicative	Livestock (source) type	Ash content of the manure in percent (%) (ASH)	Volatile solid excretion per day on a dry-matter weight basis, kg-dm/day (VS)	Maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS (B_0)
4.B.8	***SWINE***			
	Boars	2	0.31	0.29
	Breeding sows	2	0.40	0.29
4.B.9	***POULTRY***			
	Adult poultry for eggs	8	0.01	0.24
	Poultry for meat	8	0.01	0.24

Table 6.11 The values MCF used in calculation of emissions factor for each manure system management for all livestock in the 1989-2011 period

The period 1989-2010	CH_4 conversion factors for each manure management system (MCF)								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
	0.6	0.39	0.001	0.01	-	0.01	0	0.015	0.015

The values MCF used in calculation of emissions factor for manure system management anaerobic lagoon to swine is 0.39.

In the context of the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“,* in the Annex 3.3 (sheet- *Values MS*) are present MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS (Animal Waste Management Systems) in the 1989-2011 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 1989-2011 period (from 0.3 to 0.38 kg CH_4/head/year) due to the variation in MS level associated to the Solide Storage, Daily spread and Pasture Range/Paddock AWMS.

Activity data

They were used the same activity data as for calculation of CH_4 emissions from enteric fermentation. Data are presented in Chapter 6.2.2.

N_2O emissions

Methodology

Emissions of nitrous oxide from manure management were calculated using the default method, for all species, according to the provisions in the IPCC Good Practice Guidance.

For these national data are available for annual average N excretion per head of species/category (kg N/animal/yr) (Nex), fraction of animal species/category *i*'s manure handled using manure system *j* in climate region k (MS) for to estimate the nitrous oxide emissions from manure management in according default method, using and default values (EF_3 - the Table 4.12 from *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, 2000).

The nitrous oxide emissions from manure management were calculated in according with the equation 4.18 from IPCC GPG, 2000.

Equation 6.8 N_2O emissions from manure management

$$(N_2O\text{-}N)_{(mm)} = \Sigma_{(S)} \{[\Sigma_{(T)} (N_{(T)} \bullet N_{ex(T)} \bullet MS_{(T,S)})] \bullet EF_{3(S)}\}$$

where:

- $(N_2O\text{-}N)_{(mm)}$ = N_2O-N emissions from manure management in the country (kg N_2O-N/yr);
- $N_{(T)}$ = Number of head of livestock species/category *T* in the country;
- $N_{ex(T)}$ = Annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);
- $MS_{(T,S)}$ = Fraction of total annual excretion for each livestock species/category *T* that is managed in manure management system S in the country;
- $EF_{3(S)}$ = N_2O emission factor for manure management system *S* in the country (kg N_2O-N/kg N in manure management system S);
- S = Manure management system;
- T = Species/category of livestock.

Conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions is performed by using the following equation:

Equation 6.9 Conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions

$$N_2O_{(mm)} = (N_2O\text{-}N)_{(mm)} \bullet 44/28$$

In respect to the IPCC GPG 2000 provisions, N_2O emissions from Pasture range and paddock AWMS are reported under 4D – Agricultural soils (see Chapter 6.5).

Emission factors

According to the provisions in IPCC GPG 2000, the calculation methodology took into account national the values for annual average N excretion per head of species/category (kg N/animal/yr)

(Nex), fraction of animal species/category *i*'s manure handled using manure system *j* in climate region k (MS) and default values for emissions factor from IPCC, respectively EF_3 (Table 4 - 12 of IPCC GPG 2000 together with Table 4 - 22 of Reference Manual).

In CRF Report (Common Reporting Format) the nitrogen value of the management system solid manure storage nitrogen was added to value nitrogen management system „*dry lot*" manure, resulting a single value.

Also and the nitrogen value from other AWMS in report CRF is the result of sum between of nitrogen value from the manure management system „ *pit storage*" and the nitrogen values of the manure management system „ *poultry manure with bedding*" and „ *poultry manure without bedding*".

Considering membership of in Eastern Romania and developing countries, with cold climates the N_2O emission factors used in the calculation the emissions N_2O from manure management are presented in Table 6.12 depending to manure management system.

Table 6.12 N_2O emission factors [kg N_2O-N/kg N excreted] for animal waste per AWMS

Source indicative	**AWMS (source) type**	**Emission factor EF_3 [kg N_2O-N/kg N excreted]**
4B11	Anaerobic Lagoon	0.001
4B12	Liquid/Slurry	0.001
4B13	Daily Spread	0
4B14	Solid storage	0.02
4B15	Dry lot	0.02
4B16	Pasture/range/paddock	0.02
4B17	Pit storage	0.001
4B18	Poultry manure wit bedding	0.02
4B19	Poultry manure without bedding	0.005

Activity data

They were used the same livestock population numbers as for calculation of CH_4 emissions from enteric fermentation. Data are presented in Chapter 6.2.2.

In the context of the implementation in 2011 of the study „Elaboration of national emission factors/other parameters relevant to NGHGI Sector Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“, the values Nitrogen excretion [kg N/head/year] were calculated according to solid manure and liquid manure using following equation:

Equation 6.10 Nitrogen excretion

$$N_{ex} = \text{the amount of solid manure} \bullet 365 \bullet N\% \text{ from solid manure} / 100 + \text{the amount of liquid manure} \bullet 365 \bullet N\% \text{ from liquid manure} / 100$$

The MS values were established by expert opinion in the context of the above study.

In the Table 6.13 are presented the values for N_{ex} and the data on the amount of solid manure, N% from solid manure, the amount of liquid manure, and N% from liquid manure (Daily quantities of solid manure (S) and liquid (L) of animals and their composition – by various authors, quoted by Dana Sandulescu, PhD Thesis, 2005).

In poultry the N_{ex} value is considered sum of solid manure with liquid manure. The phases are not separated physiological.

Table 6.13 Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2011 period

Source indicative	**Livestock (source) type**	**The amount of solid manure (kg)**	**The amount of liquid manure (l)**	**N% from solid manure**	**N% from liquid manure**	**Annual average N excretion per head of species/category N_{ex} (kg N/animal/yr)**
4 B1	***CATTLE***					
4 B1 a	***Dairy cattle***	23.5	9	0.4031	0.58	53.63
4 B1 b	***Non dairy cattle***					
	Calves for slaughter younger than 1 year	6.5	1.69	0.4031	0.58	13.14
	Young cattle of breeding under 1 year	13	3	0.4031	0.58	25.5
	Young cattle of breeding between 1 and 2 years	13	3	0.4031	0.58	25.5
	Young cattle of slaughter between 1 and 2 years	13	3	0.4031	0.58	25.5
	Cattle 2 years and over - Breeding bulls	24.26	9	0.4031	0.58	54.75

Table 6.13 (continued) Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2011 period

Source indicative	Livestock (source) type	The amount of solid manure (kg)	The amount of liquid manure (l)	N% from solid manure	N% from liquid manure	Annual average N excretion per head of species/category N_{ex} (kg N/animal/yr)
4 B1	***CATTLE***					
	Cattle 2 years and over-Heifers	23.5	9	0.4031	0.58	53.63
	Males and females for sacrificed older than 2 years	23.5	9	0.4031	0.58	53.63
	Cattle for work	23.5	9	0.4031	0.58	53.63
4 B2	***BUFFALO***					
	Female buffalo	23.5	9	0.4031	0.58	53.63
	Other buffalo	23.5	9	0.4031	0.58	53.63
4 B3	***SHEEP***					
	Ewes of milk and fitted	1.1	0.7	0.8	0.43	4.3
	Reproducers rams	1.183	0.7	0.8	0.43	4.55
	Other sheep	1.183	0.7	0.8	0.43	4.55
4 B4	***GOATS***					
	Female goats for milk and females by first mount	1.39	0.8	0.8	0.43	5.3
	Other Goats	1.4	0.78	0.8	0.43	5.3
4 B6	***HORSES***	16	3.6	0.6	1.55	55.4

Table 6.13 (continued) Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2011 period

Source indicative	**Livestock (source) type**	**The amount of solid manure (kg)**	**The amount of liquid manure (l)**	**N% from solid manure**	**N% from liquid manure**	**Annual average N excretion per head of species/category N_{ex} (kg N/animal/yr);**
4 B7	***MULES AND ASSES***	11	2.2	0.6	1.55	36.53
4 B8	***SWINE***					
	Pigs under 20 kg	1.4	0.94	0.55	1.95	9.5
	Pigs between 20 and 50 kg	2.65	1.75	0.55	1.95	17.8
	Pigs fattening	2.7	1.798	0.55	1.95	18.21
	Boars	3.549	2.5	0.55	1.95	24.91
	Breeding sows	2.7	1.798	0.55	1.95	18.21
4 B9	***POULTRY***					
	Adult poultry for eggs	0.175	-	1.7	-	1.08
	Poultry for meat	0.18	-	1.84	-	1.2

6.3.3 Uncertainties and time-series consistency

CH_4 emissions

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

- AD: 10 %;
- EF: 30%;
- 31.6% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“* and were obtained using the same method (the use of one methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; detailed information is provided in Section 6.2.2), emission factors were obtained using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2011 is consistent.

N_2O emissions

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

- AD: 10 %;
- EF: 30%;
- 10% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“* and were obtained using the same method (the use of two methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; detailed information is provided in Section 6.2.2), were used default emission factors using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2011 is consistent.

6.3.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *Rice cultivation, Agricultural soils* and *Field burning of agricultural residues* categories, the results of these being mentioned on the Checklists level.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved as part of the version 2 of the 2012 NGHGI; they are described in the Chapter 6.3.5 – 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 6.3.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level; the major part of unconformities have beensolved as part of 2012 NGHGI submissions, the rest being envisaged as planned improvement. The solved unconformities are presented as specified in the paragraph above, in the context of version 1 of the 2012 NGHGI.

The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.3.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.3.6 Source-specific planned improvements, including those in response to the review process

Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species are envisaged:

- ❖ ash content of the manure (ASH);
- ❖ maximum CH_4 producing capacity for manure produced by an animal within defined population (B_0);
- ❖ CH_4 conversion factors for each manure management system by climate region (MCF).

6.4 Source category Rice Cultivation (CRF source category 4.C)

6.4.1 Source category description

Anaerobic decomposition of organic material in flooded rice fields produces methane. Methane escapes to the atmosphere primarily by transport through the rice plants and its flux depends upon the input of organic carbon, water regimes, time and duration of drainage, soil type, etc.

Rice Cultivation:

- ❖ is the smallest source of CH_4 emissions in the Agriculture sector (in 2011, CH_4 emissions from Rice Cultivation represented 0.22% of total CH_4 emissions in the Agriculture sector);
- ❖ is the smallest source in the Agriculture sector (in 2011, CH_4 emissions from Rice Cultivation as CO_2 equivalent represented 0.10% from Total Agriculture emissions);
- ❖ contributed with 0.02% to Total GHG emissions of Romania.

Emissions from rice cultivation are declining since 1989 due to the decrease of rice cultivated area (Figure 6.6). The rice area cultivated with is decreased in 21.6 thousands ha in 1991 by 100 ha in 2003. In 2011 the rice area cultivated is 12.7 thousands ha. The reduction due to areas privatization process and concession of the land from state patrimony, which ended in 2004.

Due to natural conditions, Romania dispose a production of rice relatively balanced while the cultivated area and the emissions from rice continue to fall.

Figure 6.6 Methane emission trend due to the Rice Cultivation

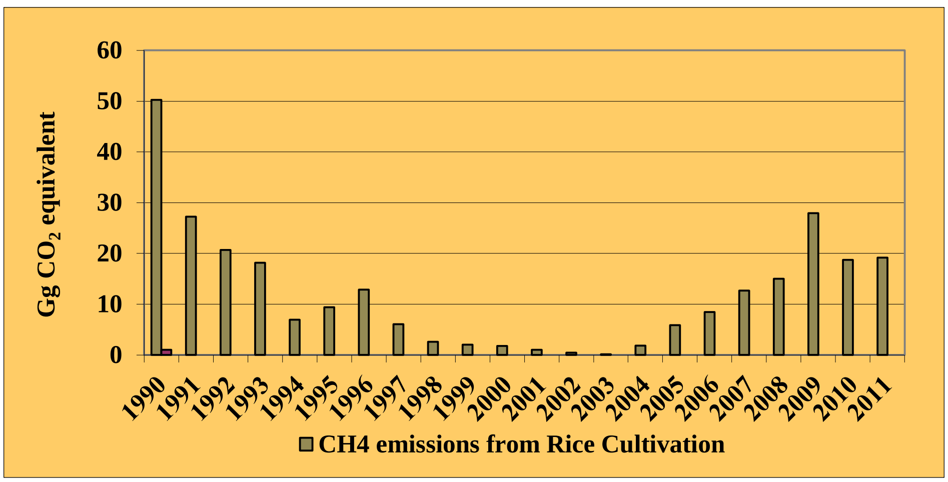


Table 6.14 Observations on source category 4C – "Rice Cultivation"

Source indicative	Source type	Observation	Data source
4.C.1.2.2	Rice harvested area		AD: SY, NIS, 1989-2011; expert judgment; EF: IPCC GPG 2000

6.4.2 Methodological issues

Methodology

Due to small importance of source category Rice Cultivation into Total GHG emission level (Rice Cultivation does not meet the key category thresholds) a Tier 1 method has been applied. For calculation of methane emissions from rice cultivation, the equations 4.41 and 4.42 of IPCC GPG 2000 were used.

Equation 6.11 CH_4 emissions from rice production

$$\text{Emissions from Rice Production (Tg/yr)} = \Sigma_i \Sigma_j \Sigma_k (EF_{ijk} \bullet A_{ijk} \bullet 10^{-12})$$

where:

- ❖ EF_{ijk} = a seasonally integrated emission factor for *i*, *j*, and *k* conditions, in g CH_4/m^2;
- ❖ A_{ijk} = annual harvested area for *i*, *j*, and *k* conditions, in m^2/yr;
- ❖ i, j, and k = represent different ecosystems, water management regimes, and other conditions under which CH_4 emissions from rice may vary (e.g. addition of organic amendments)

Equation 6.12 Adjusted Seasonally Integrated Emission Factor

$$EF_i = EFc \bullet SFw \bullet SFo \bullet SFs$$

where:

- ❖ EF_i = Adjusted seasonally integrated emission factor for a particular harvested area;
- ❖ EF_c = Seasonally integrated emission factor for continuously flooded fields without organic amendments;
- ❖ SF_w = Scaling factor to account for the differences in ecosystem and water management regime (from Table 4.20 from IPCC GPG 2000);
- ❖ SF_o = Scaling factors should vary for both types and amount of amendment applied (from Table 4.21, from IPCC GPG 2000 - Dose - Response Table for Non - Fermented Organic Amendments);

- SF_s = Scaling factor for soil type, if available.

Emission factors

Considering the provisions in IPCC GPG 2000 and the data provided by the Ministry of Agriculture, the calculation methodology took into account:

- a seasonally integrated emission factor value for continuously flooded fields without organic amendments (EF_c) of 20 g CH_4/m^2;
- a default value of 0.2 for the scaling factor to account for the differences in ecosystem and water management regime (SF_W) corresponding to lowland – irrigated – intermittently flooded – multiple aeration water management regime;
- yearly default values for the scaling factor to account for both type and amount of amendment applied (SF_O). Default values were selected after the estimation of the rice residues productivity values, considering that all rice residues were incorporated into the soil following the harvesting. Rice residues productivity values and default values for the scaling factor to account for the type and amount of amendment applied are presented in the Table 6.15.

Table 6.15 Rice residues productivity values and default values for the scaling factor to account for the type and amount of amendment applied (SF_O)

Year	Rice residues productivity [tones d.m./ha]	Scaling factor to account for the type and amount of amendment applied (SF_O)
1989	1.07	1.5
1990	1.25	1.5
1991	1.09	1.5
1992	1.78	1.5
1993	2.28	1.8
1994	2.48	1.8
1995	2.92	1.8
1996	2.04	1.8
1997	2.01	1.8
1998	2.25	1.8
1999	1.78	1.5
2000	1.93	1.5
2001	0.94	1
2002	0.90	1
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

Activity data

Total rice cultivated area is provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook 1989-2011.

By expert judgment, total harvested area equals total cultivated area (the number of harvests per year equals 1). Harvested area data series are presented in Table 6.16.

Table 6.16 Harvested area data series for 1989-2011

Year	Harvested area [10^8 m^2]
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

6.4.3 Uncertainties and time-series consistency

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

- AD: 5 %;
- EF: 50%;
- 5% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Due to the fact that all activity data are provided by NIS and were obtained using the same method, that default emission factors were used and the same estimation method was used for the whole period, the data series 1989-2011 is consistent.

6.4.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *Enteric fermentation, Manure management* categories, the results of these being mentioned on the Checklists level.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

No unconformity has been noted following the UNFCCC review of the NGHGI.

The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.4.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.4.6 Source-specific planned improvements, including those in response to the review process

In respect to the IPCC GPG 2000 provisions, more detailed data on rice cultivation techniques used are proposed to be obtained.

6.5 Source category Agricultural soils (CRF source category 4.D)

6.5.1 Source category description

Microbial processes of nitrification and denitrification in agricultural soils produce nitrous oxide emissions. There can be distinguished three types of emissions:

- direct soils emissions result from the following nitrogen input to soils:
  - synthetic fertilizers (F_{SN});
  - nitrogen from animal waste (F_{AM});
  - biological nitrogen fixation (F_{BN});
  - reutilized nitrogen from crop residues (F_{CR});
  - sewage sludge application.

Cultivation of organic soils may increase soil organic matter mineralization and, in effect, N_2O emissions.

- direct soil emissions from animal production include those emissions induced by grazing animals (Pasture, Range and Paddock Manure);
- indirect emissions take place after nitrogen is lost from the field as NO_x and NH_3 or after leaching or runoff.

Increases in the amount of nitrogen added to the soil generally result in higher N_2O emissions.

Direct soil emissions (4D1)

Direct soil emissions:

- is the first source of N_2O emissions in the Agriculture sector (in 2011, N_2O Direct soil emissions represented 51.81% of total N_2O emissions in the Agriculture sector);
- is the second source in the Agriculture sector (in 2011, N_2O Direct soil emissions as CO_2 equivalent represented 28.24% from Total Agriculture emissions);
- contributed with 4.34% to Total GHG emissions of Romania.

Pasture, Range and Paddock Manure (4D2)

Pasture, Range and Paddock Manure:

- is the fourth source of N_2O emissions in the Agriculture sector (in 2011, N_2O emissions from Pasture, Range and Paddock Manure represented 8.04% of total N_2O emissions in the Agriculture sector);
- is the fifth source in the Agriculture sector (in 2011, N_2O emissions from Pasture, Range and Paddock as CO_2 equivalent represented 4.39% from Total Agriculture emissions);
- contributed with 0.67% to Total GHG emissions of Romania.

Indirect soil emissions (4D3)

Indirect soil emissions:

- the second source of N_2O emissions in the Agriculture sector (in 2011, N_2O Indirect soil emissions represented 28.01% of total N_2O emissions in the Agriculture sector);
- is the third source in the Agriculture sector (in 2011, N_2O Indirect soil emissions as CO_2 equivalent represented 15.27% from Total Agriculture emissions);
- contributed with 2.35% to Total GHG emissions of Romania.

Emissions from Agricultural Soils are declining since 1989 (Figures 6.7 and 6.8) due to the decrease of the:

- amount of synthetic fertilizer applied;

- ❖ livestock populations (the details can be found in Chapter 6.1);
- ❖ crop productions level.

The amount of N_2O emissions from application of synthetic fertilizers have decreased from 11.76 Gg N_2O in 1989, to 5.54 Gg N_2O in 2011.

The quantity of synthetic fertilizer has decreased considerably after the 1989 year from 665,300 tonnes/year to 313,333 tonnes/year. This decrease is reflected in the decrease of the nitrogen fraction volatilized into the atmosphere as N_2O. The main cause was a decrease of crop production and the inability of farmers to use the agricultural technology correctly (Table 6.16).

The amount of N_2O emissions from N – fixing crop have decreased from 10.89 Gg N_2O in 1989, to 8.06 Gg N_2O in 1990, there was a slight increase in 1991, respectively 8.54 Gg N_2O, then were decreased to 5.97 Gg N_2O in 1992. Subsequent, in the period 1993-2011 largest increase in emissions N_2O was recorded in 1999, respectively 7.01 Gg N_2O, and the lowest it was recorded in 2007, 3.70 Gg N_2O.

The decrease of crops, for example in 1992 was caused by unfavorable weather conditions, while the situation was completely opposite in 2004. In the 2007 year, the crop was reduced from 2006 due to drought.

Cultivated areas were maintained crop except soybeans which recorded significant decreases.

Figure 6.7 Overall emissions trend of Agricultural Soils

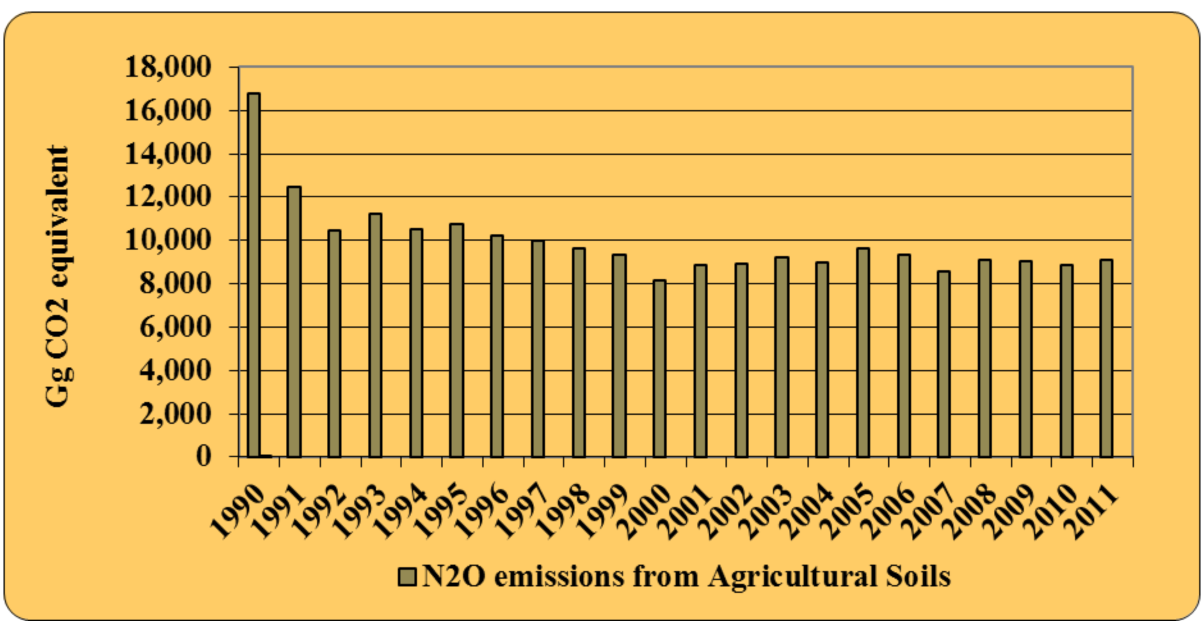


Figure 6.8 N_2O emissions trends – Agricultural Soils

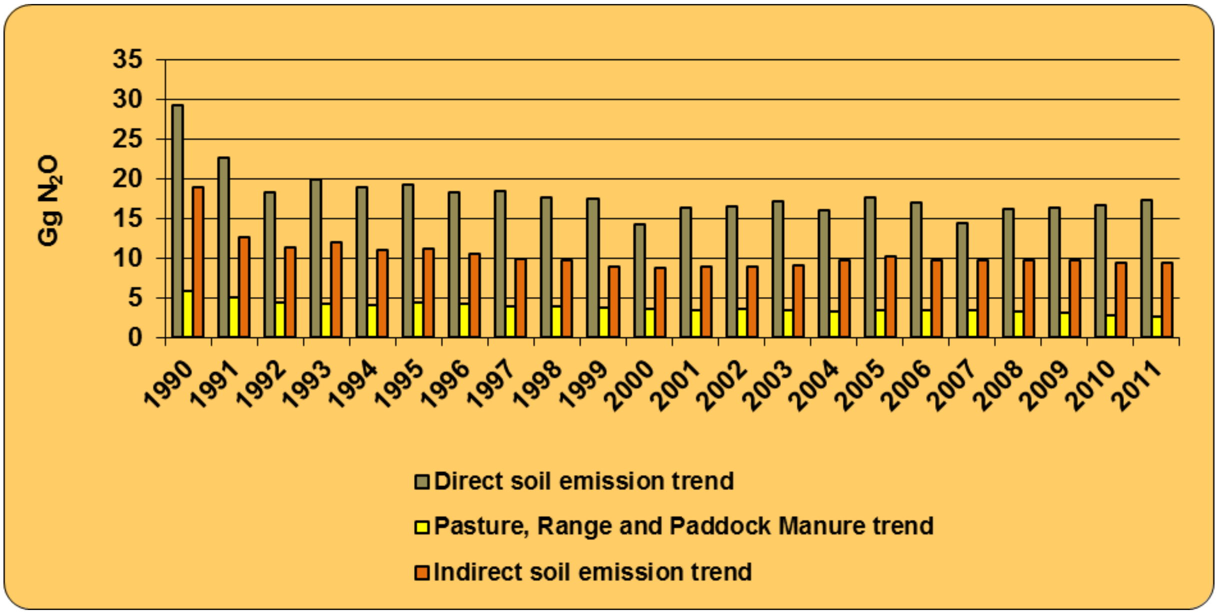


Table 6.17 Observations on source category 4D – "Agricultural Soils"

Source indicative	Source (livestock) type	Observation	Data source
4.D.1.1, 4.D.3	Amount of N synthetic fertilizer used		AD: SY, NIS, 1989-2011; EF: IPCC GPG 2000
4.D.1.2, 4.D.2, 4.D.3	Animals number by livestock	Includes data on eight different livestock types: cattle (Dairy cattle and Non-dairy cattle), buffalo (buffalo milk and other buffalo), sheep (Ewes of milk and fitted, reproducers rams and other sheep), goats (Female goats for milk and females by first mount and other goats), horses, mules and asses, swine (pigs under 20 kg, pigs between 20 and 50 kg, pigs fattening, boars, breeding sows) and poultry (adult poultry for eggs, poultry for meat).	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2011; 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*" EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4.D.1.3	Productions of N-fixing crops	Includes data on four types of N-fixing crops: *pea beans, dry bean, other leguminous for dry bean, soybeans, Annual leguminous, lucerne, clover, other perennial leguminous.*	AD: SY, other correspondence, NIS, 1989-2011; 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*" EF: IPCC GPG 2000

Table 6.17 (continued) Observations on source category 4D – "Agricultural Soils"

Source indicative	**Source (livestock) type**	**Observation**	**Data source**
4.D.1.4	Production of non - N fixing crops	Includes data on 34 types of non-N-fixing crops: *rye, wheat, barley and two-row barley, oats, maize, sorghum, rice, other grains, rape, sunflower, flax for oil, other oilseed plants (castor), in fiber- textile plants, hemp for fiber - plant textiles, other textile plants – cotton, tobacco, hop, medicinal aromatic plants/spices grown, other industrial crops (sorghum for brooms, potatoes, sugar beet, fodder roots, tomatoes, eggplant, dry onion, dry garlic, cabbage, green peppers, cultivated mushrooms, root vegetables – edible roots, water melons and melons, other vegetables, annual grasses, other perennial grasses.*	AD: SY, other correspondence, NIS, 1989-2011; 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"*. EF: IPCC GPG 2000
4.D.1.5	Area of cultivated organic soils		AD: The study *„Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods"* EF: IPCC GPG 2000

6.5.2 Methodological issues

N_2O Direct soil emissions

Methodology

Despite the fact that Direct soil emissions is a key category, both from level and trend views,Tier 2 method could not be applied, due to the lack of detailed data needed. Therefore, a Tier 1 method has been applied. For calculation of nitrous oxide Direct soil emissions, the equations 4.20 of IPCC GPG 2000 were used.

Equation 6.13 Direct N_2O emissions from agricultural soils

$$N_2O_{Direct}\text{-}N = [(F_{SN} + F_{AM} + F_{BN} + F_{CR}) \cdot EF_1] + (F_{OS} \cdot EF_2)$$

where:

- N_2O_{Direct} -N = Emission of N_2O in units of Nitrogen;
- F_{SN} = Annual amount of synthetic fertilizer nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x (kg N/year);
- F_{AM} = Annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilizes as NH_3 and NOx (kg N/year);
- F_{BN} = Amount of nitrogen fixed by N-fixing crops cultivated annually (kg N/year);
- F_{CR} = Amount of nitrogen in crop residues returned to soils annually (kg N/year);
- F_{OS} = Area of organic soils cultivated annually (ha);
- EF_1 = Emission factor for emissions from N inputs (kg N_2O-N/kg N input);
- EF_2 = Emission factor for emissions from organic soil cultivation (kg N_2O-N/ha-yr).

The conversion of emissions N_2O-N in the N_2O emissions in the view of reporting was realized for all the parameters, after equation:

Equation 6.14 Conversion of emissions N_2O-N in the N_2O emissions

$$N_2O = N_2O\text{-}N \cdot 44/28$$

For the calculation nitrogen from synthetic fertilizers (F_{SN}) application were used the equation 4.22 from IPCC GPG 2000:

Equation 6.15 N from synthetic fertiliser application

$$F_{SN} = N_{FERT} \bullet (1 - Frac_{GASF})$$

where:

- ❖ F_{SN} = Annual amount of synthetic fertiliser nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x;
- ❖ N_{FERT} = fertilizer nitrogen use in country (kg N/yr);
- ❖ $Frac_{GASF}$ = fraction of synthetic fertiliser nitrogen applied to soils that volatilises as NH_3 and NO_x (kg NH_3 – N and NO_x – N/kg of N input).

N from animal manure (F_{AM}) application was calculated using the equation 4.24 from IPCC GPG 2000:

Equation 6.16 N from animal manure application

$$F_{AM} = \Sigma_T(N_{(T)} \bullet Nex_{(T)}) \bullet (1 - Frac_{GASM}) \bullet [1 - (Frac_{FUEL\text{-}AM} + Frac_{PRP} + Frac_{FEED\text{-}AM} + Frac_{CNST\text{-}AM})]$$

where:

- ❖ F_{AM} = Annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilizes as NH_3 and NOx;
- ❖ $N_{(T)}$ = Number of head of livestock species/category *T* in the country;
- ❖ $N_{ex(T)}$ = Annual average N excretion per head of species/category T in the country (kg N/animal/yr);
- ❖ $Frac_{GASM}$ = fraction of livestock nitrogen excretion that volatilizes as NH_3 and NO_x (kg NH_3 – N and NO_x – N/kg of N excreted);
- ❖ $Frac_{FUEL\text{-}AM}$ = fraction of animal manure used as fuel (kg N/kg N totally excreted);
- ❖ $Frac_{PRP}$ = fraction of livestock nitrogen excreted and deposited onto soil during grazing (kg N/kg N excreted) country estimate;
- ❖ $Frac_{FEED\text{-}AM}$ = fraction of animal manure used as feed (kg N/kg N totally excreted);

- $Frac_{CNST-AM}$ = fraction of animal manure used as construction (kg N/kg N totally excreted).

For the amount estimation of fixed biologically annual nitrogen (F_{BN}) by the fixing crop of nitrogen was used equation 4.26 (IPCC GPG 2000):

Equation 6.17 N fixed by crops (Tier 1b)

$$F_{BN} = \Sigma i\ [Crop_{BFi} \bullet (1 + Res_{BFi}/Crop_{BFi}) \bullet Frac_{DMi} \bullet Frac_{NCRBFi}]$$

where:

- F_{BN} = Amount of nitrogen fixed by N-fixing crops cultivated annually (kg N/year);
- $Crop_{BFi}$ = products of all N-fixing crops (kg dry biomass/year);
- Res_{BFi}/ $Crop_{BFi}$ = residue to crop product mass ratio specific to each crop type *i;*
- $Frac_{DMi}$ = is the fraction of dry matter in the aboveground biomass of each crop type *i;*
- $Frac_{NCRBFi}$ = fraction of nitrogen in N- fixing crop type *i* (kg N/kg of dry biomass).
- i = indicative plants nitrogen fixed.

For the estimation amount of N results from incorporating in soil of crop residues (F_{CR}) were used the equation 4.29 (IPCC GPG 2000).

Equation 6.18 N in crop residue returned to soils (Tier 1b)

$$F_{CR} = \Sigma i\ [(Crop_{Oi} \bullet Res_{Oi} /Crop_{Oi} \bullet Frac_{DMi} \bullet Frac_{NCROi}) \bullet (1 - Frac_{BURNi} - Frac_{FUEL-Cri} - Frac_{CNST-CRi} - Frac_{FODi})] + \Sigma j\ [(Crop_{BFj} \bullet Res_{BFj}/Crop_{BFj} \bullet Frac_{DMj} \bullet Frac_{NCRBFj}) \bullet (1 - Frac_{BURNj} - Frac_{FUEL-CRj} - Frac_{CNST-CRj} - Frac_{FODj})]$$

where:

- F_{CR} = Amount of nitrogen in crop residues returned to soils annually (kg N/year);
- $Crop_{Oi}$ = represents nitrogen unfixed crop type *i* production (kg dry biomass/year);
- Res_{Oi} /$Crop_{Oi}$ = the residue to crop type *i* product mass ratio (fraction);
- $Frac_{DMi}$ = the dry matter content of the type *i* aboveground biomass (fraction);
- $Frac_{NCROi}$ = the nitrogen content of the type *i* aboveground biomass (kg N/ kg of dry biomass);
- $Frac_{BURNi}$ = the fraction of residue burned in the type *i* field before and after harvest (kg N/kg crop-N);

- $Frac_{FUEL-CRi}$ = the fraction of residue type *i* used as fuel (fraction);
- $Frac_{CNST-CRi}$ = the fraction of residue type *i* used for construction (fraction);
- $Frac_{FODi}$ = the fraction of residue type *i* used as fodder (fraction);
- $Crop_{BFj}$ = represents nitrogen fixed crop type *j* production (kg dry biomass/year);
- $Res_{BFj}/Crop_{BFj}$ = the residue to crop type *j* product mass ratio (fraction);
- $Frac_{DMj}$ = the dry matter content of the type *j* aboveground biomass (fraction);
- $Frac_{NCRBFj}$ = the nitrogen content of the type *j* aboveground biomass (kg N/kg of dry biomass);
- $Frac_{BURNj}$ = the fraction of residue burned in the type *j* field before and after harvest (kg N/kg crop-N);
- $Frac_{FUEL-CRj}$ = the fraction of residue type *j* used as fuel (fraction);
- $Frac_{CNST-CRj}$ =the fraction of residue type *j* used for construction (fraction);
- $Frac_{FODj}$ = the fraction of residue type *j* used as fodder (fraction).
- i = indicative plants nitrogen unfixed;
- j = indicative plants nitrogen fixed.

By expert judgment, $Frac_{PRP}$ values were calculated for every year using the following equation:

Equation 6.19 Calculation of fraction of livestock nitrogen excreted and deposited onto soil during grazing ($Frac_{PRP}$)

$$Frac_{PRP} = N_{ex}(\text{Pasture Range and Paddock})/N_{ex}$$

where:

- $N_{ex(\text{Pasture Range and Paddock})}$ = nitrogen excretion from Pasture Range and Paddock;
- N_{ex} = nitrogen excretion from all Animal Waste Management Systems.

Emission factors

The calculation methodology took into account IPCC GPG 2000 default emissions factors (Table 4.17 of IPCC GPG 2000):

- EF_1 = 0.0125 (fraction of N-input, kg N_2O-N/kg N);
- EF_2 = 8 (value specific to Middle-Latitude Organic Soils; kg N_2O-N/ha/year).

Activity data

Data used for calculation of the annual amount of synthetic fertilizer nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x (F_{SN})

The amount of synthetic fertilizer applied to soils data are provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook 1989-2011.
Data series are presented in Table 6.18.
Default IPCC GPG 2000 value of $Frac_{GASF}$ used is presented in Table 6.19.

Data used for calculation of the annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x and excluding manure produced during grazing (F_{AM})

Livestock data are presented in Chapter 6.2.2.
Nitrogen excretion per head of animal and fraction of nitrogen excretion produced in different AWMS values used are presented in Chapter 6.3.2.
Fraction of livestock nitrogen excreted and deposited onto soil during grazing ($Frac_{PRP}$) values are presented in Table 6.18.
Fraction of livestock nitrogen excretion contained in excrements burned for fuel ($Frac_{FUEL-AM}$) and fraction of livestock nitrogen excretion that volatilizes as NH_3 and NO_x ($Frac_{GASM}$) default values are presented in Table 6.19.
For fraction $Frac_{FEED-AM}$ and $Frac_{CNST-AM}$ were used the 0 value, because were not identified sources of national statistical data (the expert opinion).
The use or recycling manure by the introduction in manufacturing processes of materials building, although it is known the technique, not was used.

Table 6.18 Activity data series used for calculation of F_{AM} and F_{SN}, for 1989-2011

Year	Amount of synthetic fertilizer applied to soil [thousands tonnes/year]	Fraction of livestock nitrogen excreted and deposited onto soil during grazing [fraction]
1989	665.3	0.3006
1990	656.0	0.2758
1991	275.0	0.2645
1992	258.0	0.2633
1993	346.0	0.2734
1994	313.0	0.2871
1995	306.0	0.2906
1996	268.0	0.2848
1997	262.0	0.2969
1998	254.0	0.2883
1999	225.0	0.3004
2000	239.0	0.3049
2001	268.0	0.3025
2002	239.0	0.2956
2003	252.0	0.2833
2004	270.0	0.2471
2005	299.0	0.2540
2006	252.0	0.2639
2007	265.0	0.2664
2008	279.8	0.2594
2009	296.06	0.2584
2010	306.0	0.2465
2011	313.0	0.2475

Table 6.19 Default IPCC values for specific fractions used (described in IPCC GPG 2000 and in Table 4-19 of Reference Manual)

Specific fraction	Default IPCC value	Associated measurement unit
$Frac_{BURN}$	0.1 or less in developed countries (accordingly to the provisions in page 4.89 of IPCC GPG 2000), for 1989 - 2001; 0 for 2002 - 2008	kg N/kg crop-N
$Frac_{R}$	0.5	kg N/kg crop-N
$Frac_{FUEL-AM}$	0	kg N/kg N excreted
$Frac_{GASF}$	0.1	kg NH_3-N + NO_x-N/kg of synthetic fertilizer N applied
$Frac_{GASM}$	0.2	kg NH_3-N + NO_x-N/kg of N excreted by livestock
$Frac_{NCRBF}$	0.03	kg N/kg of dry biomass
$Frac_{NCR0}$	0.015	kg N/kg of dry biomass

Data used for calculation of amount of nitrogen fixed by N-fixing crops cultivated annually (F_{BN})

Primary data

The primary data on Crop production of nitrogen fixing crop are obtained from the NIS through SY 1989-2011 and data base. They are presented in Table 6.20.
Based on questionnaire and of the database from NIS *other perennial forage* was obtained decreasing from *total perennial forage* the sum of the values of *lucerne* and *clover*.

Table 6.20 The primary data on Crop production of nitrogen fixing crop obtained from the NIS, in the 1989-2011 period

Year	**Crop production of nitrogen fixing crop (tonnes/year)**							
	Peas beans	**Dry Bean**	**Total Leguminous for dry**	**Soy beans**	**Annual green fodder**	**Plant used for silage**	**Total Annual green**	**Lucerne in equivalent green fodder**
1989	98,500	143,600	255,900	303,900	9,705,200	6,096,600	15,801,800	11,131,700
1990	49,395	57,542	112,116	141,173	6,882,641	7,520,906	14,403,547	8,057,219
1991	32,292	46,019	79,491	178,593	5,645,816	5,390,442	11,036,258	9,661,207
1992	33,180	41,184	74,678	126,159	4,077,623	3,047,204	7,124,827	6,409,569
1993	36,406	48,421	85,232	95,370	3,971,900	3,029,541	7,001,441	6,879,385
1994	38,091	37,379	76,112	100,078	4,155,947	2,335,423	6,491,370	6,944,354
1995	54,262	41,769	97,017	107,861	4,127,358	1,892,078	6,019,436	7,081,202
1996	33,705	42,078	77,016	113,084	3,930,367	,2084,169	6,014,536	6,984,832
1997	27,263	50,194	78,560	121,148	3,741,430	1,602,720	5,344,150	7,727,622
1998	24,382	46,856	72,497	200,820	3,773,666	1,145,649	4,919,315	7,004,112
1999	27,011	47,698	76,755	183,403	4,334,489	1,028,431	5,362,920	7,737,980
2000	14,159	21,803	36,929	69,473	2,840,370	476,958	3,317,328	5,120,710
2001	21,661	36,492	61,174	72,688	3,146,175	579,428	3,725,603	6,476,805
2002	20,450	33,592	55,313	145,932	3,816,927	565,477	4,382,404	6,887,361
2003	23,497	36,679	60,645	224,908	4,118,584	606,706	4,725,290	7,237,492
2004	58,036	53,517	112,331	298,506	1,923,528	0	1,923,528	4,655,262
2005	39,096	41,733	80,913	312,781	2,454,958	0	2,454,958	6,274,555
2006	36,147	34,942	71,574	344,909	3,182,639	0	3,182,639	6,381,270
2007	17,748	18,014	36,185	136,094	2,222,483	0	2,222,483	4,166,344
2008	36,917	25,157	62,466	90,579	2,860,655	0	2,860,655	5,505,795
2009	30,009	22,348	52,918	84,268	2,898,188	0	2,898,188	5,642,588
2010	39,677	21,059	61,344	149,940	3,041,978	0	3,041,978	5,799,305
2011	55,076	21,351	76,830	142,636	3,371,352	0	3,371,352	6,015,839

Table 6.20 (continued) The primary data on Crop production of nitrogen fixing crop obtained from the NIS, in the 1989-2011 period

Year	**Crop production of nitrogen fixing crop (tonnes/year)**		
	Clover in equivalent green fodder	**Other perennial forage**	**Perennial forage**
1989	2,937,100	3,988,200	18,057,000
1990	1,926,004	2,980,701	12,963,924
1991	2,054,329	3,513,112	15,228,648
1992	1,792,567	2,787,324	10,989,460
1993	1,988,099	2,890,764	11,758,248
1994	2,059,289	2,665,781	11,669,424
1995	2,367,015	2,761,694	12,209,911
1996	2,400,569	2,702,844	12,088,245
1997	2,725,409	2,848,141	13,301,172
1998	2,632,031	2,695,283	12,331,426
1999	2,863,116	2,908,083	13,509,179
2000	2,018,423	2,072,818	9,211,951
2001	2,494,521	2,564,330	11,535,656
2002	2,534,648	3,047,404	12,469,413
2003	2,421,292	2,955,120	12,613,904
2004	866,398	1,087,129	6,608,789
2005	1,601,385	2,251,574	10,127,514
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

The data on Crop production of nitrogen fixing crop obtained through the dedicated study *„Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods.“*

In the context of the study above, by expert opinion using the primary data from the Table 6.20 (NIS) for the calculation F_{BN} are used the data on Crop production of nitrogen fixing crop presented in the Table 6.21.

The values for *pea beans, dry bean, soybeans, lucerne* and *clover* were used in the primary data table (Table 6.20).

The values for *other leguminous for dry beans* were obtained from the difference between *total leguminous for dry beans* and the sum of the values from *pea beans* and *dry beans*.

In the context of the study above, by expert opinion were considered that the *Annual leguminous* were obtained by multiplying *annual green fodder* with 0.3.

In the context of the study above, by expert opinion the values for *other perennial leguminous* represent 40% from *other perennial forage.*

The value $Res_{BF}/Crop_{BFi}$, $Frac_{DMi}$ and $Frac_{NCRBFi}$ are default, they being taken from the Table 4.16 in IPCC GPG 2000 and the Table 4.19 from Reference Manual, 1996. They are presented in Table 6.28 for each plant.

The value $Res_{BF}/Crop_{BFi}$, $Frac_{DMi}$ and $Frac_{NCRBFi}$ for *peas beans* were used in IPCC GPG 2000, Table 4.16.

For *dry bean* the value $Res_{BF}/Crop_{BFi}$, and $Frac_{DMi}$ were used in IPCC GPG 2000, Table 4.16. Were chose an average of the two values from $Frac_{DMi}$. For $Frac_{NCRBF}$ was used the value from Table 4.19, Reference Manual, 1996.

For *other leguminous for dry bean,* the value was defined in the context of the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“depending* on the species considered. In the made estimation using the national data sources, *peas beans* and *dry bean* are included in the leguminous for *dry bean* category for whom were used the parameters presented in the Table 6.22, as average for two species.

For the soybeans were used the default parameters (the result of the $Frac_{DM}$ is average between two values).

The values $Frac_{NCRBFi}$ for *Lucerne in equivalent green fodder*, *Clover in equivalent green fodder*, *Annual leguminous* and *Other perennial leguminous* were used for Table 4.19 from Reference Manual 1996, and the value $Res_{BF}/Crop_{BFi}$ is considered to be 0, because they are used completely as feed (the expert opinion).

According to provisions in IPCC 1996, a default value of 0.85 was used to adjust for the default water content in crop productions.

Table 6.21 The data on Crop production of nitrogen fixing crop obtained through the dedicated study (tonnes/year), in the 1989-2011 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
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

Table 6.22 The values used in the calculation F_{BN} ($Res_{BF}/Crop_{BFi}$, $Frac_{DMi}$ and $Frac_{NCRBFi}$), in the 1989-2011 period

Parameters	*The values used in the calculation F_{BN}*							
	Peas beans	**Dry Bean**	**Other leguminous for dry beans**	**Soy beans**	**Lucerne in equivalent green fodder**	**Clover in equivalent green fodder**	**Annual leguminous**	**Other perennial leguminous**
$Res_{BF}/Crop_{BFi}$ (fraction)	1.5	2.1	1.8	2.1	0	0	0	0
$Frac_{DMi}$ (fraction)	0.87	0.85	0.85	0.865	0.85	0.85	0.85	0.85
$Frac_{NCRBFi}$ (kg N/kg of dry biomass)	0.0142	0.03	0.03	0.023	0.03	0.03	0.03	0.03

Data used for calculation of amount of nitrogen in crop residues returned to soils annually (F_{CR})

Primary Data

For the calculation F_{CR} are necessary and the nitrogen fixing crop production. The primary data on crop production of nitrogen fixing crop were presented in the Table 6.20 (Chapter 6.5.2).
The primary data on Crop production of nitrogen non-N-fixing crop are provided by NIS through SY 1989-2011 and data base. They are presented in Table 6.23.

Table 6.23 The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2011 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
2011	31,382	7,131,590	1,329,692	375,855	11,717,591	39,696	65,261	20,842,160

Table 6.23 (continued) The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2011 period

Year	Productions of non-N-fixing crops (tonnes/year)							
	Wheat and rye	Triticale	Rape	Sunflower	Flax for oil	Total Oilseed plants	Soy beans	In fiber-textile plants
1989	7,935,200	0	18,000	655,800	48,900	1,034,300	303,900	127,200
1990	7,379,022	0	10,860	556,242	28,040	739,319	141,173	53,192
1991	5,558,909	0	8,764	611,956	22,766	823,375	178,593	15,438
1992	3,227,614	0	1,372	773,986	17,877	920,295	126,159	25,648
1993	5,354,513	0	1,355	695,833	28,036	820,786	95,370	7,237
1994	6,186,500	0	322	763,697	6,457	874,093	100,078	4,821
1995	7,709,266	0	357	932,932	4,744	1,055,371	107,861	7,246
1996	3,164,058	0	1,867	1,095,596	4,517	1,218,725	113,084	4,108
1997	7,185,601	3,657	11,646	858,060	4,758	1,001,845	121,148	1,884
1998	5,207,911	3,435	28,742	1,073,316	3,019	1,317,567	200,820	735
1999	4,682,531	3,634	108,221	1,300,929	2,773	1,606,642	183,403	690
2000	4,456,240	7,431	76,126	720,871	994	868,531	69,473	881
2001	7,763,767	17,055	101,789	823,549	1,985	1,005,541	72,688	388
2002	4,441,074	23,006	35,906	1,002,813	1,760	1,194,506	145,932	794
2003	2,496,410	19,473	8,080	1,506,398	1,498	1,760,436	224,908	710
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

Table 6.23 (continued) The primary data on Crop production of non- nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2011 period

Year	**Productions of non-N-fixing crops (tonnes/year)**							
	Hemp for fiber-Plant textiles	**Cotton**	**Tobacco**	**Hop**	**Medicinal aromatic plants/spices grown**	**Sorghum for brooms**	**Potatoes**	**Sugar beet**
1989	113,900	0	27,500	0	33,300	12,656	4,420,300	6,771,100
1990	72,105	484	14,168	2,451	20,459	6,505	3,185,624	3,277,705
1991	58,345	200	13,919	2,626	20,867	6,001	1,872,767	4,702,693
1992	38,554	75	7,574	2,638	21,517	9,272	2,601,648	2,896,691
1993	7,433	0	10,503	2,470	12,092	6,517	3,708,903	1,776,327
1994	4,492	40	12,993	1,559	6,257	7,387	2,946,721	2,763,783
1995	5,862	21	13,358	1,823	12,114	11,156	3,019,921	2,654,610
1996	12,953	0	12,092	1,455	6,565	9,875	3,591,378	2,848,169
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

Table 6.23 (continued) The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2011 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

Table 6.23 (continued) The primary data on Crop production of non- nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2011 period

Years	Productions of non-N-fixing crops (tonnes/year)						
	Root vegetables – Edible roots	Water melons and melons	Total vegetables	Annual green fodder	Plant used for silage	Annual green fodder new	Total Perennial forage
1989	251,900	215,700	4,195,600	9,705,200	6,096,600	15,801,800	18,057,000
1990	158,554	381,585	3,051,200	6,882,641	7,520,906	14,403,547	12,963,924
1991	193,047	740,464	3,246,400	5,645,816	5,390,442	11,036,258	15,228,648
1992	214,880	623,036	3,461,200	4,077,623	3,047,204	7,124,827	10,989,460
1993	256,907	601,429	3,992,100	3,971,900	3,029,541	7,001,441	11,758,248
1994	244,890	611,102	3,548,700	4,155,947	2,335,423	6,491,370	11,669,424
1995	281,339	639,352	3,868,500	4,127,358	1,892,078	6,019,436	12,209,911
1996	253,148	693,883	3,934,400	3,930,367	2,084,169	6,014,536	12,088,245
1997	273,629	625,663	3,559,600	3,741,430	1,602,720	5,344,150	13,301,172
1998	284,708	689,620	3,939,900	3,773,666	1,145,649	4,919,315	12,331,426
1999	308,408	853,231	4,365,600	4,334,489	1,028,431	5,362,920	13,509,179
2000	253,853	531,127	3,381,100	2,840,370	476,958	3,317,328	9,211,951
2001	301,749	550,503	3,848,300	3,146,175	579,428	3,725,603	11,535,656
2002	303,279	651,317	3,973,400	3,816,927	565,477	4,382,404	12,469,413
2003	332,795	764,585	4,684,500	4,118,584	606,706	4,725,290	12,613,904
2004	351,183	765,118	4,773,916	1,923,528	0	1,923,528	6,608,789
2005	229,569	691,760	3,624,612	2,454,958	0	2,454,958	10,127,514
2006	292,579	641,791	4,138,862	3,182,639	0	3,182,639	10,622,291
2007	209,029	407,973	3,116,801	2,222,483	0	2,222,483	7,330,212
2008	265,999	562,260	3,819,890	2,860,655	0	2,860,655	9,273,329
2009	238,748	652,844	3,901,862	2,898,188	0	2,898,188	9,461,506
2010	241,578	662,863	3,863,617	3,041,978	0	3,041,978	9,974,033
2011	275,145	645,486	4,176,298	3,371,352	0	3,371,352	10,661,681

The data on Crop production of non - nitrogen fixing crop obtained through the dedicated study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*"

In the context of the study above, by expert opinion using the primary data from the Table 6.23 (NIS) were considered the data on Crop production of non - nitrogen fixing crop presented in the Annex 3.3 – sheet *Crop production of non N fixing.*

For the 1989 period the value of production of by *rye, wheat, cotton, hop* has made an extrapolation with reference year 1990.

The data on Crop production of nitrogen fixing crop were considered the presented in the Table 6.21 (Chapter 6.5.2).

For the calculation F_{CR} were used the data on Crop production of non - nitrogen fixing crop and the data on Crop production of nitrogen fixing crop.

The crop production values from the these plants (*rye, wheat, barley and two-row barley, oats, maize, sorghum, rice, rape, sunflower, flax for oil, in fiber- textile plants, hemp for fiber - plant textiles, tobacco, hop, medicinal aromatic plants/spices grown, potatoes, sugar beet, fodder roots, tomatoes, eggplant, dry onion, dry garlic, cabbage, green peppers, cultivated mushrooms, root vegetables – edible roots, water melons and melons)* were used from the primary data table (Table 6.23).

By expert opinion, the values for *other grains* were obtained from the difference between *total cereal grains* and the sum *wheat and rye, barley and two-row barley, oats, maize, sorghum, rice and triticale.*

The values for other oilseed plants (castor) were obtained from the difference between *total oilseed plants* and the sum *rape, sunflower, flax for oil and soya beans.*

By expert opinion, the values of *other textile plants* were taken from *castor*.

In the context of the study above, by expert opinion were taken from *sorghum for brooms*.

The values for *other vegetable* were obtained from the difference between *total vegetables* and the sum *tomatoes, eggplant, dry onion, dry garlic, cabbage, green peppers, cultivated mushrooms, root vegetables – edible roots, water melons and melons.*

In the context of the study above, by expert opinion, were considered that the *annual green fodder new* the values of *annual grasses* represent 70%.

The productions of *annual green fodder new* were obtained from the of sum *annual green fodder* and *plant used for silage*.

In the context of the study above, by expert opinion, were considered that the *other perennial forage* the values of *other perennial grasses* represent 60%.

The values for *other perennial forage* were obtained from the difference between *total perennial forage* and the sum *the lucerne in equivalent green fodder* and *clover in equivalent green fodder.*

$Res_O/Crop_O$

The values this parameter were used from the Table 4.16 (IPCC GPG 2000) and the Table 4.17 (Reference Manual, 1996) .

In the context of the study noted, by expert opinion, for the calculation was used the average of values of the differents species. To textile plant species (*flax, hemp, cotton), sunflower, rape, flax for oil, other oilseed plants-castor, tobacco and vegetables*, were estimated the national values based on data of different parts of the productions presented in national bibliography.

To *other grains*, *other leguminous for dry beans*, *other oilseed plants (castor)*, and *other industrial crops (sorghum for brooms),* were estimated the national values based on data of different parts of the productions presented in national bibliography.

For the category *other perennial leguminous, other perennial grasses* were used the 0 value, because they are fully used as feed.

$Frac_{DM}$

Were used the default values from the Table 4.16 (IPCC GPG 2000), the Table 4.17 (Manual Reference) for some plants (*grains*), and the national values based on data presented in national bibliography.

$Frac_{NCRO}$

Were used the default values from the Table 4.16 (IPCC GPG 2000), the Table 4.17 (Reference Manual) and the Table 4.19 (Reference Manual) for all plants.

$Frac_{NCRBF}$

Were used the default values from the Table 4.16 (IPCC GPG 2000), the Table 4.17 (Reference Manual) and the Table 4.19 (Reference Manual) for all plants.

$Frac_{BURN}$

As the national level are reported the activities of burning of crop residues in the conditions compliance of the legislation in existing, for the considered period, were estimated at the value of the fraction 10% for majority cereal grains, for dry bean, sunflower, soybean, tobacco, potatoes, other industrial crops (Sorghum for brooms).
According to provisions in IPCC 1996, a default value of 0.85 was used to adjust for default water content in crop productions.

$Frac_{FUEL-CR}$

In rural areas subsistence farmers use *maize strains, sunflower*, *tobacco, rape, hemp for fiber* for production of warmth to burning furnaces. In the context of the study noted, by expert opinion, was estimated a 10% value for 1989-2011, and for hemp for fiber was used a 50% value.

$Frac_{CNST-CR}$

In the context of the study noted, by expert opinion, was estimated a the 0.0025 value for 1989-2011 to *wheat, barley* and *two-row barley*, to *rape, sunflower, other textile plant-cotton*, *other industrial crop-sorghum for brooms* was used 0.1, to *in fiber textile plants* and *hemp for fiber* was used 0.3.

$Frac_{FOD}$

In the context of the study noted, by expert opinion were estimated the national values for some plants.

In the Table 6.24 are presented the values used in the calculation F_{CR} (kg N/year).

Table 6.24 The values used in the calculation F_{CR} (kg N/year) of non-nitrogen fixing crop, in the 1989-2011 period

Parameters	Rye	Wheat	Barley and two-row barley	Oats	Maize	Sorghum	Rice	Other cereals	Rape
$Res_O/Crop_O$	1.6	1.3	1.2	1.3	1	1.4	1.4	1	1.5
$Frac_{DM}$	0.9	0.85	0.85	0.92	0.78	0.91	0.85	0.85	0.85
$Frac_{NCRO}$	0.0048	0.0028	0.0043	0.007	0.0081	0.0108	0.0067	0.015	0.015
$Frac_{BURN}$	0.1	0.1	0.1	0	0.1	0.1	0	0.1	0
$Frac_{FUEL-CR}$	0	0	0	0	0.1	0	0	0	0.1
$Frac_{CNST-CR}$	0	0.0025	0.0025	0	0	0	0	0	0.1
$Frac_{FOD}$	0	0.25	0	0.2	0.2	0	0	0	0.3

Table 6.24 (continued) The values used in the calculation F_{CR}** (kg N/year) **of non-nitrogen fixing crop, in the 1989-201 period1

Parameters	Sunflower	Flax for oil	Other oilseed plants-castor	Flax fiber-textile plants	Hemp for fiber-Plant textiles	Other textile plants - cotton	Tobacco	Hop	Medicinal aromatic plants/ spices grown
$Res_O/Crop_O$	1	3.08	2	0.18	1	2	1	1	0
$Frac_{DM}$	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
$Frac_{NCRO}$	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
$Frac_{BURN}$	0.1	0	0	0	0	0	0.1	0	0
$Frac_{FUEL-CR}$	0.1	0	0	0	0.5	0.1	0.1	0	0
$Frac_{CNST-CR}$	0.1	0	0	0.3	0.3	0.1	0	0	0
$Frac_{FOD}$	0.3	0.1	0	0	0	0.2	0	0	0

Table 6.24 (continued) The values used in the calculation F_{CR}** (kg N/year) **of non-nitrogen fixing crop, in the 1989-2011 period

Parameters	Other industrial crops	Total potatoes	Sugar beet	Fodder roots	Tomatoes	Eggplan t	Dry onion	Dry garlic	Cabbage
$Res_O/Crop_O$	1.4	0.33	0.3	0	0.3	0.3	0.3	0.3	0.2
$Frac_{DM}$	0.91	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
$Frac_{NCRO}$	0.0108	0.011	0.022 8	0.0228	0.015	0.015	0.015	0.015	0.015
$Frac_{BURN}$	0.1	0.1	0	0	0	0	0	0	0
$Frac_{FUEL-CR}$	0	0	0	0	0	0	0	0	0
$Frac_{CNST-CR}$	0.1	0	0	0	0	0	0	0	0
$Frac_{FOD}$	0	0	0.4	0	0	0	0	0	0

Table 6.24 (continued) The values used in the calculation F_{CR}* (kg N/year) *of non - nitrogen fixing crop, in the 1989-2011 period

Parameters	Green peppers	Cultivated mushrooms	Root vegetables- Edible roots	Water melons and melons	Other vegetables	Annual grasses	Other perennial grasses
$Res_O/Crop_O$	0.3	0	0.3	0.3	0.3	0	0
$Frac_{DM}$	0.85	0.85	0.85	0.85	0.85	0.85	0.85
$Frac_{NCRO}$	0.015	0.015	0.015	0.015	0.015	0.015	0.015
$Frac_{BURN}$	0	0	0	0	0	0	0
$Frac_{FUEL-CR}$	0	0	0	0	0	0	0
$Frac_{CNST-CR}$	0	0	0	0	0	0	0
$Frac_{FOD}$	0	0	0.1	0	0	0	0

Table 6.24 (continued) The values used in the calculation F_{CR}* (kg N/year) *of nitrogen fixing crop, in the 1989-2011 period

Parameters	Other perennial leguminous	Annual leguminous	Peas beans	Dry Bean	Other leguminous for dry beans	Soy beans	Lucerne in equivalent green fodder	Clover in equivalent green fodder
$Res_{BF}/Crop_{BF}$	0	0	1.5	2.1	1.8	2.1	0	0
$Frac_{DM}$	0.85	0.85	0.87	0.85	0.85	0.865	0.85	0.85
$Frac_{NCRBF}$	0.03	0.03	0.0142	0.03	0.03	0.023	0.03	0.03
$Frac_{BURN}$	0	0	0	0.1	0	0.1	0	0
$Frac_{FUEL-CR}$	0	0	0	0	0	0	0	0
$Frac_{CNST-CR}$	0	0	0	0	0	0	0	0
$Frac_{FOD}$	0	0	0.1	0.025	0.1	0	0	0

Area of organic soils cultivated

Histosols of Romania occupy an area of 5.000 hectares (Florea and Buza, 2004) is spread in the mountains, lowlands, floodplain or delta.

Although the of organic matter large reserve is (over 500t/ha) soils are poor in humus and nutrients (Chirita, 1974; Puiu and coll., 1983).

The formats Histosols are maintained only in conditions of excessive moisture (Blaga and collaborators, 2008).

The fertility of Histosols is decreased and are used the pasture, but the quality is very low (Stanga,1971; Florea and Buza, 2004).

After the above citations, in Romania the not cultivate histosols.

Pasture, Range and Paddock Manure emissions

Methodology

Despite the fact that Pasture, Range and Paddock Manure is a key category, by level view, Tier 2 method could not be applied, due to the lack of detailed data needed. Therefore, a Tier 1 method has been applied for the estimation of the emissions levels. The methodology described in Chapter 6.3.2 applies also in this case with the specification that it should be applied only for Pasture, Range and Paddock Manure system.

Emission factors

IPCC 1996 default emission factor used according to the provisions in IPCC GPG 2000 (the Table 4.12) is specified in Chapter 6.3.2 – N_2O emissions section.

Activity data

Activity data took into consideration are presented in Chapter 6.3.2 – N_2O emissions section.

Indirect soil emissions

Methodology

Method IPCC Guidelines for indirect estimating emission of nitrogen used in agriculture describe four methods different ways by which anthropic intake of nitrogen become available for the formation of N_2O:

- atmospheric deposition of NO_x and (NH_4) on soil, nitrogen source inputs including nitrogen volatilization from soil, and sources of combustion and industrial processes;
- the nitrogen leaching and runoff applied or stored on the soil;
- the resulted nitrogen of sludge elimination, not was considered this form of nitrogen because practice of using sludge in Agriculture is not yet in Romania; in next year is can appear value from this indicator, because in year 2012 in the new strategy is to apply sewage sludge management in Romania, method including;
- the formation of N_2O in atmosphere from emission of NH_3 original from anthropic activities;
- the elimination process of the resulting effluent from food processing.

Despite the fact that Indirect soil emissions is a key category, from level view, Tier 2 method could not be applied, due to the lack of detailed data needed. Therefore, a Tier 1 method has been applied. For calculation of indirect nitrous oxide soil emissions, the equations 4.30, 4.32 and 4.37 from IPCC GPG 2000 were used.

Equation 6.20 Indirect N_2O Emissions

$$N_2O\ indirect\text{-}N = N_2O_{(G)} + N_2O_{(L)} + N2O_{(S)}$$

where:

- N_2O indirect-N = Emissions of N_2O in units of nitrogen;
- $N_2O_{(G)}$ = N_2O produced from volatilization of applied synthetic fertilizer and animal manure N, and its subsequent atmospheric deposition as NOx and NH_4 (kg N/year);
- $N_2O_{(L)}$ = N_2O produced from leaching and runoff of applied fertilizer and animal manure N (kg N/year);

- $N_2O_{(S)}$ = N_2O produced from discharge of human sewage N into rivers or estuaries (kg N/year);

Conversion of N_2O-N emissions to N_2O emissions for reporting purposes is performed by using the following equation:

Equation 6.21 Conversion of N_2O-N emissions to N_2O emissions

$$N_2O = N_2O\text{-}N \bullet 44/28$$

To apply equation were calculated:

Equation 6.22 N_2O from Atmospheric Deposition of N (Tier 1b)

$$N_2O_{(G\text{-}SOIL)}\text{-}N = \{(N_{FERT} \bullet Frac_{GASF}) + [\Sigma_T(N_{(T)} \bullet N_{ex(T))} + N_{SEWSLUDGE}\ ] \bullet Frac_{GASM}\} \bullet EF_4$$

where:

- $N_2O_{(G\text{-}SOIL)}$-N = N_2O from Atmospheric Deposition of N;
- $N_{SEWSLUDGE}$ = the amount of sewage N that is applied to soils in the form of sewage sludge (kg N/year) ;
- N_{FERT} = amount of N fertilizer applied (kg N/year);
- $Frac_{GASF}$ = fraction of synthetic fertiliser nitrogen applied to soils that volatilises as NH_3 and NO_x;
- $N_{(T)}$ = number of animals of type T in the country;
- $Nex_{(T)}$ = Annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);
- $Frac_{GASM}$ = fraction of livestock nitrogen excretion that volatilises as NH_3 and NO_x (kg NH_3 – N and NO_x – N/kg of N excreted);
- EF_4 = indirect emissions factor for nitrogen stored; is use default value this fraction (Table 4.18, pages 4.73) of Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, used value 0.01 N_2O-N/kg NH_4-N and NO_X-N stored.

Equation 6.23 Deposited N from Leaching/Runoff (Expanded for major animal species/categories)

$$N_2O(_{L\text{-}SOIL})\text{-}N = \{N_{FERT} + \Sigma_i (N_{(EX)i} \bullet [1 - (Frac_{(FUEL\text{-}AM)i} + Frac_{(FEED\text{-}AM)i} + Frac_{(CNST\text{-}AM)i})] + N_{SEWSLUDGE}\} \bullet Frac_{LEACH} \bullet EF_5$$

where:

- $N_2O(_{L\text{-}SOIL})\text{-}N$ = Deposited N from Leaching/Runoff;
- $N_{FERT\,=}$ amount of N fertilizer applied (kg N /year);
- $N_{ex(T)}$ = Annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);
- $Frac_{FUEL\text{-}AM}$ = fraction of animal manure used as fuel (kg N/kg N totally excreted);
- $Frac_{FEED\text{-}AM}$ = fraction of animal manure used as feed (kg N/kg N totally excreted);
- $Frac_{CNST\text{-}AM}$ = fraction of animal manure used as construction (kg N/kg N totally excreted).
- $N_{SEWSLUDGE\,=}$ the amount of sewage N that is applied to soils in the form of sewage sludge (kg N/year);
- $Frac_{LEACH}$ = fraction of N input to soils that is lost through leaching and runoff (kg N/kg of N applied);
- $EF_{5\,=}$ has value 0.025 kg N_2O-N/ kg N leaching/runoff factor of indirectly emission for nitrogen deposed, is used default value of this fraction (Table 4.23) of Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual 0.025 kg N_2O-N/ kg N leaching / runoff.

According to IPCC GPG 2000 provisions, N_2O produced from discharge of human sewage N into rivers or estuaries are to be reported under Domestic and Commercial Wastewater in Chapter 5.

Emission factors

The calculation methodology took into account IPCC GPG 2000 default emissions factors (Table 4.18 from IPCC GPG 2000):

- EF_4 = 0.01 [kg N_2O-N/kg NH_3-N and NO_x-N emitted];

- EF_5 = 0.025 [kg N_2O-N/kg N leaching/runoff].

Activity data

A default IPCC GPG 2000 value of 0.3, specific to the fraction of fertilizer and manure nitrogen that is lost through leaching and runoff, $Frac_{LEACH}$, was considered.
For the $Frac_{GASF}$ fraction was used the 0.1 value, $Frac_{GASM}$ was used 0.2 from the Table 4.19 (Reference Manual, 1996). For the other fractions were used to value 0, according to expert opinion.
The all activity data are presented in the relevant Direct soil emissions section and Chapter 6.3.2.

6.5.3 Uncertainties and time-series consistency

Direct soil emissions

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

- AD: 20 %;
- EF: 300%;
- 301% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

The values were collected/elaborated/selected in the framework of implementing the "Environmental Integrated Informational System" study, by the Austrian Environment Agency-University of Graz consortium; additional information are included in Annex 8.1.
Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“ were obtained using the same method (the use of two methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; the use of both national and default values associated to amount of nitrogen fixed by N-fixing crops (F_{BN}) cultivated annually (kg N/year) and amount of nitrogen in crop residues returned to soils annually (kg N/year) (F_{CR}); detailed information is provided in Section 6.2.2 and 6.5.2, default emission factors were used

using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2011 is consistent.

Pasture, Range and Paddock Manure emissions

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

- AD: 20 %;
- EF: 300%;
- 301% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Due to the fact that most of activity data are provided by NIS or FAO and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“ were obtained using the same method (the use of two methods for obtaining the livestock data is ensuring the consistency of data series considering the national circumstances; the use of national values associated to the fraction of animal species/category *i*'s manure handled using manure system *j* in climate region k (MS); detailed information is provided in Section 6.2.2 and 6.3.2, default emission factors were used using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2011 is consistent.

Indirect soil emissions

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

- AD: 20 %;
- EF: 300%;
- 301% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Due to the fact that all activity data are provided by NIS, FAO, MADR or ICPA and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods",* default emission factors were used using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2011 is consistent.

6.5.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the E*nteric Fermentation, Manure management* categories, the results of these being mentioned on the Checklists level.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. The unconformities noted were solved as part of the version 2 of the 2012 NGHGI; they are described in the Chapter 6.5.5 – 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 6.5.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level; the major part of unconformities have beensolved as part of 2012 NGHGI submissions, the rest being envisaged as planned improvement. The solved unconformities are presented as specified in the paragraph above, in the context of version 1 of the 2012 NGHGI.The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.5.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.5.6 Source-specific planned improvements, including those in response to the review process

Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species, are envisaged:

- fraction that volatilizes as NH_3 and NO_x, specific to synthetic fertilizers nitrogen adjusted for volatilization ($Frac_{GASF}$);
- fraction that volatilizes as NH_3 and NO_x, specific to animal manure nitrogen used as fertilizer, adjusted for volatilization ($Frac_{GASM}$);
- national values for activity data in totality;
- fraction of N input that is last through leaching and runoff ($Frac_{LEACH}$).

6.6 Source category Prescribed Burning of Savannas (CRF source category 4.E)

Prescribed Burning of Savannas does not occur in Romania.

6.7 Source category Field Burning of Agricultural Residues (CRF source category 4.F)

6.7.1 Source category description

Burning of agricultural crop residues is a significant source of emissions of methane, carbon monoxide, nitrous oxide and nitrogen oxides. However, the burning of crop residues is not thought to be a net source of carbon dioxide because the carbon released to the atmosphere is reabsorbed during the next growing season.

Considering legislation which prohibits the burning of crop, were concluded that this the activity happening on a small scale, in the case of crop production (the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods“.*

Emissions from field burning of agricultural residues in 2011 are lower than emissions in 1989 with 5.56 Gg CO_2 equivalent, due to the lower agricultural yields. The lowest emissions are found in years 2000 and 2007 (Figure 6.9).

Figure 6.9 Cumulative emissions trend - Field Burning of Agricultural Residues

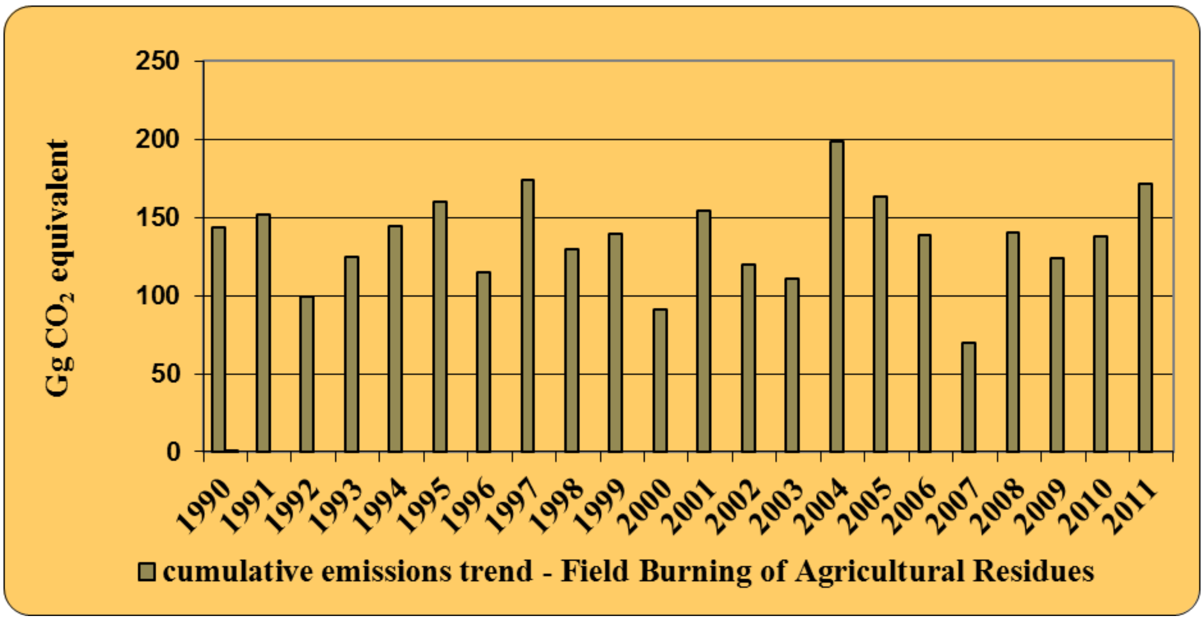


Table 6.25 Observations on source category 4F – "Field Burning of Agricultural Residues"

Source indicative	Source (livestock) type	Observation	Data source
4.F	Crop productions	Includes data on 12 types of crops productions: rye, wheat, barley and two-row barley, maize grains, sorghum, other cereals, sunflower, tobacco, other industrial crops-sorghum for brooms, potatoes, dry beans, soybeans.	AD: SY, other correspondence NIS, 1989-2011;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*" EF: IPCC GPG 2000, IPCC 1996

6.7.2 Methodological issues

Methodology

Due to the fact that CH_4 and N_2O emissions from field burning of agricultural residues are not key categories, neither from level nor from trend views, a Tier 1 method has been applied. For calculation of methane, carbon monoxide, nitrous oxide and nitrogen oxides emissions, the equation on page 4.82 of IPCC 1996 - Reference Manual was used.

Equation 6.24 Total carbon released

Total carbon released (tonnes of carbon) *= ∑ all crop types annual production (tonnes of biomass per year) • the ratio of residue to crop product (fraction) • the average dry matter fraction of residue (tonnes of dry matter / tonnes of biomass) • the fraction actually burned in the field • the fraction oxidised • the carbon fraction (tonnes of carbon / tonnes of dry matter)*

Emission factors

According to the provisions in IPCC GPG 2000, the calculation methodology took into account IPCC 1996 default emissions ratios (Table 4-16 of Reference Manual). Emission ratios are presented in Table 6.26.

Table 6.26 Default emission ratios for agricultural residue burning of residues calculations

Gas	Default IPCC 1996 emission ratios
Methane	0.005
Carbon monoxide	0.06
Nitrous oxide	0.007
Nitrogen oxides	0.121

Activity data

Crop Production

Crop production data are presented in Chapter 6.5.2.

Other parameters

Default IPCC 1996 values of Residue to crop ratios, Dry matter fraction of residue, Fraction burned in fields, Fraction oxidized, Carbon fraction of residue and Nitrogen - carbon ratios (partially described in Table 4-17 of Reference Manual) are presented in Table 6.27.

Table 6.27 Specific parameters used for calculation of Total carbon released

Type of crop production	Parameters used for calculation of Total C released					
	Residue to crop ratios [fraction]	Dry matter fraction of residue [to. dry matter/to. Biomass]	Fraction burned in fields [fraction]	Fraction oxidized [fraction]	Carbon fraction of residue [to.C/to. dry matter]	Nitrogen-carbon ratio [fraction]
Rye	1.6	0.9	0.1	0.9	0.4853	0.012
Wheat	1.3	0.85	0.1	0.9	0.4853	0.012
Barley and two-row barley	1.2	0.85	0.1	0.9	0.4567	0.015
Maize grains	1	0.78	0.1	0.9	0.4709	0.015
Sorghum	1.4	0.91	0.1	0.9	0.45	0.015
Other grains	1	0.85	0.1	0.9	0.45	0.015
Sunflower	1	0.85	0.1	0.9	0.45	0.015
Tobacco	1	0.85	0.1	0.9	0.45	0.02
Other industrial crop- sorghum for brooms	1.4	0.91	0.1	0.9	0.45	0.02
Potatoes	0.33	0.85	0.1	0.9	0.4226	0.015
Dry bean	2.1	0.85	0.1	0.9	0.45	0.015
Soybeans	2.1	0.87	0.1	0.9	0.45	0.05

6.7.3 Uncertainties and time-series consistency

CH_4 emissions

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

- AD: 20 %;
- EF: 50%;
- 54% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

N_2O emissions

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

- AD: 20 %;
- EF: 50%;
- 54% associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

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

Due to the fact that most of activity data are provided by NIS and the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“ were obtained using the same method, is ensuring the consistency of data series considering the national circumstances (detailed information is provided in Section 6.5.2), default emission factors were used using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2011 is consistent.

6.7.4 Source-specific QA/QC and verification

All quality control activities described in the QA/QC Programme were performed. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the *Enteric Fermentation, Manure management* categories, the results of these being mentioned on the Checklists level.

In 2012 year, the GHG emissions estimates have been subject to a thorough review within the European Union, in the context of implementing the Decision no. 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. No unconformity has been noted following the UNFCCC review of the NGHGI.

The activity data series were also compared to those on FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.4.

6.7.5 Source-specific recalculations, including changes made in response to the review process

There was not any recalculation done since last submission.

6.7.6 Source-specific planned improvements, including those in response to the review process

Aiming to their incorporation into next inventory submissions, the development of national values for activity data in totality, for to significant species, is envisaged.

7 LULUCF (CRF Sector 5)

7.1 Overview of sector

Agricultural lands, including arable, orchards, vineyards, pastures and hayfields makes up 61.2% of Romania's total national area. Forests cover 28.5% while constructed areas and road/railways, cover some 4.7%, humid areas, water and lakes some 3.5% and other land 2.1%. The official statistics provide annual data on land use categories for entire country territory since 1989. All of Romania's territory is included in the national GHG inventory.

Estimating emissions and removals of greenhouse gas (GHG) from the land use, land use change and forestry (LULUCF) follows the Guidelines 1996 methodology presented in Good Practice Guidance (GPG) for LULUCF, IPCC, 2003.

The net GHG emissions for LULUCF in Romania are presented in Table 7.1.

Table 7.1 Net GHGs emissions for the LULUCF Sector in 1989, 2010 and 2011

IPCC Subcategories	Emission ("+") / removal ("-"), in GgCO_2eq		
	(BY) 1989	**2010**	**2011**
5A1. Forest land remaining Forest Land	-18863	-22263	-20384
5A2. Land converted to Forest Land	-122	-2498	-3061
5B1. Cropland remaining Cropland	-5784	-2336	-3223
5B2. Land converted to Cropland	-17	18	20
5C1. Grassland remaining Grassland	NO	NO	NO
5C2. Land converted to Grassland	-654	130	118
5D1. Wetlands remaining Wetlands	NO	NO	NO
5D2. Land converted to Wetlands	-215	-126	-130
5E1. Settlements remaining Settlements	NO	NO	NO
5E2. Land converted to Settlements	4125	419	410
5F1. Other land remaining Other Land	NO	NO	NO

IPCC Subcategories	Emission ("+") / removal ("-"), in $GgCO_2eq$		
	(BY) 1989	2010	2011
5F2. Land converted to Other Land	-30	789	835
Table I. Direct N_2O emissions from N fertilization of Forest Land and Other	IE	IE	IE
Table II. Non-CO_2 emissions from drainage of soils and wetlands	NO	NO	NO
Table III. N_2O emissions from disturbance associated with land-use conversion to cropland	NO	0.01	0.01
Table IV. CO_2 emissions from agricultural lime application	45	26	15
Table V. Biomass Burning	3	6	92

CO_2 removals have increased in forestland while CO_2 emissions from land converted to settlements have decreased compared to base year (1989). The major GHG is CO_2, with non-CO_2 GHG having insignificant contributions (Table 7.2).

Table 7.2 LULUCF emissions for the period 1989-2011 ("-"CO_2 removal, "+" GHG emission, in GgCO_2 eq)

Reported year	Total GHGs	CO_2	CH_4	N_2O	NOx	CO
BY (1989)	-21512.7	-21512.7	<0.00	<0.00	NA,NE	NA,NE
1990	-27355.4	-27355.4	<0.00	<0.00	NA,NE	NA,NE
1991	-27979.4	-27979.5	<0.00	<0.00	NA,NE	NA,NE
1992	-30665.2	-30665.2	<0.00	<0.00	NA,NE	NA,NE
1993	-29942.5	-29942.5	<0.00	<0.00	NA,NE	NA,NE
1994	-28655.1	-28655.2	<0.00	<0.00	NA,NE	NA,NE
1995	-27192.6	-27192.6	<0.00	<0.00	NA,NE	NA,NE
1996	-27188.0	-27188.0	<0.00	<0.00	NA,NE	NA,NE
1997	-28630.7	-28630.8	<0.00	<0.00	NA,NE	NA,NE
1998	-28303.7	-28303.8	<0.00	<0.00	NA,NE	NA,NE
1999	-28676.5	-28676.6	<0.00	<0.00	NA,NE	NA,NE
2000	-29219.8	-29220.4	<0.00	<0.00	NA,NE	NA,NE
2001	-29016.8	-29017.5	<0.00	<0.00	NA,NE	NA,NE
2002	-22368.8	-22369.6	<0.00	<0.00	NA,NE	NA,NE
2003	-16398.3	-16399.5	<0.00	0.01	NA,NE	NA,NE
2004	-22943.4	-22944.8	<0.00	0.01	NA,NE	NA,NE
2005	-28063.6	-28065.1	<0.00	0.01	NA,NE	NA,NE
2006	-27863.8	-27865.8	<0.00	0.01	NA,NE	NA,NE
2007	-25219.8	-25221.9	<0.00	0.01	NA,NE	NA,NE
2008	-24313.0	-24315.0	<0.00	0.01	NA,NE	NA,NE
2009	-28255.7	-28257.9	<0.00	0.01	NA,NE	NA,NE
2010	-25831.9	-25834.1	<0.00	0.01	NA,NE	NA,NE
2011	-25306.0	-25308.4	<0.00	0.01	NA,NE	NA,NE

Emission factors are based on country specific data for forestland, while for the other land categories on mixture of IPCC GPG for LULUCF (2003) default and country specific data is used.

The GHG emissions estimates include all land categories and GHG (Table 7.3).

Table 7.3 Status of estimating emissions / removals by sinks in the LULUCF Sector (for completeness on C pools and GHG sources more information is available with the specific chapters in the NIR)

GHG source and sink categories	CO_2	CH_4	N_2O
5.A Forest Land			
5.A.1. Forest Land remaining Forest Land	**R**	**R**	**R**
NFF			
Living biomass	R		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
VFAFF			
Living biomass	R		
DOM	NE		
SOMmin	NO		
SOMorg	NO		
5.A.2. Land converted to Forest Land	**R**	**NO**	**IE, NO**
5A2.1 Cropland converted to Forest Land			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5.A.2.2 Grassland converted to Forest Land			

GHG source and sink categories	CO_2	CH_4	N_2O
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5.A.2.3 Wetlands converted to Forest Land			
Living biomass	R		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5.A.2.4 Settlements converted to Forest Land			
Living biomass	NO		
DOM	R		
SOMmin	NO		
SOMorg	NO		
5.A.2.4 Other Land converted to Forest Land			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5.B Cropland			
5.B.1 Cropland remaining Cropland	**R**	**NO**	**NO**
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	R		
5.B.2 Land converted to Cropland	**R**	**NO**	**R**
5.B.2.1 Forest Land converted to Cropland			
Living biomass	NO		

GHG source and sink categories	CO_2	CH_4	N_2O
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5.B.2.2 Grassland converted to Cropland			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5.B.2.3 Wetlands converted to Cropland			
Living biomass	R		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.B.2.4 Settlements converted to Cropland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.B.2.5 Other Land converted to Cropland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.C Grassland			
5.C.1 Grassland remaining Grassland	**NO**	**NO**	**NO**
Living biomass	NO		
DOM	NO		
SOMmin	NO		

GHG source and sink categories	CO_2	CH_4	N_2O
SOMorg	NO		
5.C.2 Land converted to Grassland	**R**	**NO**	**NO**
5.C.2.1 Forest Land converted to Grassland			
Living biomass	NO		
DOM	R		
SOMmin	R		
SOMorg	NO		
5.C.2.2 Cropland converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.C.2.3 Wetlands converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5.C.2.4 Settlements converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.C.2.5 Other Land converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.D Wetlands			

GHG source and sink categories	CO_2	CH_4	N_2O
5.D.1. Wetlands remaining Wetlands	**NO**	**NO**	**NO**
Living biomass	NO		
DOM	NO		
SOM	NO		
5.D.2. Land converted to Wetlands	**R**	**NO**	**NO**
5.D.2.1 Forest Land converted to Wetlands			
Living biomass	R		
DOM	R		
SOM	R		
5.D.2.2 Cropland converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	R		
5.D.2.3 Grasslands converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	NO		
5.D.2.4 Settlements converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	NO		
5.D.2.5 Other Land converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	R		
5.E Settlements			
5.E.1 Settlements remaining Settlements	**NO**	**NE**	**NE**
Living biomass	NO		

GHG source and sink categories	CO_2	CH_4	N_2O
DOM	NO		
SOM	NO		
5.E.2 Land converted to Settlements	**R**	**NE**	**NE**
5.E.2.1 Forest Land converted to Settlements			
Living biomass	R		
DOM	R		
SOM	R		
5.E.2.2 Cropland converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5.E.2.3 Grassland converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5.E.2.4 Wetlands converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5.E.2.5 Other Land converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5.F Other Land			
5.F.1 Other Land remaining Other Land			
5.F.2 Land converted to Other Land	**R**	**NE**	**NE**
5.F.2.1 Forest Land converted to Other Land			
Living biomass	R		

GHG source and sink categories	CO_2	CH_4	N_2O
DOM	R		
SOM	R		
5.F.2.2 Cropland converted to Other Land			
Living biomass	NO		
DOM	NO		
SOM	R		
5.F.2.3 Grassland converted to Other Land			
Living biomass	R		
DOM	NO		
SOM	R		
5.F.2.4 Wetlands converted to Other Land			
Living biomass	NO		
DOM	NO		
SOM	R		
5.F.2.5 Settlements converted to Other Land			
Living biomass	NO		
DOM	NO		
SOM	R		
5.G Other	**NA**		
Harvested Wood Products	NA		
5(I) Direct N2O emissions from N fertilization			IE
5(II) Non-CO2 emissions from drainage of soils and Wetlands		NA, NO	NA, NO
5(III) N2O emissions from disturbance associated with land-use conversions to cropland			R
5(IV) CO2 emissions from agricultural lime application	R		
5(V) Biomass burning	R	R	R

* R- reported

Key categories in the national GHG inventory are 5A1 Forest Land remaining Forest Land, 5A2 Land converted to Forest Land, 5B1 Cropland remaining Cropland, 5E2 Land converted to Settlements and 5F2 Land converted to Other Land.

7.1.1 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The IPCC specify six land-use categories for the LULUCF sector: Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land. Each of these categories is further divided into two subcategories:

i. Land remaining in the same category during the inventory year;
ii. Land converted from one category to another.

According to the GPG LULUCF (2003), the main requirement for reporting land-use is "consistency". This requires that land be well defined and correctly allocated to subcategory through time and prevent errors of omission or double accounting. This is important to avoid over- or under-estimation of emissions.

Reporting of land categories in Romania is based on two data sources:

i. National statistics on land-use categories (i.e. forest vegetation area on "national forest fund" and "forest vegetation outside the national forest fund", arable, vineyard, orchards, pasture and hayfields, road and constructed areas, wetlands and waters, other land); and,
ii. Forestry statistics on national forest fund, the afforestation area (forest plantations on non-forest lands) and deforestation.

The National Institute of Statistics (NIS) is responsible for the annual compilation of land data of the national territory. Information is presented as the "net area" for each category of land at the end of the calendar year. The data sums to the country's total area, so that entire national territory is counted in the national GHG inventory. Time series are available since 1989 and are collected using constant definitions. Definitions are set according the Law of Cadastre and Real Estate (Law 7/1996, consistent with previous laws). For non-forest land use categories, the NIS data allows for further disaggregation of the land use categories (e.g. 'agricultural' land is reported both as an aggregate and split in arable lands, vineyards and orchards) Table 7.4.

Table 7.4 National definitions of lands and correspondence with the IPCC land categories

NIS datasets / IPCC land category	**National land definitions**
Forestry land /Forestland	This category includes: forest lands or those that serve the culture, production or administration of forest, lands for afforestation and unproductive lands comprising rocks, steep and stony slopes, ravines, gullies, torrents, if they are included in forestry planning (for better understanding of forest vegetation issue please check the section 5A1 Forestland and descriptions of other land categories, i.e. Grassland).
Agricultural land / Cropland, Grassland	This category includes: arable land, vineyards, orchards, vineyards and orchards, nurseries, hops and mulberry trees, pastures, hayfields, greenhouses, solariums, greenhouses, the land covered with forest vegetation if it is not part of forest fund, wooded pastures, land occupied with agro-zoo-technical constructions and land improvements, fishery facilities, roads and technological storage.
Construction, road and railways land/ Settlements	This category includes all lands, regardless of the category of use, located in urban and rural area, inside a certain boundary according legal provisions. It also includes, special purpose land category used for roads, railways, air and water transport, those representing works of hydraulic engineering, heating systems, electricity and gas transport, mining and oil fields, those needed for the national defense; natural reserves and monuments as well as those for archaeological sites and historical ensembles and others alike.
Land permanently covered by water and humid zones / Wetlands	This category includes minor beds of watercourses, natural lakes and artificial basins at their maximum retention, arms and canals of the Danube Delta, the bottom of the inland maritime waters and territorial and contiguous sea.
Other lands/ Other Land	Lands which are not included under the other categories (i.e. small rocks and stony areas, river levees and deposits)

The data compiling system managed by NIS is implemented according Law 226/2009 (Law on the organization and functioning of official statistics in Romania) which provides the legal framework, institutional responsibilities, reporting procedures and information processing, as well as own system of quality control and quality assurance. County and national level aggregated datasets are publicly available on the NIS site (www.insse.ro). Specific information on each of the classifiers mentioned in the Figure 7.1 above is further explained in the description of 5A1 and KP-LULUCF sections of NIR.

Forest administration structures (forest districts) prepare annual sector statistical reports (SILV), based on annually updated management plans information. Conversions from/to national forest fund are operated at the end of each year in the management plan registry and related maps are updated with each new planning cycle. Forest districts provide data on the total area of forest fund under management at the end of each year. Data is centralized by NIS bodies, first at the county level and then at the national level.

The national statistics report the net area in each land category at the end of the year, but do not report change from one category to another. Additional information is used to show the lands in conversion subcategories at the national level. More detailed information from forestry sectorial statistics are incorporated to allow identification and consistency with land activities under Marrakesh Accords. This data is available from the NIS (afforestation/ reforestation from the SILV 4 – "Forest regeneration works performed in the forestry fund, degraded lands and other lands outside the forest fund") and at the central public authority responsible for forestry (synoptic of definitive "leaving land" from national forest fund which is equivalent to "deforestation"; statistics on forest fires affected areas). For these procedures there is a template officially approved by Ministerial Order which is consistently used for reporting. The Territorial Inspectorates for Forestry and Hunting Regime (ITRSV), which are the regional representative of the central public authority responsible for forestry, annually collect data and accurate information on forest land area and on conversions from/ to forest lands, as follows:

i. "National forest fund" area, which is continuously assessed on annually around 10% from the national forest fund area (i.e. forests status is described based on field assessments), along with the new forest management planning of the forest districts.

However, the forest fund area is updated annually based on all conversions from/ to forest land (additions- as inputs/ subtraction-as exits from the forestry fund) operated into the management plans, including changes from “forest” to “other lands” within the national forest fund. Changes of areas associated to these conversions are measured by ground techniques, whenever they occur.

ii. Land area with “forest vegetation outside the national forest fund” is also reported annually by the ITRSV.

iii. Information on conversions from forest land: highly detailed standard documentation of "permanent “leaving land from national forest fund" (namely deforestation), the exact location of the land (i.e. administrative and geographical location), the surface, the subsequent destination of the land, as well as information on forest stand (e.g. full description of the stand and site characteristics). In the case of land conversion of areas affected by damaging factors (e.g. windfalls, fires) the same procedure is followed.

iv. Information on conversions to the forest land by plantation of non-forest lands: legally approved detailed standard documentation about the exact location of the area (administrative and geographical location), the area of land involved.

v. Ministry and its regional branches of ITRSV also records data on conversions between any land (including “forest vegetation outside the national forest fund” and “wooded land”). This is obligation under the Law 18/1991 when a land is converted from one use to another.

Such information is collected at national scale following officially approved procedures.

Data is archived by the central public authority responsible for forestry in Romania and NIS. Also, a copy of each forest management plan, mentioned under (i), is archived by the Forest Research and Management Institute in Bucharest, since ~ 1950.

The type of land information currently available in Romania allows an Approach 2 for forest land and conversions from/to forest land, seconded by explicit historical observation of all these three types of land. Further on, the national GHG inventory land datasets allows a level corresponding to Tier 2 for forest land and conversions, while a Tier 1 for the other land-use categories, according IPCC GPG LULUCF (2003).

The land-use and land-use change area matrix is built using the above data, ranking them according to their quality (i.e. ability to provide explicit location) and reporting requirement:

1. Annual net area of afforestation and deforestation (“permanent leaving land from the forest fund”), available from the forestry statistics (central public authority responsible for forestry).
2. Annual net area of the land use categories from the national statistics (NIS).
3. Share of land use categories converted to Forest Land. This is based on the results of a desk study on the change to forest land, complemented with expert judgment. This study reviewed the documentation of funding for afforestation projects from 2002 to 2005 (covering about one fifth from the total afforested area since 1990). This review found that afforestation occurred as follows: 80% on arable land (Cropland) and 20% on pastures (Grassland). The exact method is detailed in “Romania Afforestation of Degraded Agricultural Land Project: Baseline Study, Emission Reductions Projections and Monitoring Plans”, de S. Brown et al., May 2002. It was also assumed that this proportion remained constant for the entire afforested area for each year of the time series.
4. Land area permanently leaving the forest fund from the archives of the central public authority responsible for forestry. The most likely destination of lands converted from forest land is for construction areas and roads (e.g. residential, infrastructure). Also, Forest land can convert to "other land" taking into account natural causes (landslides, erosion of rivers banks) that cannot be associated with true deforestation (as non-human induced), but conservatively accounted for as conversion to the category "other land" by the national GHG inventory and “deforestation” under KP LULUCF (this will be reconsidered in the future following `Eighth Meeting of Inventory Lead Reviewers, Bonn Germany 21-22 March 2011). According the forest code interdiction of reducing the national forest fund area, the conversions of forestland to the other land-use categories is not occurring.
5. The area of the most likely conversions among non-forest land categories was considered as following “expert judgments”:
    - The land area in conversion is estimated taking into consideration the maximum area of land possible to remain in the same category from one year to another;
    - In the case of arable lands, the most likely conversion was assumed to occur to pastures/hayfields;
    - In the case of pastures, the most likely conversion was assumed to occur to “forest vegetation outside the forest fund” under the natural expansion of forest vegetation into the abandoned pastures in the mountain and hilly areas, especially after 1991.

- In the Grassland category it was assumed that there were mainly transitions between subcategories within this category (from pastures to hayfields or to forest vegetation outside the forest fund).
- Areas of “forests vegetation outside the forest fund” was considered to move to “national forest fund” (considered under Kyoto directly under FM) following the start of the implementation of management planning of such forest vegetation.
- In the case of construction land (e.g. waste dumps, industrial perimeters) the most likely conversion was assumed to occur to "other land", as far as large areas of industrial dumps were re-classified in the post-communist regime (early ‘90) with the privatization of industrial facilities (in order to not overcharge investors with environmental burdens of the past) or later on converted to settlements with the reactivation of industrial dump with increasing economic activity (i.e. dumps for ash or mining residues).
- The wetlands conversion was made most likely to pastures, “forests vegetation outside the forest fund” and "other land" categories.
- The "other land" category area is relatively constant over time and it is used in the matrix as a buffer for transitions that could not be attributed to other categories of land.

Also, in the very few cases of large differences of land category areas reported by the national statistics on consecutive years, these were considered as reporting errors and not real conversions. This was the case for: i) “forest vegetation outside the forest fund" in 1999-2000 and 2003-2006; ii) pasture in 1999 and iii) other land in 1999-2003. In this case the chosen solution was to correct these values by replacing them with the simple arithmetic mean of the values from two years before and two years after the mentioned periods and allocate or subtract the land area from/to the category where the highest change was noticed (i.e. “forest vegetation outside the forest fund” to pasture or hayfields).

The land area matrix covers land that have been converted to another land use and moved to the relevant land remaining category after 20 years as per the IPCC GPG (2003).

The land area matrix is founded on the concept that the national total area must/does not change.

Therefore the sum of the six categories of land use must equal the national area. Further the area in each category at the end of the year must be equal to the value at the beginning of the year, plus/ minus conversions over the current year.

A summary of the land conversion matrix is presented below and a complete matrix can be found in Annex 8.5.1.

Table 7.5 Land area matrix 1989,1990, 1995, 2000, 2005, 2010, 2011

1989	**Arable**	**Pastures**	**Hayfields**	**Vineyards**	**Orchards**	**VFAFF**	**FF**	**Constr.**	**Roads/ railways**	**Waters/ ponds**	**Other areas**
Arable	**9458**						12				
Pastures		**2996**				0.6	3				
Hayfields			**1401.5**								
Vineyards				**268.1**							
Orchards		14.3			**317.5**						
VFAFF						**431**					
FF							**6237.1**	14			
Constr.	2	84.6						**522.4**			18
Roads/railways		20							**366.9**		
Waters/ponds		3.7								**780**	
Other lands		137.7	46.5	9				90.6	20	130	**454.7**

1990	**Arable**	**Pastures**	**Hayfields**	**Vineyards**	**Orchards**	**VFAFF**	**FF**	**Constr.**	**Roads/ railways**	**Waters/ ponds**	**Other areas**
Arable	**9448.4**	6	2.4	0.3			12.9				
Pastures		**2994.3**				2.1	3.2				
Hayfields			**1401.5**								
Vineyards				**268.1**							
Orchards		14.3	4.1		**313.4**				0.1		
VFAFF						**431**					
FF							**6236.2**	14.3			0.5
Constr.	2	84.6	3.3					**517.4**			19.7
Roads/railways		20							**366.9**		
Waters/ponds		3.7	7.6							**772.4**	
Other lands		139.7	46.5	9				90.6	22	131.2	**449.7**

1995	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	**9335.1**	65.1	21.4	25.8			15	6.8	0.8		
Pastures		**2992.1**				3.1	3.8		0.3		0.4
Hayfields		0.2	**1401.2**							0.1	
Vineyards		11.5		**256.5**							
Orchards		46	7.4	0.7	**277.6**				0.1		
VFAFF		5.7				**424**	0.5			0.8	
FF							**6225.5**	15.5	0.3		9.7
Constr.	2	84.6	3.3					**511.1**	3.3		22.8
Roads/railways		20						1.3	**365.1**		0.6
Waters/ponds		14.8	14.9			7.8				**743.9**	2.3
Other lands		152.5	49.4	9.4		0.5		92.5	26.4	145.1	**412.8**

2000	**Arable**	**Pastures**	**Hayfields**	**Vineyards**	**Orchards**	**VFAFF**	**FF**	**Constr.**	**Roads/ railways**	**Waters/ ponds**	**Other areas**
Arable	**9332.8**	65.1	21.4	25.8			17.3	6.8	0.8		
Pastures	2.1	**2983.9**	0.6			3.1	4.3	4.4	0.3		0.9
Hayfields	4.8	7.9	**1388.7**							0.1	
Vineyards	14.2	13		**235.1**		4.4			1.4		
Orchards	14.5	49.7	7.4	1.7	**254.5**	3.9			0.1		
VFAFF		13	7.5			**408.1**	0.5			2	
FF							**6201**	16.3	0.3		33.4
Constr.	2	84.6	3.3		0.1			**502.8**	4.6		29.7
Roads/railways		20						1.3	**354.3**		11.3
Waters/ponds	9.4	15	20.8			15.4				**715.6**	7.6
Other lands	1.3	162.5	57.6	9.7		2.3		101.3	26.4	151.2	**376.4**

2005	**Arable**	**Pastures**	**Hayfields**	**Vineyards**	**Orchards**	**VFAFF**	**FF**	**Constr.**	**Roads/ railways**	**Waters/ ponds**	**Other areas**
Arable	**9320.1**	66.8	21.4	25.8			28.2	6.8	0.8		
Pastures	17.7	**2959.4**	0.6			4.7	7.1	8.9	0.3		0.9
Hayfields	4.8	8.6	**1380.8**					5		2.3	
Vineyards	19.1	13	3	**186.1**		4.4		11.6	1.8		29.1
Orchards	17.1	49.7	12.4	2.4	**218.1**	3.9		6.6	0.1		21.4
VFAFF		18.6	13.4			**386.8**	8.9			3.4	
FF							**6188.8**	17.2	0.3		44.7
Constr.	2	86.1	3.3		0.1			**487.1**	6		42.4
Roads/railways		20						1.3	**348.9**		16.7
Waters/ponds	31.4	21.4	63.2			15.4		6.3		**619.9**	26.2
Other lands	7.9	162.5	58.6	9.7		10.7		106.3	32.8	216.9	**283.1**

2010	**Arable**	**Pastures**	**Hayfields**	**Vineyards**	**Orchards**	**VFAFF**	**FF**	**Constr.**	**Roads/ railways**	**Waters/ ponds**	**Other areas**
Arable	**9280.7**	60.8	26.5	25.5			20.6	15.5	1	3.1	16.6
Pastures	40.8	**3107.3**	1.2	0.9		2.6	5.2	13.9	1	42.7	47
Hayfields	4.8	8.6	**1406.2**		0.7	0.1		11.9		6.6	26.5
Vineyards	19.1	13	3	**183.9**		4.4		13.7	1.9		38.4
Orchards	17.1	35.4	8.3	2.4	**197.8**	3.9		13.1	0.4	0.7	34.2
VFAFF		21.7	16.7			**261.3**	129.5			3.9	
FF							**6198.4**	3.6	0.3		50
Constr.		1.5			0.1			**592**	6		22.7
Roads/railways								3	**367.3**		18.5
Waters/ponds	33.5	17.7	55.6			15.4		6.3		**687.7**	87.6
Other lands	7.9	22.8	12.1	0.7		116.7		55.3	10.9	90.4	**153.1**

2011	**Arable**	**Pastures**	**Hayfields**	**Vineyards**	**Orchards**	**VFAFF**	**FF**	**Constr.**	**Roads/ railways**	**Waters/ ponds**	**Other areas**
Arable	**9228.23**	42.94	49.14	17.29			19.9	15.46	1.04	3.08	46.41
Pastures	41.08	**3143.73**	2.87	0.92		4.89	5.32	13.86	0.97	42.72	53.47
Hayfields	5.16	8.58	**1408.36**		0.71	0.07		11.92	0.03	6.55	26.48
Vineyards	19.06	12.95	3.02	**190.2**		4.44		13.87	1.86		40.44
Orchards	17.12	33.29	8.31	2.43	**195.31**	3.94		13.68	0.41	0.72	36.05
VFAFF		16.04	16.71			**253.12**	138.07		0.04	3.18	
FF							**6199.66**	3.23	0.32		50.18
Constr.		1.52			0.07			**594.3**	6.04		22.27
Roads/railways								3.01	**369.19**		18.71
Waters/ponds	33.49	8.56	55.56			26.6		6.26		**677.12**	85.81
Other lands	8.07	10.08	9.56	0.5	0.04	145.31	0.02	61.42	8.89	90.37	**117.96**

IPCC land-use category mapping with the categories seen above is as follows:

- 5A – Forestland:
  - 5A1 – NFF: FF ;
  - 5A2 – VFAFF: VFAFF;
- 5B – Cropland: Arable + Vineyards + Orchards;
- 5C – Grassland: Pastures + Hayfields;
- 5D – Wetlands: Waters/ponds;
- 5E – Settlements: Construction + Roads/Railways;
- 5F – Other land: Other lands.

Table 7.6 describes the key categories in the LULUCF Sector, based on level and trend assessment, showing also the change of the annual removal compared to the base year.

Both land sub-categories of Forest Land are key categories for CO_2 in the national GHG inventory, thus higher methodological levels is required.

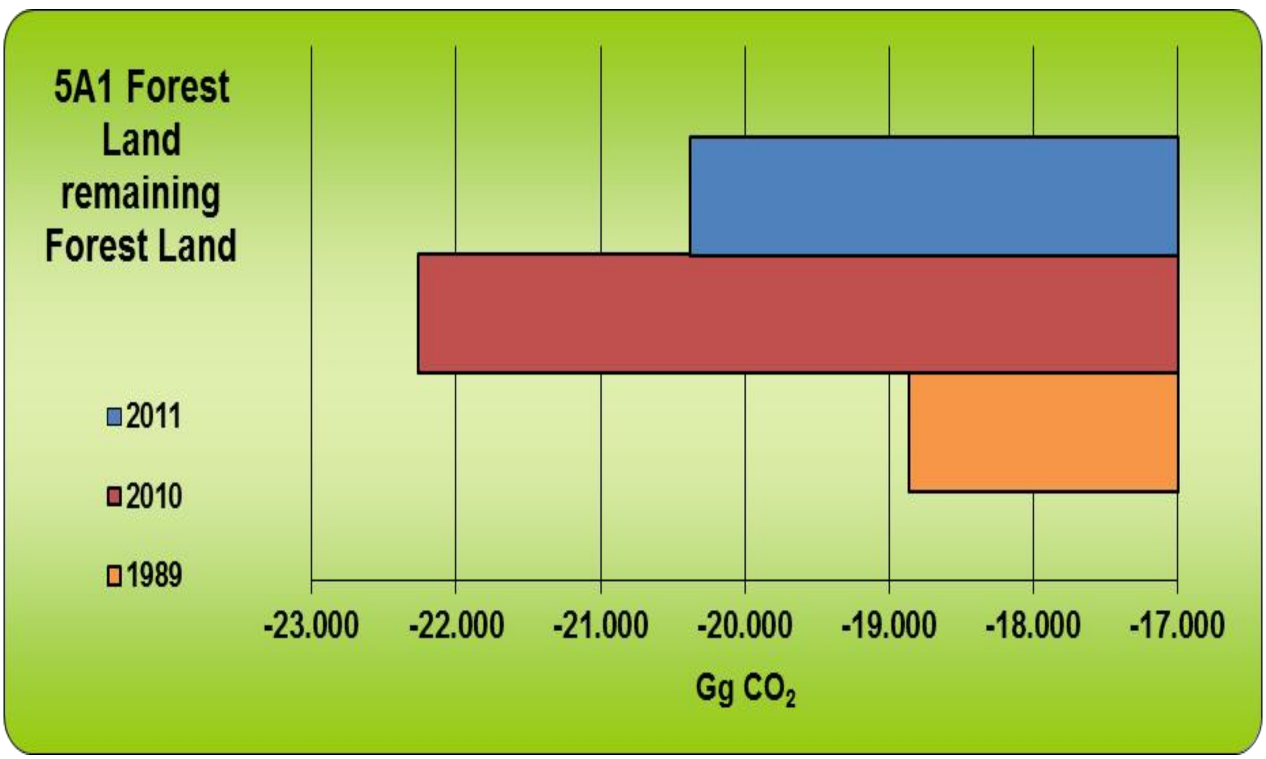
Table 7.6 Key categories overview – LULUCF, 2011

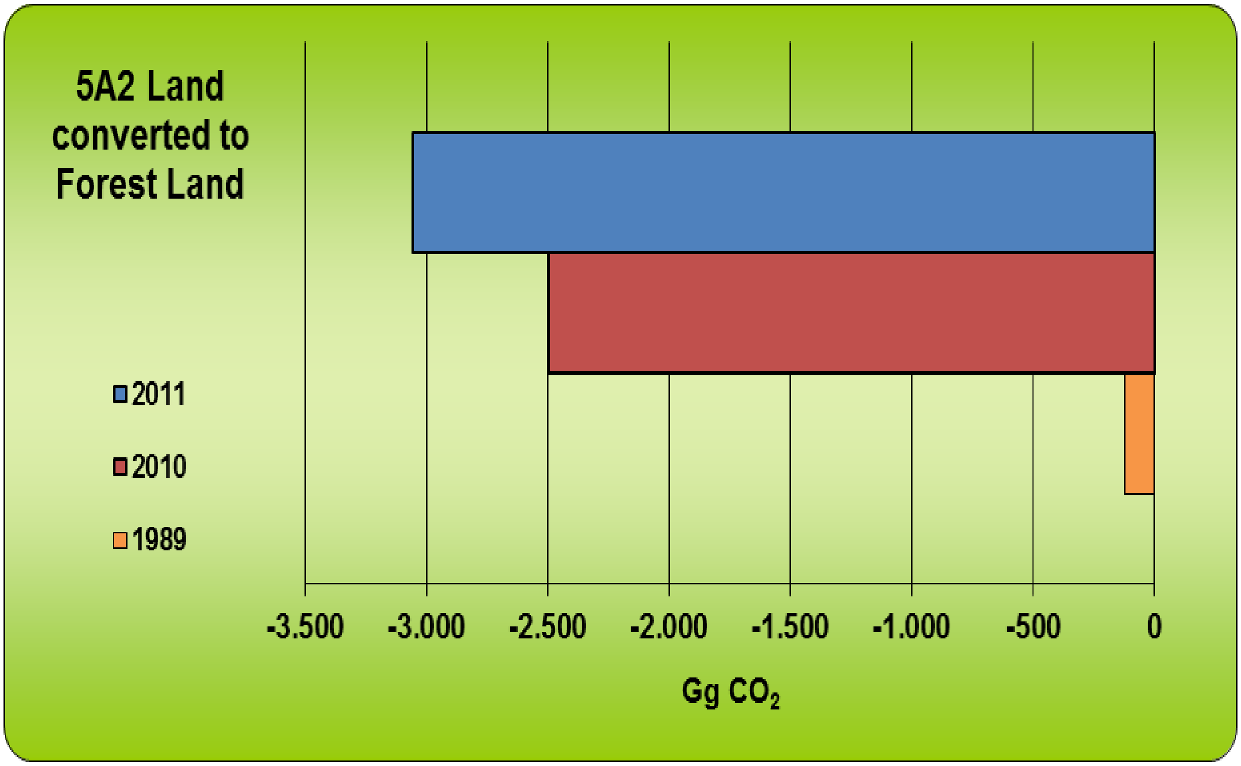
Key categories	GHG	Criteria	Contribution to the national GHG inventory [%]
5A1 Forest Land remaining Forest Land	CO_2	L (Tier 1, including LULUCF; Tier 2, including LULUCF), T (Tier 1, including LULUCF ;Tier 2, including LULUCF)	**13.46**
5A2 Land converted to Forest Land	CO_2	L (Tier 1, including LULUCF; Tier 2, including LULUCF), T (Tier 1, including LULUCF ;Tier 2, including LULUCF)	**2.02**
5B1 Cropland remaining Cropland	CO_2	L (Tier 1, including LULUCF; Tier 2, including LULUCF), T (Tier 1, including LULUCF ;Tier 2, including LULUCF)	**2.08**
5E2 Land converted to Settlements	CO_2	T (Tier 1, including LULUCF ;Tier 2, including LULUCF)	-

Key categories	GHG	Criteria	Contribution to the national GHG inventory [%]
5F2 Land converted to Other Land	CO_2	L (Tier 1, including LULUCF; Tier 2, including LULUCF), T (Tier 1, including LULUCF ;Tier 2, including LULUCF)	**0.55**

Figure 7.2 presents the change of the annual CO_2 removal in 5A1 and 5A2 in the latest years compared to the base year.

Figure 7.1 Major Key categories in LULUCF, both by level and trend





7.2 Forest Land (5.A)

7.2.1 Description

At the end of 2011, forest land area in Romania was about 6300 Kha, which represents about 27% of the country area. The total area of forest land has increased by about 1% since 1990. The deciduous forests comprise 70% of forest area, while the Coniferous comprise 30%. In the deciduous forest, beech is the most common species (32% of the forest land), followed by oak (17%), hardwood species (hornbeam, locust, maple, ash, etc. - 15%) and softwood species (poplar, willow, lime, etc. - 5%).

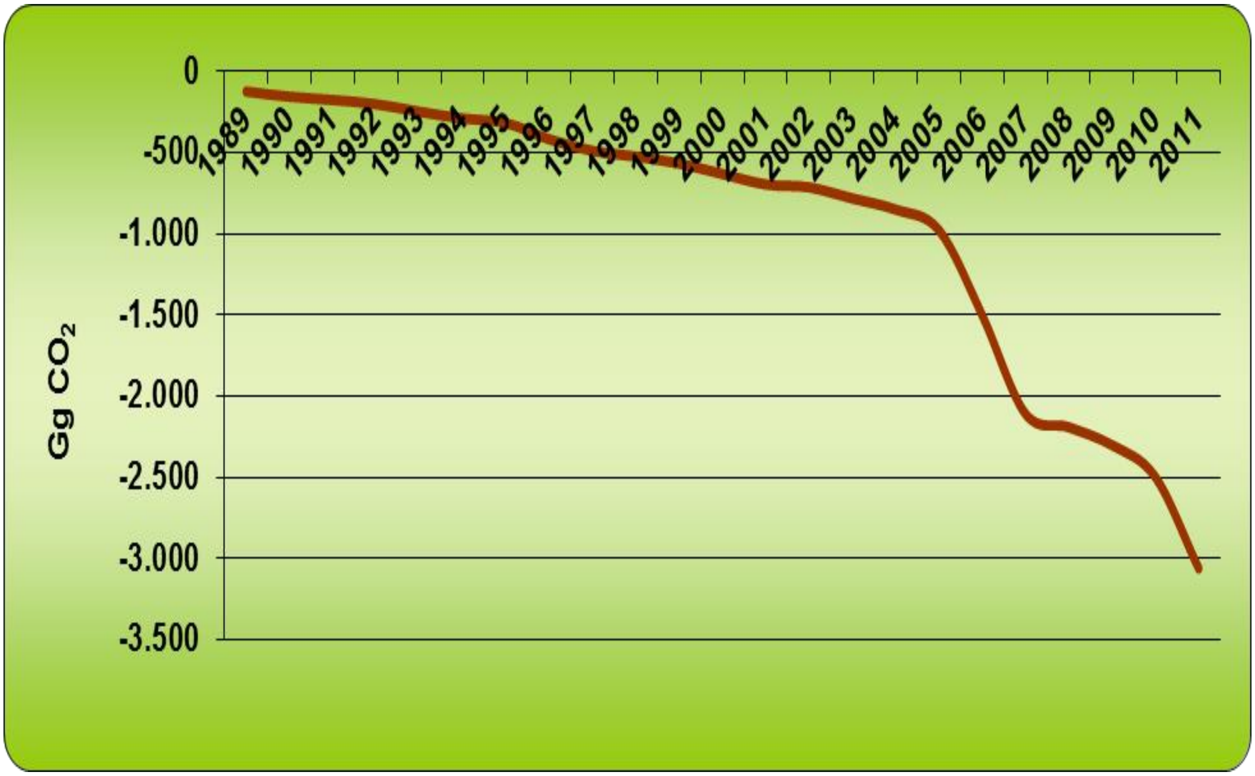
In the Coniferous forest, spruce is the most common species (21% of the forest land), followed by fir (5%) and other species (pine, larch, etc. – 5%). According to the inventory of the forest fund in 1984 the total standing wood volume was 1.341 million m^3, with an average of 218 m^3/ ha. Total annual growth of the forests was 34.6 million m^3 with an annual average increment of 5.6 m^3 / ha / year. Romanian forests grow more than is harvested from them, with a growing / harvesting ratio of about 2.

The stand age class structure reflects an unbalanced distribution of age classes, with a surplus in classes II and III and a deficit in classes I and V. According to the traditional forestry also stated in latest forest code all forest are managed following some basic prescriptions: rotation length ranging from 30 years of soft wood species (e.g. Robinia, poplar) 120-140 years for oak, beech and spruce forests under high forest regime. Coppice area is insignificant in Romania.

Forest fires do not occur frequently and affect only small scattered areas. Litter fires, which affect only the forest floor (litter and deadwood), are the most common, while crown fires rarely occur. Wildfires rarely affect annually more than 1,000 ha of forest land and always in a very high number of locations also spread around the country. Major fall and breakings due to wind or snow occur at least once in a decade, especially in the coniferous species forests, whose effect on the annual sink is estimated via harvest reported by the national statistics.

Figure 7.2 Emissions for 5A1 - Forest Land remaining Forest Land (Gg CO_2)

Figure 7.3 Emissions for 5A2 - Land converted to Forest Land (Gg CO_2)



Under the current data availability there is a change of annual removal estimate only given by the annual harvest variation (i.e. total volume harvested, share on species).

7.2.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

In Romania, the national statistics provides data on two types of land covered by forest vegetation (included into the forest vegetation terminology) (See also Chapter 7.1.1):

i. "National forest fund" (short NFF), which includes forest land subject to forest management planning; of which "lands covered by forest" are considered **managed forest land.** These lands are managed according management plans, which are renewed every 10 (5) years, and subject of approval by the central public authority responsible for forestry and implemented by the forest administrators (namely a state or private forest districts);.

ii. "Forest vegetation outside the national forest fund" (short VFAFF), made up of areas covered with forest vegetation which is not subject to forest management planning, which is further considered **unmanaged forest land**. Although national land statistics classify such areas under Grassland, for GHG inventory reporting purpose such forest vegetation areas are reported under 5A1 Forestland, as far as they meet forest definition criteria (but not "forest management" national criteria). VFAFF historically is not a subject to forestry regime, and for which the development of management plans is not mandatory. Under much less management of grazing land after 1990 with the communist regime drop, such lands became covered by forest vegetation (being especially in hilly and mountainous areas). With restitution of land to pre-communist owners, a very long process taking place practically since 1990 to some 2005 (or later), large areas of land were practically abandoned. This reporting need was also acknowledged by Romania because such land should become part of the national forest fund and subject to forest management, with the application of new forest code in force starting 2008), also that NFI will be able to identify all tree/forest vegetation in the country. Till such lands will have a management plan they are considered "unmanaged forest lands" under the KP.

After 1991, by applying the laws on the rights of property restitution, many lands have been abandoned (pastures, hayfields, orchards, vineyards, croplands).

Since these wooded lands are expected to be become managed forests, the forest code applies protective rules by conditioning wood harvesting and transport of wood on public roads, as well as on land conversions. Under this approach, it also includes in NFF the protective forest belts, junipers area, and wooded pastures with the crown cover over 0.4 (which according to the Forest Law 1996 were included in the VFAFF), but they are still considered as "unmanaged" till management plans are prepared for them.

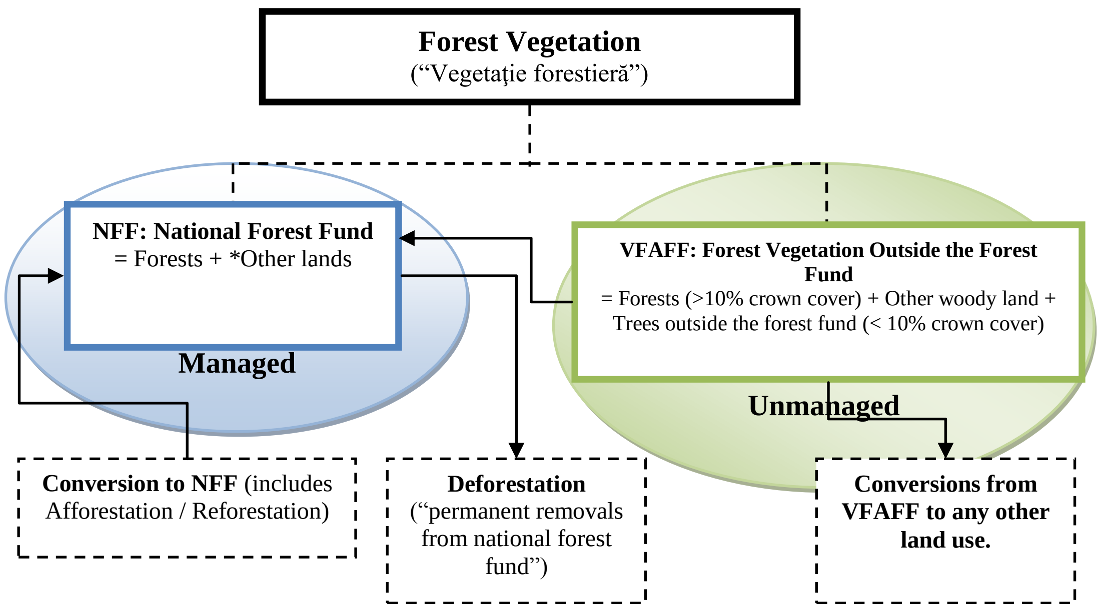
In many cases, on those lands, forest vegetation appeared by spontaneous regeneration. They cannot be mistaken with forest funds areas that are subject to a rigorous regime (e.g., are subject to forest management planning; strict regulations on land entries and leaving from the forest fund; mapped and land-marked boundaries in the field).

Data collected by the national and forest statistics are consistent with these definitions, and further on with the definitions implemented by the new NFI.

Since 2008, Romania began implementing a National Forest Inventory (NFI) based on statistical inventory of the all forest vegetation. NFI uses a forest definition harmonized with FAO's one and is fully consistent with the land categories used for defining the two categories above.

Figure 7.4 shows how the forest vegetation land is split into the NIS/IPCC land categories.

Figure 7.4 Forest vegetation definitions and data on associated land categories



* which are areas from the forest fund which are not covered by forests (e.g. unproductive lands, lands for forestry administration, forest roads, etc.). These areas are excluded from the calculation of GHG removal/emission estimation.

"Forests" are defined as forest vegetation land larger than 0.25 ha and tree height potentially superior to 5m. Although the new forest code in force since 2008 the crown cover criteria is not anymore explicitly defined, a crown cover criteria (>10 %) is implicitly implemented by forest management planning for land classified as "forest" under the national forest fund (otherwise the land is classified as "other lands from national forest fund"). According to the nationally approved technical norms, the stands showing lower density and vegetation status are automatically subject to ecological restoration (in regime of forest regeneration as artificial plantations, including change of the main species). NFI implements a similar threshold for differentiating "forest" for both NFF and VFAFF, on top of additional criteria defining the two forest vegetation land categories.

Also, although "forests" can occur under both "national forest fund" and "forest vegetation outside the national forest fund", the second category is considered unmanaged, under national definition of forest management (see further explanation under Ch. 11 KP LULUCF). Fact is that with latest forest code in force since 2008 all "forests" on" forest vegetation outside the forest fund" lands included in "forested pastures" with crown cover more than 40% are under the requirement to be identified and included in national forest fund and get managed in a short period of time, under a management plan (in which case they become automatically managed forests as parts of national forest fund). Noteworthy, any conversion to national forest fund by natural expansion on non-forest land, in some special circumstances (i.e. on newly formed alluvial deposits), is included by the procedure mentioned under i) above, thus not considered as direct human induced afforestation/reforestation. Changes of status of VFAFF are also subject to strict rules. According to the law, any change of any land use is subject to approval by the relevant authorities and recorded, further reflected in INS datasets. Thus, forest authority (ministry in charge with forests, by regional inspectorate - ITRSV) has to approve an officially required documentation related to any conversion, while it registers the change in its annual operational reports. Documentation is submitted by the land owner and includes cadastral records and information on land use and cover. In any case, VFAFF area increased after 1989 by massive land abandonment. These lands are slowly moving into the national forest fund (e.g. see the increase of NFF after 2005 by some 18kha per year).

Data sets currently available allow the use of different estimation methods for the two subcategories included in forest land: Forest Land remaining Forest Land (CRF 5A1) and Land converted to Forest Land (CRF 5A2).

7.2.3 Methodological issues

7.2.3.1 Forest Land remaining Forest Land (5A1)

CO_2 removals and emissions have been calculated following the default "gain-loss" method. The method involves estimating the C stock change for all C pools on all forest area (the activity data) and various proxy and parameters (used to estimate the emission/removal factors).
Actual and updated data was used for the estimation in the national GHG inventory, as currently available. Generally, a Tier 2 applies in the case of Forest Land remaining Forest Land sub-category, as long as the country specific estimates of activity data and emission/ removal factors are available.

7.2.3.1.1 Change of C stocks in living biomass

Estimation of C stock change uses equation 3.2.2, IPCC GPG LULUCF (2003):

Equation 7.1 Estimation of C stock change

$$\Delta CFF_{LB} = (\Delta CFF_G - \Delta CFF_L)$$

where:

- ΔCFF_{LB} = annual change in carbon stocks in living biomass (includes above- and belowground biomass) in forest land remaining forest land, tonnes C yr^{-1}
- ΔCFF_G = annual increase in carbon stocks due to biomass growth, tonnes C yr^{-1}. These estimates result from the multiplication of the activity data and country specific emission factors.
- ΔCFF_L = annual decrease in carbon stocks due to biomass loss, tonnes C yr^{-1}. These estimates are derived from statistics on removal of biomass (i.e. wood harvest) and other losses (i.e. forest fires).

Activity data

Forestland area under the national GHG inventory is composed from “national forest fund”, respectively NFF area and “forest vegetation outside the national forest fund, respectively VFAFF area.

The national statistics provide time series of national forest fund area for the 1989-2010 period, both for the total Forest Land category and broken down on major species / groups of species (i.e. Coniferous, beech, oaks, deciduous hardwood and softwood). National forest fund area consists of two types of land:

i. "forest” area, which is the area actually covered with forests (softwood, hardwood and mixed), where forest vegetation meet the forest definition thresholds as being subject to forest management. If definition is not met, area is included under following type of land with the occasion of the following planning cycle.
ii. “other lands from the forest fund”, which are areas from the forest fund which are not covered by forests (e.g. unproductive lands, lands for forestry administration, forest roads, etc.). These areas are excluded from the calculation of GHG removal/emission estimation.

In the land-use change matrix, the forest fund (called NFF) comprises only "forest area", described under i) above, because only on these occur CO_2 removal and GHG emission processes.

The other type of lands ("other lands” from the forest fund) is actually conventionally included in the land use change matrix under “forest vegetation outside the forest fund”, because on these areas do not occur CO_2 removal and emission. "Other lands from the forest fund" represents about 30% of the total surface of the VFAFF category, while the rest is represented by tree/forest vegetation on pasture and hayfields.

Further on, as there is no reliable historical data on “forest vegetation outside the national forest fund” and they result as land abandonment and not subject to any kind of management, its share of “forest” is computed based on NFI preliminary result that 71 % of this land category has over 10% crown cover (which explains the difference between VFAFF area in the CRF and “activity data” used for CO_2 removal estimation, mentioned in Table 7.7).

Activity data is provided by the land-use change matrix (the area, see Table 7.5).

The area and the structure of the forest land by species/groups of species are annually obtained from the statistical survey SILV I, where there are presented annually updated data on the structure of the species / groups of species of the forest fund.

Table 7.7 Activity data on area of species/ groups of species used for calculation of the "increase" in carbon stocks due to living biomass growth

Year/ Parameter	Forest land [kha]						
	"Forests" area under		Forest land area structure on species				
	NFF	VFAFF	Coniferous	Beech	Oaks	Various Hardwood	Various Softwood
1989	6237	431	2017	1982	1200	1013	331
1990	6236	431	2019	1984	1198	1011	331
1991	6236	424	2018	1989	1194	1008	330
1992	6236	424	2014	1993	1195	1007	329
1993	6231	424	2003	2002	1191	1007	330
1994	6228	424	2000	1995	1196	1008	330
1995	6226	424	1989	2012	1184	1011	331
1996	6221	424	1975	2022	1182	1011	331
1997	6217	424	1974	2021	1181	1011	331
1998	6207	417	1963	2022	1177	1010	331
1999	6205	409	1948	2026	1175	1014	332
2000	6201	408	1940	2026	1170	1021	334
2001	6202	397	1934	2034	1167	1018	333
2002	6199	394	1929	2037	1163	1019	333
2003	6194	394	1926	2048	1159	1009	333
2004	6191	394	1914	2065	1153	1010	329
2005	6198	387	1929	2079	1144	1004	323
2006	6233	351	1958	2114	1133	984	326

Year/ Parameter	Forest land [kha]						
	"Forests" area under		Forest land area structure on species				
	NFF	VFAFF	Coniferous	Beech	Oaks	Various Hardwood	Various Softwood
2007	6274	310	1979	2120	1132	997	327
2008	6268	303	1991	2116	1115	998	325
2009	6308	279	2022	2140	1105	996	321
2010	6328	261	2018	2124	1123	1002	338
2011	6338	253	1939	2066	1058	957	317

Annual increase in C stocks in living biomass

Annual estimation of C stock increment uses country specific data, meeting the Tier 2 methodological level (with the exception of belowground biomass, where Tier 1 applies). Thus, the average annual increment in biomass (G_{TOTAL}) is calculated with the equation 3.2.5 from GPG LULUCF 2003, as follows:

$$G_{TOTAL} = I_v * D * (1+R)$$

where:

- G_{TOTAL} = average annual biomass increment above and belowground, tonnes d.m. $ha^{-1}yr^{-1}$
- I_V =average annual increment of the growing stock on species/group of species, $m^3ha^{-1}yr^{-1}$;
- R = root-to-shoot ratio appropriate to increments, dimensionless;
- D = basic wood density, tonnes d.m. m^{-3}.

Details of the country specific data used for estimation are as following:

- ❖ **Average annual increment in volume** (I_V) by species and groups of species is obtained from the „Summary of the Forest Fund Inventory of Romanian Socialist Republic" (by ICAS, Ministry of Forests, 1984). This report is based on forest inventory data drawn from the forest management plans for the national forest fund.

Forest management plans are renewed every 10 (5) years and include specific estimates at the forest stands in terms of area, volume, species composition, current growth, etc. Growths values were calculated by summing the corresponding updated forest management plans data in force for the year 1984. Annual growth is the increase in the aboveground stand volume, including trunk and branches, with *bark but not the foliage. C stock in the foliage is assumed to be constant in time and not change from a year to another.* For this reason no biomass expansion factor (BEF) is applied. These data are the only data available at this time and are used in all national and international reporting (e.g. FAO). New estimates of the indicators of the forest vegetation are expected with the finalization of the National Forest Inventory (expected by the end of 2012);

- ❖ **Wood density** (D). Country specific values were obtained are available from "Studies and research for expansion of wood industry raw material base taking into account the structure, the physical-mechanical and technological characteristics of national forest tree species", ICPIL Manuscript, 1985. This data is provided by The National Institute of Wood (2008), which resulted from a national evaluation that took place as part of an assessment of the national forest resources, completed in 1985 (along with the Forest Fund Inventory). These values represent the best estimates for the breakdown used in forestry statistics and applied therefor in the national GHG inventory;
- ❖ **The values of the ratio "root-to-shoot"** (R) are country specific established as country wide average on group of species/major species. Data is derived "Biometrics Trees and Forest Stands from Romania, Dendrometric Tables". These values are lower than those from Table 3A.1.8 of IPCC GPG 2003, previously used;
- ❖ **C fraction** (CF) is assumed to be 0.5 of the dry biomass according to the IPCC GPG LULUCF (2003).

These parameters are consistent with the species and groups of species reported in the annual NIS reports (Table 7.8). The same structure is also used in the 1984 forest fund inventory.

Table 7.8 Parameter values used to estimate annual increment of the stock of C in biomass

Species / groups of species	I_V [m^3/ha/yr]	D [tone d.m./m^3]	R [dimensionless]
Coniferous	6.5	0.4	1.215
Beech	5.5	0.655	1.165
Oaks	4.7	0.645	1.185
Various hardwood	4.7	0.6	1.165
Various softwood	7.4	0.41	1.165

For “forest” associated with “forest vegetation outside the national forest fund” it is assumed an identical species structure on areas as in the national forest fund (Table 7.7) and the annual increment is calculated using same parameters as in Table 7.8 above. This assumption relies on the fact that all VFAFF lands are spread across the country.

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 common practice in Romania. Thus it is not included in the forest statistics and therefore is not quantified in the GHG inventory.

Unlawful cutting of trees is accounted for separately using field check data collected by forest administrators. This data is summarized regionally by ITRSV offices, and then completed as national forestry statistics by the central public authority responsible for forestry. The volume of unauthorized harvested trees is finally estimated based on the official yield tables.

Wood obtained following windfalls is included in the national statistics as a normal harvest, in the year when the wood is harvested (not necessarily in the year of disturbance).

For forest fires CO_2, CH_4, N_2O emissions are calculated using country-specific activity data and default emission factors and are reported in CRF Table 5 (V) "Emissions from biomass burning".

The variation in C stocks due to losses, are calculated using equation 3.2.6-3.2.8 from IPCC LULUCF GPG (2003) and are tailored to specific available data. Currently available data allow the use of Tier 1, thus assuming that the belowground biomass C stock is entirely emitted in the same year. Also, under Tier 1 it is assumed that entire C stock in aboveground biomass is emitted in the event year, thus there is no debris or slash factor applied.

Annual decrease of carbon stock due to biomass loss (ΔL_{FF})

Equation 7.2 Annual decrease of carbon stock due to biomass loss

$$\Delta L_{FF} = L_{fellings} + L_{other\ losses}$$

where:

- $L_{felings}$= annual carbon loss due to wood harvesting [tC/year];
- $L_{other\ losses}$= other annual carbon losses, due to illegal logging [tC/year].

Further on, the annual carbon loss due to timber harvest ($L_{harvest}$) is computed as following:

Equation 7.3 Annual carbon loss due to wood harvesting

$$L_{fellings} = H \times D \times (1+R) \times CF$$

where:

- H = annual volume of wood extracted [m^3/year].

Parameters D, R and CF have the same meaning as in the other equations in section 7.2.3.1.1. As well, for the estimation of the gain or loss, the values of these parameters are identical for same breakdown (i.e. on species/ group of species).

The NIS provides annual data on the volume of wood extracted from forests.

Data is collected and compiled at the same level of disaggregation as any other forest information following same procedure by the NIS. Worthy to notice, the suppliers of data on wood harvesting are forest land administrators (i.e. forest districts).

The statistics include i) the normal harvest, respectively the allowable cut composed by main and secondary products resulting from the implementation of management plans, and ii) any wood volume removed as a result of forest disturbances. The national statistics report entire wood volume extracted from forest, which non-explicitly include both commercial wood (for industrialization) and firewood (Table 7.9), with the specific destination that could be revealed from other statistics. Harvest statistics refer to entire aboveground volume of the stands, over-bark and include all branches (Technical Norms for commercial wood volume assessment, MAPPM 2000). Under intensive forest management in Romania the standing dead wood is also considered as part of the harvest as this is harvested and used as firewood. This way, the forest growth, standing volume and harvested volume are fully consistent within Romanian forestry.

Table 7.9 Activity data for harvested wood volume during 1989-2011 (thousands cubic meters/ year)

Year	**Harvest from national forest fund**					**unauthorized logging volume**	**Estimate of wood volume in "VFAFF"**	**Total**
	Coniferous	**Beech**	**Oaks**	**Various hardwood**	**Various softwood**			
1989	6516	6636	1842	2268	2004	83	1530	20879
1990	5813	4958	2045	2071	1762	121	1530	18300
1991	4956	4644	1919	2090	1769	187	1507	17071
1992	4418	4629	1739	2109	1524	282	1507	16208
1993	4564	4073	1629	1872	1452	158	1507	15256
1994	4285	4037	1651	1741	1228	146	1507	14595
1995	4973	4215	1551	1774	1300	122	1507	15442
1996	5751	4266	1658	1876	1252	129	1507	16439
1997	5836	4263	1489	1757	1164	137	1506	16151

Year	Harvest from national forest fund					unauthorized logging volume	Estimate of wood volume in "VFAFF"	Total
	Coniferous	Beech	Oaks	Various hardwood	Various softwood			
1998	5195	3635	1277	1491	1045	122	1506	14270
1999	5565	4115	1358	1588	1093	130	1454	15302
2000	5346	4508	1333	1731	1366	143	1450	15878
2001	4915	4260	1288	1673	1274	141	1416	14967
2002	7166	4439	1495	1805	1478	102	1405	17890
2003	7139	4748	1532	1823	1450	81	1405	18177
2004	6357	5412	1694	2031	1589	71	1405	18557
2005	6061	4794	1586	1852	1378	86	1405	17162
2006	5765	4997	1632	1915	1375	65	1405	17153
2007	7491	5182	1485	1668	1412	176	1405	18818
2008	6766	5208	1653	1760	1318	174	1381	18259
2009	6635	5489	1403	1845	1148	180	1382	18081
2010	6832	5654	1566	1784	1155	238	1387	18617
2011	7521	6175	1747	1946	1315	266	1387	20358

Other annual carbon losses* (unauthorized *logging)

Equation 7.4 Other annual carbon losses

$$L_{other\ losses} = H_i \times D \times (1+R) \times CF$$

where:

- H_i = volume extracted annually by illegal logging [m^3/year].

Other parameters have the same meaning as the previous equation.

Unauthorized logging statistics refer to entire aboveground volume of the stands/trees.

Losses from "forest" under "forest vegetation outside the national forest fund"

A very conservative annual harvest of 5 mc/year/ha is assumed to occur on such land, despite wood collection or harvesting may not occur at all. Assuming that, the annual harvest we applied Romania's weighted average of wood density (520 kg/m^3, root to shoot ratio (1.18)) and C content.

7.2.3.1.2 Change of C stocks in dead organic matter

It is assumed that the average transfer rates in and from the C pools in dead organic matter, are equal, and that annual net change is zero (Tier 1 according to the IPCC GPG LULUCF (2003)). This assumption is consistent with GPG as far as entire annual change of aboveground and belowground C stock in biomass is accounted as emission in the year of disturbance (i.e. for forestry operations). Currently there is no consistent data on these C pools. Because 5A1 is a key category in the national GHG inventory, a higher methodological level will be addressed in future submissions (see section 7.2.7 on the planned improvements).

7.2.3.1.3 *Change of C stocks in forest soils*

The change of C stocks in mineral soil is assumed to be zero (Tier 1 of the IPCC GPG LULUCF 2003). To improve the reporting of soil, several existing data sets were considered. A first set of test data from projects on forest monitoring ICP Forests (MO4/2005 Report "Evaluation of carbon stored in forest soils at surveillance levels I and II, author A. Surdu). This allowed comparison of data from two successive measurements in the same sample plots (i.e. 16x16 km grid, 240 sample plots in the national forest fund). The soil samples were collected in 1994 and 2004. Estimates show an annual decline in soil C stock of about 0.4 tC $yr^{-1}ha^{-1}$ for all major soil types. Given that both forest management and site conditions have not changed during this period, the differences seem not credible, but as provided in the development plan below further check of data is endeavoured. Rather these differences are likely caused by different methodologies of soil samples collection (e.g. different depths: 30 cm in 1994 and 40 cm in 2004).

For these reasons it was considered that these data sets cannot be used in reporting until it is confirmed from other or improved data sources. Since 5A1 is a key category, a higher methodological level will be applied in future reports (see section 7.2.7).

The area of organic soil in forest land in Romania is 95.3 kha and is not considered in the GHG inventory, since such areas are scattered in mountainous areas and in most cases are included under protected areas under national forest fund, based on communication from the National Forest Administration Romsilva which administrates all national parks and natural reserves containing forest vegetation in Romania (including NATURA2000 network).

Activity data is available from the forest management plans, thus the emissions are reported as NO.

7.2.3.2 Land converted to Forest Land (5A2)

Activity data

Conversion of land to forest land occurs primarily through the planting of forest trees on land ‘taken in the national forest fund’, namely i) artificial afforestation (which is later considered as afforestation/reforestation activity (A/R) under the Kyoto Protocol) and ii) natural expansion of forest. Under specific circumstances the natural expansion of forest vegetation is considered a conversion to national forest fund, if such areas are included in the forest management plans (e.g. new forest vegetation on alluvial deposits), otherwise not. These areas are further considered under forest management activity (FM) under the Kyoto Protocol (which explains why FM area is higher than NFF area reported under Forestland). Area of natural expansion of forest vegetation which is not included in the “national forest fund” contributes to the increase of area of “forest vegetation outside the national forest fund”.

We should also note the fact that a large area increase in the Other Land converted to Forest Land (5.A.2.5) sub-category, between the following years 2005-2011 is explained by large transfers of VFAFF to NFF, following expansion of forest on non-forest land along Danube where forest vegetation encroaches (i.e. levees along existing islands).

As these are lands in property of the state, they are included under “national forest fund” land as soon as covered by forest and become subject to forest management planning.
The activity data for conversions to forest land is detailed in the land area matrix (see Table 7.5). The total area converted to forest since 1990 is 136.6 kha, of which 29.8 kha are artificial plantations (eligible as A/R activity). These two cases are further down detailed.

Estimation of C stock change in living biomass

Annual change of C stock in living biomass in artificial plantations

The change of C stock in living biomass was determined based on the data and information from two research projects:

1) Reports on the implementation of the monitoring plan of the project "Afforestation of Degraded Agricultural Land Project in Romania" as a flexible mechanism of "Joint Implementation (JI)" under the Kyoto Protocol. The monitoring is carried out by the Forest Research and Management Institute (Romania) according to “Monitoring Plan for Changes in Carbon Stocks in Forest Plantations”, agreed by partners in the project. *Project related documents are available with Forest Research and Management Institute Bucharest.* This plan covers all issues related to sampling, measuring, processing, reporting and archiving data and information. The first verification of carbon stock accumulated in the project was made in 2007 and the second is scheduled for 2012 (to cover 2008-2012).
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 are currently being published in peer-review journals.

The data obtained in the 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 measurements in about 250 sampling plots (out of which 185 are permanent which monitor all C pools, subject to re-measurement in the JI project).

Plots position was established based on a randomized sampling design, which allowed the establishment of geographical coordinates (latitude, longitude) of each sample areas in part.

For the 185 permanent plots, the centres are land marked and flagged according to the requirements of the monitoring plan. Non-permanent plots can be also re-identify based on GPS coordinates measurements of the plot centres.

For plantations younger than 10 years the annual change of C stock in living biomass is calculated as function of plantations age, based on the measurements in sample areas. The older plantations (> 10 years old) are estimated using *CO_2 fix v.2.0* (Masera et al., 2002), which uses the yield table data from "Trees and Forest Stands Biometrics in Romania" (Giurgiu et al. 1972). Since the species composition of the national artificial forest area is not known, the calculations assumed the proportion of the species from the JI project (50% acacia, 30% indigenous poplars and willow, and 20% oaks). Data includes entire tree biomass, including foliage. The data used to calculate the annual amount of C stored in biomass in forest plantations, are presented in Table 7.10. The drops of annual growth are caused by simulation of forest operations (i.e. thinning in year 14 of acacia), which is not necessarily directly visible in the annual sink under different age structure of areas of artificial afforestation. More data collection on early operations (i.e. thinning) is underway. These data will be reviewed and updated by the end of 2013 after the second monitoring in 2012 and validation of results expected for spring 2013 of the JI project and the incorporation of biomass equations involving data collected over 2010-2011.

Table 7.10 Annual amount of C (t/ha) sequestered in biomass in forestry plantations

Plantation age (years)	**Poplar & Willow**	**Acacia**	**Oak**	**Average**
1	0.1	0.1	0.3	0.2
2	0.2	0.4	0.4	0.2
3	0.4	0.5	0.2	0.4
4	0.7	0.7	0.3	0.6
5	0.9	1.8	0.4	1.3

Plantation age (years)	Poplar & Willow	Acacia	Oak	Average
6	1.4	2.3	0.5	1.7
7	1.7	2.5	0.6	1.9
8	1.8	2.8	0.6	2.0
9	2.1	3.1	0.6	2.3
10	2.3	3.1	0.6	2.4
11	2.5	3.2	0.8	2.5
12	2.7	3.3	0.9	2.6
13	2.9	3.3	1.0	2.6
14	2.9	2.6	1.1	2.6
15	2.9	2.9	1.2	2.6
16	2.9	3.1	0.9	2.6
17	2.8	2.6	0.7	2.7
18	2.8	2.9	0.8	2.7
19	2.7	3.1	0.9	2.7
20	2.8	3.2	1.0	2.7
21	2.9	3.3	1.0	2.9
22	3.0	3.3	1.1	3.0
23	3.0	3.3	1.1	3.0
24	3.3	3.3	1.2	3.3
25	3.0	3.2	1.2	3.0

The data collected allows a Tier 2 estimation of C stock change in living biomass.

Annual change of C stock in living biomass in conversions to forestland by natural expansion of forest vegetation on non-forest land

As far as such areas occur by natural expansion and are included in the forest fund they are assumed to be part of the forest fund and included under the normal regeneration process following forest management plans. Structure of areas being under conversion to forestland by natural expansion of forest vegetation is not yet known, it could be available either by check of the management plans database or from NFI (in which case more will be known also on expansions of VFAFF).

Preliminarily, based on well-known dynamics of vegetation encroached on lands which are subject to expansion of forest vegetation (i.e. on wetlands and other lands) we assume an annual growth rate equaling the average growth in afforestation areas for similar stand age (“average” column in Table 7.10).

Annual change of C stocks in the soils and dead organic matter in artificial plantations

At this time there is no information on changes of the C stocks in the forest soils of land converted to forest land (through artificial afforestation). Currently, for the estimation of C stock change in soils in lands converted to forest a Tier 1 is approached based on national level reference C stocks (Table 7.11). National reference values for C stock are computed from "Monitoring soil quality in the Romania" (ICPA, 2006). For Forest Land, the values are provided from Forest management plan archive.

Table 7.11 National reference C stocks in mineral soils on land use categories (tC/ha) and annual C stock change (tC $ha^{-1}yr^{-1}$) in conversions from to, assuming 20 years transition period

Land categories / C stock		**from**					
		FL	**CL**	**GL**	**WL**	**SL**	**OTL**
to	**FL**	**85**	+1.85	+1.75	+1.75	+2.65	+2.2
	CL	-1.85	**48**	-0.1	-0.1	+0.8	+0.35
	GL	-1.75	+0.1	**50**	0	+0.9	+0.45
	WL	-1.75	+0.1	0	**50**	+0.9	+0.45
	SL	-2.65	-0.8	-0.9	-0.9	**32**	-0.45
	OTL	-2.2	-0.35	-0.45	-0.45	+0.45	**41**

Based on Table 7.11 there is a built up of C stock in all types of conversion to Forest Land. Under tier 1 approach several assumptions have been made like: i) because majority of wetlands in Romania occur on mineral soils similar C stock was accepted as for Grassland; ii) C stock in settlements has been computed as 32t/h estimated assuming that top 10 cm of the mineral soils have been removed in a cropland soil; iii) 41tC/ha in soils under other land, computed as weighted average of stony areas (5t C/ha), deposits of interior rivers (10tC) and Danube (60 tC, each with 33 % of the total area of other land.

Definition adopted for reporting emissions from organic soils in the National GHG inventory is in line with nationally available soil data: organic soils under any land use which are classified as histosols and are characterized by more than 50 cm peat layer having over 20 % organic content. Additionally, peat lands occur in Romania on very small areas (under natural reserves) at high altitudes where there are no AR activities.

Regarding the change of C stocks in the dead organic matter on lands under conversion to forests land (young plantations), there is only partial data from the first monitoring of JI project. The net values of annual increase of the C stock are computed as a time average according to the plantation age. Values are species-specific: 0.3 tC $ha^{-1}yr^{-1}$ in plantations of acacia and 0.1 tC $ha^{-1}yr^{-1}$ in plantations of poplar and willow. For oak plantations, the values were negligible (thus assumed “no change”).

These data are applied using the same structure of the planted area on species as for the calculation of changes in biomass. Updated data on soil and dead organic matter will be reported based on the re-measurements in 2012 of soils in the JI project (expected to be validated in spring 2013). Additionally, in order to better estimate the change in litter C pool, an average standing stock of dead biomass is estimated as 7% of total standing biomass (this biomass results by early competition and high natural mortality in young stands). Thus the C stock change in Litter pool is some 0.4 tC/ha/yr, with 60 % change in ground layer and 40 % in dead standing biomass.

7.2.4 Uncertainties and time-series consistency

Preliminary estimates of the uncertainty determined for annual 5A1 sink in 2011 was 33% (ranging between 25% and 50%) for growth of biomass and 35% for loss of biomass (between 26% and 54%). Under current completeness, total average net sink uncertainty in 2011 was 53%, ranging from 34% to 117%. Uncertainty estimation was done with the @Risk application (Palisade Corporation). It was assumed that all input parameters have normal distributions and they are not correlated (as far as data sources are fully independent). Nominal uncertainty of the parameters and proxies used in the GHG inventory range from 6% to 100% according to the specifications of data sources (Table 7.12).

A parallel investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project “Assessing the uncertainty of the Romanian Greenhouse Gas Inventory” which resulted in a relative uncertainty of 51%. Further investigations on the differences are performed.

Table 7.12 Nominal uncertainty input parameters of national GHG inventory for 5A1 - Forest Land remaining Forest Land (95 % confidence interval, defined as ± 2 * StDev / mean, in %)

<table>
<tr><th>Parameter</th><th>Nominal uncertainty and 95% confidence interval (% of average)</th><th>Source</th></tr>
<tr><td>Annual increment in wood volume, Harvested wood volume</td><td>15</td><td rowspan="2">Assumed equal to volume standing stock. Technical standards for the forest management planning (Ministry of Forestry, 1986, 2000)</td></tr>
<tr><td>Activity data for living biomass</td><td>6</td></tr>
<tr><td>Wood density</td><td>20 (16-25)</td><td>Values are-simulated based on average, min and max data, available from Mos (1985)</td></tr>
<tr><td>“Root-to-shoot” ratio</td><td>30 (22 - 39)</td><td>Values are-simulated based on IPCC data (Table 3A.1.8)</td></tr>
<tr><td>Unauthorized logging volume</td><td>100</td><td rowspan="3">Expert judgment (from experts from National Forest Administration Romsilva)</td></tr>
<tr><td>Forest fires emissions – activity data</td><td>30</td></tr>
<tr><td>Forest fires emissions – emission factors</td><td>100</td></tr>
</table>

For 5A2, there is an estimation of uncertainty for the afforestation lands for plantations aged less than 10 years on some 7,000 hectares included under the JI project. The uncertainty of the cumulated C stock was ± 15% (for 95% confidence interval).The area the uncertainty was less than 1%. According to the latest JI estimates, the uncertainty in C stocks in living biomass is around 35 %.

7.2.5 Category-specific QA/QC verification

There are three levels of QA/QC currently implemented within the Sector LULUCF of the national GHG inventory.

The first level of QA/QC is conducted by the data providers. The data providers apply official procedures in order to ensure and control the quality of data provided to the GHG inventory compilers.

Secondly, LULUCF GHG inventory compilers perform basic checks consisting of various procedures currently applied to avoid errors associated with different stages of data processing or calculation. Currently these QA/QC checks are:

- Archiving of hard copies of the original data on the land categories (i.e. statistical reports).
- Methods are established and followed step by step to avoid handling errors, especially by the implementation of complex excel spreadsheets.
- Verification of land use change matrix and land allocation according the predefined criteria according the procedures mentioned in the section 1.1.1.
- Expert consultation for specific issues (i.e. suitability of ICP Forests data on soils; allocation of land under conversions among various categories; land definitions; forest data parameters and testing various proxies).
- Cross-checks of IEFs values (C stock change factors) against values from other EU countries.
- Graphic check of the smoothness of the time series for each land categories and emissions of each individual C pool, check and fix any outlier and provide the explanation in the text for any real outlier.
- The completion of the “List for Quality Control of the Greenhouse Gas National Inventory” in accordance with the provisions on quality assurance and quality control, approved by NEPA President Decision no. 24/2009. A list that verifies entries regarding AD, EF, emissions, uncertainties and other, with 10 main categories, 18 secondary categories, and 106 rows with observations, checks carried out, rechecks and references.

  The list is completed and verified by different employees of Forest Research and Management Institute Bucharest.

- The project contractor on LULUCF sector (current contract duration till November 2011), namely Forest Research and Management Institute Bucharest, implements steps to ensure that the staff involved has gradually increasing understanding of the national GHG inventory requirements. This included short training sessions on the IPCC GPG for LULUCF 2003 guidelines and relevant UNFCCC decisions.

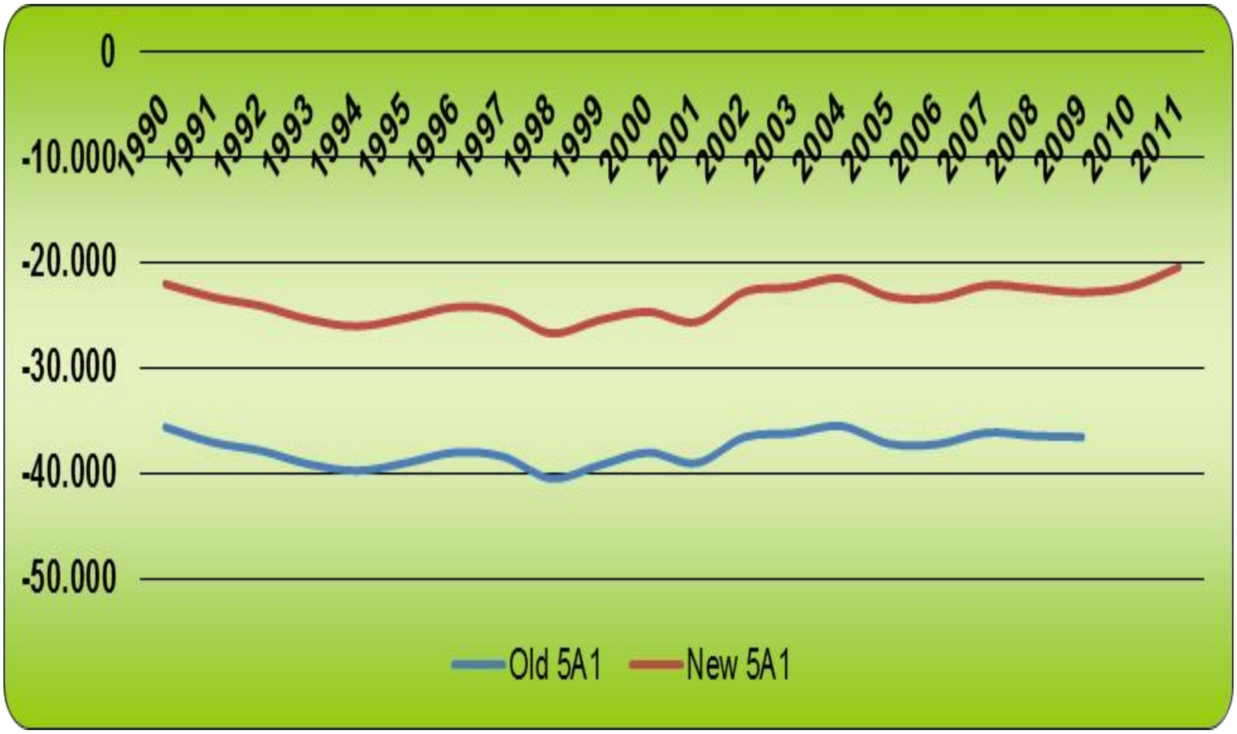
Third level is implemented within National System by the NEPA, which QAQC consists in checks related to both CRF and NIR chapters. So far, there is no verification of the inventory estimate or the various parameters used in the inventory. Nevertheless, some scientific papers were issued recently on the sink in Romanian forests.

7.2.6 Category-specific recalculations, including changes made in response to the review process

With 2013 submission there were only a few recalculations in 5A1 and 5A2, details can be seen in Chapter 10 - Recalculations and improvements.

With previous submission in 2011, LULUCF included a strong recalculation in 5A1 Forest Land remaining Forest Land for entire time series (Figure 7.5).

Figure 7.5 Recalculation of 5A1 - Forest Land remaining Forest Land sink for 2012 compared to the 2010 submission



The reasons for recalculation were:

- ✓ Development of a complete land use change matrix for 1989-2010. This resulted in reporting of all land use sub-categories, with 20 years transition period for lands under various conversions. Land use change matrix is able to provide both conversions among land categories and subcategories, and within the subcategories (among various types of land as provided by national statistics). Forestland remaining forest land (5A1) areas are now max 2% higher compared to previous submission, after more accurate estimation of VFAFF areas and extraction of 5A2 areas (Table 7.13). With current reporting, 5A1 area did not change significantly numerically, but structurally, with area of lands under conversion reported separately (some cumulated 160 kha in 2009), while area of VFAFF meeting forest definition (some 300 kha) added to previously reported area under 5A1.

Table 7.13 Change of area reported under 5A1 Forest Land remaining Forest Land

Year	5A1 (2010 submission)	5A1 (current submission)
1990	6685	6668
1991	6680	6667
1992	6682	6660
1993	6681	6660
1994	6680	6656
1995	6680	6652
1996	6690	6650
1997	6689	6645
1998	6672	6641
1999	6791	6624
2000	6457	6614
2001	6653	6610
2002	6663	6600
2003	6752	6593
2004	6779	6588
2005	6743	6585
2006	6755	6585
2007	6741	6584
2008	6729	6584
2009	6753	6572

- ✓ BEF was excluded from the calculation of annual growth for all forest species, because the Romania's yield table include the volume of the whole standing stock, respectively stem and branches, and the same situation is in the case of annual increment, which refers at stem and branches, too. This correction generated a reduction of the previously computed annual sink by some 25 %. The recalculation has no impact on the trend.
- ✓ The index "fraction of biomass residues" was excluded from the formula for calculating the loss of biomass, as far as annual harvest of wood reported by national statistics includes the entire wood standing volume. The effect of this correction led to additional decrease of the previously computed sink by some 10%. The recalculation has no impact on the trend.
- ✓ Values of root-to-shoot factor (R) were reduced to the IPCC default values. These are considered more realistic based on data from a national research study (Giurgiu, et al, 2004, Forest Mensuration Methods and Tables). The recalculation has no impact on the trend.

The current submission has emissions/removals reported for all soils in the 5.A.2 - Land converted to Forest Land sub-category regarding the entire time-series, as well as updated estimates of CO_2 removal by the JI project according to the most recent estimation (JI is included under AR, with individual estimates of area and emission/removal).

7.2.7 Category-specific planned improvements, including those in response to the review process

Although an improvement has been brought by the 2011 re-submission (in September 2011) (e.g. land use change matrix and correction of parameters used for the estimation of emissions), there is still a major bottleneck in reporting given by the outdated data, as well as use of “NE” or “NO” under Tier 1 for some C pools changes.

- The key planned improvement is the use of the NFI data for reporting ***living biomass*** for the category “Forest Land remaining Forest Land". This is likely to happen in the 2014 submission or as soon as the growth data become available. When available, the time series will be totally or partially recalculated, thus updated data will be used, at least since 2008 on (ar adequately bridged between IFF 84 and NFI 2008). Meanwhile, other parameters currently used can be updated (for example, the volume of standing timber, dead wood, etc.).

The improvement will also allow better estimates for all parameters and proxies related to “forest vegetation outside the national forest fund”, both in terms of structure (composition, age, annual growth, etc), as well as related to the activity data.

- The stock of C from ***dead wood*** (DW) pool in Forest Land remaining Forest Land from NFI data will be available for the years of the commitment period (2008-2012). Historically there is no quantitative data on dead organic matter pool in Romanian forests. For the entire time series the C stock change from dead wood has to be obtained by simulation with a model based on the forest inventory data. First data from IFF 1984 will be employed, as a workaround before NFI data will be available, and validated with NFI data (as far as NFI will only provide dead mass at a point in time and additional work has to be done to generate time changes in this pool). For this, 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 started running 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). Bridging between IFF 84 and NFI 2008 is currently tested. Estimating changes in this C pool, using simulation and new NFI data will provide results by the end of 2013 and expected to be reported in 2014 submission. This will allow a Tier 3 method.
- A simulation based approach is expected to be also used to estimate C stock change in litter (LT) in Forest Land remaining Forest Land and Land converted to Forest Land. Upon the availability of resources, estimating of changes in the litter C pool would follow same schedule and method with the dead wood pool estimation.
- To report change of C stocks of the organic matter in ***mineral soils*** (SOC), an assessment is further expected, mainly focusing on three approaches:
    i. It is planned an exercise of simulation of C stocks and changes with the forest increment data given by the IFF 1984 (as far as data from NFI is not yet available). Simulations would be further validated with the results measured in the NFI and/or management plans database (all/part of C pools: biomass, dead wood, litter).

Further on, once the actual increment data would be available by the NFI, final simulations would be run as to obtain the changes in these C polls. CBM empirical models are preferred for this upon the type of data available (IF84/NFI and harvest statistics) as far as the model operates based on forestry parameters/statistics. Later validation exercise would also involve the actual NFI data of C stocks in available pools (dead wood and organic matter in mineral soils). This work could provide preliminary results by the end of 2013 and reported in the 2014 submission.

ii. Soil database of the forest management plans (FMP) combined with the NFI soil available data, to be used for validation of simulations outputs and also to support application of "not a source" principle for forest management areas. The FMP database contains soil analysis associated to management activity, accumulated since 1960 on. Datasets are expected complete regarding the humus content, site and stand description parameters. 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" in 10 years period, so several time series since 1960 are available. The work assumes retrieval of datasets (data is currently as archived prints) and definition of the statistical processing method. This work could provide preliminary results by the end of 2012.

Work already carried out by exploring ICP Forest datasets 1994 and 2004. Processing of ICP Forest datasets have shown an annual drop of C stock which is considered non credible under national circumstances (~0.5 tC/ha/yr for many type of soils). The problem seems to be related to the methodological differences in 1994 (humus on 30 cm depth determined by Kjeldahl) and 2004 (method involved elemental analyser on 40 cm depth) or incomplete information on the management approaches in the sampling plots (issues are further analysed). Under limited data, it was no possible to credibly harmonize these data, but further analysis on this is expected to be achieved next year. Thus, another option would be to re-sample the C content in the same known plots in 2012, having used a method consistent with the one in 2004.

Improvements envisaged for the next submission are related to the defining the methodology for the estimation of wood removal in “forest vegetation outside the national forest fund” and development of time series of burnt areas for 5A1 and 5A2 (as well as for other land categories 5B, 5C, 5D).

7.3 Cropland (5.B)

7.3.1 Description

Cropland covers about 41% of the total country territory, and has decreased slightly since 1990. Of the total area, about 96% is arable land, 2% is orchards and 2% is land covered with vineyards. In 2011 there were some 9760 Kha of cropland, including 1.35% lands in conversion from other categories. Cropland category also includes the lands subject to revegetation activities eligible for reporting under the Kyoto Protocol. Such areas are reported in sectorial statistics as tree plantations (more information can be found at 11.1.3), but as a separate item then afforestation/reforestation. These areas are not included under the national forest fund, thus not mapped and not having forest management plans.

Their administrators are always (small, large) farmers or local communities (thus managed as part of the agricultural land – mainly arable, or transport infrastructure) and not by forest administrators as it is the case of forestland. These areas were recorded in statistics because of public funding and a long standing policy to improve the tree cover in plain areas of Romania. In practice data is available at disaggregate level, able to be reported under Reporting Method 1.

They occupy a very small area (less than 0.1% of total area of land included under 5.B.1 Cropland remaining Cropland category).

While area of 5B1 was steadily decreasing since the base year, the annual CO_2 removal generally also decreases (Figure 7.6).

Figure 7.6 Emissions for 5B1 - Cropland remaining Cropland (Gg CO_2)

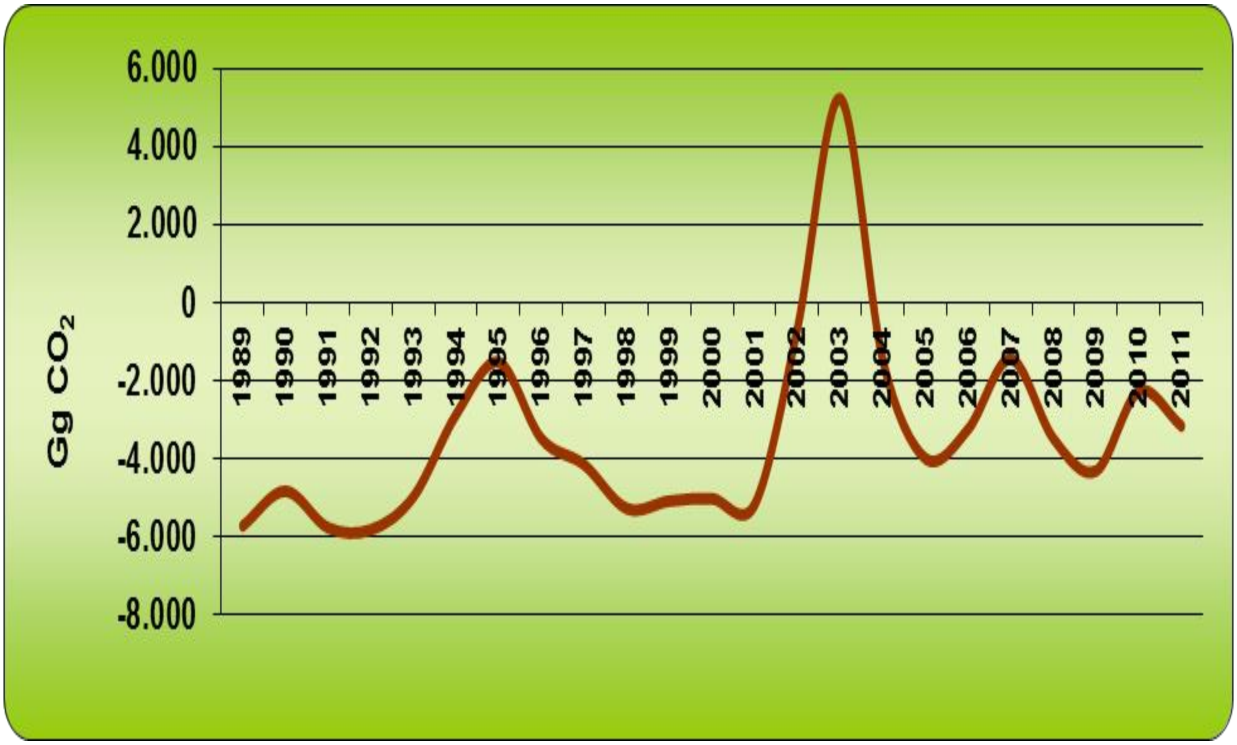
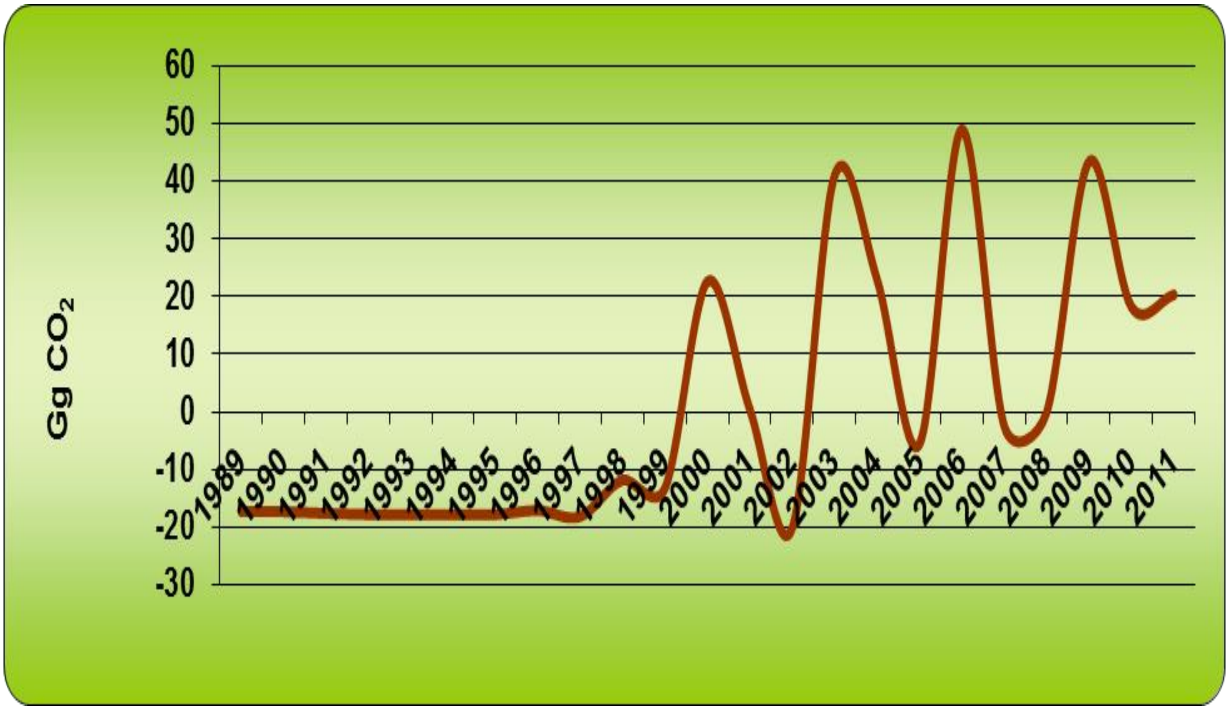


Figure 7.7 Emissions for 5B2 - Land converted to Cropland (Gg CO_2)



Trend in Cropland remaining Cropland is under the influence of two main components: permanent woody crops (orchards, vineyards) and “revegetation”. Revegetated areas “behave” as forest plantations with regard to all pools, and same data and approach is used as for Land converted to Forest Land (5A2) and AR. The IEF living biomass spikes shown actually result from loss of living biomass in permanent woody crops (while annual growth is constant, i.e. the IPCC default), whose areas are decreasing drastically after 1990, with major drops in several years (e.g. 30 kha drop in 1994 and 1995 and 75kha in 2002-2004). The size of spike is also little modified by the contribution of sink in revegetated area, especially how the biomass regrowth in the very young stages matches the years of large removal of orchards.

Annual variability of the sink is generated by the net change of total area occupied by permanent crops (vineyard, orchards) and the rate of the annual conversion to other land uses (i.e. to non-woody crops), under general decrease of its area, which is 24 % less compared to 1990.

Under significant drop of orchards and vineyards area in 2002 (by 5% compared to previous year) and 2003 (by 9 % compared to previous year), cropland category turns in emissions in 2003 (while in 2002 the emissions are compensated by sink in the area revegetated on 5B1 Cropland remaining Cropland).

Cropland remaining Cropland (5B1) is a key category based on level & trend assessment.

7.3.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The definition of this land category and the types of lands included in here are reported in section 7.1.1.

7.3.3 Methodological issues

Activity data (i.e. area) used to calculate GHG emissions for the lands included in this category is provided in land use change matrix, for both 5B1 and 5B2 subcategories. Activity data results from the land use change matrix, where same principles apply regarding the gross areas moving among various land. Estimation of carbon stock changes corresponds to Tier 1 or 2, estimating annual rates of growth and loss for national level data on the major type of crops.

7.3.3.1 Change of C stock in living biomass

Estimation of C stocks changes was made individually on each of the three different types of land included in the Cropland category:

Lands with woody perennial crops (vineyards and orchards):

Woody perennial species occupy about 38% of area of the Cropland. Estimation of the above-ground biomass C stock change, the IPCC default emission factors were used, as following:

annual biomass accumulation rate of 2.1 tC ha^{-1} yr^{-1} and a C stock in biomass loss of 63 tC ha. There is no biomass or growth data available at national level.

For the estimation of *annual* C stock changes on lands with woody perennial crops (vineyards and orchards) the following equation was applied:

Equation 7.5 Annual C stock changes on lands with woody perennial crops

$$C_{stock\ change} = C_{stock\ increase} - C_{stock\ decrease}$$

Equation 7.6 Annual C stock increase

$$C_{stock\ increase} = A_{CLp} * C_{biomass\ stock\ increment}$$

where:

- A_{CLp} – area of permanent cropland in a year [ha], which includes the old woody perennial crops (established in the previous years) and newest perennial crops established in the respective year (assumed in case of increase of area).
- $C_{biomass\ stock\ increment}$ – annual growth of carbon stock in the living biomass [=2.1 tC ha^{-1} $year^{-1}$], as default value (Table 3.3.2 from the IPCC GPG LULUCF 2003).

When there is a decrease of area between successive years that is considered as permanent removal of woody crops as a conversion to other land use, in which case a C stock decrease is calculated in equation 7.5 above, as following:

Equation 7.7 Annual C stock decrease

$$C_{stock\ decrease} = (A_{CLp\ previous\ year} - A_{CLp\ current\ year})) * C_{standing\ C\ stock}$$

where:

- $A_{CLp\ current\ year}$ – area of permanent cropland in the current year [ha];
- $A_{CLp\ previous\ year}$ – area of permanent cropland in the previous year [ha];

- $C_{standing\ C\ stock}$ – default value for standing carbon stock of woody biomass in permanent croplands [=63 tC ha^{-1}], as default value (Table 3.3.2 from the IPCC GPG LULUCF 2003).

There is large fluctuation of annual removal in time (with a maximum of 1200 GgC/yr/ha) and emissions in only two years, with a maximum in 2002 of some 1600 GgC/yr/ha.

Lands which are subject to revegetation

These lands are included in the category 5B1, but not highlighted as a specific land use in the land use change matrix (under scattered and non-identifiable locations) and such lands once covered by trees remain this way and not at all converted to arable lands. Calculation of C stocks changes in all pools is identical with that for artificial afforestation reported in the subcategory 5A2 (see sub-chapter 7.2.3.2), as they differ only by land use category on which they occur. Average C stock change in biomass in such patches is 2.09 tC/ha/yr, which is quite realistic under these trees benefiting the fertilization and irrigation of neighbor agricultural crops. Annul sink on these lands is around 1GgCO_2/year.

Land in conversion to agricultural land

There is no conversion of Forest Land to Cropland. For the conversions of non-forest lands to croplands, C stock changes in biomass are calculated assuming Tier 1 for all C pools. Conversion to Cropland occurs from Grassland, Wetlands, Settlements and Other land (i.e. industrial dumps and ecologization, reclamation of river deposits and islands along Danube). Conversions from settlements are negligible (2kha in 20 years) and other lands (6kha in 20 years), for which reasons they are reported as NO in the CRF Tables. For the other type of conversions, the estimation of C stock change in biomass relies on Tier 1, assuming an initial biomass C stock of 1.6 t dm/ha, respectively 0.8t C/ha, according Table 3.4.2 of IPCC GPG (2003), the default value for the warm temperate dry eco-region. Entire amount of C stock in biomass in grasslands is assumed to be lost in the moment of conversion to cropland (usually the technology implies deep soil preparation and removal of any pre-existing vegetation).

7.3.3.2 Change of C stock in dead organic matter and soil

Carbon stock change in mineral soils on land category 5B1 is currently estimated only for areas under revegetation which cumulates 55k ha over 50 years. The assumption is that under cropland management by tree plantations there is an increase of soil C stock from value specific to arable land to that specific to forest (namely an increase of 1.85 tC/ha/year is assumed for 20 years).
Normally for such tree patches there is a management cycle of ~ 25 years when such plantations are cut and rejuvenated without the change of location and followed by regeneration of same spot (generally ensured by assisted natural regeneration). For this reason starting age of 25 years of plantations since the establishment it is assumed there is no change in the soils (i.e. C stock is constant in time). Same approach is applied for DOM which follows for first 20 years since the establishment the same accumulation pattern as forest plantations, after which it is assumed no change.
For the category 5B2, there are available the average values of C stocks in soils under (Table 7.11), as reference values nationwide on major land use categories. Under conversion of land use, the change in the soil C stocks is considered occurring linearly over a transition period of 20 years. As such conversions do not occur, informatively and for comparison purpose to other national values in Europe or region, for land conversion from Forest Land to Grassland, there is expected an annual decrease in C stock of 1.75 tC $yr^{-1}ha^{-1}$. Also, there is expected an annual decrease of 1.85 tC $yr^{-1}ha^{-1}$ for the conversion from Forestland to Cropland. In conversions from grassland and wetlands, there is a decrease of 0.1 tC $yr^{-1}ha^{-1}$, while increase is expected in conversions from settlements (+0.8 tC) and other lands (+0.35tC).
Details about organic soils can be found in the Agricultural sector at 4.D.1.5 Cultivation of Histosols.
Change of C stock of the dead organic matter is estimated for the areas eligible for re-vegetation activities under the Kyoto Protocol (as 7% of standing C stock, corresponding to mortality rate in young stands).

7.3.4 Uncertainties and time series consistency

An investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project "Assessing the uncertainty of the Romanian Greenhouse Gas Inventory" which resulted in a relative uncertainty of 30%.

7.3.5 Category-specific QA/QC and verification

General QA/QC rules are mentioned in the section 7.2.5 subcategory, under Forest Land (5.A).

7.3.6 Category-specific recalculations, including changes made in response to the review process

With 2013 submission there were only a few recalculations in the Cropland category, details can be seen in Chapter 10 - Recalculations and improvements

Starting with 2011 submission a land use change matrix is available, which led to re-calculation of all activity data and emission factors. GHG emissions/removals are practically estimated for this category for the first time.

There have been recalculations in the current submission of about 2% for 5.B.1 and for 5.B.2 of about -65% for the year 2009 compared to the last submission.

5.B.1 - Cropland remaining Cropland changes were caused by the development of time series for plantations of trees on arable land (relevant as revegetation under KP). Following ERT 2011 revegetation area was extracted from archives and net removal for the base year 1989 was computed in order to compute the accounting amount from this activity.

In 5.B.1 there were recalculations of the activity data for 2009 for Grassland converted to Cropland following the check of land use matrix and revision of value of reference C stocks for soils.

Figure 7.8 Recalculation of 5B1 - Cropland remaining Cropland sink (Gg CO_2)

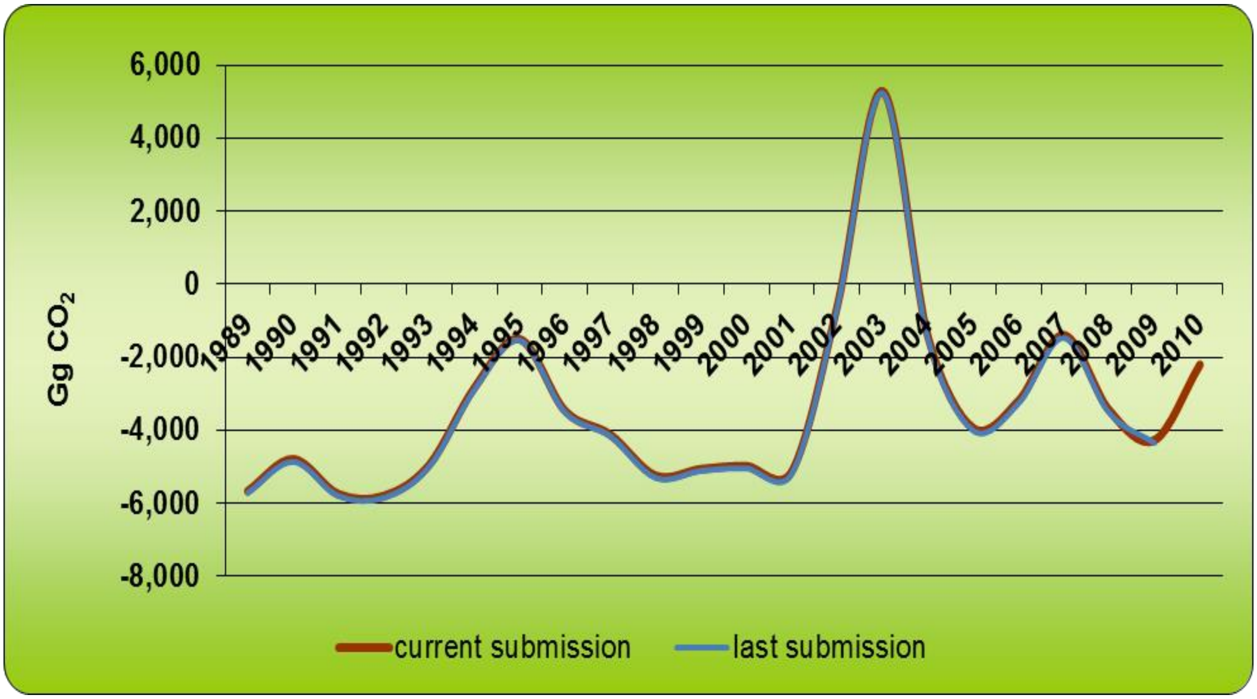
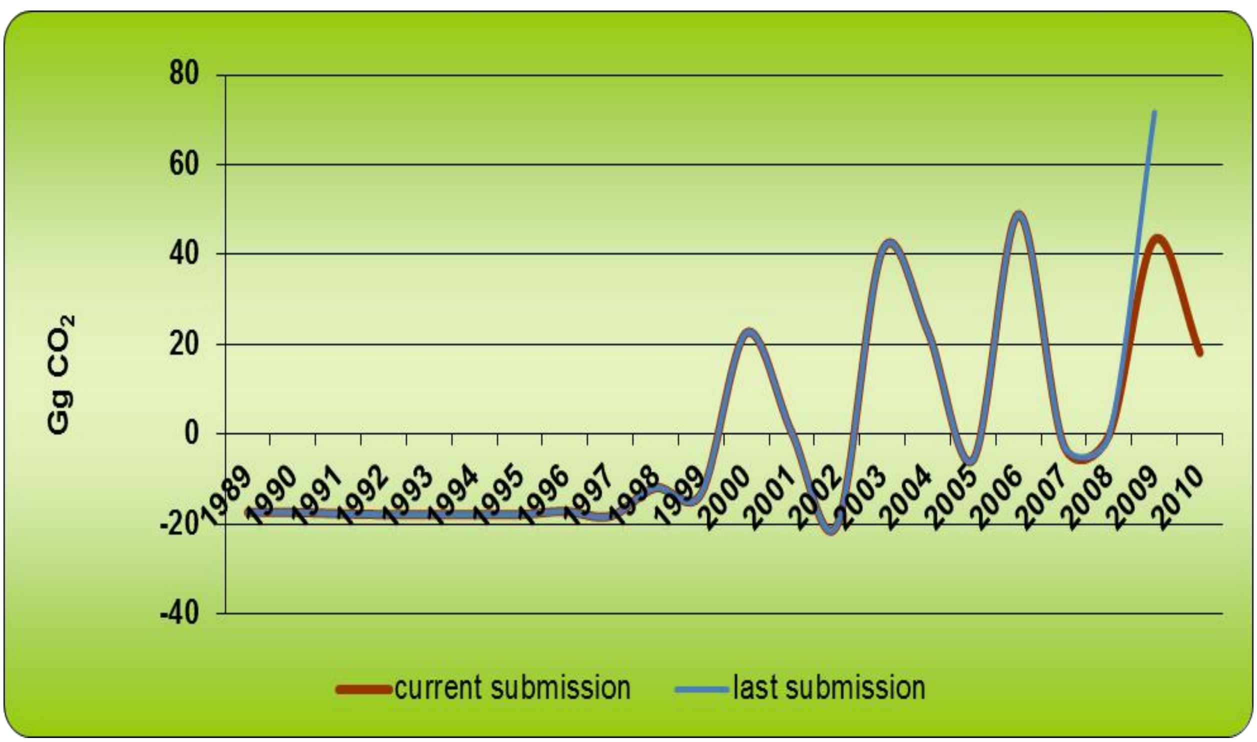


Figure 7.9 Recalculation of 5B2 - Land converted to Cropland sink (Gg CO_2)



7.3.7 Category-specific planned improvements, including those in response to the review process

For land remaining in the same category and lands under conversion to Cropland, existing data and information would allow a combined approach of country specific data (namely the C stock in soils) with default IPCC data (C stock change adjustment factors). Future improvement of estimation of C stock changes in soils organic matter is endeavoured by exploration of the database related to "Monitoring soil quality in Romania" (ICPA, 2006) based on 2000-2002 reference period. Despite currently available aggregated data from this database (used above in Table 7.11), the nationwide reference C stocks on soil types and land categories is considered highly uncertain, derived based on basic input, at this stage, of adequate expertise from agricultural field.

Currently, there is an ongoing procedure by the Ministry of Environment to ensure the funding of a research project related to reporting soils for all land categories and various conversions. The purpose of the project is to reach Tier 2 of IPCC for emission factors, starting from country specific data on soils C stocks and development of C stock adjustment factors starting from IPCC default values and structure on crop rotation, fertilization and technology applied. The works would be based on "Monitoring soil quality in Romania" dataset and other available national data and references.

7.4 Grassland (5.C)

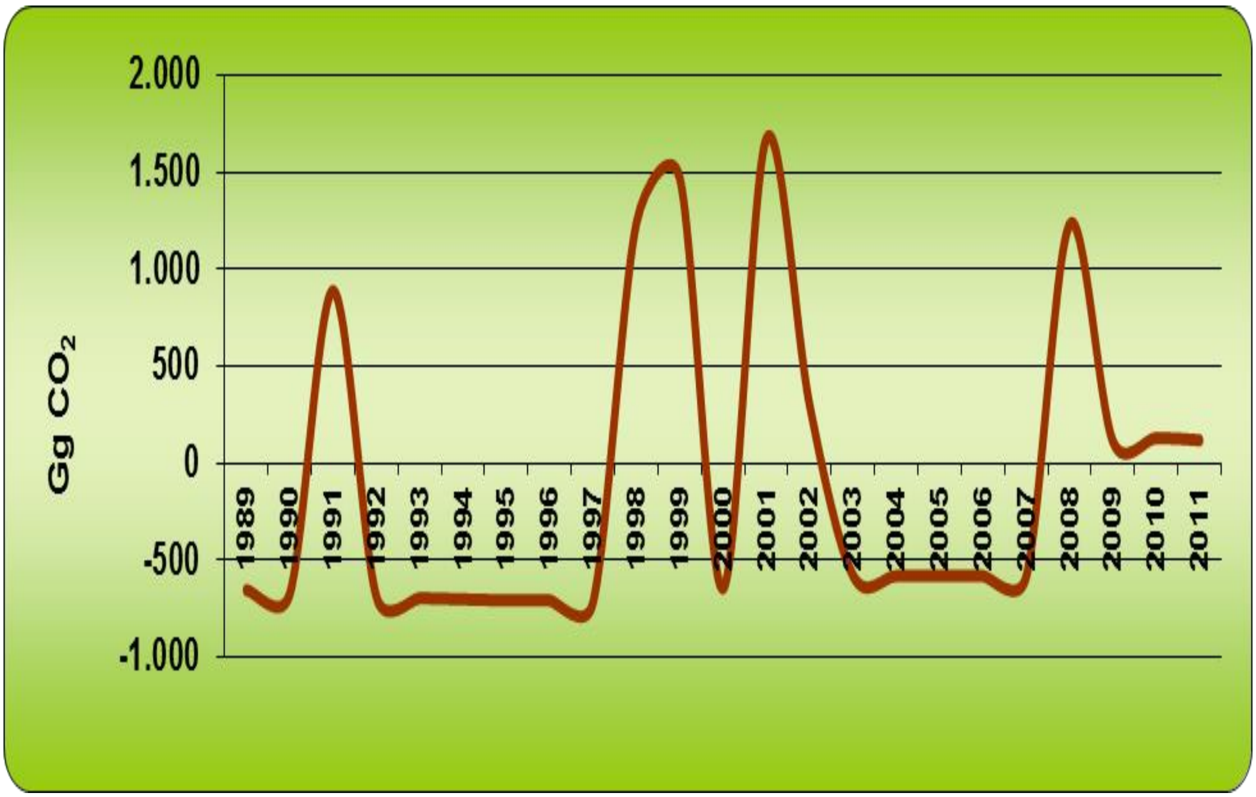
7.4.1 Description

Grassland remaining Grassland area is approximately 4500 kha, about 21% of the total country area. According national land statistics, this category includes pastures (which represents 68 % of total area and it is mainly associated with grazing) and hayfields (31% of grassland area, mainly associated with harvesting hay and forage). The difference of 1% is represented by the lands reported under conversion among them, under versatile and local change of use.

According to the national legislation, "forest vegetation outside the forest fund" is also part of the grassland and not part of the national forest fund, thus being considered as unmanaged land from forestry point of view. Nevertheless, because this forest vegetation land apparently meets the criteria for forest such lands is reported for the national GHG inventory purpose under Forestland (see 5A1).

Lands in conversion to grassland sum up to around 300 kha over 20 years. The main transition is from Other Land and Cropland.

Figure 7.10 Emissions for 5C2 - Land converted to Grassland (Gg CO_2)



7.4.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The definition of this land category and the types of lands included in here are reported in section 7.1.1. From GHG inventory perspective, it is assumed there is no difference between hayfield and pasture.

Land use change matrix reveals conversions from “forest vegetation outside the national forest fund” to “hayfield or pasture” or to “wetlands” which cannot be associated with “deforestation” as far as these are related to reporting practices (as far as VFAFF is not assimilated with forestland but with grassland) and not associated with factual land use change.

7.4.3 Methodological issues

Activity data used to calculate GHG emissions for the land included in the Grassland category is provided by the land use change matrix, both for the 5C1 and 5C2 category. Estimation of carbon stock change in the Grassland category corresponds to Tier 1, with country specific data on reference C stock in soils.

7.4.3.1 Change of C stock in living biomass

Estimate of the change of C stocks vary by type of land included in this land category:

- *Land remaining under the same use.* In the case of grasslands where there are no changes in usage it was considered that there are no changes in the C stocks of any pool (aboveground, belowground);
- *Land in conversion to grassland.* There is no conversion of forest land to grassland. For conversions from other, non-forest lands, the changes in the biomass C stocks are considered negligible, thus reported as NO. Major conversions occur from Other land, Cropland and Settlements (the last one by transfer of land from the industrial perimeters to local communities after 1989).

7.4.3.2 Change of C stock in dead organic matter and soil

For the estimation of C stock changes in soils of “land remaining grasslands” there is an improvement plan available.

For land in conversion to Grassland the reference C stocks from Table 7.11 are used for the calculation of emissions and removals under various conversions to grassland (assuming 20 years transition period).
Organic soils area is reported 101 kha under “remaining grassland” according "Monitoring soil quality in Romania" and because such land are expected to be under natural regime (no inputs like fertilizers) the emissions are reported as NO.

7.4.4 Uncertainties and time-series consistency

A investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project “Assessing the uncertainty of the Romanian Greenhouse Gas Inventory” which resulted in an relative uncertainty of 30%.

7.4.5 Category-specific QA/QC and verification

General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A). Area of organic soils and drained areas was subject of repeated checks and identification of most reliable data sources with the Ministry of Agriculture.

7.4.6 Category-specific recalculations, including changes made in response to the review process

With 2013 submission there were only a few recalculations in the Grassland category, details can be seen in Chapter 10 - Recalculations and improvements.

7.4.7 Category-specific planned improvements, including those in response to the review process

For “5.C.1 - Grassland remaining Grassland” there is an ongoing procedure by the Ministry of Environment to fund a research project related to reporting emissions from soils for all land categories and related conversions.

The purpose of that project is to reach a Tier 2 of IPCC for emission factors, starting from country specific data on soils C stocks (reference values) and adaptation of C stock adjustment factors (starting from IPCC default values) based on other information on pasture and hayfield management and adequate expertise from these sectors.

The works would be based on "Monitoring soil quality in Romania" dataset and other available national data and references. Most likely, the deadline would be the end of 2013 as to include it under 2014 submission.

7.5 Wetlands (5.D)

7.5.1 Description

Wetlands area is about 3.5% of total land area. Absolute area is about 833 Kha, out of which 17% 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). Emissions related to these sources are discussed under Tables 5(II).

Figure 7.11 Emissions for 5D2 - Land converted to Wetlands (Gg CO_2)

7.5.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The definition of this land category and the types of lands included in here are reported under the section 7.1.1.

7.5.3 Methodological issues

7.5.3.1 Changes of C stock change in living biomass

Despite the existence of data concerning areas of land included in the two land subcategories (5D1 and 5D2), C stock changes associated with 5D1 are not estimated in the absence of appropriate methodologies in IPCC GPG 2003 and lacking at national level.

According to the land use change matrix, there were conversions from "Grassland" and "Other Lands", on some 150 kha over the 20 years transition period. A very small area of conversion from “forest vegetation outside the national forest fund” to wetlands occurred on some 4 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 Forestland” are used also here for estimation of related emissions (later described under section “Forest converted to Settlements”).

7.5.3.2 Changes of C stock change in dead organic matter and soils

In case of forest land conversion, the emissions associated with dead organic matter pool is computed by same approach as in 5E2. Soils emissions under various conversions to wetlands are computed based on reference C stocks provided in Table 7.11 (assuming a 20 years transition).

7.5.4 Uncertainties and time-series consistency

A investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project “Assessing the uncertainty of the Romanian Greenhouse Gas Inventory” which resulted in an relative uncertainty of 30%.

7.5.5 Category-specific QA/QC and verification

General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A).

7.5.6 Category-specific recalculations, including changes made in response to the review process

With 2013 submission there were only a few recalculations in the Wetlands category, details can be seen in Chapter 10 - Recalculations and improvements.

7.5.7 Category-specific planned improvements, including those in response to the review process

As previously mentioned for grassland and cropland, the calculation of emissions from conversion to wetlands will hopefully be presented in a future version of the national GHG inventory, based on national data available in the database of the project "Monitoring soil quality in Romania" (ICPA, 2006), considering the IPCC methodologies available.

7.6 Settlements (5.E)

7.6.1 Description

Area of settlements is about 5% of the total land area, respectively 1125 kha. 200 kha conversions to "Settlements" during the last 20 years are about 20% of the total area of this category. From 1990 to 2010 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 “Forestland” (12 kha cumulated over 20 years) and a major one in the case of conversions from “Other land” (some 130 kha under reintroduction of old industrial dumps in the economic cycles).

Land conversion to Settlements is a key category based on trend assessment.

Figure 7.12 Emissions for 5E2 - Land converted to Settlements (Gg CO_2)

7.6.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The definition of this land category and the types of lands included here are reported under the section 7.1.1.

Area of forest leaving national forest fund to settlements is subject to national legislation on construction permission which generally requires the removal of trees and/or soils upper layers in few months since permit is issued.

7.6.3 Methodological issues

7.6.3.1 Changes of C stock in living biomass and dead organic matter and in soils

GHG emissions associated with the 5E1 are not estimated in the absence of an appropriate methodology in IPCC GPG LULUCF 2003.

In the case of conversions from forest land it was considered that the emissions from biomass and dead organic matter occur in the year of conversion.

To estimate LB carbon stock change in Forestland converted to Settlements, we have considered instant oxidation of carbon stock in living biomass pool in the reporting year divided by 20 years cumulated area since 1989, following IPCC. Starting with 2009, in the 21st year, the area from 1989 is moved under 5A1. Bellow it is an excerpt from the spread sheet. This effect is generated by the dominance of very large conversion area in 1989 over very small annual areas cumulated in post-1990. Calculation is shown in the table below.

Table 7.14 Instant oxidation of CSC in LB in Forestland converted to Settlements

Area converted in (Kha)	Cumulated area 1990-on (kha)	Comments on area	LB stock assumed as oxydized in that year (MgC/ha)	Check of CSC LB input (Gg)	IEF (CSC / cumulated area since 1989)
1989	13,95	Area converted in 1989	-933,01	-66,88	-66,88
1990	14,28	Sum of areas converted in 1989 and 1990	-22,09	-66,88	-1,55
1991	14,64	...	-24,01	-66,88	-1,64
1992	14,84	Sum of areas converted in 1989,	-13,52	-66,88	-0,91

Area converted in (Kha)	Cumulated area 1990-on (kha)	Comments on area	LB stock assumed as oxydized in that year (MgC/ha)	Check of CSC LB input (Gg)	IEF (CSC / cumulated area since 1989)
		1990, 1991 and 1992			
1993	15,16	...	-21,27	-66,88	-1,40
1994	15,58	...	-28,07	-66,88	-1,80
1995	15,84	...	-17,46	-66,88	-1,10
1996	16,09	...	-16,69	-66,88	-1,04
1997	16,19	...	-6,74	-66,88	-0,42
1998	16,33	...	-9,19	-66,88	-0,56
1999	16,45	...	-8,01	-66,88	-0,49
2000	16,59	...	-9,50	-66,88	-0,57
2001	16,66	...	-4,40	-66,88	-0,26
2002	16,77	...	-7,71	-66,88	-0,46
2003	16,92	...	-9,71	-66,88	-0,57
2004	17,19	...	-18,04	-66,88	-1,05
2005	17,48	...	-19,86	-66,88	-1,14
2006	17,66	...	-12,04	-66,88	-0,68
2007	17,83	...	-11,30	-66,88	-0,63
2008	17,95	Sum of areas converted in 1990, 1991 … and 2008	-8,09	-66,88	-0,45
2009	4,12	Sum of areas converted in 1990, 1991 … and 2009 minus the area converted in 1989	-7,83	-66,88	-1,90
2010	3,90	...	-7,22	-66,88	-1,85

Area converted in (Kha)	Cumulated area 1990-on (kha)	Comments on area	LB stock assumed as oxydized in that year (MgC/ha)	Check of CSC LB input (Gg)	IEF (CSC / cumulated area since 1989)
2011	3,59	...	-3,42	-66,88	-0,95

C stock change in biomass was estimated based on national average standing stock wood volume per hectare. According to the 1984 Forest Fund Inventory, this value is 218 m^3ha^{-1}. Estimation also considered a weighted average of the wood density of 520 kg/m^3, as nationwide value and the default C fraction in dry matter. 1+R, root-to-shoot value was 1.18, also obtained as a weighted average among all species. No BEF was applied as the reported volume refers to aboveground wood standing stock. Consequently, a country specific value of 66.88 $tCha^{-1}$ of the wood standing stock in living biomass resulted.

Emissions from DOM were also estimated from two different databases: i) lying dead wood C pool was preliminary available from NFI as a national average of 0.63 m^3ha^{-1} and ii) national average litter pool C stock of 7.42 tC/ha from ICP Forest database (author Surdu A., 2006). Dead wood density was considered 400kg/m^3. An average standing dead wood stock is also estimated from NFI, with the national average of 3.13 m^3ha^{-1} or 0.62 tC ha^{-1}, but the standing dead wood is not included in this pool because it is harvested, and it is reported in the regular harvest statistics, under very intensive forest management in Romania.

For conversions of non-forest lands to settlements, the CO_2 emissions from biomass and dead organic matter were considered negligible, with the exception of conversion from grassland where default value of the C stock in biomass was used (Tier 1), assuming an initial biomass C stock of 1.6 t dm/ha, respectively 0.8t C/ha, according Table 3.4.2 of IPCC GPG (2003), the default value for the warm temperate dry eco-region. Entire amount of C stock in the biomass in grasslands is assumed to be lost in the moment of conversion, so for years when such conversions do not occur NO is reported in the CRF. CO_2 emissions from soils under conversion to settlements were computed based on C stock data in Table 7.11 and it associated with emissions no matter of origin land category.

7.6.4 Uncertainties and time-series consistency

A investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project “Assessing the uncertainty of the Romanian Greenhouse Gas Inventory” which resulted in an relative uncertainty of 30%.

7.6.5 Category-specific QA/QC and verification

General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A).

7.6.6 Category-specific recalculations, including changes made in response to the review process

With 2013 submission there were only a few recalculations in the Settlements category, details can be seen in Chapter 10 - Recalculations and improvements.

7.6.7 Category-specific planned improvements, including those in response to the review process

Improvements under this land category are related to the targets assumed for the other land categories and expected under the same schedule (submission of 2013). Reference C stock in the soils under settlements could be reanalyzed as well as the transition period to this category.

7.7 Other land (5.F)

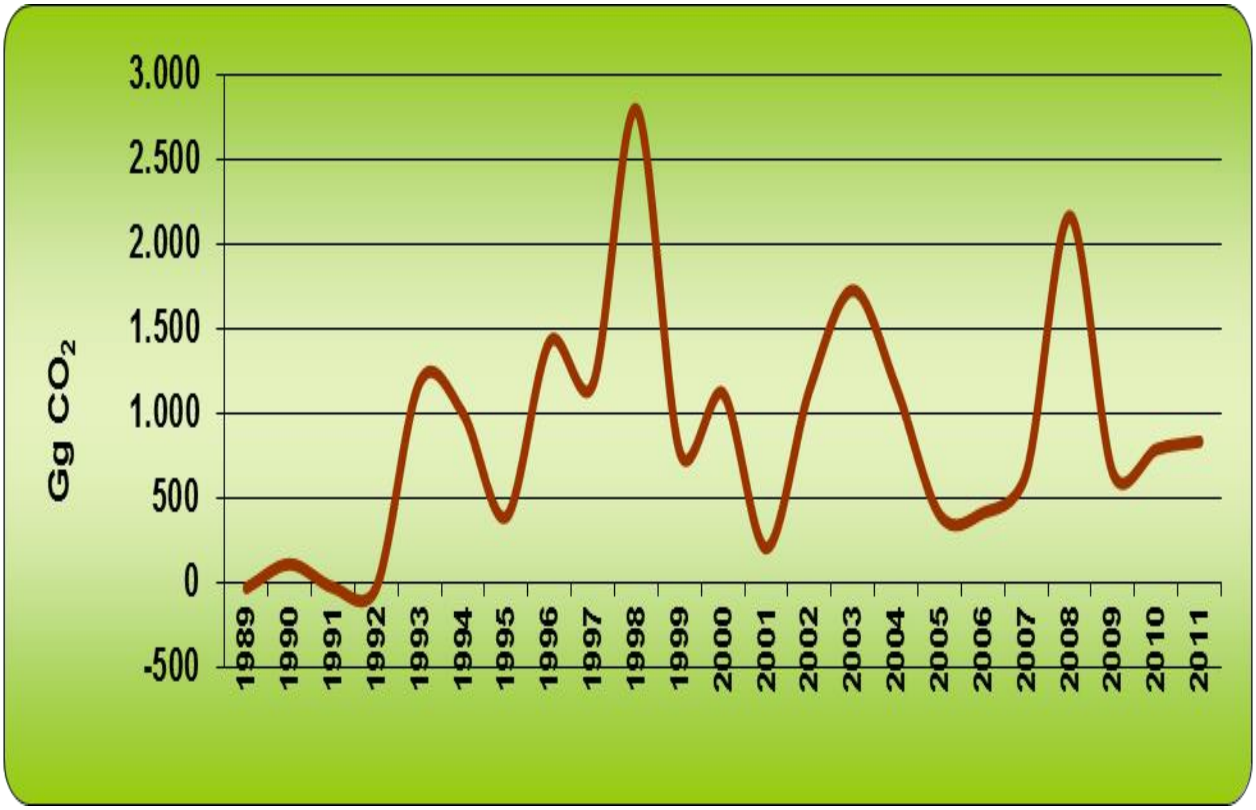
7.7.1 Description

Area occupied by "Other Lands" is about 2% of the total land area, 498 kha respectively. Out of this, 62% are areas under conversion to Other Land. This category was used as a "buffer" in the matrix of land use change (for relocation of areas among categories, so total area of land remaining in the same category and under conversion always equals to the net values reported by the national statistics at the end of each calendar year). It was also assumed that the country area is constant to 23839.1 kha, while sometimes the statistics varied in the narrow range of ±0.01%.

Thus, one of the features is the conversion to "Other Lands" of some 50kha of forest land (for a period of 20 years). This cannot be considered "definitive leave from the forest fund" respectively legal forest “leaving” (associated with "deforestation" under the Kyoto Protocol), as not being resulted from legal proceedings (which are strictly regulated). This is nevertheless considered as “deforestation” under reduced area of “managed forestland”. Explaining the transition of the area concerned to "Other Lands" is, first, by the continuous erosion of the Danube banks on the Romanian side (the forest fund stretches along the Danube on a length of some 1000 km) and inland rivers, as well as some decrease in the forest fund area over planning cycle because of changing the cartographical base used in the determination of the area of forest parcels in subsequent planning.

Land conversion to Other Land is a key category based on trend assessment.

Figure 7.13 Emissions for 5F2 - Land converted to Other land (Gg CO_2)



7.7.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The definition of this land category and the types of lands included in here are reported under section 7.1.1.

7.7.3 Methodological issues

7.7.3.1 Changes of C stock in living biomass and dead organic matter and in soils

For category 5F1, GPG LULUCF IPCC does not recommend a method for calculating GHG emissions.

There were not calculated emissions from C stock change in biomass in conversions of non-forest lands.

In the case of Forest Land conversion to Other Land (5.F.2.1), CO_2 emissions from living biomass removal were estimated according to the national average standing wood volume per hectare, considering that the emission occurs in the year of conversion. The estimations of LB emissions of Forest Land converted to Other Land follows exactly the same pattern used in Forest Land converted to Settlements at 7.6.3.1.

C stock changes in DOM pool were also reported. The parameters used and computation assumptions are reported in the section covering the category 5E2.

Soils C stock changes are estimated based on C stock data in Table 7.11 and it is associated with emissions no matter of origin land category.

7.7.4 Uncertainties and time series consistency

An investigation was done by a consortium consisting of Umweltbundesamt, Vienna, and University of Graz in a twinning project “Assessing the uncertainty of the Romanian Greenhouse Gas Inventory” which resulted in an relative uncertainty of 30%

7.7.5 Category specific QA/Qc and verification

General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A).

7.7.6 Category specific recalculations, including changes made in response to the review process

With 2013 submission there were only a few recalculations in the Other land category, details can be seen in Chapter 10 - Recalculations and improvements.

7.7.7 Category-specific planned improvements, including those in response to the review process

The land use change matrix is subject to continuous verification and improvement, and ways to control and verify the parameters specific to this land category used are extremely poor. Further exploration of national soils databases is necessary in order to improve reporting on soils.

7.8 GHG emission from sources

7.8.1 Direct N_2O emissions from N fertilization of Forest Land and Other (CRF Table 5(I))

Fertilization of forest land is extremely limited (i.e. rarely occurs in forest nurseries) under very extensive forest management practices in the country. In any case, although it may occasionally occur, the statistics on fertilizer amount applied is not breakdown on land uses. Thus related emissions are assumed as reported under Chapter 4 Agriculture of the national GHG inventory. Thus, these emissions are reported as “IE” in CRF Table 5(I).

7.8.2 Non-CO_2 emissions from drainage of soils and wetlands (CRF Table 5(II))

Since 1989 there is not reported any activity of drainage of forest lands in Romania. Thus, such emissions are reported as “NO” in the national GHG inventory.
Peatland area and related activities are insignificant.
Floodings are also considered negligible.

7.8.3 N_2O emissions from disturbance associated with land-use conversion to cropland (CRF Table 5(III))

Land use change from forestland to cropland is not legally allowed, and does not occur in Romania.
Nevertheless, there are such conversions from grassland and wetlands, which summed some 90kha since 1989.

To this adds the drainage of non-forestlands, a total of some 215 kha in 1990 with some 65 % of total area as drainage of organic soils. In 2010 there are no new drained areas, but only areas under 20 years transition period (since drainage occurred).

Drainage leads to soil perturbation which associates with N_2O emissions by humus decomposition. According the land use matrix, from total cumulated area under conversion to arable land, in 2009, 53% were conversions from grasslands, 38 % from wetlands and 10 % from other land (they are all reported under 5B2). N_2O emissions are estimated assuming 20 years transition period. Activity data results from the land use change matrix. The amount of soil C mineralized (100 kgC/yr) is a country specific value, based on Table 7.11. Calculation relies on equation 3.3.14 din IPCC GPG 2003 and it is based on default factors: N released by net mineralization (112.5 kg N $yr^{-1}ha^{-1}$), a default C/N ratio (15) and IPCC N_2O Emission factor (0.0125 kgN_2O/ 1kg N).

7.8.4 CO_2 emissions from agricultural lime application (CRF Table 5(IV))

Lime application does not occur on forest land since the conversion natural forest to other forest on acidic soils does not occur, according to the address of Ministry of Agriculture and Rural Development and Ministry of Environmental and Climate Change.

An average amount of 56000 Mg/yr was applied during the 1989-2011 time series for Grassland remaining Grassland. The CO_2 was calculated using the default EF of 12% for Limestone ($CaCO_3$) and 12,2% for Dolomite ($CaMg(CO_3)_2$).

In 2011, 33550 Mg were reported which resulted in 14.76 Gg of CO_2.

7.8.5 Biomass Burning (CRF Table 5(V))

Controlled biomass burning is not allowed in Romania, while the wildfire frequency is very limited. Nevertheless, occasionally it is practiced unlawfully on arable or grass lands.

For forestland, the area annually affected by wildfires is reported in sectoral forest statistics. Characteristically, the forest fires consist in ground floor dead mass burning (litter and lying dead wood), and in extremely few cases of the stand crown fires (in average 2 % of annually affected area).

As far as the wood is not qualitatively affected, it is harvested and reported in the annual wood harvest statistics (while the land remains forest land). From all these reasons, CO_2, N_2O and CH_4 are all reported in CRF Table 5(V). Annually affected area is reported by National Forest Administration ROMSILVA (Table 7.15), which administrates only part of national forest fund area. For the rest of forest lands there is no activity data available, but it is likely to be small. So far there is only information on the fires affecting forestland, with no reference if these occur in 5A1 or 5A2.

Table 7.15 Forest fires area

Year	Total affected area (ha)
1989	93
1990	444
1991	277
1992	729
1993	518
1994	312
1995	208
1996	227
1997	68
1998	137
1999	379
2000	3607
2001	1020
2002	3590
2003	762
2004	124
2005	212
2006	946

Year	Total affected area (ha)
2007	2925
2008	844
2009	974
2010	206
2011	3057
Average area	942

GHG emissions from forest fires are computed based on Eq. 3.2.19 of the IPCC GPG 2003.

Equation 7.8 GHG emissions from forest fires

$$L_{forest\ fires} = S_{forest\ fires} \ x \ M_f$$

where:

- $L_{forest\ fires}$ = total amount of C annually emitted (tC yr^{-1});
- $S_{forest\ fires}$ = annually affected area (ha yr^{-1});
- $\mathbf{M}_f$ = amount of C in „dead wood lying on the soil surface” [MgC ha^{-1}].

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 (= 3.13 mc/ha of standing dead wood and 0.62 mc/ha lying dead wood). Then, C stock in dead organic matter is 8.18tC/ha. Conversion from dead wood volume to dead mass was done assuming 400 kg/m^3 (same input data as for the estimation of DOM related emissions in land converted to settlements 5E2). Carbon content was 0.5 according to the GPG LULUCF 2003.

It was also assumed that entire available dead wood was burnt in the fires. It was also assumed that there are no understory emissions. They will be taken into account once the simulation of all C pools would be available (see the improvements expected under 5A).

For the calculation of absolute CO_2 and non-CO_2 emissions from forest fires, IPCC default factors are used in the formulas 3.2.19 of IPCC GPG 2003.

Equation 7.9 Calculation of absolute CO_2 and non-CO_2 emissions from forest fires

Emission of CO_2 [$Gg\ yr^{-1}$] = (C emitted) [$tC\ yr^{-1}$] x (44/12)/1000,
Emission of CH_4 [$Gg\ yr^{-1}$] = (C emitted) [$tC\ yr^{-1}$] x (emission ratio) x (16/12)/1000,
Emission of CO [$Gg\ yr^{-1}$] = (C emitted) [$tC\ yr^{-1}$] x (emission ratio) x (28/12)/1000,
Emission of N_2O [$Gg\ yr^{-1}$] = (C emitted) [$tC\ yr^{-1}$] x (N/C ratio) x (emission ratio) x (44/28)/1000,
Emission of NOx [$Gg\ yr^{-1}$] = (C emitted) x [N/C ratio] x (emission ratio) x (46/14)/1000,

where:

- *(C emitted)* = $L_{forest\ fires}$, respectively total amount of C annual emitted (tC/year),
- *N/C ratio* = ratio of nitrogen/carbon in the burnt dead mass,
- *(emission ratio)* = default values of direct and indirect GHG emission factors from forest fires. According Table 3A.1.15 of IPCC GPG 2003 these values are: CH_4 – 0.012; CO – 0.06; N_2O – 0.007 and NOx – 0.121.

Emissions for Biomass Burning in the Cropland category are included under Agriculture Sector - 4.F Field Burning of Agricultural Residues.

7.8.6 Category-specific planned improvements, including those in response to the review process

Effort to improve the data is endeavoured, but linked to the improvements under other land categories (i.e. 5A). Effort to report non CO2 emissions is underway. Despite their small importance at country level accurate numbers are provided in 2012 submission following data provided by the Ministry of Agriculture, also because highlighted by the ERT's reports.

7.8.7 Recalculations of non CO_2 emissions from sources

For 5(IV) CO_2 emissions from agriculture lime application, new data reported by the Ministry of Agriculture shows that the soil amendments were applied on pastures and hayfields. This resulted in moving the amounts of lime from Cropland remaining Cropland to Grassland remaining Grassland. Additionally, in 2008, some amount of lime was disaggregated to dolomite because of improved data.

For 5(V) Biomass Burning in 1989, the area burned in Forest Land remaining Forest Land was erroneous submitted. This led to a change in emissions of about 52% for the respective year.

8 WASTE (CRF Sector 6)

8.1 Overview of the sector

This chapter provides information on the estimation of the greenhouse gas emissions from the Waste Sector.

The following direct GHG emissions and source categories are quantified and reported:

- CH_4 and CO_2 emissions from Solid Waste Disposal on Land;
- CH_4 and N_2O emissions from Wastewater Handling;
- CO_2 emissions from Waste Incineration.

Starting with 2012 submission NMVOC emissions from Solid Waste Disposal on Land ware estimated.

Table 8.1 Status of the direct GHG emissions estimation in the Waste Sector

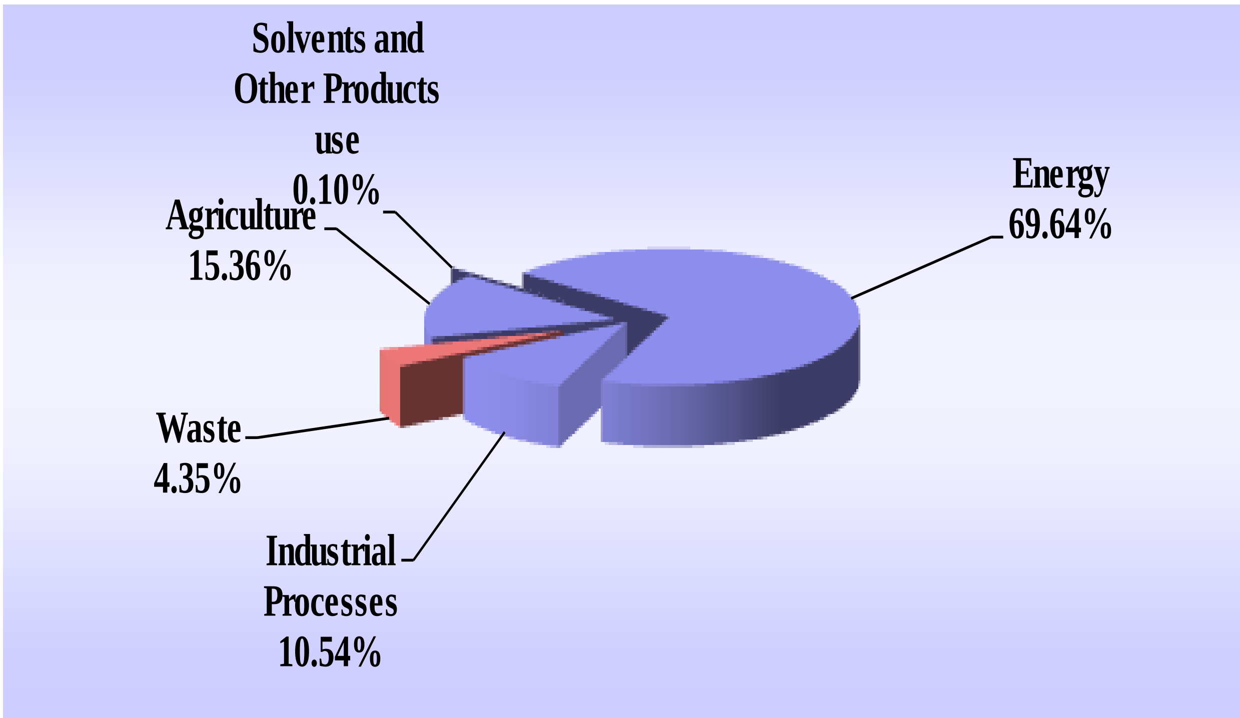
IPCC category	Emissions estimation status		
	CO_2	**CH_4**	**N_2O**
6.A Solid Waste Disposal on Land			
6.A.1 Managed Waste Disposal on Land	✓	✓	NA
6.A.2 Unmanaged Waste Disposal on Land	✓	✓	NA
6.A.2.1 deep (>5m)	✓	✓	NA
6.A.2.2 shallow (<5 m)	✓	✓	NA
6.A.3 Other	NA	NA	NA
6.B Wastewater Handling			
6.B.1 Industrial Wastewater	NA	✓	NE

IPCC category	Emissions estimation status		
	CO_2	CH_4	N_2O
6.B.1.a. wastewater	NA	✓	NE
6.B.1.b. sludge	NA	IE*	NE
6. B.2 Domestic and Commercial Wastewater			
6.B.2.1 Domestic and Commercial Wastewater (w/o human sewage)	NA	✓	NE
6.B.2.1.a wastewater	NA	✓	NE
6.B.2.1.b sludge	NA	✓	NE
6.B.2.2 Human sewage	NA	NA	✓
6.B.3 Other	NA	NA	NA
6.C Waste Incineration			
6.C.1 Biogenic	NE	NE	NE
6.C.2 Non-biogenic	✓	NE	NE
6.C.2.a. Hazardous waste	✓	NE	NE
6.C.2.b. Clinical waste	✓	NE	NE
6.D Other	NA	NA	NA

* CH_4 emissions from industrial sludge are reported under 6.B.1.a – Industrial wastewater.

In 2011 GHG emissions from the Waste Sector accounted for 5,415.21 Gg CO_2 equivalent, which represent 4.39% of the total national GHG emissions in this year (Figure 8.1).

Figure 8.1 The contribution of Waste Sector to the total GHG emissions in Romania, 2011



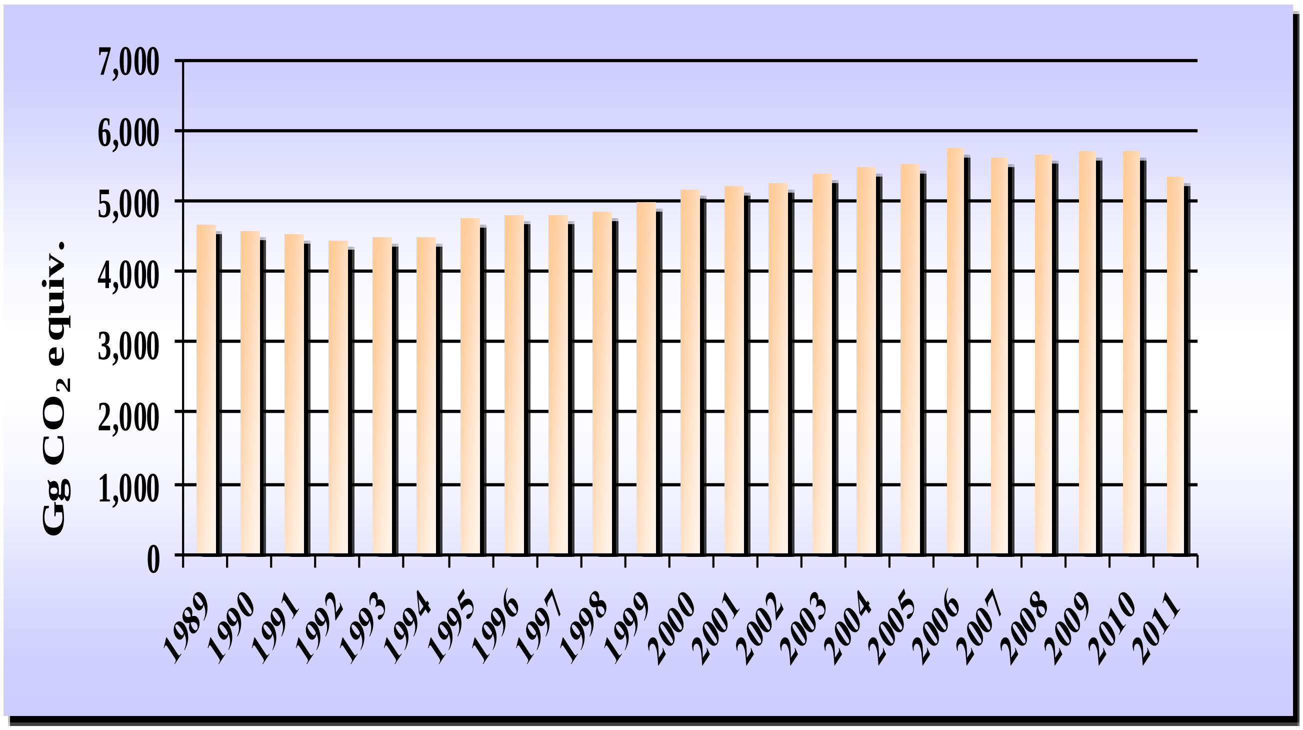
In the base year (1989), the total GHG emissions from the waste sector amounted to 4,670.31 Gg CO_2 equivalent, which accounted for 1.60% of the total national GHG emissions in this year. Compared with the other sectors, emissions from the waste sector showed a significant increase from the base year, with 14.91%, due to increasing of population consumption in parallel with increasing of living standards (Table 8.2, Figure 8.2).

Table 8.2 The contribution of Waste Sector to the total GHG emissions in Romania, for 1989–2011 period

Year	Total GHG emissions (excl. LULUCF) [Gg CO_2 equiv.]	GHG emissions from Waste [Gg CO_2 equiv.]	Contribution of Waste in total GHG emissions [%]
1989	273,232.94	4,670.31	1.71
1990	244,403.58	4,580.08	1.87
1991	199,511.85	4,510.85	2.26
1992	174,050.45	4,457.86	2.56
1993	169,364.31	4,477.69	2.64
1994	166,094.28	4,509.23	2.71
1995	172,790.63	4,764.89	2.76
1996	175,402.43	4,812.25	2.74
1997	161,968.44	4,820.47	2.98
1998	145,489.16	4,867.34	3.35
1999	130,778.15	4,978.99	3.81
2000	133,525.98	5,157.70	3.86
2001	136,259.37	5,221.35	3.83
2002	138,217.02	5,277.29	3.82
2003	145,084.67	5,407.87	3.73
2004	142,300.84	5,461.70	3.84
2005	141,560.49	5,539.28	3.91
2006	145,880.11	5,765.54	3.95
2007	142,703.65	5,602.38	3.93
2008	140,464.22	5,677.92	4.04
2009	120,294.40	5,703.17	4.74
2010	116,621.20	5,715.62	4.90
2011	123,345.54	5,366.48	4.35

* Preliminary data

Figure 8.2 Total GHG emissions trend from Waste Sector for 1989–2011 period



The most important contribution to GHG emissions from Waste Sector, in 2011 year, has Wastewater Handling Subsector, contributing with 53.67% in the total (Figure 8.3); Solid Waste Disposal on Land Sub-sector contribute with 46.13% and Waste Incineration Sub-sector accounts for only 0.20%.

Wastewater Handling and Solid Waste Disposal on Land Subsectors are key category sources both by level and trend (Table 8.3 and Figure 8.4).

Figure 8.3 Contribution of the sub-sectors in the total GHG emissions from Waste Sector in 2011

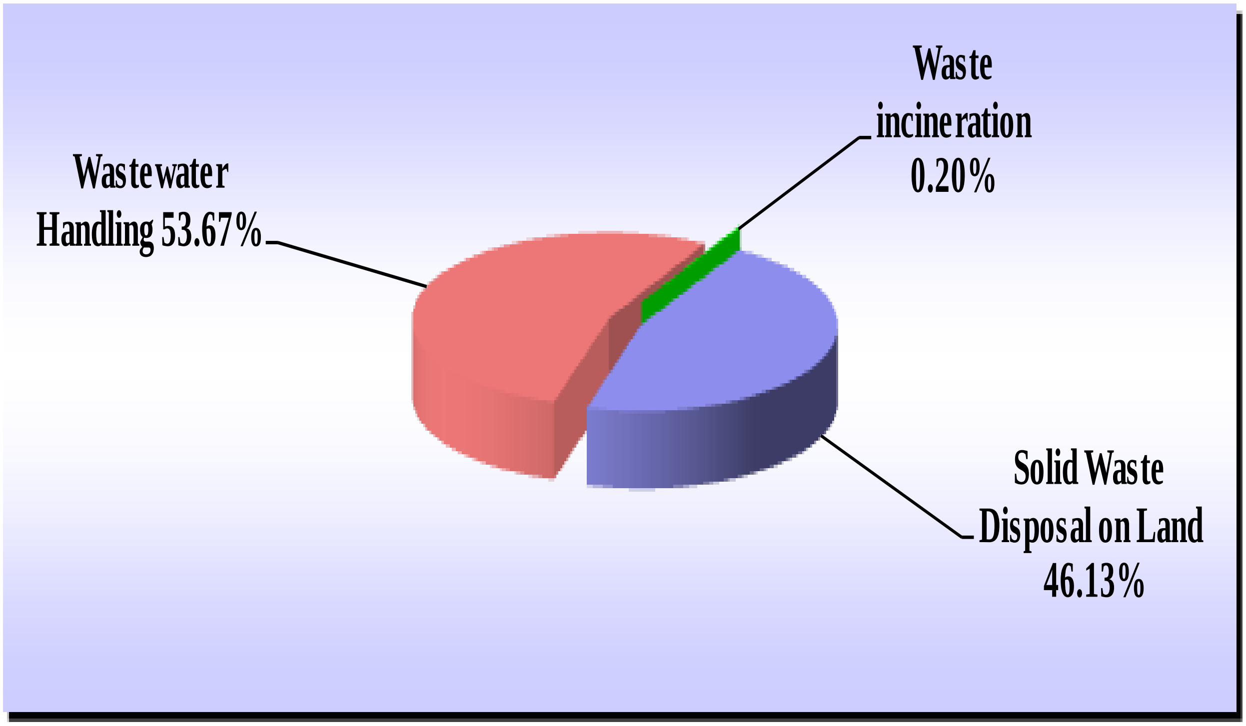
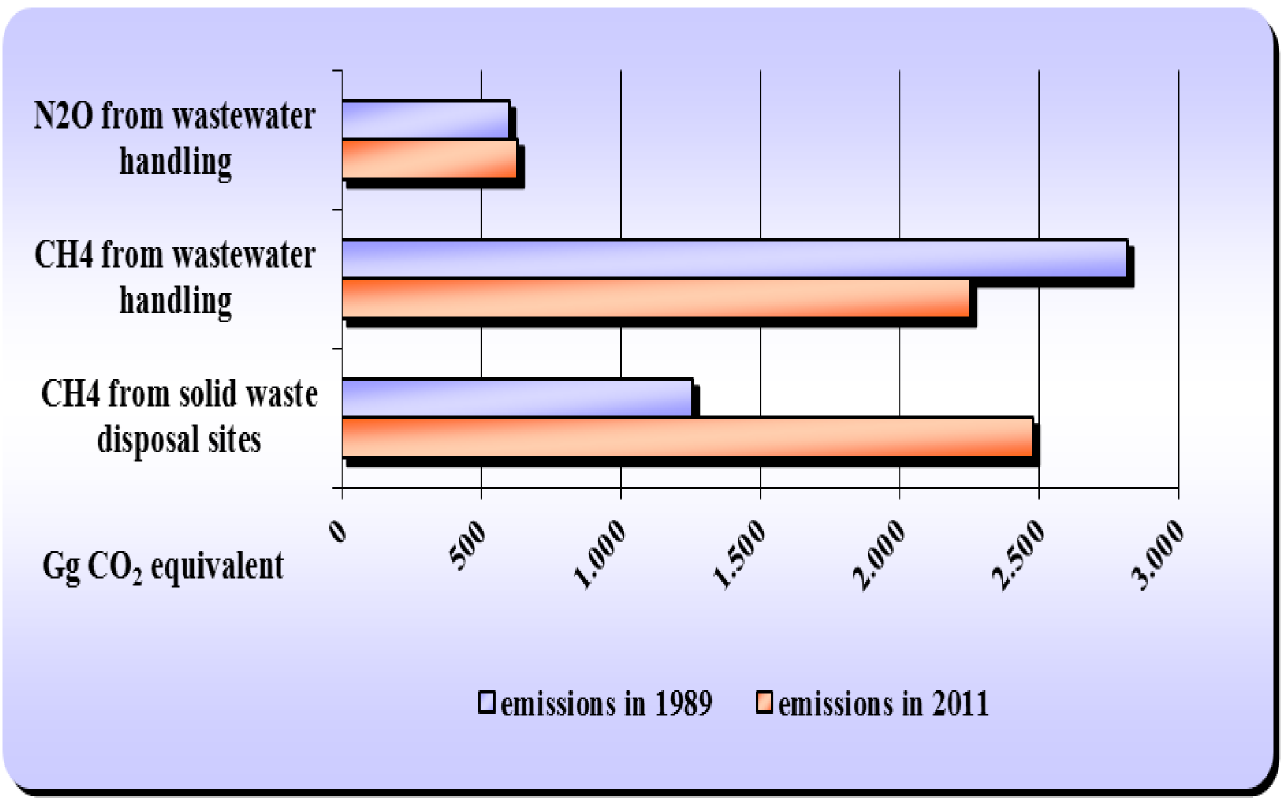


Table 8.3 Key categories in Waste Sector based on the level and trend assessment in 2011

Key category	Direct GHG	Criteria for identification	Contribution of key category in total GHG emissions [%] - (excluding LULUCF)
6.A Solid waste disposal sites	CH_4	**L,T (Tier 1, excluding and including LULUCF, Tier 2, excluding and including LULUCF)**	2.01
6.B Wastewater handling	CH_4	**L,T (Tier 1, excluding and including LULUCF, Tier 2, excluding and including LULUCF)**	1.83

Key category	Direct GHG	Criteria for identification	Contribution of key category in total GHG emissions [%] - (excluding LULUCF)
	N_2O	**L,T (Tier 1, excluding and including LULUCF, Tier 2, excluding and including LULUCF)**	0.51

Figure 8.4 Key categories in Waste Sector both by level and trend criteria, in 2011



The direct GHG emissions by gas are presented in Table 8.4.

Methane represents the major greenhouse gas from this sector with a contribution of 21.24% to the total methane emissions in Romania, in 2011. In the same year, nitrous protoxide has a contribution of 4.95% to the total N_2O emissions in our country.

According to Revised 1996 IPCC Guidelines, CO_2 emissions from Solid Waste Disposal on Land category mainly derive from biomass sources and are not treated as net emissions. Only CO_2 emissions from Waste Incineration category are reported, these representing 0.01% of total net CO_2 emissions in Romania.

Table 8.4 GHG emissions from Waste Sector per gas and contribution of these in total GHG emissions from Waste Sector, for the 1989–2011 period

Year	**Total emissions from Waste [Gg CO_2 equiv.]**	**CH_4 emissions**		**N_2O emissions**	
		Gg CO_2 equiv.	**%**	**Gg CO_2 equiv.**	**%**
1989	4,670.31	4,070.95	87.17	599.36	12.83
1990	4,580.08	3,979.29	86.88	600.79	13.12
1991	4,510.85	3,910.62	86.69	600.23	13.31
1992	4,457.86	3,856.98	86.52	589.98	13.23
1993	4,477.69	3,859.43	86.19	602.05	13.45
1994	4,509.23	3,886.30	86.19	601.40	13.34
1995	4,764.89	4,125.05	86.57	612.99	12.86
1996	4,812.25	4,167.13	86.59	611.01	12.70
1997	4,820.47	4,171.46	86.54	609.34	12.64
1998	4,867.34	4,200.55	86.30	620.98	12.76
1999	4,978.99	4,296.27	86.29	626.13	12.58
2000	5,157.70	4,453.46	86.35	638.26	12.37
2001	5,221.35	4,509.19	86.36	637.50	12.21
2002	5,277.29	4,578.97	86.77	620.04	11.75
2003	5,407.87	4,648.05	85.95	673.95	12.46
2004	5,461.70	4,682.30	85.73	672.08	12.31
2005	5,539.28	4,689.94	84.67	670.55	12.11
2006	5,765.54	4,719.46	81.86	681.60	11.82

Year	Total emissions from Waste [Gg CO_2 equiv.]	CH_4 emissions		N_2O emissions	
		Gg CO_2 equiv.	%	Gg CO_2 equiv.	%
2007	5,602.38	4,911.64	87.67	680.12	12.14
2008	5,677.92	4,984.13	87.78	685.20	12.07
2009	5,703.17	5,035.77	88.30	659.67	11.57
2010	5,715.62	5,075.88	88.81	628.90	11.00
2011	5,366.48	4,728.44	88.11	627.48	11.69

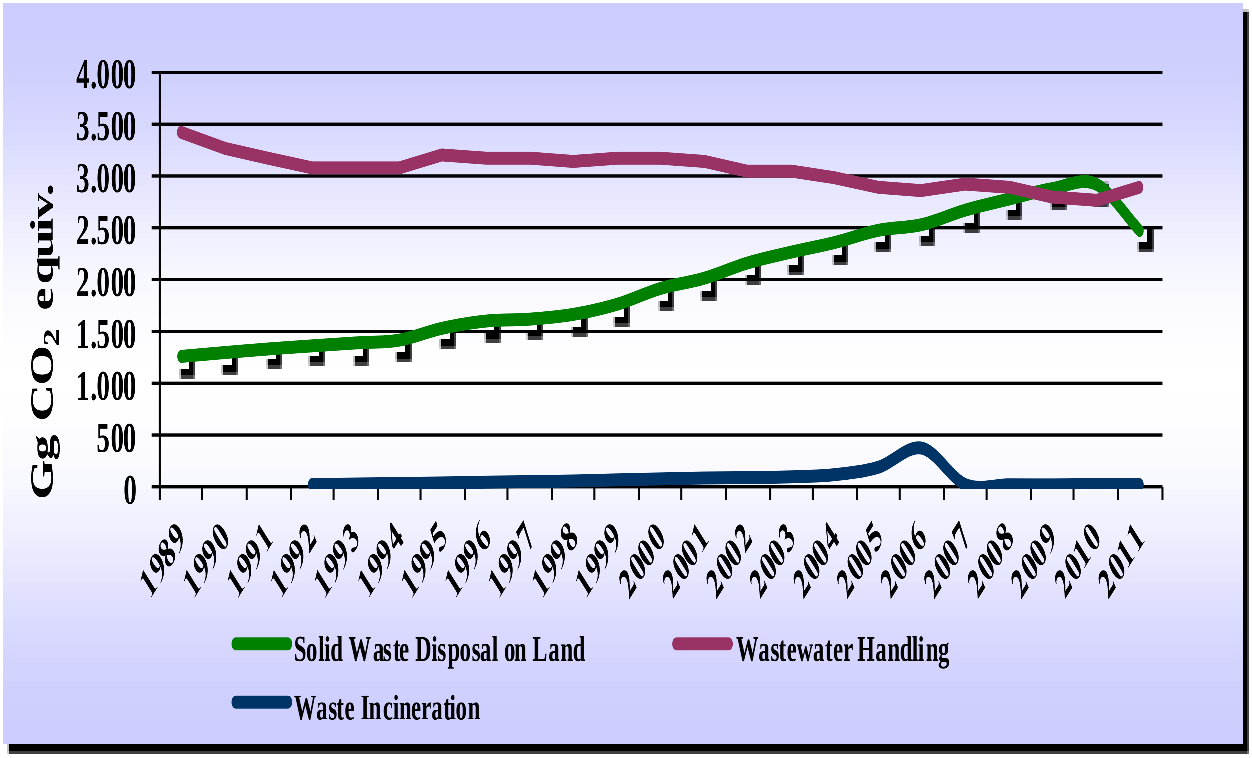
* Preliminary data

After 2000, Romania began to comply with EU standards, implementing European legislation both in waste and wastewater treatment management. However, the GHG emissions trend is different for the three subsectors of Waste Sector due to improvement of living standards which is reflected differently in the evolution of these subsectors.

GHG emissions trend from Solid Waste Disposal on Land category (SWDL) increased significantly in 2011 year comparing with the level in the base year, with a percentage of 97.29% (Figure 8.5). This increase is due to the increasing trend of waste generation rate following the increasing trend of population consumption. Emissions from wastewater handling decreased with 15.67% in 2011 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.

In Waste Incineration Subsector the emissions trend has remained almost constant because the amount of waste destined for incineration was constantly, except for the period 2004-2006 when there was intensified burning of industrial hazardous waste due to compliance with Directive 2000/76/CE.

Figure 8.5 GHG emissions trend from Waste Sector, by sub-sectors for 1989–2011 period



8.2 Source category Solid Waste Disposal on Land (CRF Sector 6.A)

8.2.1 Source category description

Waste generation rate follows consumption and production tendency. With increasing of living standards also the amount of generated waste increased. Over time the amounts of waste generated do not have a linear evolution due to variability of production.

Solid Waste Disposal on Land is responsible for CH_4 and CO_2 generation. To estimate CH_4 emissions from Solid Waste Disposal on Land category the amounts of Municipal Solid Waste (MSW) deposited in Solid Waste Disposal Sites (SWDS) were used. Starting with this submission, the amounts of sewage sludge deposited to SWDS were taken into account in order to estimate CH_4 emissions from SWDL.

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 2010 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 2006-2010 period, the percentage of MSW collected from total MSW generated ranged between 77% and 82%. Of the total amount of MSW collected in 2010, 92.22% was deposited and the rest was recovered. No information on the destination of the amounts of generated and uncollected waste is available. It is assumed that they are generally recovered/reused/composted in households. For 2011, the data regarding recovered/deposited MSW categories will finalized later this year after statistical survey.

In Table 8.5 the percentages of municipal solid waste categories which have been recovered and stored in 2010 are presented.

Table 8.5 Percentages of recovered and deposited MSW from the total amount of collected MSW, in 2009 (Source www.anpm.ro)

Municipal Solid Waste categories	Recovered from total collected MSW (%)	Deposited from total collected MSW (%)
Household and similar waste	5.37	94.57
Waste from municipal services	6.76	93.24
Waste from construction and demolition activities	31.14	69.07

After the implementation of European legislation, the percentage of population served by sanitation services increased to 85.06% in urban areas and 52.39% in rural areas for 2010 year.

Waste collection system, complies with European standards and the method is the most common, accounting for a share of about 70.38%. 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 is deposited both in managed and unmanaged SWDS. In the last years, in accordance with European regulations, the number of unmanaged SWDS decreased reaching a number of 70 sites in 2011 year (Table 8.6). In accordance with European regulations, the unmanaged SWDS are subject to a transition period, storage activity being stopped gradually until 2017.

Table 8.6 Number of Solid waste Disposal Sites (Source Waste Directorate of NEPA)

<table>
<tr><th>Type of SWDS/Year</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th></tr>
<tr><td>Managed</td><td>20</td><td>20</td><td>20</td><td>26</td><td>27</td><td>30</td></tr>
<tr><td>Unmanaged deep</td><td>90</td><td>92</td><td>87</td><td>87</td><td>40</td><td rowspan="2">70</td></tr>
<tr><td>Unmanaged shallow</td><td>130</td><td>109</td><td>96</td><td>14</td><td>35</td></tr>
</table>

A large amount of recyclable materials (paper, cardboard, glass, plastics, metals) are not recovered but are finally stored together with other municipal wastes. The percentage of biodegradable waste in deposited waste is 62 % for 2011 year.

CH_4 emissions from SWDS

The methane emissions from Solid Waste Disposal to managed landfills were estimated for the period 1995-2011, because in 1995 year was opened the first managed SWDS.

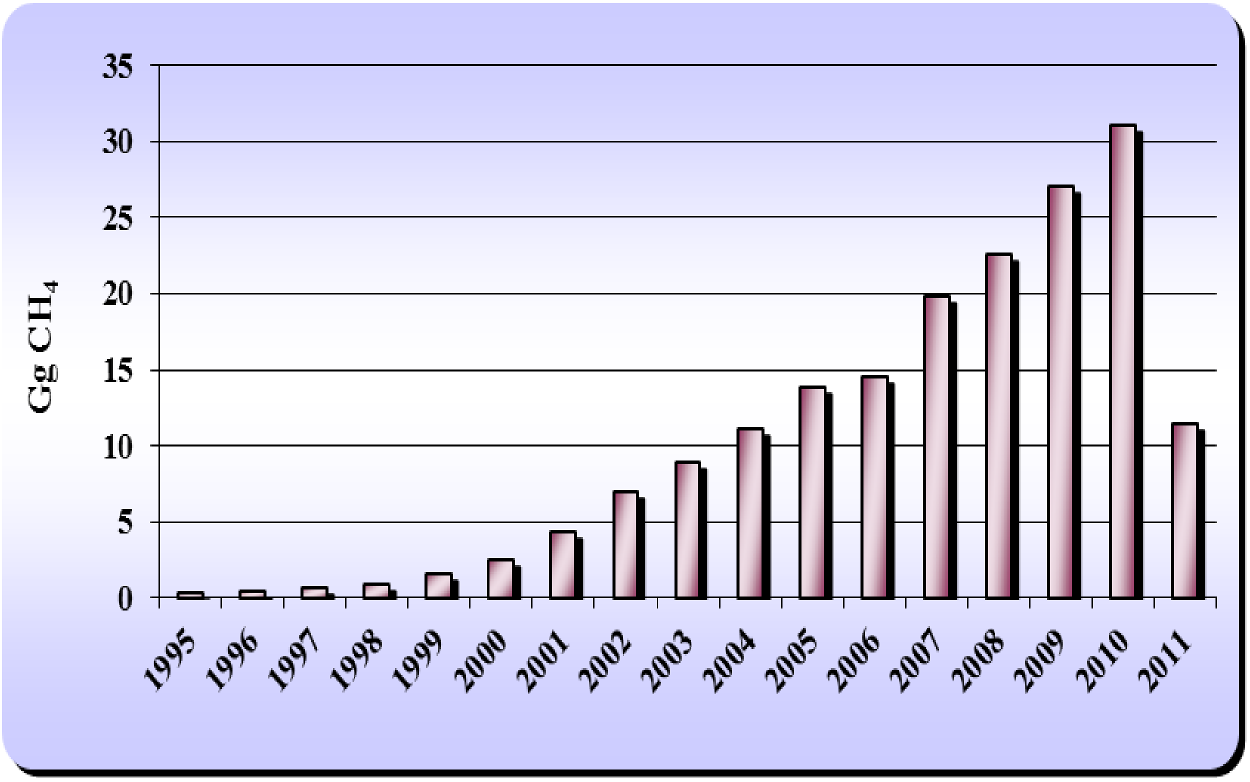
The methane emissions from managed SWDS have an increasing trend between 1995 – 2010 period. The significant difference between the level in 2010 and 2011 years is associated to the amount of CH_4 recovered in 2011 which register a value of 42.69 Gg and determine in 2011 a lower level of CH_4 emissions from managed solid waste disposal sites of about 11.4 Gg (Table 8.7 and Figure 8.6).

Table 8.7 CH_4 emissions from solid waste disposal sites

Year	CH_4 emissions [Gg]		
	managed	unmanaged deep	unmanaged shallow
1989	NO	45.26	14.49
1990	NO	46.60	14.92
1991	NO	47.86	15.33
1992	NO	48.94	15.67
1993	NO	49.97	16.00
1994	NO	50.94	16.32
1995	0.32	54.89	17.58
1996	0.37	57.35	18.37
1997	0.60	57.84	18.53
1998	0.93	59.27	18.98
1999	1.53	62.32	19.96
2000	2.44	67.18	21.52
2001	4.38	69.29	22.19
2002	6.92	72.72	23.29
2003	8.93	74.99	24.02
2004	11.12	76.68	24.58
2005	13.90	78.95	25.15
2006	14.51	80.81	25.33
2007	19.85	82.36	25.16
2008	22.59	85.21	24.64
2009	27.03	86.35	23.91
2010	31.03	85.27	23.03
2011	11.40*	84.29*	22.20*

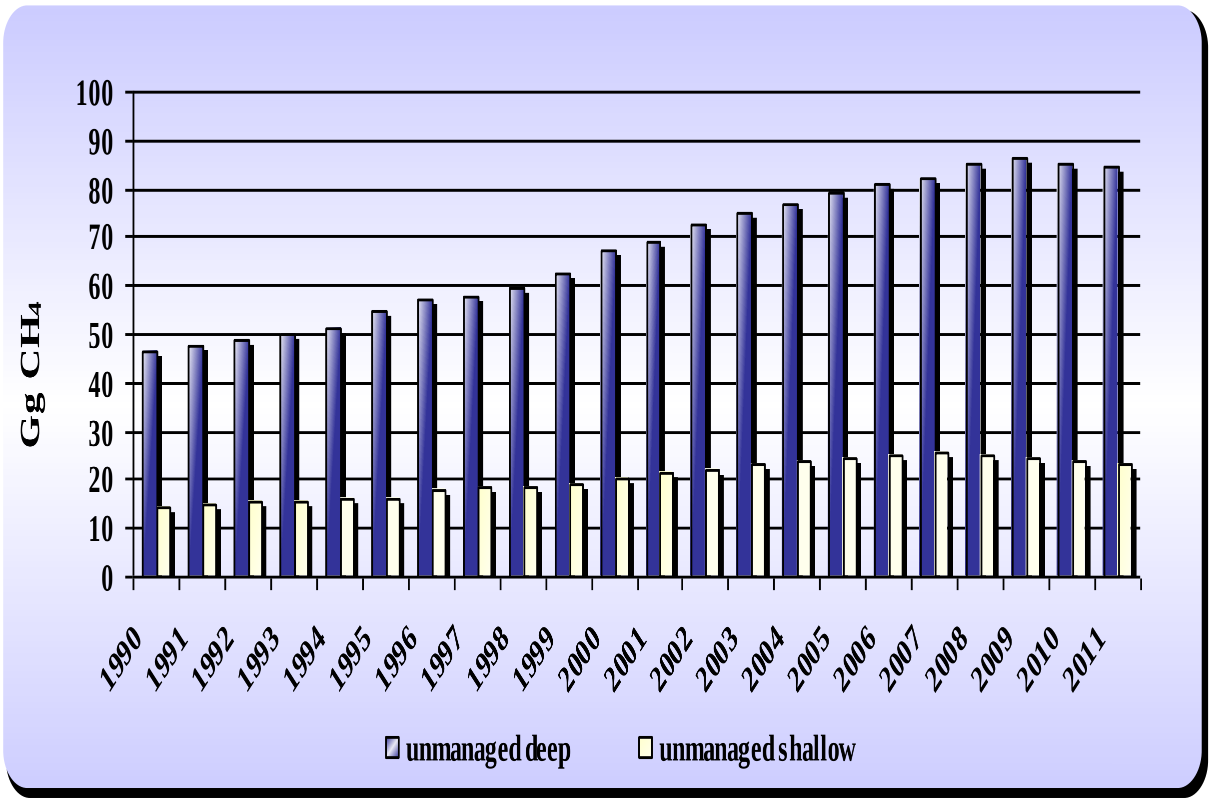
* Preliminary data

Figure 8.6 CH_4 emissions trend from waste disposed to managed sites for 1995–2011 period



During 1950-2009, CH_4 emissions from unmanaged deep SWDS had an increasing trend similar to the trend associated with the emissions from unmanaged shallow SWDS (Table 8.7 and Figure 8.7), following the increasing of the amounts of waste generated and storage in unmanaged landfills. After 2009 the CH_4 emissions had a decreasing trend due to the decrease of the amounts of waste stored in unmanaged landfills.

Figure 8.7 CH_4 emissions trend from waste disposed to unmanaged sites for 1989–2011 period



8.2.2 Methodological issues

Methodology

Given the key category status both by level and trend, CH_4 emissions from managed and unmanaged SWDS were calculated using First Order Decay method, in accordance with IPCC GPG 2000. To estimate methane emissions from managed landfills historical data prior to those associated with the 1995 year were not necessary, because the first managed landfill was opened in 1995 year.

For unmanaged SWDS methane emissions were estimated based on data associated with the 1950-2011 period, according to the IPCC GPG 2000 provisions, to achieve an acceptably accurate result.

In order to estimate CH_4 emissions from managed and unmanaged sites, starting with this submission were taken into account also the amount of sewage sludge deposited to SWDS.
The following equations were used in CH_4 emissions estimates:

Equation 8.1 CH_4 generated from managed and unmanaged SWDS

$$CH_4 \text{ generated in year } t \text{ (Gg/yr)} = \Sigma_x [(A \bullet k \bullet MSW_D (x) \bullet L_0(x)) \bullet e^{-k(t-x)}]$$

$$\text{for } x = \text{initial year to } t$$

where:

- $MSW_D(x)$ is representing the quantity of solid waste disposed in managed/ unmanaged (deep, shallow) landfills. In accordance with experts on waste management, $MSW_D(x)$ replace the product between $MSW_T(x)$ and $MSW_F(x)$.

Firstly, *CH_4 generated in year t* was calculated separately for sewage sludge and municipal waste, then the two values of CH_4 generated in year t were summed and applied in the following formula:

Equation 8.2 CH_4 emissions from managed and unmanaged SWDS

$$CH_4 \text{ emitted in year } t \text{ (Gg/yr)} = [(CH_4 \text{ generated from SWDL in year } t + CH_4 \text{ generated from sludge in year } t) - R(t)] \bullet (1-OX)$$

Emission factors

Municipal solid waste

Except Degradable Organic Carbon (DOC), country specific emissions factors and parameters were not available to estimate CH_4 emissions. DOC was calculated based on municipal waste composition, using estimated data associated with 1950-2002 period and data provided by NEPA Waste Directorate for period 2003-2011 (see the Table 8.8).

Given the statistical survey on waste for 2011 has not yet finalised, for this year it was considered the same value as in 2010.

Table 8.8 The percentage composition of municipal solid waste

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescible [%]	Food waste [%]	Wood/straw [%]	DOC	Source
1950	4.82	5.77	14.79	0.37	0.05	Study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"*
1951	4.88	5.83	14.95	0.37	0.05	
1952	5.00	5.97	15.33	0.38	0.05	
1953	5.12	6.11	15.69	0.39	0.06	
1954	5.22	6.24	16.02	0.40	0.06	
1955	5.33	6.37	16.34	0.41	0.06	
1956	5.30	6.34	16.27	0.40	0.06	
1957	5.53	6.61	16.96	0.42	0.06	
1958	5.61	6.70	17.20	0.43	0.06	
1959	5.67	6.78	17.40	0.43	0.06	
1960	5.79	6.92	17.74	0.44	0.06	
1961	5.86	7.00	17.95	0.45	0.06	
1962	5.90	7.06	18.10	0.45	0.06	
1963	5.97	7.13	18.30	0.46	0.06	
1964	6.02	7.19	18.45	0.46	0.07	
1965	6.07	7.25	18.60	0.46	0.07	

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescible [%]	Food waste [%]	Wood/straw [%]	DOC	Source
1966	6.35	7.59	19.48	0.48	0.07	Study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation" calculation methods implementation"*
1967	6.42	7.67	19.68	0.49	0.07	
1968	6.43	7.68	19.71	0.49	0.07	
1969	6.54	7.82	20.05	0.50	0.07	
1970	6.64	7.93	20.35	0.51	0.07	
1971	6.73	8.04	20.63	0.51	0.07	
1972	6.82	8.15	20.90	0.52	0.07	
1973	6.90	8.24	21.15	0.53	0.07	
1974	7.00	8.37	21.46	0.53	0.08	
1975	7.10	8.49	21.78	0.54	0.08	
1976	7.21	8.62	22.11	0.55	0.08	
1974	7.00	8.37	21.46	0.53	0.08	
1977	7.53	9.00	23.08	0.57	0.08	
1978	7.64	9.14	23.44	0.58	0.08	
1979	7.72	9.22	23.66	0.59	0.08	
1980	7.83	9.36	24.01	0.60	0.09	
1981	7.95	9.51	24.39	0.61	0.09	
1982	8.09	9.67	24.81	0.62	0.09	

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescible [%]	Food waste [%]	Wood/straw [%]	DOC	Source
1983	8.16	9.75	25.02	0.62	0.09	Study *"Elaboration/documentation of national emission factors/other parameters relevant to N GHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"*
1984	8.20	9.80	25.14	0.63	0.09	
1985	8.29	9.90	25.41	0.63	0.09	
1986	8.35	9.99	25.62	0.64	0.09	
1987	8.45	10.10	25.90	0.64	0.09	
1988	8.52	10.19	26.14	0.65	0.09	
1989	8.64	10.33	26.51	0.66	0.09	
1990	8.74	10.45	26.80	0.67	0.09	
1991	8.72	10.42	26.74	0.67	0.09	
1992	8.58	10.25	26.31	0.65	0.09	
1993	8.58	10.26	26.32	0.65	0.09	
1994	8.58	10.26	26.32	0.65	0.09	
1995	11.92	14.25	36.55	0.91	0.13	
1996	10.77	12.87	33.02	0.82	0.12	
1997	11.22	13.41	34.41	0.86	0.12	
1998	10.45	12.49	32.05	0.80	0.11	
1999	11.85	14.17	36.35	0.90	0.13	
2000	13.68	16.36	41.96	1.04	0.15	

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescible [%]	Food waste [%]	Wood/straw [%]	DOC	Source
2001	12.33	14.74	37.80	0.94	0.13	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"*
2002	13.86	16.56	42.49	1.06	0.15	
2003	13.11	15.67	40.20	1.00	0.14	NEPA
2004	11.67	12.53	38.12	1.00	0.13	
2005	12.76	14.50	38.60	1.00	0.14	
2006	12.68	14.36	36.45	1.00	0.13	
2007	11.48	13.77	34.45	1.00	0.12	
2008	8.32	6.03	45.29	1.58	0.12	
2009	10.18	5.54	44.40	1.97	0.12	

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescible [%]	Food waste [%]	Wood/straw [%]	DOC	Source
2010	8.86	6.29	45.55	1.89	0.12	NEPA
2011	8.86*	6.29*	45.55*	1.89*	0.12*	

* Preliminary data

In order to calculate the CH_4 emissions from municipal solid waste, default values associated with the other parameters, provided through IPCC GPG 2000, taking into account the national circumstances, were used (Table 8.9).

Table 8.9 Other parameters used to calculate the emission factors (SWDS) for municipal solid waste disposed to SWDS

Type of site	MCF	DOC_F	F	k	$A=(1-e^{-k})/k$	OX
MSW disposed to managed SWDS	1.00	0.55	0.50	0.05	0.975	0.1
MSW disposed to unmanaged-deep	0.80	0.55	0.50	0.05	0.975	0.00
MSW disposed to unmanaged-shallow	0.40	0.55	0.50	0.05	0.975	0.00
Source	IPCC GPG 2000					

Sewage sludge disposed to SWDS

In order to estimate the CH_4 emissions from sewage sludge disposed to SWDS it has been used the default parameters from IPCC GPG 2000 and IPCC 2006, as presented in the Table 8.10.

Table 8.10 Parameters used to calculate the emission factors (SWDS) for sewage sludge disposed to SWDS

Type of site	MCF	DOC	DOC_F	F	k	$A=(1-e^{-k})/k$	OX
Sewage sludge disposed to managed SWDS	1.00	0.05	0.50	0.50	0.185	0.919	0.1
Sewage sludge disposed to unmanaged SWDS - deep	0.80	0.05	0.50	0.50	0.185	0.919	0.00
Sewage sludge disposed to unmanaged SWDS - shallow	0.40	0.05	0.50	0.50	0.185	0.919	0.00
Source	IPCC GPG 2000	IPCC 2006	IPCC 2006	IPCC GPG 2000	IPCC 2006	IPCC 2006	IPCC GPG 2000

Activity data

Municipal solid waste

For 2003-2010 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 2011 the statistical survey on waste has not yet finalised in this case data estimated based on the waste generation rate being used.

The historical data on MSW storage were estimated in the context of implementing the study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"*, in 2011 year (see the Table 8.11).

Table 8.11 Total annual MSW disposed to Solid Waste Disposal Sites

Year	**Amount of waste in Gg disposed to**			**Source**
	managed sites	**unmanaged deep sites**	**unmanaged shallow sites**	
1950	NO	1,420.71	910.06	Study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"*
1951	NO	1,435.61	919.61	
1952	NO	1,472.02	942.93	
1953	NO	1,506.35	964.92	
1954	NO	1,538.18	985.31	
1955	NO	1,569.46	1005.35	
1956	NO	1,562.08	1000.62	
1957	NO	1,629.21	1043.62	
1958	NO	1,651.55	1057.93	
1959	NO	1,670.59	1070.13	
1960	NO	1,703.69	1091.33	
1961	NO	1,724.23	1104.49	
1962	NO	1,738.34	1113.53	
1963	NO	1,757.34	1125.70	
1964	NO	1,771.71	1134.91	
1965	NO	1,786.60	1144.44	
1966	NO	1,870.61	1198.26	
1967	NO	1,890.37	1210.91	
1968	NO	1,892.51	1212.29	
1969	NO	1,925.74	1233.57	
1970	NO	1,954.03	1251.69	
1971	NO	1,981.17	1269.08	

Table 8.11 (continued) 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	
1972	NO	2,006.88	1285.55	Study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"*
1973	NO	2,031.14	1301.09	
1974	NO	2,061.29	1320.40	
1975	NO	2,091.78	1339.93	
1976	NO	2,122.92	1359.88	
1977	NO	2,216.33	1419.72	
1978	NO	2,250.90	1441.86	
1979	NO	2,272.55	1455.73	
1980	NO	2,306.24	1477.30	
1981	NO	2,342.09	1500.27	
1982	NO	2,382.34	1526.05	
1983	NO	2,402.33	1538.86	
1984	NO	2,414.28	1546.52	
1985	NO	2,439.76	1562.84	
1986	NO	2,460.34	1576.02	
1987	NO	2,487.09	1593.16	
1988	NO	2,510.33	1608.04	
1989	NO	2,545.70	1630.70	
1990	NO	2,573.86	1648.74	
1991	NO	2,567.78	1644.84	
1992	NO	2,526.33	1618.29	
1993	NO	2,527.31	1618.92	

Table 8.11 (continued) 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	
1994	NO	2,527.45	1619.01	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"*
1995	150.00	3,418.33	2189.67	
1996	235.00	3,027.61	1939.39	
1997	320.00	1,883.49	1206.51	
1998	405.00	2,584.57	1655.60	
1999	490.00	3,192.01	2044.70	
2000	565.66	3,684.89	2360.43	
2001	1,500.00	2,791.10	1787.89	
2002	1,705.00	3,145.04	2014.62	
2003	1,723.55	2,810.00	1800.00	NEPA
2004	1,933.00	2,850.00	1850.00	
2005	2,079.84	3,020.00	1780.00	
2006	2,558.26	2,817.22	1392.41	
2007	2,841.68	2,874.98	1132.44	
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	3,194.73*	1,851.12*	367.42*	

* Preliminary data (final data for 2011 will b,e provided after statistical survey of the end of this year)

Sewage sludge disposed to SWDS

Data associated with the amounts of sewage sludge disposed to managed and unmanaged SWDS, were estimated through 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"* implemented in 2011 year, based on the available data regarding the total amounts of sewage sludge disposed to SWDS for period 1998-2010 period.
In order to obtain the necessary data, the experts used the following formula:

Equation 8.3 The calculation of the Sewage sludge disposed to SWDS

$$Q_{sws\ managed} = (Q_{sws\ tot\ disposed} * Q_{MSW\ disposed\ to\ managed\ SWDS} / Q_{MSW\ disposed\ to\ SWDS})$$

where:

- $Q_{sws\ managed}$ - represent the quantity of sewage sludge disposed in managed landfills, in year t;
- $Q_{sws\ tot\ disposed}$ - represent the total quantity of sewage sludge disposed in landfills, in year t;
- $Q_{MSW\ disposed\ to\ managed\ SWDS}$ - represent the quantity of MSW disposed in managed landfills, in year t;
- $Q_{MSW\ disposed\ to\ SWDS}$ - represent the total quantity of MSW disposed in landfills, in year t.

A similar formula was used in order to estimate the quantities of sewage sludge disposed in deep and shallow unmanaged landfills.
The sewage sludge disposed in landfills is generated in the municipal sewage treatment plants.
By expert judgement, the NIS data on the total quantities of sewage sludge landfilled in the period 2006-2010 were considered in the emission estimation.
For 2011 year was considered the same value for sewage sludge landfilled as in previous year, taking into account that the statistical survey on waste has not yet finalized.
The Table 8.12 shows the activity data for the period 1950-2011.

Table 8.12 Total annual sewage sludge disposed to Solid Waste Disposal Sites (1950–2011 period)

Year	Amount of sewage sludge in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1950	NO	37.58	24.07	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"*
1951	NO	37.97	24.32	
1952	NO	38.94	24.94	
1953	NO	39.84	25.52	
1954	NO	40.68	26.06	
1955	NO	41.51	26.59	
1956	NO	41.32	26.47	
1957	NO	43.09	27.60	
1958	NO	43.68	27.98	
1959	NO	44.19	28.31	
1960	NO	45.06	28.87	
1961	NO	45.61	29.21	
1962	NO	45.98	29.45	
1963	NO	46.48	29.77	
1964	NO	46.86	30.02	
1965	NO	47.26	30.27	
1966	NO	49.48	31.69	
1967	NO	50.00	32.03	
1968	NO	50.06	32.07	
1969	NO	50.94	32.63	
1970	NO	51.68	33.11	
1971	NO	52.40	33.57	

Table 8.12 (continued)Total annual sewage sludge disposed to Solid Waste Disposal Sites (1950–2011 period)

Year	**Amount of sewage sludge in Gg disposed to**			**Source**
	managed sites	**unmanaged deep sites**	**unmanaged shallow sites**	
1972	NO	53.08	34.00	Study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"*
1973	NO	53.72	34.41	
1974	NO	54.52	34.92	
1975	NO	55.33	35.44	
1976	NO	56.15	35.97	
1977	NO	58.62	37.55	
1978	NO	59.54	38.14	
1979	NO	60.11	38.50	
1980	NO	61.00	39.07	
1981	NO	61.95	39.68	
1982	NO	63.01	40.36	
1983	NO	63.54	40.70	
1984	NO	63.86	40.91	
1985	NO	64.53	41.34	
1986	NO	65.08	41.69	
1987	NO	65.78	42.14	
1988	NO	66.40	42.53	
1989	NO	67.33	43.13	
1990	NO	68.08	43.61	
1991	NO	67.92	43.51	
1992	NO	66.82	42.80	
1993	NO	66.85	42.82	

Table 8.12 (continued)Total annual sewage sludge disposed to Solid Waste Disposal Sites (1950–2011 period)

Year	**Amount of sewage sludge in Gg disposed to**			**Source**
	managed sites	**unmanaged deep sites**	**unmanaged shallow sites**	
1994	NO	66.85	42.82	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"*
1995	3.97	90.41	57.92	
1996	3.58	81.68	52.32	
1997	2.35	53.55	34.30	
1998	3.20	72.94	46.72	
1999	11.30	73.60	47.15	
2000	12.48	81.31	52.09	
2001	36.00	66.98	42.90	
2002	36.38	67.10	42.98	
2003	55.38	90.29	57.84	
2004	73.66	108.60	70.50	
2005	71.40	103.68	61.11	
2006	199.41	219.59	108.53	
2007	241.88	244.71	96.39	
2008	524.85	550.63	124.25	
2009	146.50	140.21	26.64	
2010	162.57	94.20	18.70	
2011	162.57*	94.20*	18.70*	

* Preliminary data (final data for 2011 will be provided after statistical survey of the end of this year)

CH_4 recovery

Since 1996 to 2001, only a single landfill began to recover the methane emitted. In period 2001-2011 the amounts of methane recovered recorded a significant increase, because many more operators have reported their activity.

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 2011 the quantity of methane recovered from landfill register a significant increase, determining a large difference between the CH_4 recovered in 2010 and 2011. This fact is due to the compliance of waste operators with the European and national legislation, by installing capture and measurement systems for landfill gas (Table 8.13).

Considering information from this time, the methane is recovered from 9 managed SWDS and is not used for energy purposes.

According to the data sources used there is no methane recovery from the unmanaged sites and the emissions are reported as NO.

Table 8.13 The amounts of CH_4 recovered from managed SWDS (Source: operators of landfills)

Year	Amount of CH_4 recovered (Gg)	Year	Amount of CH_4 recovered (Gg)
1989	NA	**2000**	1.97
1990	NA	**2001**	3.27
1991	NA	**2002**	4.72
1992	NA	**2003**	6.40
1993	NA	**2004**	7.76
1994	NA	**2005**	8.91
1995	NA	**2006**	13.61
1996	0.43	**2007**	13.09

Year	Amount of CH_4 recovered (Gg)	Year	Amount of CH_4 recovered (Gg)
1997	0.83	**2008**	15.91
1998	1.23	**2009**	15.99
1999	1.60	**2010**	16.37
		2011	42.69

CO_2 and NMVOC emissions from solid waste disposal on land

CO_2 and NMVOC emissions from managed and unmanaged SWDS were estimated based on the study "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation", finished in 2011.

In accordance with 1996 IPCC Guidelines:

"In addition to CH_4, solid waste disposal sites can also produce substantial amounts of CO_2 and non-methane volatile organic compounds (NMVOCs). Decomposition of organic material derived from biomass sources (e.g., crops, forests) which are reground on an annual basis is the primary source of CO_2 released from waste. Hence, these CO_2 emissions are not treated as net emissions from waste in the IPCC Methodology".

"Organic waste in SWDS is broken down by bacterial action in a series of stages that result in the formation of CH4 and CO2 (termed biogas or landfill gas) and further bacterial biomass.

In the initial phase of degradation, organic matter is broken down to small soluble molecules including a variety of sugars. These are broken down further to hydrogen, CO_2 and a range of carboxylic acids. These acids are then converted to acetic acid which, together with hydrogen and CO_2, forms the major substrate for growth of methanogenic bacteria.

Landfill gas consists of approximately 50 per cent CO_2 and 50 per cent CH_4 by volume. However, the percentage of CO_2 in landfill gas may be smaller because of decomposition of substrates with a high hydrogen/oxygen ratio (e.g., fats, hemicelluloses) and because some of the CO_2 dissolves in water within the site."

Taking into account these issues and considering the expert judgement, according to which CO_2 represent about 40% from landfill gas, there were estimated CO_2 emissions from SWDS, using CH_4 emissions already calculated (Table 8.14). These emissions come mainly from biodegradable waste and a small part from waste with content of fossil C (plastics, certain textiles, rubber, waste oil, liquid solvents). On the other hand, according to the studies in this field, degradation of, is done in time periods of hundreds years. In consequence, CO_2 emissions from waste with fossil carbon content are insignificant and were not included in total emissions from Waste Sector.

By expert judgement, in the study mentioned above, NMVOC emissions from SWDS were considered to 0.7% from landfill gas and were estimated using CH_4 emissions.

The NMVOC emissions were updated based on revised methane emissions for the entire time series (Table 8.14).

Table 8.14 Percentage of direct and indirect Greenhouse Gas emissions from waste category 6A (Source: International Solid Waste Association – "Landfill Operational Guideline, 2nd Edition")

Year	Greenhouse Gas					
	CH_4		CO_2		NMVOC	
	Gg	%	Gg	%	Gg	%
1989	59.75	50	47.80	40	0.84	0.7
1990	61.52	50	49.22	40	0.86	0.7
1991	63.18	50	50.55	40	0.88	0.7
1992	64.61	50	51.69	40	0.90	0.7
1993	65.97	50	52.77	40	0.92	0.7
1994	67.26	50	53.81	40	0.94	0.7
1995	72.79	50	58.23	40	1.02	0.7
1996	76.09	50	60.87	40	1.07	0.7
1997	76.97	50	61.57	40	1.08	0.7
1998	79.18	50	63.35	40	1.11	0.7
1999	83.80	50	67.04	40	1.17	0.7
2000	91.14	50	72.91	40	1.28	0.7

Year	Greenhouse Gas					
	CH_4		CO_2		NMVOC	
	Gg	%	Gg	%	Gg	%
2001	95.86	50	76.69	40	1.34	0.7
2002	102.93	50	82.34	40	1.44	0.7
2003	107.93	50	86.34	40	1.51	0.7
2004	112.39	50	89.91	40	1.57	0.7
2005	118.00	50	94.40	40	1.65	0.7
2006	120.65	50	96.52	40	1.69	0.7
2007	127.36	50	101.89	40	1.78	0.7
2008	132.44	50	105.95	40	1.85	0.7
2009	137.29	50	109.83	40	1.92	0.7
2010	139.33	50	111.46	40	1.95	0.7
2011	117.89*	50	94.31	40	1.65	0.7

* Preliminary data

8.2.3 Uncertainties and time series consistency

Accuracy in CH_4 and CO_2 emissions estimates from SWDS is determined by the available data on collected, recovered and stored municipal waste.

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

The uncertainties associated to CH_4 emissions estimates on managed and unmanaged SWDS are presented in Table 8.15.

Table 8.15 Uncertainties associated with CH_4 emissions estimates from managed and unmanaged SWDS

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
CH_4 from managed solid waste disposal	CH_4	20.00	36.10	41.00
CH_4 from unmanaged solid waste disposal	CH_4	20.00	36.10	41.00

The percentages associated with the overall uncertainty, are based on the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

Due to the fact that most of activity data are provided by NEPA and the contractor of the study „*Elaboration of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Process, Agriculture and Waste, to allow for the higher tier calculation methods*“ and to the fact that they were obtained using the same method (the use of two methods for obtaining the quantities of MSW disposed in managed landfills in years 1996-1998 and 2000 is ensuring the consistency of data series considering the national circumstances), emission factors were obtained using the same method and the fact that the same estimation method was used for the whole period, the data series 1989-2011 is consistent.

8.2.4 Source specific QA/QC and verification

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

Following these activities there were no unconformities recorded.

No recalculations were needed following the QA activities developed under the procedures for the compilation of the European Community GHG Inventory, described in the Decision 280/2004/EC 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 following these activities are described in the Chapter 8.2.5 – 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 8.2.5 – Source-specific recalculations, including changes made in response to the review process.

All noted unconformities following the UNFCCC review of the 2011 submission of the NGHGI are described at the Improvements list level, their solving being envisaged as planned improvement.

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 2003-2011 period, the data regarding total municipal solid waste deposited in SWDS were provided by Waste Directorate from National Environmental Protection Agency and for this reason has not made any comparison with other data source.

8.2.5 Source specific recalculation, including changes made in response to the review process

In order to improve the quality emissions estimates the following recalculation was done:

- **activity data**
    - activity data on the quantities of sewage sludge deposited in managed and unmanaged deep and shallow sites were estimated through the study *"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", finalized in 2011; CO_2 and NMVOC emissions from managed and unmanaged landfills were revised based on the revised data regarding methane emissions.

The recalculations effects on the CH_4 emissions from managed sites, due to the changes in AD and other parameters, are described in Table 8.16. The differences in CH_4 emissions between 2012 v. 3.1 and 2013 submissions originate firstly from recalculating AD being included the amount of sewage sludge disposed to SWDS and second from recalculation of DOC values using an arithmetic average between DOC_f = 0.55 for MSW and DOC_f = 0.5 for sewage sludge disposed to SWDS and third from new data on methane recovered.

Also in Table 8.17 are presented the recalculations effects on the CH_4 emissions from unmanaged sites. It can be observed that CH_4 emissions have declined comparing with the 2012 v. 3.1 submission with a range between 0.4 and 8%. This decrease is mainly due to maintain the superior method of calculation: FOD method.

The differences between methane emissions in 2012 v.2.1 submission and 2013 v.1.3 submission can be explained by the introduction of CH_4 emissions from sewage sludge disposed to SWDS (Table 8.16, Table 8.17).

Table 8.16 Changes made in AD and parameters and their effects on emission estimates

Year	Degradable Organic Carbon [%]		Municipal solid waste and sewage sludge disposed to managed sites [Gg]		Effects of recalculations at methane emissions level[Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	NO	NO	NO	NO	NO	NO	-
1990	NO	NO	NO	NO	NO	NO	-
1991	NO	NO	NO	NO	NO	NO	-
1992	NO	NO	NO	NO	NO	NO	-
1993	NO	NO	NO	NO	NO	NO	-
1994	NO	NO	NO	NO	NO	NO	-
1995	0.11	0.13	150.00	153.97	0.29	0.32	+9.81
1996	0.12	0.12	235.00	238.58	0.34	0.37	+10.81
1997	0.11	0.12	320.00	322.35	0.53	0.60	+13.75
1998	0.11	0.11	405.00	408.20	0.84	0.93	+10.87
1999	0.13	0.13	490.00	501.30	1.48	1.53	+3.35
2000	0.14	0.15	565.66	578.14	2.41	2.44	+0.98
2001	0.14	0.13	1,500.00	1,536.00	4.68	4.38	-6.39
2002	0.15	0.15	1,705.00	1,741.38	7.35	6.92	-5.88
2003	0.14	0.14	1,723.55	1,778.93	9.47	8.93	-5.74
2004	0.13	0.13	1,933.00	2,006.66	11.77	11.12	-5.47
2005	0.14	0.14	2,079.84	2,151.25	14.74	13.90	-5.70
2006	0.13	0.13	2,558.26	2,757.67	14.96	14.51	-3.02
2007	0.12	0.12	2,841.68	3,083.55	20.39	19.85	-2.68
2008	0.12	0.12	3,024.99	3,549.84	22.23	22.59	+1.63
2009	0.12	0.12	3,158.06	3,304.56	27.07	27.03	-0.15
2010	0.12	0.12	3,183.32	3,331.94	31.60	31.03	-1.81

Table 8.17 Changes made at parameters level and their effects on emission estimates

Year	Municipal solid waste and sewage sludge disposed to unmanaged sites [Gg]		Methane Emissions [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1950	2,330.78	2,392.42	1.41	1.52	8.00
1951	2,355.22	2,417.52	2.77	2.98	7.47
1952	2,414.95	2,478.83	4.15	4.44	6.96
1953	2,471.27	2,536.63	5.53	5.88	6.50
1954	2,523.49	2,590.24	6.97	7.34	5.39
1955	2,574.81	2,642.92	8.28	8.76	5.72
1956	2,562.70	2,630.48	9.58	10.10	5.40
1957	2,672.84	2,743.53	10.96	11.52	5.10
1958	2,709.48	2,781.15	12.33	12.92	4.83
1959	2,740.73	2,813.22	13.67	14.30	4.59
1960	2,795.01	2,868.94	15.02	15.68	4.37
1961	2,828.71	2,903.53	16.36	17.04	4.17
1962	2,851.87	2,927.30	17.67	18.37	3.98
1963	2,883.03	2,959.29	18.96	19.68	3.82
1964	2,906.62	2,983.50	20.22	20.96	3.67
1965	2,931.04	3,008.57	21.46	22.22	3.53
1966	3,068.87	3,150.04	22.85	23.63	3.41
1967	3,101.27	3,183.30	24.22	25.02	3.29
1968	3,104.80	3,186.92	25.54	26.35	3.18
1969	3,159.31	3,242.87	26.88	27.70	3.08
1970	3,205.72	3,290.51	28.22	29.07	2.98
1971	3,250.25	3,336.22	29.58	30.44	2.90
1972	3,292.43	3,379.51	30.95	31.82	2.81

Year	Municipal solid waste and sewage sludge disposed to unmanaged sites [Gg]		Methane Emissions [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1973	3,332.23	3,420.37	32.31	33.19	2.74
1974	3,381.69	3,471.14	33.69	34.59	2.67
1975	3,431.71	3,522.48	35.10	36.01	2.60
1976	3,482.80	3,574.92	36.53	37.45	2.54
1977	3,636.05	3,732.22	38.17	39.11	2.48
1978	3,692.76	3,790.43	39.83	40.80	2.42
1979	3,728.28	3,826.89	41.49	42.47	2.36
1980	3,783.54	3,883.61	43.17	44.17	2.31
1981	3,842.36	3,943.99	44.89	45.90	2.26
1982	3,908.39	4,011.76	46.65	47.68	2.21
1983	3,941.19	4,045.44	48.40	49.44	2.16
1984	3,960.80	4,065.56	50.10	51.16	2.12
1985	4,002.60	4,108.46	51.80	52.87	2.08
1986	4,036.37	4,143.13	53.49	54.58	2.04
1987	4,080.25	4,188.17	55.19	56.29	2.00
1988	4,118.37	4,227.30	56.89	58.00	1.96
1989	4,176.39	4,286.86	58.63	59.75	1.92
1990	4,222.60	4,334.29	60.38	61.52	1.89
1991	4,212.62	4,324.04	62.03	63.18	1.86
1992	4,144.63	4,254.25	63.45	64.61	1.82
1993	4,146.24	4,255.90	64.81	65.97	1.79
1994	4,146.47	4,256.14	66.10	67.26	1.76
1995	5,608.00	5,756.33	71.23	72.47	1.74
1996	4,967.00	5,101.01	74.44	75.72	1.71
1997	3,090.00	3,177.85	75.15	76.37	1.62

Year	Municipal solid waste and sewage sludge disposed to unmanaged sites [Gg]		Methane Emissions [Gg]		Difference [%]
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1998	4,240.17	4,359.83	77.03	78.26	1.60
1999	5,236.72	5,357.47	81.03	82.27	1.54
2000	6,045.32	6,178.72	87.42	88.70	1.46
2001	4,579.00	4,688.88	90.22	91.48	1.40
2002	5,159.66	5,269.75	94.76	96.01	1.32
2003	4,610.00	4,758.13	97.69	99.00	1.34
2004	4,700.00	4,879.10	99.85	101.26	1.42
2005	4,800.00	4,964.79	102.62	104.10	1.44
2006	4,209.63	4,537.75	104.29	106.14	1.77
2007	4,007.42	4,348.52	105.31	107.51	2.09
2008	4,261.42	4,936.30	106.63	109.85	3.02
2009	3,596.83	3,763.68	107.24	110.26	2.82
2010	3,625.61	2,313.82	107.86	108.30	0.40

The differences between methane emissions in 2012 v 3.1 submission and 2013 v 1.3 submission can be explained by the introduction of CH_4 emissions from sewage sludge disposed to SWDS (Table 8.16, Table 8.17)

8.2.6 Source specific planned improvement including those in response to the review process

In order to improve the next submissions, the to the development of a study for determination of the industrial waste quantities with biodegradable content, data for the period 1950-2012, is analyzed.

8.3 Source category Wastewater Handling (CRF sector 6.B)

8.3.1 Source category description

This sector includes methane emissions from industrial and domestic/commercial wastewater handling and nitrous oxide emissions from human sewage.

In Romania, the European legislation in the field of wastewater treatment and discharge into the environment has been implemented during 2002-2005, but further steps are necessary to comply fully implementing the requirements of the Directive. Final transition period for implementation of this Directive has been set at December 31, 2018, with intermediate deadlines for urban wastewater collection and treatment.

In 2011, from a total volume of 5,241.30 million m^3/year wastewater evacuated, 43.13% was wastewater which requiring treatment**.** From this, 11.04% was represented wastewater sufficient (appropriate) treated, 15.66% untreated wastewater and 16.42% insufficient treated wastewater (Table 8.18).

Table 8.18 Wastewater evacuated into Romania, in 2011 (Source: National Administration "Romanian Waters")

Wastewater category	Volume (mil. mc)	Percentage (%)
Total wastewater evacuated	5,241.30	-
Total domestic wastewater evacuated	1,300.00	24.80
Total industrial wastewater evacuated	3,941.30	75.20
Domestic wastewater treated	759.99	14.50
Industrial wastewater treated	649.92	12.40
Total wastewater requiring	2,260.43	43.13

Wastewater category	**Volume (mil. mc)**	**Percentage (%)**
treatment		
Sufficient treated wastewater	578.75	11.04
Insufficient treated wastewater	860.68	16.42
Untreated wastewater	821.00	15.66

Urban wastewater treatment plants can receive for treatment: wastewater from households or commercial institutions; water from streets cleaning; water from rainfall, and industrial wastewater. Industrial wastewater treatment plants are built on industrial sites and treats only industrial wastewater.

Discharge conditions of industrial wastewater in the sewage system and maximum concentrations of water quality indicators used are given in Standard NTPA 002.

Wastewater treatment processes are: mechanical, mechanical- chemical and mechanical - biological methods, most of the times using a combination of these.

According to data provided by N.A. “Romanian Waters”, the largest amount of wastewater comes from industry, about 3,941.3 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 2011 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: 87 treatment plants;
- secondary stage: 338 treatment plants;
- tertiary stage: 6 treatment plants.

This situation is changing every year because the sewage system extends under projects financed by government programs, enhancing the connection to the sewerage and wastewater treatment.

CH_4 emissions from wastewater handling

CH_4 emissions from industrial wastewater and sludge (CRF 6.B.1)

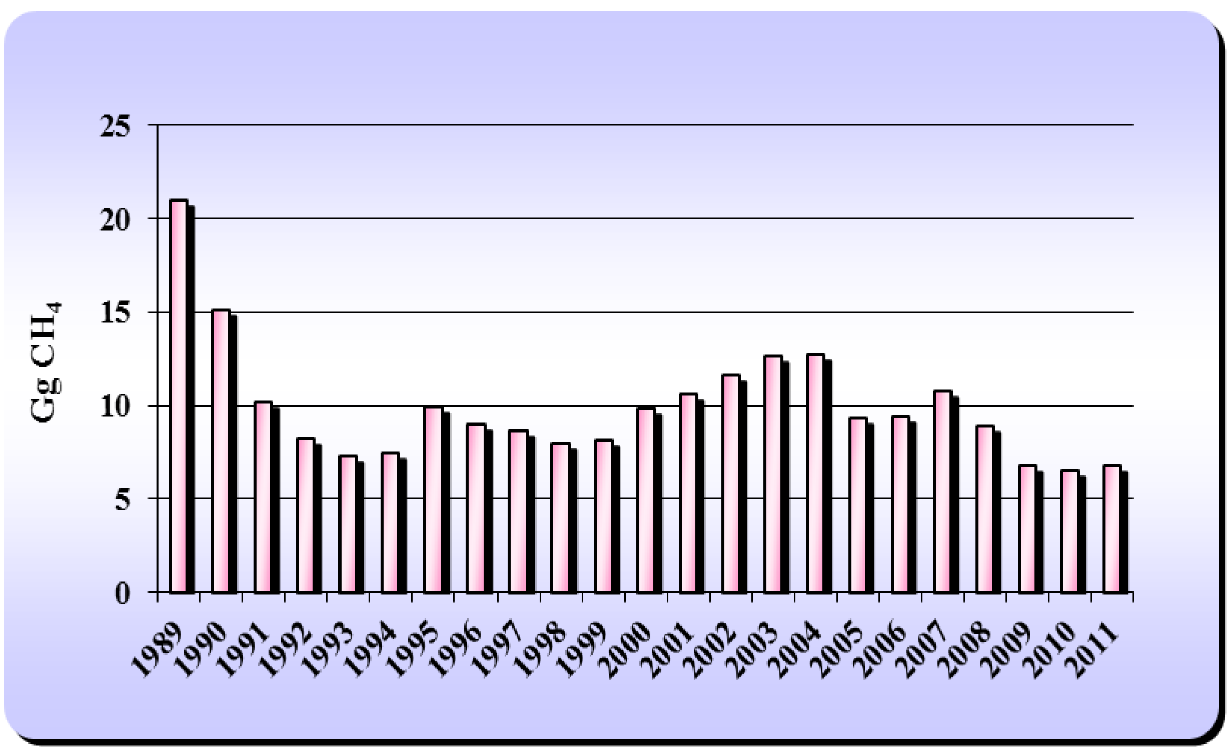
Depending on the industry of origin, industrial wastewaters have a different composition.

The sensitive issues of industrial wastewater treatment are associated with time-varying flows, extreme temperatures and excessive quantities of the following substances: petroleum products, organic oils, fats; acids and bases; materials in suspension; organic and inorganic substances; explosives and flammable materials; corrosive or volatile smelling gases.

Analysing the trend of methane emissions from industrial wastewater handling it can remark several periods when the emissions increased or decreased. These fluctuations are due to the increasing or decreasing of industrial production, reflecting in the emissions trend fluctuation (Figure 8.8, Table 8.21).

Since 2007, CH_4 emissions from industrial wastewater treatment have begun to fall due to the drastic decline of pulp production, industrial branch which produces wastewater with the highest organic load (Figure 8.8).

Figure 8.8 CH_4 emissions trend from industrial wastewater handling for 1989–2011 period



Compared with the base year (1989), CH_4 emissions from industrial wastewater treatment decreased with 67.70 %.

CH_4 emissions from domestic and commercial wastewater and sludge (CRF 6.B.2.1)

In estimation of CH_4 emissions from domestic/commercial wastewater and sludge, was considered a large category of population including both the population connected to sewerage with treatment and population unconnected to sewerage. Domestic wastewater collected from the population connected to sewerage without treatment suffers a self-cleaning aerobic process with minor methane emissions. This wastewater is directly discharged into the environment (rivers or underground).

Analysing the chart below, it can observe a mainly decreasing trend due to the increasing number of population connected to sewerage *(Figure 8.9)*. The methane emissions level of 2011 compared to base year (1989) is in decreasing with 11.14 %.

Figure 8.9 CH_4 emissions trend from domestic/commercial wastewater and sludge treatment for 1989–2011 period

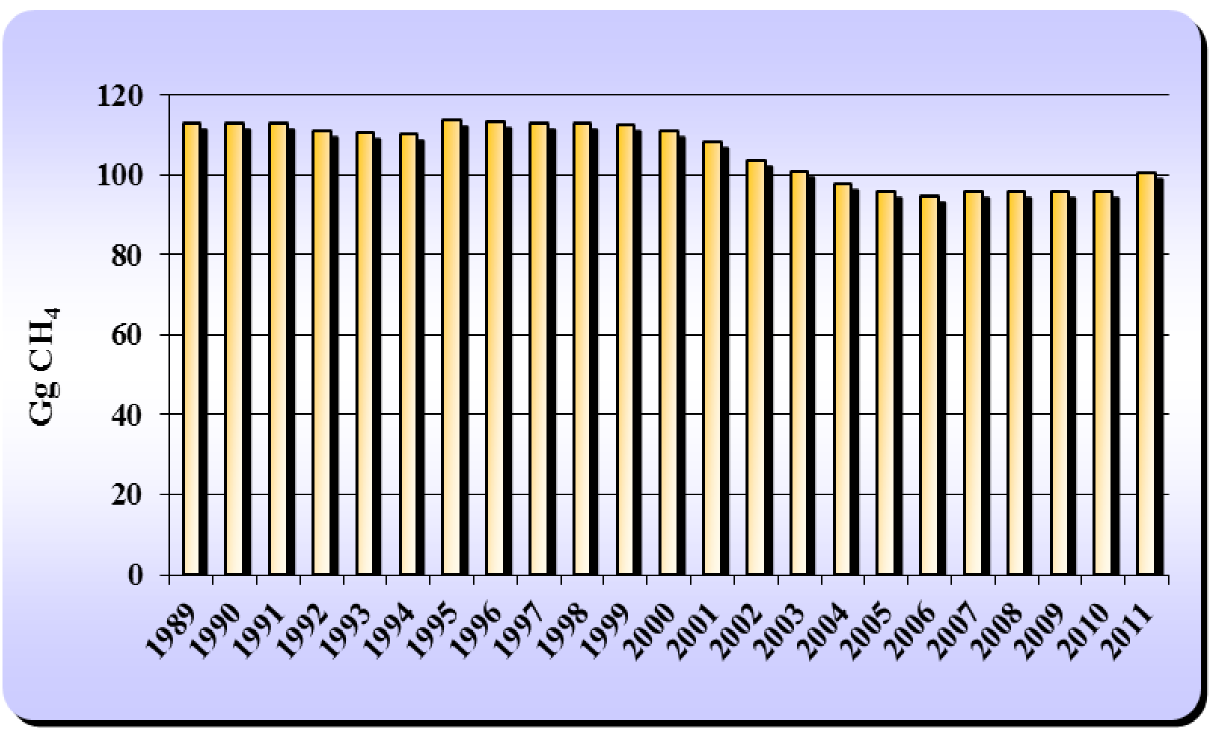
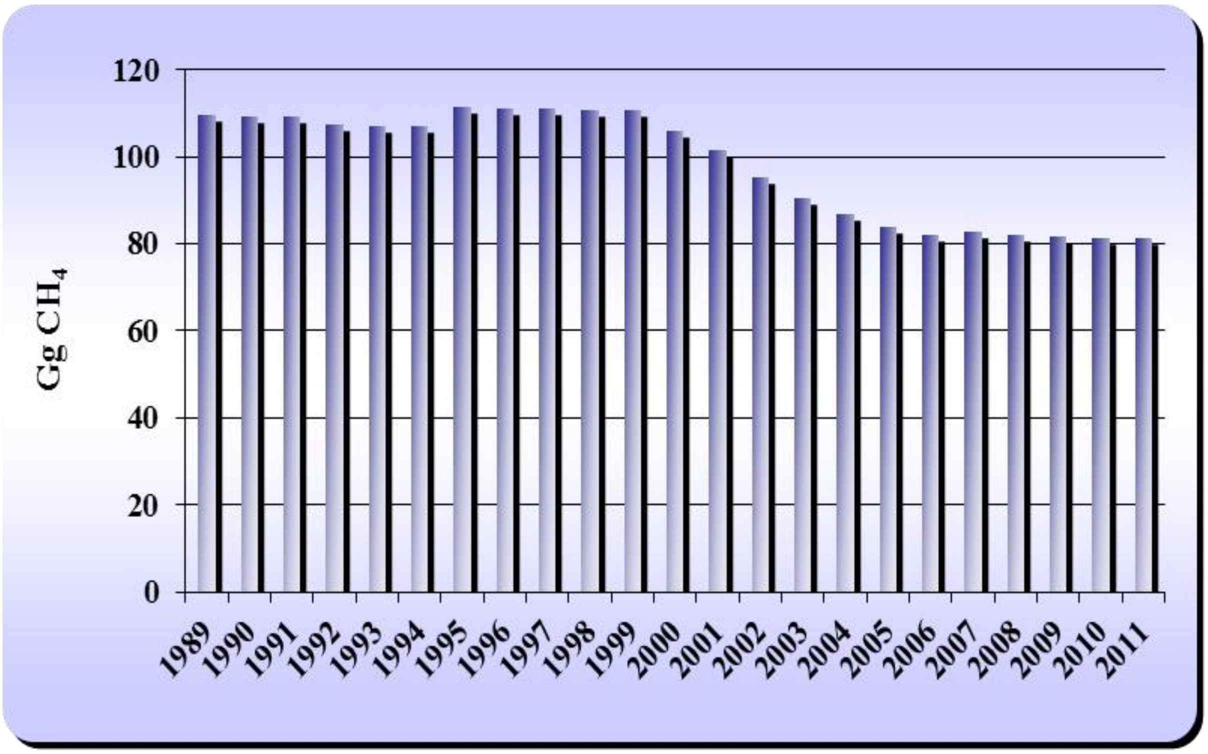


Table 8.19 Explanations on methane emissions estimates

Period	Methane emissions from industrial wastewater treatment - Explanations
1989-1996	Values between 21.01–8.96 Gg These values are decreasing following decreasing industrial production.
1997-2004	Values between 8.65–12.77 Gg These values are relatively higher than previous period due to: • progress in Romanian economy, increase of the production • increasing of fraction of wastewater treated anaerobically.
2005-2011	Values between 9.32–6.79 Relatively lower values compared with 1997-2004 period, but since 2009 following a sharp decline due to economic crisis

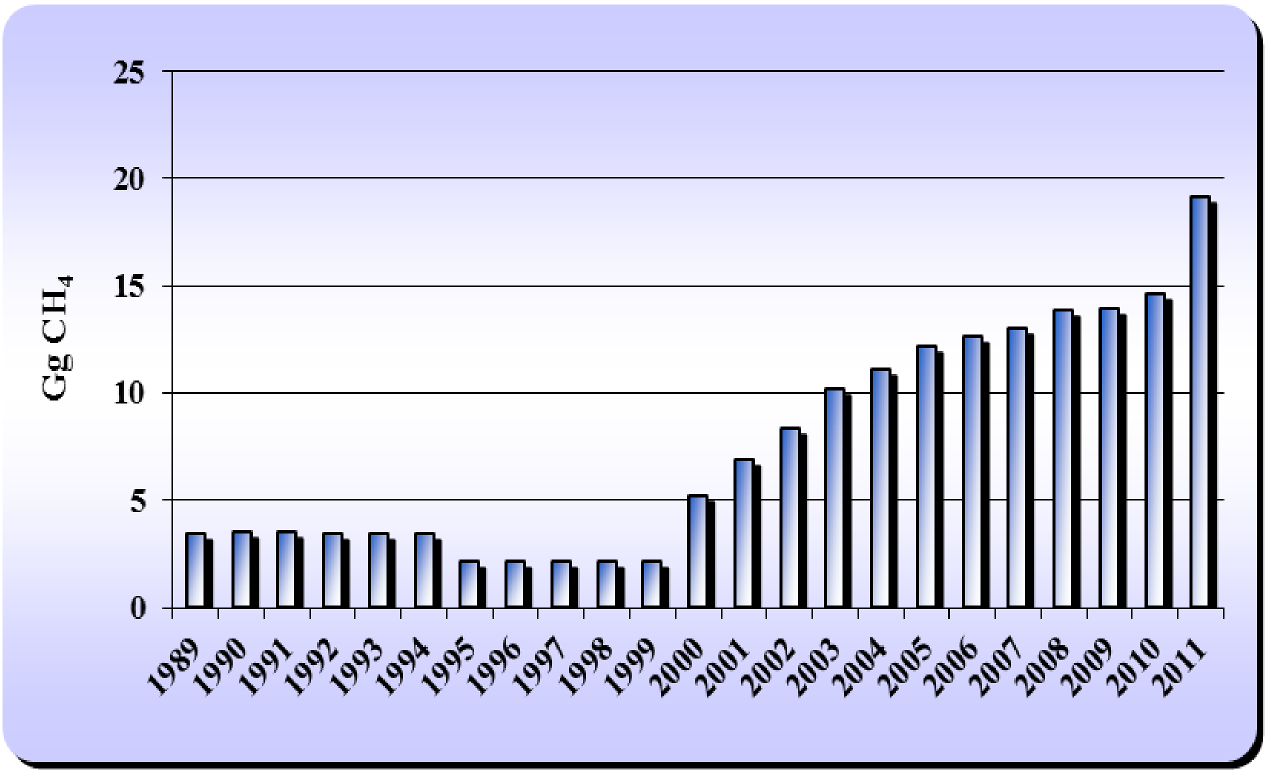
The same decreasing tendency is noted for CH_4 emissions from domestic/commercial wastewater without taking into account the emissions from domestic/commercial sludge (Figure 8.10).

Figure 8.10 CH_4 emissions trend from domestic/commercial wastewater treatment for 1989–2011 period



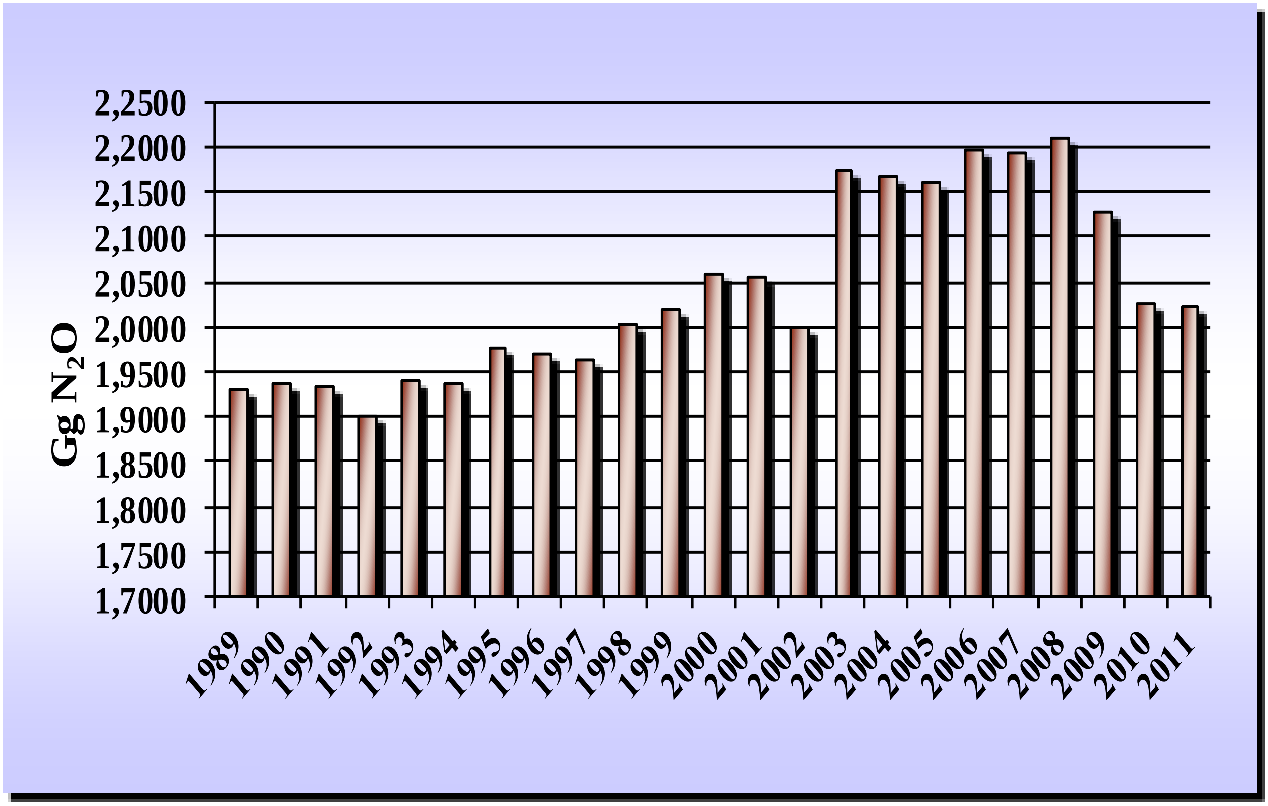
In 2011, CH_4 emissions from domestic/commercial sludge increased almost 6 times compared with 1989 (Figure 8.11). As for emissions from domestic/commercial wastewater treatment the explanation is the increasing of number population connected to sewerage, in particular connected to sewerage with treatment.

Figure 8.11 CH_4 emissions trend from domestic/commercial sludge treatment for 1989–2011 period



For estimate N_2O emissions from human sewage was used the total population of our country. The fluctuations are in generally due to the population consumption values provided by Food and Agriculture Organization of the United Nations and National Institute for Statistics. Over the 1989–2009 period, N_2O emissions from Human sewage category have maintained an increasing trend, due to the decreasing number of population, on the one hand and on the other hand due to the increasing values of protein consumption. The sharp decrease of N_2O emissions recorded in 2002, compared with 2001 year, is due to the severe loss of population number. Additional, the increasing trend of N_2O emissions recorded in 2003, compared with 2002 year is due to the increasing values of protein consumption. After 2009 year, the emissions register a sharply decrease, being influenced by the several decrease of protein consumption values, reflecting so the impact of recent economic crisis. (Figure 8.12 and Table 8.30).

Figure 8.12 N_2O emissions trend from human sewage for 1989–2011 period



8.3.2 Methodological issues

CH_4 emissions from industrial wastewater and sludge (CRF 6.B.1)

Methane is the result of anaerobic processes that occur during treatment of industrial wastewater in wastewater industrial treatment plants.

To establish the approach to estimate methane emissions from this sub-category we using the decision tree from IPCC Good Practice Guidance, figure 5.4, according which it is necessary to identify three or four industries that produce large quantities of wastewater with high content of degradable organic component.

By study *"Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"* has been identified three industrial sectors with the greatest potential for methane emissions from wastewater treatment: brewing, pulp and paper, oil refining. These sectors have wastewater treatment plants containing potential biological treatment step in CH_4 emissions.

Classical procedures of wastewater treatment, available in almost all cases to municipal wastewater, offer limited opportunities for industrial wastewater treatment. Thus, these methods are not able to lower the dissolved mineral impurities content in wastewater, some organic substances, especially synthetic, are not being degraded by microorganisms and pass unchanged through wastewater treatment. These impurities remain in the water emissaries and are not eliminate during natural self-cleaning processes. The methods to remove pollutants from industrial wastewater are: physical, chemical and biological methods. Application of these methods depends on the composition of wastewater.

Methodology

Default method was used for calculating CH_4 emissions from industrial wastewater according to the IPCC GPG 2000.

After recent investigation, experts identified that only in several breweries wastewater is treated in anaerobic conditions. In pulp, paper and petroleum refining industries as well as in the most of breweries wastewater is treated in aerobic conditions with minor methane emissions.

For methane emissions from industrial wastewater calculation, the equation 5.5 from page 5.14 was used:

Equation 8.4 CH_4 emissions from industrial wastewater

*Emissions = (Total Organic Waste * Emission Factor) – Methane Recovery*

The following steps were considered:

1. Calculation of Total Organic Wastewater for each of the three industrial branches, using equation 8 from Revised 1996 IPCC Guidelines:

Equation 8.5 Total Organic Wastewater for each of the three industrial branches

$$TOW_{ind}\ (kg\ COD/yr) = W * O * D_{ind} * (1 - DS_{ind})$$

2. Calculation of Total Industrial Organic Wastewater for pulp, paper and petroleum refining, by summing TOW obtained for each industry in step 1.

Equation 8.6 Total Industrial Organic Wastewater for pulp, paper and petroleum refining

$$TOW_{ind\ total} = TOW_{beer} + TOW_{pulp\&paper} + TOW_{petroleum\ ref.}$$

Estimation of CH_4 emissions on the one hand for pulp, paper, petroleum refining and on the other hand separately for anaerobic and aerobic treatment in beer industry:

Equation 8.7 Estimation of CH_4 emissions

$$CH_{4emissions\ pulp,\ paper,\ petroleum\ ref} = (TOW_{beer} * EF_{pulp,\ paper,\ petroleum\ ref.})$$

$$CH_{4emissions\ anaerobic\ treat.\ beer} = (TOW_{beer} * EF_{anaerobic\ treat.}) - Methane\ Recovery$$

$$CH_{4emissions\ aerobic\ treat.\ beer} = (TOW_{beer} * EF_{aerobic\ treat.})$$

Methane is recovered only in beer industry which treating their wastewater in anaerobic conditions.

Emission factor

To calculate Emission Factor we used the equation 10 from Revised 1996 IPCC Guidelines:

Equation 8.8 The emission factor for industrial wastewater

$$EF_i = B_{oi} * \sum(WS_{ix} * MCF_x)$$

The fraction of wastewater treated anaerobically (WS anaerobic) was calculated based on the wastewater generated in beer industry with anaerobic treatment and the total wastewater generated in the beer industry (Table 8.20).

In accordance with IPCC 2006 Guidelines, Methane Conversion Factor for aerobic treatment is 0.05 and for anaerobic treatment is 0.80.

Table 8.20 The Emissions Factors for aerobic and anaerobic treatment

	EMISSION FACTORS						
Industry - Period	Fraction of wastewater treated anaerobically - WS anaerobic	Fraction of wastewater treated aerobically - WS aerobic	Methane Conversion Factor in anaerobic treatment – MCF anaerobic	Methane Conversion Factor in aerobic treatment – MCF aerobic	Maximum methane producing capacity - Bo (kg CH_4/kg COD)	Emission factor for industrial wastewater treated anaerobically - EF (kg CH_4/kg COD) - ANAEROBIC	Emission factor for industrial wastewater treated aerobically - EF (kg CH_4/kg COD) - AEROBIC
Beer industry							
1989-1997	0.000	1.000	0.800	0.050	0.250	0.000	0.013
1998	0.106	0.894	0.800	0.050	0.250	0.021	0.011
1999	0.103	0.897	0.800	0.050	0.250	0.021	0.011
2000	0.107	0.893	0.800	0.050	0.250	0.021	0.011
2001	0.124	0.876	0.800	0.050	0.250	0.025	0.011
2002	0.149	0.851	0.800	0.050	0.250	0.030	0.011
2003	0.144	0.856	0.800	0.050	0.250	0.029	0.011
2004	0.144	0.856	0.800	0.050	0.250	0.029	0.011
2005	0.155	0.845	0.800	0.050	0.250	0.031	0.011
2006	0.191	0.809	0.800	0.050	0.250	0.038	0.010
2007	0.212	0.788	0.800	0.050	0.250	0.042	0.010
2008	0.408	0.592	0.800	0.050	0.250	0.082	0.007
2009	0.447	0.553	0.800	0.050	0.250	0.089	0.007
2010	0.469	0.531	0.800	0.050	0.250	0.094	0.007
2011	0.462	0.538	0.800	0.050	0.250	0.092	0.007
Pulp, paper and petroleum refinery							
1989-2011	0.000	1.000	0.800	0.050	0.250	0.000	0.013
Source	Expert judgement based on data provided by economic operators		IPCC 2006		IPCC GPG 2000, page 5.17	Calculated	

For Maximum methane producing capacity (B_{oi}) were not found national values, in this case has been used the default value of 0.25 kg CH_4/kg COD (Chemical Oxygen Demand) from IPCC GPG 2000.

The weighted MCF (Methane conversion factor) values were determined according to equation 5.8 from IPCC GPG 2000:

Equation 8.9 The weighted Methane Conversion Factor for industrial wastewater

$$Weighted\ MCF_i = \sum(WS_{ix} * MCF_x)$$

Activity data

The activity data as regard industrial production of sectors taking into account have been provided by National Institute for Statistics (Table 8.21).

Table 8.21 Industrial production of the industrial sectors with the greatest potential for methane emissions (source: NIS - Statistical Yearbook 2011)

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

Year	Production (t/year)			
	Beer	Paper	Pulp	Petroleum Refining
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
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

* Confidential data

As regards Degradable Organic Component and Wastewater generated, we used the default values from IPCC GPG 2000 (Table 8. 22).

Table 8.22 Parameters used to estimate Total organic industrial wastewater (Source: IPCC GPG 2000, table 5-4)

Default Parameters	Industry type		
	Beer	Pulp &Paper	Petroleum Refineries
Degradable Organic Component – COD [g/l]	2.9	9.0	1.0
Wastewater Generation [m^3/Mg]	6.3	162	0.6

In estimation of methane emissions from industrial wastewater Degradable Organic Component removed as sludge was considered zero.

CH_4 recovery

Starting with the current submission, data on methane recovered from industrial wastewater treatment became available. Considering information that we have at this time, the methane is recovered by most important 4 operators of breweries (Table 8.23).

Table 8.23 The amounts of CH_4 recovered from industrial wastewater treatment (Source: economic operators)

Year	Amount of Methane recovery Gg/year
1989-1997	-
1998	0.18
1999	0.28
2000	0.41
2001	0.54
2002	0.60
2003	0.61
2004	0.74
2005	0.84
2006	1.02
2007	1.14
2008	1.62
2009	2.17
2010	2.54
2011	2.51

CH_4 emissions from industrial sludge

CH_4 emissions from industrial sludge are reported IE because the emissions are included at the industrial wastewater level. According IPCC GPG 2000, the theoretical default Bo values for sludge and wastewater are the same and if default factors are being used, emissions from wastewater and sludge can be estimated together.

CH_4 emissions from domestic and commercial wastewater handling (CRF 6.B.2)

Domestic wastewater is treated in municipal treatment plants wastewater by the following processes: mechanical treatment, chemical-mechanical treatment or biological-mechanical treatment.

In biological treatment are two types of processes:

- aerobic processes, when result energy by oxidation of organic substances. Aerobic processes depend on the existence of aerobic bacteria, and these on the presence of dissolved oxygen. By aerobic treatment process organic material is removed from the wastewater.
- anaerobic processes, characterized by reducing oxygen and energy consumption. Anaerobic treatment of wastewater leads to nitrogen removal by nitrification and denitrification processes. During anaerobic processes occur methane emissions.

In Romania, most municipal treatment plants have old equipment and technologies, leading to low efficiency and quality of treated wastewater over the limit imposed by the Standard NTPA - 011. About 30% of treatment plants are equipped with sludge digestion tanks. Most of the sludge resulting from the treatment (70%) is deposited directly on drying platforms *(Source 2.13 – Development of national policy for managing sewage sludge, page 128).*

After 2000, number of projects for new wastewater plants and for rehabilitation and modernization begun to increase, in the period 2000-2007 the number of municipalities with wastewater treatment plants increasing to 45 cities.

Methodology

To estimate CH_4 emissions from domestic and commercial wastewater, we taking into account the decisions tree from IPCC GPG 2000, page 5.15 and we used the following equations from the same methodology:

Equation 8.10 CH_4 emissions from domestic and commercial wastewater

*Emissions = (Total Organic Waste * Emission Factor) – Methane Recovery*

Were estimated CH_4 emissions both from the population connected to sewerage with treatment and population unconnected to sewerage.

The following steps were considered:

1. Calculation of Total Organic Wastewater for population connected to sewerage with treatment, using equation 6 from Revised 1996 IPCC Guidelines:

Equation 8.11 Total Organic Wastewater

$$TOW_{dom} = P * D_{dom} *(1 - DS_{dom})$$

2. Calculation of Total Organic Wastewater for population unconnected to sewerage, using the same equation as in step 1.
3. Estimation of CH_4 emissions provided from the population connected to sewerage with treatment, using TOW_{dom} obtained in step 1 and the Emission Factor provided by study finished in 2011.
4. Estimation of CH_4 emissions provided from the population unconnected to sewerage, using TOW_{dom} obtained in step 2 and the Emission Factor provided by study finished in 2011.
5. Summing the CH_4 emissions provided from the population connected to sewerage with treatment and those provided from the population unconnected to sewerage

Emission factor

To calculate Emission Factor we used the equation 10 from Revised 1996 IPCC Guidelines:

Equation 8.12 Emission Factor for domestic and commercial wastewater

$$EF_i = B_{oi} * \sum(WS_{ix} * MCF_x)$$

According to methodology it was taking in consideration only the fraction of domestic/commercial wastewater treated anaerobically because only in this case methane issue. The percentages of domestic/commercial wastewater treated anaerobically are presented in Table 8.24.

Table 8.24 Calculation of Emission Factors domestic/commercial wastewater, for 1989-2011 period

Parameter	**B_{oi}** ($kg\ CH_4/kg$ BOD)	**WS_{ix}**	**MCF_x**	**EFs**
Population connected to sewerage with treatment	0.60	0.05	0.9	**0.03**
Population unconnected to sewerage	0.60	1.00	0.5	**0.30**
Source:	IPCC GPG 2000	Expert opinion	Expert opinion	-

The weighted MCF (Methane conversion factor) values were determined according to equation 5.8 from IPCC GPG 2000:

Equation 8.13 The weighted Methane Conversion Factor for domestic and commercial wastewater

$$Weighted\ MCF_i = \sum(WS_{ix} * MCF_x)$$

where:

- WS_{ix} *– fraction of wastewater type treated using wastewater handling system*
- MCF_x *– methane conversion factor of wastewater handling system*

Activity data

To estimates methane emissions from domestic/commercial wastewater handling were used data provided by study "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation".

The number of population connected to sewerage with treatment was calculated using total population and fraction of population connected to sewerage with treatment. The data on total population were obtained from National Institute for Statistics (NIS). The fraction of total population connected to sewerage with treatment is obtained by different sources (Table 8.26).

The data regarding population unconnected to sewerage were obtained making the difference between total population and population connected to sewerage (Table 8.25).

Table 8.25 Activity data for methane emissions estimates from domestic/commercial wastewater (Source: Study finished in 2011)

Year	**Total population [1000 persons]**	**Total population connected to sewerage with treatment**	**Total population unconnected to sewerage**
	(1000 persons)		
1989	23,151.56	2,770.16	16,527.28
1990	23,206.72	2,836.99	16,472.95

Year	Total population [1000 persons]	Total population connected to sewerage with treatment	Total population unconnected to sewerage
	(1000 persons)		
1991	23,185.08	2,824.29	16,473.23
1992	22,788.97	2,782.66	16,181.50
1993	22,755.26	2,791.40	16,137.56
1994	22,730.62	2,796.21	16,107.90
1995	22,680.95	1,744.01	16,880.17
1996	22,607.62	1,737.56	16,827.43
1997	22,545.93	1,736.66	16,772.75
1998	22,502.80	1,728.70	16,751.26
1999	22,458.02	1,722.38	16,724.51
2000	22,435.21	2,460.77	16,028.52
2001	22,408.40	3,254.53	15,311.64
2002	21,794.79	3,935.02	14,332.20
2003	21,733.56	4,788.86	13,616.12
2004	21,673.33	5,203.79	13,013.89
2005	21,623.85	5,738.36	12,547.12
2006	21,584.37	6,068.66	12,539.65
2007	21,537.56	6,130.40	12,369.22
2008	21,504.44	6,215.16	12,290.81
2009	21,469.96	6,236.53	12,246.79
2010	21,462.19	6,541.22	12,148.16
2011	21,413.82	8,568.77	12,094.59

The data sources are presented in the next table:

Table 8.26 The sources of activity data used in methane emissions estimates from domestic/commercial wastewater treatment

Activity Data	Source
Total population [1000 persons]	*National Institute for Statistics*
Total population connected to sewerage with treatment [1000 persons] - $P_{tot\ tr}$	*1989 -2005 period:* $P_{tot\ tr} = P_{urb\ tr} + P_{rur\ tr}$; *2006 – 2011 : National Institute for Statistics*
Total population unconnected to sewerage [1000 persons] – $P_{tot\ uncon}$	*1989 -2005 period:* $P_{tot\ uncon} = P_{urb\ uncon} + P_{rur\ uncon}$ *2006 – 2011 :* $P_{tot\ uncon} = P_{tot} – P_{tot\ tr}$
Total population [1000 persons]	*National Institute for Statistics*

To calculate Total Organic Wastewater we used the parameters provided by the study (Table 8.27).

Table 8.27 Parameters used to estimate Total organic domestic/commercial wastewater (Source: Study finished in 2011)

Parameters	Years				
	1989-1999	2000-2005	2006	2007	2008-2011
Degradable Organic Component – BOD [kg/1000 persons/yr]	21,900	21,900	21,438	21,900	21,900
Fraction of BOD removed as sludge	0.35	0.60	0.60	0.60	0.63

The value of BOD for year 2006 is a single national value and was provided by NIS. The other value of BOD is assumed by expert judgement and is provided by study finished in 2011.

The fraction of BOD removed as sludge for 1989-2007 was provided by expert Prof. Dr. Vladimir Rojanschi and for 2008-2011 period was provided by NIS.

CH_4 from domestic/commercial wastewater recovered and/or flared are reported NO. In the future we will investigate this issue by sending the specific questionnaires to the operators of the municipal wastewater treatment plants.

CH_4 emissions from domestic and commercial sludge

Quantities of sludge retained in various stages of treatment are different from one source to another, depending on the physic-chemical characteristics of raw water, the method and degree of treatment required. Thus, in municipal wastewater treatment, the sludge quantities are between 65 and 90 g/person/day.

Methodology

To estimate methane emissions from domestic/commercial sludge we used the equations 13 from Revised 1996 IPCC Guidelines:

Equation 8.14 Methane emissions from domestic/commercial sludge

$$SM = \sum_j (TOS_j * EF_j - MR_j)$$

The following steps were considered:

1. Calculation of Total Organic Waste for sludge, using the equation 7 from Revised 1996 IPCC Guidelines:

Equation 8.15 Total Organic Waste for sludge

$$TOS_{dom} = P * D_{dom} * DS_{dom}$$

2. Calculation of Emission Factor, using the equation 11 from Revised 1996 IPCC Guidelines:

Equation 8.16 Emission Factor for sludge

$$EF_j = B_{oj} * \sum(SS_{jy} * MCF_y)$$

3. Estimation of CH_4 emissions from domestic/commercial sludge, using TOS_{dom} and EF_j obtained in previous steps.

Emissions factor

The emission factor was calculated as mentioned in the previous paragraph, using the following values of parameters describes in the next table. By expert opinion it was considered a percentage of 30% domestic/commercial wastewater sludge treated by anaerobic processes and 70% by aerobic processes.

Table 8.28 Calculation of Emission Factor for domestic/commercial sludge, for 1989-2011 period

B_{oi} (kg CH_4/kg BOD)	SS_{jy}	MCF_y	EFs
0.60	0.30	0.9	**0.162**
IPCC GPG 2000	Expert opinion	Expert opinion	-

The weighted MCF (Methane conversion factor) values were determined according to equation 5.8 from IPCC GPG 2000:

Activity data

The same activity data presented to CH_4 emissions from domestic/commercial wastewater were used in calculation of methane emissions from domestic/commercial sludge.

N_2O emissions from Human Sewage (CRF 6.B.2.2)

Methodology

To estimate N_2O emissions from human sewage, we used the equation 15 from Revised 1996 IPCC Guidelines:

Equation 8.17 N_2O emissions from human sewage

$$N_2O_{(S)} = Protein * Frac_{NPR} * NR_{people} * EF_6$$

Emissions factor

Default emissions factors according to the provisions in IPCC 1996 have been used. The emissions factors are presented in Table 8.29.

Table 8.29 Parameters used to calculate emission factor from Human Sewage

Fraction of Nitrogen in Protein - $Frac_{NPR}$ [g N/kg protein]	**Emission factor - EF_6** [kg N_2O-N/kg sewage=N produced]
Source: IPCC 1996	Source: IPCC 1996
0.16	0.01

Activity data

In estimation of N_2O emissions from human sewage was taking into account the total population of our country. The number of population was provided by National Institute for Statistics for 1989-2011 period.

The data regarding Protein Consumption were provided by Food and Agriculture Organization site and by National Institute for Statistics being presented in the Table 8.30.

Table 8.30 Values of Protein Consumption for Romania in period 1989-2011

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	
2010	37,595	
2011	37,595*	*Preliminary data*

Table 8.31 The differences on N_2O emissions

Year	Protein consumption [Protein in kg/person/yr]		N_2O emissions [Gg]		Difference %
	NGHGI 2012 v. 2.1	NGHGI 2013	NGHGI 2012 v.2.1	NGHGI 2013	
1989	33.22	33.22	1.93	1.93	0.00
1990	33.22	33.22	1.94	1.94	0.00
1991	33.22	33.22	1.94	1.94	0.00
1992	33.22	33.22	1.90	1.90	0.00
1993	33.95	33.95	1.94	1.94	0.00
1994	33.95	33.95	1.94	1.94	0.00
1995	34.68	34.68	1.98	1.98	0.00
1996	34.68	34.68	1.97	1.97	0.00
1997	34.68	34.68	1.97	1.97	0.00
1998	35.41	35.41	2.00	2.00	0.00
1999	35.77	35.77	2.02	2.02	0.00
2000	36.50	36.50	2.06	2.06	0.00
2001	36.50	36.50	2.06	2.06	0.00
2002	36.50	36.50	2.00	2.00	0.00
2003	39.79	39.79	2.17	2.17	0.00
2004	39.79	39.79	2.17	2.17	0.00
2005	39.79	39.79	2.16	2.16	0.00
2006	40.52	40.52	2.20	2.20	0.00
2007	40.52	40.52	2.19	2.19	0.00
2008	40.52	40.88	2.19	2.21	0.90
2009	40.52	39.42	2.19	2.13	-2.70
2010	40.52	37.60	2.19	2.03	-7.21

The differences between 2012 v. 3.1 – 2013 v. 1.3 submissions associated to N_2O emissions from subcategory 6.B.2.2 for 2008 – 2009 period are due to the changes on activity data regarding protein consumption.

8.3.3 Uncertainties and time series consistency

CH_4 emissions from industrial wastewater

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

The uncertainties associated with CH_4 emissions from industrial wastewater are presented in the next table:

Table 8.32 Uncertainties for estimation of CH_4 emissions from industrial wastewater

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
CH_4 from industrial wastewater	CH_4	20.00	42.40	47.00

The percentages are associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

CH_4 from domestic and commercial wastewater

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

In the table below are presented the uncertainties associated CH_4 emissions from domestic/commercial wastewater treatment.

Table 8.33 Uncertainties for estimation of CH_4 emissions from domestic/commercial Wastewater

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
CH_4 from domestic and commercial wastewater	CH_4	20.00	42.40	47.00

The percentages are associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

N_2O from human sewage

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

In the table below are presented the uncertainties associated to N_2O emissions from human sewage.

Table 8.34 Uncertainties for estimation of N_2O emissions from human sewage

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
N_2O from wastewater handling	N_2O	20.00	50.00	54.00

The percentages are associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

8.3.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in the QA/QC Programme have been undertaken. A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectorial expert administrating the Solid Waste Disposal on Land category, the results of these being mentioned on the Checklists level.

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. 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 280/2004/EC of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

The number of population was provided by National Institute for Statistics the same parameter being reported to EUROSTAT. The differences between the two data sources come from different reference data (Table 8.35).

The data reported to EUROSTAT were estimated for 1 January of each year considered while the data taking into account in NGHGI 2012 were estimated for 1 July of each year. Both data are corrected and are provided by NIS.

Table 8.35 Comparison between data provided by EUROSTAT and data provided by NIS

Year	**Total number of population (1000 persons)**		**Difference (persons)**
	NGHGI 2013 (Source NIS) ***1 July***	**EUROSTAT** ***1 January***	
1989	23,151.564	-	-
1990	23,206.720	23,211.395	4.675
1991	23,185.084	23,192.274	7.190
1992	22,788.969	22,811.392	22.423
1993	22,755.260	22,778.533	23.273
1994	22,730.622	22,748.027	17.405
1995	22,680.951	22,712.394	31.443
1996	22,607.620	22,656.145	48.525
1997	22,545.925	22,581.862	35.937
1998	22,502.803	22,526.093	23.290
1999	22,458.022	22,488.595	30.573
2000	22,435.205	22,455.485	20.280
2001	22,408.393	22,430.457	22.064
2002	21,794.793	21,833.483	38.690
2003	21,733.556	21,772.774	39.218
2004	21,673.328	21,711.252	37.924
2005	21,623.849	21,658.528	34.679
2006	21,584.365	21,610.213	25.848
2007	21,537.563	21,565.119	27.556
2008	21,504.442	21,528.627	24.185

Year	**Total number of population (1000 persons)**		**Difference (persons)**
	NGHGI 2013 (Source NIS) ***1 July***	**EUROSTAT** ***1 January***	
2009	21,469.959	21,498.616	28.657
2010	21,462.186	21,462.186	0.000

Taking into account the previous mentions we can consider that the two data sets are comparable.

8.3.5 Source specific recalculation, including changes made in response to the review process

In order to improve the quality emissions estimates the following recalculation was done:

- **activity data**
  - CH_4 emissions from domestic and commercial wastewater were recalculated for 2006-2010 period using the number of population connected to sewerage with treatment and the number of population unconnected to sewerage provided by NIS;
  - Were reviewed the data regarding Protein Consumption provided by Food and Agriculture Organization of the United Nations.
- **Emission Factor**
  - Based on country specific values for Fraction of industrial wastewater treated anaerobically and Fraction of industrial wastewater treated aerobically (WSx) and using values for Methane Conversion Factor (MCF) in accordance with IPCC 2006 Guidelines, new Emission Factors were calculated.
- **Methane recovery**
  - Data on methane recovered from industrial wastewater treatment were collected from the operators and used in the estimation of methane emissions.

Table 8.36 Effects of activity data on emission estimates from industrial wastewater

Year	**CH_4 emissions**		**Difference (%)**
	NGHGI 2012 v. 3.1	**NGHGI 2013 v. 1.4**	
1989	18.91	21.01	11.11
1990	13.61	15.13	11.11
1991	9.19	10.22	11.11
1992	7.40	8.22	11.11
1993	6.53	7.25	11.11
1994	6.68	7.42	11.11
1995	8.91	9.90	11.11
1996	8.07	8.96	11.11
1997	15.57	8.65	-44.44
1998	14.03	7.98	-43.16
1999	14.37	8.10	-43.63
2000	17.56	9.81	-44.15
2001	19.04	10.57	-44.48
2002	20.98	11.65	-44.47
2003	22.64	12.62	-44.25
2004	23.03	12.77	-44.55
2005	25.24	9.32	-63.06
2006	25.01	9.39	-62.48
2007	28.36	10.76	-62.05
2008	20.75	8.90	-57.14
2009	16.60	6.75	-59.35
2010	17.22	6.52	-62.16

The differences regarding CH_4 emissions identified in 1996-2010 period are due to the changes on fraction of wastewater treated anaerobically and methane conversion factor. Changes made in activity data were improved in response to the review process.

Table 8.37 Changes made in activity data and their effects on emission estimates from domestic/commercial wastewater

Year	Fraction of wastewater treated anaerobically - WS_x		Methane Conversion Factor - MCF_x		Degradable Organic Component - D_{dom} [kg BOD/1000 persons/yr]		Fraction of BOD removed as sludge - DS_{dom}		CH_4 emissions		Difference (%)
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	109.65	109.65	0.00
1990	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	109.32	109.32	0.00
1991	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	109.31	109.31	0.00
1992	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	107.38	107.38	0.00
1993	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	107.10	107.10	0.00
1994	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	106.90	106.90	0.00
1995	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	111.57	111.57	0.00
1996	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	111.22	111.22	0.00
1997	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	110.86	110.86	0.00
1998	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	110.72	110.72	0.00
1999	0.05	0.05	0.90	0.90	21,900	21,900	0.35	0.35	110.54	110.54	0.00
2000	0.05	0.05	0.90	0.90	21,900	21,900	0.60	0.60	105.89	105.89	0.00
2001	0.05	0.05	0.90	0.90	21,900	21,900	0.60	0.60	101.37	101.37	0.00
2002	0.05	0.05	0.90	0.90	21,900	21,900	0.60	0.60	95.09	95.09	0.00
2003	0.05	0.05	0.90	0.90	21,900	21,900	0.60	0.60	90.59	90.59	0.00
2004	0.05	0.05	0.90	0.90	21,900	21,900	0.60	0.60	86.73	86.73	0.00
2005	0.05	0.05	0.90	0.90	21,900	21,900	0.60	0.60	83.79	83.79	0.00
2006	0.05	0.05	0.90	0.90	21,438	21,438	0.60	0.60	67.96	82.05	20.74
2007	0.05	0.05	0.90	0.90	21,900	21,900	0.60	0.60	67.10	82.72	23.27
2008	0.05	0.05	0.90	0.90	21,900	21,900	0.63	0.63	65.24	82.11	25.86
2009	0.05	0.05	0.90	0.90	21,900	21,900	0.63	0.63	63.11	81.83	29.66
2010	0.05	0.05	0.90	0.90	21,900	21,900	0.63	0.63	61.11	81.24	32.95

Table 8.38 Changes made in activity data and their effects on emission estimates from domestic/commercial sludge

Year	Fraction of sludge treated anaerobically – SS_y		Methane Conversion Factor – MCF_y		Degradable Organic Component - D_{dom} [kg BOD/1000 persons/yr]		Fraction of BOD removed as sludge - DS_{dom}		CH_4 emissions		Difference (%)
	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	NGHGI 2012 v. 3.1	NGHGI 2013 v. 1.4	
1989	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	3.44	3.44	0.00
1990	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	3.52	3.52	0.00
1991	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	3.51	3.51	0.00
1992	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	3.46	3.46	0.00
1993	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	3.47	3.47	0.00
1994	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	3.47	3.47	0.00
1995	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	2.17	2.17	0.00
1996	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	2.16	2.16	0.00
1997	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	2.16	2.16	0.00
1998	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	2.15	2.15	0.00
1999	0.3	0.3	0.9	0.9	21,900	21,900	0.35	0.35	2.14	2.14	0.00
2000	0.3	0.3	0.9	0.9	21,900	21,900	0.60	0.60	5.24	5.24	0.00
2001	0.3	0.3	0.9	0.9	21,900	21,900	0.60	0.60	6.93	6.93	0.00
2002	0.3	0.3	0.9	0.9	21,900	21,900	0.60	0.60	8.38	8.38	0.00
2003	0.3	0.3	0.9	0.9	21,900	21,900	0.60	0.60	10.19	10.19	0.00
2004	0.3	0.3	0.9	0.9	21,900	21,900	0.60	0.60	11.08	11.08	0.00
2005	0.3	0.3	0.9	0.9	21,900	21,900	0.60	0.60	12.22	12.22	0.00
2006	0.3	0.3	0.9	0.9	21,438	21,438	0.60	0.60	16.07	12.65	-21.32
2007	0.3	0.3	0.9	0.9	21,900	21,900	0.60	0.60	16.96	13.05	-23.04
2008	0.3	0.3	0.9	0.9	21,900	21,900	0.63	0.63	18.43	13.89	-24.63
2009	0.3	0.3	0.9	0.9	21,900	21,900	0.63	0.63	18.90	13.94	-26.24
2010	0.3	0.3	0.9	0.9	21,900	21,900	0.63	0.63	20.10	14.62	-27.26

The differences regarding CH_4 emissions estimates from domestic/commercial wastewater and sludge, identified in 2006 - 2010 period are due to the changes on total number of population provided by NIS. These changes were made due to an error on statistical survey.

8.3.6 Source specific planned improvement including those in response to the review process

In order to improve the next submissions, the national authority is analysing the possibility to develop a study for determination the parameters/emission factors associated on sludge that result from industrial wastewater treatment.

8.4 Source category Waste Incineration (CRF sector 6.C)

8.4.1 Source category description

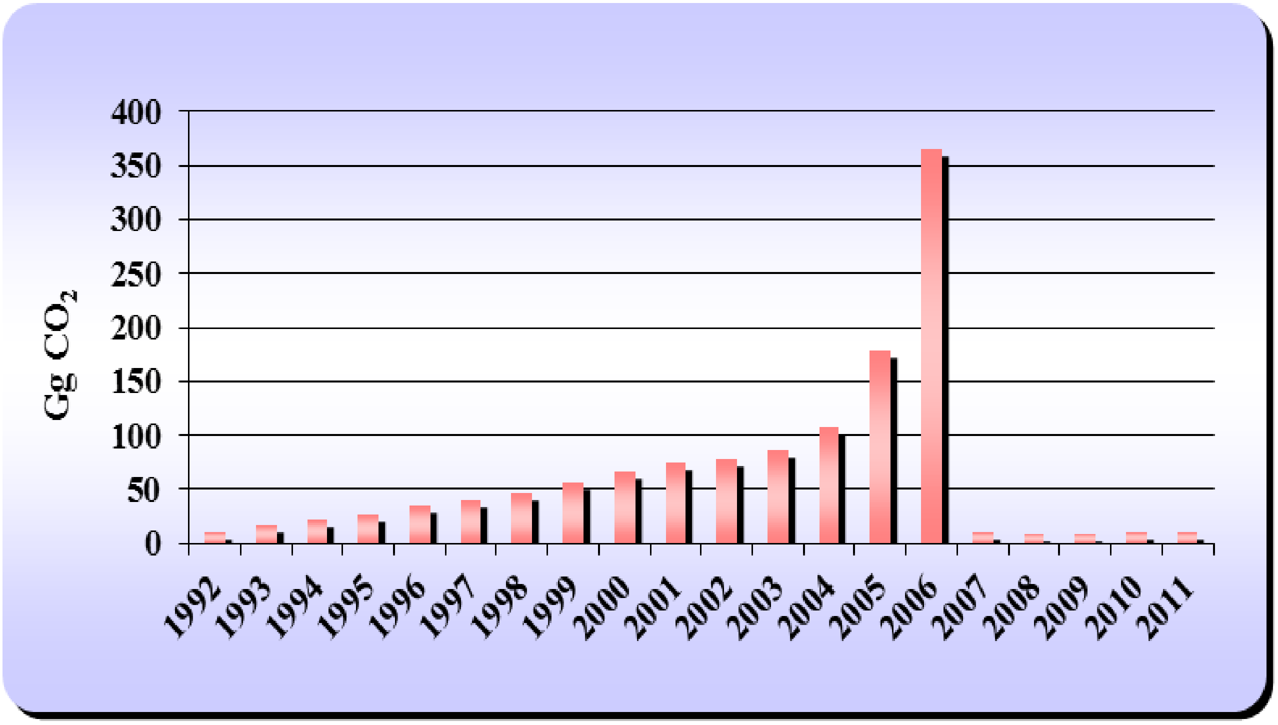
Waste incineration includes emissions resulted from the incineration of clinical waste and hazardous waste and, like other types of combustion, is a source of CO_2 and N_2O emissions.

The N_2O emissions from clinical and hazardous waste incineration were noted as NE because in IPCC GPG 2000 there are no emission factors for calculation of N_2O emissions from clinical waste incineration and, in hazardous waste incineration case, there is one single emission factor for rotating plant (table 5.7, p. 5.30) but in our country, the type of incinerators is different from the rotating plant.

The biogenic emissions from waste incineration cannot be estimated because the most important part provides by the incineration of municipal solid waste and, in case of Romania, MSW are not incinerated due to the higher costs implied by this method in specific conditions of our country (humidity about 50% and calorific power < 8400 kJ/kg). As regards the clinical waste, this contain biogenic and fossil Carbon but we cannot determine with accurately in which proportion are each of these.

The CO_2 emissions from incinerated waste were calculated starting with 1992, because since this year we have activity data.

Figure 8.13 CO_2 emissions trend from waste incineration, for 1992–2011 period



The CO_2 emissions trend was increasing in 1992-2006 period with an intensified activity in 2006-2007, to comply with European regulations. In this period, have functioned much more private incinerators that were closed after the period mentioned before. During 2008-2011, the relevant emissions level remained relatively constant.

Clinical wastes 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.

Figure 8.14 CO_2 emissions trend from clinical waste incineration, for 1996–2011 period

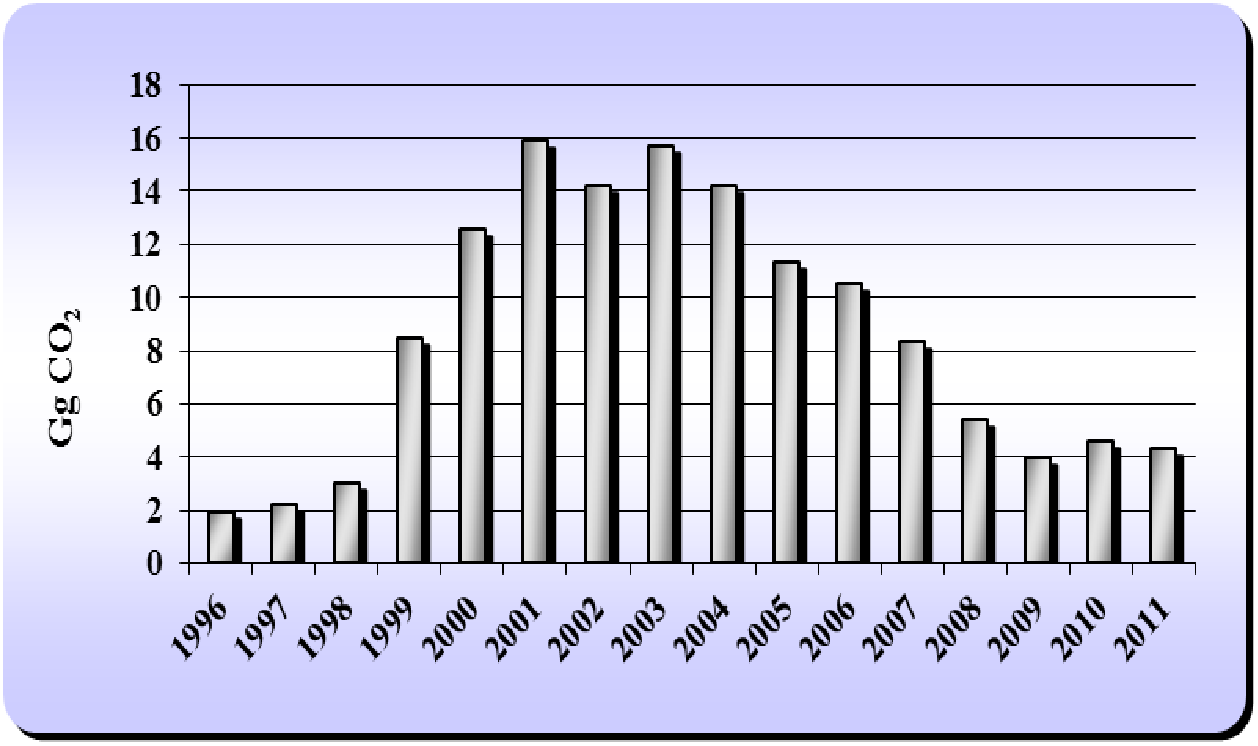
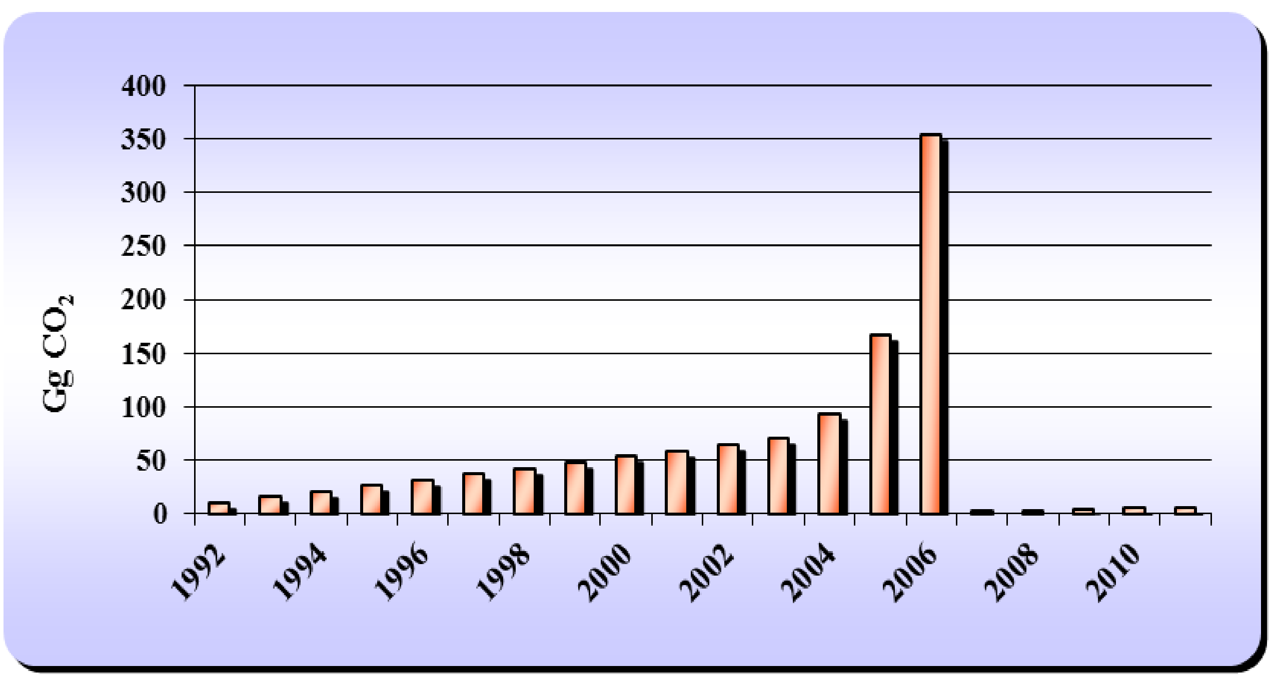


Figure 8.15 CO_2 emissions trend from hazardous waste incineration, for 1992–2011 period



8.4.2 Methodological issues

Methodology

To calculate carbon dioxide emissions from waste incineration, the equation 5.11 from page 5.25 of IPCC GPG 2000 was used:

Equation 8.18 Carbon dioxide emissions from waste incineration

$$CO_2 \text{ emissions (Gg/yr)} = \sum_i (IW_i * CCW_i * FCF_i * EF_i * 44/12)$$

Emissions factor

Default emissions factors according to the provisions in IPCC GPG 2000 have been used. The emissions factors are presented in Table 8.39.

Table 8.39 Default data for estimation of CO_2 emissions from waste incineration (Source: IPCC GPG 2000. table 5-6)

Emission Factors	Clinical Waste	Hazardous Waste
C content of Waste	60%	50%
Fossil Carbon as % of Total Carbon	40%	90%
Efficiency of Combustion	95%	99.5%

Activity data

Public Health Institute of Bucharest (ISPB) was provided the data on amounts of clinical waste generated and of clinical waste incinerated. From 2008, this type of waste was not burnt in improper installation. The data for 1996-1998 period were provided by National Research and Development Institute for Environmental Protection (see the Table 8.40).

Table 8.40 Amounts of clinical waste generated and incinerated (Source: ISPB and ICIM)

Year	**Clinical waste generated**	**Clinical waste incinerated**
	Unit [Gg/yr]	
1996	4.05	2.35
1997	4.96	2.63
1998	6.47	3.63
1999	10.15	10.15
2000	15.03	15.03
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

Hazardous waste is generated by industrial sector. Data regarding the amounts of incinerated hazardous waste were provided by Waste Directorate of NEPA for 2003-2010 period and for 2011 was maintain the same value as in 2010 until the end of associated statistical survey that will be finalised later this year. The amounts were estimated using backward trend extrapolation for 1992-2002 period, by expert judgment.

The amount of industrial waste has been increased from 2003 until 2006 because operators must comply with European regulations and they incinerated a large amount of hazardous industrial waste.

Table 8.41 Amount of hazardous waste incinerated (Source: NEPA)

<table>
<tr><th rowspan="2">Year</th><th colspan="2">Hazardous waste</th><th colspan="2">Clinical waste</th></tr>
<tr><th>Incinerated waste[Gg/yr]</th><th>Source</th><th>Incinerated waste[Gg/yr]</th><th>Source</th></tr>
<tr><td>1992</td><td>6.64</td><td rowspan="11">Extrapolation by expert judgement</td><td>-</td><td></td></tr>
<tr><td>1993</td><td>9.88</td><td>-</td><td>-</td></tr>
<tr><td>1994</td><td>13.11</td><td>-</td><td>-</td></tr>
<tr><td>1995</td><td>16.35</td><td>-</td><td>-</td></tr>
<tr><td>1996</td><td>19.58</td><td>2.35</td><td rowspan="3">ICIM</td></tr>
<tr><td>1997</td><td>22.82</td><td>2.63</td></tr>
<tr><td>1998</td><td>26.06</td><td>3.63</td></tr>
<tr><td>1999</td><td>29.29</td><td>10.15</td><td>Interpolation</td></tr>
<tr><td>2000</td><td>32.53</td><td>15.03</td><td rowspan="12">ISPB</td></tr>
<tr><td>2001</td><td>35.77</td><td>19.06</td></tr>
<tr><td>2002</td><td>39.00</td><td>17.03</td></tr>
<tr><td>2003</td><td>42.74</td><td rowspan="9">Waste Directorate of NEPA</td><td>18.79</td></tr>
<tr><td>2004</td><td>56.70</td><td>17.03</td></tr>
<tr><td>2005</td><td>102.00</td><td>13.55</td></tr>
<tr><td>2006</td><td>215.59</td><td>12.61</td></tr>
<tr><td>2007</td><td>1.38</td><td>10.00</td></tr>
<tr><td>2008</td><td>1.95</td><td>6.44</td></tr>
<tr><td>2009</td><td>2.27</td><td>4.79</td></tr>
<tr><td>2010</td><td>3.82</td><td>5.46</td></tr>
<tr><td>2011</td><td>3.82*</td><td>5.13</td></tr>
</table>

* Preliminary data (final data for 2010 will be provided after statistical survey of the end of this year)

8.4.3 Uncertainties and time series consistency

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

In the table below are presented the uncertainties associated to CO_2 emissions from waste incineration.

Table 8.42 Uncertainties for estimation of CO_2 emissions from waste incineration

IPCC source category	GHG	AD uncertainty (%)	EF uncertainty (%)	Combined uncertainty (%)
CO_2 from waste incineration	CO_2	5.00	20.00	20.62

The percentages are associated with the overall uncertainty, as resulted after the aggregation of AD and EF related uncertainties, according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000.

8.4.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in the QA/QC Programme have been undertaken.

A cross-checking approach was used in the implementation of QC activities: the activities were implemented by the sectoral expert administrating the Solid Waste Disposal on Land category, the results of these being mentioned on the Checklists level.

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.

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 280/2004/EC of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

8.4.5 Source specific recalculation, including changes made in response to the review process

The CO_2 emissions from hazardous waste were recalculated only for 2010 based on the final data provided by annual statistical survey made by Waste Directorate from NEPA.

8.4.6 Source specific planned improvement including those in response to the review process

In order to improve the emissions level from waste incineration, the national authority is analysing the possibility to develop a study for determination the types/quantities of waste incinerated and specific parameters of those for the period 1989-2012, including also the estimating of N_2O emissions from waste incineration.

9 OTHER (CRF sector 7)

There are no GHG emissions calculated, and could not be allocated to one of the categories.

10 Recalculations and improvements

This chapter presents the changes in GHG emissions/removals between the 2012 Greenhouse Gas Inventory submissions version 3.1 and 2013 Greenhouse Gas Inventory submissions. Since the 2012 version 3.1 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 2012 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 2012 NGHGI, are presented in Table 10.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**DESCRIPTION OF METHODS**	**RECALCULATIONS**	**REFERENCE**
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (Sectoral Approach)			
1. Energy Industries			
2. Manufacturing Industries and Construction			
3. Transport	√	√	The major changes in methododological descriptions are associated to the Road Transport Subsector and to all gases; they are included in the NIR section 3.2.9.3.2 i-pages.
4. Other Sectors			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	Please tick where this is also reflected in recalculations compared to the previous year CRF	If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes			
A. Mineral Products			
B. Chemical Industry			
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6			
G. Other			
3. Solvent and Other			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
Product Use			
4. Agriculture			
A. Enteric Fermentation			
B. Manure Management			
C. Rice Cultivation			
D. Agricultural Soils			
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry			
A. Forest Land			
B. Cropland			
C. Grassland			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	Please tick where this is also reflected in recalculations compared to the previous year CRF	If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
D. Wetlands			
E. Settlements			
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on Land	√	√	The major methodological descriptions changes are related to the estimation of emissions associated to managed and unmanaged sites; starting with this submission, the amount of sewage sludge deposited to SWDS was taken into account. The changes are included in the 8.2.2 section of the NIR- pages ....
B. Waste-water Handling		√	At subcategory 6.B.2.2 related to Human Sewage, the N_2O emissions were

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
			recalculated for 2008-2011 period using the values of protein consumption provided by NIS. The changes are included in the 8.3 section of the NIR, pages 849-850.
C. Waste Incineration			
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			
Aviation			
Marine			
Multilateral Operations			
CO_2 Emissions from			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	Please tick where this is also reflected in recalculations compared to the previous year CRF	If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
Biomass			
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 for KP-LULUCF activities

10.1.1 GHG Inventory

Recalculations by categories

The inventory contains improvements in the following sectors:

Energy

➢ **Public Electricity and Heat Production (1.A.1.a)**

Liquid Fuels

Activity data (AD)

- *Residual Fuel Oil:* 2001 year – the non-energy use of the fuel data, was subtracted;
- *Motor Gasoline*: 2010 year – Energy Balance correction;
- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.

Solid Fuels

Activity data

- *Lignite*: 2009, 2010 years - activity data correction provided through the Energy Balance;
- *Blast Furnace Gas – avoiding double counting activity data with Industrial Processes Sector*: due to the fact that in the Iron and Steel Production - 2.C.1. IP activity category, the mass balance approach to estimate CO_2 emissions is used, the fuel Blast furnace Gas was subtracted; the associated emissions are reported under 2.C.1. activity category, 1992 – 2010 period.

CO_2 emission factors (EFs)

- *Coking Coal*: 1992–1995 period – correction of the CO_2 EF (country specific EF was changed with a default EF).

Other Fuels

CO_2 emission factors

- *Industrial Wastes*: the entire reported time-series - country specific CO_2 EF was determinate and used.

- **Petroleum Refining (1.A.1.b)**

Liquid Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series (2005-2010 reported period), was used.

- **Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c)**

Liquid Fuels

Activity data

- *Motor Gasoline*: 2010 year – Energy Balance correction;
- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.

The non-energy use data associated with the following fuels was subtracted:

- *Transport Diesel:* 1999, 2001 years;
- *Residual Fuel Oil:* 1999 year.

Solid Fuels

***Activity* data**

- *Coking Coal*: 2007, 2010 years - activity data correction provided through the Energy Balance;
- *Blast Furnace Gas – avoiding double counting activity data with Industrial Processes Sector*: due to the fact that in the Iron and Steel Production - 2.C.1. IP activity category, the mass balance approach to estimate CO_2 emissions is used, the fuel Blast furnace Gas was subtracted; the associated emissions are reported under 2.C.1. activity category, 1992 – 1994, 1997 - 2009 periods.

CO_2 emission factors

- *Coking Coal*: 1989, 1991 years, 1994-2003 period – correction of the CO_2 EF (country specific EF was changed with a default EF).

- **Iron and Steel (1.A.2.a)**

Liquid Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- *Petroleum Coke*: 2000–2010 period – the non-energy use of the fuel data was subtracted.

Solid Fuels

Activity data

- *Coking Coal*: 2009 year - activity data correction provided through the Energy Balance;
- *Blast Furnace Gas – avoiding double counting activity data with Industrial Processes Sector*: due to the fact that in the Iron and Steel Production - 2.C.1. IP activity category, the mass balance approach to estimate CO_2 emissions is used, the fuel Blast furnace Gas was subtracted; the associated emissions are reported under 2.C.1. activity category, 1990 – 2010 period.

CO_2 emission factors

- *Coking Coal*: 1992–1996 period, 2000 year, 2004–2010 period – correction of the CO_2 EF (country specific EF was changed with a default EF);
- *Coke Oven Coke*: 1989–2010 period – correction of the CO_2 EF (default EF was changed with a country specific EF).

Other Fuels

CO_2 emission factors

- *Industrial Wastes*: the entire reported time-series - country specific CO_2 emission factor was determinated and used.

- **Manufacturing Industries and Construction, Non-Ferrous Metals (1.A.2.b)**

Solid Fuels

CO_2 emission factors

- *Coke Oven Coke*: 1989–1990 period - correction of the CO_2 EF (default EF was changed with a country specific EF).

- **Manufacturing Industries and Construction, Chemicals (1.A.2.c)**

Liquid Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.

The non-energy use data associated with the following fuels was subtracted:

- *Refinery Gas*: 1992–1994 period, 1999 year, 2004–2010 period;
- *Residual Fuel Oil*: 1993–1995, 1998-1999, 2006–2008 periods;
- *Naphtha*: 1994 year, 1996–2010 period;
- *Transport Diesel*: 2001 year;
- *Other Kerosene*: 2002, 2003 years;
- *White Spirit &SPB*: 2006 year.

Solid Fuels

CO_2 emission factors

- *Coke Oven Coke*: 1989, 1990, 1992, 1993 years, 1996-2008 period - correction of the CO_2 EF (default EF was changed with a country specific EF).

Other Fuels

CO_2 emission factors

- *Industrial Wastes*: the entire reported time-series - country specific CO_2 emission factor was determinated and used.

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

Other Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used.
- *Industrial Wastes:* 2000, 2002 years **-** correction of the activity data provided through the Energy Balance.

CO_2 emission factors

- *Industrial Wastes:* 1995, 2000, 2002 years - country specific CO_2 emission factor was determinated and used.

- **Manufacturing Industries and Construction, Food Processing, Beverages and Tobacco (1.A.2.e)**

Liquid Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- *Naphtha*: 2000, 2005 years - the non-energy use data was subtracted.

Solid Fuels

CO_2 emission factors

- *Coke Oven Coke*: 1989, 1990, 1992–2007 period, 2010 year, correction of the CO_2 EF (default EF was changed with a country specific EF).

Other Fuels

CO_2 emission factors

- *Industrial Wastes:* 1995, 2000-2002 period, 2009, 2010 years - country specific CO_2 emission factor was determinate and used.

- **Fuel combustion, Manufacturing Industries and Construction, Other (1.A.2.f)**

Liquid Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- *Petroleum Coke:* 2000–2010 period, the non-energy use data associated with the Non Metallic Minerals activity was subtracted; 1990–1999 period, the non-energy use data associated with the Non-specified (Industry) activity was subtracted;
- *Paraffin Wax*: 2010 year, the non-energy use data was subtracted;
- *Other Products*: 1993–2000 period, 2003–2006 period, the non-energy use data associated with the Non-specified (industry) activity was subtracted;
- *White Spirit & SPB:* 1993–2004 period, 2009 year, the non-energy use data associated with the Non-specified (Industry) activity was subtracted;
- *Transport Diesel:* 2007–2010 period, the non-energy use data associated with the Non-specified (Industry) activity was subtracted.

Solid Fuels

Activity data

- *Lignite**:*** 2006, 2008, 2009 years – correction provided through the Energy Balance;
- *Blast Furnace Gas – avoiding double counting activity data with Industrial Processes Sector*: due to the fact that in the Iron and Steel Production - 2.C.1. IP activity category, the mass balance approach to estimate CO_2 emissions is used, the fuel Blast furnace Gas was subtracted; the associated emissions are reported under 2.C.1. activity category, 1992 - 2010 period.

CO_2 emission factors

- *Coking Coal:*1995–1998 period – correction of the CO_2 EF (country specific EF was changed with a default EF);
- *Coke Oven Coke*: 1989-2010 period - correction of the CO_2 EF (default EF was changed with a becomes country specific EF).

Other Fuels

Activity data

- *Industrial Wastes:* 2000, 2001 years, 2004–2008 period **- c**orrection of the activity data provided through the Energy Balance.

CO_2 emission factors

- *Industrial Wastes:* 1992–1997 period, 2000–2010 period - country specific CO_2 EF was determinate and used.

Energy Transport

Civil aviation (1.A.3.A)

Civil aviation/Liquid fuels (1.A.3.A)

Aviation Gasoline

- recalculation for 1993-2010 period at CO_2 emissions, due to a transcription error of the CO_2 emissions values, for this period from the spreadsheet in the CRF.

Jet Kerosene

- recalculation for the 2004-2006 period at AD: due to update of values AD. Recalculation for the 2004-2006 period at CO_2 and CH_4 emissions due to change values AD for this period;
- recalculation for the 2004-2010 period at N_2O emissions due to change values AD for 2004-2006 period and for 2007-2010 period was a transcription error of the N_2O emissions values, from the spreadsheet in the CRF.

Road Transportation/Liquid fuels (1.A.3.B)

Motor Gasoline

- recalculations for 1989–2004 time-series: at CO_2 emissions level, the share of the transport activities in the total domestic Energy Balance data, was applied to the Romanian Energy Balance IEA/Eurostat/UNECE format data; also, EFs values were changed with improved CS EFs;
- recalculations for 2005-2010 time-series: at CO_2 emissions level, the share of the transport activities in the total domestic Energy Balance data was applied to the Romanian Energy Balance IEA/Eurostat/UNECE format data; also, the fleet data provided by the Romanian Automobile Registry (RAR) began to be used within the COPERT 4 model;
- recalculations for 1989–2004 time-series: at CH_4 and N_2O emissions level, the share of the transport activities in the total domestic Energy Balance data was applied to the Romanian Energy Balance IEA/Eurostat/UNECE format data; default EFs began in to used, solving an error;
- recalculations for 2005-2010 time-series: at CH_4 and N_2O emissions level, the share of the transport activities in the total domestic Energy Balance data was applied, to the Romanian Energy Balance IEA/Eurostat/UNECE format data; also, fleet data provided by the RAR began to be used within the COPERT 4 model in estimating the CH_4 and N_2O emissions.

Diesel Oil

- recalculations for 1989–2004 time-series: at CO_2 emission level the non-energy use of the fuel data was subtracted from the corresponding activity category consumption; also, EFs values were changed with improved CS EFs;
- recalculations for 2005-2010 time-series: at CO_2 emission level the non-energy use of the fuel was subtracted from the corresponding activity category consumption; also, the fleet data provided by the RAR began to be used within the COPERT 4 model in estimating the CO_2 emission;
- recalculations for 1989–2004 time-series: at CH_4 and N_2O emissions the non-energy use of the fuel was subtracted from the corresponding activity category consumption; default EFs began in to used, solving an error.

- recalculations for 2005-2010 time series: for CH_4 and N_2O emissions the non-energy use of the fuel was subtracted from the corresponding activity category consumption; also, the fleet data provided by the RAR began to be used within the COPERT 4 model in estimating the CH_4 and N_2O emissions;

LPG

- recalculations for 1989–2004 time series: for CO_2 emission at AD due to the change of the source of the activity data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used; EF derived as average from COPERT III model usage in the 2012 mars transmission;
- recalculations for 2005-2010 time series: for CO_2 emission at AD due to the change of the source of the activity data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used, and fleet data taken from the RAR use COPERT 4 model in estimating the CO_2 emission;
- recalculations for 1989–2004 time series: for CH_4 and N_2O emissions at AD due to the change of the source of the activity data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used; EF derived as average from COPERT III model usage in the 2012 mars transmission;
- recalculations for 2005-2010 time series: for CH_4 and N_2O emissions at AD due to the change of the source of the activity data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used; and fleet data taken from the RAR use COPERT 4 model in estimating the CH_4 and N_2O emissions;

Road Transportation/Gaseous Fuels (1.A.3.B)

Gaseous Fuels

- recalculations for the 1989–2000 and 2003-2011 period: at CO_2, CH_4 and N_2O emissions level: change of values with notation key ”NO” due to changed AD, the source of the activity data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used;

- recalculations for the 2001–2002 period: at CO_2 emissions at AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used;
- recalculations for the 2001–2002 period: for CH_4 and N_2O emissions at AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used; were used default EFs from 1996 IPCC GL.

Road Transportation/Biomass (1.A.3.B)

Biomass

- recalculations for the 1989–2010 period: for CO_2, CH_4 and N_2O emissions at AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used; were used default EFs from 1996 IPCC GL;

Railways (1.A.3.C)

Railways/ Liquid fuels (1.A.3.C)

- recalculations for the 1989 – 2010 period at AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Diesel Oil

- recalculations for the 1989 – 2010 period at AD: the non-energy use of the fuel was subtracted ;
- recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed AD and CO_2 country specific emission factor were updated;
- recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed AD.

Motor Gasoline

- recalculations for the 1989 – 2010 period at activity data: the share of the transport activities in the total domestic Energy Balance, to the Romanian Energy Balance IEA/Eurostat/UNECE format, was applied;
- recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed activity data and CO_2 country specific emission factor were updated;
- recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed activity data.

Residual Oil

- recalculations for the 1989 – 2010 period at AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic Romanian Energy Balance is used;
- recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed activity data and CO_2 country specific emission factor were updated;
- recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed activity data.

Railways/ Solid fuels (1.A.3.C)

Lignit, Sub-bitouminous Coal, Other bitouminous coal, Coking coal

- recalculations for the 1989 – 2010 period at AD due to the change of the source of the activity data: EUROSTAT instead of domestic Romanian Energy Balance is used;
- recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed activity data and CO_2 country specific emission factor were updated;
- recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed activity data.
- the **Biomass fuel** started to be characterized Other transport (please specify)/Other non-specified/Biomass 1.A3.E.

Navigation (1A.3.D)

Navigation/Liquid fuels (1.A.3.D)

Residual Oil

- recalculations for the 1989 – 2009 period at AD due to the change of the source of the activity data: EUROSTAT instead of domestic Romanian Energy Balance is used;
- change of values AD for 2007-2009 period with notation key ,,NO" due to changed AD.
- recalculations for the 1989 – 2009 period at CO_2 emissions level due to changed activity data and CO_2 country specific emission factor were updated;
- recalculation for the 2007-2009 period at CO_2 emissions level: change of values with notation key ,"NO" due to changed AD;
- recalculations for the 1989 – 2009 period at CH_4 and N_2O emissions level due to changed activity data;
- recalculation for the 2007-2009 period at CH_4 and N_2O emissions levels: change of values with notation key ,"NO" due to changed AD.

Diesel oil

- recalculations for the 1989 – 2010 period: the non-energy use of the fuel was subtracted;
- recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed AD and CO_2 country specific emission factor were updated;
- recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed AD.

Motor Gasoline

- recalculations for the 1989 – 2010 period at activity data: the share of the transport activities in the total domestic Energy Balance, to the Romanian Energy Balance IEA/Eurostat/UNECE format, was applied;
- for the 1989-1992 period notation key "NA" for AD was changed with activity data were taken from IEA/Eurostat Questionnaire 2011 - Petrol – Motor gasoline;
- recalculations for the 1989 – 2010 period at CO_2 emissions due to changed activity data and CO_2 country specific emission factor were updated;

- for the 1989-1992 period notation key "NA" for CO_2 emissions level was changed with values due to changed AD;
- recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level due to changed AD;
- for the 1989-1992 period notation key "NA" for CH_4 and N_2O emissions level was changed with values due to changed AD.

Other Transportation (please specify) (1.A.3.E)

Other Transportation (please specify)/Other non-specified (1.A.3.E)

- recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level: the notation key "NO" was changed with values, because available data were found in IEA/Eurostat Questionnaire 2011, and was used new default EF.

Other Transportation (please specify)/Other non-specified/Liquid fuels (1.A.3.E)

- recalculations for the 1989 – 2010 period due to the change of the source of the AD and EF;
    - for the 1989 – 1992 period at AD: The notation key "NA" was changed with values, because available data were found in IEA/Eurostat Questionnaire 2011
- recalculations for the 1989 – 2010 period at CO_2 emissions level due to the change of the source of the AD and EF;
    - for the 1989 – 1992 period at CO_2 emissions level. The notation key "NA" was changed with values, because changed AD and country specific EF;
- recalculations for the 1989 – 2010 period at CH_4 and N_2O emissions level: the notation key "NA" was changed with values, because changed AD, and was used new EF.

Diesel Oil

- recalculations for the 1989 – 2009 period at AD due to the change of the source of the AD:

- for Pipeline Transport for this period change AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic Romanian Energy Balance is used;
- for Non-Specified, Off Road Transport use AD from EUROSTAT;

➢ recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed AD and CO_2 country specific emission factor were updated;

➢ for the 1989-2010 period notation key "NA" for CH_4 and N_2O emissions level was changed with values due to changed AD.

Motor Gasoline

➢ recalculations for the 1989 – 2009 period at AD due to the change of the source of the AD;

- For Pipeline Transport for this period change AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic Romanian Energy Balance is used.
- For Off Road use AD from EUROSTAT

➢ recalculations for the 1989 – 2010 period at CO_2 emissions due to changed AD and CO_2 country emission factor;

➢ for the 1989-2010 period notation key "NA" for CH_4 and N_2O emissions was changed with values due to changed AD.

Other Transportation (please specify)/Other non-specified/Gaseous fuels (1.A.3.E)

➢ recalculations for the 1989 – 2010 period at AD due to the change of the source of the AD

- For Pipeline Transport and Non-specified for this period change AD due to the change of the source of the Activity Data: EUROSTAT instead of domestic Romanian Energy Balance is used. (Change of values AD for 1989-1991 period with notation key „NO" due to changed AD);

➢ recalculations for the 1989 – 2010 period at CO_2 emissions level due to changed AD and CO_2 emission factor (Change of values CO_2 emissions for 1989-1991 period with notation key „NO" due to changed AD);

- recalculations for the 1992 – 2010 period at CH_4 and N_2O emissions level due to changed AD.

Other Transportation (please specify)/Other non-specified/Biomass (1.A.3.E)

- recalculations for the 1990 – 2010 period at AD due to the change of the source of the AD:
  - For Pipeline Transport and Railways (wood/wood) the notation key "NO" was changed with values, because available data were found in IEA/Eurostat Questionnaire 2011;
- recalculations for the 1990 – 2010 at CO_2, CH_4 and N_2O emissions levels: The notation key "NO" was changed with values, because changed AD ,and was used new EF;

- **Other Sectors, –Commercial/Institutional (1.A.4.a)**

Liquid Fuels

Activity data

- *White Spirit & SPB:* 2000 year, the non-energy use data was subtracted.

Solid Fuels

Activity data

- *Lignite*: 2006, 2007 years - correction of the consumption data provided through the Energy Balance.

Other Fuels

CO_2 emission factors

- *Industrial Wastes:* 2003, 2004 years - country specific CO_2 EF was determinated and used.

- **Other Sectors, Residential (1.A.4.b)**

Solid Fuels

CO_2 emission factors

- *Coking Coal:* 2002 year - correction of the CO2 EF (country specific EF was changed with a default EF);

- **Other Sectors, Agriculture/ Forestry/ Fisheries (1.A.4.c)**

Solid Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- *Peat:* 2002–2005 period – correction of the consumption data provided through the Energy Balance.

CO_2 emission factors

- *Coke Oven Coke:* 1993–1995 period **-** correction of the CO2 EF (default EF was changed with a country specific EF).

Other Fuels

CO_2 emission factors

- *Industrial Wastes:* 1995 year, 2000-2006 period - country specific CO_2 EF was determinate and used.

- **Other (Not specified elsewhere), Stationary (1.A.5.a)**

Liquid Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- *White Spirit & SPB:* 2000, 2011 years, the non-energy use data was subtracted.

Solid Fuels

Activity data

- *Lignite:* 2002, 2006, 2007 years – correction of the consumption data provided through the Energy Balance.

Other Fuels

CO_2 emission factors

- *Industrial Wastes:* 1995 year, 2000-2006 period - country specific CO_2 emission factor was determinate and used.

- **1AB – Reference Approach**

Liquid Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- for the following type of fuels, correction on the Stock Changes associated with the 2009 year was conducted: *Natural Gas Liquids, Gas/Diesel Oil (Transport Diesel), Residual Fuel Oil*;
- for the following type of fuels, the Energy Balance provides correction on the Stock Changes, for 2010 year: *Crude Oil, Natural Gas Liquids, LPG, Motor Gasoline, Kerosene Type Jet Fuel, Gas/Diesel Oil (Transport Diesel), Heating and Other Gas Oil, Residual Fuel Oil, Lubricants, Petroleum Coke, Other Products*;
- *Paraffin Wax* fuel, the Energy Balance provides correction on the Imports, for 2010 year;
- *Additives Oxygenates*: the fuel was added, as secondary fuel (aggregated with the Refinery Feedstock's fuel), for the entire time-series reported through the Energy Balance;
- *Other Hydrocarbons*: the fuel was added as primary fuel (as Orimulsion), for the entire time-series reported through the Energy Balance;
- *Petroleum Coke* reported as Non-energy use in the industry sector was analyzed: the carbon stored in the Petroleum Coke has been subtracted from the carbon content of this fuel, for the entire time-series reported through the Energy Balance.

Solid Fuels

Activity Data

- *Coking Coal:* 2010 year - correction of the Stock Changes provided through the Energy Balance;

- *Peat:* 2003–2005 period - correction of the Indigenous production provided through the Energy Balance; 2004, 2005 years - correction of the Imports provided through the Energy Balance; 2010 year - correction of the Stock Changes provided through the Energy Balance;
- *BKB & Patent Fuels*: the Other Solid Fuel – Patent Fuels was deleted and the values were moved under *BKB & Patent Fuels;*
- *Coke Oven Coke:* 2003 year - correction of the Imports provided through the Energy Balance;
- *Coke Oven Coke:* 1989 – 2010 period – the non-energy use of the fuel in blast furnace, Iron and Steel Production activity, from the Reference Approach was subtracted.

CO_2 emission factors

- *Coking Coal:* correction of the CO_2 EF (country specific EF was changed with a default EF);
- *Coke Oven Coke:* 1989–2010 period - correction of the CO_2 EF (default EF was changed with a country specific EF).

Gaseous Fuels

Activity data

- *Natural gas:* 2005–2010 period - correction of the Stock Changes provided through the Energy Balance.

Other Fuels

Activity data

- *Industrial Wastes*: 1995, 1998, 1999, 2000–2002, 2006, 2007 years - corrections of the Indigenous Production provided through the Energy Balance were made; 1995, 2000–2002, 2006, 2007 - corrections of the Stock Changes provided through the Energy Balance were made.

CO_2 emission factors

- *Industrial Wastes*: country specific EFs were determinate, for the entire time-series.

- **Feedstocks and non-energy use of fuels (1.AD)**

Liquid Fuels

Activity data

- *Transport Diesel: NCV of* Transport Diesel instead NCV of Gas/Diesel Oil value, on the entire time series, was used;
- *Petroleum Coke*: recalculations for the 1990–2010 period due to the correction of the Energy Balance, as non-energy use of the fuel.

CO_2 emissions

Associated CO_2 emissions, for the entire time series, for the following fuels, were recalculated:

- *Lubricants;*
- *Bitumen;*
- *Naphtha;*
- *LPG;*
- *Refinery gas;*
- *Motor Gasoline;*
- *Kerosene Type Jet Fuel;*
- *Other Kerosene;*
- *Gas-Diesel Oil;*
- *Petroleum Coke;*
- *Residual Fuel Oil;*
- *Other Products;*
- *Paraffin waxes;*
- *White spirit.*

Gaseous Fuels

CO_2 emissions

- associated CO_2 emissions, for the entire time series, for the *Natural Gas as Feedstock*, were recalculated.

Solid Fuels

Activity data

- *Coke Oven Coke:* 1989 – 2010 period – the non-energy use of the fuel in blast furnace, Iron and Steel Production activity, was calculated.

CO_2 emission factors

- *Coal Oil and Tars (from Coking Coal):* correction of the CO_2 EF (country specific EF was changed with a default EF);

CO_2 emissions

Associated CO_2 emissions, for the entire time series, for the following fuels, were recalculated:

- *Lignite/Brown Coal;*
- *Coal Oil and Tars (from coking coal);*
- *Other Bituminous Coal.*

Fugitive Emissions from Solid Fuels

Solid Fuels (1.B.1)

- recalculation in the Coal Mining and Handing category because CH_4 and CH_4 recovered emissions have been updated in order that CH_4 recovered emissions be correctly considered (1.B.1.A.1.1);
- recalculation in the Solid Fuel Transformation category: AD value for 2010 was changed due to the update of the associated domain in IEA/Eurostat Questionnaire, for 2011 and Coking Coal (1.B.1.B).

Fugitive Emissions from Oil and Natural Gas (1.B.2.B)

Natural Gas

- recalculation in the Transmission category (1.B.2.B.3): updatedactivity data (AD-pipeline length) values were provided by the National Company of Natural Gas Transport “TRANSGAZ”;
- recalculation in the Distribution category (1.B.2.B.4) subsector: due to a transcription error of the activity data (AD-pipeline length) from the spreadsheet in the CRF, for 2010;
- recalculation for Other Leakage (1.B.2.B.5.): the notation key "NA" was changed with the notation key "NE" because no estimation method and emission factor for CO_2 are available in the IPCC good practice guidance/IPCC 1996 and on national level.

Aviation (1.C.1.A)

Jet Kerosene

- recalculations for the 1989 year at AD level due to the change of the AD source: EUROSTAT instead of domestic Romanian Energy Balance is used.
- recalculations were performed at CO_2, CH_4 and N_2O emissions.

Aviation Gasoline

- recalculations for the 2007–2010 period at AD level due to the change of the AD source: EUROSTAT instead of domestic Romanian Energy Balance is used (Change of AD values, for 2009-2010 period, with notation key ,”NO”);
- recalculations for the 2007–2010 period at CO_2 emissions level due to changed AD (change of CO_2 emissions values, for 2009-2010 period, with notation key ,”NO” due to changed AD);
- recalculation for the 1991-2008 period at CH_4 and N_2O emissions level due to a transcription error of the emissions values, for this period from the spreadsheet in the CRF;

- recalculation for the 2009-2010 period at CH_4 and N_2Oemissions level: change of CH_4 and N_2O emissions values with notation key ,"NO" due to changed AD.

Marine (1.C.1.B)

- recalculations for the 1989–2010 period due to EF change and the change of the source of the AD: EUROSTAT instead of domestic Romanian Energy Balance is used;
- recalculation for the 1989-1997 and 1999-2005 periods at AD, and CO_2, CH_4 and N_2O emissions levels: change of values with notation key ,"NO" due to changed AD);
- recalculation for the 1998 year and 2006-2010 period at AD and CO_2, CH_4 and N_2O emissions level due to changed AD and EF.

Motor Gasoline

- recalculations for the 1993–2010 period: the change of the AD source: EUROSTAT instead of domestic Romanian Energy Balance is used;
- recalculation for the 1993-2010 period at AD and CO_2, CH_4 and N_2O emissions level: change of values with "NO" notation key due to changed AD.

Diesel Oil

- recalculations for the 1989–2010 period due to the change of EF and to the change of the AD source: EUROSTAT instead of domestic Romanian Energy Balance is used;
- recalculation for the 1989-2006 period at AD, CO_2, CH_4 and N_2O emissions level: change of values with ",NO" notation key due to changed AD;
- recalculation for the 2007-2010 period at AD, CO_2, CH_4 and N_2O emissions level due to changes AD and EF.

Residual Oil

- recalculations for the 1989–2010 period due to the change of EF and of the AD source: EUROSTAT instead of domestic Romanian Energy Balance is used;
- recalculation for the 1989-2005 period at AD, CO_2, CH_4 and N_2O emissions level: change of values with "NO" notation key due to changed AD;

- recalculation for the 2006-2010 period at AD , CO_2, CH_4 and N_2O emissions due to changed AD and EF.

Industrial Processes

- recalculations for 1989-2010 period at the limestone and dolomite use level due to the subtraction from the total consumption of limestone data provided by economic agents of the lime used in iron and steel industry data, for avoiding the double accounting with lime production category (2.A.3);
- recalculations for 1989-2010 period at the glass production **level** due to the use of improved activity data on production of glass (other flat glass and mineral wool). (2A.7.1);
- emissions from coke production are characterized for the first time, for the 1989-2010 period: CH_4 emissions are estimated while CO_2, N_2O, HFC, PFC and SF_6 are characterized using the NA notation key (2B.5).
- recalculations for 1989-2010 period at the iron and steel production level due to keeping the amount of coke used in blast furnaces and all other solid fuels are found in the Energy Sector in 1.AA.2.A Iron and Steel category (2C.1.2).

LULUCF

- wrong referencing of the activity data in the Cropland converted to Forest Land category (5.A.2.1), for 1997-2010 time-series, and in the Grassland converted to Forest Land category (5.A.2.2), for 1991 – 2009 time-series, led to overestimation of DOM net carbon stock change. Also wrong referencing for the 2010 year in the same sub-categories for the SOM emissions. Therefore, these changes resulted in no increasing trend for CSC IEF for DOM and SOM in Land converted to Forest Land category (5.A.2) as ERT in the 5th Centralized Review in 2012 noticed;
- the official reporter of land-use areas, the National Institute for Statistics, has changed the official data for 2010 year. For this reason, a number of various values have been changed, but no impact on the trend has been registered:

  - 5.A.1 category–NFF: CSC in LB Gains led to a 0.24 % difference. Same for FM in KP for Above-ground biomass gains and below-ground biomass gains;
  - 5.A.2.3 category: CSC in LB Gains led to a -1.77% difference;
  - 5.A.2.5 category: CSC in LB Gains led to a 0.75% difference and for Net CSC in DOM and SOM led to a 4.03% impact of recalculation;
  - 5.B.1 category: CSC in LB Gains and Losses which led to a 0.02% difference and -1.52% respectively;
  - 5.D sub-sector: CSC in SOM led to a -1.73% impact of recalculation;
  - 5.E sub-sector: CSC in SOM led to a -0.04% impact of recalculation;
  - 5.F sub-sector: CSC in SOM and LB led to a change of 0.79% in CO_2 emissions level.

- lime application amounts moved across the entire time-series from Cropland remaining Cropland (5(IV)) to Grassland remaining Grassland (5(IV)). Also, improved data led to a disaggregation of data from Limestone to Dolomite in the year 2008;
- in the or Forest Land related Table 5(V)–Wildfires there was a correction in AD for the year 1989;
- for the entire time-series, Cropland Table 5(V)–Controlled Burning notation key changed from NO to IE for the CH_4 and N_2O emissions because emissions were already included under Agriculture Sector–Field Burning of Agricultural Residues (4.F) category;
- for KP LULUCF, as already stated above, 5.A.1–NFF and FM area, for 2010 year, changed according to the official data reporter. This resulted in recalculations of about 0.24% in LB CSC. Computing errors in the worksheet resulted in a small change (0.33%) of CSC in litter for AR in Grassland to FL.

Waste

- **Managed Waste Disposal on Land (6.A.1):**

  CH_4 emissions were recalculated, for the entire time-series, using FOD method and considering both the amount of MSW and the amount of sewage sludge deposited to SWDS.

The data on the amounts of sewage sludge deposited in managed SWDS were estimated within 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”, based on the total amounts of sewage sludge deposited in SWDS in period 1998-2011 provided by the National Research and Development Institute for Environmental Protection and the National Institute for Statistics.

Regarding the EFs, for sewage sludge were taking into account k = 0.185, A = 0.919, DOCf = 0.50, according with the IPCC Waste Model 2006.

The amount of MSW deposited in managed SWDS in 2010 was updated based on the annual statistical survey made by Waste directorate of NEPA.

The amount of MSW deposited in managed SWDS in 2011 was estimated by the Waste Directorate of NEPA using the amount of MSW deposited in 2010 and the waste generation rate.

- **Unmanaged Waste Disposal on Land (6.A.2):**

CH_4 emissions were recalculated for the entire time-series using the FOD method and considering both the amount of MSW and the amount of sewage sludge disposal in deep and shallow unmanaged sites. The data on the amounts of sewage sludge deposited in unmanaged SWDS were estimated within 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”, based on the total amounts of sewage sludge deposited in SWDS in the 1998-2011 period, data provided by the National Research and Development Institute for Environmental Protection and the National Institute for Statistics.

Regarding the EFs, for sewage sludge were taking into account k = 0.185, A = 0.919, DOCf = 0.50, according with the IPCC Waste Model 2006.

The amount of MSW deposited in unmanaged SWDS in 2010 year was updated based on the annual statistical survey made by the Waste Directorate of NEPA.

The amount of MSW deposited in unmanaged SWDS in 2011 year was estimated by the Waste Directorate of NEPA using the amount of MSW deposited in 2010 year and the waste generation rate.

- **Industrial Wastewater (6.B.1):**

  CH_4 emissions from Industrial Wastewater category were recalculated for 1989-2010 period, based on expert judgment, taking into account the following industries: beer, pulp, paper and petroleum refining. From these, only in several breweries the wastewater is treated anaerobically.

  There were individually estimated the CH_4 emissions from:

  - industrial wastewater generated in beer industry anaerobically treated, based on AD provided by operators and country specific EFs ;
  - industrial wastewater generated in beer industry aerobically treated, based on AD provided by NIS and country specific EFs;
  - industrial wastewater generated in pulp, paper and petroleum refining industries aerobically treated, based on AD provided by NIS and country specific EFs.

  The amounts of methane recovered provided by the operators were subtracted from the methane emissions resulted from entire beer industry.

  Total methane emissions generated from industrial wastewater treatment were obtained by summing the methane emissions from pulp, paper and petroleum refining and the methane emissions from beer industry.

- **Domestic and Commercial Wastewater (6.B.2)**

  Domestic and Commercial Wastewater and Sludge without Human Sewage (6.B.2.1):

  CH_4 emissions were recalculated for 2006-2010 period using the number of population connected to sewerage with treatment and the number of population unconnected to sewerage provided by NIS.

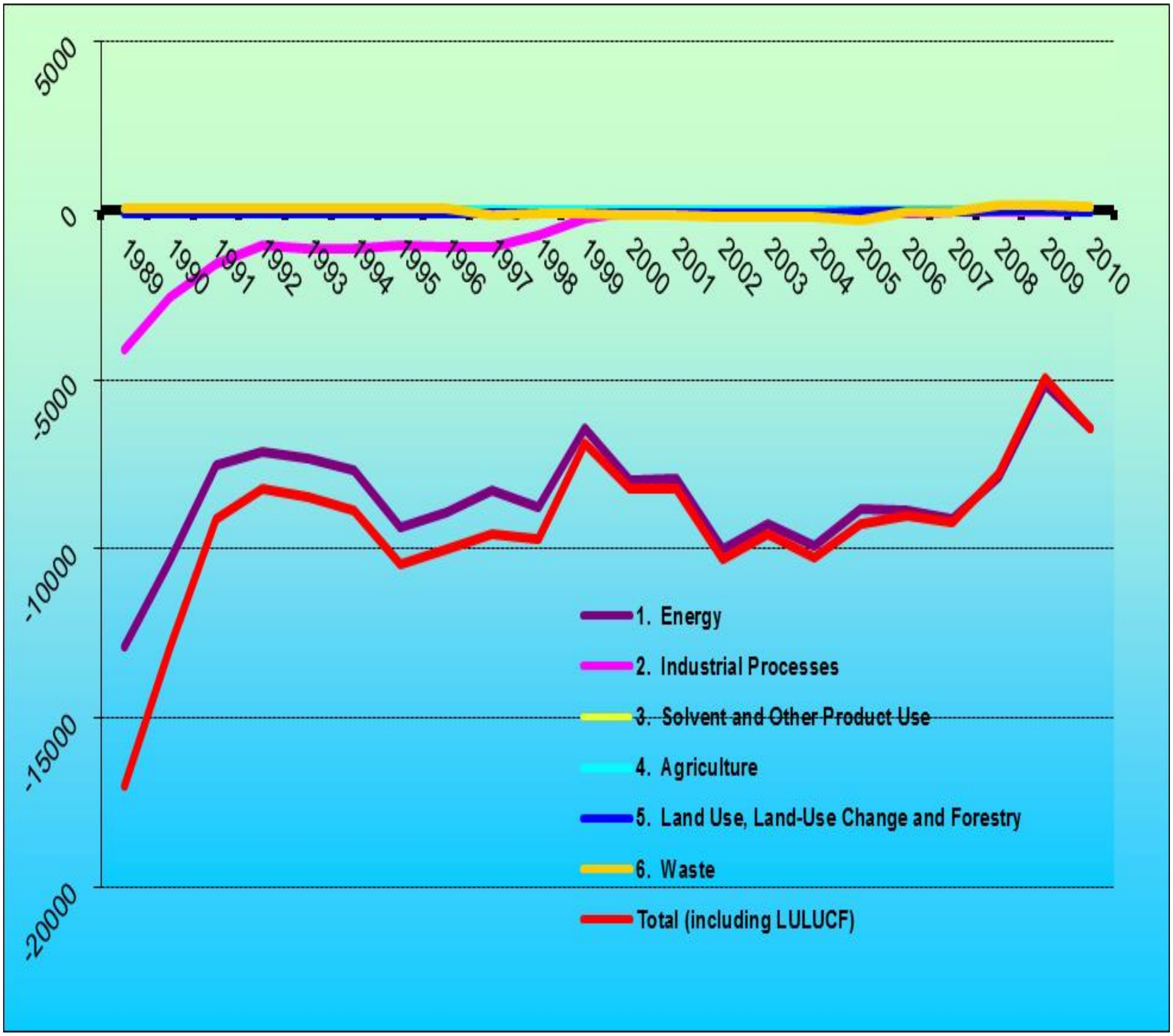
  Human Sewage (6.B.2.2):

  N_2O emissions were recalculated for 2008-2011 period using the values of protein consumption provided by NIS.

- **Waste Incineration (6.C):**

  The CO_2 emissions from hazardous waste were recalculated only for 2010 year based on the final data provided by annual statistical survey made by the Waste Directorate from NEPA.

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 2012 version 3.1 report



Recalculations by gases

CO_2 recalculations were carried out in the following sectors:

- Public Electricity and Heat Production (1.A.1.a);
- Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c);

- Iron and Steel (1.A.2.a);
- Non-Ferrous Metals (1.A.2.b);
- Chemicals (1.A.2.c);
- Pulp, Paper and Print (1.A.2.d);
- Food Processing, Beverages and Tobacco (1.A.2.e);
- Other (please specify) (1.A.2.f);
- Civil Aviation (1.A.3.A);
- Road Transport (1.A.3.B);
- Railways (1.A.3.C);
- Navigation (1.A.3.D);
- Other Transportation (1.A.3.E);
- Commercial/Institutional (1A4a);
- Residential (1A4b);
- Agriculture/Forestry/Fisheries (1A4c);
- Other (Not specified elsewhere) (A.5);
- Stationary (please specify) (1A5a);
- Reference Approach Subsector (1.AB);
- Feedstock’s and non-energy use of fuels Subsector (1.AD);
- Solid Fuel Transformation (1.B.1.B.);
- Transmission (1.B.2.B.3.)
- Other Leakage (1.B.2.B.5.);
- International Transport –Bunkers (1.C.1);
- Limestone and dolomite use (2A.3);
- Glass production (2A.7.1);
- Coke production (2B.5)
- Iron and Steel Production (2C.1);
- Forest Land (5.A);
- Forest Lands remaining Forest Land (5.A.1);
- Land converted to Forest Land (5.A.2);
- Cropland (5.B);
- Cropland remaining Cropland (5.B.1);

- Grassland converted to Cropland (5.B.2.2)
- Grassland (5.C);
- Forest Land converted to Grassland (5.C.2.1);
- Cropland converted to Grassland (5.C.2.2);
- Settlements converted to Grassland (5.C.2.4);
- Other Lands converted to Grassland (5.C.2.5);
- Wetlands (5.D);
- Forest Land converted to Wetlands (5.D.2.1);
- Other Lands converted to Wetlands (5.D.2.5);
- Settlements (5.E);
- Forest Land converted to Settlements (5.E.2.1);
- Cropland converted to Settlements (5.E.2.2);
- Other Lands converted to Settlements (5.E.2.5);
- Other Lands (5.F);
- Cropland converted to Other Lands (5.F.2.2);
- Wetlands converted to Other Lands (5.F.2.4);
- Settlements converted to Other Lands (5.F.2.5).
- Waste incineration (6.C).

CH_4/N_2O recalculations were carried out in the following sectors:

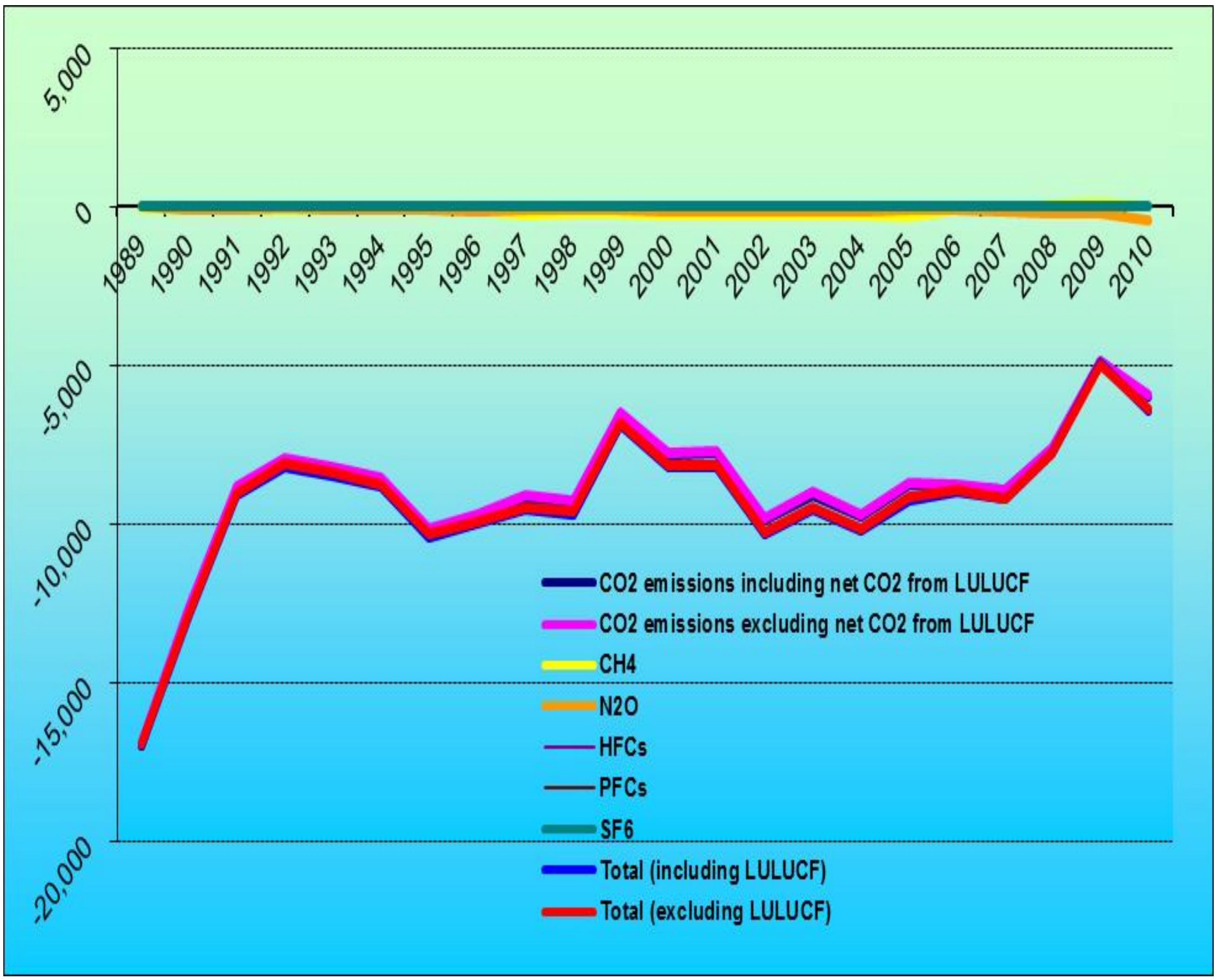
- Civil Aviation (1.AA.3.A);
- Road Transport (1.AA.3.B);
- Railways (1.AA.3.C);
- Navigation (1.AA.3.D);
- Other Transportation (1.AA.3.E);
- Underground Mines – Mining Activities (1.B.1.A.1.1.);
- Solid Fuel Transformation (1.B.1.B.);
- Transmission (1.B.2.B.3.);
- International Transport –Bunkers (1.C.1);
- Coke production (2B.5);

- Cropland (5.B);
- Wetlands converted to Cropland (5.B.2.3);
- Solid Waste Disposal on Land (6.A);
- Wastewater Handling (6.B).

HFC/PFC/SF_6 recalculations were carried out in the following sectors:

- Coke production (2B.5).

Figure 10.2 Category total emissions/removals change, for all gases, and for the entire time series, in comparison to the figures in the 2012 version 3.1 submission



10.1.2 KP-LULUCF inventory

Recalculations by categories

The inventory contains improvements in the following sectors:

- recalculations were made on Change in Carbon Stock (emissions/removals) for 2008-2009 period in Afforestation and Reforestation (KP.A.1.1);
- recalculations were made on Change in Carbon Stock (emissions/removals) for 2008-2009 period in Forest Management (KP.B.1);

Recalculations by gases

CO_2 recalculations were carried out in the following sectors:

- Afforestation and Reforestation – Grassland to FL and Cropland to FL (KP.A.1.1);
- Forest Management (KP.B.1).

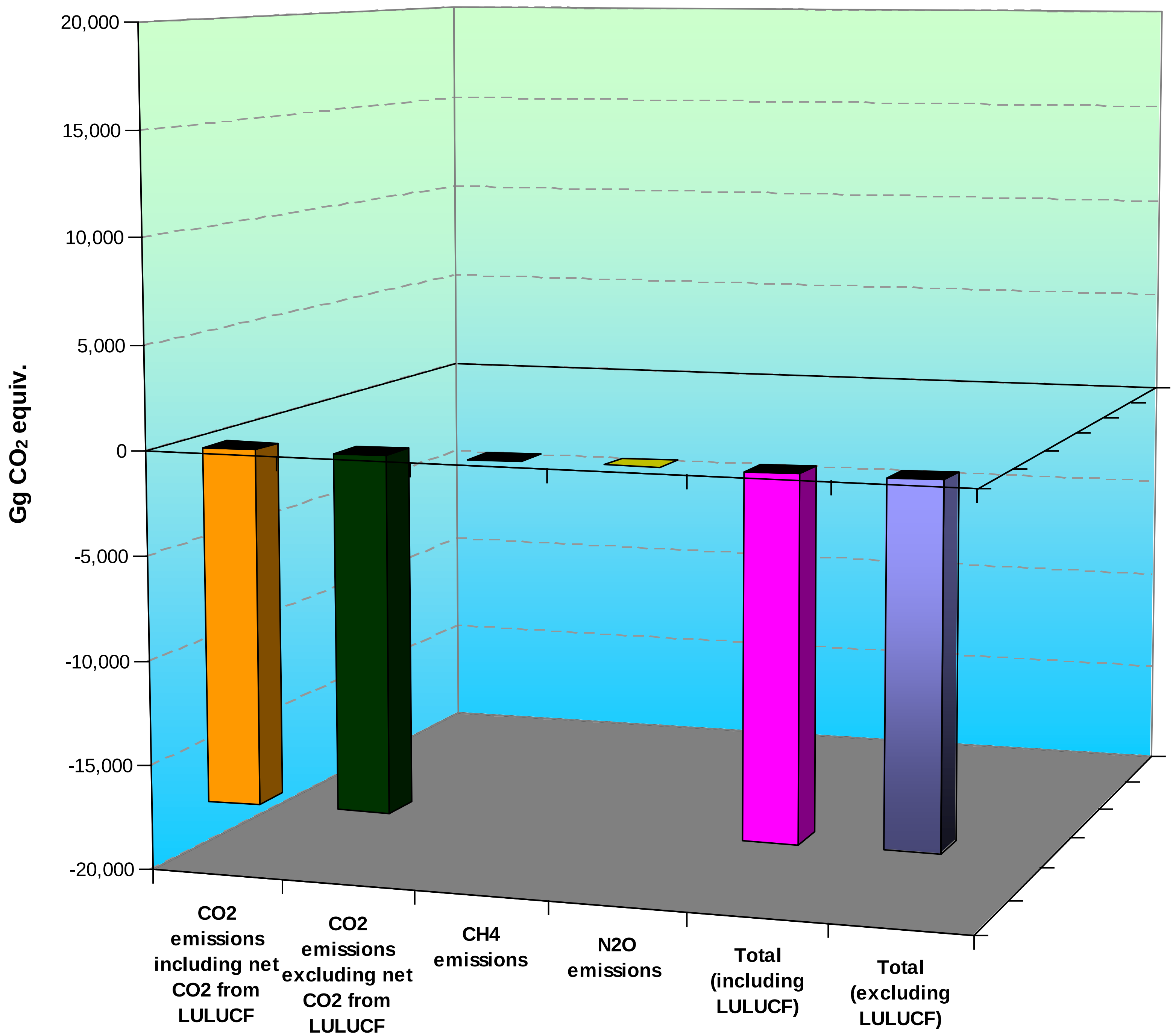
10.2 Implications for emissions levels, including on KP-LULUCF emissions levels

10.2.1 GHG inventory

Emissions changes due to recalculations, for 1989 are as follows:

- CO_2 excluding LULUCF (-7.96%), CO_2 including LULUCF (-8.89%)
- CH_4 (-0.04%);
- N_2O (0.01%);
- Total GHG including LULUCF (-6.32%), excluding LULUCF (-5.83%);

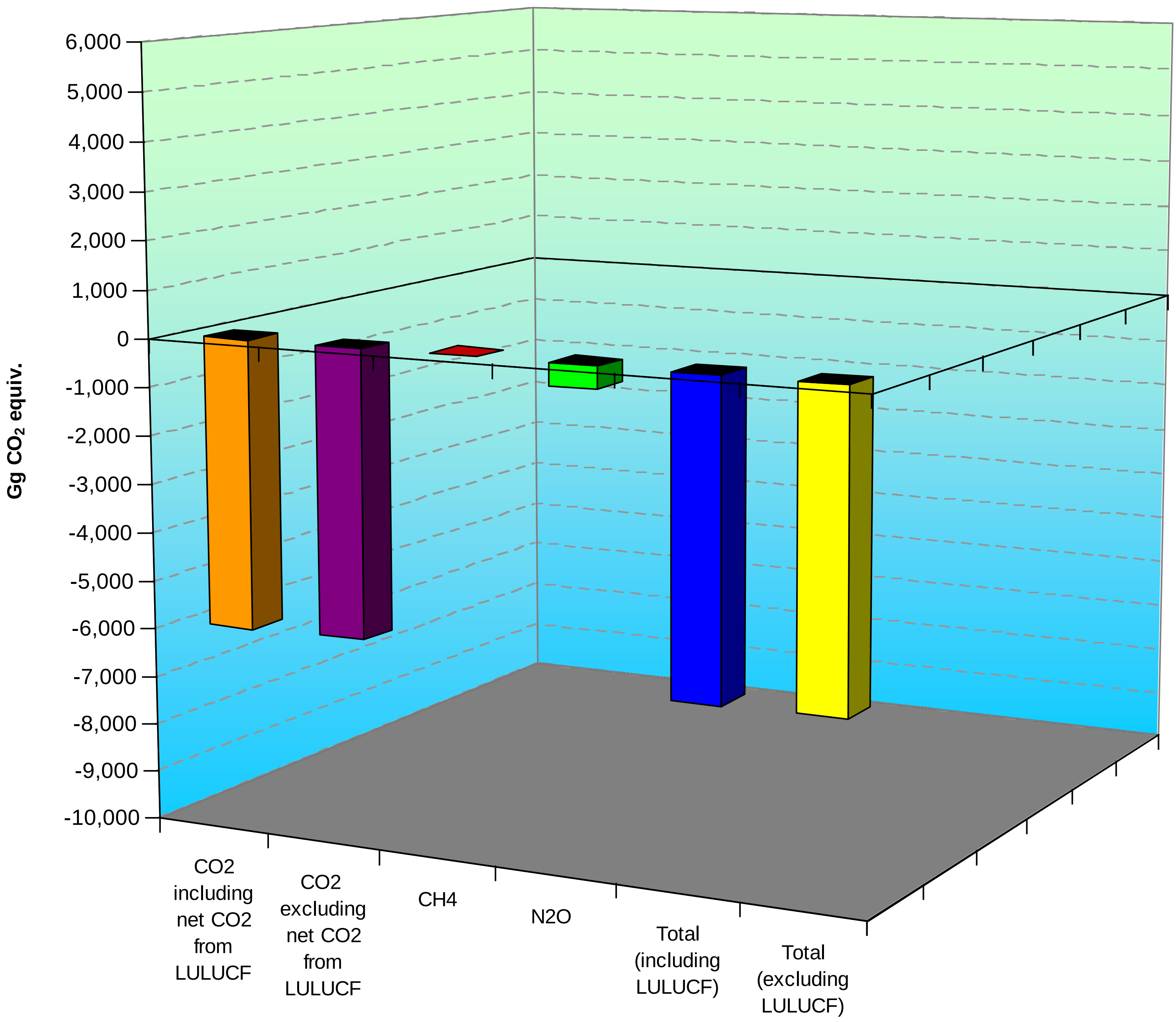
Figure 10.3 Effects of recalculations (presented in the 2013 submission) for 1989, by gas



Emissions changes due to recalculations, for 2010, are as follows:

- CO_2 including LULUCF (-9.81%), CO_2 excluding LULUCF (-6.84%);
- CH_4 (0.07%);
- N_2O including LULUCF (-3.53%), N_2O excluding LULUCF (-3.55%);
- Total GHG including LULUCF (-6.61%);
- Total GHG excluding LULUCF (-5.19%).

Figure 10.4 Effects of recalculations (presented in the 2013 submission) for 2010, by gas



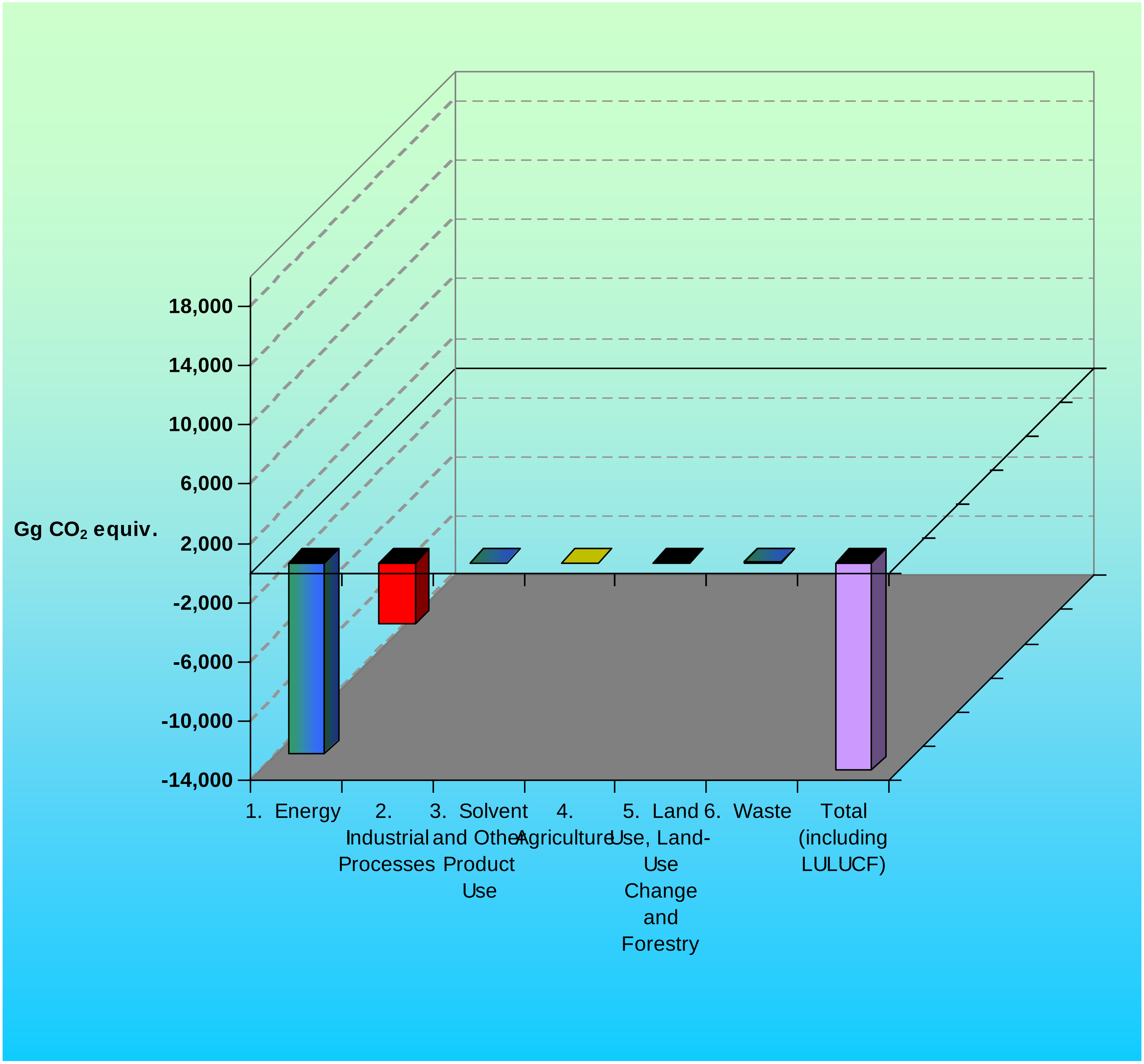
Impacts on 1989 emissions levels

Total emissions in 1989 including LULUCF have decreased by 6.32% compared to the 2012 version 3.1 submission.

Table 10.2 Recalculation of total emissions/removals, by sector, for all gases, for 1989

Differences for 1989 estimates	**Differences**		**2013 v. 1.4**	**2012 v. 3.1**
	Gg CO_2 eq.	**%**	**Gg CO_2 eq.**	**Gg CO_2 eq.**
1. Energy	-12,866.89	-6.29	191,809.14	204,676.03
2. Industrial Processes	-4,117.93	-10.43	35,373.55	39,491.48
3. Solvent and Other Product Use	0.00	0.00	645.80	645.80
4. Agriculture	0.00	0.00	40,734.14	40,734.14
5. Land Use, Land-Use Change and Forestry	-71.55	0.33	-21,512.67	-21,441.12
6. Waste	67.74	1.47	4,670.31	4,602.57
Total (including LULUCF)	-16,988.63	-6.32	251,720.27	268,708.90

Figure 10.5 Changes of 1989 emissions/removals, in respect to the 2013 figures

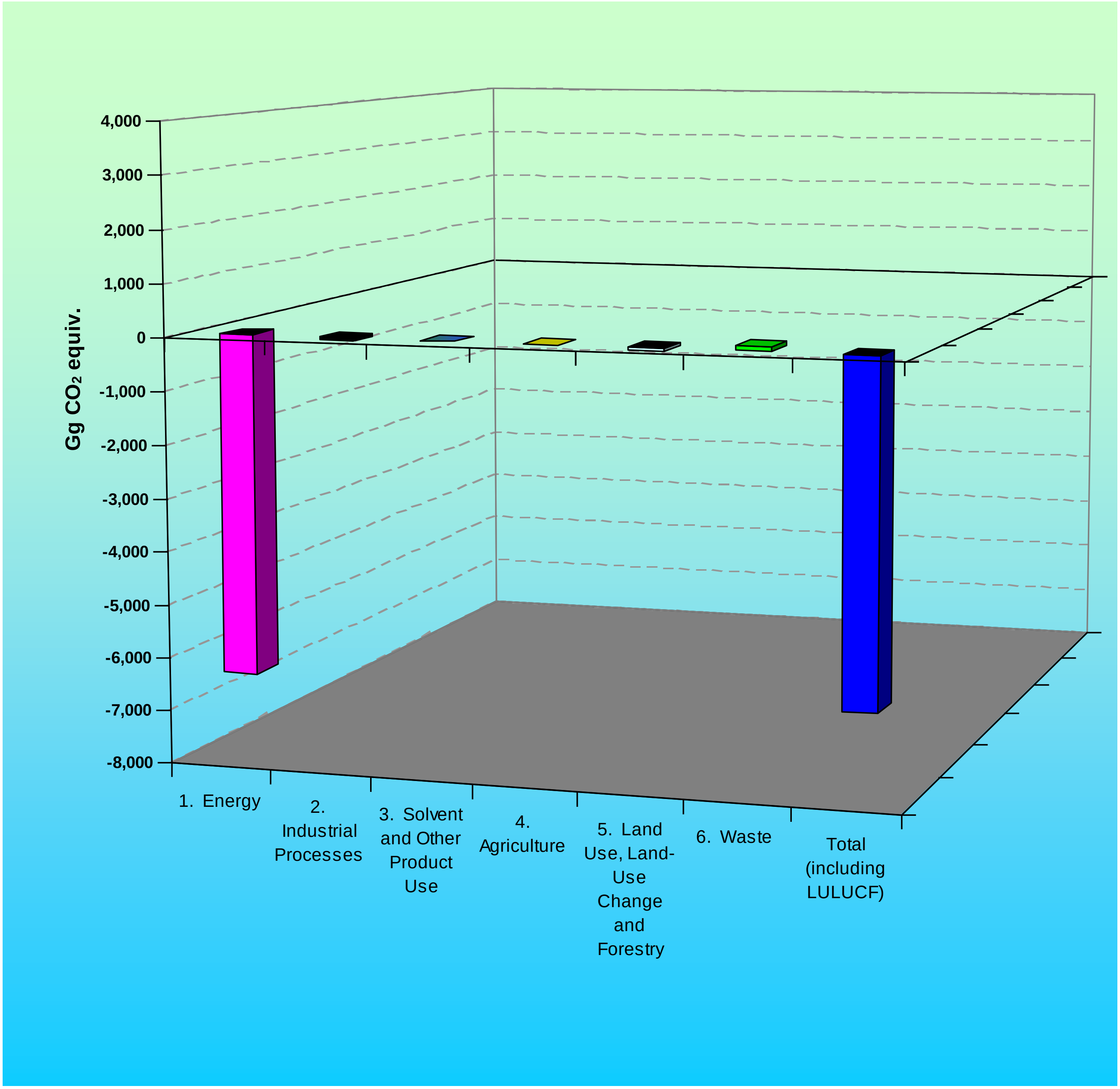


Total emissions in 2010, including LULUCF have decreased by 6.61% compared to the 2012 submission Version 3.1.

Table 10.3 Recalculation of total emissions/removals, by sector, for all gases, for 2010

Differences for 2010 estimates	**Differences**		**2013 v.1.4**	**2012 v.3.1**
	Gg CO_2 eq.	**%**	**Gg CO_2 eq.**	**Gg CO_2 eq.**
1. Energy	-6,417.01	-7.46	79,624.01	86,041.01
2. Industrial Processes	-56.28	-0.45	12,395.89	12,452.18
3. Solvent and Other Product Use	0.00	0.00	124.74	124.74
4. Agriculture	0.00	0.00	18,760.94	18,760.94
5.Land Use, Land-Use Change and Forestry	-48.38	0.19	-25,830.81	-25,782.42
6. Waste	93.23	1.66	5,715.62	5,622.39
Total (including LULUCF)	-6,428.45	-6.61	90,790.39	97,218.84

Figure 10.6 ***Changes of 2010 emissions/removals, in respect to the 2013 figures***



10.2.2 KP-LULUCF inventory

Emissions changes due to recalculations, as follows:

Afforestation and Reforestation

- compared to 2008 year, in 2010 year Net CO_2 equivalent emissions/removals have increased with 12%.

Deforestation

- compared to 2008 year, in 2010 year Net CO_2 equivalent emissions/removals have decreased with 77.21%.

Forest Management

- compared to 2008 year, in 2010 year Net CO_2 equivalent emissions/removals have increased with 0.16%.

Revegetation

- compared to 1989 year, in 2008 year Net CO_2 equivalent emissions/removals have decreased with 81%.
- compared to 2008 year, in 2010 year Net CO_2 equivalent emissions/removals have increased with 12%.

10.3 Implications for emissions trends, including time series consistency, and also for KP-LULUCF trends and time series consistency

10.3.1 GHG inventory

The time-series consistency has been improved as a result of recalculations.

10.3.2 KP-LULUCF inventory

The time-series consistency has been improved as a result of recalculations.

10.4 Recalculations, including in response to the review process, and planned improvements to the inventory including for the KP-LULUCF activities

10.4.1 GHG inventory

The planned improvements for GHG Inventory activities are presented in table below:

Table 10.4 Summary of planned improvements GHG Inventory activities

No.	Category subject to improvement	Description of improvement
Energy		
1	Fuel combustion (CRF 1.A)	**Activity Data** Further investigations and co-operation with Romanian Institute for Statistics will be conducted in order to have a fully correspondence, concerning the definitions (fuel's calorific power) and quantities of the fuels, between the declarations of the operators must report both, on EU-ETS and to NIS. The assumptions of NCVs associated to the Energy Balance consumption of the fuels, on a sum of years, will be submitted to the provider of the documents, in order to be approved and included in the future in the Energy Balance. ISPE Study provided an analysis regarding the share of EU-ETS reporting to the Energy Balance. A further analysis on the EU-ETS 2012 reporting (object of a further

No.	Category subject to improvement	Description of improvement
		Study) will be conducted in order to take into consideration these emissions, as Tier 3 approach, on the activity category where these operators have to report. **Emission Factors** Further to the recommendation of the Study, regarding the National Emission Factors usage, annually, following the procedure provided by this document (or, as an object of further Study), will be calculated the emission factors resulting from the EU-ETS operators reporting.
2	Public Electricity And Heat Production (CRF 1.A.1.a)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
3	Petroleum Refining (CRF 1.A.1.b)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
4	Manufacture of Solid Fuels and Other Energy Industries (CRF 1.A.1.c.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
5	Fuel combustion, Manufacturing Industries and Construction - Iron and Steel (CRF 1.A.2.a)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.

No.	Category subject to improvement	Description of improvement
6	Fuel combustion, Manufacturing Industries and Construction, Chemicals (CRF 1.A.2.c.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
7	Fuel combustion, Manufacturing Industries and Construction, Pulp, Paper and Print (CRF 1.A.2.d.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
8	Fuel combustion, Manufacturing Industries and Construction, Food Processing, Beverages and Tobacco (CRF 1.A.2.e.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
9	Fuel combustion, Manufacturing Industries and Construction, Other (please specify) (CRF 1.A.2.f.)	It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions. See the chapter 3.2.6.6 for more details.
10	Transport- Civil aviation (CRF 1.A.3.a)	It is planned further investigations and co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.
11	Transport - Road ransport (CRF 1.A.3.b)	In order to improve the inventory quality, the investigation of the country-specific values associated to parameters used in the Copert IV model is planned, as follows: - ability to separately report in Copert 4 biofuel consumption data (biogasoline, biodiesel); - the availability of fleet data for each year of the period

No.	Category subject to improvement	Description of improvement
		1989-2004
12	Transport – Railways (CRF 1.A.3.c)	It is planned further investigations and co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.
13	Transport- Navigation (CRF 1.A.3.d)	It is planned further investigations and co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.
14	Transport - Other Transportation (CRF 1.A.3.e)	It is planned further investigations and co-operation with National Institute for Statistics in order to have a fully correspondence concerning the quantities of the fuels.
15	Fuel combustion, Other Sectors – Commercial / Institutional (CRF 1.A.4.a)	See the chapter 3.2.6.6 for more details.
16	Fuel combustion, Other Sectors – Agriculture / Forestry / Fisheries (CRF 1.A.4.c)	See the chapter 3.2.6.6 for more details.
17	Fuel combustion, Other (Not specified elsewhere) - Stationary (CRF 1.A.5.a)	See the chapter 3.2.6.6 for more details.
18	Fugitive emission (CRF 1.B.2.b) Oil and gas	It is necessary to realize a new data base for the length of distribution pipelines of natural gas from Romanian National Energy Regulatory Agency (ANRE), increase the accuracy of fugitive emissions determination.
Industrial Processes		
1	Consumption of halocarbons and SF_6 (2F)	Improve the emission estimation within this category.
Agriculture		
1	Source category Enteric	Aiming to their incorporation into next inventory

No.	Category subject to improvement	Description of improvement
	Fermentation (CRF source category 4.A)	submissions, the development of national values for the methane conversion rate (Y_m), for significant categories, is envisaged.
2	Source category Manure Management (CRF source category 4.B)	Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species, are envisaged: - ash content of the manure (ASH); - maximum CH_4 producing capacity for manure produced by an animal within defined population (B_0); - CH_4 conversion factors for each manure management system by climate region (MCF).
3	Source category Rice Cultivation (CRF source category 4.C)	In respect to the IPCC GPG 2000 provisions, more detailed data on rice cultivation techniques used are proposed to be obtained.
4	Source category Agricultural soils (CRF source category 4.D)	Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species, are envisaged: - fraction that volatilizes as NH_3 and NO_x, specific to synthetic fertilizers nitrogen adjusted for volatilization ($Frac_{GASF}$); - fraction that volatilizes as NH_3 and NO_x, specific to animal manure nitrogen used as fertilizer, adjusted for volatilization ($Frac_{GASM}$); - national values for activity data in totality; - fraction of N input that is last through leaching and runoff ($Frac_{LEACH}$).
5	Source category Field	Aiming to their incorporation into next inventory

No.	Category subject to improvement	Description of improvement
	Burning of Agricultural Residues (CRF source category 4.F)	submissions, the development of national values for activity data in totality, for to significant species, is envisaged.
Waste		
1	Source category Solid Waste Disposal on Land (CRF sector 6.A)	In order to improve the next submissions, the to the development of a study for determination of the industrial waste quantities with biodegradable content, data for the period 1950-2012, is analyzed.
2	Source category Wastewater Handling (CRF sector 6.B)	In order to improve the next submissions, the national authority is analysing the possibility to develop a study for determination the parameters/emission factors associated on sludge that result from industrial wastewater treatment.
3	Source category Waste Incineration (CRF sector 6.C)	In order to improve the emissions level from waste incineration, the national authority is analysing the possibility to develop a study for determination the types/quantities of waste incinerated and specific parameters of those for the period 1989-2012, including also the estimating of N2O emissions from waste incineration.
LULUCF		
1	Forest Land (5.A)	Although an improvement has been brought by the 2011 re-submission (in September 2011) (e.g. land use change matrix and correction of parameters used for the estimation of emissions), there is still a major bottleneck in reporting given by the outdated data, as well as use of “NE” or “NO” under Tier 1 for some C pools changes.
2		The key planned improvement is the use of the NFI data for reporting living biomass for the category “Forest Land remaining Forest Land". This is likely to happen in the

No.	Category subject to improvement	Description of improvement
		2013 submission or as soon as the growth data become available. When available, the time series will be totally or partially recalculated, thus updated data will be used, at least since 2008 on (ar adequately bridged between IFF 84 and NFI 2008). Meanwhile, other parameters currently used can be updated (for example, the volume of standing timber, dead wood, etc.). The improvement will also allow better estimates for all parameters and proxies related to "forest vegetation outside the national forest fund", both in terms of structure (composition, age, annual growth, etc), as well as related to the activity data.
3		The stock of C from dead wood (DW) pool in Forest Land remaining Forest Land from NFI data will be available for the years of the commitment period (2008-2012). Historically there is no quantitative data on dead organic matter pool in Romanian forests. For the entire time series the C stock change from dead wood has to be obtained by simulation with a model based on the forest inventory data. First data from IFF 1984 will be employed, as a workaround before NFI data will be available, and validated with NFI data (as far as NFI will only provide dead mass at a point in time and additional work has to be done to generate time changes in this pool). For this, 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 started running CBM-CFS3 (Carbon Budget

No.	Category subject to improvement	Description of improvement
		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). Bridging between IFF 84 and NFI 2008 is currently tested. Estimating changes in this C pool, using simulation and new NFI data will provide results by the end of 2013 and expected to be reported in 2014 submission. This will allow a Tier 3 method.
4		A simulation based approach is expected to be also used to estimate C stock change in litter (LT) in Forest Land remaining Forest Land and Land converted to Forest Land. Upon the availability of resources, estimating of changes in the litter C pool would follow same schedule and method with the dead wood pool estimation.
5	Forest Land (5.A)	To report change of C stocks of the organic matter in mineral soils (SOC), an assessment is further expected, mainly focusing on three approaches: - It is planned an exercise of simulation of C stocks and changes with the forest increment data given by the IFF 1984 (as far as data from NFI is not yet available). Simulations would be further validated with the results measured in the NFI and/or management plans database (all/part of C pools: biomass, dead wood, litter). Further on, once the actual increment data would be available by the NFI, final simulations would be run as to obtain the changes in these C polls. CBM empirical models are preferred for this upon the type of data available (IF84/NFI and harvest statistics) as far as the model operates based on forestry parameters/statistics. Later validation exercise

No.	Category subject to improvement	Description of improvement
		would also involve the actual NFI data of C stocks in available pools (dead wood and organic matter in mineral soils). This work could provide preliminary results by the end of 2013 and reported in the 2014 submission. - Soil database of the forest management plans (FMP) combined with the NFI soil available data, to be used for validation of simulations outputs and also to support application of “not a source” principle for forest management areas. The FMP database contains soil analysis associated to management activity, accumulated since 1960 on. Datasets are expected complete regarding the humus content, site and stand description parameters. 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” in 10 years period, so several time series since 1960 are available. The work assumes retrieval of datasets (data is currently as archived prints) and definition of the statistical processing method. This work could provide preliminary results by the end of 2012. - Work already carried out by exploring ICP Forest datasets 1994 and 2004. Processing of ICP Forest datasets have shown an annual drop of C stock which is considered non credible under national circumstances (~0.5 tC/ha/yr for many type of soils). The problem seems to be related to the methodological differences in 1994 (humus on 30 cm depth determined by Kjeldahl) and 2004 (method involved elemental analyzer on 40 cm depth) or incomplete

No.	Category subject to improvement	Description of improvement
		information on the management approaches in the sampling plots (issues are further analyzed). Under limited data, it was no possible to credibly harmonize these data, but further analysis on this is expected to be achieved next year. Thus, another option would be to re-sample the C content in the same known plots in 2012, having used a method consistent with the one in 2004. Such work could provide results by the end of 2012.
6		Improvements envisaged for the next submission are related to the defining the methodology for the estimation of wood removal in “forest vegetation outside the national forest fund” and development of time series of burnt areas for 5A1 and 5A2 (as well as for other land categories 5B, 5C, 5D).
7	Cropland (5.B)	For land remaining in the same category and lands under conversion to Cropland, existing data and information would allow a combined approach of country specific data (namely the C stock in soils) with default IPCC data (C stock change adjustment factors). Future improvement of estimation of C stock changes in soils organic matter is endeavored by exploration of the database related to "Monitoring soil quality in Romania" (ICPA, 2006) based on 2000-2002 reference period. Despite currently available aggregated data from this database (used above in Table 7.11), the nationwide reference C stocks on soil types and land categories is considered highly uncertain, derived based on basic input, at this stage, of adequate expertise from agricultural field. Currently, there is an ongoing procedure by the Ministry of

No.	Category subject to improvement	Description of improvement
		Environment to ensure the funding of a research project related to reporting soils for all land categories and various conversions. The purpose of the project is to reach Tier 2 of IPCC for emission factors, starting from country specific data on soils C stocks and development of C stock adjustment factors starting from IPCC default values and structure on crop rotation, fertilization and technology applied. The works would be based on "Monitoring soil quality in Romania" dataset and other available national data and references. Deadline would be end of 2012 as to include it under 2013 submission.
8	Grassland (5.C)	For “5.C.1 - Grassland remaining Grassland” there is an ongoing procedure by the Ministry of Environment to fund a research project related to reporting emissions from soils for all land categories and related conversions. The purpose of that project is to reach a Tier 2 of IPCC for emission factors, starting from country specific data on soils C stocks (reference values) and adaptation of C stock adjustment factors (starting from IPCC default values) based on other information on pasture and hayfield management and adequate expertise from these sectors. The works would be based on "Monitoring soil quality in Romania" dataset and other available national data and references. Most likely, the deadline would be end of 2012 as to include it under 2013 submission.
9	Wetlands (5.D)	For grassland and cropland, the calculation of emissions from conversion to wetlands will hopefully be presented in a future version of the national GHG inventory, based on national data available in the database of the project

No.	Category subject to improvement	Description of improvement
		"Monitoring soil quality in Romania" (ICPA, 2006), considering the IPCC methodologies available. Reporting on wetland was repeatedly mentioned in the ERT's reports (Table 7.16).
10	Settlements (5.E)	Improvements under this land category are related to the targets assumed for the other land categories and expected under the same schedule (submission of 2013). Reference C stock in the soils under settlements could be reanalyzed as well as the transition period to this category.
11	Other land (5.F)	The land use change matrix is subject to continuous verification and improvement, and ways to control and verify the parameters specific to this land category used are extremely poor. Further exploration of national soils databases is necessary in order to improve reporting on soils.
12	GHG emission from sources	Effort to improve the data is endeavored, but linked to the improvements under other land categories (i.e. 5A). Effort to report non CO_2 emissions is underway. Despite their small importance at country level accurate numbers are provided in 2012 submission following data provided by the Ministry of Agriculture, also because highlighted by the ERT's reports (Table 7.19)

In response to the review process, recalculations were carried out as follows:

- wrong referencing of the activity data in the Cropland converted to Forest Land category (5.A.2.1), for 1997-2010 time-series, and in the Grassland converted to Forest Land category (5.A.2.2), for 1991 – 2009 time-series, led to overestimation of DOM net carbon stock change. Also wrong referencing for the 2010 year in the same sub-categories for the

SOM emissions. Therefore, these changes resulted in no increasing trend for CSC IEF for DOM and SOM in Land converted to Forest Land category (5.A.2) as ERT in the 5th Centralized Review in 2012 noticed;

- for the entire time-series, Cropland Table 5(V)–Controlled Burning notation key changed from NO to IE for the CH_4 and N_2O emissions because emissions were already included under Agriculture Sector–Field Burning of Agricultural Residues (4.F) category;
- starting with the current submission CH_4 emissions from sewage sludge deposited in managed and unmanaged Solid Waste Disposal Sites have been estimated based on the data provided within 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" (6A).

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	Planned improvements are described under item 5A Forestland, above. Available activity data are consistent with the requirements under Approach 2 for land representation of KP activities. Actions described above under 5A to develop C stock change factors will allow a Tier 2/3, for C stock changes in SOC, DW and LT pools. Results on living biomass growth are expected by the end of 2012, while those on SOM, DW and LT are expected to be reflected in the reporting by 2014 submission.
2	Afforestation / reforestation	Planned improvements are linked with the AR KP Joint

No.	Category subject to improvement	Description of improvement
		implementation project implemented in Romania, which will offer data on C stock change factors for SOC, DW and LT for this activity (to be either used for reporting estimates or support "no source" in small pools). These improvements will allow a Tier 2 for all pools and will be reported in the 2013 submission.
3	Deforestation	Activity data is further checked in order to ensure the incorporation of all emissions from deforestation of any land converted from forest. Planned improvements of C stock change factors are related to the improvements described under item 5A Forestland, mainly updated value of national /regional average biomass C stock before conversion from standing wood stock and standing and fallen dead wood stock (both from NFI), while LT can be derived from simulations and validated by direct measurements. These improvements will allow a Tier 2 for all pools and will be reported in 2013 submission.
4	Revegetation	Planned improvements refer to refining the activity data for better data structure on tree species. These improvements will allow a Tier 2 for all pools and will be reported in 2013 submission.
5	GHG emission tables	Confirmation of activity data by further in-depth checks of sectoral reporting statistics. The results will allow to reach Tier 2 for activity data and results will be reported in 2013 submission.

In response to the review process, recalculations were carried out as follows:

- Forest Management area for the year 2010 changed, according to the official data reporter. This resulted in recalculations of about 0.24% in LB CSC.
- computing errors in the worksheet resulted in a small change (0.33%) of CSC in litter for AR in Grassland to FL. The issue was flagged by the ERT in the 5th Centralized Review.

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11 KP-LULUCF

11.1 General information

Romania reports GHG emissions and CO_2 removal on the mandatory afforestation/reforestation and deforestation (ARD), and on the elected activities: forest management (FM) and revegetation (Rv). The accounting will be done at the end of the commitment period (in 2014). Specific information on planned improvements within KP – LULUCF categories are presented in the Section 10.4.2.

The land area reported and changes in land area subject to the various activities in the inventory year can be found in the KP-LULUCF NIR-2 table.

11.1.1 Definition of the forest and any other criteria

Reporting under Forest management refers to “national forest fund” (NFF), which includes lands under forestry use (forests, lands for afforestation, lands serving for the needs of forest administration, waters and unproductive lands) *included in* the forest management plans. The national forest fund is under the forest regime, which represents a system of technical, economical and juridical norms which ensure its sustainable management. The lands included in NFF are totally under management planning, which is based on plans regularly renewed and updated (every 10(5) years), for each forest management unit (forest district). Under this land category, only the lands being “forests” are considered "managed forest lands" under KP. The system allows identification of parcels and their history (which allows making difference between A/R and FM).

Forest Code (Law 46/2008), currently in force, defines the “forest” as "land area of 0.25 hectares at least, covered with trees whose height must be at least 5 m at maturity under normal conditions of vegetation". The current law does not specify a minimum width and crown cover thresholds for forest. A crown cover threshold of 10% is implicitly implemented by the inclusion of a ‘forest’ under a management plan, otherwise the land is declared “other area from forest fund” or subject to ecological reconstruction (under regeneration procedure). This definition is consistent with the 1990 and post-1990 one in terms of minimum area, although it brings further specifications related to the minimum height of the trees in normal conditions of vegetation.

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

Romania has selected two types of activities related to land use in accordance with Article 3.4 of the Kyoto Protocol, namely:

- **Forest Management** (FM) - applied to managed forest lands, respectively the forests from the “national forest fund”;
- **Revegetation** (Rev) - for the activities of establishment of woody plantations on lands outside the national forest fund.

11.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time.

According to the Romanian legislation, **"afforestation/reforestation"** means “conversion of non-forest land through forest plantations with the transfer of land in the forest fund”, also called “entries into the forest fund”. Such definition implies direct human intervention and allows full consistency with the activity defined in the Marrakesh Accords. 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 its Chapter 1 "Regenerated areas on land categories", under the following indicators:

i. unproductive lands;
ii. degraded lands included (transferred) into the national forest fund;
iii. degraded and unproductive lands;
iv. amelioration perimeters and unproductive lands;

v. degraded lands from the forest fund.

Forestry legislation in Romania does not distinguish between afforestation (A) and reforestation activities (R) in the sense of the Marrakesh Accord, so they were treated similarly in the national GHG inventory and supplementary reporting. A/R works has been funded totally or partially from public funds, and it is considered directly human induced.

Once a piece of non-forest land is transferred into “national forest fund” its afforestation process has to be started in maximum two years, according to the Forest Code. This rule has to be implemented by the forestland administrator and is checked by forest authority.

Natural expansion of forest vegetation on other lands is not considered direct human induced action, what explains less area under AR in Kyoto reporting than the area reported under conversion to Forestland in the land subcategory 5A2. Further on, if area of natural expansion of forest is included under NFF these forests become automatically subject to management planning, for which reason these areas are included under FM area and not under AR, what explains larger area of FM under KP than under the 5A1 Convention.

Under strict regulation of deforestation, the area leaving the national forest fund can only go to settlements category (roads, industrial sites), which makes very unlikely the return of such area into national forest fund.

According to Romanian legislation the "**deforestation**" (D) is identified with the "definitive leave of a land from the national forest fund”, which means permanent “change of the forest destination of a land to another destination by the law”. Definitive leave from the forest fund follows a procedure drawn by the forest laws. This activity corresponds to the sub-category "5.E.2.1. - Conversions to Settlements", as far as “permanent leave” of a land from the forest fund are only allowed for public works of infrastructures. Major part of the “definitive leave from forest fund” is reported also under 5F2 Forest land converted to Other land, under natural circumstances, which is also considered as deforestation as far as there is associated with a reduction of national forest fund. Arguments presented under ‘Ch.7.2.2. Forest land - information on approaches used for representing land areas and on land-use databases used for the inventory preparation’ demonstrate that there is no additional removal of forest vegetation that can be associated to deforestation.

"**Forest management**" (FM) applies to the forest lands included under the national forest fund. The management of the NFF is regulated by forest management plans consistent with the environmental, economic and social objectives of the forests.

Forest management activity is associated with the subcategory "Forest Land remaining Forest Land - 5A1", which matches with the area reported under the Convention (1990-2011) plus area reported under 5A2.4 Other land converted to Forestland (as far as only natural expansion of forest vegetation on state owned land can automatically be transferred to NFF).

"*Revegetation"* ***doesn't have*** a specific correspondence in the national statistics**,** but as defined in Marrakech Accords**,** it is identified with areas created by planting of trees (thus directly human induced) outside the national forest fund (thus on land which do not belong to the NFF)**.** In the statistical report SILV 4, under same Chapter 1, there are reported following additional indicators:

i. plantations on excessively degraded lands outside the forest fund;
ii. plantations on degraded lands not included in the national forest fund;
iii. trees plantations including: tree lines (like along roads), belts for field protection (implemented according the Law 83/1993, Law 107/1999), green belts around urban and industrial platforms, anti-erosional plantations and land amelioration perimeters (implemented according the Law 18/1991, Law 107 / 1999).

This activity occurs on non-forest land categories, practically entirely associated with the subcategory "5B1 - Cropland remaining Cropland”. They cannot be confounded with AR areas as far as they are not included under the national forest fund . They are not even confounded with VFAFF, as they result by plantation following grids and tree lines (while VFAFF is not accounted under the KP).

11.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

Assignment of the land with forest vegetation in one of the land uses and activities is done in the accordance with the criteria of “land classification by destination”, stipulated in the Technical Norms for the Introduction of the General Cadastre, elaborated by the National Office for Cadastre and Land Registration (ANCPI), according to the Law no. 7 / 1996. National statistics are consistent over time and there is no risk of double accounting or omission of a piece of land, as far as land assignment criteria are applied and verified, according to the Cadastre Law, across the system of data collection and reporting by the NIS.

Afforestation/reforestation and deforestation are provided by separate statistics which do not interfere with each other (in any case afforestation of a deforested land cannot occur under the allocation of such land for infrastructures, and if any further planting of tree occur that is reported under the indicators relevant for Revegetation, as shown under title 11.1.3 above). On the other hand, an area subject of AR could become subject of deforestation, which is also recorded in the “permanent leave” documentation (but this was not reported so far as AR areas are usually located in remote places and the plan for land infrastructure development is well known by local authorities who have to give their accord for afforestation of a land in their jurisdiction).

Revegetation activity is associated strictly with non-forest lands categories, and do not interfere with any other activity under the Kyoto Protocol, under strict implementation of forest regime. Revegetation can be easily identified through indicators outlined in Section 11.1.3 and will be identified by NFI based on these indicators (planted trees on line or grids), while VFAFF results by spontaneous expansion of forest.

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

Estimation and reporting CO_2 emissions from the national GHG inventory for the KP activities is made at national boundary scale. Existing information on AR, D and FM allows "Reporting Method 1" based on administrative data, according to GPG LULUCF (**IPCC** 2003).

Afforestation and Reforestation

Definition of forest is implicitly meet by the practice of afforestation/reforestation.

It is not applicable any condition of area as all afforested lands which are subject to AR enters into forest fund. Furthermore, the lands subject to AR consist in large and compact areas of land, under future need of management, thus minimal area defined for forestland has no practical relevance. If exceptionally a very small area of afforestation occurs it is usually located next to an existing forest parcel, and it becomes part of a larger unit.
Noteworthy, Romania implements an afforestation/reforestation JI under Kyoto protocol. The emissions reduction associated to this project are highlighted in the Table 5(KP-I)A1.1. in a separate line.

Forest management

It does not apply any area condition for a land which is classified as forest fund. Furthermore, the forest fund consist in large pieces of land under forest planning and management, thus minimal area defined for forestland has no practical relevance. On a land which is national forest fund there is mandatory that the regeneration starts in 2 years from clearing (this is observed by state forest authorities). Such lands are landmarked, mapped and subject to decadal management plans.

Deforestation

Activity data for D were obtained from official documents for the approval of the “definitive leave from the forest fund”, according the regulations in force. National law does not establish a minimum area for the land leaving the forest fund as subject to documentation. Very detailed information on such lands (i.e. location, limits, stands description – species, volume, soil type, etc.) is all specified in the documentation submitted for the approval of “definitive leave from the forest fund”. Official documentation is archived by the central public authority responsible for forestry in Romania and its regional branches.

11.2.2 Methodology used to develop the land transition matrix

Methodology for the preparation of the land use change matrix is described in the section 7.2.

There are developed 2 matrices: one that starts in 1989, developed for the Convention purpose and another one that starts in 1990 developed for the Kyoto reporting and accounting purpose. The two are fully consistent, the difference is that Convention's one implements 20 years transition period and under KP matrix some lands are relocated (i.e. lands under conversions to forestland resulted from natural expansion of forest, included in forest fund, are reported under FM). Since 1989 is the base year for Romania, data was needed to provide an emission/removal estimate for the Revegetation activity.

A summary of the matrix (1990, 1995, 2000, 2005, 2008, 2009, 2010 and 2011) used for estimation of emission/removal on KP eligible lands is presented in the following table and the complete land matrix can be found in Annex 8.5.2.

Table 11.1 KP land area matrix 1990, 1995, 2000, 2005, 2008, 2009, 2010 and 2011

1990	**Arable**	**Pastures**	**Hayfields**	**Vineyards**	**Orchards**	**VFAFF**	**FF**	**Constr.**	**Roads/railways**	**Waters/ponds**	**Other areas**
Arable	9450.4	6.0	2.4	0.3			0.9				
Pastures		3254.6				1.5	0.2				
Hayfields			1448.0								
Vineyards				277.1							
Orchards			4.1		313.4				0.1		
VFAFF						431.6					
FF							6251.2	0.3			0.5
Constr.			3.3					622.0			1.7
Roads/railways									386.9		
Waters/ponds			7.6							902.4	
Other lands		1.9							2.0	1.2	467.7

1995	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/railways	Waters/ponds	Other areas
Arable	9337.1	65.1	21.4	25.8			3.1	6.8	0.8		
Pastures		3252.4				2.5	0.8		0.3		0.4
Hayfields		0.2	1447.7							0.1	
Vineyards		11.5		265.5					0.0		
Orchards		31.7	7.4	0.7	277.6			0.0	0.1		
VFAFF		5.7				424.6	0.5			0.8	
FF							6240.5	1.6	0.3		9.7
Constr.			3.3					615.6	3.3		4.8
Roads/railways								1.3	385.1		0.6
Waters/ponds		11.1	14.9			7.8				873.9	2.3
Other lands		14.7	2.9	0.4		0.5		1.9	6.4	15.1	430.8

2000	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/railways	Waters/ponds	Other areas
Arable	9334.8	65.1	21.4	25.8			5.4	6.8	0.8		
Pastures	2.1	3244.2	0.6			2.5	1.3	4.4	0.3		0.9
Hayfields	4.8	7.9	1435.2						0.0	0.1	
Vineyards	14.2	13.0		244.1		4.4			1.4		
Orchards	14.5	35.4	7.4	1.7	254.5	3.9		0.0	0.1		
VFAFF		13.0	7.5			408.7	0.5			2.0	
FF							6215.9	2.3	0.3		33.4
Constr.			3.3		0.1			607.4	4.6		11.7
Roads/railways								1.3	374.3		11.3
Waters/ponds	9.4	11.3	20.8			15.4				845.6	7.6
Other lands	1.3	24.7	11.1	0.7	0.0	2.3		10.7	6.4	21.2	394.4

2005	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	9322.1	66.8	21.4	25.8			16.3	6.8	0.8		
Pastures	17.7	3219.7	0.6			4.1	4.1	8.9	0.3		0.9
Hayfields	4.8	8.6	1427.3					5.0	0.0	2.3	
Vineyards	19.1	13.0	3.0	195.1		4.4		11.6	1.8		29.1
Orchards	17.1	35.4	12.4	2.4	218.1	3.9		6.6	0.1		21.4
VFAFF		18.6	13.4			387.4	8.9			3.4	
FF							6203.8	3.2	0.3		44.7
Constr.		1.5	3.3		0.1			591.7	6.0		24.4
Roads/railways								1.3	368.9		16.7
Waters/ponds	31.4	17.7	63.2			15.4		6.3		749.9	26.2
Other lands	7.9	24.7	12.1	0.7	0.0	10.7		15.7	12.8	86.9	301.1

2008	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	9299.5	66.8	27.4	25.8			20.9	15.5	1.0	3.1	
Pastures	33.2	3143.7	1.2			4.1	5.2	13.9	1.0	32.1	22.0
Hayfields	4.8	8.6	1393.1		0.7	0.1		11.9	0.0	2.3	26.5
Vineyards	19.1	13.0	3.0	185.5		4.4		11.9	1.9		38.4
Orchards	17.1	35.4	12.4	2.4	206.5	3.9		11.5	0.1		28.3
VFAFF		21.7	16.7			303.9	85.7			3.6	
FF							6197.5	3.7	0.3		50.5
Constr.		1.5	3.3		0.1			591.7	6.0		24.4
Roads/railways								3.0	367.2		16.7
Waters/ponds	33.5	17.7	63.2			15.4		6.3		718.1	56.0
Other lands	7.9	24.7	12.1	0.7	0.0	87.5		22.9	12.8	91.3	212.7

2009	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	9299.3	66.8	27.4	25.8			21.2	15.5	1.0	3.1	
Pastures	40.8	3124.4	1.2	0.9		4.1	5.3	13.9	1.0	42.7	22.0
Hayfields	4.8	8.6	1388.8		0.7	0.1		11.9	0.0	6.6	26.5
Vineyards	19.1	13.0	3.0	185.5		4.4		11.9	1.9		38.4
Orchards	17.1	35.4	12.4	2.4	204.4	3.9		13.1	0.5		28.3
VFAFF		21.7	16.7			279.1	110.2			3.9	
FF							6197.4	3.8	0.3		50.5
Constr.		1.5	3.3		0.1			591.7	6.0		24.4
Roads/railways								3.0	366.2		17.7
Waters/ponds	33.5	17.7	63.2			15.4		6.3		686.5	87.6
Other lands	7.9	24.7	12.1	0.7	0.0	112.0		32.2	12.8	91.5	178.6

2010	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	9280.7	66.8	28.9	25.8			21.6	15.5	1.0	3.1	16.6
Pastures	40.8	3099.4	1.2	0.9		4.1	5.4	13.9	1.0	42.7	47.0
Hayfields	4.8	8.6	1388.8		0.7	0.1		11.9	0.0	6.6	26.5
Vineyards	19.1	13.0	3.0	183.7		4.4		13.7	1.9		38.4
Orchards	17.1	35.4	12.4	2.4	197.8	3.9		13.1	0.5	0.7	34.2
VFAFF		21.7	16.7			259.8	129.5			3.9	
FF							6197.3	3.9	0.3		50.5
Constr.		1.5	3.3		0.1			591.7	6.0		24.4
Roads/railways								3.0	365.3		18.5
Waters/ponds	33.5	17.7	63.2			15.4		6.3		686.5	87.6
Other lands	7.9	24.7	12.1	0.7	0.0	116.7		55.3	12.8	91.5	150.9

2011	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	9228.2	66.8	51.6	25.8			21.6	15.5	1.0	3.1	46.4
Pastures	41.1	3088.3	2.9	0.9		6.4	5.7	13.9	1.0	42.7	53.5
Hayfields	5.2	8.6	1388.5		0.7	0.1		11.9	0.0	6.6	26.5
Vineyards	19.1	13.0	3.0	181.5		4.4		13.9	1.9		40.4
Orchards	17.1	35.4	12.4	2.4	195.3	3.9		13.7	0.5	0.7	36.0
VFAFF		21.7	16.7			251.2	138.1		0.0	3.9	0.0
FF							6197.1	3.9	0.3		50.7
Constr.		1.5	3.3		0.1			591.7	6.0		24.4
Roads/railways								3.0	365.2		18.7
Waters/ponds	33.5	17.7	63.2			26.6		6.3		675.3	87.6
Other lands	8.1	24.7	12.1	0.7	0.0	145.8	0.0	63.3	12.8	91.5	113.6

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Afforestation and reforestation (AR) - mapping and identification

The identification of land area eligible as AR activities could be done based on forest management plans and their forest maps, in which these areas are included after the conversion to the forest fund. Thus, the explicit location and plantation/stand description is available for each such area. The respective areas are included in the forest fund based on a set of legal documents, which allow funding of afforestation related work. The land "entering into the forest fund" are registered in the management plan documentation and are reported at the end of each year in the SILV 1, then after the initiation of plantation work in SILV 4. With the "entering into the forestry fund" the land is measured and temporarily mapped, while it is fully included in the forest maps with next management planning of the respective forest district.
Further on, such land can be tracked in time through the numbering systems of the forest parcels (compartments), as far as the number (code) remains unchanged over the planning cycles. A piece of land "entering" the forest fund is subject of plantation and, if necessary, repeated gap filling according technical norms for afforestation. If still the area is not covered by forest it will be declared "non-productive land" and further reported in statistics as part of "other lands from the forest fund".

Deforestation (D) - mapping and identification

According to Romanian legislation the approval of areas less than 10 ha to "leave the forest fund" is directly approved by the central public authority responsible for forestry. In case of areas larger than 10 ha the approval is given by the Romanian Government. In any case, the data on the area annually "leaving the forest fund" is entirely collected by the central public authority responsible for forestry, which provides aggregated information in the "Annual Report on the status of Romanian Forests". Historical data are archived by the authority as forestry records.

Approval for an area to "leave the forest fund" is based on a special regulation which requires a standard documentation to be filed up and submitted for approval (licence/permit procedure), including a map of respective area.

The approval specifies the time when land could be cleared by trees which is then registered as official "leaving" time. Documentation allows explicit identification of the location (i.e. forest district, production units, parcel and sub-parcel) and provides accurate quantitative data on area and stand description parameters. The areas "leaving the forest fund" under natural circumstances (i.e. Danube and internal rivers banks erosion, etc.) are also reported as "leaving the forest fund" (and transferred to "Other lands"), as far as they associate with a reduction of managed forest land area.

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.

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1 Description of the methodologies and the underlying assumptions used

Afforestation/reforestation

Area subject of human induced AR is some 27.36 kha in 2011 (since 1990), out of which **6.03** kha is the area under Joint Implementation project hosted by Romania (see section below on article 6 implementation). AR area represents some 13 % of 5A2 lands under conversion to forests in 2011.

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, except for mineral soils where Tier 1 is still used.

DW is reported as NR (not reported) as such pool does not occur in young plantations (less than 20 years old), while in any case initial stock is zero and reasoning based on ecosystem functioning it could only occur an increase of C stock in this pool.

Estimation methodology and data used are thoroughly described under chapter 5, section 5A2 - Land converted to Forestland (artificial plantations). Currently there are not reported areas of afforestation which have been subject to harvest, as arguments is the normative techniques for production cycles on degraded lands in Romania.

The AR is a key category under KP.

Table 11.2 Correspondence between land areas reported under GHG Inventory and A/R activity reported under KP

Reporting Year	UNFCCC				KP			CHECK
	5A2				Afforestation and Reforestation			
	5A2.1		5A2.2		ROMANIA			
					CL to FL	GL to FL		
	Arable & vineyards & orchards -> NFF	Arable & vineyards & orchards -> VFAFF	Pastures & Hayfields -> NFF	Pastures & Hayfields -> VFAFF	Arable & vineyards & orchards -> NFF	Pastures & Hayfields -> NFF	Joint Implementation Project	
	A	B	C	D	E	F	G	(A+C) - (E+F+G)
1990	12.87	*0.00*	3.22	*2.09*	0.91	0.23		14.95
1991	13.66	*0.00*	3.42	*2.09*	1.70	0.43		14.95
1992	13.93	*0.00*	3.48	*3.09*	1.97	0.49		14.95
1993	14.16	*0.00*	3.54	*3.09*	2.20	0.55		14.95
1994	14.61	*0.00*	3.65	*3.09*	2.65	0.66		14.95
1995	15.03	*0.00*	3.76	*3.09*	3.07	0.77		14.95
1996	15.51	*8.38*	3.88	*3.09*	3.56	0.89		14.94
1997	15.85	*8.38*	3.96	*3.09*	3.89	0.97		14.95
1998	16.23	*8.38*	4.06	*3.09*	4.27	1.07		14.95
1999	16.74	*8.38*	4.19	*3.09*	4.78	1.20		14.95

Reporting Year	**UNFCCC**				**KP**			**CHECK**
	5A2				**Afforestation and Reforestation**			
	5A2.1		**5A2.2**		**ROMANIA**			
					CL to FL	**GL to FL**		
	Arable & vineyards & orchards -> NFF	**Arable & vineyards & orchards -> VFAFF**	**Pastures & Hayfields -> NFF**	**Pastures & Hayfields -> VFAFF**	**Arable & vineyards & orchards -> NFF**	**Pastures & Hayfields -> NFF**	**Joint Implementation Project**	
	A	**B**	**C**	**D**	**E**	**F**	**G**	**(A+C) - (E+F+G)**
2000	17.33	*8.38*	4.33	*3.09*	5.37	1.34		14.95
2001	18.10	*8.38*	4.52	*3.09*	6.14	1.53		14.95
2002	19.30	*8.38*	4.83	*3.09*	7.34	1.84		14.95
2003	21.99	*8.38*	5.50	*4.72*	10.04	2.51		14.94
2004	25.44	*8.38*	6.36	*4.72*	13.48	3.37		14.95
2005	28.24	*8.38*	7.06	*4.72*	16.29	4.07		14.95
2006	31.44	*8.38*	7.86	*4.72*	19.48	4.87		14.95
2007	32.52	*8.38*	8.13	*4.72*	20.56	5.14		14.95
2008	32.87	*8.38*	8.22	*4.72*	16.89	3.22	6.03	14.95
2009	21.16	*8.38*	5.29	*4.10*	17.13	3.28	6.03	**0.00**
2010	20.65	*8.38*	5.16	*2.63*	17.54	3.38	6.03	1.14
2011	19.90	*8.38*	5.32	*4.89*	17.59	3.74	6.03	2.13

Reporting Year	UNFCCC				KP			CHECK
	5A2				Afforestation and Reforestation			
	5A2.1		5A2.2		ROMANIA			
					CL to FL	GL to FL		
	Arable & vineyards & orchards -> NFF	Arable & vineyards & orchards -> VFAFF	Pastures & Hayfields -> NFF	Pastures & Hayfields -> VFAFF	Arable & vineyards & orchards -> NFF	Pastures & Hayfields -> NFF	Joint Implementation Project	
	A	B	C	D	E	F	G	(A+C) - (E+F+G)
	included under AR	FL non-AR (see explanation in Chapter 7.2)	included under AR	FL non-AR (see explanation in Chapter 7.2)	Difference between Convention's CL & GL converted to NFF area and AR area is explained by the area of 14.95 of conversion to FL in 1989, which is propagated for 20 years till 2009. JI started in 2002, although areas are shown only since 2008.			

Deforestation

The total deforested area from 1990 to 2011 is 54.93 kha including 4.24 kha reported in the land subcategory 5E2 – Land converted to Settlements and 50.69 kha in 5F2 – Land converted to Other Land. Emissions are calculated using Tier 2 methods and input data as described under the chapter 7.6.2. All C pools are reported. D is not a key activity under KP.

Table 11.3 Correspondence between land areas reported under GHG Inventory and D a reported under KP

Reporting Year	**UNFCCC**				**KP**			**CHECK**
	5E2		**5F2**		**Deforestation**			
	5E2.1			**5F2.1**	**ROMANIA**		**TOTAL**	
					FL -> SL	**FL -> OL**		
	NFF -> Constr.	**NFF -> Roads&R**	**VFAFF -> Roads&R**	**NFF -> OL**	**NFF -> Constr. & R&R**	**FL -> OL**		
	A	**B**	**C**	**D**	**E**	**F**	**E+F**	**(A+B+C+D) - (E+F)**
1990	14.28	0.00	0.00	0.51	0.33	0.51	*0.84*	13.95
1991	14.64	0.00	0.00	0.51	0.69	0.51	*1.20*	13.95
1992	14.84	0.00	0.00	0.51	0.89	0.51	*1.40*	13.95
1993	14.84	0.32	0.00	4.84	1.21	4.84	*6.05*	13.95
1994	15.26	0.32	0.00	8.38	1.63	8.38	*10.01*	13.95
1995	15.52	0.32	0.00	9.65	1.89	9.65	*11.54*	13.95
1996	15.77	0.32	0.00	14.56	2.14	14.56	*16.70*	13.95
1997	15.87	0.32	0.00	18.44	2.24	18.44	*20.68*	13.95
1998	16.01	0.32	0.00	27.98	2.38	27.98	*30.36*	13.95
1999	16.13	0.32	0.00	30.13	2.50	30.13	*32.63*	13.95
2000	16.27	0.32	0.00	33.44	2.64	33.44	*36.08*	13.95
2001	16.34	0.32	0.00	33.44	2.71	33.44	*36.15*	13.95

Reporting Year	UNFCCC				KP			CHECK
	5E2		5F2		Deforestation			
	5E2.1			5F2.1	ROMANIA		TOTAL	
					FL -> SL	FL -> OL		
	NFF -> Constr.	NFF -> Roads&R	VFAFF -> Roads&R	NFF -> OL	NFF -> Constr. & R&R	FL -> OL		
	A	B	C	D	E	F	E+F	(A+B+C+D) - (E+F)
2002	16.45	0.32	0.00	36.65	2.82	36.65	*39.47*	13.95
2003	16.60	0.32	0.00	41.70	2.97	41.70	*44.67*	13.95
2004	16.87	0.32	0.00	44.56	3.24	44.56	*47.80*	13.95
2005	17.16	0.32	0.00	44.67	3.53	44.67	*48.20*	13.95
2006	17.34	0.32	0.00	44.67	3.71	44.67	*48.38*	13.95
2007	17.51	0.32	0.00	44.67	3.88	44.67	*48.55*	13.95
2008	17.63	0.32	0.00	50.52	4.00	50.52	*54.52*	13.95
2009	3.80	0.32	0.00	50.52	4.12	50.52	*54.64*	**0.00**
2010	3.58	0.32	0.00	50.01	4.23	50.52	*54.75*	0.84
2011	3.23	0.32	0.04	50.18	4.24	50.69	*54.93*	1.16
	Included under D	included under D	included under D	included under D	Difference between Convention's sum of areas under 5E2.1 + 5F2.1 and KP D is explained by the			

Reporting Year	UNFCCC				KP			CHECK
	5E2		5F2		Deforestation			
	5E2.1			5F2.1	ROMANIA		TOTAL	
					FL -> SL	FL -> OL		
	NFF -> Constr.	NFF -> Roads&R	VFAFF -> Roads&R	NFF -> OL	NFF -> Constr. & R&R	FL -> OL		
	A	B	C	D	E	F	E+F	(A+B+C+D) - (E+F)
					fact that UNFCCC area also includes the area converted in 1989 (of 13,95 ha).			

Forest management

FM area is consistent with forest fund areas (NFF) reported under 5A1 – Forest Land remaining Forest Land in the convention tables (i.e. 6307.57 kha in 2009) which represent 6197.36 of NFF area remaining NFF in that year plus the conversion of VFAFF to NFF in that particular year of about 110.21 kha resulted by natural expansion of forest vegetation on state owned land that can be readily declared forest under national forest fund. Emissions/removals from FM activity have been calculated, using the same assumptions, formulas and parameters as used for the estimation under the convention (see section 7.2.2. of the NIR). C pools reported are aboveground and belowground biomass. Change in soil organic matter, dead wood and litter are currently reported under Tier 1. Improved reporting is expected in the GHG inventory 2013 (steps for improvement are described in the section 7.2.7).

Table 11.4 Correspondence between land areas reported under GHG Inventory and FM activity reported under KP

Reporting Year	UNFCCC				KP			CHECK
	5A1				Forest Management			
	NFF		VFAFF	TOTAL	ROMANIA		TOTAL	
	NFF remaining NFF	VFAFF in conversion to NFF	VFAFF remaining VFAFF		NFF	VFAFF -> NFF		
	A	B	C	A+B+C	D	E	D+E	(A+B) - (D+E)
1990	6236.21	0.00	*431.01*	*6667.22*	6251.16	0.00	*6251.16*	14.95
1991	6235.85	0.46	*424.15*	*6660.46*	6250.80	0.46	*6251.26*	14.95
1992	6235.65	0.46	*424.15*	*6660.26*	6250.60	0.46	*6251.06*	14.95
1993	6231.00	0.46	*424.15*	*6655.61*	6245.95	0.46	*6246.41*	14.95
1994	6227.04	0.46	*424.15*	*6651.65*	6241.99	0.46	*6242.45*	14.95
1995	6225.51	0.46	*424.01*	*6649.98*	6240.46	0.46	*6240.92*	14.95
1996	6220.35	0.46	*423.82*	*6644.63*	6235.30	0.46	*6235.76*	14.95
1997	6216.37	0.46	*423.82*	*6640.65*	6231.32	0.46	*6231.78*	14.95
1998	6206.69	0.46	*416.82*	*6623.97*	6221.64	0.46	*6222.10*	14.95
1999	6204.42	0.46	*409.07*	*6613.95*	6219.37	0.46	*6219.83*	14.95
2000	6200.97	0.46	*408.07*	*6609.50*	6215.92	0.46	*6216.38*	14.95

Reporting Year	**UNFCCC**				**KP**			**CHECK**
	5A1				**Forest Management**			
	NFF		**VFAFF**	**TOTAL**	**ROMANIA**		**TOTAL**	
	NFF remaining NFF	**VFAFF in conversion to NFF**	**VFAFF remaining VFAFF**		**NFF**	**VFAFF -> NFF**		
	A	**B**	**C**	**A+B+C**	**D**	**E**	**D+E**	**(A+B) - (D+E)**
2001	6200.90	1.49	*397.39*	*6599.78*	6215.85	1.49	*6217.34*	14.95
2002	6197.58	1.49	*394.19*	*6593.26*	6212.53	1.49	*6214.02*	14.95
2003	6192.38	1.49	*394.19*	*6588.06*	6207.33	1.49	*6208.82*	14.95
2004	6189.25	1.49	*394.19*	*6584.93*	6204.20	1.49	*6205.69*	14.95
2005	6188.85	8.88	*386.80*	*6584.53*	6203.80	8.88	*6212.68*	14.95
2006	6188.67	44.37	*351.31*	*6584.35*	6203.62	44.37	*6247.99*	14.95
2007	6188.50	85.73	*309.95*	*6584.18*	6203.45	85.73	*6289.18*	14.95
2008	6182.53	85.73	*303.25*	*6571.51*	6197.48	85.73	*6283.21*	14.95
2009	6197.36	110.21	*279.09*	*6307.57*	6197.36	110.21	*6307.57*	**0.00**
2010	6198.39	129.51	*261.26*	*6589.16*	6197.25	129.51	*6326.76*	1.14
2011	6199.66	138.07	*253.12*	*6590.85*	6197.07	138.07	*6335.14*	2.59
	included under FM	included under FM	*FL non-FM*	FL remaining	Difference between Convention's FL remaining			

Reporting Year	**UNFCCC**				**KP**			**CHECK**
	5A1				**Forest Management**			
	NFF		**VFAFF**	**TOTAL**	**ROMANIA**		**TOTAL**	
	NFF remaining NFF	**VFAFF in conversion to NFF**	**VFAFF remaining VFAFF**		**NFF**	**VFAFF -> NFF**		
	A	**B**	**C**	**A+B+C**	**D**	**E**	**D+E**	**(A+B) - (D+E)**
		(see explanation in Chapter 7.2)		FL	FL area and FM area is explained by the area of 14.95 of conversion to FL in 1989, which is propagated for 20 years till 2009.			

Revegetation

For the KP-LULUCF reporting, data on "forest vegetation outside the forest fund" established by tree planting reaches 102.3 kha in 2011 compared to 87.99 kha in January 1st 1990, taking into account the entire area planted since 1970.

All areas subject to revegetation since 1970 have been included only in the estimates for 1989 (base year) and for the years 2008-2011 only those areas subject to this activity since 1990 have been included.

Actual revegetation data is drawn from statistics back till 1975, while for 1970-1974 data is lineraly extrapolated. This activity is entirely associated with 5B1 Cropland where such emissions are reported in the national GHG inventory.

This activity is subject of "net-net accounting" (i.e. the difference between the annual sinks in 1990 and each of 2008, 2009, 2010, 2011).

C pools are estimated exactly as in the case of 5A2 land converted to forestland (artificial plantations) under assumption that plantations differ only by their legal status (land classification).

This vegetation is cut and rejuvenated (not replaced with other crops, but there is no indeed full guarantee that area is maintained not changed) 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). Revegetation is not a key activity under KP, but in any case a Tier 2 estimate is achievable under the type of data available for the estimation.

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

DW in Afforestation/Reforestation and Revegetation is reported as NR (as not occurring or it is considered as a very small sink since initial mass is null, then it could only increase in time, or in any case it cannot decrease).

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Available activity data and methodologies did not allow the exclusions of indirect and natural GHG emissions from the present estimation of anthropogenic GHG emissions for the relevant activities.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

There is no change in methods used compared to the previous submission.
Recalculations of 0.24% for the LB CSC in the Forest Management activity were recorded for the year 2010 because of changes in the land data submitted by the official reporter.

Table 11.5 Biomass recalculations in Table 5(KP.B.1) – Forest Management

	Last submission (Gg)	**Current submission (Gg)**	**Differences (%)**
	2010	**2010**	**2010**
AGB	-9629.52	-9652.59	0.24
BGB	-1742.08	-1746.25	0.24

A computing error was also fixed in the AR activity that led to recalculations of the litter in Grassland to Forestland of about -5.9% in 2008, -6.1% in 2009 and 0,3% in 2010.

11.3.1.5 Uncertainty estimates

As highlighted in the section 7.2.4, the uncertainty reported under 5A2 was estimated for the artificial plantations aged less than 10 years on some 7,000 hectares included under the JI project. The uncertainty of the cumulated C stock was ± 15% (for 95% confidence interval).
The area the uncertainty was less than 1%. New estimate will be available in 2013 inventory submission, after second monitoring and validation expected by spring 2013 of the JI project.

11.3.1.6 Information on other methodological issues

Similar methodological approaches were implemented under the convention and KP reporting. Estimation of GHG emissions from sources is consistent with data and methods used in the convention estimation, and described under the section 7.9 of NIR.
The activity data for deforestation will be reviewed and reanalysed, especially the transfers to "other land", especially to define among true loss of forest area subject to forest management by natural disasters and loss due to area measurement errors (especially because the maps and measurement methods improved substantially after 1995 compared to methods used in pre-1990 period).

11.3.1.7 The year of the onset of an activity, if after 2008

Data on the year of onset of activity is reflected in the time series used to derive the activity data.

11.4 Article 3.3

11.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

Afforested areas are reported by the national statistics (SILV 4) in the year when the planting work starts, which may be later than the year when land entered into the forest fund.

In any case, reporting of all AR and D related indicators is annual, which ensures the capture of the initiation of an activity. Afforestation could only occur on non-forest fund land, which is observed by the approval of documentation for funding and “entering the forest fund”. Otherwise it is “reforestation after wood harvesting” under national forestry regime (and included under forest management).

D areas belonged to the national forest area from 1 January 1990 to the moment in time (between 1 January 1990 and 31 December 2009) when were designated, by means of an administrative act (e.g., minister order, governmental decision), a different land use category.

A land area is subject to FM as far as it has a management plan, which data is further aggregated bottom up to national level and reported in annual national statistics (SILV 1).

Tree plantations under Rv is temporally identified exactly under same manner as AR, reported under same SILV 4.

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

A land which is included in the national forest fund cannot leave this land category without following the legal deforestation procedure. The forest disturbance alone cannot trigger land conversions from forestland. Thus distinction between harvested and disturbance affected areas, on the one hand, and deforestation, on the other, is made as follows: for the former, there is legal obligation for the forest owner/administrator to maintain the land under forests category and forestry regime, to apply the forest management plans specifications and regenerate it within a given timeframe (maximum 2 years) and under specific conditions; for the latter, with the issuance of the approval, a new land use category is assigned to this land, and the forestry regime is no longer applicable.

11.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

A land which is included under the forest fund is under forestry regime (implemented through a forest management plan), which consists in the application of a set of administrative and technical norms. A basic requirement of the forest regime is that an area has to be afforested in maximum 2 years, since entered into the forest fund or after wood harvesting, without reference to a minim area. In practice, such lands can regenerate either by plantations (usually followed by state forests) or by assisted natural regeneration (in private forests), or their mixture. Its implementation is observed by public authority responsible for forestry. These areas cannot be confounded with areas "leaving the forest fund" as far as they are subject to continuous planning and management (i.e. planting/gap filling, maintenance, etc).

11.5 Article 3.4

11.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Confirmation that the FM activity is human induced and occurred since 1990 is given by the fact that associated lands were reported as part of the national economic system by continuous planning and implementation of the management measures (in SILV 1).

Revegetation activity occurs on lands which resulted by tree plantations (also publically funded at the time of their establishment since 1970 on).

11.5.2 Information relating to Revegetation

This activity has no direct equivalent in Romanian forestry or land management system, but correspondences with plantation of trees on non-forest lands. Its election for KP compliance was due under the initiative to develop a national forest belt system, initially thought flexible in terms of meeting forest definition thresholds, legal classification of the land, ownership, management obligations and administration patterns (which actually did not start yet).

Activity data is available either as number of planted trees or km of tree lines or ha (depending on the indicator in the statistical report SILV 4). Though information on these areas is available in SILV 4, their management is in the competence of the land owners of the agricultural land or companies that own/administrate infrastructure (e.g., railways, roads, etc.), and thus there is no guarantee that area initially planted is maintained (although this is the scenario we assume in estimations). With the adoption of the new Forest Law in 2008, forestry shelterbelts are made subject to the forestry regime, even though they do not meet the definition of “forest”, which becomes effective with the initiation of the forest management planning cycle (until then they are still unmanaged). Recent decline of forest shelterbelts or tree lines establishment is caused by fragmentation of lands ownership and improved road safety rules implementation. NFI also assess the tree and vegetation outside the forest fund and will likely allow an update of the area falling under Rv.

11.5.3 Information relating to Forest Management

Forest management activity refers to forest fund land for which a management plan has been set up and the forest regime is implemented. Such lands are managed according to management plans, continually surveyed for disturbances; forest harvesting is subject to planning; forest regeneration is closely and intensively assisted. Such lands are mapped, landmarked and annually up-dated in statistics. The forestry regime relies primarily on the forest law, then in subsequent legislation and technical norms, in order to ensure sustainable forests management at national scale.

11.6 Other information

11.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

In the national GHG inventory, the Tier 1 analysis (Level Assessment, including LULUCF), showed that the CO_2 removals from the category “5A1 Forest Land remaining Forest Land” is a key category.

Country specific data is used for this category, noting that reporting some C pools is still achieved according Tier 1. Significant change regarding the two related estimates ("Forestland remaining Forestland" under the Convention tables and "Forest Management" activity under the KP) are not expected for the following years.

11.7 Information relating to Article 6

Romania is implementing an AR activity as Joint Implementation flexible mechanism under Article 3.3 of the Kyoto Protocol. The project lasts from 2002 to 2017. The transaction of the emission reductions is subject to a commercial contract between RNP Romsilva (Romania) and Carbon Prototype Fund (managed by the World Bank).

Calculation of the emissions reduction is based on the partners agreed monitoring plan, while emission reduction amount is subject to an independent verification. The 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 (achieved by TUV Sud). The net removals reported for the period 1 January 2002 to 31 December 2007 are 10767 $MgCO_2eq$ on a total area of 6.033 kha on which plantations have started in 2002 and are under various stages of development.
- net removals for the commitment period (2008-2012) will be determined by the end of 2012, with the second monitoring of the project plantations, with validation expected by spring 2013.
- post Kyoto period (starting 2013 till 2017).

The monitoring for the accomplishment of the second phase is scheduled in 2012, with the estimates subject to independent verification (under JI Track II scheme). The estimates will be calculated for each year of the commitment period and consequently also reported under the Kyoto Protocol, as a separate division under Table 5(KP-I) A1.1 and it will be fully consistent with both the monitoring report and independent verification report. This approach is consistent with GPG LULUCF (IPCC 2003), p. 4.19. CO_2 removal from the JI project activities will be further allocated to third parties (project partners) following internationally agreed procedures.

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 Background information

The standard electronic format (SEF) for providing information on ERUs, CERs, tCERs, lCERs, AAUs and RMUs for the year 2012 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 31.12.2012 as well as information on transfers of the units in 2012 to and from other Parties of the Kyoto Protocol (Table 12.1). Neither AAUs, nor RMUs have been issued in the Romanian Registry in 2012.

Table 12.1 Information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Romanian registry at 31.12.2012

Annual Submission Item	Reporting
15/CMP.1 annex I.E paragraph 11: Standard Electronic Format (SEF)	**12.2**. The Standard Electronic Format report for 2012 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 2012
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications	No CDM notifications occurred in 2012

Annual Submission Item	**Reporting**
15/CMP.1 annex I.E paragraph 15: List of non-replacement	No non-replacement occurred in 2012
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist as at 31 December 2012
15/CMP.1 annex I.E paragraph 17: Actions and changes to address discrepancies	No actions were taken or changes made to address discrepancies for the period under review
15/CMP.1 annex I.E Publicly accessible information	**12.4.** The information based on the requirements in the annex to decision 13/CMP is publicly available on the Romanian registry website: http://rnges.anpm.ro
15/CMP.1 annex I.E paragraph 18: CPR Calculation	**12.5.** Relevant data/information are presented below, under Section 12.5.

12.2 Summary of information reported in the SEF tables

The relevant information is present under Section 12.1.

12.3 Discrepancies and notifications

The relevant information is present under Section 12.1.

12.4 Publicly accessible information

The relevant information is present under Section 12.1.

12.5 Calculation of the commitment period reserve (CPR)

According to the relevant provisions in Decisions 11/CMP. 1 and 13/CMP. 1, Romania calculated the Commitment Period Reserve (CPR) based on the emissions level of 2011 excluding Land Use, Land Use Change and Forestry, as follows:

Equation 12.1 CPR (tonnes CO_2 equivalent)

*CPR (tones CO_2 equivalent) = 5 * GHG emissions level in 2011 (tones CO_2 equivalent)*

*CPR = 5 * 123,345,537.17 = 616,727,686 tones CO_2 equivalent*

12.6 KP-LULUCF accounting

Romania selected accounting of activities under Art. 3, paragraphs 3 and 4 (forest management and revegetation), of the Kyoto Protocol, for the entire commitment period and intends to report the relevant data at the end of the commitment period.

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

Description of the National System

The elements on the Romanian NS, according to paragraphs 30 and 31 of Decision 15/CMP. 1, are described within Chapter 1.

Changes in the National System

Changes implemented after submitting the version 2 of the 2012 NGHGI

Changes implemented to the National system for the estimation of anthropogenic greenhouse gas emissions by sources and removals by sinks under Article 5, para. 1 of the Kyoto Protocol comprises:

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

Based on the GD no. 48/2013, all NEPA climate change related structure, personnel, atributions and responsibilities were took over by MECC, in order to improve the institutional arrangements and capacity within the climate change domain, thus increasing the efficiency in activities implementation also in respect to the NS/NGHGI administration.
Appropriate working space, facilities and necessary IT equipment were provided to the MECC personnel took over from NEPA.

- the implementation of the studies in Table 13.1 in order to strengthen the NS and to improve the NGHGI, by third party specialized organizations;

- training of NEPA team dedicated to the administration of the NS and the NGHGI and of other partners in the NS on key category analysis and uncertainty analysis related issues was performed in 2012 by the Environment Agency of Austria-University of Graz (EAA-UG) consortium in the general framework of implementation of the study "Environmental Integrated Informational System" (by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium);
- development of the KCA integrated software by the EAA-UG consortium in the context of the study "Environmental Integrated Informational System", software allowing for:
    - automatic data import from the CRF Reporter application, through the use of CRF Tables;
    - integrate both key category and uncertainty analysis;
    - development of both Tier 1 and Tier 2 analysis;
    - automatic export of results, data and information, within the relevant reporting templates.
- development of the software to support the optimization of data collection from the operators for the Energy Industries, Manufacturing Industries and Construction categories in the Energy Sector and for the Solid Waste Disposal on Land and Waste Water Handling categories in the Waste Sector was implemented subject to the "Environmental Integrated Informational System"; additionally, software to support optimized informational fluxes from/to public institutions and to the general public have been developed;
- development of the uncertainty analysis integrated software by the EAA-UG consortium, in the context of the study "Environmental Integrated Informational System", software allowing for:
    - automatic data import from the CRF Reporter application, through the use of CRF Tables;
    - integrate both key category and uncertainty analysis;
    - development of both Tier 1 and Tier 2 analysis;
    - automatic export of results, data and information, within the relevant reporting templates.

- analyzing/updating the activity data/emission factors related uncertainties values by the EAA-UG consortium following their collection also through interviews with data providers and NEPA, in the context of implementing in 2012 the study “Environmental Integrated Informational System”;
- the QA/QC and verification activities have been enhanced as a result of the implementation of the:
    - Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, RAR and DRPCIV;
    - Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS;
    - “Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations” study;
    - “Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations” study;
- continuous consideration of QA, third party support (EU internal reviews, review under Article 8 of the KP).
- KP Annex A sources-ensuring that appropriate methods are used for key categories, improving the inventory accuracy, implementing improvements considering the previous plans and ERT recommendations: based on previously items;
- improvement/further enabling the improvement of the accuracy, completeness and transparency of KP-LULUCF data/information through the implementation of the studies “Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations” and “Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations”;
- as a result of the implementation of the activities above presented, improving the implementation of the NS general functions:

  - ensure sufficient capacity for timely performance of the functions for national systems, including data collection for estimating anthropogenic GHG emissions by sources and removals by sinks and arrangements for technical competence of the staff involved in the inventory development process;
  - provide information necessary to meet the reporting requirements defined in the guidelines under Article 7 in accordance with the relevant decisions of the COP and/or COP/MOP.
- as a result of the implementation of the activities above presented, improving the implementation of the NS specific inventory preparation functions:
  - identify key source categories following the methods described in the IPCC good practice guidance;
  - prepare estimates in accordance with the methods described in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, as elaborated by the IPCC good practice guidance, and ensure that appropriate methods are used to estimate emissions from key source categories;
  - collect sufficient activity data, process information and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks;
  - make a quantitative estimate of inventory uncertainty for each source category and for the inventory in total, following the IPCC good practice guidance;
  - compile the national inventory in accordance with Article 7, paragraph 1, and relevant decisions of the COP and/or COP/MOP;
  - implementing the QA/QC and verification procedures in accordance with its QA/QC plan following the IPCC good practice guidance.

Table 13.1 Studies implemented for strengthening the NS and improving the GHG Inventory

No.	Study title	Objectives	Contractor	Status of implementation
1.	"Development of historical data, for the period 1989-2011, for allowing to estimate direct and indirect GHG emissions from Road Transport using the COPERT 4 model associated to the Tier 2 approach"	Increasing the accuracy of the Road transport estimates, using the COPERT 4 model	DRPCIV; the study related activities were implemented under the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, RAR and DRPCIV	Finalized
2.	"Environmental Integrated Informational System"	Optimizing the informational fluxes related to the NGHGI, including also data collection from the operators for the Energy Industries, Manufacturing Industries and Construction categories in the Energy Sector and for the Solid Waste Disposal on Land and Waste Water Handling	SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium	Finalized

No.	Study title	Objectives	Contractor	Status of implementation
		categories in the Waste Sector, and data collection from public authorities		
3.	"Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations" The study is also linked with the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS	Improving the accuracy, completeness, consistency and transparency of the LULUCF Sector	ICAS	Finalized
4.	"Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP	Improving the accuracy, completeness and transparency of the LULUCF Sector	ICAS	Finalized

No.	Study title	Objectives	Contractor	Status of implementation
	obligations" The study is also linked with the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS			

Further elements, including on the implementation of studies in Table 13.1 are presented in Chapter 1 and within the relevant sectorial Sections.

Changes implemented and presented into version 2 of the 2012 NGHGI and into previous than version 2 of the 2012 NGHGI inventories

Changes implemented to the NS comprises:

- updating the National Environmental Protection Agency NS/NGHGI dedicated structure as a result of:
  - governmental approval during June-July 2011 of establishing a new unit at NEPA having exclusively the responsibilities of administrating the NS and the NGHGI and allowing for an increased staff number, from 5 to 16;
  - employment of additional staff (11 people);
  - ensuring appropriate working space and facilities;
  - ensuring necessary IT equipment through the support of study 4 in Table 13.2;

  - training of all staff using the UNFCCC Secretariat and GHG management reviewer training courses, the collaboration with the European Environment Agency and the European Topic Centre for Air Pollution and Climate change Mitigation, the collaboration with the Austrian Federal Environmental Protection Agency and the support of study 3;
  - in addition to the planned training measures, the NEPA personnel administrating the NGHGI Energy Sector received technical assistance from the Environment Agency of Austria; the results are incorporated in the NGHGI 2012.
- update of the institutional, legal and procedural arrangements associated to the NS, through modifying and completing, as part of the GD no. 668/2012, the GD no. 1570/2007 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals of CO_2 by sinks, regulated through the KP, including its Annexes,
  - as outcome of study 3 in Table 13.2;
  - based on NEPA analysis on improving the institutional and legal arrangements part of the NS, performed during 2011- january 2012;
  - including:
    - an extended list of parameters, including associated institutional arrangements, especially for ensuring the use of higher (Tier) approaches;
    - optimized institutional arrangements:
      - private institutes developing data and information using public funds provide these data and information to NEPA for free;
      - data and information providers to NEPA can request data and information to other organizations;
      - updated arrangements were established on developing data and information not available: NEPA and/or public authorities and institutions,
  - are establishing and implementing the procedures for their inclusion into the Annual Statistical Research Programme, or
  - are establishing procedures for the elaboration of specific studies and the associated responsibilities:

        - new provision on the obligation to ensure consistency for similar data and information provided to several beneficiaries was included.

- update of NEPA's President Decision no. 24/2009 for approving the QA/QC Procedure related to the NGHGI through the elaboration of NEPA's President Decision no. 417/2012 on abrogating the NEPA's President Decision no. 119/2012 (on abrogating the QA/QC Procedure approved through the Decision no. 24/2009 and on approving a updated QA/QC Procedure related to the NGHGI) and on approving a updated QA/QC Procedure related to the NGHGI, based on NEPA's work following specific recommendations during the 2011 NGHGI "in-country" review and in the Report of the individual review of the annual submission of Romania submitted in 2011, review under KP Article 8;
- the QA/QC and verification activities have been enhanced as a result of:
    - increased number of NEPA NS/NGHGI dedicated staff;
    - training of NEPA and data providers representatives through several training instruments;
    - using a cross-checking QC approach within NEPA;
    - applying on a significantly larger scale sector-specific QC, QA and verification activities;
    - their implementation also in the context of development in 2011 of the NGHGI improvement studies: "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation" and "NGHGI LULUCF both under the UNFCCC and KP obligations";
    - continuous consideration of QA, third party support (collaborations with Austria and Netherlands, EU internal reviews, review under Article 8 of the KP).
- in the context of the last two points, the QC, QA and verification activities are:

- automated data validation within the Excel model-validation is implemented on the consideration of any activity data value provided through the Energy Balance and concerning an inventory specific activity, and on the range of the determined country-specific emission factors as defined within the relevant IPCC methodologies; the model is directly linked to the International Energy Agency and Eurostat versions of the Energy Balance provided by the National Institute for Statistics and to the determination of the country-specific or default emission factors spreadsheets (Energy Sector-Stationary Combustion Subsector and Reference Approach);
- manual checks on all spreadsheets part of the model presented at the previous point (Energy Sector-Stationary Combustion Subsector and Reference Approach);
- manual checks on all spreadsheets on renewable fuel combustion; the spreadsheets are directly linked to the International Energy Agency and Eurostat versions of the Energy Balance and to the default emission factors spreadsheets (Energy Sector-Stationary Combustion Subsector and Reference Approach);
- manual checks on all spreadsheets on Fugitive Emissions Subsector; the spreadsheets are directly linked to the International Energy Agency and Eurostat versions of the Energy Balance and to the used emission factors spreadsheets (Energy Sector-Fugitive Emissions Subsector);
- implementing an analysis on the share of European Union-Emission Trading Scheme to Energy Balance fuel consumption data, in respect to equivalent activity categories (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- checks specific to country-specific emission factors determination, based on background data reported under the European Union Emission Trading Scheme and validated through the reports of Ministry of Economy accredited verifiers (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- checks on the correlation between energy demand and energy resources data in the Energy Balance (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);

- checks of the outliers on the fuel mix and on the energy consumption data changes, and of double accounting potential cases, together with the Industrial Processes Sector experts (Energy Sector except the Fugitive Emissions Subsector, Reference Approach);
- check on the potential double accounting cases through the use of carbon balance (Industrial Processes Sector);
- implement cross-sectoral checks for emissions from categories calculated using tier 1 default emission factors that do not specifically account for the sources of carbon (Industrial Processes Sector);
- implementing an analysis on the share of European Union-Emission Trading Scheme to National Greenhouse Gas Inventory data, in respect to equivalent activity categories (Industrial Processes Sector);
- comparison of activity data on the CH_4 recovery for valorizing from solid waste disposal on land facilities and on the waste incineration with corresponding data in the Energy Sector (Waste Sector-Solid Waste Disposal on Land and Waste Incineration Subsectors);
- check the potential occurrence of double accounting cases between the Agriculture and Land Use, Land-Use Change and Forestry Sectors (Agriculture and Land Use, Land-Use Change and Forestry Sectors);
- implementation of a comparative analysis of country-specific emission factors and associated uncertainties with equivalent international data, mostly from the countries having similar national circumstances (technologies, the same fuels sources) (Energy Sector except the Fugitive Emissions Subsector);
- comparison of the Enteric Fermentation and Manure Management Subsectors country-specific emission factors data and information with equivalent international data and information, especially in respect with elements available within countries with similar technical conditions (livestock characteristics, Animal Manure Management Systems characteristics) (Agriculture Sector-Enteric Fermentation and Manure Management Subsectors);

  - comparison between Agriculture and Waste Sectors data in the National Greenhouse Gas Inventory and at the level of Food and Agriculture Organization and Eurostat.

- the implementation of the studies in Table 13.2 in order to strengthen the NS and to improve the NGHGI, by third party specialized organizations;
- administration in 2011 of the Land Use, Land Use Change and Forestry (LULUCF) Sector by the Forest Research and Management Planning Institute, on contractual basis, in the context of the study "NGHGI LULUCF both under the UNFCCC and KP obligations";
- in 2012-2014 period, the NGHGI LULUCF Sector, both under the UNFCCC and KP, is administrated by ICAS, based on the Protocol of collaboration no. 3029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS;
- on an undetermined period, the preparation of Road transport category estimates based on COPERT 4 model is administered also based on the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior;
- establishing in detail the coordinates and advancing the elaboration of elements of updating the informational fluxes related to NGHGI under the study 4 in Table 13.2, elements aiming to optimize the implementation of the key category analysis, of the uncertainty analysis, of data collection and of public presentation of NGHGI data; additionally, in the context of study 4 in Table 13.2, in 2012 uncertainty data will be collected also through interviews, based on the collaboration between study contractor, Environment Agency of Austria, data providers and NEPA;
- KP Annex A sources-ensuring that appropriate methods are used for key categories, improving the inventory accuracy, implementing improvements considering the previous plans and ERT recommendations: based on previously items and on items on improving the NGHGI to be further described;
- improvement of the transparency in presenting the adequacy of funding to improve the NS through the planned studies and the specific changes to the NS to ensure its proper functioning, within the NIR part of version 3 of 2011 NGHGI;

- improvement of the accuracy of KP-LULUCF data/information through:
    - the development of Tier 2 estimates for biomass pools and Forest Management activity, based on study 2 in Table 13.2; estimates have been incorporated in version 3 of the NGHGI 2011. The elaboration of Tier 2 estimates has been supported by an improved land use change matrix (supporting also the consistency between the UNFCCC and KP estimates) developed within the study 2 in Table 13.2 and by an improved quality management performed by the study contractor and NEPA.
    - finalizing the preparation by NEPA of the Terms of References associated to the study 6 in Table 13.2; advancing the procurement procedure;
- improvement of the completeness of KP-LULUCF data/information as follows:
    - Tier 1 estimates associated to the carbon stock in litter and dead wood pools for Forest Management activity and in mineral soils pool for Revegetation activity, based on study 2 in Table 13.2 were developed and incorporated in version 4 of the 2011 NGHGI.

Observation:

Version 4 of the 2011 NGHGI comprises all elements of the responses provided to the potential problems the ERT has listed in the “Saturday paper” following the 2011 in-country review.

- updating the NEPA NS/NGHGI dedicated structure according to the previously presented relevant elements.

- improvement of the transparency of KP-LULUCF data/information, based on study 2 in Table 13.2, within the NIR part of version 3 of 2011 NGHGI;
- as a result of the implementation of the activities above presented, improving the implementation of the NS general functions:
    - establish and maintain the institutional, legal and procedural arrangements necessary to perform the functions for national systems, as appropriate, between the government agencies and other entities responsible for the performance of all functions;

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

- as a result of the implementation of the activities above presented, improving the implementation of the NS specific inventory preparation functions
  - prepare estimates in accordance with the methods described in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, as elaborated by the IPCC good practice guidance, and ensure that appropriate methods are used to estimate emissions from key source categories;
  - collect sufficient activity data, process information and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks;
  - compile the national inventory in accordance with Article 7, paragraph 1, and relevant decisions of the COP and/or COP/MOP;
  - implementing the QA/QC and verification procedures in accordance with its QA/QC plan following the IPCC good practice guidance.

Table 13.2 Studies implemented/in implementation for strengthening the NS and improving the GHG Inventory

No.	Study title	Objectives	Contractor	Status of implementation	Deadline for providing final results
1.	“Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation”	Improving the accuracy in key categories estimates, as previously presented	SC ISPE SA	Finalized	31 October 2011
2.	“NGHGI LULUCF both under the UNFCCC and KP obligations”	Improving the accuracy, completeness, consistency and transparency of the LULUCF Sector	ICAS	Finalized	31 October 2011
3.	“Support for the implementation of the European Union requirements on the monitoring and reporting of the carbon dioxide (CO_2) and other greenhouse gas emissions”	Strengthening the NS, including in respect to data collection	SC ISPE SA	Finalized	30 November 2011
4.	“Environmental Integrated Informational System”	Optimizing the informational fluxes related to the NGHGI,	SC Asesoft International SA-SC Team Net	On-going	September 2012

No.	Study title	Objectives	Contractor	Status of implementation	Deadline for providing final results
		including data collection from the operators for the Electricity and heat production category (Energy) and data collection from public authorities.	International SA-SC Star Storage SRL consortium		
5.	"Development of historical data, for the period 1989-2010, for allowing to estimate direct and indirect GHG emissions from Road Transport using the COPERT 4 model associated to the Tier 2 approach"	Increasing the accuracy of the Road transport estimates, using the COPERT 4 model	PoC between NEPA, RAR and DRPCIV	On-going	annualy, until 15 July
6.	"NGHGI LULUCF both under the UNFCCC and KP obligations"	Improving the accuracy, completeness, consistency and transparency of the LULUCF Sector	PoC between NEPA, ICAS and MEF; on-going Study 6 procurement procedure	On-going	31 October 2012

Further elements, including on the implementation of studies in Table 13.2 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 and 13.2.

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 2013 NGHGI

- ***improving the accuracy***
  - beginning of use of COPERT 4 model in Road Transport (Energy);
  - continued determination and use of CO_2 country-specific emission factors in Fuel Combustion-Sectoral Approach (for 2011 year, Energy);
  - update of emission factors (Energy);
  - update of activity data mainly following the correction of the Energy Balance (Energy);
  - use of improved activity data in Limestone and Dolomite Use and Glass Production (Industrial Processes);

  - update of the activity data mainly following the correction of related national statistics data (Land Use, Land-Use Change and Forestry, Kyoto Protocol-Land-Use, Land Use Change and Forestry);
  - use of improved activity and emission factors data (Waste).

- ***improving the completeness***
  - characterization for the first time of the coke production associated CH_4 emissions (Industrial Processes).

Progresses incorporated into the version 2 of the 2011 NGHGI

- ***improving the accuracy***

Based on the intermediary results of the study "NGHGI LULUCF both under the UNFCCC and KP obligations":

- revised estimates associated to the Forest land remaining forest land category based on a revised land use change matrix (LULUCF under the UNFCCC);
  - new estimates of emissions/removals associated to the Land converted to Forest Land, Cropland, Grassland, Settlements and Other land categories (LULUCF under the UNFCCC);
  - new characterization of the activities pertaining to the Wetlands category (LULUCF under the UNFCCC);
  - implementation of a combined Tier 1-Tier 2 approach to estimate the emissions/removals from KP Article 3.4 Forest management activity (LULUCF under the KP).

Based on NEPA's work

- Tier 2 CO_2 estimates for Public electricity and heat production (Energy);
- Tier 2 CO_2 estimates for Manufacturing industries and construction, Other sectors and Road transport (based on COPERT 3 model use)categories (Energy);

- Tier 3 CO_2 emissions estimates and Tier 2 PFC emissions estimates associated to the
- Aluminium production category (Industrial processes);
- Tier 2 estimates for Managed waste disposal on land category (Waste).

- ***improving the completeness***

Based on intermediary results of study "NGHGI LULUCF both under the UNFCCC and KP obligations":

- new estimates of emissions/removals associated to the Land converted to Forest Land, Cropland, Grassland, Settlements and Other land categories (LULUCF under the UNFCCC);
- new characterization of the activities pertaining to the Wetlands category (LULUCF under the UNFCCC);
- as a result of implementing the two activities mentioned above, the number of categories whose emissions/removals were not estimated (NE categories) decreased with 111 (from 127, for 2009, within the 2011 version 1.3 NGHGI submission, to 16, for 2009, within the version 2 of the 2011 NGHGI submission).

Based on NEPA's work

- the number of NE categories in the Energy Sector decreased with 20, from 64, for 2009, within the 2011 v. 1.3 NGHGI, to 44, for 2009, within the 2011 v. 2 NGHGI, as a result of an improved characterization of emissions/removals associated to several categories.
- in total, the number of NE categories decreased for 2009 with 131, from 247 within the 2011 v. 1.3 NGHGI submission (April 2011) to 116 within the 2011 v. 2 NGHGI submission (August 2011).

- ***improving the transparency***
    - the NIR's sections relevant for the LULUCF under the UNFCCC and, respectively, under the KP, have been updated by the Forest Research and Management Planning Institute, the contractor of the study "NGHGI LULUCF both under the UNFCCC and KP obligations", a third party organization with LULUCF advanced expertise, allowing for better transparency.

- ***improving the consistency***
    - as a result of the study "NGHGI LULUCF both under the UNFCCC and KP obligations", the time series consistency and the consistency between the LULUCF under the UNFCCC and the LULUCF under the KP have been improved through revising the land use change matrix associated to the LULUCF under the UNFCCC and the land use change matrix associated to the LULUCF under the KP.

Progresses incorporated into the version 3 of the 2011 NGHGI

- ***improving the accuracy***
    - development of Tier 2 estimates for biomass associated to the Forest Management activity.

- ***improving the transparency***
    - Industrial Processes: improving the emissions and emission factors trend explanations in the NIR;
    - Agriculture: improving the activity data trend explanations and the explanations on selection of emission factors in the NIR;
    - NS: improve the presentation of funding dedicated to the improvement of the NS and improve the presentation of changes to the NS to ensure its proper functioning in the future, within the NIR;
    - KP-LULUCF: improve the transparency of data/information within the NIR, based on the study 2 in Table 13.2.

Progresses incorporated into the 2012 NGHGI

- ***improving the accuracy***

Based on study 1

- Tier 2 in majority/Tier 1 estimates, for 1989-2010 period, for CO_2 emissions, and Tier 1 for CH_4 and N_2O emissions, for Public electricity and heat production, Manufacturing industries and construction, Other sectors (Energy);
- Tier 1a estimates for Ammonia production (Industrial processes);
- Tier 2/Tier 1/default method/Tier 1b with national/default parameter values estimates for Enteric fermentation, Manure management and Agricultural soils (Agriculture);
- Tier 2 estimates for CH_4 emissions and CO_2 estimates using the default method and national emission factors, for Solid waste disposal on land, and CH_4 and N_2O emissions estimates using the default method and national/default emission factors, for Wastewater treatment (Waste).

Based on NEPA work and on study 1 in Table 13.2

- Tier 2 in majority/Tier 1 CO_2 emissions estimates and Tier 1 CH_4 and N_2O emissions estimates, for Railways and Navigation categories (Energy).

- ***improving the completeness***
  - Energy: improving further the characterization of categories whose associated emissions are not estimated (NEs)-comparing with version 2 of the 2011 NGHGI, the characterization of NEs has been further improved within the 2012 NGHGI, based on NEPA work; the number of NEs decreased with 38 for the last characterized year (2009, associated to the version 2 of the 2011 NGHGI and, respectively, 2010, associated to the 2012 NGHGI), from 44 to 6;
  - analyze of improving the characterization of NEs within the 2012 NGHGI, compared to the version 1 of the 2011 NGHGI. As a result the number of NEs for the last characterized year (2009, associated to the version 1 of the 2011 NGHGI and, 2010, associated to the 2012 NGHGI), remained constant.

- ***improving the transparency***
  - Improvement of the Energy Sector transparency, including through the extended use of detailed data in the Energy Balance and through the inclusion in the NIR of the disaggregated data on transport and on other fuels and other petroleum oil, data provided by the National Institute for Statistics;
  - Improving the documentation of parameters, on their yearly variation and on envisaged improvements, within the NIR (Waste).

Additionally, all activities related to the NGHGI administration and part of the Greenhouse Gas Inventory preparation plan, GHG Inventory improvement plan (including the prioritization plan for moving to higher tier methods for key categories)-2011-2012 and of the Schedule for training of new staff part of NEPA team dedicated to the administration of the NS and, respectively, the Greenhouse Gas Inventory were implemented.

Elements pertaining to the studies administration

The studies in Tables 13.1 and 13.2 above have been officially approved by the designated national authority, the Ministry of Environment. The organization having the responsibility of implementing the acquisition procedure pertaining to the studies previously mentioned, including the contracting stage is the Ministry of Environment.

In respect to the provisions in the current Improvement Plan, the studies are meant to strengthen the NS and to improve the accuracy of the NGHGI through the use of higher Tier/higher methods according to the specific IPCC good practice guidance decision trees provisions, to improve its completeness by allowing for the estimation of all relevant emissions/removals, to improve the consistency of the data series and the associated transparency.

The scope of the studies is to provide additional data/information to the Romanian authorities and to optimize the NGHGI related informational fluxes in order to strengthen the compliance with the reporting obligations under the UNFCCC process and the EU monitoring mechanism. The Romanian authority in charge of the GHG emission reporting is the Ministry of Environment and Climate Change, and thus it ensures that the studies are providing adequate information. The results of the studies are providing the necessary data for the NGHGI to fully comply with the IPCC reporting requirements.

According to the specific provisions within the Romanian legislation, namely the Government Decision nr. 1635/2009, the Ministry of Environment and Climate Change is the responsible institution with implementation of UNFCCC and KP. In addition, MECC is the coordinator of funds distribution for studies in the field of environment and forests.

MECC has also the tasks of the implementation of environment policy and legislation, including the entire responsibility regarding the NGHGI.

Therefore, Ministry of Environment is:

- the contracting authority in charge with the promotion of the different studies and is ensuring the elaboration of relevant documentation necessary for the acquisition of these studies, the formal approval of documents as well as with financial disbursement;
- the beneficiary of these studies and use the results to adequately meet the reporting obligations. MECC is ensuring the development of the Terms of Reference (ToRs) of the studies, including also drawing up the technical aspects of ToRs, in a way to comply with the needs and the provisions of reporting requirements.

Technical verification of the results of studies is also performed by MECC which use the results in the inventory preparation and hence the interest of MECC in participating in the process of contracting the best institution to perform the studies in a professional and timely manner.

The quality management from the initiation, throughout the completion of the studies themselves, and the quality assurance of the findings, is ensured as follows:

- *within the initiation phase* – when drawing up the relevant ToRs, MECC as a contracting authority and as the implementing agency is ensuring that the necessary data and information provided through the studies will support the Romanian authorities to fully comply with the reporting requirements;

The required quality of these studies is assured by the following legal procedure:

- the ToRs for each of these studies are elaborated, using technical elements with the aim to fill the gaps of recent inventory, approved and published by the MECC;
- the funding is provided by the MECC;
- the contractor is developing a work plan approved by the beneficiary observing the timeline indicated in ToRs;

- the implementation is carried out in intermediate steps followed by progress reports subject to the approval by MECC as the main beneficiary of these studies;
- during the implementation phase, the contractor is required to provide MECC, after the generation of the results, the proper documentation on the scope, methods, assumptions, key parameter values and data sources; further on, MECC is ensuring the adequate use, archive and storage of the information provided;
- the studies are providing also recommendation for long terms solutions in generating similar information annually.

- *during the development phase of the studies*

The organizations/entities selected to develop the studies are performing QC activities through all the stages of the study development, are documenting all the activities performed and are providing MECC the specific documentation including the relevant methodology. In this respect, the contractor is asked to perform and document the QC activities through all stages of the study development and to provide relevant documentation to the beneficiary.

Also, through the contract, the organization elaborating the study is ensuring the implementation of QA activities in the preparation of the respective studies and is providing MECC with the relevant documentation.

The implementation of the studies is following the classic procedure: inception phase, progress phases and final phase, and thus offering the possibility to MECC to monitor closely their development and avoiding in this way the deviation from the initial scope of the studies.

- *within the reception phase*

MECC is making the payments for the contractor only after MECC's endorsement of results according to contract. Therefore, the studies are providing quality and useful information for the elaboration of GHG inventories in accordance with reporting requirements.

The entire documentation on the scope, methods, assumptions, key parameter values and data sources for each study is part of the electronic/paper archive stored within the MECC's headquarters, and are available for using further by experts and checked by review teams.

Giving its legally assigned task and its designation as the responsible authority for the National System and preparation of the National GHG Inventory management, MECC is responsible for the incorporation within the NGHGI of all studies results immediately after their delivery.

Sufficient funding to strengthen the NS and improve NGHGI including through the development of specific studies are available.

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

- Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
- Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
- Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
- Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
- The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

- ❖ The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;
- ❖ All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:
    - With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);
    - The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
    - With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
    - The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
    - In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry of Romania have therefore occurred in 2012, as a consequence of the transition to the CSEUR platform:

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	No change in the name or contact information of the registry administrator occurred during the reported period
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: ❖ **Readiness questionnaire;** ❖ **Application logging (attached as Annex 6.2.7);** ❖ **Change management procedure (attached as Annex 6.2.8);** ❖ **Disaster recovery (attached as Annex 6.2.9);** ❖ **Manual Intervention (attached as Annex 6.3.0);** ❖ **Operational Plan (attached as Annex 6.3.1);** ❖ **Roles and responsibilities (attached as Annex 6.3.2);** ❖ **Security Plan (attached as Annex 6.3.3);** ❖ **Time Validation Plan (attached as Annex 6.3.4);**

Reporting Item	Description
	❖ **Version change Management (attached as Annex 6.3.5).** A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to **successful certification on 1 June2012.**
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability

Reporting Item	Description
	testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and **the operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	The information based on the requirements in the annex to the decision 13/CMP.1 is publicly available on the Romanian registry website; (Annexes 6.2.3 – 6.2.6).
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	The new internet address of the Romanian registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/RO/index.xhtml

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan.** The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.
The previous Annual Review recommendations	Update the reports posted on the public website with complete and up-to-date data and remove duplicate or outdated links

15 INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

According to the Article 3.14 of the Kyoto Protocol, Annex I countries will take mitigation measures in such a way as to minimize adverse social, environmental and economic impacts on developing countries.

As Romania pointed out in the previous National Communications on Climate Change following the Article 12 of the UNFCCC and also to the European Commission and the European Environmental Agency, following the Decisions 280/2004/EC and 166/2005/EC, the levels of GHG emissions during 1989-2008 were far below the reduction commitment taken within the Kyoto Protocol.

This reduction was mainly the result of the reduction on the economic activities level, the upgrading of technologies and energy efficiency activities promoted in the European Union integration process.

Therefore we can appreciate that the national climate change policy developed so far to reduce GHG emissions has had no impact abroad and especially on developing countries.

The application of the Joint Implementation mechanism in our country aimed firstly at upgrading and refurbishment of old technologies and at improved energy efficiency, with no trans-boundary effects, as well as the implementation in Romania of the European Union Emission Trading Scheme.

Nevertheless Romania is of the opinion that the technical and financing assistance towards the developing countries is very important for the development international policy on climate change, and is willing to join the European Union initiative to provide a “fast start financing” for the developing countries.

Under the fast start financing Romania decided to focus its contribution for the benefit of developing countries associated to the Copenhagen Accord, countries which have committed to take GHG emissions reducing measures and have developed economic strategic partnership relations with our country.

National Environmental Protection Agency from Republic of Moldavia associated to the Copenhagen Accords and 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 resourses 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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