National Environmental
Protection Agency

Ministry of Environment
and Forests

Romania's Greenhouse Gas Inventory
1989-2010

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
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
D	Deforestation
DE	Digestible Energy
DOC	Degradable Organic Carbon
DOC_F	Fraction of DOC Dissimilated
DOM	Dead Organic Matter
DRPCIV	Directorate on DrivingLicenses and Vehicles Registration in the Ministry of Administration and Interior
DS_{dom}	Fraction of Degradable Organic Component
dm	decimeter
DW	Dead Wood
EAF	Electric Arc Furnace
EB	Energy Balance
EC	European Commission
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
MCF	Methane Conversion Factor
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
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
Poc	Protocol of collaboration
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 sixteenth version of the National Inventory Report (NIR) submitted by Romania, covering the national inventories of GHG emissions/removals for the period 1989-2010.

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

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

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

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

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

ES.2.1 GHG inventory

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

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

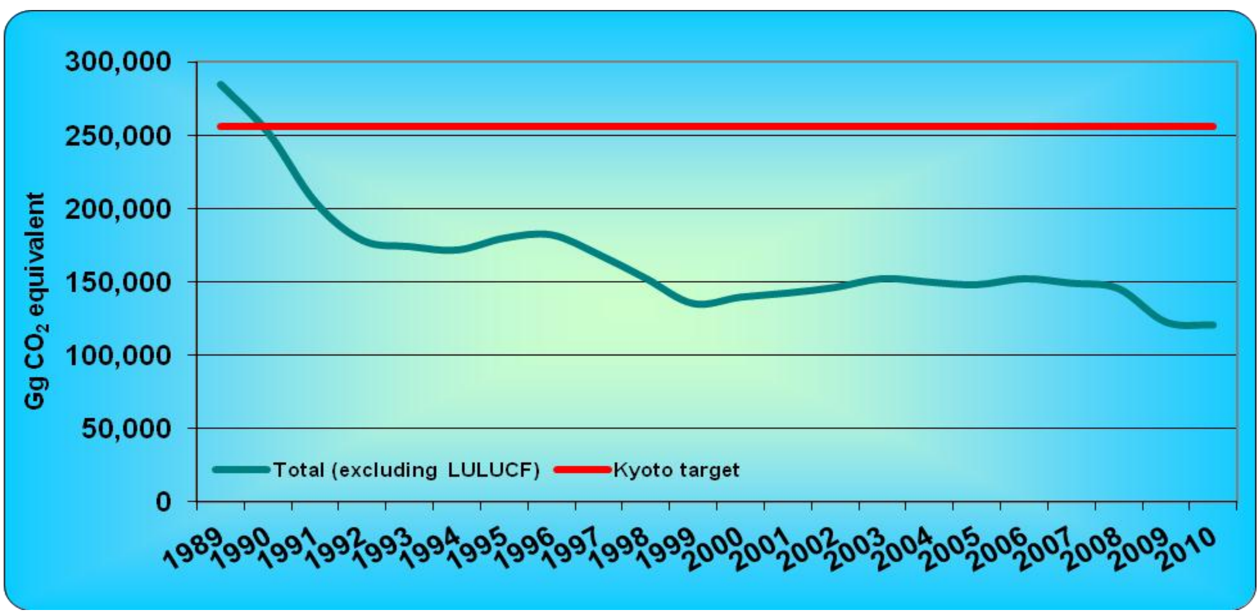
The largest contributor to the total national GHG emissions is CO_2, followed by CH_4 and N_2O. The share of each direct GHG in total emissions in 1989 and, respectively 2010, and the average share of each direct GHG in total emissions for 1989-2010 period are presented in the Table ES.1.

The total GHG emissions excluding LULUCF, in CO_2 equivalent, during 1989-2010 period, are presented in the Figure ES.1.

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

GHG	1989 (%)	2010 (%)	Average share for 1989-2010 period (%)
CO_2	74.52%	71.83%	73.50%
CH_4	15.56%	18.16%	17.21%
N_2O	8.74%	9.43%	8.48%
HFCs	0.0000%	0.0057%	0.0020%
PFCs	1.18%	0.01%	0.60%
SF_6	0.00000%	0.00004%	0.00008%

Figure ES 1 The total GHG emissions in CO_2 equivalent during 1989-2010 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 2010, the GHG emissions without LULUCF have decreased with 57.56% 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 1989–2010 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 3.5.2.

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, 27.1% represent the area covered by forests; the forests are unevenly spread on the country’s territory (51.9% in the mountain area, 37.2% in the hilly area and 10.9% in the plain area). The forest fund area accounts for 6 470 thousand ha, out of which approximately 6 309 thousand ha represents forests while the rest of the area is 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 sixteenth 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 1989-2010 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

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 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 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 NGHGI information, including supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol.

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 is to ensure the fulfillment of the relevant provisions and the obligations of Romania under the UNFCCC, the Kyoto Protocol and the European Community legislation.

The competent authority, which is responsible for administrating the National System, is the National Environmental Protection Agency (NEPA), under the subordination of the Ministry of Environment and Forests.

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

- includes all institutional, legal and procedural arrangements made as a Party included in Annex I for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and for reporting and archiving inventory information;
- represents a system for the collection, processing and adequate presentation of data and information for the elaboration of the NGHGI;
- is designed and operated to ensure the transparency, consistency, comparability, completeness and accuracy of inventories as defined in the guidelines for the preparation of inventories by Parties included in Annex I, in accordance with relevant decisions of the COP and/or COP/MOP;
- is designed and operated to ensure the quality of the NGHGI through planning, preparation and management of inventory activities;

- is designed and operated to support compliance with the Kyoto Protocol and with the European Union legislation commitments related to the estimation of anthropogenic GHG emissions by sources and removals by sink;
- is designed and operated to consistently estimate anthropogenic emissions by all sources and removals by all sinks of all GHGs, as covered by the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and IPCC good practice guidance, in accordance with relevant decisions of the COP and/or COP/MOP.

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

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

Institutional arrangements

The elements characterizing the institutional arrangements comprise:

- according to the Governmental Decision no. 1570/2007 as ulteriorly modified and completed, the single national entity with overall responsibility for the national inventory, including with the responsibilities of administrating the NS and of preparation and management of the NGHGI, is the National Environmental Protection Agency (NEPA);
- 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 NEPA the necessary activity data, emission factors and associated uncertainty data;
- the characteristics of the institutional arrangements include:
    - centralized approach – NEPA 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 NEPA (governmental agency);

- single agency – the single national entity is housed within a single governmental agency;
- 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 LULUCF Sector, both under the UNFCCC and KP, was administrated by the Forest Research and Management Planning Institute (ICAS), based on a contract with the MEF, 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 MEF, 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 MEF, 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 is identifying 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 will be 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:

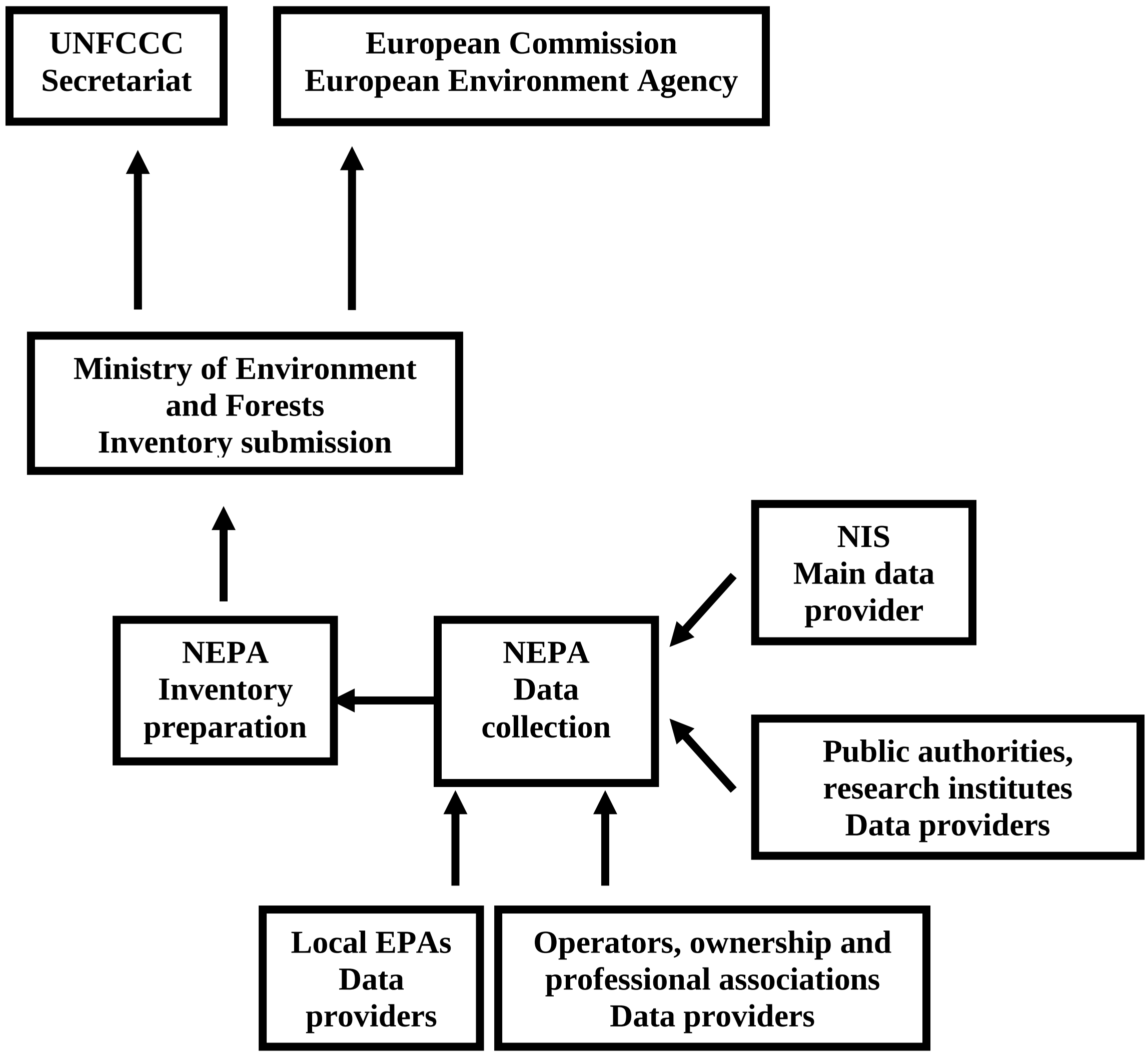
- evaluation of the Romanian capacity to report the GHG emissions according to the European Union requirements;
- improving the reporting capacity of the authorities in Romania;
- specific training session for improving the expertise of NEPA team with the attributions/responsibilities of administrating 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.

Figure 1.1 Current national inventory system description



Legal arrangements

The legal framework specific to the NS include:

- 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.

Procedural arrangements

The procedural framework specific to the NS include:

- GD no. 1570/2007, as ulteriorly modified and completed;
- Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review;
- Procedure on processing, archiving and storage of data specific to the NGHGI;
- Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels;
- QA/QC Procedure related to the NGHGI.

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 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, Sustainable Development Directorate have 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 first 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 “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 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 1.2);
    - 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 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.
- 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 (UNFCCC Reporting Guidelines), IPCC good practice guidance (IPCC GPG 2000), IPCC good practice
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
					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
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 NEPA.

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;
- version 2 of the 2012 submission of the NGHGI constitutes the sixteenth 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, and 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 NEPA.

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: National Environmental Protection Agency;
  - address: Splaiul Independentei no. 294, Sector 6, Bucharest, Postal Code 060031;
  - 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 agencies 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 NEPA 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 NIS/NGHGI administration;
    - coordinating the QA/QC activities;
    - managing the archiving system.
- the allocation of attributions/responsibilities to the NEPA team dedicated to the administration of the NS/NGHGI is presented in Table 1.3.

Table 1.3 The allocation of attributions/responsibilities to the team dedicated to the administration of the NS/NGHGI

Team size (staff)	Responsibilities
4	Administration of Energy Sector, including the Transport Subsector; implementing relevant sectorial activities associated to: key category analysis, uncertainty analysis, QA/QC, data/information archiving; implementing all relevant sectorial activities.
3	Administration of Industrial Processes and Solvents and Other Product Use Sectors; implementing all relevant sectorial activities.
2	Administration of Agriculture Sector; implementing all relevant sectorial activities.
3	Administration of LULUCF Sector; implementing all relevant sectorial activities.
2	Administration of Waste Sector; implementing all relevant sectorial activities.
1	Administration of the key category and uncertainty analysis data/information associated to the NGHGI.
1	Coordinating the team/activities relevant to the NIS/NGHGI administration; coordinating the QA/QC activities; manager of 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;
- NEPA submits the NGHGI for verification and evaluation to MoE;
- NEPA considers the observations and comments received, and as appropriate updates and resubmits 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 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, NEPA ensures the availability of human and financial resources for the implementation of review activities under Article 8 of the KP;
- NEPA 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

NEPA 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 NEPA 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 MEF, NEPA and ICAS.

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

The Ministry of Environment and Forests 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 of Chapter 7 of IPCC GPG 2000 and Chapter 5 of IPCC GPG 2003;
- ❖ 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;
- ❖ Tier 1 approach was conducted both for base year (1989) and last year of the characterized period;
- ❖ results are presented in NIR, within:
    - ➢ Chapter 1, at general level;

  - Annex 1 using the template provided by Tables 7A1-7A3 of 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 was implemented using a software application developed within NEPA, based on data provided by every sectorial expert;
- 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 in key categories;
- KCA is subject to the development of an integrated software in the context of the study “Environmental Integrated Informational System”, in implementation by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, study aiming to allow for:
  - automatic data import from the CRF Reporter databases;
  - 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 CRF Reporter and within the relevant reporting templates.

A general and a specific analysis have been implemented in 2011, while the previously mentioned software is under development, intermediary/final results being provided by May/September 2012.

Further elements are presented within the 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;
- due to NEPA's work and 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", 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", 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;
- 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 very limited number;
- data processing is performed according 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 NEPA;
- emission factors (EFs) selection 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 and 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", a significant amount of activity data and emission factors has been collected/processed/developed, enabling the development of higher estimates/tier estimates and of a 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", 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; 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 MEF, NEPA and ICAS;
- optimizing the informational fluxes on data collection from the operators for the Electricity and heat production category in the Energy Sector is subject to the on-going "Environmental Integrated Informational System" study in implementation by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, based on a contract with MEF; intermediary final results will be provided by May/September 2012;
- on an undetermined period, the collection/processing/development of activity data to support the preparation of Road transport category estimates based on COPERT 4 model is

administered based on the Protocol of collaboration no. 3136/MMP/9.07.2012 between MEF, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior.

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 on Tier 1 method according to the provisions in Chapter 6 of the IPCC GPG 2000, in the Chapter 5 of the IPCC GPG 2003;
- performed for 2010, 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" and "NGHGI LULUCF both under the UNFCCC and KP obligations" studies), expert judgment (use of values specific to neighborhood countries), default AD and EFs uncertainty sources;
- disaggregation of the inventory into categories equivalent to the key category analysis splitting, except two particular cases specific to the Waste sector;
- results presented within the NIR, in:
  - Uncertainties and time series consistency sub-sectorial section;
  - in Annex 7.
- the uncertainty analysis is subject to the development of an integrated software in the context of the study "Environmental Integrated Informational System", in implementation by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, study aiming to allow for:
  - automatic data import from the CRF Reporter databases;
  - 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.

A general and a specific analysis have been implemented in 2011, while the previously mentioned software is under development, intermediary/final results being provided by May/September 2012.

- additionally, in the context of the previously mentioned study, 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.

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, Romania implemented significant recalculations in order to account for better AD and/or EFs, based on NEPA’s work and 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”;
- 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 comprises 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, NEPA represents the competent authority responsible with the implementation of the QA/QC activities;
- ❖ the QA/QC coordinator is designated by NEPA;
- ❖ 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" and "NGHGI LULUCF 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 subject to the annual internal review under EU-Monitoring Mechanism;
- 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 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 NEPA and accessible at a single location at the NEPA'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 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, NEPA 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 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, NEPA ensures the availability of human and financial resources for the implementation of review activities under Article 8 of the KP;
- NEPA 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 2010, 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 and 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", a significant amount of activity data and emission factors has been collected/processed/developed, enabling the development of higher estimates/tier estimates and of a 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", 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; 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 MEF, NEPA and ICAS.

Optimizing the informational fluxes on data collection from the operators for the Electricity and heat production category in the Energy Sector is subject to the on-going "Environmental Integrated Informational System" study in implementation by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, based on a contract with MEF; intermediary final results will be provided by May/September 2012.

On an undetermined period, the collection/processing/development of activity data to support the preparation of Road transport category estimates based on COPERT 4 model is administered based on the Protocol of collaboration no. 3136/MMP/9.07.2012 between MEF, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior.

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" and "NGHGI LULUCF both under the UNFCCC and KP obligations" in respect to the LULUCF Sector, studies implemented in 2011; 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:

- MEF, 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;
- MEF, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior, 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.

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 national system, the IPCC 1996 and IPCC GPG 2000 provisions, and to 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 1.4 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 additional data 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 (2009-2010) 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 has been also collected through the implementation by ISPE and ICAS, in 2011, 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” and “NGHGI LULUCF both under the UNFCCC and KP obligations”.

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 very limited number.

Due to NEPA’s work and 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”, 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”, 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.

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 of Chapter 7 of IPCC GPG 2000 and Chapter 5 of IPCC GPG 2003.

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. A Tier 1 approach was conducted both for base year (1989) and last year of the characterized period (2010).

Taking into account the exclusion of the LULUCF sector, in 2010:

- 34 categories are considered as key ones both by level and trend;
- 5 categories are considered as key ones, only by level;
- 9 categories are considered as key ones, only by trend.

Taking into account the inclusion of the LULUCF sector, in 2010:

- 33 categories are considered as key ones, both by level and trend;
- 8 categories are considered as key ones, only by level;
- 11 categories are considered as key ones, only by trend.

The most important key categories in 2010 are:

- CO_2 from Forest Land remaining Forest Land;
- CO_2 from Energy Industries–Public Electricity and Heat Production-solid fuels;
- CO_2 from Road Transport;
- CH_4 from Enteric Fermentation;
- CH_4 from Fugitive Emissions-oil and natural gas;
- CO_2 from Energy Industries–Public Electricity and Heat Production-gaseous fuels;
- CO_2 from Other Sectors-Residential-gaseous fuels.

The results of the key category analysis for 1989 and 2010 are presented in NIR within:

- Chapter 1, at general level;
- Annex 1 using the template provided by Tables 7A1-7A3 of 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 was implemented using a software application developed within NEPA, based on data provided by every sectorial expert.

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) – 2011-2012 – May 2011 (attached as Annex 6.1.3).

KCA is subject to the development of integrated software in the context of the study “Environmental Integrated Informational System”, in implementation by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, study aiming to allow for:

- automatic data import from the CRF Reporter databases;
- 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 CRF Reporter and within the relevant reporting templates.

A general and a specific analysis have been implemented in 2011, while the previously mentioned software is under development, intermediary/final results being provided by May/September 2012.

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, 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" and "NGHGI LULUCF both under the 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. MEF 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.

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 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.

Additionally, QA activities were 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".

1.6.2. Verification activities

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

- Industrial Processes – comparison of data sets used with data provided by the Ministry of Economy/NIS;
- Agriculture - comparison of data sets used with relevant data on FAO/Eurostat;
- Waste – comparison of data sets used with Eurostat 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, Commerce and Business Environment 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 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 (review under Article 8 of the KP, EU internal reviews, collaborations with Austria and Netherlands).

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 the Tier 1 method according to the provisions in Chapter 6 of the IPCC GPG 2000, in the Chapter 5 of the IPCC GPG 2003 and also taking into account local conditions.

The uncertainty calculation was performed for 2010, both excluding and including the LULUCF, using the framework provided in the IPCC GPG 2000 and also in the IPCC GPG 2003. The disaggregation of the inventory into categories is equivalent to the key category analysis splitting, except two particular cases specific to the Waste sector.

The uncertainty analysis takes into consideration 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” and “NGHGI LULUCF both under the UNFCCC and KP obligations” studies), expert judgment (use of values specific to neighborhood countries) and default uncertainty values associated to AD and EFs.

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.

The uncertainty analysis is subject to the development of integrated software in the context of the study “Environmental Integrated Informational System”, in implementation by the SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, study aiming to allow for:

- automatic data import from the CRF Reporter databases;
- 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.

A general and a specific analysis have been implemented in 2011, while the previously mentioned software is under development, intermediary/final results being provided by May/September 2012

Romania built the uncertainty analysis in order to help prioritizing efforts to improve the accuracy of the inventory, to guide decisions on methodological choice and also for providing a complete NGHGI.

Additionally, in the context of the previously mentioned study, 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.

Considering version 3 of the 2011 NGHGI:

- the total NGHGI uncertainty for 2009 excluding LULUCF was 16.8%, while including LULUCF was 19,4%;
- the uncertainty introduced into the trend in total national emissions, for 2009, was 4.5% when considering excluding LULUCF criteria and 3.8, including LULUCF.

Considering the version 2 of the 2012 NGHGI:

- 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.

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 current inventory of these elements, all uncertainty values presented in the two paragraphs above significantly decreased within the 2012 v. 1.2 NGHGI when comparing to the 2011 v. 3.1 NGHGI.

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 1989-2010 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

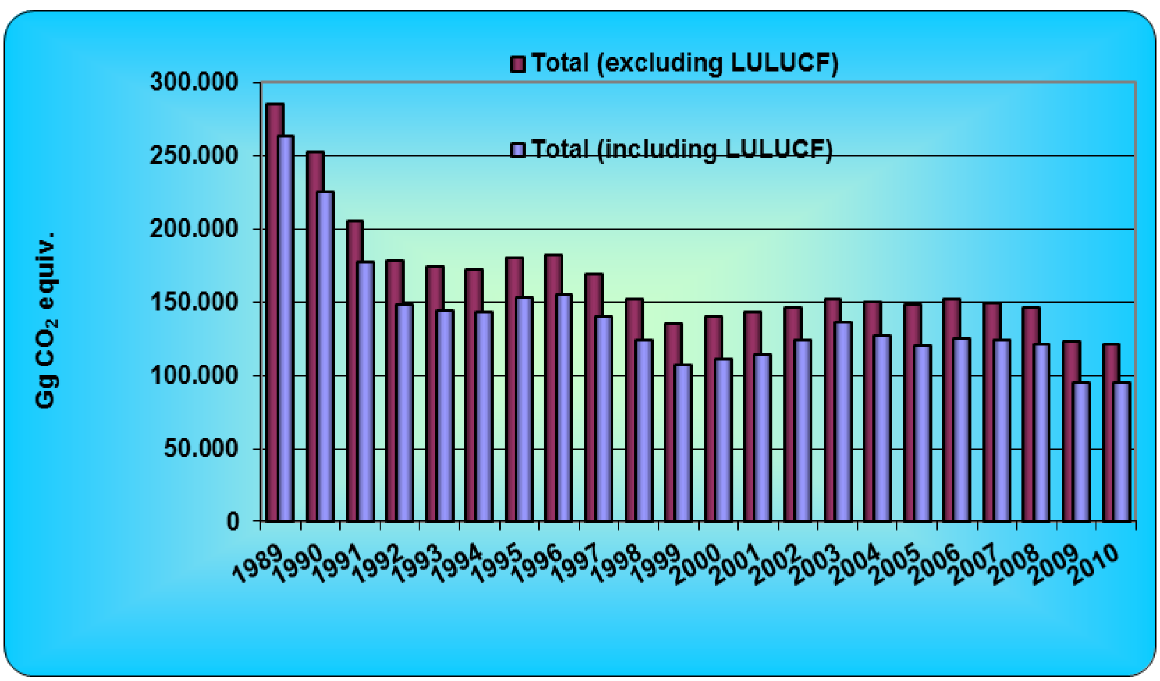
2.1 Description and interpretation of emissions trends for aggregated greenhouse gas emissions

The total GHG emissions in 2010, excluding removals by sinks, amounted to 120,920.04 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 57.56 % in 2010 in comparison to 1989 while the net GHG emissions/removals (taking into account the CO_2 removals) decreased with 63.89%. 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 2010 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: 74.52% CO_2, 15.56% CH_4, 8.74% N_2O, 1.18% PFCs. In 2010, the shares of GHG emissions were: 71.83% CO_2, 18.16% CH_4, 9.43% 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 2010, the contribution of these gases to the total GHG emissions is negligible: 0.5748% HFCs and 0.00421% 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	190,907.38	212,348.50	44,338.50	24,902.82	NA,NE,NO	3,349.56	NA,NE,NO
1990	160,926.20	188,208.60	40,896.48	20,996.61	NA,NE,NO	2,115.83	NA,NE,NO
1991	124,999.10	152,905.79	34,699.42	15,289.11	NA,NE,NO	1,942.09	NA,NE,NO
1992	102,489.43	133,081.88	30,268.08	13,980.90	NA,NE,NO	1,352.13	NA,NE,NO
1993	98,831.21	128,701.02	29,300.36	15,062.27	NA,NE,NO	1,409.43	NA,NE,NO
1994	98,364.04	126,946.48	29,487.61	14,130.17	NA,NE,NO	1,490.97	NA,NE,NO
1995	107,000.20	134,120.13	29,627.52	14,604.86	95.04	1,773.69	0.06
1996	109,936.04	137,051.43	29,219.53	14,322.67	97.64	1,769.07	0.06
1997	96,714.92	125,273.20	28,088.57	13,750.67	123.94	1,786.59	0.02
1998	83,628.41	111,859.81	26,133.15	12,785.55	154.37	1,753.54	0.01
1999	67,245.52	95,849.82	25,390.33	12,540.00	151.42	1,603.62	0.05
2000	70,997.73	100,145.85	26,056.82	12,307.98	163.43	1,292.37	0.00
2001	73,975.52	102,921.28	26,121.73	12,444.71	216.79	1,044.49	0.00
2002	84,550.56	106,848.54	26,820.30	11,957.91	239.47	717.86	0.01
2003	95,967.64	112,295.57	26,890.07	12,849.94	292.50	261.51	17.83
2004	87,980.39	110,853.95	25,974.33	12,889.03	367.96	132.60	22.64
2005	80,112.46	108,110.57	25,965.39	13,732.85	487.21	81.90	49.56
2006	85,842.19	113,661.58	25,329.58	12,748.14	641.10	55.03	67.76
2007	86,659.42	111,859.93	24,285.79	12,413.12	840.45	24.23	58.39
2008	83,412.11	107,710.36	24,261.97	12,909.79	890.27	15.34	16.33
2009	59,962.14	88,226.26	23,197.86	10,815.25	703.10	7.00	7.38
2010	61,076.28	86,858.72	21,953.73	11,399.53	695.05	7.93	5.09

Carbon dioxide (CO_2) – the most significant anthropogenic greenhouse gas is the carbon dioxide. The decrease of CO_2 emissions (from 212,348.50 Gg in 1989 to 86,858.72 Gg in 2010) 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 2010 by 50.49% compared with the levels in 1989. The decrease of CH_4 emissions in Agriculture is due to the decrease of the livestock level.

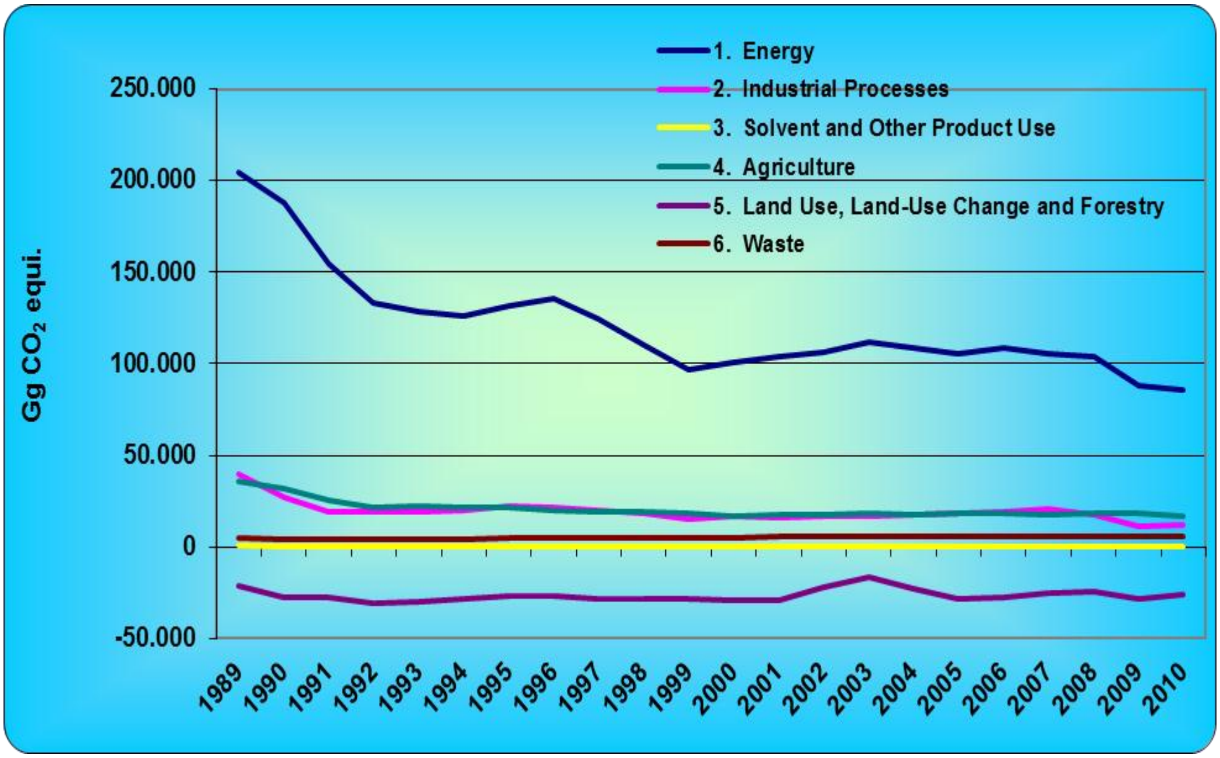
Nitrous oxide (N_2O) – the N_2O emissions are mainly generated within the Agricultural Soils activities in the Agriculture sector and within the Chemical industry activities in the Industrial Processes sector. The decline of these activities (decline of livestock, decline of N synthetic fertilizer applied on soils amounts, decrease of the crop productions level) is reflected in the N_2O emissions trend. The N_2O emissions in 2010 decreased with 54.22 % 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 (1989-2010) and have decreased with 99.76% in 2010 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 71.16% of the total national GHG emissions in 2010. The GHG emissions resulted from the Energy sector decreased with 57.96 % compared with the base year.

Industrial Processes contributes to total GHG emissions with 10.30%. A significant decrease of GHG emissions was registered in this sector (68.47% decreases in 2010 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 2010 by 80.68% in comparison with the level recorded in 1989.

Agriculture GHG emissions have also decreased. The GHG emissions in 2010 are 53.05% 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.

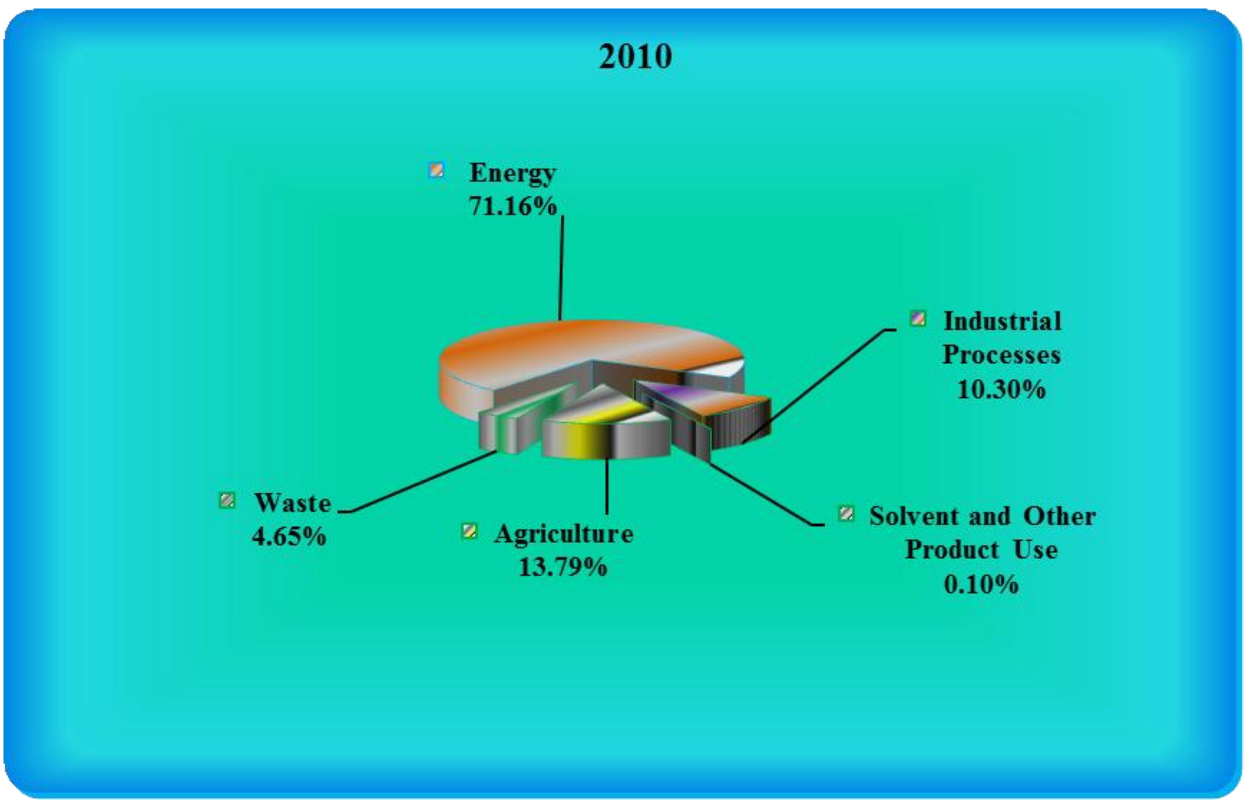
In 2010, 13.79 % of the total GHG emissions resulted from the agriculture sector.

LULUCF The net GHG removals/emissions level is 20.25% higher in 2010 in comparison with the level in the base year. The Romanian land use sector acts as a net sink, at an average uptake of 25,782.42 Gg/year, being relatively stable over the last 22 years.

Waste sector emissions have increased in 2010 with 22.16% in comparison with the level in 1989. The contribution of the waste sector to the total GHG emissions in 2010 is 4.65%.

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

Figure 2.3 Sectorial GHG emissions in 2009 [%]



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.

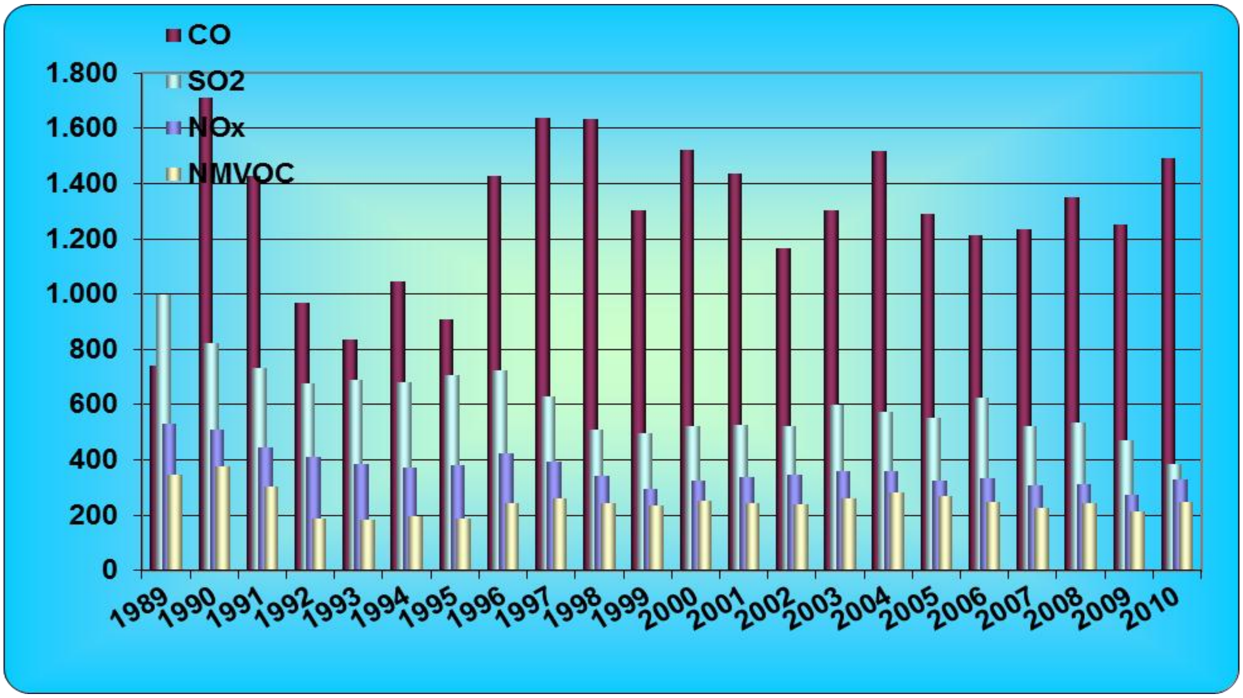
The NO_x, NMVOC and SO_2 emissions evolution follows the general direct GHG emissions trend. The SO_2 emissions decrease is caused by the decline of the fuels burnt for energy and the decrease of sulphur content in fuels.

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	531.34	741.53	348.29	998.88
1990	510.61	1,709.77	374.64	821.23
1991	447.13	1,428.39	302.80	733.57
1992	412.16	968.74	185.99	675.45
1993	384.23	833.64	183.62	691.19
1994	371.24	1,045.89	195.96	682.92
1995	379.70	909.48	189.83	706.70
1996	424.51	1,425.62	243.19	725.10
1997	393.36	1,636.54	259.22	629.36
1998	342.92	1,633.86	245.54	509.77
1999	294.00	1,302.63	235.92	497.75
2000	325.30	1,522.92	254.26	523.50
2001	337.12	1,436.18	245.66	525.07
2002	347.34	1,165.86	237.46	521.16
2003	360.78	1,304.30	261.78	600.20
2004	357.62	1,518.72	282.71	572.47
2005	327.13	1,292.20	270.65	554.17
2006	332.14	1,214.14	248.18	625.69
2007	307.87	1,234.57	227.00	521.43
2008	314.34	1,351.97	241.82	533.86
2009	274.99	1,253.32	213.37	470.13
2010	327.85	1,489.84	248.95	383.39

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;

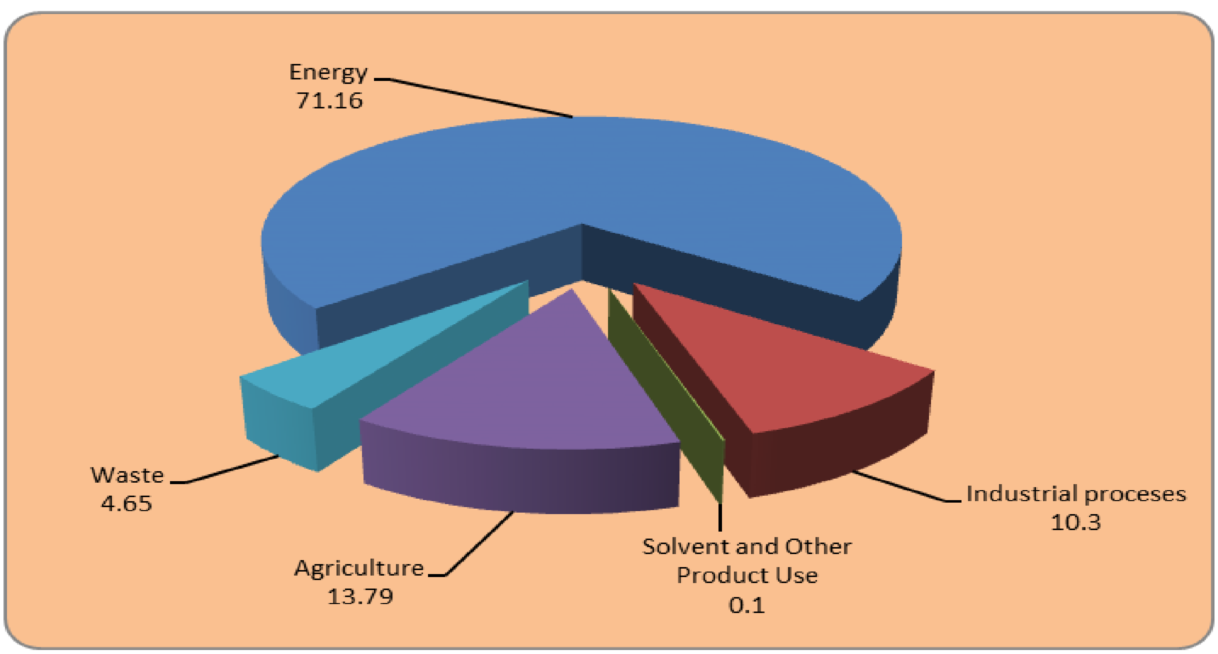
1.A.3. Transport;

1.A.4 Other sectors (commercial/ institutional, residential, agriculture/ forestry/ fisheries);

1.B. Fugitive Emissions from Fuels.

Compared to the other GHG emissions sectors (Industry, Agriculture, LULUCF, Waste), the Energy sector represents the largest source of anthropogenic GHG emissions in Romania. In 2010, the Energy sector was responsible for about 71.16 % of the total GHG emissions (120,920.04 Gg CO_2 equivalents).

Figure 3.1 The contribution of Energy Sector to the total GHG emissions in Romania, 2010



Emission trends

Emissions from the energy sector in 2010 decreased by 57,96 (86,041.01Gg CO_2e in 2010 compared to 204,676.032Gg CO_2e in 1989) compared to the base year.

Figure 3.2 Total GHG emissions from Energy Sector

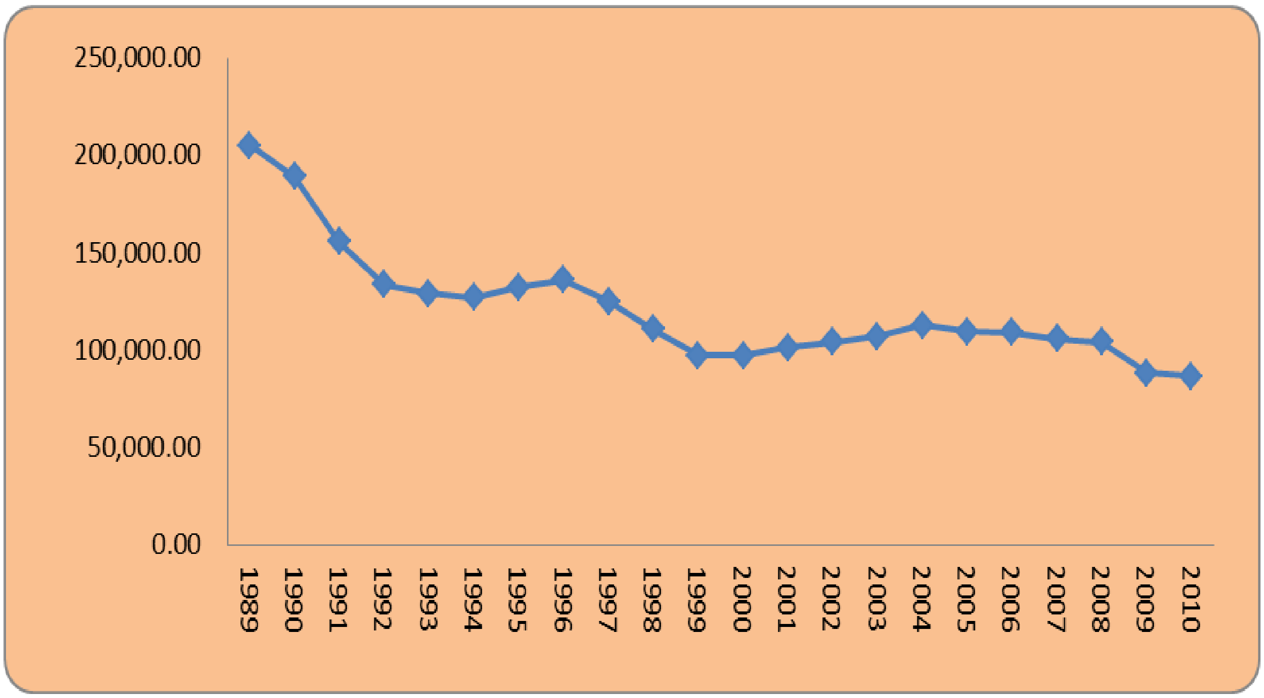
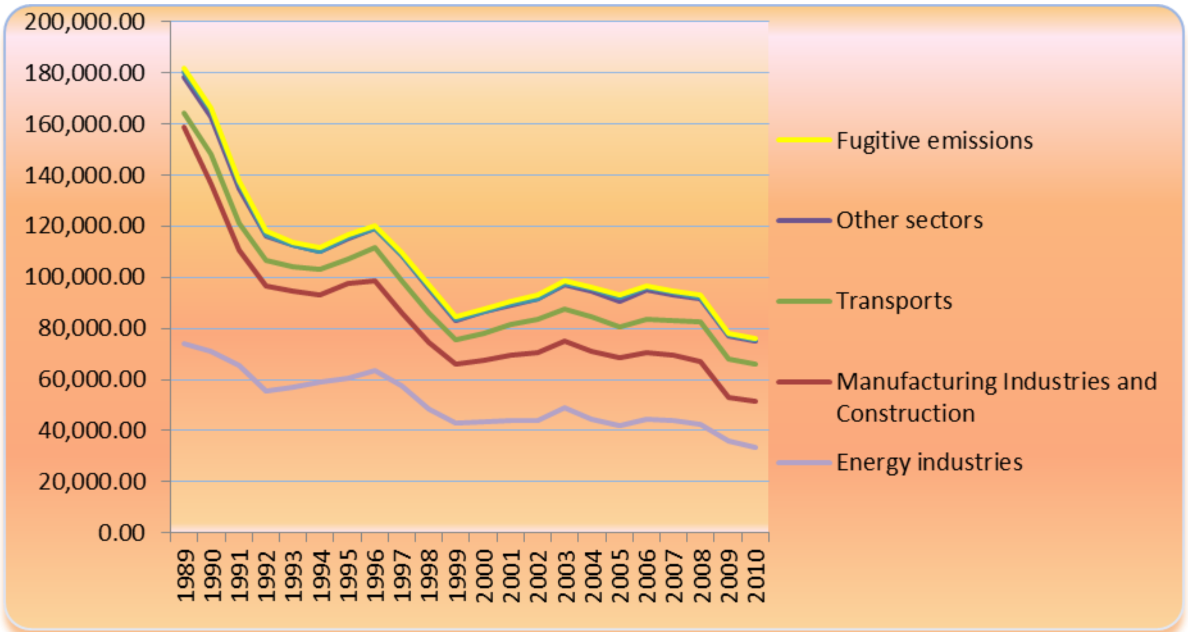


Table 3.1 GHG emissions and their trends for the years 1989-2010- Energy Sector

Year	CO_2[Gg]	CH_4 [Gg]	N_2O[Gg]	Total GHG[Gg CO_2e]
1989	181,744.09	1,095.93	1.31	204,676.03
1990	166,454.50	1,044.85	1.47	188,100.81
1991	137,808.25	830.40	1.34	154,934.86
1992	117,944.75	726.63	1.23	132,885.53
1993	113,861.48	695.66	1.28	128,192.53
1994	111,438.56	722.86	1.33	126,381.70
1995	116,639.04	724.45	1.42	131,668.67
1996	120,291.85	721.09	1.70	135,362.59
1997	109,733.69	687.61	1.74	124,139.64
1998	97,262.15	611.34	1.50	110,018.44
1999	84,366.75	583.68	1.39	96,533.55
2000	87,697.90	628.82	1.50	100,873.82
2001	90,475.61	632.22	1.47	103,737.10
2002	92,985.94	647.41	1.56	106,620.00
2003	98,594.22	638.08	1.74	112,113.82
2004	96,265.16	592.34	1.77	108,860.61
2005	92,961.11	582.49	1.90	105,415.27
2006	96,820.61	546.97	1.89	108,552.91
2007	94,706.34	483.68	2.06	105,210.70
2008	93,064.34	490.10	2.44	103,825.46
2009	78,082.97	452.40	2.30	88,004.29
2010	76,151.69	441.83	2.90	86,041.01

Figure 3.3 The energy sector emission trend for the period 1989-2010



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 with 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 started to function, therefore the decrease in emissions 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 decreasing of the fuels consumption, especially in industry, is due to the decrease of economic activities level in the second semester of 2008.

The total of the energy resources, about 44.250 million tons of oil equivalents in 2010, rising compared to 2009 with 4.45 thousand tons.

Final energy consumption shows a slight increase in 2010 compared to 2009 (1.6%), due to the growing recorded in industry (including construction) - 6.2% and other - 6.1%. A lower level in the growing of the consumption, less than 2%, was recorded in agriculture and population.

The energy exports (including international bunkers), compared to 2009 has a decreasing of 4.05 million tons, about 12.9%; exports of the motor gasoline and transport diesel accounting about 60%.

The electricity consumption in 2010 was about 51,458 GWh, with 3536 GWh (7.4%) higher than in 2009.

The consumption of the energy production plants, in 2010, was lower than 2009, with 708 thousand equivalent tons (-6.9%). The coal fuel accounts about 54.5% and the hydrocarbons accounts about 15.1% from the consumption of energy production plants.

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 2010

Energy sector-categories	**Percentages for 2010**
Energy industries	38.64%
Manufacturing Industries and Construction	21.52%
Transports	17.53%
Other sectors	11.81%
Other	0.36%
Fugitive emissions	10.15%

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

Figure 3.4 The different GHG's contribution to the 2010 Energy emissions

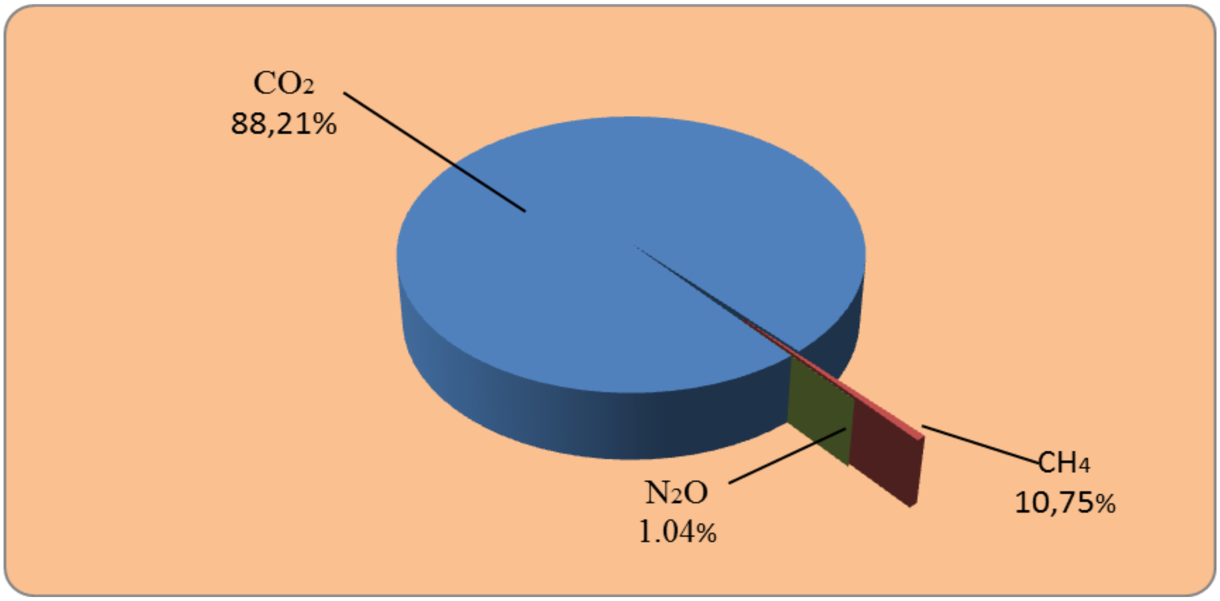


Table 3.3 Status of emissions estimation within the Energy Sector for 2010

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. Nonferrous metals	✓	✓	✓
1.A.2.c. Chemicals	✓	✓	✓
1.A.2.d. Pulp paper and print	✓	✓	✓
1.A.2.e. Food processing, beverages and tobacco	✓	✓	✓
1A2f Other (as specified in table 1.A(a)s2)	✓	✓	✓
1.A.3. Transport			
1.A.3.a. Civil Aviation	✓	✓	✓

IPCC category-Energy Sector	Emissions estimation status		
	CO_2	CH_4	N_2O
1.A.3.b. Road Transportation	✓	✓	✓
1.A.3.c. Railways	✓	✓	✓
1.A.3.d. Navigation	✓	✓	✓
1.A.3.e. Other Transportation - pipeline	✓	NO	NO
1.A.4. Other Sectors			
1.A.4.a. Commercial/institutional	✓	✓	✓
1A4b Residential	✓	✓	✓
1.A.4.c. Agriculture/Forestry/Fisheries	✓	✓	✓

Table 3.3 (continued) Status of emissions estimation within the Energy Sector for 2010

IPCC category	Emissions estimation status		
	CO_2	CH_4	N_2O
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	✓	NA
1.B.1.c. Other	NA	NA	NA
1.B.2. Oil and Natural Gas			
1.B.2.a. Oil	✓	✓	✓
1.B.2.a.i. Venting oil	✓	✓	NA
1.B.2.a.ii. Flaring oil	✓	✓	✓
1.B.2.a.iii.1. Exploration	✓	✓	NA
1.B.2.a.iii.2. Production and upgrading	✓	✓	NA
1.B.2.a.iii.3. Transport	✓	✓	NA

IPCC category	**Emissions estimation status**		
	CO_2	**CH_4**	**N_2O**
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	✓	✓	NA
1.B.2.b.iii.5.1. at industrial plants and power station	✓	✓	NA
1.B.2.b.5.iii.2. in the residential and commercial sectors	✓	✓	NA
1.B.2.b.iii.6. Other	NA	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	✓		
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 Energy key sources in 2010

Key category	GHG	Criteria (excluding LULUCF)	Contribution of Key categories in total GHG emissions [%]	Criteria (including LULUCF)	Contribution of Key categories in total GHG emissions [%]
Civil Aviation	CO_2	T	0,27	T	0,22
Energy Industries - Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	L, T	0,70	L, T	0,57
Energy Industries - Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	L, T	0,67	L, T	0,55
Energy Industries - Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CO_2	T	0,00	T	0,00
Energy Industries - Petroleum Refining - Gaseous Fuels	CO_2	L, T	0,75	L, T	0,61
Energy Industries - Petroleum Refining - Liquid Fuels	CO_2	L, T	2,23	L, T	1,81
Energy Industries - Public Electricity and Heat Production - Gaseous Fuels	CO_2	L, T	5,05	L, T	4,10
Energy Industries - Public Electricity and Heat Production - Liquid Fuels	CO_2	L, T	0,83	L, T	0,67
Energy Industries - Public	CO_2	L, T	17,02	L, T	13,82

Key category	GHG	Criteria (excluding LULUCF)	Contribution of Key categories in total GHG emissions [%]	Criteria (including LULUCF)	Contribution of Key categories in total GHG emissions [%]
Electricity and Heat Production - Solid Fuels					
Fugitive emissions-oil and natural gas	CH_4	L,	5,83	L, T	4,71
Fugitive emissions-oil and natural gas	CO_2	L, T	0,53	L	0,43
Fugitive emissions-solid fuels	CH_4	L, T	0,64	L, T	0,52
Manufacturing Industries and Construction - Chemicals - Gaseous Fuels	CO_2	L, T	0,59	L, T	1,77
Manufacturing Industries and Construction - Chemicals - Liquid Fuels	CO_2	L, T	0,90	L, T	1,04
Manufacturing Industries and Construction - Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	L, T	3,81	L, T	0,48
Manufacturing Industries and Construction - Iron and Steel - Gaseous Fuels	CO_2	L, T	1,92	L, T	0,73
Manufacturing Industries and Construction - Iron and Steel - Solid Fuels	CO_2	L, T	1,63	L, T	3,09
Manufacturing Industries and Construction - Other (please	CO_2	L, T	1,64	L, T	1,56

Key category	GHG	Criteria (excluding LULUCF)	Contribution of Key categories in total GHG emissions [%]	Criteria (including LULUCF)	Contribution of Key categories in total GHG emissions [%]
specify) - Gaseous Fuels					
Manufacturing Industries and Construction - Other (please specify) - Liquid Fuels	CO_2	T	0,20	L, T	1,32
Manufacturing Industries and Construction - Other (please specify) - Solid Fuels	CO_2	T	0,22	L, T	1,33
Other (Not specified elsewhere) - Stationary (please specify) - Liquid Fuels	CO_2	T	0,22	T	0,18
Other (Not specified elsewhere) - Stationary (please specify) - Solid Fuels	CO_2	T	0,14	T	0,00
Other Sectors - Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	L, T	0,56	T	0,11
Other Sectors - Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	L, T	1,78	L, T	0,45
Other Sectors - Commercial/Institutional - Gaseous Fuels	CO_2	L, T	0,76	L, T	1,45
Other Sectors - Residential - Biomass	CH_4	L, T	4,20	L, T	0,62
Other Sectors - Residential -	CO_2	L, T	0,51	L, T	3,41

Key category	GHG	Criteria (excluding LULUCF)	Contribution of Key categories in total GHG emissions [%]	Criteria (including LULUCF)	Contribution of Key categories in total GHG emissions [%]
Gaseous Fuels					
Other Sectors - Residential - Solid Fuels	CO_2	T	0,03	T	0,02
Road transport	CO_2	L, T	11,07	L, T	8,99
Road transport	N_2O	L, T	0,41	T	0,33

Figure 3.5 Key sources Energy sector GHG emissions in 1989 and in 2010 excluding LULUCF

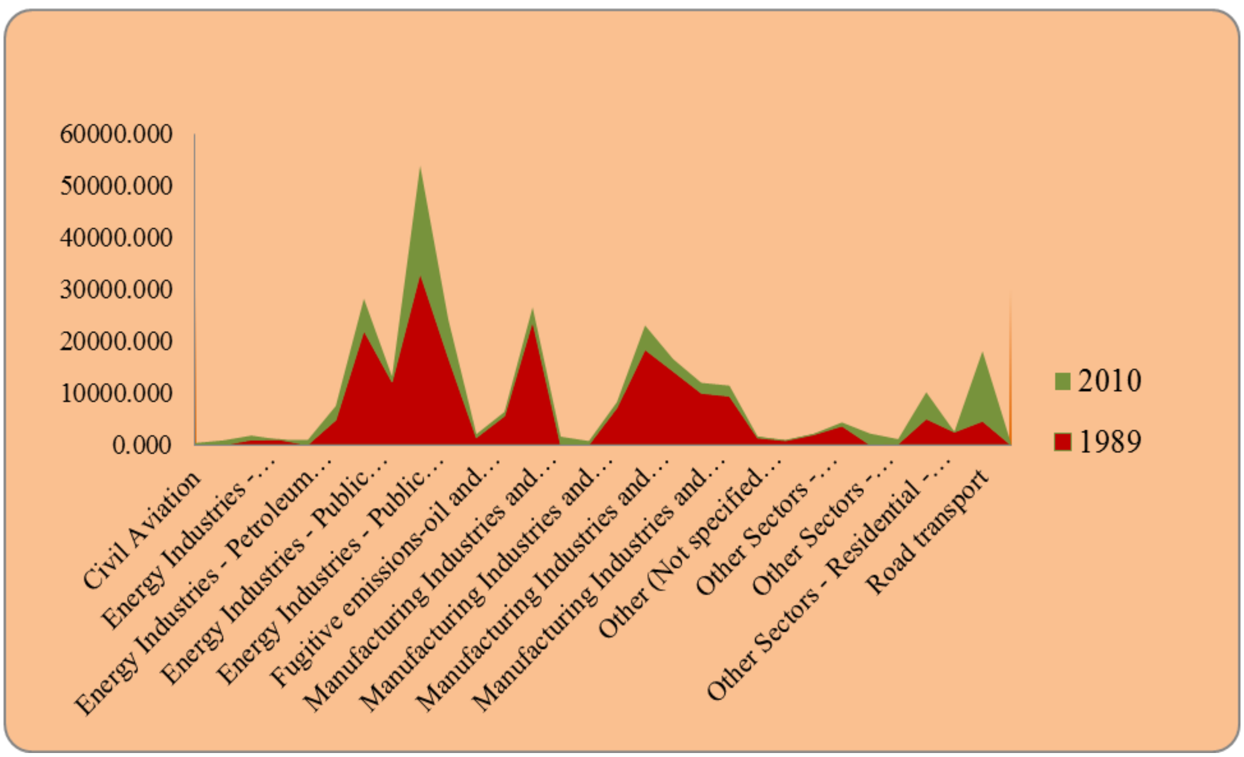
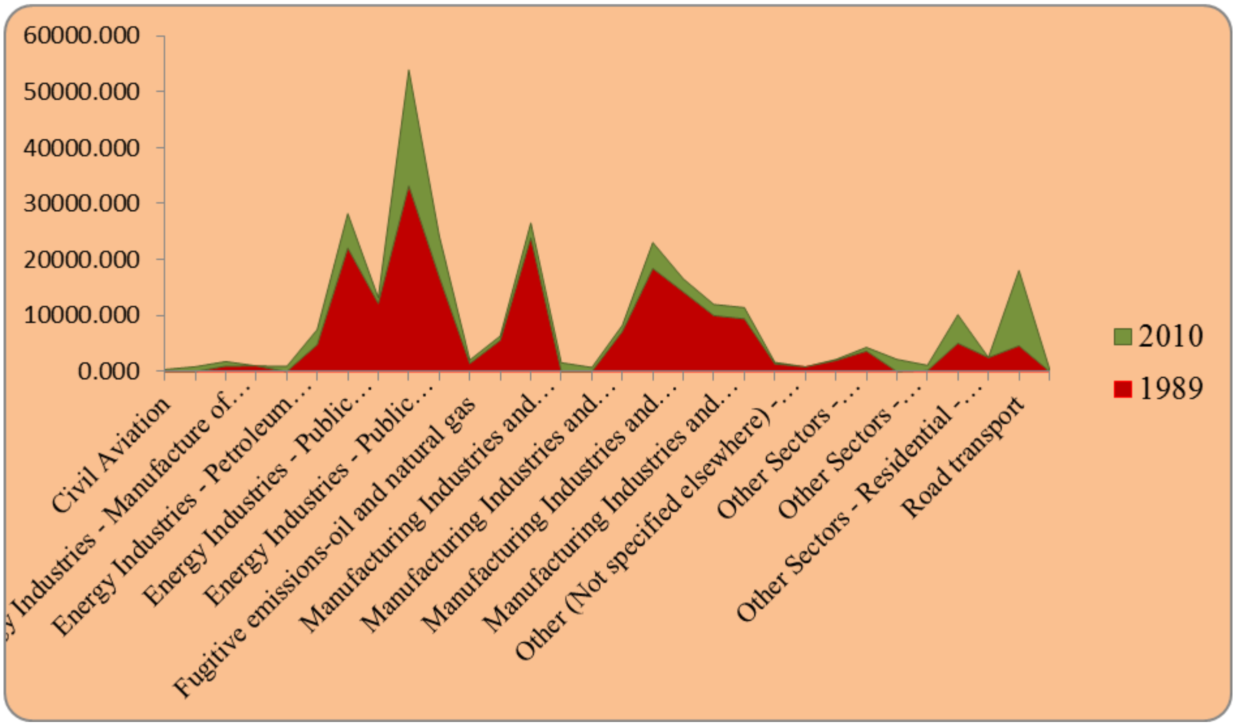


Figure 3.6 Key sources Energy sector GHG emissions in 1989 and in 2010 including LULUCF



3.2 Fuel combustion (CRF 1.A)

3.2.1 Comparison of the sectorial approach with the reference approach

According to the IPCC guidelines, two separate approaches have to be applied in order to estimate the emissions from fuel combustions activities.

In calculating GHG emissions from the Energy sector, were used two methods indicated in the guidelines:

- 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 detailed NCVs used for the reference approach can be found in ANNEX 2.

The "Sectorial Approach" is a more detailed methodology (a bottom-up method), using the fuel consumption for each of the sub-sectors:

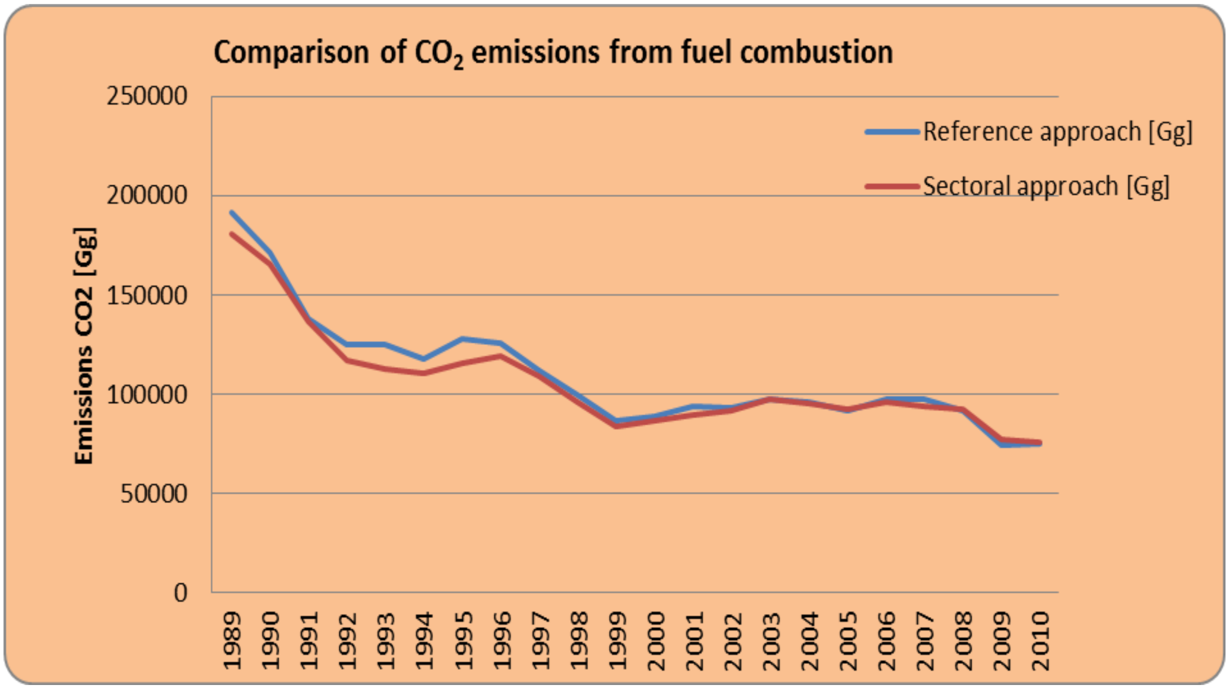
- Electricity and heat production;
- Manufacturing industries and construction;
- Transport;
- Commercial/institutional;
- Residential;
- Agriculture/forestry/fisheries;
- Other Non–specified.

Methodology

The applied methodologies are in accordance with the IPCC Worksheets provisions. For the fuels having determined Country Specific Emission Factors (CS EFs) – Tier 2 method is applied. For the fuels with default emission factors used, Tier 1 method is applied.

Results of the Reference Approach

Figure 3.7 Comparison of 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	2792.38	2506.61	9.2	191421.48	180344.15	6.1
1990	2511.26	2286.31	8.3	171362.59	165241.33	3.7
1991	2042.48	1898.87	4.8	137801.32	136773.24	0.8
1992	1837.16	1616.52	6.1	124631.43	116886.81	6.6
1993	1817.99	1557.59	10.7	124927.01	112790.61	10.8
1994	1703.80	1530.05	7.4	117759.57	110364.53	6.7
1995	1828.42	1593.30	11.4	127653.36	115570.54	10.5
1996	1817.94	1639.38	6.6	125625.28	119241.58	5.4
1997	1610.72	1485.62	3.1	111878.49	108702.69	2.9
1998	1457.27	1332.17	4.8	99659.37	96260.63	3.5
1999	1277.22	1155.86	4.5	86547.82	83391.20	3.8
2000	1293.81	1187.15	2.7	88652.84	86735.84	2.2
2001	1343.21	1223.18	4.4	93675.82	89522.84	4.6
2002	1338.66	1249.01	1.6	93152.06	91764.07	1.5
2003	1396.37	1321.66	0.9	97531.30	97405.18	0.1
2004	1382.82	1310.67	-0.4	96250.51	95387.86	0.9
2005	1337.82	1253.98	-1.3	91771.74	92060.02	-0.3
2006	1408.24	1300.87	0.8	97105.86	95901.77	1.3
2007	1391.38	1250.92	2.4	97687.54	93939.44	4.0
2008	1329.97	1241.75	-1.9	91968.44	92340.53	-0.4
2009	1082.35	1063.95	-7.0	74290.82	77400.61	-4.0
2010	1096.66	1043.13	-3.1	75093.41	75499.84	-0.5

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	727.71	536.73	27.17	49535.0	39326.09	26.0
1990	757.79	618.52	18.23	53557.4	49976.23	7.2
1991	605.61	512.78	13.35	42911.9	41939.40	2.3
1992	490.14	442.32	4.81	34025.1	34151.32	-0.4
1993	531.34	432.15	18.31	37649.4	33191.48	13.4
1994	489.68	429.69	9.78	34513.7	32783.24	5.3
1995	555.63	436.44	23.08	39349.1	33100.12	18.9
1996	553.30	501.92	5.67	39116.7	38536.68	1.5
1997	535.87	518.53	-0.31	38106.6	39639.11	-3.9
1998	491.92	467.04	-1.43	34146.3	35135.75	-2.8
1999	415.46	373.47	1.91	28363.2	28314.22	0.2
2000	404.33	384.95	-4.58	27410.9	29611.92	-7.4
2001	463.03	444.38	-2.81	32159.3	33239.37	-3.2
2002	396.04	434.29	-17.91	26717.0	32531.87	-17.9
2003	386.36	406.53	-13.73	26175.5	30372.09	-13.8
2004	408.26	442.01	-17.99	27142.4	31153.33	-12.9
2005	384.00	422.74	-21.19	25155.7	30742.43	-18.2
2006	403.05	405.38	-15.86	26053.2	29626.19	-12.1
2007	419.52	410.18	-14.84	26511.4	29669.11	-10.6
2008	403.89	405.49	-17.50	25306.4	29583.92	-14.5
2009	321.35	366.05	-28.54	19839.6	26543.08	-25.3
2010	350.78	340.65	-12.78	22356.8	24720.42	-9.6

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	720.17	625.041103	13.60	67657.22	66695.4	1.44
1990	546.07	460.060481	16.94	51145.05	48519.8	5.41
1991	440.51	387.432665	6.48	39881.30	39643.5	0.60
1992	448.60	377.511077	16.56	41605.48	37737.9	10.25
1993	423.73	370.097636	12.86	40014.43	36993.3	8.17
1994	435.60	367.501931	16.51	40775.34	36948.3	10.36
1995	451.98	382.129389	16.05	42139.39	38627.9	9.09
1996	449.90	383.119464	15.44	42114.75	38864.6	8.36
1997	406.36	325.300523	22.33	37712.35	33492.0	12.60
1998	337.97	271.359767	21.89	31285.73	28310.8	10.51
1999	286.86	254.883324	10.95	27008.64	25924.6	4.18
2000	312.72	271.05259	14.02	29659.13	27498.0	7.86
2001	318.95	270.127677	16.68	30283.85	27810.4	8.89
2002	367.33	282.141846	28.36	34715.32	29416.0	18.02
2003	389.62	339.219836	13.62	37199.86	34951.9	6.43
2004	387.25	328.844411	16.30	36841.19	34120.2	7.97
2005	366.52	316.201675	14.39	34696.17	32614.8	6.38
2006	397.33	359.217012	9.37	37749.37	36459.9	3.54
2007	423.01	359.393155	16.40	41204.68	37715.6	9.25
2008	400.49	359.590111	10.49	37946.59	35995.2	5.42
2009	315.10	298.581151	5.35	30230.95	28671.3	5.44
2010	291.19	293.937384	-1.01	27824.54	27972.0	-0.53

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	1344.51	1344.84	-0.02	74229.22	74322.7	-0.13
1990	1207.41	1207.73	-0.03	66660.15	66745.3	-0.13
1991	996.36	998.66	-0.23	55008.13	55190.4	-0.33
1992	887.38	785.65	1.98	47422.46	43419.1	9.22
1993	853.10	745.52	5.30	45858.39	41201.0	11.30
1994	777.03	731.36	1.42	42255.92	40418.4	4.55
1995	805.55	763.00	2.04	43981.54	42165.0	4.31
1996	813.01	752.61	2.63	44145.75	41592.2	6.14
1997	667.31	640.60	-3.98	35890.64	35402.7	1.38
1998	627.38	593.78	1.87	34227.33	32814.1	4.31
1999	574.89	527.51	3.12	31175.97	29152.4	6.94
2000	572.75	528.00	2.10	31007.85	29179.4	6.27
2001	551.81	504.52	3.08	29886.64	27881.2	7.19
2002	570.61	528.13	3.33	31049.79	29186.8	6.38
2003	616.69	572.95	3.60	33626.00	31663.8	6.20
2004	583.53	536.60	3.73	31726.24	29654.9	6.98
2005	583.73	512.29	5.18	31408.78	28311.4	10.94
2006	604.48	534.22	7.46	32818.95	29523.1	11.16
2007	543.53	478.13	6.25	29210.34	26166.7	11.63
2008	521.35	473.20	1.82	28108.48	26329.8	6.76
2009	443.77	397.34	3.61	23915.04	21974.6	8.83
2010	451.68	405.52	3.51	24482.08	22476.3	8.92

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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
1990	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
1991	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
1992	11.04	11.038	0.00	1578.43	1578.46	0.00
1993	9.82	9.824	0.00	1404.83	1404.85	0.00
1994	1.50	1.501	-0.01	214.64	214.65	-0.01
1995	15.27	11.731	30.15	2183.32	1677.56	30.15
1996	1.74	1.735	-0.01	248.11	248.13	-0.01
1997	1.18	1.181	-0.03	168.88	168.92	-0.02
1998	0.00	0.0002	0.00	0.03	0.02	44.93
1999	0.00	0.0001	0.00	0.01	0.01	44.93
2000	4.02	3.144	27.88	575.00	446.51	28.78
2001	9.41	4.157	126.43	1346.06	591.90	127.41
2002	4.69	4.449	5.29	669.96	629.43	6.44
2003	3.71	2.959	25.25	529.96	417.40	26.97
2004	3.78	3.214	17.64	540.68	459.43	17.68
2005	3.57	2.746	30.14	511.08	391.47	30.55
2006	3.39	2.054	64.90	484.34	292.61	65.53
2007	5.32	3.222	65.21	761.11	388.02	96.15
2008	4.24	3.471	22.28	606.95	431.60	40.63
2009	2.13	1.987	7.42	305.24	211.63	44.23
2010	3.01	3.027	-0.66	429.95	331.04	29.88

Explanation of Differences

A comparison between the Reference Approach (RA) and the Sectorial Approach (RA) indicates differences in both, the energy consumption data and CO_2 emissions, – 3.1% in terms of energy consumption and, -0.5 % in terms of CO_2 emissions for 2010.

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.

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 a sampling base, admitting a margin of error). Also there are reported losses for the consumption of the fuels.

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

3.2.2 International bunker fuels

The methodologies and AD developed in order to disaggregate emissions into domestic and international (for both civil aviation and for navigation transport) are presented in chapter 3.2 Fuel combustion, Transport (CRF sector 1.A.3), sub-chapter 3.2.1.

3.2.2.1 Source category description

The activity data for international aviation are provided by Eurostat-questionnaires and values for emissions factors used are provided by IPCC 2006.

The worksheet was worked by Mark Schuman – expert National Inventory Compiler Greenhouse Gases & Air Pollutants by Luxembourg in the training program held in December 2011 with experts from Austria European Commission representatives.

The activity data for international navigation are provided by NIS and Statistical Yearbook (Goods transport at ports, by type of goods, in 2010), presented in table 3.1, and values for emissions factors used are provide by IPCC 1996.

3.2.2.2 Methodological issues

For Air Transport, in 2010 NGHGI, calculation of GHG emissions according to IPCC 2006 was made using activity data from Eurostat - questionnaire for international flights.

The emissions have been calculated using the methodology and emission factor as described in the subchapter 3.2.2.1.

Calculation of fuel consumption per flight cycles is detailed in Annex 2.2.

3.2.2.3 International aviation

In 2010, the share of international aviation in the total fuel consumption in the Aviation Sector in Romania increased by 10.8% compared by 2009. The greenhouse gas emissions and activity data from aviation assigned to international bunkers include the transport modes international airport traffic (LTO-CYCLES) and international cruise traffic for IFR- flights (International Flight Rules) (see annex 2.2).

3.2.2.4 International navigation

In 2010, the share of international navigation in the total fuel consumption in the Navigation Sector in Romania increased by 21.04% compared to 2009.

The values for fuels consumption, by 2010 is presented in Table 3.1 and for times series 1989-2009 is presented in Annex 2.2.

Table 3.10 Consumption fuels for domestic and international navigation

	Fuels	TJ
2010	residual oil	0.00
	residual oil for domestic navigation	0.00
	residual oil for international navigation	0.00
	diesel oil	2,467.36
	diesel oil for domestic navigation	519.06
	diesel oil for international navigation	1,948.30
	gasoline	60.76
	gasoline for domestic navigation	12.78
	gasoline for international navigation	47.97
	other fuels	5.40
	other fuels domestic	1.14
	other fuels international	4.27
	goods domestic %	21.04
	goods international %	78.96

The applied methodology for estimating the total fuel consumption and greenhouse gas emissions is described in the subchapter 3.2.9.2.

3.2.2.5 Country-specific issues

For Transport sub-sector country-specific emission factors have been calculated for Energy Industry sub-sector (1.AA.1) without oxidation factor included (see Table 3.3).

The gasoline emission factor was calculated using the country specific value (0.85%) in volume percent carbon content, information provided by the Ministry of Economy, Trade and Business Environment, namely:

Equation 3.1 Calculation of emission factor for gasoline

$$EF_{CO2}\ (t_{CO2}/TJ) = (M_{CO2}/M_C \times \%C_{vol})/NCV\ (GJ/t) *100 = 71.62\ t_{CO2}\ /TJ \text{ and } 19.53\ t_C\ /TJ$$

For International and Domestic Aviation were used the values for emission factors from IPCC 2006.

3.2.2.6 Source- specific QA/QC and verification

The activities were implemented by the sectorial expert administrating the Energy Sector – Transport subsector and the verification of data entry was done of my colleague by Transport Sector by cross-checking method. No recalculations were needed following the QA activities developed under the European Community GHG Inventory compilation procedures described in the Decision 280/2004/EC of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

All the unconformities noticed and solved as result of the quality assurance and quality control activities performed are mentioned in the Improvements Lists.

A cross-checking approach was used in the implementation of QC activities:

Were made recalculations following recommendations made by ERT under Article 8 of the KP.

3.2.3 Feedstock and non-energy use of fuels

The Energy Balance provides information concerning the non-energy use of the fuels. It was taken into consideration the non-energy consumption provided to the Energy Balance activity "Total non-energy use of the fuels", containing the non-energy used in the Transformation Sector, Energy Sector, Transport, Industry, Other Sectors.

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": 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.

Table 3.11 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	55.23165	2792.38	1.98
1990	34.55899	2511.26	1.38
1991	52.33420	2042.48	2.56
1992	121.22253	1837.16	6.60
1993	94.17924	1808.17	5.21
1994	60.67413	1703.80	3.56
1995	53.95736	1813.14	2.98
1996	71.17620	1817.94	3.92
1997	79.55559	1610.72	4.94
1998	61.22842	1457.27	4.20
1999	69.85074	1277.22	5.47
2000	74.35258	1293.81	5.75
2001	66.64338	1343.21	4.96
2002	69.54249	1338.66	5.19
2003	62.96704	1396.37	4.51
2004	77.47399	1382.82	5.60
2005	100.55043	1337.82	7.52
2006	96.79202	1408.24	6.87
2007	110.38693	1391.38	7.93
2008	112.09232	1329.97	8.43
2009	92.41120	1082.35	8.54
2010	85.80474	1096.66	7.82

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 5.27% of the total apparent energy consumption during the period 1989-2010, and a 7.82% for 2010.

Table 3.12 Apparent consumption of non-energy fuels

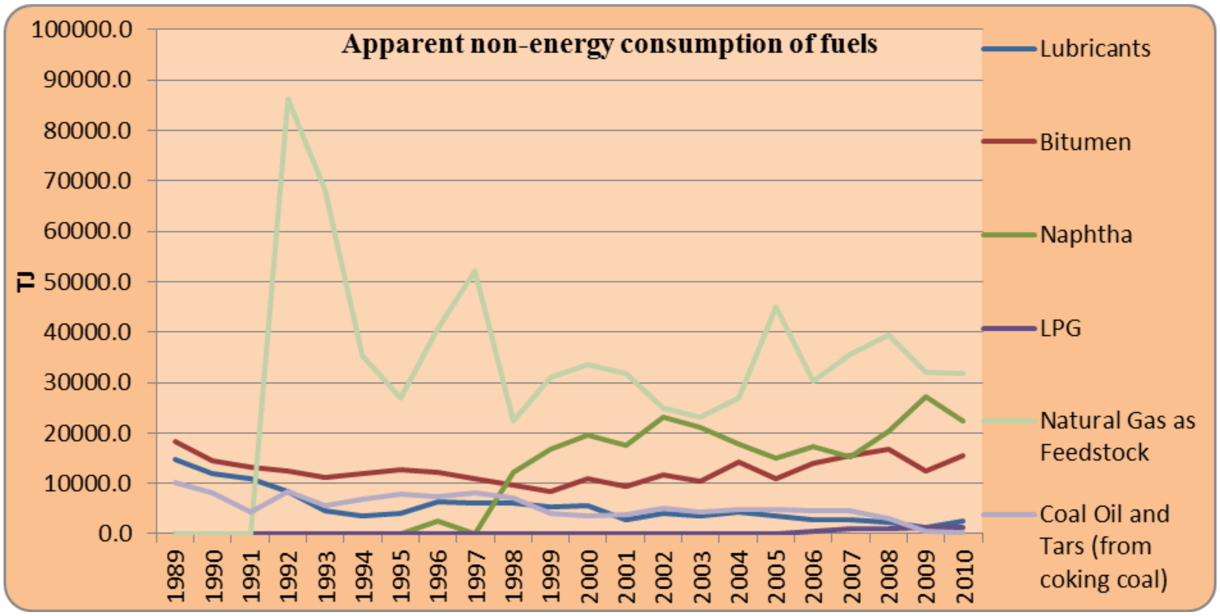
Non-energy cons. [TJ]	Lubricants	Bitumen	Naphtha	LPG	Natural Gas as Feedstock	Coal Oil and Tars	Refinery gas	Motor Gasoline	Kerosene Type Jet Fuel
1989	14742	18369	NO, NA	NO, NA	NO, NA	10089	NO, NA	NO, NA	NO, NA
1990	11934	14556	NO, NA	NO, NA	NO, NA	8069	NO, NA	NO, NA	NO, NA
1991	11021	13326	NO, NA	NO, NA	NO, NA	4202	NO, NA	NO, NA	NO, NA
1992	8424	12341	NO, NA	NO, NA	86135	8372	5295	NO, NA	NO, NA
1993	4633	11286	NO, NA	NO, NA	68090	5572	2070	NO, NA	NO, NA
1994	3440	11884	44	NO, NA	35304	6843	915	NO, NA	NO, NA
1995	4001	12658	NO, NA	NO, NA	27005	7987	NO, NA	NO, NA	NO, NA
1996	6353	12271	2637	NO, NA	40623	7252	NO, NA	NO, NA	NO, NA
1997	6213	10970	88	NO, NA	52216	8069	NO, NA	NO, NA	NO, NA
1998	6143	9774	12086	NO, NA	22488	7201	NO, NA	NO, NA	NO, NA
1999	5441	8298	16877	NO, NA	30919	4076	722	NO, NA	NO, NA
2000	5546	10864	19514	NO, NA	33658	3667	NO, NA	NO, NA	NO, NA
2001	2913	9458	17580	NO, NA	31754	3763	NO, NA	NO, NA	NO, NA
2002	4037	11814	23206	NO, NA	24868	5156	NO, NA	NO, NA	NO, NA
2003	3475	10478	21096	NO, NA	23102	4209	NO, NA	NO, NA	NO, NA
2004	4212	14240	17888	NO, NA	26889	4801	8905	NO, NA	NO, NA
2005	3615	10900	15119	NO, NA	44919	4816	14200	NO, NA	NO, NA
2006	2742	13888	17360	481	30390	4450	16656	4570	NO, NA
2007	2742	15470	15296	963	35492	4686	14971	7427	NO, NA
2008	2180	16842	20306	915	39542	3171	6788	5019	237
2009	1231	12376	27205	1155	32099	548	6788	1044	642
2010	2532	15400	22371	1300	31921	215	963	1044	641

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
1989	NO, NA	NO, NA	12032	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1990	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1991	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	23785
1992	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	468	NO, NA	NO, NA	187
1993	NO, NA	NO, NA	NO, NA	590	836	62	571	53	414
1994	NO, NA	NO, NA	NO, NA	394	396	94	791	225	346
1995	NO, NA	NO, NA	NO, NA	630	308	62	791	83	432
1996	NO, NA	NO, NA	NO, NA	NO, NA	748	218	703	NO, NA	371
1997	NO, NA	NO, NA	NO, NA	NO, NA	1056	62	527	NO, NA	354
1998	NO, NA	NO, NA	NO, NA	1810	704	187	835	NO, NA	NO, NA
1999	NO, NA	1528	NO, NA	236	220	437	1099	NO, NA	NO, NA
2000	NO, NA	NO, NA	NO, NA	NO, NA	220	312	571	NO, NA	NO, NA
2001	NO, NA	382	NO, NA	79	308	187	220	NO, NA	NO, NA
2002	43	NO, NA	NO, NA	NO, NA	NO, NA	156	264	NO, NA	NO, NA
2003	43	NO, NA	NO, NA	NO, NA	176	125	264	NO, NA	NO, NA
2004	NO, NA	NO, NA	NO, NA	NO, NA	132	187	220	NO, NA	NO, NA
2005	NO, NA	NO, NA	NO, NA	NO, NA	6732	250	NO, NA	NO, NA	NO, NA
2006	NO, NA	1994	NO, NA	1181	2728	218	132	NO, NA	NO, NA
2007	1161	1103	NO, NA	2400	8582	94	NO, NA	NO, NA	NO, NA
2008	1161	1400	NO, NA	4407	10030	95	NO, NA	NO, NA	NO, NA
2009	NO, NA	2631	NO, NA	3423	3099	126	44	NO, NA	NO, NA
2010	NO, NA	6577	NO, NA	2715	NO, NA	126	NO, NA	NO, NA	NO, NA

The most significant fuels used as feedstock are natural gas, bitumen, naphtha and lubricants.

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

Figure 3.8 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

Because of the country specific issues with the National statistics, 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 1990-2010. 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.

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

Figure 3.9 Total GHG CO_2 equiv. emissions from Fuel combustion by subsectors

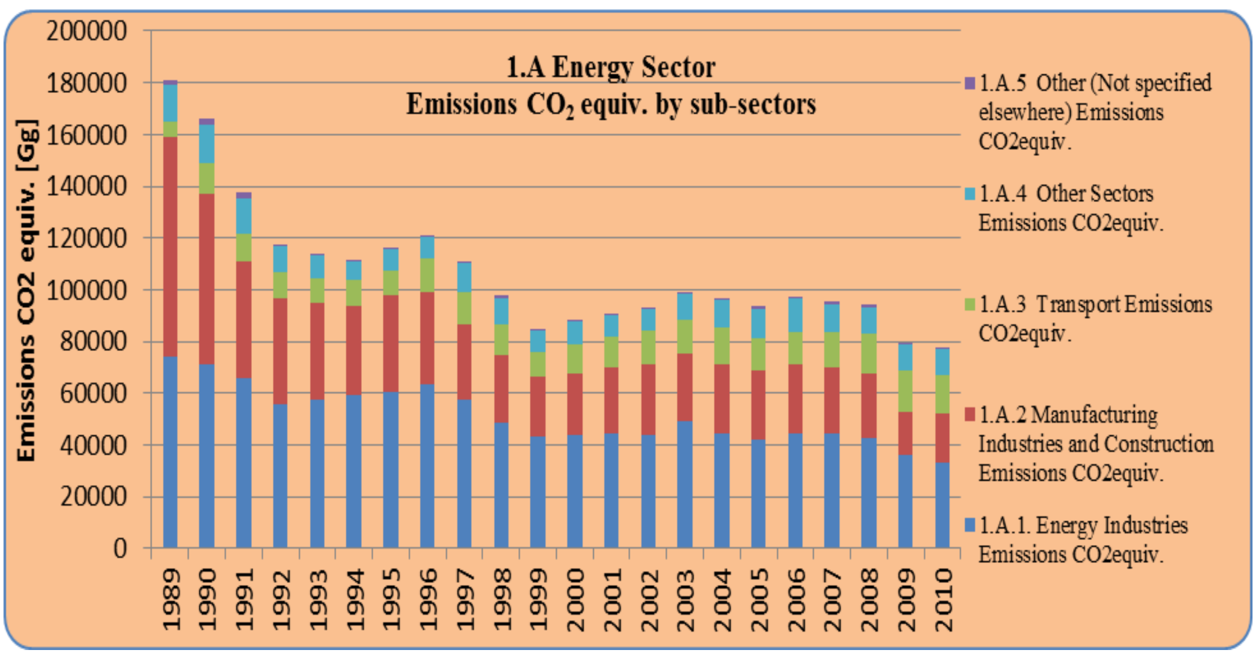
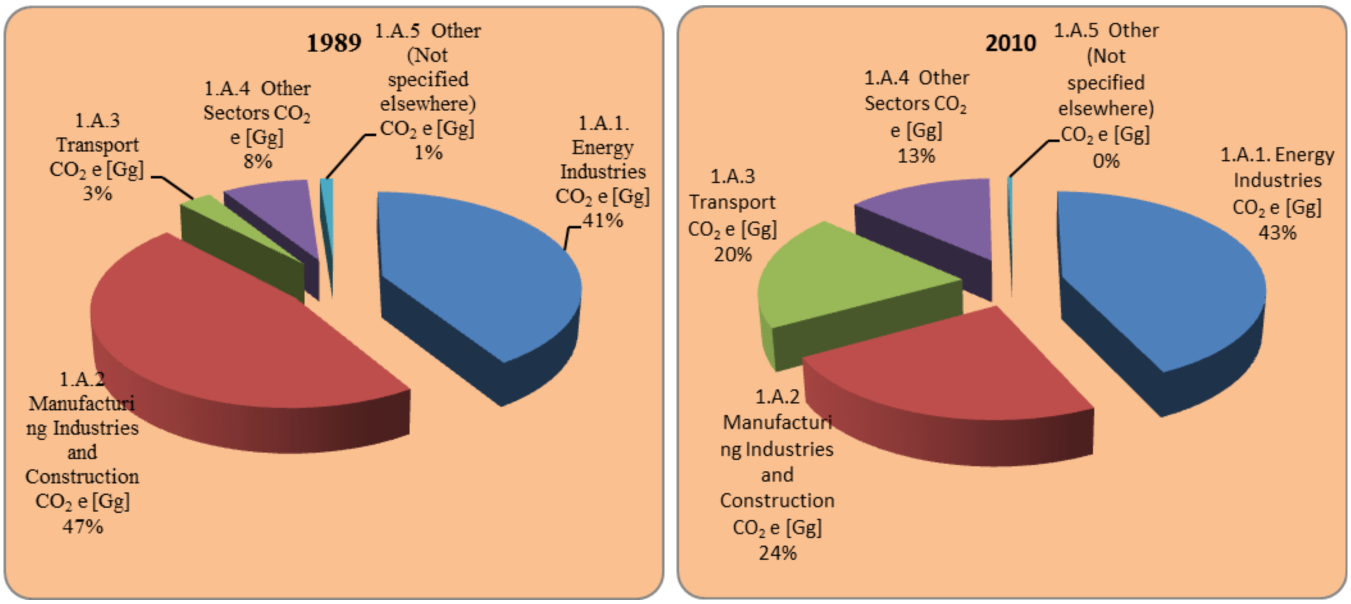


Figure 3.10 Comparison base year and current year for the contribution of the 1A sub-sectors

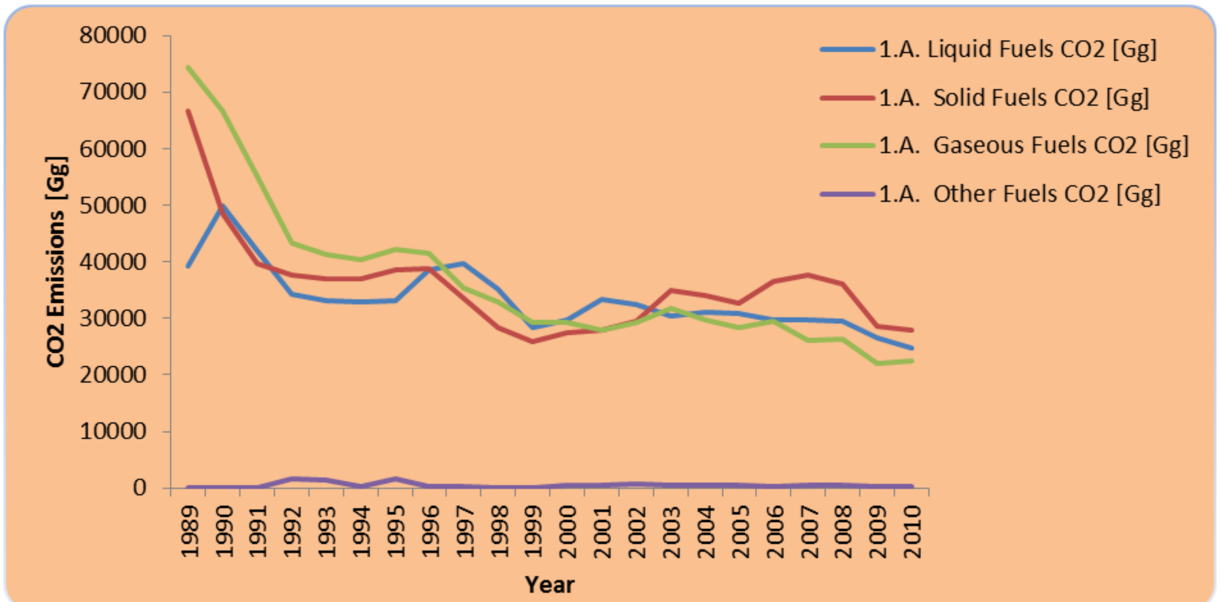


CO_2 emissions from fuel combustion activities accounted for 77566.34547Gg CO_2 equivalent in 2010. Within the fuel combustion sector, 43% of the CO_2 equivalent emissions correspond to 1.A.1 Energy Industry, 24% of the CO_2 equivalent emissions correspond to 1.A.2 Manufacturing Industries and Construction, 20% of the CO_2 equivalent emissions correspond to 1.A.3 Transport, 13% of the CO_2 equivalent emissions correspond to 1.A.4 Other Sectors and less than 1% from the CO_2 equivalent emissions correspond to 1.A.5 Other (Not specified elsewhere).

It is observed that Energy Industries are the main source of GHG emissions from fuel combustion with 43% of the emissions in 2010. 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.

Manufacturing industry and construction is the sector, which changed drastically – compared to 1989 the emissions decreased from 47% to 24%. In the same time the transport sub-sector has a substantial modification in the contribution to the emissions, rising from 3% in the base year up to 20% in 2010.

Figure 3.11 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. In 2010 the contribution of the liquid fuel was about 33%, solid 37%, 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 – 2009, 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 3.13 CO_2 emissions in 1.A. Fuel Combustion

CO_2 [Gg]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	180344.1495	39326.09	66695.35	74322.709	2986.704	NO,NA
1990	165241.3257	49976.23	48519.76	66745.333	2760.24	NO,NA
1991	136773.2407	41939.4	39643.48	55190.362	3246.992	NO,NA
1992	116886.8102	34151.32	37737.93	43419.096	3668.448	1578.463
1993	112790.6136	33191.48	36993.3	41200.981	4859.456	1404.852
1994	110364.5316	32783.24	36948.29	40418.35	5625.872	214.6545
1995	115570.5381	33100.12	38627.86	42164.999	6306.048	1677.556
1996	119241.5781	38536.68	38864.57	41592.202	11931.02	248.1282
1997	108702.6886	39639.11	33491.98	35402.674	15553.55	168.9237
1998	96260.63451	35135.75	28310.77	32814.098	13972.78	0.022398
1999	83391.19966	28314.22	25924.61	29152.364	13199.54	0.006907
2000	86735.83804	29611.92	27498.03	29179.367	12972.51	446.5148
2001	89522.83608	33239.37	27810.38	27881.187	10000.93	591.9016
2002	91764.06692	32531.87	29416.01	29186.765	11010.57	629.4266
2003	97405.1824	30372.09	34951.94	31663.76	13317.02	417.3961
2004	95387.86488	31153.33	34120.2	29654.896	14616.11	459.4347
2005	92060.02203	30742.43	32614.77	28311.359	14976.19	391.4696
2006	95901.76757	29626.19	36459.9	29523.072	14688.24	292.6073
2007	93939.43821	29669.11	37715.59	26166.719	15234	388.025
2008	92340.52672	29583.92	35995.22	26329.785	17894.74	431.5998
2009	77400.61383	26543.08	28671.33	21974.569	17670.35	211.6325
2010	75499.84204	24720.42	27972.04	22476.344	18618.87	331.0411
Decrease 1989 - 2010	58.14	37.14	58.06	69.76	-523.39	_
Decrease 1990 - 2010	54.31	50.54	42.35	66.33	-574.54	_
Decrease 2009 - 2010	2.46	6.87	2.44	-2.28	-5.37	-56.42

Table 3.14 CH_4 emissions in 1.A. Fuel Combustion

CH_4 [Gg]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	25.435	2.1911	10.265	5.1363	7.842	NO,NA
1990	28.474	6.4018	10.284	4.5421	7.246	NO,NA
1991	22.161	4.3690	6.083	3.5731	8.135	NO,NA
1992	19.106	3.8617	5.073	2.6809	7.159	0.3312
1993	19.966	3.0865	3.629	2.5912	10.365	0.2948
1994	19.860	3.6261	1.538	2.5298	12.121	0.0451
1995	21.753	3.0465	1.487	2.9730	13.582	0.6649
1996	38.041	4.3011	2.437	2.6203	28.630	0.0521
1997	46.949	4.6760	2.126	2.1045	38.007	0.0356
1998	42.078	4.6047	0.828	1.9405	34.705	0.0001
1999	38.797	3.2310	1.113	1.7838	32.669	0.0000
2000	39.052	4.4095	1.060	1.8181	31.437	0.3269
2001	31.445	4.6385	0.600	1.8823	23.999	0.3251
2002	31.489	3.7397	0.866	1.8220	24.822	0.2389
2003	37.241	4.1756	0.882	1.9552	30.044	0.1848
2004	43.174	4.5262	1.254	1.8586	35.381	0.1545
2005	43.526	3.6327	0.971	1.7889	37.029	0.1041
2006	41.251	3.1823	1.057	1.9057	35.018	0.0883
2007	43.056	3.6000	1.053	1.6535	36.554	0.1962
2008	51.519	2.9066	1.550	1.7346	45.247	0.0804
2009	50.022	2.9145	0.931	1.4977	44.656	0.0228
2010	55.709	6.6623	1.036	1.4538	46.518	0.0389
Decrease 1989 - 2010	-119.03	-204.07	89.91	71.70	-493.20	_
Decrease 1990 - 2010	-95.65	-4.07	89.93	67.99	-542.00	_
Decrease 2009 - 2010	-11.37	-128.59	-11.22	2.93	-4.17	-70.44

Table 3.15 N_2O emissions in 1.A. Fuel Combustion

N_2O [Gg]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	1.293	0.285677	0.765923	0.134471	0.106668	NO,NA
1990	1.460	0.66821	0.572585	0.12076	0.09858	NO,NA
1991	2.327	0.62377	0.4872	0.099774	0.115964	NO,NA
1992	1.219	0.494027	0.474729	0.078528	0.131016	0.044153
1993	1.268	0.513229	0.469492	0.07455	0.173552	0.039297
1994	1.318	0.580848	0.458322	0.073136	0.200924	0.006004
1995	1.407	0.586847	0.472667	0.0763	0.225216	0.046925
1996	1.684	0.70191	0.47538	0.075261	0.426108	0.006941
1997	1.724	0.706703	0.395608	0.06406	0.555484	0.004726
1998	1.488	0.607317	0.323419	0.059248	0.499028	9.08E-07
1999	1.378	0.531681	0.323223	0.052663	0.471412	2.8E-07
2000	1.492	0.619269	0.345981	0.052696	0.463304	0.012577
2001	1.457	0.692516	0.340204	0.050352	0.357176	0.016629
2002	1.543	0.729796	0.347584	0.052727	0.396176	0.017798
2003	1.724	0.749262	0.430383	0.057202	0.475608	0.011835
2004	1.761	0.760074	0.413221	0.053607	0.522004	0.012856
2005	1.889	0.897198	0.396124	0.051142	0.534864	0.010985
2006	1.884	0.839992	0.458703	0.053325	0.52458	0.008216
2007	2.049	0.984358	0.460501	0.047733	0.549268	0.009309
2008	2.433	1.260601	0.473877	0.047234	0.643216	0.009438
2009	2.290	1.207266	0.40401	0.039699	0.635496	0.002947
2010	2.891	1.768848	0.40018	0.040508	0.677608	0.005184
Decrease 1989 - 2010	-123.63	-519.18	47.75	69.88	-535.25	_
Decrease 1990 - 2010	-97.99	-164.71	30.11	66.46	-587.37	_
Decrease 2009 - 2010	-26.23	-46.52	0.95	-2.04	-6.63	-75.93

Table 3.16 GHG emissions in 1.A. Fuel Combustion

GHG [Gg]	TJ	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	2533275.77	182375.08	39538.5	67764.4	74563.4	3148.3	NO,NA
1990	2310951.48	168197.45	50244.7	49347.6	66960.0	2909.6	NO,NA
1991	1927863.45	139293.48	42155.8	40374.1	55364.6	3417.2	NO,NA
1992	1649278.90	118872.27	34301.3	38448.3	43558.0	3831.9	1621.6
1993	1600974.69	114606.45	33348.7	37700.0	41333.0	5088.5	1478.8
1994	1580283.31	112368.76	32938.5	37628.9	40547.6	5892.8	259.5
1995	1649606.57	117437.22	33262.7	39327.9	42304.3	6605.1	1770.2
1996	1745909.63	121797.03	38717.0	39574.8	41726.3	12538.4	349.2
1997	1624489.52	111326.96	39829.0	34078.1	35513.5	16355.1	314.5
1998	1456929.49	98735.72	35290.2	28780.4	32916.1	14700.8	150.5
1999	1273716.27	85456.68	28442.3	26399.2	29242.5	13885.6	80.5
2000	1302974.29	89112.06	29733.5	28007.1	29269.9	13637.2	651.5
2001	1312478.92	91778.50	33382.1	28310.3	27968.3	10510.0	683.7
2002	1347332.40	93766.77	32656.5	29925.9	29277.0	11548.0	770.9
2003	1440564.15	99656.66	30483.5	35565.7	31760.1	13967.9	564.5
2004	1441167.17	97765.24	31258.4	34712.0	29744.0	15364.5	528.3
2005	1387699.56	94166.27	30849.8	33182.4	28396.6	15754.0	470.4
2006	1432016.38	98021.31	29722.9	37120.9	29608.9	15432.6	334.4
2007	1386969.94	95980.46	29758.9	38276.7	26245.4	16007.8	463.4
2008	1401543.44	94488.25	29663.9	36576.9	26408.8	18836.9	523.2
2009	1221748.50	79391.67	26608.9	29176.3	22039.5	18600.3	214.7
2010	1209438.67	77712.83	24786.6	28391.7	22540.9	19589.8	336.5
Decrease 1989 - 2010	52.26	57.39	37.31	58.10	69.77	-522.23	_
Decrease 1990 - 2010	47.66	53.80	50.67	42.47	66.34	-573.29	_
Decrease 2009 - 2010	1.01	2.11	6.85	2.69	-2.28	-5.32	-56.71

3.2.6.2 Methodological issues

Stationary Combustion

Choice of Method

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 2006 IPCC 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.

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 3.2 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 3.3 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 for Stationary Sources

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 1990-2010. 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 was 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;

- 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.

CO_2 emission factors for stationary sources

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 3.4 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 3.17 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
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
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;
- Coking coal;
- 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.

For industrial wastes 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 industrial wastes 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 2007-2010.

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). 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 3.18 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**
Lignite	102.14	98.87	97.70	96.55	98.96
Natural gas	55.20	55.58	55.49	55.78	55.49
Refinery gas	55.12	54.05	57.99	57.42	56.10
Other bituminous coal	93.24	94.34	95.20	94.88	94.55
Coking coal	92.92	84.33	92.89	92.65	91.22
Transport diesel	74.00	72.35	74.04	72.75	73.29
Residual fuel oil	78.58	76.81	77.97	79.69	78.15
Heating and other gasoil	74.46	77.87	74.45	73.66	74.19
Petroleum Coke	0.00	94.34	91.85	94.02	93.63

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 3.19 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**
Lignite	97.80	94.23	91.65	89.04	93.38
Natural gas	54.73	55.65	55.31	55.43	55.27
Refinery gas	54.89	56.92	58.00	57.08	56.44
Other bituminous coal	92.97	93.43	95.19	97.04	94.64
Coking coal	92.06	84.46	92.97	92.65	91.11
Transport diesel	73.95	73.43	74.22	73.29	73.74
Residual fuel oil	78.09	76.86	78.00	79.71	78.02
Heating and other gasoil	74.36	78.50	74.65	73.67	74.30
Petroleum Coke	0.00	94.52	91.85	94.02	93.73

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 entire time-series and subsectors in CRF 1.A except CRF 1.A.3. The country-specific emission factors are listed in the following table:

Table 3.20 Country-specific emission factors

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
Coking coal	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

* **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 3.21 Emission factors for CH_4 for different fuels

EF CH_4 [Kg/TJ]	**Coal**	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**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 3.22 Emission factors for N_2O for different fuels

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

Table 3.23 Default emission factors for NO_x for different fuels

EF NO_x [Kg/TJ]	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Biomass and Wastes
Energy Industries	300	150	200	100	100	100
Manufacturing Industries and Construction	300	150	200	100	100	100
Commercial/Institutional	100	50	100	100	100	100
Residential	100	50	100	100	100	100
Agriculture/Forestry/Fishing	100	50	100	100	100	100

Table 3.24 Default emission factors for CO for different fuels

CO [kg/TJ]	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	Biomass and Wastes
Energy Industries	20	20	15	1000	1000	1000
Manufacturing Industries and Construction	150	30	10	2000	4000	4000
Commercial/Institutional	2000	50	20	5000	7000	5000
Residential	2000	50	20	5000	7000	5000
Agriculture/Forestry/Fishing	2000	50	20	5000	7000	5000

Table 3.25 Default emission factors for NMVOC for different fuels

NMVOC [Kg/TJ]	**Coal**	**Natural Gas**	**Oil**	**Wood/Wood Waste**	**Charcoal**	**Biomass and Wastes**
Energy Industries	5	5	5	50	100	50
Manufacturing Industries and Construction	20	5	5	50	100	50
Commercial/Institutional	200	5	5	600	100	600
Residential	200	5	5	600	100	600
Agriculture/Forestry/Fishing	200	5	5	600	100	600

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

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, were used.

Table 3.26 Default Emission Factors For SO_2 Emissions

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

In order to have consistency in estimation of SO_2 emissions with the National Inventory of Air Pollutants under the CLRTAP, the plant specific emission factors, calculated taking account national circumstances, were used.

Table 3.27 Plant Specific SO_2 emission factors - solid fuel

EF SO_2 [Kg/GJ]	1989 - 2003	2004	2005	2006	2007	2008	2009	2010
COAL combusted in 1.A.1.a Electricity and Heat Production	1.782	1.782	1.782	1.781	1.418	1.429	1.465	1.151

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

Stationary Combustion - Uncertainty of AD

Based on information from the National Institute for Statistics, declaring that the system used in aggregating statistical data has a sampling error of about 3-5%, for a conservative approach, the later 5% value has been used.

Stationary Combustion - Uncertainty for EF

Since for some of the fuels were used the default EFs from the 1996 IPCC GL, the data on default uncertainties presented in "Table A1-1 Uncertainties due to emission factors and activity data" (1996 IPCC GL, p. D 1.4) is applicable. For energy sector the uncertainty for emission factor and activity data is 5%.

For the establishing of the country-specific EFs uncertainty, the Study accomplished by the National Institute for Power Engineering, ISPE, used the database of the fuels reported on EU-ETS verified reports, which have much lower uncertainty.

For each type of analyzed EU-ETS database fuel, it was calculated the arithmetic average, the indicators of statistically variation and the standard uncertainty. Based on standard uncertainty and fuel consumption, were determined the total uncertainty of the emission factors, function to the fuel type – solid, liquid and gaseous.

Based on the above background information, the results of the uncertainties estimation are, as following:

- For solid fuels in CRF categories 1A1, 1A2, 1A4 and 1A5a: 2%
- For liquid fuels in CRF categories 1A1, 1A2, 1A4 and 1A5a: 3%
- For gaseous fuels in CRF categories 1A1, 1A2, 1A4 and 1A5a: 2%

Stationary Combustion – Aggregated uncertainty

Based on Equation 6.4 from IPCC GPG 2000, the emissions uncertainty is as follows:

CO_2 gas:

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385%
- Gaseous Fuels - 5.385%
- Other (Industrial Wastes) - 7.071%

CH_4 gas:

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625%

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.

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 1989-2010 is consistent.

Quantitative uncertainty estimates are provided in Annex 7.

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.

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 FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.3.

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

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

1A2 d	Pulp, Paper and Print	90,43	Fuel combustion for the installations having production capacity greater than >20 tones/day and nominal installed thermal power plants > 20 MWt reporting
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 >75 tones/day, - and having on sites nnominal installed thermal power plant > 20 MWt.

Also, QA/QC activities were implemented during of 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" under UNFCCC and KP obligations.

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 data was changed from domestic energy balance with 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).

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

Activity Data

There are recalculations, by all Energy stationary combustion activity categories, on the entire 1989-2009 time-series; all reported fuels, direct and indirect gases, due to the change of the source of the activity data: IEA/EUROSTAT Romanian Energy Balance instead domestic Energy Balance. This approach conducted to a fully correspondence between the definition of the reported fuels and the activity category where they are reported, with the CRF requests and

IPCC methodology. Further to the some differences in the reporting of the two energy balance, mainly due to the instructions manual, there are recalculations regarding the activity data on the entire time-series, all activity categories and reported fuels.

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.

In response to the ERT recommendations the reporting of the emissions from energy industries and manufacturing industries and construction, in the NIR and the CRF tables, were disaggregated to the specific subcategories as listed in the CRF tables.

In response to the ERT recommendation, the emissions from combustion of the other fuels – which is industrial wastes, were estimated. Other fuels – industrial wastes are reported on the almost entire time-series in the Energy Balance, on different activity categories.

Country-specific emission factors

CO_2 country specific emission factors

In the response to the review process, recalculations were carried out, to Stationary Combustion, using the values of the CO_2 emission factors, as determined by the study of ISPE.

Recalculations, on all activity categories, on the entire 1989-2009 time-series due to the new CO_2 Emission Factors (determined by the above Study developed in 2011 on EU-ETS - European Union – Emissions Trading Scheme), as it was explained to the above 3.2.6.2 chapter, were accomplished.

The calculated emission factors were applied as following:

<u>Recalculations for the 1989 – 2006 period</u>

- **For Solid fuels**

CO_2 EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, on each EU-ETS reported activity category, oxidation included, are used.

- **For liquid fuels**

CO_2 EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.

❖ **For gaseous fuels**

CO_2 EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

Recalculations for the 2007 - 2010 period

❖ **For solid Fuels**

CO_2 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.

❖ **For liquid fuels**

CO_2 EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

❖ **For gaseous fuels**

CO_2 EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.

Further, source-specific recalculations are described in detail in the relevant sub-categories.

SO_2 country specific emission factors

In order to have consistency in estimation of the SO_2 emissions with the air monitoring department, emission factors for SO_2 were determined taking account by the national circumstances. For the solid fuel combusted in the 1.A.1.a. – Electricity and Heat Production activity category, were calculated country specific SO_2 emission factors as weighted arithmetic average on the reporting of SO_2 EFs of the large combustion plants (see the values to the above 3.2.6.2 chapter).

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

Table 3.29 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	1428166.8	1014364.7	106011.6	74101.9	30.1
1990	1320867.6	986234.5	97771.3	70977.8	27.4
1991	1096235.4	906854.9	78534.9	65711.9	16.3
1992	928695.0	750379.4	68926.1	55517.3	19.5
1993	930275.0	766543.0	69574.2	57212.4	17.8
1994	867927.0	780342.1	65700.1	58944.5	10.3
1995	882133.0	808383.0	67169.0	60467.8	10.0
1996	919437.0	848517.8	69920.8	63394.4	9.3
1997	774302.0	767719.8	59513.6	57290.0	3.7
1998	710425.0	664947.8	53094.6	48642.4	8.4
1999	616412.0	579753.6	46431.8	43040.0	7.3
2000	608733.2	580664.6	46657.4	43623.5	6.5
2001	633214.2	578113.5	49826.9	44231.0	11.2
2002	647545.3	576617.5	50741.5	43835.7	13.6
2003	665191.1	641400.0	52462.7	48843.7	6.9
2004	621671.3	581108.7	49000.4	44274.9	9.6
2005	589071.6	556214.4	46269.4	42104.0	9.0
2006	614775.2	577711.9	48788.1	44558.8	8.7
2007	601142.1	555286.2	48437.9	44171.2	8.8
2008	588350.7	542103.7	46068.2	42523.1	7.7
2009	490703.5	459972.2	39188.3	35751.6	8.8

Table 3.30 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	1428166.8	1014364.7	1.9289	1.3814	28.4
1990	1320867.6	986234.5	1.9453	1.5369	21.0
1991	1096235.4	906854.9	1.5625	1.3234	15.3
1992	928695.0	750379.4	1.3352	1.0168	23.8
1993	930275.0	766543.0	1.4264	1.0483	26.5
1994	867927.0	780342.1	1.2976	1.0761	17.1
1995	882133.0	808383.0	1.3348	1.1321	15.2
1996	919437.0	848517.8	1.4458	1.2165	15.9
1997	774302.0	767719.8	1.2585	1.1623	7.6
1998	710425.0	664947.8	1.0936	0.9329	14.7
1999	616412.0	579753.6	0.9251	0.8165	11.7
2000	608733.2	580664.6	0.8771	0.7835	10.7
2001	633214.2	578113.5	0.9438	0.8338	11.7
2002	647545.3	576617.5	1.0236	0.7915	22.7
2003	665191.1	641400.0	0.9181	0.8318	9.4
2004	621671.3	581108.7	0.9246	0.7384	20.1
2005	589071.6	556214.4	0.8312	0.7055	15.1
2006	614775.2	577711.9	0.9578	0.7154	25.3
2007	601142.1	555286.2	0.7907	0.6731	14.9
2008	588350.7	542103.7	0.8073	0.6454	20.1
2009	490703.5	459972.2	0.6629	0.5524	16.7

Table 3.31 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1. submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	1428166.8	1014364.7	0.8327	0.6709	19.4
1990	1320867.6	986234.5	0.7093	0.5870	17.2
1991	1096235.4	906854.9	0.5663	0.5686	-0.4
1992	928695.0	750379.4	0.5793	0.5143	11.2
1993	930275.0	766543.0	0.6145	0.5379	12.5
1994	867927.0	780342.1	0.5951	0.5436	8.6
1995	882133.0	808383.0	0.6137	0.5669	7.6
1996	919437.0	848517.8	0.6357	0.5842	8.1
1997	774302.0	767719.8	0.5414	0.5033	7.0
1998	710425.0	664947.8	0.4539	0.4007	11.7
1999	616412.0	579753.6	0.4090	0.3846	6.0
2000	608733.2	580664.6	0.4339	0.3982	8.2
2001	633214.2	578113.5	0.4838	0.4090	15.5
2002	647545.3	576617.5	0.5007	0.3989	20.3
2003	665191.1	641400.0	0.5130	0.4709	8.2
2004	621671.3	581108.7	0.4923	0.4224	14.2
2005	589071.6	556214.4	0.4660	0.4005	14.1
2006	614775.2	577711.9	0.5282	0.4549	13.9
2007	601142.1	555286.2	0.5150	0.4477	13.1
2008	588350.7	542103.7	0.5205	0.4500	13.5
2009	490703.5	459972.2	0.4398	0.3942	10.4

Table 3.32 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	519940.9	1172439.6	37425.5	84412.5	-125.5
1990	468542.4	944651.7	31957.8	65515.5	-105.0
1991	313578.1	660825.1	21487.7	45058.6	-109.7
1992	369970.0	601674.1	23741.9	40887.5	-72.2
1993	382467.9	553107.8	25010.3	37557.3	-50.2
1994	396430.0	521335.8	25980.1	34293.4	-32.0
1995	410932.0	541020.8	26694.6	37088.0	-38.9
1996	418665.0	518219.3	27801.7	35307.6	-27.0
1997	345381.0	418567.9	23416.1	28991.6	-23.8
1998	247400.0	359175.2	17327.7	25696.1	-48.3
1999	242741.0	330972.0	16309.1	22927.2	-40.6
2000	263787.4	346577.8	17614.3	23961.4	-36.0
2001	275556.0	360083.4	18368.5	25292.2	-37.7
2002	304750.2	384241.5	20202.5	26899.7	-33.2
2003	316722.8	367631.8	21314.3	25972.6	-21.9
2004	312074.8	359124.2	21691.1	26805.4	-23.6
2005	291506.7	351610.7	20678.9	26392.3	-27.6
2006	269059.5	350921.7	19303.0	26150.6	-35.5
2007	260715.0	341418.6	18498.0	25287.2	-36.7
2008	248885.9	335431.1	17129.2	24740.0	-44.4
2009	180127.0	245229.3	11768.5	17076.3	-45.1

Table 3.33 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	519940.9	1172439.6	2.58796	6.17896	-138.8
1990	468542.4	944651.7	2.24312	4.92817	-119.7
1991	313578.1	660825.1	1.53072	3.18469	-108.1
1992	369970.0	601674.1	1.88876	3.27647	-73.5
1993	382467.9	553107.8	2.10256	3.04659	-44.9
1994	396430.0	521335.8	2.16526	2.71969	-25.6
1995	410932.0	541020.8	2.30028	3.11512	-35.4
1996	418665.0	518219.3	2.25501	2.66848	-18.3
1997	345381.0	418567.9	2.01265	2.27689	-13.1
1998	247400.0	359175.2	1.46367	1.87676	-28.2
1999	242741.0	330972.0	1.42282	1.75941	-23.7
2000	263787.4	346577.8	1.52301	1.91287	-25.6
2001	275556.0	360083.4	1.52863	1.92939	-26.2
2002	304750.2	384241.5	1.75172	2.29717	-31.1
2003	316722.8	367631.8	2.07301	2.33414	-12.6
2004	312074.8	359124.2	1.79173	2.17086	-21.2
2005	291506.7	351610.7	1.69355	2.08657	-23.2
2006	269059.5	350921.7	1.61880	2.16065	-33.5
2007	260715.0	341418.6	1.64540	2.16089	-31.3
2008	248885.9	335431.1	1.47151	2.03249	-38.1
2009	180127.0	245229.3	1.11134	1.54339	-38.9

Table 3.34 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	519940.9	1172439.6	0.2297	0.3648	-58.8
1990	468542.4	944651.7	0.1768	0.2653	-50.1
1991	313578.1	660825.1	0.1221	0.1669	-36.7
1992	369970.0	601674.1	0.1479	0.2300	-55.5
1993	382467.9	553107.8	0.1494	0.2109	-41.2
1994	396430.0	521335.8	0.1639	0.1704	-3.9
1995	410932.0	541020.8	0.1681	0.2058	-22.4
1996	418665.0	518219.3	0.1792	0.1765	1.5
1997	345381.0	418567.9	0.1712	0.1654	3.3
1998	247400.0	359175.2	0.1347	0.1495	-11.0
1999	242741.0	330972.0	0.1190	0.1386	-16.5
2000	263787.4	346577.8	0.1342	0.1615	-20.3
2001	275556.0	360083.4	0.1289	0.1600	-24.1
2002	304750.2	384241.5	0.1580	0.1982	-25.4
2003	316722.8	367631.8	0.1918	0.1982	-3.4
2004	312074.8	359124.2	0.1588	0.1922	-21.1
2005	291506.7	351610.7	0.1519	0.1807	-19.0
2006	269059.5	350921.7	0.1573	0.1996	-26.9
2007	260715.0	341418.6	0.1650	0.2004	-21.4
2008	248885.9	335431.1	0.1330	0.1796	-35.0
2009	180127.0	245229.3	0.1006	0.1370	-36.2

Table 3.35 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	171003.5	240681.7	10197.1	13969.0	-37.0
1990	184275.1	243566.0	11031.1	14308.3	-29.7
1991	165856.4	233727.5	9498.8	13298.9	-40.0
1992	188603.0	169951.6	10566.6	9675.0	8.4
1993	173514.0	164183.8	8956.6	8400.5	6.2
1994	159657.0	151429.0	7346.0	6833.4	7.0
1995	288664.0	173190.9	8636.0	7866.8	8.9
1996	329715.0	214917.0	8350.7	7538.7	9.7
1997	286239.0	283296.4	9963.3	9934.0	0.3
1998	278031.0	271087.8	9885.4	9390.5	5.0
1999	243173.0	240478.5	8031.9	7939.9	1.1
2000	242558.0	241392.4	8293.0	8193.6	1.2
2001	212421.3	207302.4	7831.4	7767.1	0.8
2002	220583.1	208389.7	8277.3	7824.7	5.5
2003	281552.0	251504.5	10708.0	9236.0	13.7
2004	303283.9	281875.0	11223.7	9879.1	12.0
2005	303642.2	288890.7	10674.7	10162.0	4.8
2006	329559.3	315498.4	12484.0	11930.5	4.4
2007	307544.5	287166.8	11161.4	10018.4	10.2
2008	314834.8	296645.8	9729.0	8874.7	8.8
2009	310707.8	300572.1	9443.3	9088.3	3.8

Table 3.36 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	171003.5	240681.7	13.7962	17.0333	-23.5
1990	184275.1	243566.0	15.6199	17.1125	-9.6
1991	165856.4	233727.5	12.9819	12.3229	5.1
1992	188603.0	169951.6	13.3487	11.7597	11.9
1993	173514.0	164183.8	13.5149	13.2645	1.9
1994	159657.0	151429.0	13.3768	12.8033	4.3
1995	288664.0	173190.9	45.7524	14.2756	68.8
1996	329715.0	214917.0	61.0053	29.7711	51.2
1997	286239.0	283296.4	40.2821	39.3274	2.4
1998	278031.0	271087.8	35.6668	35.1991	1.3
1999	243173.0	240478.5	33.7651	33.0456	2.1
2000	242558.0	241392.4	32.4210	32.1746	0.8
2001	212421.3	207302.4	24.5846	22.8718	7.0
2002	220583.1	208389.7	25.5869	23.3951	8.6
2003	281552.0	251504.5	30.7469	28.6384	6.9
2004	303283.9	281875.0	36.5750	34.8230	4.8
2005	303642.2	288890.7	37.9465	35.4750	6.5
2006	329559.3	315498.4	35.9519	33.6933	6.3
2007	307544.5	287166.8	37.6757	35.2908	6.3
2008	314834.8	296645.8	46.5276	44.6724	4.0
2009	310707.8	300572.1	45.4890	43.8865	3.5

Table 3.37 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	171003.5	240681.7	0.1740	0.1866	-7.2
1990	184275.1	243566.0	0.1936	0.1814	6.3
1991	165856.4	233727.5	0.1654	0.1424	13.9
1992	188603.0	169951.6	0.1885	0.1434	23.9
1993	173514.0	164183.8	0.1849	0.1697	8.2
1994	159657.0	151429.0	0.1900	0.1758	7.5
1995	288664.0	173190.9	0.6269	0.1990	68.3
1996	329715.0	214917.0	0.8210	0.3948	51.9
1997	286239.0	283296.4	0.5534	0.5364	3.1
1998	278031.0	271087.8	0.5015	0.4857	3.1
1999	243173.0	240478.5	0.4634	0.4474	3.5
2000	242558.0	241392.4	0.4479	0.4377	2.3
2001	212421.3	207302.4	0.3436	0.3149	8.4
2002	220583.1	208389.7	0.3562	0.3204	10.0
2003	281552.0	251504.5	0.4302	0.3914	9.0
2004	303283.9	281875.0	0.5107	0.4724	7.5
2005	303642.2	288890.7	0.5277	0.4843	8.2
2006	329559.3	315498.4	0.5018	0.4618	8.0
2007	307544.5	287166.8	0.5253	0.4818	8.3
2008	314834.8	296645.8	0.6347	0.5996	5.5
2009	310707.8	300572.1	0.6223	0.5926	4.8

Table 3.38 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	NA,NE,NO	26821.12	NA,NE,NO	2174.84	-100
1990	NA,NE,NO	30070.21	NA,NE,NO	2500.77	-100
1991	NA,NE,NO	34805.15	NA,NE,NO	2267.37	-100
1992	NA,NE,NO	8360.32	NA,NE,NO	671.29	-100
1993	NA,NE,NO	5768.31	NA,NE,NO	307.56	-100
1994	NA,NE,NO	7368.37	NA,NE,NO	429.14	-100
1995	NA,NE,NO	8824.51	NA,NE,NO	617.71	-100
1996	NA,NE,NO	6831.17	NA,NE,NO	275.73	-100
1997	NA,NE,NO	2281.87	NA,NE,NO	7.03	-100
1998	NA,NE,NO	10675.99	NA,NE,NO	698.40	-100
1999	NA,NE,NO	3695.23	NA,NE,NO	109.51	-100
2000	NA,NE,NO	3957.78	NA,NE,NO	294.64	-100
2001	NA,NE,NO	10670.60	NA,NE,NO	429.45	-100
2002	NA,NE,NO	10086.41	NA,NE,NO	294.59	-100
2003	NA,NE,NO	11267.09	NA,NE,NO	390.68	-100
2004	NA,NE,NO	14083.78	NA,NE,NO	692.96	-100
2005	NA,NE,NO	24277.36	NA,NE,NO	1239.09	-100
2006	NA,NE,NO	15086.29	NA,NE,NO	584.36	-100
2007	NA,NE,NO	18777.89	NA,NE,NO	943.15	-100
2008	NA,NE,NO	16692.97	NA,NE,NO	816.38	-100
2009	IE,NA,NO	8599.41	IE,NA,NO	270.87	-100

Table 3.39 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]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	NA,NE,NO	26821.12	NA,NE,NO	0.12	-100
1990	NA,NE,NO	30070.21	NA,NE,NO	0.16	-100
1991	NA,NE,NO	34805.15	NA,NE,NO	2.24	-100
1992	NA,NE,NO	8360.32	NA,NE,NO	0.34	-100
1993	NA,NE,NO	5768.31	NA,NE,NO	0.54	-100
1994	NA,NE,NO	7368.37	NA,NE,NO	0.53	-100
1995	NA,NE,NO	8824.51	NA,NE,NO	0.83	-100
1996	NA,NE,NO	6831.17	NA,NE,NO	0.96	-100
1997	NA,NE,NO	2281.87	NA,NE,NO	0.66	-100
1998	NA,NE,NO	10675.99	NA,NE,NO	0.39	-100
1999	NA,NE,NO	3695.23	NA,NE,NO	0.67	-100
2000	NA,NE,NO	3957.78	NA,NE,NO	0.45	-100
2001	NA,NE,NO	10670.60	NA,NE,NO	1.86	-100
2002	NA,NE,NO	10086.41	NA,NE,NO	1.99	-100
2003	NA,NE,NO	11267.09	NA,NE,NO	1.92	-100
2004	NA,NE,NO	14083.78	NA,NE,NO	1.61	-100
2005	NA,NE,NO	24277.36	NA,NE,NO	2.39	-100
2006	NA,NE,NO	15086.29	NA,NE,NO	2.21	-100
2007	NA,NE,NO	18777.89	NA,NE,NO	1.91	-100
2008	NA,NE,NO	16692.97	NA,NE,NO	1.77	-100
2009	IE,NA,NO	8599.41	IE,NA,NO	1.56	-100

Table 3.40 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 forN2O [Gg]		Decrease [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	NA,NE,NO	26821.12	NA,NE,NO	0.02	-100
1990	NA,NE,NO	30070.21	NA,NE,NO	0.03	-100
1991	NA,NE,NO	34805.15	NA,NE,NO	0.05	-100
1992	NA,NE,NO	8360.32	NA,NE,NO	0.01	-100
1993	NA,NE,NO	5768.31	NA,NE,NO	0.01	-100
1994	NA,NE,NO	7368.37	NA,NE,NO	0.01	-100
1995	NA,NE,NO	8824.51	NA,NE,NO	0.01	-100
1996	NA,NE,NO	6831.17	NA,NE,NO	0.02	-100
1997	NA,NE,NO	2281.87	NA,NE,NO	0.01	-100
1998	NA,NE,NO	10675.99	NA,NE,NO	0.01	-100
1999	NA,NE,NO	3695.23	NA,NE,NO	0.01	-100
2000	NA,NE,NO	3957.78	NA,NE,NO	0.01	-100
2001	NA,NE,NO	10670.60	NA,NE,NO	0.03	-100
2002	NA,NE,NO	10086.41	NA,NE,NO	0.03	-100
2003	NA,NE,NO	11267.09	NA,NE,NO	0.03	-100
2004	NA,NE,NO	14083.78	NA,NE,NO	0.03	-100
2005	NA,NE,NO	24277.36	NA,NE,NO	0.04	-100
2006	NA,NE,NO	15086.29	NA,NE,NO	0.03	-100
2007	NA,NE,NO	18777.89	NA,NE,NO	0.03	-100
2008	NA,NE,NO	16692.97	NA,NE,NO	0.03	-100
2009	IE,NA,NO	8599.41	IE,NA,NO	0.02	-100

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 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.

A further analysis on the EU-ETS 2011 reporting (object of a further Study) will be conducted in order to take into consideration these emissions, as Tier 3 approach, on the activity category where these operators have to report.

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.

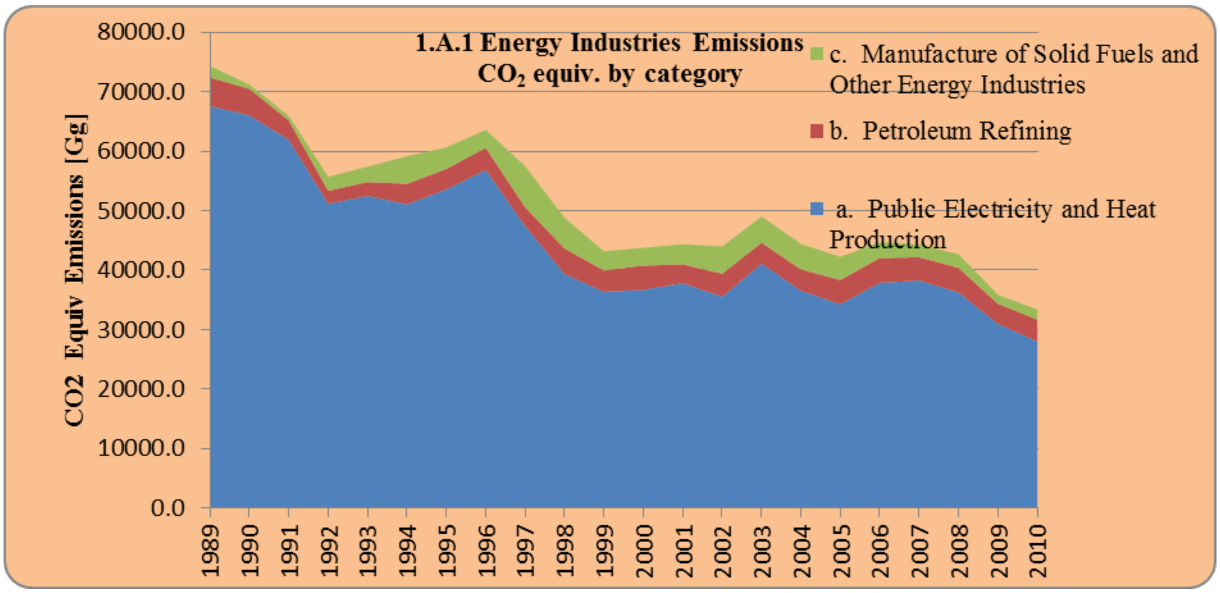
In response of ERT recommendation, "Romania further investigate and elaborate on the non-energy use of fuels reported in the energy balance, which is not reported in the energy sector, and assess whether the country specific carbon storage factors are appropriate", the Energy Sector team will investigate if a further study could be conducted on the national circumstances, with the proper results on the above recommendation.

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 3.12 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: 41% in the base year and a 43% in last year.

The contribution of this sub-sector to the 1.A. – Fuel combustion is, for the year 2010, about 33352.808 Gg CO_2 equiv. having the main contributor the activity category 1.A.1.a – Electricity and Heat Production.

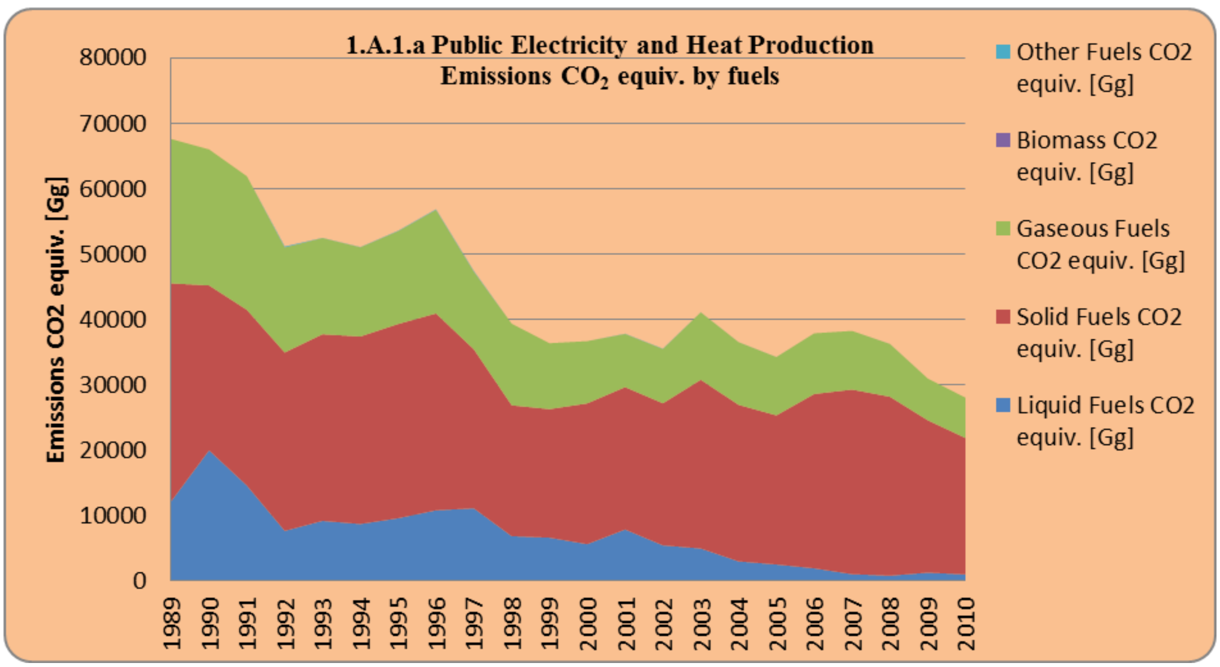
3.2.7.1 Source category - Public Electricity and Heat Production (CRF sector 1.A.1.a)

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.

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 3.13 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 37.3% in the base year and 36.1% for the year 2010. The share of this activity category to the 1.A.1. - Energy Industry is 90.9% for the base year and 84.1% for the year 2010 (about

28039.144 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.

Table 3.41 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	67383.87	12159.19	33170.23	22054.46	NO, NA	NO, NA
1990	65806.81	19931.91	25086.29	20788.61	NO, NA	NO, NA
1991	61719.55	14562.09	26740.36	20417.11	NO, NA	NO, NA
1992	50993.97	7651.217	27141.02	16054.59	22.512	147.147
1993	52307.3	9176.016	28402.65	14701.74	0.224	26.884
1994	50907.16	8694.57	28544.68	13625	7.728	42.9
1995	53394.16	9579.459	29562.01	14197.49	7.616	55.198
1996	56671	10780.65	29973.93	15832.05	30.016	84.37
1997	47261.65	11092.06	24198.33	11862.86	10.08	108.394
1998	39234.38	6845.738	19915.94	12472.71	0.336	NO, NA
1999	36247.63	6617.819	19558.34	10071.48	20.944	NO, NA
2000	36564.01	5628.621	21424.46	9505.351	33.376	5.577
2001	37699.17	7857.829	21664.38	8142.214	24.304	34.749
2002	35410.37	5438.333	21618.56	8311.574	31.248	41.899
2003	40965.49	4967.921	25676.62	10307.93	24.752	13.013
2004	36411.12	2998.418	23828.03	9575.383	23.52	9.295
2005	34141.82	2518.933	22693.93	8919.081	30.464	9.867
2006	37741.74	1935.495	26530.89	9275.359	79.184	NO, NA
2007	38119.01	1050.627	28101.74	8966.639	89.3158	NO, NA
2008	36129.78	822.981	27226.45	8077.347	60.8678	3.003
2009	30845.14	1276.257	23197.35	6371.529	62.1572	NO, NA
2010	27923.49	1008.087	20753.67	6161.733	146.832	NO, NA
Decrease 1989 - 2010	58.56	91.71	37.43	72.06	_	_
Decrease 1990 - 2010	57.57	94.94	17.27	70.36	_	_
Decrease 2009 - 2010	9.47	21.01	10.53	3.29	-136.23	_

Table 3.42 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	1.223242	0.46752	0.356655	0.399066	NO, NA	NO, NA
1990	1.412364	0.766381	0.269822	0.376161	NO, NA	NO, NA
1991	1.216845	0.559911	0.287495	0.369439	NO, NA	NO, NA
1992	0.907548	0.290259	0.289887	0.290501	0.00603	0.03087
1993	0.924232	0.349787	0.302723	0.266022	0.00006	0.00564
1994	0.893051	0.331833	0.303609	0.246539	0.00207	0.009
1995	0.950218	0.366338	0.313362	0.256898	0.00204	0.01158
1996	1.041256	0.412983	0.316058	0.286475	0.00804	0.0177
1997	0.919951	0.424553	0.255304	0.214654	0.0027	0.02274
1998	0.696215	0.262653	0.207784	0.225689	0.00009	NO, NA
1999	0.648742	0.253071	0.207822	0.182239	0.00561	NO, NA
2000	0.623751	0.214814	0.226832	0.171995	0.00894	0.00117
2001	0.686191	0.29883	0.226231	0.14733	0.00651	0.00729
2002	0.601193	0.207539	0.2261	0.150395	0.00837	0.00879
2003	0.65752	0.191314	0.270328	0.186518	0.00663	0.00273
2004	0.547629	0.115276	0.25084	0.173263	0.0063	0.00195
2005	0.507985	0.096762	0.239606	0.161387	0.00816	0.00207
2006	0.545101	0.074004	0.282053	0.167834	0.02121	NO, NA
2007	0.514234	0.039336	0.284172	0.163846	0.02688	NO, NA
2008	0.482868	0.030501	0.28732	0.145157	0.01926	0.00063
2009	0.434724	0.048782	0.252117	0.115205	0.01862	NO, NA
2010	0.413822	0.032032	0.23129	0.11117	0.03933	NO, NA
Decrease 1989 - 2010	66.17	93.15	35.15	72.14	_	_
Decrease 1990 - 2010	70.70	95.82	14.28	70.45	_	_
Decrease 2009 - 2010	4.81	34.34	8.26	3.50	-111.22	_

Table 3.43 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	0.632728	0.093504	0.499317	0.039907	NO, NA	NO, NA
1990	0.568643	0.153276	0.377751	0.037616	NO, NA	NO, NA
1991	0.551419	0.111982	0.402493	0.036944	NO, NA	NO, NA
1992	0.495134	0.0577	0.403463	0.02905	0.000804	0.004116
1993	0.518749	0.069697	0.42169	0.026602	0.000008	0.000752
1994	0.514293	0.066155	0.422008	0.024654	0.000276	0.0012
1995	0.535629	0.073051	0.435072	0.02569	0.000272	0.001544
1996	0.552321	0.082414	0.437828	0.028647	0.001072	0.00236
1997	0.462719	0.084684	0.353177	0.021465	0.00036	0.003032
1998	0.359538	0.052425	0.284532	0.022569	0.000012	NO, NA
1999	0.357431	0.050455	0.288004	0.018224	0.000748	NO, NA
2000	0.373596	0.042809	0.31224	0.0172	0.001192	0.000156
2001	0.386549	0.059458	0.310518	0.014733	0.000868	0.000972
2002	0.370162	0.041359	0.311476	0.015039	0.001116	0.001172
2003	0.432415	0.038239	0.374277	0.018652	0.000884	0.000364
2004	0.388688	0.023036	0.347226	0.017326	0.00084	0.00026
2005	0.369195	0.019328	0.332364	0.016139	0.001088	0.000276
2006	0.427562	0.014753	0.393198	0.016783	0.002828	NO, NA
2007	0.421886	0.007766	0.394252	0.016385	0.003484	NO, NA
2008	0.423922	0.00597	0.400884	0.014516	0.002468	0.000084
2009	0.37604	0.009723	0.352381	0.01152	0.002416	NO, NA
2010	0.345036	0.005877	0.322798	0.011117	0.005244	NO, NA
Decrease 1989 - 2010	45.47	93.71	35.35	72.14	_	_
Decrease 1990 - 2010	39.32	96.17	14.55	70.45	_	_
Decrease 2009 - 2010	8.24	39.55	8.39	3.50	-117.05	_

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

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	911561.6	67385.73	12159.8	33171.1	22054.9	NO, NA	NO, NA
1990	901443.8	65808.79	19932.8	25086.9	20789.0	NO, NA	NO, NA
1991	843571	61721.32	14562.8	26741.0	20417.5	NO, NA	NO, NA
1992	680714.1	50995.37	7651.6	27141.7	16054.9	22.5	147.2
1993	687263.9	52308.74	9176.4	28403.4	14702.0	0.2	26.9
1994	662540	50908.56	8695.0	28545.4	13625.3	7.7	42.9
1995	694270.7	53395.65	9579.9	29562.8	14197.8	7.6	55.2
1996	742271.5	56672.59	10781.1	29974.7	15832.4	30.0	84.4
1997	613831.7	47263.03	11092.6	24198.9	11863.1	10.1	108.4
1998	521732.1	39235.44	6846.1	19916.4	12473.0	0.3	NO, NA
1999	475664.2	36248.64	6618.1	19558.8	10071.7	21.0	NO, NA
2000	471796	36565.01	5628.9	21425.0	9505.5	33.4	5.6
2001	475684.6	37700.24	7858.2	21664.9	8142.4	24.3	34.8
2002	447240.7	35411.34	5438.6	21619.1	8311.7	31.3	41.9
2003	521089.3	40966.58	4968.2	25677.3	10308.1	24.8	13.0
2004	462931.6	36412.06	2998.6	23828.6	9575.6	23.5	9.3
2005	433748.2	34142.69	2519.0	22694.5	8919.3	30.5	9.9
2006	475582.5	37742.72	1935.6	26531.6	9275.5	79.2	NO, NA
2007	462602.7	38119.94	1050.7	28102.4	8966.8	89.3	NO, NA
2008	444076.6	36130.69	823.0	27227.1	8077.5	60.9	3.0
2009	384363.2	30845.95	1276.3	23198.0	6371.7	62.2	NO, NA
2010	357978.3	27924.25	1008.1	20754.2	6161.9	146.9	NO, NA
Decrease 1989 - 2010	60.73	58.56	91.71	37.43	72.06	_	_
Decrease 1990 - 2010	60.29	57.57	94.94	17.27	70.36	_	_
Decrease 2009 - 2010	6.86	9.47	21.01	10.53	3.29	-136.22	_

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

<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 - 2010 period</u>

- **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, and precursors gases -** EFs default are used.
- **SO_2 gas** – CS emission factors 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.1.a Energy Industries - Public Electricity and Heat Production. The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385%
- Gaseous Fuels - 5.385%
- Other (Industrial Wastes) - 7.071%

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625%

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.

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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting are used;

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.
For Solid fuels, the plant specific emission factors, calculated taking account on national circumstances, were used.
For more details and effect of the activity data changes on the emissions estimation, see the chapter 3.2.6.5

3.2.7.1.6 Source-specific planned improvements, if applicable

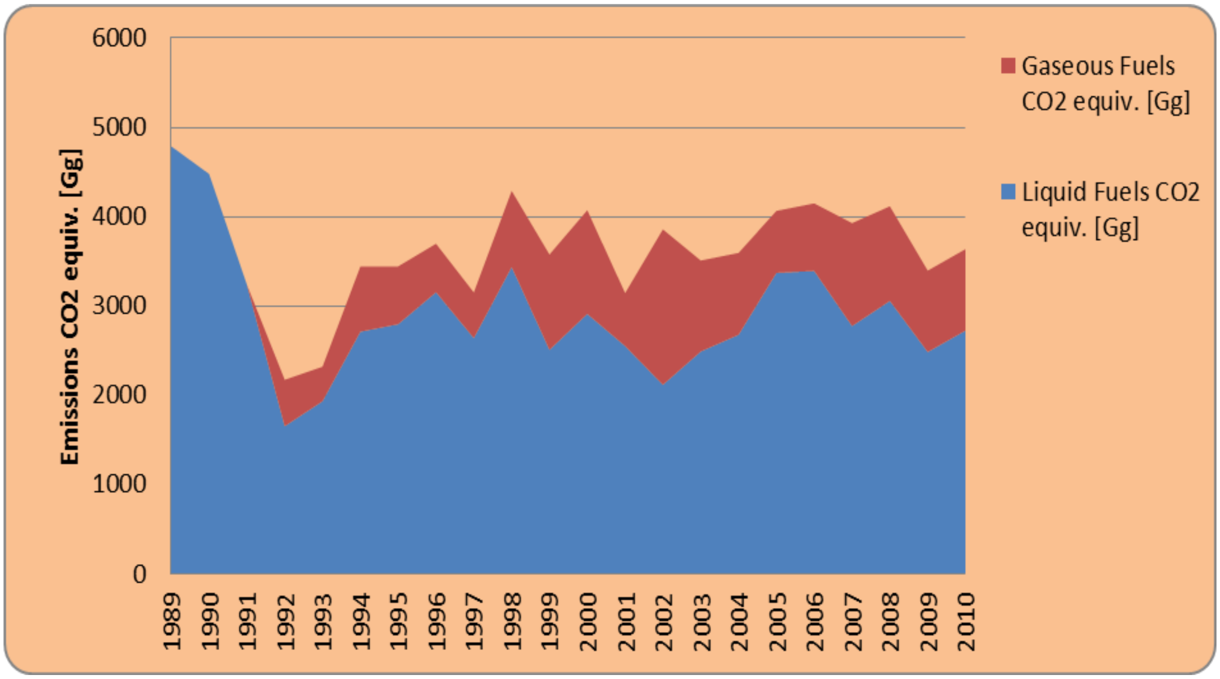
It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.
See the chapter 3.2.6.6 for more details.

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

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



The share in total GHG emissions 1.A – fuel Combustion of this activity is 2.6% for the year 1989 and 4.7% for the year 2010. The main fuels reported are liquids which are: Refinery gas, Transport diesel and Residual fuel oil, together with natural gas having a contribution about 3636.411 Gg in 2010.

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	4780.442	4780.442	NO, NA	NO, NA	NO, NA	NO, NA
1990	4472.525	4472.525	NO, NA	NO, NA	NO, NA	NO, NA
1991	3234.316	3234.316	NO, NA	NO, NA	NO, NA	NO, NA
1992	2170.121	1650.899	NO, NA	519.2216	NO, NA	NO, NA
1993	2316.143	1929.873	NO, NA	386.2702	NO, NA	NO, NA
1994	3435.735	2707.064	NO, NA	728.6709	NO, NA	NO, NA
1995	3437.083	2790.431	NO, NA	646.6519	NO, NA	NO, NA
1996	3689.321	3146.872	NO, NA	542.4495	NO, NA	NO, NA
1997	3145.378	2635.557	NO, NA	509.821	NO, NA	NO, NA
1998	4280.858	3429.88	NO, NA	850.9782	NO, NA	NO, NA
1999	3569.924	2504.075	NO, NA	1065.849	NO, NA	NO, NA
2000	4064.613	2906.15	NO, NA	1158.462	NO, NA	NO, NA
2001	3138.702	2547.31	NO, NA	591.3923	NO, NA	NO, NA
2002	3852.624	2113.662	NO, NA	1738.962	NO, NA	NO, NA
2003	3503.416	2485.714	NO, NA	1017.702	NO, NA	NO, NA
2004	3588.172	2672.783	NO, NA	915.3897	NO, NA	NO, NA
2005	4058.144	3364.589	NO, NA	693.5555	NO, NA	NO, NA
2006	4140.998	3385.966	NO, NA	755.0324	NO, NA	NO, NA
2007	3921.226	2769.779	NO, NA	1151.447	NO, NA	NO, NA
2008	4109.085	3050.976	NO, NA	1058.109	NO, NA	NO, NA
2009	3389.57	2480.717	NO, NA	908.8531	NO, NA	NO, NA
2010	3630.208	2719.682	NO, NA	910.527	NO, NA	NO, NA
Decrease 1989 - 2010	24.06	43.11	_	_	_	_
Decrease 1990 - 2010	18.83	39.19	_	_	_	_
Decrease 2009 - 2010	-7.10	-9.63	_	- 0.18	_	_

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	0.10851	0.10851	NO, NA	NO, NA	NO, NA	NO, NA
1990	0.095984	0.095984	NO, NA	NO, NA	NO, NA	NO, NA
1991	0.075637	0.075637	NO, NA	NO, NA	NO, NA	NO, NA
1992	0.046793	0.037398	NO, NA	0.009395	NO, NA	NO, NA
1993	0.051622	0.044632	NO, NA	0.006989	NO, NA	NO, NA
1994	0.083363	0.070178	NO, NA	0.013185	NO, NA	NO, NA
1995	0.083653	0.071952	NO, NA	0.011701	NO, NA	NO, NA
1996	0.098769	0.088954	NO, NA	0.009815	NO, NA	NO, NA
1997	0.079992	0.070767	NO, NA	0.009225	NO, NA	NO, NA
1998	0.107517	0.092119	NO, NA	0.015398	NO, NA	NO, NA
1999	0.083797	0.06451	NO, NA	0.019286	NO, NA	NO, NA
2000	0.093989	0.073027	NO, NA	0.020962	NO, NA	NO, NA
2001	0.072707	0.062006	NO, NA	0.010701	NO, NA	NO, NA
2002	0.081365	0.049899	NO, NA	0.031466	NO, NA	NO, NA
2003	0.076955	0.058541	NO, NA	0.018415	NO, NA	NO, NA
2004	0.082191	0.065627	NO, NA	0.016564	NO, NA	NO, NA
2005	0.095665	0.083116	NO, NA	0.01255	NO, NA	NO, NA
2006	0.10449	0.090828	NO, NA	0.013662	NO, NA	NO, NA
2007	0.095742	0.074702	NO, NA	0.02104	NO, NA	NO, NA
2008	0.095745	0.076729	NO, NA	0.019015	NO, NA	NO, NA
2009	0.079666	0.063233	NO, NA	0.016433	NO, NA	NO, NA
2010	0.088956	0.072528	NO, NA	0.016428	NO, NA	NO, NA
Decrease 1989 - 2010	18.02	33.16	_	_	_	_
Decrease 1990 - 2010	7.32	24.44	_	_	_	_
Decrease 2009 - 2010	-11.66	-14.70	_	0.03	_	_

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	0.015267	0.015267	NO, NA	NO, NA	NO, NA	NO, NA
1990	0.012703	0.012703	NO, NA	NO, NA	NO, NA	NO, NA
1991	0.010964	0.010964	NO, NA	NO, NA	NO, NA	NO, NA
1992	0.00619	0.005251	NO, NA	0.00094	NO, NA	NO, NA
1993	0.007098	0.006399	NO, NA	0.000699	NO, NA	NO, NA
1994	0.012456	0.011138	NO, NA	0.001319	NO, NA	NO, NA
1995	0.012562	0.011391	NO, NA	0.00117	NO, NA	NO, NA
1996	0.016062	0.015081	NO, NA	0.000982	NO, NA	NO, NA
1997	0.012501	0.011578	NO, NA	0.000923	NO, NA	NO, NA
1998	0.016849	0.015309	NO, NA	0.00154	NO, NA	NO, NA
1999	0.012323	0.010394	NO, NA	0.001929	NO, NA	NO, NA
2000	0.013746	0.01165	NO, NA	0.002096	NO, NA	NO, NA
2001	0.010521	0.00945	NO, NA	0.00107	NO, NA	NO, NA
2002	0.010614	0.007467	NO, NA	0.003147	NO, NA	NO, NA
2003	0.010666	0.008825	NO, NA	0.001841	NO, NA	NO, NA
2004	0.011951	0.010295	NO, NA	0.001656	NO, NA	NO, NA
2005	0.014407	0.013152	NO, NA	0.001255	NO, NA	NO, NA
2006	0.016807	0.015441	NO, NA	0.001366	NO, NA	NO, NA
2007	0.014777	0.012673	NO, NA	0.002104	NO, NA	NO, NA
2008	0.014479	0.012578	NO, NA	0.001902	NO, NA	NO, NA
2009	0.012085	0.010442	NO, NA	0.001643	NO, NA	NO, NA
2010	0.013982	0.012339	NO, NA	0.001643	NO, NA	NO, NA
Decrease 1989 - 2010	8.42	19.18	_	_	_	_
Decrease 1990 - 2010	-10.07	2.86	_	_	_	_
Decrease 2009 - 2010	-15.70	-18.17	_	0.03	_	_

Table 3.48 GHG emissions in CRF 1.A.1.b Petroleum refining

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1A.1.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	79070	4787.454	4780.6	NO, NA	NO, NA	NO, NA	NO, NA
1990	75285.86	4478.479	4472.6	NO, NA	NO, NA	NO, NA	NO, NA
1991	52971.31	3239.303	3234.4	NO, NA	NO, NA	NO, NA	NO, NA
1992	36719.33	2173.022	1650.9	NO, NA	519.2	NO, NA	NO, NA
1993	38714.73	2319.428	1929.9	NO, NA	386.3	NO, NA	NO, NA
1994	55896.62	3441.347	2707.1	NO, NA	728.7	NO, NA	NO, NA
1995	55677.75	3442.734	2790.5	NO, NA	646.7	NO, NA	NO, NA
1996	57534.02	3696.374	3147.0	NO, NA	542.5	NO, NA	NO, NA
1997	49982.9	3150.933	2635.6	NO, NA	509.8	NO, NA	NO, NA
1998	66867.61	4288.339	3430.0	NO, NA	851.0	NO, NA	NO, NA
1999	57509.18	3575.504	2504.2	NO, NA	1065.9	NO, NA	NO, NA
2000	65008.34	4070.848	2906.2	NO, NA	1158.5	NO, NA	NO, NA
2001	51041.8	3143.491	2547.4	NO, NA	591.4	NO, NA	NO, NA
2002	64850.4	3857.623	2113.7	NO, NA	1739.0	NO, NA	NO, NA
2003	57151.12	3508.338	2485.8	NO, NA	1017.7	NO, NA	NO, NA
2004	57309.13	3593.603	2672.9	NO, NA	915.4	NO, NA	NO, NA
2005	63392.67	4064.62	3364.7	NO, NA	693.6	NO, NA	NO, NA
2006	62102.87	4148.402	3386.1	NO, NA	755.0	NO, NA	NO, NA
2007	61055.82	3927.817	2769.9	NO, NA	1151.5	NO, NA	NO, NA
2008	63045.33	4115.584	3051.1	NO, NA	1058.1	NO, NA	NO, NA
2009	52209.6	3394.989	2480.8	NO, NA	908.9	NO, NA	NO, NA
2010	55045.73	3636.411	2719.8	NO, NA	910.5	NO, NA	NO, NA
Decrease 1989 - 2010	30.38	24.04	43.11	_	_	_	_
Decrease 1990 - 2010	26.88	18.80	39.19	_	_	_	_
Decrease 2009 - 2010	-5.43	-7.11	-9.63	_	-0.18	_	_

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 - 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, and precursors gases -** EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.1.b Energy Industries – Petroleum Refining. The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.

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.

3.2.7.2.4 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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting are used;
For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.

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

3.2.7.2.6 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.

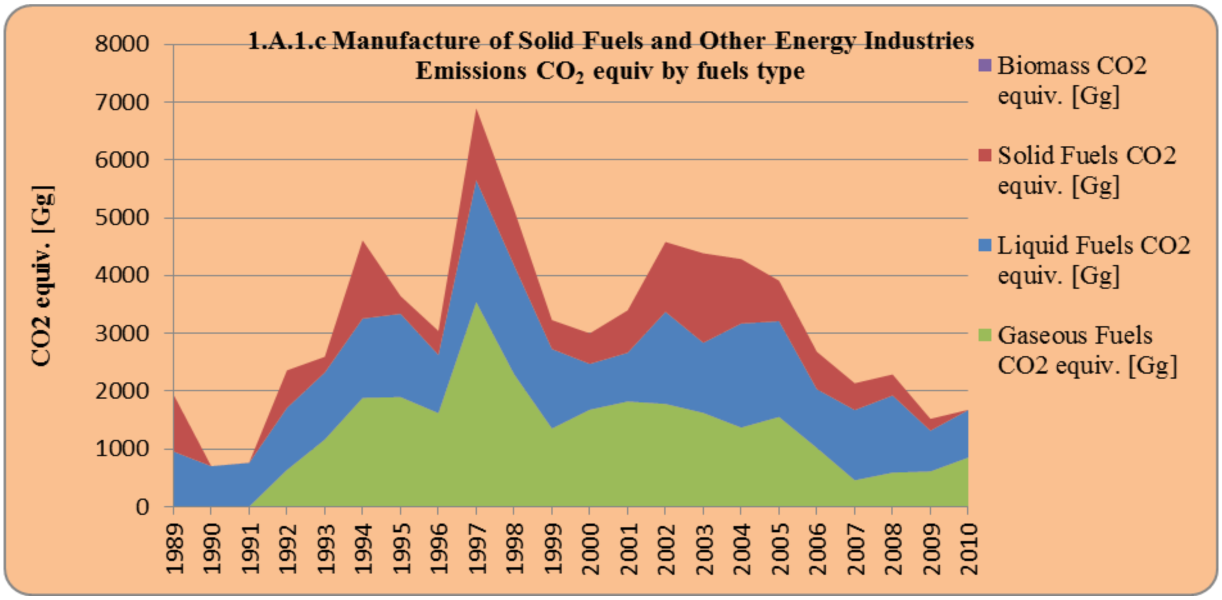
3.2.7.3 Source category - Manufacture of Solid Fuels and Other Energy Industries (CRF 1.A.1.c.)

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 and gaseous fuels - level and trend, including and excluding LULUCF and key category by solid fuels – trend, including and excluding LULUCF.

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



The share in total GHG emissions - sector 1A, is 2.16% for the year 2010, starting to a share of 1.07% in the base year, 1989. The emissions from this activity increased by 100% 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 being a deep crisis year), 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).

Table 3.49 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	1937.582	952.625	984.957	NO, NA	NO, NA	NO, NA
1990	698.516	698.516	NO, NA	NO, NA	NO, NA	NO, NA
1991	758.018	755.540	2.477	NO, NA	NO, NA	NO, NA
1992	2353.254	1070.885	647.206	635.162	NO, NA	NO, NA
1993	2588.948	1156.367	271.582	1160.999	NO, NA	NO, NA
1994	4601.645	1369.044	1351.934	1880.667	NO, NA	NO, NA
1995	3636.537	1435.961	304.887	1895.688	NO, NA	NO, NA
1996	3034.039	1004.543	411.897	1617.600	NO, NA	NO, NA
1997	6882.996	2103.223	1243.456	3536.317	NO, NA	NO, NA
1998	5127.174	1878.618	958.093	2290.464	NO, NA	NO, NA
1999	3222.423	1371.274	499.701	1351.448	NO, NA	NO, NA
2000	2994.908	789.288	528.881	1676.739	0.896	NO, NA
2001	3393.098	841.902	733.100	1818.096	3.472	NO, NA
2002	4572.673	1587.554	1208.355	1776.763	2.576	NO, NA
2003	4374.808	1210.484	1543.442	1620.882	2.240	NO, NA
2004	4275.612	1795.944	1112.204	1367.464	1.120	NO, NA
2005	3904.064	1651.641	701.473	1550.950	0.560	NO, NA
2006	2676.014	1014.502	646.596	1014.917	0.224	NO, NA
2007	2130.955	1212.207	462.169	456.579	0.112	NO, NA
2008	2284.253	1330.106	365.196	588.951	0.000	NO, NA
2009	1516.897	705.144	203.246	608.507	0.896	NO, NA
2010	1674.107	821.802	3.534	848.771	0.112	NO, NA
Decrease 1989 - 2010	13.598	13.733	99.641	_	_	_
Decrease 1990 - 2010	-139.666	-17.650	_	_	_	_
Decrease 2009 - 2010	-10.364	-16.544	98.261	-39.484	87.500	_

Table 3.50 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, NA	NO, NA	NO, NA
1990	0.02851	0.02851	NO, NA	NO, NA	NO, NA	NO, NA
1991	0.03088	0.03086	0.00003	NO, NA	NO, NA	NO, NA
1992	0.06248	0.04430	0.00669	0.01149	NO, NA	NO, NA
1993	0.07248	0.04788	0.00360	0.02101	NO, NA	NO, NA
1994	0.09967	0.05665	0.00899	0.03403	NO, NA	NO, NA
1995	0.09823	0.05970	0.00423	0.03430	NO, NA	NO, NA
1996	0.07645	0.04160	0.00558	0.02927	NO, NA	NO, NA
1997	0.16231	0.08760	0.01072	0.06399	NO, NA	NO, NA
1998	0.12913	0.07917	0.00851	0.04145	NO, NA	NO, NA
1999	0.08399	0.05611	0.00342	0.02445	NO, NA	NO, NA
2000	0.06576	0.03250	0.00268	0.03034	0.00024	NO, NA
2001	0.07493	0.03421	0.00689	0.03290	0.00093	NO, NA
2002	0.10891	0.06577	0.01030	0.03215	0.00069	NO, NA
2003	0.09731	0.05035	0.01703	0.02933	0.00060	NO, NA
2004	0.10858	0.07234	0.01120	0.02474	0.00030	NO, NA
2005	0.10185	0.06539	0.00825	0.02806	0.00015	NO, NA
2006	0.06577	0.03978	0.00757	0.01836	0.00006	NO, NA
2007	0.06312	0.04834	0.00640	0.00834	0.00003	NO, NA
2008	0.06675	0.05054	0.00563	0.01058	0.00000	NO, NA
2009	0.03797	0.02454	0.00219	0.01100	0.00024	NO, NA
2010	0.04457	0.02918	0.00004	0.01531	0.00003	NO, NA
Decrease 1989 - 2010	10.20110	24.87031	99.63201	_	_	_
Decrease 1990 - 2010	-56.29204	-2.34317	_	_	_	_
Decrease 2009 - 2010	-17.37395	-18.92169	98.18537	-39.18200	87.50000	_

Table 3.51 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, NA	NO, NA	NO, NA
1990	0.00570	0.00570	NO, NA	NO, NA	NO, NA	NO, NA
1991	0.00621	0.00617	0.00004	NO, NA	NO, NA	NO, NA
1992	0.01303	0.00886	0.00302	0.00115	NO, NA	NO, NA
1993	0.01204	0.00958	0.00036	0.00210	NO, NA	NO, NA
1994	0.01686	0.01133	0.00213	0.00340	NO, NA	NO, NA
1995	0.01868	0.01194	0.00331	0.00343	NO, NA	NO, NA
1996	0.01579	0.00832	0.00454	0.00293	NO, NA	NO, NA
1997	0.02804	0.01752	0.00412	0.00640	NO, NA	NO, NA
1998	0.02432	0.01583	0.00434	0.00414	NO, NA	NO, NA
1999	0.01488	0.01122	0.00122	0.00245	NO, NA	NO, NA
2000	0.01089	0.00650	0.00133	0.00303	0.00003	NO, NA
2001	0.01189	0.00682	0.00166	0.00329	0.00012	NO, NA
2002	0.01814	0.01314	0.00170	0.00321	0.00009	NO, NA
2003	0.02782	0.01007	0.01474	0.00293	0.00008	NO, NA
2004	0.02178	0.01435	0.00491	0.00247	0.00004	NO, NA
2005	0.01689	0.01293	0.00113	0.00281	0.00002	NO, NA
2006	0.01056	0.00783	0.00089	0.00184	0.00001	NO, NA
2007	0.01106	0.00955	0.00067	0.00083	0.00000	NO, NA
2008	0.01164	0.00982	0.00076	0.00106	0.00000	NO, NA
2009	0.00610	0.00460	0.00036	0.00110	0.00003	NO, NA
2010	0.00713	0.00554	0.00006	0.00153	0.00000	NO, NA
Decrease 1989 - 2010	68.83	28.71	99.63	_	_	_
Decrease 1990 - 2010	-25.01	2.89	_	_	_	_
Decrease 2009 - 2010	-16.89	-20.27	84.65	-39.18	87.50	_

Table 3.52 GHG emissions - 1.A.1.c. Manufacture of Solid Fuels and Other Energy Ind.

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1.A.1.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	23733.11	1937.65	952.67	984.98	NO, NA	NO, NA	NO, NA
1990	9504.80	698.55	698.55	NO, NA	NO, NA	NO, NA	NO, NA
1991	10312.60	758.05	755.58	2.48	NO, NA	NO, NA	NO, NA
1992	32945.98	2353.33	1070.94	647.22	635.17	NO, NA	NO, NA
1993	40564.46	2589.03	1156.42	271.59	1161.02	NO, NA	NO, NA
1994	61905.55	4601.76	1369.11	1351.94	1880.70	NO, NA	NO, NA
1995	58434.56	3636.65	1436.03	304.89	1895.73	NO, NA	NO, NA
1996	48712.31	3034.13	1004.59	411.91	1617.63	NO, NA	NO, NA
1997	103905.25	6883.19	2103.33	1243.47	3536.39	NO, NA	NO, NA
1998	76348.05	5127.33	1878.71	958.11	2290.51	NO, NA	NO, NA
1999	46580.16	3222.52	1371.34	499.71	1351.48	NO, NA	NO, NA
2000	43860.27	2994.98	789.33	528.89	1676.77	0.90	NO, NA
2001	51387.12	3393.18	841.94	733.11	1818.13	3.47	NO, NA
2002	64526.38	4572.80	1587.63	1208.37	1776.80	2.58	NO, NA
2003	63159.54	4374.93	1210.54	1543.47	1620.91	2.24	NO, NA
2004	60867.95	4275.74	1796.03	1112.22	1367.49	1.12	NO, NA
2005	59073.49	3904.18	1651.72	701.48	1550.98	0.56	NO, NA
2006	40026.50	2676.09	1014.55	646.60	1014.94	0.22	NO, NA
2007	31627.62	2131.03	1212.26	462.18	456.59	0.11	NO, NA
2008	34981.69	2284.33	1330.17	365.20	588.96	0.00	NO, NA
2009	23399.43	1516.94	705.17	203.25	608.52	0.90	NO, NA
2010	27071.38	1674.16	821.84	3.53	848.79	0.11	NO, NA
Decrease 1989 - 2010	-14.07	13.60	13.73	99.64	_	_	_
Decrease 1990 - 2010	-184.82	-139.66	-17.65	_	_	_	_
Decrease 2009 - 2010	-15.69	-10.36	-16.54	98.26	-39.48	87.50	_

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

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, and precursors gases -** EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.1.c Energy Industries – Manufacture of Solid Fuels and Other Energy Industries.

The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.

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.

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

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

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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

- ❖ Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting, are used;
- ❖ For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
- ❖ For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

- ❖ Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

- For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.

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

3.2.7.3.6 Source-specific planned improvements, if applicable

It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a 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 3.16 Total GHG emissions trend for the subsector 1.A.2. Manufacturing Industries and Constructions by category

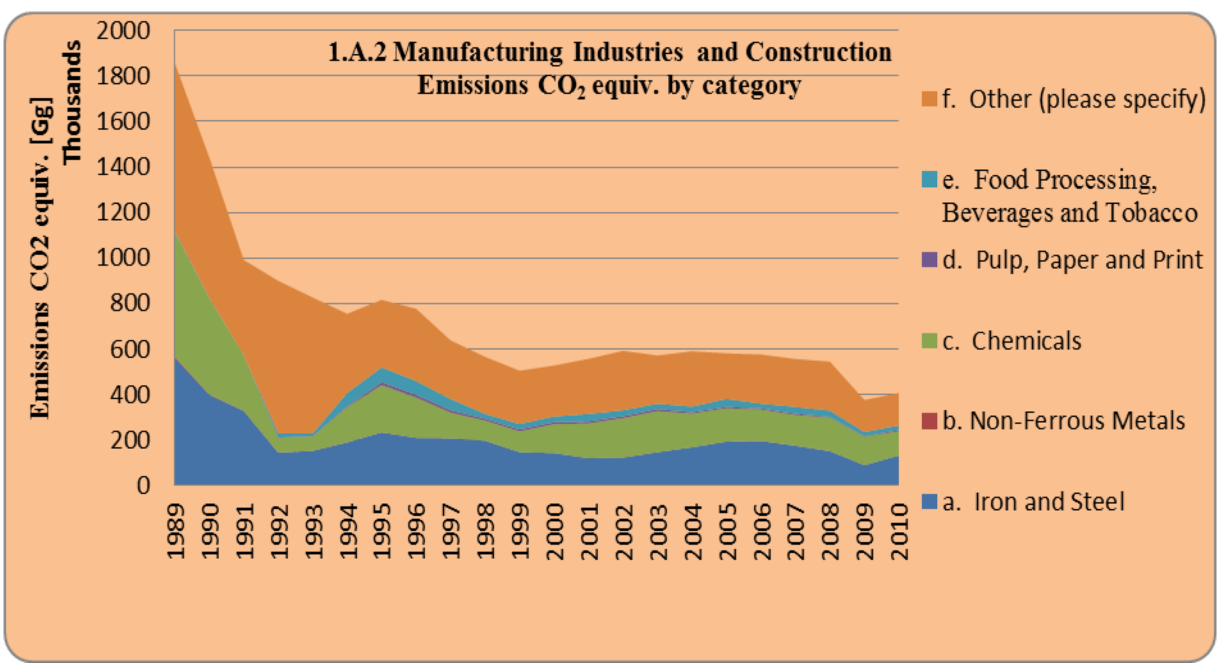
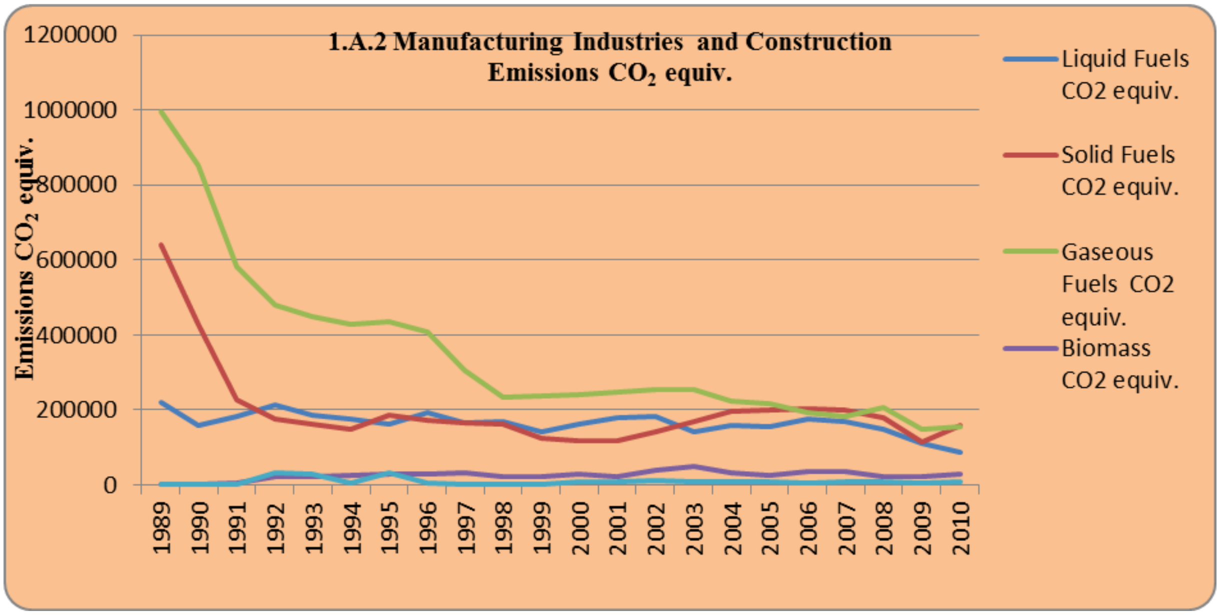


Figure 3.17 GHG emissions trend for the subsector 1.A.2. Manufacturing Industries and Constructions by fuels



The subsector Manufacturing Industries and Construction was responsible in 2010 for 24 % of the total Energy sector GHG emissions (about 18576.691 Gg CO_2 equivalents).

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

Energy Use in the Petrochemical Sector

Transformation Sector

- 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).

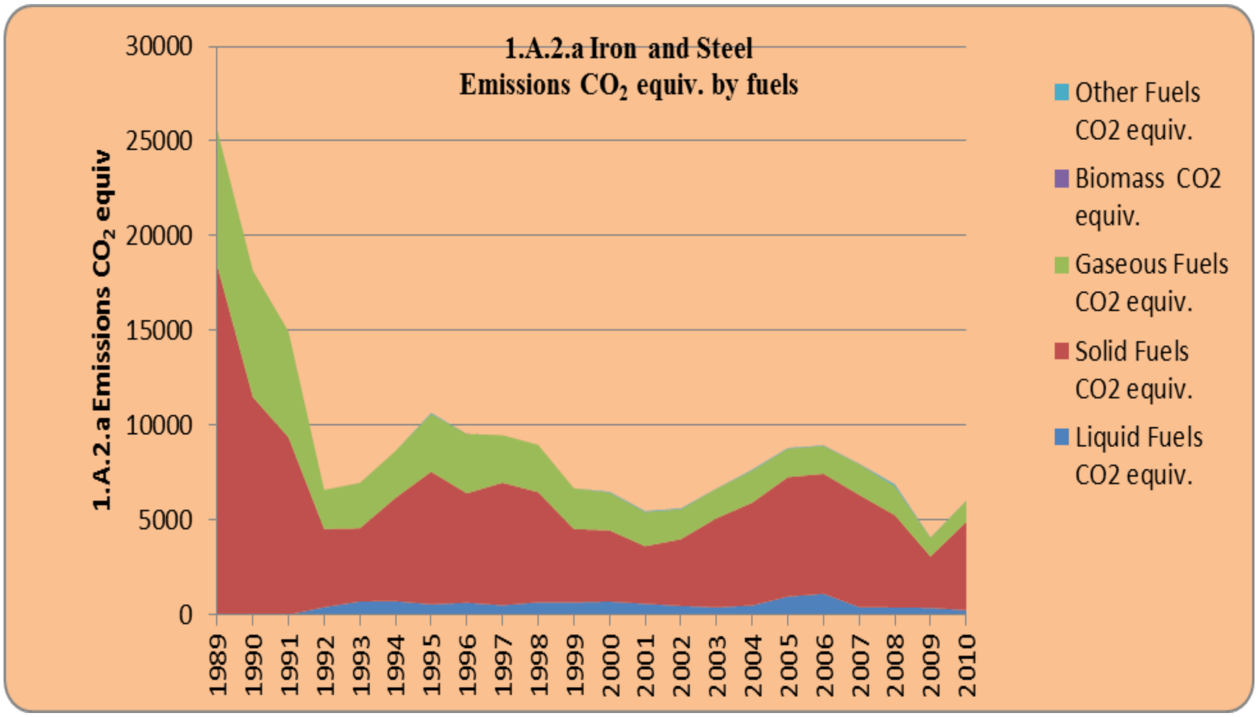
3.2.8.1 Source category – Iron and Steel (CRF 1.A.2.a)

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.

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.2.a – Iron and Steel, by fuels



The share of the total GHG emissions of the 1.A.2.a category to the 1.A.2 sub-sector remains almost constant among the period, from the base year 30.3% to 32.4% - current year, 2010. The contribution of this category is about 131784.5037 Gg CO_2 equiv., in 2010.

Table 3.53 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	25561.01	NO, NA	18403.72	7157.29	NO, NA	NO, NA
1990	18131.30	NO, NA	11470.50	6660.80	NO, NA	NO, NA
1991	14916.96	NO, NA	9340.91	5576.05	1.12	NO, NA
1992	6567.91	387.78	4122.65	2057.49	13.78	NO, NA
1993	6932.25	693.30	3854.58	2384.37	12.43	NO, NA
1994	8618.56	705.85	5445.33	2467.38	20.61	NO, NA
1995	10625.46	541.94	6987.34	3042.41	23.86	53.77
1996	9526.06	629.16	5766.35	3130.55	22.96	NO, NA
1997	9451.03	494.36	6450.78	2505.88	9.86	NO, NA
1998	8946.62	647.18	5803.70	2495.74	0.22	NO, NA
1999	6655.67	647.35	3860.31	2148.01	1.68	NO, NA
2000	6473.60	684.07	3755.89	1990.74	0.67	42.90
2001	5452.78	571.12	3035.87	1801.04	0.34	44.76
2002	5599.22	457.47	3520.95	1577.91	2.69	42.90
2003	6650.11	383.84	4699.44	1553.39	0.67	13.44
2004	7637.31	485.04	5411.72	1690.22	NO, NA	50.34
2005	8777.84	946.90	6293.27	1498.92	NO, NA	38.75
2006	8914.81	1095.90	6326.86	1459.88	1.01	32.18
2007	7950.01	398.74	5912.08	1612.31	0.67	26.88
2008	6863.16	376.53	4861.29	1522.96	NO, NA	102.39
2009	4059.05	353.04	2705.20	986.50	NO, NA	14.30
2010	5989.58	228.93	4646.11	1099.54	NO, NA	15.02
Decrease 1989 - 2010	76.57	_	74.75	84.64	_	_
Decrease 1990 - 2010	66.97	_	59.50	83.49	_	_
Decrease 2009 - 2010	-47.56	35.16	-71.75	-11.46	_	-5.00

Table 3.54 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	1.3795	NO, NA	0.7320	0.6475	NO, NA	NO, NA
1990	1.0209	NO, NA	0.4182	0.6026	NO, NA	NO, NA
1991	0.9291	NO, NA	0.4244	0.5045	0.0003	NO, NA
1992	0.4418	0.0100	0.2419	0.1861	0.0037	NO, NA
1993	0.4569	0.0161	0.2218	0.2157	0.0033	NO, NA
1994	0.5173	0.0179	0.2706	0.2232	0.0055	NO, NA
1995	0.6332	0.0138	0.3265	0.2753	0.0064	0.0113
1996	0.5322	0.0156	0.2272	0.2832	0.0062	NO, NA
1997	0.5509	0.0127	0.3088	0.2267	0.0026	NO, NA
1998	0.4995	0.0166	0.2570	0.2258	0.0001	NO, NA
1999	0.3694	0.0166	0.1580	0.1943	0.0005	NO, NA
2000	0.3608	0.0176	0.1539	0.1801	0.0002	0.0090
2001	0.2732	0.0148	0.0860	0.1629	0.0001	0.0094
2002	0.2652	0.0117	0.1010	0.1428	0.0007	0.0090
2003	0.3027	0.0099	0.1493	0.1405	0.0002	0.0028
2004	0.3926	0.0124	0.2167	0.1529	NO, NA	0.0106
2005	0.4519	0.0230	0.2852	0.1356	NO, NA	0.0081
2006	0.4659	0.0267	0.3001	0.1321	0.0003	0.0068
2007	0.4204	0.0088	0.2585	0.1473	0.0002	0.0056
2008	0.3879	0.0083	0.2213	0.1368	NO, NA	0.0215
2009	0.2344	0.0082	0.1341	0.0892	NO, NA	0.0030
2010	0.4251	0.0049	0.3178	0.0992	NO, NA	0.0032
Decrease 1989 - 2010	69.19	_	56.58	84.68	_	_
Decrease 1990 - 2010	58.36	_	24.01	83.54	_	_
Decrease 2009 - 2010	-81.32	40.05	-137.03	-11.22	_	-5.00

Table 3.55 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	0.0651	NO, NA	0.0521	0.0130	NO, NA	NO, NA
1990	0.0376	NO, NA	0.0256	0.0121	NO, NA	NO, NA
1991	0.0441	NO, NA	0.0339	0.0101	0.0000	NO, NA
1992	0.0280	0.0030	0.0208	0.0037	0.0005	NO, NA
1993	0.0285	0.0048	0.0189	0.0043	0.0004	NO, NA
1994	0.0308	0.0054	0.0202	0.0045	0.0007	NO, NA
1995	0.0359	0.0041	0.0239	0.0055	0.0009	0.0015
1996	0.0225	0.0047	0.0113	0.0057	0.0008	NO, NA
1997	0.0334	0.0038	0.0247	0.0045	0.0004	NO, NA
1998	0.0277	0.0050	0.0182	0.0045	0.0000	NO, NA
1999	0.0201	0.0050	0.0111	0.0039	0.0001	NO, NA
2000	0.0203	0.0053	0.0102	0.0036	0.0000	0.0012
2001	0.0115	0.0044	0.0025	0.0033	0.0000	0.0013
2002	0.0102	0.0035	0.0025	0.0029	0.0001	0.0012
2003	0.0144	0.0030	0.0083	0.0028	0.0000	0.0004
2004	0.0253	0.0037	0.0171	0.0031	NO, NA	0.0014
2005	0.0362	0.0069	0.0255	0.0027	NO, NA	0.0011
2006	0.0394	0.0080	0.0278	0.0026	0.0000	0.0009
2007	0.0290	0.0026	0.0227	0.0029	0.0000	0.0008
2008	0.0296	0.0024	0.0216	0.0027	NO, NA	0.0029
2009	0.0188	0.0024	0.0141	0.0018	NO, NA	0.0004
2010	0.0441	0.0015	0.0402	0.0020	NO, NA	0.0004
Decrease 1989 - 2010	32.27	_	22.86	84.68	_	_
Decrease 1990 - 2010	-17.17	_	-57.28	83.54	_	_
Decrease 2009 - 2010	-134.65	40.05	-184.09	-11.22	_	-5.00

Table 3.56 GHG emissions in CRF 1.A.2.a. – Iron and Steel

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1.A.2.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	244678.30	25562.46	NO, NA	18404.51	7157.95	NO, NA	NO, NA
1990	189848.17	18132.36	NO, NA	11470.95	6661.41	NO, NA	NO, NA
1991	164575.37	14917.93	NO, NA	9341.36	5576.56	1.12	NO, NA
1992	77473.69	6568.38	387.79	4122.91	2057.68	13.78	NO, NA
1993	83597.35	6932.74	693.33	3854.82	2384.59	12.44	NO, NA
1994	95581.22	8619.11	705.87	5445.62	2467.61	20.61	NO, NA
1995	113361.94	10626.13	541.96	6987.69	3042.69	23.86	53.78
1996	104452.29	9526.61	629.18	5766.59	3130.84	22.97	NO, NA
1997	98155.82	9451.61	494.38	6451.12	2506.11	9.86	NO, NA
1998	93954.71	8947.15	647.20	5803.98	2495.97	0.22	NO, NA
1999	72141.60	6656.06	647.38	3860.48	2148.21	1.68	NO, NA
2000	69982.07	6473.98	684.10	3756.05	1990.92	0.67	42.91
2001	56795.31	5453.06	571.13	3035.95	1801.20	0.34	44.77
2002	54506.38	5599.49	457.48	3521.05	1578.05	2.69	42.91
2003	58600.11	6650.42	383.85	4699.60	1553.53	0.67	13.45
2004	69887.98	7637.73	485.05	5411.96	1690.37	NO, NA	50.35
2005	79472.52	8778.33	946.93	6293.58	1499.06	NO, NA	38.76
2006	81834.79	8915.32	1095.94	6327.18	1460.01	1.01	32.18
2007	71177.34	7950.46	398.75	5912.36	1612.46	0.67	26.89
2008	62132.97	6863.58	376.54	4861.53	1523.10	NO, NA	102.41
2009	39276.97	4059.31	353.06	2705.35	986.59	NO, NA	14.30
2010	57756.38	5990.05	228.93	4646.46	1099.64	NO, NA	15.02
Decrease 1989 -	76.39	_	_	74.75	_	_	_
Decrease 1990 - 2010	69.58	_	_	59.49	_	_	_
Decrease 2009 -	-47.05	-47.56	35.16	-71.75	_	_	-5.00

3.2.8.1.2 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 – 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, and precursors gases -** EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.2.a – Manufacturing Industries and Construction - Iron and Steel.
The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.
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.

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

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

See the chapter 3.2.6.4 for more details.

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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

- Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting are used;
- For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
- For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

- Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

- For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.

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

3.2.8.1.6 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)

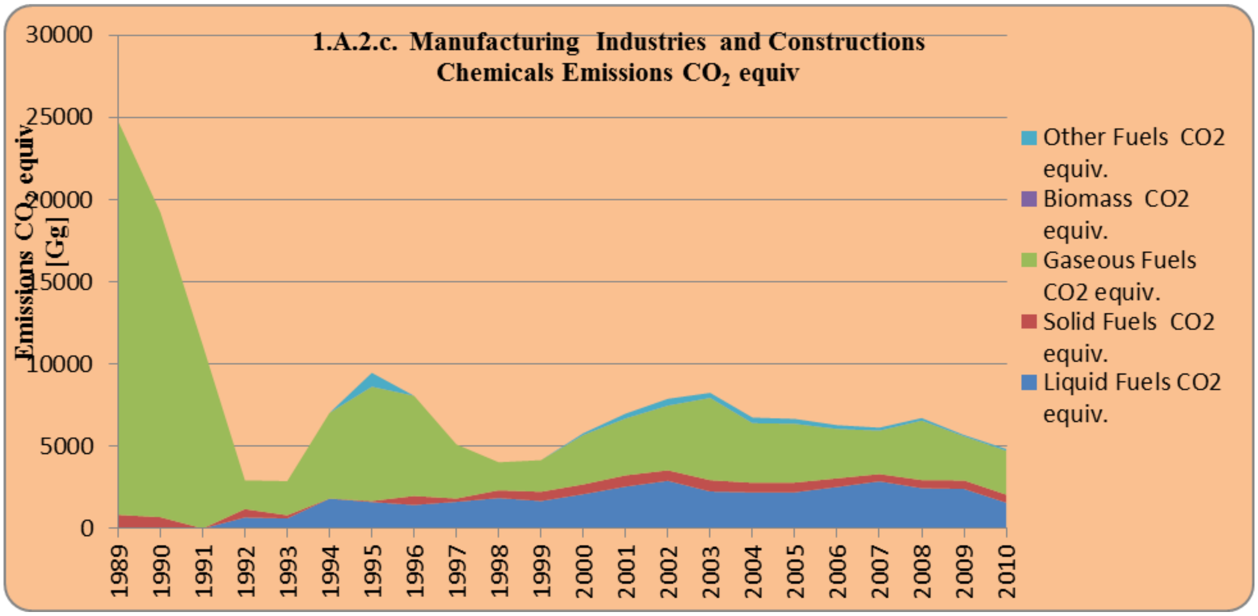
This activity category mostly is included in the 1.A.1.a Iron and steel reporting. The Energy Balance provided fuel consumption only on 1989, 1990, 2007 years. For the rest of the time-range the notation key is IE – included elsewhere.

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 gaseous fuels, level and trend, including and excluding LULUCF.
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 3.19 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 remains almost constant among the period, from the base year 29% to 26% - current year, 2010. The contribution of this category is about 106064.7985 Gg CO_2 equiv., in 2010.

Table 3.57 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	24723.22	NO, NA	831.86384	23891.354	NO, NA	NO, NA
1990	19182.02	NO, NA	682.88456	18499.1394	NO, NA	NO, NA
1991	11134.96	NO, NA	5.2912017	11129.665	1.12	NO, NA
1992	2920.29	673.14891	504.89938	1742.24473	52.64	NO, NA
1993	2875.22	616.06354	188.08696	2071.06681	40.544	NO, NA
1994	7014.16	1817.2608	4.5370949	5192.36479	27.776	NO, NA
1995	9434.07	1608.5855	62.083688	6933.71422	39.424	829.686
1996	8047.76	1431.9788	540.45187	6075.32494	62.384	NO, NA
1997	5102.07	1618.6641	198.86315	3284.54016	91.056	NO, NA
1998	4017.10	1850.2957	470.02115	1696.78362	37.632	NO, NA
1999	4148.22	1667.5297	558.29609	1922.39804	2.576	NO, NA
2000	5780.51	2082.6833	587.7863	2995.21055	3.92	114.829
2001	6960.49	2546.1016	674.10054	3451.86091	2.912	288.431
2002	7862.79	2892.7638	633.55782	3923.4826	2.464	412.984
2003	8220.77	2249.6612	678.95705	4989.13275	5.376	303.017
2004	6724.72	2191.9471	580.62982	3613.66068	3.584	338.481
2005	6644.71	2199.1304	587.94901	3561.33564	0.448	296.296
2006	6262.45	2518.2937	525.35365	2992.5744	NO, NA	226.226
2007	6113.59	2863.5851	435.55414	2637.27573	2.576	177.177
2008	6698.84	2448.8463	488.13804	3605.12337	1.344	156.728
2009	5673.71	2401.4405	512.88605	2676.7339	1.2292	82.654
2010	4820.74	1567.4666	485.20955	2657.95257	9.8658	110.11
Decrease 1989 - 2010	80.50	–	41.67	88.87	–	–
Decrease 1990 - 2010	74.87	–	28.95	85.63	–	–
Decrease 2009 - 2010	15.03	34.73	5.40	0.70	-702.62	-33.22

Table 3.58 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	2.24025063	NO, NA	0.07873	2.161521	NO, NA	NO, NA
1990	1.73865737	NO, NA	0.064986	1.673672	NO, NA	NO, NA
1991	1.0077782	NO, NA	0.000545	1.006934	0.0003	NO, NA
1992	0.262423983	0.043051	0.047647	0.157626	0.0141	NO, NA
1993	0.241926679	0.025943	0.017748	0.187376	0.01086	NO, NA
1994	0.564324029	0.086641	0.000475	0.469769	0.00744	NO, NA
1995	0.92005146	0.101573	0.006545	0.627314	0.01056	0.17406
1996	0.676264291	0.058318	0.051584	0.549653	0.01671	NO, NA
1997	0.4228108	0.082263	0.018996	0.297162	0.02439	NO, NA
1998	0.290009665	0.079541	0.046875	0.153513	0.01008	NO, NA
1999	0.281314435	0.050612	0.056087	0.173925	0.00069	NO, NA
2000	0.417878169	0.063855	0.057898	0.270986	0.00105	0.02409
2001	0.535938982	0.09566	0.066689	0.3123	0.00078	0.06051
2002	0.632869605	0.127954	0.062647	0.354969	0.00066	0.08664
2003	0.680221558	0.09695	0.06688	0.451382	0.00144	0.06357
2004	0.56047331	0.103682	0.057883	0.326939	0.00096	0.07101
2005	0.558530009	0.114583	0.059463	0.322205	0.00012	0.06216
2006	0.498213268	0.126903	0.053103	0.270747	NO, NA	0.04746
2007	0.492224125	0.168721	0.044691	0.240953	0.00069	0.03717
2008	0.536562322	0.128046	0.05134	0.323937	0.00036	0.03288
2009	0.443387222	0.126237	0.055519	0.241992	0.0023	0.01734
2010	0.432093944	0.080678	0.053383	0.239774	0.03516	0.0231
Decrease 1989 - 2010	80.71	_	32.19	88.91	_	_
Decrease 1990 - 2010	75.15	_	17.85	85.67	_	_
Decrease 2009 - 2010	2.55	36.09	3.85	0.92	-1428.7	-33.22

Table 3.59 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	0.05425257	NO, NA	0.0110221	0.0432304	NO, NA	NO, NA
1990	0.04257145	NO, NA	0.009098	0.0334734	NO, NA	NO, NA
1991	0.02025493	NO, NA	7.626E-05	0.0201387	0.00004	NO, NA
1992	0.01457698	0.0028738	0.0066706	0.0031525	0.00188	NO, NA
1993	0.01175658	0.0040763	0.0024848	0.0037475	0.001448	NO, NA
1994	0.02110011	0.0106943	1.849E-05	0.0093954	0.000992	NO, NA
1995	0.04417793	0.0068848	0.0001309	0.0125463	0.001408	0.023208
1996	0.02923456	0.0094758	0.0065377	0.0109931	0.002228	NO, NA
1997	0.02062913	0.0087745	0.0026594	0.0059432	0.003252	NO, NA
1998	0.02229405	0.011934	0.0059458	0.0030703	0.001344	NO, NA
1999	0.02384924	0.0130271	0.0072516	0.0034785	0.000092	NO, NA
2000	0.03300118	0.0161237	0.0081057	0.0054197	0.00014	0.003212
2001	0.04146517	0.0177131	0.0093341	0.006246	0.000104	0.008068
2002	0.04615024	0.0186403	0.0087706	0.0070994	0.000088	0.011552
2003	0.04185671	0.0147978	0.0093633	0.0090276	0.000192	0.008476
2004	0.03768634	0.013448	0.0081036	0.0065388	0.000128	0.009468
2005	0.03547801	0.0124052	0.0083248	0.0064441	0.000016	0.008288
2006	0.03379449	0.0146171	0.0074345	0.0054149	NO, NA	0.006328
2007	0.03055068	0.0144269	0.0062567	0.0048191	0.000092	0.004956
2008	0.0315085	0.0134102	0.0071876	0.0064787	0.000048	0.004384
2009	0.02816598	0.0130015	0.0077726	0.0048398	0.00024	0.002312
2010	0.02757232	0.0086352	0.0074736	0.0047955	0.003588	0.00308
Decrease 1989 - 2010	49.18	_	32.19	88.91	_	_
Decrease 1990 - 2010	35.23	_	17.85	85.67	_	_
Decrease 2009 - 2010	2.11	33.58	3.85	0.92	-1395	-33.22

Table 3.60 GHG emissions in 1.A.2.c. – Chemicals

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1.A.2.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	440177.163	24725.51	NO, NA	831.95	23893.56	NO, NA	NO, NA
1990	341232.887	19183.81	NO, NA	682.96	18500.85	NO, NA	NO, NA
1991	201451.17	11135.98	NO, NA	5.29	11130.69	1.12	NO, NA
1992	47526.672	2920.57	673.19	504.95	1742.41	52.66	NO, NA
1993	48612.055	2875.47	616.09	188.11	2071.26	40.56	NO, NA
1994	121218.856	7014.75	1817.36	4.54	5192.84	27.78	NO, NA
1995	158440.255	9435.03	1608.69	62.09	6934.35	39.44	829.88
1996	136782.421	8048.46	1432.05	540.51	6075.89	62.40	NO, NA
1997	86236.082	5102.51	1618.76	198.88	3284.84	91.08	NO, NA
1998	63230.411	4017.41	1850.39	470.07	1696.94	37.64	NO, NA
1999	63912.767	4148.53	1667.59	558.36	1922.58	2.58	NO, NA
2000	89502.939	5780.96	2082.76	587.85	2995.49	3.92	114.86
2001	107234.328	6961.07	2546.22	674.18	3452.18	2.91	288.50
2002	122989.091	7863.47	2892.91	633.63	3923.84	2.46	413.08
2003	132298.571	8221.49	2249.77	679.03	4989.59	5.38	303.09
2004	106498.2	6725.32	2192.06	580.70	3613.99	3.59	338.56
2005	106215.643	6645.31	2199.26	588.02	3561.66	0.45	296.37
2006	99364.154	6262.98	2518.44	525.41	2992.85	NO, NA	226.28
2007	99507.645	6114.11	2863.77	435.61	2637.52	2.58	177.22
2008	108262.737	6699.40	2448.99	488.20	3605.45	1.34	156.77
2009	91012.752	5674.19	2401.58	512.95	2676.98	1.23	82.67
2010	77826.744	4821.20	1567.56	485.27	2658.20	9.90	110.14
Decrease 1989 - 2010	82.32	80.50	_	41.67	88.87	_	_
Decrease 1990 - 2010	77.19	74.87	_	28.95	85.63	_	_
Decrease 2009 - 2010	14.49	15.03	34.73	5.40	0.70	-704.11	-33.22

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 - 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, and precursors gases -** EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.2.c – Manufacturing Industries and Construction - Chemicals.
The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.
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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

- Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting, are used;
- For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
- For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

- Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.

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

3.2.8.3.6 Source-specific planned improvements, if applicable

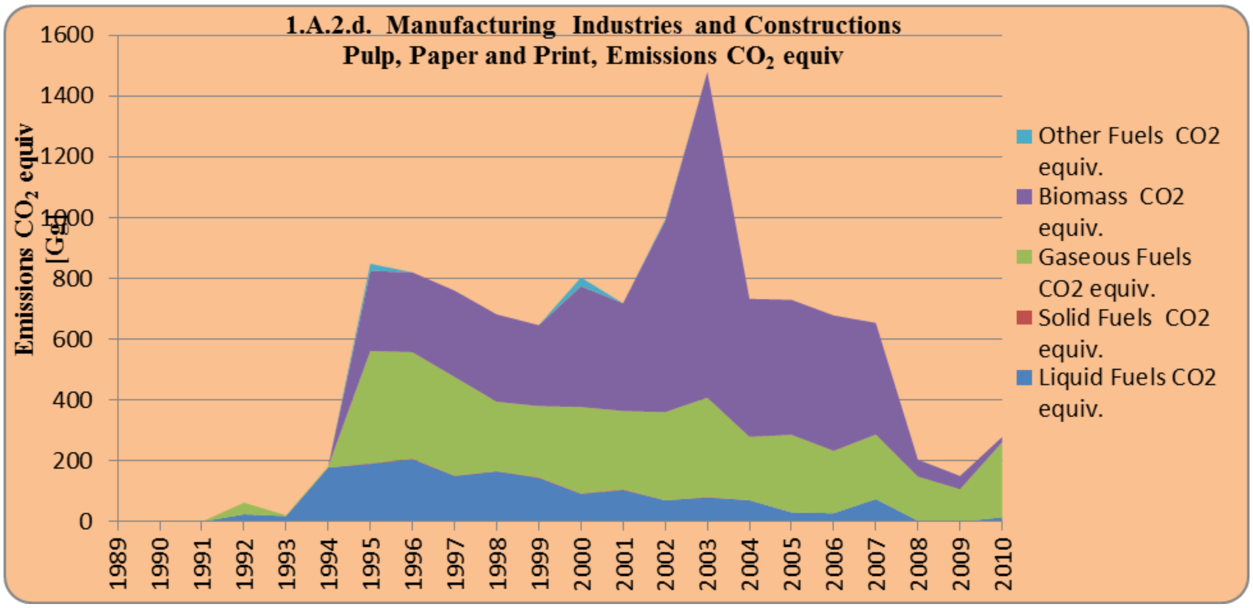
It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.

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

Figure 3.20 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 1.4% - in the current year, 2010. The contribution of this category is about 5753.277846 Gg CO_2 equiv., in 2010, an important contribution having the biomass fuel.

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 3.61 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	0.718331768	NO, NA	0.7183318	NO, NA	NO, NA	NO, NA
1990	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1991	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1992	62.41900263	24.667383	NO, NA	37.7516201	0.112	NO, NA
1993	21.26547344	18.48011	NO, NA	2.78536327	NO, NA	NO, NA
1994	182.1109998	178.13191	NO, NA	3.97909039	NO, NA	NO, NA
1995	584.8121943	190.35407	2.1320152	369.160111	263.312	23.166
1996	557.4046707	205.47305	2.1695792	349.762045	262.528	NO, NA
1997	476.0040573	150.26771	1.4902186	324.246128	283.808	NO, NA
1998	394.5240291	165.67617	0.7464978	228.101357	287.056	NO, NA
1999	380.2763363	144.058	2.247824	233.970515	265.888	NO, NA
2000	406.2749584	91.817321	1.4148448	284.156792	396.592	28.886
2001	363.9869224	104.43453	2.3539338	257.198455	354.144	NO, NA
2002	366.0627378	70.615219	NO, NA	289.727519	628.432	5.72
2003	408.0371284	79.913478	1.5398066	326.583844	1070.832	NO, NA
2004	278.935701	70.779535	NO, NA	208.156166	453.936	NO, NA
2005	285.8117016	30.702269	NO, NA	255.109433	443.52	NO, NA
2006	232.9414266	27.819317	NO, NA	205.12211	445.2	NO, NA
2007	286.8332964	74.403187	NO, NA	212.43011	367.024	NO, NA
2008	148.1502218	3.1159473	NO, NA	145.034275	56	NO, NA
2009	106.9180379	NO, NA	NO, NA	106.918038	43.344	NO, NA
2010	261.4962069	14.7216	NO, NA	246.774607	17.36	NO, NA
Decrease 1989 - 2010	-36303.26	–	–	–	–	–
Decrease 1990 - 2010	–	–	–	–	–	–
Decrease 2009 - 2010	-144.58	–	–	-130.81	59.95	–

Table 3.62 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	0.00007243	NO, NA	7.24E-05	NO, NA	NO, NA	NO, NA
1990	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1991	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1992	0.00409471	0.000649	NO, NA	0.003416	0.00003	NO, NA
1993	0.00073037	0.000478	NO, NA	0.000252	NO, NA	NO, NA
1994	0.00493077	0.004571	NO, NA	0.00036	NO, NA	NO, NA
1995	0.11389486	0.004879	0.000226	0.033399	0.07053	0.00486
1996	0.10746899	0.005275	0.00023	0.031644	0.07032	NO, NA
1997	0.10936987	0.003864	0.00015	0.029336	0.07602	NO, NA
1998	0.10185289	0.004251	7.53E-05	0.020637	0.07689	NO, NA
1999	0.096330524	0.003716	0.000227	0.021168	0.07122	NO, NA
2000	0.14051079	0.00237	0.000143	0.025709	0.10623	0.00606
2001	0.121062374	0.002684	0.000249	0.02327	0.09486	NO, NA
2002	0.1975526	0.00181	NO, NA	0.026213	0.16833	0.0012
2003	0.318763298	0.002231	0.000155	0.029547	0.28683	NO, NA
2004	0.142253284	0.001831	NO, NA	0.018833	0.12159	NO, NA
2005	0.1426675	0.000787	NO, NA	0.023081	0.1188	NO, NA
2006	0.138549676	0.000742	NO, NA	0.018558	0.11925	NO, NA
2007	0.119692684	0.001974	NO, NA	0.019409	0.09831	NO, NA
2008	0.02811687	8.49E-05	NO, NA	0.013032	0.015	NO, NA
2009	0.021276	NO, NA	NO, NA	0.009666	0.01161	NO, NA
2010	0.02747026	0.000559	NO, NA	0.022262	0.00465	NO, NA
Decrease 1989 - 2010	-37826.63	_	_	_	_	_
Decrease 1990 - 2010	_	_	_	_	_	_
Decrease 2009 - 2010	-29.11	_	_	-130.31	59.95	_

Table 3.63 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	1.014E-05	NO, NA	1.014E-05	NO, NA	NO, NA	NO, NA
1990	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1991	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1992	0.00026707	0.0001948	NO, NA	6.831E-05	0.000004	NO, NA
1993	0.00014855	0.0001435	NO, NA	5.04E-06	NO, NA	NO, NA
1994	0.00137843	0.0013712	NO, NA	0.0000072	NO, NA	NO, NA
1995	0.0122155	0.0014638	3.17E-05	0.000668	0.009404	0.000648
1996	0.01162351	0.0015824	3.226E-05	0.0006329	0.009376	NO, NA
1997	0.01190298	0.0011592	2.104E-05	0.0005867	0.010136	NO, NA
1998	0.01195046	0.0012752	1.054E-05	0.0004127	0.010252	NO, NA
1999	0.01106585	0.0011148	3.173E-05	0.0004234	0.009496	NO, NA
2000	0.01621703	0.0007109	1.997E-05	0.0005142	0.014164	0.000808
2001	0.01395346	0.0008052	3.482E-05	0.0004654	0.012648	NO, NA
2002	0.02367128	0.000543	NO, NA	0.0005243	0.022444	0.00016
2003	0.0394586	0.0006019	2.174E-05	0.0005909	0.038244	NO, NA
2004	0.01713789	0.0005492	NO, NA	0.0003767	0.016212	NO, NA
2005	0.01653771	0.0002361	NO, NA	0.0004616	0.01584	NO, NA
2006	0.01649366	0.0002225	NO, NA	0.0003712	0.0159	NO, NA
2007	0.01408843	0.0005923	NO, NA	0.0003882	0.013108	NO, NA
2008	0.0022861	2.546E-05	NO, NA	0.0002606	0.002	NO, NA
2009	0.00174132	NO, NA	NO, NA	0.0001933	0.001548	NO, NA
2010	0.00116547	0.0001002	NO, NA	0.0004452	0.00062	NO, NA
Decrease 1989 - 2010	-11393.54	–	–	–	–	–
Decrease 1990 - 2010	–	–	–	–	–	–
Decrease 2009 - 2010	33.07	–	–	-130.31	59.95	–

Table 3.64 GHG emissions in 1.A.2.d. - Pulp, Paper and Print

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1.A.2.d Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	7.243	0.72	NO, NA	0.72	NO, NA	NO, NA	NO, NA
1990	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1991	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1992	1008.705	62.42	24.67	NO, NA	37.76	0.11	NO, NA
1993	289.585	21.27	18.48	NO, NA	2.79	NO, NA	NO, NA
1994	2357.385	182.12	178.14	NO, NA	3.98	NO, NA	NO, NA
1995	11655.146	584.94	190.36	2.13	369.19	263.39	23.17
1996	11333.115	557.52	205.48	2.17	349.79	262.61	NO, NA
1997	10348.181	476.13	150.27	1.49	324.28	283.89	NO, NA
1998	8823.237	394.64	165.68	0.75	228.12	287.14	NO, NA
1999	8488.202	380.38	144.06	2.25	233.99	265.97	NO, NA
2000	10083.781	406.43	91.82	1.42	284.18	396.71	28.89
2001	9182.845	364.12	104.44	2.35	257.22	354.25	NO, NA
2002	11798.55	366.28	70.62	NO, NA	289.75	628.62	5.72
2003	16529.241	408.40	79.92	1.54	326.61	1071.16	NO, NA
2004	8734.892	279.10	70.78	NO, NA	208.18	454.07	NO, NA
2005	8969.6	285.97	30.70	NO, NA	255.13	443.65	NO, NA
2006	8057.438	233.10	27.82	NO, NA	205.14	445.34	NO, NA
2007	8145.792	286.97	74.41	NO, NA	212.45	367.14	NO, NA
2008	3148.835	148.18	3.12	NO, NA	145.05	56.02	NO, NA
2009	2320.2	106.94	NO, NA	NO, NA	106.93	43.36	NO, NA
2010	4814.476	261.52	14.72	NO, NA	246.80	17.37	NO, NA
Decrease 1989 - 2010	-66370.74	-36303.07	_	_	_	_	_
Decrease 1990 - 2010	_	_	_	_	_	_	_
Decrease 2009 - 2010	-107.50	-144.55	_	_	-130.81	59.95	_

3.2.8.4.2 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 – 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, and precursors gases** - EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.2.d – Manufacturing Industries and Construction - Pulp, Paper and Print.
The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category. 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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

- Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting, are used;
- For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
- For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

- Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

- For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.

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

3.2.8.4.6 Source-specific planned improvements, if applicable

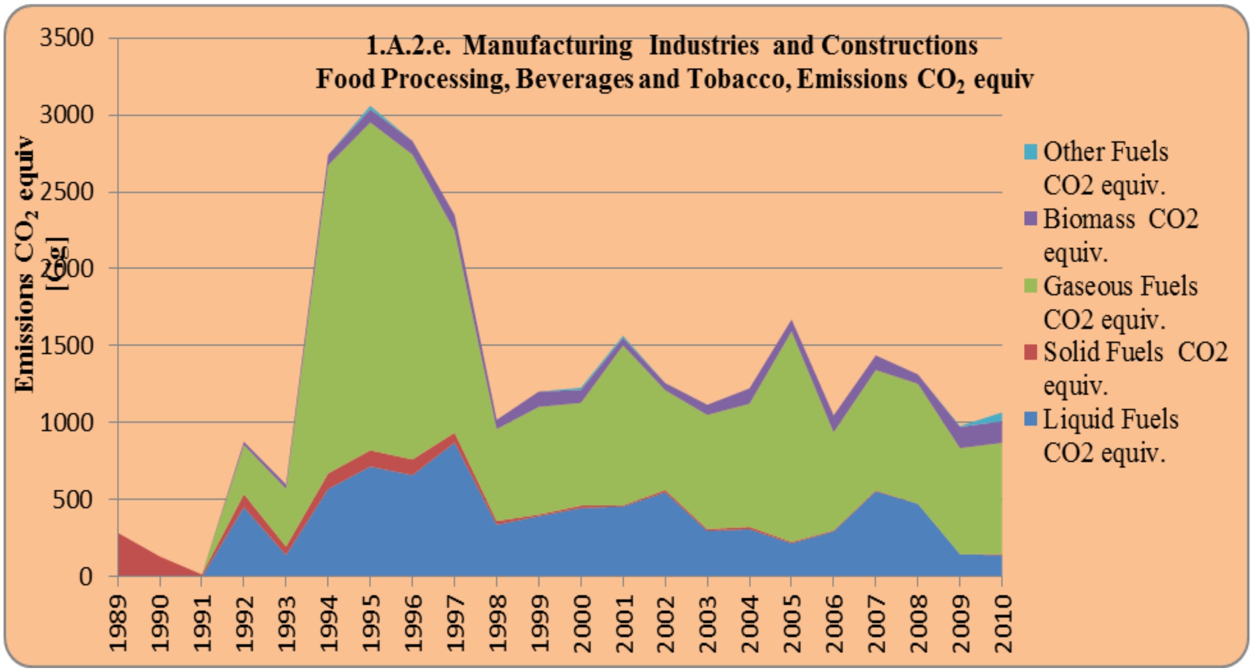
It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.
See the chapter 3.2.6.6 for more details.

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 and trend, including and excluding LULUCF.
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 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 0.3% - base year to the 5%, current year, 2010. The contribution of this category is about 20438.89516 Gg CO_2 equiv., in 2010. It is observed a rising of the natural gas usage as fuel in this activity category, mostly on the period 1993 - 1996. Also, starting to 1994 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 3.65 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	286.7736	NO, NA	286.7736	NO, NA	NO, NA	NO, NA
1990	132.5970	NO, NA	132.5970	NO, NA	NO, NA	NO, NA
1991	15.7144	NO, NA	15.7144	NO, NA	NO, NA	NO, NA
1992	856.5897	452.1245	84.8945	319.5707	20.8320	NO, NA
1993	573.0813	141.9479	54.6618	376.4717	27.7760	NO, NA
1994	2674.0178	571.0494	100.9388	2002.0296	66.7520	NO, NA
1995	2974.1840	716.5584	105.2421	2129.3605	85.0080	23.0230
1996	2742.8420	661.0100	101.4387	1980.3933	88.5920	NO, NA
1997	2247.7559	872.4177	63.8299	1311.5082	102.3680	NO, NA
1998	960.0850	338.4311	23.8453	597.8086	59.4720	NO, NA
1999	1103.9193	394.5579	9.8870	699.4744	99.3440	NO, NA
2000	1145.0516	447.3604	15.4326	667.2437	83.5520	15.0150
2001	1516.4545	457.2641	7.0131	1038.5923	49.8400	13.5850
2002	1212.8907	549.7950	14.7215	647.9451	46.1440	0.4290
2003	1051.8557	298.9223	11.1812	741.7522	65.8560	NO, NA
2004	1124.6430	309.3320	15.7625	799.5485	99.4560	NO, NA
2005	1594.4911	218.4421	8.3859	1367.6631	77.0560	NO, NA
2006	939.2437	296.0038	5.5906	637.6492	109.5360	NO, NA
2007	1343.1387	555.8959	5.5906	781.6522	95.1258	NO, NA
2008	1253.9018	474.9436	NO, NA	778.9583	60.9280	NO, NA
2009	841.7895	147.5297	NO, NA	688.3969	137.7600	5.8630
2010	928.8810	141.3203	5.5906	723.9121	139.5184	58.0580
Decrease 1989 - 2010	-223.91	_	98.05	_	_	_
Decrease 1990 - 2010	-600.53	_	95.78	_	_	_
Decrease 2009 - 2010	-10.35	4.21	_	-5.16	-1.28	-890.24

Table 3.66 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	0.027683	NO, NA	0.027683	NO, NA	NO, NA	NO, NA
1990	0.012709	NO, NA	0.012709	NO, NA	NO, NA	NO, NA
1991	0.001596	NO, NA	0.001596	NO, NA	NO, NA	NO, NA
1992	0.054838	0.012194	0.008152	0.028913	0.005580	NO, NA
1993	0.050546	0.003722	0.005323	0.034061	0.007440	NO, NA
1994	0.223985	0.015054	0.009921	0.181130	0.017880	NO, NA
1995	0.249208	0.018844	0.010115	0.192650	0.022770	0.004830
1996	0.230083	0.017329	0.009852	0.179172	0.023730	NO, NA
1997	0.175470	0.023221	0.006173	0.118656	0.027420	NO, NA
1998	0.081447	0.009172	0.002259	0.054086	0.015930	NO, NA
1999	0.101243	0.010407	0.000942	0.063284	0.026610	NO, NA
2000	0.099590	0.012209	0.001483	0.060368	0.022380	0.003150
2001	0.124369	0.013515	0.000689	0.093965	0.013350	0.002850
2002	0.088626	0.016161	0.001394	0.058622	0.012360	0.000090
2003	0.095857	0.010054	0.001055	0.067109	0.017640	NO, NA
2004	0.109577	0.009042	0.001557	0.072338	0.026640	NO, NA
2005	0.152248	0.007080	0.000791	0.123737	0.020640	NO, NA
2006	0.098316	0.010759	0.000527	0.057690	0.029340	NO, NA
2007	0.126146	0.015913	0.000527	0.071415	0.038290	NO, NA
2008	0.099596	0.013283	NO, NA	0.069993	0.016320	NO, NA
2009	0.104768	0.004403	NO, NA	0.062235	0.036900	0.001230
2010	0.143910	0.004879	0.000527	0.065304	0.061020	0.012180
Decrease 1989 - 2010	-419.85	_	98.09	_	_	_
Decrease 1990 - 2010	-1032.35	_	95.85	_	_	_
Decrease 2009 - 2010	-37.36	-10.82	_	-4.93	-65.37	-890.24

Table 3.67 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	0.003876	NO, NA	0.003876	NO, NA	NO, NA	NO, NA
1990	0.001779	NO, NA	0.001779	NO, NA	NO, NA	NO, NA
1991	0.000223	NO, NA	0.000223	NO, NA	NO, NA	NO, NA
1992	0.006122	0.003658	0.001141	0.000578	0.000744	NO, NA
1993	0.003535	0.001117	0.000745	0.000681	0.000992	NO, NA
1994	0.011904	0.004516	0.001381	0.003623	0.002384	NO, NA
1995	0.014602	0.005653	0.001416	0.003853	0.003036	0.000644
1996	0.013326	0.005199	0.001379	0.003583	0.003164	NO, NA
1997	0.013792	0.006899	0.000864	0.002373	0.003656	NO, NA
1998	0.006206	0.002684	0.000316	0.001082	0.002124	NO, NA
1999	0.008068	0.003122	0.000132	0.001266	0.003548	NO, NA
2000	0.008347	0.003528	0.000208	0.001207	0.002984	0.000420
2001	0.007651	0.003515	0.000096	0.001879	0.001780	0.000380
2002	0.007269	0.004242	0.000195	0.001172	0.001648	0.000012
2003	0.005982	0.002140	0.000148	0.001342	0.002352	NO, NA
2004	0.007592	0.002376	0.000218	0.001447	0.003552	NO, NA
2005	0.006922	0.001585	0.000111	0.002475	0.002752	NO, NA
2006	0.007154	0.002014	0.000074	0.001154	0.003912	NO, NA
2007	0.010544	0.004370	0.000074	0.001428	0.004672	NO, NA
2008	0.007359	0.003783	NO, NA	0.001400	0.002176	NO, NA
2009	0.007447	0.001119	NO, NA	0.001245	0.004920	0.000164
2010	0.011332	0.000992	0.000074	0.001306	0.007336	0.001624
Decrease 1989 - 2010	-192.39	_	98.09	_	_	_
Decrease 1990 - 2010	-536.89	_	95.85	_	_	_
Decrease 2009 - 2010	-52.16	11.32	_	-4.93	-49.11	-890.24

Table 3.68 GHG emissions in 1.A.2.e. - Food Processing, Beverages and Tobacco

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1.A.2.e Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	2768.31	286.81	NO, NA	286.81	NO, NA	NO, NA	NO, NA
1990	1270.90	132.61	NO, NA	132.61	NO, NA	NO, NA	NO, NA
1991	159.57	15.72	NO, NA	15.72	NO, NA	NO, NA	NO, NA
1992	12880.50	856.65	452.14	84.90	319.60	20.84	NO, NA
1993	9453.54	573.14	141.95	54.67	376.51	27.78	NO, NA
1994	45347.51	2674.25	571.07	100.95	2002.21	66.77	NO, NA
1995	49883.49	2974.45	716.58	105.25	2129.56	85.03	23.03
1996	46275.25	2743.09	661.03	101.45	1980.58	88.62	NO, NA
1997	36800.68	2247.95	872.45	63.84	1311.63	102.40	NO, NA
1998	16087.75	960.17	338.44	23.85	597.86	59.49	NO, NA
1999	18841.69	1104.03	394.57	9.89	699.54	99.37	NO, NA
2000	19033.01	1145.16	447.38	15.43	667.31	83.58	15.02
2001	25581.71	1516.59	457.28	7.01	1038.69	49.86	13.59
2002	19709.14	1212.99	549.82	14.72	648.00	46.16	0.43
2003	18203.36	1051.96	298.93	11.18	741.82	65.88	NO, NA
2004	19671.25	1124.76	309.34	15.76	799.62	99.49	NO, NA
2005	28476.95	1594.65	218.45	8.39	1367.79	77.08	NO, NA
2006	16648.28	939.35	296.02	5.59	637.71	109.57	NO, NA
2007	22715.11	1343.28	555.92	5.59	781.73	95.17	NO, NA
2008	20967.48	1254.01	474.96	NO, NA	779.03	60.95	NO, NA
2009	15702.61	841.90	147.54	NO, NA	688.46	137.80	5.86
2010	16711.62	929.04	141.33	5.59	723.98	139.59	58.07
Decrease 1989 - 2010	-503.68	-223.93	_	98.05	_	_	_
Decrease 1990 - 2010	-1214.94	-600.57	_	95.78	_	_	_
Decrease 2009 - 2010	-6.43	-10.35	4.21	_	-5.16	-1.30	-890.24

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 – 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, and precursors gases -** EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.2.e – Manufacturing Industries and Construction - Food Processing, Beverages and Tobacco.

The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.

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.

3.2.8.5.4 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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

- ❖ Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting, are used;
- ❖ For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
- ❖ For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

- ❖ Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

- For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.

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

3.2.8.5.6 Source-specific planned improvements, if applicable

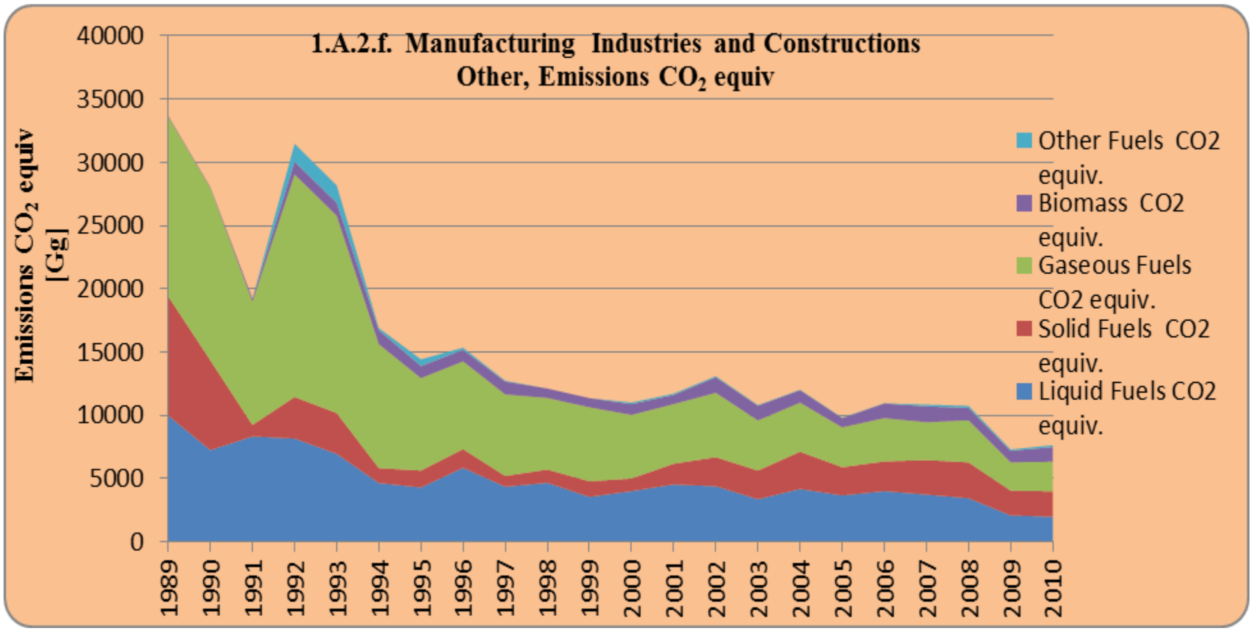
It is planned to take into consideration the emissions from the operators reporting on EU-ETS (having their reports verified by accredited verifiers) in order to achieve a hire tier approach in the estimation of the CO_2 emissions.
See the chapter 3.2.6.6 for more details.

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 – trend excluding LULUCF, level and trend including LULUCF and key category by gaseous fuels – level and trend including and excluding LULUCF.
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.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 - 1995. In the last three 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 40% - base year to the 35%, current year, 2010. The contribution of this category is about 142630.5751 Gg CO_2 equiv., in 2010.

Table 3.69 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	33621.30	9990.04	9420.64	14210.62	65.63	NO, NA
1990	27982.92	7250.62	7097.15	13635.15	61.26	NO, NA
1991	18990.96	8332.34	899.66	9758.97	230.83	NO, NA
1992	30480.31	8167.69	3284.70	17596.63	996.46	1431.29
1993	27155.52	6955.60	3220.85	15601.12	1018.98	1377.95
1994	15804.56	4653.90	1174.04	9804.88	1100.06	171.74
1995	13469.52	4298.56	1330.83	7313.17	953.57	526.96
1996	14433.52	5855.79	1471.58	6942.42	914.14	163.74
1997	11714.77	4361.54	844.48	6448.27	1018.53	60.49
1998	11377.82	4664.41	1051.81	5661.60	744.58	NO, NA
1999	10639.13	3551.33	1232.87	5854.93	724.19	NO, NA
2000	10155.93	4010.22	997.33	5029.12	854.34	119.26
2001	10998.48	4541.25	1630.26	4720.15	722.06	106.82
2002	11858.74	4399.67	2290.37	5092.19	1236.33	76.51
2003	9641.82	3370.96	2260.35	3967.75	1164.46	42.76
2004	11039.83	4180.18	2943.47	3885.43	981.90	30.75
2005	9089.47	3669.13	2231.73	3152.29	727.89	36.32
2006	9801.19	4009.71	2344.97	3425.35	1159.20	21.16
2007	9590.63	3740.25	2727.30	2985.30	1256.11	137.77
2008	9775.91	3453.42	2830.59	3325.92	976.16	165.97
2009	6394.79	2087.17	1959.96	2239.11	906.72	108.56
2010	6481.91	1987.82	2003.49	2342.74	1157.61	147.86
Decrease 1989 - 2010	80.72	80.10	78.73	83.51	-1663.79	_
Decrease 1990 - 2010	76.84	72.58	71.77	82.82	-1789.55	_
Decrease 2009 - 2010	-1.36	4.76	-2.22	-4.63	-27.67	-36.21

Table 3.70 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	2.51071	2.51071	0.94627	1.28568	0.01758	NO, NA
1990	2.14776	2.14776	0.71110	1.23361	0.01641	NO, NA
1991	1.24617	1.24617	0.08661	0.88292	0.06183	NO, NA
1992	2.51333	2.51333	0.13689	1.59202	0.26691	0.30027
1993	2.29647	2.29647	0.12926	1.41148	0.27294	0.28908
1994	1.40913	1.40913	0.06999	0.88708	0.29466	0.03603
1995	1.19875	1.19875	0.05782	0.66164	0.25542	0.11055
1996	1.12249	1.12249	0.06080	0.62810	0.24486	0.03435
1997	1.01835	1.01835	0.03648	0.58339	0.27282	0.01269
1998	0.90400	0.90400	0.07204	0.51222	0.19944	NO, NA
1999	0.91114	0.91114	0.09612	0.52971	0.19398	NO, NA
2000	0.89405	0.89405	0.08362	0.45500	0.22884	0.02502
2001	0.87485	0.87485	0.11862	0.42705	0.19341	0.02241
2002	1.11293	1.11293	0.16537	0.46071	0.36072	0.01605
2003	0.93656	0.93656	0.17294	0.35897	0.31191	0.00897
2004	0.96591	0.96591	0.24385	0.35153	0.26301	0.00645
2005	0.78118	0.78118	0.20092	0.28520	0.19497	0.00762
2006	0.95971	0.95971	0.20818	0.30990	0.31050	0.00444
2007	1.00218	1.00218	0.25901	0.27275	0.35715	0.01296
2008	0.98031	0.98031	0.28946	0.29885	0.28512	0.01473
2009	0.73953	0.73953	0.20235	0.20243	0.26849	0.00045
2010	0.84675	0.84675	0.20688	0.21134	0.36427	0.00045
Decrease 1989 - 2010	66.27	66.27	78.14	83.56	-1972.07	_
Decrease 1990 - 2010	60.58	60.58	70.91	82.87	-2119.80	_
Decrease 2009 - 2010	-14.50	-14.50	-2.24	-4.40	-35.67	0.00

Table 3.71 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	0.23870	0.07816	0.13248	0.02571	0.00234	NO, NA
1990	0.18220	0.05579	0.09955	0.02467	0.00219	NO, NA
1991	0.10240	0.06438	0.01213	0.01766	0.00824	NO, NA
1992	0.18107	0.06214	0.01147	0.03184	0.03559	0.04004
1993	0.16694	0.05286	0.01092	0.02823	0.03639	0.03854
1994	0.10519	0.03553	0.00782	0.01774	0.03929	0.00480
1995	0.09895	0.03211	0.00481	0.01323	0.03406	0.01474
1996	0.09981	0.04483	0.00519	0.01256	0.03265	0.00458
1997	0.08574	0.03295	0.00306	0.01167	0.03638	0.00169
1998	0.08133	0.03568	0.00881	0.01024	0.02659	NO, NA
1999	0.07558	0.02659	0.01253	0.01059	0.02586	NO, NA
2000	0.08358	0.02946	0.01117	0.00910	0.03051	0.00334
2001	0.08545	0.03300	0.01513	0.00854	0.02579	0.00299
2002	0.11086	0.03134	0.02107	0.00921	0.04710	0.00214
2003	0.09644	0.02405	0.02243	0.00718	0.04159	0.00120
2004	0.10450	0.02911	0.03243	0.00703	0.03507	0.00086
2005	0.08563	0.02559	0.02733	0.00570	0.02600	0.00102
2006	0.10279	0.02642	0.02819	0.00620	0.04140	0.00059
2007	0.11614	0.02645	0.03558	0.00545	0.04692	0.00173
2008	0.10882	0.02347	0.04019	0.00598	0.03722	0.00196
2009	0.08086	0.01381	0.02801	0.00405	0.03493	0.00006
2010	0.09233	0.01281	0.02850	0.00423	0.04674	0.00006
Decrease 1989 - 2010	61.32	83.61	78.48	83.56	-1893.86	_
Decrease 1990 - 2010	49.32	77.04	71.37	82.87	-2036.01	_
Decrease 2009 - 2010	-14.19	7.28	-1.77	-4.40	-33.79	0.00

Table 3.72 GHG emissions in 1.A.2.f. – Other

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1.A.2.f Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	482733.9	33624.1	9990.4	9421.7	14211.9	65.7	NO, NA
1990	411481.8	27985.2	7250.9	7098.0	13636.4	61.3	NO, NA
1991	294639.0	18992.3	8332.6	899.8	9759.9	230.9	NO, NA
1992	462784.5	30483.0	8168.0	3284.9	17598.3	996.8	1431.6
1993	411155.3	27158.0	6955.8	3221.0	15602.6	1019.3	1378.3
1994	256830.8	15806.1	4654.1	1174.1	9805.8	1100.4	171.8
1995	207679.9	13470.8	4298.7	1330.9	7313.8	953.9	527.1
1996	219376.2	14434.7	5856.0	1471.6	6943.1	914.4	163.8
1997	187027.2	11715.9	4361.7	844.5	6448.9	1018.8	60.5
1998	177079.1	11378.8	4664.6	1051.9	5662.1	744.8	NO, NA
1999	167587.7	10640.1	3551.4	1233.0	5855.5	724.4	NO, NA
2000	157976.0	10156.9	4010.4	997.4	5029.6	854.6	119.3
2001	161289.2	10999.4	4541.4	1630.4	4720.6	722.3	106.8
2002	175238.3	11860.0	4399.8	2290.6	5092.7	1236.7	76.5
2003	142000.5	9642.8	3371.1	2260.5	3968.1	1164.8	42.8
2004	154331.9	11040.9	4180.3	2943.7	3885.8	982.2	30.8
2005	128476.0	9090.3	3669.2	2232.0	3152.6	728.1	36.3
2006	145017.0	9802.3	4009.9	2345.2	3425.7	1159.6	21.2
2007	139824.6	9591.7	3740.4	2727.6	2985.6	1256.5	137.8
2008	140919.1	9777.0	3453.5	2830.9	3326.2	976.5	166.0
2009	96916.8	6395.6	2087.2	1960.2	2239.3	907.0	108.6
2010	100565.4	6482.8	1987.9	2003.7	2343.0	1158.0	147.9
Decrease 1989 - 2010	79.17	80.72	80.10	78.73	83.51	-1663.88	–
Decrease 1990 - 2010	75.56	76.83	72.58	71.77	82.82	-1789.64	–
Decrease 2009 - 2010	-3.76	-1.36	4.76	-2.22	-4.63	-27.67	-36.21

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 - 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, and precursors gases -** EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.2.f – Manufacturing Industries and Construction - Other.
The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.
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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.
To the category "Other non-specified, Other Fuels" – it is taken into consideration the industrial waste, reported by the operators on the EU-ETS scheme and reporting to the statistics under biomass section.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

- Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting, are used;
- For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
- For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

- Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

- For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.

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

3.2.8.6.6 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 Fuel combustion, Transport (CRF sector 1.A.3.)

3.2.9.1 Source category description

In 2010 the emissions from transport categories accounted for 15,132.55 Gg CO_2 equivalents. The GHG covered are: CO_2, CH_4, N_2O, NO_x, NMVOC, CO and SO_2.
Within the fuel combustion sector, 17.86% of the GHG emissions expressed in CO_2 equivalent are represented by the sub-sector 1.A.3 Transport. This sector includes emissions from road transportation, civil aviation, railways, navigation and pipeline transportation.
For Road Transport we used the Tier 2 approach using COPERT III model. Activity data used are taken from the Romanian Automobile Registry (RAR) and Eurostat-questionnaires.
For Civil Aviation, Railways and Domestic Navigation were used the nationals emission factors and activity data in the Eurostat questionnaires - the Tier 2 approach.

Figure 3.23 The total consumption fuel from the transport sector

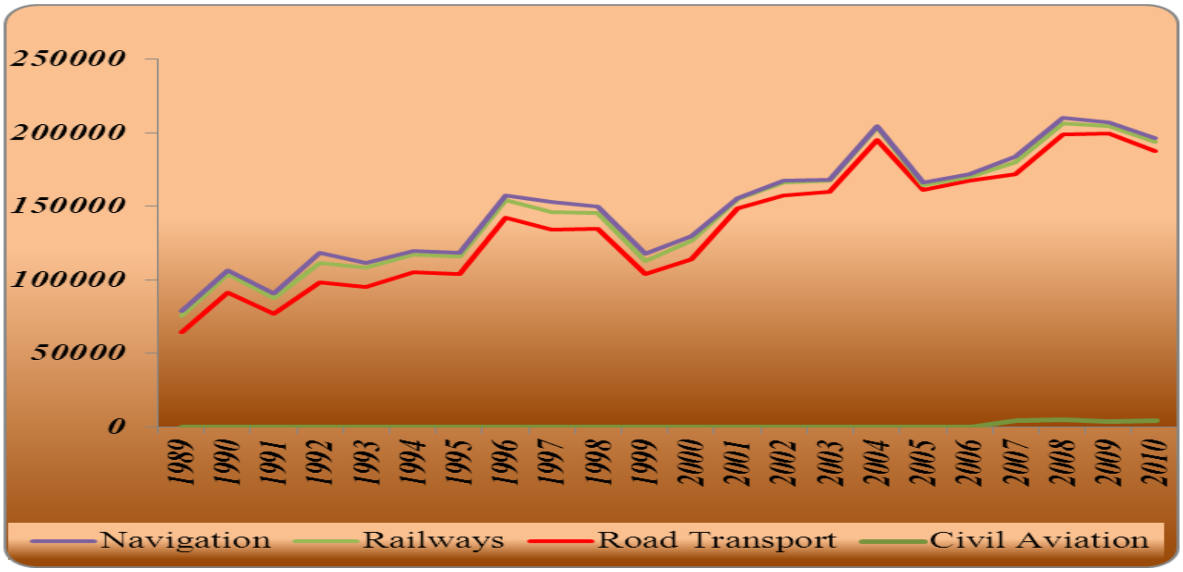
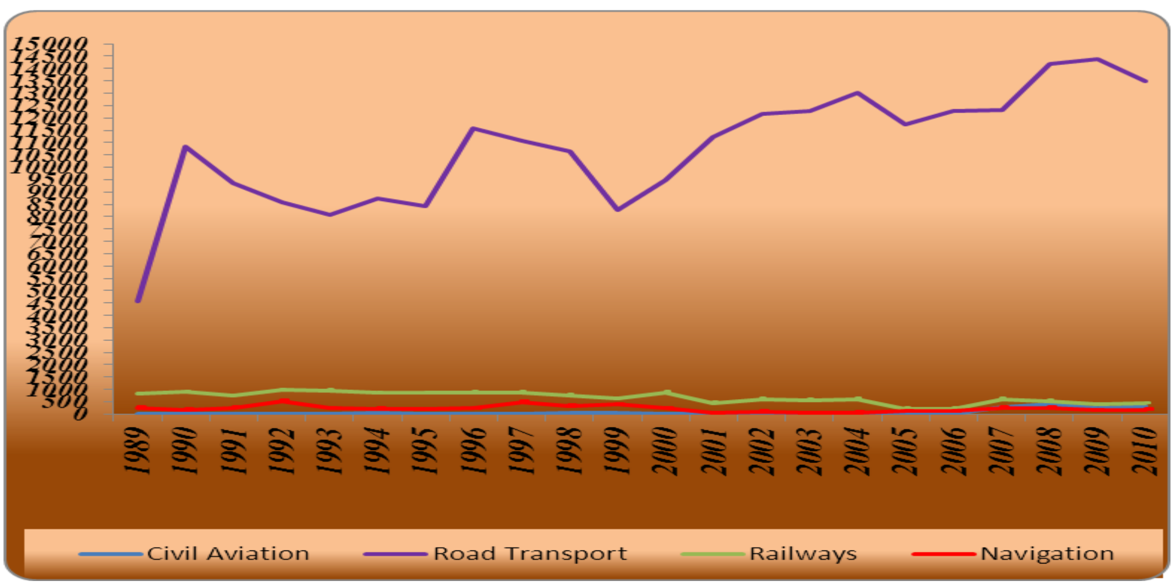


Figure 3.24 Transport categories in 2010



The overall decreases emission trend of the transport sub-sector is given by the emissions trend of the road transport.

In 2010, emissions of CO_2, CH_4 and N_2O are in decreases compared with those in 2009 for Road Transport sub-sector (1.AA.3.B).

For Civil Aviation sub-sector (1AA.3.A), an increase in CO_2 emissions could be remarked compared with 2009 due to increasing domestic and international flights.

3.2.9.2 Methodological issues

Methodology

The emission data have been estimated using the amounts of fuel used in the transport sector.
Road transportation represents a key category both level and trend view for CO_2 emissions (including and excluding LULUCF).
Tier 2 method was applied for all the transport activities, were used the values of emissions factors country specified for CO_2 emissions and tier 1 method was applied for all the transport activity for N_2O and CO (IPCC 1996 and IPCC 2006) (please see Annex 8.2).

3.2.9.3 Domestic civil aviation transport

Starting with 2009 submission, a new approach was used, in order to estimate emissions from domestic aviation, separately from the international aviation (bunker fuels issue):

- ❖ Data provided by the Romanian Civil Aeronautical Authority through the Romanian Ministry of Transport, regarding fuel consumption activity for domestic and international operators;
- ❖ For national operators, distances travelled in Romania in comparison to distances travelled abroad served as the basis for disaggregation of fuels consumption into domestic and international for Romanian operators, therefore to determine domestic emissions, respectively emissions from international flights for the national operators;
- ❖ Emissions related to fuel consumption from international operators are considered to be fully international;
- ❖ The information regarding gasoline consumption covers the period 1999 to 2009 and for jet kerosene 1994 to 2009. After the calculation of the fuels used respectively in domestic and international civil aviation for these time series, the values were extrapolated to the base

year 1989. The information concerning the distances travelled by the Romanian operators inside Romania and abroad covers the period 1990 to 2009.

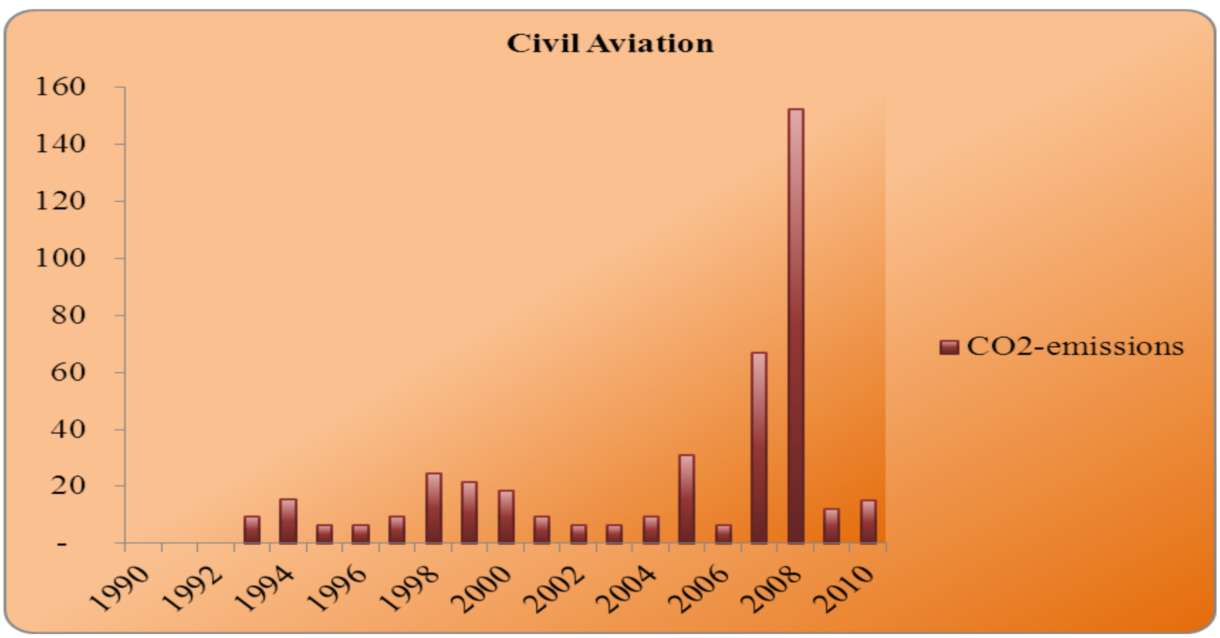
Starting witch 2010 submissions, consumptions fuels were calculated for the cycles of the fly LTO (landing/take off) /Cruise.

Fuel consumption was calculated for each cycle type of aircraft flight (kg fuel / LTO) using the 2006 IPCC methodology, Volume 2, Chapter 3, Table 3.6.9. The same methodology was used for emission factor value.

The LTO flight cycles / Cruise were taken from Eurostat website (aircraft traffic reporting date by country) for both domestic transport and for the international.

The exception is the use of aviation gasoline for which Eurostat have not reported values and values used in reporting the Romanian Civil Aviation Authority.

Figure 3.25 Transport categories in 2010 – subsector Civil Aviation



3.2.9.4 Domestic Navigation Transport

For navigation the following approach was used, in order to separate the fuels consumption into domestic and international:

- Since Romania has only 2 ports at the Black Sea it was considered that there is no maritime domestic traffic;
- The inland waterways of transports are the Danube and some channels related to the Danube;
- Based on the comparison of the Statistical Yearbook data concerning distance covered by goods and distance covered by passengers (without the domestic/international split and using a conversion factor of about 70 kg/passenger proposed by NIS), which proved that the share of the distance travelled by passengers is very small (of about 0.0003%) comparing to the distance travelled by goods, it was decided to use only the data concerning the loaded goods, available in the Statistical Yearbook, in order to disaggregate the fuels consumption from international and domestic navigation.

The statistical indicator representing loaded goods (in thousands tones) was used, for export and for domestic navigation, for the time series 1993-2009, in order to obtain the percentage applied for disaggregating into domestic and international the overall navigation fuels consumption (on a fuel basis) provided by the NIS . For the remaining time series, the fuels consumptions series were extrapolated.

Emission factors used: default IPCC 1996 values for the emission factors (Workbook: Table. I-2 and I-4; Reference Manual: Tables I-7, I-8, I-9, I-10, I-11 and I-12) and country specific emission factors, the values being provided in the context of 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”, by ISPE.

Table 3.73 Activity data comparison between Energy Balance and EUROSTAT for Domestic Navigation Transport

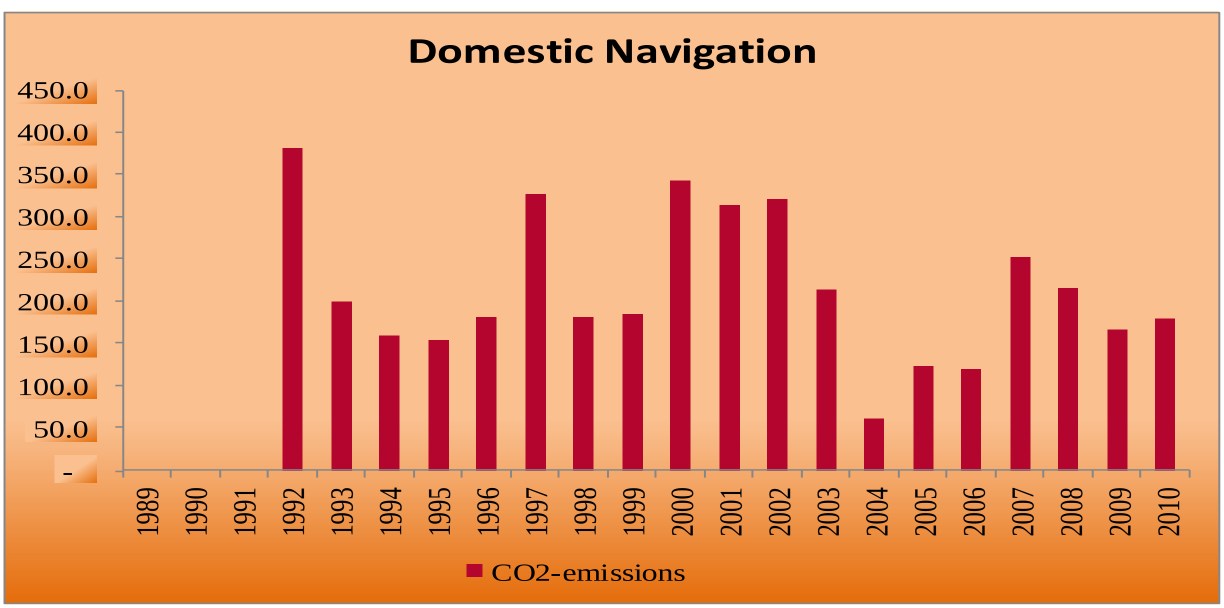
Year	Fuel type	Diesel oil		Residual oil		Gasoline	
		TJ	TJ	TJ	TJ	TJ	TJ
	Source	Energy balance	EUROSTAT	Energy balance	EUROSTAT	Energy balance	EUROSTAT
1989		451.21	0.00	2925.72	0.00	0.00	0.00
1990		536.31	0.00	1900.24	0.00	0.00	0.00
1991		488.26	0.00	2819.08	0.00	0.00	0.00
1992		784.51	5268.14	1835.08	0.00	0.00	0.00
1993		1054.63	2761.53	589.89	0.00	2.03	0.00
1994		512.36	2209.22	710.33	0.00	0.43	0.00
1995		519.03	2124.25	511.18	0.00	0.35	0.00
1996		547.87	2506.62	775.10	0.00	0.14	0.00
1997		1044.59	4503.41	2187.56	0.00	7.80	0.00
1998		807.94	2506.62	2006.26	0.00	2.05	0.00
1999		1086.49	2549.10	2705.92	0.00	4.92	0.00
2000		866.70	2166.74	980.89	2400.35	8.86	0.00
2001		193.22	509.82	0.00	3580.85	8.20	0.00
2002		433.69	1274.55	49.99	2951.25	8.79	0.00
2003		173.77	552.31	0.00	2242.95	7.96	0.00
2004		313.65	849.70	10.54	0.00	6.99	0.00
2005		599.10	1699.40	21.88	0.00	0.85	0.00
2006		519.31	1656.92	15.20	0.00	1.01	0.00
2007		1018.92	3483.77	165.30	0.00	3.22	0.00
2008		980.04	2973.95	587.92	0.00	3.10	0.00
2009		324.16	2294.19	0.005	0.00	2.08	0.00
2010		2467.36	2464.13	0	0.00	60.76	0.00

National emission factors were used according to Table 3.3.

Table 3.74 National emission factors values associated to CO_2 emissions and carbon content

Fuel	EF_Ox naţ (tCO_2/TJ)	C nat (tC/TJ)	EF naţ (tCO_2/TJ)	C nat (tC/TJ)
Lignit	93.38	25.47	98.96	26.99
Natural Gas	55.27	15.07	55.49	15.13
Rafinery Gas	56.44	15.39	56.10	15.30
Other Bituminous Coal	94.64	25.81	94.55	25.79
Coke Oven Coke	91.11	24.85	91.22	24.88
Gas/Diesel oil	73.74	20.11	73.29	19.99
Residual Fuel Oil	78.02	21.28	78.15	21.31
LPG	74.30	20.26	74.19	20.23
Petroleum Coke	93.73	25.56	93.63	25.54
Gasoline	71.62	19.53	71.62	19.5327

Figure 3.26 Transport categories in 2010 – subsector Civil Aviation



3.2.9.5 Railways Transport

In calculating GHG emissions for Railways sub-sector, on the recommendation of Marc Schuman (National Greenhouse Gas Inventory Compiler & Air Pollutants - expert in Luxembourg, European Commission representative) a new worksheet in which values of fuel consumption and net calorific values from EUROSTAT-questionnaires was used.

Figure 3.27 Transport categories in 2010 – subsector Civil Aviation

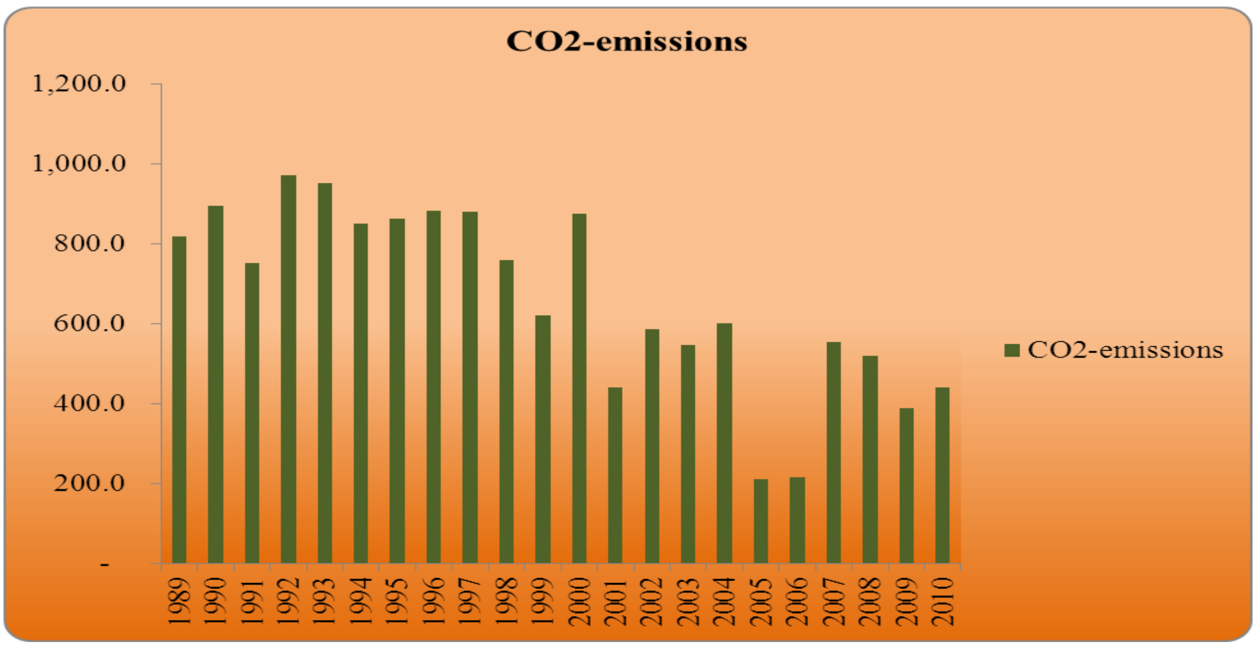


Table 3.75 Comparison the activity data between of Energy Balance and EUROSTAT for Railways Transport

FUEL TYPE	DIESEL OIL		RESIDUAL FUEL OIL		COKE OVEN COKE		SUB-BITOMINUOUS	
A D	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ
SOURCE	Energy balance	EURO TAT	Energy balance	EURO STAT	Energy balance	EURO STAT	Energy balance	EURO STAT
1989	11294.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1990	12322.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1991	10366.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1992	15482.20	13381.20	0.00	0.00	0.00	0.00	0.00	0.00
1993	13120.10	13126.32	6.65	0.00	0.00	0.00	0.09	0.00
1994	11727.68	11724.48	3.14	0.00	0.00	0.00	0.06	0.00
1995	11871.07	11851.92	43.22	0.00	0.00	0.00	0.06	0.02
1996	12167.82	12149.28	7.76	0.00	0.00	0.00	0.06	0.02
1997	12122.46	12106.80	8.91	0.00	0.00	0.00	0.06	0.06
1998	10439.77	10450.08	5.65	0.00	0.00	0.00	0.04	0.04
1999	8532.57	8538.48	0.00	0.00	0.00	0.00	0.01	0.00
2000	11984.29	11979.36	72.52	78.70	0.65	0.00	3.58	0.00
2001	6013.71	6074.64	0.00	0.00	0.15	0.00	21.59	0.00
2002	8067.40	8071.20	9.49	0.00	0.00	0.00	2.37	0.00
2003	7220.34	7221.60	289.72	0.00	0.00	0.00	19.02	0.00
2004	8267.61	8283.60	0.00	0.00	0.00	0.00	16.17	0.02
2005	2857.16	2846.16	45.36	39.35	0.00	0.00	0.12	0.00
2006	2992.32	2973.60	3.39	0.00	0.00	0.00	0.00	0.00
2007	7664.46	7646.40	0.00	0.00	0.00	0.00	0.35	0.00
2008	7123.16	7136.64	24.03	39.35	0.56	0.00	0.06	0.00
2009	5356.25	5352.48	0.00	0.00	0.00	0.00	0.00	0.00
2010	6061.89	6074.64	0.00	0.00	0.00	0.00	0.00	0.00

Recalculation was made for the entire time series (1989 - 2009) and is presented in table 3.80.

3.2.9.6 Road Transport

To run the COPERT III model were used activity data on fuel consumption data from EUROSTAT-questionnaires and fleet activity on the link www.emisia.com /TOOLS/Vehicle FLEET for the years 1990-2004. Since 2005 the fleet information has been provided by RAR (Romanian Auto Register). Both SNEEGES (Service National Emission Estimate of Greenhouse Gases) and SCECA (Service the Center for Air Quality Assessment) using the same database on the fleet.

Because the data taken from www.emisia.com link was not structured in the worksheet for import in COPERT III model, we compiled for this.

Estimating the number of miles for each type cars was made starting from the database for 2005-2009 by extrapolation the data for 2004-1990.

Consumption fuel was divided in four categories in according to lead content, so:

- for 1990-1995 – was considered the gasoline with content of 100% lead;
- for 1996-2000 – was considered the gasoline with content of 70% leaded and 30% unleaded;
- for 2001-2004 - was considered the gasoline with content of 40% leaded and 60% unleaded;
- for 2005-2010 - was considered the gasoline with content of 100% unleaded.

Content lead and sulfur in gasoline is regulated by Government Decision HG 15/2006, according of Table 3.76.

Table 3.76 Extract from GD 15/2006 of lead and sulfur content in gasoline and diesel oil

Admissible values for characteristics of liquid fuels according Decision no 689/ 2004,update by GD no 15/2006								
	Sulfur (% m/m)		**Hidrocarbons**		**Benzene (% v/v)**	**E100 (% v/v)**	**E150 (% v/v)**	**%O_2**
			aromatic (% v/v)	**olefine (% v/v)**				
from 1 ian 2005								
Lead gasoline	-	0.08	42	-	3			
Unleaded gasoline	Sulfur (mg/kg)							
	min	max						
	-	150	42	-	3			
Gasoline								
from 1 ian 2005	-	150	42	18	1	46	75	2.7
from 1 ian 2007	-	50	35	18	1	46	75	2.7
from 1 ian 2009	-	10	35	18	1	46	75	2.7
Diesel oil								
	Sulfur (mg/kg)		HAP (% m/m)		Density (kg/mc)	T95	number cetane	
			max				min	
from 1 ian 2007	-	350	11		845	360	51	
from 1 ian 2007	-	50	11		845	360	51	
from 1 ian 2009	-	10	11		845	360	51	

Maximum permissible lead content of gasoline: 0,005 g/l

3.2.9.7 Uncertainties and time- series consistency

Because there was no data available regarding uncertainty estimates at this level of disaggregation, the uncertainty was estimated using the key categories ranking (mobile combustion civil aviation, navigation, railways, road respectively other transportation-pipeline, for every GHG: CO_2, CH_4, and N_2O).

The combined uncertainty estimates are the following: 7% (for CO_2 estimates), 40.3% (for CH_4 estimates) and 200% for N_2O emissions estimates.

The uncertainties used in calculating combined uncertainty are:

- activity data uncertainty (5%) – based on information from the National Institute for Statistics (the system used in aggregating statistical data has a sampling error of about 3-5%);
- emission factors (5% for CO_2 emissions, 40% for CH_4, and 200% for N_2O emission estimates) using expert judgment.

Due to the fact that emissions have been calculated using the same emission factors, the same sources of activity data and the same methods and expert judgments (for civil aviation and navigation disaggregation into domestic and international) the time series are consistent.

3.2.9.7.1 Uncertainties and time- series consistency for road transport

Table 3.77 Uncertainties and time- series consistency for road transport

A	B	C	D	E	F	G	G
Base year	**Year**	**Gas**	**Base year emissions or removals Gg CO_2 equiv.**	**Year t emissions or removals Gg CO_2 equiv.**	**Activity data uncertainty %**	**Emission factor/estimation parameter uncertainty %**	**Combined uncertainty %**
1990	**1991**	CO_2	5,429.44	9,357.669	5%	10%	11.18%
1990	**1992**	CO_2	5,429.44	8,597.618	5%	10%	11.18%
1990	**1993**	CO_2	5,429.44	8,115.966	5%	10%	11.18%
1990	**1994**	CO_2	5,429.44	8,793.496	5%	10%	11.18%
1990	**1995**	CO_2	5,429.44	8,491.371	5%	10%	11.18%
1990	**1996**	CO_2	5,429.44	11,678.17	5%	10%	11.18%
1990	**1997**	CO_2	5,429.44	11,221.16	5%	10%	11.18%
1990	**1998**	CO_2	5,429.44	10,783.17	5%	10%	11.18%
1990	**1999**	CO_2	5,429.44	8,358.326	5%	10%	11.18%
1990	**2000**	CO_2	5,429.44	9,655.361	5%	10%	11.18%
1990	**2001**	CO_2	5,429.44	11,321.17	5%	10%	11.18%
1990	**2002**	CO_2	5,429.44	12,273.17	5%	10%	11.18%
1990	**2003**	CO_2	5,429.44	12,424.73	5%	10%	11.18%
1990	**2004**	CO_2	5,429.44	13,073.61	5%	10%	11.18%
1990	**2005**	CO_2	5,429.44	11,799.81	2%	7%	7.28%
1990	**2006**	CO_2	5,429.44	12,300.42	2%	7%	7.28%
1990	**2007**	CO_2	5,429.44	12,376.04	2%	7%	7.28%
1990	**2008**	CO_2	5,429.44	14,251.64	2%	7%	7.28%
1990	**2009**	CO_2	5,429.44	14,391.26	2%	7%	7.28%

Table 3. 77 (continued) Uncertainties and time- series consistency for road transport

A	B	C	D	E	F	G	G
Base year	**Year**	**Gas**	**Base year emissions or removals Gg CO_2 equiv.**	**Year t emissions or removals Gg CO_2 equiv.**	**Activity data uncertainty %**	**Emission factor/estimation parameter uncertainty %**	**Combined uncertainty %**
1990	**1991**	CH_4	23.87	3.02	5%	80%	80.15%
1990	**1992**	CH_4	23.87	2.62	5%	80%	80.15%
1990	**1993**	CH_4	23.87	1.99	5%	80%	80.15%
1990	**1994**	CH_4	23.87	2.66	5%	80%	80.15%
1990	**1995**	CH_4	23.87	2.33	5%	80%	80.15%
1990	**1996**	CH_4	23.87	3.36	5%	80%	80.15%
1990	**1997**	CH_4	23.87	3.41	5%	80%	80.15%
1990	**1998**	CH_4	23.87	3.61	5%	80%	80.15%
1990	**1999**	CH_4	23.87	2.43	5%	80%	80.15%
1990	**2000**	CH_4	23.87	3.60	5%	80%	80.15%
1990	**2001**	CH_4	23.87	3.86	5%	80%	80.15%
1990	**2002**	CH_4	23.87	2.89	5%	80%	80.15%
1990	**2003**	CH_4	23.87	3.40	5%	80%	80.15%
1990	**2004**	CH_4	23.87	3.76	5%	80%	80.15%
1990	**2005**	CH_4	23.87	2.85	2%	60%	60.03%
1990	**2006**	CH_4	23.87	2.45	2%	60%	60.03%
1990	**2007**	CH_4	23.87	2.82	2%	60%	60.03%
1990	**2008**	CH_4	23.87	2.33	2%	60%	60.03%
1990	**2009**	CH_4	23.87	2.44	2%	60%	60.03%

Table 3. 77 (continued) Uncertainties and time- series consistency for road transport

A	B	C	D	E	F	G	G
Base year	**Year**	**Gas**	**Base year emissions or removals Gg CO_2 equiv.**	**Year t emissions or removals Gg CO_2 equiv.**	**Activity data uncertainty %**	**Emission factor/estimation parameter uncertainty %**	**Combined uncertainty %**
1990	**1991**	N_2O	0.04	1.39	5%	380%	380.03%
1990	**1992**	N_2O	0.04	0.31	5%	380%	380.03%
1990	**1993**	N_2O	0.04	0.32	5%	380%	380.03%
1990	**1994**	N_2O	0.04	0.41	5%	380%	380.03%
1990	**1995**	N_2O	0.04	0.41	5%	380%	380.03%
1990	**1996**	N_2O	0.04	0.50	5%	380%	380.03%
1990	**1997**	N_2O	0.04	0.45	5%	380%	380.03%
1990	**1998**	N_2O	0.04	0.42	5%	380%	380.03%
1990	**1999**	N_2O	0.04	0.36	5%	380%	380.03%
1990	**2000**	N_2O	0.04	0.43	5%	380%	380.03%
1990	**2001**	N_2O	0.04	0.49	5%	380%	380.03%
1990	**2002**	N_2O	0.04	0.54	5%	380%	380.03%
1990	**2003**	N_2O	0.04	0.58	5%	380%	380.03%
1990	**2004**	N_2O	0.04	0.60	5%	380%	380.03%
1990	**2005**	N_2O	0.04	0.77	2%	320%	320%
1990	**2006**	N_2O	0.04	0.73	2%	320%	320%
1990	**2007**	N_2O	0.04	0.86	2%	320%	320%
1990	**2008**	N_2O	0.04	1.15	2%	320%	320%
1990	**2009**	N_2O	0.04	1.12	2%	320%	320%

The uncertainty analysis is based on Table 3.4. from IPCC 2006, adapted for Romania.

For the activity data for the period 1990-2004 we kept the percentage uncertainty of 5% recommended by the NIS statistics as activity data used within COPERT III were:

- Fuel consumption - energy balance provided by NIS;
- Number of vehicles / categories - www.emisia.com/TOOLS/Vehicle FLEET
- Number mileage and other parameters - alternative sources and calculation estimates.

For the period 2005-2009 the percentage had dropped to 2% because:

- Fuel consumption - energy balance provided by NIS;
- Number of vehicles / categories, total mileage and other parameters – RAR.

Fuel consumption has been awarded a 3% share of uncertainty and data from RAR a percentage uncertainty of 2%.

Parameter Estimation Uncertainty (%) for emission factor is the arithmetic mean of the uncertainties for each fuel type and each category of vehicles (gasoline cars, cars with catalytic converters, cars without catalytic converters and diesel cars).

Combined uncertainty was calculated using the formula:

Equation 3.5 Combined uncertainty

$$\sqrt{\%\,\text{uncertainty activity data}^2 + \%\,\text{uncertainty emission factor}^2}$$

In 2012 is going to run a study on the topic of activity data, model uncertainty for running back COPERT 4. Parameters resulting from the study will be used in INEGES 2013.

3.2.9.8 Source- specific QA/QC and verification

The activities were implemented by the sectorial expert administrating the Energy Sector – Transport subsector. No recalculations were needed following the QA activities developed under the European Community GHG Inventory compilation procedures described in the Decision 280/2004/EC of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.

All the unconformities noticed and solved as result of the quality assurance and quality control activities performed are mentioned in the Improvements Lists.

A cross-checking approach was used in the implementation of QC activities:

Were made recalculations following recommendations made by experts of ERT.

The unconformities noted and solved following these activities are described in the Chapter 3.2.2.7 – 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 10 – page 832– Source-specific recalculations, including changes made in response to the review process.

3.2.9.9 Source- specific recalculation, 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

1AA.3.A – Civil Aviation for 1993-2009

It was passed on the level approach (T2) using activity data from Eurostat-questionnaires and used a new methodology for calculating the emissions depending on the consumption of fuel per flight cycles.

Table 3.78 Change made at methodology and activity data with their effects on emission estimates for Civil Aviation

Year	Sub-sector	Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for CO_2 (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1993	1 AA.3.A – Civil Aviation	305.54	439.14	30.42	21.63	30.89	29.98
1994		412.13	634.80	35.08	29.17	44.60	34.60
1995		353.50	442.55	20.12	25.02	31.19	19.78
1996		216.57	305.61	29.14	15.33	21.50	28.70
1997		249.72	383.28	34.85	17.68	26.93	34.37
1998		145.58	501.79	70.99	10.30	34.99	70.55
1999		187.24	498.93	62.47	13.25	34.85	61.97
2000		109.31	375.98	70.93	7.74	26.22	70.49
2001		117.11	250.38	53.23	8.29	17.52	52.70
2002		118.47	207.33	42.86	8.39	14.54	42.34
2003		200.46	289.20	30.69	14.19	20.34	30.24
2004		189.93	323.26	41.25	13.44	22.68	40.74
2005		204.27	648.16	68.49	14.46	45.22	68.03
2006		168.03	255.37	34.20	11.89	17.94	33.74
2007		762.80	4245.80	82.03	53.98	300.72	82.05
2008		24.50	5374.30	99.54	1.73	386.00	99.55
2009		579.34	3536.06	83.62	41.00	249.34	83.56
2010		0.00	4660.49	100.00	0.00	329.12	100.00

Table 3. 78 (continued) Change made at methodology and activity data with their effects on emission estimates for Civil Aviation

Year	Sub-sector	Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for CH_4 (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1993	1 AA.3.A – Civil Aviation	305.54	439.14	30.42	0.00	30.89	100.00
1994		412.13	634.80	35.08	0.00	44.60	100.00
1995		353.50	442.55	20.12	0.00	31.19	100.00
1996		216.57	305.61	29.14	0.00	21.50	100.00
1997		249.72	383.28	34.85	0.00	26.93	100.00
1998		145.58	501.79	70.99	0.00	34.99	100.00
1999		187.24	498.93	62.47	0.00	34.85	100.00
2000		109.31	375.98	70.93	0.00	26.22	100.00
2001		117.11	250.38	53.23	0.00	17.52	100.00
2002		118.47	207.33	42.86	0.00	14.54	100.00
2003		200.46	289.20	30.69	0.00	20.34	100.00
2004		189.93	323.26	41.25	0.00	22.68	100.00
2005		204.27	648.16	68.49	0.00	45.22	100.00
2006		168.03	255.37	34.20	0.00	17.94	100.00
2007		762.80	4245.80	82.03	0.00	300.72	100.00
2008		24.50	5374.30	99.54	0.00	386.00	100.00
2009		579.34	3536.06	83.62	0.00	249.34	100.00
2010		0.00	4660.49	100.00	0.00	329.12	100.00

Table 3. 78 (continued) Change made at methodology and activity data with their effects on emission estimates for Civil Aviation

Year	Sub-sector	Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for N_2O (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1993	1 AA.3.A – Civil Aviation	305.54	439.14	30.42	0.00	0.00	30.42
1994		412.13	634.80	35.08	0.00	0.00	35.08
1995		353.50	442.55	20.12	0.00	0.00	20.12
1996		216.57	305.61	29.14	0.00	0.00	29.14
1997		249.72	383.28	34.85	0.00	0.00	34.85
1998		145.58	501.79	70.99	0.00	0.00	70.99
1999		187.24	498.93	62.47	0.00	0.00	62.47
2000		109.31	375.98	70.93	0.00	0.00	70.93
2001		117.11	250.38	53.23	0.00	0.00	53.23
2002		118.47	207.33	42.86	0.00	0.00	42.86
2003		200.46	289.20	30.69	0.00	0.00	30.69
2004		189.93	323.26	41.25	0.00	0.00	41.25
2005		204.27	648.16	68.49	0.00	0.00	68.49
2006		168.03	255.37	34.20	0.00	0.00	34.20
2007		762.80	4245.80	82.03	0.00	0.00	24.56
2008		24.50	5374.30	99.54	0.00	0.00	98.93
2009		579.34	3536.06	83.62	0.00	0.01	83.62
2010		0.00	4660.49	100.00	0.00	0.01	100.00

1AA.3.B – Road Transport for 1990-2009

Were used the values for national emission factors provided by ISPE study for gasoline, diesel oil and LPG.

Table 3.79 Change made at methodology and their effects on emission estimates for Road Transport

Year	Sub-sector	Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for CO_2 (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1990	1 AA.3.B – Road Transport	91192.67	91192.67	0.00	10827.25	10827.09	0.00
1991		76721.67	76721.67	0.00	9357.67	9356.52	-0.01
1992		97738.83	97738.83	0.00	8597.62	8597.62	0.00
1993		94886.79	94426.05	-0.49	8115.97	8081.78	-0.42
1994		105067.87	104523.88	-0.52	8793.50	8753.12	-0.46
1995		103799.82	103212.44	-0.57	8491.37	8441.91	-0.59
1996		142994.46	141677.89	-0.93	11678.17	11579.65	-0.85
1997		135391.81	133423.62	-1.48	11221.16	11077.29	-1.30
1998		136340.87	134268.48	-1.54	10783.17	10630.72	-1.43
1999		104743.16	103634.19	-1.07	8358.33	8276.81	-0.98
2000		116306.29	113679.08	-2.31	9655.36	9463.21	-2.03
2001		149410.02	148389.44	-0.69	11321.17	11244.70	-0.68
2002		159060.59	157354.01	-1.08	12273.17	12148.50	-1.03
2003		161179.56	159319.31	-1.17	12424.73	12289.08	-1.10
2004		195711.83	194951.08	-0.39	13073.61	13017.70	-0.43
2005		161474.09	160542.06	-0.58	11799.81	11731.41	-0.58
2006		167358.44	166901.10	-0.27	12300.42	12266.50	-0.28
2007		168433.97	167505.22	-0.55	12376.04	12307.88	-0.55
2008		194801.72	193672.90	-0.58	14251.64	14168.37	-0.59
2009		195836.71	195836.71	0.00	14391.26	14389.72	-0.01
2010		0.00	183027.29	100.00	0.00	13498.11	100.00

1AA.3.C – Railways - Liquid – for 1992 – 2009 ;

Following ERT under KP Article 8 advice, the activity data was provided from Eurostat-questionnaires and have replaced the values used from the Energy Balance.

Were used the values for national emission factors provided through the study implemented in 2011 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", by ISPE.

Table 3.80 Change made at activity data and their effects on emission estimates

Year	Sub-sector	Changes at AD level (TJ)		Differences of consumption fuel (%)	Effects of changes on emission estimates for CO_2 (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1989	1AA.3.C – Railways - liquid	11,294.58	11,294.58	0.00	828.19	819.46	-1.07
1990		12,322.40	12,322.40	0.00	903.55	894.03	-1.07
1991		10,366.87	10,366.87	0.00	760.16	752.15	-1.07
1992		15,482.20	13,381.20	-15.70	1,135.25	970.85	-16.93
1993		13,349.78	13,132.97	-1.65	978.75	952.87	-2.72
1994		11,986.10	11,727.62	-2.20	878.72	850.89	-3.27
1995		12,124.72	11,895.14	-1.93	889.05	863.24	-2.99
1996		12,397.33	12,157.04	-1.98	908.91	882.07	-3.04
1997		12,374.91	12,115.71	-2.14	907.26	879.07	-3.21
1998		10,620.99	10,455.73	-1.58	778.69	758.62	-2.64
1999		8,545.23	8,538.48	-0.08	626.58	619.49	-1.14
2000		12,184.82	12,051.88	-1.10	893.61	874.75	-2.16
2001		6,086.46	6,074.64	-0.19	446.24	440.73	-1.25
2002		8,170.25	8,080.69	-1.11	599.05	586.32	-2.17
2003		7,623.39	7,511.32	-1.49	559.86	546.37	-2.47
2004		8,357.03	8,283.60	-0.89	612.72	601.00	-1.95
2005		2,990.71	2,891.52	-3.43	219.38	210.01	-4.46
2006		3,045.33	2,976.99	-2.30	223.28	216.01	-3.37
2007		7,721.96	7,646.40	-0.99	566.18	554.77	-2.06
2008		7,241.14	7,160.67	-1.12	530.97	519.64	-2.18
2009		5,356.25	5,352.48	-0.07	392.75	388.34	-1.14
2010		0	6,074.64	100.00	0	440.73	100.00

Table 3. 80 (continued) Change made at activity data and their effects on emission estimates

Year		Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for CH_4 (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1989	1AA.3.C – Railways - liquid	11,294.58	11,294.58	0.00	0.06	0.06	0.00
1990		12,322.40	12,322.40	0.00	0.06	0.06	0.00
1991		10,366.87	10,366.87	0.00	0.05	0.05	0.00
1992		15,482.20	13,381.20	-15.70	0.08	0.08	0.00
1993		13,349.78	13,132.97	-1.65	0.07	0.07	-1.70
1994		11,986.10	11,727.62	-2.20	0.06	0.06	-2.18
1995		12,124.72	11,895.14	-1.93	0.06	0.06	-1.77
1996		12,397.33	12,157.04	-1.98	0.06	0.06	-1.82
1997		12,374.91	12,115.71	-2.14	0.06	0.06	-2.01
1998		10,620.99	10,455.73	-1.58	0.05	0.05	-1.68
1999		8,545.23	8,538.48	-0.08	0.04	0.04	-0.15
2000		12,184.82	12,051.88	-1.10	0.06	0.06	-1.06
2001		6,086.46	6,074.64	-0.19	0.03	0.03	-1.21
2002		8,170.25	8,080.69	-1.11	0.04	0.04	-1.16
2003		7,623.39	7,511.32	-1.49	0.04	0.04	-1.51
2004		8,357.03	8,283.60	-0.89	0.04	0.04	-1.08
2005		2,990.71	2,891.52	-3.43	0.01	0.01	-3.04
2006		3,045.33	2,976.99	-2.30	0.02	0.01	-1.66
2007		7,721.96	7,646.40	-0.99	0.04	0.04	-0.75
2008		7,241.14	7,160.67	-1.12	0.04	0.04	-1.31
2009		5,356.25	5,352.48	-0.07	0.03	0.03	0.00
2010		0	6,074.64	100.00	0.00	0.03	100.00

Table 3. 80 (continued) Change made at activity data and their effects on emission estimates

Year		Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for N_2O (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1989	1AA.3.C – Railways - liquid	11,294.58	11,294.58	0.00	0.01	0.01	0.00
1990		12,322.40	12,322.40	0.00	0.01	0.01	0.00
1991		10,366.87	10,366.87	0.00	0.01	0.01	0.00
1992		15,482.20	13,381.20	-15.70	0.01	0.01	0.00
1993		13,349.78	13,132.97	-1.65	0.01	0.01	-1.70
1994		11,986.10	11,727.62	-2.20	0.01	0.01	-2.18
1995		12,124.72	11,895.14	-1.93	0.01	0.01	-1.77
1996		12,397.33	12,157.04	-1.98	0.01	0.01	-1.82
1997		12,374.91	12,115.71	-2.14	0.01	0.01	-2.01
1998		10,620.99	10,455.73	-1.58	0.01	0.01	-1.68
1999		8,545.23	8,538.48	-0.08	0.01	0.01	-0.15
2000		12,184.82	12,051.88	-1.10	0.01	0.01	-1.06
2001		6,086.46	6,074.64	-0.19	0.00	0.00	-1.21
2002		8,170.25	8,080.69	-1.11	0.00	0.00	-1.16
2003		7,623.39	7,511.32	-1.49	0.00	0.00	-1.51
2004		8,357.03	8,283.60	-0.89	0.01	0.00	-1.08
2005		2,990.71	2,891.52	-3.43	0.00	0.00	-3.04
2006		3,045.33	2,976.99	-2.30	0.00	0.00	-1.66
2007		7,721.96	7,646.40	-0.99	0.00	0.00	-0.75
2008		7,241.14	7,160.67	-1.12	0.00	0.00	-1.31
2009		5,356.25	5,352.48	-0.07	0.00	0.00	0.00
2010		0.00	6,074.64	100.00	0.00	0.00	100.00

1AA.3.C – Railways – solid fuel – for 1992 – 2009;

Following expert advice ERT, the activity data was provided from Eurostat-questionnaires and have replaced the values used of the national energy balance.

Were used the values for national emission factors provided by ISPE study.

Table 3. 80 (continued) Change made at activity data and their effects on emission estimates

Year		Changes at AD level (TJ)		Differences of consumption fuel (%)	Effects of changes on emission estimates for CO_2 (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1989	1AA.3.C – Railways - solid	987.70	0.00	100.00	91.57	0.00	-100.00
1990		577.74	0.00	100.00	53.56	0.00	-100.00
1991		120.60	0.00	100.00	11.18	0.00	-100.00
1992		146.65	0.00	100.00	13.60	0.00	-100.00
1993		26.72	0.09	-99.66	2.48	0.01	-99.60
1994		6.62	0.06	-99.09	0.61	0.01	-98.36
1995		16.76	0.06	-99.64	1.55	0.01	-99.35
1996		34.22	0.06	-99.82	3.17	0.01	-99.68
1997		69.71	0.06	-99.91	6.46	0.01	-99.85
1998		24.04	0.04	-99.83	2.23	0.00	-100.00
1999		0.01	0.01	0.00	0.00	0.00	0.00
2000		5.34	4.22	-20.97	0.51	0.40	-21.57
2001		43.34	21.74	-49.84	4.05	2.05	-49.38
2002		4.72	2.37	-49.79	0.44	0.22	-50.00
2003		38.68	19.02	-50.83	3.62	1.79	-50.55
2004		32.58	16.17	-50.37	3.05	1.52	-50.16
2005		0.26	0.12	-53.85	0.02	0.01	-50.00
2006		0.00	0.00	0.00	0.00	0.00	0.00
2007		0.53	0.35	-33.96	0.05	0.03	-40.00
2008		0.65	0.62	-4.62	0.07	0.06	-14.29
2009		0.15	0.15	0.00	0.01	0.01	0.00
2010		0.00	0.00	0.00	0.00	0.00	0.00

Table 3. 80 (continued) Change made at activity data and their effects on emission estimates

Year		Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for CH_4 (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1989	1AA.3.C – Railways - solid	987.70	0.00	100.00	0.01	0.00	-100
1990		577.74	0.00	100.00	0.01	0.00	-100
1991		120.60	0.00	100.00	0.00	0.00	-100
1992		146.65	0.00	100.00	0.00	0.00	-100
1993		26.72	0.09	-99.66	0.00	0.00	-99.67
1994		6.62	0.06	-99.09	0.00	0.00	-99.12
1995		16.76	0.06	-99.64	0.00	0.00	-99.64
1996		34.22	0.06	-99.82	0.00	0.00	-99.83
1997		69.71	0.06	-99.91	0.00	0.00	-99.92
1998		24.04	0.04	-99.83	0.00	0.00	-99.85
1999		0.01	0.01	0.00	0.00	0.00	-37.50
2000		5.34	4.22	-20.97	0.00	0.00	-21.14
2001		43.34	21.74	-49.84	0.00	0.00	-49.84
2002		4.72	2.37	-49.79	0.00	0.00	-49.68
2003		38.68	19.02	-50.83	0.00	0.00	-50.83
2004		32.58	16.17	-50.37	0.00	0.00	-50.36
2005		0.26	0.12	-53.85	0.00	0.00	-55.51
2006		0.00	0.00	0.00	0.00	0.00	0.00
2007		0.53	0.35	-33.96	0.00	0.00	-33.33
2008		0.65	0.62	-4.62	0.00	0.00	-6.22
2009		0.15	0.15	0.00	0.00	0.00	0.00
2010		0.00	0.00	0.00	0.00	0.00	0.00

1AA.3.D – Navigation for 1989 – 2010

It was passed on the level approach (T2) using EF as for Diesel Oil, Residual Fuel Oil and Gasoline for emissions to CO_2 and activity data from Eurostat-questionnaires.

Were used the values for national emission factors provided by ISPE study.

Table 3.81 Change made at activity data and their effects on emission estimates

Year		Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for CO_2 (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1989	1.AA.3.D. Sub-sector Domestic Navigation	3376.93	3376.93	0.00	257.18	259.11	0.75
1990		2436.55	2436.55	0.00	184.87	185.94	0.57
1991		3307.34	3307.34	0.00	251.72	253.54	0.72
1992		2619.59	7103.22	63.12	198.08	524.20	62.21
1993		1667.86	3353.44	50.26	124.20	246.14	49.54
1994		1241.55	2919.98	57.48	93.34	215.28	56.64
1995		1048.01	2635.78	60.24	78.50	193.70	59.47
1996		1336.98	3281.86	59.26	100.56	241.84	58.42
1997		3282.90	6698.77	50.99	247.80	496.55	50.10
1998		2838.16	4514.93	37.14	214.64	337.24	36.35
1999		3831.82	5259.94	27.15	289.76	394.66	26.58
2000		1875.51	3156.49	40.58	140.67	233.73	39.81
2001		204.32	518.02	60.56	14.94	37.57	60.23
2002		496.82	1333.33	62.74	36.55	96.96	62.31
2003		186.24	560.26	66.76	13.62	40.64	66.49
2004		337.66	867.23	61.06	24.76	62.96	60.68
2005		624.57	1722.13	63.73	45.86	125.05	63.32
2006		542.84	1673.12	67.56	39.84	121.46	67.20
2007		1200.08	3652.29	67.14	88.51	265.78	66.70
2008		1154.28	3564.97	67.62	85.13	261.48	67.44
2009		326.24	2296.27	85.79	23.91	166.60	85.65
2010		0.00	2476.91	100.00	0.00	179.69	100.00

Table 3.82 Change made at activity data and their effects on emission estimates

Year		Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for CH_4 (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1989	1.AA.3.D. Sub-sector Domestic Navigation	3376.93	3376.93	0.00	0.02	0.02	0.00
1990		2436.55	2436.55	0.00	0.01	0.01	0.00
1991		3307.34	3307.34	0.00	0.02	0.02	0.00
1992		2619.59	7103.22	63.12	0.01	0.01	-42.34
1993		1667.86	3353.44	50.26	0.01	0.01	35.86
1994		1241.55	2919.98	57.48	0.01	0.01	-8.73
1995		1048.01	2635.78	60.24	0.01	0.00	-22.54
1996		1336.98	3281.86	59.26	0.01	0.00	-45.71
1997		3282.90	6698.77	50.99	0.02	0.05	66.90
1998		2838.16	4514.93	37.14	0.01	0.02	29.75
1999		3831.82	5259.94	27.15	0.02	0.04	49.45
2000		1875.51	3156.49	40.58	0.01	0.05	80.78
2001		204.32	518.02	60.56	0.00	0.04	97.48
2002		496.82	1333.33	62.74	0.00	0.04	94.32
2003		186.24	560.26	66.76	0.00	0.04	97.64
2004		337.66	867.23	61.06	0.00	0.03	95.13
2005		624.57	1722.13	63.73	0.00	0.00	27.64
2006		542.84	1673.12	67.56	0.00	0.01	46.75
2007		1200.08	3652.29	67.14	0.01	0.02	64.29
2008		1154.28	3564.97	67.62	0.01	0.02	68.47
2009		326.24	2296.27	85.79	0.00	0.01	84.16
2010		0.00	2476.91	100.00	0.00	0.06	100.00

Table 3.83 Change made at activity data and their effects on emission estimates

Year	Sub-sector	Changes at AD level (TJ)		Differences of consumption fuels (%)	Effects of changes on emission estimates for N_2O (Gg)		Differences of emissions (%)
		2011 v.4.1 submissions	2012 v.2.1 submissions		2011 v.4.1 submissions	2012 v.2.1 submissions	
1989	1.AA.3.D. Sub-sector Domestic Navigation	3376.93	3376.93	0.00	0.00	0.00	0.00
1990		2436.55	2436.55	0.00	0.00	0.00	0.00
1991		3307.34	3307.34	0.00	0.00	0.00	0.00
1992		2619.59	7103.22	63.12	0.00	0.00	63.12
1993		1667.86	3353.44	50.26	0.00	0.01	92.88
1994		1241.55	2919.98	57.48	0.00	0.00	82.79
1995		1048.01	2635.78	60.24	0.00	0.00	82.69
1996		1336.98	3281.86	59.26	0.00	0.00	71.44
1997		3282.90	6698.77	50.99	0.00	0.05	96.09
1998		2838.16	4514.93	37.14	0.00	0.01	88.57
1999		3831.82	5259.94	27.15	0.00	0.03	92.90
2000		1875.51	3156.49	40.58	0.00	0.05	97.94
2001		204.32	518.02	60.56	0.00	0.05	99.75
2002		496.82	1333.33	62.74	0.00	0.05	99.44
2003		186.24	560.26	66.76	0.00	0.05	99.77
2004		337.66	867.23	61.06	0.00	0.04	99.52
2005		624.57	1722.13	63.73	0.00	0.01	93.83
2006		542.84	1673.12	67.56	0.00	0.01	95.36
2007		1200.08	3652.29	67.14	0.00	0.02	96.63
2008		1154.28	3564.97	67.62	0.00	0.02	96.63
2009		326.24	2296.27	85.79	0.00	0.01	98.57
2010		0.00	2476.91	100.00	0.00	0.08	100.00

3.2.9.10 Source- specific planned improvements, if applicable

To improve the accuracy of estimates by applying more accurate methods, were used activity data to COPERT III model, data by type of vehicle (with or without catalytic converters) in order to improve the reporting of emissions for CO_2, CH_4, N_2O and were introduced in the CRF tables (detailed within the Table 3.12).

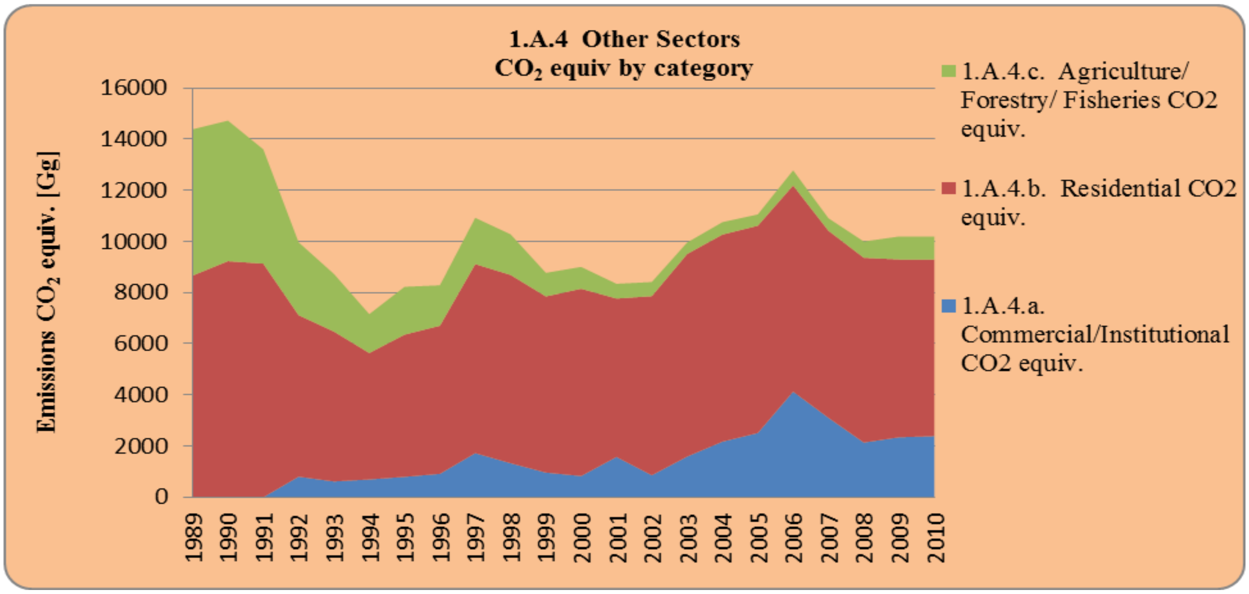
The uncertainty of the stock data will be assessed by collecting information from different sources and by building detailed models to disseminate this uncertainty down to technology level. This could be achieved by studying the following objectives:

- asses the uncertainty linked with the various input parameters of the COPERT 4 model;
- assess the uncertainty of road transport emissions in two test cases, at national level;
- including these uncertainty estimates in the COPERT 4 model;
- preparing guidance on the assessment of uncertainty for the Tier 2 method for use COPERT model in estimation GES.

3.2.10 Fuel combustion, Other Sectors (CRF sub-sector 1.A.4.)

3.2.10.1 Source description

Figure 3.28 GHG emissions from 1.A.4. – Other, by category



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

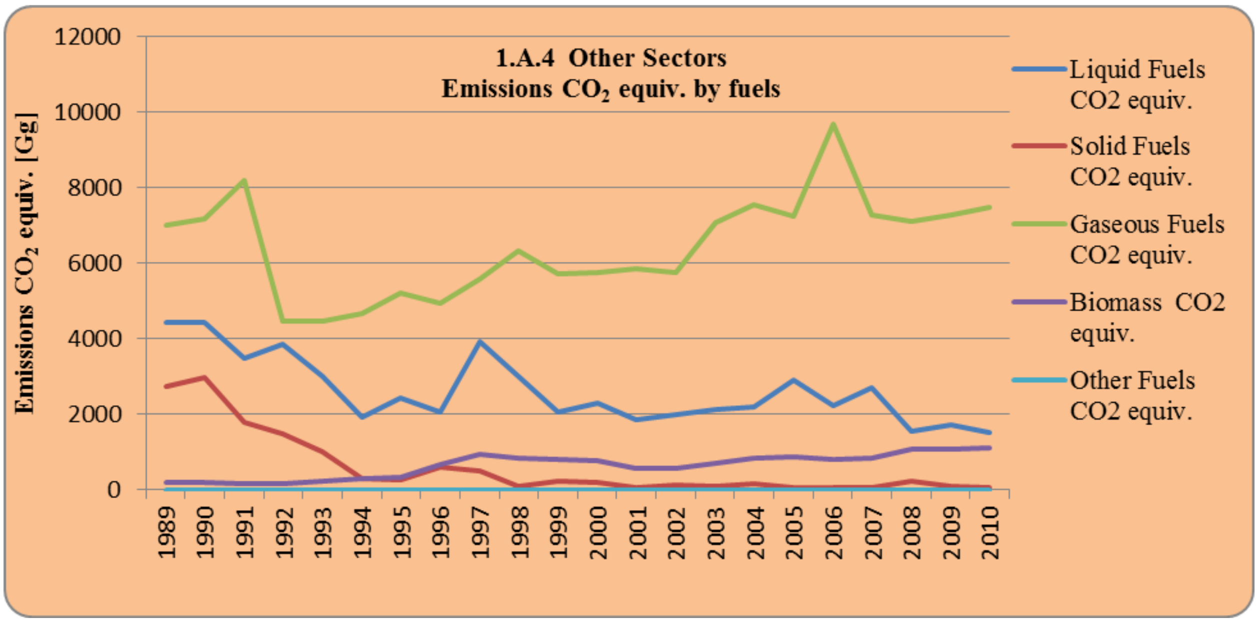
- Commercial/Institutional
- Residential
- Agriculture/ Forestry/ Fisheries

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



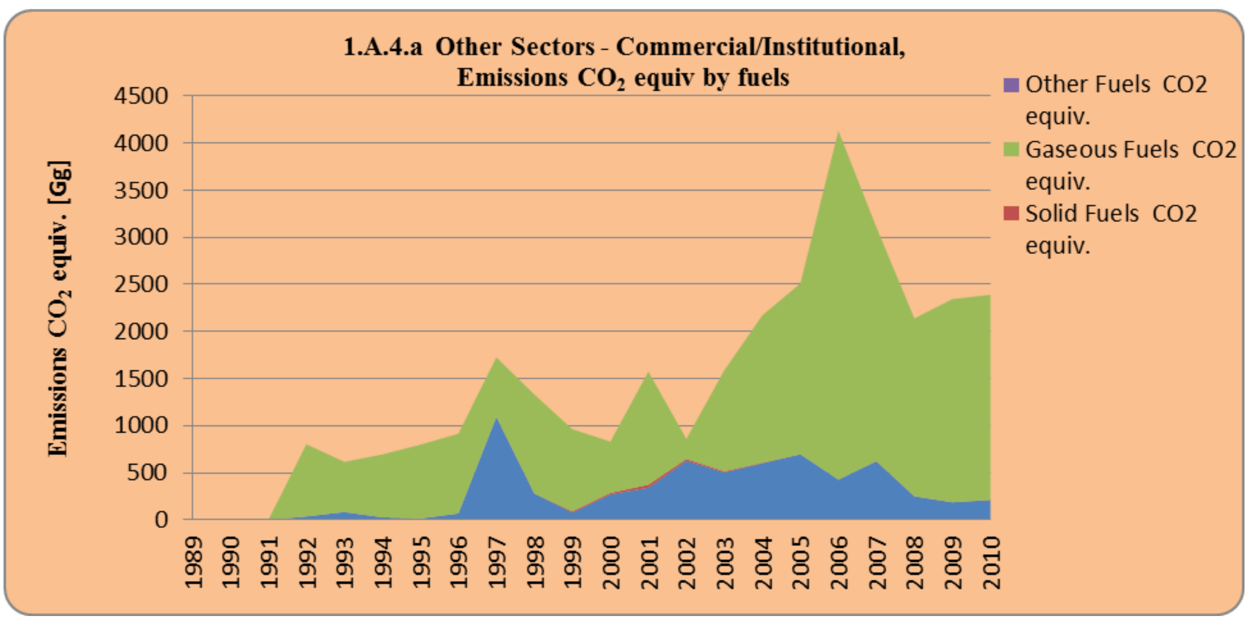
3.2.10.2 Fuel combustion, Other Sectors – Commercial/Institutional (CRF category 1.A.4.a)

3.2.10.2.1 Source description

CRF category 1.A.4.a - Commercial/Institutional is a key category by gaseous fuel, level and trend, excluding and including LULUCF.

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

Figure 3.30 GHG emissions from 1.A.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 23.5%, current year, 2010. The reporting of combustion on this category started with the 1992 year. The contribution of this category is about 2390.714 Gg CO_2 equiv., in 2010.

It is observed a main contribution of the natural gas usage as fuel in this activity category, mostly on the period 2002 - 2010.

Table 3.84 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, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1990	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1991	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1992	801.59	37.40	NO, NA	764.18	NO, NA	NO, NA
1993	615.02	84.16	NO, NA	530.86	NO, NA	NO, NA
1994	693.76	28.05	NO, NA	665.70	NO, NA	NO, NA
1995	796.98	15.59	NO, NA	781.39	NO, NA	NO, NA
1996	913.14	68.58	NO, NA	844.56	NO, NA	NO, NA
1997	1719.64	1091.40	NO, NA	628.25	NO, NA	NO, NA
1998	1328.01	279.97	NO, NA	1048.04	NO, NA	NO, NA
1999	961.62	79.12	12.38	870.13	NO, NA	NO, NA
2000	828.83	270.84	15.14	542.85	NO, NA	NO, NA
2001	1570.28	341.02	31.01	1198.25	NO, NA	NO, NA
2002	856.70	626.17	18.29	212.23	NO, NA	NO, NA
2003	1586.17	503.41	11.56	1069.48	NO, NA	1.72
2004	2167.37	600.36	4.63	1561.10	NO, NA	1.29
2005	2504.03	693.89	1.54	1808.60	NO, NA	NO, NA
2006	4120.08	426.84	NO, NA	3693.24	NO, NA	NO, NA
2007	3098.20	621.76	0.62	2475.82	NO, NA	NO, NA
2008	2134.34	250.41	1.53	1882.39	NO, NA	NO, NA
2009	2338.22	186.29	0.73	2151.20	NO, NA	NO, NA
2010	2384.41	211.17	2.06	2171.19	NO, NA	NO, NA
Decrease 1989 - 2010	–	–	–	–	–	–
Decrease 1990 - 2010	–	–	–	–	–	–
Decrease 2009 - 2010	-1.98	-13.35	-182.80	-0.93	_	_

Table 3.85 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, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1990	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1991	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1992	0.0744	0.0052	NO, NA	0.0691	NO, NA	NO, NA
1993	0.0598	0.0118	NO, NA	0.0480	NO, NA	NO, NA
1994	0.0641	0.0039	NO, NA	0.0602	NO, NA	NO, NA
1995	0.0729	0.0022	NO, NA	0.0707	NO, NA	NO, NA
1996	0.0860	0.0096	NO, NA	0.0764	NO, NA	NO, NA
1997	0.1155	0.0587	NO, NA	0.0568	NO, NA	NO, NA
1998	0.1324	0.0376	NO, NA	0.0948	NO, NA	NO, NA
1999	0.0905	0.0106	0.0012	0.0787	NO, NA	NO, NA
2000	0.0844	0.0338	0.0015	0.0491	NO, NA	NO, NA
2001	0.1568	0.0453	0.0031	0.1084	NO, NA	NO, NA
2002	0.1046	0.0836	0.0018	0.0192	NO, NA	NO, NA
2003	0.1652	0.0636	0.0012	0.0968	NO, NA	0.0036
2004	0.2155	0.0711	0.0005	0.1412	NO, NA	0.0027
2005	0.2458	0.0820	0.0002	0.1636	NO, NA	NO, NA
2006	0.3876	0.0535	NO, NA	0.3341	NO, NA	NO, NA
2007	0.2959	0.0696	0.0001	0.2262	NO, NA	NO, NA
2008	0.2000	0.0307	0.0002	0.1691	NO, NA	NO, NA
2009	0.2175	0.0230	0.0001	0.1945	NO, NA	NO, NA
2010	0.2217	0.0256	0.0002	0.1959	NO, NA	NO, NA
Decrease 1989 - 2010	–	–	–	–	–	–
Decrease 1990 - 2010	–	–	–	–	–	–
Decrease 2009 - 2010	-1.92	-11.48	-191.10	-0.71	–	–

Table 3.86 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, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1990	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1991	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1992	0.0017	0.0003	NO, NA	0.0014	NO, NA	NO, NA
1993	0.0017	0.0007	NO, NA	0.0010	NO, NA	NO, NA
1994	0.0014	0.0002	NO, NA	0.0012	NO, NA	NO, NA
1995	0.0015	0.0001	NO, NA	0.0014	NO, NA	NO, NA
1996	0.0021	0.0006	NO, NA	0.0015	NO, NA	NO, NA
1997	0.0101	0.0089	NO, NA	0.0011	NO, NA	NO, NA
1998	0.0041	0.0022	NO, NA	0.0019	NO, NA	NO, NA
1999	0.0024	0.0006	0.0002	0.0016	NO, NA	NO, NA
2000	0.0030	0.0018	0.0002	0.0010	NO, NA	NO, NA
2001	0.0052	0.0026	0.0004	0.0022	NO, NA	NO, NA
2002	0.0056	0.0049	0.0003	0.0004	NO, NA	NO, NA
2003	0.0057	0.0035	0.0002	0.0019	NO, NA	0.0000
2004	0.0066	0.0036	0.0001	0.0028	NO, NA	0.0000
2005	0.0075	0.0042	0.0000	0.0033	NO, NA	NO, NA
2006	0.0096	0.0029	NO, NA	0.0067	NO, NA	NO, NA
2007	0.0078	0.0033	0.0000	0.0045	NO, NA	NO, NA
2008	0.0050	0.0016	0.0000	0.0034	NO, NA	NO, NA
2009	0.0052	0.0013	0.0000	0.0039	NO, NA	NO, NA
2010	0.0053	0.0014	0.0000	0.0039	NO, NA	NO, NA
Decrease 1989 - 2010	–	–	–	–	–	–
Decrease 1990 - 2010	–	–	–	–	–	–
Decrease 2009 - 2010	-2.70	-7.19	-191.10	-0.71	_	_

Table 3.87 GHG emissions in 1.A.4.a. - Commercial/Institutional

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1.A.4.a Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1990	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1991	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1992	14349.86	801.66	37.41	NO, NA	764.25	NO, NA	NO, NA
1993	10780.79	615.08	84.17	NO, NA	530.91	NO, NA	NO, NA
1994	12437.30	693.82	28.06	NO, NA	665.76	NO, NA	NO, NA
1995	14356.61	797.05	15.59	NO, NA	781.47	NO, NA	NO, NA
1996	16239.48	913.23	68.59	NO, NA	844.64	NO, NA	NO, NA
1997	26253.48	1719.77	1091.46	NO, NA	628.31	NO, NA	NO, NA
1998	22815.50	1328.14	280.01	NO, NA	1048.14	NO, NA	NO, NA
1999	16946.18	961.71	79.13	12.38	870.21	NO, NA	NO, NA
2000	13836.70	828.92	270.88	15.15	542.90	NO, NA	NO, NA
2001	26784.95	1570.44	341.07	31.01	1198.36	NO, NA	NO, NA
2002	12552.57	856.81	626.26	18.30	212.25	NO, NA	NO, NA
2003	26566.26	1586.34	503.48	11.56	1069.58	NO, NA	1.72
2004	36976.51	2167.60	600.44	4.63	1561.24	NO, NA	1.29
2005	42844.55	2504.28	693.97	1.54	1808.76	NO, NA	NO, NA
2006	72948.89	4120.48	426.90	NO, NA	3693.58	NO, NA	NO, NA
2007	54500.30	3098.51	621.84	0.62	2476.05	NO, NA	NO, NA
2008	37443.36	2134.54	250.45	1.53	1882.56	NO, NA	NO, NA
2009	41488.87	2338.45	186.31	0.73	2151.40	NO, NA	NO, NA
2010	42212.27	2384.64	211.19	2.06	2171.39	NO, NA	NO, NA
Decrease 1989 - 2010	–	–	–	–	–	–	–
Decrease 1990 - 2010	–	–	–	–	–	–	–
Decrease 2009 - 2010	-1.74	-1.98	-13.35	-182.80	_	_	_

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 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 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 - 2010 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007 – 2010 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 – 2010 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 – 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, and precursors gases** - EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.4.a. Other Sectors - Commercial/Institutional.

The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.

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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

- Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting, are used;
- For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
- For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

- Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

- For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.

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

3.2.10.2.6 Source-specific planned improvements, if applicable

See the chapter 3.2.6.6 for more details.

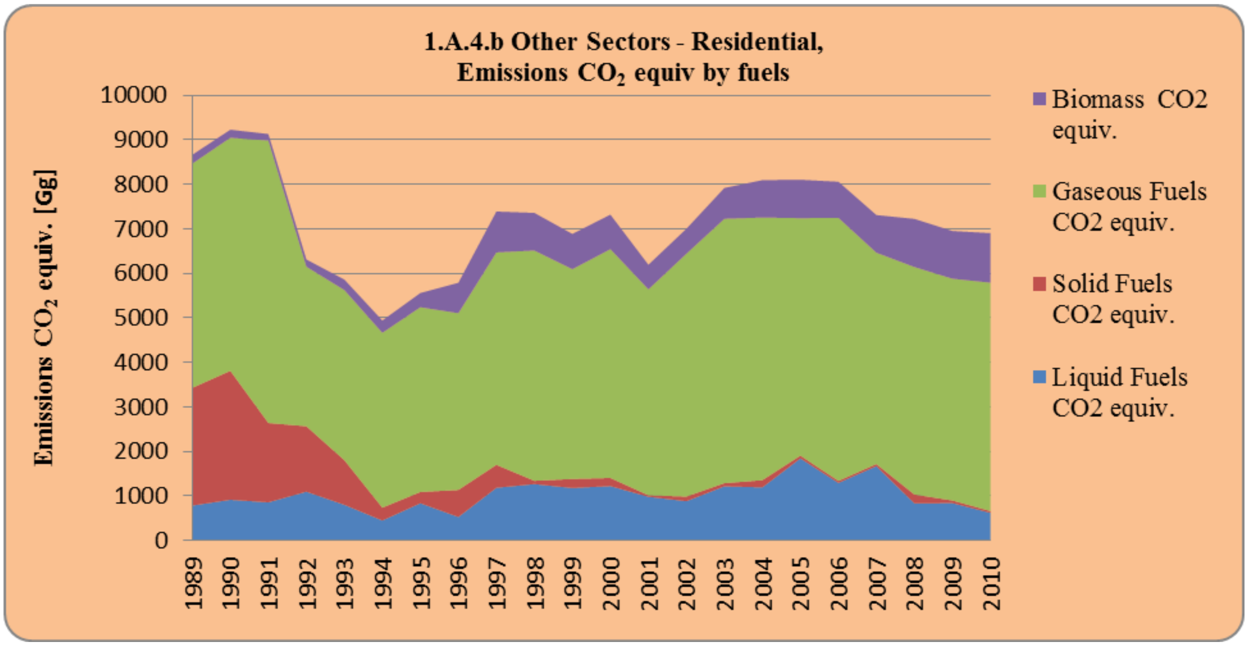
3.2.10.3 Fuel combustion, Other Sectors – Residential (CRF category 1.A.4.b)

3.2.10.3.1 Source description

CRF category 1.A.4.b - Residential is a key category by solid – trend excluding and including LULUCF and key category by gaseous and biomass fuels, level and trend, including and excluding LULUCF.

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 3.31 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 68%, current year, 2010. The contribution of this category is about 6905.277 Gg CO_2 equiv., in 2010. 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 3.88 CO_2 emissions in 1.A.4.a. – Residential

CO_2 [Gg]	1A.4.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	8280.80	782.26	2471.95	5026.59	2921.07	NO, NA
1990	8842.64	912.13	2705.67	5224.84	2698.98	NO, NA
1991	8851.60	853.82	1666.25	6331.53	2181.42	NO, NA
1992	6043.05	1092.53	1373.57	3576.95	2400.27	NO, NA
1993	5548.83	798.20	937.42	3813.21	3507.62	NO, NA
1994	4635.21	447.88	267.98	3919.35	4130.22	NO, NA
1995	5212.33	835.09	234.96	4142.28	4707.70	NO, NA
1996	5056.13	526.96	568.43	3960.74	10143.50	NO, NA
1997	6422.49	1180.03	481.48	4760.98	13645.97	NO, NA
1998	6492.60	1262.36	69.30	5160.93	12564.61	NO, NA
1999	6066.85	1174.96	189.80	4702.09	11769.74	NO, NA
2000	6517.16	1217.29	170.37	5129.50	11505.20	NO, NA
2001	5626.20	980.98	29.53	4615.70	8210.27	NO, NA
2002	6419.81	880.73	97.32	5441.75	8328.54	NO, NA
2003	7205.15	1213.47	65.52	5926.16	10284.06	NO, NA
2004	7227.30	1190.18	151.85	5885.27	12475.90	NO, NA
2005	7219.90	1840.17	56.35	5323.38	12812.24	NO, NA
2006	7226.63	1290.21	41.69	5894.72	12055.57	NO, NA
2007	6445.69	1665.18	43.55	4736.95	12572.45	NO, NA
2008	6116.62	832.67	185.07	5098.89	16053.07	NO, NA
2009	5863.59	839.29	53.21	4971.09	15917.89	NO, NA
2010	5775.36	619.51	37.34	5118.52	16535.12	NO, NA
Decrease 1989 - 2010	30.26	20.81	98.49	-1.83	-466.06	_
Decrease 1990 - 2010	34.69	32.08	98.62	2.04	-512.64	_
Decrease 2009 - 2010	1.50	26.19	29.83	-2.97	-3.88	_

Table 3.89 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, NA
1990	16.2615	0.0888	8.4706	0.4727	7.2294	NO, NA
1991	11.6774	0.0798	5.1817	0.5728	5.8431	NO, NA
1992	11.1095	0.1150	4.2416	0.3236	6.4293	NO, NA
1993	12.7084	0.0770	2.8910	0.3450	9.3954	NO, NA
1994	12.2957	0.0399	0.8381	0.3546	11.0631	NO, NA
1995	13.8067	0.0818	0.7402	0.3748	12.6099	NO, NA
1996	29.3209	0.0457	1.7468	0.3583	27.1701	NO, NA
1997	38.5826	0.1186	1.4815	0.4307	36.5517	NO, NA
1998	34.4637	0.1299	0.2117	0.4669	33.6552	NO, NA
1999	32.6533	0.1146	0.5872	0.4254	31.5261	NO, NA
2000	31.9336	0.1224	0.5296	0.4641	30.8175	NO, NA
2001	22.5854	0.0870	0.0890	0.4176	21.9918	NO, NA
2002	23.1685	0.0711	0.2964	0.4923	22.3086	NO, NA
2003	28.3890	0.1080	0.1982	0.5362	27.5466	NO, NA
2004	34.5213	0.1119	0.4593	0.5325	33.4176	NO, NA
2005	35.1370	0.1664	0.1705	0.4816	34.3185	NO, NA
2006	33.0783	0.1272	0.1261	0.5333	32.2917	NO, NA
2007	34.4044	0.1598	0.1356	0.4328	33.6762	NO, NA
2008	44.1294	0.0822	0.5897	0.4582	42.9993	NO, NA
2009	43.3302	0.0694	0.1741	0.4494	42.6372	NO, NA
2010	44.9276	0.0500	0.1253	0.4617	44.2905	NO, NA
Decrease 1989 - 2010	-179.25	33.32	98.38	-1.53	-466.06	_
Decrease 1990 - 2010	-176.28	43.63	98.52	2.32	-512.64	_
Decrease 2009 - 2010	-3.69	27.93	28.04	-2.74	-3.88	_

Table 3.90 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, NA
1990	0.14861	0.00324	0.03953	0.00945	0.09639	NO, NA
1991	0.11621	0.00266	0.02418	0.01146	0.07791	NO, NA
1992	0.11709	0.00510	0.01979	0.00647	0.08572	NO, NA
1993	0.14851	0.00285	0.01349	0.00690	0.12527	NO, NA
1994	0.15969	0.00118	0.00391	0.00709	0.14751	NO, NA
1995	0.18219	0.00311	0.00345	0.00750	0.16813	NO, NA
1996	0.37883	0.00124	0.00815	0.00717	0.36227	NO, NA
1997	0.50763	0.00475	0.00691	0.00861	0.48736	NO, NA
1998	0.46447	0.00541	0.00099	0.00934	0.44874	NO, NA
1999	0.43589	0.00429	0.00274	0.00851	0.42035	NO, NA
2000	0.42754	0.00489	0.00247	0.00928	0.41090	NO, NA
2001	0.30456	0.00257	0.00042	0.00835	0.29322	NO, NA
2002	0.31016	0.00149	0.00138	0.00985	0.29745	NO, NA
2003	0.38218	0.00325	0.00092	0.01072	0.36729	NO, NA
2004	0.46216	0.00380	0.00214	0.01065	0.44557	NO, NA
2005	0.47332	0.00532	0.00080	0.00963	0.45758	NO, NA
2006	0.44677	0.00496	0.00059	0.01067	0.43056	NO, NA
2007	0.46421	0.00590	0.00063	0.00866	0.44902	NO, NA
2008	0.58840	0.00316	0.00275	0.00916	0.57332	NO, NA
2009	0.57989	0.00160	0.00081	0.00899	0.56850	NO, NA
2010	0.60141	0.00105	0.00058	0.00923	0.59054	NO, NA
Decrease 1989 - 2010	-295.22572	60.50087	98.37976	-1.53275	-466.06342	_
Decrease 1990 - 2010	-304.68211	67.62249	98.52051	2.31994	-512.64420	_
Decrease 2009 - 2010	-3.71026	34.30163	28.03775	-2.74257	-3.87760	_

Table 3.91 GHG emissions in 1.A.4.b. – Residential

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1.A.4.b Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	154944.5	8297.0	782.3	2479.7	5027.0	2929.0	NO, NA
1990	160973.9	8859.1	912.2	2714.2	5225.3	2706.3	NO, NA
1991	164615.2	8863.4	853.9	1671.5	6332.1	2187.3	NO, NA
1992	116294.8	6054.3	1092.7	1377.8	3577.3	2406.8	NO, NA
1993	122085.4	5561.7	798.3	940.3	3813.6	3517.1	NO, NA
1994	117608.2	4647.7	447.9	268.8	3919.7	4141.4	NO, NA
1995	132136.6	5226.3	835.2	235.7	4142.7	4720.5	NO, NA
1996	176379.9	5085.8	527.0	570.2	3961.1	10171.0	NO, NA
1997	230707.2	6461.6	1180.2	483.0	4761.4	13683.0	NO, NA
1998	225235.0	6527.5	1262.5	69.5	5161.4	12598.7	NO, NA
1999	210032.4	6099.9	1175.1	190.4	4702.5	11801.7	NO, NA
2000	215682.6	6549.5	1217.4	170.9	5130.0	11536.4	NO, NA
2001	172441.7	5649.1	981.1	29.6	4616.1	8232.6	NO, NA
2002	187885.5	6443.3	880.8	97.6	5442.3	8351.2	NO, NA
2003	218602.6	7233.9	1213.6	65.7	5926.7	10312.0	NO, NA
2004	237897.3	7262.3	1190.3	152.3	5885.8	12509.8	NO, NA
2005	239603.6	7255.5	1840.3	56.5	5323.9	12847.0	NO, NA
2006	234134.1	7260.2	1290.3	41.8	5895.3	12088.3	NO, NA
2007	224462.3	6480.6	1665.3	43.7	4737.4	12606.6	NO, NA
2008	249575.4	6161.3	832.8	185.7	5099.4	16096.6	NO, NA
2009	245957.9	5907.5	839.4	53.4	4971.5	15961.1	NO, NA
2010	250290.5	5820.9	619.6	37.5	5119.0	16580.0	NO, NA
Decrease 1989 - 2010	-61.54	29.84	20.81	98.49	-1.83	-466.06	_
Decrease 1990 - 2010	-55.49	34.29	32.08	98.62	2.04	-512.64	_
Decrease 2009 - 2010	-1.76	1.47	26.19	29.82	-2.97	-3.88	_

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 - 2010 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007 – 2010 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 – 2010 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 – 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, and precursors gases** - EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.4.b. Other Sectors - Residential.
The results of the combined uncertainty are, as follows:

CO_2 gas

- ❖ Liquid Fuels - 5.831 %
- ❖ Solid Fuels - 5.385 %
- ❖ Gaseous Fuels - 5.385 %
- ❖ Other (Industrial Wastes) - 7.071 %

CH_4 gas

- ❖ Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- ❖ Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.
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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

- Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting, are used;
- For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
- For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.
For more details and effect of the activity data changes on the emissions estimation, see the chapter 3.2.6.5.

3.2.10.3.6 Source-specific planned improvements, if applicable

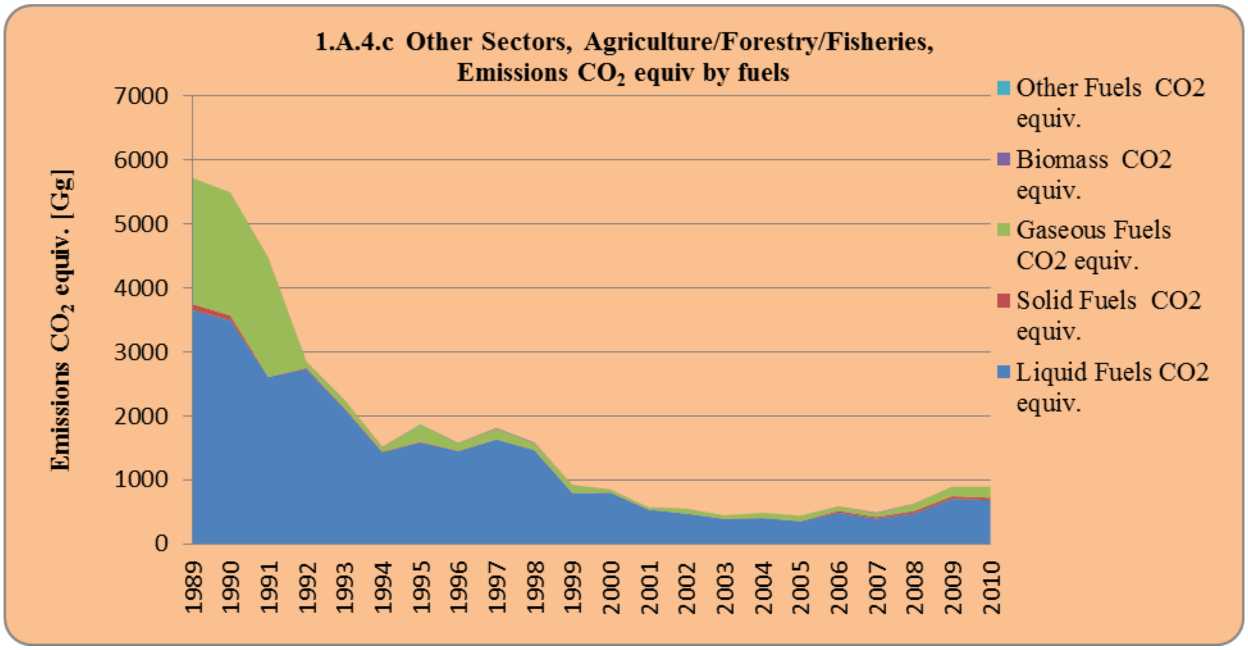
See the chapter 3.2.6.6 for more details.

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

3.2.10.4.1 Source description

CRF category 1.A.4.c. - Agriculture/ Forestry/ Fisheries is a key category by liquid, level and trend including and excluding LULUCF and key category by gaseous fuels – level and trend excluding LULUCF and trend including LULUCF.
See more details about trends and key categories in the chapters 3.1 – Overview of the sector and 3.2.6 Source category - Fuel combustion (CRF sector 1.A.).

Figure 3.32 GHG emissions 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 8.8%, current year, 2010. The contribution of this category is about 895.5456 Gg CO_2 equiv., in 2010. It is observed a main contribution of the liquid fuel combustion in this activity category, on the entire time-series.

Table 3.92 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	5688.171	3634.199	89.943	1964.029	NO, NA	NO, NA
1990	5465.703	3479.233	67.404	1919.066	NO, NA	NO, NA
1991	4447.291	2596.815	NO, NA	1850.476	47.040	NO, NA
1992	2830.333	2721.842	13.541	94.951	58.352	NO, NA
1993	2236.660	2096.154	18.050	122.457	55.104	NO, NA
1994	1504.458	1424.224	10.550	69.684	79.408	NO, NA
1995	1857.532	1580.101	8.401	262.023	44.352	7.007
1996	1569.427	1442.220	5.795	121.412	52.416	NO, NA
1997	1791.869	1624.303	2.235	165.331	144.592	NO, NA
1998	1569.867	1455.595	7.035	107.236	140.336	NO, NA
1999	911.477	793.406	0.788	117.284	67.648	NO, NA
2000	847.629	797.272	0.922	49.291	15.344	0.143
2001	570.596	534.534	0.710	35.066	19.152	0.286
2002	548.191	472.440	NO, NA	75.752	19.040	NO, NA
2003	444.650	390.491	1.542	52.474	8.064	0.143
2004	484.433	403.117	1.542	79.632	7.280	0.143
2005	438.064	353.240	0.772	83.909	12.768	0.143
2006	583.751	487.297	27.336	68.689	28.448	0.429
2007	474.517	394.809	22.131	57.577	175.168	NO, NA
2008	623.703	475.938	36.885	110.879	62.832	NO, NA
2009	886.478	703.150	38.730	144.598	46.816	NO, NA
2010	887.267	681.674	35.041	170.552	31.920	NO, NA
Decrease 1989 - 2010	84.40	81.24	61.04	91.32	_	_
Decrease 1990 - 2010	83.77	80.41	48.01	91.11	_	_
Decrease 2009 - 2010	-0.09	3.05	9.52	-17.95	31.82	_

Table 3.93 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	0.9444	0.4929	0.2739	0.1777	NO, NA	NO, NA
1990	0.8510	0.4718	0.2056	0.1736	NO, NA	NO, NA
1991	0.6455	0.3521	NO, NA	0.1674	0.1260	NO, NA
1992	0.5758	0.3693	0.0416	0.0086	0.1563	NO, NA
1993	0.4963	0.2843	0.0533	0.0111	0.1476	NO, NA
1994	0.4435	0.1931	0.0314	0.0063	0.2127	NO, NA
1995	0.3961	0.2143	0.0246	0.0237	0.1188	0.0147
1996	0.3642	0.1958	0.0171	0.0110	0.1404	NO, NA
1997	0.6293	0.2203	0.0068	0.0150	0.3873	NO, NA
1998	0.6030	0.1970	0.0204	0.0097	0.3759	NO, NA
1999	0.3019	0.1077	0.0024	0.0106	0.1812	NO, NA
2000	0.1566	0.1081	0.0026	0.0045	0.0411	0.0003
2001	0.1296	0.0724	0.0021	0.0032	0.0513	0.0006
2002	0.1220	0.0641	NO, NA	0.0069	0.0510	NO, NA
2003	0.0843	0.0530	0.0047	0.0047	0.0216	0.0003
2004	0.0862	0.0545	0.0047	0.0072	0.0195	0.0003
2005	0.0922	0.0478	0.0023	0.0076	0.0342	0.0003
2006	0.2273	0.0656	0.0784	0.0062	0.0762	0.0009
2007	0.5906	0.0528	0.0633	0.0053	0.4692	NO, NA
2008	0.3430	0.0593	0.1055	0.0100	0.1683	NO, NA
2009	0.3388	0.0895	0.1108	0.0131	0.1254	NO, NA
2010	0.2902	0.0891	0.1002	0.0154	0.0855	NO, NA
Decrease 1989 - 2010	69.27	81.91	63.41	91.34	_	_
Decrease 1990 - 2010	65.89	81.11	51.25	91.14	_	_
Decrease 2009 - 2010	14.32	0.43	9.52	-17.69	31.82	_

Table 3.94 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, NA	NO, NA
1990	0.03274	0.02831	0.00096	0.00347	NO, NA	NO, NA
1991	0.02615	0.02113	NO, NA	0.00335	0.00168	NO, NA
1992	0.02461	0.02216	0.00019	0.00017	0.00208	NO, NA
1993	0.01950	0.01706	0.00025	0.00022	0.00197	NO, NA
1994	0.01469	0.01159	0.00015	0.00013	0.00284	NO, NA
1995	0.01523	0.01286	0.00011	0.00047	0.00158	0.00020
1996	0.01392	0.01175	0.00008	0.00022	0.00187	NO, NA
1997	0.01871	0.01322	0.00003	0.00030	0.00516	NO, NA
1998	0.01709	0.01179	0.00010	0.00019	0.00501	NO, NA
1999	0.00910	0.00646	0.00001	0.00021	0.00242	NO, NA
2000	0.00713	0.00648	0.00001	0.00009	0.00055	0.00000
2001	0.00510	0.00433	0.00001	0.00006	0.00068	0.00001
2002	0.00466	0.00385	NO, NA	0.00014	0.00068	NO, NA
2003	0.00359	0.00318	0.00002	0.00009	0.00029	0.00000
2004	0.00369	0.00326	0.00002	0.00014	0.00026	0.00000
2005	0.00348	0.00286	0.00001	0.00015	0.00046	0.00000
2006	0.00541	0.00390	0.00037	0.00012	0.00102	0.00001
2007	0.00979	0.00313	0.00030	0.00011	0.00626	NO, NA
2008	0.00617	0.00324	0.00049	0.00020	0.00224	NO, NA
2009	0.00751	0.00506	0.00052	0.00026	0.00167	NO, NA
2010	0.00704	0.00513	0.00047	0.00031	0.00114	NO, NA
Decrease 1989 - 2010	79.53	82.66	63.41	91.34	_	_
Decrease 1990 - 2010	78.49	81.89	51.25	91.14	_	_
Decrease 2009 - 2010	6.27	-1.26	9.52	-17.69	31.82	_

Table 3.95 GHG emissions in 1.A.4.c. - Agriculture/Forestry/Fisheries

Year/GHG emissions by category [Gg]	Total fuel consumption [TJ]	1.A.4.c Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1989	85737.18	5689.15	3634.72	90.22	1964.21	NO, NA	NO, NA
1990	82592.04	5466.59	3479.73	67.61	1919.24	NO, NA	NO, NA
1991	69112.31	4447.96	2597.19	NO, NA	1850.65	47.17	NO, NA
1992	39306.91	2830.93	2722.23	13.58	94.96	58.51	NO, NA
1993	31317.67	2237.18	2096.46	18.10	122.47	55.25	NO, NA
1994	21383.43	1504.92	1424.43	10.58	69.69	79.62	NO, NA
1995	26697.61	1857.94	1580.33	8.43	262.05	44.47	7.02
1996	22297.56	1569.81	1442.43	5.81	121.42	52.56	NO, NA
1997	26335.74	1792.52	1624.54	2.24	165.35	144.98	NO, NA
1998	23037.27	1570.49	1455.80	7.06	107.25	140.72	NO, NA
1999	13499.90	911.79	793.52	0.79	117.29	67.83	NO, NA
2000	11873.01	847.79	797.39	0.92	49.30	15.39	0.14
2001	8075.75	570.73	534.61	0.71	35.07	19.20	0.29
2002	7951.65	548.32	472.51	NO, NA	75.76	19.09	NO, NA
2003	6335.66	444.74	390.55	1.55	52.48	8.09	0.14
2004	7001.26	484.52	403.17	1.55	79.64	7.30	0.14
2005	6442.53	438.16	353.29	0.77	83.92	12.80	0.14
2006	8415.44	583.98	487.37	27.41	68.70	28.53	0.43
2007	8204.18	475.12	394.86	22.19	57.58	175.64	NO, NA
2008	9627.04	624.05	476.00	36.99	110.89	63.00	NO, NA
2009	13125.30	886.82	703.24	38.84	144.61	46.94	NO, NA
2010	13164.57	887.56	681.77	35.14	170.57	32.01	NO, NA
Decrease 1989 - 2010	84.65	84.40	81.24	61.05	91.32	_	_
Decrease 1990 - 2010	84.06	83.76	80.41	48.02	91.11	_	_
Decrease 2009 - 2010	-0.30	-0.08	3.05	9.52	-17.95	31.82	_

3.2.10.4.2 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 - 2010 period

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007 – 2010 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 – 2010 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 – 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, and precursors gases** - EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.4.c. Other Sectors - Agriculture/Forestry/Fisheries.
The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.
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 recalculations, if applicable, including changes made in response to the review process

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

- Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting, are used;
- For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
- For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.

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

3.2.10.4.6 . Source-specific planned improvements, if applicable1.A.4.c. Agriculture/ Forestry/ Fisheries

See the chapter 3.2.6.6 for more details.

3.2.11 Fuel combustion, Other (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 and solid fuels, trend, including and excluding LULUCF.

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.

Table 3.96 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	2174.8	1359.8	815.1	NO, NA	NO, NA	NO, NA
1990	2500.8	1310.2	1190.6	NO, NA	NO, NA	NO, NA
1991	2267.4	1294.6	972.8	NO, NA	785.5	NO, NA
1992	671.3	105.8	565.5	NO, NA	103.5	NO, NA
1993	307.6	262.1	45.4	NO, NA	196.8	NO, NA
1994	429.1	380.8	48.3	NO, NA	193.3	NO, NA
1995	617.7	429.0	30.0	NO, NA	181.2	158.7
1996	275.7	253.2	22.5	NO, NA	354.5	NO, NA
1997	7.0	NO, NA	7.0	NO, NA	247.3	NO, NA
1998	698.4	688.1	10.3	NO, NA	138.5	NO, NA
1999	109.5	109.5	NO, NA	NO, NA	247.5	NO, NA
2000	294.6	181.7	NO, NA	NO, NA	78.6	113.0
2001	429.4	331.9	NO, NA	NO, NA	614.4	97.5
2002	294.6	247.2	13.7	NO, NA	713.1	33.7
2003	390.7	360.1	NO, NA	NO, NA	690.7	30.6
2004	693.0	595.4	68.8	NO, NA	569.4	28.7
2005	1239.1	1192.5	39.3	NO, NA	871.2	7.3
2006	584.4	563.6	10.6	NO, NA	809.9	10.2
2007	943.2	938.3	4.8	NO, NA	675.4	NO, NA
2008	816.4	816.4	NO, NA	NO, NA	623.5	NO, NA
2009	270.9	270.9	NO, NA	NO, NA	553.5	NO, NA
2010	270.6	270.6	NO, NA	NO, NA	580.5	NO, NA
Decrease 1989 - 2010	13.4	13.0	_	_	7.7	_
Decrease 1990 - 2010	66.8	66.8	_	_	11.2	_
Decrease 2009 - 2010	0.1	0.1	_	_	-4.9	_

Table 3.97 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	0.121	0.037	0.084	NO, NA	NO, NA	NO, NA
1990	0.159	0.036	0.123	NO, NA	NO, NA	NO, NA
1991	2.240	0.035	0.101	NO, NA	2.104	NO, NA
1992	0.341	0.005	0.059	NO, NA	0.277	NO, NA
1993	0.539	0.007	0.005	NO, NA	0.527	NO, NA
1994	0.533	0.010	0.005	NO, NA	0.518	NO, NA
1995	0.833	0.012	0.003	NO, NA	0.485	0.333
1996	0.959	0.007	0.002	NO, NA	0.950	NO, NA
1997	0.663	NO, NA	0.001	NO, NA	0.662	NO, NA
1998	0.391	0.019	0.001	NO, NA	0.371	NO, NA
1999	0.666	0.003	NO, NA	NO, NA	0.663	NO, NA
2000	0.453	0.005	NO, NA	NO, NA	0.211	0.237
2001	1.859	0.009	NO, NA	NO, NA	1.646	0.205
2002	1.989	0.007	0.001	NO, NA	1.910	0.071
2003	1.924	0.010	NO, NA	NO, NA	1.850	0.064
2004	1.609	0.016	0.007	NO, NA	1.525	0.060
2005	2.385	0.032	0.004	NO, NA	2.334	0.015
2006	2.207	0.015	0.001	NO, NA	2.169	0.021
2007	1.913	0.025	0.000	NO, NA	1.887	NO, NA
2008	1.765	0.022	NO, NA	NO, NA	1.743	NO, NA
2009	1.563	0.007	NO, NA	NO, NA	1.556	NO, NA
2010	1.645	0.007	NO, NA	NO, NA	1.638	NO, NA
Decrease 1989 - 2010	7.7	12.4	_	_	7.6	_
Decrease 1990 - 2010	11.5	67.2	_	_	10.8	_
Decrease 2009 - 2010	-5.3	-1.2	_	_	-5.3	_

Table 3.98 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, NA	NO, NA	NO, NA
1990	0.0279	0.0106	0.0172	NO, NA	NO, NA	NO, NA
1991	0.0528	0.0106	0.0141	NO, NA	0.0281	NO, NA
1992	0.0125	0.0006	0.0082	NO, NA	0.0037	NO, NA
1993	0.0098	0.0021	0.0006	NO, NA	0.0070	NO, NA
1994	0.0107	0.0031	0.0007	NO, NA	0.0069	NO, NA
1995	0.0148	0.0035	0.0004	NO, NA	0.0065	0.0044
1996	0.0150	0.0020	0.0003	NO, NA	0.0127	NO, NA
1997	0.0089	NO, NA	0.0001	NO, NA	0.0088	NO, NA
1998	0.0107	0.0056	0.0001	NO, NA	0.0049	NO, NA
1999	0.0097	0.0009	NO, NA	NO, NA	0.0088	NO, NA
2000	0.0074	0.0015	NO, NA	NO, NA	0.0028	0.0032
2001	0.0274	0.0027	NO, NA	NO, NA	0.0219	0.0027
2002	0.0286	0.0020	0.0002	NO, NA	0.0255	0.0009
2003	0.0285	0.0029	NO, NA	NO, NA	0.0247	0.0009
2004	0.0270	0.0049	0.0010	NO, NA	0.0203	0.0008
2005	0.0415	0.0096	0.0006	NO, NA	0.0311	0.0002
2006	0.0340	0.0046	0.0001	NO, NA	0.0289	0.0003
2007	0.0334	0.0076	0.0001	NO, NA	0.0257	NO, NA
2008	0.0304	0.0067	NO, NA	NO, NA	0.0237	NO, NA
2009	0.0234	0.0022	NO, NA	NO, NA	0.0212	NO, NA
2010	0.0246	0.0022	NO, NA	NO, NA	0.0224	NO, NA
Decrease 1989 - 2010	8.9	12.4	_	_	7.6	_
Decrease 1990 - 2010	23.0	67.2	_	_	10.5	_
Decrease 2009 - 2010	-5.1	-1.2	_	_	-5.5	_

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.5 – Other.

For the liquid and gaseous fuels, being a mix between import and exports supply, 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 analyze, 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, 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.

<u>For the 2007 - 2010 period</u>

- **Solid Fuels**, EFs calculated as weighted arithmetic average (WA), on each year of 2007 – 2010 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 – 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, and precursors gases** - EFs default 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 uncertainty was estimated using the key categories analysis ranking, formula 64, chapter 6, GPG 2000, in 1.A.5.a. Other - Stationary.

The results of the combined uncertainty are, as follows:

CO_2 gas

- Liquid Fuels - 5.831 %
- Solid Fuels - 5.385 %
- Gaseous Fuels - 5.385 %
- Other (Industrial Wastes) - 7.071 %

CH_4 gas

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 20.615 %

N_2O

- Liquid Fuels, Solid Fuels, Gaseous Fuels, Biomass, Other (Industrial Wastes) - 200.0625 %

The uncertainties used in calculating combined uncertainty are the same as those for the Energy Industries category.

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

Activity Data

Recalculations for the 1989 – 2009 period due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

Emission Factors

Recalculations for the 1989 – 2009 period, due to the new calculated emission factors and due to the change of the source of the Activity Data.

CO_2 Emission Factors

Country Specific Emission Factors for the analyzed fuels (liquid, solid and biomass) on EU-ETS reporting, are used;
For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used;
For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

❖ Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

SO_2 Emission Factors

For Solid fuels, Liquid fuels, Gaseous fuels and Biomass, the default EFs from the site EMEP/EEA Air Pollutant Emission Inventory Guidebook — 2009, were used.
For more details and effect of the activity data changes on the emissions estimation, see the chapter 3.2.6.5.

3.2.11.6 Source-specific planned improvements, if applicable

See the chapter 3.2.6.6 for more details.

3.3 Fugitive emissions from Solid Fuels and Oil and Natural Gas (CRF 1.B)

3.3.1 Overview of the subsector

This chapter provides information on the estimation of the greenhouse gas emissions from the Fugitive Emissions 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;

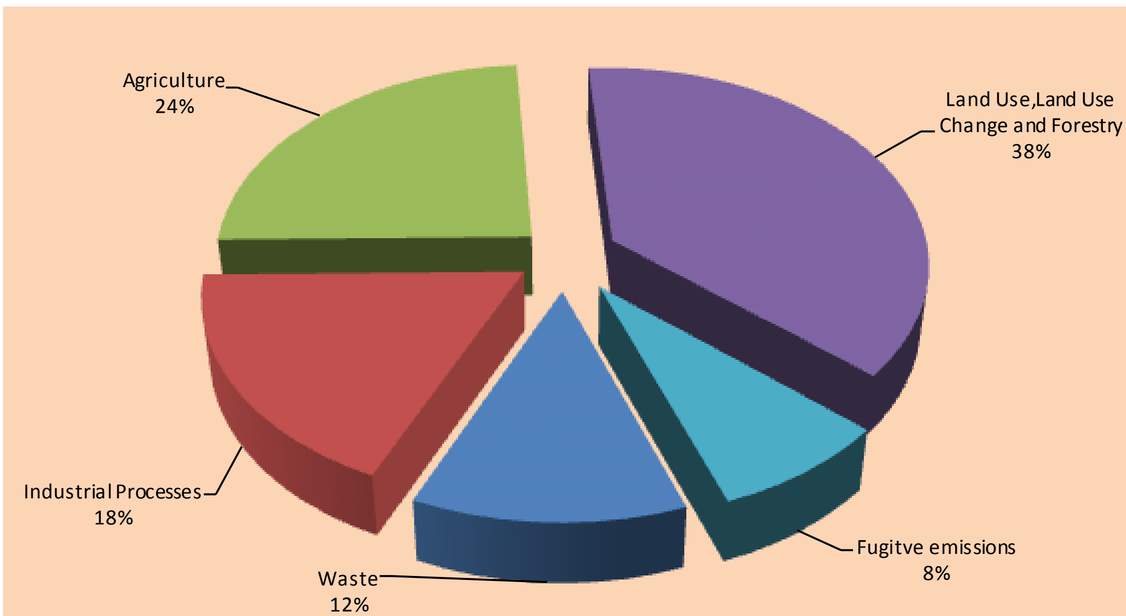
Table 3.99 Status of the direct GHG emissions estimation in the Fugitive Emissions Subsector

IPCC category	Emissions estimation status		
	CO_2	CH_4	N_2O
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 activities	NA	✓	NA
1.B.1.a.i.1. Surface mines	NA	✓	NA
1.B.1.a.i.1. Post - Mining Surface activities	NA	✓	NA
1.B.1.b. Solid fuel transformation	NA	✓	NA
1.B.1.c. Other	NA	NA	NA
1.B.2. Oil and Natural Gas			
1.B.2.a. Oil	✓	✓	✓
1.B.2.a.i. Venting oil	✓	✓	NA
1.B.2.a.ii. Flaring oil	✓	✓	✓
1.B.2.a.iii.1. Exploration	✓	✓	NA
1.B.2.a.iii.2. Production and upgrading	✓	✓	NA
1.B.2.a.iii.3. Transport	✓	✓	NA
1.B.2.a.iii.4. Refining and storage	NA	✓	NA
1.B.2.a.iii.5. Distribution of oil products	NA	NA	NA
1.B.2.a.iii.6. Other	NO	NO	NO
1.B.2.b. Natural Gas	✓	✓	✓
1.B.2.b.i. Venting gas	✓	✓	NA
1.B.2.b.ii. Flaring gas	✓	✓	✓
1.B.2.b.iii.1. Exploration	IE[1)]	IE[1)]	NA
1.B.2.b.iii.2. Production/Processing	NA	✓	NA
1.B.2.b.iii.3. Transmission	✓	✓	NA
1.B.2.b.iii.4. Distribution and storage	✓	✓	NA
1.B.2.b.iii.5. Other Leakage	✓	✓	NA
1.B.2.b.iii.5.1. at industrial plants and power station	✓	✓	NA
1.B.2.b.5.iii.2. in the residential and commercial sectors	✓	✓	NA
1.B.2.b.iii.6. Other	NA	NA	NA

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

In 2010 GHG emissions from the Fugitive Emissions Subsector were estimated to 8474.67 Gg CO_2 equivalent, which represent 8% of the total national GHG emissions in this year (figure 33).

Figure 3.33 The contribution of Fugitive Emissions Subsector to the total GHG emissions in Romania, 2010



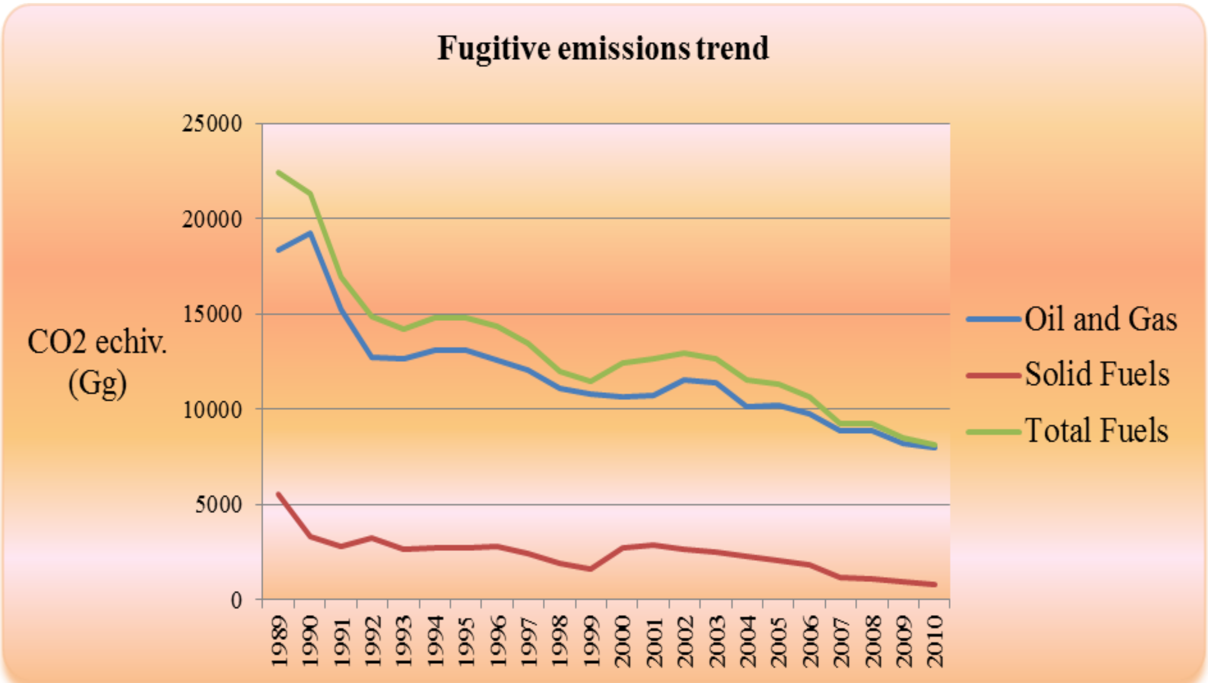
In the base year (1989), the total GHG emissions from the fugitive emissions subsector amounted to 23397.01Gg CO_2 equivalent, which accounted for 8,18% of the total national GHG emissions. Compared with the other sectors, emissions from the fugitive emissions subsector showed a significant decrease from the base year, with 36,69%.

Table 3.100 The contribution of Fugitive Emissions Subsector to the total GHG emissions in Romania, for 1989–2010 period

Year	Total GHG emissions (excl. LULUCF) [Gg CO_2 equiv.]	GHG emissions from Fugitive Emissions [Gg CO_2 equiv.]	Contribution of Fugitive Emissions in total GHG emissions [%]
1989	285,936.60	23,397.01	8.18
1990	253,623.02	21,808.90	8.60
1991	206,527.25	17,284.96	8.37
1992	179,963.18	15,218.54	8.46
1993	175,769.10	14,588.89	8.30
1994	173,322.96	15,191.14	8.76
1995	181,544.14	15,204.86	8.38
1996	183,713.86	14,799.61	8.06
1997	170,214.68	13,915.78	8.18
1998	153,659.63	12,412.58	8.08
1999	136,487.02	11,900.13	8.72
2000	140,809.66	12,854.81	9.13
2001	143,401.91	13,102.30	9.14
2002	147,456.21	13,716.01	9.30
2003	153,347.79	13,392.05	8.73
2004	150,993.38	12,019.94	7.96
2005	149,179.28	11,855.20	7.95
2006	153,081.84	11,200.57	7.32
2007	150,536.42	9,731.22	6.46
2008	146,956.16	9,648.39	6.57
2009	123,673.12	8,843.48	7.15
2010	121,645.37	8,474.67	6.97

In 2003-2009 period, GHG emissions began to reduce, this decrease has been set to a value of 7.15% decrease in 2009 compared to 2003-2004.

Figure 3.34 Total GHG emissions trend from Fugitive Emissions Subsector for 1989–2010 period



The most important GHG emissions are resulting from category Oil and Natural Gas (1.B.2.) responsible for 90,76% in total GHG emissions from this subsector and category Solid Fuels (1.B.1.) contributes with 9,24% in the total GHG emissions from Fugitive Emissions. These two categories of subsector are key category sources: by level for CH_4 and CO_2 emissions from 1.B.2.*Oil and Natural Gas* and level and trend for CH_4 emissions from 1.B.1.*Solid Fuels*.

Table 3.101 Key categories in Fugitive Emissions Subsector based on the level and trend assessment in 2010

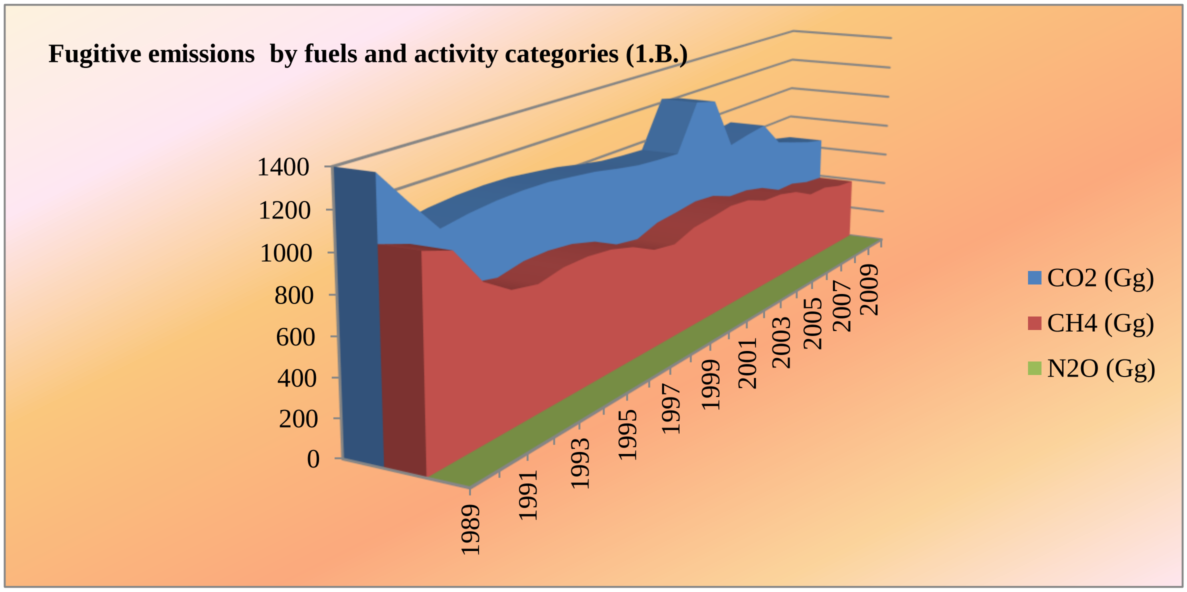
Key category	Direct GHG	Criteria for identification (excluding LULUCF)	Contribution of key category in total GHG emissions [%]	Criteria for identification (including LULUCF)	Contribution of key category in total GHG emissions [%]
1.B.1. Solid fuels	CH_4	**L, T**	0.64	**L, T**	0.52
1.B.2. Oil and Natural Gas	CH_4	**L**	5.83	**L, T**	4.71
	CO_2	**L**	0.53	**L**	0.43

The direct GHG emissions from Fugitive Emissions per gas are presented in T*able 3.100.* Methane represents the major greenhouse gas from this subsector with a contribution of 35,62% to the total CH_4 emissions in Romania, in 2010. In the same year, CO_2 emissions has a contribution of 0,75% and N_2O has a contribution of 0,02% to the total emissions in our country.

Table 3.102 GHG emissions from Fugitive Emissions Subsector per gas and contribution of these in total GHG emissions from Fugitive Emissions Subsector for the 1989 – 2010 period

Year	Total emissions from Fugitive Emissions [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	23,397.01	21,992.84	94.00	1,399.94	5.86	4.23	0.018
1990	21,808.90	20,592.12	94.42	1,213.18	5.38	3.60	0.017
1991	17,284.96	16,246.86	93.99	1,035.01	5.75	3.09	0.018
1992	15,218.54	14,157.42	93.03	1,057.95	6.65	3.17	0.021
1993	14,588.89	13,514.81	92.64	1,070.86	7.02	3.21	0.022
1994	15,191.14	14,113.89	92.91	1,074.03	6.78	3.22	0.021
1995	15,204.86	14,133.15	92.95	1,068.50	6.75	3.21	0.021
1996	14,799.61	13,746.18	92.88	1,050.28	6.82	3.16	0.021
1997	13,915.78	12,881.68	92.57	1,030.99	7.12	3.10	0.022
1998	12,412.58	11,408.06	91.91	1,001.52	7.73	3.01	0.024
1999	11,900.13	10,921.64	91.78	975.55	7.85	2.94	0.025
2000	12,854.81	11,889.84	92.49	962.06	7.21	2.90	0.023
2001	13,102.30	12,146.66	92.71	952.77	7.02	2.87	0.022
2002	13,716.01	12,490.43	91.06	1,221.88	8.63	3.70	0.027
2003	13,392.05	12,199.41	91.09	1,189.03	8.61	3.60	0.027
2004	12,019.94	11,140.01	92.68	877.29	7.07	2.64	0.022
2005	11,855.20	10,951.40	92.38	901.09	7.37	2.72	0.023
2006	11,200.57	10,278.95	91.77	918.85	7.96	2.78	0.025
2007	9,731.22	8,962.00	92.10	766.91	7.65	2.31	0.024
2008	9,648.39	8,922.40	92.48	723.81	7.28	2.18	0.023
2009	8,843.48	8,159.07	92.26	682.36	7.47	2.06	0.023
2010	8,474.67	7,820.85	92.29	651.85	7.44	1.97	0.023

Figure 3.35 GHG emissions from Fugitive Emissions Subsector per gas



The inventory preparation, including identification of key categories, uncertainty estimates and QC procedures, has to be performed according to the '2000 Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance and Uncertainty Management of Greenhouse Gas Inventories' (IPCC GPG 2000).

According to the thirty-fifth session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) the obligatory use by Parties of the '2006 Intergovernmental Panel on Climate Change Guidelines for national greenhouse gas inventories' (2006 IPCC Guidelines) starts in 2015, in Annex I, Parties are invited to use the revised reporting guidelines voluntarily during a trial period from October 2012 to May 2013.

The GHG inventory for the whole sector 1 B Fugitive emissions is complete revised for the entire time series.

Impacts of recalculations in 2012 inventory submission differ significantly between some years due to changes in activity data level. Following further checks with the National Institute for Statistics, the actual data are correct.

The overall increase of the Fugitive emissions level since comparing to the level in the 2007 inventory submission is due to the changes implemented since 2007 submission:

- in this submission, all emission source are considered according with methodology for Tier 1 of the 2006 IPCC guidelines, Volume 2, Chapter 4;
- compared with 2011 GHG Inventory submission (and all Inventory submission since with 2007), where activity data from domestic Energy Balance used, in this submission, activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and used for estimating the emissions for the years 1990-2010; the National Statistics Institute have not prepared balances in the Eurostat format for the years before 1990, so the IEA Energy balances were used for the year 1989;
- improvements of emission factors, which are taken from the 2006 IPCC guidelines, Volume 2, Chapter 4, in general; for some subsectors it was more applicable to use the EF from the Revised 1996 IPCC GL and IPCC GPG 2000 (emission factor from the Revised 1996 IPCC GL were used for subsectors: 1.B.2.A.4 Oil — Combined EF for Refining and Storage Tank;1.B.2.B.5. Other Leakage - residential and commercial sectors; emission factor from the IPCC GPG 2000 were used for subsectors: 1.B.2.B.2. Production/ Processing; 1.B.2.B.3. Transmission; 1.B.2.B.4. Distribution; 1.B.2.B.5. Other Leakage - at industrial plants and power stations) ;
- improvements due to new categories introduced (solid fuel transformation, exploration, transmission and distribution through pipelines)
- Previous venting and flaring data accuracy was improved, emissions from transport and distribution pipeline were estimated, all notations keys NA, NO and IE were corrected and no notation key NE is used anymore, compared to previous Inventory submissions.

3.3.2 Source category Fugitive Emissions from Solid Fuels (CRF sector 1.B.1)

3.3.2.1 Source category description

The source category "Solid fuels" (1.B.1) consists of three subs - source categories:

- the source category "Coal mining and handling" (1.B.1.a), the source category "Solid fuel transformation" (1.B.1.b) and the source category "Other" (1.B.1.c).

3.3.2.1.1 Coal mining and handling sub-source category (1.B.1.a)

The source category "Coal mining and handling" is a key source of CH_4 emissions in terms of both emissions level and trend.

This source category includes all fugitive emissions from coal.

Romania has superior coal (anthracite and coal) and lowers (brown coal and lignite). Besides these, there are peat coal and shale. Coal in the form of coking coal used in power plants.

In Romania, lignite resources are estimate at 1490 million tones, and coal resources are estimate at 1900 million tones.

After 1989 the extraction of coal was in a continuous process of restructuring in connection with the requirements of the electricity sector and thermal and other industries.

Since 1998, started a process of conservation and closing of unprofitable mines and quarries. By the end of 2006 mining activities were carried out in 12 mines (7 for coal and 5 for lignite) and in 24 quarries (1for 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 provided to estimate 1B1 category related emissions from are Eurostat data (Energy Balance) for 1989 and International Energy Agency (IEA)/Eurostat data for the entire 1990-2010 time series.

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 1989-2010 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 3.36 Lignite – Brown Coal Production trend

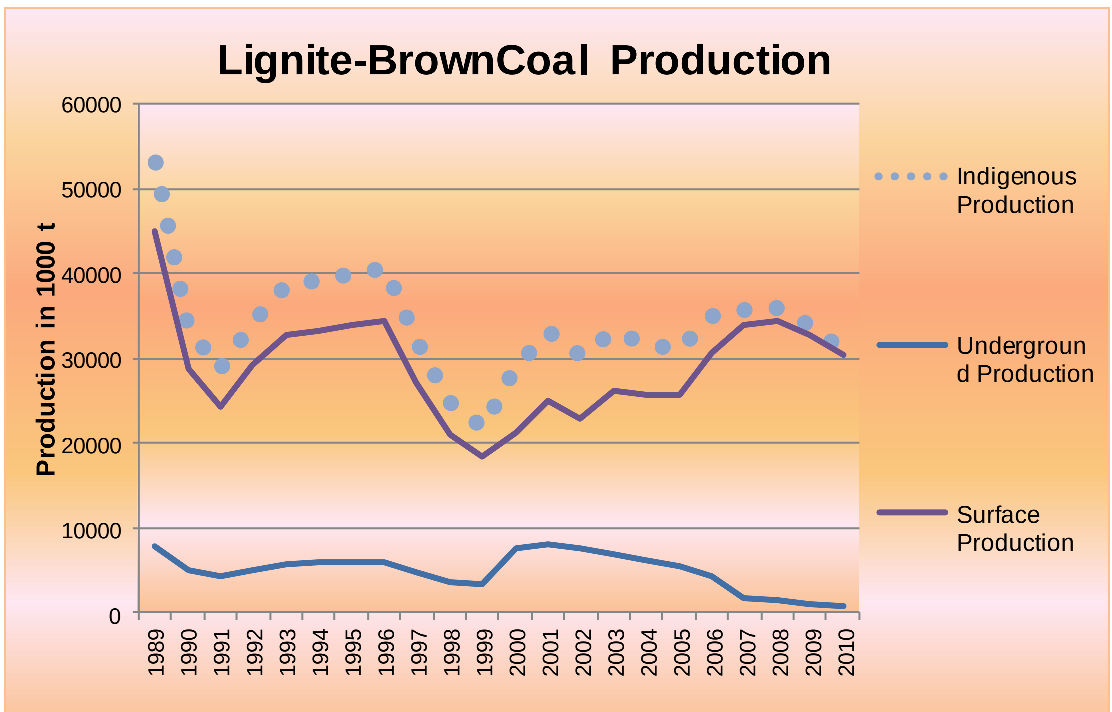
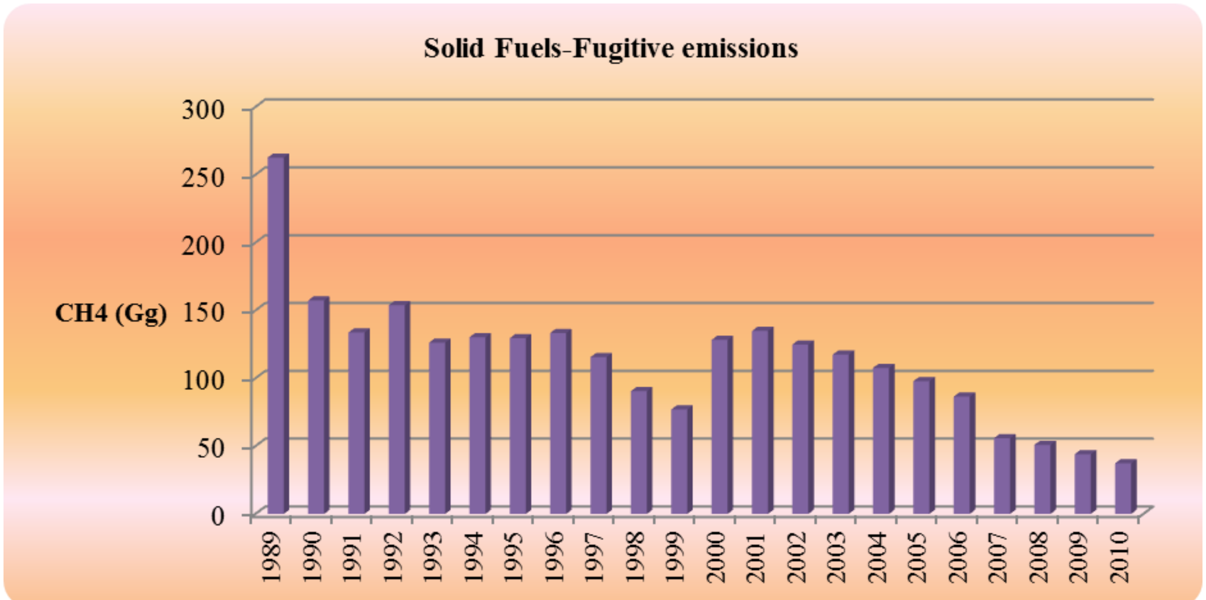


Figure 3.37 Fugitive Emissions of CH_4 from Solid Fuels (1.B.1)



The emissions of methane are most important for solid fuels fugitive 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 of 2000-2007 years and the period of 2008 – 2010 years.

Emissions have started to increase starting with 2000, because of economy revitalization.

From 2007-2008 the emissions started to decrease again after the begining of global financial crise which conducted to economic contraction

Table 3.108 shows the activity data and CH_4 emissions from Solid Fuels category (1.B.1.).

3.3.2.2 Methodological issues

3.3.2.2.1 Coal mining and handling category (1.B.1)

- Emission: CH_4;
- Key source: Yes.

Underground mines sub-source category (1.B.1.a.i):

- *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 3.6 Emissions of CH_4 in Underground mines sub-source category (1.B.1.a.i)

$$\mathbf{CH_4\ emissions}\ (Gg) = [EF\ (m^3\ CH_4/tonne\ of\ coal\ mined) \times Conversion\ Factor\ (Gg/10^6\ m^3) \times Underground\ Coal\ Production\ (Mt)] \times 1000$$

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 2010 - Indigenous Production (Anthracite – 100 %, Coking Coal – 100 %, Other Bituminous Coal - 100 %, Sub-bituminous Coal - 100 %, Lignite/Brown Coal - 15 %).
- *Activity Data*: from RO_EnergyBalalnce_2010\[1989_BAL_Romania have been used for 1989 , and IEA/Eurostat Questionnaire 2010 - for entire 1990-2010 time series have been used.

Surface mines sub-source category (1.B.1.a.ii):

- *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 3.7 Emissions of CH_4 in Surface mines sub-source category (1.B.1.a.ii)*:**

$$\mathbf{CH_4\ emissions}\ (Gg) = [EF\ (m^3\ CH_4/\text{tonne of coal mined}) \times \text{Conversion Factor}\ (Gg/10^6\ m^3) \times \text{Surface Coal Production}\ (Mt)] \times 1000$$

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 2010 - Indigenous Production (Lignite/Brown Coal - 85 %).
- *Activity Data*: from RO_EnergyBalalnce_2010\[1989_BAL_Romania have been used for 1989 , and IEA/Eurostat Questionnaire 2010 - for entire 1990-2010 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 3.38 Fugitive Emissions of CH_4 from Underground Mines sub-source category (1.B.1.a.i)

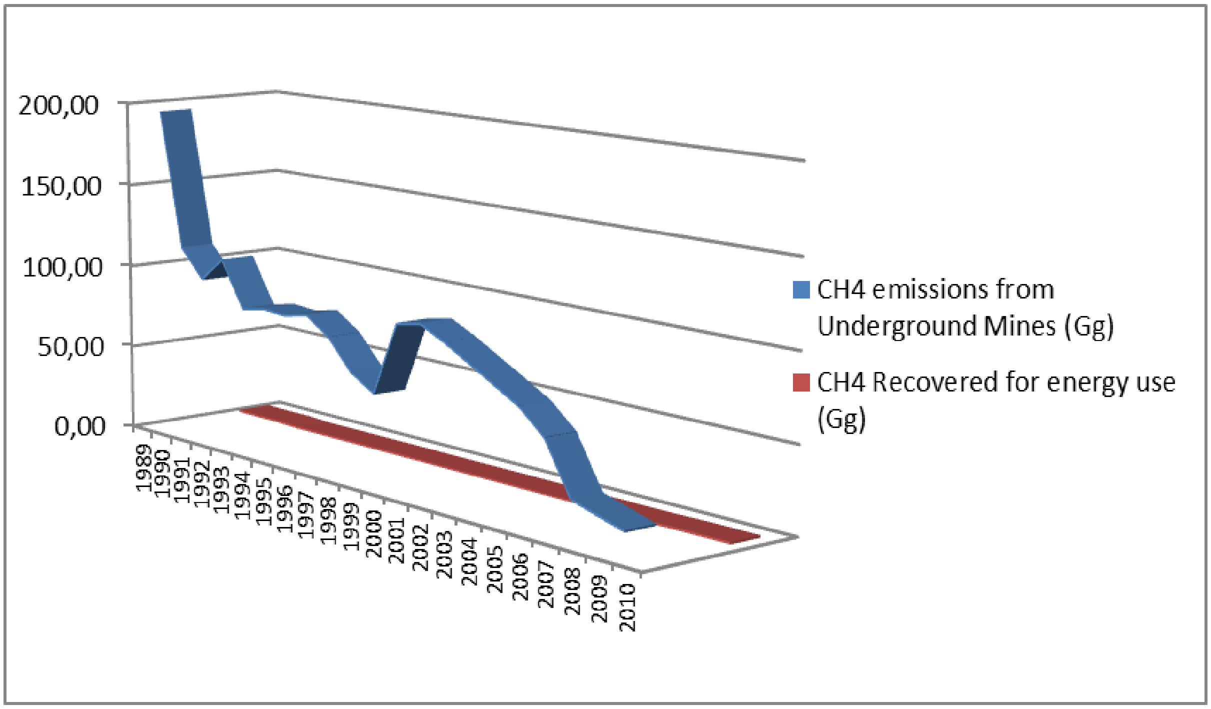


Table 3.103 Fugitive Emissions of CH_4 from Underground Mines and CH_4 Recovered for energy use

Year	**Underground mines**	
	CH_4 fugitive emissions (Gg)	**Recovery CH_4 (Gg)**
1989	196.05	1.36
1990	114.65	1.25
1991	97.96	1.25
1992	111.42	0.58
1993	84.46	0.58
1994	87.34	0.58
1995	86.16	0.58
1996	89.30	0.58
1997	79.12	0.58
1998	61.86	0.45
1999	52.64	0.45
2000	95.52	0.45
2001	98.42	0.45
2002	91.16	0.45
2003	82.29	0.19
2004	74.13	0.53
2005	65.44	0.59
2006	51.63	0.50
2007	22.31	0.58
2008	17.85	0.91
2009	13.34	0.95
2010	9.53	1.02

3.3.2.2.2 Solid Fuel Transformation sub- source category (1.B.1.b.)

Tier 1 Methodology of the 2006 IPCC Guidelines, Volume 2, Chapter 4 and Default Emission Factors for the Solid Fuels transformation reporting are used.
The formula used in the calculations is the following:

Equation 3.8 Emissions of CH_4 in Solid Fuel Transformation sub- source category (1.B.1.b.)

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 2010 – Transformation Sector (Coking Coal – 100 %,).
- *Activity Data*: from RO_EnergyBalalnce_2010\[1989_BAL_Romania have been used for 1989 , and IEA/Eurostat Questionnaire 2010 - for entire 1990-2010 time series have been used.

In Table 3.109 and the figure 3.34 shows the activity data and fugitive methane emission trends from solid fuels.

3.3.2.3 Uncertainties and time-series consistency

According to 2006 IPCC, volume 2, chapter 4.1.3.6, page 4.16, provisions, for Tier 1 methodology, the uncertainty associated to the activity data are 2% for underground mining and 3% for surface mining activities.

According to the I 2006 IPCC, volume 2, chapter 4.1.3.6, page 4.15, table 4.1.2, provisions, for Tier 1 methodology ,the uncertainty associated to default emission factor is ± 100% for underground and surface mining.

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to 2006 IPCC, volume 1, chapter 3.2.3.1, page 3.2.8, equation 3.1 are 100,02% for underground mining and 100,04% for surface mining.

According to Equation 6.4 in Chapter 6, page 6.12 of the IPCC GPG 2000, the values are 84% for emission factor and 3% activity data for Solid Fuels category.

Due to the fact that all activity data used from IEA/Eurostat Questionnaire 2010 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 1989-2010 is consistent.

3.3.2.4 Source-specific QA/QC and verification

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

The unconformities noted and solved following these activities are described in the Chapter 3.3.2 – 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. – 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.

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 unconformities noted and solved following the previously specified activities are described at the Improvements list level.

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

The inventory preparation, including identification of key categories, uncertainty estimates and QC procedures, has to be performed according to the '2000 Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance and Uncertainty Management of Greenhouse Gas Inventories' (IPCC GPG 2000).

According to the thirty-fifth session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) the obligatory use by Parties of the '2006 Intergovernmental Panel on Climate Change Guidelines for national greenhouse gas inventories' (2006 IPCC Guidelines) starts in 2015, in Annex I, Parties are invited to use the revised reporting guidelines voluntarily during a trial period from October 2012 to May 2013.

The GHG inventory for the whole sector 1 B Fugitive emissions is complete revised for the entire time series.

All these due to the following reasons:

- ❖ in this submission, all emission source are considered – at the present no notation key NE is used anymore;
- ❖ all notation keys NA, NO and IE were corrected;
- ❖ corrections of errors in data transfer or processing: wrong data, unit-conversion, software errors, etc. Furthermore the data transfer or processing is done as much as possible automatically by linking AD, EF and other parameters (model based on Microsoft excel);
- ❖ update of activity data: activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and used for estimating the emissions for the years 1990-2010; the National Statistics Institute have not prepared balances in the Eurostat format for the years before 1990, so the IEA Energy balances were used for the year 1989;
- ❖ source/data supplier have delivered new data: pipeline length, etc.;

- improvements of methodologies and emission factors: for all sectors of 1B the applied methodology is TIER 1 of the 2006 IPCC guidelines, Volume 2, Chapter 4.
- in general, all emission factors are taken from the 2006 IPCC guidelines, Volume 2, Chapter 4. For some subsectors it was more applicable to use the EF from the Revised 1996 IPCC GL and IPCC GPG 2000.
- emission factor from the Revised 1996 IPCC GL were used for subsector:
  - 1.B.2.A.4 Oil “Combined EF for Refining and Storage Tank”;
  - 1.B.2.B.5. Other Leakage -residential and commercial sectors.
- emission factor from the IPCC GPG 2000 were used for subsectors:
  - 1.B.2.B.2. Production/ Processing;
  - 1.B.2.B.3. Transmission;
  - 1.B.2.B.4. Distribution;
  - 1.B.2.B.5. Other Leakage - at industrial plants and power stations.
- for the category 1.B.1.b. Solid Fuel Transformation, it is expected that the implied emission factor for CH4 emissions from solid fuel transformation is constant throughout the time series. The exception is 2010, where there is a sharp increase. By an error, in 2010, the IEF has a wrong higher value: 0.50 kg/t, instead 0.35 kg/t. The correction was performed: the real value of CH_4 emissions is 0.0007Gg instead the rounded up to three decimal places, 0.001 Gg.

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 (coal, lignite) and for oil and natural gas extraction to increase the accuracy in determination of fugitive emissions.

Table 3.104 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 emission estimates for CH_4 [Gg]		Decrease [%]
	2011 v.4.1. submission	2012 v.2.1 submission	
1989	303,922.1807	265,236.8758	12.7
1990	174,340.5895	157,224.6522	9.8
1991	153,271.9604	133,641.0068	12.8
1992	171,920.4423	153,774.1932	10.6
1993	176,615.8659	126,247.3562	28.5
1994	184,698.9838	130,165.3842	29.5
1995	187,197.9732	129,510.1638	30.8
1996	195,819.7644	133,325.5326	31.9
1997	158,560.2704	115,528.953	27.1
1998	122,480.7034	90,439.305	26.2
1999	106,508.9051	76,927.366	27.8
2000	127,062.006	128,176.115	-0.9
2001	137,450.232	134,783.823	1.9
2002	129,257.7568	124,732.57	3.5
2003	128,780.8.374	117,316.945	8.9
2004	122,876.392	107,560.84	12.5
2005	118,732.3884	97,743.39	17.7
2006	123,738.002	86,398.717	30.2
2007	127,566.0235	55,799.78	56.3
2008	129,089.2953	50,853.651	60.6
2009	115,866.2122	43,981.615	62.0

3.3.2.7 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

3.3.3 Oil and Natural Gas - source category (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.

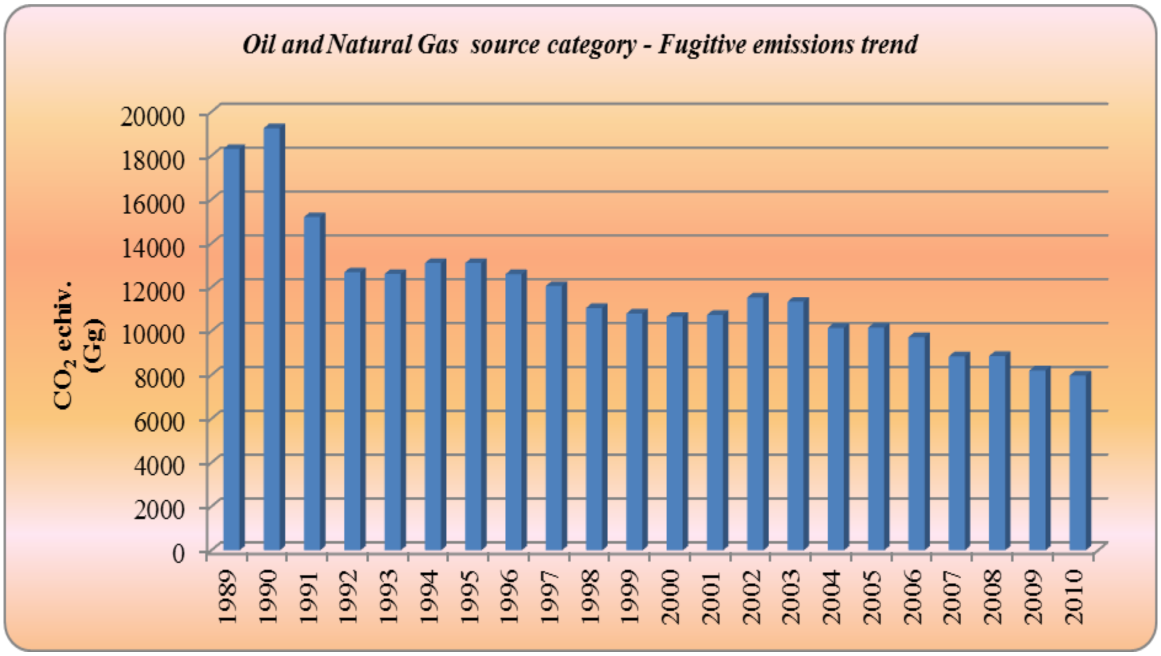
The most important companies of the fuel distribution in Romania are: OMV (PETROM), LUKOIL, ROMPETROL and MOL. In 2006, in Romania there were a total of 2140 gas-stations.

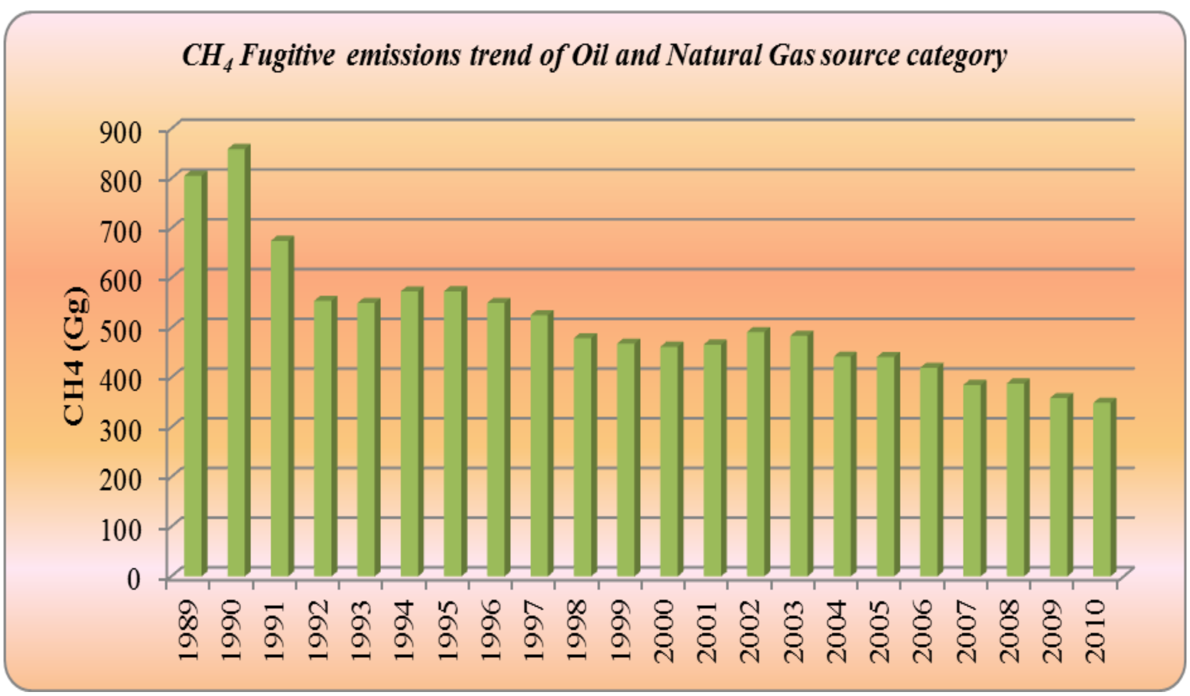
According to the estimations of the 2007, the Romania’s natural gas pools reseves are limited and they were estimated at about 185 billions cubic metters taking into account of the domestic production decline.

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 13110 km of the transporting pipelines and, as well as, of the feeding points, includding also over 560 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 3.39 Total GHG emissions trend for the 1.B.2 Oil and Natural Gas source category





The fugitive emissions trend from Oil and Natural Gas source category, for the entire period is an 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 and this is reflected in the GHG emissions reduction especialy during 1989-1999 period;
- ❖ The decrease of the natural gas national reserves;
- ❖ Increase 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 system of centralized supply of heat, combined with the increasing trend of using individual apartment heating systems.

The table 3.109 and the table 3.110 shows the activity data from Oil and Natural Gas source category (1.B.2.) and the CH_4 fugitive emissions from Oil and Natural Gas category (1.B.2.).

3.3.3.2 Oil sub-source category (1.B.2.a.)

Emission: CH_4, CO_2, N_2O

Key source: Yes

This *sub-source category* comprises emissions from venting, flaring and all other fugitive sources associated with exploration, production, transmission, upgrading, and refining of crude oil and distribution of crude oil products.

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 3.9 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 [CO₂] = *[(Production of crude oil [kt] / density [Gg/10³ m³])*EF CO₂ [Gg/10³ m³]*1000*

*+[(Production of natural gas liquid [kt] / density [Gg/10³ m³])*EF CO₂ [Gg/10³ m³]*1000*

*+[(Production of other hydrocarbons [kt] / density [Gg/10³ m³])*EF CO₂ [Gg/10³ m³]*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 0.080417Gg/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 2010 - Petrol – Crude oil, Natural Gas Liquids and Other Hydrocarbons) in [kJ/kg]

Activity Data (oil production): from *IEA/Eurostat Questionnaire 2010 Petrol* - Indigenous Production: Crude Oil [*1000 t*], Natural Gas Liquids [*1000 t*], Other Hydrocarbons [*1000 t*]

Activity Data: from RO_EnergyBalalnce_2010\[1989_BAL_Romania have been used for 1989 , and IEA/Eurostat Questionnaire 2010 - for entire 1990-2010 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 2010 - Petrol - Crude Oil] - fugitive emissions from atmospheric distillation
Residual Fuel Oil [1000t] - Refinery Gross Output [IEA/Eurostat Questionnaire 2010 - Petrol - Residual Fuel Oil] - fugitive emissions from vacuum distillation
Bitumen [1000t] - Refinery Gross Output [IEA/Eurostat Questionnaire 2010 - 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 2010 - 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 2010 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 2010 - Petrol – Crude oil, Natural Gas Liquids and Other Hydrocarbons) in [kJ/kg]

The default value of 0,0000054 *Gg/$10^3$$m^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/$10^3$$m^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 2010 - Petrol - Crude Oil]
Natural Gas Liquids [1000t] - Refinery Intake (Observed) [IEA/Eurostat Questionnaire 2010 - Petrol - Natural Gas Liquids]
Other Hydrocarbons [1000t] - Refinery Intake (Observed) [IEA/Eurostat Questionnaire 2010 - 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

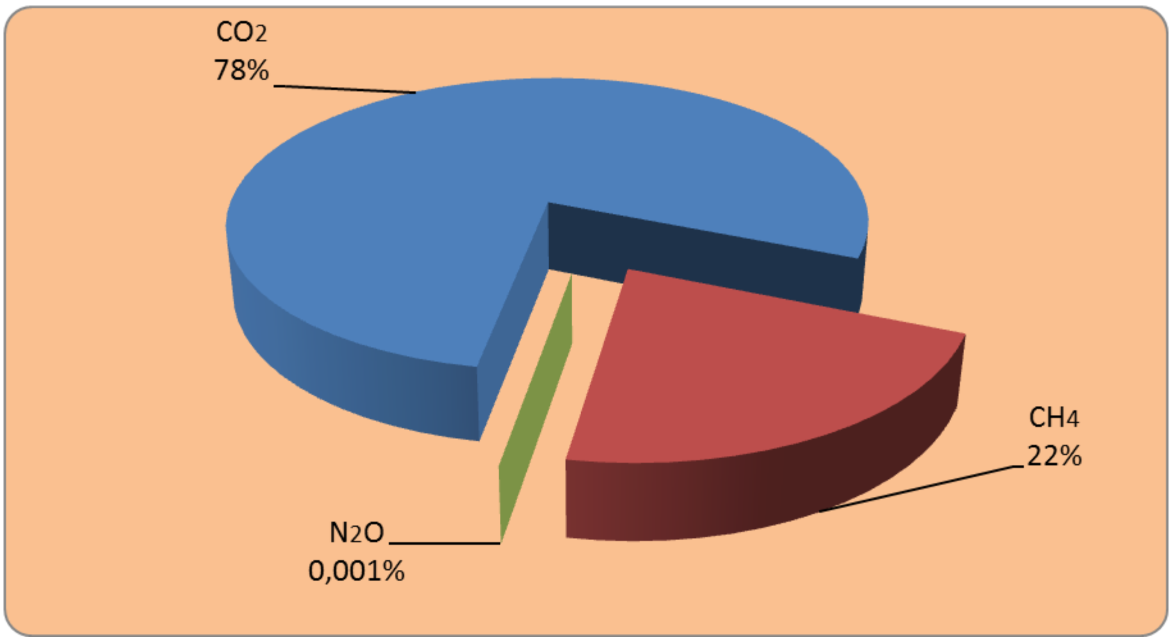
Refined Product Distribution: Gasoline, Diesel, Aviation Fuel, Jet Kerosene

EF CO_2 – N.A.

EF CH_4 – N.A.

EF N_2O – N.A.

Figure 3.40 The different GHG's Fugitive emissions contribution from Oil sub-source category



The most important GHG in the Energy sector is CO_2 emissions and small amounts of CH_4 and N_2O are emitted in Fugitive emissions from Oil sub-source category also.

3.3.3.3 Natural Gas sub-source category (1.B.2.b.)

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

This *sub-source category* ccomprises emission from venting, flaring and all other fugitive sources associated with the exploration, production, processing, transmission, storage and distribution of natural gas (including both associated and non-associated gas).

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

The formula used in the calculations is presented 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 2010 – 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*

Table 3.105 The default emission factor

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 2010 – 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 2010 – 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

	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 2010 – 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 m3

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 2010 – 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

	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 2010 – 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

	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 3.41 The different GHG's contribution to the 2010 Fugitive emissions from Natural Gas source category

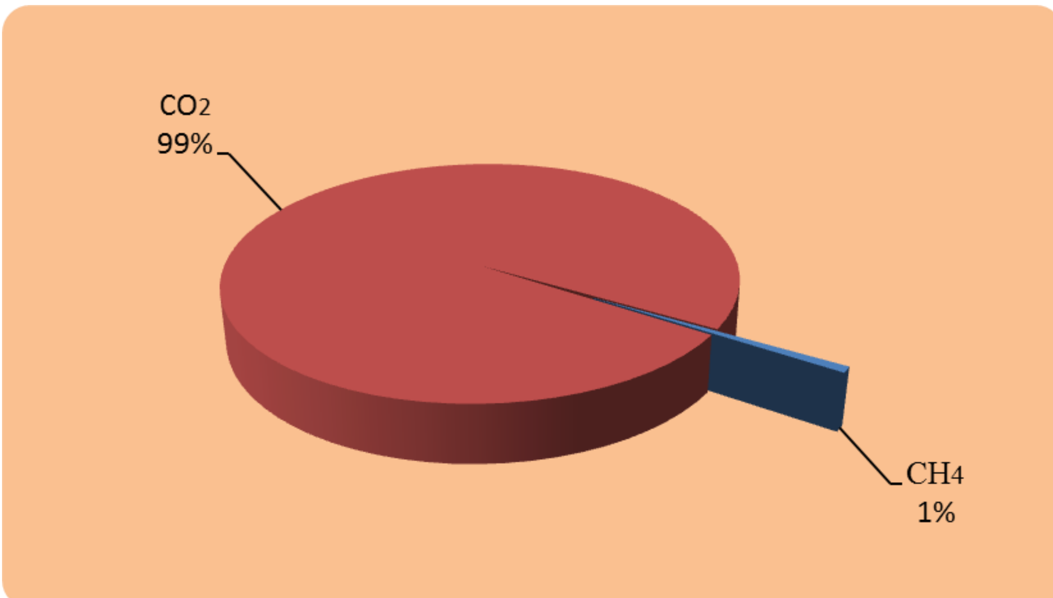


Figure 3.42 The different GHG's contribution to the 2010 Fugitive emissions from Venting oil sub-source category

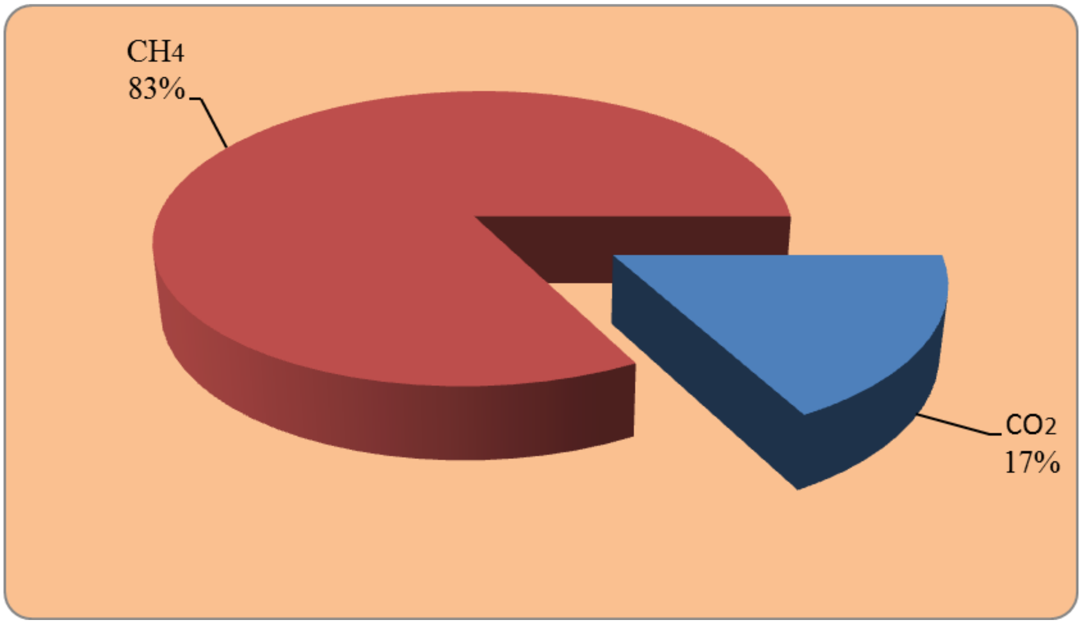
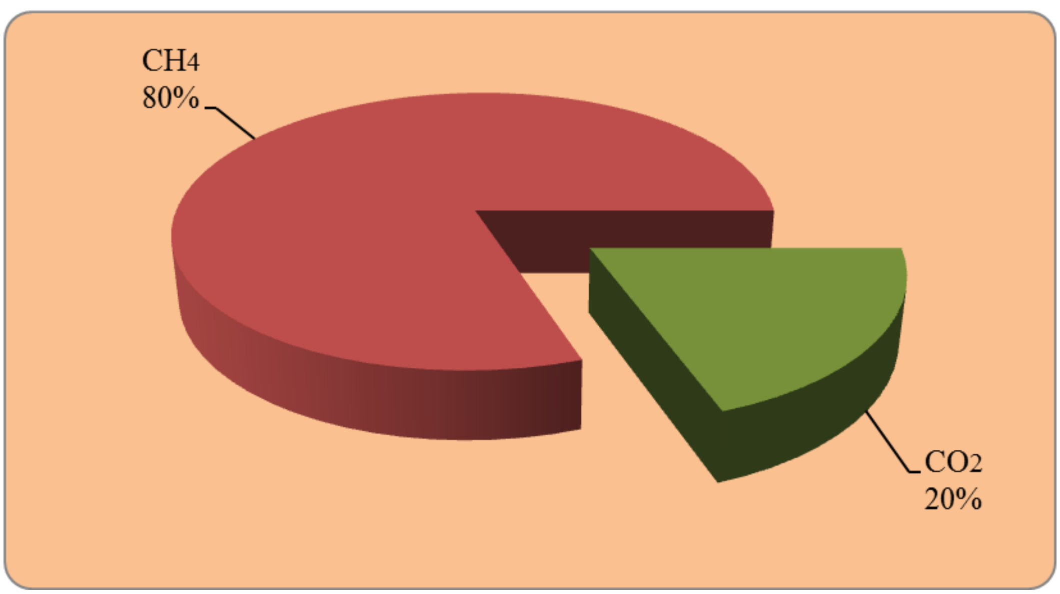


Figure 3.43 The different GHG's contribution to the 2010 Fugitive emissions from Venting gas sub-source category



3.3.3.4 Uncertainties and time-series consistency

According to the 2006 IPCC, volume 2, chapter 4.2.2.7, page 4.72 provisions, for Tier 1 methodology, the uncertainty associated to the default emission factors provided in Table 4.2.5.
According to the 2006 IPCC, volume 2, chapter 4.2.2.7, page 4.72, provisions for Tier 1 methodology, the uncertainty associated to activity data is ± 5%.
The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties combined according to the Equation 6.4 in Chapter 6, page 6.12 of the IPCC GPG 2000 the values are 150.03% for CH_4 emissions, 75, 10% for CO_2 emissions and 3, 10% for N2O from Oil and Natural Gas category.
Due to the fact that all activity data used from IEA/Eurostat Questionnaire 2010 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 1989-2010 is consistent.

3.3.3.5 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.
The unconformities noted and solved following these activities are described in the Chapter 3.3.3. – 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. – 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.
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.

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

The inventory preparation, including identification of key categories, uncertainty estimates and QC procedures, has to be performed according to the '2000 Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance and Uncertainty Management of Greenhouse Gas Inventories' (IPCC GPG 2000).

According to the thirty-fifth session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) the obligatory use by Parties of the '2006 Intergovernmental Panel on Climate Change Guidelines for national greenhouse gas inventories' (2006 IPCC Guidelines) starts in 2015, in Annex I, Parties are invited to use the revised reporting guidelines voluntarily during a trial period from October 2012 to May 2013.

The GHG inventory for the whole sector 1 B Fugitive emissions is complete revised for the entire time series.

All these due to the following reasons:

- ❖ in this submission, all emission source are considered – at the present no notation key NE is used anymore;
- ❖ all notation keys NA, NO and IE were corrected;
- ❖ corrections of errors in data transfer or processing: wrong data, unit-conversion, software errors, etc. Furthermore the data transfer or processing is done as much as possible automatically by linking AD, EF and other parameters (model based on Microsoft excel);
- ❖ update of activity data: activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and used for estimating the emissions for the years 1990-2010; the National Statistics Institute have not prepared balances in the Eurostat format for the years before 1990, so the IEA Energy balances were used for the year 1989;
- ❖ source/data supplier have delivered new data: pipeline length, etc.;

- improvements of methodologies and emission factors: for all sectors of 1B the applied methodology is TIER 1 of the 2006 IPCC guidelines, Volume 2, Chapter 4.
- in general, all emission factors are taken from the 2006 IPCC guidelines, Volume 2, Chapter 4. For some subsectors it was more applicable to use the EF from the Revised 1996 IPCC GL and IPCC GPG 2000.
- emission factor from the Revised 1996 IPCC GL were used for subsector:
  - 1.B.2.A.4 Oil "Combined EF for Refining and Storage Tank";
  - 1.B.2.B.5. Other Leakage -residential and commercial sectors.
- emission factor from the IPCC GPG 2000 were used for subsectors:
  - 1.B.2.B.2. Production/ Processing;
  - 1.B.2.B.3. Transmission;
  - 1.B.2.B.4. Distribution;
  - 1.B.2.B.5. Other Leakage - at industrial plants and power stations.
- Flaring (1.B.2.a.ii.)-Emissions from flaring of natural gas and waste gas/vapour streams at oil Facilities – Recalculations:
  - Due to a transcription error of the fuel consumption from the spreadsheet in the CRF we provide in the 1.B.2.C.2.1. Flaring Oil category the following correct values: for 2001 year 255.61 PJ (instead 244.28PJ), for 2002 year 299.31PJ (instead 236.11 PJ) for 2003 year 291.20 PJ (instead 229.66 PJ), for 2004 year 234.10 PJ (instead 221.97 PJ), for 2005 year 234.52 PJ (instead 211.93 PJ), for 2006 year 230.83 PJ (instead 194.13PJ) for 2007 year 200.94 PJ (instead 184.58PJ) and for 2008 year 193.40 PJ (instead 184.58 PJ).
- Exploration Oil - 1 B 2 a iii 3 category – recalculations:
  - Due to a transcription error of the fuel consumption from the spreadsheet in the CRF there are provided the correction in the CRF tables of the 1 B 2 A.1. Exploration Oil category. The following values are modified: for 2001 year 255.61 PJ (instead 244.28PJ), for 2002 year 299.31PJ (instead 236.11 PJ) for 2003 year 291.20 PJ (instead 229.66 PJ), for 2004 year 234.10 PJ (instead 221.97 PJ), for 2005 year 234.52 PJ (instead 211.93 PJ), for 2006 year 230.83 PJ (instead 194.13PJ) for 2007 year 200.94 PJ (instead 184.58PJ) and for 2008 year 193.40 PJ (instead 184.58 PJ).

- 1.B.2.b. iv. Natural Gas Distribution. For 2007 to 2009 the pipelines length provided by the Romanian National Energy Regulatory Authority was used, whereas for the rest of the time series (1990–2006) the average value of the available pipeline length values (2007–2009) was used.

Since cannot be considered as plausible that the pipeline length first decreases (from 2006 to 2007) and then significantly increases, the extrapolation method for the 2005 pipeline length was reconsidered, such as: the pipeline length development provided by the National regulating Authority is expected to be similar also for previous years; pipeline length values from 2007 to 2009 are therefore extrapolated to 2005 to yield the corresponding pipeline length in that year (a linear trend is assumed for the extrapolation); the same CH_4 EF is applied for 2005 as for 2007 to 2009 (770 kg CH_4/km).

3.3.3.7 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 (coal, lignite) and for oil and natural gas extraction to increase the accuracy in determination of fugitive emissions.

Table 3.106 Change made at activity data and their effects on CO_2 emission estimates Sub-sector 1.B 2. - Oil and Natural Gas

Year	Effects of changes on emission estimates for CO_2 [Gg]		Decrease [%]
	2011 v.4.1. submissions	2012 v.2.1. submissions	
1989	56.19976743	1,399.937091	-2,391.0
1990	96.149511	1,213.17749	-1,161.8
1991	82.86739883	1,035.012847	-1,149.0
1992	77.37067994	1057.944502	-1,267.4
1993	76.12374277	1070.863574	-1,306.7
1994	72.44308227	1,074.032461	-1,382.6
1995	71.5266026	1,068.503827	-1,393.9
1996	69.36637572	1050.27482	-1,414.1
1997	63.79820581	1,030.996807	-1,516.0
1998	61.62864121	1001.514846	-1,525.1
1999	60.52304429	975.5493178	-1,511.9
2000	59.54173182	962.0625367	-1,515.8
2001	59.05755378	952.7699646	-1,513.3
2002	57.15305184	1221.87549	-2,037.9
2003	56.64041039	1,189.035132	-1,999.3
2004	54.80173526	877.2917771	-1,500.8
2005	51.90040909	901.0880141	-1,636.2
2006	49.24411968	918.8467092	-1,765.9
2007	48.39533535	766.9060867	-1,484.7
2008	47.90580412	723.8093007	-1,410.9
2009	45.86435886	682.3583831	-1,387.8

Table 3.107 Change made at activity data and their effects on CH_4 emission estimate Sub-sector 1.B 2. - Oil and Natural Gas

Year	Effects of changes on emission estimates for CH_4 [Gg]		Decrease [%]
	2011 v.4.1. submissions	2012 v.2.1. submissions	
1989	1,040.710472	1,047.278133	-0.63
1990	1,021.151084	980.5771215	3.97
1991	863.3295731	773.6600659	10.39
1992	764.6017647	674.1629032	11.83
1993	738.5830882	643.5625611	12.87
1994	687.8067935	672.0899126	2.29
1995	696.6311698	673.0069795	3.39
1996	687.4265106	654.5801075	4.78
1997	569.1187919	613.413251	-7.78
1998	549.5406889	543.2407202	1.15
1999	519.6705751	520.0780255	-0.08
2000	515.4271473	566.1830487	-9.85
2001	503.6650877	578.4122333	-14.84
2002	503.6861155	594.7823665	-18.09
2003	539.6499202	580.9242371	-7.65
2004	512.9144713	530.4766027	-3.42
2005	487.5867635	521.4950594	-6.95
2006	479.0584207	489.4738136	-2.17
2007	446.24149	426.7617954	4.37
2008	435.60737	424.8762965	2.46
2009	387.1391607	388.5270784	-0.36

Table 3.108 Change made at activity data and their effects on N_2O emission estimates Sub-sector 1.B 2. - Oil and Natural Gas

Year	Effects of changes on emission estimates for N_2O [Gg]		Decrease [%]
	2011 v.4.1. submissions	2012 v.2.1. submissions	
1989	0.000654365	0.013642999	-1,984.9
1990	0.000564863	0.011611056	-1,955.6
1991	0.000489099	0.009955889	-1,935.6
1992	0.000429261	0.010224482	-2,281.9
1993	0.000409437	0.010355011	-2,429.1
1994	0.000367677	0.010393289	-2,726.7
1995	0.000358405	0.010347515	-2,787.1
1996	0.000341586	0.010182652	-2,881.0
1997	0.000296041	0.010005011	-3,279.6
1998	0.000278417	0.009723049	-3,392.3
1999	0.000278259	0.009475135	-3,305.1
2000	0.000272699	0.009352204	-3,329.5
2001	0.000270794	0.009253632	-3,317.2
2002	0.000258268	0.011937809	-4,522.2
2003	0.000261722	0.0116167	-4,338.6
2004	0.000253434	0.008521747	-3,262.5
2005	0.000237106	0.008762452	-3,595.6
2006	0.000233396	0.008958769	-3,738.4
2007	0.000225394	0.007460554	-3,210.0
2008	0.000223079	0.007030527	-3,051.6
2009	0.000222518	0.006634535	-2,881.6

Table 3.109 Activity Data and CH_4 emissions from Solid Fuels category (1.B.1.)

Year	1.B.1.a Coal Mining and Handling						1.B.1.b Solid Fuels Transformation	
	i.Underground mines			ii. Surface Mines				
	AD	Mining, CH_4	Post-Mining, CH_4	AD	Mining, CH_4	Post-Mining, CH_2	AD	Emissions,CH_2
	kt	Gg	Gg	kt	Gg	Gg	kt	Gg
1989	16.26	196.05	27.23	45.09	36.25	3.02	7.67	2.68
1990	9.51	114.65	15.92	28.68	23.06	1.92	4.79	1.68
1991	8.12	97.96	13.61	24.29	19.53	1.63	2.62	0.92
1992	9.24	111.42	15.47	29.13	23.42	1.95	4.30	1.51
1993	7.00	84.46	11.73	32.75	26.33	2.19	4.39	1.54
1994	7.24	87.34	12.13	33.30	26.78	2.23	4.81	1.68
1995	7.14	86.16	11.97	33.98	27.32	2.28	5.13	1.79
1996	7.40	89.30	12.40	34.46	27.71	2.31	4.57	1.60
1997	6.56	79.12	10.99	27.25	21.91	1.83	4.83	1.69
1998	5.13	61.86	8.59	21.10	16.97	1.41	4.58	1.60
1999	4.36	52.64	7.31	18.52	14.89	1.24	2.43	0.85
2000	7.92	95.52	13.27	21.37	17.18	1.43	2.25	0.79
2001	8.16	98.42	13.67	25.13	20.20	1.68	2.30	0.81
2002	7.56	91.16	12.66	22.86	18.38	1.53	2.87	1.00
2003	6.82	82.29	11.43	26.24	21.10	1.76	2.14	0.75
2004	6.15	74.13	10.30	25.65	20.62	1.72	2.27	0.80
2005	5.43	65.44	9.09	25.68	20.65	1.72	2.43	0.85
2006	4.28	51.63	7.17	30.64	24.64	2.05	2.6	0.91
2007	1.85	22.31	3.10	33.93	27.28	2.27	2.39	0.84
2008	1.48	17.85	2.48	34.38	27.64	2.30	1.656	0.58
2009	1.11	13.34	1.85	32.86	26.42	2.20	0.496	0.17
2010	0.79	9.53	1.32	30.34	24.39	2.03	0.002	0.0007

Table 3.110 Activity Data from Oil and Natural Gas source category (1.B.2.)

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	km	10^6 m^3	km	PJ	PJ	PJ	PJ	PJ	PJ
1989	372.84	405.11	372.84	1240.93	1115.46	13055.67	52382.35	8387	909.94	126.49	372.84	1115.46	372.84	1115.46
1990	322.25	666.58	974.88	961.75	1065.81	13055.67	35667.00	9974	779.98	143.63	322.25	1065.81	322.25	1065.81
1991	276.00	495.16	617.31	617.39	933.07	13055.67	29433.00	11561	532.08	164.50	276.00	933.07	276.00	933.07
1992	279.41	433.44	546.51	533.35	819.29	13055.67	26234.00	13148	276.39	89.19	279.41	819.29	279.41	819.29
1993	283.61	430.07	591.72	544.16	779.68	13055.67	25230.00	14735	273.71	89.80	283.61	779.68	283.61	779.68
1994	285.53	418.61	615.62	604.18	689.59	13055.67	23152.00	16322	398.55	93.58	285.53	689.59	285.53	689.59
1995	284.72	402.67	636.53	626.50	672.01	13055.67	24001.00	17909	430.91	104.26	284.72	672.01	284.72	672.01
1996	280.63	376.17	571.42	550.96	640.30	13055.67	24275.00	19496	413.99	99.05	280.63	640.30	280.63	640.30
1997	276.59	357.45	530.35	510.32	553.96	13055.67	19972.00	21083	386.29	111.68	276.59	553.96	276.59	553.96
1998	268.56	341.24	511.35	514.15	518.68	13055.67	18740.00	22670	264.90	126.99	268.56	518.68	268.56	518.68
1999	261.46	328.51	436.08	411.49	520.67	13055.67	17180.00	24257	266.12	114.39	261.46	520.67	261.46	520.67
2000	257.83	310.97	451.15	440.37	510.24	13055.67	17120.00	25844	282.70	115.03	257.83	510.24	257.83	510.24
2001	255.61	321.46	480.81	477.43	501.50	13055.67	16447.00	27431	283.84	117.60	255.61	501.50	255.61	501.50
2002	299.31	308.95	557.74	548.69	493.06	13055.67	17216.00	29018	305.81	115.20	299.31	493.06	299.31	493.06
2003	291.20	298.29	503.11	498.79	485.14	13055.67	18350.00	30605	301.11	141.70	291.20	485.14	291.20	485.14
2004	234.10	290.46	531.23	532.81	482.76	13055.67	18094.00	32192	271.53	151.31	234.10	482.76	234.10	482.76
2005	234.52	284.62	587.53	584.64	451.31	13055.67	17379.00	33779	285.87	145.08	234.52	451.31	234.52	451.31
2006	230.83	253.91	583.39	572.94	444.66	13055.67	17955.00	35366	235.93	194.15	230.83	444.66	230.83	444.66
2007	200.93	236.88	547.65	541.92	429.51	13110.00	16374.00	37151	230.34	147.61	200.93	429.51	200.93	429.51
2008	193.39	238.98	535.87	534.28	418.33	12960.00	15801.00	38144	254.17	141.61	193.39	418.33	193.39	418.33
2009	183.78	218.68	463.95	461.80	415.82	13097.00	13258.00	40325	194.91	145.99	183.78	415.82	183.78	415.82
2010	175.27	202.19	415.23	414.65	400.94	13097.00	13134.00	40514	206.48	149.55	175.27	400.94	175.27	400.94

Table 3.111 CH_4 Fugitive emissions from Oil and Natural Gas category (1.B.2.)

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
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg
1989	17.72	221.68	0.06	1.09	117.68	20.11	6.46	254.33	17.65	107.76	16.78	0.26	0.47
1990	15.32	358.50	0.15	0.85	77.92	20.11	7.68	218.00	20.04	93.15	11.11	0.23	0.31
1991	13.12	267.40	0.09	0.54	68.22	20.11	8.90	148.71	22.95	79.78	9.72	0.19	0.27
1992	13.58	234.87	0.08	0.47	59.90	20.11	10.12	77.25	12.44	82.59	8.54	0.20	0.24
1993	13.79	233.01	0.09	0.48	57.03	20.11	11.35	76.50	12.53	83.88	8.13	0.20	0.23
1994	13.91	227.10	0.09	0.53	50.91	20.11	12.57	111.39	13.05	84.60	7.26	0.20	0.20
1995	13.86	218.72	0.10	0.55	49.62	20.11	13.79	120.44	14.54	84.29	7.07	0.20	0.20
1996	13.66	204.76	0.09	0.48	47.43	20.11	15.01	115.71	13.82	83.04	6.76	0.20	0.19
1997	13.48	194.67	0.08	0.45	41.15	20.11	16.23	107.97	15.58	81.94	5.87	0.20	0.16
1998	13.11	185.77	0.08	0.45	38.51	20.11	17.46	74.04	17.71	79.73	5.49	0.19	0.15
1999	12.77	178.79	0.07	0.36	38.57	20.11	18.68	74.38	15.96	77.63	5.50	0.19	0.15
2000	12.60	169.70	0.07	0.39	37.81	20.11	19.90	79.01	16.05	76.64	5.39	0.19	0.15
2001	12.47	174.90	0.07	0.42	37.31	20.11	21.12	79.33	16.40	75.84	5.32	0.18	0.15
2002	16.21	168.09	0.09	0.48	36.97	20.11	22.34	85.47	16.07	98.56	5.27	0.24	0.15
2003	15.77	162.49	0.08	0.44	35.83	20.11	23.57	84.16	19.77	95.92	5.11	0.23	0.14
2004	11.47	158.20	0.08	0.47	35.65	20.11	24.79	75.89	21.11	69.76	5.08	0.17	0.14
2005	11.83	154.73	0.09	0.51	33.33	20.11	26.01	79.90	20.24	71.94	4.75	0.17	0.13
2006	12.11	138.54	0.09	0.50	32.84	20.11	27.23	65.94	27.08	73.63	4.68	0.18	0.13
2007	10.04	129.08	0.08	0.48	31.69	20.19	28.61	64.38	20.59	61.04	4.52	0.15	0.13
2008	9.44	130.48	0.08	0.47	31.26	19.96	29.37	71.04	19.76	57.43	4.46	0.14	0.13
2009	8.90	119.40	0.07	0.41	30.94	20.17	31.05	54.48	20.37	54.10	4.41	0.13	0.12
2010	8.50	110.23	0.06	0.36	29.85	20.17	31.20	57.71	20.86	51.70	4.26	0.12	0.12

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 IPCC Category 1A2 Fuel Combustion - Manufacturing Industries and Construction.

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), Consumption of halocarbons and SF_6 (CRF 2.F) and other production (CRF 2.D).

The direct GHG emissions reported in this sector are: CO_2, CH_4, N_2O, HFCs, PFCs and SF_6.

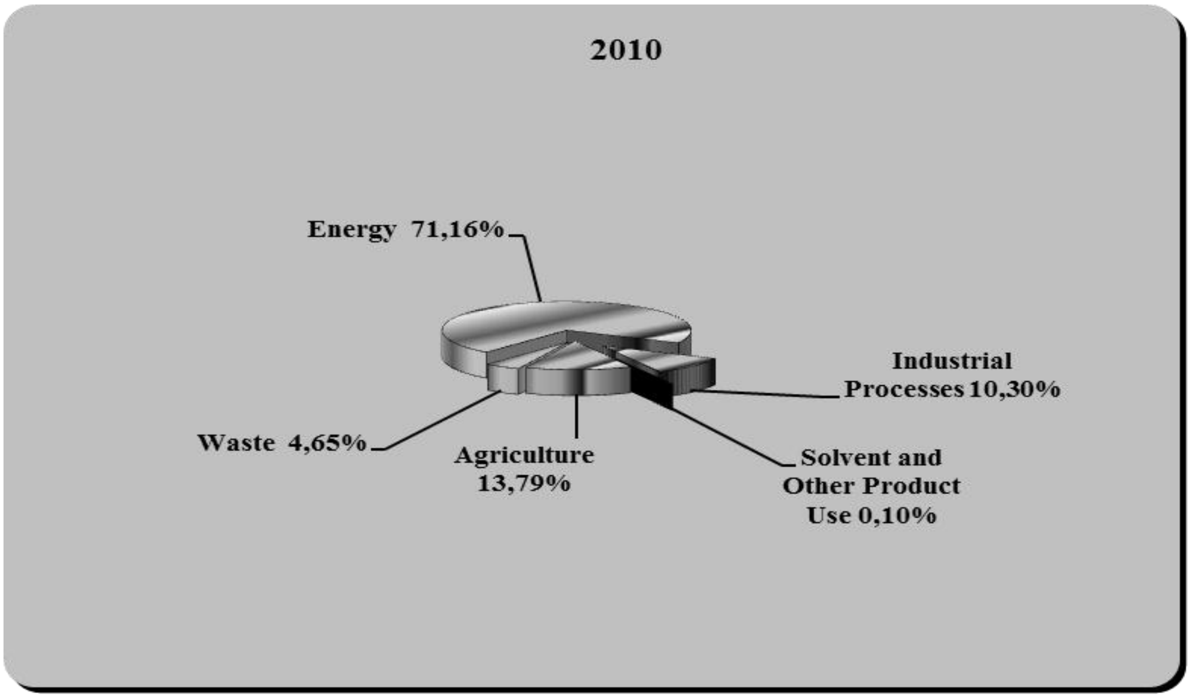
Table 4.1 Status of emissions estimation within the Industrial processes sector

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 B3 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 INDUSTRIAL PROCESSES	**Emissions estimation status**			
IPCC category	**CO_2**	**CH_4**	**N_2O**	**PFC**
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 SF6 USED IN ALUMINIUM AND MAGNESIUM FOUNDRIES	NO	NO	NO	NO
2 C 5 OTHER	NA	NA	NA	NA
2 D OTHER PRODUCTION				
2 D 1 PULP AND PAPER	NA	NA	NA	NA
2 D 2 FOOD AND DRINK	NE	NA	NA	NA
2 E PRODUCTION OF HALOCARBONS AND SULPHUR HEXAFLUORIDE				
2 E 1 BY-PRODUCT EMISSIONS	NO	NO	NO	NO
2 E 2 FUGITIVE EMISSIONS	NO	NO	NO	NO
2 E 3 OTHER	NO	NO	NO	NO
2 F CONSUMPTION OF HALOCARBONS AND SULPHUR HEXAFLUORIDE				
2 F 1 REFRIGERATION AND AIR CONDITIONING EQUIPMENT	NA	NA	NA	✓
2 F 2 FOAM BLOWING	NA	NA	NA	✓
2 F 3 FIRE EXTINGUISHERS	NA	NA	NA	✓
2 F 4 AEROSOLS	NA	NA	NA	✓
2 F 5 SOLVENTS	NA	NA	NA	✓
2 F 6 OTHER Please specify.	NA	NA	NA	✓
2 G OTHER	NA	NA	NA	NA

In 2010 the GHG emissions from Industrial Processes contributed with 10.30% to the total GHG emissions in Romania.

Figure 4.1 The contribution of Industrial Processes sector to the total GHG emissions in Romania, 2010



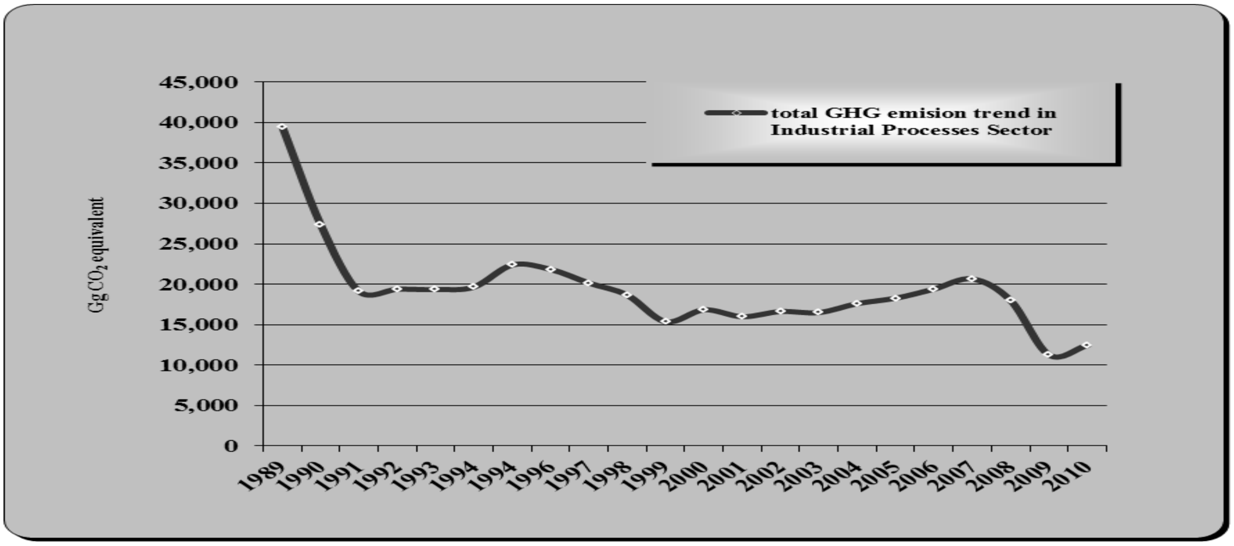
Emissions from this sector estimated in 2010 decreased by 68.47 % compared with 1989 and increased with 10.60 % compared with 2009. The decrease from 1989 to 2010 is the result of the restructuration and privatization in various activity sectors. Starting with 2008 the trend of emission mainly decreased due to reduction of various productions. In 2009 the emissions trends had also decreased due to the economic crisis recorded in many activity areas. In 2010 the emissions trends have recorded an increased due to increase of various productions industry.

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;
- In 2010 the emissions trends have recorded an increased due to increase of various production activities (ammonia production, nitric acid production, silicon carbide production);

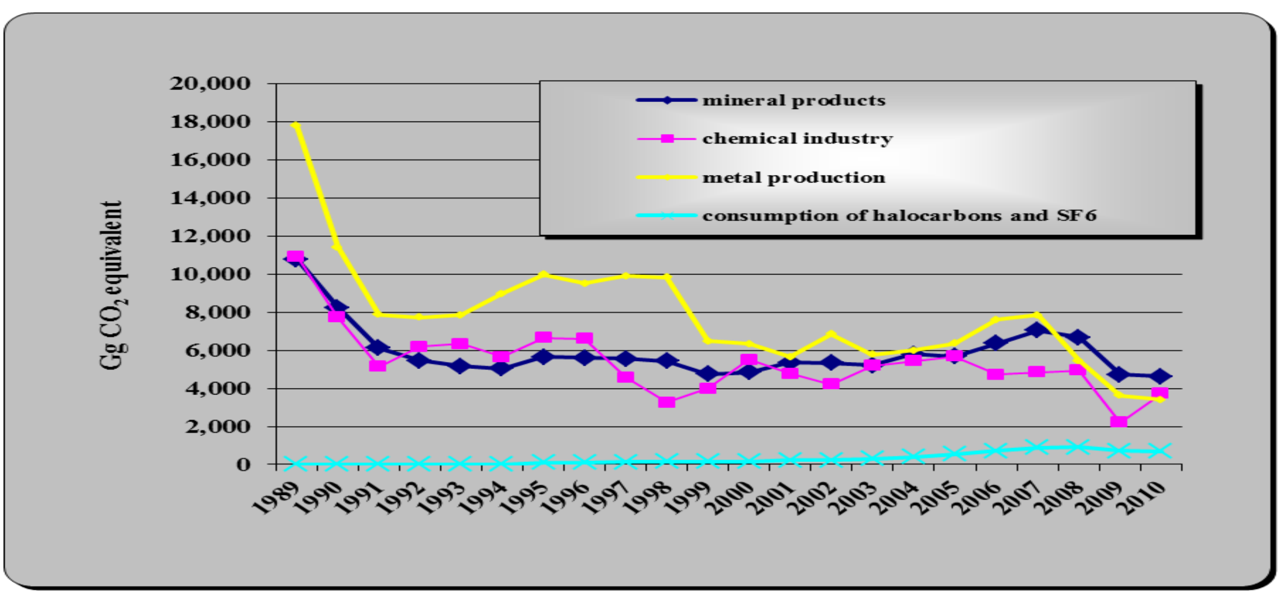
- The lowest level of emissions from ammonia production was recorded in 1998, due to the activity data whose level decreased by almost a half compared to the previous and next year. This happened as one producing plant has stopped its activity since 1998 and another plant has been closed in 1998 and 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.

Figure 4.2 Total GHG emissions trend in Industrial Processes, for 1989 – 2010 period



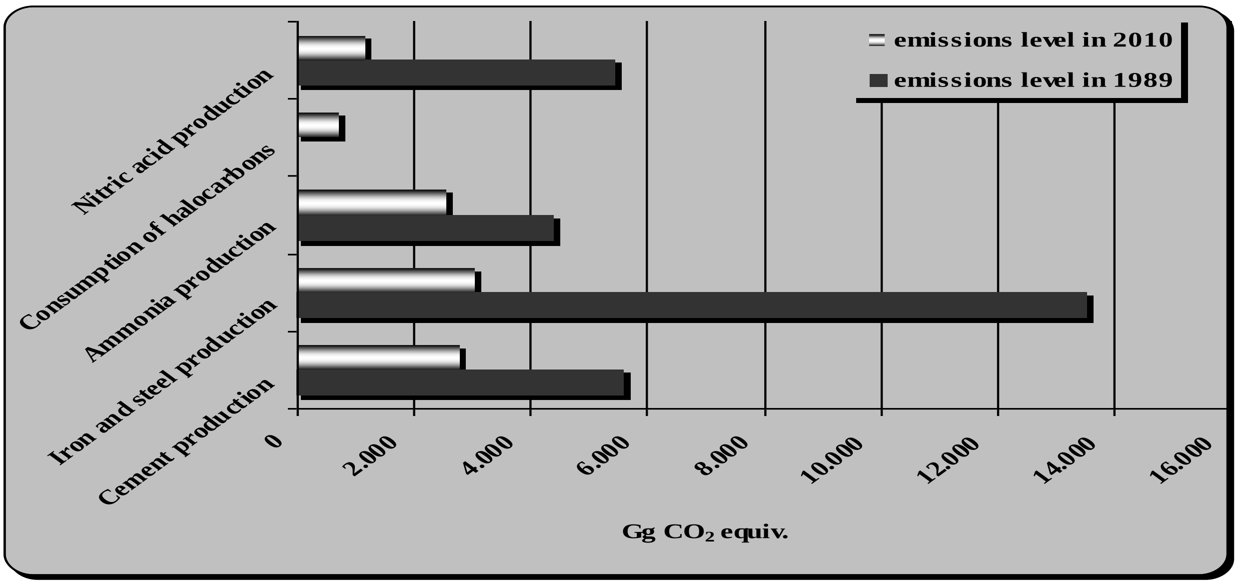
Metal production contributes with 27.36 % to the total GHG emissions from Industrial Processes in 2010. Mineral Product and Chemical Industry are the two other main contributing sectors with 37.20 % and 29.82 %, respectively, of the total GHG emissions in this sector. The contribution of Consumption of halocarbons and SF_6 to the overall sector is very low: 5.62 %.

Figure 4.3 GHG emissions trends in Industrial Processes, by sub-sectors, for 1989 – 2010 period



In the base year, various industrial processes sub-sectors contributions were: Mineral products 27.32 %, Chemical industry 27.65 %, and Metal production 45.03 %, Consumption of halocarbons and SF_6 0%.

Figure 4.4 Key categories in Industrial Processes in 2010, both by level and trend criteria



The Tier 1 key category analysis performed for 2010 has revealed the following key categories presented in the Table 4.2.

Table 4.2 Key categories in industrial processes sector in 2010

2010						
CRF categories	**Key category**	**GHG**	**Criteria-excluding LULUCF**	**Contribution of Key categories in total GHG emissions [%]**	**Criteria-including LULUCF**	**Contribution of Key categories in total GHG emissions [%]**
2.B.1	**Ammonia production**	CO_2	L,T	2.10%	L,T	1.70%
2C.1	**Iron and steel production**	CO_2	L,T	2.51%	L,T	2.03%
2.A.2	**Lime production**	CO_2	L	1.05%	L	0.85%
2.B.3	**Adipic acid production**	N_2O	T	0.00%	T	0.00%
2.A.1	**Cement production**	CO_2	L,T	2.30%	L	1.86%
2.B.2	**Nitric acid production**	N_2O	L,T	0.95%	L,T	0.77%
2.C.3	**Aluminium production**	PFC	T	0.01%	T	0.005%
2.F	**Consumption of halocarbons**	HFC,PFC,SF_6	L,T	0.58%	L,T	0.47%
2.A.3	**Limestone and dolomite production**	CO_2	-	-	T	0.33%

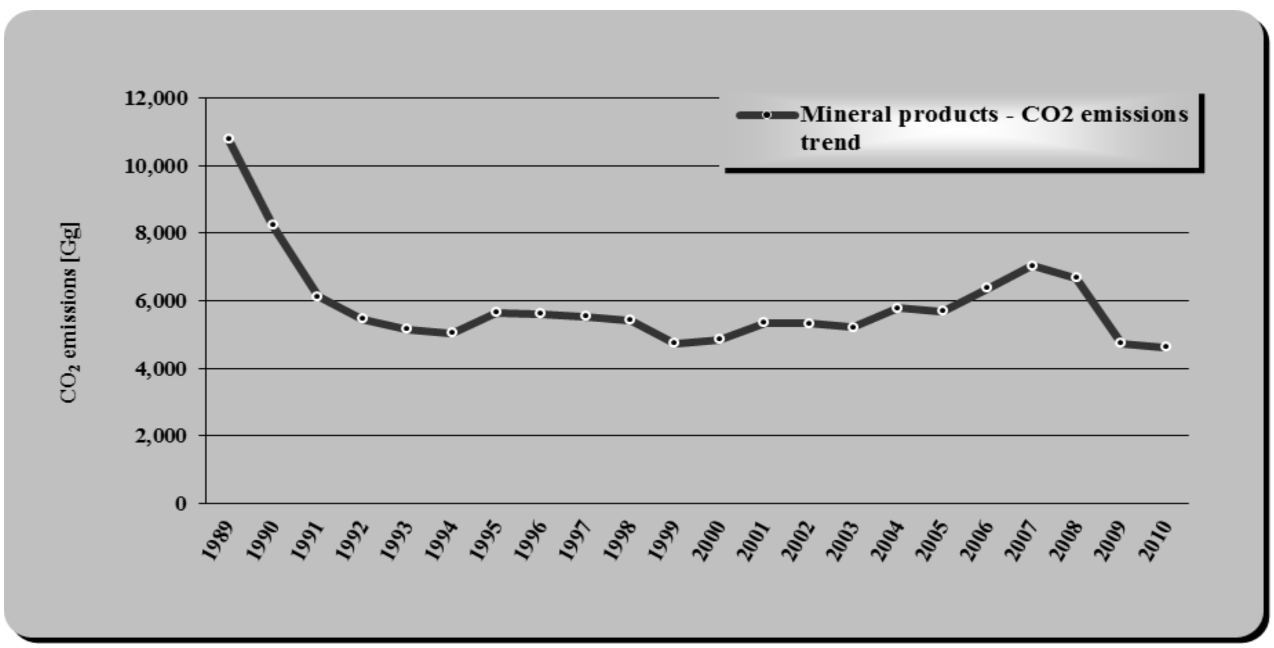
4.2 Source category Mineral products (CRF sector 2.A)

4.2.1 Source category description

GHG emissions reported include estimates for cement production (2A1), lime production (2A2), limestone and dolomite use (2A3), soda ash production and use (2A4), asphalt roofing (2A5) and road paving with asphalt (2A6) and other: glass production (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 2010 CO_2 emissions from production of cement contributed with 2.30% to total greenhouse gas emissions). In the base year, these emissions accounted for 1.97% from the total GHG emissions.

Figure 4.5 GHG emissions trend in the Mineral Products sub-sector for 1989 – 2010 period [Gg CO_2]



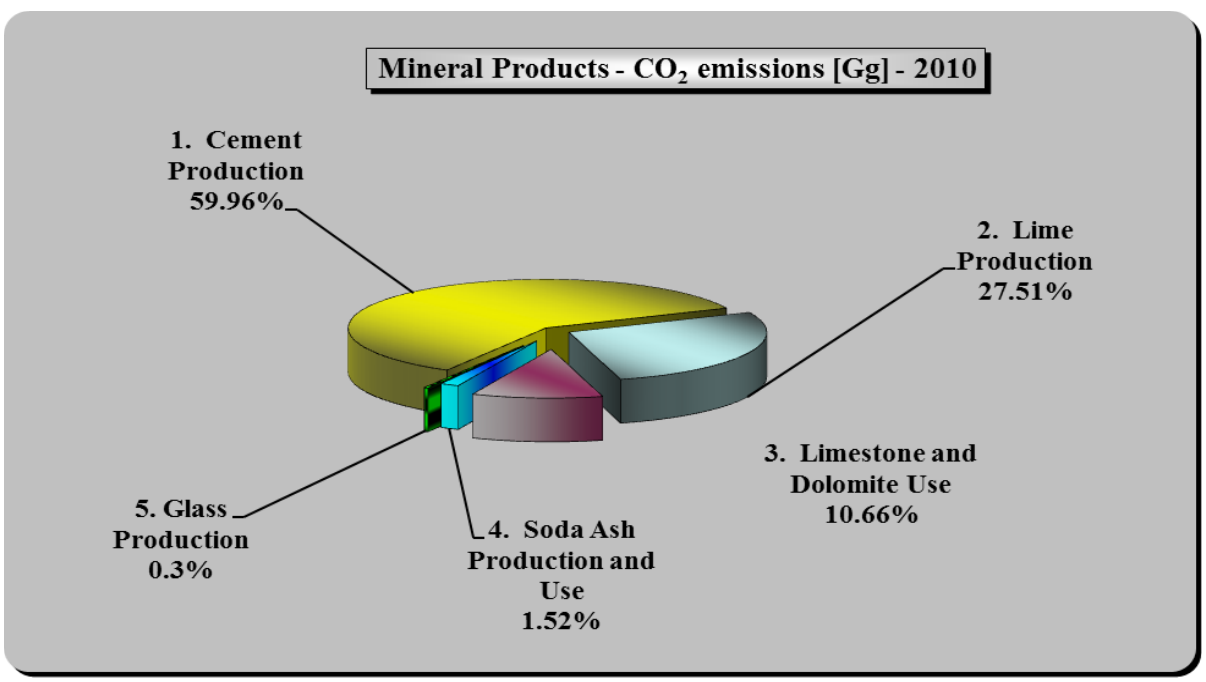
GHG emissions trend in the Mineral Products sub-sector was decreasing during 1989–2010 period due to the decrease recorded after 1989 in cement production, lime production, limestone and dolomite consumption, soda ash production and use, glass production; the emissions were relatively stable during 1993–2007. 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.

Mineral products sub-sector was responsible for 37.20% of the Industrial Processes sector's GHG emissions in 2010.

Table 4.3 CO_2 emissions in the Mineral products sector, in the year 2010

Sector	CO_2 emissions [Gg] 2010
2.A Mineral Products	4,632.57
2.A.1 Cement Production	2,777.89
2.A.2 Lime Production	1,274.52
2.A.3 Limestone and Dolomite Use	493.91
2.A.4 Soda Ash Production and Use	70.40
2.A.7.1 Glass production	15.85

Figure 4.6 Structure of the Mineral products sub-sector, in 2010



4.2.2 Methodological issues

Cement production (2.A.1)

Methodology

The cement production is a key category from both level and trend point of view (excluding 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 1989-2010 period;
- plant specific content of CaO (%) in clinker was provided by each companies (according with laboratory analyses) starting with 2008 year;
- plant specific content of MgO (%) in clinker was provided by each companies (according with laboratory analyses) starting with 2008 year;
- cement kiln dust (CKD) is completely recycled to 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. Starting with 2007 year there was no reported **a** correction factor for discarded amounts of dust.

Emission factors

The CO_2 EF also estimated considering the issues from 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.

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 **0.53 t CO_2/t clinker**.

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). 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 0.53 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.

Equation 4.4 Calculation of CO_2 emissions

$$Emissions = Emissions\ from\ Clinker\ Production + Emissions\ from\ CKD$$

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 plan of 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 – 2010

Years	**Activity data and CO_2 emissions from Cement Production subsector (2.A.1) 2012 v.2.1 submission**		
	Clinker production [kt]	**Emission factor [tCO_2/t clinker]**	**CO_2 Emissions [Gg]**
1989	10,571.00	0.53	5,609.10
1990	8,379.00	0.53	4,445.30
1991	6,037.00	0.53	3,200.75
1992	5,488.00	0.53	2,905.96
1993	5,349.00	0.53	2,833.43
1994	5,232.00	0.53	2,770.91
1995	5,937.82	0.53	3,145.84
1996	6,037.50	0.53	3,200.04
1997	5,669.27	0.53	3,004.94
1998	5,497.25	0.53	2,915.95
1999	4,971.03	0.53	2,644.77
2000	5,005.78	0.53	2,655.96
2001	5,218.31	0.53	2,768.36
2002	4,984.02	0.53	2,642.09
2003	4,995.76	0.53	2,650.04
2004	5,661.24	0.53	2,992.09
2005	6,006.96	0.53	3,174.81
2006	6,916.22	0.53	3,655.57
2007	7,670.40	0.53	4,053.98
2008	7,780.03	0.53	4,142.66
2009	5,801.76	0.53	3,093.07
2010	5,198.98	0.53	2,777.89

SO_2 emissions from cement production are estimated using the following formula:

Equation 4.5 Calculation emissions of SO_2 from cement

$$SO_2\ [Gg] = \text{Quantity of Cement Produced (t)} \times \text{Emission Factor} \times 10^{-6}$$

The default emission factor 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 – 2010

Years	**Activity data and SO_2 emissions from Cement Production subsector (2.A.1) 2012 v.2.1 submission**		
	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

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 (2.A.2)

Methodology

The lime production is a key category only considering the level criteria.

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 CO2 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 period 1998 to 2000 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, 3.5 B, 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 – 2010

Year	Emissions from Lime Production subsector (2.A.2) 2012 v.2.1 submission
	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

Limestone and dolomite use (2.A.3)

Methodology

Limestone and dolomite use is a key category only considering the trend criteria (including LULUCF). The IPCC methodology has been followed for estimating the CO_2 emissions from limestone and dolomite used. According with IPCC 1996 and GPG 2000 Methodology there are no described methods in order to estimate the CO_2 emissions on higher levels, therefore it was followed the methodology from Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.6 and Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual, page 2.10. The method estimates the amount of limestone and dolomite used in the iron and steel production, pulp and paper production, sugar mills production, ceramics plants, for all-time series.

Activity data

The activity data were provided directly by the plants (iron and steel producers, pulp and paper producers, sugar mills producers, ceramics producers).

In order to estimate CO_2 emissions from limestone and dolomite used subsector 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. In order to avoid the double counting with lime production subsector there was improve the data on statistics lime production subtracting from the total amount of statistics lime production, the amount of lime used in the two iron and steel integrated plants, which produce lime for its own use.

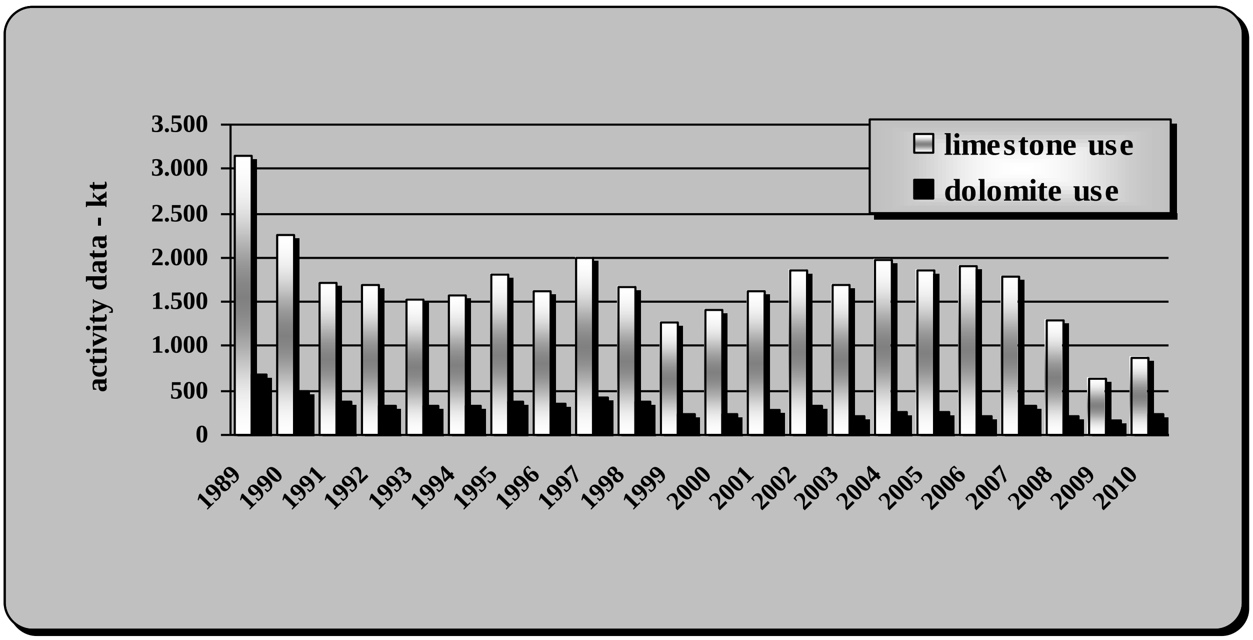
Table 4.7 Amount of limestone and dolomite used and CO_2 emissions in the period 1989 – 2010

Year	Activity data from Limestone and Dolomite Use subsector (2.A.3) 2012 v.2.1 submission			
	Limestone use	Dolomite use	Total limestone and dolomite consumption	CO_2 emission from limestone and dolomite consumption
	[kt]			[Gg]
1989	3,148.89	680.28	3,829.17	1,710.01
1990	2,244.56	489.84	2,734.40	1,221.26
1991	1,721.31	386.41	2,107.72	941.69
1992	1,687.14	323.59	2,010.73	896.69
1993	1,525.24	330.03	1,855.27	828.53
1994	1,581.70	335.71	1,917.41	856.08
1995	1,815.37	382.23	2,197.60	981.08
1996	1,628.11	354.48	1,982.59	885.45
1997	1,998.62	421.32	2,419.94	1,080.36
1998	1,658.89	384.09	2,042.98	913.12
1999	1,266.73	241.20	1,507.94	672.42
2000	1,410.08	242.75	1,652.84	736.23
2001	1,625.89	272.90	1,898.79	845.57
2002	1,867.23	319.13	2,186.36	973.81
2003	1,691.64	219.40	1,911.04	848.97
2004	1,981.16	264.95	2,246.11	998.09
2005	1,848.52	247.50	2,096.02	931.41
2006	1,909.57	221.73	2,131.30	945.98
2007	1,790.28	332.00	2,122.27	946.08
2008	1,300.54	201.27	1,501.80	668.24
2009	644.11	168.70	812.81	363.88
2010	874.36	228.91	1,103.27	493.91

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 – 2010



Soda ash production and use (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 subsector 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 – 2010

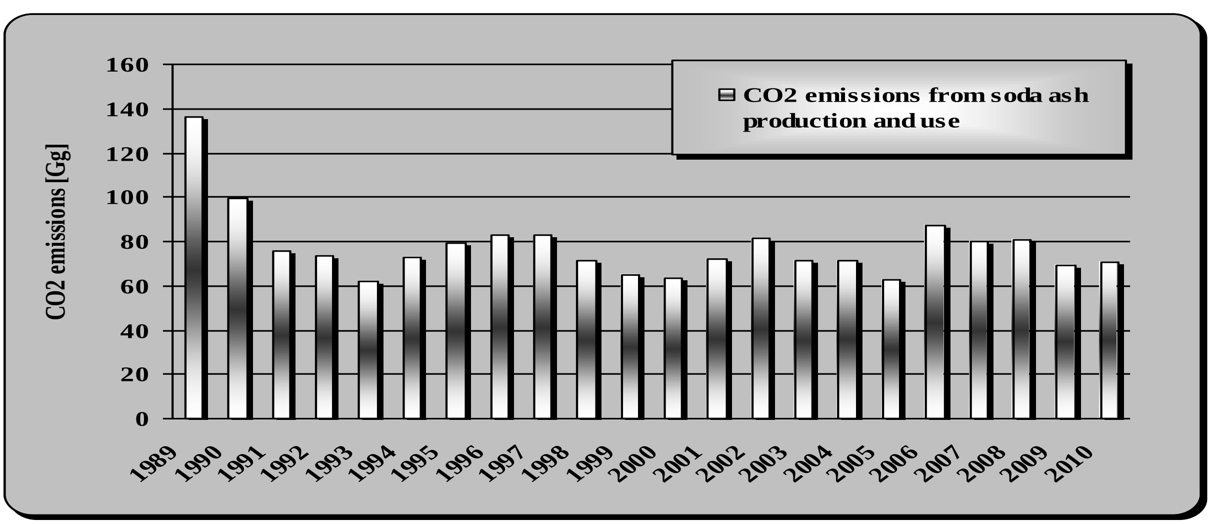


Table 4.8 CO_2 emissions from soda ash production and use in the period 1989 – 2010

Year	**Emissions from Soda Ash Production and Use subsector (2.A.4) 2012 v.2.1 submission**
	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

Asphalt roofing production (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 (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 (2.A.7.1)

Methodology

CO_2 emissions are estimated for both container glass and flat glass. 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 methodology.

Activity data

Emissions are estimated for both container glass and flat glass based on data provided by National Statistics. Starting with 2007 the data related with container glass and flat glass production are confidential.

Emission factors

For confidentiality reasons the presentation of CO_2 and NMVOC emission factors used to estimate emission from both container glass and flat glass production are omitted.

Table 4.10 CO_2 emissions from Container glass and flat glass production in the period 1989 – 2010

Year	**Emissions from Glass Production subsector (2.A.7.1) 2012 v.2.1 submission**
	CO_2 emissions [Gg]
1989	109.75
1990	85.95
1991	69.70
1992	61.70
1993	56.95
1994	53.75
1995	59.85
1996	61.10
1997	48.70
1998	45.70
1999	33.15
2000	40.35
2001	42.50
2002	49.50
2003	64.25
2004	45.20
2005	35.35
2006	30.10
2007	25.55
2008	23.70
2009	16.95
2010	15.85

4.2.3 Uncertainties and time series consistency

Cement production (2.A.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 1989–2010.
The uncertainty related to the activity data for CO_2 emissions is 1.5% (based on clinker production data) in line with the IPCC 2006 and the uncertainty associated with emission factor for CO_2 is 1.5 % in line with the IPCC Good Practice Guidance (based on plant specific CaO and MgO content in clinker) **(**Table 3.2.).
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in chapter 6 of IPCC GPG 2000 is 2.12%.

Lime production (2.A.2)

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 1989–2010.
The uncertainty related to the activity data for CO_2 emissions is 2% in line with the IPCC 2006 and the uncertainty associated with emission factor for CO_2 emissions is ± 2% in line with the IPCC Good Practice Guidance.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in chapter 6 of IPCC GPG 2000 is 2.83%.

Limestone and dolomite use (2.A.3)

Time series is consistent; emissions have been calculated using the same emission factors, the same sources of activity data and the same methods for the entire time series 1989–2010.
By expert judgment the uncertainty related to the activity data for CO_2 emissions is 7.5% and the uncertainty associated with emission factor for CO_2 emissions is 30%.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in chapter 6 of IPCC GPG 2000 is 30.92%.

Soda ash production and use (2.A.4)

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 1989–2010.
By expert judgment the uncertainty related to the activity data for CO_2 emissions is 7.5% and the uncertainty associated with emission factor for CO_2 emissions is 30%.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in Chapter 6 of IPCC GPG 2000 is 30.92%.

Glass production (2.A.7.1)

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 1989–2010.
The uncertainty related to the activity data for CO_2 emissions is 5% and the uncertainty associated with emission factor for CO_2 emissions is 60%.
The uncertainty associated with emission factor and activity data are in line with the IPCC 2006.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in Chapter 6 of IPCC GPG 2000 is 60.21%.

4.2.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in QA/QC Program 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 Chemical industry subsector.
Following these activities there were unconformities recorded.
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 unconformities noted and solved following these activities 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.

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.

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 unconformities noted and solved following the previously specified activities are described at the Improvements list level.

4.2.5 Source specific recalculation, including changes made in response to the review process

Table 4.11 The effects of recalculations in Mineral Industry subsector (2A)

The effects of recalculations in Mineral Industry subsector (2A)			
Years	**2011 v. 4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 equivalent [Gg]		
1989	11,337.86	10,787.48	-4.85
1990	8,901.97	8,241.09	-7.42
1991	6,804.87	6,118.79	-10.08
1992	6,050.27	5,467.71	-9.63
1993	5,764.89	5,152.35	-10.63
1994	5,707.39	5,034.89	-11.78
1995	6,442.25	5,657.49	-12.18
1996	6,337.58	5,603.80	-11.58
1997	6,299.92	5,545.07	-11.98
1998	5,983.13	5,423.33	-9.36
1999	5,240.38	4,738.05	-9.59
2000	5,307.68	4,843.15	-8.75
2001	5,631.70	5,349.27	-5.02
2002	5,877.10	5,325.25	-9.39
2003	5,648.65	5,215.92	-7.66
2004	6,218.58	5,792.66	-6.85
2005	6,165.19	5,687.03	-7.76
2006	6,669.39	6,364.30	-4.57
2007	7,845.92	7,046.39	-10.19
2008	7,577.38	6,674.51	-11.92
2009	5,092.66	4,729.28	-7.14
2010		4,632.57	

Cement production (2.A.1)

Recalculations for 1989–2007 period at the cement production sub sector for CO_2 emission factor (EF) level due to change the default EF (0.525 t CO_2/t clinker) used in the last 2011 submission. The new specific EF was calculated considering the average between the base year 1989 implied emission factor (0.527 t CO_2/t clinker) and 2008 emission factor (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 0.53 t CO_2/t clinker (2A.1).

Table 4.12 Recalculations of CO_2 emissions [Gg] in the Cement Production sub - sector

The effects of recalculations in Cement Production subsector (2.A.1)			
Years	**2011 v. 4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	5,571.72	5,609.10	0.67
1990	4,415.68	4,445.30	0.67
1991	3,179.42	3,200.75	0.67
1992	2,886.60	2,905.96	0.67
1993	2,814.55	2,833.43	0.67
1994	2,752.45	2,770.91	0.67
1995	3,124.87	3,145.84	0.67
1996	3,178.71	3,200.04	0.67
1997	2,984.91	3,004.94	0.67
1998	2,896.51	2,915.95	0.67
1999	2,627.14	2,644.77	0.67
2000	2,638.26	2,655.96	0.67
2001	2,749.91	2,768.36	0.67
2002	2,624.48	2,642.09	0.67
2003	2,632.38	2,650.04	0.67
2004	2,972.15	2,992.09	0.67
2005	3,153.65	3,174.81	0.67
2006	3,631.21	3,655.57	0.67
2007	4,026.96	4,053.98	0.67
2008	4,142.66	4,142.66	0.00
2009	3,093.07	3,093.07	*0.00*
2010		2,777.89	

Lime production (2.A.2)

Recalculations for 1989–2009 period at the Lime production sub sector due to wrong manipulation of data in lime production, for the entire time series. In the estimation of emissions from lime production were taken into account production data from crude dolomite. This data are not considered in IPCC GPG 2000.

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 period 1998 to 2000 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.

Table 4.13 Recalculations of CO_2 emissions [Gg] in the Lime Production sub - sector

The effects of recalculations in Lime Production subsector (2.A.2)			
Years	**2011 v. 4.1. submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	3,810.03	3,222.27	-15.43
1990	3,079.97	2,389.47	-22.42
1991	2,538.15	1,830.74	-27.87
1992	2,131.90	1,529.98	-28.23
1993	2,002.94	1,371.52	-31.52
1994	1,972.52	1,281.56	-35.03
1995	2,197.02	1,391.29	-36.67
1996	2,129.78	1,374.67	-35.45
1997	2,102.86	1,327.99	-36.85
1998	2,056.60	1,477.36	-28.16
1999	1,842.79	1,322.83	-28.22
2000	1,829.65	1,347.42	-26.36
2001	1,921.54	1,620.66	-15.66
2002	2,147.65	1,578.18	-26.52
2003	2,031.61	1,581.22	-22.17
2004	2,131.59	1,685.73	-20.92
2005	1,982.07	1,482.76	-25.19
2006	1,974.76	1,645.31	-16.68
2007	2,767.49	1,940.95	-29.87
2008	2,662.19	1,759.32	-33.91
2009	1,565.94	1,185.85	-24.27
2010		1,274.52	

Soda ash production and use (2.A.4)

Recalculation for 2009 year at the soda ash production sub sector activity data (AD) level due to wrong manipulation of data (2A.4.1).

Table 4.14 Recalculations of CO_2 emissions [Gg] in the Soda Ash Production and use sub-sector

The effects of recalculations in Soda Ash Production and Use subsector (2.A.4)			
Years	**2011 v.4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	136.35	136.35	0.00
1990	99.11	99.11	0.00
1991	75.90	75.90	0.00
1992	73.38	73.38	0.00
1993	61.92	61.92	0.00
1994	72.59	72.59	0.00
1995	79.43	79.43	0.00
1996	82.54	82.54	0.00
1997	83.08	83.08	0.00
1998	71.20	71.20	0.00
1999	64.88	64.88	0.00
2000	63.20	63.20	0.00
2001	72.18	72.18	0.00
2002	81.66	81.66	0.00
2003	71.43	71.43	0.00
2004	71.54	71.54	0.00
2005	62.71	62.71	0.00
2006	87.34	87.34	0.00
2007	79.84	79.84	0.00
2008	80.58	80.58	0.00
2009	52.81	69.53	31.66
2010		70.40	

Asphalt roofing production (2.A.5)

Recalculations for 2005–2009 period at the Asphalt roofing production sector for NMVOC and CO due to addition a new parameter as activity data: asphalt board, starting with 2005.

Table 4.15 Recalculations of NMVOC and CO emissions [Gg] in the Asphalt roofing production sub-sector

The effects of recalculations in Asphalt Roofing Production subsector (2.A.5)			
Years	**2011 v.4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	NMVOC emissions [Gg]		
1989	0.00	0.00	0.00
1990	0.00	0.00	0.00
1991	0.00	0.00	0.00
1992	0.00	0.00	0.00
1993	0.00	0.00	0.00
1994	0.00	0.00	0.00
1995	0.00	0.00	0.00
1996	0.00	0.00	0.00
1997	0.00	0.00	0.00
1998	0.00	0.00	0.00
1999	0.00	0.00	0.00
2000	0.00	0.00	0.00
2001	0.00	0.00	0.00
2002	0.00	0.00	0.00
2003	0.00	0.00	0.00
2004	0.00	0.00	0.00
2005	0.00	0.03	0.00
2006	0.00	0.02	0.00
2007	0.01	0.01	87.40
2008	0.01	0.01	50.21
2009	0.01	0.01	35.82
2010		0.01	

Road paving with asphalt (2.A.6)

Recalculations for 1998–2009 period at the Road paving with asphalt sub sector for NMVOC emission factor (EF) level due to change the default IPCC EF (320 kg NMVOC/ tone material used) used in the last 2011 submission with the default CORINAIR emission inventory guidebook EF used for estimate NMVOC emissions (0.016 kg NMVOC/ tone material used) (2.A.6);

Table 4.16 Recalculations of NMVOC emissions [Gg] in the Road paving with asphalt sub-sector

The effects of recalculations in road paving with asphalt (2.A.6)			
Years	**2011 v. 4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	NMVOC emissions [Gg]		
1989	0.000	0.000	0.000
1990	0.000	0.000	0.000
1991	0.000	0.000	0.000
1992	0.000	0.000	0.000
1993	0.000	0.000	0.000
1994	0.000	0.000	0.000
1995	0.000	0.000	0.000
1996	0.000	0.000	0.000
1997	0.000	0.000	0.000
1998	61.547	0.003	-99.995
1999	54.905	0.003	-99.995
2000	71.423	0.004	-99.995
2001	49.741	0.002	-99.995
2002	49.885	0.002	-99.995
2003	60.883	0.003	-99.995
2004	304.679	0.015	-99.995
2005	216.449	0.011	-99.995
2006	303.812	0.015	-99.995
2007	766.021	0.038	-99.995
2008	170.528	0.009	-99.995
2009	442.881	0.022	*-99.995*
2010		0.026	

4.2.6 Source specific planned improvements, including those in response to the review process

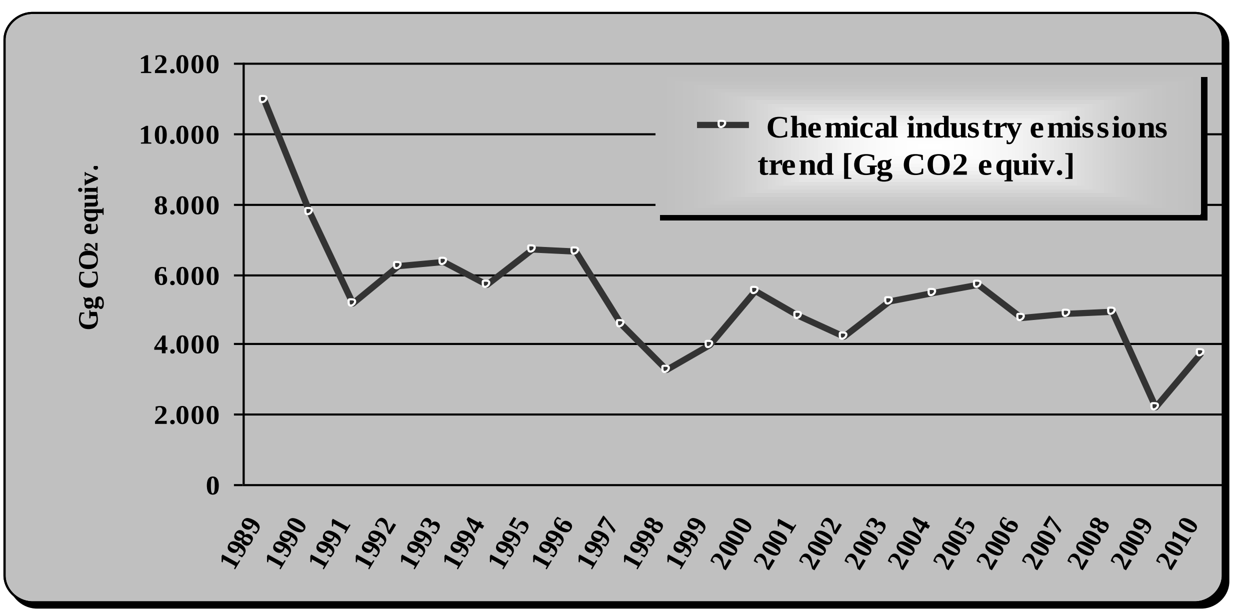
More detailed data will try to be obtained, in respect to the IPCC GPG 2000 provisions.

4.3 Source category Chemical Industry (CRF sector 2.B)

4.3.1 Source category Description

CRF sector 2.B includes: ammonia production (2B.1), nitric acid production (2B.2), adipic acid production (2B.3) -until 2001, silicon carbide production (2B.4.1) calcium carbide production (2B.4.2) and other productions (2B.5): carbon black, methanol, ethylene, etc. Chemical industry sub-sector was responsible for 29.82 % of the total Industrial Processes sector's GHG emissions in 2010.

Figure 4.9 GHG emissions trend in the Chemical Industry sub-sector for 1989 – 2010 period [Gg CO_2 equiv.]



GHG emissions trend in the Chemical Industry sub-sector for 1989–2010 period due:

- The lowest level of emissions from ammonia production 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;
- Nitric acid production recorded a decreased after 1989;
- Adipic acid production stopped at the end of 2001. Starting 2002, this activity is suspended;
- Carbide production had recorded a decrease after 1989 and it was stopped the production starting with 2007;
- For 2009 year a significant decrease of emissions level was recorded due to the economic crisis;
- In 2010 the emissions trends have recorded an increased due to increase of various production activities (ammonia production, nitric acid production, silicon carbide production).

Table 4.17 GHG emissions from the Chemical Industry sector, in 2010 (Gg)

Sector	**CO_2**	**CH_4**	**N_2O**
	[Gg] - 2010		
2.B Chemical Industry	2,542.69	0.85	3.72
2.B.1 Ammonia Production	2,542.69	0.00	0.00
2.B.2 Nitric Acid Production	0.00	0.00	3.72
2.B.3 Adipic Acid Production	NO	NO	NO
2.B.4.1 Silicon Carbide Production	IE	0.46	0.00
2.B.4.2 Calcium Carbide Production	NO	NO	NO
2.B.5 Others (ethylene, carbon black, methanol, sulphuric acid)	0.00	0.39	0.00

4.3.2 Methodological issues

Ammonia production (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** 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.

During the production process of ammonia use Kellogg process the raw material used are: methane gas and atmospheric air.

The main steps of technological process are:

- Compression of natural gas;
- Desulphurization of natural gas;
- Primary catalytic reforming of natural gas;
- Secondary catalytic reforming, with air and water vapor;
- Catalytic conversion of carbon monoxide into carbon dioxide, in two steps of temperature;
- Synthesis gas purification (CO_2 removal with K_2CO_3);
- Synthesis gas methanation;
- Ammonia synthesis;

The main product is liquid ammonia.

On industrial scale, ammonia is produced by synthesis from nitrogen and hydrogen. In Romania the raw materials used are:

  - Natural gas as hydrogen source;

  - Air, as nitrogen sources.

From ammonia production process results the next main products:

  - Liquid ammonia 99.7%-99.9%;
  - Carbon dioxide CO_2

Liquid ammonia could be used for:

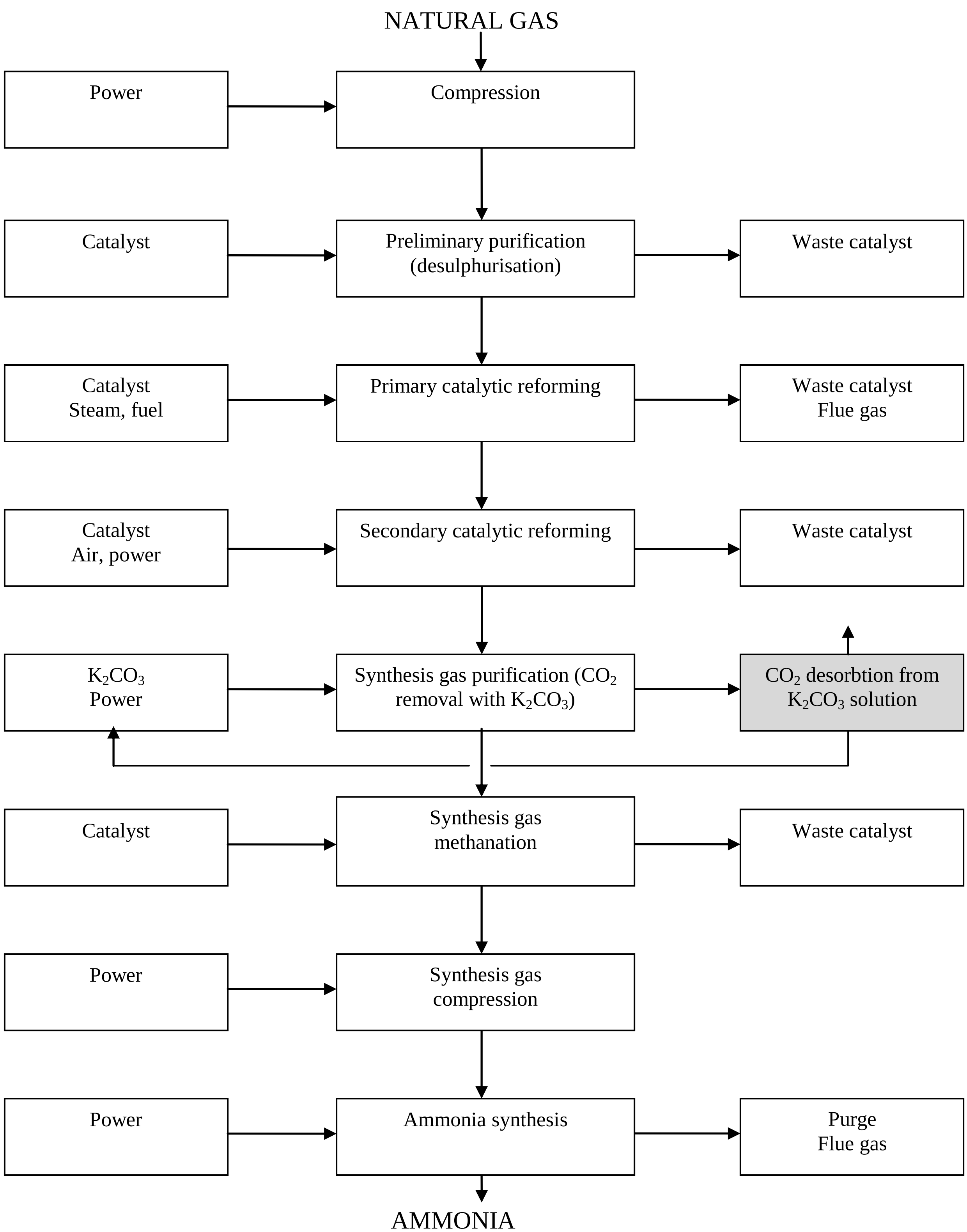
- Urea production;
- Production of ammonium nitrate (NH_4NO_3);
- Production of complex fertilizers.

Carbon dioxide could be used for:

  - Urea production;
  - Methanol production.

The figure below illustrates the Kellogg diagram flow process of the ammonia obtaining process.

Figure 4.10 Diagram flow process of the ammonia obtaining process



Because in all the ammonia production facilities Kellogg process is using (process than is based on the steam reforming of methane) main chemical reactions are common to all installations:

Prior purification of natural gas:

In the presence of hydrogen and a catalyst with molybdenum, oxygen is converted completely into water and sulfur from organic compounds is related to hydrogen sulfide, according to reactions:

$1/2\ O_2 + H_2 = H_2O$

$R\text{-}SH + H_2 = R\text{-}H + H_2S$

H_2S is detained by ZnO catalyst:

$H_2S + ZnO = ZnS + H_2O$

Catalytic reforming of natural gas;

Obtaining the hydrogen to synthesize ammonia takes place in two stages:

- The primary steam reforming on NiO catalyst:

$CH_4 + H_2O = CO + 3\ H_2$

$CO + H_2O = CO_2 + H_2$

- Secondary reforming on NiO catalyst at 950-980 ° C:

$CH_4 + 1/2\ O_2 = CO + H_2$

$CH_4 + O_2 = CO_2 + H_2$

$CO + 1/2O_2 = CO_2$

$2H_2 + O_2 = 2H_2O$

Obtained gas containing 56% H_2, 12% CO, 9% CO_2, 22% N_2 and CH_4 below 0.4%

Purification of carbon dioxide gas resulting in earlier stages

Gas purification is done by washing with hot potassium carbonate solution:

$K_2CO_3 + CO_2 + H_2O = 2\ KHCO_3$

Synthesis gas Methanisation

Residual content of carbon oxides ($CO + CO_2$) is removed by hydrogenation based on NiO catalysts:

$CO + 3 H_2 = CH_4 + H_2O$

$CO_2 + 4 H_2 = CH_4 + 2H_2O$

Resulting gas has the composition required for ammonia synthesis: 74% H_2, 24% N_2, and 1% CH_4.

Ammonia synthesis

The chemical reactions for ammonia production occur in the presence of a catalyst according with:

$N_2 + 3H_2 = 2 NH_3$

Methodology

The ammonia production is a key category, from both level and trend point of view.

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 1989-2010. 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

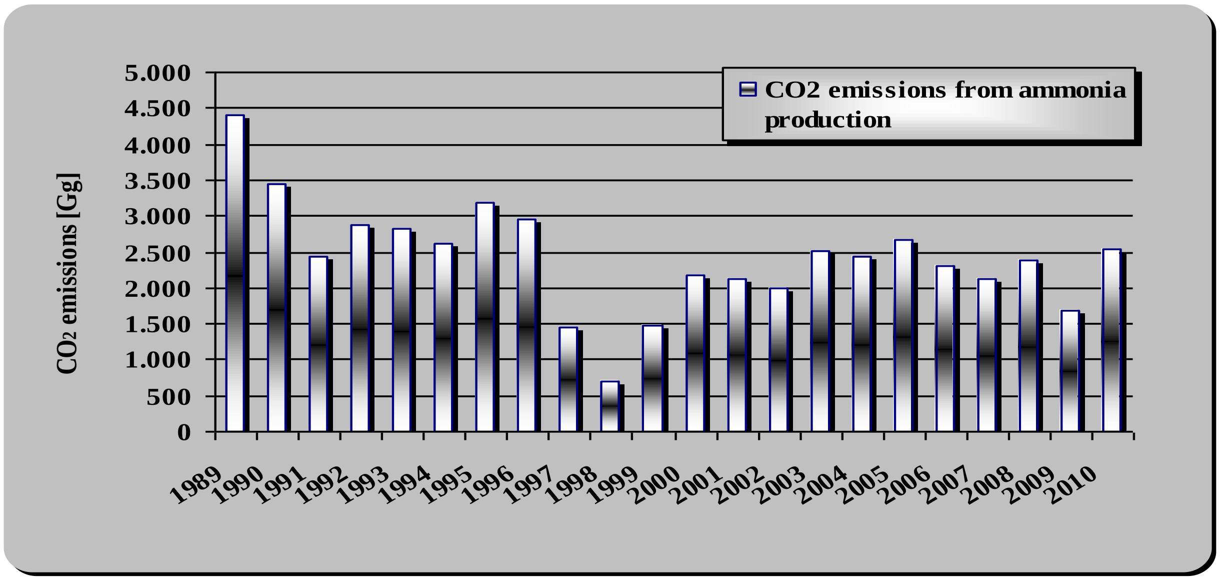
- Unit measurement: t/year (tone ammonia production 100%/year);
- Annual production is annually obtained from operators.

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 4.18 Ammonia production related to the CO_2 emissions in the period 1989 – 2010

Year	Activity data and emissions from Ammonia Production subsector (2.B.1)	
	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

Figure 4.11 The trend of CO_2 emissions from Ammonia Production in the period 1989 – 2010



Nitric acid production (2.B.2)

Methodology

The nitric acid production is a key category, from both level and trend point of view. 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 2012.

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 year 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:

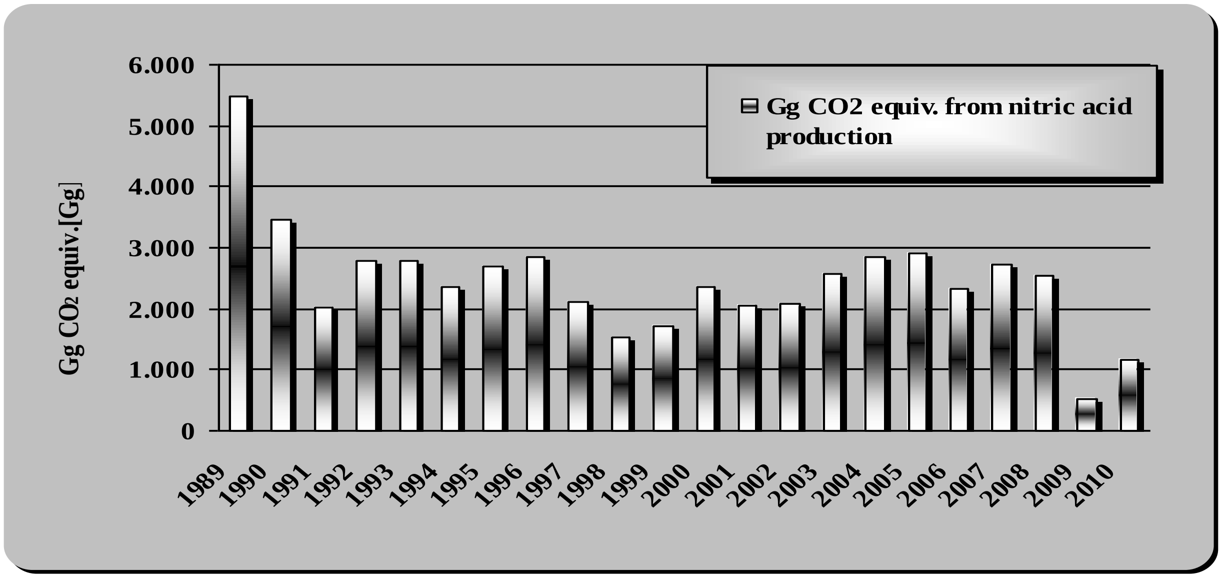
- extended absorption for NO_x – used at one factory (it was used since 1997);
- selective catalytic reduction (SCR) for NO_x – used at one single plant since 2003;
- selective catalytic reduction (SCR) for N_2O - used at two plants starting with 2009.

These abatement techniques are used both for NO_x and N_2O reduction emissions.

Table 4.19 Nitric acid production related to the N_2O and NO_x emissions in the period 1989 – 2010

Years	Activity data and emissions from Nitric Acid Production subsector (2.B.2) 2012 v.2.1 submission		
	Nitric acid production [kt]	N_2O emissions [Gg]	NO_x emissions [Gg]
1989	1,913.76	17.63	14.68
1990	1,205.92	11.16	9.30
1991	710.92	6.52	5.43
1992	979.13	8.99	7.49
1993	978.06	8.97	7.48
1994	837.50	7.59	6.33
1995	959.74	8.68	7.23
1996	1,020.64	9.21	7.67
1997	749.26	6.77	4.78
1998	550.47	4.98	3.88
1999	603.48	5.50	4.10
2000	831.48	7.58	5.32
2001	720.62	6.60	4.88
2002	745.11	6.75	4.98
2003	917.50	8.28	2.07
2004	1,000.14	9.17	2.67
2005	1,037.32	9.42	3.19
2006	821.55	7.53	2.08
2007	962.52	8.77	2.54
2008	883.12	8.16	3.24
2009	589.89	1.67	1.94
2010	1,055.32	3.72	4.12

Figure 4.12 The trend of CO_2 emissions from nitric acid production, 1989 – 2010 [Gg CO_2 equivalent]



Adipic acid production (2.B.3)

Methodology

The Adipic acid production is a key category only considering the trend criteria. 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.

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 4.20 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 (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 (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 4.21 CO_2 emissions from Calcium Carbide Production in the period 1989 – 2010

Years	**Emissions from Calcium Carbide Production subsector (2.B.4.2) 2012 v.2.1 submission**
	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

Other production: carbon black, ethylene, methanol, propylene, polystyrene, polyethylene, sulphuric acid, phthalic anhydride, polypropylena, polyvinylchloride, 1, 2 dichloroethane (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 (2.B.1)

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 1989–2010. The uncertainty related to the activity data for CO_2 emissions is 5% and the uncertainty associated with default emission factor for CO_2 and for the carbon content of natural gas is 8.5%.
The uncertainty associated with emission factor and activity data are in line with the study "Elaboration of national emission factors/other parameters relevant to NGHGI Industrial Processes Sector in order to improve the ammonia production sub sector".

Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in chapter 6 of IPCC GPG 2000 is 9.86%.

Nitric acid production (2.B.2)

Time series is consistent; emissions have been calculated using the same emission factors (considering the process type and the NOx abatement technology installed at each plant), the same sources of activity data and the same methods were used for the entire time series 1989–2010.
The uncertainty related to the activity data for N_2O emissions is 2% and the uncertainty associated with emission factor for N_2O emissions is 40%.
The uncertainty associated with emission factor and activity data are in line with the IPCC 2006.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in Chapter 6 of IPCC GPG 2000 is 40.05%.

Adipic acid production (2.B.3)

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 1989–2010.
The uncertainty related to the activity data for CO_2 emissions is 2% and the uncertainty associated with default emission factor for CO_2 emissions is 10%.
The uncertainty associated with emission factor and activity data are in line with the IPCC 2006.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in Chapter 6 of IPCC GPG 2000 is 10.2%.

Silicon Carbide production (2.B.4.1)

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 time series 2003–2010.
The uncertainty related to the activity data for CH_4 emissions is 5% and the uncertainty associated with default emission factor for CH_4 emissions is 10%.
The uncertainty associated with emission factor and activity data are in line with the IPCC 2006.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF

uncertainties according to the previsions in Chapter 6 of IPCC GPG 2000 is 11.18%.

Calcium Carbide production (2.B.4.2)

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 1989–2010. The uncertainty related to the activity data for CO_2 emissions is 5% and the uncertainty associated with default emission factor for CO_2 emissions is 10%.
The uncertainty associated with emission factor and activity data are in line with the IPCC 2006.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in Chapter 6 of IPCC GPG 2000 is 11.18%.

Other production (2.B.5)

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 1989-2010. By expert judgment the uncertainty related to the activity data for CH_4 emissions is 7.5% and the uncertainty associated with default emission factors for CH_4 emissions are 30%.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in Chapter 6 of IPCC GPG 2000 is 30.92%.

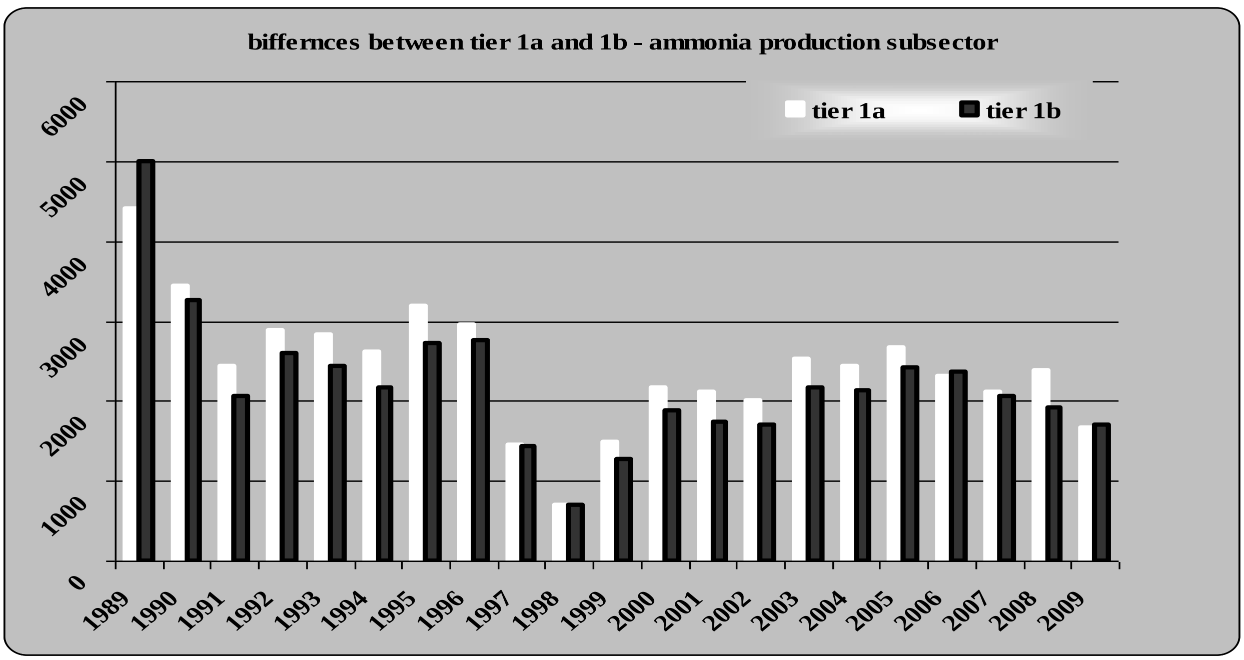
4.3.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in QA/QC Program 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 Mineral industry subsector.
After these activities unconformities have not been notified.

Ammonia production

There were made comparisons between the emissions estimated using Tier 1a and 1b method in ammonia production subsector. There were identified some differences which are explained below. In 2011 submission the CO_2 emissions were estimated using the National Statistics production data and a default emission factor (1b method). Starting with 2012 submission the CO_2 emission are have been estimated considering the plant data (1a) – according with IPCC 1996 Methodology.

Figure 4.13 The differences between Tier 1a and 1b method in ammonia production subsector 1989 – 2009 period



In the periods 1990–1997; 1999–2005; 2007–2008 the CO_2 emissions estimated using the ammonia production as activity data (provided by National Statistics) and a default EF according to Tier 1b are less than the CO_2 emissions estimated using the 1a method. In order to explain the difference there was estimated for all-time series the specific natural gas consumption for each installation using relation between natural gas consumption and ammonia production.

The reasons of the positive differences in CO_2 emissions between the two methods (CO_2 Emissions Tier 1a - CO_2 Emissions 1b) are:

- Differences in calculation formulas for Tier 1a and 1b, using different emission factors;
- Some operators have specific natural gas consumption too high;
- In the 1b method formula there was used a default EF (1,5 t CO_2/t NH_3). This value corresponds to about 770 m^3/t NH_3 specific natural gas consumption and 0,525 kg Carbon/m^3 gas content of carbon in natural gas. Average specific consumption of natural gas for all economic agents and all years is 892.22 m^3 natural gas/t ammonia in comparison with about 770, the value corresponding to the default emission factor of 1.5 t CO_2/t ammonia, used in the calculation according to the level 1b.

For the 1989, 1998, 2006 and 2009 the reasons of the negative differences in CO_2 emissions between the two methods (CO_2 Emissions tier 1a - CO_2 Emissions 1b) are:

- Differences between the ammonia production provided by Nation Statistics and economic agents;
- The amount of ammonia production provided by National Statistic are to higher therefore the share of ammonia production in E_{1b} formula was so high that surpassed the share of specific natural gas consumption in E_{1a} formula.

It was verified the accuracy of reporting parameter "carbon content of natural gas" using data from "Annual Report on GHG emissions for the period 2007 - 2010 verified by accredited organizations". By comparing the information submitted by operators, used to calculate emissions of carbon dioxide, with values from this document was found that the data are similar.

During the elaboration of the final report there have been made the activities in order to check the quality. The quality of the results was ensured by involving third parties - evaluator - which was not directly involved in the process of calculating carbon dioxide emissions from ammonia production facilities.

Nitric acid production

AD obtained regarding nitric acid production from economic agents has been checked against the data obtained from the national statistics. The differences between the two sets of data are very large (the data from factories are higher than national statistics). This probably due to nitric acid production that is integrated as part of larger production processes and it is not counted in the national statistics. According to IPCC Good Practice Guidance, the statistics may miss an average of one-half of a national total and it is good practice to use plant level data.

In order to improve the accuracy of activity data, emission factors and emissions have been developed, there were developed new approaches which are presented in the sub- sectors “Source specific recalculation” and Chapter 10.

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.

All notified and solved recommendations following various QA/QC activities are described in Improvement Lists.

4.3.5 Source specific recalculation, including changes made in response to the review process

Table 4.22 The effects of recalculations in Chemical Industry subsector (2B)

The effects of recalculations in Chemical Industry subsector (2B)			
Years	**2011 v.4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 equivalent [Gg]		
1989	11,386.81	10,920.27	-4.10
1990	7,470.42	7,738.51	3.59
1991	4,696.67	5,133.01	9.29
1992	5,841.47	6,190.69	5.98
1993	5,865.65	6,324.26	7.82
1994	5,148.19	5,653.94	9.82
1995	6,112.55	6,653.85	8.86
1996	6,346.09	6,612.24	4.19
1997	4,480.32	4,568.70	1.97
1998	3,204.00	3,253.11	1.53
1999	3,719.04	3,989.01	7.26
2000	5,176.43	5,498.51	6.22
2001	4,349.43	4,770.09	9.67
2002	3,873.92	4,206.56	8.59
2003	4,813.46	5,198.65	8.00
2004	5,087.20	5,443.64	7.01
2005	5,412.41	5,688.16	5.09
2006	4,769.04	4,719.44	-1.04
2007	4,789.18	4,853.61	1.35
2008	4,465.54	4,933.66	10.48
2009	2,236.85	2,199.45	-1.67
2010		3,712.81	

Ammonia production (2.B.1)

Recalculations for all-time series 1989–2009 at ammonia production sub sector method level for estimated CO_2 due to improvement in CO_2 emissions estimations (from T1b to T1a) based on the study "Elaboration of national emission factors/other parameters relevant to NGHGI Industrial Processes Sector in order to improve the ammonia production sub sector"(2.B.1).

Table 4.23 The effects of recalculations in Ammonia Production subsector

The effects of recalculations in Ammonia Production subsector (2.B.1)			
Years	**2011 v.4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	5,005.50	4,403.96	-12.02
1990	3,267.00	3,438.34	5.24
1991	2,062.50	2,428.34	17.74
1992	2,599.50	2,883.47	10.92
1993	2,430.00	2,825.62	16.28
1994	2,164.50	2,620.00	21.04
1995	2,713.50	3,187.29	17.46
1996	2,761.50	2,948.14	6.76
1997	1,426.50	1,446.63	1.41
1998	702.00	696.36	-0.80
1999	1,251.00	1,480.47	18.34
2000	1,882.50	2,163.33	14.92
2001	1,732.50	2,113.41	21.99
2002	1,705.50	1,998.39	17.17
2003	2,167.50	2,518.94	16.21
2004	2,133.00	2,442.19	14.50
2005	2,416.50	2,666.76	10.36
2006	2,370.00	2,305.40	-2.73
2007	2,056.50	2,120.93	3.13
2008	1,912.50	2,380.62	24.48
2009	1,708.50	1,671.10	-2.19
2010		2,542.69	

Calcium Carbide production (2.B.4.2)

Recalculations for 1989–2009 period at the Calcium Carbide production sub sector for CO_2 emission factor (EF) level due to change the default EF for use of product step (1.1 t CO_2/t carbide) used in the last 2011 submission. The new EF use was calculated considering default emission factors provided in production process of calcium carbide (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 4.24 Recalculations of CO_2 [Gg] emissions in the Calcium Carbide production sub–sector

The effects of recalculations in Calcium Carbide Production subsector (2.B.4.2)			
Years	**2011 v.4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	198.00	333.00	68.18
1990	141.90	238.65	68.18
1991	103.40	173.90	68.18
1992	95.70	160.95	68.18
1993	92.40	155.40	68.18
1994	73.70	123.95	68.18
1995	99.00	166.50	68.18
1996	116.60	196.10	68.18
1997	100.10	168.35	68.18
1998	80.30	135.05	68.18
1999	59.40	99.90	68.18
2000	60.50	101.75	68.18
2001	58.30	98.05	68.18
2002	58.30	98.05	68.18
2003	49.50	83.25	68.18
2004	69.30	116.55	68.18
2005	37.40	62.90	68.18
2006	22.00	37.00	68.18
2007	NO	NO	NO
2008	NO	NO	NO
2009	NO	NO	NO
2010		NO	

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)

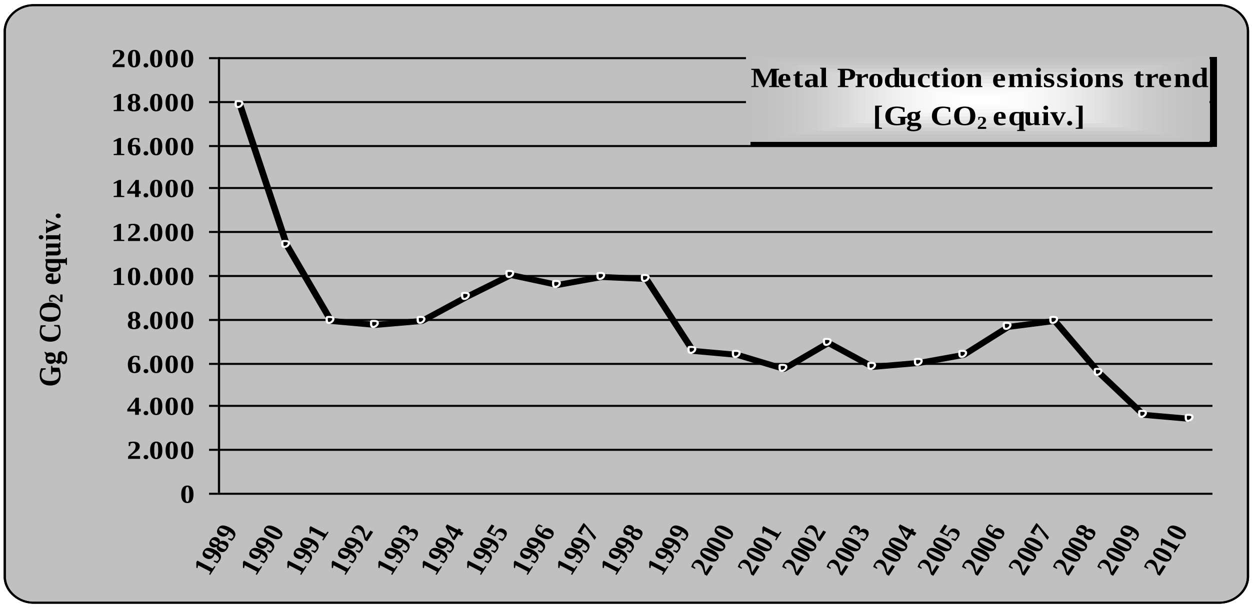
4.4.1 Source category description

The emission estimates cover sub-categories 2C.1 Iron and steel production, 2C.2 Ferroalloy 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 27.36 % of the total Industrial Processes sector's GHG emissions in 2010.

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 2010 CO_2 emissions from production of iron and steel contributed 2.51 % to total greenhouse gas emissions). In the base year, these emissions accounted for 4.76 % 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 4.14 GHG emissions trend in the Metal Products sub-sector for 1989 – 2010 period [Gg CO_2 equiv.]



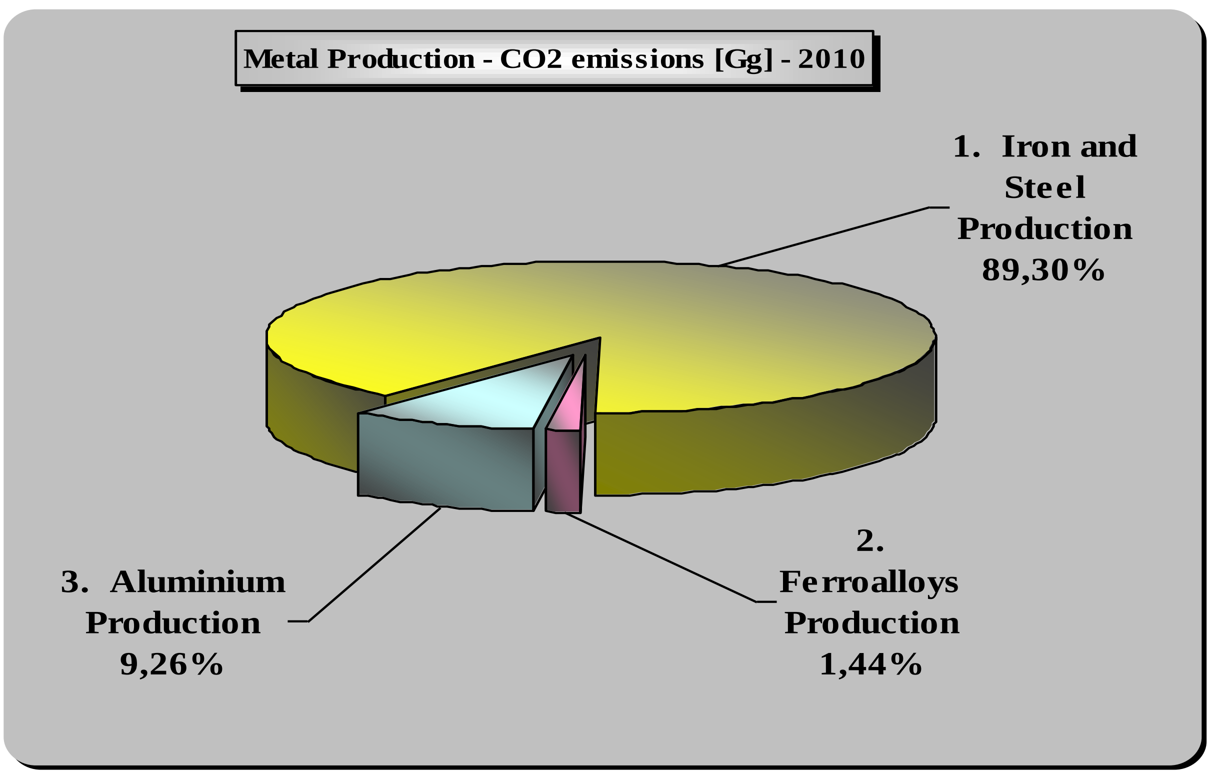
GHG emissions trend in the Metal Products sub-sector for 1989–2010 period due:

- Iron and steel production recorded a decreased after 1989;
- Ferroalloys production has recorded a decreased after 1989. The lowest level of emissions from Ferroalloys production was recorded in 1999, due to the activity data 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 aluminum due to changes in technology starting with 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.

Table 4.25 GHG emissions from Metal Production sub-sector, in the year 2010 [Gg CO_2 equiv.]

Sector	CO_2	PFCs
	CO_2 equivalent [Gg] 2010	
2.C Metal Production	**3,398.73**	**7.84**
2.C.1 Iron and Steel Production	3,035.03	0.00
2.C.2 Ferroalloys Production	48.95	0.00
2.C.3 Aluminium Production	314.75	7.84

Figure 4.15 Structure of the Metal Production sub-sector, in 2010



4.4.2 Methodological issues

Iron and steel production (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.
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.

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 from pig iron production

CO_2 emissions were calculated following closely the IPCC GPG guidelines Tier 2 approach, according to the formula:

Equation 4.7 Calculation of CO_2 emissions from pig iron production

$$Emissions_{\text{pig iron}} = Emission\ Factor_{\text{reducing agent}} \times Mass\ of\ Reducing\ Agent + (Mass\ of\ Carbon\ in\ the\ ore - Mass\ of\ Carbon\ in\ the\ Crude\ Iron) \times 44/12$$

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: 0 (default value);
- Carbon content in iron in 2010: average 3.11% (country specific value);

CO_2 emissions from steel production

CO_2 emissions resulted from steel productions were estimated based on IPCC GPG formula, Tier 2 approach:

Equation 4.8 Calculation of CO_2 emissions from steel production

$$Emissions_{\text{crude steel}} = (Mass\ of\ Carbon\ in\ the\ Crude\ Iron\ used\ for\ Crude\ Steel\ Production - Mass\ of\ Carbon\ in\ the\ Crude\ Steel) \times 44/12 + Emission\ Factor_{EAF} \times Mass\ of\ Steel\ Produced\ in\ EAF$$

where:

- Carbon content in crude iron used for crude steel in 2010: average 3.11% (country specific value);

- Carbon content in crude steel in 2010: average 0.26 % (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.

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 4.26 Emission factors for NMVOC, NOx, CO, SO_2 from Iron and Steel sector

The NMVOC, NOx, CO, SO_2 emission factors for Iron and Steel sector			
gNMVOC/tonne produce	g NOx/tonne produce	g CO/tonne produce	g SO_2/tonne produce
20	76	112	30

Figure 4.16 The trend of CO_2 emissions from iron and steel production sub-sector in the period 1989 – 2010

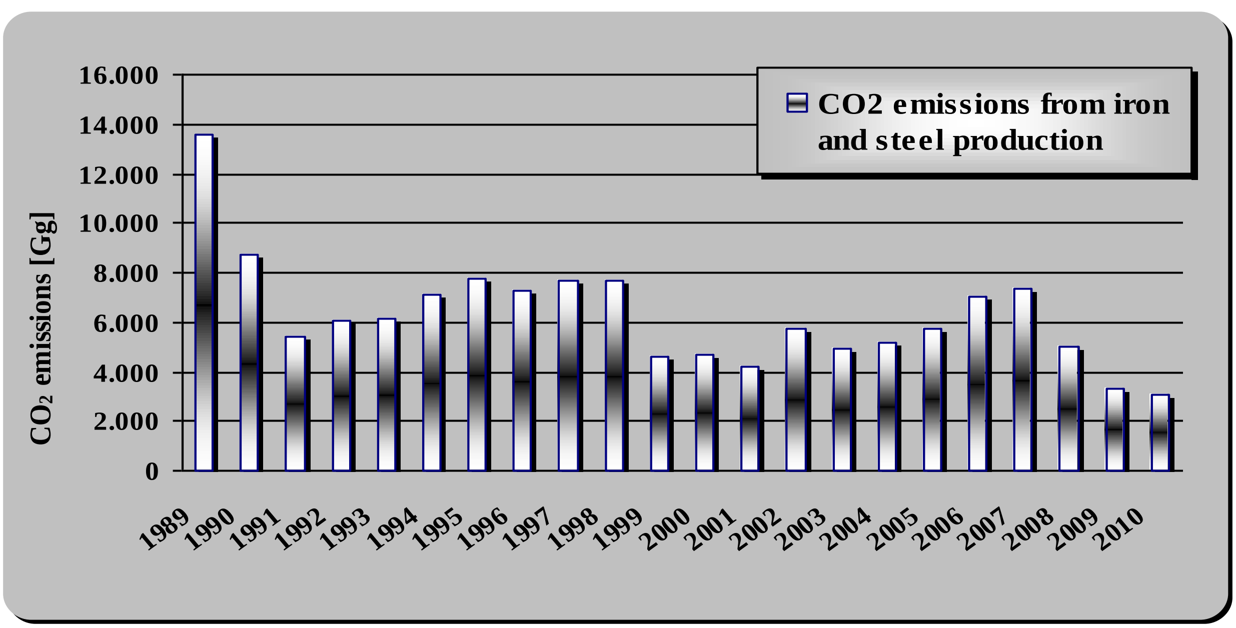


Table 4.27 The input data used to calculate emissions from iron and steel industry in the period 1989 – 2010

Years	**Activity data from Iron and Steel Production subsector (2.C.1) 2012 v.2.1 submission**			
	steel production (BOF and EAF)	**pig iron production**	**sinter**	**coke**
	[kt]			
1989	13,277.49	8,495.13	13,626.00	4,484.93
1990	8,946.33	5,916.27	11,357.00	2,885.29
1991	6,469.65	4,231.80	7,290.00	1,813.25
1992	4,898.15	3,001.32	4,761.00	1,983.73
1993	4,973.05	3,118.79	3,346.00	2,022.36
1994	5,517.41	3,421.21	5,452.00	2,328.98
1995	6,231.60	4,118.57	6,671.00	2,556.48
1996	5,730.68	3,905.79	5,449.00	2,393.18
1997	6,407.76	4,445.20	6,532.00	2,542.14
1998	6,200.39	4,463.69	6,514.00	2,533.64
1999	4,205.03	2,943.28	4,164.00	1,526.91
2000	4,511.78	3,041.54	3,875.00	1,535.27
2001	4,769.68	3,221.86	6,185.00	1,391.06
2002	5,397.01	3,969.80	6,979.00	1,887.50
2003	5,644.58	4,084.94	6,609.00	1,639.11
2004	6,182.77	4,246.50	6,601.00	1,713.40
2005	6,260.40	4,117.92	6,600.00	1,892.03
2006	6,226.21	3,984.65	5,780.00	2,330.18
2007	6,271.24	3,946.68	6,359.22	2,404.92
2008	5,068.86	3,238.79	3,445.55	1,647.09
2009	2,835.51	1,568.86	1,806.98	1,070.40
2010	3,734.56	1,721.75	1,977.60	988.17

Ferroalloys production (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. According with Revised 1996 IPCC Guidelines for National GHG Inventories: Workbook, page 2.36 the default values on CO_2 emission factors were used (Table 2-17), considering that the ferroalloys production sub-sector is not a key source category.

In order to estimate the emission the production data are take into account in a disaggregate manner, by type of products (ferromanganese production, ferrosilicon production, silicon manganese production, ferrochromium production).

During de time series the ferroalloys production have decreased therefore there were just silicon manganese and ferrochromium production, for 2007 and 2008 and only ferrochromium production for 2009. In 2010 the ferroalloys production and the CO_2 emissions have increased due to improve the production of silicon manganese.

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 4.28 CO_2 emission from Ferroalloys Production in the period 1989 – 2010

Years	Emissions from Ferroalloys Production subsector (2.C.2) 2012 v.2.1 submission
	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

Aluminium production (2.C.3)

Methodology

The aluminium production is a key category, only from trend point of view.

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 1989–2010:

- 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 (1989–2010), 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 4.29 The activity data, PFC and CO_2 emissions from aluminium production subsector in the period 1989 – 2010

Year	Emissions and activity data from Aluminium Production subsector (2.C.3) 2012 v.2.1 submission			
	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

Emission factors

Along the period 1989–2010 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 calcu**late**d 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).**

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)]**

In order to **calculate C_2F_6 emission** there was used **IPCC 2006 Methodology (Tier 2 Method –** Equation 4.27).

Equation 4.11 C_2F_6 emissions by Overvoltage Method (Tier 2 Method - IPCC 2006 Methodology)

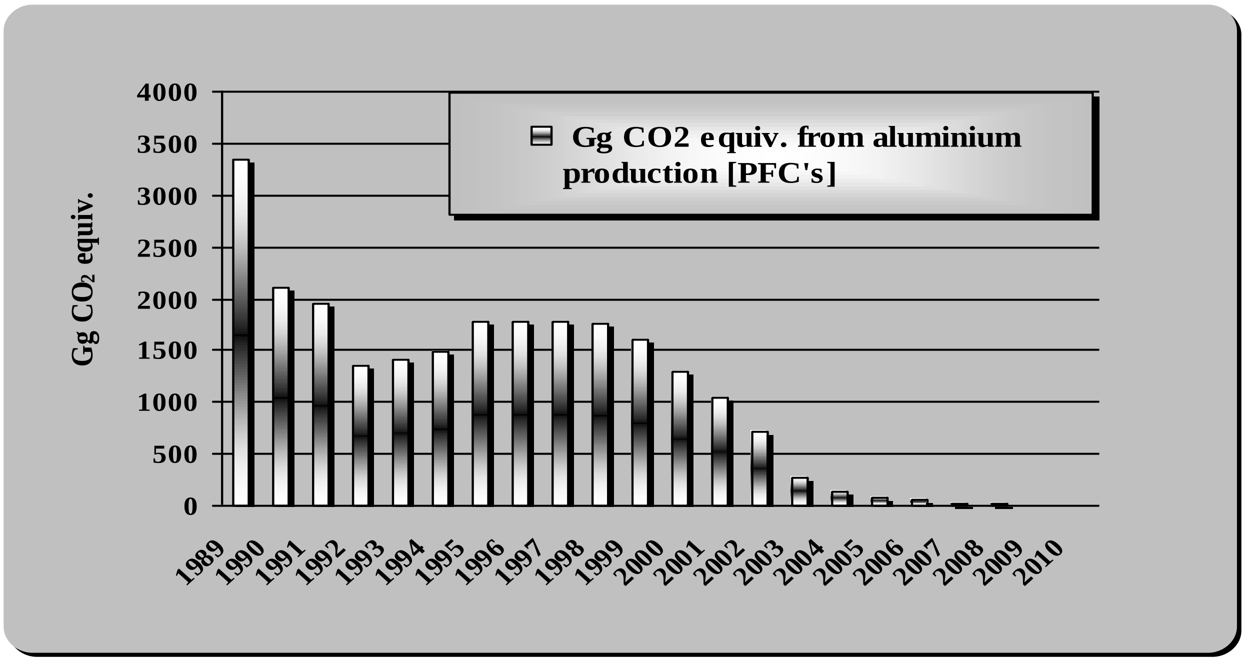
$$EC_2F_6 = ECF_4 \bullet FC_2F_6 / CF_4$$

where:

- E_{C2F6} = emissions of C_2F_6 from aluminium production, kg C_2F_6
- $F_{C2F6/CF4}$ = weight fraction of C_2F_6/CF_4, kg C_2F_6/kg CF_4

The data related with weight fraction of C_2F_6/CF_4, kg C_2F_6/kg CF_4 was in line with **IPCC 2006 Methodology (Tier 2 Method – table 4.16):** weight fraction **C_2F_6/CF_4 = 0.121**

Figure 4.17 The trend of PFC emissions [GgCO_2 equiv] from Primary aluminium production sub-sector in the period 1989 – 2010



The **CO, SO_2 emissions** are also estimated related to primary aluminium production.

Table 4.30 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 (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 (2.C.1)

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 1989–2010. According to the IPCC GPG, the information on the carbon contents of pig iron and crude steel collected at plant level has an uncertainty of 5% and uncertainty in the emission factors for the reducing agents is within 5%.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in chapter 6 of IPCC GPG 2000 is 7.07%.

Ferroalloys production (2.C.2)

Time series is consistent; emissions have been calculated using the same emission factors, two sources of activity data and the same methods were used for the entire time series 1989–2010.
The uncertainty related to the activity data for CO_2 emissions is 5% and the uncertainty associated with default emission factor for CO_2 emissions is 37.5%.
The uncertainty associated with emission factor and activity data are in line with the IPCC 2006.
Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in chapter 6 of IPCC GPG 2000 is 37.83%.

Aluminium production (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 1989–2010.

CO_2 emissions

For the first period 1989–**2002** the uncertainty related to the **activity data for CO_2** emissions is **1 %** and the uncertainty associated with the **default emission factor for CO_2** emissions is **10%**.
For the **last period 2003-2010** the uncertainty associated with **CO_2 emission factor** is **5 %** and the uncertainty related to **activity data for CO_2** is **2 %.** These uncertainty data are in line with the **IPCC 2006 Methodology**.

PFC emissions

For the first period 1989-2002 the uncertainty related to the **activity data for PFC** emissions is **1 %** and the uncertainty associated with the **default emission factors for PFC** emissions is **6%**.
For the **last period 2003-2010** the uncertainty associated with **PFC emission factor** is **6%** and the uncertainty related to **activity data for PFC** is **2 %.** These uncertainty data are in line with the **IPCC 2006 Methodology**.
Aggregated uncertainty value: the overall uncertainty for CO_2 resulted after aggregation of the AD and EF uncertainties according to the previsions in Chapter 6 of IPCC GPG 2000 is 5.39% and for PFC is 6.32%.

4.4.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in QA/QC Program 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 Consumption of Halocarbons and SF_6 subsector.

After these activities unconformities have not been notified.

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).

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.

In order to improve the accuracy of activity data, emission factors and emissions have been developed, there were developed new approaches which are presented in the sub- sectors “Source specific recalculation” and Chapter 10.

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.

All notified and solved recommendations following various QA/QC activities are described in Improvement Lists.

4.4.5 Source specific recalculation, including changes made in response to the review process.

Table 4.1 The effects of recalculations in Metal Production sub-sector (2.C)

The effects of recalculations in Metal Production subsector (2C)			
Years	**2011 v.4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 equivalent [Gg]		
1989	20,026.45	17,783.73	-11.20
1990	12,973.25	11,411.35	-12.04
1991	8,987.58	7,870.39	-12.43
1992	8,520.98	7,728.63	-9.30
1993	8,685.25	7,861.89	-9.48
1994	9,874.26	8,973.13	-9.13
1995	11,066.42	9,987.10	-9.75
1996	10,546.98	9,520.97	-9.73
1997	11,080.20	9,907.17	-10.59
1998	11,006.49	9,828.54	-10.70
1999	7,266.04	6,489.02	-10.69
2000	7,144.51	6,341.54	-11.24
2001	6,504.56	5,653.99	-13.08
2002	7,906.24	6,858.21	-13.26
2003	6,857.39	5,778.96	-15.73
2004	7,105.87	5,984.79	-15.78
2005	7,453.27	6,366.14	-14.59
2006	8,668.24	7,616.29	-12.14
2007	8,903.95	7,862.02	-11.70
2008	6,048.25	5,462.50	-9.68
2009	3,999.41	3,619.86	-9.49
2010		3,406.57	

Iron and steel production sub-sector (2.C.1.)

Recalculations for all-time series 1989–2009 at pig iron production category *due to detected an error in the formula* used for calculating CO_2 emissions (2C1.2);

Table 4.31 Recalculations of CO_2 [Gg] emissions in the Iron and steel Production sub–sector

The effects of recalculations in Iron and Steel Production subsector (2.C.1)			
Years	**2011 v.4.1. submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	15,804.43	13,561.71	-14.19
1990	10,274.62	8,712.73	-15.20
1991	6,565.82	5,448.62	-17.02
1992	6,815.25	6,022.90	-11.63
1993	6,964.48	6,141.11	-11.82
1994	7,982.36	7,079.16	-11.31
1995	8,852.45	7,765.15	-12.28
1996	8,301.58	7,270.45	-12.42
1997	8,885.24	7,711.71	-13.21
1998	8,870.94	7,692.53	-13.28
1999	5,400.61	4,623.58	-14.39
2000	5,450.97	4,648.01	-14.73
2001	5,045.04	4,194.47	-16.86
2002	6,764.47	5,716.44	-15.49
2003	6,019.38	4,940.95	-17.92
2004	6,280.22	5,159.14	-17.85
2005	6,797.42	5,710.29	-15.99
2006	8,120.36	7,068.41	-12.95
2007	8,431.94	7,390.01	-12.36
2008	5,614.65	5,025.62	-10.49
2009	3,681.54	3,293.82	-10.53
2010		3,035.03	

Ferroalloys production (2.C.2)

Recalculation for 1994–1998 and 2008–2009 at ferroalloys production sub sector *due to finding an error in the formula* used for calculating CO_2 emissions. (2C.2);

Table 4.32 Recalculations of CO_2 [Gg] emissions in the Ferroalloys Production sub–sector

The effects of recalculations in Ferroalloys Production subsector (2.C.2)			
Years	**2011 v.4.1 submission**	**2012 v.2.1 submission**	**Differences [%]**
	CO_2 emissions [Gg]		
1989	474.15	474.15	0.00
1990	331.19	331.19	0.00
1991	248.73	248.73	0.00
1992	192.81	192.81	0.00
1993	143.74	143.74	0.00
1994	*223.63*	*225.69*	*0.92*
1995	*229.54*	*237.53*	*3.48*
1996	*266.19*	*271.31*	*1.92*
1997	*163.03*	*163.53*	*0.31*
1998	*120.15*	*120.61*	*0.39*
1999	0.98	0.98	0.00
2000	141.53	141.53	0.00
2001	145.59	145.59	0.00
2002	144.02	144.02	0.00
2003	241.55	241.55	0.00
2004	331.39	331.39	0.00
2005	201.43	201.43	0.00
2006	95.57	95.57	0.00
2007	45.68	45.68	0.00
2008	*18.32*	*21.60*	*17.90*
2009	*11.83*	*19.99*	*69.00*
2010		48.95	

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 **(2.D.1),** alcoholic beverages production and food production **(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 (2.D.1*)* sub-sector the pulp production was broken down by kraft and acid sulphite processes.

In the food and drink production (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 (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 (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 1989–2010.

4.5.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in QA/QC Program 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 Consumption of Halocarbons and SF_6 subsector. After these activities unconformities have not been notified.

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.

All notified and solved recommendations following various QA/QC activities are described in Improvement Lists.

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

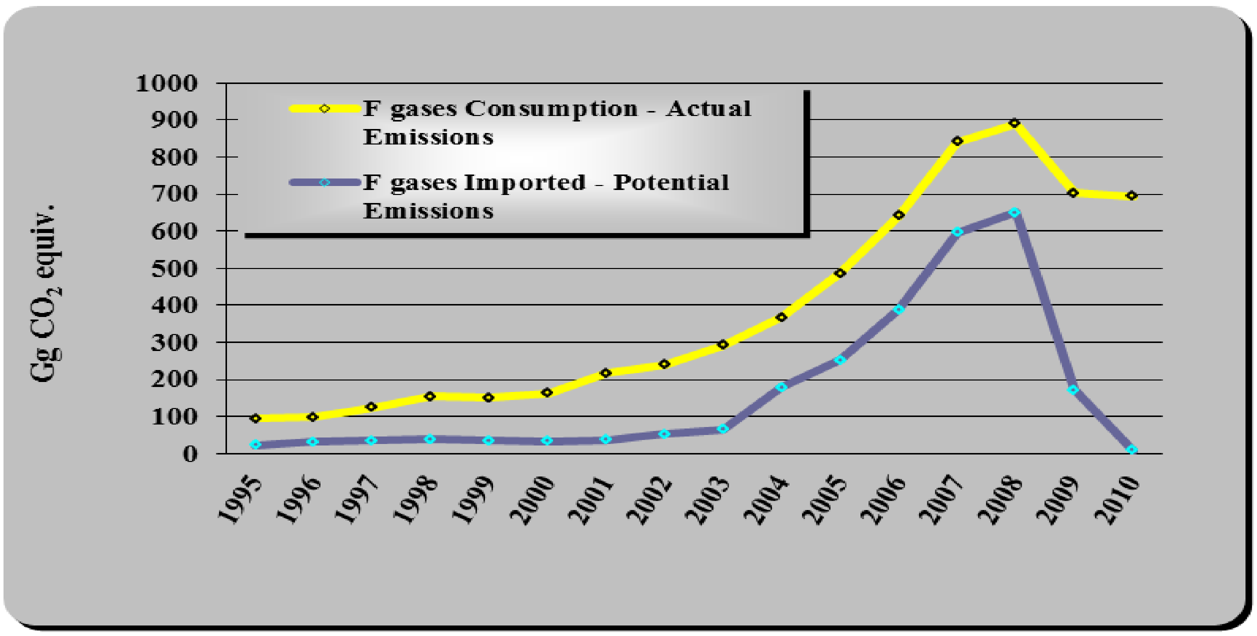
F-gases are not produced in Romania and therefore there are no fugitive emissions from manufacturing. Additionally, there is no production of other fluorinated gases (HCFC) that could lead to by-product F-gas emissions.

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 4.18 The trend of CO_2 emissions [Gg CO_2 equiv.] Consumption of Halocarbons and SF_6 sub-sector in the period 1995 – 2010



4.7.2 Methodological issues

Methodology

Consumption of halocarbons and SF_6 is a key category within the Industrial Processes sub-sector, from both level and trend point of view.

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 1995-2010 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 4.33 Actual and potential emissions from Consumption of Halocarbons and SF_6 sub-sector in the period 1995 – 2010

Years	Emissions from Consumption of halocarbons and SF_6 subsector (2F) 2012 v.2.1 submission
	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

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 2010
- 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 the same formula as 2009 was applied.

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 were identified in 2010);
- 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 4.34 ***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 2010, the sub-sector 2F Consumption of halocarbons and SF_6 includes the following source categories and the following F-gases:

Table 4.35 Source categories and the F-gases in Consumption of halocarbons and SF_6 sub-sector

Source category	Sub-sector	HFCs/PFCs/SF_6
2F1 Refrigeration and air conditioning equipment	Domestic refrigeration	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2F1 Refrigeration and air conditioning equipment	Commercial refrigeration	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2F1 Refrigeration and air conditioning equipment	Industrial refrigeration	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2F1 Refrigeration and air conditioning equipment	Transport refrigeration	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2F1 Refrigeration and air conditioning equipment	Stationary air conditioning	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2F1 Refrigeration and air conditioning equipment	Mobile air conditioning	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2F2 Foam Blowing	Foam Blowing	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2F3 Fire extinguishers	Fire extinguishers	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2F4 Aerosols/Metered Dose Inhalers	Aerosols/Metered Dose Inhalers	cluster method – HFC IPCC Tier 2 method – PFC, SF_6
2F5 Solvents	Solvents	IPCC Tier 2 method – HFC, PFC, SF_6
2F6 Other applications using ODS substitutes	Other applications using ODS substitutes	IPCC Tier 2 method – HFC, PFC, SF_6
2F7 Semiconductors	Semiconductors	IPCC Tier 2 method – HFC, PFC, SF_6
2F8 Electrical equipment's	Electrical equipment's	IPCC Tier 2 method – HFC, PFC, SF_6

2F9 Other non-specified	Other	IPCC Tier 2 method – HFC, PFC, SF_6

For the 1995–2010 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 1995–2010 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

By expert judgment the uncertainty related to the activity data for HFC/PFC/SF_6 emissions is 30% and the uncertainty associated with the default emission factor for HFC/PFC/SF_6 emissions is 50%. Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in chapter 6 of IPCC GPG 2000 is 58.31%.

4.7.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in QA/QC Program 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 Metal production subsector. After these activities unconformities have not been notified.

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.

All notified and solved recommendations following various QA/QC activities are described in Improvement Lists.

4.7.5 Source specific recalculation, including changes made in response to the review process

There are no recalculations.

4.7.6 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.

5 SOLVENT AND OTHER PRODUCT USE (CRF sector 3)

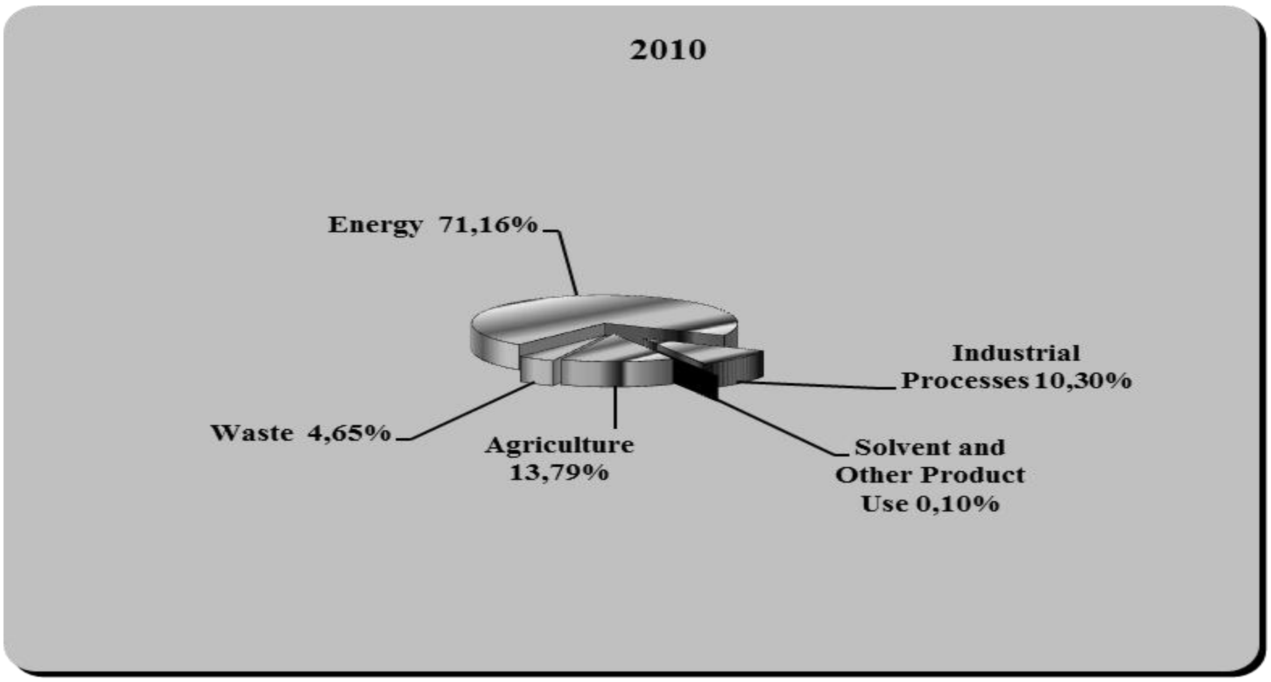
5.1 Overview of the sector

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 (3A), Degreasing and Dry Cleaning (3B), Chemical Products, Manufacture and Processing (3C), Other (3D). In 2009 the GHG emissions from Solvent and other product use sector contributed to 0.10% of the total GHG emissions in Romania.

Figure 5.1The contribution of Solvent and other product use sector to the total GHG emissions in Romania, 2010



5.2.1 *Source category description*

- 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
3A Paint application	**0601 Paint application**
3B Degreasing and Dry Cleaning	**0602 Degreasing, dry cleaning and electronics**
3C Chemical Products, Manufacture and Processing	**0603 Chemical products manufacturing and processing**
3D Other	**0604 Other use of solvents & related activities**

Activity data

For 2012 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:

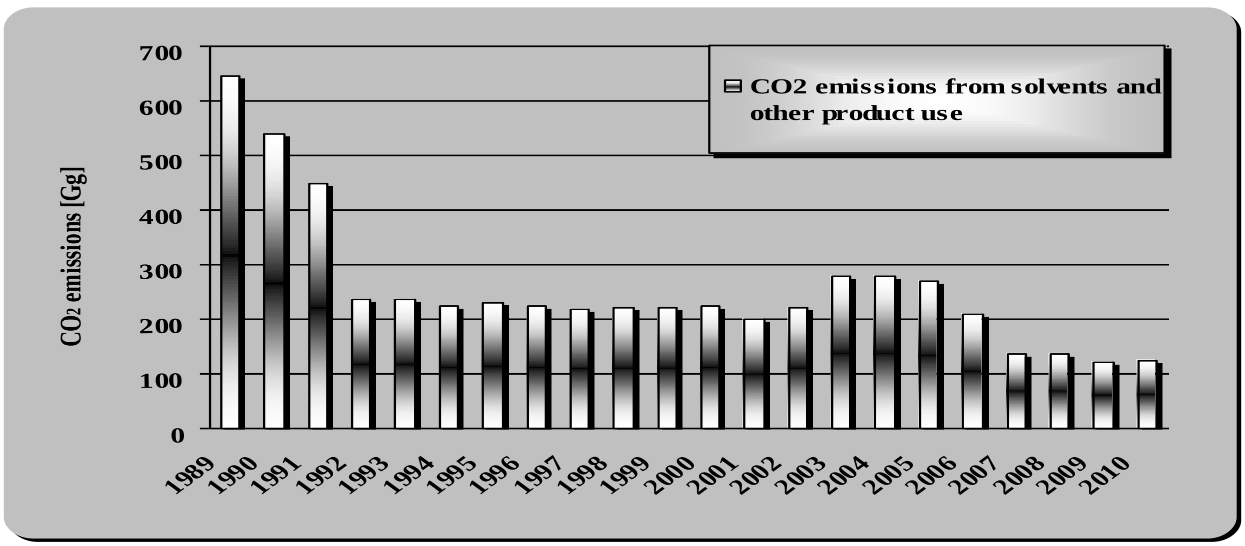
0.85 is carbon content conversion factor.

Table 5.2 CO_2 emissions resulted from Solvent and other product use in the period 1989 – 2010

Solvents and Other Product Use 2012 v.2.1 submission					
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**

Figure 5.2 The trend of CO_2 emissions resulted from Solvent and other product use sector, in the year 2010



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

Uncertainties are rather large due to the diverse nature of many solvent-using processes.

By expert judgment the uncertainty related to the activity data is 30% and the uncertainty associated with the CO_2 emissions is 50%.

Aggregated uncertainty value: the overall uncertainty resulted after aggregation of the AD and EF uncertainties according to the previsions in Chapter 6 of IPCC GPG 2000 is 58.31%.

5.2.4 Source specific QA/QC and verification

All activities regarding quality control (QC) as described in QA/QC Program 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 Chemical industry subsector.

After these activities unconformities have not been notified.

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.

All notified and solved recommendations following various QA/QC activities are described in Improvement Lists.

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 (Sectorial Report for Agriculture, Table 4 in the Common Reporting Format). 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
4A Enteric fermentation		
4A1 Cattle	✓	NA
4A1a Dairy cattle	✓	NA
4A1b Non-dairy cattle	✓	NA
4A2 Buffalo	✓	NA
4A3 Sheep	✓	NA
4A4 Goats	✓	NA
4A5 Camels and lamas	NO	NO
4A6 Horses	✓	NA
4A7 Mules and asses	✓	NA
4A8 Swine	✓	NA
4A9 Poultry	✓	NA
4A10 Other livestock	NA	NA
4B Manure management		
4B1 Cattle	✓	✓
4B1a Dairy cattle	✓	✓
4B1b Non-dairy cattle	✓	✓
4B2 Buffalo	✓	✓
4B3 Sheep	✓	✓
4B4 Goats	✓	✓
4B5 Camels and lamas	NO	NO
4B6 Horses	✓	✓
4B7 Mules and asses	✓	✓
4B8 Swine	✓	✓
4B9 Poultry	✓	✓
4B10 Other livestock	NA	NA

IPCC category	Emissions estimation status	
4B11 Anaerobic lagoon	NA	✓
4B12 Liquid/Slurry	NA	✓
4B13 Daily spread	NA	IE[1)]
4B14 Solid storage	NA	✓
4B15 Dry lot	NA	✓
4B16 Pasture/range/paddock	NA	IE[1)]
4B17 Pit storage	NA	✓
4B18 Poultry manure wit bedding	NA	✓
4B19 Poultry manure without bedding	NA	✓
4C Rice cultivation		
4C1 Irrigated	✓	NA
4C11 Continuously flooded	NO	NA
4C12 Intermittently flooded	✓	NA
4C121 Single aeration	NO	NA
4C122 Multiple aeration	✓	NA
4C2 Rainfed	NO	NA
4C3 Deep water	NO	NA
4C4 Other	NO	NA
4D Agricultural soils		
4D1 Direct soil emissions	NA	✓
4D11 Synthetic fertilizers	NA	✓
4D12 Animal manure applied to soils	NA	✓
4D13 N-fixing crops	NA	✓
4D14 Crop residue	NA	✓
4D15 Cultivation of Histosols	NA	✓
4D16 Other direct emissions	NA	NA

IPCC category	Emissions estimation status	
4D2 Pasture range and paddock manure	NA	✓
4D3 Indirect emissions	NE	✓
4D31 Atmospheric Deposition	NA	✓
4D32 Nitrogen Leaching and Run-off	NA	✓
4D4 Other	NA	NA
4E Prescribed burning of savannas	NO	NO
4F 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 1989–2010

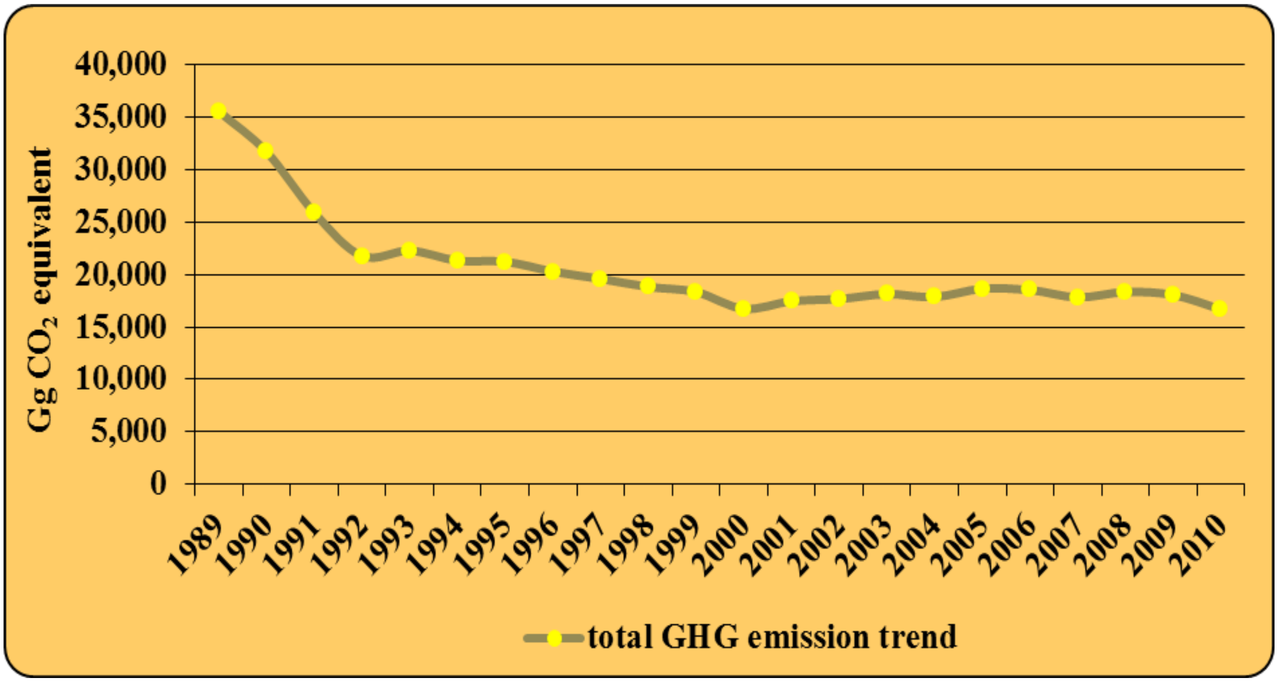
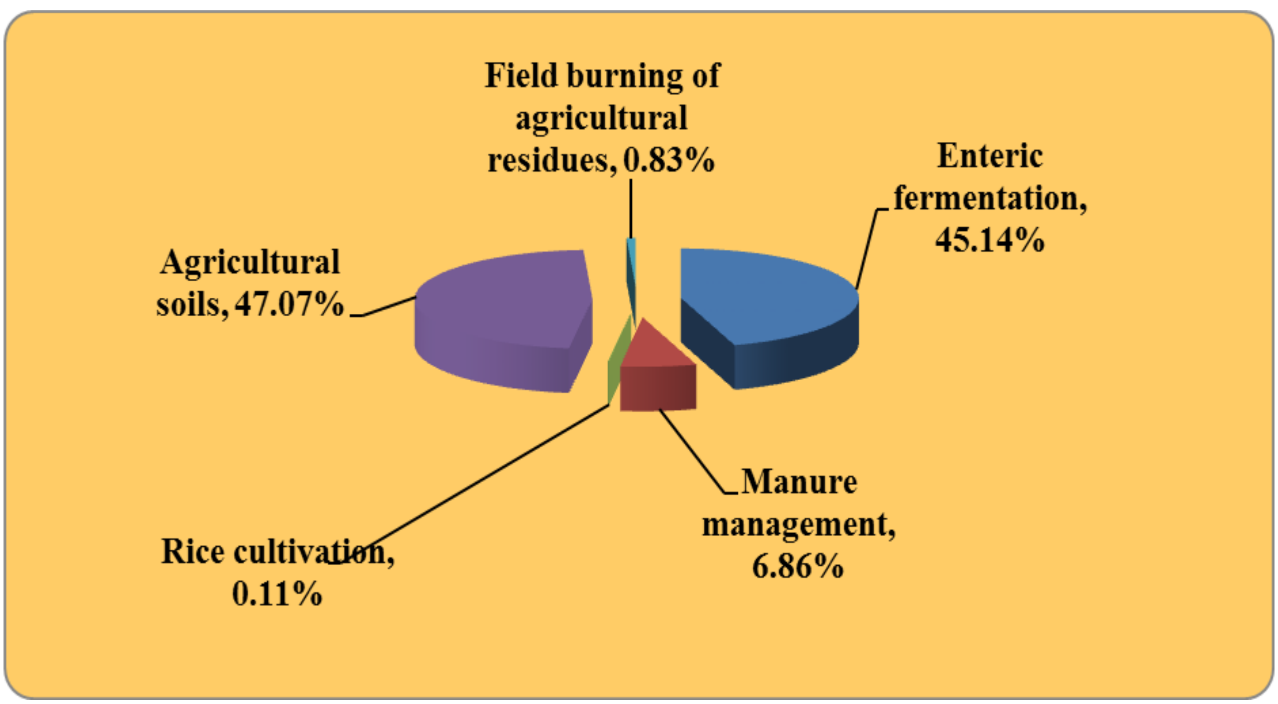


Figure 6.2 Contribution of the sub-sectors in the total GHG emissions from Agriculture, in 2010



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).

Burning of agricultural residues is a net source of CH_4, CO, N_2O and NO_x emissions for 1989-2010. Emissions from prescribed burning of savannas do not occur in Romania.

The Agriculture sector accounted for 13.79% of the total GHG emissions in 2010, reaching 16,679.72 Gg CO_2 equivalent (Table 6.2). Within the GHG emissions from the agriculture sector, the N_2O emissions have the largest contribution (in 2010, N_2O emissions contribution is 51.98% to the total Agriculture sector's CO_2 equivalent emissions), followed by the CH_4 emissions (that account for the remaining 48.02%).

Over the period 1989 – 2010, the GHG emissions resulted from agriculture sector decreased by 53.05% (Figure 6.1).

The number of animals decreased in this period whatever of the species and type of operation. After an easy recovery of national livestock situation, another dramatic regression occured, result of economic situation extremely difficult Romania passed in the period 1997-2000. After years 2001-2002 and in present, for the livestock species of interest is recorded fluctuations in the livestock influenced by the economic context, the emergence of various forms of associative that have acquired economic power and by the, interest shown of 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 beingsacrificed in large numbers for meat. On the other hand, in most rural areas, too many 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. All cattle exploited in Romania, in the period analyzed are declining.

Buffalo from Romania was subject to the same reduction, because the animals are privately owned both in subsistence farms and individual households. The lack of interest for these species is also due 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 (Table 6.12).

Pork meat consumption per capita has fluctuated from 19.8 kg/inhabitant/year to 27.9 kg/inhabitant/year, representing 43-49.5% of the total consumption of meat.

The reducing of the swine number was due to the following causes (Dinu I. - *Swiniculture*, Ed. Coral Sanivet, Bucharest, 2002, pages. 28-29):

- the overgrowth of prices from upstream area, prices associated to the energy, to fuel, to materials and to other materials and services, while the price of meat has registered insignificant increases;
- significant mistakes in the restructuring and the liquidation of state owned or in majority state owned companies;
- the liquidation almost entirely of the forms of financial support of farmers;
- the import of meat and meat products made an unfair competition to the local producers, on the internal market.

The sheep breeding in our country it characterized in some regions through extensively, increasing of proportion of primitive type species 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, as a result of foreign investors 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; the interes for heavy type horse species, less viable considering the economic criteria, has been lost, mixed type horse species being kept (Creta V, Morar M., Culea C.- *General and special animal husbandry*, E.D.P., Bucharest, 1995).

Since 2007, horse number is decreasing due to the biological disappearance of populationemployed 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 varies over the period with maximum 8,000 heads. Mules and asses are found only in households.

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 and is subject to the modern exploitation technologies development.

For the 2004-2010 period, goats and sheep, poultry for meat number is only growing slightly; for the rest of species, their downward trend of 1989-2003 period continued.

The rice cultivation generated in 2010 a significantly reduced emission compared to the base year 1989 (69.81% decrease comparing with the base year).

In case of agricultural soils, the emissions decreased over the period (51.74% decrease in 2010 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.

As presented in the Table 6.3, the Agriculture sector's CH_4 emissions decreased in 2010 with 54.92% compared to basic. Because the methane emissions are mainly resulted in domestic livestock, the decrease of their level is due to the decline of the domestic livestock.

Table 6.4 indicates that N_2O emissions from the Agriculture sector decreased in 2010 with 51.17% comparing with the base year. 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.

Table 6.2 Contribution of Agriculture sector in total GHG emissions, in 1989–2010

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	284,939.38	35,523.49	12.42	17,767.17	50.02	17,756.33	49.98
1990	252,217.51	31,660.89	12.48	15,754.70	49.76	15,906.19	50.24
1991	204,836.41	25,865.94	12.52	14,102.04	54.52	11,763.90	45.48
1992	178,683.00	21,756.53	12.09	11,880.74	54.61	9,875.80	45.39
1993	174,473.07	22,266.47	12.67	11,531.94	51.79	10,734.53	48.21
1994	172,055.24	21,317.02	12.30	11,090.90	52.03	10,226.12	47.97
1995	180,221.30	21,211.68	11.68	10,941.69	51.58	10,269.99	48.42
1996	182,460.40	20,271.29	11.03	10,536.03	51.98	9,735.26	48.02
1997	169,023.00	19,579.47	11.50	9,908.78	50.61	9,670.69	49.39
1998	152,686.42	18,818.43	12.25	9,527.15	50.63	9,291.28	49.37
1999	135,535.23	18,327.99	13.43	9,242.48	50.43	9,085.52	49.57
2000	139,966.46	16,729.30	11.88	8,738.20	52.23	7,991.10	47.77
2001	142,749.00	17,451.50	12.17	8,640.83	49.51	8,810.67	50.49
2002	146,584.10	17,669.95	11.98	8,905.46	50.40	8,764.49	49.60
2003	152,607.41	18,125.85	11.82	9,055.78	49.96	9,070.07	50.04
2004	150,240.50	17,852.41	11.82	9,027.83	50.57	8,824.58	49.43
2005	148,427.48	18,633.65	12.49	9,079.09	48.72	9,554.56	51.28
2006	152,503.18	18,522.40	12.10	9,377.02	50.63	9,145.38	49.37
2007	149,481.92	17,822.56	11.84	9,446.29	53.00	8,376.28	47.00
2008	145,804.05	18,324.87	12.47	9,380.68	51.19	8,944.19	48.81
2009	122,956.86	18,047.08	14.59	9,138.34	50.64	8,908.74	49.36
2010	120,920.04	16,679.72	13.71	8,008.78	48.02	8,670.95	51.98

Table 6.3 Distribution of CH_4 emissions within Agriculture sub-sectors, in 1989–2010 [Gg]

Year	Total CH_4 emission - Agriculture	Enteric Fermentation	Manure Management	Rice Cultivation	Agricultural Soils	Prescribed Burning of Savannas	Field burning of agricultural residues
1989	846.06	783.74	53.65	2.96	NA, NE	NO	5.71
1990	750.22	695.88	46.86	2.39	NA, NE	NO	5.09
1991	671.53	635.56	29.34	1.30	NA, NE	NO	5.33
1992	565.75	539.05	22.24	0.98	NA, NE	NO	3.47
1993	549.14	521.85	22.00	0.86	NA, NE	NO	4.42
1994	528.14	503.27	19.42	0.33	NA, NE	NO	5.11
1995	521.03	495.70	19.20	0.45	NA, NE	NO	5.69
1996	501.72	478.20	18.87	0.61	NA, NE	NO	4.04
1997	471.85	449.62	15.79	0.29	NA, NE	NO	6.16
1998	453.67	433.75	15.27	0.12	NA, NE	NO	4.54
1999	440.12	421.47	13.65	0.10	NA, NE	NO	4.90
2000	416.10	399.27	13.53	0.08	NA, NE	NO	3.22
2001	411.47	388.22	17.71	0.05	NA, NE	NO	5.49
2002	424.07	397.12	22.71	0.02	NA, NE	NO	4.22
2003	431.23	402.11	25.28	0.01	NA, NE	NO	3.83
2004	429.90	396.24	26.59	0.09	NA, NE	NO	6.98
2005	432.34	406.25	20.08	0.28	NA, NE	NO	5.72
2006	446.52	410.80	30.50	0.40	NA, NE	NO	4.82
2007	449.82	420.34	26.43	0.60	NA, NE	NO	2.45
2008	446.70	417.23	23.77	0.71	NA, NE	NO	4.99
2009	435.16	408.31	21.15	1.33	NA, NE	NO	4.37
2010	381.37	358.51	17.11	0.89	NA, NE	NO	4.86

Table 6.4 Distribution of N_2O emissions within Agriculture sub-sectors, in 1989–2010 [Gg]

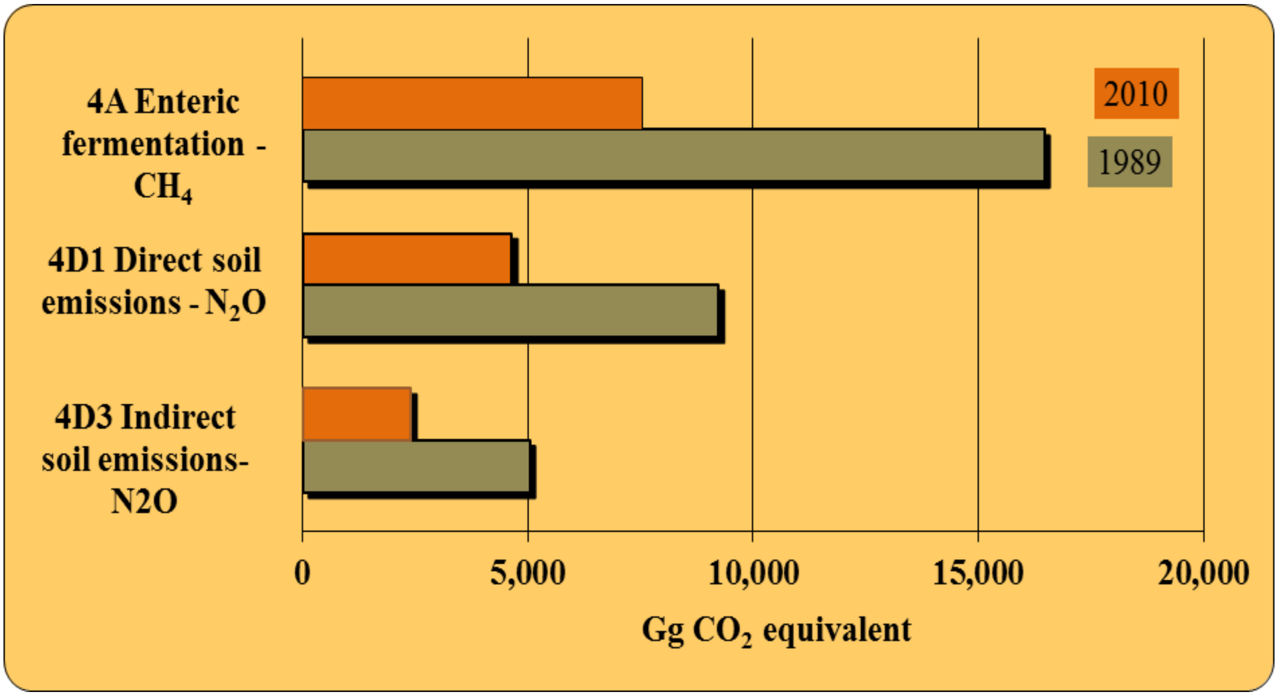
Year	Total N_2O emission - Agriculture	Enteric Fermentation	Manure Management	Rice Cultivation	Agricultural Soils	Prescribed Burning of Savannas	Field burning of agricultural residues
1989	57.28		4.67		52.48	NO	0.14
1990	51.31		4.13		47.06	NO	0.12
1991	37.95		3.65		34.17	NO	0.13
1992	31.86		3.25		28.52	NO	0.08
1993	34.63		3.28		31.25	NO	0.10
1994	32.99		3.09		29.78	NO	0.12
1995	33.13		2.89		30.11	NO	0.13
1996	31.40		2.82		28.49	NO	0.10
1997	31.20		2.67		28.39	NO	0.14
1998	29.97		2.61		27.25	NO	0.11
1999	29.31		2.44		26.75	NO	0.12
2000	25.78		2.21		23.49	NO	0.07
2001	28.42		2.33		25.96	NO	0.13
2002	28.27		2.37		25.80	NO	0.10
2003	29.26		2.60		26.56	NO	0.10
2004	28.47		2.92		25.37	NO	0.17
2005	30.82		3.25		27.43	NO	0.14
2006	29.50		3.05		26.33	NO	0.12
2007	27.02		3.12		23.84	NO	0.06
2008	28.85		3.15		25.59	NO	0.11
2009	28.74		2.93		25.70	NO	0.10
2010	27.97		2.53		25.32	NO	0.12

Table 6.5 and Figure 6.3 describe Key categories in Agriculture, both from level and trend and including and excluding LULUCF views.

Table 6.5 Key categories overview – Agriculture, 2010

Key categories	GHG	Excluding LULUCF		Including LULUCF	
		Criteria	Contribution in total GHG emissions [%]	Criteria	Contribution in total GHG emissions and removals [%]
4A Enteric fermentation	CH_4	L, T	**6.23**	L	**5.04**
4D1 Direct soil emissions	CH_4	L, T	**3.83**	L	**3.10**
4D3 Indirect soil emissions	N_2O	L, T	**1.98**	L	**1.60**
4D2 Pasture, Range and Paddock Manure	N_2O	L	**0.68**	L	**0.55**
4B Manure management	N_2O	L	**0.65**	L	**0.53**

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 2010, CH_4 emissions from Enteric Fermentation represented 94.01% of total CH_4 emissions in the Agriculture sector);
- ❖ is the second source in the Agriculture sector (in 2010, CH_4 emissions from Enteric Fermentation as CO_2 equivalent represented 45.14% from Total Agriculture emissions);

❖ contributed with 6.23% to Total GHG emissions of Romania.

Compared to 1989, total CH_4 emissions from Enteric Fermentation decreased with 54.25% in 2010 (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 more refined consumer taste, 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

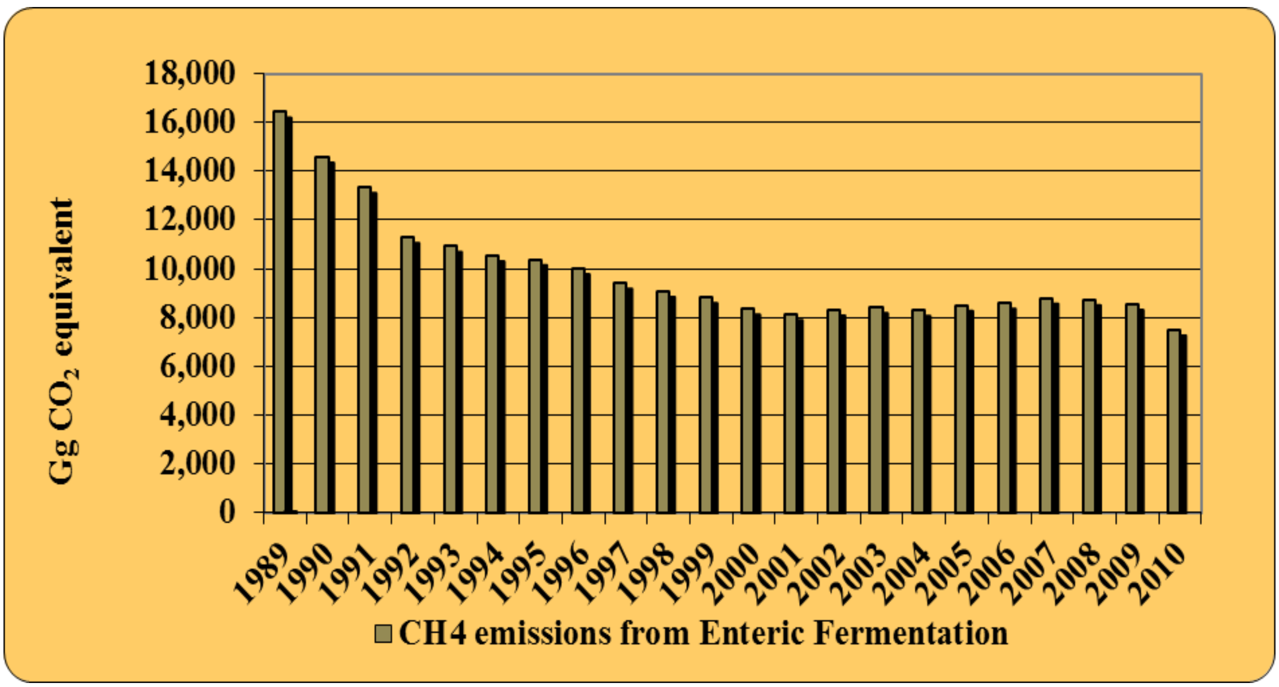


Table 6.6 Observations on source category 4A – "Enteric Fermentation"

Source indicative	Source (livestock) type	Observation	Data source
4A1	Cattle	Includes livestock data from nine different cattle categories: dairy cows and non-dairy cattle.	AD: NIS and expert judgment, 1989-2003; NIS, 2004-2010 EF: Country specific, expert judgment
4A2	Buffalo	Includes livestock data from two different buffalo:buffalo milk and other buffalo	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2010; EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4A3	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, 2004-2010; EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4A4	Goats	Includes livestock data from two different goats: Female goats for milk and females by first mount and other goats	
4A6	Horses		
4A7	Mules and asses		AD: FAO, 2010; EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4A8	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, 2004-2010 EF: IPCC GPG 2000, IPCC 1996, Country specific, expert judgment
4A9	Poultry	Includes livestock data from two different poultry: adult poultry for eggs, poultry for meat	

6.2.2 Methodological issues

Methodology

The amount of enteric methane emitted 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 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.

Emissions of methane from enteric fermentation were calculated using equations 4.12, 4.13 and 4.14 in the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000.*

Equation 6.1 Emissions from a livestock category

$$Emissions = EF \bullet population/(10^6 kg/Gg)$$

where:

- Emissions = methane emissions from enteric fermentation, Gg CH_4/year;
- EF = emission factor for the specific population, kg/head/year;
- Population = the number of animals, head.

Equation 6.2 Total emissions from livestock

$$Total\ CH_4\ Emissions = \Sigma_i E_i$$

where:

- Total Emissions = total methane emissions from enteric fermentation, Gg CH_4/year;
- index *i* = sums all livestock categories and sub-categories;
- E_i = is the emissions for the *i* the livestock categories and sub-categories.

Equation 6.3 Emission factor development

$$EF = (GE \bullet Y_m \bullet 365\ days/yr) / (55.65\ MJ/kg\ CH_4)$$

where:

- EF = emission factor, kg CH_4/head/yr;
- GE = gross energy intake, MJ/head/day;
- Y_m = methane conversion rate which is the fraction of gross energy in feed converted to methane.

Emission factors

According to the provisions of IPCC GPG 2000, to use equation 4.14 have been considered national values for gross energy intake, MJ/head/day (GE) and default values for countries developed for methane conversion rate which is the fraction of gross energy in feed converted to methane (Y_m) from *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000* (Tables 4.8 and 4.9) and Reference Manual 1996 (Table A-4).

For calculation of gross energy was chosen another method of estimation based on the species and subcategory exploited, respectively based on an average rations, both in summer and in winter. This rations can ensure the necessary of maintenance (allows normal animal organism functioning on basal metabolic level, providing vital functions), and a required for the productions elaboration in cattle, buffalo, sheep, goats and horses productions. At 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 energy gross ingested were established by correlating nutritional requirements of each species and exploitation category with food intake of rations and average prescriptions which were considered for ensuring production from official statistics (NIS).

For calculation of gross energy caloricity for each prescription or rations the equivalent following were used:

- 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), so in the rations and prescriptions calculation, 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 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 digestible content nutritive of nutrients, which to multiply with the coefficients of specific digestibility of each feed 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 6.7 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, and was considered a ration that may contain 3 kg hay mountain, 10 kg pickled corn, mixture of farm 3 kg, which corresponds on an energy intake of 143.07 MJ, DE (digestible energy expressed in MJ) = 81.23 MJ and DE (%) (Digestible energy expressed in %) = 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 dairy cattle production can vary within very large limits depending on geographic region, of race, type of holding, level of education and training of farmers.

To livestock, feeding dairy cattle is differentiated according to milk production, but the ration it adjusts from 5 to 5 l production/head/day, supplementing the daily energy requirements by 0,5 UN/l milk.

In the table 6.8 are presented of milk productions per year, for the period 1989-2010 for dairy cows and buffalo.

For dairy cattle DE = 154.46 MJ, but DE (%) = 67.93.

Table 6.8 Milk production in cows and buffalo in the period 1989-2010 (NIS)

Years	Dairy cattle production (thousand hl)	Milk buffalo production (thousand hl)
1989	40477	717
1990	39698	613
1991	41326	497
1992	40659	420
1993	43097	410
1994	49235	397
1995	52431	399
1996	53085	392
1997	52212	369
1998	50544	358
1999	48901	348
2000	48191	327
2001	49717	319
2002	51472	328
2003	53869	330
2004	55107	337
2005	54976	357
2006	57981	326
2007	54517	358
2008	52761	327
2009	5026	304
2010	42585	239

❖ ***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 hay mountain, 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 kg 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 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, 2000, because 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 Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories 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 6.9.

The gross energy intake is in direct correlation with weight of the animal.

Table 6.9 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 1989-2010

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 A1	**CATTLE**			
4 A1 a	***Dairy cattle***	89.47	227.37	0.06
4 A1 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 A2	***BUFFALO***			
	Female buffalo	106.15	269.74	0.06
	Other buffalo	50.70	128.85	0.06
4 A3	***SHEEP***			
	Ewes of milk and fitted	19.64	42.78	0.07

Table 6.9 (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 1989-2010

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 A3	***SHEEP***			
	Reproducers rams	23.06	50.23	0.07
	Other sheep	20.78	45.27	0.07
4 A4	***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 A6	***HORSES***	37.02	225.79	0.025
4 A7	***MULES AND ASSES***	29.70	181.18	0.025
4 A8	***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 A9	***POULTRY***			
	Adult poultry for eggs	0	1.83	0
	Poultry for meat	0	1.3	0

In the Table 6.10 are summarized the values energy digestible DE (Mj), the percentage of digestible energy DE (%) and the weight for each subcategory.

Table 6.10 The values energy digestible expressed in Mj/day and percent and weight (kg) for livestock, in the 1989-2010

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
4 A1	***CATTLE***			
4 A1 a	***Dairy cattle***	154.46	67.93	650
4 A1 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 A2	***BUFFALO***			
	Female buffalo	145	53.75	500
	Other buffalo	71.3	55.34	400
4 A3	***SHEEP***			
	Ewes of milk and fitted	19.7	44.57	60

Table 6.10 (continued) The values energy digestible expressed in Mj/day and percent and weight (kg) for livestock, in the 1989-2010

Source indicative	Livestock (source) type	Energy digestible DE (Mj/day)	Percentage of digestible energy DE(%)	Animal weight (kg)
4 A3	***SHEEP***			
	Reproducers rams	30.07	59.86	77
	Other sheep	20.84	46.04	48
4 A4	***GOATS***			
	Female goats for milk and females by first mount	23.91	45.21	48
	Other Goats	20.82	42.27	50
4 A6	***HORSES***	121.84	53.96	500
4 A7	***MULES AND ASSES***	99.2	54.75	300
4 A8	***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 A9	***POULTRY***			
	Adult poultry for eggs	1.5	81.96	1.9
	Poultry for meat	1.086	83.53	1.8

Activity data

Primary livestock data

1989-2003

The primary data on all categories of animals have been published by NIS in the Statistical Yearbook.

2004-2010

The primary data on all categories of animals 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 Table 6.11 raw data on livestock in the period 1989-2010, are presented.

Table 6.11 Livestock data series for 1989-2010 [heads] (NIS)

Year	Livestock data series [heads]								
	Cattle	Cattle under 1 year	Calves for slaughter	Other cattle - total (4+5)	Males	Females	Cattle between 1 and 2 years- total (7+8)	Males	Females (9+10)
1989		-	-	-	-	-	-	-	-
1990		-	-	-	-	-	-	-	-
1991		-	-	-	-	-	-	-	-
1992		-	-	-	-	-	-	-	-
1993		-	-	-	-	-	-	-	-
1994		-	-	-	-	-	-	-	-
1995		-	-	-	-	-	-	-	-
1996		-	-	-	-	-	-	-	-
1997		-	-	-	-	-	-	-	-
1998		-	-	-	-	-	-	-	-
1999		-	-	-	-	-	-	-	-
2000		-	-	-	-	-	-	-	-
2001		-	-	-	-	-	-	-	-
2002		-	-	-	-	-	-	-	-
2003		-	-	-	-	-	-	-	-
2004		711,283	281,783.00	429,500.00	186,489.00	243,011.00	240,706.00	98,392.00	142,314.00
2005		709,315	263,246.00	446,069.00	187,296.00	258,773.00	236,041.00	88,755.00	147,286.00
2006		741,020	262,763.00	478,257.00	203,248.00	275,009.00	279,728.00	109,908.00	169,820.00
2007		714,279	260,330.00	453,949.00	193,252.00	260,697.00	277,205.00	108,741.00	168,464.00
2008		665,774	236,897.00	428,877.00	177,593.00	251,284.00	284,833.00	114,917.00	169,916.00
2009		592,200	207,876.00	384,324.00	149,335.00	234,989.00	263,143.00	101,100.00	162,043.00
2010		420,347	134,012.00	286,335.00	97,004.00	189,331.00	214,665.00	78,371.00	136,294.00

Table 6.11 (continued) Livestock data series for 1989-2010 [heads] (NIS)

Year	Livestock data series [heads]							
	For slaughter	Other	Cattle 2 years and over - total (12+16)	Males -total (13+14+15)	For breeding	For slaughter	For work	Females (17+20)
1989	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-
2002	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-
2004	16,707.00	125,607.00	1,822,279.00	56,508.00	9,578.00	19,750.00	27,180.00	1,765,771.00
2005	17,969.00	129,317.00	1,871,507.00	53,552.00	8,842.00	16,123.00	28,587.00	1,817,955.00
2006	25,514.00	144,306.00	1,872,256.00	53,283.00	9,219.00	15,951.00	28,113.00	1,818,973.00
2007	27,053.00	141,411.00	1,795,343.00	46,746.00	9,227.00	17,114.00	20,405.00	1,748,597.00
2008	27,101.00	142,815.00	1,702,888.00	46,512.00	12,360.00	14,599.00	19,553.00	1,656,376.00
2009	23,826.00	138,217.00	1,627,031.00	45,482.00	10,257.00	14,915.00	20,310.00	1,581,549.00
2010	14,163.00	122,131.00	1,340,659.00	33,468.00	7,410.00	12,782.00	13,276.00	1,307,191.00

Table 6.11 (continued) Livestock data series for 1989-2010 [heads] (NIS)

Year	Livestock data series [heads]						
	Heifers (18+19)	Heifers for slaughter	Heifers for breeding	Cows (21+22)	Dairy cattle	Other Cows	Cattle total (1+6+11)
1989	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-
2002	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-
2004	172,002.00	8,071.00	163,931.00	1,593,769.00	1,566,397.00	27,372.00	2,774,268.00
2005	164,706.00	11,086.00	153,620.00	1,653,249.00	1,625,681.00	27,568.00	2,816,863.00
2006	153,836.00	12,678.00	141,158.00	1,665,137.00	1,639,362.00	25,775.00	2,893,004.00
2007	145,130.00	9,178.00	135,952.00	1,603,467.00	1,572,927.00	30,540.00	2,786,827.00
2008	144,988.00	11,959.00	133,029.00	1,511,388.00	1,483,281.00	28,107.00	2,653,495.00
2009	140,008.00	11,915.00	128,093.00	1,441,541.00	1,419,027.00	22,514.00	2,482,374.00
2010	108,428.00	7,416.00	101,012.00	1,198,763.00	1,178,565.00	20,198.00	1,975,671.00

Table 6.11 (continued) Livestock data series for 1989-2010 [heads] (NIS)

Year	Livestock data series [heads]								
	Buffalo	Buffaloes total (25+26)	Buffalo (breeding females)	Other buffaloes	Bovines total (23+24)	Swine	Pigs under 20 kg	Pigs between 20 and 50 kg	Pigs fattening total (4+5+6)
1989		-	-	-	6,291,000.00		-	-	-
1990		-	-	-	5,381,000.00		-	-	-
1991		-	-	-	4,355,000.00		-	-	-
1992		-	-	-	3,683,000.00		-	-	-
1993		-	-	-	3,597,000.00		-	-	-
1994		-	-	-	3,481,000.00		-	-	-
1995		-	-	-	3,496,000.00		-	-	-
1996		-	-	-	3,435,000.00		-	-	-
1997		-	-	-	3,235,000.00		-	-	-
1998		-	-	-	3,143,000.00		-	-	-
1999		-	-	-	3,051,000.00		-	-	-
2000		-	-	-	2,870,000.00		-	-	-
2001		-	-	-	2,800,000.00		-	-	-
2002		-	-	-	2,878,000.00		-	-	-
2003		-	-	-	2,897,000.00		-	-	-
2004		33,793.00	25,132.00	8,661.00	2,808,061.00		908,475.00	1,424,162.00	3,724,879.00
2005		44,808.00	32,686.00	12,122.00	2,861,671.00		844,937.00	1,324,861.00	3,942,575.00
2006		40,592.00	29,312.00	11,280.00	2,933,596.00		916,811.00	1,403,500.00	3,956,841.00
2007		32,156.00	23,272.00	8,884.00	2,818,983.00		903,040.00	1,394,902.00	3,810,454.00
2008		30,083.00	22,206.00	7,877.00	2,683,578.00		816,222.00	1,299,843.00	3,668,252.00
2009		29,922.00	22,371.00	7,551.00	2,512,296.00		767,201.00	1,227,740.00	3,425,881.00
2010		25,434.00	19,524.00	5,910.00	2,001,105.00		704,323.00	1,058,643.00	3,301,584.00

Table 6.11 (continued) Livestock data series for 1989-2010 [heads] (NIS)

Year	Livestock data series [heads]						
	Weight of 50-80 kg	Weight of 81-110 kg	Over 110 kg	Breeding pigs over 50 kg - total (8+9)	Boars	Breeding sows-total (10+12)	Sows mounted
1989	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-
2002	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-
2004	905,427.00	1,322,816.00	1,496,636.00	427,150.00	11,500.00	425,650.00	273,911.00
2005	904,850.00	1,374,288.00	1,663,437.00	509,929.00	15,438.00	494,491.00	305,684.00
2006	889,996.00	1,426,108.00	1,640,737.00	537,453.00	16,999.00	520,454.00	316,047.00
2007	917,696.00	1,398,831.00	1,493,927.00	456,511.00	14,033.00	442,478.00	263,719.00
2008	878,073.00	1,352,408.00	1,437,771.00	389,297.00	12,866.00	376,431.00	215,335.00
2009	868,137.00	1,217,638.00	1,340,106.00	372,593.00	13,294.00	359,299.00	218,841.00
2010	832,922.00	1,237,972.00	1,230,690.00	363,722.00	8,119.00	355,603.00	222,865.00

Table 6.11 (continued) Livestock data series for 1989-2010 [heads] (NIS)

Year	Livestock data series [heads]							
	Which: sows the first mount	Sows unmounted	Which:sows unmounted	Swine total (1+2+3+7)	Sheep	Sheep total-(2+5+6)	Sheep ewes and ewe mounted-total (3+4)	Sheep for milk
1989	-	-	-	11,671,000.00		15,435,000.00	-	-
1990	-	-	-	12,003,000.00		14,062,000.00	-	-
1991	-	-	-	10,954,000.00		13,879,000.00	-	-
1992	-	-	-	9,852,000.00		12,079,000.00	-	-
1993	-	-	-	9,262,000.00		11,499,000.00	-	-
1994	-	-	-	7,758,000.00		10,897,000.00	-	-
1995	-	-	-	7,960,000.00		10,381,000.00	-	-
1996	-	-	-	8,235,000.00		9,663,000.00	-	-
1997	-	-	-	7,097,000.00		8,937,000.00	-	-
1998	-	-	-	7,194,000.00		8,409,000.00	-	-
1999	-	-	-	5,848,000.00		8,121,000.00	-	-
2000	-	-	-	4,797,000.00		7,657,000.00	-	-
2001	-	-	-	4,447,000.00		7,251,000.00	-	-
2002	-	-	-	5,058,000.00		7,312,000.00	-	-
2003	-	-	-	5,145,000.00		7,447,000.00	-	-
2004	49,869.00	151,739.000	52,793.000	6,794,666.00		7,425,327.00	6,192,358.00	5,345,494.00
2005	60,387.00	188,807.000	75,056.000	6,622,302.00		7,610,958.00	6,452,817.00	5,525,682.00
2006	74,193.00	204,407.000	95,559.000	6,814,605.00		7,678,207.00	6,526,303.00	5,675,837.00
2007	90,604.00	178,759.000	97,286.000	6,564,907.00		8,469,195.00	7,206,980.00	6,636,944.00
2008	57,664.00	161,096.000	83,700.000	6,173,614.00		8,881,582.00	7,597,413.00	6,950,939.00
2009	54,275.00	140,458.000	69,496.000	5,793,415.00		9,141,482.00	7,817,798.00	7,174,278.00
2010	42,822.00	132,738.000	53,959.000	5,428,272.00		8,417,437.00	7,337,777.00	6,640,835.00

Table 6.11 (continued) Livestock data series for 1989-2010 [heads] (NIS)

Year	Livestock data series [heads]							
	Sheep mounted	Reproducers rams	Other sheep	Goats	Total goats - (8+11)	Goats which have littered and goats fitted (9+10)	Goats which have already calved	goats mounted for the first mount
1989	-	-	-		1,017,000.00	-	-	-
1990	-	-	-		1,005,000.00	-	-	-
1991	-	-	-		954,000.00	-	-	-
1992	-	-	-		805,000.00	-	-	-
1993	-	-	-		776,000.00	-	-	-
1994	-	-	-		745,000.00	-	-	-
1995	-	-	-		705,000.00	-	-	-
1996	-	-	-		654,000.00	-	-	-
1997	-	-	-		610,000.00	-	-	-
1998	-	-	-		585,000.00	-	-	-
1999	-	-	-		558,000.00	-	-	-
2000	-	-	-		538,000.00	-	-	-
2001	-	-	-		525,000.00	-	-	-
2002	-	-	-		633,000.00	-	-	-
2003	-	-	-		678,000.00	-	-	-
2004	846,864.00	196,332.00	1,036,637.00		660,716.00	551,722.00	474,910.00	76,812.00
2005	927,135.00	212,806.00	945,335.00		686,765.00	581,300.00	500,236.00	81,064.00
2006	850,466.00	219,300.00	932,604.00		727,406.00	615,637.00	524,990.00	90,647.00
2007	570,036.00	219,204.00	1,043,011.00		865,070.00	713,437.00	620,368.00	93,069.00
2008	646,474.00	280,083.00	1,004,086.00		898,307.00	740,549.00	632,519.00	108,030.00
2009	643,520.00	285,586.00	1,038,098.00		917,304.00	754,744.00	644,114.00	110,630.00
2010	696,942.00	255,428.00	824,232.00		1,240,786.00	1,031,951.00	861,027.00	170,924.00

Table 6.11 (continued) Livestock data series for 1989-2010 [heads] (NIS)

Year	Livestock data series [heads]						
	Other goats	Sheep and goats total (1+7)	Horses	Poultry	Total poultry	From which: adult poultry for eggs	Mules and asses
1989	-	-	663,000.00		113,968,000.00	-	36,000.00
1990	-	-	670,000.00		121,379,000.00	-	35,000.00
1991	-	-	749,000.00		106,032,000.00	-	35,000.00
1992	-	-	721,000.00		87,725,000.00	-	35,000.00
1993	-	-	751,000.00		76,532,000.00	-	34,000.00
1994	-	-	784,000.00		70,157,000.00	-	33,000.00
1995	-	-	806,000.00		80,524,000.00	-	32,000.00
1996	-	-	816,000.00		78,478,000.00	-	31,000.00
1997	-	-	822,000.00		66,620,000.00	-	30,000.00
1998	-	-	839,000.00		69,480,000.00	-	30,500.00
1999	-	-	858,000.00		69,143,000.00	-	31,000.00
2000	-	-	865,000.00		70,076,000.00	-	30,000.00
2001	-	-	860,000.00		71,413,000.00	-	31,000.00
2002	-	-	879,000.00		77,379,000.00	-	28,000.00
2003	-	-	897,000.00		76,616,000.00	-	28,000.00
2004	108,994.00	8,086,043.00	840,000.00		87,014,405.00	51,889,000.00	28,000.00
2005	105,465.00	8,297,723.00	834,000.00		86,552,203.00	49,725,000.00	29,000.00
2006	111,769.00	8,405,613.00	805,000.00		84,990,600.00	50,278,000.00	29,000.00
2007	151,633.00	9,334,265.00	862,000.00		81,952,424.00	45,208,000.00	29,000.00
2008	157,758.00	9,779,889.00	820,000.00		84,372,215.00	45,529,000.00	29,000.00
2009	162,560.00	10,058,786.00	764,000.00		83,843,079.00	45,046,000.00	30,000.00
2010	208,835.00	9,658,223.00	610,000.00		80,844,859.00	44,503,000.00	30,000.00

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 Table 6.12 and for which are official data for 2004-2010.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 Table 6.12.

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 1989-2010 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 2010), 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.

2004-2010

In the Table 6.12 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 Table 6.11, the values of *young cattle breeding* is the sum of *males* and *females* from Table 6.11.

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 Table 6.11. For *young cattle for slaughter* were used the values from in according with 6.11.

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 Table 6.12 are used in according with Table 6.11.

Sheep

The values for *ewes of milk and fitted* were taken from Table 6.11, 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 Table 6.11. 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 Table 6.11.

Table 6.12 Livestock data primary obtained through the dedicated study [heads]

Year	Livestock data series [heads]								
	Cattle	Cattle under 1 year	Calves for slaughter	Young Cattle breeding-	Cattle between 1 and 2 years-	Young Cattle breeding	Young Cattle for slaughter	Cattle 2 years and over	Bulls for breeding
1989			630,987.30	962,523.00		501,392.70	37,746		21,389.40
1990			539,714.30	823,293.00		428,865.70	32,286		18,295.40
1991			436,806.50	666,315.00		347,093.50	26,130		14,807.00
1992			369,404.90	563,499.00		293,535.10	22,098		12,522.20
1993			360,779.10	550,341.00		286,680.90	21,582		12,229.80
1994			349,144.30	532,593.00		277,435.70	20,886		11,835.40
1995			350,648.80	534,888.00		278,631.20	20,976		11,886.40
1996			344,530.50	525,555.00		273,769.50	20,610		11,679.00
1997			324,470.50	494,955.00		257,829.50	19,410		10,999.00
1998			315,242.90	480,879.00		250,497.10	18,858		10,686.20
1999			306,015.30	466,803.00		243,164.70	18,306		10,373.40
2000			287,861.00	439,110.00		228,739.00	17,220		9,758.00
2001			280,840.00	428,400.00		223,160.00	16,800		9,520.00
2002			288,663.40	440,334.00		229,376.60	17,268		9,785.20
2003			290,569.10	443,241.00		230,890.90	17,382		9,849.80
2004			281,783.00	429,500.00		223,999.00	16,707		9,578.00
2005			263,246.00	446,069.00		218,072.000	17,969		8,842.00
2006			262,763.00	478,257.00		254,214.000	25,514		9,219.00
2007			260,330.00	453,949.00		250,152.000	27,053		9,227.00
2008			236,897.00	428,877.00		257,732.000	27,101		12,360.00
2009			207,876.00	384,324.00		239,317.000	23,826		10,257.00
2010			134,012.00	286,335.00		200,502.000	14,163		7,410.00

Table 6.12 (continued) Livestock data primary obtained through the dedicated study [heads]

Year	Livestock data series [heads]							
	Heifers	Dairy cattle	Males and females sacrificed	For work	Buffalo	Buffalo (breeding females)	Other buffaloes	Swine
1989	366,765.30	3,509,748.90	62910	122,045.40		55,989.90	19,502.10	
1990	313,712.30	3,002,059.90	53810	104,391.40		47,890.90	16,681.10	
1991	253,896.50	2,429,654.50	43550	84,487.00		38,759.50	13,500.50	
1992	214,718.90	2,054,745.70	36830	71,450.20		32,778.70	11,417.30	
1993	209,705.10	2,006,766.30	35970	69,781.80		32,013.30	11,150.70	
1994	202,942.30	1,942,049.90	34810	67,531.40		30,980.90	10,791.10	
1995	203,816.80	1,950,418.40	34960	67,822.40		31,114.40	10,837.60	
1996	200,260.50	1,916,386.50	34350	66,639.00		30,571.50	10,648.50	
1997	188,600.50	1,804,806.50	32350	62,759.00		28,791.50	10,028.50	
1998	183,236.90	1,753,479.70	31430	60,974.20		27,972.700	9,743.30	
1999	177,873.30	1,702,152.90	30510	59,189.40		27,153.90	9,458.10	
2000	167,321.00	1,601,173.00	28700	55,678.00		25,543.00	8,897.00	
2001	163,240.00	1,562,120.00	28000	54,320.00		24,920.00	8,680.00	
2002	167,787.40	1,605,636.20	28780	55,833.20		25,614.20	8,921.80	
2003	168,895.10	1,616,236.30	28970	56,201.80		25,783.30	8,980.70	
2004	163,931.00	1,566,397.00	27821	54,552.00		25,132.00	8,661.00	
2005	153,620.00	1,625,681.00	27209	56,155.00		32,686.00	12,122.00	
2006	141,158.00	1,639,362.00	28629	53,888.00		29,312.00	11,280.00	
2007	135,952.00	1,572,927.00	26292	50,945.00		23,272.00	8,884.00	
2008	133,029.00	1,483,281.00	26558	47,660.00		22,206.00	7,877.00	
2009	128,093.00	1,419,027.00	26830	42,824.00		22,371.00	7,551.00	
2010	101,012.00	1,178,565.00	20198	33,474.00		19,524.00	5,910.00	

Table 6.12 (continued) Livestock data primary obtained through the dedicated study [heads]

Year	Livestock data series [heads]							
	Pigs under 20 kg	Pigs between 20 and 50 kg	Pigs fattening	Boars	Breeding sows	Sheep	Ewes of milk and fitted	Reproducers rams
1989	1,594,005.60	2,498,020.80	6,535,742.40	20,231.20	1,023,000.00		9,292,000.00	977,965.60
1990	1,654,484.40	2,592,799.20	6,783,717.60	20,998.80	951,000.00		9,050,000.00	797,910.40
1991	1,524,395.10	2,388,931.80	6,250,325.40	19,347.70	771,000.00		11,496,000.00	379,373.60
1992	1,356,282.00	2,125,476.00	5,561,028.00	17,214.00	792,000.00		8,854,000.00	513,420.00
1993	1,285,024.80	2,013,806.40	5,268,859.20	16,309.60	678,000.00		8,371,000.00	497,977.60
1994	1,075,145.40	1,684,897.20	4,408,311.60	13,645.80	576,000.00		8,049,000.00	453,401.60
1995	1,103,289.00	1,729,002.00	4,523,706.00	14,003.00	590,000.00		7,688,000.00	428,725.60
1996	1,145,354.70	1,794,924.60	4,696,183.80	14,536.90	584,000.00		7,188,000.00	394,020.00
1997	986,672.70	1,546,248.60	4,045,555.80	12,522.90	506,000.00		6,714,000.00	353,901.60
1998	999,846.30	1,566,893.40	4,099,570.20	12,690.10	515,000.00		6,354,000.00	327,156.00
1999	814,817.10	1,276,927.80	3,340,913.40	10,341.70	405,000.00		6,166,000.00	311,236.00
2000	669,757.80	1,049,600.40	2,746,141.20	8,500.60	323,000.00		5,870,000.00	284,490.40
2001	615,716.10	964,909.80	2,524,559.40	7,814.70	334,000.00		5,823,000.00	227,337.60
2002	702,991.20	1,101,681.60	2,882,404.80	8,922.40	362,000.00		5,795,000.00	241,506.40
2003	720,057.00	1,128,426.00	2,952,378.00	9,139.00	335,000.00		5,879,000.00	249,625.60
2004	908,475.00	1,424,162.00	3,724,879.00	11,500.00	425,650.00		6,192,358.00	196,332.00
2005	844,937.00	1,324,861.00	3,942,575.00	15,438.00	494,491.00		6,452,817.00	212,806.00
2006	916,811.00	1,403,500.00	3,956,841.00	16,999.00	520,454.00		6,526,303.00	219,300.00
2007	903,040.00	1,394,902.00	3,810,454.00	14,033.00	442,478.00		7,206,980.00	219,204.00
2008	816,222.00	1,299,843.00	3,668,252.00	12,866.00	376,431.00		7,597,413.00	280,083.00
2009	767,201.00	1,227,740.00	3,425,881.00	13,294.00	359,299.00		7,817,798.00	285,586.00
2010	704,323.00	1,058,643.00	3,301,584.00	8,119.00	355,603.00		7,337,777.00	255,428.00

Table 6.12 (continued) Livestock data primary obtained through the dedicated study [heads]

Year	Livestock data series [heads]							
	Other sheep	Goats	Female goats for milk and females by first mount	Other goats	Horses	Poultry	From which: adult poultry for eggs	Poultry for meat
1989	5,165,034.40		706,000.00	311,000.00	663,000.00		49,390,000.00	64,578,000.00
1990	4,214,089.60		697,000.00	308,000.00	670,000.00		51,475,000.00	69,904,000.00
1991	2,003,626.40		734,000.00	220,000.00	749,000.00		50,213,000.00	55,819,000.00
1992	2,711,580.00		613,000.00	192,000.00	721,000.00		42,406,000.00	45,319,000.00
1993	2,630,022.40		562,000.00	214,000.00	751,000.00		37,981,000.00	38,551,000.00
1994	2,394,598.40		542,000.00	203,000.00	784,000.00		36,233,000.00	33,924,000.00
1995	2,264,274.40		514,000.00	191,000.00	806,000.00		38,574,000.00	41,950,000.00
1996	2,080,980.00		475,000.00	179,000.00	816,000.00		38,883,000.00	39,595,000.00
1997	1,869,098.40		453,000.00	157,000.00	822,000.00		35,089,000.00	31,531,000.00
1998	1,727,844.00		429,000.00	156,000.00	839,000.00		37,272,000.00	32,208,000.00
1999	1,643,764.00		411,000.00	147,000.00	858,000.00		38,497,000.00	30,646,000.00
2000	1,502,509.60		404,000.00	134,000.00	865,000.00		40,760,000.00	29,316,000.00
2001	1,200,662.40		406,000.00	119,000.00	860,000.00		42,156,000.00	29,257,000.00
2002	1,275,493.60		469,000.00	164,000.00	879,000.00		44,667,000.00	32,712,000.00
2003	1,318,374.40		491,000.00	187,000.00	897,000.00		44,122,000.00	32,494,000.00
2004	1,036,637.00		551,722.00	108,994.00	840,000.00		51,889,000.00	35,125,000.00
2005	945,335.00		581,300.00	105,465.00	834,000.00		49,725,000.00	36,827,000.00
2006	932,604.00		615,637.00	111,769.00	805,000.00		50,278,000.00	34,712,000.00
2007	1,043,011.00		713,437.00	151,633.00	862,000.00		45,208,000.00	36,828,000.00
2008	1,004,086.00		740,549.00	157,758.00	820,000.00		45,529,000.00	38,844,000.00
2009	1,038,098.00		754,744.00	162,560.00	764,000.00		45,046,000.00	38,797,000.00
2010	824,232.00		1,031,951.00	208,835.00	610,000.00		44,503,000.00	36,341,000.00

Table 6.12 (continued) Livestock data primary obtained through the dedicated study [heads]

Year	Livestock data series [heads]
	Mules and asses
1989	36,000.00
1990	35,000.00
1991	35,000.00
1992	35,000.00
1993	34,000.00
1994	33,000.00
1995	32,000.00
1996	31,000.00
1997	30,000.00
1998	30,500.00
1999	31,000.00
2000	30,000.00
2001	31,000.00
2002	28,000.00
2003	28,000.00
2004	28,000.00
2005	29,000.00
2006	29,000.00
2007	29,000.00
2008	29,000.00
2009	30,000.00
2010	30,000.00

Data used in emissions calculation

For the estimation of emissions of methane and nitrous oxide from manure management, the livestock data from NIS have been corrected, with the factor "*days of exploitation*", the specific factor to each of subcategory exploitation of the specie.

This correction factor refers to the number days in a year, period in which the animal is exploited and applies to categories of young exploited for meat (irrespective of species). The livestock correction was made using the following relation:

Equation 6.5 Corrected livestock

$$\textit{Corrected livestock} = (\textit{number of exploitation days} \bullet \textit{livestock})/365$$

where:

❖ corrected livestock = corrected number of animal heads;

❖ number of exploitation days = number of days of exploitation (days).

The correction factor was necessary to prevent emission estimates, because the life period of the slaughter animal is a few weeks (42 days for chicken for meat, 56 days in pigs under 20 kg, 75 days in pigs between 20 and 50 kg) to months (3 months from cattle over 2 year, 6 months on cattle between 1 and 2 years, 6 months on young sheep and 7 months young goats).

The milk calves of small weight, 70-90 kg, which are valorified at 5-6 weeks age are fed exclusively on liquid diet (milk or milk substitute); the milk calves of larger weight, 160-200 kg, which are valorified 15-20 weeks are fed with 85-90% liquid diet and 10-15% fodder plant (Velea C., Marginean GH. - *The production, reproduction and improvement of cattle*, vol. III, Ed. AgroTehnical, Bucharest, pages.860).

For this reason calves for slaughter of less than 1 year are exploited in Romania for 365 days, they moving further within youth to slaughter aged 1 to 2 years category.

In this category, to achieve average slaughter weight of 400 kg, animal is exploited only 180 days (is an average exploitation of period between the growth assured in farm and the accumulated in households).

Concerning technologies fattening of cattle these are efficient and suitable for any breed of cattle. The valorifying is made at 12-17 months, at a 450-580 kg weight.

In the period fattening is registered daily accumulation of 1.1 – 1.3 kg (Velea C., Marginean GH. - *The production, reproduction and improvement of cattle*, vol. III, Ed. AgroTehnical, Bucharest, pages 862).

In the group these technologies it include those and the producing of the heavy foal, represented of young cattle or young production for meat at age 18-22 months and the weight 500-600 kg. The performances production is 900-1000 g the average daily.

Cattle over 2 years for slaughter and resulting from the previous categories are those from extensive systems to increase or are the cattle during of the reconditioning.

The subcategory pigs less than 20 kg are exploited about 56 days to get this weight.

The first 3 weeks and breast feeding stay one week with the sow, time period to accommodate with the feed then weaned.

The average daily growth in this period is 270-300 g/day, getting a weaning weight of approximately 8 kg. The accumulation of remaining of 12 kg, with an average daily gain of 400 g/day is done in another 28 days.

Considering the technological view at industrial farm level, pigs under 20 kg category not exist, it was registered only statistically (because the nursery pigs with weighing out the 30 kg will be delivered to the fattening sector, which will stand up to a weight of 100-110 kg) (I. Dinu – *Special problems of improvement and exploitation of pigs*, 1981, D.P.E., Bucharest, pages 223).

Pigs coming from above category and enter in the category 20-50 kg must accumulate 30 kg.

Considering an average daily gain of 400 g, accumulation of 30 kg is done in 75 days.

The fattening pig's category accumulates in complex level at 80 kg in 100 days, and in farm level or household 60 kg in 100 days.

For sheep, in the category of other sheep enter both lambs and young for fattening sheep.

The lambs are slaughtered for meat at age 4-6 weeks, the weight of 12-15 kg. The young sheep to fatten up to 5-6 months with an average weight of 35-40 kg.

The young goats to fatten up to 7 months when touch weighing of 35-38 kg, realizing an average gain of 100-120 g/day.

The livestock values in the Table 6.13 are used to calculate emissions associated.

Table 6.13 Livestock data corrected according to the number of days of operation for the series 1989-2010 [heads]

Year	Livestock data series [heads]								
	Cattle	Cattle under 1 year	Calves for slaughter	Young Cattle breeding-	Cattle between 1 and 2 years-	Young Cattle breeding	Young Cattle for slaughter	Cattle 2 years and over	Bulls for breeding
1989			630,987.30	962,523.00		501,392.70	18,614.46		21,389.40
1990			539,714.30	823,293.00		428,865.70	15,921.86		18,295.40
1991			436,806.50	666,315.00		347,093.50	12,886.02		14,807.00
1992			369,404.90	563,499.00		293,535.10	10,897.64		12,522.20
1993			360,779.10	550,341.00		286,680.90	10,643.17		12,229.80
1994			349,144.30	532,593.00		277,435.70	10,299.94		11,835.40
1995			350,648.80	534,888.00		278,631.20	10,344.32		11,886.40
1996			344,530.50	525,555.00		273,769.50	10,163.83		11,679.00
1997			324,470.50	494,955.00		257,829.50	9,572.05		10,999.00
1998			315,242.90	480,879.00		250,497.10	9,299.83		10,686.20
1999			306,015.30	466,803.00		243,164.70	9,027.61		10,373.40
2000			287,861.00	439,110.00		228,739.00	8,492.05		9,758.00
2001			280,840.00	428,400.00		223,160.00	8,284.93		9,520.00
2002			288,663.40	440,334.00		229,376.60	8,515.72		9,785.20
2003			290,569.10	443,241.00		230,890.90	8,571.94		9,849.80
2004			281,783.00	429,500.00		223,999.00	8,239.06		9,578.00
2005			263,246.00	446,069.00		218,072.000	8,861.42		8,842.00
2006			262,763.00	478,257.00		254,214.000	12,582.24		9,219.00
2007			260,330.00	453,949.00		250,152.000	13,341.20		9,227.00
2008			236,897.00	428,877.00		257,732.000	13,364.87		12,360.00
2009			207,876.00	384,324.00		239,317.000	11,749.80		10,257.00
2010			134,012.00	286,335.00		200,502.000	6,984.49		7,410.00

Table 6.13 (continued) Livestock data corrected according to the number of days of operation for the series 1989-2010 [heads]

Year	Livestock data series [heads]							
	Heifers	Dairy cattle	Males and females sacrificed	For work	Buffalo	Buffalo (breeding females)	Other buffaloes	Swine
1989	366,765.30	3,509,748.90	15,512.05	122,045.40		55,989.90	19,502.10	
1990	313,712.30	3,002,059.90	13,268.21	104,391.40		47,890.90	16,681.10	
1991	253,896.50	2,429,654.50	10,738.35	84,487.00		38,759.50	13,500.50	
1992	214,718.90	2,054,745.70	9,081.37	71,450.20		32,778.70	11,417.30	
1993	209,705.10	2,006,766.30	8,869.31	69,781.80		32,013.30	11,150.70	
1994	202,942.30	1,942,049.90	8,583.28	67,531.40		30,980.90	10,791.10	
1995	203,816.80	1,950,418.40	8,620.27	67,822.40		31,114.40	10,837.60	
1996	200,260.50	1,916,386.50	8,469.86	66,639.00		30,571.50	10,648.50	
1997	188,600.50	1,804,806.50	7,976.71	62,759.00		28,791.50	10,028.50	
1998	183,236.90	1,753,479.70	7,749.86	60,974.20		27,972.700	9,743.30	
1999	177,873.30	1,702,152.90	7,523.01	59,189.40		27,153.90	9,458.10	
2000	167,321.00	1,601,173.00	7,076.71	55,678.00		25,543.00	8,897.00	
2001	163,240.00	1,562,120.00	6,904.11	54,320.00		24,920.00	8,680.00	
2002	167,787.40	1,605,636.20	7,096.43	55,833.20		25,614.20	8,921.80	
2003	168,895.10	1,616,236.30	7,143.28	56,201.80		25,783.30	8,980.70	
2004	163,931.00	1,566,397.00	6,859.97	54,552.00		25,132.00	8,661.00	
2005	153,620.00	1,625,681.00	6,709.06	56,155.00		32,686.00	12,122.00	
2006	141,158.00	1,639,362.00	7,059.20	53,888.00		29,312.00	11,280.00	
2007	135,952.00	1,572,927.00	6,482.95	50,945.00		23,272.00	8,884.00	
2008	133,029.00	1,483,281.00	6,548.54	47,660.00		22,206.00	7,877.00	
2009	128,093.00	1,419,027.00	6,615.61	42,824.00		22,371.00	7,551.00	
2010	101,012.00	1,178,565.00	4,980.32	33,474.00		19,524.00	5,910.00	

Table 6.13 (continued) Livestock data corrected according to the number of days of operation for the series 1989-2010 [heads]

Year	Livestock data series [heads]							
	Pigs under 20 kg	**Pigs between 20 and 50 kg**	**Pigs fattening total**	**Boars**	**Breeding sows**	**Sheep**	**Ewes of milk and fitted**	**Reproducers rams**
1989	244,559.76	513,291.94	1,790,614.35	20,231.20	1,023,000.00		9,292,000.00	977,965.60
1990	253,838.70	532,766.95	1,858,552.76	20,998.80	951,000.00		9,050,000.00	797,910.40
1991	233,879.79	490,876.39	1,712,417.91	19,347.70	771,000.00		11,496,000.00	379,373.60
1992	208,087.10	436,741.64	1,523,569.31	17,214.00	792,000.00		8,854,000.00	513,420.00
1993	197,154.49	413,795.83	1,443,523.06	16,309.60	678,000.00		8,371,000.00	497,977.60
1994	164,953.81	346,211.75	1,207,756.60	13,645.80	576,000.00		8,049,000.00	453,401.60
1995	169,271.73	355,274.38	1,239,371.50	14,003.00	590,000.00		7,688,000.00	428,725.60
1996	175,725.65	368,820.12	1,286,625.69	14,536.90	584,000.00		7,188,000.00	394,020.00
1997	151,379.92	317,722.31	1,108,371.45	12,522.90	506,000.00		6,714,000.00	353,901.60
1998	153,401.07	321,964.39	1,123,169.91	12,690.10	515,000.00		6,354,000.00	327,156.00
1999	125,013.03	262,382.42	915,318.74	10,341.70	405,000.00		6,166,000.00	311,236.00
2000	102,757.36	215,671.31	752,367.45	8,500.60	323,000.00		5,870,000.00	284,490.40
2001	94,466.03	198,269.13	691,660.11	7,814.70	334,000.00		5,823,000.00	227,337.60
2002	107,856.18	226,372.93	789,699.94	8,922.40	362,000.00		5,795,000.00	241,506.40
2003	110,474.49	231,868.35	808,870.68	9,139.00	335,000.00		5,879,000.00	249,625.60
2004	139,382.46	292,636.02	1,020,514.79	11,500.00	425,650.00		6,192,358.00	196,332.00
2005	129,634.17	272,231.71	1,080,157.53	15,438.00	494,491.00		6,452,817.00	212,806.00
2006	140,661.41	288,390.41	1,084,066.02	16,999.00	520,454.00		6,526,303.00	219,300.00
2007	138,548.60	286,623.69	1,043,960.00	14,033.00	442,478.00		7,206,980.00	219,204.00
2008	125,228.58	267,091.02	1,005,000.54	12,866.00	376,431.00		7,597,413.00	280,083.00
2009	117,707.55	252,275.34	938,597.53	13,294.00	359,299.00		7,817,798.00	285,586.00
2010	108,060.51	217,529.38	904,543.56	8,119.00	355,603.00		7,337,777.00	255,428.00

Table 6.13 (continued) Livestock data corrected according to the number of days of operation for the series 1989-2010 [heads]

Year	Livestock data series [heads]							
	Other sheep	Goats	Female goats for milk and females by first mount	Other goats	Horses	Poultry	From which: adult poultry for eggs	Poultry for meat
1989	2,547,140.25		706,000.00	187,452.05	663,000.00		49,390,000.00	7,430,893.15
1990	2,078,181.17		697,000.00	185,643.83	670,000.00		51,475,000.00	8,043,747.94
1991	988,089.73		734,000.00	132,602.74	749,000.00		50,213,000.00	6,423,008.21
1992	1,337,217.53		613,000.00	115,726.02	721,000.00		42,406,000.00	5,214,789.04
1993	1,296,997.34		562,000.00	128,986.30	751,000.00		37,981,000.00	4,436,005.47
1994	1,180,897.84		542,000.00	122,356.16	784,000.00		36,233,000.00	3,903,583.56
1995	1,116,628.47		514,000.00	115,123.28	806,000.00		38,574,000.00	4,827,123.28
1996	1,026,236.71		475,000.00	107,890.41	816,000.00		38,883,000.00	4,556,136.98
1997	921,747.15		453,000.00	94,630.13	822,000.00		35,089,000.00	3,628,224.65
1998	852,087.45		429,000.00	94,027.39	839,000.00		37,272,000.00	3,706,126.02
1999	810,623.34		411,000.00	88,602.74	858,000.00		38,497,000.00	3,526,389.04
2000	740,963.63		404,000.00	80,767.12	865,000.00		40,760,000.00	3,373,347.94
2001	592,107.48		406,000.00	71,726.02	860,000.00		42,156,000.00	3,366,558.90
2002	629,010.54		469,000.00	98,849.31	879,000.00		44,667,000.00	3,764,120.54
2003	650,157.23		491,000.00	112,712.32	897,000.00		44,122,000.00	3,739,035.61
2004	511,218.24		551,722.00	65,695.01	840,000.00		51,889,000.00	4,041,780.82
2005	466,192.60		581,300.00	63,567.94	834,000.00		49,725,000.00	4,237,627.39
2006	459,914.30		615,637.00	67,367.61	805,000.00		50,278,000.00	3,994,257.53
2007	514,361.58		713,437.00	91,395.23	862,000.00		45,208,000.00	4,237,742.46
2008	495,165.69		740,549.00	95,087.01	820,000.00		45,529,000.00	4,469,720.54
2009	511,938.74		754,744.00	97,981.37	764,000.00		45,046,000.00	4,464,312.32
2010	406,470.57		1,031,951.00	125,873.15	610,000.00		44,503,000.00	4,181,704.11

Table 6.13 (continued) Livestock data corrected according to the number of days of operation for the series 1989-2010 [heads]

Year	**Livestock data series [heads]**
	Mules and asses
1989	36,000.00
1990	35,000.00
1991	35,000.00
1992	35,000.00
1993	34,000.00
1994	33,000.00
1995	32,000.00
1996	31,000.00
1997	30,000.00
1998	30,500.00
1999	31,000.00
2000	30,000.00
2001	31,000.00
2002	28,000.00
2003	28,000.00
2004	28,000.00
2005	29,000.00
2006	29,000.00
2007	29,000.00
2008	29,000.00
2009	30,000.00
2010	30,000.00

In the Table 6.14 are presented the number of days of exploitation to all subcategories of animals.

Table 6.14 The number of days of exploitation to all subcategories of animals

Source indicative	Livestock (source) type	Number of exploitation days
4 A1	**CATTLE**	
4 A1 a	***Dairy cattle***	365
4 A1 b	***Non dairy cattle***	
	Calves for slaughter younger than 1 year	365
	Young cattle of breeding under 1 year	365
	Young cattle of breeding between 1 and 2 years	365
	Young cattle of slaughter between 1 and 2 years	180
	Cattle 2 years and over - Breeding bulls	365
	Cattle 2 years and over -Heifers	365
	Males and females for sacrificed older than 2 years	90
	Cattle for work	365
4 A2	***BUFFALO***	
	Female buffalo	365
	Other buffalo	365
4 A3	***SHEEP***	
	Ewes of milk and fitted	365
	Reproducers rams	365
	Other sheep	180
4 A4	***GOATS***	
	Female goats for milk and females by first mount	365
	Other Goats	220
4 A6	***HORSES***	365
4 A7	***MULES AND ASSES***	365

Table 6.14 (continued) The number of days of exploitation to all subcategories of animals

Source indicative	Livestock (source) type	Number of exploitation days
4 A8	***SWINE***	
	Pigs under 20 kg	56
	Pigs between 20 and 50 kg	75
	Pigs fattening	100
	Boars	365
	Breeding sows	365
4 A9	***POULTRY***	
	Adult poultry for eggs	365
	Poultry for meat	42

6.2.3 Uncertainties and time-series consistency

In the context of the implementation in 2011 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“:*

- ❖ by expert judgment, it is considered that the uncertainty related to the activity data is 10%, due to the uncertainty associated to the animal average weight and to gross energy intake value;
- ❖ the uncertainty associated to the emission factor was considered to be 20% (0-40%), because the livestock was corrected with the exploitation days (activity days) factor and due to the use of the default values for methane conversion rate (Y_m).

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000 is 22.36%. 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), 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 1989-2010 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.

QA/QC activities were performed 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.“*

Following these activities there were unconformities recorded.

The unconformities noted and solved following these activities 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.

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.

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 FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.1.

The unconformities noted and solved following the previously specified activities are described at the Improvements list level.

6.2.5 Source-specific recalculations, including changes made in response to the review process

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

Methodology

Tier 2 calculation methods were used for all livestock for estimating CH_4 emissions and for 1989-2010 period comparing to the Tier 1 method applied within the v.4.1 2011 NGHGI submission, following the collection/processing/development of enhanced livestock data and national emission factors in the context of implementation in 2011 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“*; the recalculations follow the relevant methodological requirements and previous ERT recommendations.

Emission factors

National emission factors for all livestock began to be used for 1989-2010 period, comparing to the use of default emission factors, within v.4.1 2011 NGHGI submission, as a result of implementation in 2011 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* considering the relevant methodological requirements and previous ERT recommendations;

Activity data

More disaggregated livestock data, in the format the National Institute for Statistics uses to report them to Eurostat, began to be used, for 1989-2010 period, comparing to primary livestock data used within v.4.1 2011 NGHGI submission; the recalculations follow the relevant methodological requirements and previous ERT recommendations.

The implications of all changes made on emission estimates are described in Table 6.15.

Table 6.15 Implication of recalculations on emission estimates

Year	**Effects of changes on emission estimates**		
	2011 v.4.1 submission – CH_4 emissions [Gg]	**2012 v.2.1 submission – CH_4 emissions [Gg]**	**Difference [%]**
1989	561.32	783.74	222.42
1990	544.86	695.88	151.02
1991	486.58	635.56	148.98
1992	427.76	539.05	111.29
1993	376.53	521.85	145.32
1994	374.38	503.27	128.89
1995	364.89	495.70	130.81
1996	362.91	478.20	115.29
1997	353.27	449.62	96.35
1998	332.69	433.75	101.06
1999	312.62	421.47	108.85
2000	296.18	399.27	103.09
2001	290.09	388.22	98.13
2002	298.78	397.12	98.34
2003	304.32	402.11	97.79
2004	302.07	396.24	94.17
2005	306.39	406.25	99.86
2006	314.29	410.80	96.51
2007	311.89	420.34	108.45
2008	304.38	417.23	112.85

2009	292.81	408.31	115.50
2010		358.51	

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. Some manure nitrogen is converted to N_2O during storage of manure.

Manure Management:

- is the ultimate source of CH_4 and the fourth source of N_2O emissions in the Agriculture sector (in 2010, CH_4 emissions from Manure Management represented 4.48% of total CH_4 emissions while N_2O accounted for 9.04% of total N_2O emissions in the Agriculture sector);
- is the ultimate source in the Agriculture sector (in 2010, CH_4 and N_2O emissions from Manure Management as CO_2 equivalent represented 6.86% from Total Agriculture emissions);
- contributed with 0.94% 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 6.16.

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

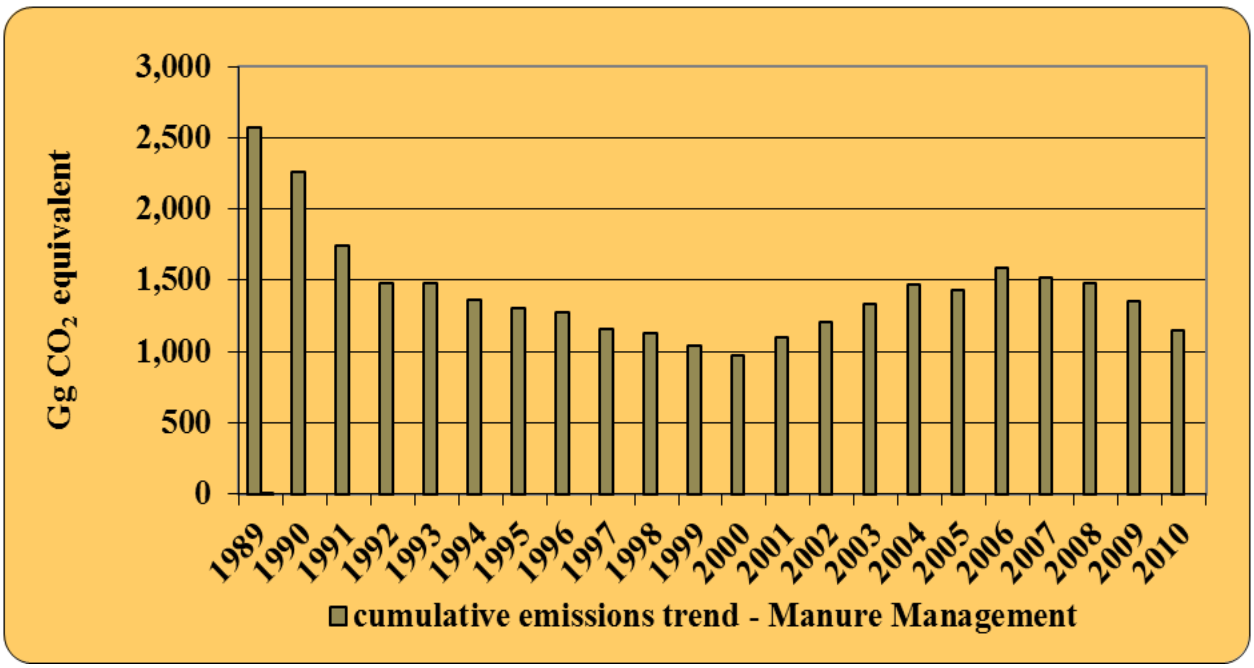


Table 6.16 Observations on source category 4B – "Manure Management"

Source indicative	Source type	Observation	Data source
Observations on source category 4B – "Manure Management – CH_4 and N_2O emissions"			
4B1	Cattle	Includes livestock data from nine different cattle categories: dairy cows and non-dairy cattle	AD: NIS and expert judgment, 1989-2003; NIS, 2004-2010 EF: Country specific, expert judgment
4B2	Buffalo	Includes livestock data from two different buffalo:buffalo milk and other buffalo	AD: SY, other correspondence, NIS and expert judgment, 1989-2003; NIS, 2004-2010; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4B3	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, 2004-2010; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4B4	Goats	Includes livestock data from two different goats: Female goats for milk and females by first mount and other goats	
4B6	Horses		
4B7	Mules and asses		AD: FAO, 2010; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4B8	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, 2004-2010 EF: IPCC GPG 2000, IPCC 1996, expert judgment
4B9	Poultry	Includes livestock data from two different	

		poultry: adult poultry for eggs, poultry for meat	

Table 6.16 (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"			
4B11	Anaerobic Lagoon		AD: IPCC GPG 2000, IPCC 1996; EF: IPCC GPG 2000, IPCC 1996, expert judgment
4B12	Liquid/Slurry		
4B13	Daily Spread		
4B14	Solid storage		
4B15	Dry lot		
4B16	Pasture/range/paddock		
4B17	Pit storage		
4B18	Poultry manure wit bedding		
4B19	Poultry manure without bedding		

6.3.2 Methodological issues

CH_4 emissions

Methodology

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 6.6 CH_4 emission from manure management

$$CH_4\ Emissions_{(mm)} = Emission\ Factor \bullet Population\ /\ (10^6\ kg/Gg)$$

where:

- ❖ CH_4 Emissions$_{(mm)}$ = CH_4 emissions from manure management, for a defined population Gg/year;
- ❖ Emission Factor = emission factor for the defined livestock population, kg/head/year;
- ❖ Population = the number of head in the defined livestock population.

Equation 6.7 Volatile solid excretion rates

$$VS = GE \bullet (1\ kg\text{-}dm/18.45\ MJ) \bullet (1 - DE/100) \bullet (1 - ASH/100)$$

where:

- ❖ VS = volatile solid excretion per day on a dry-matter weight basis, kg-dm/day;
- ❖ GE = Estimated daily average feed intake in MJ/day;
- ❖ DE = Digestible energy of the feed in percent;
- ❖ ASH = Ash content of the manure in percent.

Equation 6.8 Emission factor from manure management

$$EF_i = VS_i \bullet 365\ days/year \bullet B_{oi} \bullet 0.67\ kg/m^3 \bullet \Sigma_{(jk)} MCF_{jk} \bullet MS_{ijk}$$

where:

- EF_i = annual emission factor for defined livestock population *i*, in kg;
- VS_i = daily VS excreted for an animal within defined population *i*, in kg;
- B_o = maximum CH_4 producing capacity for manure produced by an animal within defined population *i*, m^3/kg of VS;
- MCF_{jk} = CH_4 conversion factors for each manure management system j by climate region *k*;
- MS_{ijk} = fraction of animal species/category *i*'s manure handled using manure system *j* in climate region k (fraction).

Emission factors

According to the provisions of IPCC GPG 2000, to use equation 4.15, 4.16, 4.17 have been considered national values for gross energy intake, MJ/head/day (GE), digestible energy (DE), excretion rates (VS), fraction of animal species/category *i*'s manure handled using manure system (MS) and the default values for ASH, Bo and MCF used from *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000 and Manual Reference.*

The 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 this country to the.

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 Table 6.17 are summarized the values used in the calculation of emissions factors for 1989-2010 period for each livestock and in Table 6.18 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 6.17 The values used in the calculation of emissions factors from Manure management for 1989-2010

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 B1	**CATTLE**			
4 B1 a	***Dairy cattle***	8	3.63	0.24
4 B1 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 6.17 (continued) The values used in the calculation of emissions factors from Manure management for 1989-2010

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 B2	***BUFFALO***			
	Female buffalo	8	6.22	0.1
	Other buffalo	8	2.86	0.1
4 B3	***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 B4	***GOATS***			
	Female goats for milk and females by first mount	8	1.44	0.13
	Other Goats	8	1.41	0.13
4 B6	***HORSES***	8	5.18	0.26
4 B7	***MULES AND ASSES***	8	4.08	0.26
4 B8	***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 6.17 (continued) The values used in the calculation of emissions factors from Manure management for 1989-2010

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 B8	***SWINE***			
	Boars	2	0.31	0.29
	Breeding sows	2	0.40	0.29
4 B9	***POULTRY***			
	Adult poultry for eggs	8	0.01	0.24
	Poultry for meat	8	0.01	0.24

Table 6.18 The values MCF used in calculation of emissions factor for each manure system management for all livestock in the 1989-2010 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 Table 6.19 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 1989-2010 period, and in the Table 6.20 are found emissions factors necessary for calculation of methane emissions from manure management.

Table 6.19 The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Dairy cattle									
1989	0	0.05	0	0.35	0	0.6	0	0	0
1990	0	0.05	0	0.35	0	0.6	0	0	0
1991	0	0.025	0	0.375	0	0.6	0	0	0
1992	0	0.01	0	0.39	0	0.6	0	0	0
1993	0	0.01	0	0.39	0	0.6	0	0	0
1994	0	0.009	0	0.391	0	0.6	0	0	0
1995	0	0.009	0	0.341	0	0.65	0	0	0
1996	0	0.009	0	0.341	0	0.65	0	0	0
1997	0	0.008	0	0.342	0	0.65	0	0	0
1998	0	0.008	0	0.342	0	0.65	0	0	0
1999	0	0.007	0	0.343	0	0.65	0	0	0
2000	0	0.01	0	0.34	0	0.65	0	0	0
2001	0	0.03	0	0.37	0	0.6	0	0	0
2002	0	0.05	0	0.35	0	0.6	0	0	0
2003	0	0.06	0	0.39	0	0.55	0	0	0
2004	0	0.06	0	0.43	0	0.51	0	0	0
2005	0	0.02	0	0.48	0	0.5	0	0	0
2006	0	0.07	0	0.43	0	0.5	0	0	0
2007	0	0.05	0	0.45	0	0.5	0	0	0
2008	0	0.04	0	0.46	0	0.5	0	0	0
2009	0	0.03	0	0.47	0	0.5	0	0	0
2010	0	0.02	0	0.48	0	0.5	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	MS (fraction)								
	Anaerobic lagoon	Liquid slurry	Daily spread	Solid Storage	Dry lot	Pasture/ range/ paddock	Pit storage	Poultry manure with bedding	Poultry manure without bedding
Non dairy cattle - Cattle for slaughter									
1989	0	0.01	0	0.59	0	0.4	0	0	0
1990	0	0.01	0	0.59	0	0.4	0	0	0
1991	0	0.01	0	0.59	0	0.4	0	0	0
1992	0	0.01	0	0.49	0	0.5	0	0	0
1993	0	0.01	0	0.49	0	0.5	0	0	0
1994	0	0	0	0.5	0	0.5	0	0	0
1995	0	0	0	0.5	0	0.5	0	0	0
1996	0	0	0	0.5	0	0.5	0	0	0
1997	0	0	0	0.5	0	0.5	0	0	0
1998	0	0	0	0.5	0	0.5	0	0	0
1999	0	0	0	0.5	0	0.5	0	0	0
2000	0	0.01	0	0.49	0	0.5	0	0	0
2001	0	0.02	0	0.48	0	0.5	0	0	0
2002	0	0.04	0	0.48	0	0.48	0	0	0
2003	0	0.05	0	0.55	0	0.4	0	0	0
2004	0	0.06	0	0.43	0	0.51	0	0	0
2005	0	0	0	0.45	0	0.55	0	0	0
2006	0	0.03	0	0.43	0	0.54	0	0	0
2007	0	0.03	0	0.47	0	0.5	0	0	0
2008	0	0.02	0	0.48	0	0.5	0	0	0
2009	0	0.02	0	0.58	0	0.4	0	0	0

2010	0	0.01	0	0.59	0	0.4	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	MS (fraction)								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Young cattle of breeding under 1 year									
1989	0	0.05	0	0.35	0	0.6	0	0	0
1990	0	0.05	0	0.35	0	0.6	0	0	0
1991	0	0.025	0	0.375	0	0.6	0	0	0
1992	0	0.01	0	0.39	0	0.6	0	0	0
1993	0	0.01	0	0.39	0	0.6	0	0	0
1994	0	0.009	0	0.391	0	0.6	0	0	0
1995	0	0.009	0	0.341	0	0.65	0	0	0
1996	0	0.009	0	0.341	0	0.65	0	0	0
1997	0	0.008	0	0.342	0	0.65	0	0	0
1998	0	0.008	0	0.342	0	0.65	0	0	0
1999	0	0.007	0	0.343	0	0.65	0	0	0
2000	0	0.01	0	0.34	0	0.65	0	0	0
2001	0	0.03	0	0.37	0	0.6	0	0	0
2002	0	0.05	0	0.35	0	0.6	0	0	0
2003	0	0.06	0	0.39	0	0.55	0	0	0
2004	0	0.06	0	0.43	0	0.51	0	0	0
2005	0	0	0	0.45	0	0.55	0	0	0
2006	0	0.03	0	0.43	0	0.54	0	0	0
2007	0	0.03	0	0.47	0	0.5	0	0	0
2008	0	0.02	0	0.48	0	0.5	0	0	0
2009	0	0.02	0	0.58	0	0.4	0	0	0

2010	0	0.01	0	0.59	0	0.4	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Young cattle of breeding between 1 and 2 years									
1989	0	0.05	0	0.35	0	0.6	0	0	0
1990	0	0.05	0	0.35	0	0.6	0	0	0
1991	0	0.025	0	0.375	0	0.6	0	0	0
1992	0	0.01	0	0.39	0	0.6	0	0	0
1993	0	0.01	0	0.39	0	0.6	0	0	0
1994	0	0.009	0	0.391	0	0.6	0	0	0
1995	0	0.009	0	0.341	0	0.65	0	0	0
1996	0	0.009	0	0.341	0	0.65	0	0	0
1997	0	0.008	0	0.342	0	0.65	0	0	0
1998	0	0.008	0	0.342	0	0.65	0	0	0
1999	0	0.007	0	0.343	0	0.65	0	0	0
2000	0	0.01	0	0.34	0	0.65	0	0	0
2001	0	0.03	0	0.37	0	0.6	0	0	0
2002	0	0.05	0	0.35	0	0.6	0	0	0
2003	0	0.06	0	0.39	0	0.55	0	0	0
2004	0	0.05	0	0.45	0	0.5	0	0	0
2005	0	0	0	0.45	0	0.55	0	0	0
2006	0	0.05	0	0.45	0	0.5	0	0	0
2007	0	0.03	0	0.47	0	0.5	0	0	0
2008	0	0.02	0	0.58	0	0.4	0	0	0
2009	0	0.02	0	0.48	0	0.5	0	0	0

2010	0	0.01	0	0.49	0	0.5	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Young cattle of slaughter between 1 and 2 years									
1989	0	0.01	0	0.59	0	0.4	0	0	0
1990	0	0.01	0	0.59	0	0.4	0	0	0
1991	0	0.01	0	0.59	0	0.4	0	0	0
1992	0	0.01	0	0.49	0	0.5	0	0	0
1993	0	0.01	0	0.49	0	0.5	0	0	0
1994	0	0	0	0.5	0	0.5	0	0	0
1995	0	0	0	0.5	0	0.5	0	0	0
1996	0	0	0	0.5	0	0.5	0	0	0
1997	0	0	0	0.5	0	0.5	0	0	0
1998	0	0	0	0.5	0	0.5	0	0	0
1999	0	0	0	0.5	0	0.5	0	0	0
2000	0	0.01	0	0.49	0	0.5	0	0	0
2001	0	0.02	0	0.48	0	0.5	0	0	0
2002	0	0.04	0	0.48	0	0.48	0	0	0
2003	0	0.05	0	0.55	0	0.4	0	0	0
2004	0	0.05	0	0.45	0	0.5	0	0	0
2005	0	0.01	0	0.44	0	0.55	0	0	0
2006	0	0.05	0	0.45	0	0.5	0	0	0
2007	0	0.03	0	0.47	0	0.5	0	0	0
2008	0	0.02	0	0.58	0	0.4	0	0	0

2009	0	0.02	0	0.48	0	0.5	0	0	0
2010	0	0.01	0	0.49	0	0.5	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Cattle 2 years and over - Breeding bulls									
1989	0	0	0	1	0	0	0	0	0
1990	0	0	0	1	0	0	0	0	0
1991	0	0	0	1	0	0	0	0	0
1992	0	0	0	1	0	0	0	0	0
1993	0	0	0	1	0	0	0	0	0
1994	0	0	0	1	0	0	0	0	0
1995	0	0	0	1	0	0	0	0	0
1996	0	0	0	1	0	0	0	0	0
1997	0	0	0	1	0	0	0	0	0
1998	0	0	0	1	0	0	0	0	0
1999	0	0	0	1	0	0	0	0	0
2000	0	0	0	1	0	0	0	0	0
2001	0	0	0	1	0	0	0	0	0
2002	0	0	0	1	0	0	0	0	0
2003	0	0	0	1	0	0	0	0	0
2004	0	0	0	1	0	0	0	0	0
2005	0	0	0	1	0	0	0	0	0
2006	0	0	0	1	0	0	0	0	0
2007	0	0	0	1	0	0	0	0	0

2008	0	0	0	1	0	0	0	0	0
2009	0	0	0	1	0	0	0	0	0
2010	0	0	0	1	0	0	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Cattle 2 years and over - Heifers for breeding									
1989	0	0.05	0	0.35	0	0.6	0	0	0
1990	0	0.05	0	0.35	0	0.6	0	0	0
1991	0	0.025	0	0.375	0	0.6	0	0	0
1992	0	0.01	0	0.39	0	0.6	0	0	0
1993	0	0.01	0	0.39	0	0.6	0	0	0
1994	0	0.009	0	0.391	0	0.6	0	0	0
1995	0	0.009	0	0.341	0	0.65	0	0	0
1996	0	0.009	0	0.341	0	0.65	0	0	0
1997	0	0.008	0	0.342	0	0.65	0	0	0
1998	0	0.008	0	0.342	0	0.65	0	0	0
1999	0	0.007	0	0.343	0	0.65	0	0	0
2000	0	0.01	0	0.34	0	0.65	0	0	0
2001	0	0.03	0	0.37	0	0.6	0	0	0
2002	0	0.05	0	0.35	0	0.6	0	0	0
2003	0	0.06	0	0.39	0	0.55	0	0	0
2004	0	0.06	0	0.43	0	0.51	0	0	0
2005	0	0.02	0	0.48	0	0.5	0	0	0
2006	0	0.07	0	0.43	0	0.5	0	0	0

2007	0	0.05	0	0.45	0	0.5	0	0	0
2008	0	0.04	0	0.46	0	0.5	0	0	0
2009	0	0.03	0	0.47	0	0.5	0	0	0
2010	0	0.02	0	0.48	0	0.5	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Males and females for sacrificed older than 2 years									
1989	0	0.01	0	0.59	0	0.4	0	0	0
1990	0	0.01	0	0.59	0	0.4	0	0	0
1991	0	0.01	0	0.59	0	0.4	0	0	0
1992	0	0.01	0	0.49	0	0.5	0	0	0
1993	0	0.01	0	0.49	0	0.5	0	0	0
1994	0	0	0	0.5	0	0.5	0	0	0
1995	0	0	0	0.5	0	0.5	0	0	0
1996	0	0	0	0.5	0	0.5	0	0	0
1997	0	0	0	0.5	0	0.5	0	0	0
1998	0	0	0	0.5	0	0.5	0	0	0
1999	0	0	0	0.5	0	0.5	0	0	0
2000	0	0.01	0	0.49	0	0.5	0	0	0
2001	0	0.02	0	0.48	0	0.5	0	0	0
2002	0	0.04	0	0.48	0	0.48	0	0	0
2003	0	0.05	0	0.55	0	0.4	0	0	0
2004	0	0.05	0	0.45	0	0.5	0	0	0
2005	0	0.02	0	0.5	0	0.48	0	0	0

2006	0	0.01	0	0.49	0	0.5	0	0	0
2007	0	0.03	0	0.57	0	0.4	0	0	0
2008	0	0.02	0	0.58	0	0.4	0	0	0
2009	0	0.01	0	0.59	0	0.4	0	0	0
2010	0	0.01	0	0.6	0	0.39	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Cattle for work									
1989	0	0	0	0	0	1	0	0	0
1990	0	0	0	0	0	1	0	0	0
1991	0	0	0	0	0	1	0	0	0
1992	0	0	0	0	0	1	0	0	0
1993	0	0	0	0	0	1	0	0	0
1994	0	0	0	0	0	1	0	0	0
1995	0	0	0	0	0	1	0	0	0
1996	0	0	0	0	0	1	0	0	0
1997	0	0	0	0	0	1	0	0	0
1998	0	0	0	0	0	1	0	0	0
1999	0	0	0	0	0	1	0	0	0
2000	0	0	0	0	0	1	0	0	0
2001	0	0	0	0	0	1	0	0	0
2002	0	0	0	0	0	1	0	0	0
2003	0	0	0	0	0	1	0	0	0
2004	0	0	0	0	0	1	0	0	0

2005	0	0	0	0	0	1	0	0	0
2006	0	0	0	0	0	1	0	0	0
2007	0	0	0	0	0	1	0	0	0
2008	0	0	0	0	0	1	0	0	0
2009	0	0	0	0	0	1	0	0	0
2010	0	0	0	0	0	1	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Female buffalo									
1989	0	0	0	0.4	0	0.6	0	0	0
1990	0	0	0	0.4	0	0.6	0	0	0
1991	0	0	0	0.4	0	0.6	0	0	0
1992	0	0	0	0.4	0	0.6	0	0	0
1993	0	0	0	0.4	0	0.6	0	0	0
1994	0	0	0	0.4	0	0.6	0	0	0
1995	0	0	0	0.4	0	0.6	0	0	0
1996	0	0	0	0.4	0	0.6	0	0	0
1997	0	0	0	0.4	0	0.6	0	0	0
1998	0	0	0	0.4	0	0.6	0	0	0
1999	0	0	0	0.4	0	0.6	0	0	0
2000	0	0	0	0.4	0	0.6	0	0	0
2001	0	0	0	0.4	0	0.6	0	0	0
2002	0	0	0	0.4	0	0.6	0	0	0
2003	0	0	0	0.4	0	0.6	0	0	0

2004	0	0	0	0.4	0	0.6	0	0	0
2005	0	0	0	0.4	0	0.6	0	0	0
2006	0	0	0	0.4	0	0.6	0	0	0
2007	0	0	0	0.4	0	0.6	0	0	0
2008	0	0	0	0.6	0	0.4	0	0	0
2009	0	0	0	0.6	0	0.4	0	0	0
2010	0	0	0	0.6	0	0.4	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Other buffalo									
1989	0	0	0	0.4	0	0.6	0	0	0
1990	0	0	0	0.4	0	0.6	0	0	0
1991	0	0	0	0.4	0	0.6	0	0	0
1992	0	0	0	0.4	0	0.6	0	0	0
1993	0	0	0	0.4	0	0.6	0	0	0
1994	0	0	0	0.4	0	0.6	0	0	0
1995	0	0	0	0.4	0	0.6	0	0	0
1996	0	0	0	0.4	0	0.6	0	0	0
1997	0	0	0	0.4	0	0.6	0	0	0
1998	0	0	0	0.4	0	0.6	0	0	0
1999	0	0	0	0.4	0	0.6	0	0	0
2000	0	0	0	0.4	0	0.6	0	0	0
2001	0	0	0	0.4	0	0.6	0	0	0
2002	0	0	0	0.4	0	0.6	0	0	0

2003	0	0	0	0.4	0	0.6	0	0	0
2004	0	0	0	0.4	0	0.6	0	0	0
2005	0	0	0	0.4	0	0.6	0	0	0
2006	0	0	0	0.4	0	0.6	0	0	0
2007	0	0	0	0.4	0	0.6	0	0	0
2008	0	0	0	0.6	0	0.4	0	0	0
2009	0	0	0	0.6	0	0.4	0	0	0
2010	0	0	0	0.6	0	0.4	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Ewes of milk and fitted									
1989	0	0	0.15	0.25	0	0.6	0	0	0
1990	0	0	0.15	0.25	0	0.6	0	0	0
1991	0	0	0.15	0.25	0	0.6	0	0	0
1992	0	0	0.1	0.3	0	0.6	0	0	0
1993	0	0	0	0.4	0	0.6	0	0	0
1994	0	0	0	0.4	0	0.6	0	0	0
1995	0	0	0	0.4	0	0.6	0	0	0
1996	0	0	0	0.4	0	0.6	0	0	0
1997	0	0	0	0.4	0	0.6	0	0	0
1998	0	0	0	0.4	0	0.6	0	0	0
1999	0	0	0	0.4	0	0.6	0	0	0
2000	0	0	0	0.4	0	0.6	0	0	0
2001	0	0	0	0.4	0	0.6	0	0	0

2002	0	0	0	0.4	0	0.6	0	0	0
2003	0	0	0	0.4	0	0.6	0	0	0
2004	0	0	0	0.4	0	0.6	0	0	0
2005	0	0	0	0.4	0	0.6	0	0	0
2006	0	0	0	0.4	0	0.6	0	0	0
2007	0	0	0	0.4	0	0.6	0	0	0
2008	0	0	0	0.4	0	0.6	0	0	0
2009	0	0	0	0.4	0	0.6	0	0	0
2010	0	0	0	0.4	0	0.6	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Reproducers rams									
1989	0	0	0.15	0.25	0	0.6	0	0	0
1990	0	0	0.15	0.25	0	0.6	0	0	0
1991	0	0	0.15	0.25	0	0.6	0	0	0
1992	0	0	0.1	0.3	0	0.6	0	0	0
1993	0	0	0	0.4	0	0.6	0	0	0
1994	0	0	0	0.4	0	0.6	0	0	0
1995	0	0	0	0.4	0	0.6	0	0	0
1996	0	0	0	0.4	0	0.6	0	0	0
1997	0	0	0	0.4	0	0.6	0	0	0
1998	0	0	0	0.4	0	0.6	0	0	0
1999	0	0	0	0.4	0	0.6	0	0	0
2000	0	0	0	0.4	0	0.6	0	0	0

2001	0	0	0	0.4	0	0.6	0	0	0
2002	0	0	0	0.4	0	0.6	0	0	0
2003	0	0	0	0.4	0	0.6	0	0	0
2004	0	0	0	0.4	0	0.6	0	0	0
2005	0	0	0	0.4	0	0.6	0	0	0
2006	0	0	0	0.4	0	0.6	0	0	0
2007	0	0	0	0.4	0	0.6	0	0	0
2008	0	0	0	0.4	0	0.6	0	0	0
2009	0	0	0	0.4	0	0.6	0	0	0
2010	0	0	0	0.4	0	0.6	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Other sheep									
1989	0	0	0.4	0.2	0	0.4	0	0	0
1990	0	0	0.4	0.2	0	0.4	0	0	0
1991	0	0	0.4	0.2	0	0.4	0	0	0
1992	0	0	0.2	0.3	0	0.5	0	0	0
1993	0	0	0	0.4	0	0.6	0	0	0
1994	0	0	0	0.4	0	0.6	0	0	0
1995	0	0	0	0.4	0	0.6	0	0	0
1996	0	0	0	0.4	0	0.6	0	0	0
1997	0	0	0	0.4	0	0.6	0	0	0
1998	0	0	0	0.4	0	0.6	0	0	0
1999	0	0	0	0.4	0	0.6	0	0	0

2000	0	0	0	0.4	0	0.6	0	0	0
2001	0	0	0	0.4	0	0.6	0	0	0
2002	0	0	0	0.4	0	0.6	0	0	0
2003	0	0	0	0.4	0	0.6	0	0	0
2004	0	0	0	0.4	0	0.6	0	0	0
2005	0	0	0	0.4	0	0.6	0	0	0
2006	0	0	0	0.4	0	0.6	0	0	0
2007	0	0	0	0.4	0	0.6	0	0	0
2008	0	0	0	0.4	0	0.6	0	0	0
2009	0	0	0	0.4	0	0.6	0	0	0
2010	0	0	0	0.4	0	0.6	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Female goats for milk and females by first mount									
1989	0	0	0	0.3	0	0.7	0	0	0
1990	0	0	0	0.3	0	0.7	0	0	0
1991	0	0	0	0.3	0	0.7	0	0	0
1992	0	0	0	0.3	0	0.7	0	0	0
1993	0	0	0	0.3	0	0.7	0	0	0
1994	0	0	0	0.3	0	0.7	0	0	0
1995	0	0	0	0.3	0	0.7	0	0	0
1996	0	0	0	0.3	0	0.7	0	0	0
1997	0	0	0	0.3	0	0.7	0	0	0
1998	0	0	0	0.3	0	0.7	0	0	0

1999	0	0	0	0.3	0	0.7	0	0	0
2000	0	0	0	0.3	0	0.7	0	0	0
2001	0	0	0	0.3	0	0.7	0	0	0
2002	0	0	0	0.3	0	0.7	0	0	0
2003	0	0	0	0.3	0	0.7	0	0	0
2004	0	0	0	0.3	0	0.7	0	0	0
2005	0	0	0	0.3	0	0.7	0	0	0
2006	0	0	0	0.3	0	0.7	0	0	0
2007	0	0	0	0.3	0	0.7	0	0	0
2008	0	0	0	0.3	0	0.7	0	0	0
2009	0	0	0	0.3	0	0.7	0	0	0
2010	0	0	0	0.3	0	0.7	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Other Goats									
1989	0	0	0	0.3	0	0.7	0	0	0
1990	0	0	0	0.3	0	0.7	0	0	0
1991	0	0	0	0.3	0	0.7	0	0	0
1992	0	0	0	0.3	0	0.7	0	0	0
1993	0	0	0	0.3	0	0.7	0	0	0
1994	0	0	0	0.3	0	0.7	0	0	0
1995	0	0	0	0.3	0	0.7	0	0	0
1996	0	0	0	0.3	0	0.7	0	0	0
1997	0	0	0	0.3	0	0.7	0	0	0

1998	0	0	0	0.3	0	0.7	0	0	0
1999	0	0	0	0.3	0	0.7	0	0	0
2000	0	0	0	0.3	0	0.7	0	0	0
2001	0	0	0	0.3	0	0.7	0	0	0
2002	0	0	0	0.3	0	0.7	0	0	0
2003	0	0	0	0.3	0	0.7	0	0	0
2004	0	0	0	0.3	0	0.7	0	0	0
2005	0	0	0	0.3	0	0.7	0	0	0
2006	0	0	0	0.3	0	0.7	0	0	0
2007	0	0	0	0.3	0	0.7	0	0	0
2008	0	0	0	0.3	0	0.7	0	0	0
2009	0	0	0	0.3	0	0.7	0	0	0
2010	0	0	0	0.3	0	0.7	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Horses									
1989	0	0	0.5	0.2	0	0.3	0	0	0
1990	0	0	0.5	0.2	0	0.3	0	0	0
1991	0	0	0.65	0.15	0	0.2	0	0	0
1992	0	0	0.65	0.15	0	0.2	0	0	0
1993	0	0	0.65	0.15	0	0.2	0	0	0
1994	0	0	0.65	0.15	0	0.2	0	0	0
1995	0	0	0.65	0.15	0	0.2	0	0	0
1996	0	0	0.65	0.15	0	0.2	0	0	0

1997	0	0	0.65	0.15	0	0.2	0	0	0
1998	0	0	0.65	0.15	0	0.2	0	0	0
1999	0	0	0.65	0.15	0	0.2	0	0	0
2000	0	0	0.65	0.15	0	0.2	0	0	0
2001	0	0	0.55	0.15	0	0.3	0	0	0
2002	0	0	0.55	0.12	0	0.33	0	0	0
2003	0	0	0.5	0.15	0	0.35	0	0	0
2004	0	0	0.45	0.2	0	0.35	0	0	0
2005	0	0	0.35	0.25	0	0.4	0	0	0
2006	0	0	0.3	0.2	0	0.5	0	0	0
2007	0	0	0.32	0.2	0	0.48	0	0	0
2008	0	0	0.35	0.2	0	0.45	0	0	0
2009	0	0	0.4	0.15	0	0.45	0	0	0
2010	0	0	0.45	0.1	0	0.45	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Mules and asses									
1989	0	0	0	0	0	1	0	0	0
1990	0	0	0	0	0	1	0	0	0
1991	0	0	0	0	0	1	0	0	0
1992	0	0	0	0	0	1	0	0	0
1993	0	0	0	0	0	1	0	0	0
1994	0	0	0	0	0	1	0	0	0
1995	0	0	0	0	0	1	0	0	0

1996	0	0	0	0	0	1	0	0	0
1997	0	0	0	0	0	1	0	0	0
1998	0	0	0	0	0	1	0	0	0
1999	0	0	0	0	0	1	0	0	0
2000	0	0	0	0	0	1	0	0	0
2001	0	0	0	0	0	1	0	0	0
2002	0	0	0	0	0	1	0	0	0
2003	0	0	0	0	0	1	0	0	0
2004	0	0	0	0	0	1	0	0	0
2005	0	0	0	0	0	1	0	0	0
2006	0	0	0	0	0	1	0	0	0
2007	0	0	0	0	0	1	0	0	0
2008	0	0	0	0	0	1	0	0	0
2009	0	0	0	0	0	1	0	0	0
2010	0	0	0	0	0	1	0	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Pigs under 20 kg									
1989	0.7	0	0	0.2	0	0	0.1	0	0
1990	0.7	0	0	0.2	0	0	0.1	0	0
1991	0.7	0	0	0.2	0	0	0.1	0	0
1992	0.6	0	0	0.3	0	0	0.1	0	0
1993	0.6	0	0	0.3	0	0	0.1	0	0
1994	0.6	0	0	0.3	0	0	0.1	0	0

1995	0.5	0	0	0.4	0	0	0.1	0	0
1996	0.5	0	0	0.4	0	0	0.1	0	0
1997	0.4	0	0	0.5	0	0	0.1	0	0
1998	0.4	0	0	0.5	0	0	0.1	0	0
1999	0.4	0	0	0.5	0	0	0.1	0	0
2000	0.4	0	0	0.3	0	0	0.3	0	0
2001	0.4	0	0	0.3	0	0	0.3	0	0
2002	0.3	0	0	0.3	0	0	0.4	0	0
2003	0.3	0	0	0.3	0	0	0.4	0	0
2004	0.3	0	0	0.3	0	0	0.4	0	0
2005	0.3	0	0	0.3	0	0	0.4	0	0
2006	0.5	0	0	0.2	0	0	0.3	0	0
2007	0.49	0	0	0.2	0	0	0.31	0	0
2008	0.5	0	0	0.2	0	0	0.3	0	0
2009	0.52	0	0	0.15	0	0	0.33	0	0
2010	0.45	0	0	0.2	0	0	0.35	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Pigs between 20 and 50 kg									
1989	0.6	0	0	0.3	0	0	0.1	0	0
1990	0.6	0	0	0.3	0	0	0.1	0	0
1991	0.6	0	0	0.3	0	0	0.1	0	0
1992	0.5	0	0	0.4	0	0	0.1	0	0
1993	0.4	0	0	0.5	0	0	0.1	0	0

1994	0.4	0	0	0.5	0	0	0.1	0	0
1995	0.4	0	0	0.5	0	0	0.1	0	0
1996	0.4	0	0	0.5	0	0	0.1	0	0
1997	0.3	0	0	0.6	0	0	0.1	0	0
1998	0.3	0	0	0.6	0	0	0.1	0	0
1999	0.3	0	0	0.6	0	0	0.1	0	0
2000	0.4	0	0	0.3	0	0	0.3	0	0
2001	0.4	0	0	0.3	0	0	0.3	0	0
2002	0.3	0	0	0.3	0	0	0.4	0	0
2003	0.3	0	0	0.3	0	0	0.4	0	0
2004	0.3	0	0	0.3	0	0	0.4	0	0
2005	0.3	0	0	0.3	0	0	0.4	0	0
2006	0.45	0	0	0.3	0	0	0.25	0	0
2007	0.4	0	0	0.3	0	0	0.3	0	0
2008	0.35	0	0	0.4	0	0	0.25	0	0
2009	0.47	0	0	0.2	0	0	0.33	0	0
2010	0.4	0	0	0.3	0	0	0.3	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Pigs fattening									
1989	0.6	0	0	0.3	0	0	0.1	0	0
1990	0.6	0	0	0.2	0	0	0.2	0	0
1991	0.3	0	0	0.2	0	0	0.5	0	0
1992	0.32	0	0	0.2	0	0	0.48	0	0

1993	0.35	0	0	0.2	0	0	0.45	0	0
1994	0.32	0	0	0.2	0	0	0.48	0	0
1995	0.31	0	0	0.2	0	0	0.49	0	0
1996	0.31	0	0	0.2	0	0	0.49	0	0
1997	0.23	0	0	0.28	0	0	0.49	0	0
1998	0.22	0	0	0.28	0	0	0.5	0	0
1999	0.19	0	0	0.28	0	0	0.53	0	0
2000	0.2	0	0	0.3	0	0	0.5	0	0
2001	0.3	0	0	0.3	0	0	0.4	0	0
2002	0.35	0	0	0.3	0	0	0.35	0	0
2003	0.38	0	0	0.25	0	0	0.37	0	0
2004	0.4	0	0	0.25	0	0	0.35	0	0
2005	0.47	0	0	0.22	0	0	0.31	0	0
2006	0.5	0	0	0.2	0	0	0.3	0	0
2007	0.49	0	0	0.2	0	0	0.31	0	0
2008	0.51	0	0	0.2	0	0	0.29	0	0
2009	0.5	0	0	0.15	0	0	0.35	0	0
2010	0.45	0	0	0.15	0	0	0.4	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Boars									
1989	0	0	0	0.2	0	0	0.8	0	0
1990	0	0	0	0	0	0	1	0	0
1991	0	0	0	0	0	0	1	0	0

1992	0	0	0	0	0	0	1	0	0
1993	0	0	0	0	0	0	1	0	0
1994	0	0	0	0	0	0	1	0	0
1995	0	0	0	0	0	0	1	0	0
1996	0	0	0	0	0	0	1	0	0
1997	0	0	0	0	0	0	1	0	0
1998	0	0	0	0	0	0	1	0	0
1999	0	0	0	0	0	0	1	0	0
2000	0	0	0	0	0	0	1	0	0
2001	0	0	0	0	0	0	1	0	0
2002	0	0	0	0	0	0	1	0	0
2003	0	0	0	0	0	0	1	0	0
2004	0	0	0	0	0	0	1	0	0
2005	0	0	0	0	0	0	1	0	0
2006	0	0	0	0	0	0	1	0	0
2007	0	0	0	0	0	0	1	0	0
2008	0	0	0	0	0	0	1	0	0
2009	0	0	0	0	0	0	1	0	0
2010	0	0	0	0	0	0	1	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Breeding sows									
1989	0.55	0	0	0.25	0	0	0.2	0	0
1990	0.35	0	0	0.25	0	0	0.4	0	0

1991	0.35	0	0	0.25	0	0	0.4	0	0
1992	0.3	0	0	0.3	0	0	0.4	0	0
1993	0.32	0	0	0.3	0	0	0.38	0	0
1994	0.3	0	0	0.3	0	0	0.4	0	0
1995	0.28	0	0	0.3	0	0	0.42	0	0
1996	0.27	0	0	0.3	0	0	0.43	0	0
1997	0.2	0	0	0.35	0	0	0.45	0	0
1998	0.18	0	0	0.35	0	0	0.47	0	0
1999	0.15	0	0	0.35	0	0	0.5	0	0
2000	0.19	0	0	0.35	0	0	0.46	0	0
2001	0.22	0	0	0.35	0	0	0.43	0	0
2002	0.26	0	0	0.35	0	0	0.39	0	0
2003	0.3	0	0	0.33	0	0	0.37	0	0
2004	0.35	0	0	0.33	0	0	0.32	0	0
2005	0.3	0	0	0.3	0	0	0.4	0	0
2006	0.45	0	0	0.3	0	0	0.25	0	0
2007	0.43	0	0	0.3	0	0	0.27	0	0
2008	0.45	0	0	0.3	0	0	0.25	0	0
2009	0.4	0	0	0.2	0	0	0.4	0	0
2010	0.44	0	0	0.2	0	0	0.36	0	0

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Adult Poultry for eggs									
1989	0	0	0.56	0	0	0	0	0	0.44

1990	0	0	0.56	0	0	0	0	0	0.44
1991	0	0	0.6	0	0	0	0	0	0.4
1992	0	0	0.73	0	0	0	0	0	0.27
1993	0	0	0.73	0	0	0	0	0	0.27
1994	0	0	0.8	0	0	0	0	0	0.2
1995	0	0	0.79	0	0	0	0	0	0.21
1996	0	0	0.82	0	0	0	0	0	0.18
1997	0	0	0.9	0	0	0	0	0	0.1
1998	0	0	0.9	0	0	0	0	0	0.1
1999	0	0	0.95	0	0	0	0	0	0.05
2000	0	0	0.97	0	0	0	0	0	0.03
2001	0	0	0.8	0	0	0	0	0	0.2
2002	0	0	0.67	0	0	0	0	0	0.33
2003	0	0	0.6	0	0	0	0	0	0.4
2004	0	0	0.45	0	0	0	0	0	0.55
2005	0	0	0.35	0	0	0	0	0	0.65
2006	0	0	0.34	0	0	0	0	0	0.66
2007	0	0	0.3	0	0	0	0	0	0.7
2008	0	0	0.25	0	0	0	0	0	0.75
2009	0	0	0.27	0	0	0	0	0	0.73
2010	0	0	0.25	0	0	0	0	0	0.75

Table 6.19 (continued) The MS values used in emission factor calculation from manure management for each animal category and subcategory and each AWMS in the period 1989-2010

Year/ AWMS	**MS (fraction)**								
	Anaerobic lagoon	**Liquid slurry**	**Daily spread**	**Solid Storage**	**Dry lot**	**Pasture/ range/ paddock**	**Pit storage**	**Poultry manure with bedding**	**Poultry manure without bedding**
Poultry for meat									

1989	0	0	0.2	0	0	0	0	0.55	0.25
1990	0	0	0.2	0	0	0	0	0.55	0.25
1991	0	0	0.25	0	0	0	0	0.55	0.2
1992	0	0	0.33	0	0	0	0	0.47	0.2
1993	0	0	0.38	0	0	0	0	0.42	0.2
1994	0	0	0.505	0	0	0	0	0.395	0.1
1995	0	0	0.49	0	0	0	0	0.36	0.15
1996	0	0	0.57	0	0	0	0	0.33	0.1
1997	0	0	0.72	0	0	0	0	0.22	0.06
1998	0	0	0.75	0	0	0	0	0.2	0.05
1999	0	0	0.91	0	0	0	0	0.09	0
2000	0	0	0.98	0	0	0	0	0.02	0
2001	0	0	0.8	0	0	0	0	0.15	0.05
2002	0	0	0.7	0	0	0	0	0.22	0.08
2003	0	0	0.59	0	0	0	0	0.31	0.1
2004	0	0	0.43	0	0	0	0	0.4	0.17
2005	0	0	0.28	0	0	0	0	0.52	0.2
2006	0	0	0.27	0	0	0	0	0.53	0.2
2007	0	0	0.2	0	0	0	0	0.7	0.1
2008	0	0	0.2	0	0	0	0	0.8	0
2009	0	0	0.17	0	0	0	0	0.83	0
2010	0	0	0.23	0	0	0	0	0.77	0

Table 6.20 Emission factors used [kg CH_4/head/year] for calculation of methane emissions from Manure management, in the 1989-2010 period

Year	**Emission Factors [kg CH_4/head/year]**								
	Cattle	**Cattle under 1 year**	**Calves for slaughter**	**Young Cattle breeding-**	**Cattle between 1 and 2 years-**	**Young Cattle breeding**	**Young Cattle for slaughter**	**Cattle 2 years and over**	**Bulls for breeding**
1989			1.76	2.99		3.93	1.99		2.25

1990			1.76	2.99		3.93	1.99		2.25
1991			1.76	2.01		2.64	1.99		2.25
1992			1.76	1.42		1.87	1.99		2.25
1993			1.76	1.42		1.87	1.99		2.25
1994			1.28	1.38		1.82	1.44		2.25
1995			1.28	1.38		1.82	1.44		2.25
1996			1.28	1.38		1.82	1.44		2.25
1997			1.28	1.34		1.77	1.44		2.25
1998			1.28	1.34		1.77	1.44		2.25
1999			1.28	1.30		1.72	1.44		2.25
2000			1.76	1.42		1.87	1.99		2.25
2001			2.25	2.20		2.90	2.54		2.25
2002			3.23	2.99		3.93	3.64		2.25
2003			3.71	3.38		4.44	4.19		2.25
2004			4.20	3.38		3.93	4.19		2.25
2005			1.28	1.03		1.35	1.99		2.25
2006			2.74	2.20		3.93	4.19		2.25
2007			2.74	2.20		2.90	3.09		2.25
2008			2.25	1.81		2.38	2.54		2.25
2009			2.25	1.81		2.38	2.54		2.25
2010			1.76	1.42		1.87	1.99		2.25

Table 6.20 (continued) Emission factors [kg CH_4/head/year] used for calculation of methane emissions from Manure management, in the 1989-2010 period

Year	**Emission Factors [kg CH_4/head/year]**							
	Heifers	**Dairy cattle**	**Males and females sacrificed**	**For work**	**Buffalo**	**Buffalo (breeding females)**	**Other buffaloes**	**Swine**

1989	5.22	6.19	2.05	2.69		1.52	0.70	
1990	5.22	6.19	2.05	2.69		1.52	0.70	
1991	3.51	4.16	2.05	2.69		1.52	0.70	
1992	2.49	2.94	2.05	2.69		1.52	0.70	
1993	2.49	2.94	2.05	2.69		1.52	0.70	
1994	2.42	2.86	1.49	2.69		1.52	0.70	
1995	2.42	2.86	1.49	2.69		1.52	0.70	
1996	2.42	2.86	1.49	2.69		1.52	0.70	
1997	2.35	2.78	1.49	2.69		1.52	0.70	
1998	2.35	2.78	1.49	2.69		1.52	0.70	
1999	2.28	2.70	1.49	2.69		1.52	0.70	
2000	2.49	2.94	2.05	2.69		1.52	0.70	
2001	3.86	4.57	2.62	2.69		1.52	0.70	
2002	5.22	6.19	3.75	2.69		1.52	0.70	
2003	5.91	7.00	4.31	2.69		1.52	0.70	
2004	5.91	7.00	4.31	2.69		1.52	0.70	
2005	3.17	3.76	2.62	2.69		1.52	0.70	
2006	6.59	7.81	2.05	2.69		1.52	0.70	
2007	5.22	6.19	3.18	2.69		1.52	0.70	
2008	4.54	5.38	2.62	2.69		1.52	0.70	
2009	3.86	4.57	2.05	2.69		1.52	0.70	
2010	3.17	3.76	2.05	2.69		1.52	0.70	

Table 6.20 (continued) Emission factors [kg CH_4/head/year] used for calculation of methane emissions from Manure management, in the 1989-2010 period

Year	**Emission Factors [kg CH_4/head/year]**							
	Pigs under 20 kg	**Pigs between 20 and 50 kg**	**Pigs fattening**	**Boars**	**Breeding sows**	**Sheep**	**Ewes of milk and fitted**	**Reproducers rams**

1989	1.45	1.60	5.53	0.05	6.25		0.33	0.28
1990	1.45	1.60	5.51	0.00	4.00		0.33	0.28
1991	1.45	1.60	2.78	0.00	4.00		0.33	0.28
1992	1.25	1.34	2.96	0.00	3.46		0.34	0.29
1993	1.25	1.08	3.23	0.00	3.68		0.38	0.32
1994	1.25	1.08	2.96	0.00	3.46		0.38	0.32
1995	1.05	1.08	2.87	0.00	3.23		0.38	0.32
1996	1.05	1.08	2.87	0.00	3.12		0.38	0.32
1997	0.85	0.83	2.16	0.00	2.35		0.38	0.32
1998	0.85	0.83	2.07	0.00	2.12		0.38	0.32
1999	0.85	0.83	1.80	0.00	1.79		0.38	0.32
2000	0.84	1.07	1.89	0.00	2.23		0.38	0.32
2001	0.84	1.07	2.80	0.00	2.57		0.38	0.32
2002	0.63	0.81	3.26	0.00	3.02		0.38	0.32
2003	0.63	0.81	3.52	0.00	3.46		0.38	0.32
2004	0.63	0.81	3.70	0.00	4.03		0.38	0.32
2005	0.63	0.81	4.33	0.00	3.46		0.38	0.32
2006	1.04	1.20	4.60	0.00	5.14		0.38	0.32
2007	1.02	1.07	4.51	0.00	4.92		0.38	0.32
2008	1.04	0.95	4.69	0.00	5.14		0.38	0.32
2009	1.08	1.25	4.59	0.00	4.55		0.38	0.32
2010	0.94	1.07	4.13	0.00	5.00		0.38	0.32

Table 6.20 (continued) Emission factors [kg CH_4/head/year] used for calculation of methane emissions from Manure management, in the 1989-2010 period

Year	**Emission Factors [kg CH_4/head/year]**

	Other sheep	Goats	Female goats for milk and females by first mount	Other goats	Horses	Poultry	From which: adult poultry for eggs	Poultry for meat	Mules and asses
1989	0.25		0.46	0.45	1.81		0.01	0.01	2.60
1990	0.25		0.46	0.45	1.81		0.01	0.01	2.60
1991	0.25		0.46	0.45	1.37		0.01	0.01	2.60
1992	0.32		0.46	0.45	1.37		0.00	0.01	2.60
1993	0.39		0.46	0.45	1.37		0.00	0.01	2.60
1994	0.39		0.46	0.45	1.37		0.00	0.00	2.60
1995	0.39		0.46	0.45	1.37		0.00	0.01	2.60
1996	0.39		0.46	0.45	1.37		0.00	0.00	2.60
1997	0.39		0.46	0.45	1.37		0.00	0.00	2.60
1998	0.39		0.46	0.45	1.37		0.00	0.00	2.60
1999	0.39		0.46	0.45	1.37		0.00	0.00	2.60
2000	0.39		0.46	0.45	1.37		0.00	0.00	2.60
2001	0.39		0.46	0.45	1.66		0.00	0.00	2.60
2002	0.39		0.46	0.45	1.66		0.01	0.00	2.60
2003	0.39		0.46	0.45	1.81		0.01	0.00	2.60
2004	0.39		0.46	0.45	1.96		0.01	0.01	2.60
2005	0.39		0.46	0.45	2.26		0.01	0.01	2.60
2006	0.39		0.46	0.45	2.41		0.01	0.01	2.60
2007	0.39		0.46	0.45	2.35		0.01	0.01	2.60
2008	0.39		0.46	0.45	2.26		0.01	0.01	2.60
2009	0.39		0.46	0.45	2.11		0.01	0.01	2.60
2010	0.39		0.46	0.45	1.96		0.01	0.01	2.60

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 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 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 method 2, 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 6.9 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 6.10 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 6.21 depending to manure management system.

Table 6.21 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 6.11 Nitrogen excretion

$$N_{ex} = \text{the amount of solid manure} \cdot 365 \cdot \text{N\% from solid manure} /100 + \text{the amount of liquid manure} \cdot 365 \cdot \text{N\% from liquid manure}/100$$

In the Table 6.22 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 6.22 Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2010 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 6.22 (continued) Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2010 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 6.22 (continued) Data necessary for calculating the rate of excretion of nitrogen, in the 1989-2010 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

In the context of the implementation in 2011 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*“:

- by expert judgment, it is considered that the uncertainty related to the activity data is 10%;
- the uncertainty associated to the emission factor was considered to be 50%, due to the defaults for ASH, the maximum capacity methane production by a certain category of

animal, in a manure management system (Bo) and methane conversion factors for each manure management system (MCF).

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the provisions in Chapter 6 of the IPCC GPG 2000 is 50.99%.

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), 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 1989-2010 is consistent.

N_2O emissions

In the context of the implementation in 2011 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*", by expert judgment, it is considered that the uncertainty related to the activity data is 10%;

According to the IPCC GPG 2000 provisions, the uncertainty associated to the emission factors was considered to be 100%, because uncertainty associated EF_3 is between -50% and +100%, at which add the associated uncertainty of the nitrogen value excreted and management considered systems.

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000 is 101.98%.

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 1989-2010 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.

QA/QC activities were performed 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*“.

Following these activities there were unconformities recorded.

The unconformities noted and solved following these activities 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.

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.

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 FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.1.

The unconformities noted and solved following the previously specified activities are described at the Improvements list level.

6.3.5 Source-specific recalculations, including changes made in response to the review process

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

CH_4

Methodology

Tier 2 calculation methods were used for all livestock for estimating CH_4 emissions and for 1989-2010 period comparing to the Tier 1 method applied within the v.4.1 2011 NGHGI submission, following the collection/processing/development of enhanced livestock data and national emission factor in the context of implementation in 2011 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*“; the recalculations follow the relevant methodological requirements and previous ERT recommendations.

Emission factors

National emission factors began to be used for calculating the CH_4 emissions associated with 1989-2010 period, comparing to the use of default emission factors, within v.4.1 2011 NGHGI submission, as a result of implementation in 2011 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 considering the relevant methodological requirements and previous ERT recommendations;
The values national emission factors are presented in Chapter 6.3.2.

Activity data

More disaggregated livestock data, in the format the National Institute for Statistics uses to report them to Eurostat, began to be used, for 1989-2010 period, comparing to primary livestock data used within v.4.1 2011 NGHGI submission; the recalculations follow the relevant methodological requirements and previous ERT recommendations.

N_2O

Activity data

National values for the Nitrogen excretion per head of animal per region (N_{ex}) and for percentages of manure N produced in different Animal Waste Management Systems (MS) began to be used for calculating the N_2O emissions, comparing to default data used within v.4.1 2011 NGHGI submission; the recalculations follow the relevant methodological requirements and previous ERT recommendations.

The values national data (N_{ex}) are presented in Chapter 6.3.2.

The implications of all changes made on emission estimates are described in Table 6.23.

Table 6.23 Implication of recalculations on emission estimates

Year	Effects of changes on emission estimates		
	2011 v.4.1 submission – CH_4 emissions [Gg]	2012 v.2.1 submission – CH_4 emissions [Gg]	Difference [%]
1989	53.64	-164.1	53.64
1990	46.86	-147.27	46.86
1991	29.34	-155.48	29.34
1992	22.24	-139.57	22.24
1993	22.00	-120.67	22.00
1994	19.42	-116.57	19.42
1995	19.20	-103.97	19.20
1996	18.86	-106.92	18.86
1997	15.78	-110.39	15.78
1998	15.26	-98.53	15.26
1999	13.65	-88.95	13.65
2000	13.52	-79.64	13.52
2001	17.71	-72.13	17.71
2002	22.70	-73.15	22.70
2003	25.27	-71.49	25.27
2004	26.59	-78.80	26.59
2005	20.08	-87.21	20.08
2006	30.50	-78.95	30.50
2007	26.42	-79.45	26.42
2008	23.77	-77.38	23.77
2009	21.14	-74.63	21.14
2010	53.64	-164.1	53.64

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 2010, CH_4 emissions from Rice Cultivation represented 0.23% of total CH_4 emissions in the Agriculture sector);
- is the smallest source in the Agriculture sector (in 2010, CH_4 emissions from Rice Cultivation as CO_2 equivalent represented 0.11% from Total Agriculture emissions);
- contributed with 0.01% to Total GHG emissions of Romania.

Emissions from rice cultivation are declining since 1989 due to the decrease of rice cultivated area (Figure 6.6). The rice area cultivated with is decreased in 21.6 thousands ha in 1991 by 100 ha in 2003. In 2010 the rice area cultivated is 12.4 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

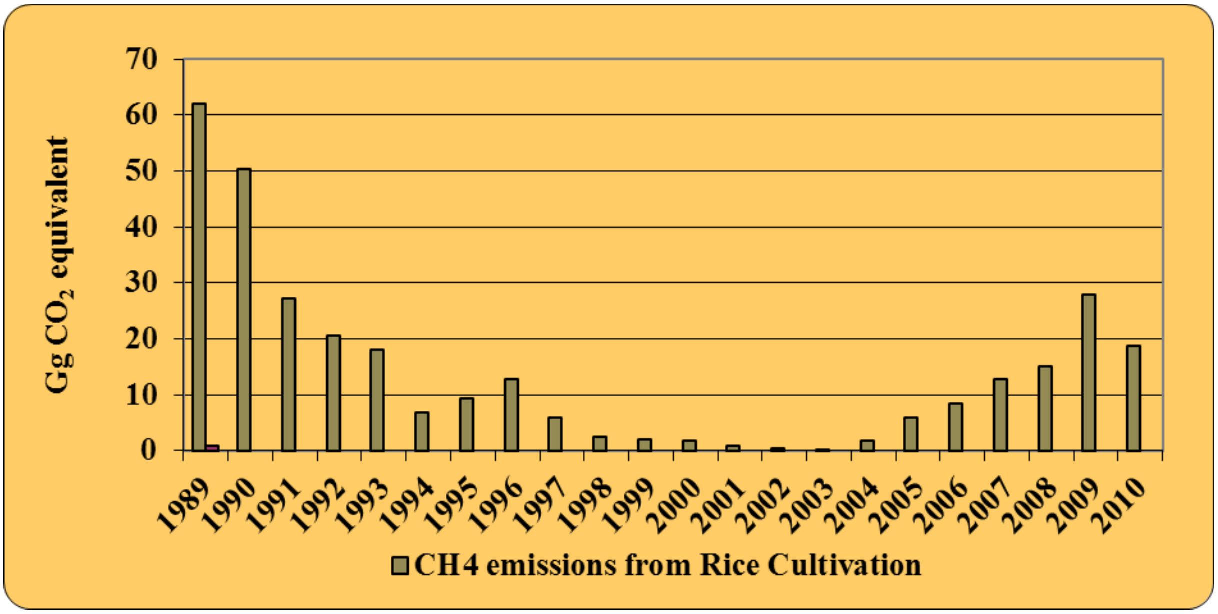


Table 6.24 Observations on source category 4C – "Rice Cultivation"

Source indicative	Source type	Observation	Data source
4C122	Rice harvested area		AD: SY, NIS, 1989-2010; 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 6.12 CH_4 emissions from rice production

$$Emissions\ from\ Rice\ Production\ (Tg/yr) = \Sigma_i \Sigma_j \Sigma_k (EF_{ijk} \bullet A_{ijk} \bullet 10^{-12})$$

where:

- EF_{ijk} = a seasonally integrated emission factor for *i, j*, and *k* conditions, in g CH_4/m^2;
- A_{ijk} = annual harvested area for *i, j*, and *k* conditions, in m^2/yr;
- i, j, and k = represent different ecosystems, water management regimes, and other conditions under which CH_4 emissions from rice may vary (e.g. addition of organic amendments)

Equation 6.13 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 6.25.

Table 6.25 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

Activity data

Total rice cultivated area is provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook 1989-2010.

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 6.26.

Table 6.26 Harvested area data series for 1989-2010

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

6.4.3 Uncertainties and time-series consistency

By expert judgment, due to the lack of national value and considering similar relevant practices in Romania and Hungary, the uncertainty associated to the activity data was considered to be 5%, being collected from the 2010 NGHGI of Hungary.

According to the IPCC GPG 2000 provisions, the uncertainty associated to the emission factors is ± 40%.

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000 is 40.31%.

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 1989-2010 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.

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.

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 FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.1.

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 2010, N_2O Direct soil emissions represented 53.46% of total N_2O emissions in the Agriculture sector);
- is the second source in the Agriculture sector (in 2010, N_2O Direct soil emissions as CO_2 equivalent represented 27.79% from Total Agriculture emissions);
- contributed with 3.83% to Total GHG emissions of Romania.

Pasture, Range and Paddock Manure (4D2)

Pasture, Range and Paddock Manure:

- is the three source of N_2O emissions in the Agriculture sector (in 2010, N_2O emissions from Pasture, Range and Paddock Manure represented 9.47% of total N_2O emissions in the Agriculture sector);
- is the four source in the Agriculture sector (in 2010, N_2O emissions from Pasture, Range and Paddock as CO_2 equivalent represented 4.93% from Total Agriculture emissions);
- contributed with 0.68% to Total GHG emissions of Romania.

Indirect soil emissions (4D3)

Indirect soil emissions:

- is the second source of N_2O emissions in the Agriculture sector (in 2010, N_2O Indirect soil emissions represented 27.59% of total N_2O emissions in the Agriculture sector);
- is the third source in the Agriculture sector (in 2010, N_2O Indirect soil emissions as CO_2 equivalent represented 14.35% from Total Agriculture emissions);
- contributed with 1.98% 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.

According registered in NIS for the 1989-2010, the total area of Romania know a downward trend. This situation as one related to the evolution of agricultural productions, justify the trend downward emissions of greenhouse gases generated by agriculture.

The amount of N_2O emissions from application of synthetic fertilizers have decreased from 11.76 Gg N_2O in 1989, to 5.41 Gg N_2O in 2010.

The quantity of synthetic fertilizer has decreased considerably after the 1989 year from 665,300 tonnes/year to 305,757 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 6.26).

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 1993-2010 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

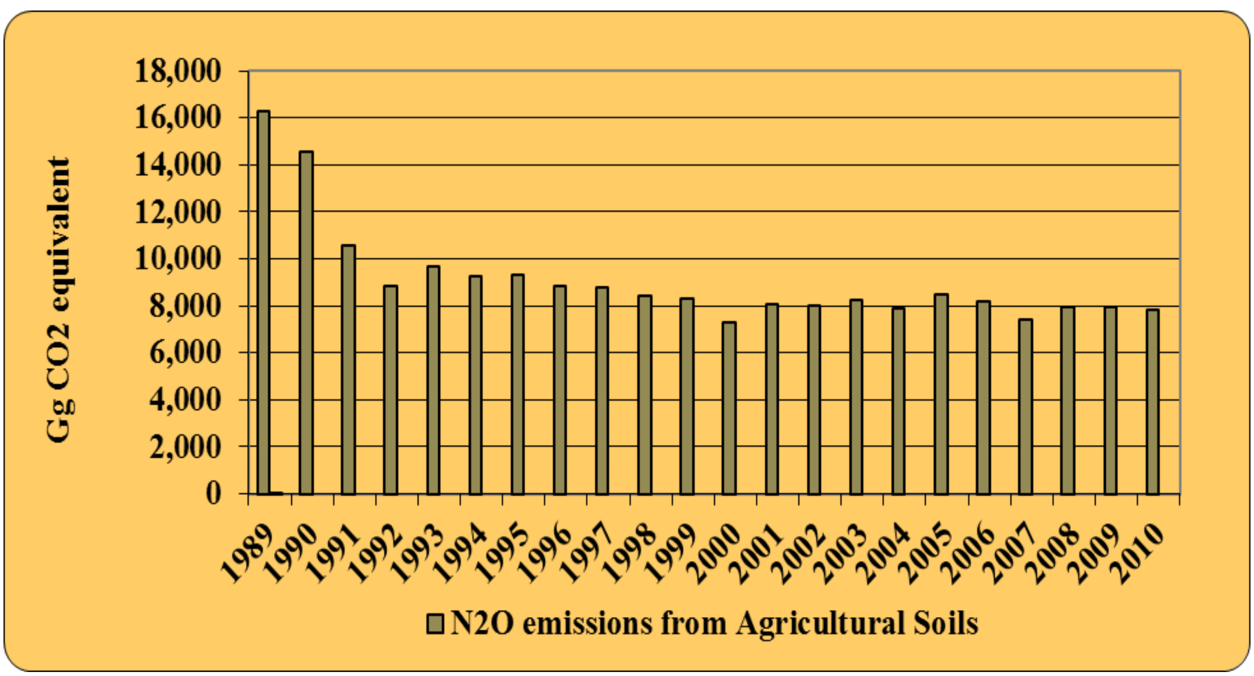


Figure 6.8 N_2O emissions trends – Agricultural Soils

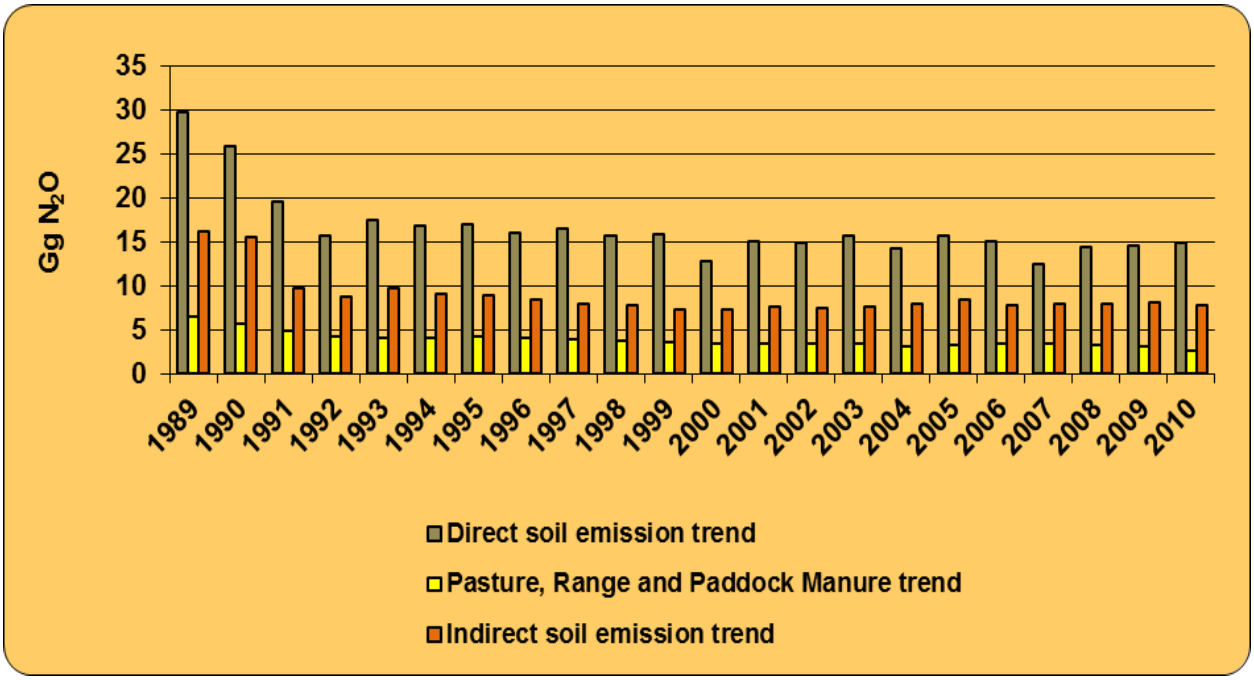


Table 6.27 Observations on source category 4D – "Agricultural Soils"

Source indicative	Source (livestock) type	Observation	Data source
4D11, 4D3	Amount of N synthetic fertilizer used		AD: SY, NIS, 1989-2010; EF: IPCC GPG 2000
4D12, 4D2, 4D3	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, 2004-2010; 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
4D13	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, 1989-2010; 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 6.27 (continued) Observations on source category 4D – "Agricultural Soils"

Source indicative	Source (livestock) type	Observation	Data source
4D14	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, 1989-2010; 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
4D15	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 6.14 Direct N_2O emissions from agricultural soils

$$N_2O_{\ Direct}\text{-}N = [(F_{SN} + F_{AM} + F_{BN} + F_{CR}) \bullet EF_1\ ] + (F_{OS} \bullet EF_2)$$

where:

- ❖ $N_2O_{\ Direct}$ -N = Emission of N_2O in units of Nitrogen;
- ❖ F_{SN} = Annual amount of synthetic fertilizer nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x (kg N/year);
- ❖ F_{AM} = Annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilizes as NH_3 and NOx (kg N/year);
- ❖ F_{BN} = Amount of nitrogen fixed by N-fixing crops cultivated annually (kg N/year);
- ❖ F_{CR} = Amount of nitrogen in crop residues returned to soils annually (kg N/year);
- ❖ F_{OS} = Area of organic soils cultivated annually (ha);
- ❖ EF_1 = Emission factor for emissions from N inputs (kg N_2O-N/kg N input);
- ❖ EF_2 = Emission factor for emissions from organic soil cultivation (kg N_2O-N/ha-yr).

The conversion of emissions N_2O-N in the N_2O emissions in the view of reporting was realized for all the parameters, after equation:

Equation 6.15 Conversion of emissions N_2O-N in the N_2O emissions

$$N_2O = N_2O\text{-}N \bullet 44/28$$

For the calculation nitrogen from synthetic fertilizers (F_{SN}) application were used the equation 4.22 from IPCC GPG 2000:

Equation 6.16 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 6.17 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 6.18 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 6.19 N in crop residue returned to soils (Tier 1b)

$$F_{CR} = \Sigma i\ [(Crop_{Oi} \bullet Res_{Oi} / Crop_{Oi} \bullet Frac_{DMi} \bullet Frac_{NCROi}) \bullet (1 - Frac_{BURNi} - Frac_{FUEL\text{-}Cri} - Frac_{CNST\text{-}CRi} - Frac_{FODi})] + \Sigma j\ [(Crop_{BFj} \bullet Res_{BFj}/Crop_{BFj} \bullet Frac_{DMj} \bullet Frac_{NCRBFj}) \bullet (1 - Frac_{BURNj} - Frac_{FUEL\text{-}CRj} - Frac_{CNST\text{-}CRj} - Frac_{FODj})]$$

where:

- F_{CR} = Amount of nitrogen in crop residues returned to soils annually (kg N/year);
- $Crop_{Oi}$ = represents nitrogen unfixed crop type *i* production (kg dry biomass/year);
- Res_{Oi} /$Crop_{Oi}$ = the residue to crop type *i* product mass ratio (fraction);
- $Frac_{DMi}$ = the dry matter content of the type *i* aboveground biomass (fraction);
- $Frac_{NCROi}$ = the nitrogen content of the type *i* aboveground biomass (kg N/ kg of dry biomass);
- $Frac_{BURNi}$ = the fraction of residue burned in the type *i* field before and after harvest (kg N/kg crop-N);

- $Frac_{FUEL-CRi}$ = 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 6.20 Calculation of fraction of livestock nitrogen excreted and deposited onto soil during grazing ($Frac_{PRP}$)

$$Frac_{PRP} = N_{ex}(Pasture\ Range\ and\ Paddock)/N_{ex}$$

where:

- $N_{ex(Pasture\ Range\ and\ Paddock)}$ = nitrogen excretion from Pasture Range and Paddock;
- N_{ex} = nitrogen excretion from all Animal Waste Management Systems.

Emission factors

The calculation methodology took into account IPCC GPG 2000 default emissions factors (Table 4.17 of IPCC GPG 2000):

- EF_1 = 0.0125 (fraction of N-input, kg N_2O-N/kg N);
- EF_2 = 8 (value specific to Middle-Latitude Organic Soils; kg N_2O-N/ha/year).

Activity data

Data used for calculation of the annual amount of synthetic fertilizer nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x (F_{SN})

The amount of synthetic fertilizer applied to soils data are provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook 1989-2010.
Data series are presented in Table 6.28.
Default IPCC GPG 2000 value of $Frac_{GASF}$ used is presented in Table 6.29.

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 6.28.
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 6.29.
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 6.28 Activity data series used for calculation of F_{AM} and F_{SN}, for 1989-2010

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	0.42
1990	656.0	0.40
1991	275.0	0.38
1992	258.0	0.38
1993	346.0	0.39
1994	313.0	0.39
1995	306.0	0.41
1996	268.0	0.40
1997	262.0	0.41
1998	254.0	0.40
1999	225.0	0.40
2000	239.0	0.40
2001	268.0	0.39
2002	239.0	0.39
2003	252.0	0.37
2004	270.0	0.34
2005	299.0	0.35
2006	252.0	0.36
2007	265.0	0.37
2008	279.8	0.36
2009	296.06	0.36
2010	306.0	0.35

Table 6.29 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 1989-2010 and data base. They are presented in Table 6.28.
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 6.30 The primary data on Crop production of nitrogen fixing crop obtained from the NIS, in the 1989-2010 period

Years	Crop production of nitrogen fixing crop (tonnes/year)							
	Peas beans	Dry Bean	Total Leguminous for dry beans	Soy beans	Annual green fodder	Plant used for silage	Total Annual green fodder	Lucerne in equivalent green fodder
1989	98,500	143,600	255,900	303,900	9,705,200	6096600	15,801,800	11,131,700
1990	49,395	57,542	112,116	141,173	6,882,641	7520906	14,403,547	8,057,219
1991	32,292	46,019	79,491	178,593	5,645,816	5390442	11,036,258	9,661,207
1992	33,180	41,184	74,678	126,159	4,077,623	3047204	7,124,827	6,409,569
1993	36,406	48,421	85,232	95,370	3,971,900	3029541	7,001,441	6,879,385
1994	38,091	37,379	76,112	100,078	4,155,947	2335423	6,491,370	6,944,354
1995	54,262	41,769	97,017	107,861	4,127,358	1892078	6,019,436	7,081,202
1996	33,705	42,078	77,016	113,084	3,930,367	2084169	6,014,536	6,984,832
1997	27,263	50,194	78,560	121,148	3,741,430	1602720	5,344,150	7,727,622
1998	24,382	46,856	72,497	200,820	3,773,666	1145649	4,919,315	7,004,112
1999	27,011	47,698	76,755	183,403	4,334,489	1028431	5,362,920	7,737,980
2000	14,159	21,803	36,929	69,473	2,840,370	476958	3,317,328	5,120,710
2001	21,661	36,492	61,174	72,688	3,146,175	579428	3,725,603	6,476,805
2002	20,450	33,592	55,313	145,932	3,816,927	565477	4,382,404	6,887,361
2003	23,497	36,679	60,645	224,908	4,118,584	606706	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

Table 6.30 (continued) The primary data on Crop production of nitrogen fixing crop obtained from the NIS, in the 1989-2010 period

Years	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

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 6.30 (NIS) for the calculation F_{BN} are used the data on Crop production of nitrogen fixing crop presented in the Table 6.31.

The values for *pea beans*, *dry bean*, *soybeans*, *lucerne* and *clover* were used in the primary data table (Table 6.30).

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 6.32 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 6.32, 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 6.31 The data on Crop production of nitrogen fixing crop obtained through the dedicated study (tonnes/year), in the 1989-2010 period

Years	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

Table 6.32 The values used in the calculation F_{BN} ($Res_{BF}/Crop_{BFi}$, $Frac_{DMi}$ and $Frac_{NCRBFi}$), in the 1989-2010 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 6.30 (Chapter 6.5.2).
The primary data on Crop production of nitrogen non-N-fixing crop are provided by NIS through SY 1989-2010 and data base. They are presented in Table 6.33.

Table 6.33 The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2010 period

Years	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

Table 6.33(continued) The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2010 period

Years	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

The table 6.33(continued) The primary data on Crop production of non- nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2010 period

Years	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

The table 6.33(continued) The primary data on Crop production of non - nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2010 period

Years	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

The table 6.33(continued) The primary data on Crop production of non- nitrogen fixing crop obtained from the NIS (tonnes/year), in the 1989-2010 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	9705200	6,096,600	15,801,800	18,057,000
1990	158,554	381,585	3,051,200	6882641	7,520,906	14,403,547	12,963,924
1991	193,047	740,464	3,246,400	5645816	5,390,442	11,036,258	15,228,648
1992	214,880	623,036	3,461,200	4077623	3,047,204	7,124,827	10,989,460
1993	256,907	601,429	3,992,100	3971900	3,029,541	7,001,441	11,758,248
1994	244,890	611,102	3,548,700	4155947	2,335,423	6,491,370	11,669,424
1995	281,339	639,352	3,868,500	4127358	1,892,078	6,019,436	12,209,911
1996	253,148	693,883	3,934,400	3930367	2,084,169	6,014,536	12,088,245
1997	273,629	625,663	3,559,600	3741430	1,602,720	5,344,150	13,301,172
1998	284,708	689,620	3,939,900	3773666	1,145,649	4,919,315	12,331,426
1999	308,408	853,231	4,365,600	4334489	1,028,431	5,362,920	13,509,179
2000	253,853	531,127	3,381,100	2840370	476,958	3,317,328	9,211,951
2001	301,749	550,503	3,848,300	3146175	579,428	3,725,603	11,535,656
2002	303,279	651,317	3,973,400	3816927	565,477	4,382,404	12,469,413
2003	332,795	764,585	4,684,500	4118584	606,706	4,725,290	12,613,904
2004	351,183	765,118	4,773,916	1923528	0	1,923,528	6,608,789
2005	229,569	691,760	3,624,612	2454958	0	2,454,958	10,127,514
2006	292,579	641,791	4,138,862	3182639	0	3,182,639	10,622,291
2007	209,029	407,973	3,116,801	2222483	0	2,222,483	7,330,212
2008	265,999	562,260	3,819,890	2860655	0	2860655	9,273,329
2009	238,748	652,844	3,901,862	2898188	0	2898188	9,461,506
2010	241578	662863	3863617	3041978	0	3041978	9974033

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 6.33 (NIS) were considered the data on Crop production of non - nitrogen fixing crop presented in the Table 6.34.

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 6.31 (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 6.33).

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*.

Table 6.34 The data on Crop production of non-nitrogen fixing crop obtained through the dedicated study (tonnes/year), in the 1989-2010 period

Years	Productions of non-N-fixing crops (tonnes/year)							
	Rye	Wheat	Barley and two-row barley	Oats	Maize grains	Sorghum	Rice	Other cereals
1989	89,678	7,845,522	3,436,300	167,800	6,761,800	7,600	70,100	500
1990	89,678	7,289,344	2,679,558	234,025	6,809,604	3,500	66,460	1,370
1991	85,753	5,473,156	2,950,698	258,160	10,497,338	6,004	31,449	4,063
1992	21,232	3,206,382	1,677,956	507,733	6,828,270	4,532	38,920	3,427
1993	40,409	5,314,104	1,552,793	553,577	7,987,450	5,481	36,448	2,812
1994	51,201	6,135,299	2,133,563	496,803	9,343,224	7,128	15,229	1,330
1995	42,728	7,666,538	1,816,267	404,428	9,923,132	4,408	24,066	1,260
1996	20,240	3,143,818	1,107,547	290,505	9,607,944	4,295	23,100	2,239
1997	29,413	7,156,188	1,889,343	325,389	12,686,700	4,776	10,669	1,165
1998	26,088	5,181,823	1,238,001	362,137	8,623,370	11,369	5,142	1,354
1999	21,092	4,661,439	1,018,586	389,556	10,934,815	2,535	3,813	1,876
2000	21,802	4,434,438	867,018	243,830	4,897,603	1,479	3,551	354
2001	28,631	7,735,136	1,580,048	382,354	9,119,194	5,584	1,459	1,465
2002	20,079	4,420,995	1,160,387	327,444	8,399,779	2,557	597	1,660
2003	17,358	2,479,052	540,849	323,060	9,576,985	4,991	253	2,383
2004	55,000	7,812,428	1,405,996	447,079	14,541,564	28,374	4,963	6,604
2005	48,962	7,340,664	1,079,148	377,456	10,388,499	1,912	14,251	430
2006	35,720	5,526,190	772,929	346,918	8,984,729	1,331	18,420	1,802
2007	20,583	3,044,465	531,420	251,633	3,853,918	1,193	27,518	2,327
2008	31,446	7,180,984	1,209,411	382,030	7,849,083	20,899	48,917	2,853
2009	32,959	5,202,526	1,182,062	295,832	7,973,258	14,440	72,418	2,206
2010	34,281	5,811,810	1,311,035	304,462	9,042,032	18,677	61,588	5,878

Table 6.34 (continued) The data on Crop production of non-nitrogen fixing crop obtained through the dedicated study (tonnes/year), in the 1989-2010 period

Years	Productions of non-N-fixing crops (tonnes/year)							
	Rape	Sunflower	Flax for oil	Other oilseed plants - castor	In fiber-textile plants	Hemp for fiber-Plant textiles	Other textile plants-cotton	Tobacco
1989	18,000	655,800	48,900	7,700	127,200	113,900	484	27,500
1990	10,860	556,242	28,040	3,004	53,192	72,105	484	14,168
1991	8,764	611,956	22,766	1,296	15,438	58,345	200	13,919
1992	1,372	773,986	17,877	901	25,648	38,554	75	7,574
1993	1,355	695,833	28,036	192	7,237	7,433	0	10,503
1994	322	763,697	6,457	3,539	4,821	4,492	40	12,993
1995	357	932,932	4,744	9,477	7,246	5,862	21	13,358
1996	1,867	1,095,596	4,517	3,661	4,108	12,953	0	12,092
1997	11,646	858,060	4,758	6,233	1,884	9,590	0	18,119
1998	28,742	1,073,316	3,019	11,670	735	11,137	0	17,536
1999	108,221	1,300,929	2,773	11,316	690	7,343	0	14,754
2000	76,126	720,871	994	1,067	881	1,398	0	10,869
2001	101,789	823,549	1,985	5,530	388	2,769	0	10,088
2002	35,906	1,002,813	1,760	8,095	794	5,586	0	15,979
2003	8,080	1,506,398	1,498	19,552	710	3,163	0	7,862
2004	98,661	1,557,813	2,465	37,611	1,060	1,868	0	7,471
2005	147,566	1,340,940	55	1,738	538	4,698	0	3,682
2006	175,050	1,526,232	321	3,576	1,522	2,415	0	1,686
2007	361,500	546,922	394	1,648	72	479	0	1,128
2008	673,033	1,169,936	221	8,520	96	181	0	2,366
2009	569,611	1,098,047	1,099	11,022	0	2	0	1,566
2010	943,033	1,262,926	1,817	19,935	0	45	0	2,971

Table 6.34 (continued) The data on Crop production of non- nitrogen fixing crop obtained through the dedicated study (tonnes/year), in the 1989-2010 period

Years	Productions of non-N-fixing crops (tonnes/year)							
	Hop	Medicinal aromatic plants/ spices grown	Other industrial crops- sorghum for brooms	Potatoes	Sugar beet	Fodder roots	Tomatoes	Eggplant
1989	2,451	33,300	12,656	4,420,300	6,771,100	4,094,200	1,011,300	0
1990	2,451	20,459	6,505	3,185,624	3,277,705	2,575,013	813,561	51,951
1991	2,626	20,867	6,001	1,872,767	4,702,693	2,139,294	692,828	39,902
1992	2,638	21,517	9,272	2,601,648	2,896,691	1,343,408	830,980	59,659
1993	2,470	12,092	6,517	3,708,903	1,776,327	1,465,107	798,859	72,898
1994	1,559	6,257	7,387	2,946,721	2,763,783	1,245,305	716,354	73,759
1995	1,823	12,114	11,156	3,019,921	2,654,610	1,332,449	730,945	88,506
1996	1,455	6,565	9,875	3,591,378	2,848,169	1,301,142	689,325	90,360
1997	534	9,200	7,913	3,206,058	2,725,512	1,247,927	463,294	78,984
1998	206	19,876	9,155	3,319,150	2,361,359	1,119,479	677,517	91,180
1999	184	5,191	10,007	3,957,115	1,414,928	1,174,612	708,616	119,008
2000	142	1,397	6,300	3,469,805	666,870	800,587	628,675	94,823
2001	155	6,463	7,803	3,997,057	875,485	1,035,203	651,733	112,192
2002	142	5,351	7,342	4,077,633	954,630	1,042,467	658,777	121,576
2003	209	5,404	7,097	3,947,177	764,475	985,637	818,936	131,030
2004	37	9,240	11,813	4,230,210	672,723	280,348	1,330,085	149,681
2005	194	3,297	6,712	3,738,594	729,658	711,939	626,960	97,902
2006	435	16,969	8,716	4,015,899	1,152,200	776,951	834,968	101,159
2007	374	2,857	5,437	3,712,410	748,839	594,956	640,785	63,716
2008	257	7,488	3,170	3,649,020	706,660	756,292	814,376	153,677
2009	245	7,063	6,006	4,003,980	816,814	567,499	755,596	168,588
2010	232	15,828	5,392	3,283,866	837,895	489,740	768,532	144,391

Table 6.34 (continued) The data on Crop production of non-nitrogen fixing crop obtained through the dedicated study (tonnes/year), in the 1989-2010 period

Years	Productions of non-N-fixing crops (tonnes/year)							
	Dry onion	Dry garlic	Cabbage	Green peppers	Cultivated mushrooms	Root vegetables – Edible roots	Water melons and melons	Other vegetables
1989	412,700	46,600	877,300	253,300	0	251,900	215,700	1,126,800
1990	225,440	30,611	551,914	182,033	0	158,554	381,585	655,551
1991	218,525	32,210	616,530	166,840	0	193,047	740,464	546,054
1992	339,266	43,537	676,197	181,660	901	214,880	623,036	491,084
1993	344,013	48,931	853,948	176,287	638	256,907	601,429	838,190
1994	310,938	56,387	711,335	163,154	570	244,890	611,102	660,211
1995	362,969	69,476	824,412	195,648	600	281,339	639,352	675,253
1996	305,610	54,108	857,435	186,575	587	253,148	693,883	803,369
1997	337,015	63,341	761,183	167,375	401	273,629	625,663	788,715
1998	365,162	71,960	837,824	191,376	176	284,708	689,620	730,377
1999	401,057	84,542	885,407	212,294	34	308,408	853,231	793,003
2000	296,297	68,338	731,897	174,836	3	253,853	531,127	601,251
2001	396,527	82,901	819,184	184,815	2	301,749	550,503	748,694
2002	340,784	72,423	821,419	197,442	5	303,279	651,317	806,378
2003	350,400	76,523	1,019,234	248,732	80	332,795	764,585	942,185
2004	332,827	65,884	919,092	237,240	7,050	351,183	765,118	615,756
2005	363,625	68,374	1,009,430	203,751	563	229,569	691,760	332,678
2006	390,694	64,222	1,106,006	279,126	2,559	292,579	641,791	425,758
2007	324,993	49,948	893,153	184,939	1,083	209,029	407,973	341,182
2008	395,579	72,333	964,625	238,682	1,664	265,999	562,260	350,695
2009	378,106	63,245	1,001,940	245,661	7,317	238,748	652,844	389,817
2010	369,142	67,215	981,219	243,493	9,973	241,578	662,863	375,211

Table 6.34 (continued) The data on Crop production of non-nitrogen fixing crop obtained through the dedicated study (tonnes/year), in the 1989-2010 period

Years	Productions of non-N-fixing crops (tonnes/year)	
	Annual grasses	Other perennial grasses
1989	11,061,260	2,392,920
1990	10,082,483	1,788,421
1991	7,725,381	2,107,867
1992	4,987,379	1,672,394
1993	4,901,009	1,734,458
1994	4,543,959	1,599,469
1995	4,213,605	1,657,016
1996	4,210,175	1,621,706
1997	3,740,905	1,708,885
1998	3,443,521	1,617,170
1999	3,754,044	1,744,850
2000	2,322,130	1,243,691
2001	2,607,922	1,538,598
2002	3,067,683	1,828,442
2003	3,307,703	1,773,072
2004	1,346,470	652,277
2005	1,718,471	1,350,944
2006	2,227,847	1,476,962
2007	1,555,738	1,020,002
2008	2,002,459	1,209,630
2009	2,028,732	1,219,445
2010	2,129,385	1,334,996

$Res_O/Crop_O$

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 1989-2010, 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 1989-2010 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 6.35 are presented the values used in the calculation F_{CR} (kg N/year).

Table 6.35 The values used in the calculation F_{CR} (kg N/year) of non-nitrogen fixing crop, in the 1989-2010

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 6.35(continued) The values used in the calculation F_{CR} (kg N/year) ***of non-nitrogen fixing crop, in the 1989-2010***

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 6.35 (continued) The values used in the calculation F_{CR} (kg N/year) ***of non-nitrogen fixing crop, in the 1989-2010 period***

Parameters	Other industrial crops	Total potatoes	Sugar beet	Fodder roots	Tomatoes	Eggplant	Dry onion	Dry garlic	Cabbage
$Res_O/Crop_O$	1.4	0.33	0.3	0	0.3	0.3	0.3	0.3	0.2
$Frac_{DM}$	0.91	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
$Frac_{NCRO}$	0.0108	0.011	0.0228	0.0228	0.015	0.015	0.015	0.015	0.015
$Frac_{BURN}$	0.1	0.1	0	0	0	0	0	0	0
$Frac_{FUEL-CR}$	0	0	0	0	0	0	0	0	0
$Frac_{CNST-CR}$	0.1	0	0	0	0	0	0	0	0
$Frac_{FOD}$	0	0	0.4	0	0	0	0	0	0

Table 6.35 (continued) The values used in the calculation F_{CR} (kg N/year) ***of non-nitrogen fixing crop, in the 1989-2010 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 6.35 (continued) The values used in the calculation F_{CR} (kg N/year) ***of nitrogen fixing crop, in the 1989-2010 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 6.21 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 6.22 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 6.23 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 6.24 Deposited N from Leaching/Runoff (Expanded for major animal species/categories)

$$N_2O(_{L\text{-}SOIL})\text{-}N = \{N_{FERT} + \Sigma_i\,(N_{(EX)i} \bullet [1 - (Frac_{\ (FUEL\text{-}AM)i} + Frac_{(FEED\text{-}AM)i} + Frac_{(CNST\text{-}AM)i}\ )] + N_{SEWSLUDGE}\} \bullet Frac_{LEACH} \bullet EF_5$$

where:

- $N_2O(_{L\text{-}SOIL})$-N = Deposited N from Leaching/Runoff;
- $N_{FERT\ =}$ amount of N fertilizer applied (kg N /year);
- $N_{ex(T)}$ = Annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);
- $Frac_{FUEL\text{-}AM}$ = fraction of animal manure used as fuel (kg N/kg N totally excreted);
- $Frac_{FEED\text{-}AM}$ = fraction of animal manure used as feed (kg N/kg N totally excreted);

- $Frac_{CNST-AM}$ = 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

In the context of the implementation in 2011 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“,* by expert judgment, it is considered that the uncertainty related to the activity data is 20%.

According to the IPCC GPG 2000 provisions, the uncertainty associated to the emission factors is the uncertainty associated to the emission factor was considered to be 80%, since values could not be used for national emission factors on the parameters, and due the use of an results from the estimating values made of expert based on bibliographic data and not resulting from statistical analysis of dataset collected from field.

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000 is 101.98%.

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 1989-2010 is consistent.

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the provisions in Chapter 6 of the IPCC GPG 2000 is 82.46%.

Pasture, Range and Paddock Manure emissions

In the context of the implementation in 2011 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“,* by expert judgment, it is considered that the uncertainty related to the activity data is 20%.

According to the IPCC GPG 2000 provisions, the uncertainty associated to the emission factors is 100 %.

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000 is 101.98%.

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 1989-2010 is consistent.

Indirect soil emissions

In the context of the implementation in 2011 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“,* by expert judgment, it is considered that the uncertainty related to the activity data is 30%.

According to the IPCC GPG 2000 provisions, the uncertainty associated to the emission factors is ±50 %.

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000 is

58.31%.

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 1989-2010 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.

Following these activities there were unconformities recorded.

The unconformities noted and solved following these activities 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.

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.

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 FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.1.

The unconformities noted and solved following the previously specified activities are described at the Improvements list level.

6.5.5 Source-specific recalculations, including changes made in response to the review process

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

Agricultural soils (4D)

Methodology

- Tier 1b calculation method began to be used for estimating N_2O emissions and for 1989-2010 period comparing to the Tier 1 method applied within the v.4.1 2011 NGHGI submission;
- A combination of national and default values for the fractions associated with the manure in the context of using a Tier 1b method was used for 1989-2010 period comparing to the Tier 1 method applied within the v.4.1 2011 NGHGI submission;
- A combination of national and default values for the fractions associated with the crop productions in the context of using a Tier 1b method was used for 1989-2010 period comparing to the Tier 1 method applied within the v.4.1 2011 NGHGI submission;

Activity data

- More disaggregated livestock data, in the format the National Institute for Statistics uses to report them to Eurostat, began to be used, for 1989-2010 period comparing to primary livestock data used within v.4.1 2011 NGHGI submission; the recalculations follow the relevant methodological requirements and previous ERT recommendations;
- National values for the Nitrogen excretion per head of animal per region (N_{ex}) and for percentages of manure N produced in different Animal Waste Management Systems (MS) began to be used for calculating the N_2O emissions, for 1989-2010 period comparing to default data used within v.4.1 2011 NGHGI submission; the recalculations follow the

relevant methodological requirements and previous ERT recommendations. The values national data (Nex) are presented in Chapter 6.3.2.

- New information/data on crop productions were considered for the 1989-2010 period comparing to data used within v.4.1 2011 NGHGI submission; the recalculations follow the relevant methodological requirements and previous ERT recommendations.
- New data/information on annual cultivated organic soils areas have been provided through a dedicated study; the recalculation is relevant to the 1989-2010 time series, comparing to data used within v.4.1 2011 NGHGI submission;

The details are provided in Chapter 6.5.2.

All the changes made at the activity data level and their implications on emission estimates are described in Table 6.36.

Cultivation of Histosol

Activity data

New data/information on annual cultivated organic soil areas have been provided through a dedicated study.

Table 6.36 Implication of recalculations on emission estimates

Year	*Implication of recalculations on emission estimates*		
	2011 v.4.1 submission – N_2O emissions [Gg]	2012 v.2.1 submission – N_2O emissions [Gg]	Difference [%]
1989	96.85	52.48	-44.37
1990	83.52	47.06	-36.46
1991	72.49	34.17	-38.32
1992	60.05	28.52	-31.53
1993	61.08	31.25	-29.83
1994	59.21	29.78	-29.43
1995	58.58	30.11	-28.47
1996	56.10	28.49	-27.61
1997	58.53	28.39	-30.14
1998	53.62	27.25	-26.37
1999	53.35	26.75	-26.60
2000	43.40	23.49	-19.91
2001	49.45	25.96	-23.49
2002	51.41	25.80	-25.61
2003	52.39	26.56	-25.83
2004	46.96	25.37	-21.59
2005	52.04	27.43	-24.61
2006	51.35	26.33	-25.02
2007	43.88	23.84	-20.04
2008	49.91	25.59	-24.32
2009	49.85	25.70	-24.15
2010		25.32	

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 2010 are lower than emissions in 1989 with 15.17 Gg CO_2 equivalent, due to 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

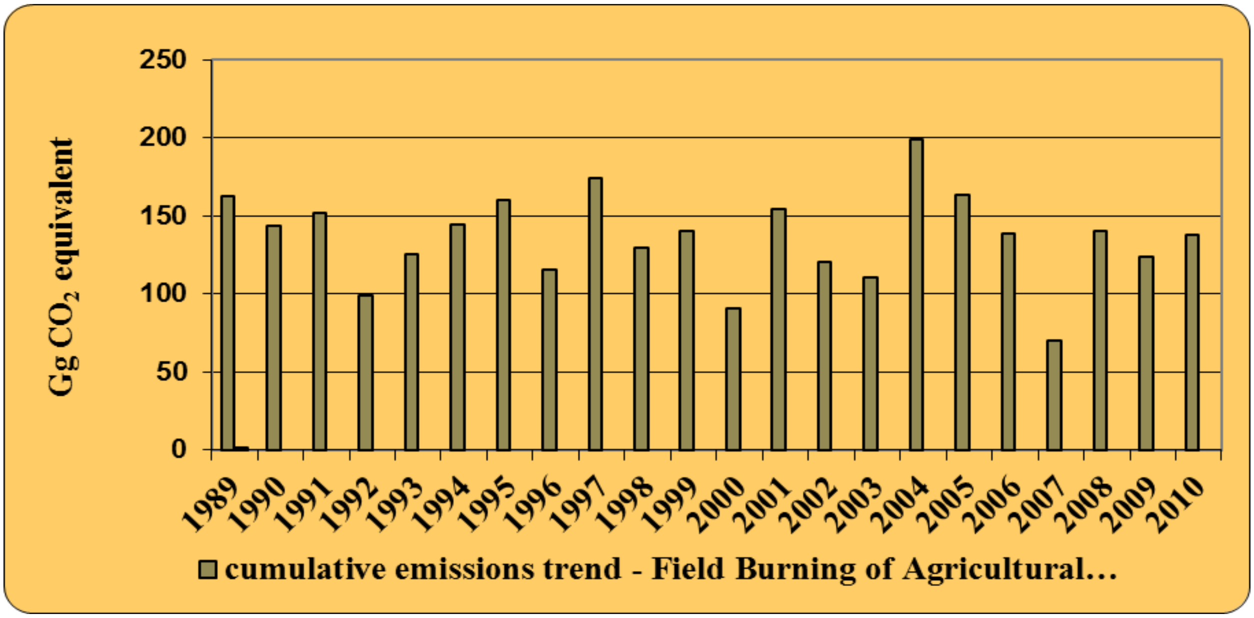


Table 6.37 Observations on source category 4F – "Field Burning of Agricultural Residues"

Source indicative	**Source (livestock) type**	**Observation**	**Data source**
4F	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, 1989-2010;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 6.25 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 6.38.

Table 6.38 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 6.39.

Table 6.39 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

According to the IPCC GPG 2000 provisions, the uncertainty associated to the emission factors is 20 %.
By expert judgment, due to the lack of a national value and considering the similarities between activity data associated to the Direct N_2O emissions from agricultural soils category, a value of 20% as uncertainty associated to the activity data and specific to the previously mentioned category was used.

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000 is 28.28%.

N_2O emissions

According to the IPCC GPG 2000 provisions, the uncertainty associated to the emission factors is 20 %.
By expert judgment, due to the lack of a national value and considering the similarities between activity data associated to the Direct N2O emissions from agricultural soils category, a value of 20% as uncertainty associated to the activity data and specific to the previously mentioned category was used.

The overall uncertainty resulted after the aggregation of the activity data and of the emission factors uncertainties according to the equation 6.4 in Chapter 6 of the IPCC GPG 2000 is 28.28%.

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 1989-2010 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.

QA/QC activities were performed 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".*

Following these activities there were unconformities recorded.

The unconformities noted and solved following these activities are described in the Chapter 6.7.5 – 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 6.7.5 – 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.

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 FAO and Eurostat, the data being reported at the same level of aggregation and the figures comparable. Further elements are presented within Annex 8.1.

The unconformities noted and solved following the previously specified activities are described at the Improvements list level.

6.7.5 Source-specific recalculations, including changes made in response to the review process

Activity data

- New information/data on crop productions were considered.
- A combination of national and default values for the fractions associated with the crop productions was used.

Detailed information is provided in Section 6.5.2.

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 61.4% of Romania's total national area. Forests cover 28.3% 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, 2009 and 2010

IPCC Subcategories	Emission ("+") / removal ("-"), in GgCO$_2$eq		
	(BY) 1989	**2009**	**2010**
5A1. Forest land remaining Forest Land	-18863.26	-22056.32	-21407.44
5A2. Land converted to Forest Land	-229.26	-2093.14	-2477.73
5B1. Cropland remaining Cropland	-5711.07	-4303.16	-2231.96
5B2. Land converted to Cropland	-17.30	43.37	18.26
5C1. Grassland remaining Grassland	NO	NO	NO
5C2. Land converted to Grassland	-654.32	112.30	130.26
5D1. Wetlands remaining Wetlands	NO	NO	NO
5D2. Land converted to Wetlands	-214.50	-45.38	-127.78
5E1. Settlements remaining Settlements	NO	NO	NO
5E2. Land converted to Settlements	4125.22	384.04	419.62
5F1. Other land remaining Other Land	NO	NO	NO

IPCC Subcategories	**Emission (“+”) / removal (“-“), in $GgCO_2eq$**		
	(BY) 1989	**2009**	**2010**
5F2. Land converted to Other Land	-29.70	648.07	782.43
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	<0.00	<0.00	<0.00
Table IV. CO_2 emissions from agricultural lime application	44.54	33.75	25.59
Table V. Biomass Burning	1.32	29.20	6.16

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 1989-2010 ("-"CO_2 removal, "+" GHG emission, in GgCO_2 eq)

Reported year	Total GHGs	CO_2	CH_4	N_2O	NOx	CO
BY (1989)	-21441.12	-21441.11894	<0.00	<0.00	NA,NE	NA,NE
1990	-27282.37	-27282.39646	<0.00	<0.00	NA,NE	NA,NE
1991	-27906.68	-27906.69184	<0.00	<0.00	NA,NE	NA,NE
1992	-30592.41	-30592.45031	<0.00	<0.00	NA,NE	NA,NE
1993	-29869.78	-29869.81037	<0.00	<0.00	NA,NE	NA,NE
1994	-28582.43	-28582.44249	<0.00	<0.00	NA,NE	NA,NE
1995	-27119.92	-27119.92885	<0.00	<0.00	NA,NE	NA,NE
1996	-27115.38	-27115.38901	<0.00	<0.00	NA,NE	NA,NE
1997	-28558.28	-28558.2822	<0.00	<0.00	NA,NE	NA,NE
1998	-28231.39	-28231.40032	<0.00	<0.00	NA,NE	NA,NE
1999	-28604.28	-28604.29996	<0.00	<0.00	NA,NE	NA,NE
2000	-29147.93	-29148.12057	<0.00	<0.00	NA,NE	NA,NE
2001	-28945.71	-28945.76397	<0.00	<0.00	NA,NE	NA,NE
2002	-22297.80	-22297.98715	<0.00	<0.00	NA,NE	NA,NE
2003	-16327.89	-16327.92919	<0.00	<0.00	NA,NE	NA,NE
2004	-22873.55	-22873.55498	<0.00	<0.00	NA,NE	NA,NE
2005	-27998.10	-27998.11409	<0.00	<0.00	NA,NE	NA,NE
2006	-27819.33	-27819.38539	<0.00	<0.00	NA,NE	NA,NE
2007	-25200.35	-25200.50696	<0.00	<0.00	NA,NE	NA,NE
2008	-24298.20	-24298.24803	<0.00	<0.00	NA,NE	NA,NE
2009	-28264.07	-28264.11927	<0.00	<0.00	NA,NE	NA,NE
2010	-25782.42	-25782.43445	<0.00	<0.00	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			
5A1. 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		
5A2. 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		
5A2.2 Grassland converted to Forest Land			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5A2.3 Wetlands converted to Forest Land			
Living biomass	R		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5A2.4 Settlements converted to Forest Land			
Living biomass	NO		

GHG source and sink categories	CO_2	CH_4	N_2O
DOM	R		
SOMmin	NO		
SOMorg	NO		
5A2.4 Other Land converted to Forest Land			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5.B Cropland			
5B1. Cropland remaining Cropland	**R**	**NO**	**NO**
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	R		
5B2 Land converted to Cropland	**R**	**NO**	**R**
5B2.1 Forest Land converted to Cropland			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5B2.2 Grassland converted to Cropland			
Living biomass	R		
DOM	R		
SOMmin	R		
SOMorg	NO		
5B2.3 Wetlands converted to Cropland			
Living biomass	R		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5B2.4 Settlements converted to Cropland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5B2.5 Other Land converted to Cropland			
Living biomass	NO		

GHG source and sink categories	CO_2	CH_4	N_2O
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.C Grassland			
5C1. Grassland remaining Grassland	**NO**	**NO**	**NO**
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5C2. Land converted to Grassland	**R**	**NO**	**NO**
5C2.1 Forest Land converted to Grassland			
Living biomass	NO		
DOM	R		
SOMmin	R		
SOMorg	NO		
5C2.2 Cropland converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5C2.3 Wetlands converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	NO		
SOMorg	NO		
5C2.4 Settlements converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5C2.5 Other Land converted to Grassland			
Living biomass	NO		
DOM	NO		
SOMmin	R		
SOMorg	NO		
5.D Wetlands			
5D1. Wetlands remaining Wetlands	**NO**	**NO**	**NO**

GHG source and sink categories	CO_2	CH_4	N_2O
Living biomass	NO		
DOM	NO		
SOM	NO		
5D2. Land converted to Wetlands	**R**	**NO**	**NO**
5D2.1 Forest Land converted to Wetlands			
Living biomass	R		
DOM	R		
SOM	R		
5D2.2 Cropland converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	R		
5D2.3 Grasslands converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	NO		
5D2.4 Settlements converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	NO		
5D2.5 Other Land converted to Wetlands			
Living biomass	NO		
DOM	NO		
SOM	R		
5.E Settlements			
5E1. Settlements remaining Settlements	**NO**	**NE**	**NE**
Living biomass	NO		
DOM	NO		
SOM	NO		
5E2 Land converted to Settlements	**R**	**NE**	**NE**
5E2.1 Forest Land converted to Settlements			
Living biomass	R		
DOM	R		
SOM	R		
5E2.2 Cropland converted to Settlements			
Living biomass	NO		
DOM	NO		

GHG source and sink categories	CO_2	CH_4	N_2O
SOM	R		
5E2.3 Grassland converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5E2.4 Wetlands converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5E2.5 Other Land converted to Settlements			
Living biomass	NO		
DOM	NO		
SOM	R		
5.F Other Land			
5F1. Other Land remaining Other Land			
5F2. Land converted to Other Land	**R**	**NE**	**NE**
5F2.1 Forest Land converted to Other Land			
Living biomass	R		
DOM	R		
SOM	R		
5F2.2 Cropland converted to Other Land			
Living biomass	NO		
DOM	NO		
SOM	R		
5F2.3 Grassland converted to Other Land			
Living biomass	R		
DOM	NO		
SOM	R		
5F2.4 Wetlands converted to Other Land			
Living biomass	NO		
DOM	NO		
SOM	R		
5F2.5 Settlements converted to Other Land			
Living biomass	NO		
DOM	NO		
SOM	R		
5.G Other	**NA**		

GHG source and sink categories	**CO_2**	**CH_4**	**N_2O**
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

The LULUCF sink has 33% less compared to earlier version of the national GHG inventory. This is due to major re-calculation in particular for Forest Land remaining Forest Land.

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	This category includes all lands, regardless of the category of use,

NIS datasets / IPCC land category	National land definitions
and railways land/ Settlements	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)

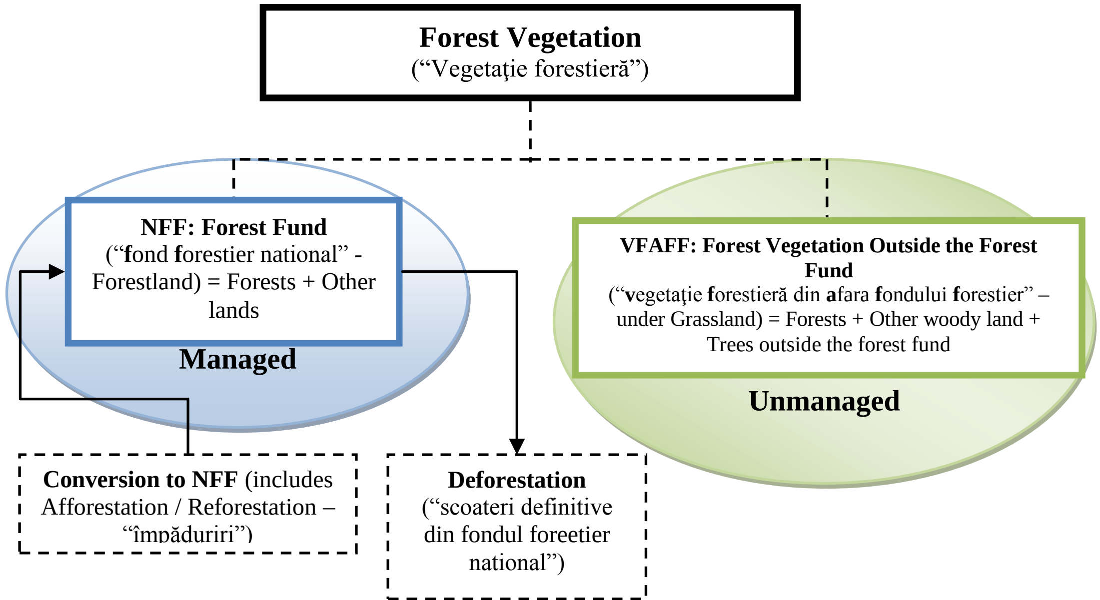
NIS, the national statistics provides data on two types of land covered by forest vegetation:

i. "National forest fund" includes lands under forest management planning. 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); and,
ii. "Forest vegetation outside the national forest fund", comprises areas with forest vegetation not included under forest management planning and where specific rules are applied only on the harvesting and transport of wood by forest landowners.

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 7.1 shows how the forest vegetation land is split into the NIS/IPCC land categories.

Figure 7.1 Forest vegetation definitions and land categories data.



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 (inputs / outputs from the forestry fund) operated into the management plans, including changes from "forest" to "other lands" within the national forest fund.

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.

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.

The complete land conversion matrix over 1989-2010 is presented in below *Table 7.5*.

Table 7.5 Land area matrix 1989–2010

1989	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	**9458.0**	0.0	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0
Pastures	0.0	**2996.0**	0.0	0.0	0.0	0.6	3.0	0.0	0.0	0.0	0.0
Hayfields	0.0	0.0	**1401.5**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vineyards	0.0	0.0	0.0	**268.1**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orchards	0.0	14.3	0.0	0.0	**317.5**	0.0	0.0	0.0	0.0	0.0	0.0
VFAFF	0.0	0.0	0.0	0.0	0.0	**431.0**	0.0	0.0	0.0	0.0	0.0
FF	0.0	0.0	0.0	0.0	0.0	0.0	**6237.1**	14.0	0.0	0.0	0.0
Constr.	2.0	84.6	0.0	0.0	0.0	0.0	0.0	**522.4**	0.0	0.0	18.0
Roads/railways	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	**366.9**	0.0	0.0
Waters/ponds	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**780.0**	0.0
Other lands	0.0	137.7	46.5	9.0	0.0	0.0	0.0	90.6	20.0	130.0	**454.7**
1990	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	**9448.4**	6.0	2.4	0.3	0.0	0.0	12.9	0.0	0.0	0.0	0.0
Pastures	0.0	**2994.3**	0.0	0.0	0.0	2.1	3.2	0.0	0.0	0.0	0.0
Hayfields	0.0	0.0	**1401.5**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vineyards	0.0	0.0	0.0	**268.1**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orchards	0.0	14.3	4.1	0.0	**313.4**	0.0	0.0	0.0	0.1	0.0	0.0

VFAFF	0.0	0.0	0.0	0.0	0.0	**431.0**	0.0	0.0	0.0	0.0	0.0
FF	0.0	0.0	0.0	0.0	0.0	0.0	**6236.2**	14.3	0.0	0.0	0.5
Constr.	2.0	84.6	3.3	0.0	0.0	0.0	0.0	**517.4**	0.0	0.0	19.7
Roads/railways	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	**366.9**	0.0	0.0
Waters/ponds	0.0	3.7	7.6	0.0	0.0	0.0	0.0	0.0	0.0	**772.4**	0.0
Other lands	0.0	139.7	46.5	9.0	0.0	0.0	0.0	90.6	22.0	131.2	**449.7**
1995	Arable	Pastures	Hayfields	ds	s	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	**9335.1**	65.1	21.4	25.8	0.0	0.0	15.0	6.8	0.8	0.0	0.0
Pastures	0.0	**2992.1**	0.0	0.0	0.0	3.1	3.8	0.0	0.3	0.0	0.4
Hayfields	0.0	0.2	**1401.2**	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Vineyards	0.0	11.5	0.0	**256.5**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orchards	0.0	46.0	7.4	0.7	**277.6**	0.0	0.0	0.0	0.1	0.0	0.0
VFAFF	0.0	5.7	0.0	0.0	0.0	**424.0**	0.5	0.0	0.0	0.8	0.0
FF	0.0	0.0	0.0	0.0	0.0	0.0	**6225.5**	15.5	0.3	0.0	9.7
Constr.	2.0	84.6	3.3	0.0	0.0	0.0	0.0	**511.1**	3.3	0.0	22.8
Roads/railways	0.0	20.0	0.0	0.0	0.0	0.0	0.0	1.3	**365.1**	0.0	0.6
Waters/ponds	0.0	14.8	14.9	0.0	0.0	7.8	0.0	0.0	0.0	**743.9**	2.3
Other lands	0.0	152.5	49.4	9.4	0.0	0.5	0.0	92.5	26.4	145.1	**412.8**
2000	Arable	Pastures	Hayfields	s	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	**9332.8**	65.1	21.4	25.8	0.0	0.0	17.3	6.8	0.8	0.0	0.0
Pastures	2.1	**2983.9**	0.6	0.0	0.0	3.1	4.3	4.4	0.3	0.0	0.9
Hayfields	4.8	7.9	**1388.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Vineyards	14.2	13.0	0.0	**235.1**	0.0	4.4	0.0	0.0	1.4	0.0	0.0
Orchards	14.5	49.7	7.4	1.7	**254.5**	3.9	0.0	0.0	0.1	0.0	0.0
VFAFF	0.0	13.0	7.5	0.0	0.0	**408.1**	0.5	0.0	0.0	2.0	0.0
FF	0.0	0.0	0.0	0.0	0.0	0.0	**6201.0**	16.3	0.3	0.0	33.4
Constr.	2.0	84.6	3.3	0.0	0.1	0.0	0.0	**502.8**	4.6	0.0	29.7
Roads/railways	0.0	20.0	0.0	0.0	0.0	0.0	0.0	1.3	**354.3**	0.0	11.3

Waters/ponds	9.4	15.0	20.8	0.0	0.0	15.4	0.0	0.0	0.0	**715.6**	7.6
Other lands	1.3	162.5	57.6	9.7	0.0	2.3	0.0	101.3	26.4	151.2	**376.4**
2005	Arable	Pastures	Hayfield s	ds	s	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	**9320.1**	66.8	21.4	25.8	0.0	0.0	28.2	6.8	0.8	0.0	0.0
Pastures	17.7	**2959.4**	0.6	0.0	0.0	4.7	7.1	8.9	0.3	0.0	0.9
Hayfields	4.8	8.6	**1380.8**	0.0	0.0	0.0	0.0	5.0	0.0	2.3	0.0
Vineyards	19.1	13.0	3.0	**186.1**	0.0	4.4	0.0	11.6	1.8	0.0	29.1
Orchards	17.1	49.7	12.4	2.4	**218.1**	3.9	0.0	6.6	0.1	0.0	21.4
VFAFF	0.0	18.6	13.4	0.0	0.0	**386.8**	8.9	0.0	0.0	3.4	0.0
FF	0.0	0.0	0.0	0.0	0.0	0.0	**6188.8**	17.2	0.3	0.0	44.7
Constr.	2.0	86.1	3.3	0.0	0.1	0.0	0.0	**487.1**	6.0	0.0	42.4
Roads/railways	0.0	20.0	0.0	0.0	0.0	0.0	0.0	1.3	**348.9**	0.0	16.7
Waters/ponds	31.4	21.4	63.2	0.0	0.0	15.4	0.0	6.3	0.0	**619.9**	26.2
Other lands	7.9	162.5	58.6	9.7	0.0	10.7	0.0	106.3	32.8	216.9	**283.1**
2009	Arable	Pastures	Hayfield s	ds	s	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	**9299.3**	66.8	27.4	25.8	0.0	0.0	21.2	15.5	1.0	3.1	0.0
Pastures	40.8	**3124.4**	1.2	0.9	0.0	4.1	5.3	13.9	1.0	42.7	22.0
Hayfields	4.8	8.6	**1388.8**	0.0	0.7	0.1	0.0	11.9	0.0	6.6	26.5
Vineyards	19.1	13.0	3.0	**185.5**	0.0	4.4	0.0	11.9	1.9	0.0	38.4
Orchards	17.1	35.4	12.4	2.4	**204.4**	3.9	0.0	13.1	0.5	0.0	28.3
VFAFF	0.0	21.7	16.7	0.0	0.0	**279.1**	110.2	0.0	0.0	3.9	0.0
FF	0.0	0.0	0.0	0.0	0.0	0.0	**6197.4**	3.8	0.3	0.0	50.5
Constr.	0.0	1.5	3.3	0.0	0.1	0.0	0.0	**591.7**	6.0	0.0	24.4
Roads/railways	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	**366.2**	0.0	17.7
Waters/ponds	33.5	17.7	63.2	0.0	0.0	15.4	0.0	6.3	0.0	**686.5**	87.6
Other lands	7.9	24.7	12.1	0.7	0.0	112.0	0.0	32.2	12.8	91.5	**178.6**
2010	Arable	Pastures	Hayfield s	ds	s	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas

Arable	**9281.7**	60.8	26.6	25.5	0.0	0.0	20.6	15.5	1.0	3.1	15.5
Pastures	40.8	**3107.4**	1.2	0.9	0.0	2.6	5.2	13.9	1.0	42.7	46.9
Hayfields	4.8	8.6	**1406.2**	0.0	0.7	0.1	0.0	11.9	0.0	6.6	26.5
Vineyards	19.1	13.0	3.0	**183.8**	0.0	4.4	0.0	13.9	1.9	0.0	38.4
Orchards	17.1	35.4	8.3	2.4	**197.8**	3.9	0.0	13.1	0.4	6.6	28.3
VFAFF	0.0	21.7	16.7	0.0	0.0	**276.4**	114.4	0.0	0.0	3.9	0.0
FF	0.0	0.0	0.0	0.0	0.0	0.0	**6198.4**	3.6	0.3	0.0	50.0
Constr.	0.0	1.5	0.0	0.0	0.1	0.0	0.0	**592.0**	6.0	0.0	22.7
Roads/railways	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	**367.2**	0.0	18.7
Waters/ponds	33.5	17.7	55.6	0.0	0.0	19.5	0.0	6.3	0.0	**681.4**	89.6
Other lands	7.9	22.8	12.1	0.7	0.0	112.0	0.0	55.2	10.9	90.4	**157.9**

Table 7.6 describe 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.

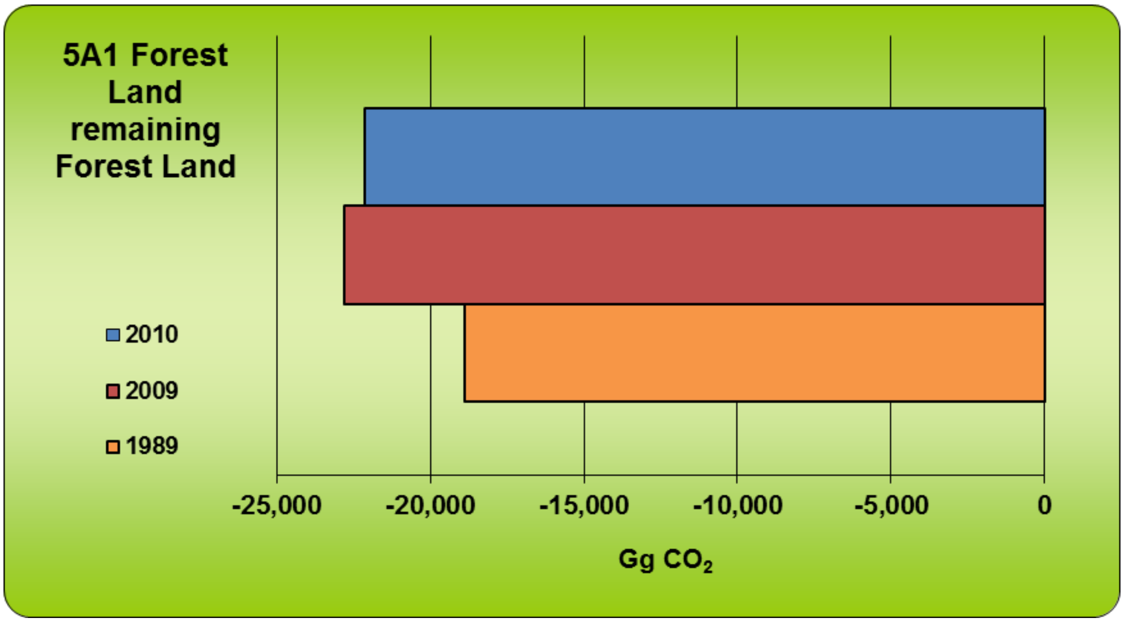
Both land sub-categories of Forest Land are key categories for CO_2 in the national GHG inventory (Table 7.6), thus higher methodological levels is required.

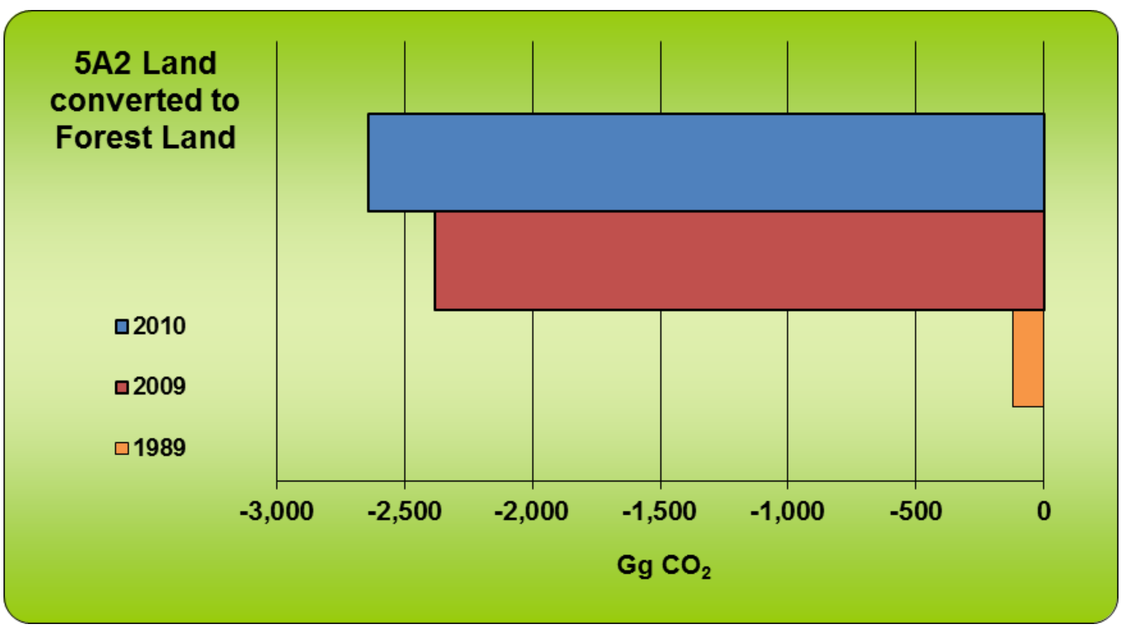
Table 7.6 Key categories overview – LULUCF, 2010

Key categories	**GHG**	**Criteria**	**Contribution to the national GHG inventory [%]**
5A1 Forest Land remaining Forest Land	CO_2	L, T	**14,83**
5A2 Land converted to Forest Land	CO_2	L, T	**1,77**
5B1 Cropland remaining Cropland	CO_2	L, T	**1.47**
5E2 Land converted to Settlements	CO_2	T	**-**
5F2 Land converted to Other Land	CO_2	L, T	**0,52**

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 7.2 Major Key categories in LULUCF, both by level and trend





7.2 Forest Land (5.A)

7.2.1 Description

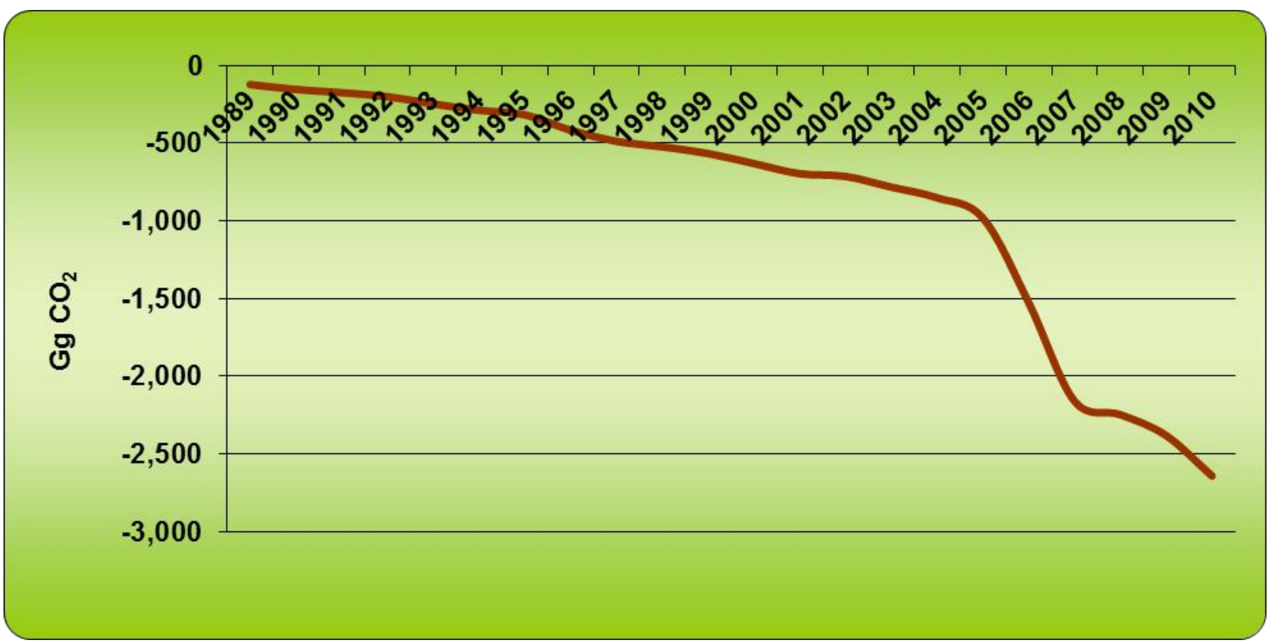
At the end of 2010, forest land area in Romania was about 6300 Kha, which represents about 27% of the country area. The total area of forest land has increased by about 1% since 1990. The deciduous forests comprise 69% of forest area, while the Coniferous comprise 31%. In the deciduous forest, beech 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.

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 7.3 Emissions for 5A1 - Forest Land remaining Forest Land (Gg CO_2)

Figure 7.4 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 there are two types of lands 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.**

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” criteria).

“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”). 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 an 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.

Although 5A1 is the most important key category, the current version of national GHG inventory data still uses heterogeneous data sources. A recalculation is expected when data from the National Forest Inventory (NFI) which currently performs its first cycle with field measurements be completed most likely become available in 2012). 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):

$\Delta C_{FF_{LB}} = (\Delta C_{FF_G} - \Delta C_{FF_L})$, 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:

- "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.
- “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 forest vegetation on pasture and hayfields. After 1991, by applying the laws on the rights of property restitution, many lands have been abandoned (pastures, hayfields, orchards, vineyards, croplands). 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).

Further on, as there is no reliable historical data on “forest vegetation outside the national forest fund” and they are result of 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 have 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*).

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	6237.1	431.0	2017	1982	1200	1013	331
1990	6236.2	431.0	2019	1984	1198	1011	331
1991	6236.3	424.2	2018	1989	1194	1008	330
1992	6236.1	424.2	2014	1993	1195	1007	329
1993	6231.5	424.2	2003	2002	1191	1007	330
1994	6227.5	424.2	2000	1995	1196	1008	330
1995	6226.0	424.0	1989	2012	1184	1011	331
1996	6220.8	423.8	1975	2022	1182	1011	331
1997	6216.8	423.8	1974	2021	1181	1011	331
1998	6207.2	416.8	1963	2022	1177	1010	331
1999	6204.9	409.1	1948	2026	1175	1014	332
2000	6201.4	408.1	1940	2026	1170	1021	334
2001	6202.4	397.4	1934	2034	1167	1018	333
2002	6199.1	394.2	1929	2037	1163	1019	333
2003	6193.9	394.2	1926	2048	1159	1009	333
2004	6190.7	394.2	1914	2065	1153	1010	329
2005	6197.7	386.8	1929	2079	1144	1004	323
2006	6233.0	351.3	1958	2114	1133	984	326
2007	6274.2	310.0	1979	2120	1132	997	327
2008	6268.3	303.3	1991	2116	1115	998	325

2009	6307.6	279.1	2022	2140	1105	996	321
2010	6312.8	276.4	2013	2119	1121	1000	337

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:

- wood harvesting, according with management plans allowable cuts;
- disturbances (wind storms, illegal 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.

Illegal 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 illegally 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}) is:

$\Delta L_{FF} = L_{fellings} + L_{other\ losses}$, 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:

$L_{fellings} = H \times D \times (1+R) \times CF$, 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 1989-2009 (thousands cubic meters/year)

Year	Harvest from national forest fund					Illegal logging volume	Estimate of wood volume in "VFAFF"	Total
	Coniferous	Beech	Oaks	Various hardwood	Various softwood			
1989	6516	6636	1842	2268	2004	83.2	1530	20879
1990	5813	4958	2045	2071	1762	120.8	1530	18300
1991	4956	4644	1919	2089	1769	186.6	1507	17071
1992	4418	4629	1739	2109	1524	281.5	1507	16208
1993	4564	4073	1629	1872	1452	157.7	1507	15255
1994	4285	4037	1651	1741	1228	145.8	1507	14595
1995	4973	4215	1551	1774	1300	122.2	1507	15442
1996	5751	4266	1658	1876	1252	128.7	1507	16439
1997	5836	4263	1489	1757	1164	136.6	1506	16152
1998	5195	3635	1276	1491	1045	122.3	1506	14270
1999	5564	4115	1358	1588	1093	130.3	1454	15302
2000	5346	4509	1333	1731	1366	142.9	1450	15878
2001	4915	4260	1288	1673	1274	141.1	1416	14967
2002	7166	4439	1495	1805	1478	102	1405	17890
2003	7139	4748	1532	1823	1450	80.8	1405	18177
2004	6357	5412	1694	2030	1589	70.5	1405	18557
2005	6061	4794	1586	1852	1378	86	1405	17162
2006	5765	4997	1632	1915	1375	64.6	1405	17153
2007	7491	5182	1485	1668	1412	175.7	1405	18818

Year	Harvest from national forest fund					Illegal logging volume	Estimate of wood volume in “VFAFF”	Total
	Coniferous	Beech	Oaks	Various hardwood	Various softwood			
2008	6766	5208	1653	1760	1318	173.8	1381	18260
2009	6635	5489	1403	1845	1148	179.5	1382	18082
2010	6832	5654	1566	1784	1155	238	1387	18617

Other annual carbon losses (illegal logging):

$\boldsymbol{L_{other\ losses} = H_i \times D \times (1+R) \times CF}$, where:

H_i = volume extracted annually by illegal logging [m^3/year].

Other parameters have the same meaning as the previous equation.

Illegal 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 endeavored. 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, as far as such areas are scattered in mountainous areas and in most cases are included under protected areas under national forest fund (i.e. local natural reserve or national parks, including Natura 2000 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”. 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 "Modeling 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 centers 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 centers.

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 2012 after the second monitoring of the JI project (scheduled for 2012) 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
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 7.7*).

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.

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 in a future submission, after the re-measurements in 2012 of soils in the JI project. 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 5A1 sink in 2010 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 2010 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*).

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>Illegal 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 –</td><td>100</td></tr>
</table>

Parameter	Nominal uncertainty and 95% confidence interval (% of average)	Source
emission factors		

Current estimate of the uncertainty is still preliminary, as far as the uncertainty introduced by using some very old data is not yet accounted for (like the annual growth dated 1984).

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%. New estimate will be available in 2012 submission, after second monitoring of the JI project.

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 7.1.1.

- 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. Thorough verification procedures will be established in the future, while the reporting will move toward use of the NFI data (in 2013).

7.2.6 Category-specific recalculations, including changes made in response to the review process

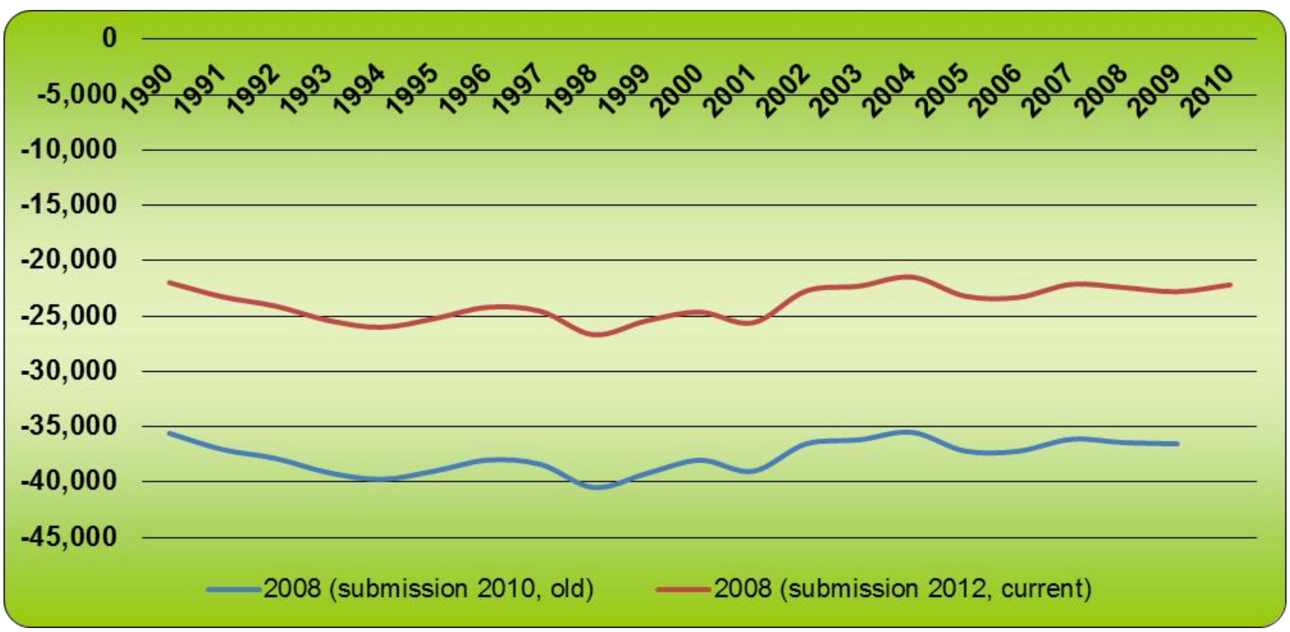
With 2012 submission there are only few recalculations in 5A1 and 5A2:

i. reanalyzing time series for VFAFF which is now considered to move to NFF if its area decreases in certain years;

ii. Correct an overestimation in average of 600% of the removal from DOM in 5A2. This was caused by wrong referencing in the spreadsheet of the activity data (for all conversions from any categories to forestland).

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 are:

- 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	6667
1991	6680	6660
1992	6682	6660
1993	6681	6656
1994	6680	6652
1995	6680	6650
1996	6690	6645
1997	6689	6641
1998	6672	6624
1999	6791	6614
2000	6457	6610
2001	6653	6600

2002	6663	6593
2003	6752	6588
2004	6779	6585
2005	6743	6585
2006	6755	6584
2007	6741	6584
2008	6729	6572
2009	6753	6587

- 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 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.
- 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.

iii. 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 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.

Related to previous ERT's assessment reports several steps of improvement have been made (*Table 7.14*).

Table 7.14 Approach of the issues raised by the Report of the individual review of the annual submission of Romania submitted in 2010 (with additional reference to issues pointed in ARR 2009)

Nr. crt	Report paragraph	Identified issue	Current status of implementation
1	106 (also highlighted in para 81, 82 of ARR 2009) /ARR 2010	In 2008, net removals from the LULUCF sector amounted to 36,414.56 Gg CO_2 eq, offsetting 22.3 per cent of total emissions excluding the LULUCF sector. Since the base year (1989), net removals have increased by 12.3 per cent. The key driver for the rise in net removals is the reduction of losses in living biomass (from 6,523.46 to 5,888.39 Gg C from 1989 to	Current resubmission for 2010 recalculate the 5A sink based on official available data, land use-change

Nr. crt	Report paragraph	Identified issue	Current status of implementation
		2008) in forest land remaining forest land. Within the sector, 100.0 per cent of the removals were from forest land remaining forest land, since this is the only category for which the Party provides quantitative estimates of emissions and removals. Romania has not improved the inventory of the LULUCF sector since its previous submission and emissions and removals are reported as “NA” or “NE”, except for CO_2 removals from carbon stock changes in living biomass in forest land remaining forest land and CO_2, CH_4 and N_2O emissions from biomass burning (wildfires). The ERT concludes that the inventory of the LULUCF sector is very incomplete. Romania justifies the absence of emission estimates for the other categories as due to the lack of availability of relevant data.	matrix and removing errors made by using inappropriate BEFs and other factors used in the calculation.
2	107 (82/ARR 2009) /ARR 2010	In addition, Romania reports areas under land-use change – grassland converted to forest land (339 ha), forest land converted to cropland (4,339 ha), cropland converted to settlements (6,694 ha), forest land converted to settlements (6 ha), forest land converted to other land (8,294 ha), cropland converted to other land (4,306 ha) and wetlands converted to other land (600 ha) – but does not provide estimates of removals or sinks.	Estimates are provided in the current submission, for land conversions. Assumptions, methodology and datasets used are described in the relevant sub-chapters of the NIR
3	108 (82/	The NIR does not provide a land-use matrix for the	Land use change

Nr. crt	Report paragraph	Identified issue	Current status of implementation
	ARR 2009) /ARR 2010	consistent representation of lands, and it only mentions that a land-use change matrix was built for determining the area of forest land remaining forest land and afforested and deforested areas, based on expert judgement. Responding to questions raised by the ERT during the review, the Party provided a land-use matrix for all years since 1989. The ERT concluded that Romania is using the IPCC approach 2, but the Party did not provide information on the methods and sources used to construct these matrices. The ERT considers that the use of expert judgement in this case is not appropriate or consistent with the IPCC good practice guidance for LULUCF, and that the Party needs to use other methodologies to construct the matrices, such as surveys, sampling or remote sensing. The ERT concluded that the problems with data collection on land use and land-use change reflect problems regarding the ability of the national system to provide the necessary information for the inventory of the LULUCF sector, and these problems also impact on the quality of reporting of the additional information on Article 3, paragraphs 3 and 4, of the Kyoto Protocol (see para. 145 below), in particular paragraph 6 of the annex to decision 15/CMP.1. The ERT strongly recommends that the Party significantly improve the reporting of land areas in its next annual submission and provide estimates of emissions and removals for the missing categories and pools.	matrix principle and data is shown under the section 7.1.1. Full land use matrix on 1989-2010 is presented in Table 7.5. Current land data is considered robust to respond the UNFCCC requirements.

Nr. crt	Report paragraph	Identified issue	Current status of implementation
4	109/ARR 2010	The QC procedures for the LULUCF sector are briefly explained in the NIR; however, the NIR does not provide sufficient information on the QC process to enable the ERT to verify how this was done and its results. To improve transparency, the ERT recommends that Romania include detailed information on QC procedures in its next and future annual submissions.	Current QA/QC procedure implemented for LULUCF sector is described under section 7.2.5.
5	110/ARR 2010	The ERT also notes that no significant improvements have been introduced in the 2010 submission for the LULUCF sector and that most of the recommendations made in several previous reviews reports have not been followed. The ERT strongly recommends that Romania elaborate and implement improvement plans for this sector as a matter of urgency.	Major issue taken into consideration with current submission is development of land use change matrix. Also, an improvement plan for this sector is provided in the section 7.2.6 above.
	111 (85/ARR 2009) /ARR 2010	Romania uses the IPCC method 1 and a mixture of tier 1 and tier 2 methodologies to estimate gains and losses in carbon stock changes from living biomass. Gains in carbon stock changes in living biomass were estimated using country-specific data on the average annual net increment in volume, Iv (m3/ha/year), for commercial	The 5A1 removal was recalculated by removing parameters inappropriately

Nr. crt	Report paragraph	Identified issue	Current status of implementation
		wood. The Party also applies country-specific wood densities, which are higher than the IPCC default values. However, Romania uses constant values for Iv and wood densities through the whole period 1989–2008 which, for the main species, were derived from the national forest inventory published in 1985. The ERT considers that values established from measurements taken 20 years ago may not be appropriate for the entire time series, taking into consideration the possible changes in the age/class distribution in the forest of Romania. Given that the Party informed the ERT during the review that it plans to have data from a new national forest inventory in 2011, the ERT recommends that the Party use this data to improve the estimates in its 2012 annual submission. The ERT also recommends that Romania use remote-sensing data and geographic information tools to make better use of the information collected.	used before, which led to the overestimation of annual sink. Nevertheless, data is still outdated, as new NFI data will be delivered only in 2013. An improvement plan is shown under section 7.2.6 above.
6	112/ARR 2010	Biomass expansion factors (BEFs) and root-to-shoot (R) values were based, respectively, on tables 3A.1.10 and 3A.1.8 of the IPCC good practice guidance for LULUCF. From these tables, the Party decided to use intermediate values for BEFs. The ERT considers that, given that Romanian forests are approximate mature forests, it would have been more appropriate to use the values in the lower limit of the interval the range. This simple option may reduce the estimates of removals by 14.6 per cent. In addition, R values were chosen to be	In the previous calculation of 5A1, BEF1 and BEF2 were both incorrectly involved in the calculation (so they were removed in the current

Nr. crt	Report paragraph	Identified issue	Current status of implementation
		around the average IPCC default ranges, but it is not transparent in the NIR what assumptions were used to select the values from among the several aboveground classes presented in table 3A.1.8. The ERT recommends that the Party revise the BEF and R values and improve the transparency of reporting by providing information on the assumptions that it uses.	submission). Explanations are provided under section 7.2.3.1.1. R values were also reviewed to smaller values. Wood density data were not changed, considering country specific data priority over the default data and lacking arguments for lower density under similar forest structure and management as before.
7	113/ARR 2010	To estimate losses from carbon stock, Romania uses many expert judgements to overcome problems regarding the availability of AD (e.g. that the annual extracted volume includes branches and leaves and the consideration of the BEF is not necessary). The NIR is not transparent because it does not describe in detail	Construction of harvest statistics procedure is described, together with the reason why the

Nr. crt	Report paragraph	Identified issue	Current status of implementation
		the source of harvesting data or provide references to the information used. The ERT reiterates the recommendation made in the previous review report 21 that Romania provide detailed information on the use of expert judgements (e.g. the number of experts consulted, institutions) and on the planned improvements to obtain more objective information based on monitoring data or scientific studies. In addition, information on losses of carbon is not provided in a disaggregated form for commercial felling and use for fuelwood. The ERT recommends that the Party disaggregate these figures to improve transparency and to allow the estimation of non-CO_2 emissions due to the use of fuelwood.	BEF2 has not to been applied anymore (see section 7.2.3.1.1.
8	114 (84/ARR 2009) /ARR 2010	The ERT identified inconsistent reporting for the pools dead organic matter and soil organic carbon: Romania reports emissions/removals as "NE" in CRF table 5.A, but the NIR states that changes in these pools are assumed to be zero, following the IPCC tier 1 approach. Romania did not provide transparent and verifiable information to justify that the use of the tier 1 methodology is appropriate (i.e. that the pools are stable) and, therefore, the ERT encourages the Party to make all necessary improvements in order to report this key category using a tier 2 or tier 3 methodology and make the best use of data from its updated national forestry inventory.	These pools are reported under Tier 1 in 2010 resubmission, assuming that all these C pools are under steady state. The effort to explore and utilize existing databases is ongoing, as described at the first part of

Nr. crt	Report paragraph	Identified issue	Current status of implementation
			current section (7.2.7), with first results expected in 2012.
9	138 /ARR 2011	Romania reported the changes in organic soil carbon for forest land remaining forest land as "NO". However, the AD show that forest land does occur on organic soils in Romania. During the review, the Party explained that, while forest land occurs on organic soils, they are specifically protected from management due to issues of access and regeneration of the forest following harvesting. The ERT notes this explanation and recommends that Romania provide evidence of this explanation in the next NIR.	Information is added in the 7.2.3.1.3.
10	140/ARR 2011	In the 2011 NIR, the change in soil carbon in mineral soils was reported as "NO".	Country specific data on C stock change in mineral soils will be available at the end of 2012, following the Monitoring plan of JI project.
11	171/ARR 2011	The ERT noted that the definition of forest as elected by Romania in its initial report and how lands that meet this definition are identified was not transparently described in the submission.	Specifications included under 7.2.3.1.1.

Nr. crt	Report paragraph	Identified issue	Current status of implementation
12	173, 175/ARR 2011	In particular, Romania did not estimate the changes in the carbon stocks for the litter, dead wood or mineral soil carbon pools for any activity, and little information was included in the NIR to indicate that the non-accounted pools were not net sources.	More information is included under relevant sub-chapters.
13	176/ARR 2011	The ERT encourages the Party to provide further evidence that this assumption is valid in the next annual submission, in particular that all of the land transferred to the NFF will be established with vegetation that meets the definition of forest.	Specifications included under 11.1.3.
14	177/ARR 2011	Romania also uses the NFF data to determine whether the land meets the definition of reforestation set out by the Marrakesh Accords. The ERT recommends that the Party transparently describe how it ensures that only lands that did not contain forest on 31 December 1989 are considered for reforestation.	Specifications included under 11.1.3.
15	178/ARR 2011	The ERT notes that Romania has a JI project as per Article 6 of the Kyoto Protocol ("Romania afforestation/reforestation Kyoto Protocol flexible Joint Implementation project 2003–2017") (see para. 139 above). This project has its own sampling regime that is different, but still consistent with, that applied to the areas of reforestation outside the project.	Split is provided (JI is reported separately in the CRF). Updated data will be available in 2013 submission as far as 2012 is the year of 2nd project monitoring and

Nr. crt	Report paragraph	Identified issue	Current status of implementation
			verification.
16	179/ARR 2011	The ERT noted that Romania does not report any lands subject to afforestation and reforestation as harvested during the commitment period (table 5(KP-1)A.1.2). The Party explained to the ERT that, as the minimum rotation age for forests is 20 years, it is unlikely that any lands subject to afforestation and reforestation have been harvested, or that they may be harvested prior to 2012.	Data from JI project is available and eventually a reporting of such areas will be considered after the 2nd monitoring of the project.

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 2010 there were some 9817 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. 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)

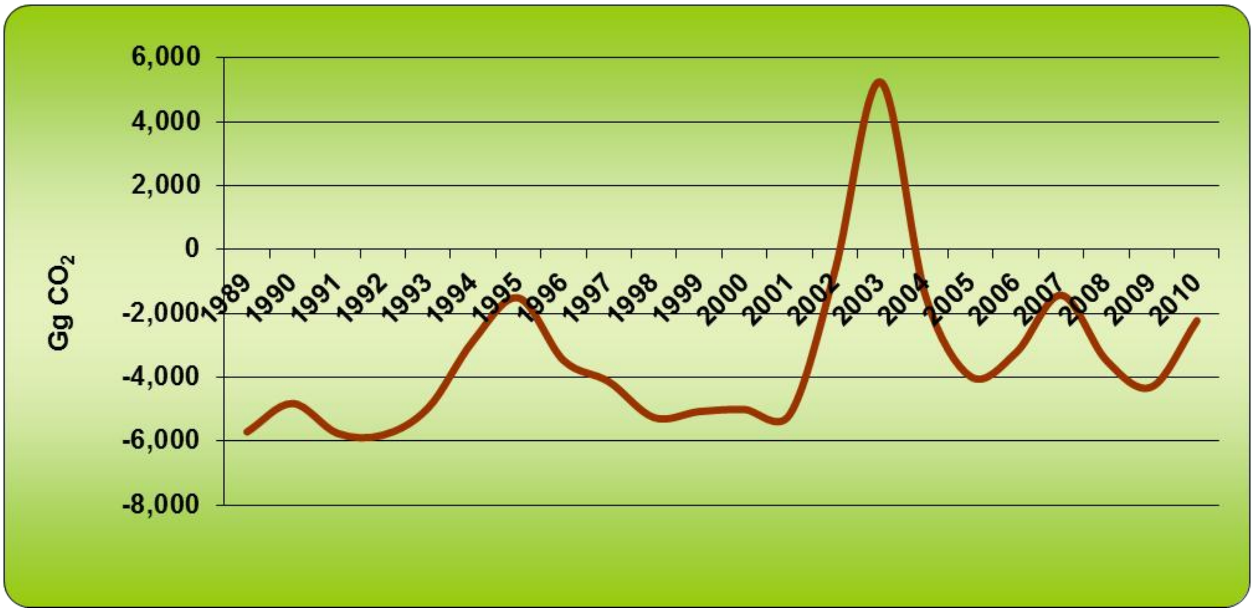
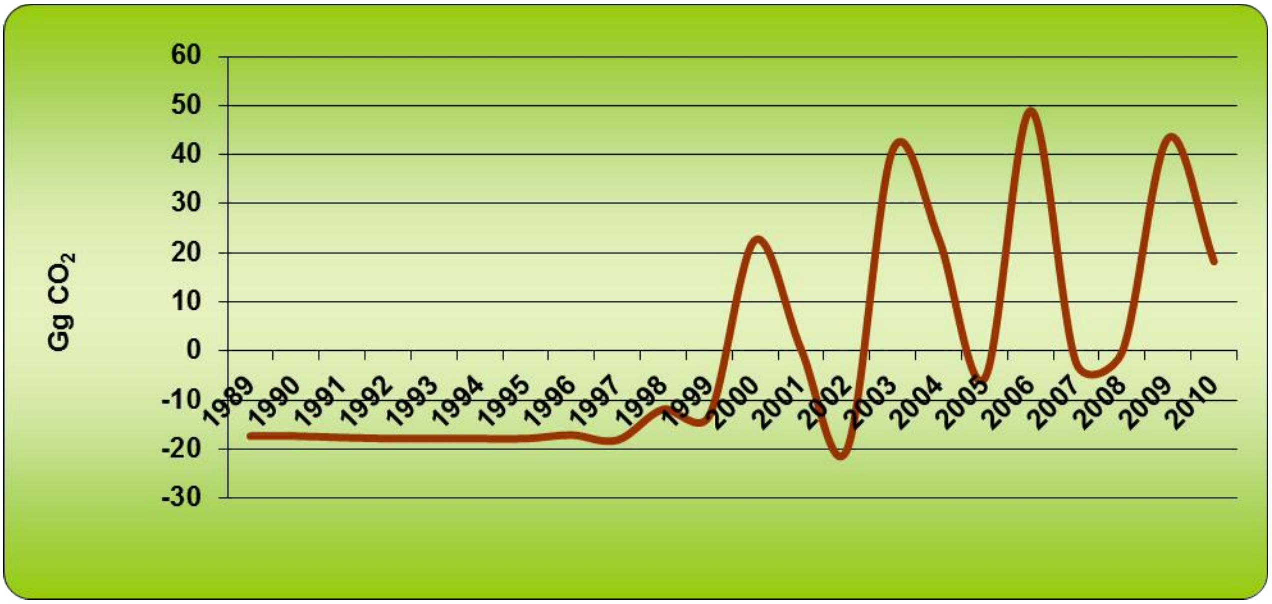


Figure 7.7 Emissions for 5B2 - Land converted to Cropland (Gg CO_2)



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:

$C_{stock\ change} = C_{stock\ increase} - C_{stock\ decrease}$, *(1) where:*

$C_{stock\ increase} = A_{CLp} * C_{biomass\ stock\ increment}$

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 (1) above, as following:

$C_{stock\ decrease} = (A_{CLp\ previous\ year} - A_{CLp\ current\ year})) * C_{standing\ C\ stock}$

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 preexisting 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).

Organic soil surface is some 19 kha in Romania according the soil database ("Monitoring soil quality in the Romania", ICPA, 2006). Annual emissions is estimated based on default emission factor for temperate cold region from IPCC (Table 3.3.5), which has a value of 1tC/ha/yr loss.

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

Data and information currently available does not allow an assessment of uncertainties in estimating emissions for this category of land. The estimation of uncertainties will be performed with a future reporting, to the extent that more documented and country specific data will be available.

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

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)

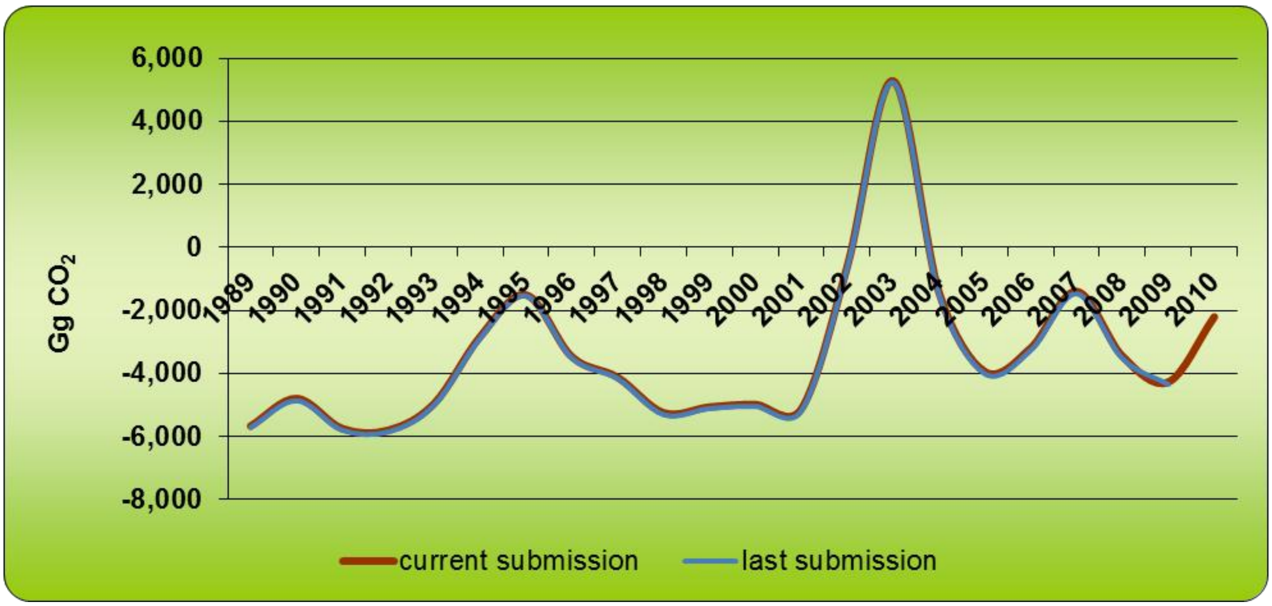
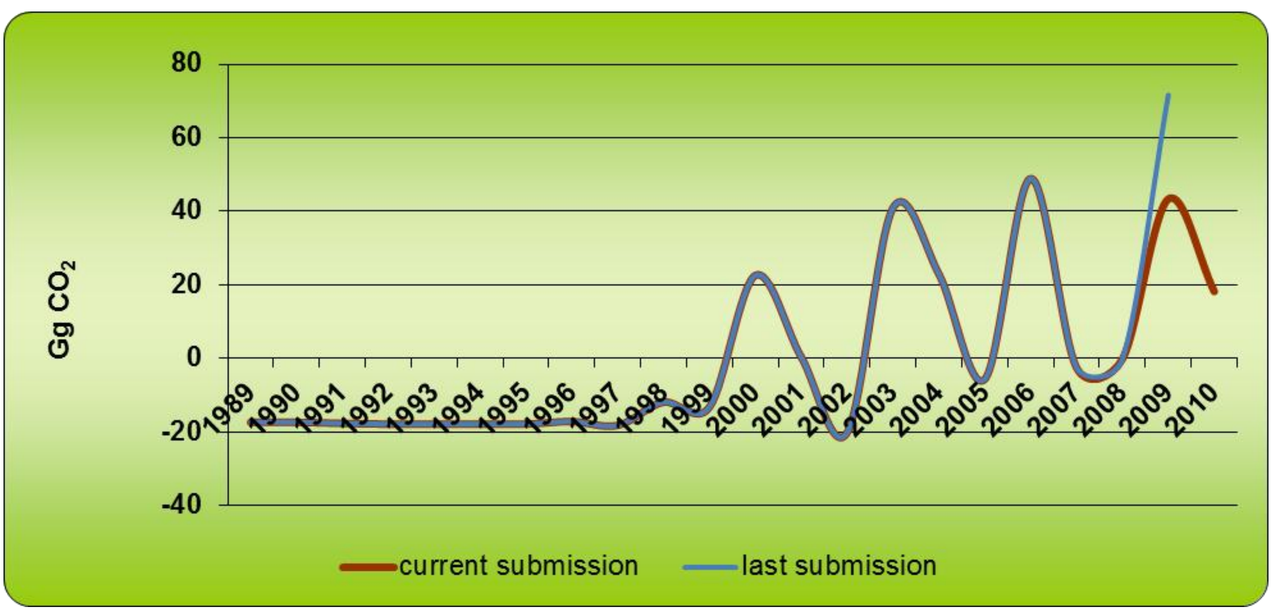


Figure 7.9 Recalculation of 5B2 - Land converted to Cropland sink (Gg CO_2)



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 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 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.

Table 7.15 Implementation of the issues identified in the report of the individual review of the annual submission of Romania submitted in 2010

Nr. crt	**Report paragraph**	**Identified issue**	**Current status of implementation**
Sector overview			
1	107/ARR 2010	Given that cropland and grassland together represent 61.7 per cent of the country's area, and that no estimates of potential carbon fluxes from these lands are	GHG emissions/ removal from CL and GL are estimated, including the improvement plan for next years.

Nr. crt	Report paragraph	Identified issue	Current status of implementation
		reported, the ERT considers that net removals may be overestimated.	
2	107/ARR 2010	In addition, Romania reports areas under land-use change – grassland converted to forest land (339 ha), forest land converted to cropland (4,339 ha), cropland converted to settlements (6,694 ha), forest land converted to settlements (6 ha), forest land converted to other land (8,294 ha), cropland converted to other land (4,306 ha) and wetlands converted to other land (600 ha) – but does not provide estimates of removals or sinks.	Estimates are reported for several of mentioned land sub-categories, they are also subject of future improvement, as showed under each land category section.
3	82/ARR 2009	The total reported area of the country is 23,839.10 kha, consisting of 28.3 per cent forest land, 41.3 per cent cropland, 20.4 per cent grassland, 3.6 per cent wetlands, 4.5 per cent settlements and 1.9 per cent other land. The total land area fluctuates slightly over the reporting period. The data on land use were derived from different statistical information using expert judgment. Romania has reported for all land-use categories the area remaining and the area converted to that category. However, except for forest land remaining forest land, emissions and removals were not estimated for any categories, which have instead been reported as “NA” or “NE”.	Data is derived from unique source of data: the national statistics, as explained in the section 7.1.1. GHG estimates are reported for several of mentioned land sub-categories, they are also subject of future improvement, as showed under each land category section.

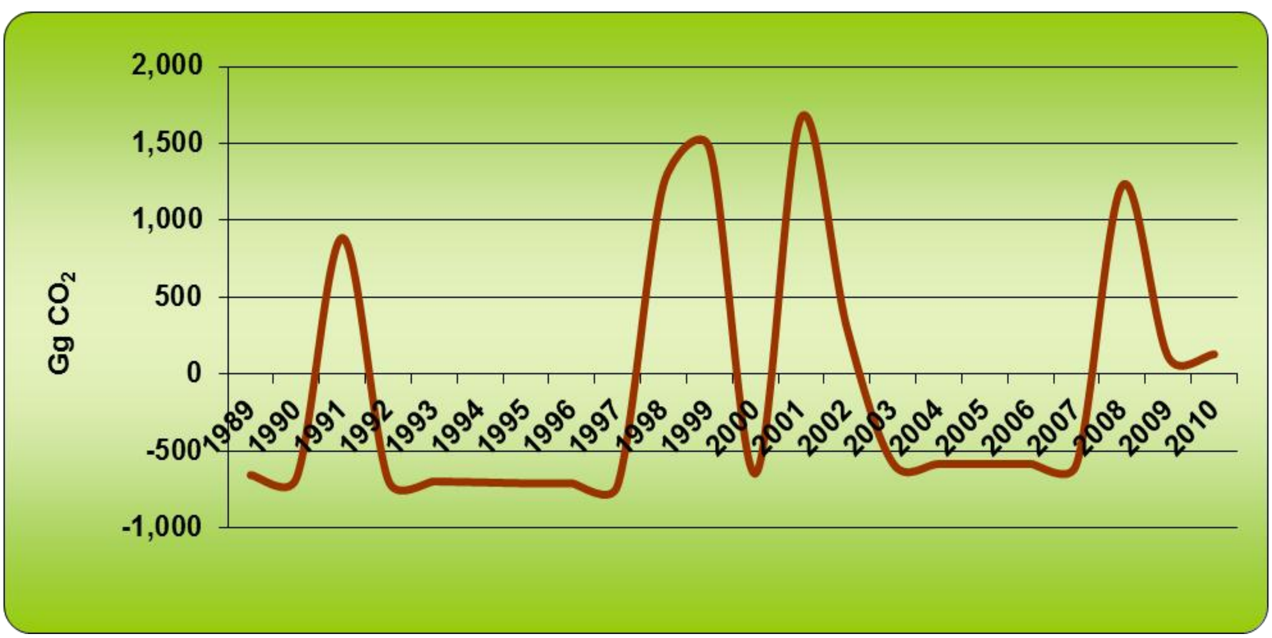
Nr. crt	Report paragraph	Identified issue	Current status of implementation
4	180/ARR 2011	The ERT noted that, in the land-use matrices, there is a considerable area of land (55 kha) that is reported as moving from VFAFF (the area of forest outside the NFF) to pastures and hayfields.	This area decreased to 37kha. Land matrix was rechecked and improved following discussions with experts from forest authority that confirmed that change from VFAFF occur only to national forest fund and there are no official records on converting VFAFF to hayfield or pasture by tree removal and reporting differences are due to the change of use from one year to another (i.e. reported as grazing land with economic recovery in rural areas).
5	188, 189, 191 /ARR 2011	The ERT found that the calculation of the base year removals for revegetation was not in line with the IPCC good practice guidance for LULUCF,	Net removal from Rv was recomputed for 1989 assuming a time series which starts in 1970. For CP period, the removal was correctly computed assuming newly established activities implemented starting 1990.

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 under conversion to grassland sum up to around 300 kha over 20 years, with the main transition being 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**

Data and information currently available does not allow an assessment of uncertainties in estimating emissions for this category of land.

The estimation of uncertainties will be performed with a future reporting, to the extent that data will be available.

7.4.5 Category-specific QA/QC and verification

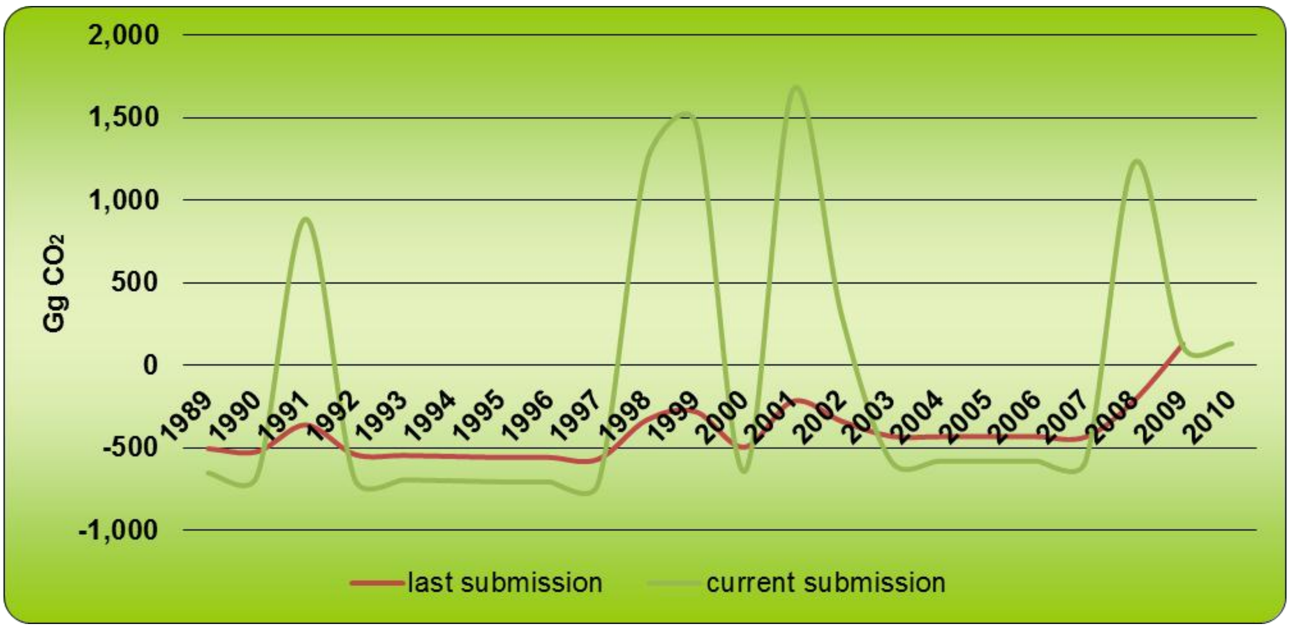
General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A). Area of organic soils and drained areas was subject of repeated checks and identification of most reliable data sources with the Ministry of Agriculture.

7.4.6 Category-specific recalculations, including changes made in response to the review process

Starting with the 2011 re-submission, a land use change matrix is available, which led to re-calculation of activity data for all land subcategories, thus, for the first time, the emissions on these land subcategories are estimated in the national GHG inventory.

There have been recalculations in the current submission of about 23% for 5.C.2 for the entire time-series compared to the last submission, caused by the revision of soil C stocks reference values, for all land uses.

Figure 7.11 Recalculation of 5C2 - Land converted to Grassland sink (Gg CO_2)



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.

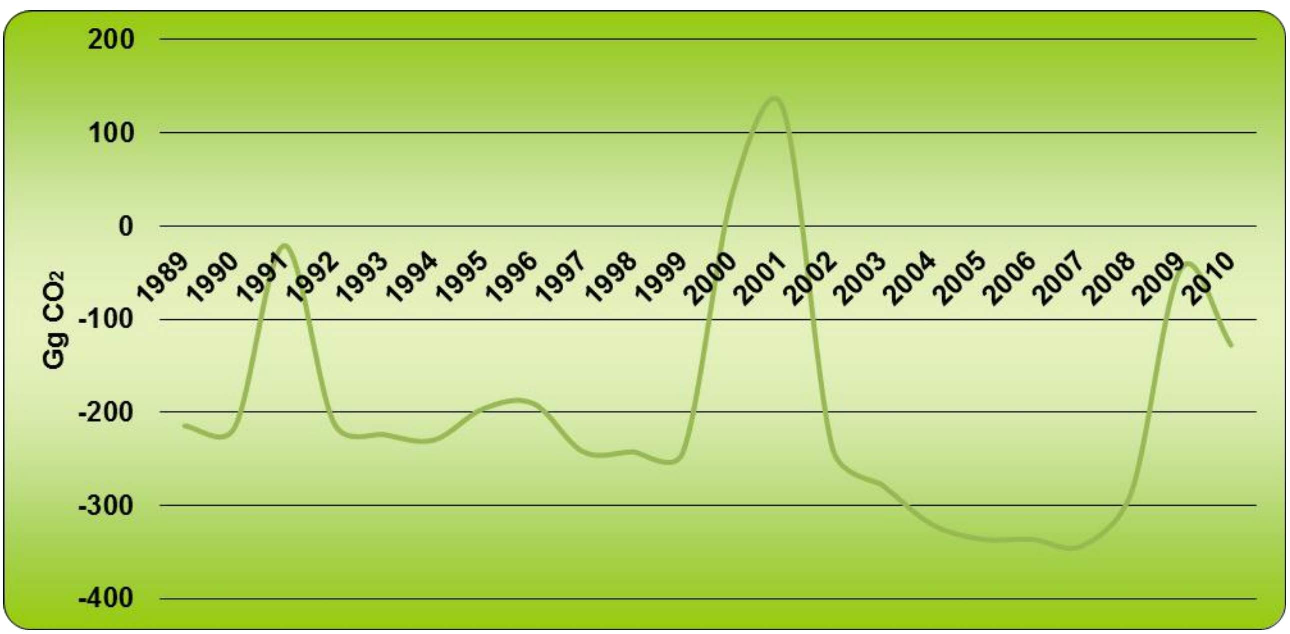
The works would be based on "Monitoring soil quality in Romania" dataset and other available national data and references. Most likely, the deadline would be the end of 2012 as to include it under 2013 submission.

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 7.12 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

Data and information currently available does not allow an assessment of uncertainties in estimating emissions for this category of land. The estimation of uncertainties will be performed with a future reporting, to the extent that data will be available.

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

Starting with 2011 re-submission a land use change matrix is available, which led to re-calculation of activity data for all land categories, when, for first time, the emissions on these land subcategories are estimated in the national GHG inventory.

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. Reporting on wetland was repeatedly mentioned in the ERT’s reports (*Table 7.16*).

Table 7.16 Report of the individual review of the annual submission of Romania submitted in 2010

Nr. crt	**Report paragraph**	**Identified issue**	**Current status of implementation**
Sector overview			
1	107	In addition, Romania reports areas under land-use change – grassland converted to forest land (339 ha), forest land converted to cropland (4,339 ha), cropland converted to settlements (6,694 ha), forest land converted to settlements (6 ha), forest land converted to other land (8,294 ha), cropland converted to other land (4,306 ha) and wetlands converted to other land (600 ha) – but does not provide estimates of removals or sinks.	Activity data are provided by a consistent land use change matrix. For land subcategories which are not key categories Tier 1 is assumed for biomass, while for SOM changes estimates are provided or are under preparation as stipulated in the development plan above.

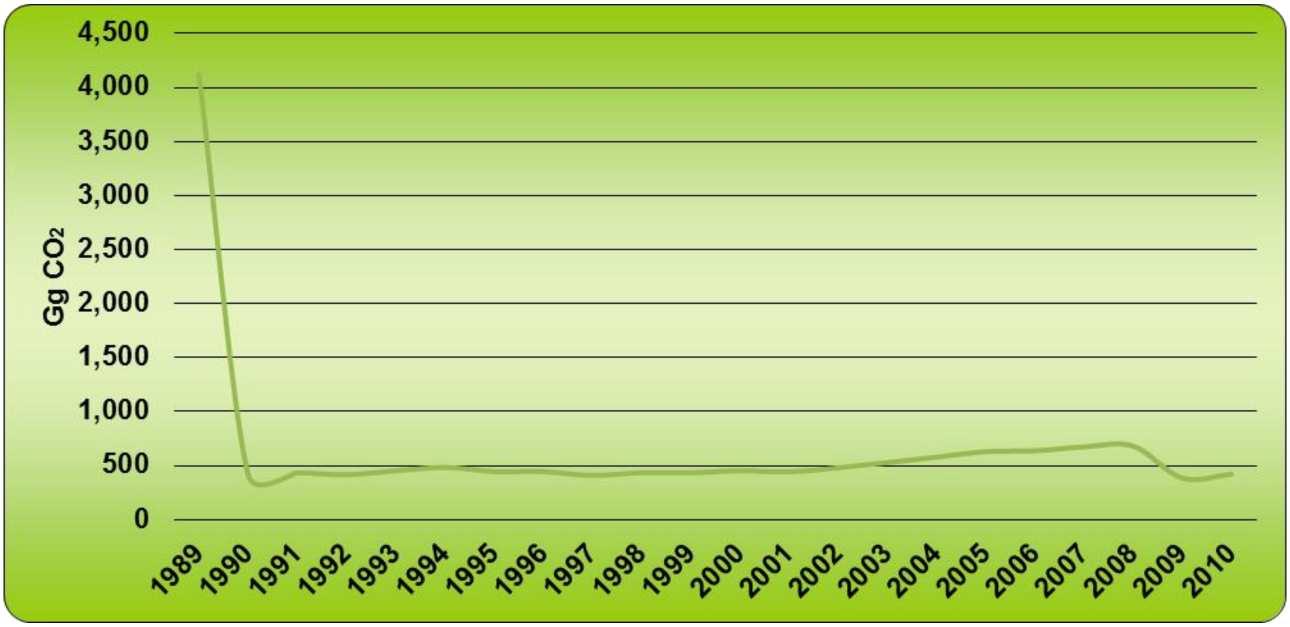
7.6 Settlements (5.E)

7.6.1 Description

Area of settlements is about 5% of the total land area, respectively 1100 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” (12kha cumulated over 20 years) and a major one in the case of conversions from “Other land” (some 130kha under reintroduction of old industrial dumps in the economic cycles).

Land conversion to Settlements is a key category based on trend assessment.

Figure 7.13 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.

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. 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

Data and information currently available does not allow an assessment of uncertainties in estimating emissions for this category of land. The estimation of uncertainties will be performed with a future reporting, to the extent that data will be available.

7.6.5 Category-specific QA/QC and verification

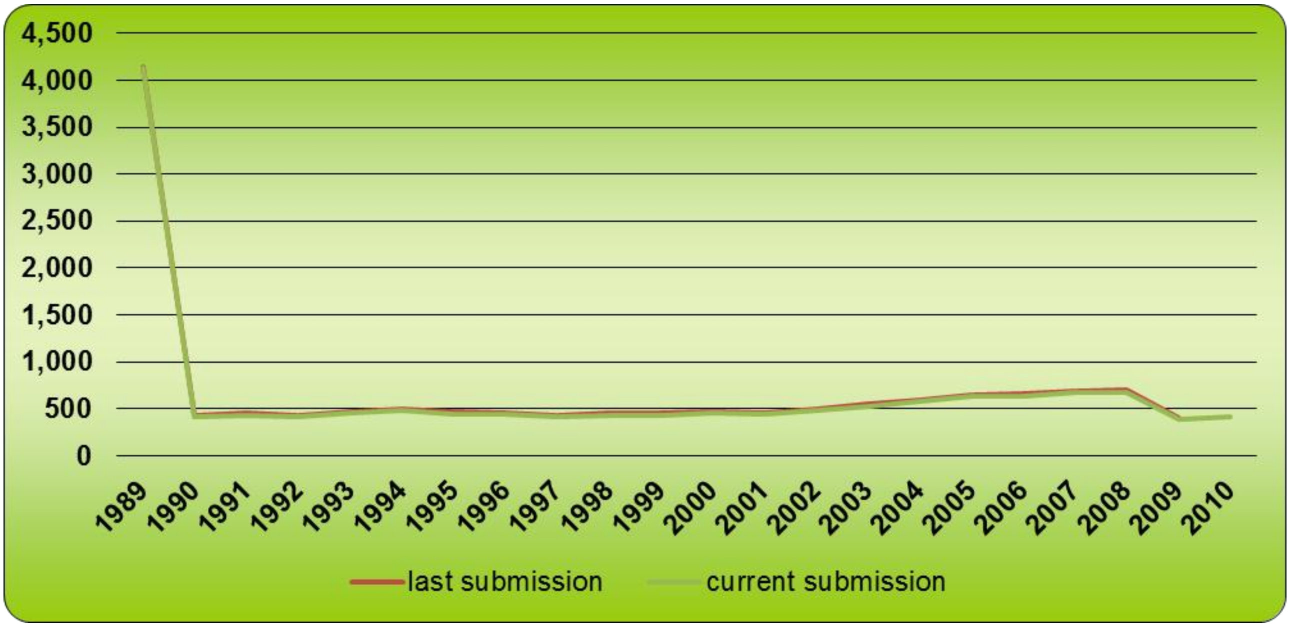
General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A).

7.6.6 Category-specific recalculations, including changes made in response to the review process

Starting with 2011 re-submission a land use change matrix is available, which led to re-calculation of all activity data, thus emissions data from this land category were computed for first time in the national GHG inventory.

There have been recalculations in the current submission of about -4% for 5.E.2 for the entire time-series compared to the last submission, caused by the revision of soils C stocks reference values.

Figure 7.14 Recalculation of 5E2 - Land converted to Settlements sink (Gg CO_2)



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.

Table 7.17 Report of the individual review of the annual submission of Romania submitted in 2011

Nr. crt	Report paragraph	Identified issue	Current status of implementation
1	181/ARR 2011	The area of deforestation reported by Romania includes both land converted to settlements and land converted to other land under the Convention reporting.	Consideration of this issue will be given following `Eighth Meeting of Inventory Lead Reviewers, Bonn Germany 21-

Nr. crt	Report paragraph	Identified issue	Current status of implementation
			22 March 2011`, in a future submission.
2	182/ARR 2011	Romania reports lands as deforestation upon their removal from the NFF. While the assumption that all land that leaves the NFF is deforested is a conservative approach, the ERT encourages the Party to provide further evidence that this assumption is valid in the next annual submission.	Information provided in the 7.6.2

7.7 Other land (5.F)

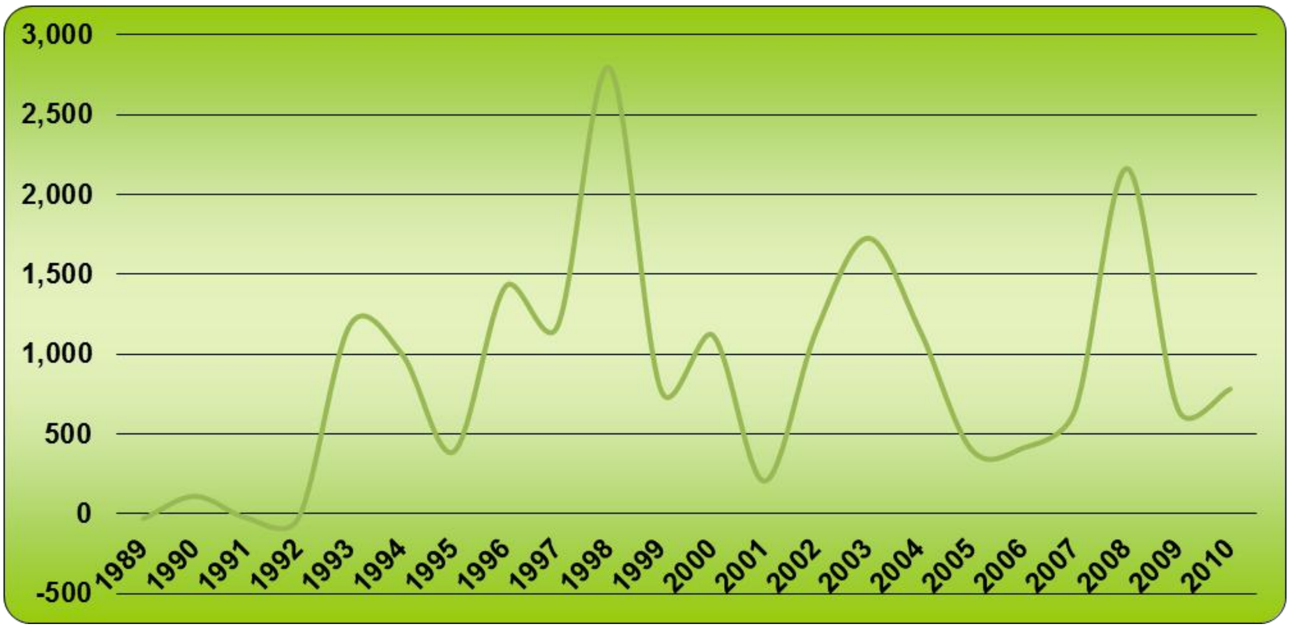
7.7.1 Description

Area occupied by "Other Lands" is about 2% of the total land area, 495 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 7.15 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. 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

Data and information currently available does not allow an assessment of uncertainties in estimating emissions for this category of land. The estimation of uncertainties will be performed in a future reporting, if the data will be available.

7.7.5 Category-specific QA/QC and verification

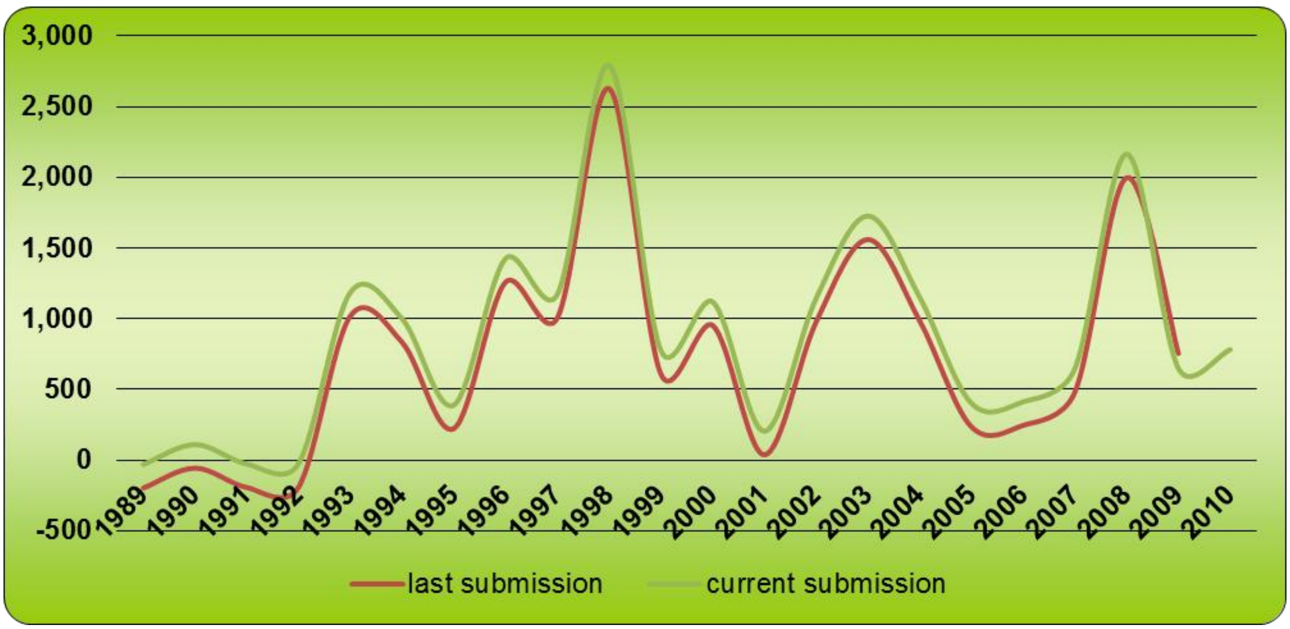
General QA/QC rules are mentioned in the 7.2.5 subcategory, under Forest Land (5.A).

7.7.6 Category-specific recalculations, including changes made in response to the review process

Starting with 2011 re-submission a land use change matrix is available, which led to re-calculation of all activity data and emission estimates are provided.

There have been recalculations in the current submission of about 113% for 5.C.2 for the entire time-series compared to the last submission, caused by the revision of soil C stocks reference values.

Figure 7.16 Recalculation of 5F2 - Land converted to Other land sink (Gg CO_2)



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 no reported any activity of drainage of forest lands in Romania. Thus, such emissions are reported as “NO” in the national GHG inventory. Peat land area and related activities are insignificant. Flooding’s 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))

For the first time there have been reported emissions of the agricultural lime application on the Cropland Limestone subcategory.

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 illegally 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 7.17), 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 7.18 Forest fires area

Year	Total affected area (ha)
1989	93
1990	444
1991	277
1992	729
1993	518
1994	312
1995	208
1996	227
1997	68
1998	137
1999	379
2000	3607
2001	1020
2002	3590
2003	762
2004	124
2005	212
2006	946
2007	2949
2008	843
2009	974
2010	206
Average area	847

GHG emissions from forest fires are computed based on Eq. 3.2.19 of the IPCC GPG 2003.

$\boldsymbol{L_{forest\ fires} = S_{forest\ fires} \times M_f}$, where:

$L_{forest\ fires}$ = total amount of C annually emitted (tC yr^{-1});

$\boldsymbol{S}_{forest\ fires}$ = annually affected area (ha yr^{-1});

$\mathbf{M}_f$ = amount of C in „dead wood lying on the soil surface” [MgC ha^{-1}].

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.

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.

7.8.6 Category-specific planned improvements, including those in response to the review process

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*).

Table 7.19 Approach of the issues raised by the Report of the individual review of the annual submission of Romania submitted in 2010 (with additional reference to issues pointed in ARR 2009)

Nr. crt	**Report paragraph**	**Identified issue**	**Current status of implementation**
Non-key categories *Forest Land – CH_4 and N_20*			
1	115 (86/ARR 2009)	To estimate emissions from biomass burning, the Party assumed that only biomass on the forest floor is burnt during a wildfire (i.e. about 6,755 kg C/ha). This assumption and the value or the parameters used to derive this value are based on expert judgment, but the information in the NIR is not sufficient to assess how the value was established. The ERT recommends that Romania provide additional documentation in the NIR, including references to literature, to support the assumptions used in the expert judgment in its next annual submission.	*Reference is available and the assumption for C stock change factor in DOM is presented in the section 7.2. Further on, the data availability will be increased with NFI data on lying dead wood (DW), while litter data is not yet available. The effort to completely estimate litter pool is described under the section 7.2.7. Reporting is expected in the submission for 2013.*

7.8.7 Recalculations of non CO_2 emissions from sources

For the first time in 2012 submission there are included emissions from "drainage of land" upon the availability of a consistent time series at national level by the Ministry of Agriculture. Data is available from 1970 and it is reported as a 20 years transition period associated with drainage of non-forest lands (reported under *Table 5(III)).*

Emissions from liming are also calculated based on consistent time series data from the Ministry of Agriculture.

Both estimates are calculated using default emission factors from IPCC.

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 this submission it was estimated NMVOC emissions from Solid Waste Disposal on Land.

Table 8.1 Status of the direct GHG emissions estimation in the Waste Sector

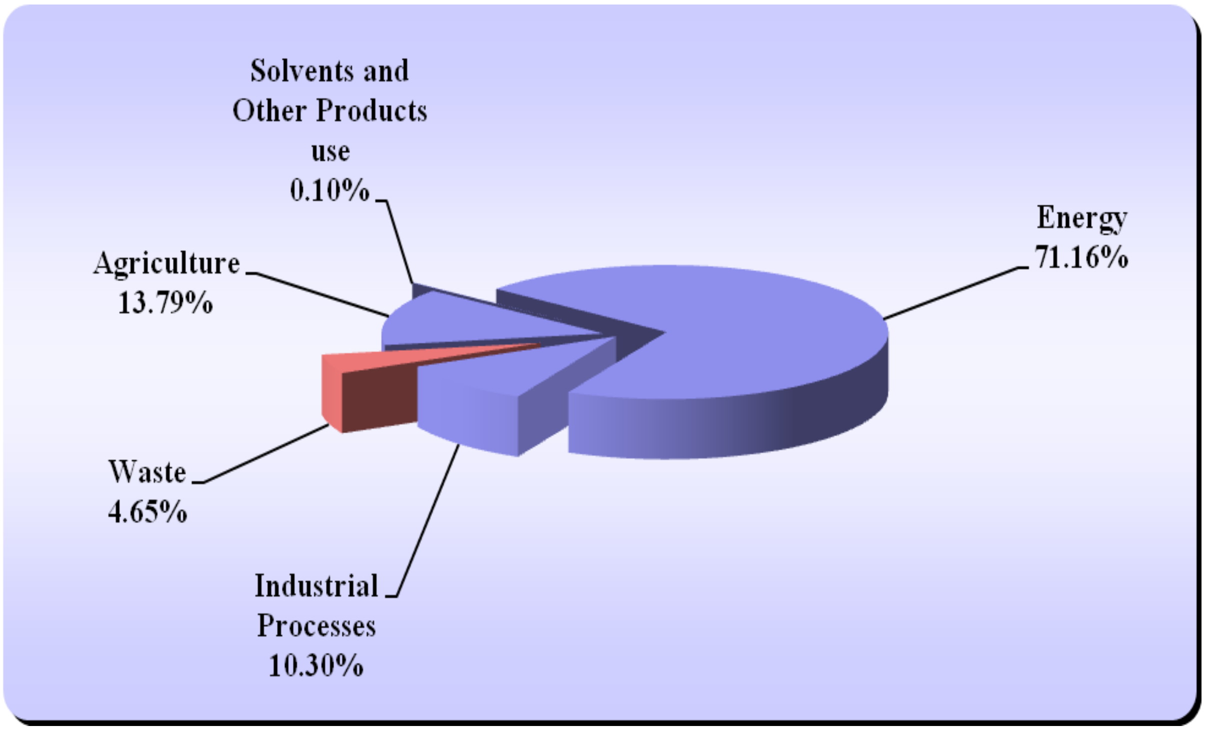
IPCC category	Emissions estimation status		
	CO_2	**CH_4**	**N_2O**
6.A Solid Waste Disposal on Land			
6.A.1 Managed Waste Disposal on Land	✓	✓	NA
6.A.2 Unmanaged Waste Disposal on Land	✓	✓	NA
6.A.2.1 deep (>5m)	✓	✓	NA
6.A.2.2 shallow (<5 m)	✓	✓	NA
6.A.3 Other	NA	NA	NA
6.B Wastewater Handling			
6.B.1 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 2010 GHG emissions from the Waste Sector accounted for 5622.39 Gg CO_2 equivalent, which represent 4.65% 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, 2010



In the base year (1989), the total GHG emissions from the Waste Sector amounted to 4602.57 Gg CO_2 equivalent, which accounted for 1.62% of the total national GHG emissions. Compared with the other sectors, emissions from the Waste Sector showed a significant increase from the base year, with 22.16%, due to increasing of population consumption in parallel with increasing of living standards.

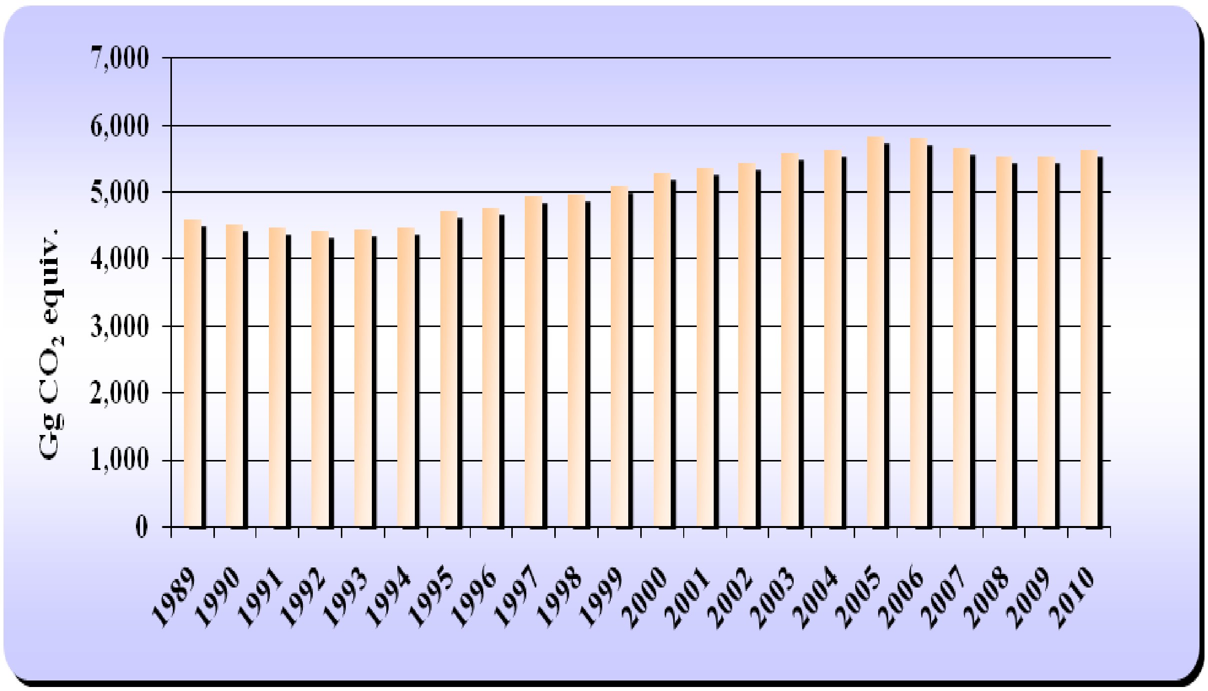
Table 8.2 The contribution of Waste Sector to the total GHG emissions in Romania, for 1989–2010 period

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	284939.380	4602.570	1.62
1990	252217.515	4524.359	1.79
1991	205146.409	4465.220	2.18
1992	178682.998	4416.303	2.47
1993	174473.073	4438.071	2.54
1994	172055.239	4469.161	2.60
1995	180221.299	4717.858	2.62
1996	182460.399	4766.306	2.61
1997	169022.996	4939.772	2.92
1998	152686.424	4968.089	3.25
1999	135535.229	5083.483	3.75
2000	139966.459	5292.135	3.78
2001	142749.002	5369.470	3.76
2002	146584.103	5442.351	3.71
2003	152607.407	5583.967	3.66
2004	150240.504	5637.913	3.75
2005	148427.387	5830.627	3.93
2006	152503.181	5810.467	3.81
2007	149481.919	5649.939	3.78
2008	145804.054	5541.317	3.80
2009	122956.858	5524.097	4.49
2010	120920.041	5622.390*	4.65

* Preliminary data

In 2005-2009 period, GHG emissions began to reduce, following the downward trend of the amounts of municipal waste generated and stored. This decrease has been set to a value of 3.57% decrease in 2010 compared to 2005 *(Figure 8.2).*

Figure 8.2 Total GHG emissions trend from Waste Sector for 1989–2010 period



The most important GHG emissions are resulting from Subsector Solid Waste Disposal on Land (6.A), responsible for 51.03% in total GHG emissions from this sector. Wastewater Handling contributes with 48.82% in the total GHG emissions from Waste *(Figure 8.3)*. The two subsectors are key category sources both by level and trend (*Table 8.3* and *Figure 8.4*).

Waste Incineration accounts for only 0.15% of GHG emissions in this sector *(Figure 8.3)*.

Figure 8.3 Contribution of the sub-sectors in the total GHG emissions from Waste Sector in 2010

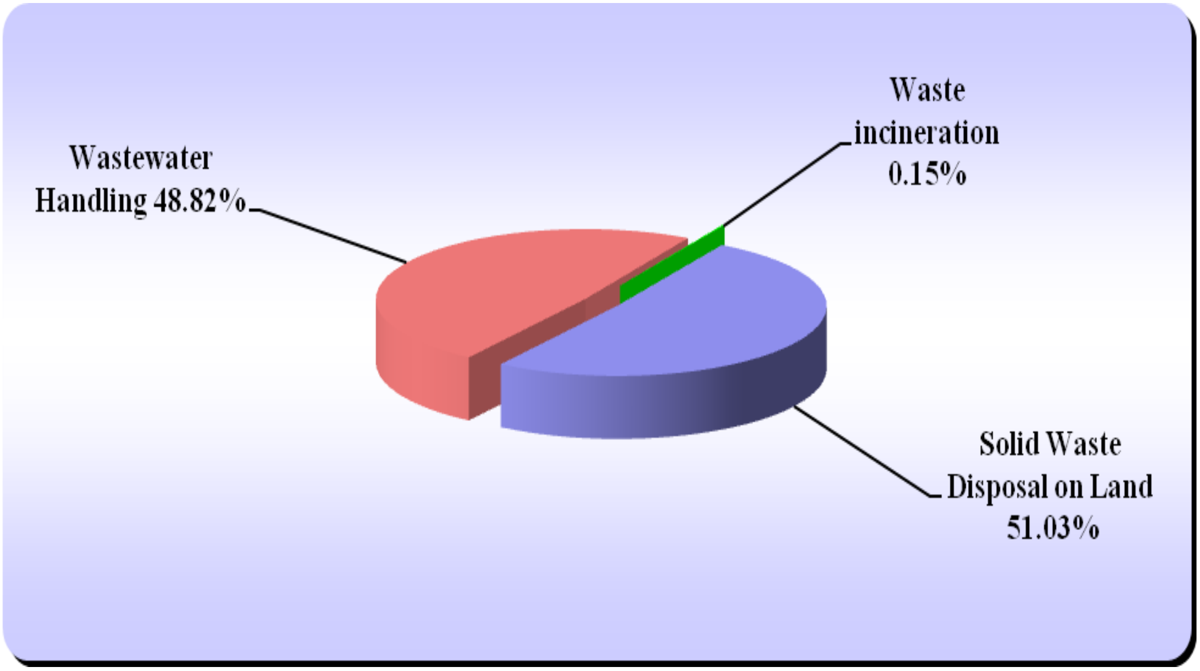
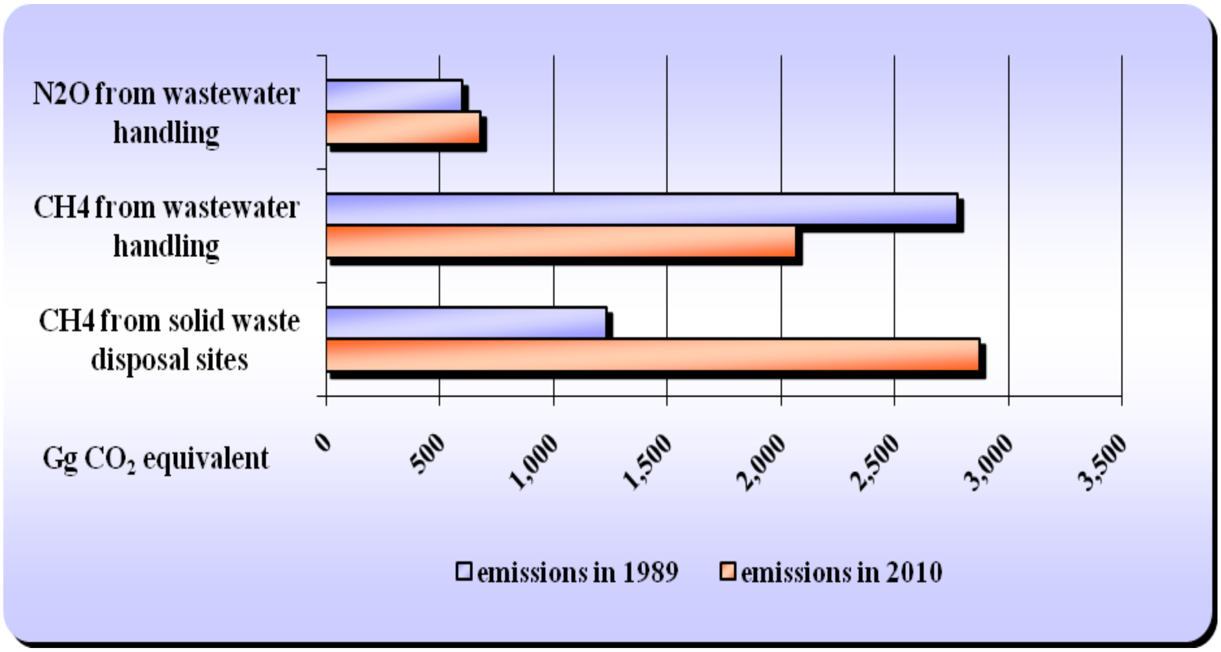


Table 8.3 Key categories in Waste Sector based on the level and trend assessment in 2010

Key category	Direct GHG	Criteria for identification (excluding LULUCF)	Contribution of key category in total GHG emissions [%]	Criteria for identification (including LULUCF)	Contribution of key category in total GHG emissions [%]
6.A Solid waste disposal sites	CH_4	**L, T**	2.37	**L, T**	1.92
6.B Wastewater handling	CH_4	**L, T**	1.71	**L, T**	1.38
	N_2O	**L, T**	0.56	**L, T**	0.45

Figure 8.4 Key categories in Waste Sector both by level and trend criteria, in 2010



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 22.49% to the total methane emissions in Romania, in 2010. In the same year, nitrous protoxide had a contribution of 5.96% to the total N_2O emissions in our country.

According to Revised 1996 IPCC Guidelines, CO_2 emissions from Solid Waste Disposal Sites mainly derive from biomass sources and are not treated as net emissions. Only CO_2 emissions from Waste Incineration 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 – 2010 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	4602.57	4003.21	86.98	599.36	13.02
1990	4524.36	3923.57	86.72	600.79	13.28
1991	4465.22	3864.99	86.56	600.23	13.44
1992	4416.30	3815.43	86.39	589.98	13.36
1993	4438.07	3819.81	86.07	602.05	13.57
1994	4469.16	3846.23	86.06	601.40	13.46
1995	4717.86	4078.03	86.44	612.99	12.99
1996	4766.31	4121.18	86.46	611.01	12.82
1997	4939.77	4290.76	86.86	609.34	12.34
1998	4968.09	4301.29	86.58	620.98	12.50
1999	5083.48	4400.77	86.57	626.13	12.32
2000	5292.14	4587.90	86.69	638.26	12.06
2001	5369.47	4657.32	86.74	637.50	11.87
2002	5442.35	4744.04	87.17	620.04	11.39
2003	5583.97	4824.14	86.39	673.95	12.07
2004	5637.91	4858.51	86.18	672.08	11.92
2005	5830.63	4981.29	85.43	670.55	11.50
2006	5810.47	4764.38	82.00	681.60	11.73
2007	5649.94	4959.19	87.77	680.12	12.04
2008	5541.32	4853.65	87.59	679.08	12.25
2009	5524.10	4838.37	87.59	677.99	12.27
2010	5622.39*	4936.35*	87.80	677.74	12.05

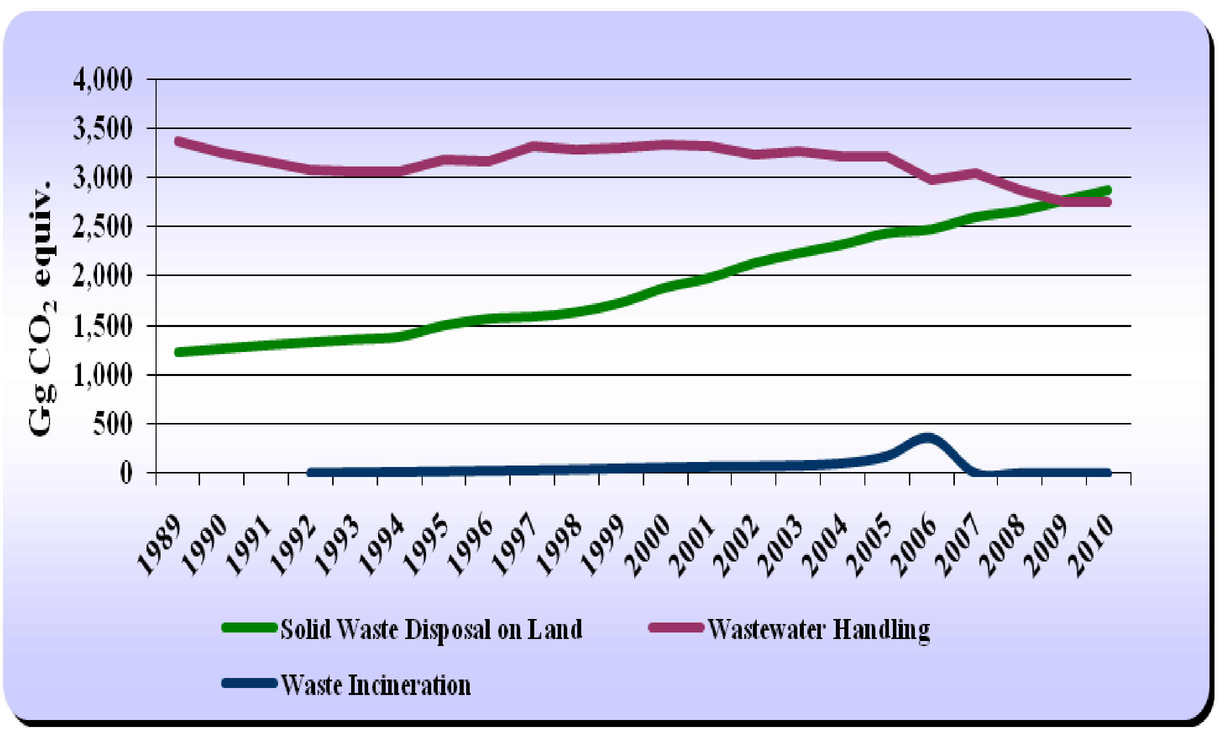
* Preliminary data

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 due to improvement of living standards which is reflecting different in the evolution of these subsectors.

GHG emissions trend from Solid Waste Disposal on Land increased significant with a percentage of 133.05% between 2010 and base year *(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 18.58% in 2010 compared to 1989.

In Waste Incineration Subsector the emissions trend has remained almost constant 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 1989–2010 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 don't have a linear evolution due to variability of production. However, in the last decade, in Romania, it has been observed an upward evolution and between 2003 and 2008 these increased linearly.

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 we used the amounts of Municipal Solid Waste (MSW) deposited in Solid Waste Disposal Sites (SWDS). To estimate CH_4 emissions from the other categories of deposited waste such as industrial waste and sludge we are going to collect activity data, results will be transmitted in the next submissions.

According to 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 2009 and 2010 followed the evolution of declining consumption due to economic crisis. Also, in these two years the quantities of waste deposited, following the implementation of European legislation in this area, have decreased. According to national legislation requirements, the amounts of waste recovered increased in 2009-2010 period in an unfavourable economic environment from reducing consumption, as reflected by significant decreases in the amounts of packaging placed on the market.

Given that the survey statistics on the quantities of waste generated in 2010 will be realized in 2012, data on quantities of waste generated, collected, recovered in 2010 were estimated by Waste Directorate from NEPA, based on domain-specific methodology.

In 2006-2009 period, the percentage of MSW collected from total MSW generated ranged between 77% and 82%. Of the total amount of MSW collected in 2009, 97.35% was deposited and the rest was recovered. We have no information about destination of the amounts of generated and uncollected waste. It is assumed that they are generally recovered in households.

Table 8.5 shows the percentages of municipal solid waste categories which have been recovered and stored in 2009.

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	1.17	98.83
Waste from municipal services	3.92	96.08
Waste from construction and demolition activities	12.47	87.53

After implementation of European legislation, the percentage of population served by sanitation services increased to 91.53 % in urban areas and 70.28% in rural areas. Regarding of waste collection system, the traditional method is the most common, accounting for a share of about 98%. Newer methods of waste management such as selective collection and separate collection of bulky waste were very small share.

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 75 sites in 2010 *(Table 8.6).* In accordance with European regulations, the unmanaged SWDS have a transition period and storage activity will be stopped gradually until 2017.

Table 8.6 Number of Solid waste Disposal Sites (Source Waste Directorate of NEPA)

Type of SWDS	2006	2007	2008	2009	2010
Managed	20	20	20	26	27
Unmanaged deep	90	92	87	87	61
Unmanaged shallow	130	109	96	14	14

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 62.11%.

CH_4 emissions from SWDS

The methane emissions from Solid Waste Disposal to managed landfills were estimated for the period 1995-2010, because in 1995 opened the first managed SWDS.

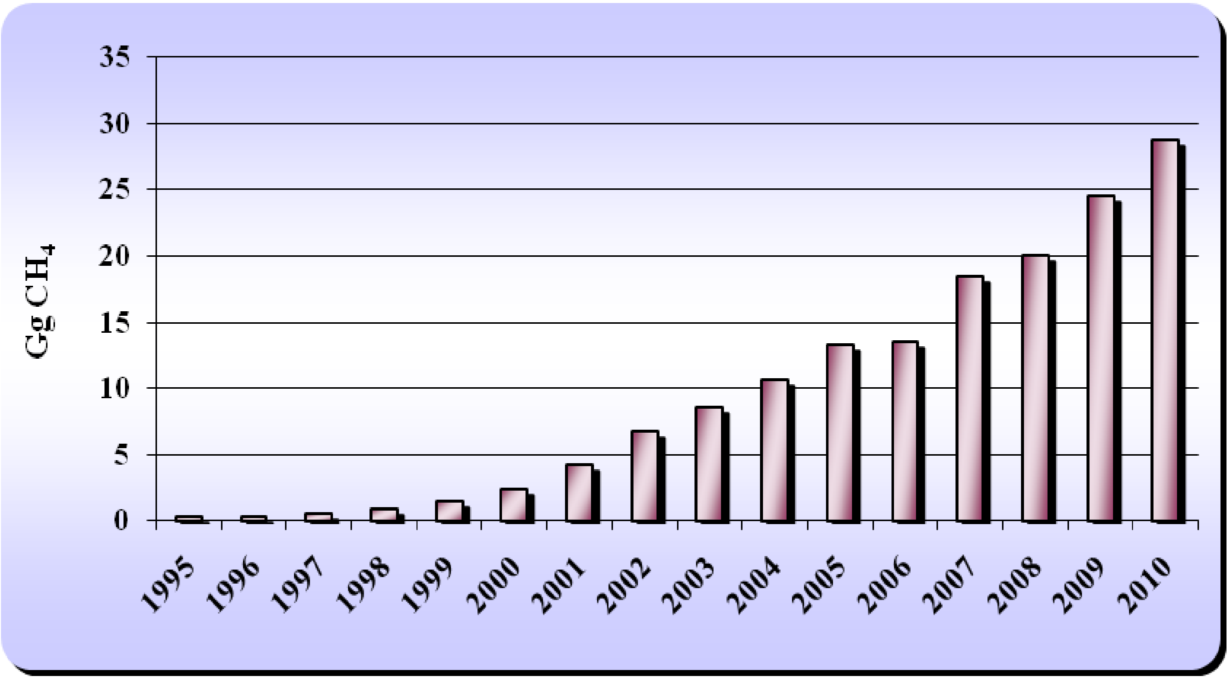
The methane emissions from managed SWDS have an upward trend, reaching in 2010 a value of 31.60 Gg *(Table 8.7 and Figure 8.6).* This tendency follows the increasing tendency of the amounts of municipal solid waste generated and deposited in managed landfills.

Table 8.7 CH_4 emissions from solid waste disposal sites

Year	**CH_4 emissions [Gg]**		
	managed	**unmanaged deep**	**unmanaged shallow**
1989	NO	44.41	14.22
1990	NO	45.73	14.65
1991	NO	46.98	15.05
1992	NO	48.06	15.39
1993	NO	49.09	15.72
1994	NO	50.06	16.03
1995	0.31	53.95	17.28
1996	0.36	56.38	18.06
1997	0.58	56.92	18.23
1998	0.90	58.34	18.69
1999	1.48	61.37	19.66
2000	2.36	66.21	21.21
2001	4.23	68.33	21.89
2002	6.70	71.77	22.99
2003	8.61	73.99	23.70
2004	10.66	75.61	24.24
2005	13.34	77.82	24.80
2006	13.54	79.38	24.91
2007	18.42	80.61	24.70
2008	20.07	82.51	24.12
2009	24.55	83.79	23.45
2010	28.77*	85.05*	22.81*

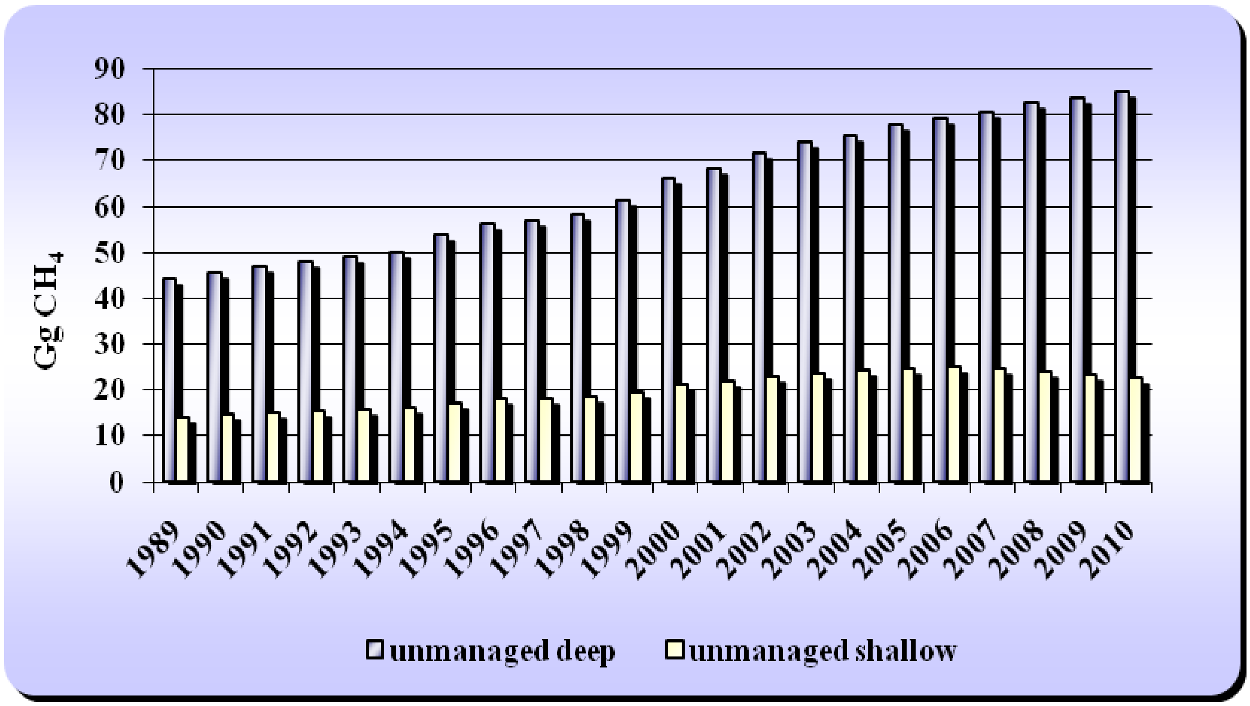
* Preliminary data

Figure 8.6 CH_4 emissions trend from waste disposed to managed sites for 1995–2010 period



During 1950-2010, CH_4 emissions from unmanaged deep SWDS had an increasing trend towards the emissions from unmanaged shallow SWDS *(Table 8.7 and Figure 8.7).* This increase follows the increasing of the amounts of waste generated; a part of them are still storing in unmanaged landfills, because a number of 75 unmanaged landfills have a transition period until later 2017.

Figure 8.7 CH_4 emissions trend from waste disposed to unmanaged sites for 1989–2010 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 were not necessary, because the first managed landfill was opened in 1995 year.

For unmanaged SWDS methane emissions were estimated between 1950 and 2010, according IPCC GPG 2000 to achieve an acceptably accurate result.

The following equations were used in CH_4 emissions estimates:

Equation 8.1 CH_4 generated from managed and unmanaged SWDS

$$CH_4 \text{ generated in year } t\ (Gg/yr) = \Sigma_x\ [(A \bullet k \bullet MSW_T(x) \bullet MSW_F(x) \bullet L_0(x)) \bullet e^{-k(t-x)}]$$

$$\text{for } x = \text{initial year to } t$$

Equation 8.2 CH_4 emissions from managed and unmanaged SWDS

$$CH_4 \text{ emitted in year } t\ (Gg/yr) = [CH_4 \text{ generated in year } t - R(t)] \bullet (1-OX)$$

Emission factors

Except Degradable organic Carbon (DOC), country specific emissions factors and parameters are not available to estimate CH_4 emissions. Therefore we used the default values provided by IPCC GPG 2000, taking into account the national circumstances *(Table 8.8)*.

Table 8.8 Parameters used to calculate the emission factors (SWDS)

Type of site	MCF	DOC_F	F	k	$A=(1-e^{-k})/k$	OX
Managed	1	0.55	0.5	0.05	0.975	0.1
Unmanaged-deep	0.8	0.55	0.5	0.05	0.975	0
Unmanaged-shallow	0.4	0.55	0.5	0.05	0.975	0

The fraction of Degradable Organic Carbon (DOC) in MSW was calculated using equation 5.4 from page 5.9 of IPCC GPG 2000. The data on municipal waste composition, for 2003-2010 period, were provided by Waste Directorate from National Environmental Protection Agency (NEPA). Because the statistical survey for 2010 will be at the end of this year, we considered for 2010 the same percentage composition of MSW as in 2009.

To estimate emissions from unmanaged landfills using FOD method were necessary data on municipal waste composition since 1950. These data were estimated 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" (Table 8.9).*

Table 8.9 The percentage composition of municipal solid waste

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescibles [%]	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	
1966	6.35	7.59	19.48	0.48	0.07	
1967	6.42	7.67	19.68	0.49	0.07	
1968	6.43	7.68	19.71	0.49	0.07	

Table 8.9 (continued) The percentage composition of municipal solid waste

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescibles [%]	Food waste [%]	Wood/straw [%]	DOC	Source
1969	6.54	7.82	20.05	0.50	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*"
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	
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	
1983	8.16	9.75	25.02	0.62	0.09	
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	

Table 8.9 (continued) The percentage composition of municipal solid waste

Year	Paper and textiles [%]	Garden & park waste/ other non-food organic putrescibles [%]	Food waste [%]	Wood/straw [%]	DOC	Source
1994	8.58	10.26	26.32	0.65	0.09	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	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	
2001	12.33	14.74	37.80	0.94	0.13	
2002	13.86	16.56	42.49	1.06	0.15	
2003	13.11	15.67	40.20	1.00	0.14	NEPA
2004	11.67	12.53	38.12	1.00	0.13	
2005	12.76	14.50	38.60	1.00	0.14	
2006	12.68	14.36	36.45	1.00	0.13	
2007	11.48	13.77	34.45	1.00	0.12	
2008	8.32	6.03	45.29	1.58	0.12	
2009	10.18	5.54	44.40	1.97	0.12	
2010	10.18*	5.54*	44.40*	1.97*	0.12*	

Based on the municipal waste composition for 2003-2009 period, the experts involved in the study mentioned above were used the following formula:

Equation 8.3 Fraction of MSW that represent component "x"

$$F_n = F_{n+1} * Q_{t\,dep\,n} / Q_{t\,dep\,n+1}$$

where:

- F_n – fraction of MSW that represent component "x" (paper & textiles/garden &park waste/food waste/wood & straw) in year "n"
- F_{n+1} - fraction of MSW that represent component "x" (paper & textiles/garden &park waste/food waste/wood & straw) in year "n+1"
- $Q_{t\ dep\ n}$ – total quantity of MSW deposited in solid waste disposal sites in year "n"
- $Q_{t\ dep\ n+1}$ - total quantity of MSW deposited in solid waste disposal sites in year
- "n+1"

Activity data

For 2003-2009, the data on the amounts of MSW and percentage composition 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). Indicators resulting from statistical surveys are constructed in accordance with European regulations in the field, but their quality depends greatly on conditions existing at the level of reporting, such as: availability of technical requirements for registration of waste; recording of waste at the companies' level; competence of responsible for statistical questionnaires. Due to the fact that statistical survey for 2010 will take place later this year, data on amounts of MSW are estimated for 2010. Data for years 2003-2006 and 2008 were corrected by Waste Directorate from NEPA after finding errors in their calculation.

For 1995-2002 period, activity data on MSW disposed to managed landfills were provided by National Research and Development Institute for Environmental Protection but were revised for years: 1996, 1997, 1998 and 2000 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"*, finished in 2011. Because in the last year's submission, the quantities of MSW disposed in managed landfills were the same in 1996-1998 period with the quantity from 1995 and in 1999 with the quantity from 2000 *(table 8.10)*, this issue being mentioned by ERT in 2011 country review, were necessary estimation of the quantities from years 1996, 1997, 1998 and 2000. For 1996-1998 period, the Waste Sector experts, involved in the mentioned study, were used interpolation method, applying the following formulas:

Equation 8.4 The quantity of MSW disposed in managed landfills for 1996-1998 period

$$Q_{1996} = Q_{1995} + 1/4 * (Q_{1999} - Q_{1995})$$
$$Q_{1997} = Q_{1995} + 2/4 * (Q_{1999} - Q_{1995})$$
$$Q_{1998} = Q_{1995} + 3/4 * (Q_{1999} - Q_{1995})$$

where:

- ❖ Q represent the quantity of MSW disposed in managed landfills and the numbers 1 to 4 represent the years taken into account in interpolation, respectively:

1 = 1996; **2** = 1997; **3** = 1998; **4** = 1999

Table 8.10 The quantities of MSW disposed in managed SWDS in period 1995-2000 – Comparison between 2011 v.4.1 submission and 2012 v.1.2 submission

Year	MSW disposed in managed landfills (Gg)	
	2011 v.4.1 submission	*2012 v.2.1 submission*
1995	150.00	150.00
1996	150.00	235.00
1997	150.00	320.00
1998	150.00	405.00
1999	490.00	490.00
2000	490.00	565.66

For the year 2000 it was applied the following formula:

Equation 8.5 The quantity of MSW disposed in managed landfills for 2000 year

$$Q_{man\ 2000} = Q_{man\ 1999} * Q_{t\ dep\ 2000} / Q_{t\ dep\ 1999}$$

where:

- $Q_{man\ 2000}$ – quantity of MSW deposited in managed sites in 2000;
- $Q_{man\ 1999}$ - quantity of MSW deposited in managed sites in 1999;
- $Q_{t\ dep\ 2000}$ – total quantity of MSW deposited in solid waste disposal sites in 2000;
- $Q_{t\ dep\ 1999}$ - total quantity of MSW deposited in solid waste disposal sites in 1999.

They used two different formulas because for the first period was needed a more accurate estimate, taking in consideration the values specific for the years 1995 and 1999. For 2000 is not applicable this formula, but a simple formula based on the amount of MSW deposited in managed SWDS in 1999 and the ratio of total municipal waste disposed in SWDS in 2000 and 1999.

For switching to a higher level of CH_4 emissions estimates from unmanaged landfills were needed data for the period 1950-2002, but no records of historical data are in our country for this long period. In this case, the activity data on MSW disposed to unmanaged landfills were estimated by this study, since 1950, taking into account the existing data, the data reported to EUROSTAT, the database owned by other institutions, waste generation rate at the rural and urban level and population of rural and urban areas.

The experts involved in the study used the data on:

- Total MSW deposited in landfills provided by NEPA for 2003-2009 period and by EUROSTAT for 1995-2002 period;
- MSW deposited in managed landfills provided by NEPA for 2003-2009 period and ICIM for 1995-2002 period, including the corrected data.

To estimate missing data, the following formulas were used:

Equation 8.6 Quantity of MSW deposited in unmanaged deep/shallow sites in year "n"

$$Q_{Tot\ n} = Q_{Tot\ n+1} * Q_{gen\ n} / Q_{gen\ n+1} \quad \text{- for 1950-1994 period}$$

$$Q_n = Q_{n+1} * Qt_n / Qt_{n+1} \quad \text{- for 1950-2002 period}$$

$$Qt_n = Q_{Tot\ n} - Qm_n \quad \text{- for 1950-2002 period}$$

where:

- Q_n – quantity of MSW deposited in unmanaged deep/shallow sites in year "n";
- Q_{n+1} – quantity of MSW deposited in unmanaged deep/shallow sites in year "n+1";
- Qt_n – total quantity of MSW deposited in unmanaged sites in year "n";
- Qt_{n+1} – total quantity of MSW deposited in unmanaged sites in year "n+1";
- $Q_{Tot\ n}$ – total quantity of MSW deposited in solid waste disposal sites in year "n";
- $Q_{Tot\ n+1}$ – total quantity of MSW deposited in solid waste disposal sites in year "n+1";
- Qm_n – total quantity of MSW deposited in managed sites in year "n";
- $Q_{gen\ n}$ – total quantity of MSW generated in year "n";
- $Q_{gen\ n+1}$ – total quantity of MSW generated in year "n+1";

In the following table shows the activity data for the period 1950-2010.

Table 8.11 Total annual MSW disposed to Solid Waste Disposal Sites (1950 – 2010)

Year	**Amount of waste in Gg disposed to**			**Source**
	managed sites	**unmanaged deep sites**	**unmanaged shallow sites**	
1950	NO	1420.71	910.06	
1951	NO	1435.61	919.61	
1952	NO	1472.02	942.93	
1953	NO	1506.35	964.92	
1954	NO	1538.18	985.31	
1955	NO	1569.46	1005.35	
1956	NO	1562.08	1000.62	

Year	Amount of waste in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1957	NO	1629.21	1043.62	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"*
1958	NO	1651.55	1057.93	
1959	NO	1670.59	1070.13	
1960	NO	1703.69	1091.33	
1961	NO	1724.23	1104.49	
1962	NO	1738.34	1113.53	
1963	NO	1757.34	1125.70	
1964	NO	1771.71	1134.91	
1965	NO	1786.60	1144.44	
1966	NO	1870.61	1198.26	
1967	NO	1890.37	1210.91	
1968	NO	1892.51	1212.29	
1969	NO	1925.74	1233.57	
1970	NO	1954.03	1251.69	
1971	NO	1981.17	1269.08	
1972	NO	2006.88	1285.55	
1973	NO	2031.14	1301.09	
1974	NO	2061.29	1320.40	
1975	NO	2091.78	1339.93	
1976	NO	2122.92	1359.88	
1977	NO	2216.33	1419.72	
1978	NO	2250.90	1441.86	
1979	NO	2272.55	1455.73	
1980	NO	2306.24	1477.30	
1981	NO	2342.09	1500.27	
1982	NO	2382.34	1526.05	
1983	NO	2402.33	1538.86	

Year	Amount of waste in Gg disposed to			Source
	managed sites	unmanaged deep sites	unmanaged shallow sites	
1984	NO	2414.28	1546.52	
1985	NO	2439.76	1562.84	
1986	NO	2460.34	1576.02	
1987	NO	2487.09	1593.16	
1988	NO	2510.33	1608.04	
1989	NO	2545.70	1630.70	
1990	NO	2573.86	1648.74	
1991	NO	2567.78	1644.84	
1992	NO	2526.33	1618.29	
1993	NO	2527.31	1618.92	
1994	NO	2527.45	1619.01	
1995	150.00	3418.33	2189.67	
1996	235.00	3027.61	1939.39	
1997	320.00	1883.49	1206.51	
1998	405.00	2584.57	1655.60	
1999	490.00	3192.01	2044.70	
2000	565.66	3684.89	2360.43	
2001	1500.00	2791.10	1787.89	
2002	1705.00	3145.04	2014.62	
2003	1723.55	2810.00	1800.00	NEPA
2004	1933.00	2850.00	1850.00	
2005	2079.84	3020.00	1780.00	
2006	2558.26	2817.22	1392.41	
2007	2841.68	2874.98	1132.44	
2008	3024.99	3506.79	754.62	
2009	3158.06	3022.59	574.24	
2010	3183.32*	3046.77*	578.83*	

* Preliminary data (final data for 2010 will be provided after statistical survey of the end of this year)

CH_4 recovery

Starting with the current submission, data on methane recovered from landfills were improved with new and more accurate data, because a large number of operators answered to the specific questionnaires. We obtained additional data for the period 1996-2000, for which were no data in the last year's submission. Also, for period 2001-2009 the amounts of methane recovered generally increased about 2-3 times, because many more operators have reported their activity *(Table 8.12)*.

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 (476380.27 tones in 2005 and 561427.36 tones in 2006) with a higher content of biodegradable waste due to increasing recovery activities of waste.

Considering information we have at this time, the methane is recovered from 11 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 8.12 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
1997	0.83	**2008**	15.91
1998	1.23	**2009**	15.99
1999	1.60	**2010**	16.37

CO_2 and NMVOC emissions from solid waste disposal on land

Starting with this submission 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 SWDSs is broken down by bacterial action in a series of stages that result in the formation of CH_4 and CO_2 (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, hemicellulose) and because some of the CO_2 dissolves in water within the site."

Taking into account these issues and considering 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 8.13).* 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 of 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 *(Table 8.13).*

Table 8.13 Percentage of direct and indirect Greenhouse Gas Emissions from Waste Sector

Year	Greenhouse Gas					
	CH_4		CO_2		NMVOC	
	Gg	%	Gg	%	Gg	%
1989	58.63	50	46.90	40	0.82	0.7
1990	60.38	50	48.31	40	0.85	0.7
1991	62.03	50	49.62	40	0.87	0.7
1992	63.45	50	50.76	40	0.89	0.7
1993	64.81	50	51.85	40	0.91	0.7
1994	66.10	50	52.88	40	0.93	0.7
1995	71.54	50	57.23	40	1.00	0.7
1996	74.80	50	59.84	40	1.05	0.7
1997	75.73	50	60.58	40	1.06	0.7
1998	77.93	50	62.34	40	1.09	0.7
1999	82.51	50	66.01	40	1.16	0.7
2000	89.79	50	71.83	40	1.26	0.7
2001	94.44	50	75.55	40	1.32	0.7
2002	101.46	50	81.17	40	1.42	0.7
2003	106.30	50	85.04	40	1.49	0.7
2004	110.51	50	88.41	40	1.55	0.7
2005	115.96	50	92.77	40	1.62	0.7
2006	117.83	50	94.26	40	1.65	0.7
2007	123.73	50	98.98	40	1.73	0.7
2008	126.70	50	101.36	40	1.77	0.7
2009	131.79	50	105.43	40	1.85	0.7
2010	136.63*	50	109.31*	40	1.91*	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 uncertainties associated CH_4 emissions estimates from managed SWDS are presented in *Table 8.14.*

Table 8.14 Uncertainties associated CH_4 emissions estimates from managed SWDS

Parameters	Uncertainty	Source
Amount of MSW	30%	Table 5.2, IPCC GPG 2000
MCF	-10%, +0 %	Table 5.2, IPCC GPG 2000
DOC	±20%	Table 5.2, IPCC GPG 2000
DOC_F	±30%	Table 5.2, IPCC GPG 2000
F	+20%	Table 5.2, IPCC GPG 2000
k	-40%	Table 5.2, IPCC GPG 2000

Using equation 6.4 from IPCC GPG 2000, page 6.12, we calculated the uncertainty associated with the emission factor for managed SWDS:

Equation 8.7 Uncertainty associated with the emission factor for managed SWDS

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2}$$

Result **EF uncertainty for managed SWDS = 58.31%.**

According to IPCC GPG 2000, to calculate the uncertainties associated CH_4 emissions estimates from unmanaged SWDS we used the following:

❖ To calculate **EFs uncertainties for deep and shallow unmanaged sites**

Equation 8.8 EFs uncertainties for deep and shallow unmanaged sites

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2}$$

where:

- U_1, U_2, …, U_n represent the percentages uncertainties associated with MCF, DOC, DOC_F, F and k, according to *Table 8.15*.

Table 8.15 Uncertainties associated CH_4 emissions estimates from managed SWDS

Parameters		Uncertainty	Source
Amount of MSW	Deep	30%	Table 5.2, IPCC GPG 2000
	Shallow	30%	Table 5.2, IPCC GPG 2000
MCF	Deep	20%	Expert judgement
	Shallow	30%	Table 5.2, IPCC GPG 2000
DOC	Deep	20%	Table 5.2, IPCC GPG 2000
	Shallow		
DOC_F	Deep	30%	Table 5.2, IPCC GPG 2000
	Shallow		
F	Deep	20%	Table 5.2, IPCC GPG 2000
	Shallow		
k	Deep	40%	Table 5.2, IPCC GPG 2000
	Shallow		

❖ To calculate **total uncertainty of AD for unmanaged sites**

Equation 8.9 The total uncertainty of AD for unmanaged sites

$$U_{total} = \frac{\sqrt{(U_1 * x_1)^2 + (U_2 * x_2)^2 + \ldots + (U_n * x_n)^2}}{x_1 + x_2 + \ldots + x_n}$$

where:

❖ U_1, U_2, …, U_n represent the percentages uncertainties associated with quantities of MSW disposed in unmanaged deep and shallow sites and x_1, x_2, …, x_n represent the quantities of MSW disposed in unmanaged deep and shallow sites, according to *Table 8.16.* .

Table 8.16 Total uncertainty of AD for unmanaged sites

Total AD uncertainty	**AD deep**		**AD shallow**	
	Uncertainty (%)	**Value (Gg)**	**Uncertainty (%)**	**Value (Gg)**
25.66	30	3046,77	30	578,83

❖ To calculate **total uncertainty of EF for unmanaged sites**

Equation 8.10 The total uncertainty of EF for unmanaged sites

$$U_{total} = \frac{\sqrt{(U_1 * x_1)^2 + (U_2 * x_2)^2 + \ldots + (U_n * x_n)^2}}{x_1 + x_2 + \ldots + x_n}$$

where:

❖ U_1, U_2, …, U_n represent the percentages uncertainties associated with EFs for unmanaged deep and shallow sites, calculated according to equation 6.4 mentioned above and x_1, x_2, …, x_n represent the EFs values for unmanaged deep and shallow sites *(Table 8.17).*

Table 8.17 Total uncertainty of EF for unmanaged sites

Total EF uncertainty	**EF deep**		**EF shallow**	
	Uncertainty (%)	**Value**	**Uncertainty (%)**	**Value**
45.95	60.82763	0.00132	64.80741	0.00066

The equation 6.4 was used to calculate combined uncertainties of AD and EF. The results are as follows:

- Total uncertainty for CH_4 emissions from managed sites is 65.57%;
- Total uncertainty for CH_4 emissions from unmanaged sites is 52.63%.

In generally, to ensure consistency of time series, in estimation of missing data were used the same methods of calculation for the entire period counted. To estimate the quantities of MSW disposed in managed landfills in years 1996-1998 and 2000, were used two different formulas for the reasons mentioned in subchapter *8.2.2 Methodological issues – Activity data*.

Due to the fact that most of activity data are provided by NEPA 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 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 1989-2010 is consistent.

8.2.4 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 Wastewater Handling category, the results of these being mentioned on the Checklists level.

QA/QC activities were performed 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 unconformities noted and solved following QA/QC 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.

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.

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. Taking into account this mention no difference are registered.

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:

- **method**
  - the FOD method has been used for unmanaged sites.
- **activity data**
  - activity data on the quantities of solid waste deposited in unmanaged deep and shallow sites were estimated for the period 1950-2002 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”*, finished in 2011;

- the quantities of solid waste deposited in managed sites in years: 1996-1998, 2000 were estimated by study mentioned above and for years 2003-2006 and 2008 were corrected by Waste Directorate of NEPA.
- data regarding Degradable Organic Component (DOC) were estimated for 1950-2002 period by study mentioned above;

❖ **methane recovered**

- data on methane recovered from managed landfills have been improved, by adding new data sources.

Starting with this submission CO_2 and NMVOC emissions from managed and unmanaged landfills were estimated by mentioned study, the methodology was described in *subchapter 8.2.2 Methodological issues.*

The recalculations effects on the CH_4 emissions from managed sites, due to the changes in AD and other parameters, are described in *Table 8.18*. The differences in CH_4 emissions between 2011 v.4.1 submission and 2012 v.2.1 submissions comes first from recalculation of AD for 1996-1998, 2000, 2003-2006, 2008 and second from recalculation of DOC values for 1995-2002 period and third from new data on methane recovered.

Also in *Table 8.18* are presented the recalculations effects on the CH_4 emissions from unmanaged sites. It can be observe that CH_4 emissions have declined from the 2011 v.4.1 submission with a range between 16 and 55%. This decrease is mainly due to change the calculation method switching to a superior method of calculation: FOD method. Activity data also have been changed by adding new data for 1950-2000 period.

Table 8.18 Changes made in AD and parameters and their effects on emission estimates

Year	Methane recovered from managed sites [Gg]		Degradable Organic Carbon [%]		Municipal solid waste disposed to managed sites [Gg]		Methane Emissions [Gg]		Difference [%]
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	NO	NO	NO	NO	NO	NO	NO	NO	-
1990	NO	NO	NO	NO	NO	NO	NO	NO	-
1991	NO	NO	NO	NO	NO	NO	NO	NO	-
1992	NO	NO	NO	NO	NO	NO	NO	NO	-
1993	NO	NO	NO	NO	NO	NO	NO	NO	-
1994	NO	NO	NO	NO	NO	NO	NO	NO	-
1995	NO	0.00	0.14	0.13	150.00	150.00	0.36	0.31	-14.16
1996	NO	0.43	0.14	0.12	150.00	235.00	0.71	0.36	-49.79
1997	NO	0.83	0.14	0.12	150.00	320.00	1.04	0.58	-44.18
1998	NO	1.23	0.14	0.11	150.00	405.00	1.35	0.90	-33.33
1999	NO	1.60	0.14	0.13	490.00	490.00	2.48	1.48	-40.23
2000	NO	1.97	0.14	0.15	490.00	565.66	3.54	2.36	-33.31
2001	0.95	3.27	0.14	0.13	1500.00	1500.00	6.06	4.23	-30.29
2002	1.87	4.72	0.14	0.15	1705.00	1705.00	8.94	6.70	-25.06
2003	2.74	6.40	0.14	0.14	1720.00	1723.55	11.92	8.61	-27.78
2004	3.59	7.76	0.13	0.13	1930.00	1933.00	14.78	10.66	-27.84
2005	4.40	8.91	0.14	0.14	2080.00	2079.84	18.15	13.34	-26.52
2006	8.68	13.61	0.13	0.13	2558.26	2558.26	18.85	13.54	-28.18
2007	11.95	13.09	0.12	0.12	2841.68	2841.68	20.54	18.42	-10.33
2008	13.11	15.91	0.12	0.12	3187.59	3024.99	24.42	20.07	-17.81
2009	13.30	15.99	0.12	0.12	3500.00	3158.06	29.67	24.55	-17.25

Table 8.18 (continued) Changes made at parameters level and their effects on emission estimates

Year	Municipal solid waste disposed to unmanaged sites [Gg]		Methane Emissions [Gg]		Difference [%] 2011 v.4.1 submission
	2011 v.4.1 submission	2012 v.2.1. submission	2011 v.4.1 submission	2012 v.2.1 submission	
1950	NE	2330.78	NE	**1950**	NE
1951	NE	2355.22	NE	**1951**	NE
1952	NE	2414.95	NE	**1952**	NE
1953	NE	2471.27	NE	**1953**	NE
1954	NE	2523.49	NE	**1954**	NE
1955	NE	2574.81	NE	**1955**	NE
1956	NE	2562.70	NE	**1956**	NE
1957	NE	2672.84	NE	**1957**	NE
1958	NE	2709.48	NE	**1958**	NE
1959	NE	2740.73	NE	**1959**	NE
1960	NE	2795.01	NE	**1960**	NE
1961	NE	2828.71	NE	**1961**	NE
1962	NE	2851.87	NE	**1962**	NE
1963	NE	2883.03	NE	**1963**	NE
1964	NE	2906.62	NE	**1964**	NE
1965	NE	2931.04	NE	**1965**	NE
1966	NE	3068.87	NE	**1966**	NE
1967	NE	3101.27	NE	**1967**	NE
1968	NE	3104.80	NE	**1968**	NE
1969	NE	3159.31	NE	**1969**	NE
1970	NE	3205.72	NE	**1970**	NE
1971	NE	3250.25	NE	**1971**	NE
1972	NE	3292.43	NE	**1972**	NE
1973	NE	3332.23	NE	**1973**	NE

Table 8.18 (continued) Changes made at parameters level and their effects on emission estimates

Year	Municipal solid waste disposed to unmanaged sites [Gg]		Methane Emissions [Gg]		Difference [%] 2011 v.4.1 submission
	2011 v.4.1 submission	2012 v.2.1. submission	2011 v.4.1 submission	2012 v.2.1 submission	
1974	NE	3381.69	NE	33.69	-
1975	NE	3431.71	NE	35.10	-
1976	NE	3482.80	NE	36.53	-
1977	NE	3636.05	NE	38.17	-
1978	NE	3692.76	NE	39.83	-
1979	NE	3728.28	NE	41.49	-
1980	NE	3783.54	NE	43.17	-
1981	NE	3842.36	NE	44.89	-
1982	NE	3908.39	NE	46.65	-
1983	NE	3941.19	NE	48.40	-
1984	NE	3960.80	NE	50.10	-
1985	NE	4002.60	NE	51.80	-
1986	NE	4036.37	NE	53.49	-
1987	NE	4080.25	NE	55.19	-
1988	NE	4118.37	NE	56.89	-
1989	3825.60	4176.39	111.79	58.63	-47.56
1990	3873.80	4222.60	113.95	60.38	-47.01
1991	3863.66	4212.62	114.41	62.03	-45.78
1992	3801.94	4144.63	113.32	63.45	-44.01
1993	3804.66	4146.24	114.15	64.81	-43.23
1994	3805.63	4146.47	114.92	66.10	-42.49
1995	4746.85	5608.00	144.27	71.23	-50.63
1996	5092.09	4967.00	155.76	74.44	-52.21
1997	5266.09	3090.00	162.12	75.15	-53.65

Table 8.18 (continued) Changes made at parameters level and their effects on emission estimates

Year	Municipal solid waste disposed to unmanaged sites [Gg]		Methane Emissions [Gg]		Difference [%] 2011 v.4.1 submission
	2011 v.4.1 submission	2012 v.2.1. submission	2011 v.4.1 submission	2012 v.2.1 submission	
1998	4495.17	4240.17	139.29	77.03	-44.70
1999	5236.72	5236.72	163.25	81.03	-50.36
2000	6120.99	6045.32	191.66	87.42	-54.39
2001	4579.00	4579.00	144.75	90.22	-37.67
2002	5159.66	5159.66	163.53	94.76	-42.05
2003	4610.00	4610.00	154.59	97.69	-36.80
2004	4700.00	4700.00	141.77	99.85	-29.57
2005	4800.00	4800.00	156.66	102.62	-34.49
2006	4209.63	4209.63	137.12	104.29	-23.94
2007	4007.42	4007.42	125.60	105.31	-16.15
2008	4261.41	4261.42	132.86	106.63	-19.74
2009	4000.00	3596.83	128.67	107.24	-16.66

8.2.6 Source specific planned improvement including those in response to the review process

In order to improve accuracy of activity data regarding amounts of MSW deposited in managed landfills for 1995-2002 period we will try to make a statistical research by collecting these data from the landfills operators.

As regarding methane recovered, in present we have only CH_4 recovered from managed landfills, but there is the possibility that methane to be recovered also from unmanaged landfills. We will make a thorough statistical survey for improving this information.

More investigation will be necessary for collecting data on industrial waste and sludge deposited in solid waste disposal sites.

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 2010, from a total a total volume of 4842.2 million m^3/an wastewater evacuated, 39.94% was wastewater which requiring treatment. From this, 17.83% was represented wastewater sufficient (appropriate) treated, 13.27% untreated wastewater and 8.84% insufficient treated wastewater *(Table 8.19)*.

Table 8.19 Wastewater evacuated into Romania, in 2010 (Source: National Administration "Romanian Waters"

Wastewater category	Volume (mil. mc)	Percentage (%)
Total wastewater evacuated	4842.20	-
Total domestic wastewater evacuated	1352.60	27.93
Total industrial wastewater evacuated	3489.60	72.07
Domestic wastewater treated	760.23	15.70
Industrial wastewater treated	503.59	10.40
Total wastewater requiring treatment	1933.90	39.94
Sufficient treated wastewater	863.40	17.83
Insufficient treated wastewater	428.10	13.27
Untreated wastewater	642.40	8.84

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 3489.6 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 2010 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. About 20% of cities in Romania have a sewage system sewer separation, the remaining 80% with single drainage system.

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

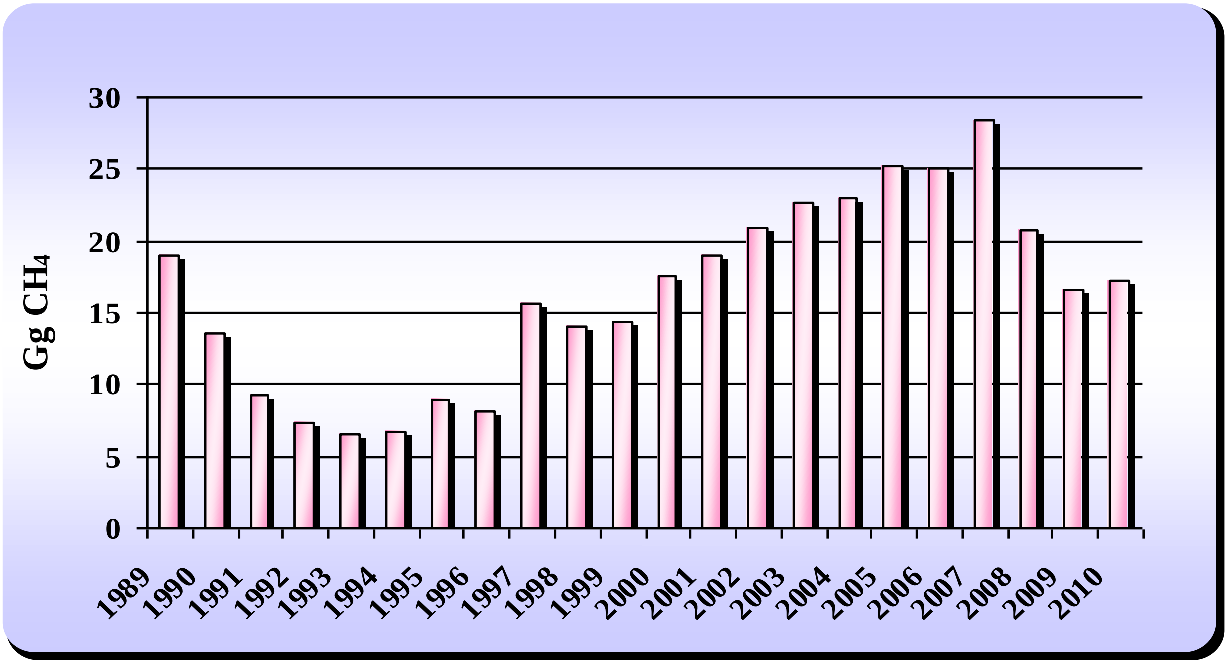
CH_4 emissions from industrial wastewater and sludge (CRF 6.B.1)

Depending on the industry of origin, industrial wastewaters have a different composition. The problems 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.

Analyzing 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. After 1989 the industrial production in generally decreased affected by political and economical changes in our country. This decreasing can be observed also in decreasing of methane emissions. From 1995 to 2000 followed a period of economical fluctuation, but since 2000 industrial production has increased over the level of year 1989 *(Table 8.23)*.

Since 2007, CH_4 emissions from industrial wastewater treatment have begun to fall again 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 1989–2010 period



Compared with base year (1989), CH_4 emissions from industrial wastewater treatment decreased with 18.58%.

CH_4 emissions from domestic and commercial wastewater and sludge (CRF 6.B.2.1)

Starting with this submission in estimation of CH_4 emissions from domestic/commercial wastewater and sludge, we 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).

Analyzing the chart bellow, it can observe a mainly decreasing trend due to increasing number of population connected to sewerage *(Figure 8.9)*. The methane emissions level of 2010 compared to base year (1989) is in increasing with 28.18%.

Figure 8.9 CH_4 emissions trend from domestic/commercial wastewater and sludge treatment for 1989–2010 period

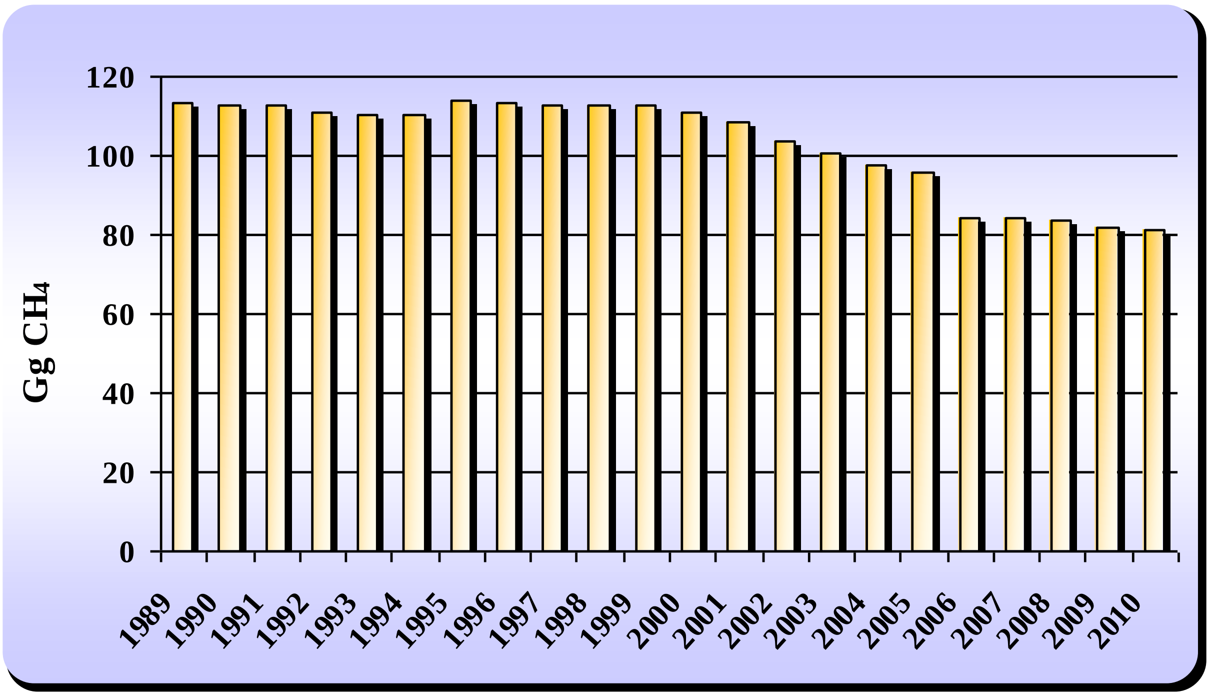


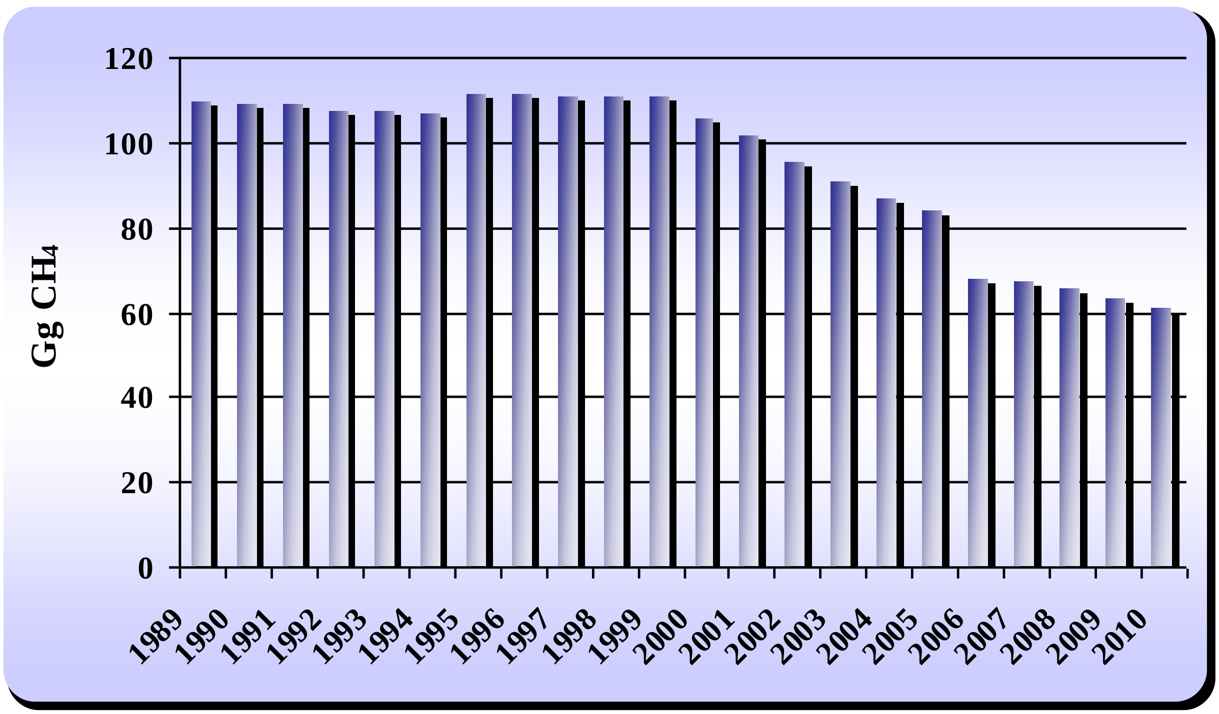
Table 8.20 Explanations on methane emissions estimates

(Source: Study finished in 2011)

Period	Methane emissions from industrial wastewater treatment -Explanations
1989 - 1996	Values between 18.91 – 8.07 Gg These values are decreasing following decreasing industrial production.
1997 - 2004	Values between 15.57 – 23.03 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 - 2010	Values between 25.24 – 17.22 Relatively higher values compared with 1997-2004 period, but since 2007 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)*.

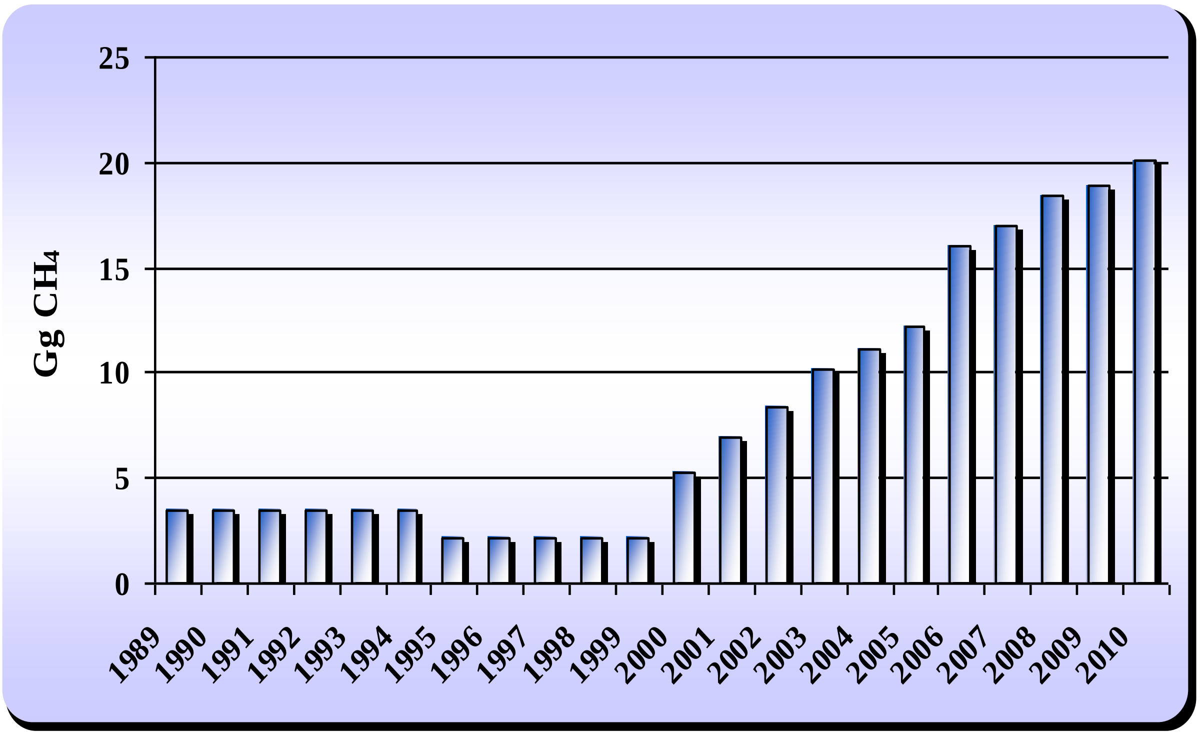
Figure 8.10 CH_4 emissions trend from domestic/commercial wastewater treatment for 1989–2010 period



Compared to 2011 v.4.1 submission, CH_4 emissions from domestic/commercial sludge have a much lower values, in some cases reaching a third of emissions of 2011 last submission. This is due to using of a country specific emission factor 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 major changes and assumptions will be presented in *sub-chapter 8.3.2 Methodological issues*.

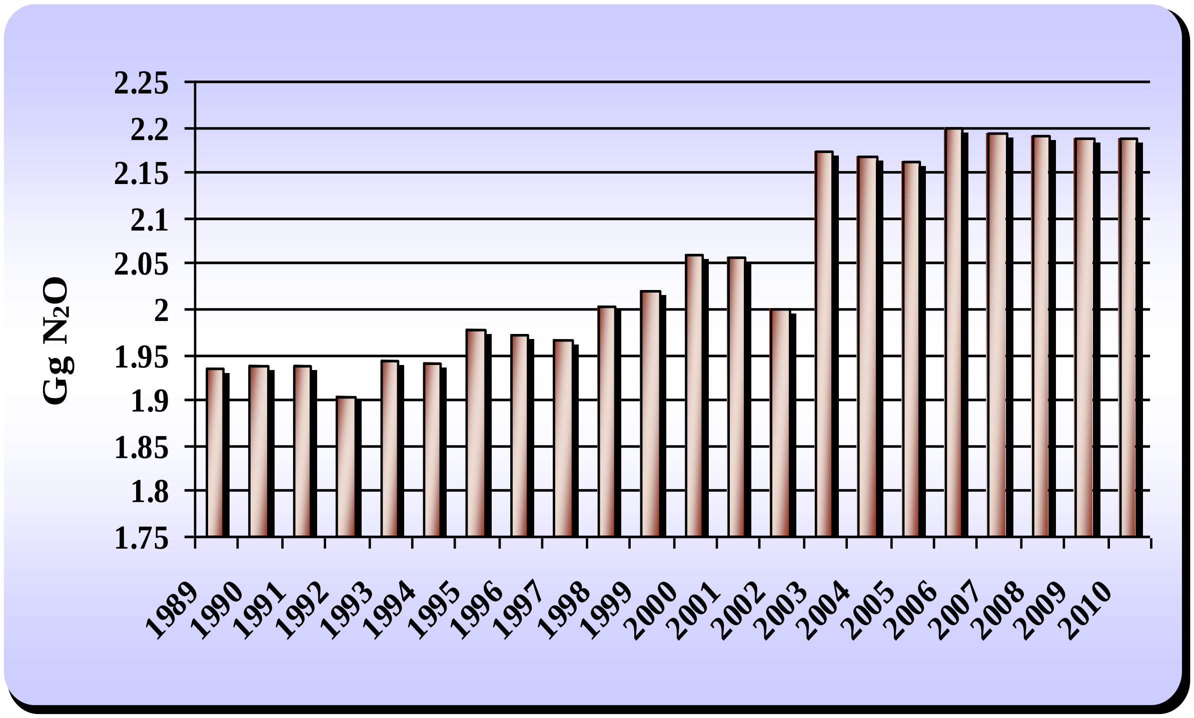
In 2010, CH_4 emissions from domestic/commercial sludge increased almost 6 times compared with 1989 *(Figure 8.11)*. As for emissions from domestic/commercial wastewater treatment the explanation is the increasing of number population connected to sewerage, in particular connected to sewerage with treatment.

Figure 8.11 CH_4 emissions trend from domestic/commercial sludge treatment for 1989–2010 period



At the recommendation of ERT, starting with the 2011 v.4.1 submission, we estimate N_2O emissions from human sewage using 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, but sudden drops in 1992 and 2002 it explain by abrupt decreases of population number in these two years *(Figure 8.12 and Table 8.26)*.

Figure 8.12 N_2O emissions trend from human sewage for 1989–2010 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.

For methane emissions from industrial wastewater calculation, the equation 5.5 from page 5.14 was used:

Equation 8.11 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 8.12 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 by summing TOW obtained for each industry in step 1.

Equation 8.13 Total Industrial Organic Wastewater

$$TOW_{ind\ total} = TOW_{beer} + TOW_{pulp\&paper} + TOW_{petroleum\ ref.}$$

3. Estimation of CH_4 emissions using $TOW_{ind\ total}$ obtained in step 2 and the Emission Factor provided by study finished in 2011.

Emission factor

To calculate Emission Factor we used the equation 10 from Revised 1996 IPCC Guidelines:

Equation 8.14 The emission factor for industrial wastewater

$$EF_i = B_{oi} * \sum(WS_{ix} * MCF_x)$$

According to methodology it was taking in consideration only the fraction of industrial wastewater treated anaerobically because only in this case methane issue.
The expert Nicoleta Chiriac researcher in wastewater treatment field considers that the analyzed period, from 1989 – 2010, can be divided into three distinct periods, in terms of values for fractions of treated industrial wastewater by anaerobic process. The table below illustrates the fractions of treated industrial wastewater by anaerobic process.

Table 8.21 Fraction of industrial wastewater treated anaerobically (Source: Study finished in 2011)

Period	Fraction of wastewater treated by anaerobic process	Explanations
1989 – 1996	0.05	In this period a small number of industrial treatment plants had anaerobic treatment due to the permissive legislation which was not in compliance with European legislation.
1997 - 2004	0.10	The European regulations in this field begun to implemented in Romania and industrial enterprises were required to comply with these by modernization and rehabilitation of treatment plants.
2005 - 2010	0.15	In this period modernization activities were intensified by using the European funds or another financial sources

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.

In accordance with Revised 1996 IPCC Guidelines: *"Methane conversion factor defines the portion of CH_4 producing potential that is achieved. The MCF varies between 0.0, for a completely aerobic system, to 1.0 for a completely anaerobic system. Countries should contact wastewater experts to determine MCFs"*. Taking into account these mentions, by study finished in 2011 was provided MCF value for our country *(Table 8.22)*.

Table 8.22 Calculation of Emission Factors for industrial wastewater, for 1989-2010 period

Period	B_{oi} (kg CH_4/kg COD)	WS_{ix}	MCF_x	**EFs**
1989–1996	0.25	0.05	0.9	**0.01125**
1997-2004	0.25	0.10	0.9	**0.02250**
2005-2010	0.25	0.15	0.9	**0.03375**
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 8.15 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 8.23).*

Table 8.23 Industrial production of the industrial sectors with the greatest potential for methane emissions (source: NIS - Statistical Yearbook 2010)

Year	**Production (t/year)**			
	Beer	**Paper**	**Pulp**	**Petroleum Refining**
1989	1151300	552000	574000	30615000
1990	1052700	427000	380000	23664000
1991	980300	307000	235000	15191000
1992	1001400	262000	171000	13299000
1993	992900	248000	132000	13191000
1994	904600	262000	128000	14744000
1995	876800	332000	194000	15259000
1996	811800	299000	177000	13426000
1997	765100	306000	154000	12429000
1998	998900	281000	129000	12520000
1999	1113300	276000	144000	9894000
2000	1266400	328000	187000	10532000
2001	1266300	388000	172000	10948000
2002	1162700	421000	199000	11906000
2003	1329200	457000	212000	10736000
2004	1440600	492000	187000	12371000
2005	1529500	385000	103000	13890000
2006	1748400	401000	80000	13237000
2007	1921300	461000	86000	13006000
2008	2024000	369000	22000	13095000
2009	1809000	310000	*	11340000
2010	1665600	325000	*	9931000

* Confidential

Using values on wastewater generated extracted from the environmental authorizations for several industrial enterprises such as brewing, pulp and paper, the experts involved in the study tried to obtain national values for wastewater generated and COD within these sectors. Unfortunately, these data are incomplete and not be used, in some cases having a single data provider. In this case, we used the default values from IPCC GPG 2000 *(Table 8. 24).*

Table 8.24 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	1
Wastewater Generation [m^3/Mg]	6.3	162	0.6

Degradable Organic Component removed as sludge in modern treatment plants represents 80-95% DC from industrial wastewater, according to expert opinion, scientific research Nicoleta Chiriac. In estimation of methane emissions from industrial wastewater it can consider zero for DC removed by the sludge, taking into account all of the DC from the wastewater (source: expert - Nicoleta Chiriac scientific research).

Recovered CH_4 from industrial wastewater treatment was reported as NO. In the future we will investigate this issue by collecting the answers from the economic operators that produce wastewater.

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 8.16 CH_4 emissions from domestic and commercial wastewater

*Emissions = (Total Organic Waste * Emission Factor) – Methane Recovery*

Starting with this submission we 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 8.17 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 8.18 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 8.25.*

Table 8.25 Calculation of Emission Factors domestic/commercial wastewater, for 1989-2010 period

Parameter	$\mathbf{B_{oi}}$ **(**kg CH_4/kg BOD)	$\mathbf{WS_{ix}}$	$\mathbf{MCF_x}$	**EFs**
Population connected to sewerage with treatment	0.60	0.05	0.9	**0.027**
Population unconnected to sewerage	0.60	1.00	0.5	**0.300**
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 8.19 The weighted Methane Conversion Factor for domestic and commercial wastewater

$$Weighted\ MCF_i = \sum(WS_{ix} * MCF_x)$$

Activity data

To estimates methane emissions from domestic/commercial wastewater handling we 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 population from urban and rural areas and fraction of urban/rural population connected to sewerage with treatment. The data on urban/rural population were obtained from National Institute for Statistics (NIS). The fraction of urban/rural 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 8.26).*

Table 8.26 Activity data for methane emissions estimates from domestic/commercial wastewater (Source: Study finished in 2011)

ACTIVITY DATA	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Urban population [1000 persons]	12311.80	12608.84	12552.41	12367.36	12406.20	12427.61	12457.20	12411.17	12404.69	12347.89	12302.73
Rural population [1000 persons]	10839.76	10597.88	10632.68	10421.61	10349.06	10303.01	10223.76	10196.45	10141.24	10154.92	10155.29
Total population [1000 persons]	23151.56	23206.72	23185.08	22788.97	22755.26	22730.62	22680.95	22607.62	22545.93	22502.80	22458.02
Fraction of urban population connected to sewerage	0.450	0.450	0.450	0.450	0.450	0.450	0.400	0.400	0.400	0.400	0.400
Fraction of urban population connected to sewerage with treatment	0.500	0.500	0.500	0.500	0.500	0.500	0.350	0.350	0.350	0.350	0.350
Urban population connected to sewerage [1000 persons]	5540.31	5673.98	5648.58	5565.31	5582.79	5592.43	4982.88	4964.47	4961.88	4939.15	4921.09
Urban population connected to sewerage with treatment [1000 persons]	2770.16	2836.99	2824.29	2782.66	2791.40	2796.21	1744.01	1737.56	1736.66	1728.70	1722.38
Urban population connected to sewerage without treatment [1000 persons]	2770.16	2836.99	2824.29	2782.66	2791.40	2796.21	3238.87	3226.91	3225.22	3210.45	3198.71
Urban population unconnected to sewerage [1000 persons]	6771.49	6934.86	6903.82	6802.05	6823.41	6835.19	7474.32	7446.70	7442.81	7408.73	7381.64
Fraction of rural population connected to sewerage	0.100	0.100	0.100	0.100	0.100	0.100	0.080	0.080	0.080	0.080	0.080
Fraction of rural population connected to sewerage with treatment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rural population connected to sewerage [1000 persons]	1083.98	1059.79	1063.27	1042.16	1034.91	1030.30	817.90	815.72	811.30	812.39	812.42
Rural population connected to sewerage with treatment [1000 persons]	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rural population connected to sewerage without treatment [1000 persons]	1083.98	1059.79	1063.27	1042.16	1034.91	1030.30	817.90	815.72	811.299	812.393	812.42
Rural population unconnected to sewerage [1000 persons]	9755.79	9538.09	9569.41	9379.45	9314.15	9272.71	9405.86	9380.73	9329.936	9342.524	9342.87
Total population connected to sewerage with treatment [1000 persons]	**2770.16**	**2836.99**	**2824.29**	**2782.66**	**2791.40**	**2796.21**	**1744.01**	**1737.56**	**1736.66**	**1728.70**	**1722.38**
Total population connected to sewerage without treatment [1000 persons]	**3854.13**	**3896.78**	**3887.56**	**3824.82**	**3826.30**	**3826.51**	**4056.77**	**4042.62**	**4036.52**	**4022.84**	**4011.13**
Total population unconnected to sewerage [1000 persons]	**16527.28**	**16472.95**	**16473.23**	**16181.50**	**16137.56**	**16107.90**	**16880.17**	**16827.44**	**16772.75**	**16751.26**	**16724.51**

Table 8.26 (continued) Activity data for methane emissions estimates from domestic/commercial wastewater

ACTIVITY DATA	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Urban population [1000 persons]	12244.60	12243.76	11608.74	11600.16	11895.60	11879.90	11913.94	11877.66	11835.33	11823.52	11818.67
Rural population [1000 persons]	10190.61	10164.65	10186.06	10133.40	9777.73	9743.95	9670.43	9659.90	9669.11	9646.44	9643.52
Total population [1000 persons]	22435.21	22408.40	21794.79	21733.56	21673.33	21623.85	21584.37	21537.56	21504.44	21469.96	21462.19
Fraction of urban population connected to sewerage	0.440	0.480	0.520	0.560	0.580	0.600	0.761	0.774	0.781	0.782	0.792
Fraction of urban population connected to sewerage with treatment	0.400	0.450	0.500	0.550	0.570	0.600	0.669	0.667	0.673	0.674	0.704
Urban population connected to sewerage [1000 persons]	5387.62	5877.00	6036.54	6496.09	6899.45	7127.94	9070.56	9195.90	9237.82	9251.84	9354.90
Urban population connected to sewerage with treatment [1000 persons]	2155.05	2644.65	3018.27	3572.85	3932.69	4276.76	6068.66	6130.40	6215.16	6236.54	6582.10
Urban population connected to sewerage without treatment [1000 persons]	3232.57	3232.35	3018.27	2923.24	2966.76	2851.18	3001.91	3065.50	3022.66	3015.30	2772.80
Urban population unconnected to sewerage [1000 persons]	6856.98	6366.75	5572.19	5104.07	4996.15	4751.96	2843.37	2681.76	2597.51	2571.68	2463.77
Fraction of rural population connected to sewerage	0.100	0.120	0.140	0.160	0.180	0.200	0.230	0.250	0.270	0.300	0.322
Fraction of rural population connected to sewerage with treatment	0.030	0.060	0.090	0.120	0.130	0.150	0.170	0.190	0.210	0.230	0.250
Rural population connected to sewerage [1000 persons]	1019.06	1219.76	1426.05	1621.34	1759.99	1948.79	2224.20	2414.98	2610.66	2893.93	3105.21
Rural population connected to sewerage with treatment [1000 persons]	305.72	609.88	916.75	1216.01	1271.11	1461.59	1643.97	1835.38	2030.51	2218.68	2410.88
Rural population connected to sewerage without treatment [1000 persons]	713.34	609.88	509.30	405.34	488.89	487.20	580.23	579.59	580.15	675.25	694.33
Rural population unconnected to sewerage [1000 persons]	9171.55	8944.89	8760.01	8512.06	8017.74	7795.16	7446.23	7244.93	7058.45	6752.51	6538.30
Total population connected to sewerage with treatment [1000 persons]	**2460.77**	**3254.53**	**3935.02**	**4788.86**	**5203.79**	**5738.36**	**7712.63**	**7965.78**	**8245.68**	**8455.22**	**8992.98**
Total population connected to sewerage without treatment [1000 persons]	**3945.92**	**3842.23**	**3527.57**	**3328.58**	**3455.65**	**3338.37**	**3582.14**	**3645.10**	**3602.80**	**3690.55**	**3467.13**
Total population unconnected to sewerage [1000 persons]	**16028.52**	**15311.64**	**14332.20**	**13616.12**	**13013.89**	**12547.12**	**10289.60**	**9926.69**	**9655.96**	**9324.19**	**9002.07**

The data sources are presented in the next table:

Table 8.27 The sources of activity data used in methane emissions estimates from domestic/commercial wastewater treatment

Activity Data	Source
Urban population [1000 persons] - P_{urb}	National Institute for Statistics
Rural population [1000 persons] -P_{rur}	National Institute for Statistics
Total population [1000 persons]	National Institute for Statistics
Fraction of urban population connected to sewerage - F_{urb}	1989 – 1999 period and 2005 – expert prof. dr. Vladimir Rojanschi. 2000 - 2004 period – interpolation 2006 - 2010 period – National Institute for Statistics
Fraction of urban population connected to sewerage with treatment – $F_{urb\ tr}$	1989 – 1999 period and 2005 – expert prof. dr. Vladimir Rojanschi. 2000 - 2004 period – interpolation 2006 - 2010 period – National Institute for Statistics
Urban population connected to sewerage [1000 persons] - $P_{urb\ con}$	1989 – 2005 period : $P_{urb\ con} = P_{urb} * F_{urb}$ 2006 - 2010 period: National Institute for Statistics
Urban population connected to sewerage with treatment [1000 persons] – $P_{urb\ tr}$	1989 – 2005 period: $P_{urb\ tr} = P_{urb} * F_{urb\ tr}$ 2006 - 2010 period: National Institute for Statistics.
Urban population connected to sewerage without treatment [1000 persons] - $P_{urb\ w\ tr}$	1989 – 2005 period: $P_{urb\ w\ tr} = P_{urb\ con} - P_{urb\ tr}$ 2006 - 2010 period: National Institute for Statistics.
Urban population unconnected to sewerage [1000 persons] - $P_{urb\ uncon}$	1989 – 2005 period: $P_{urb\ uncon} = P_{urb} - P_{urb\ con}$ 2006 - 2010 period: National Institute for Statistics
Fraction of rural population connected to sewerage - F_{rur}	1989 - 1999 period, 2005 - expert prof. dr. Vladimir Rojanschi 2000 - 2004 period - interpolation. 2006 - 2010 period - extrapolation
Fraction of rural population connected to sewerage with treatment – $F_{rur\ tr}$	1989 – 1999 period, 2005 - expert prof. dr. Vladimir Rojanschi. 2000 - 2004 period - interpolation 2006 - 2010 period - extrapolation
Rural population connected to sewerage [1000 persons] – $P_{rur\ con}$	1989 – 2005 period: $P_{rur\ con} = P_{rur} * F_{rur}$. 2006 - 2010 period: National Institute for Statistics.

Table 8.27 (continued) The sources of activity data used in methane emissions estimates from domestic/commercial wastewater treatment

Activity Data	Source
Rural population connected to sewerage with treatment [1000 persons] – $P_{rur\ tr}$	1989 – 2005 period: $P_{rur\ tr} = P_{rur} * F_{rur\ tr}$ 2006 - 2010 period: National Institute for Statistics.
Rural population connected to sewerage without treatment [1000 persons] – $P_{rur\ w\ tr}$	1989 – 2005 period: $P_{rur\ w\ tr} = P_{rur\ con} - P_{rur\ tr}$ 2006 - 2010 period: National Institute for Statistics.
Rural population unconnected to sewerage [1000 persons] – $P_{rur\ uncon}$	1989 – 2005 period: $P_{rur\ uncon} = P_{rur} - P_{rur\ con}$ 2006 - 2010 period: National Institute for Statistics.
Total population connected to sewerage with treatment [1000 persons] - $P_{tot\ tr}$	1989 -2010 period: $P_{tot\ tr} = P_{urb\ tr} + P_{rur\ tr}$
Total population connected to sewerage without treatment [1000 persons] – $P_{tot\ w\ tr}$	1989 -2010 period: $P_{tot\ w\ tr} = P_{urb\ w\ tr} + P_{rur\ w\ tr}$
Total population unconnected to sewerage [1000 persons] – $P_{tot\ uncon}$	1989 -2010 period: $P_{tot\ uncon} = P_{urb\ uncon} + P_{rur\ uncon}$

To calculate Total Organic Wastewater we used the parameters provided by the study *(Table 8.28).*

Table 8.28 Parameters used to estimate Total organic domestic/commercial wastewater (Source: Study finished in 2011)

Parameters	Years				
	1989-1999	**2000-2005**	**2006**	**2007**	**2008-2010**
Degradable Organic Component – BOD [kg/1000 persons/yr]	21900	21900	21438	21900	21900
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 2008-2010 period was provided by NIS.
CH_4 emissions from domestic/commercial wastewater recovered and/or flared are reported as 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 8.20 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 8.21 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 8.22 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.

Table 8.29 Calculation of Emission Factor for domestic/commercial sludge, for 1989-2010 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 8.23 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 8.30*.

Table 8.30 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 1989-2010 period.

The data regarding Protein Consumption were provided by Food and Agriculture Organization site and are presented in the *Table 8.31*.

Table 8.31 Values of Protein Consumption for Romania in period 1989-2010

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	40.515	
2009	40.515	It was considered the value for 2008
2010	40.515	

8.3.3 Uncertainties and time series consistency

CH_4 emissions from industrial wastewater

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

Activity Data	Uncertainty	Source
Industrial production (t/yr) [Reporting errors in NIS database]	± 25%	IPCC GPG 2000, table 5.5
Wastewater generated/unit production (mc/t)	± 100%	IPCC GPG 2000, table 5.5
COD/unit wastewater (kg /mc wastewater)		
Emission factor	**Uncertainty**	**Source**
Fraction of wastewater anaerobically treated (%)	± 10%	Expert judgement – researcher Nicoleta Chiriac
Methane Conversion Factor in anaerobic process (%)	± 7%	Expert judgement – researcher Nicoleta Chiriac
Maximum methane producing capacity (kg CH_4/kg COD)	± 30%	IPCC GPG 2000, page. 5.17

The uncertainty associated with the emission factor specific to CH_4 emissions from industrial wastewater is estimated to be 32.39% and the uncertainty associated with the activity data is estimated to 143.61%.

The overall uncertainty resulted after the aggregation of the AD and EF uncertainties according to the provisions in Chapter 6 of IPCC GPG 2000 is 147.22%.

CH_4 from domestic and commercial wastewater

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

Activity Data	Uncertainty	Source
Population (number of persons) [Reporting errors in NIS database]	$\pm$ 5%	IPCC GPG 2000, table 5.3
Fraction of population connected to sewerage with treatment	$\pm$ 5%	Prof. dr. V. Rojanschi
BOD (kg /pers/yr)	$\pm$ 10%	Prof. dr. V. Rojanschi and dr. eng. T. Ognean *"Book of the operator of the domestic wastewater treatment plants"*, page. 249
Fraction of BOD removed as sludge	$\pm$ 5%	Prof. dr. V. Rojanschi
Emission factor	**Uncertainty**	**Source**
Fraction of wastewater/sludge anaerobically treated (%)	$\pm$ 5%	Expert judgement – researcher Nicoleta Chiriac
Methane Conversion Factor in anaerobic process (%)	$\pm$ 7%	Expert judgement – researcher Nicoleta Chiriac
Maximum methane producing capacity (kg CH_4/kg COD)	$\pm$ 30%	IPCC GPG 2000, page. 5.17

The uncertainty associated with the emission factor specific to CH_4 emissions from domestic and commercial wastewater is estimated to be 31.21% and the uncertainty associated with the activity data is estimated to 13.23%.

The overall uncertainty resulted after the aggregation of the AD and EF uncertainties according to the provisions in Chapter 6 of IPCC GPG 2000 is 33.90%.

N_2O from human sewage

In the table below are presented the uncertainties associated N_2O emissions from human sewage.

Table 8.34 Uncertainties for estimation of N_2O emissions from human sewage

Activity Data	**Uncertainty**	**Source**
Population (number of persons) [Reporting errors in NIS database]	± 5%	NIS expert
Protein Consumption (kg protein/pers/yr)	± 10%	Agriculture Sector expert– prof. Vasilica Stan
Emission factor	**Uncertainty**	**Source**
Fraction of Nitrogen in protein (kg N/kg protein)	± 10%	Agriculture Sector expert– prof. Vasilica Stan
Emission Factor (kg N_2O-N/kg sewage N produced)	± 7%	Agriculture Sector expert– prof. Vasilica Stan

The uncertainty associated with emission factor for N_2O emissions from human sewage is 12.21% and the uncertainty associated with activity data is 11.18%.

The overall uncertainty resulted after the aggregation of the AD and EF uncertainties according to the provisions in Chapter 6 of IPCC GPG 2000 is 16.56%.

The time series is consistent, emissions resulted from this source category were estimated for the entire period using the same assumptions and the same emission factors (default values, indicated in the methodology).

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 sectoral expert administrating the Solid Waste Disposal on Land category, the results of these being mentioned on the Checklists level.

QA/QC activities were performed 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.* “

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.

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 number of population was provided by National Institute for Statistics the same parameter being reported to EUROSTAT. The small 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 2012 (Source NIS) *1 July*	EUROSTAT *1 January*	
1989	23151.564	-	-
1990	23206.720	23211.395	4.675
1991	23185.084	23192.274	7.190
1992	22788.969	22811.392	22.423
1993	22755.260	22778.533	23.273
1994	22730.622	22748.027	17.405
1995	22680.951	22712.394	31.443
1996	22607.620	22656.145	48.525
1997	22545.925	22581.862	35.937
1998	22502.803	22526.093	23.290
1999	22458.022	22488.595	30.573
2000	22435.205	22455.485	20.280
2001	22408.393	22430.457	22.064
2002	21794.793	21833.483	38.690
2003	21733.556	21772.774	39.218
2004	21673.328	21711.252	37.924
2005	21623.849	21658.528	34.679
2006	21584.365	21610.213	25.848
2007	21537.563	21565.119	27.556
2008	21504.440	21528.627	24.187
2009	21469.960	21498.616	28.656
2010	21462.186	21462.186	0

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**
  - In estimation of CH_4 emissions from domestic /commercial wastewater and sludge we took into consideration both the population connected to sewerage with treatment and the population unconnected to sewerage;
  - By study finished in 2011 were provided country specific values for Degradable Organic Component (Ddom) and Fraction of Degradable Organic Component removed as sludge (DSdom);
  - Were reviewed data regarding Protein Consumption provided by Food and Agriculture Organization of the United Nations.
- **Emission Factor**

Were used country specific values for Fraction of wastewater treated anaerobically (WSx) and Methane Conversion Factor (MCF) for CH_4 emissions estimates from industrial wastewater, domestic/commercial wastewater and sludge.

Table 8.36 Changes made in activity data and their effects on emission estimates from industrial wastewater

Year	Fraction of wastewater treated anaerobically - WS_x		Methane Conversion Factor - MCF_x		CH_4 emissions		Difference (%)
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	0.02	0.05	1.00	0.90	8.49	18.91	+122.80
1990	0.02	0.05	1.00	0.90	6.13	13.61	+121.89
1991	0.02	0.05	1.00	0.90	4.18	9.19	+120.18
1992	0.02	0.05	1.00	0.90	3.37	7.40	+119.39
1993	0.02	0.05	1.00	0.90	3.02	6.53	+116.36
1994	0.02	0.05	1.00	0.90	3.12	6.68	+114.33
1995	0.02	0.05	1.00	0.90	4.09	8.91	+117.86
1996	0.02	0.05	1.00	0.90	3.70	8.07	+117.78
1997	0.02	0.10	1.00	0.90	3.59	15.57	+333.78
1998	0.02	0.10	1.00	0.90	3.21	14.03	+337.41
1999	0.02	0.10	1.00	0.90	3.29	14.37	+336.22
2000	0.02	0.10	1.00	0.90	4.00	17.56	+339.04
2001	0.02	0.10	1.00	0.90	4.33	19.04	+339.80
2002	0.02	0.10	1.00	0.90	4.76	20.98	+340.77
2003	0.02	0.10	1.00	0.90	5.13	22.64	+341.46
2004	0.02	0.10	1.00	0.90	5.24	23.03	+339.24
2005	0.02	0.15	1.00	0.90	3.79	25.24	+566.38
2006	0.02	0.15	1.00	0.90	3.80	25.01	+558.83
2007	0.02	0.15	1.00	0.90	4.30	28.36	+560.21
2008	0.02	0.15	1.00	0.90	3.17	20.75	+554.83
2009	0.02	0.15	1.00	0.90	2.55	16.60	+551.69

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 (%)
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.39	109.65	+27706.26
1990	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.40	109.32	+26969.18
1991	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.40	109.31	+27090.13
1992	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.40	107.38	+27009.05
1993	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.40	107.10	+26852.37
1994	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.40	106.90	+26757.44
1995	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.25	111.57	+44842.11
1996	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.25	111.22	+44867.67
1997	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.25	110.86	+44745.71
1998	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.25	110.72	+44893.38
1999	0.02	0.050	1.00	0.90	18250	21900	0.35	0.35	0.25	110.54	+44985.86
2000	0.02	0.050	1.00	0.90	18250	21900	0.60	0.60	0.21	105.89	+51315.48
2001	0.02	0.050	1.00	0.90	18250	21900	0.60	0.60	0.26	101.37	+38836.59
2002	0.02	0.050	1.00	0.90	18250	21900	0.60	0.60	0.31	95.09	+30114.23
2003	0.02	0.050	1.00	0.90	18250	21900	0.60	0.60	0.37	90.59	+24442.25
2004	0.02	0.050	1.00	0.90	18250	21900	0.60	0.60	0.42	86.73	+20379.25
2005	0.02	0.050	1.00	0.90	18250	21900	0.60	0.60	0.48	83.79	+17433.24
2006	0.02	0.050	1.00	0.90	18250	21438	0.60	0.60	0.53	67.96	+12684.13
2007	0.02	0.050	1.00	0.90	18250	21900	0.60	0.60	0.54	67.10	+12395.26
2008	0.02	0.050	1.00	0.90	18250	21900	0.60	0.63	0.54	65.24	+11883.44
2009	0.02	0.050	1.00	0.90	18250	21900	0.60	0.63	0.55	63.11	+11451.80

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 (%)
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	10.19	3.44	-66.25
1990	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	10.44	3.52	-66.25
1991	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	10.39	3.51	-66.25
1992	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	10.24	3.46	-66.25
1993	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	10.27	3.47	-66.25
1994	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	10.29	3.47	-66.25
1995	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	6.42	2.17	-66.25
1996	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	6.39	2.16	-66.25
1997	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	6.39	2.16	-66.25
1998	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	6.36	2.15	-66.25
1999	0.96	0.30	1.00	0.90	18250	21900	0.35	0.35	6.34	2.14	-66.25
2000	0.96	0.30	1.00	0.90	18250	21900	0.60	0.60	14.83	5.24	-64.67
2001	0.96	0.30	1.00	0.90	18250	21900	0.60	0.60	18.74	6.93	-63.04
2002	0.96	0.30	1.00	0.90	18250	21900	0.60	0.60	22.66	8.38	-63.04
2003	0.96	0.30	1.00	0.90	18250	21900	0.60	0.60	26.58	10.19	-61.64
2004	0.96	0.30	1.00	0.90	18250	21900	0.60	0.60	30.49	11.08	-63.67
2005	0.96	0.30	1.00	0.90	18250	21900	0.60	0.60	34.41	12.22	-64.50
2006	0.96	0.30	1.00	0.90	18250	21438	0.60	0.60	38.28	16.07	-58.01
2007	0.96	0.30	1.00	0.90	18250	21900	0.60	0.60	38.67	16.96	-56.15
2008	0.96	0.30	1.00	0.90	18250	21900	0.60	0.63	39.20	18.43	-52.98
2009	0.96	0.30	1.00	0.90	18250	21900	0.60	0.63	39.34	18.90	-51.96

Table 8.39 Changes made in activity data and their effects on emission estimates from human sewage

Year	Protein consumption [Protein in kg/person/yr]		N_2O emissions [Gg]		Difference %
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
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	33.54	33.95	1.92	1.94	+1.04
1994	33.95	33.95	1.94	1.94	0.00
1995	33.95	34.68	1.94	1.98	+2.06
1996	33.95	34.68	1.93	1.97	+2.07
1997	34.68	34.68	1.97	1.97	0.00
1998	35.22	35.41	1.99	2.00	+0.50
1999	35.77	35.77	2.02	2.02	0.00
2000	35.77	36.50	2.02	2.06	+1.98
2001	35.77	36.50	2.02	2.06	+1.98
2002	39.79	36.50	2.18	2.00	-8.26
2003	40.15	39.79	2.19	2.17	-0.91
2004	40.15	39.79	2.19	2.17	-0.91
2005	40.15	39.79	2.18	2.16	-0.92
2006	40.15	40.52	2.18	2.20	0.92
2007	40.15	40.52	2.19	2.19	0.00
2008	40.15	40.52	2.17	2.19	+0.92
2009	40.15	40.52	2.17	2.19	+0.92

8.3.6 Source specific planned improvement including those in response to the review process

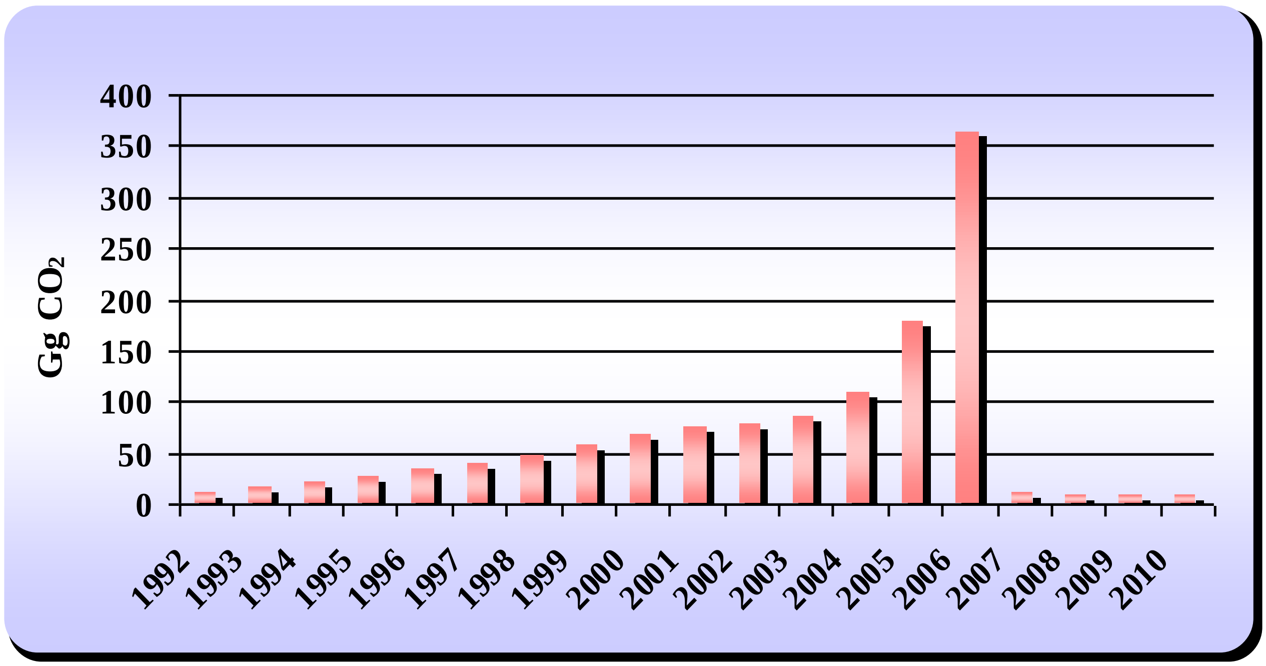
In order to improve the next submissions, in the future we will develop studies regarding wastewater treatment for obtaining of more accurate data and emission factors.
As regarding methane recovered, more investigation will be necessary for collecting these data.

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 we don't have any data about the type of the incinerators.
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 1992–2010 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 were functioned much more private incinerators which after this period were closed. During 2008-2010, the relevant emissions level remained relatively constant.

Clinical wastes are incinerated since 1996, but more accurate data there are after 2000. It can observe a period of increasing activity between 1999 and 2007, after 2007 mainly clinical incinerators ending their activity in according with European regulations.

Figure 8.14 CO_2 emissions trend from clinical waste incineration, for 1992–2010 period

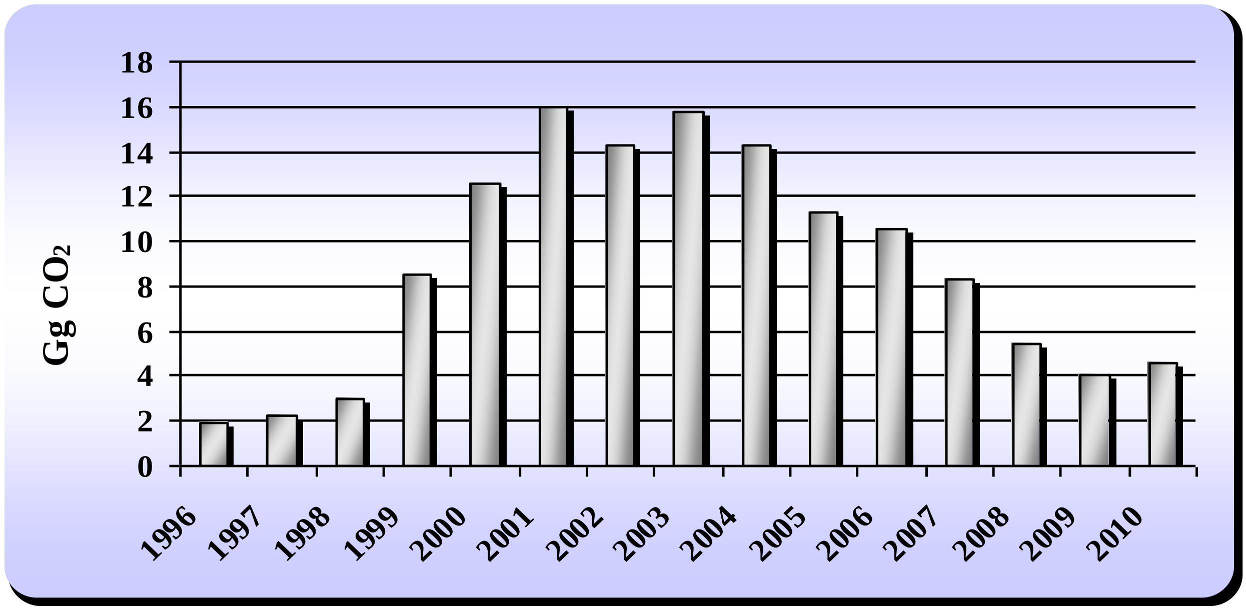
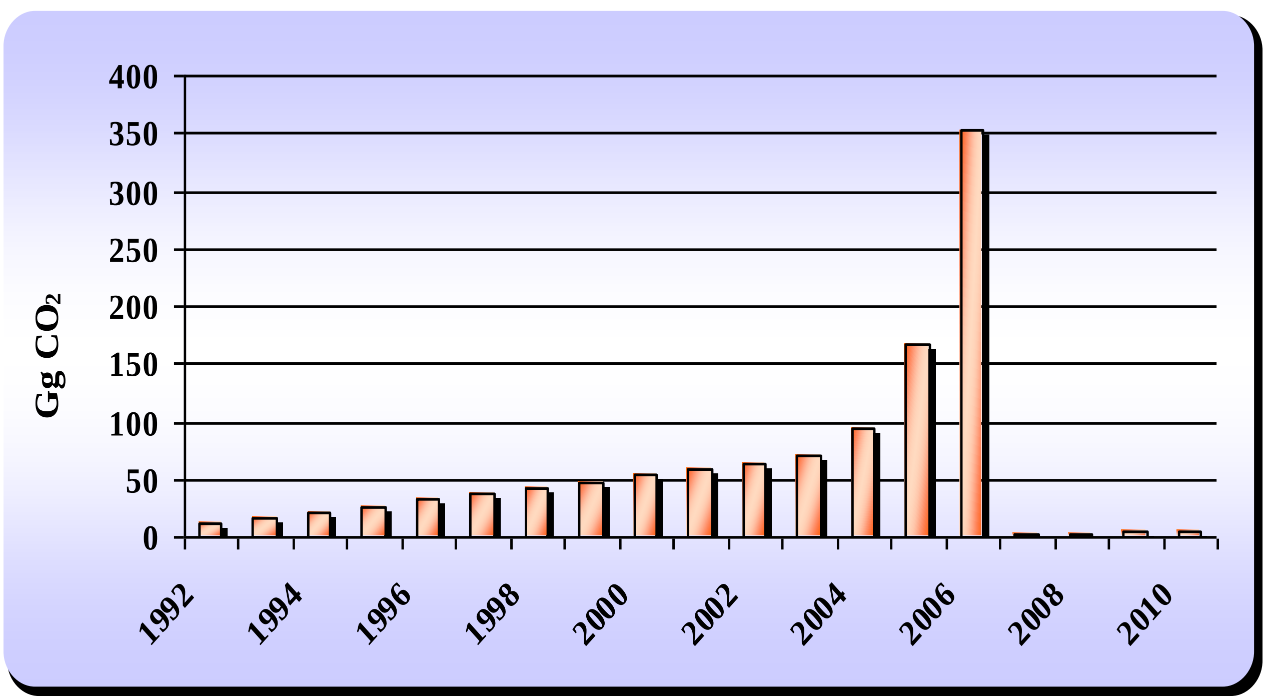


Figure 8.15 CO_2 emissions trend from hazardous waste incineration, for 1992–2010 period



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 8.24 Carbon dioxide emissions from waste incineration

$$CO_2\ emissions\ (Gg/yr) = \sum_i (IW_i * CCW_i * FCF_i * EF_i * 44/12)$$

Emissions factor

Default emissions factors according to the provisions in IPCC GPG 2000 have been used. The emissions factors are presented in *Table 8.40*.

Table 8.40 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.

Table 8.41 Amounts of clinical waste generated and incinerated (Source: ISPB and ICIM)

Year	**Clinical waste generated**	**Clinical waste incinerated**
	Unit [Gg/yr]	
1996	-	2.35
1997	-	2.63
1998	-	3.63
1999	-	10.15
2000	15.03	15.03
2001	19.06	19.06
2002	17.6	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

Hazardous waste is generated by industrial sector. Data regarding the amounts of incinerated hazardous waste were provided by Waste Directorate of NEPA for 2003-2008 period. 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 8.42 Amount of hazardous waste incinerated (Source: NEPA)

Year	**Hazardous waste**		**Clinical waste**	
	Incinerated waste[Gg/yr]	**Source**	**Incinerated waste[Gg/yr]**	**Source**
1992	6.64	Extrapolation by expert judgement	-	
1993	9.88		-	-
1994	13.11		-	-
1995	16.35		-	-
1996	19.58		2.35	ICIM
1997	22.82		2.63	
1998	26.06		3.63	
1999	29.29		10.15	Interpolation
2000	32.53		15.03	ISPB
2001	35.77		19.06	
2002	39.00		17.03	
2003	42.74	Waste Directorate of NEPA	18.79	
2004	56.70		17.03	
2005	102.00		13.55	
2006	215.59		12.61	
2007	1.38		10.00	
2008	1.95		6.44	
2009	2.27		4.79	
2010	2.27*		5.46	

* 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 uncertainty estimate associated with activity data amounts to 50% and uncertainty estimate associated with emissions factor amounts 30%, based on expert judgments.

The overall uncertainty resulted after the aggregation of the AD and EF uncertainties according to the provisions in Chapter 6 of IPCC GPG 2000 is 58.31%.

Time series is consistent, emissions resulted from this source category were estimated using the same assumptions and the same emission factors (default values, indicated in the methodology).

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 sectorial expert administrating the Solid Waste Disposal on Land category, the results of these being mentioned on the Checklists level.

QA/QC activities were performed 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.* "

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.

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.

8.4.5 Source specific recalculation, including changes made in response to the review process

- **activity data**

A new data source was used for the amounts of clinical waste incinerated in period 1996-1998.

Table 8.43 Changes made in activity data and their effects on emission estimates

Year	Amount of clinical waste incinerated [Gg]		CO_2 emissions [Gg]		Difference
	2011 v.4.1 submission	2012 v.2.1 submission	2011 v.4.1 submission	2012 v.2.1 submission	
1989	-	-	-	-	-
1990	-	-	-	-	-
1991	-	-	-	-	-
1992	-	-	-	-	-
1993	-	-	-	-	-
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	2.35	-	1.97	+1.97
1997	-	2.63	-	2.20	+2.20
1998	-	3.63	-	3.03	+3.03
1999	-	10.15	-	8.48	+8.48
2000	15.03	15.03	12.57	12.57	0.00
2001	19.06	19.06	15.93	15.93	0.00
2002	17.03	17.03	14.23	14.23	0.00
2003	18.79	18.79	15.71	15.71	0.00
2004	17.03	17.03	14.23	14.23	0.00
2005	13.55	13.55	11.33	11.33	0.00
2006	12.61	12.61	10.54	10.54	0.00
2007	10.00	10.00	8.36	8.36	0.00
2008	6.44	6.44	5.39	5.39	0.00
2009	4.79	4.79	4.00	4.00	0.00

8.4.6 Source specific planned improvement including those in response to the review process

In order to estimate N_2O emissions from waste incineration, we will try to obtain more data by sending some questionnaires to the operators of incinerators and collecting all this information.

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 *2011 Greenhouse Gas Inventory submissions version 4.1 and 2012 Greenhouse Gas Inventory submissions v 1.2.* Since the 2011 version 4.1 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.

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:

- Recalculations for the 1989 – 2009 period at sub-sector 1.A.1 - Energy Industries due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

The concerned categories of sub-sector 1.A.1 - Energy Industries are, as follows:

1. A.1.a. Public Electricity and Heat Production / Producer Electricity Plants,

1. A.1.b. Petroleum Refining,

1. A.1.c. Manufacture of Solid Fuels.

CO_2 Emission Factors

- Recalculations for the 1989 – 2006 period at the sub-sector 1.A.1 - Energy Industries due to the new calculated emission factors.

The concerned categories of the sub-sector 1.A.1 Energy Industries are, as follows:

1. A.1.a. Public Electricity and Heat Production / Producer Electricity Plants,

1. A.1.b. Petroleum Refining,
1. A.1.c. Manufacture of Solid Fuels.

For Solid fuels

EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, on each EU-ETS reported activity category, oxidation included, are used.
●Analyzed solid fuels are: Lignite, Other bituminous coal.

For liquid fuels*,*

EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
●Analyzed fuels by the Study are: Transport diesel, Residual fuel oil, Heating and other gasoil, Refinery gas.
●**For the *Motor gasoline* fuel**, the country specific emission factor, CS EF, is calculated based on the content of the carbon, reported by Romanian authorities and using the formula provided by the above Study.

For gaseous fuels*,*

EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.
●Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 2007 - 2010 period at the sub-sector 1.A.1 - Energy Industries due to the new calculated emission factors.

The concerned categories are, as follows:

1. A.1.a. Public Electricity and Heat Production / Producer Electricity Plants,

1. A.1.b. Petroleum Refining,

1. A.1.c. Manufacture of Solid Fuels.

For 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.

●Analyzed fuels by the Study are: Lignite, Other bituminous coal.

For 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.

●Analyzed fuels by the Study are: Transport diesel, Residual fuel oil, Heating and other gasoil, Refinery gas.

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

For 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.

●Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

- Recalculations for the 1989 – 2009, all activity categories 1.A – Stationary Fuel Combustion

Biomass gas - new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 1989 – 2009 period at sub-sector 1.A.2 – Manufacturing Industries and Construction due to the change of the source of Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.
- The concerned categories of 1.A.2 – Manufacturing Industries and Construction are, as follows:

  1. A.2.a. Iron and Steel,

  1. A.2.b. Non-Ferrous Metals,

  1. A.2.c. Chemicals, 1.A.2.d. Pulp, Paper and Print,

  1. A.2.d. Pulp, Paper and Print,

  1. A.2.e. Food Processing, Beverages and Tobacco,

  1. A.2.f. Other.

  - Recalculations for the 2006 – 2009 period at category 1.A.2f Other (please specify) – Other non-specified, Other Fuels – it is taken into consideration the industrial waste, reported by the operators on the EU-ETS scheme.
- Recalculations for the 1989 – 2006 period at the sub-sector 1.A.2 – Manufacturing Industries and Construction due to the new calculated emission factors.

  The concerned categories are, as follows:

  1. A.2.a. Iron and Steel,

  1. A.2.b. Non-Ferrous Metals,

  1. A.2.c. Chemicals, 1.A.2.d. Pulp, Paper and Print,

  1. A.2.d. Pulp, Paper and Print,

  1. A.2.e. Food Processing, Beverages and Tobacco,

  1. A.2.f. Other.

For Solid fuels,

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

●Analyzed solid fuels are: Other bituminous coal, Coking coal.

For liquid fuels,

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

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

●Analyzed fuels by the Study are: Residual fuel oil, Heating and other gasoil, Petroleum Coke.

For gaseous fuels,

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

Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

➢ Recalculations for the 2007 - 2010 period at the sub-sector 1.A.2 – Manufacturing Industries and Construction due to the new calculated emission factors.

The concerned categories are, as follows:

1. A.2.a. Iron and Steel,
1. A.2.b. Non-Ferrous Metals,
1. A.2.c. Chemicals,
1. A.2.d. Pulp, Paper and Print,
1. A.2.e. Food Processing, Beverages and Tobacco,
1. A.2.f. Other.

***For 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.

●Analyzed solid fuels are: Other bituminous coal, Coking coal.

***For 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.

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

●Analyzed fuels by the Study are: Residual fuel oil, Heating and other gasoil, Petroleum Coke.

***For 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.

Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

➢ In transport sub-sector (1.AA.3) were done the following recalculations:

Aviation sub-sector (1.AA.3.A):

- Emissions of GHG were calculated using the values of activity data on flight cycles (LTO-CRUISE)/types of aircraft flight to domestic and international flights from Romania and was passed on the level approach (T2) for time-series 2004-2009 and the values for the fuel consumption by JET KEROSENE for time series 2007-2009 on EUROSTAT site.

Road Transport sub-sector (1.AA.3.B):

- It was passed on the level approach (T2) using EF cs for Gasoline, Residual Fuel Oil for times - series 1990-2009 and the values for activity data on EUROSTAT site.

Railways sub-sector (1.AA.3.C):

- It was passed on the level approach (T2) using EF cs for Diesel Oil, Residual Fuel Oil, Coke oven coke, Sub-bituminous for time series 1989 – 2009, for emissions to CO_2;
- Have been used the values for activity date supplied by EUROSTATE for following fuels:
  - Diesel Oil for 1990 – 2009;
  - Wood/wood for 1992-2009;

Navigation sub-sector (1.AA.3.D):

- It was passed on the level approach (T2) using EF cs for Diesel Oil, Residual Fuel Oil, Gasoline for time series 1989 – 2009, for emissions to CO_2;
- Have been used the values for activity date supplied by EUROSTATE for following fuels:
  - Diesel Oil for 1992 – 2009;
  - Residual Fuel Oil for 2000-2003;
  - Gasoline for 1993-2009.

➢ Recalculations for the 1989 – 2009 period at 1.A.4 – Other Sectors due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

The concerned categories of the sub-sector 1.A.4 Other Sectors are, as follows:

1. A.4.a. Commercial/Institutional,

1. A.4.b. Residential,

1. A.4.c. Agriculture/Forestry/Fisheries.

➢ Recalculations for the 1989 – 2006 period at the sub-sector 1.A.4 – Other Sectors due to the new calculated emission factors.

The concerned categories are, as follows:

1. A.4.a. Commercial/ Institutional,

1. A.4.b. Residential,

1. A.4.c. Agriculture/Forestry/Fisheries.

For Solid fuels,

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

For liquid fuels,

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

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

For gaseous fuels,

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

Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 2007 - 2010 period at the sub-sector 1.A.4 – Other Sectors due to the new calculated emission factors.

The concerned categories are, as follows:

1. A.4.a. Commercial/ Institutional,

1. A.4.b. Residential,

1. A.4.c. Agriculture/Forestry/Fisheries.

For solid Fuels,

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

For liquid fuels,

EFs calculated as weighted arithmetic average (WA) on each year of 2007 – 2010 period, ALL EU-ETS reported activity categories, oxidation included, are used.
●**For the *Motor gasoline* fuel**, the country specific emission factor, CS EF, is calculated based on the content of the carbon, reported by Romanian authorities and using the formula provided by the above Study.

For 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.
Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 1989 – 2009 period at 1.A.5 - Other (Not specified elsewhere) due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used. The concerned categories of the sub-sector 1.A.5 - Other (Not specified elsewhere) are, as follows:

1. A.5 a. Other (Not specified elsewhere) - Stationary (please specify)

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.

- Recalculations for the 1989 – 2006 period at the sub-sector 1.A.5 - Other (Not specified elsewhere) due to the new calculated emission factors.

The concerned categories of the sub-sector 1.A.5 - Other (Not specified elsewhere) are, as follows:
1. A.5 a. Other (Not specified elsewhere) - Stationary (please specify)

For Solid fuels,

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

For liquid fuels,

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

For gaseous fuels,

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

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 2007 - 2010 period at the sub-sector 1.A.5 - Other (Not specified elsewhere) due to the new calculated emission factors.

The concerned categories of the sub-sector 1.A.5 - Other (Not specified elsewhere) are, as follows:
1. A.5 a. Other (Not specified elsewhere) - Stationary (please specify)

***For solid Fuels**,*

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

For 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.

***For 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.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 1989 – 2009 period at 1.AB Fuel Combustion – Reference Approach 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 1989 – 2009 period at 1.AB Fuel Combustion – Reference Approach due to the new calculated emission factors.

***For solid, liquid and gaseous fuels**, Country Specific EFs are calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported activity categories, without oxidation included, are used.*

The analyzed fuels are as following:

Lignite, Natural gas, Refinery gas, Other bituminous coal, Coking coal, Transport diesel, Residual fuel oil, Heating and other gasoil, Petroleum Coke, Motor Gasoline

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 1989 – 2009 period at 1.AC Fuel Combustion – Feedstocks and non-energy use of fuels due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.
- recalculation for Coal Mining and Handing in category, because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and emission factors (EFs) were changed with the default EFs, taken from 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC GL); notation key "NE" was changed in "NA" for CO_2 and N_2O (1.B.1.A);
- change in notation key for Solid Fuel Transformation: "NE" was changed with values, because AD were found for this domain in IEA/Eurostat Questionnaire 2010 - Coking Coal and EF to CH_4 was taken from UNFCCC-EFDB; notation key "NE" was changed in "NA" for CO_2 and N_2O (1.B.1.B);
- change in notation key for CH4 Recovery, notation key "NE" was changed with values, because CH4 is recovered for energy use, only from two underground mines; the values are provided by Ministry of Economy, Trade and Business (MECMA) and National Institute for Research and Development in Mine Safety (INSEMEX) (1.B.1.A.1.1.);
- change in notation key for CH4 Recovery, notation key "NE" was changed in "NO" (1.B. 1.A.1.2., 1.B.1.A.2.1., 1. B.1.A.2.2, 1.B.1.B.);
- change in notation key for Exploration (1.B.2.A.1.): "NE" for AD was changed, because available data were found in IEA/Eurostat Questionnaire 2010 - Petrol -Crude Oil;
- change in notation key "NE" for CO_2, CH_4 and N_2O were used default EFs for “Oil extraction” from 2006 IPCC GL;
- recalculation for Production and Upgrading (1.B.2.A.2.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and emission factors (EFs) for CO_2 and CH_4 were replaced with the default EF for “*Oil production*” from GL 2006 IPCC, while N_2O is notation “NA”;
- recalculation for Transport (1.B.2.A.3.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and emission factors (EFs) for CO_2 and CH_4 were replaced with the default EF “*Oil Transport Pipelines*” from 2006 IPCC GL, while N_2O is notation “NA”;

- recalculation for Refining/Storage (1.B.2.A.4.) because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Petrol -Crude Oil and emission factors (EFs) for CH_4 was replaced with **“***Combined EF for Refining and Storage Tank*” from Revised 1996 IPCC;
- change in notation key for CO_2 and N_2O (1.B.2.A.4.): notation key "NE" was change in "NA";
- change in notation key for Distribution of oil products (1.B.2.A.5.): notation key "NE" was changed in "NA" for CO_2, CH_4 and N_2O;
- change in notation key for Exploration (1.B.2.B.1.): notation key "NE" was changed in "IE" for CO_2, CH_4 and N_2O because considered in (1.B.2.A.1.);
- recalculation for Production/Processing (1.B.2.B.2.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and emission factors (EFs) for CO_2 and CH_4 were replaced with the default EF for “*Production/ Processing*” from GPG 2000 IPCC; for N_2O notation key change in "NA";
- recalculation for Transmission (1.B.2.B.3.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and emission factors (EFs) for CO_2 and CH_4 were replaced with the default EFs for “*Transmission*” from GPG 2000 IPCC; for N_2O notation key change in "NA";
- recalculation for Distribution (1.B.2.B.4.) subsector was split into:
    - recalculation for Distribution (1.B.2.B.4.): replaced notation key “IE” with activity data (AD-pipeline length) were taken from National Regulation Authority of Energy (ANRE) and notation key "IE" for CH_4 were replaced with the default EFs for “*Distribution*” from GPG 2000 IPCC; for CO_2 notation key change in "IE" and N_2O notation key change in "NA";
    - recalculation for Distribution (1.B.2.B.4.): replaced notation key “IE” with activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and notation key "IE" for CO_2 were replaced with the default EFs for “*Distribution*” from 2006 IPCC GL; for N_2O notation key change in "NA"; this part of subsector (1.B.2.B.4.) was added as a new subcategory to “Other (please specify)” (1.B.2.D.) in CRF Reporter.
- recalculation for Other Leakage - at industrial plants and power stations (1.B.2.B.5.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and emission factors (EFs) for CH_4 was replaced with the default EF from GPG 2000 IPCC; notation key "NE" was changed in "NA" for CO_2 and N_2O;

- recalculation for Other Leakage -residential and commercial sectors (1.B.2.B.5.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and emission factors (EFs) for CH_4 was replaced with the default EF from Revised 1996 IPCC; notation key "NE" was changed in "NA" for CO_2 and N_2O;
- recalculation for Venting - Oil (1.B.2.C.1.1.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Petrol -Crude Oil and emission factors (EFs) for CO_2 and CH_4 was replaced with the default EF for "*Venting*" from GL 2006 IPCC; notation key "NE" was changed in "NA" for N_2O;
- recalculation for Venting - Natural Gas (1.B.2.C.1.2.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and emission factors (EFs) for CH_4 and CO_2 were replaced with the default EF for "*Venting*" from GL 2006 IPCC; notation key "NE" was changed with notation key "NA" for N_2O;
- change in notation key for Flaring - Oil (1.B.2.C.2.1.): notation key "NE" for AD was changed with activity data were taken from IEA/Eurostat Questionnaire 2010 - Petrol - Crude Oil;
- change in notation key for CO_2,$CH_4$and N_2O from Flaring- Oil (1.B.2.C.2.1.): notation key "NE" were changed because were used default EF for "*Flaring*" from GL 2006 IPCC;
- change in notation key for Flaring - Natural Gas (1.B.2.C.2.2.): notation key "IE" for AD was changed with activity data were taken from IEA/Eurostat Questionnaire 2010- Natural Gas;
- change in notation key for CO_2,CH_4 and N_2O from Flaring- Gas (1.B.2.C.2.2.): notation key "NE" were changed because were used default EFs for "*Flaring*" from GL 2006 IPCC;

- International Transport –Bunkers (1.C.1)

For Aviation Transport:

- emissions GHG were calculated using values of the activity data on flight cycles (LTO-CRUISE)/types of aircraft flight to domestic and international flights from Romania and was passed on the approach level (T2) for time-series 2004-2009 and the values of fuel consumption by KEROSENE JET for the time series 1990-2009 and for AVIATION GASOLINE for the time series of the 2007-2008 on EUROSTAT site.

For Navigation Transport:

- The use for EFcs for Gasoline, Residual Fuel Oil and Gas/Diesel Oil for times series 1989-2009.

Industrial Processes:

- Recalculations for all-time series 1989-2009 at ammonia production sub sector method level for estimated CO_2 due to improvement in CO_2 emissions estimations (from T1b to T1a) based on the study "Elaboration of national emission factors/other parameters relevant to NGHGI Industrial Processes Sector in order to improve the ammonia production sub sector"(2.B.1).
- Recalculations for 1989-2009 period at the Calcium Carbide production sub sector for CO_2 emission factor (EF) level due to change the default EF for use of product step (1.1 t CO_2/t carbide) used in the last 2011 submission. The new EF use was calculated considering default emission factors provided in production process of calcium carbide (CaO step and reduction step): 0.76 tonnes CO_2/tonne carbide and 1.09 tonnes CO_2/tonne carbide. The resulted EF is 0.85 tonnes CO_2/tonne carbide (2.B.4.2).
- Recalculations for all-time series 1989-2009 at pig iron production category due to detected an error in the formula used for calculating CO_2 emissions (2C1.2);
- Recalculation for 1994-1998 and 2008-2009 at ferroalloys production sub sector due to finding an error in the formula used for calculating CO_2 emissions. (2C.2);
- Recalculations for 1989-2007 period at the cement production sub sector for CO_2 emission factor (EF) level due to change the default EF (0.525 t CO_2/t clinker) used in the last 2011 submission. The new specific EF was calculated considering the average between the base year 1989 implied emission factor (0.527 t CO_2/t clinker) and 2008 emission factor (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 0.53 t CO_2/t clinker (2A.1).
- The recalculation has been done due to wrong manipulation of data in lime production, for the entire time series. In the estimation of emissions from lime production were taken into account production data from crude dolomite. This data are not considered in IPCC GPG 2000. For 1990-1997 period and 2001-2010 period we have the activity data provided by NIS, activity data for dolomitic lime production where is disaggregated in calcined/sintered dolomite and agglomerate dolomite. For this period we calculated an average percentage with which we determined values for dolomitic lime for the 1989 and 1998-2000 period (2.A.2).

- Recalculation for 2009 year at the soda ash production sub sector activity data (AD) level due to wrong manipulation of data. (2A.4.1).

Agriculture:

- More disaggregated livestock data, in the format the National Institute for Statistics uses to report them to Eurostat, began to be used, for 1989-2010 period (4.A, 4.B, 4.D);
- National emission factors began to be used for 1989-2010 period (4.A);
- Tier 2 calculation methods were used for all livestock for estimating CH_4 emissions and for 1989-2010 period (4.A; 4.B);
- National emission factors began to be used for calculating the CH_4 emissions associated with 1989-2010 period (4.B);
- National values for the Nitrogen excretion per head of animal per region (Nex) and for percentages of manure N produced in different Animal Waste Management Systems (MS) began to be used for calculating the N_2O emissions (4.B; 4.D);
- Tier 1b calculation method began to be used (4.D.1.2, 4.D.1.3, 4.D.1.4, 4.D.3.1, 4.D.3.2);
- A combination of national and default values for the fractions associated with the manure in the context of using a Tier 1b method was used for 1989-2010 period (4.D.1.2);
- New information/data on crop productions were considered (4.D.1.3, 4.D.1.4, 4.F);
- A combination of national and default values for the fractions associated with the crop productions in the context of using a Tier 1b method was used for 1989-2010 period (4.D.1.3, 4.D.1.4);
- New data/information on annual cultivated organic soils areas have been provided through a dedicated study; the recalculation is relevant to the 1989-20010 time series (4.D.1.5);
- A combination of national and default values for the fractions associated with the crop productions was used (4.F).

LULUCF:

- 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. 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);

- 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 (5A);
- 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 (5A);
- 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 (5A);
- Regarding the changes of emissions in living biomass from 1996–2009 there was an estimation error in the calculation sheets (5A1);
- Recalculations have been done at the current submission of about 1% for the years 1991 to 2010 compared to the last submission, caused by the revision of activity data in Forest Land remaining Forest Land (5.A.1) in accordance with the ERT recommendations;
- Regarding the changes of emissions in living biomass-gains for NFF for the year 1992 where was an error in the calculation sheets (5.A.1);
- Few computing errors were fixed. One was related to BGB percentage applied which is fixed in order to ensure full match with the convention tables in Forest Land remaining Forest Land, which resulted in an low increase of the sink, the quantitative impact is very small (< 5 %) (5A1);
- With 2012 submission there are only few recalculations:

  - reanalyzing time series for VFAFF which is now considered to move to NFF if its area decreases in certain years (5A1);
  - correct an overestimation in average of 600% of the removal from DOM in Land converted to Forest Land. This was caused by wrong referencing in the spreadsheet of the activity data (for all conversions from any categories to forestland) (5A2);

- Another computing error consisting in the not inclusion of soils pools changes in the total estimates in Land converted to Forest Land was fixed, the quantitative impact is very small (<1 %) (5A2);
- 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; this led to re-calculation of all activity data and emission factors. GHG emissions/removals are practically estimated for this category for the first time (5.B);
- Changes were caused by the development of time series for plantations of trees on arable land (relevant as revegetation under KP) (5.B.1);
- For 2009 the activity data were recalculated following the check of land use matrix and revision of value of reference C stocks for soils (5.B.1-5.B.2.2);
- Starting with 2011 re-submission, a land use change matrix is available, which led to re-calculation of activity data for all land subcategories, thus, for the first time, the emissions on these land subcategories are estimated in the national GHG inventory (5.C);
- Revision of soil C stocks reference values, for all land uses (5.C.2.1-5.C.2.2-5.C.2.4-5.C.2.5);
- Starting with 2011 re-submission a land use change matrix is available, which led to re-calculation of activity data for all land categories, when, for first time, the emissions on these land subcategories are estimated in the national GHG inventory (5.D-5.D.2.1-5.D.2.5);
- Starting with 2011 re-submission a land use change matrix is available, which led to re-calculation of all activity data, thus emissions data from this land category were computed for first time in the national GHG inventory (5.E);
- Recalculations have been done at the current submission of about -4% for the entire time-series compared to the last submission, caused by the revision of soils C stocks reference values. (5.E.2.1-5.E.2.2-5.E.2.5);

- Starting with 2011 re-submission a land use change matrix is available, which led to re-calculation of all activity data and emission estimates are provided (5.F);
- Recalculations have been done in the current submission of about 113% for for the entire time-series compared to the last submission, caused by the revision of soil C stocks reference values (5.F.2.2-5.F.2.4-5.F.2.5).

Waste:

- **6.A.1. Managed Waste Disposal on Land:** CH_4 emissions were recalculated for 1995-2009 period, using the updated data on the amounts of deposited waste provided by the study "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation" finished at the end of 2011. Because in 1995-2000 period there were inaccurate data for the amounts of deposited waste, through above study, the data were estimated for 1996, 1997, 1998, 2000 years. Also DOC (Degradable Organic Carbon) was recalculated for 1989-2002 period through this study; for 2008-2009 period DOC was recalculated based on the data provided by National Environmental Protection Agency (NEPA).

  The data on the amounts of deposited waste for 2003-2005 period and for 2008 year were corrected based on data provided by Waste Directorate from NEPA. For 2009 year the Waste Directorate from NEPA provided the final data resulted from 2011 statistical investigation and for 2010 the data were estimated.

  Compared to INEGES 2011 v 4.1, it used an oxidation factor OX = 0.1 for CH4 emissions from managed SWDS, in accordance with IPCC GPG 2000.

  The data on methane recovered from landfills have been collected from the operators at the end of 2011. The collected data are more accurate, because a large number of operators answered to the specific questionnaires. Based on information obtained until now, in Romania the methane is recovered only in managed sites, since 1996.

  Starting with the current submission CO_2 and NMVOC emissions from Managed Waste Disposal on Land have been estimated based on expert judgement in the study mentioned above.

- **6.A.2. Unmanaged Waste Disposal on Land:**

  FOD method has been used to estimate CH_4 emissions from solid waste disposal in deep and shallow unmanaged sites. The Activity Data and DOC were provided by the study for 1950-2002 period and by the Waste Directorate from NEPA for 2003-2010 period. For 2010 year estimated data were used based on waste generation rate.

Starting with the current submission CO_2 and NMVOC emissions from Unmanaged Waste Disposal on Land have been estimated based on expert judgement in the study mentioned above.

- **6.B.1. Industrial Wastewater:**

There were recalculated CH_4 emissions from Industrial wastewater for 1989-2009 period based on the data and information provided by the study "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation". This study took into account the three most important industries that produce large volumes of organic wastewater: beer, pulp and paper, petroleum refining. There were considered by expert judgement three major periods regarding the industrial wastewater treatment in Romania: 1989-1996 period, when the percentage of anaerobic treatment was 0.05; 1997-2004 period, the percentage increased to 0.10; 2005-2010 period, the percentage is 0.15. Also, by expert judgement the Methane Conversion Factor (MCF) is 0.9 for anaerobic systems. Based on the values for Fraction of wastewater treated anaerobically and Methane Conversion Factor there were obtained three country specific values for the Emission factor according with the three periods mentioned above. For Total Organic Wastewater (TOW) there were considered the default parameters from IPCC GPG 2000.

- **6.B.2. Domestic and Commercial Wastewater**

6.B.2.1. Domestic and Commercial Wastewater and Sludge without Human Sewage:

CH_4 emissions were recalculated for 1989-2009 period both for wastewater and sludge based on the data and the information provided by the study "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation".

To estimate emissions from domestic/commercial wastewater there took into account both the population connected to sewerage with treatment and the population unconnected to sewerage. There were not considered the domestic/commercial wastewater collected to sewerage and discharged into the emissary without treatment because in this case the wastewater undergoes a self-cleaning process with minor emissions of methane. There used country specific values for Degradable Organic

Component (Ddom), Fraction of Degradable Organic Component removed as sludge (DSdom), Fraction of wastewater treated anaerobically (WSx) and Methane Conversion Factor (MCF).

To estimate emissions from domestic/commercial sludge there were considered the population connected to sewerage with treatment and country specific values for Degradable Organic Component (Ddom), Fraction of Degradable Organic Component removed as sludge (DSdom), Fraction of sludge treated anaerobically (SSx) and Methane Conversion Factor (MCF).

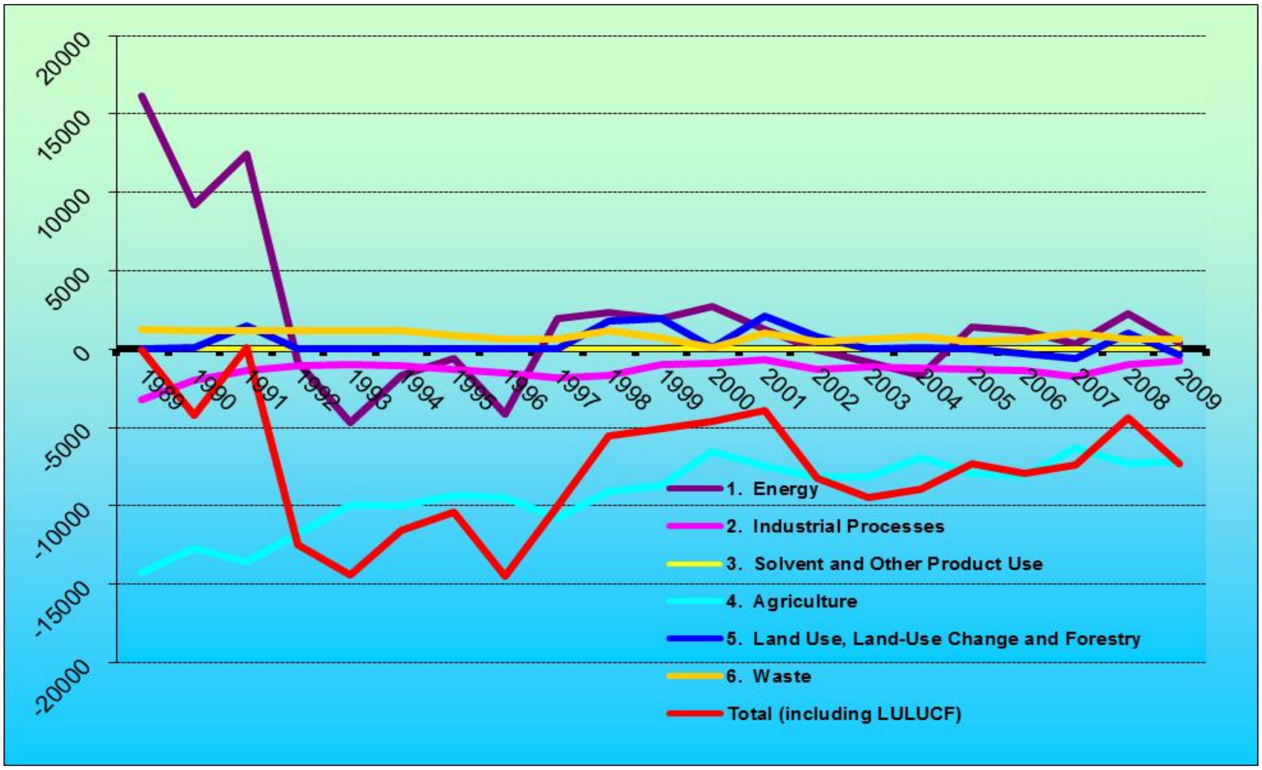
6.B.2.2. Human Sewage:

The N_2O emissions were recalculated for 1993, 1995-1996, 1998, 2000-2009 based on revised data regarding Protein Consumption provided by Food and Agriculture Organization of the United Nations.

- **6.C. Waste Incineration:**

The recalculations were mainly made for Clinical Waste based on a new source of Activity Data (National Research and Development Institute for Environmental Protection) for 1996-1998 period. For 1999 data were obtained by interpolation method. The CO_2 emissions from hazardous waste were recalculated only for 2009 following the final data provided by 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 2011 version 4.1 report



Recalculations by gases

CO_2 recalculations were carried out in the following sectors:

- Public Electricity and Heat Production (1A1a);
- Petroleum Refining (1A1b);
- Manufacture of Solid Fuels and Other Energy Industries (1A1c);
- Iron and Steel (1A2a);
- Non-Ferrous Metals (1A2b);
- Chemicals (1A2c);
- Pulp, Paper and Print(1A2d);
- Food Processing, Beverages and Tobacco (1A2e);
- Other (please specify) (1A2f);
- 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)
- Commercial/Institutional (1A4a);
- Residential (1A4b);
- Agriculture/Forestry/Fisheries (1A4c);
- Other (Not specified elsewhere) (A.5);
- Stationary (please specify) (1A5a);
- Reference Approach Subsector (1.AB);
- Feedstocks and non-energy use of fuels Subsector (1.AD);
- Coal Mining and Handing (1.B.1.A);
- Solid Fuel Transformation (1.B.1.B);
- Exploration (1.B.2. A.1.);
- Production and Upgrading (1.B.2.A.2.);
- Transport (1.B.2.A.3.);
- Refining/Storage (1.B.2.A.4.) ;
- Distribution of oil products (1.B.2.A.5.);
- Exploration (1.B.2.B.1.);
- Production/Processing (1.B.2.B.2.);
- Transmission (1.B.2.B.3.);
- Other Leakage - at industrial plants and power stations (1.B.2.B.5.);
- Other Leakage - at industrial plants and power stations (1.B.2.B.5.);
- Venting - Oil (1.B.2.C.1.1.);
- Venting - Natural Gas (1.B.2.C.1.2.);
- Flaring - Oil (1.B.2.C.2.1.);
- Flaring- Gas (1.B.2.C.2.2.);
- International Transport –Bunkers (1.C.1);
- Cement Production (2A.1);
- Lime Production (2.A.2).
- Soda Ash Production (2A.4.1);
- Ammonia Production (2.B.1);

- Calcium Carbide Production (2.B.4.2).
- Pig Iron Production (2.C.1.2);
- Ferroalloys Production (2C.2);
- Enteric fermentation (4.A);
- Manure management (4.B);
- Agricultural soils (4.D);
- Field burning of agricultural residues (4.F);
- 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).
- Solid Waste Disposal on Land (6.A)
- Waste incineration (6.C).

CH_4/N_2O recalculations were carried out in the following sectors:

- Public Electricity and Heat Production (1A1a);
- Petroleum Refining (1A1b);
- Manufacture of Solid Fuels and Other Energy Industries (1A1c);
- Iron and Steel (1A2a);
- Non-Ferrous Metals (1A2b);
- Chemicals (1A2c);
- Pulp, Paper and Print (1A2d);
- Food Processing, Beverages and Tobacco (1A2e);
- Other (please specify) (1A2f **);**
- Civil Aviation (1.AA.3.A);
- Railways (1.AA.3.C);
- Navigation (1.AA.3.D);
- Commercial/Institutional (1A4a);
- Residential (1A4b);
- Agriculture/Forestry/Fisheries (1A4c**);**
- Stationary (please specify) (1A5a);
- Coal Mining and Handing (1.B.1.A);
- Solid Fuel Transformation (1.B.1.B);
- Exploration (1.B.2. A.1.);
- Production and Upgrading (1.B.2.A.2.);
- Transport (1.B.2.A.3.);
- Refining/Storage (1.B.2.A.4.) ;
- Distribution of oil products (1.B.2.A.5.);
- Exploration (1.B.2.B.1.);
- Production/Processing (1.B.2.B.2.);
- Transmission (1.B.2.B.3.);
- Other Leakage - at industrial plants and power stations (1.B.2.B.5.);
- Other Leakage - at industrial plants and power stations (1.B.2.B.5.);
- Venting - Oil (1.B.2.C.1.1.);
- Venting - Natural Gas (1.B.2.C.1.2.);

- Flaring - Oil (1.B.2.C.2.1.);
- Flaring- Gas (1.B.2.C.2.2.);
- International Transport –Bunkers (1.C.1);
- Cropland (5.B);
- Wetlands converted to Cropland (5.B.2.3);
- Solid Waste Disposal on Land (6.A).
- Wastewater Handling (6.B)
- Solid Waste Disposal on Land (6.A).

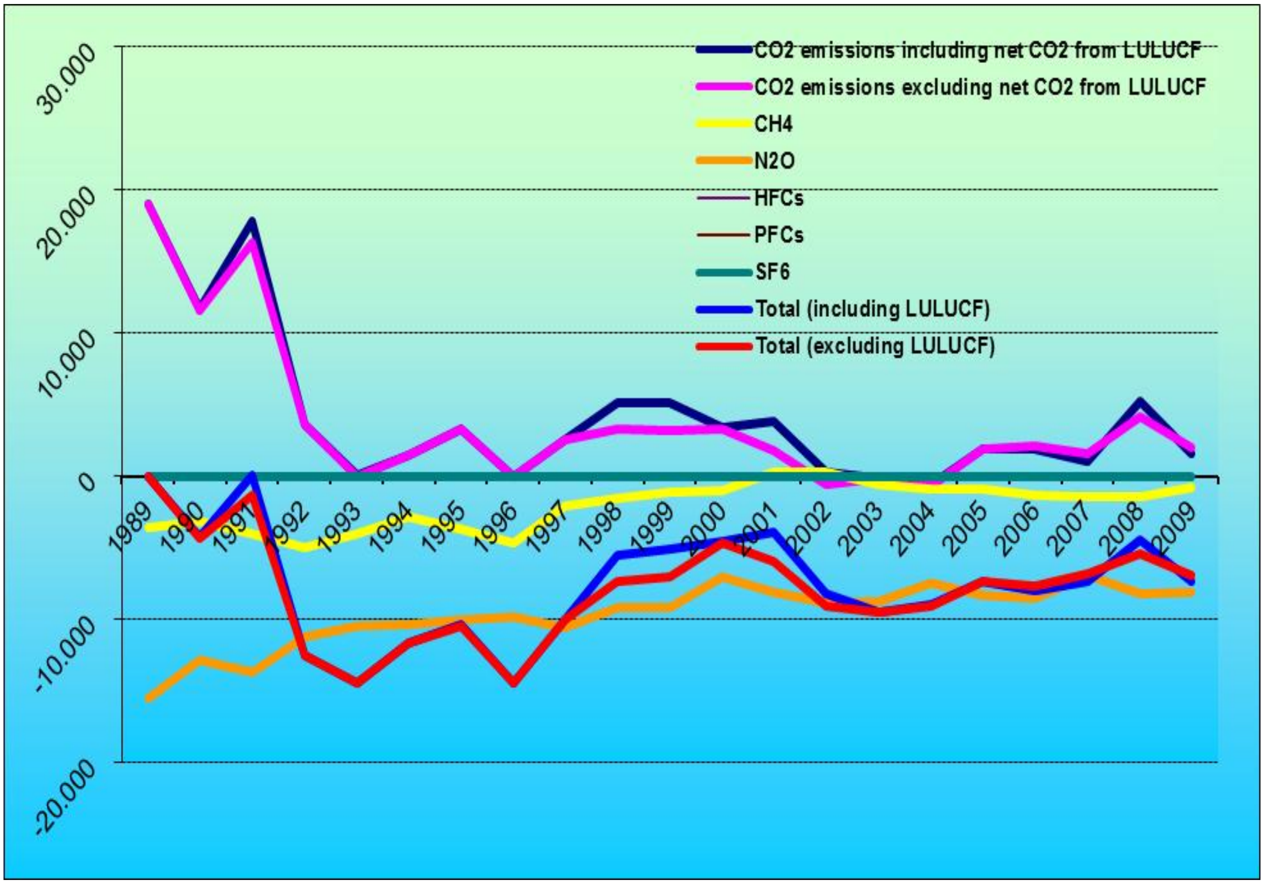
NMVOC recalculations were carried out in the following sectors:

- Solid Waste Disposal on Land (6.A)

PFC recalculations were carried out in the following sectors:

- There are no recalculations of these emissions.

Figure 10.2 Category total emissions/removals change, for all gases, and for the entire time series, in comparison to the figures in the 2011 version 4.1 submission



10.1.2 KP-LULUCF inventory

Recalculations by categories

The inventory contains improvements in the following sectors:

- Were made recalculation on Change in Carbon Stock (Emissons/removals) for 2008-2009 period in Afforestation and Reforestation (KP.A.1.1);
- Were made recalculation on Change in Carbon Stock (Emissons/removals) for 2008-2009 period in Forest Management (KP.B.1).
- The major change with 2010 re-submission results from the strict implementation of the

definitions of land use: 1) separation of “national forest fund” by the “vegetation outside the national forest fund”, 2) consistency in using SILV 4 reported indicators for reporting afforestation/reforestation and revegetation, and 3) reporting entire area “leaving of national forest fund” as deforestation.

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).

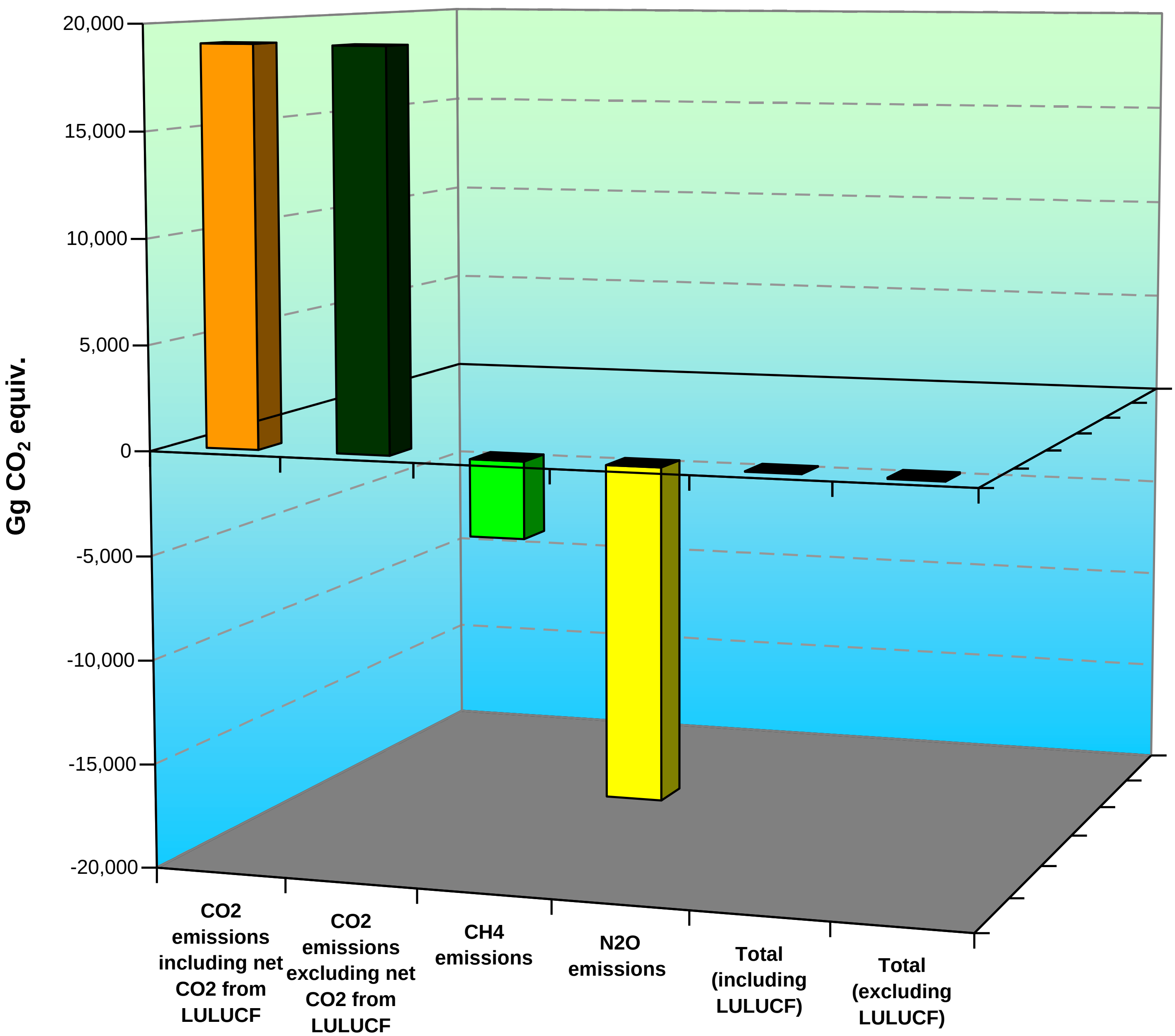
10.2 Implications for emissions levels, including on KP-LULUCF emissions levels

10.2.1 GHG inventory

Emissions changes due to recalculations, for 1989 are as follows:

- Total GHG including LULUCF (-0.01%), excluding LULUCF (-0.02%);
- N_2O (-38.31%);
- CH_4 (-7.53%);
- CO_2 excluding LULUCF (9.83%), CO_2 including LULUCF (11.09%).

Figure 10.3 Effects of recalculations (presented in the 2012 submission) for 1989, by gas

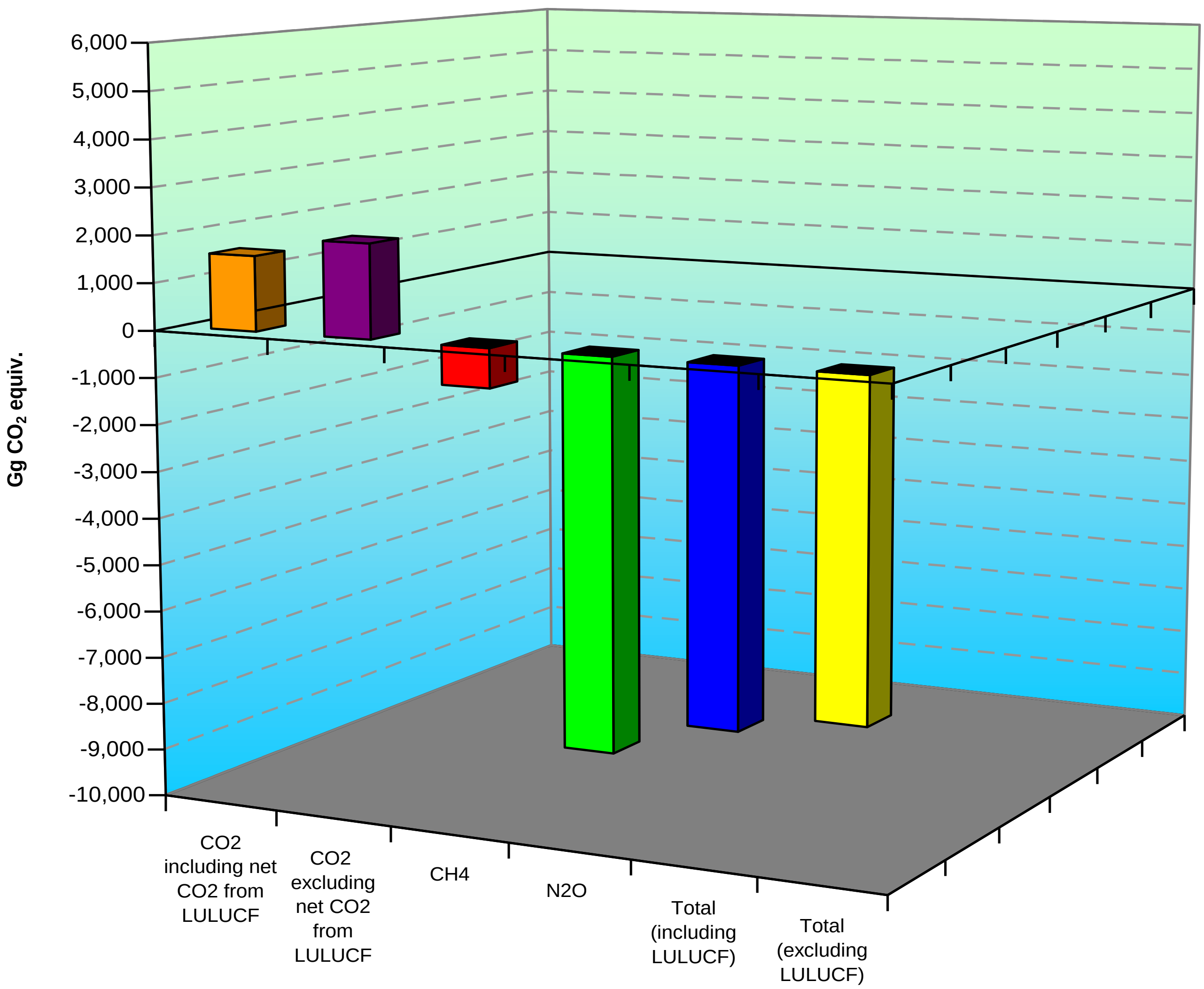


Emissions changes due to recalculations, for 2009, are as follows:

- CO_2 including LULUCF (2.72%), excluding LULUCF (2.30%);
- CH_4 (-3.44%);
- N_2O (-42.82%);

- Total GHG including LULUCF (-7.19%);
- Total GHG excluding LULUCF (-5.34%).

Figure 10.4 Effects of recalculations (presented in the 2012 submission) for 2009, by gas



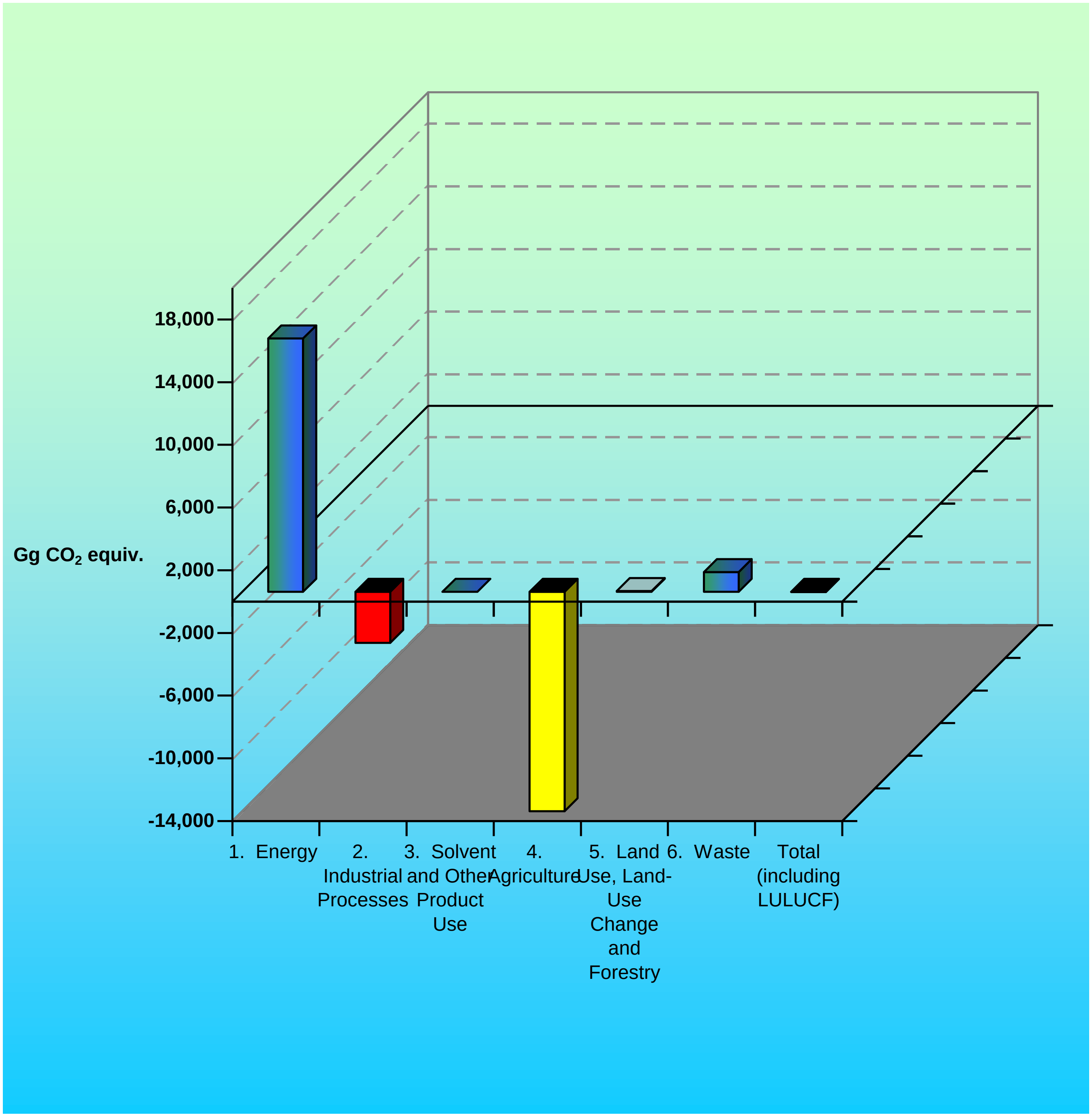
Impacts on 1989 emissions levels

Total emissions in 1989 including LULUCF have decreased by 0.01% compared to the 2011 submission Version 4.1.

Table 10.1 Recalculation of total emissions/removals, by sector, for all gases, for 1989

Differences for 1989 estimates	Differences		2012 v.2.1	2011 v.4.1
	Gg CO_2 eq.	%	Gg CO_2 eq.	Gg CO_2 eq.
1. Energy	16,165.166	8.58	204,676.03	188,510.87
2. Industrial Processes	- 3,259.637	-7.62	39,491.48	42,751.12
3. Solvent and Other Product Use	0	0	645.80	645.80
4. Agriculture	-14,227.808	-28.60	35,523.49	49,751.30
5. Land Use, Land-Use Change and Forestry	44.543	-0,21	-21,441.12	-21,485.66
6. Waste	1,255.098	37.49	4,602.57	3,347.47
Total (including LULUCF)	**-22.638**	**-0.01**	**263,498.26**	**263,520.90**

Figure 10.5 Changes of 1989 emissions/removals, in respect to the 2012 figures

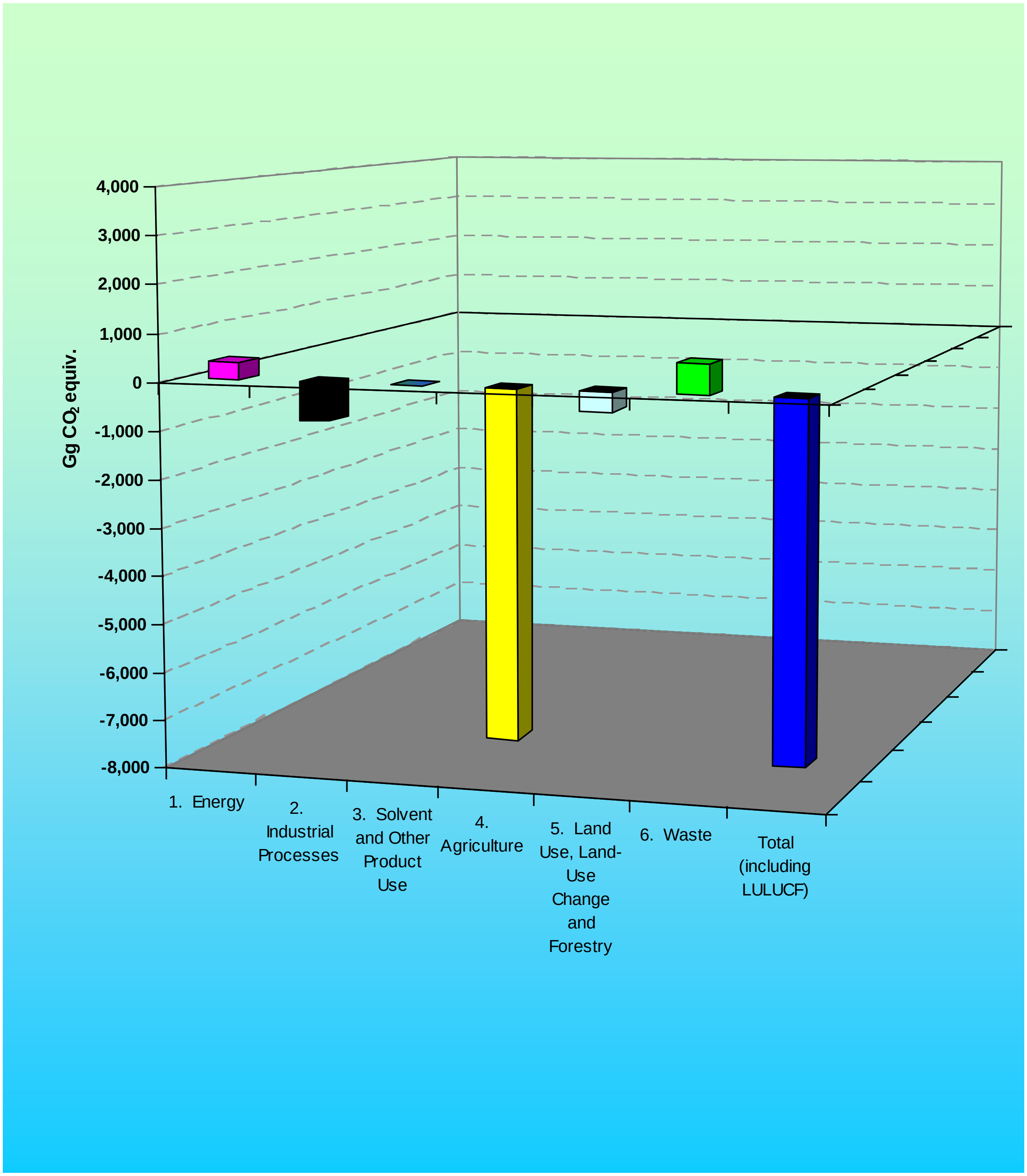


Total emissions in 2009, including LULUCF have decreased by 7.19% compared to the 2011 submission Version 4.1.

Table 10.2 Recalculation of total emissions/removals, by sector, for all gases, for 2009

Differences for 2009 estimates	**Differences**		**2012 v.2.1**	**2011 v.4.1**
	Gg CO_2 eq.	**%**	**Gg CO_2 eq.**	**%**
1. Energy	372.922	0.43	88,004.29	87,631.37
2. Industrial Processes	-780.332	-6.48	11,259.07	12,039.40
3. Solvent and Other Product Use	0	0	122.33	122.33
4. Agriculture	-7,158.623	-28.40	18,047.08	25,205.70
5.Land Use, Land-Use Change and Forestry	-402.106	1.44	-28,264.07	-27,861.96
6. Waste	627.558	12.82	5,524.10	4,896.54
Total (including LULUCF)	**-7,340.581**	**-7.19**	**94,692.79**	**102,033.37**

Figure 10.6 ***Changes of 2009 emissions/removals, in respect to the 2012 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 decreased with 27.69%.

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 0.71%.

Revegetation

- Compared to 2008 year, in 2010 year Net CO_2 equivalent emissions/removals have increased with 58.06%.

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 10.3 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 2011 reporting (object of a further Study) will be conducted in order to take into consideration these emissions, as Tier 3 approach, on the activity category where these operators have to report. ***Emission Factors***

No.	Category subject to improvement	Description of improvement
		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. 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", the Energy Sector team will investigate if a further study could be conducted on the national circumstances, with the proper results on the above recommendation.
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,	It is planned to take into consideration the emissions from

No.	Category subject to improvement	Description of improvement
	Manufacturing Industries and Construction - Iron and Steel (CRF 1.A.2.a)	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.
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	Fuel combustion, Other Sectors – Commercial / Institutional (CRF 1.A.4.a)	See the chapter 3.2.6.6 for more details.
11	Fuel combustion, Other Sectors – Agriculture /	See the chapter 3.2.6.6 for more details.

No.	Category subject to improvement	Description of improvement
	Forestry / Fisheries (CRF 1.A.4.c)	
12	Fuel combustion, Other (Not specified elsewhere) - Stationary (CRF 1.A.5.a)	See the chapter 3.2.6.6 for more details.
13	Transport - Road Transport (1.A.3.b)	Using Copert 4 - model
Industrial Processes		
1	Lime production (2A.2)	Higher tier in CO_2 emission estimation.
2	Consumption of halocarbons and SF_6 (2F)	Improve the emission estimation within this category.
Agriculture		
1	Source category Enteric Fermentation (CRF source category 4.A)	Aiming to their incorporation into next inventory submissions, the development of national values for the methane conversion rate (Y_m), for significant categories, is envisaged.
2	Source category Manure Management (CRF source category 4.B)	Aiming to their incorporation into next inventory submissions, the development of national values for the following parameters, parameters relevant to significant species, are envisaged: - ash content of the manure (ASH); - maximum CH_4 producing capacity for manure produced by an animal within defined population (B_0); - CH_4 conversion factors for each manure management system by climate region (MCF).
3	Source category Rice Cultivation (CRF source category 4.C)	In respect to the IPCC GPG 2000 provisions, more detailed data on rice cultivation techniques used are proposed to be obtained.

No.	Category subject to improvement	Description of improvement
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 Burning of Agricultural Residues (CRF source category 4.F)	Aiming to their incorporation into next inventory submissions, the development of national values for activity data in totality, for to significant species, is envisaged.
Waste		
1	Source category Solid Waste Disposal on Land (CRF sector 6.A)	In order to improve accuracy of activity data regarding amounts of MSW deposited in managed landfills for 1995-2002 period we will try to make a statistical research by collecting these data from the landfills operators. As regarding methane recovered, in present we have only CH_4 recovered from managed landfills, but there is the possibility that methane to be recovered also from unmanaged landfills. We will make a thorough statistical survey for improving this information. More investigation will be necessary for collecting data on industrial waste and sludge deposited in solid waste disposal

No.	Category subject to improvement	Description of improvement
		sites.
2	Source category Wastewater Handling (CRF sector 6.B)	In order to improve the next submissions, we will develop in the future studies regarding wastewater treatment for obtaining of more accurate data and emission factors.
3	Source category Waste Incineration (CRF sector 6.C)	In order to estimate N_2O emissions from waste incineration, we will try to obtain more data by sending some questionnaires to the operators of incinerators and collecting all this information.
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 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.

No.	Category subject to improvement	Description of improvement
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 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

No.	Category subject to improvement	Description of improvement
		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 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

No.	Category subject to improvement	Description of improvement
		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 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

No.	Category subject to improvement	Description of improvement
		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, 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. 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

No.	Category subject to improvement	Description of improvement
		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 "Monitoring soil quality in Romania" (ICPA, 2006), considering the IPCC methodologies available.
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

No.	Category subject to improvement	Description of improvement
		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.

In response to the review process, recalculations were carried out as follows:

- Recalculations for the 1989 – 2009 period at sub-sector 1.A.1 - Energy Industries due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

The concerned categories of sub-sector 1.A.1 - Energy Industries are, as follows:

1. A.1.a. Public Electricity and Heat Production / Producer Electricity Plants,
1. A.1.b. Petroleum Refining,
1. A.1.c. Manufacture of Solid Fuels.

CO_2 Emission Factors

- Recalculations for the 1989 – 2006 period at the sub-sector 1.A.1 - Energy Industries due to the new calculated emission factors.

The concerned categories of the sub-sector 1.A.1 Energy Industries are, as follows:

1. A.1.a. Public Electricity and Heat Production / Producer Electricity Plants,
1. A.1.b. Petroleum Refining,
1. A.1.c. Manufacture of Solid Fuels.

For Solid fuels,

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

●Analyzed solid fuels are: Lignite, Other bituminous coal.

For liquid fuels,

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

●Analyzed fuels by the Study are: Transport diesel, Residual fuel oil, Heating and other gasoil, Refinery gas.

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

For gaseous fuels,

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

●Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines, are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 2007 - 2010 period at the sub-sector 1.A.1 - Energy Industries due to the new calculated emission factors.

The concerned categories are, as follows:

1. A.1.a. Public Electricity and Heat Production / Producer Electricity Plants,

1. A.1.b. Petroleum Refining,

1. A.1.c. Manufacture of Solid Fuels.

For 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.

●Analyzed fuels by the Study are: Lignite, Other bituminous coal.

For 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.

●Analyzed fuels by the Study are: Transport diesel, Residual fuel oil, Heating and other gasoil, Refinery gas.

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

For 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.

●Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

CH_4, N_2O Emission factors

- Recalculations for the 1989 – 2009, all activity categories 1.A – Stationary Fuel Combustion

***Biomass gas* -** new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 1989 – 2009 period at sub-sector 1.A.2 – Manufacturing Industries and Construction due to the change of the source of Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

The concerned categories of 1.A.2 – Manufacturing Industries and Construction are, as follows:

1. A.2.a. Iron and Steel,

1. A.2.b. Non-Ferrous Metals,

1. A.2.c. Chemicals, 1.A.2.d. Pulp, Paper and Print,

1. A.2.d. Pulp, Paper and Print,

1. A.2.e. Food Processing, Beverages and Tobacco,

1. A.2.f. Other.

● Recalculations for the 2006 – 2009 period at category 1.A.2f Other (please specify) – Other non-specified, Other Fuels – it is taken into consideration the industrial waste, reported by the operators on the EU-ETS scheme.

➢ Recalculations for the 1989 – 2006 period at the sub-sector 1.A.2 – Manufacturing Industries and Construction due to the new calculated emission factors.

The concerned categories are, as follows:

1. A.2.a. Iron and Steel,

1. A.2.b. Non-Ferrous Metals,

1. A.2.c. Chemicals, 1.A.2.d. Pulp, Paper and Print,

1. A.2.d. Pulp, Paper and Print,

1. A.2.e. Food Processing, Beverages and Tobacco,

1. A.2.f. Other.

For Solid fuels,

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

●Analyzed solid fuels are: Other bituminous coal, Coking coal.

For liquid fuels,

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

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

●Analyzed fuels by the Study are: Residual fuel oil, Heating and other gasoil, Petroleum Coke.

For gaseous fuels,

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

Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 2007 - 2010 period at the sub-sector 1.A.2 – Manufacturing Industries and Construction due to the new calculated emission factors.

The concerned categories are, as follows:

1. A.2.a. Iron and Steel,

1. A.2.b. Non-Ferrous Metals,

1. A.2.c. Chemicals,

1. A.2.d. Pulp, Paper and Print,

1. A.2.e. Food Processing, Beverages and Tobacco,

1. A.2.f. Other.

For 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.

●Analyzed solid fuels are: Other bituminous coal, Coking coal.

***For 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.

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

●Analyzed fuels by the Study are: Residual fuel oil, Heating and other gasoil, Petroleum Coke.

***For 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.
Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.
For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations were proposed in the review process for the Energy Sector-Transport subsector by use the values of the national emission factors, as determined by the study of ISPE (January 2012), in the table below:

Table 10.4 Values of the national emission factors, as determined by the study of ISPE (January 2012)

Fuel	FE ^{naţ} (tCO_2/TJ)	C ^{nat} (tC/TJ)
Lignit	98.96	26.99
Natural Gas	55.49	15.13
Rafinery Gas	56.10	15.30
Other Bituminous Coal	94.55	25.79
Coke Oven Coke	91.22	24.88
Gas/Diesel oil	73.29	19.99
Residual Fuel Oil	78.15	21.31
LPG	74.19	20.23
Petroleum Coke	93.63	25.54
Gasoline	71.62	19.53

Note: the values of emission factors do not have included the oxidation factor.

- Recalculations for the 1989 – 2009 period at 1.A.4 – Other Sectors due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.

The concerned categories of the sub-sector 1.A.4 Other Sectors are, as follows:

1. A.4.a. Commercial/Institutional,

1. A.4.b. Residential,

1. A.4.c. Agriculture/Forestry/Fisheries.

- Recalculations for the 1989 – 2006 period at the sub-sector 1.A.4 – Other Sectors due to the new calculated emission factors.

The concerned categories are, as follows:

1. A.4.a. Commercial/ Institutional,

1. A.4.b. Residential,

1. A.4.c. Agriculture/Forestry/Fisheries.

For Solid fuels*,*

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

For liquid fuels*,*

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

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

For gaseous fuels*,*

EFs calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported category activities, oxidation included, are used.
Natural gas is the analyzed fuel.

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 2007 - 2010 period at the sub-sector 1.A.4 – Other Sectors due to the new calculated emission factors.

The concerned categories are, as follows:

1. A.4.a. Commercial/ Institutional,

1. A.4.b. Residential,

1. A.4.c. Agriculture/Forestry/Fisheries.

For solid Fuels,

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

For liquid fuels,

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

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

For 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.
Natural gas is the analyzed fuel.
For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 1989 – 2009 period at 1.A.5 - Other (Not specified elsewhere) due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used. The concerned categories of the sub-sector 1.A.5 - Other (Not specified elsewhere) are, as follows:

1. A.5 a. Other (Not specified elsewhere) - Stationary (please specify)

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.

- Recalculations for the 1989 – 2006 period at the sub-sector 1.A.5 - Other (Not specified elsewhere) due to the new calculated emission factors.

The concerned categories of the sub-sector 1.A.5 - Other (Not specified elsewhere) are, as follows:

1. A.5 a. Other (Not specified elsewhere) - Stationary (please specify)

For Solid fuels*,*

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

For liquid fuels*,*

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

For gaseous fuels*,*

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

For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 2007 - 2010 period at the sub-sector 1.A.5 - Other (Not specified elsewhere) due to the new calculated emission factors.

The concerned categories of the sub-sector 1.A.5 - Other (Not specified elsewhere) are, as follows:

1. A.5 a. Other (Not specified elsewhere) - Stationary (please specify)

For solid Fuels,

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

For 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.

For 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.
For Biomass fuels, new emission factors referenced in IPCC 2006 guidelines are used.

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 1989 – 2009 period at 1.AB Fuel Combustion – Reference Approach 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 1989 – 2009 period at 1.AB Fuel Combustion – Reference Approach due to the new calculated emission factors.

For solid, liquid and gaseous fuels, *Country Specific EFs are calculated as weighted arithmetic average (WA), on 2007 – 2010 period, ALL EU-ETS reported activity categories, without oxidation included, are used.*
The analyzed fuels are as following:
Lignite, Natural gas, Refinery gas, Other bituminous coal, Coking coal, Transport diesel, Residual fuel oil, Heating and other gasoil, Petroleum Coke, Motor Gasoline

For other fuels – industrial wastes, new emission factors referenced in IPCC 2006 guidelines, are used.

- Recalculations for the 1989 – 2009 period at 1.AC Fuel Combustion – Feedstocks and non-energy use of fuels due to the change of the source of the Activity Data: EUROSTAT instead of domestic version of the Romanian Energy Balance is used.
- Recalculation for Coal Mining and Handing in category, because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and emission factors (EFs) were changed with the default EFs, taken from 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC GL); notation key "NE" was changed in "NA" for CO_2 and N_2O (1.B.1.A);
- change in notation key for Solid Fuel Transformation : "NE" was changed with values, because AD were found for this domain in IEA/Eurostat Questionnaire 2010 - Coking Coal and EF to CH_4 was taken from UNFCC-EFDB; notation key "NE" was changed in "NA" for CO_2 and N_2O (1.B.1.B);
- change in notation key for Recovery CH_4: "NE" was changed with values, because CH_4 is recovered for energy use, only from two underground mines; the values are provided by Ministry of Economy, Trade and Business (MECMA) and National Institute for Research and Development in Mine Safety (INSEMEX) (1.B.1.A.1.1.);
- change in notation key for CH_4 Recovery, notation key "NE" was changed in "NO" (1.B. 1.A.1.2., 1.B.1.A.2.1., 1. B.1.A.2.2, 1.B.1.B.)
- change in notation key for Exploration (1.B.2.A.1.): "NE" for AD was changed, because available data were found in IEA/Eurostat Questionnaire 2010 - Petrol -Crude Oil;
- change in notation key "NE" for CO_2, CH_4 and N_2O were used default EFs for “Oil extraction” from 2006 IPCC GL;
- recalculation for Production and Upgrading (1.B.2.A.2.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and emission factors (EFs) for CO_2 and CH_4 were replaced with the default EF for “*Oil production*” from GL 2006 IPCC, while N_2O is notation “NA”;
- recalculation for Transport (1.B.2.A.3.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and emission factors (EFs) for CO_2 and CH_4 were replaced with the default EF “*Oil Transport Pipelines*” from 2006 IPCC GL, while N_2O is notation “NA”;

- recalculation for Refining/Storage (1.B.2.A.4.) because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Petrol -Crude Oil and emission factors (EFs) for CH_4 was replaced with **"***Combined EF for Refining and Storage Tank*" from Revised 1996 IPCC;
- change in notation key for CO_2 and N_2O (1.B.2.A.4.): notation key "NE" was change in "NA";
- change in notation key for Exploration (1.B.2.B.1.): notation key "NE" was changed in "IE" for CO_2, CH_4 and N_2O because considered in (1.B.2.A.1.);
- recalculation for Production/Processing (1.B.2.B.2.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 and emission factors (EFs) for CO_2 and CH_4 were replaced with the default EF for "*Production/ Processing*" from GPG 2000 IPCC; for N_2O notation key change in "NA";
- recalculation for Transmission (1.B.2.B.3.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and emission factors (EFs) for CO_2 and CH_4 were replaced with the default EFs for "*Transmission*" from GPG 2000 IPCC; for N_2O notation key change in "NA";
- recalculation for Distribution (1.B.2.B.4.): replaced notation key "IE" with activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and notation key "IE" for CO_2 and CH_4 were replaced with the default EFs for "*Distribution*" from GPG 2000 IPCC; for N_2O notation key change in "NA";
- recalculation for Distribution (1.B.2.B.4.) subsector was split into:
    - recalculation for Distribution (1.B.2.B.4.): replaced notation key "IE" with activity data (AD-pipeline length) were taken from National Regulation Authority of Energy (ANRE) and notation key "IE" for CH_4 were replaced with the default EFs for "*Distribution*" from GPG 2000 IPCC; for CO_2 notation key change in "IE" and N_2O notation key change in "NA";
    - recalculation for Distribution (1.B.2.B.4.): replaced notation key "IE" with activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and notation key "IE" for CO_2 were replaced with the default EFs for "*Distribution*" from 2006 IPCC GL; for N_2O notation key change in "NA"; this part of subsector (1.B.2.B.4.) was added as a new subcategory to "Other (please specify)" (1.B.2.D.) in CRF Reporter.
- recalculation for Other Leakage - at industrial plants and power stations (1.B.2.B.5.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and

emission factors (EFs) for CH_4 was replaced with the default EF from GPG 2000 IPCC; notation key "NE" was changed in "NA" for CO_2 and N_2O;

- recalculation for Other Leakage -residential and commercial sectors (1.B.2.B.5.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and emission factors (EFs) for CH_4 was replaced with the default EF from Revised 1996 IPCC; notation key "NE" was changed in "NA" for CO_2 and N_2O;
- recalculation for Venting - Oil (1.B.2.C.1.1.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Petrol -Crude Oil and emission factors (EFs) for CO_2 and CH_4 was replaced with the default EF for "*Venting*" from GL 2006 IPCC; notation key "NE" was changed in "NA" for N_2O;
- recalculation for Venting - Natural Gas (1.B.2.C.1.2.): because the activity data (AD) were taken from IEA/Eurostat Questionnaire 2010 - Natural Gas and emission factors (EFs) for CH_4 and CO_2 were replaced with the default EF for "*Venting*" from GL 2006 IPCC; notation key "NE" was changed with notation key "NA" for N_2O;
- change in notation key for Flaring - Oil (1.B.2.C.2.1.): notation key "NE" for AD was changed with activity data were taken from IEA/Eurostat Questionnaire 2010 - Petrol - Crude Oil;
- change in notation key for CO_2,CH_4 and N_2O from Flaring- Oil (1.B.2.C.2.1.): notation key "NE" were changed because were used default EF for "*Flaring*" from GL 2006 IPCC;
- change in notation key for Flaring - Natural Gas (1.B.2.C.2.2.): notation key "IE" for AD was changed with activity data were taken from IEA/Eurostat Questionnaire 2010- Natural Gas;
- change in notation key for CO_2, CH_4 and N_2O from Flaring- Gas (1.B.2.C.2.2.): notation key "NE" were changed because were used default EFs for "*Flaring*" from GL 2006 IPCC;
- Recalculations for 1989-2007 period at the Cement Production sub sector for CO_2 emission factor (EF) level due to change the default EF (0.525 t CO_2/t clinker) used in the last 2011 submission. The new specific EF was calculated considering the average between the base year 1989 implied emission factor (0.527 t CO_2/t clinker) and 2008 emission factor (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 0.53 t CO_2/t clinker (2A.1).
- The recalculation has been done due to wrong manipulation of data in Lime Production, for the entire time series. In the estimation of emissions from lime production were taken into account production data from crude dolomite. This data are not considered in IPCC GPG 2000. For

1990-1997 period and 2001-2010 period we have the activity data provided by NIS, activity data for dolomitic lime production where is disaggregated in calcined/sintered dolomite and agglomerate dolomite. For this period we calculated an average percentage with which we determined values for dolomitic lime for the 1989 and 1998-2000 period. (2.A.2);

- Recalculations for all-time series 1989-2009 at Ammonia Production sub sector method level for estimated CO_2 due to improvement in CO_2 emissions estimations (from T1b to T1a) based on the study “Elaboration of national emission factors/other parameters relevant to NGHGI Industrial Processes Sector in order to improve the Ammonia Production sub sector”(2.B.1);
- Recalculations for 1989-2009 period at the Calcium Carbide Production sub sector for CO_2 emission factor (EF) level due to change the default EF for use of product step (1.1 t CO_2/t carbide) used in the last 2011 submission. The new EF use was calculated considering default emission factors provided in production process of calcium carbide (CaO step and reduction step): 0.76 tonnes CO_2/tonne carbide and 1.09 tonnes CO_2/tonne carbide. The resulted EF is 0.85 tonnes CO_2/tonne carbide (2.B.4.2).
- Recalculations for all-time series 1989-2009 at Pig Iron Production category due to detected an error in the formula used for calculating CO_2 emissions (2C1.2);
- More disaggregated livestock data, in the format the National Institute for Statistics uses to report them to Eurostat, began to be used, for 1989-2010 period (4.A, 4.B, 4.D);
- National emission factors began to be used for 1989-2010 period (4.A);
- Tier 2 calculation methods were used for all livestock for estimating CH_4 emissions and for 1989-2010 period (4.A; 4.B);
- National emission factors began to be used for calculating the CH_4 emissions associated with 1989-2010 period (4.B);
- National values for the Nitrogen excretion per head of animal per region (Nex) and for percentages of manure N produced in different Animal Waste Management Systems (MS) began to be used for calculating the N_2O emissions (4.B; 4.D);
- Tier 1b calculation method began to be used (4.D.1.2, 4.D.1.3, 4.D.1.4, 4.D.3.1, 4.D.3.2);
- A combination of national and default values for the fractions associated with the manure in the context of using a Tier 1b method was used for 1989-2010 period (4.D.1.2);
- New information/data on crop productions were considered (4.D.1.3, 4.D.1.4, 4.F);

- A combination of national and default values for the fractions associated with the crop productions in the context of using a Tier 1b method was used for 1989-2010 period (4.D.1.3, 4.D.1.4);
- New data/information on annual cultivated organic soils areas have been provided through a dedicated study; the recalculation is relevant to the 1989-20010 time series (4.D.1.5);
- A combination of national and default values for the fractions associated with the crop productions was used (4.F).
- 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. 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 (5A);
- 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 (5A);
- 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 (5A);
- 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 (5A);
- Regarding the changes of emissions in living biomass from 1996–2009 there was an estimation error in the calculation sheets (5A1);

- 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; this led to re-calculation of all activity data and emission factors. GHG emissions/removals are practically estimated for this category for the first time (5.B);
- Changes were caused by the development of time series for plantations of trees on arable land (relevant as revegetation under KP) (5.B.1);
- For 2009 the activity data were recalculated following the check of land use matrix and revision of value of reference C stocks for soils (5.B.1-5.B.2.2);
- Starting with 2011 re-submission, a land use change matrix is available, which led to re-calculation of activity data for all land subcategories, thus, for the first time, the emissions on these land subcategories are estimated in the national GHG inventory (5.C);
- Revision of soil C stocks reference values, for all land uses (5.C.2.1-5.C.2.2-5.C.2.4-5.C.2.5);
- Starting with 2011 re-submission a land use change matrix is available, which led to re-calculation of activity data for all land categories, when, for first time, the emissions on these land subcategories are estimated in the national GHG inventory (5.D-5.D.2.1-5.D.2.5);
- Starting with 2011 re-submission a land use change matrix is available, which led to re-calculation of all activity data, thus emissions data from this land category were computed for first time in the national GHG inventory (5.E);
- Recalculations have been done at the current submission of about -4% for the entire time-series compared to the last submission, caused by the revision of soils C stocks reference values. (5.E.2.1-5.E.2.2-5.E.2.5);
- Starting with 2011 re-submission a land use change matrix is available, which led to re-calculation of all activity data and emission estimates are provided (5.F);
- Recalculations have been done in the current submission of about 113% for the entire time-series compared to the last submission, caused by the revision of soil C stocks reference values (5.F.2.2-5.F.2.4-5.F.2.5);
- Starting with the current submission CO_2 and NMVOC emissions from Solid Waste Disposal on Land have been estimated based on expert judgement in the study mentioned above.
- Taking into account ERT recommendation, since this submission we estimated the amounts of MSW deposited in unmanaged landfills in 1950-2002 period and we calculated CH_4 emissions from

unmanaged landfills using FOD method.

- We corrected inter-annual changes in emissions trend from unmanaged SWDS through changing the estimation method (from the default method to FOD method) and including new activity data and values of MSW composition for 1950-2002 period .
- Have been recalculated CH_4 emissions from domestic/commercial wastewater taking in consideration a large part of country population.
- At the ERT recommendation, starting with v.4.1 2011 submission, N_2O emissions from human sewage have been recalculated based on entire population of the country.

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 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

No.	Category subject to improvement	Description of improvement
		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 sectorial reporting statistics. The results will allow reaching 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:

- Romania provided revised estimates for afforestation and reforestation in accordance with the request made by the ERT, with the result that the total area under afforestation and reforestation in 2008 was reduced from 28,187 ha to 26,134 ha;
- The area currently reported under forest management is 2 % less than that reported previously, due to the improved reporting on land remaining in the same category and land in conversion to forestland. The sink also decreased by 40 % due to the corrections of inappropriate use of some factors in the past submission;
- For afforestation/reforestation, current estimates include all C pools (with the exception of DW which is not reported).
- Areas erroneously counted under AR (Wetlands to FL) they are not AR, but natural expansion of forest taken directly under FM.
- For Forest management, changes have been made to provide consistency with the NIR-2 Table.

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.

11.1.1. Definition of the forest and any other criteria

In Romania, the forest vegetation refers to two main land categories (see also the section 7.1.1 on land representation):

i. "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.

ii. "Forest vegetation from outside the national forest fund" (VFAFF), which historically is not a subject to forestry regime, and for which the development of management plans is not mandatory. Under the Convention it is still included under 5A1 after request from ERT 2010 despite fact that under national land system that is reported under Grassland. 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.

Romania's 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 threshold for forest. A crown cover threshold of 10% is implicitly implemented by the inclusion of a ‘forest’ under a management plans, otherwise the land is declared “other area from forest fund”. This also includes: forest belts, junipers and "wooded grasslands with crown cover greater than 40%." This definition is consistent with the 1990 definition in terms of minimum area of forest land, although it brings further specifications related to the minimum height of the trees in normal conditions of vegetation.

The new forest code 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. Data collected by the national and forest statistics are consistent with these definitions, and further on with the definitions implemented by the new NFI.

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.

"**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 (1990-2009) 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). Additionally, under the CRFs of the convention there are also reported conversions from various lands to VFAFF which are not counted under FM.

Meantime, any other land category which gets covered by forest vegetation it is reported under as VFAFF in the national statistics.

"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 or VFAFF). 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 (i.e. landmarked, mapped, or subject to management plans). 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). 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 / 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.

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).

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 are 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).

The matrix used for estimation of emission/removal on KP eligible lands is presented in the following table.

Table 11.1 Land area matrix 1990 – 2010

1990	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	**9450**	6	2	0	0	0	1	0	0	0	0
Pastures	0	**3255**	0	0	0	1	0	0	0	0	0
Hayfields	0	0	**1448**	0	0	0	0	0	0	0	0
Vineyards	0	0	0	**277**	0	0	0	0	0	0	0
Orchards	0	0	4	0	**313**	0	0	0	0	0	0
VFAFF	0	0	0	0	0	**432**	0	0	0	0	0
FF	0	0	0	0	0	0	**6251**	0	0	0	1
Constr.	0	0	3	0	0	0	0	**622**	0	0	2
Roads/railways	0	0	0	0	0	0	0	0	**387**	0	0
Waters/ponds	0	0	8	0	0	0	0	0	0	**902**	0
Other lands	0	2	0	0	0	0	0	0	2	1	**468**

2008	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	9300	67	27	26	0	0	**21**	15	1	3	0
Pastures	33	3144	1	0	0	4	**5**	14	1	32	22
Hayfields	5	9	1393	0	1	0	**0**	12	0	2	26
Vineyards	19	13	3	185	0	4	**0**	12	2	0	38
Orchards	17	35	12	2	206	4	**0**	11	0	0	28
VFAFF	0	22	17	0	0	304	**86**	0	0	4	0
FF	**0**	**0**	**0**	**0**	**0**	**0**	**6197**	**4**	**0**	**0**	**51**
Constr.	0	2	3	0	0	0	**0**	592	6	0	24
Roads/railways	0	0	0	0	0	0	**0**	3	367	0	17
Waters/ponds	33	18	63	0	0	15	**0**	6	0	718	56
Other lands	8	25	12	1	0	88	**0**	23	13	91	213
2009	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	9299	67	27	26	0	0	**21**	15	1	3	0
Pastures	41	3124	1	1	0	4	**5**	14	1	43	22
Hayfields	5	9	1389	0	1	0	**0**	12	0	7	26
Vineyards	19	13	3	185	0	4	**0**	12	2	0	38
Orchards	17	35	12	2	204	4	**0**	13	0	0	28
VFAFF	0	22	17	0	0	279	**110**	0	0	4	0
FF	**0**	**0**	**0**	**0**	**0**	**0**	**6197**	**4**	**0**	**0**	**51**
Constr.	0	2	3	0	0	0	**0**	592	6	0	24
Roads/railways	0	0	0	0	0	0	**0**	3	366	0	18
Waters/ponds	33	18	63	0	0	15	**0**	6	0	687	88
Other lands	8	25	12	1	0	112	**0**	32	13	92	179

Table 11.1 (contined) Land area matrix 1990 – 2010

2010	Arable	Pastures	Hayfields	Vineyards	Orchards	VFAFF	FF	Constr.	Roads/ railways	Waters/ ponds	Other areas
Arable	9282	67	29	26	0	0	**22**	15	1	3	15
Pastures	41	3099	1	1	0	4	**5**	14	1	43	47
Hayfields	5	9	1389	0	1	0	**0**	12	0	7	26
Vineyards	19	13	3	184	0	4	**0**	14	2	0	38
Orchards	17	35	12	2	198	4	**0**	13	0	7	28
VFAFF	0	22	17	0	0	275	**114**	0	0	4	0
FF	**0**	**0**	**0**	**0**	**0**	**0**	**6197**	**4**	**0**	**0**	**51**
Constr.	0	2	3	0	0	0	**0**	592	6	0	24
Roads/railways	0	0	0	0	0	0	**0**	3	365	0	19
Waters/ponds	33	18	63	0	0	20	**0**	6	0	680	90
Other lands	8	25	12	1	0	112	**0**	55	13	92	156

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 or NFI.

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 31.13 kha in 2010 (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 17 % of 5A2 lands under conversion to forests in 2010.

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.

Deforestation

The total deforested area from 1990 to 2010 is 54.75 kha including 4.23 kha reported in the land subcategory 5E2 – Land converted to Settlements and 50.52 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.

Forest management

FM area is consistent with forest fund areas reported under 5A1 – Forest Land remaining Forest Land in the convention tables (i.e. ~ 6198 kha in 2010) plus area reported under 5A2.4 conversion from other lands (~ 137 kha in 2010, 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).

Revegetation

For the LULUCF-KP reporting, data on “forest vegetation outside the forest fund” established by tree planting reaches 101.55 kha in 2010 compared to 87.99 kha in January 1990, taking into account the entire area planted since 1970. Actual revegetation data is drawn from statistics back till 1975, while for 1970-1974 data is 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 2008, 2009, 2010).

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 are no major changes compared to 2010 re-submission (dated September 2011). The major change with 2010 re-submission results from the strict implementation of the definitions of land use:

1) separation of “national forest fund” by the “vegetation outside the national forest fund”;
2) consistency in using SILV 4 reported indicators for reporting afforestation/reforestation and revegetation;
3) reporting entire area “leaving of national forest fund” as deforestation.

Few computing errors were fixed. One was related to BGB percentage applied which is fixed in order to ensure full match with the convention tables in 5A1, which resulted in an low increase of the sink, the quantitative impact is very small (< 5 %).

Table 11.2 Biomass recalculations in Table 5(KP.B.1) – Forest Management

	Last submission (Gg)		**Current submission (Gg)**		**Differences (%)**	
	2008	**2009**	**2008**		**2008**	**2009**
AGB - Gains	9629.19	9629.19	9436.78	**AGB - Gains**	9629.19	9629.19
AGB - Losses	-4436.59	-4413.53	-4878.55	**AGB - Losses**	-4436.59	-4413.53
BGB - Gains	1746.49	1746.49	1707.47	**BGB - Gains**	1746.49	1746.49
BGB - Losses	-953.87	-948.91	-368.45	**BGB - Losses**	-953.87	-948.91

Another computing error consisting in the not inclusion of soils pools changes in the total estimates in 5A2 was fixed, the quantitative impact is very small (<1 %).

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 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 over 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 $MgCO_2$eqon 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;
- 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 subtracted from the total AR emissions/removals at the end of the commitment period, which will be further allocated to third parties (project partners).

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 2010 for the Romanian registry is submitted together with this report (Annex 6.2.3). 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 31.12.2010 as well as information on transfers of the units in 2010 to and from other Parties of the Kyoto Protocol (Table 12.1). Neither AAUs, nor RMUs have been issued in the Romanian Registry in 2010.

Table 12.1 Information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Romanian registry at 31.12.2010

Annual Submission Item	Reporting
15/CMP.1 annex I.E paragraph 11: Standard Electronic Format (SEF)	**12.2**. The Standard Electronic Format report for 2011 has been submitted to the UNFCCC Secretariat electronically and the contents of the report can also be found in annex 6 of this document.
15/CMP.1 annex I.E paragraph 12: List of discrepant transactions	**12.3.** During the 2011 year, in Romanian registry occurred a discrepant transaction, and report R-2 is reproduced in annex 6.2.2
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications	No CDM notifications occurred in 2011
15/CMP.1 annex I.E paragraph 15: List of non-replacement	No non-replacement occurred in 2011
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist as at 31 December 2011
15/CMP.1 annex I.E paragraph 17: Actions and changes to address discrepancies	**Changes to the national registry to prevent a discrepancy from reoccurring** The Registry software was upgraded to version 5.1.24, which should aid in making certain that discrepancies identified in previous years should not reoccur. **Resolution of any previously identified questions of implementation pertaining to transactions** There were no previously identified questions.
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 2010 excluding Land Use, Land Use Change and Forestry, as follows:

Equation 12.1 CPR (tonnes CO_2 equivalent)

$$\text{CPR (tones } CO_2 \text{ equivalent)} = 5 * \text{GHG emissions level in 2010 (tones } CO_2 \text{ equivalent)}$$

$$\text{CPR} = 5 * 120{,}920{,}040.65 = 604{,}600{,}203 \text{ tones CO2 equivalent}$$

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 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 (NS) comprises:

- updating the National Environmental Protection Agency (NEPA) 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 13.1;
    - 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 13.1;
- 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 (review under Article 8 of the KP, EU internal reviews, collaborations with Austria and Netherlands).
- 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, Commerce and Business Environment 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 below 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 MEF, 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 MEF, 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, 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 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; 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 and by an improved quality management performed by study 2 contractor and NEPA.
- finalizing the preparation by NEPA of the Terms of References associated to the study 6; 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 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, 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.

Further elements, including on the implementation of studies in Table 13.1 are presented in Chapter 1 and within the relevant sectorial Sections.

Table 13.1 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

Table 13.1 (continued) 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
4.	"Environmental Integrated Informational System"	Optimizing the informational fluxes related to the NGHGI, including data collection from the operators for the Electricity and heat production category (Energy) and data collection from public authorities.	SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium	On-going	September 2012
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

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 Table 13.1.

Elements on strengthening the NS

In order to strengthen the NS the activities described in paragraph 2 of current Chapter have been implemented.

Elements on improving the GHG Inventory

Improvements of the NGHGI comprise:

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.

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

- 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 Table 11.2 above have been officially approved by the designated national authority, the Ministry of Environment and Forests. 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 and Forests (MEF).

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 authorities in charge of the GHG emission reporting are the MEF and the National Environmental Protection Agency (NEPA), and thus both institutions ensure 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 MEF is the responsible institution with implementation of UNFCCC and KP. In addition, MEF is the coordinator of funds distribution for studies in the field of environment and forests.

The NEPA, institution subordinated to MEF, has tasks in the implementation of environment policy and legislation, including the entire responsibility regarding the NGHGI.

Therefore MEF 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. NEPA is the beneficiary of these studies and will use the results to adequately meet the reporting obligations.

MEF is ensuring the development of the Terms of Reference (ToRs) of the studies and NEPA is supporting MEF in drawing up the technical aspects of ToRs, in a way to comply with the needs and the provisions of reporting requirements.
The authority responsible with the technical verification of the results of studies is NEPA which will need to use the results in the inventory preparation and hence the interest of NEPA 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, will be ensured as follows:

- *within the initiation phase – when drawing up the relevant ToRs, MEF as a contracting authority and NEPA as the implementing agency are ensuring that the necessary data and information provided by 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 Terms of Reference (ToRs) for each of these studies are approved and published by the MEF by using technical elements developed by NEPA with the aim to fill the gaps of recent inventory;
- the funding is provided by the MEF;
- 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 of the NEPA as the main beneficiary of these studies;
- during the implementation phase, the contractor is required to provide NEPA, after the generation of the results, the proper documentation on the scope, methods, assumptions, key parameter values and data sources; further on, NEPA 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 NEPA 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 NEPA 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 MEF and NEPA to monitor closely their development and avoiding in this way the deviation from the initial scope of the studies.

- *within the reception phase*

MEF is making the payments for the contractor only after NEPA'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 NEPA's headquarters, and are available for using further by experts and checked by review teams. Copies of the relevant documentation are stored at the MEF's headquarters.

Giving its legally assigned task and its designation as the responsible authority for the national system and preparation of the National GHG Inventory management, NEPA 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

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 of cooperation arrangement	No change of cooperation arrangement occurred during the reported period
15/CMP.1 annex II.E paragraph 32.(c) Change to database or the capacity of national registry	No change to the database or the capacity of the national registry occurred during the reported period
15/CMP.1 annex II.E paragraph 32.(d) Change of conformance to technical standards	No change in the registry's conformance to technical standards occurred for the reported period
15/CMP.1 annex II.E paragraph 32.(e) Change of discrepancies procedures	No change of discrepancies procedures occurred during the reported period
15/CMP.1 annex II.E paragraph 32.(f) Change of security	No major change of security measures occurred during the reported period. In 2011 the RO Registry implemented the AAR representative-that became mandatory for all the accounts.
15/CMP.1 annex II.E paragraph 32.(g) Change of 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	No change of the registry Internet address occurred during the reported period
15/CMP.1 annex II.E paragraph 32.(i) Change of data integrity measures	Romania implemented in 2011 a Secondary Recovery site, administrated by the IT department of registry administrator. The Disaster Recovery site was tested successfully in May 2011.(Annex 6.2.7, 6.2.8). We mention that the document "UNFCCC ITL VPN Connectivity Testing v0.5- RO DR Link, is considered confidential.
15/CMP.1 annex II.E paragraph 32.(j) Change of test results	No change of test results occurred during the reported period
The previous Annual Review recommendations	The ERT identified that the national registry has not fulfilled some of the requirements regarding the public availability of information in accordance with section II.E of the annex to decision 13/CMP.1.

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.

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.

This contribution will strengthen the cooperation for developing the climate change policy in Europe and will support the European integration of the Republic of Moldavia.

According to the provisions in paragraph 25 of Decision 15/CMP. 1, no changes in reporting the information under KP Article 3 paragraph 14 occurred since the previous NGHGI submission.

16 OTHER INFORMATION

There is no other relevant information which needs to be reported.

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