Ministry of Environment and Water Management

National Environmental Protection Agency

Romania's Greenhouse Gas Inventory 1989-2004

National Inventory Report

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CONTENT

ANNEXES

LIST OF FIGURES

LIST OF TABLES

LIST OF EQUATIONS

LIST OF ABBREVIATIONS

AD	Activity Data
BOD	Biochemical Oxygen Demand
BOF	Basic Oxygen Furnace
C	Carbon
C_2F_6	Hexafluoroethane
$CaCO_3$	Calcium Carbonate (limestone)
CaO	Calcium Oxide (lime)
CaO*MgO	Dolomitic lime
CF_4	Tetrafluoromethane
CH_4	Methane
CKD	Cement Kiln Dust
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CORINAIR	Coordination of Information on the Environment, sub-project: Air
CRF	Common Reporting Format
CWPB	Centre Worked Pre-baked
DOC	Degradable Organic Carbon
DOC_F	Fraction of DOC Dissimilated
EAF	Electric Arc Furnace
EF	Emission Factor
EUROSTAT	Statistical Office of the European Communities
FAO	Food and Agriculture Organization
GD	Governmental Decision
GHG	Greenhouse Gas
GPG	Good Practice Guidance
GWP	Global Warming Potential
HCFC	Fluorinated Gases
HFCs	Hydrofluorocarbons

ICAS	Forest Research and Management Institute
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
LULUCF	Land Use, Land Use Change and Forestry
MCF	Methane Conversion Factor
$MgCO_3$	Magnesium Carbonate
MgO	Magnesium Oxide
MSW	Municipal Solid Waste
N	Nitrogen
N_2O	Nitrous Oxide
NACE	National Classification of Economic Activities
NEPA	National Environmental Protection Agency
NIR	National Inventory Report
NIS	National Institute for Statistics
NMVOC	Non-methane Volatile Organic Compound
NOx	Nitrogen Oxides
NSCR	Non Selective Catalytic Reduction
PFCs	Perfluorocarbons
QC/QA	Quality Assurance/Quality Control
RNP	Public National Forest Administration
SF_6	Sulphur Hexafluoride
SNAP	Selected Nomenclature for Air Pollution
SNFI 1984	Synthesis of National Forest Inventory, 1988
SO_2	Sulphur Dioxide
SRC	Selective Catalytic Reduction
SWDS	Solid Waste Disposal Sites

SWPB	Side Worked Pre-baked
SY	Statistical Yearbook
UNFCCC	United Nations Framework Convention on Climate Change
YR	Year

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

ES. EXECUTIVE SUMMARY

ES.1 Background information

In 1994, Romania ratified the United Nations Framework Convention on Climate Change (UNFCCC) by Law 24/1994. As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), Romania is required to elaborate, regularly update and submit the National Greenhouse Gas Inventory.

Romania signed the Kyoto Protocol in 1999 and ratified it in January 2001, being the first Annex I country Party that ratified it. With Kyoto Protocol, the Parties to the Convention assumed the obligation to reduce the GHG emissions with a certain rate regarding the base year for each country. Romania committed itself to reduce the greenhouse gas emissions by 8% comparing to 1989 (base year) levels in the first commitment period 2008 - 2012.

In compliance with the reporting requirements, this is the fifth version of the National Inventory Report (NIR) submitted by Romania.

In order to ensure transparency, Romania is delivering herewith the revised national inventories of GHG emissions for 1989-2004 period (second version of 2006 submission). This report contains necessary information on reviewing the GHG national inventories as a result of improvements at data series consistency, expert judgments, consistency in emissions factors use and institutional arrangements levels.

This report documents Romania's National Inventory Report for anthropogenic emissions of direct greenhouse gases: CO_2, CH_4, N_2O, HFC, PFC, SF_6 as well as of indirect greenhouse gases: NO_x, CO, NMVOC and SO_2.

This report includes descriptions of methods, data sources, key sources, uncertainties, quality assurance and quality control (QA/QC) activities carried out and a trend analysis. Due to lack of uncertainties values related to activity data, a full quantitative assessment of uncertainty could not be made; uncertainty analysis is presented only on subsectoral level.

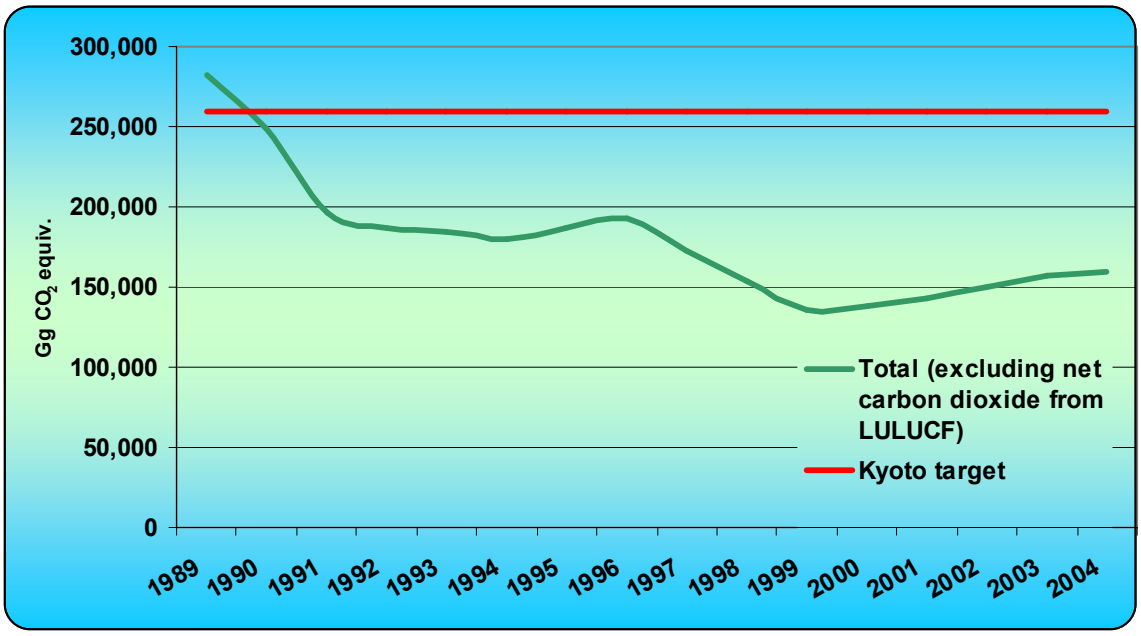
ES.2 Summary of trends

For the trends analysis, the GHG emissions resulted from each sector were converted into CO_2 equivalent according to the IPCC's Global Warming Potential (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.

The largest contributor to the total national GHG emissions is CO_2, followed by CH_4 and N_2O. The CO_2 emissions accounted for some 67.94 to 73.43 % of the total GHG emissions. The CH_4 emissions accounted for some 16.2 to 19.8 % and N_2O for 9.64 to 11.98% of the total GHG emissions. The F-gases contributed to the total GHG emissions with 0.23 to 1.2 %, depending on year.

Figure ES 1 The total GHG emissions in CO_2 equivalent in the period 1989-2004



According to the figure above, there is a great probability for Romania to meet the Kyoto Protocol commitments regarding the limitation of the GHG emissions in the first commitment period (2008-2012). The GHG emissions (without LULUCF) have decreased with 43.34% since the base year.

ES.3 Overview of the source and sink category emission estimates and trends

The present GHG inventory for the period 1989 – 2004 was compiled according to the recommendations for GHG inventories set out in the UNFCCC Guidelines on Reporting and Review, (FCCC/CP/2002/8 and FCCC/SBSTA/2004/8), using the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines, 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 for LULUCF, 2003).

The inventories cover all sectors and the majority of the IPCC source categories. The direct greenhouse gases (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 calculations of emissions of the precursors and indirect greenhouse gases NO_x, NMVOC, CO and SO_2, which should be included according to the reporting guidelines. The main remaining gap in the inventory is related to the disaggregated estimate of the international bunker fuels. Some minor IPCC source categories are not estimated, such as the emissions from asphalt roofing, from road paving with asphalt, and from histosols due to the lack of activity data.

GHG emissions inventories have been reported since the 2005 submission by using the software CRF Reporter, delivered by the UNFCCC Secretariat. This version of NIR refers to figures in CRF tables generated using CRF Reporter version 3.0.37.

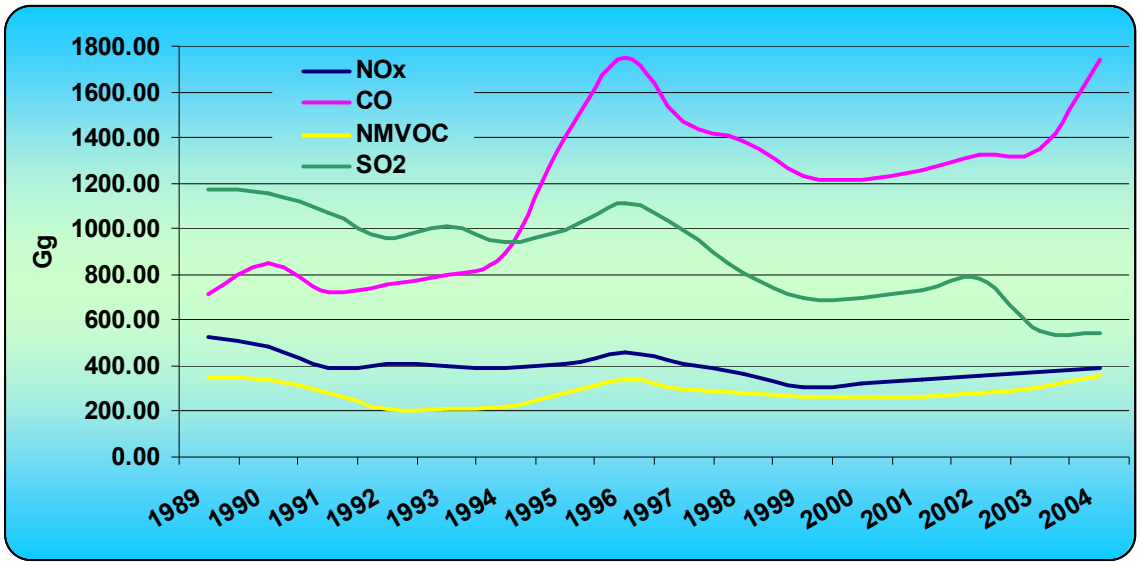
ES.4 Indirect greenhouse gases and SO_2

The emissions of the precursors and indirect greenhouse gases (NO_x, NMVOC, CO and SO_2) are included in the report, as requested by the UNFCCC guidelines. These gases are called “precursor or indirect” gases because their influence (decrease or increase) upon the warming of the atmosphere is

indirectly, through secondary effects. 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. For the NMVOC emissions, another important source is the "Solvent and Other Product Use" sector.

Figure ES 2 Indirect gases emissions



The NO_x, NMVOC and SO_2 emissions evolution follows the general GHG emissions trend. The SO_2 emissions decrease is caused by the decline of the fuels burnt for energy and by the decrease of sulphur content in fuels. The unusual increase of CO emissions after 1994 is due to the increase of firewood for households.

1. INTRODUCTION

1.1 Background information

As a Party to the Convention, Romania is required to produce and regularly update the national GHG inventory. According to the COP decision to implement 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 sixth complete submission of the national GHG inventory of Romania. The structure of the National Inventory Report is in line with the Annex I of the Guidelines for the preparation of national communication by parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories (FCCC/CP/2002/8 and FCCC/SBSTA/2004/8).

For this submission, Romania prepared: the CFR Reporter database containing emission estimates for the period 1989-2004 and the National Inventory Report.

The greatest attention during the preparation was focused on direct greenhouse gases regulated by the Kyoto Protocol - CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. In addition, the precursors of greenhouse gases and aerosols (NO_X, CO, NMVOCs, 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 object of the following international reviews:

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

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

1.2 Institutional arrangements

As it has been mentioned in the previous NIR submitted in 2006, the Ministry of Environment and Water Management (MEWM) has the overall responsibility on the national GHG inventories and submits them to the European Commission and UNFCCC Secretariat.
In 2006, the MEWN has designated the National Environmental Protection Agency (NEPA) as the entity responsible with the preparation of the annual National GHG Inventory.

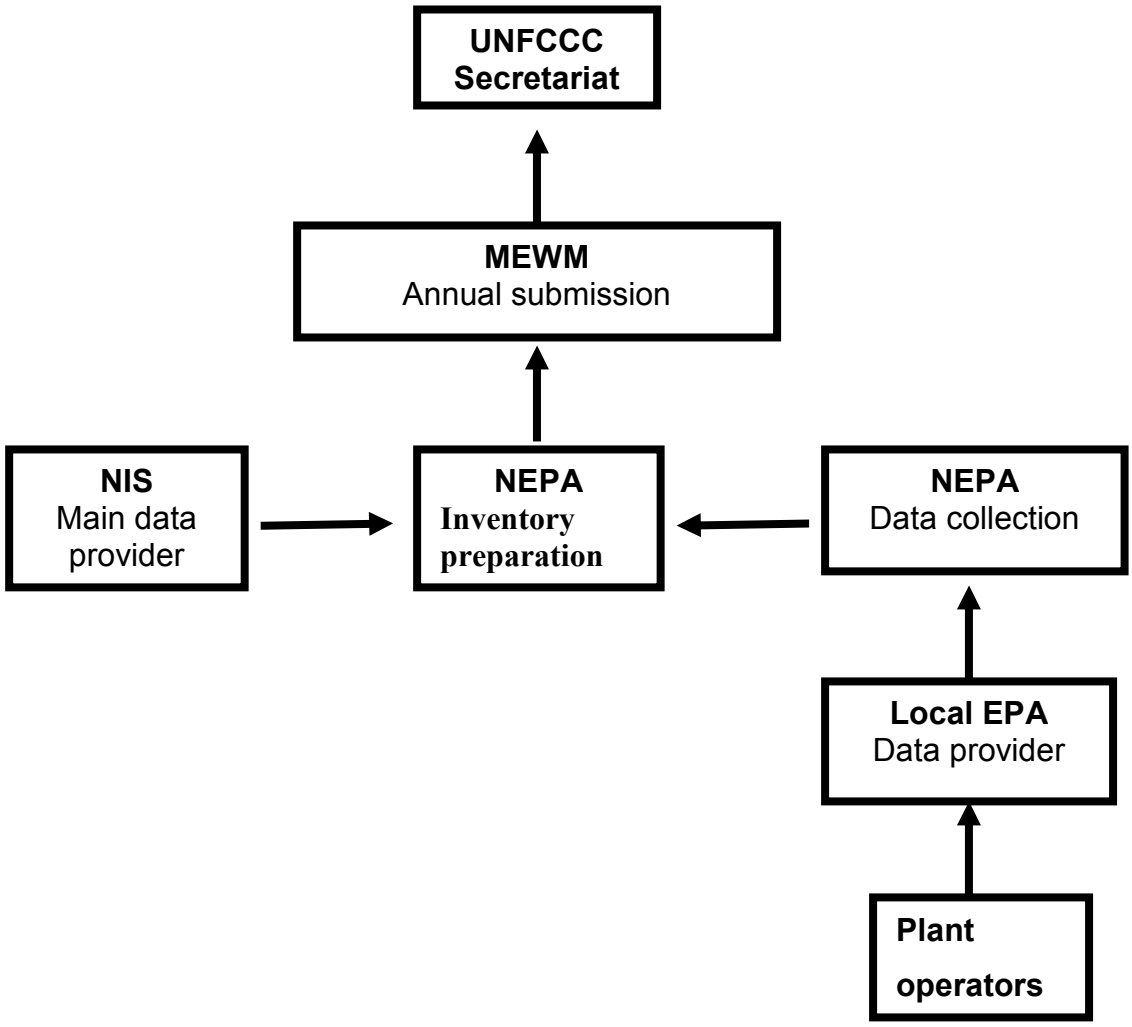
The main activity data supplier is the National Institute for Statistics (NIS) through the yearly-published documents like National Statistical Yearbook and the Energy Balance. In 2002, the Ministry of Environment and Water Management and the National Institute for Statistics signed a protocol of co-operation. Under this protocol, NIS agreed to provide, besides its yearly publication, additional data, necessary for the inventory preparation. There are still some timing problems related to the NIS relevant publications like the Energy Balance and the Statistical Yearbook data that are made available to the inventory team. The Energy Balance is not presented until December next year and the Statistical Yearbook is usually published in March two years after.

Starting with this submission, the LULUCF sector begun to be prepared by NEPA experts. For the previous submission, the LULUCF sector has been prepared by the Forest Research Institute (ICAS), under a contract with the National Research and Development Institute for Environmental Protection (ICIM Bucharest; the entity previously responsible for inventory preparation). Moreover, contacts were established with ministries, research institutes, organizations and companies that were requested to provide data for the inventory preparation.

National System

Based on art. 5 of the Kyoto Protocol, Romania is establishing a national system to estimate anthropogenic emissions for all GHGs not covered by the Montreal Protocol. The system will comply with provisions in the subsequent decisions of the COP/MOPs of the Kyoto Protocol and with provisions in Decision 280/2004/EC of the European Parliament and of the Council and in Decision 166/2005/EC of European Commission concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol. Romania has regularly prepared and submitted annually the GHG inventory, based on a clear internal plan and structure.
The inventory system currently used in Romania is presented in the Figure 1.1.

Figure 1.1 Current national inventory system description



The new Governmental Decision for establishing the National System for estimation of anthropogenic GHG level will sustain NEPA in preparing National GHG Inventories by defining a legal, institutional and procedural framework to involve actively the relevant authorities: ministries, National Institute for Statistics, other authorities, research institutes, professional associations and operators.

A good impetus to develop the GHG Inventories was represented by the implementation of European Parliament and of the Council Directive 2003/87/EC for establishing a scheme for GHG allowance trading.

The direct participation of operators ("installations") in this trading scheme is expected to enhance concern in GHG emissions and develop database for inventories.
The following three stages will be considered in the elaboration of the inventory: planning, preparation and management. In the first stage specific responsibilities will be defined and allocated, the second stage refers to inventory preparation process (data collection, relevant information needed for estimating emissions, methodological choices) and the third stage refers to the inventory management that also includes quality management, as well as documentation on QA/QC activities.

Establishment of the national system for estimating anthropogenic GHG emissions represents one of the eligibility criteria for the Romanian participation in the flexible mechanism (JI Track 1 and IET) under the Kyoto Protocol.

1.3 Inventory preparation

The present GHG inventory for the period 1989-2004 was compiled according to the recommendations for inventories set out in the UNFCCC Guidelines on Reporting and Review (FCCC/CP/2002/8 and FCCC/SBSTA/2004/8) and the report includes detailed information on the inventories for all years from the base year to the year 2004, 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 LULUCF 2003).

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
- Data collection
- Data verification: activity data received are examined (time series discrepancies, large changes in values from the previous to the current inventory year)

Data processing and emission calculation

Activities carried out at NEPA:

- primary data processing (aggregation, disaggregation)
- application of methods
- emission estimates, using the most recent data
- internal review (errors are rectified)
- preparation of the national inventory report

Data archive

The input data used to estimate emissions; the outputs and all other relevant information including procedures followed are archived at NEPA.

1.4 Methodology

The emissions are estimated using "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).

Emissions in LULUCF sector are estimated using the new methodology "IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry" (IPCC GPG LULUCF 2003).

The following table presents the main data sources used for activity data:

Sector	Data sources
Energy	• National Institute for Statistics - Energy Balance and other additional data
Industrial Processes	• National Institute for Statistics- Statistical Yearbook and other additional data • 42 local Environmental Protection Agencies • Direct information from industry
Solvent and other product use	• National Institute for Statistics • 42 local Environmental Protection Agencies
Agriculture	• National Institute for Statistics
LULUCF	• National Institute for Statistics through Statistical Yearbook • National Forest Administration (RNP)
Waste	• National Institute for Statistics • National Environmental Protection Agency • Public Health Institute

The sources of the emission factors used are: IPCC 1996, IPCC GPG 2000 and very limited plant specific. The methods used to estimate emissions and the sources of EF are described in Summary 3 of CRF Reporter (mostly Tier1, Tier 2 for some industrial processes and CORINAIR methodology in case of solvents and other product use).

1.5 Key source categories

Key sources are defined as the sources of emissions that have a significant influence on the inventory as a whole, in terms of the absolute level of the emissions, the trend, or both. Based on the guidance provided by the "IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories", the key source categories have been determined with the application of Tier 1 method. All greenhouse gases and all sectors, except for LULUCF were considered in this process. Both level and trend analysis were performed for determining the key source categories. The base year 1989 has been used for comparison. By using the level method, 17 key source categories resulted. The trend method resulted in 18 key source categories. Key categories analysis are presented in Annex 1 of the NIR.

Most important emissions sources are the stationary combustion of fossil fuels, mobile combustion-road, fugitive emissions-oil and natural gas. Iron and steel, nitric acid and cement production within the industrial processes has also significant contribution to the total GHG emissions.

1.6 QA/QC information

In the preparation of every annual GHG emission inventory several quality control (QC) procedures are carried out already by the inventory experts from NEPA.

QC activities

The expert team involved in the inventory preparation process, performed some general QC activities related to the processing, archiving and reporting of data. Some basic QC activities made are: checking for transcription errors in data input, checking whether the parameters and emission units are correctly recorded, comparing within the time series, in order to obtain consistent trends.

The GHG emissions inventories for the whole period 1989-2004 have been archived in the NEPA database.

QA activities

No QA activities were performed beyond the UNFCCC annual reviews (in-country review in 2003, desk review in 2004 and centralized review in 2005). In some cases, the 42 local environmental protection agencies were used as a source of bottom-up data for some source categories and data were checked against the data provided in national statistics. There are also conducted activity data series checking by comparing with similar data from FAO and Eurostat databases. Comparisons made show the correlation of the two data series.

1.7 Uncertainty

Romania has not done a full quantitative estimate of uncertainty as described in the "IPCC Good Practice Guidance". IPCC GPG 2000 reports some uncertainty estimates associated with emission factors, but those associated with activity data are not estimated since the official statistics have not provided any uncertainty values.

1.8 Completeness

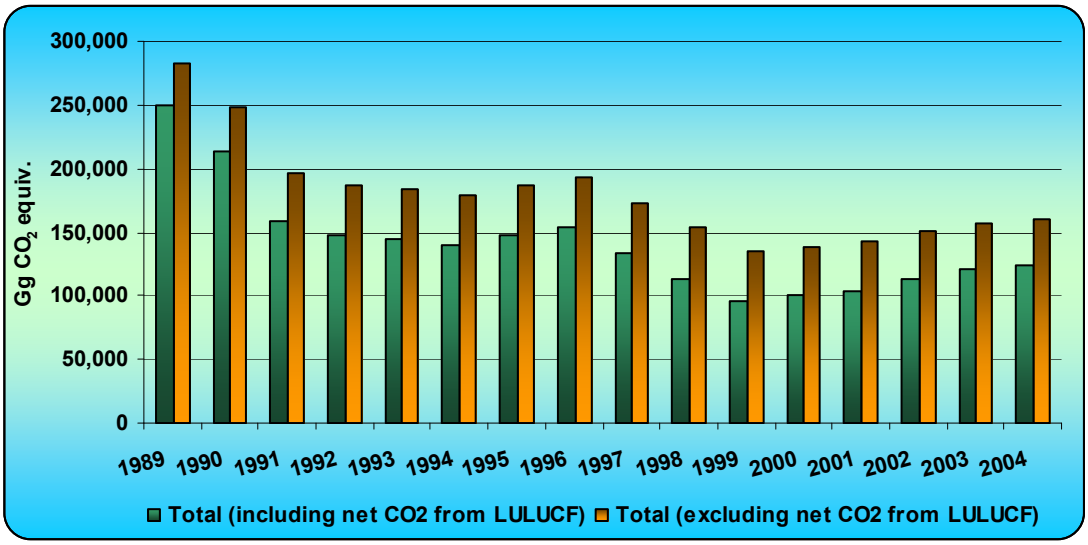
The inventory covers all sectors and all gases for the period 1989-2004 and it is complete in terms of geographical coverage. Emissions are presented by sector, by sub-sector and by gas. There are still some gaps in the inventory, such as: a separate estimate of international bunker fuels, asphalt roofing, and road paving with asphalt estimates. Comparing with the 2005 submission, the completeness of the inventory has been improved by adding the emissions from waste incineration.

2. TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 Trends of the aggregated GHG emissions

The total GHG emissions in 2004, excluding removals by sinks, amounted to 160,059.73 Gg CO_2 equivalent, which is still below the base year emissions level: 282,467.18 Gg CO_2 equivalent. In accordance with the Kyoto Protocol, Romania has committed itself to reduce the GHG emissions by 8% in the period 2008-2012 comparing to the base year 1989. The total GHGs emissions (without considering sinks) decreased with 43.34% in the period 1989-2004, and the net GHG emissions (taking into account the CO_2 removals) decreased with 50.25% in the same period. Based on these observations, there is a great probability for Romania to meet the commitments to reduce the GHG emissions in the first commitment period 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 two parts: the period 1989-1996 and the period 1996-2004. The decline of economic activities and energy consumption in the period 1989-1992 had directly caused the decline in total emissions in that period. With the entire economy in transition, some energy intensive industries reduced their activities and this is reflected in the GHG emissions reduction. Emissions have started to increase until 1996, 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.

2.2 Trends by gas

All GHG emissions 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: 68.65% CO_2, 18.18% CH_4, 11.98% N_2O, 1.19% PFCs. In 2004, the shares of GHG emissions were: 73% CO_2, 16% CH_4, 10.53% N_2O, 0.32% PFCs. The F gases started to be use as substitutes for ODS in refrigerating and air conditioning systems since 1995. In 2004, the contribution of these gases to the total GHG emissions is negligible: 0.0043 % HFCs and 0.00005% SF_6. Next table presents the trend of aggregated emissions, divided by gases.

Table 2.1 Trends by gas (Gg CO_2 equivalent)

	CO_2 including LULUCF	**CO_2 excluding LULUCF**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**
1989	161,284.31	193,925.73	51,352.53	33,839.41	NE	3,349.52	NE
1990	136,803.91	172,652.15	44,690.81	29,276.30	NE	2,115.77	NE
1991	96,029.53	133,349.25	38,841.61	22,148.98	NE	1,942.01	NE
1992	92,868.13	130,994.24	33,330.75	20,817.76	NE	1,352.05	NE
1993	92,369.17	131,800.79	31,172.23	19,952.08	NE	1,409.32	NE
1994	88,572.98	128,607.40	30,159.43	19,026.19	NE	1,490.97	NE
1995	95,539.60	134,824.58	31,321.91	19,047.46	0.22	1,773.67	0.06023
1996	102,107.88	140,401.15	31,913.87	18,600.91	0.44	1,768.98	0.06023
1997	87,260.78	125,949.71	28,526.92	17,976.91	0.73	390.19	0.02438
1998	71,056.57	111,857.79	25,787.27	16,062.19	1.97	416.47	0.00574
1999	55,054.29	94,567.65	25,126.82	15,427.86	2.43	415.04	0.04876
2000	59,177.34	97,474.49	25,693.40	15,008.67	2.93	413.14	0.0043
2001	62,863.46	102,171.22	25,214.94	15,183.19	2.78	428.75	0.0043
2002	72,984.83	109,829.25	25,784.79	14,521.26	3.25	444.59	0.01147
2003	79,198.45	115,667.27	26,140.68	15,228.92	5.12	471.9	0.00244
2004	80,978.43	116,746.88	25,935.04	16,857.45	6.94	513.34	0.08102

Carbon dioxide (CO_2) – The most significant anthropogenic greenhouse gas is carbon dioxide (CO_2). The decrease of CO_2 emissions (from 193,925.72 Gg in 1989 to 116,746.88 Gg in 2004) 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 construction sectors) as a consequence of activity decline in this sector.

Methane (CH_4) – The methane emissions, related to the Fugitive emissions from fossil fuels extraction and distribution and to the livestock, declined in the same period. The CH_4 emissions estimated for the year 2004 decreased with 49.5% comparing with the CH_4 emissions in the year 1989.

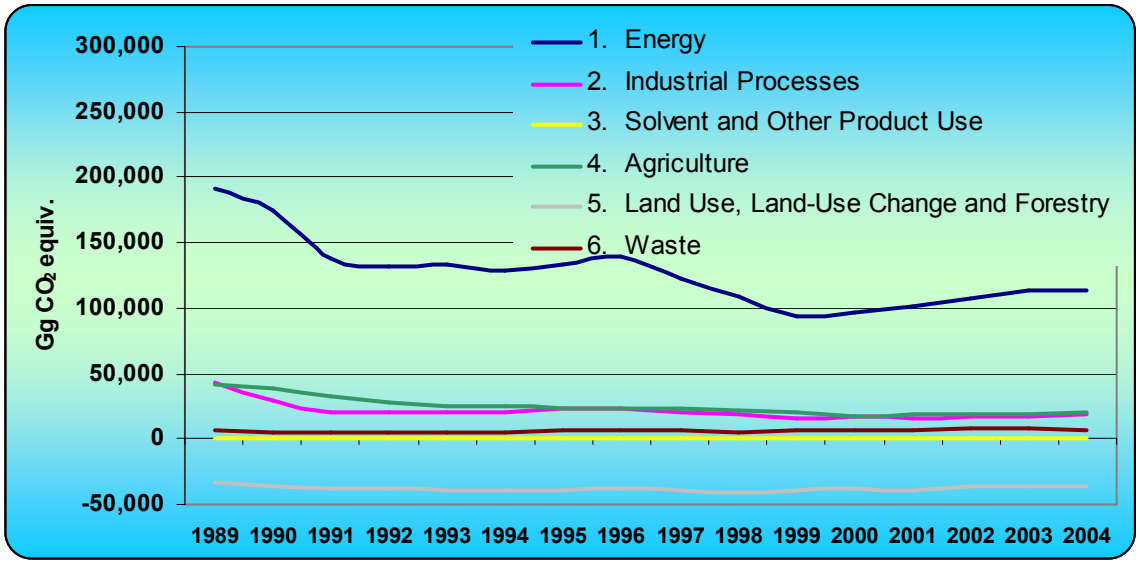
Nitrous oxide (N_2O) – The N_2O emissions are mainly provided by the Agricultural Soils in the "Agriculture" sector and the Chemical industry in the "Industrial processes" sector. The decline of these activities is reflected in the N_2O emissions trend. The decrease in N_2O emissions is about 50.18% comparing with 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. The emissions resulted as a consequence of the use of these substances are estimated since 1995. The PFCs emissions generated in the production of the primary aluminium are reported for the entire period since 1989 (and have decreased with 84.67% since 1989).

2.3 Trends by sector

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 is the most important IPCC sector. The Energy sector accounted for 71 percent of the total national GHG emissions in 2004. The GHG emissions resulted from the Energy sector decreased with 40.5% comparing with the base year.

Industrial Processes contributes to total GHG emission with 11.7%. A significant decrease of GHG emissions is registered in this sector (56.72% decrease from 1989 to 2004). The reason is the decline or phase out certain production.

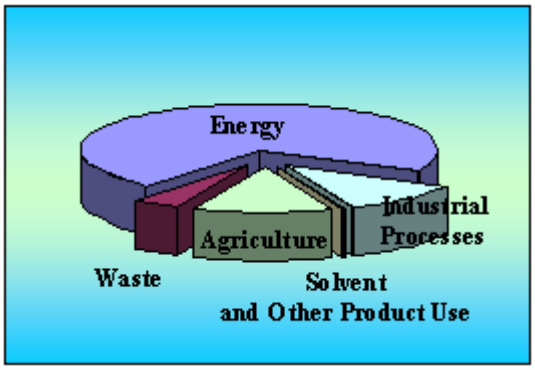
Agriculture GHG emissions have also decreased. The GHG emissions in 2004 are 51.82% lower in comparison with the 1989 emissions. In 2004, 12.6% of the total GHG emissions result from the agriculture sector.

LULUCF CO_2 removals by sinks are 9.58 % higher in comparison with the base year.

Waste sector emissions have increased in the period 1989-2004 (25.89%). Contribution of the waste sector to the total GHG emission is 4.6% in 2004.

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

Figure 2.3 Sectoral GHG emissions in 2004 [%]



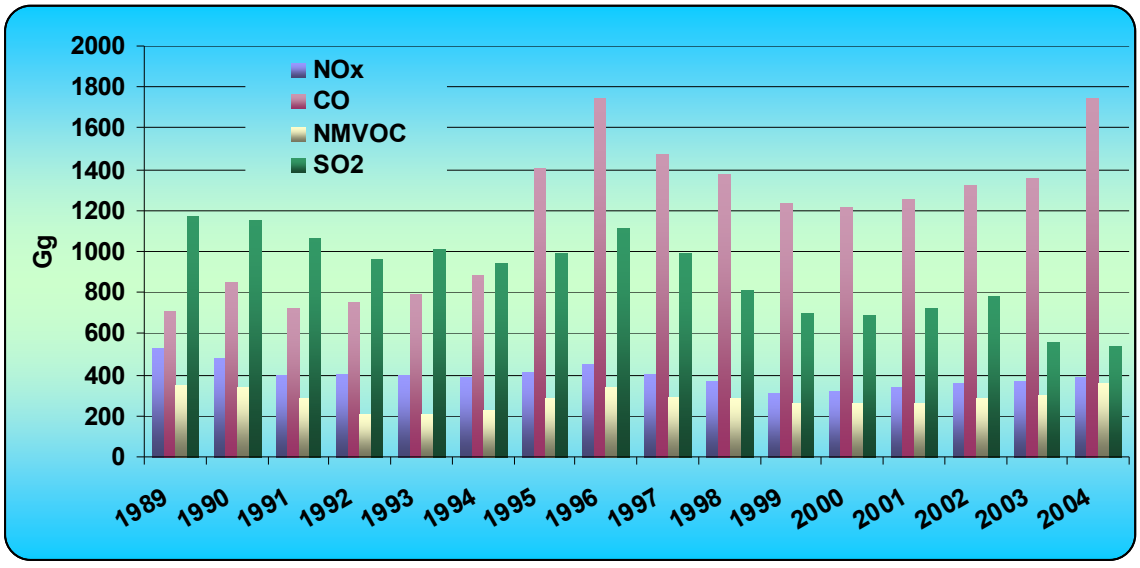
2.4 Trends of the indirect greenhouse gases and SO_2

The trends of the indirect greenhouse gases are similar with the GHG trends, except for CO emissions, which strongly increased staring with 1995, due to the raise of the firewood used in households.

Table 2.2 Indirect gases emissions [Gg]

	NO_x	CO	NMVOC	SO_2
1989	524.75	710.1	348.6	1172.24
1990	483.58	846.43	338.52	1151.61
1991	392.26	723.4	279.53	1066.49
1992	406.91	759.11	210.2	962.66
1993	396.87	795.52	211.92	1008.97
1994	391.32	887.44	224.02	940.8
1995	410.79	1401.11	282.81	991.04
1996	454.82	1745.61	337.55	1111.91
1997	409.19	1471.1	296.6	991.11
1998	366.1	1380.01	284.19	809.04
1999	307.42	1231.74	261.08	699.83
2000	319.1	1217.43	265.98	692.98
2001	336.74	1255.76	267.25	726.64
2002	359.97	1323.03	283.29	778.52
2003	371.8	1353.86	302.22	553.53
2004	389.75	1743.21	360.61	542.00

Figure 2.4 Indirect gases emissions [Gg]



3. ENERGY (CRF SECTOR 1)

3.1 Overview of the sector

The Energy sector comprises emissions resulting from fuel combustion activities (Category 1 A) as well as fugitive emissions from fuels (Category 1 B).

Following the IPCC classification, the combustion processes are divided into the following sub-sectors:

- A.1 energy industries
- A.2 manufacturing industries and construction
- A.3 transport
- A.4 other sectors (commercial/institutional, residential, agriculture/forestry/fisheries).

The fugitive emissions from fuels refers to:

- 1.B.1 Solid fuels
- 1.B.2 Oil and natural gas

The Energy sector represents the largest source of anthropogenic GHG emissions in Romania. In 2004 emissions from the energy sector accounted for 113.601 Tg CO_2 equivalent, which represent 71 % of the total GHG emissions. Within the Energy sector, energy industries sector is the most significant, followed by manufacturing industries and constructions sector. In terms of greenhouse gases, the most important is CO_2; small amounts of CH_4 and N_2O are also present.

Figure 3.1 The different GHGs contribution to the 2004 Energy emissions.

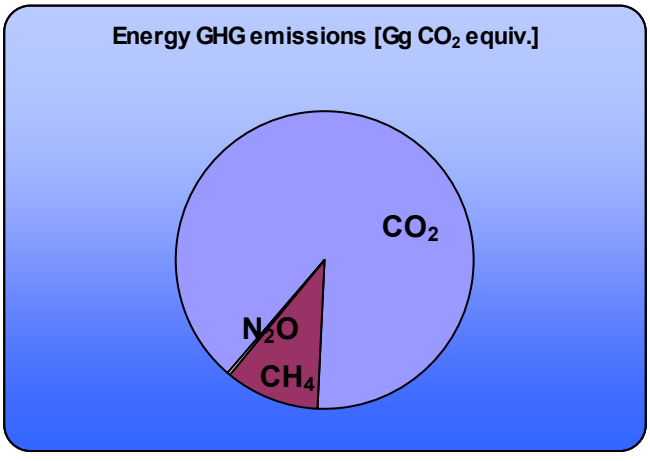
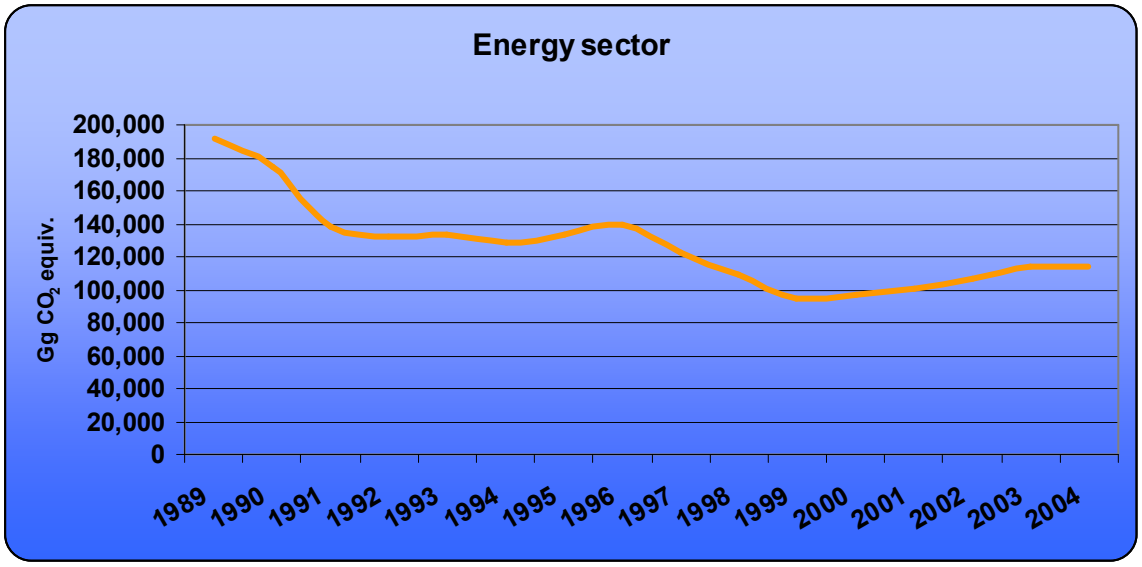
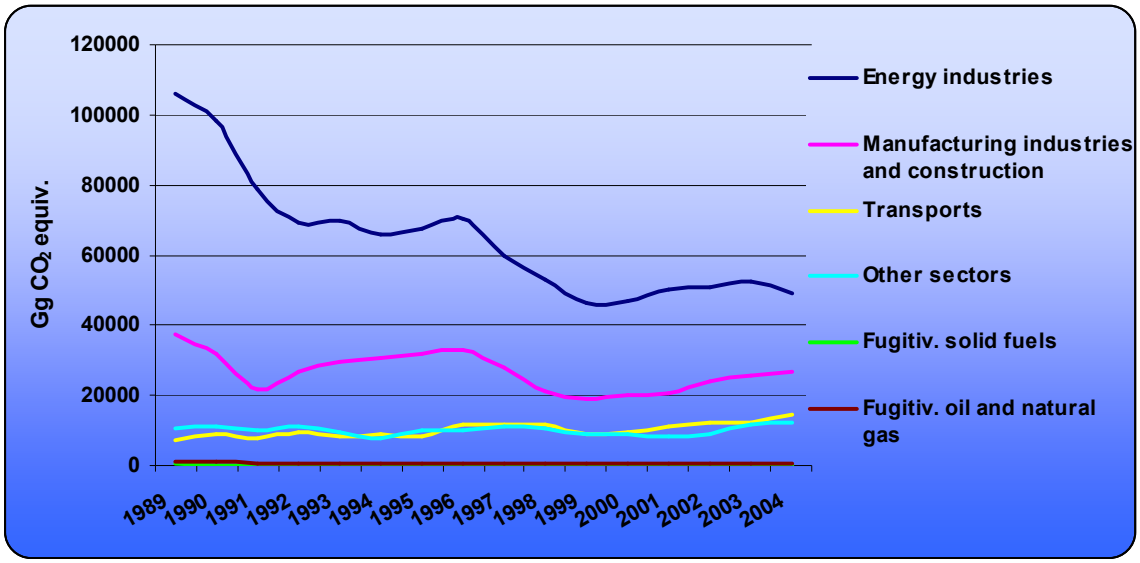


Figure 3.2 The energy sector emissions in the period 1989-2004



The Energy sector emissions decreased among the entire period 1989-2004. The GHG emissions decrease is mainly caused by the decline in fuel combustion activities and the amount of fossil fuels extracted. The emission trend reflects the changes in this period characterized by a process of transition to a market economy. The trend can be split in two parts: the period 1989-1996 and the period 1996-2004. After 1989 a significant decrease is observed in all economic activities (1989-1992), followed by an increase (1993-1996). After bringing into operation the first reactor of the Cernavoda nuclear power plant (1996), the emissions decreased until 1999. After 1999, the emissions have started to increase as a consequence of economy revitalization.

Figure 3.3 GHG emissions in the Energy sector in the period 1989-2004 (Gg CO_2 eq.)



In the base year 1989 and in 2004, various sub-sectors contributions to the total GHG emissions in the "Energy" sector were those presented in the following tables.

Table 3.1. Contributions to the Energy sector emissions.

A. Fossil fuels combustion for 1989	
1. Energy industry	55.68%
2. Manufacturing industries and construction	19.62%
3. Transports	3.84%
4. Other sectors	5.52%
B. Fugitive emissions for 1989	
1. Solid fuels	3.34%
2. Liquid and gaseous fuels	12.00%

A. Fossil fuels combustion for 2004	
1. Energy industry	43.3%
2. Manufacturing industries and construction	23.5%
3. Transports	13%
4. Other sectors	10,7%
B. Fugitive emissions for 2004	
1. Solid fuels	2,2%
2. Liquid and gaseous fuels	7,3%

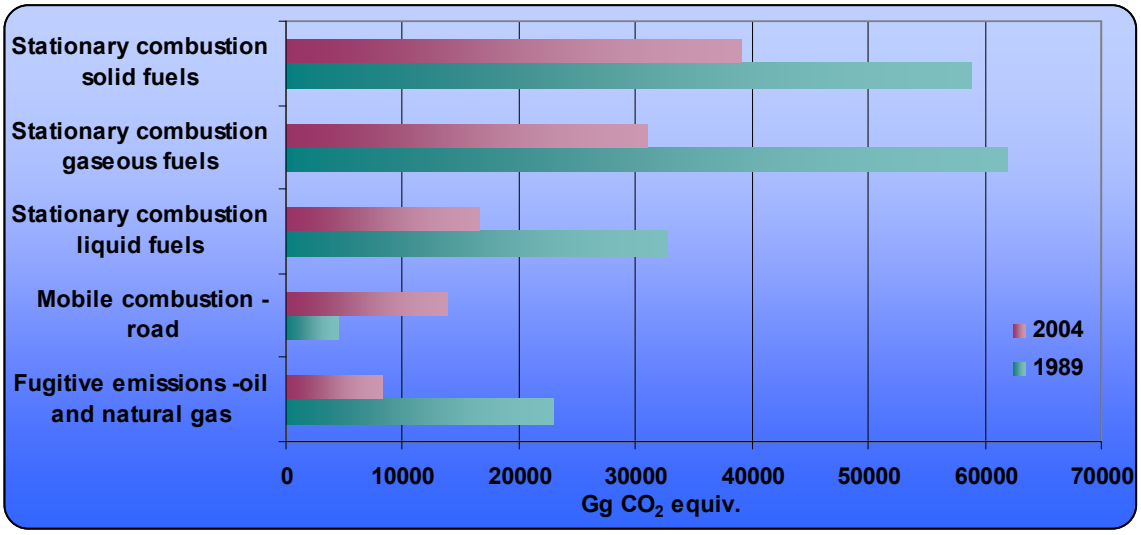
3.1.1 Key sources

Following the 2004 key sources ranking in the Energy sector, the contribution of these subsectors to the total GHG emissions is presented in the next table.

Table 3.2 Key categories for the Energy sector and the contribution to the overall GHG emissions for the year 2004

CRF categories	Key category	GHG	Key	Percentage (from the total 2004 GHG emissions)
1.AA	Stationary combustion solid fuels	CO_2	Yes	24.39%
1.AA	Stationary combustion gaseous fuels	CO_2	Yes	19.43%
1.AA	Stationary combustion liquid fuels	CO_2	Yes	10.41%
1.AA.3.B	Mobile combustion -road	CO_2	Yes	8.64%
1.B.2	Fugitive emissions – oil and natural gas	CH_4	Yes	5.12%

Figure 3.4 The trend of the 2004 key categories: comparing with 1989 key categories GHG emissions.



As seen in the previous figure, most of the 2004 key categories have decreased the emissions compared to 1989 level, except the mobile combustion-road subsector (probably due to the increasing number of road vehicles).

Table 3.3 GHG emissions in the "Energy" sector (year 2004) in CO_2 equivalent

Sources	CO_2	CH_4	N_2O
Total GHG emissions (A + B)	**101.415,94**	**11.768,07**	**417,21**
A. Fossil fuels combustion	101.415,94	887,62	417,21
1. Energy industry	49.000,40	19,39	152,41
2. Manufacturing industries and construction	26.604,53	47,37	69,34
3. Transports	14.603,38	52,71	37,2
4. Other sectors	11.207,62	768,15	158,26
B. Fugitive emissions	0,00	10.880,45	0,00
1. Solid fuels	0,00	2.580,42	0,00
2. Liquid and gaseous fuels	0,00	8.300,04	0,00

3.1.2 Reference and sectoral approaches

The GHG emissions from the "Energy" sector were calculated on the basis of those two methods indicated in the guidelines: "Reference Approach" and "Sectoral Approach". The "Reference Approach" is a top down method, which uses the apparent fuel consumption taking into account the carbon flows into and out of the country (that requires information regarding the fuels production, import, export and the stored amount of fuels). The "Sectoral Approach" is a more detailed method, a bottom-up method needing input data on each sub-sector (power and thermal energy production, fuels consumption in the processing and construction industry, and transports, fuels consumption in trade, institutional and residential sectors, as well as fuels consumption in agriculture and other economic branches) that emits GHG.

The CO_2 emissions estimated by the "Reference Approach (RA)" are higher than those resulted from the "Sectoral Approach (SA)" for the period, except for 2002 and 2004.

Table 3.4 The differences between CO_2 emissions estimated using RA and SA methods

Difference (%)	
1989	19,64
1990	12,67
1991	20,52
1992	9,44
1993	8,57
1994	6,84
1995	10,46
1996	3,38
1997	4,63
1998	5,96
1999	9,02
2000	7,84
2001	7,69
2002	-0,69
2003	0,44
2004	-2,21

Table 3.5 The difference between CO_2 emissions estimated using RA and SA in 2004

	Liquid fuels	**Solid fuels**	**Gaseous fuels**	**Total**
Fuel cons. difference (%)	-3.24	4,92	3,22	**1,6**
Emissions difference (%)	-2,18	-5,29	1,61	**-2,21**

A comparison between the Reference Approach (RA) and the Sectoral Approach (RA) indicates differences in both the energy consumption data (1,6%) and CO_2 emissions (-2,21%) in 2004. For earlier years the differences are even larger.

One of the reasons 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 fuel use, but the information related to this area is limited in the national energy balance. The highest difference is observed in 1991 due to the large amount of non-energy use of fuels. Another reason is probably caused by the high statistical differences reported in the energy balance.

3.1.2 International bunker fuels

No information regarding the international bunker fuels is reported in the Romanian Energy Balance. For this submission, experts maintained the assumption that only 20% of the entire fuel consumption reported for aviation is used for domestic aviation sector. For marine bunkers, other sources besides

Energy Balance were consulted (such as IEA statistics), but no relevant information was found.

3.1.3 Feedstock and non-energy use of fuels

The Romanian Energy Balance reports aggregated data on non-energy use of fuels. There are no data regarding feedstock or the specific sectors in which they are used. Fractions of carbon stored were used for the available data, in accordance with the IPCC guidelines, and the CO_2 emissions estimates were subtracted from the "Reference Approach".

3.2 Fuel combustion, Energy Industry (CRF sector 1.A.1.)

3.2.1 Description

CO_2 emissions from fuel combustion activities accounted for 102.721,28 Gg in 2004. Within the fuel combustion sector, 47,87 % of the CO_2 emissions correspond to 1.A.1 Energy Industry (this sub-sector is the main contributor to the fuel combustion sector). The fuel consumption in conventional thermal power stations and in the heat plants, petroleum refining plants, solid transformation plants, oil and gas extraction and coal mining are included in this category. The consumption in the energy sector (own consumption) is also included in this category.

Figure 3.5 Contribution of various subsectors to GHG emissions within the Energy Industry category in 2004 [Gg CO_2 equiv.]

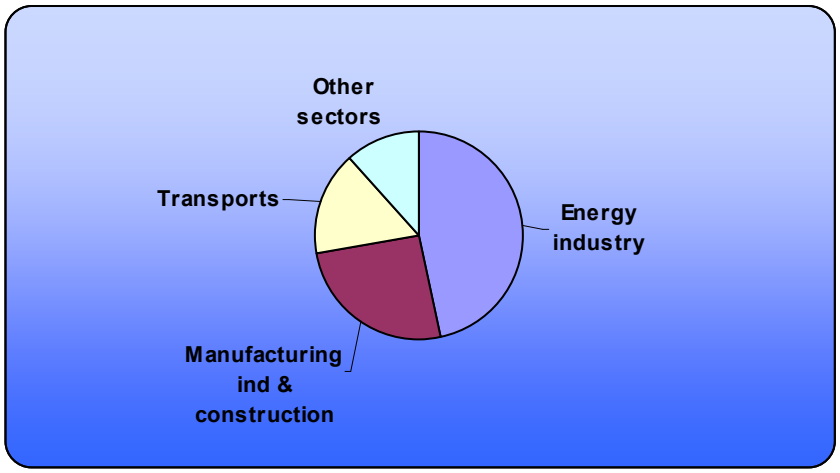
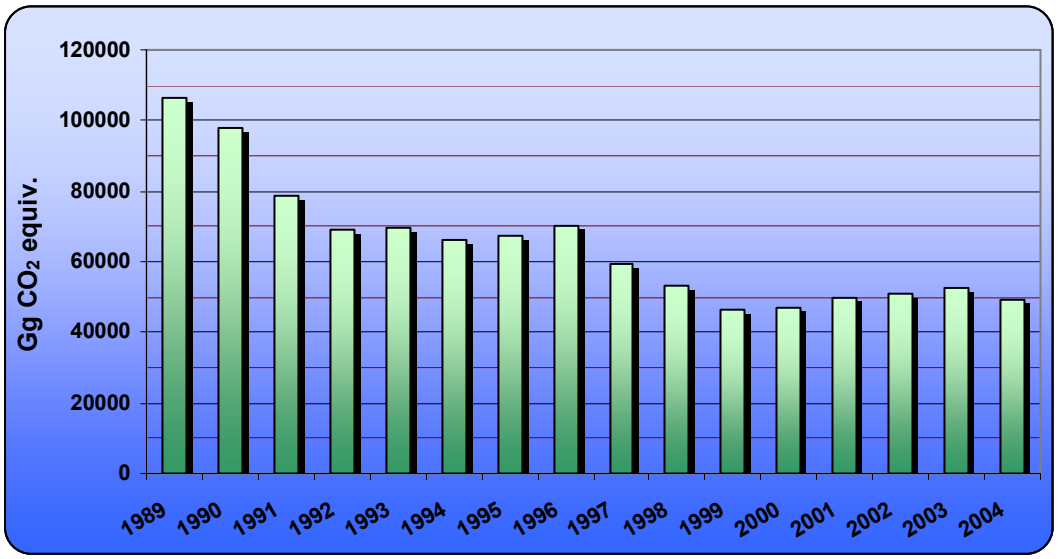


Figure 3.6 The total GHG emissions from the energy industries



3.2.2 Methodological issues

Fuel consumptions data were taken from the Energy Balance, which is a yearly publication of the National Institute for Statistics. Fuel consumptions are reported in the Energy Balance, for each fuel and each sector, in tonnes and also in TJ.

The fuel consumptions are reported in the Energy Balance based on NACE codes (National Economy Activities Classification). The NIS experts dealing with energy balance were consulted regarding the correspondence between NACE codes and IPCC source categories and they concluded that it is very difficult at this moment to make the correspondance. The inventory team, without any technical support from the statistics experts, cannot perform the reallocation of fuels based on IPCC categories. Considering also that the same EFs are used to estimate emissions resulted from 1.A1.a, 1.A1.b, 1.A1.c, these categories are reported in an aggregate manner, otherwise the associated AD uncertainties will increase strongly and uncontrolled.

As in previous reports, the fuel consumptions are aggregately reported in 1.A.1.a sub-sector (public electricity and heat production also includes petroleum refining and manufacture of solid fuels and other energy industries). The Energy Balance for 2004 is presented in Annex 4 to this report.

Emissions factors used to estimate CO_2, CH_4, N_2O, NO_x, CO, NMVOC, and SO_2, are the default

emission factors indicated in the IPCC methodology. SO_2 emissions were estimated taking into account the fuels net calorific values.

3.2.3 Uncertainties and time series consistency

There weren't performed any quantitative uncertainties, since the official statistics have not provided the uncertainty values. Activity data, emission factors and methodology implied for GHG emission calculation are consistent for the entire period.

3.2.4 Source specific QA/QC and verification

Energy data from the Romanian Energy Balance have been used after multiple checking. The activities related to quality control were focused on the completeness and consistency of the estimates and on the adequate use of notation keys in the CRF Reporter.

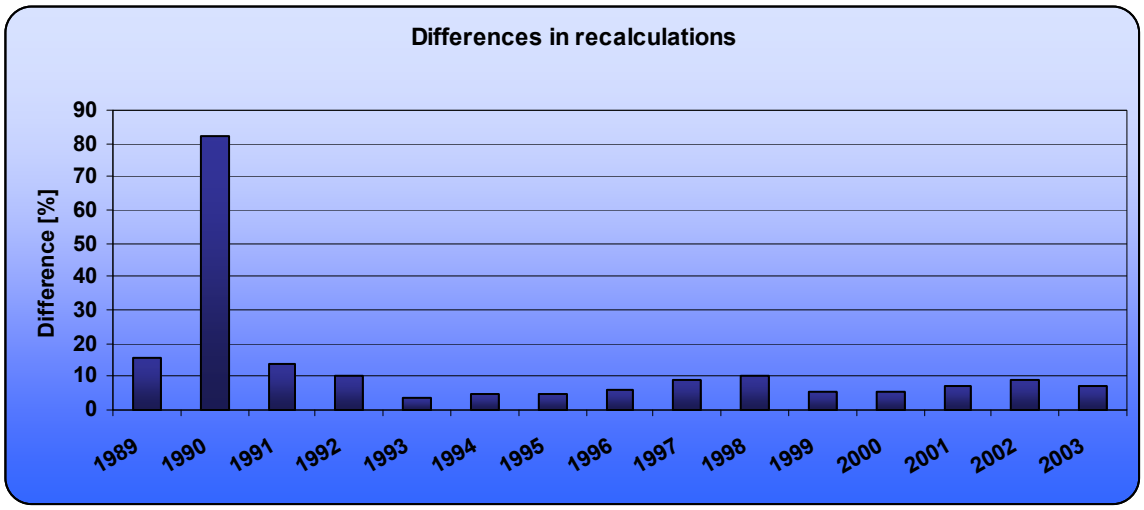
3.2.5 Source specific recalculation, including changes made in response to the review process

Recalculations to correct the misallocation of fuels within liquid, solid and gaseous fuel categories, that happened while transferring IPCC worksheets to the CRF tables (for example refinery gas was reported under gaseous fuels category in previous submission). Some fuels skipped while transferring process, have also been added to the total fuel consumption. This error was systematically repeated in previous submissions; even the IPCC worksheets are not used anymore to transfer data into CRF tables. The error was corrected for all fuel combustion categories and all years. Correcting this issue, the problems related to higher or lower IEFs than the IPCC default are also resolved.

The entire coke oven gas and blast furnace gas time series were recalculated for the 1989-2004 period, using specific EFs from the methodology; previously those two fuels were assimilated with the coke oven/gas coke regarding the EFs used.

The differences between the previous and the new/recalculated time series for the solid fuels (where coke oven gas and blast furnace gas are included) are presented in the next figure.

Figure 3.7 The differences in recalculating the solid fuel time series in the energy industries



The big difference for 1990 may be due to the following:

- the consumption of blast furnace gas is the highest in 1990, compared to all the 1989-2004 time series,
- in recalculating the CO_2 emissions from this gas, the EF used has been raised considerably (from 30 to 66 tC/TJ).

3.2.6 Source specific planned improvements

Efforts should be made together with National Institute for Statistics to establish the correspondence between NACE codes and IPCC categories in order to be able to report disaggregated emissions.

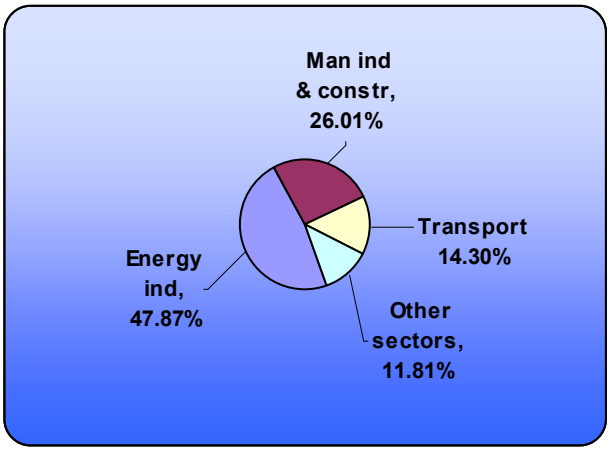
3.3 Fuel combustion, Manufacturing Industries and Construction (CRF sector 1.A.2.)

3.3.1 Description

CO_2 emissions from fuel combustion activities accounted for 103.757,795 Gg in 2004. Within the fuel combustion sector, 26,01 % of the CO_2 emissions correspond to 1.A.2 Manufacturing Industries and Construction. Manufacturing Industries and Construction sector include the emissions from fuel combustion in different industries, such as iron and steel industries, industries of non-ferrous metals,

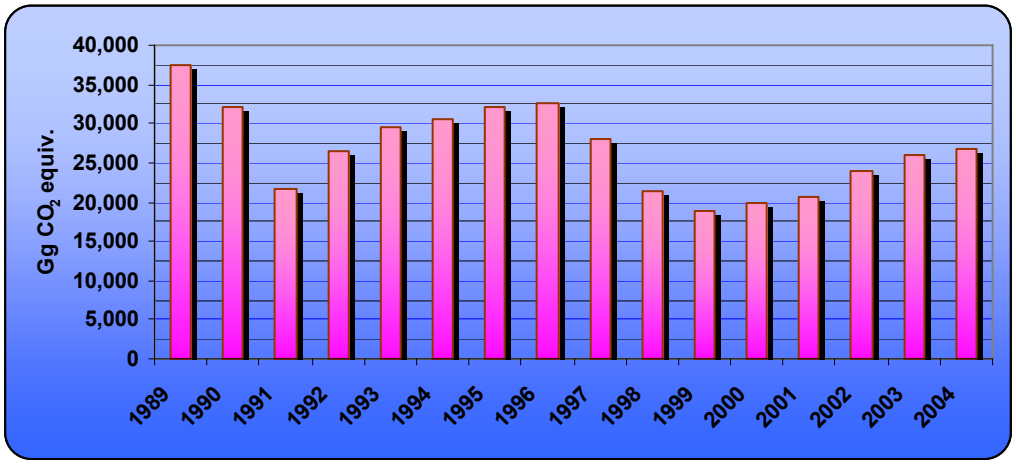
chemicals, pulp and paper, food processing, beverages and tobacco, construction and building material industries.

Figure 3.8 The different participation of subsectors to the overall Energy emissions in 2004



As in the Energy Balance the fuel consumptions are reported based on NACE codes (National Economy Activities Classification), in the CRF Reporter, the fuel consumptions are aggregately reported under 1.A.2.f Other. This category includes: a. Iron and Steel; b. Non-Ferrous Metals; c. Chemicals; d. Pulp, Paper and Print; e. Food Processing, Beverages and Tobacco and also Other industries. A disaggregation of fuel consumption into IPCC categories was not performed, for reasons mentioned in the paragraph 3.2.2 above.

Figure 3.9 The total GHG emissions from manufacturing industries and construction



3.3.2 Methodological issues

The source of data is the Energy Balance. As in the Energy Balance the fuel consumptions are reported based on NACE codes and a clear correspondence between IPCC codes and NACE codes is not establish yet, the fuel consumptions are aggregately reported under 1.A.2.f Other in the CRF Reporter. This category includes: a. Iron and Steel; b. Non-Ferrous Metals; c. Chemicals; d. Pulp, Paper and Print; e. Food Processing, Beverages and Tobacco and also Other industries.
A disaggregation of fuel consumption into IPCC categories was not performed, for reasons mentioned in the paragraph 3.2.2 above. The emission factors used to estimate CO_2, CH_4, N_2O, NO_x, CO, NMVOC, SO_2, are the default emission factors indicated in the IPCC methodology.

3.3.3 Uncertainties and time series consistency

There weren't performed any quantitative uncertainties, since the official statistics have not provided the uncertainty values. Activity data, emission factors and methodology implied for GHG emission calculation are consistent for the entire period.

3.3.4 Source specific QA/QC and verification

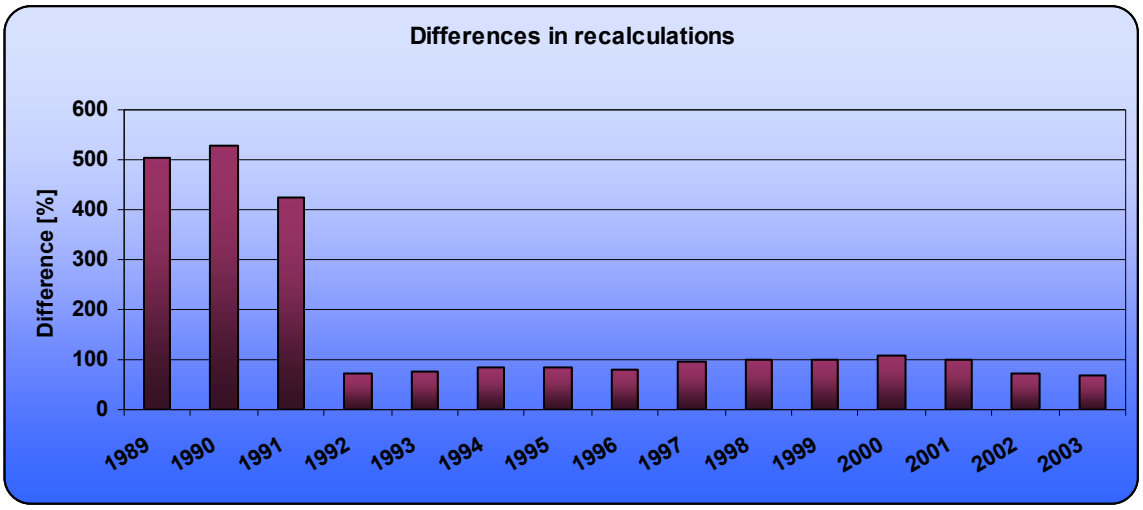
The activities related to quality control were focused on the completeness and consistency of the estimates and on the adequate use of notation keys in the CRF Reporter.

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

Recalculations to correct the misallocation of fuels within liquid, solid and gaseous fuel categories, that happened while transferring IPCC worksheets to the CRF tables (for instance refinery gas was reported under gaseous fuels category in previous submission). Some fuels skipped while transferring process, have also been added to the total fuel consumption. This error was systematically repeated in previous submissions; even the IPCC worksheets are not used anymore to transfer data into CRF tables. The error was corrected for all fuel combustion categories and all years. Correcting this issue, the problems related to higher or lower IEFs than the IPCC default will also be resolved.
The entire coke oven gas and blast furnace gas time series were recalculated for the 1989-2004 period, using specific EFs from the methodology; previously those two fuels were assimilated with the coke oven/gas coke regarding the EFs used. The differences between the previous submission and the

recalculated time series are presented in the next figure.

Figure 3.10 The differences in recalculating the solid fuel time series in the energy industries, subsector of manufacturing industries and constructions.



The big difference for the 1989-1991 period may be due to the fact that for that period, the biggest fuel consumptions (blast furnace gas and coke oven gas) initially was included elsewhere (in the gaseous fuels category).

3.3.6 Source specific planned improvements

Efforts should be made together with National Institute for Statistics to establish the correspondence between NACE codes and IPCC categories; in order to be able to report disaggregated emissions.

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

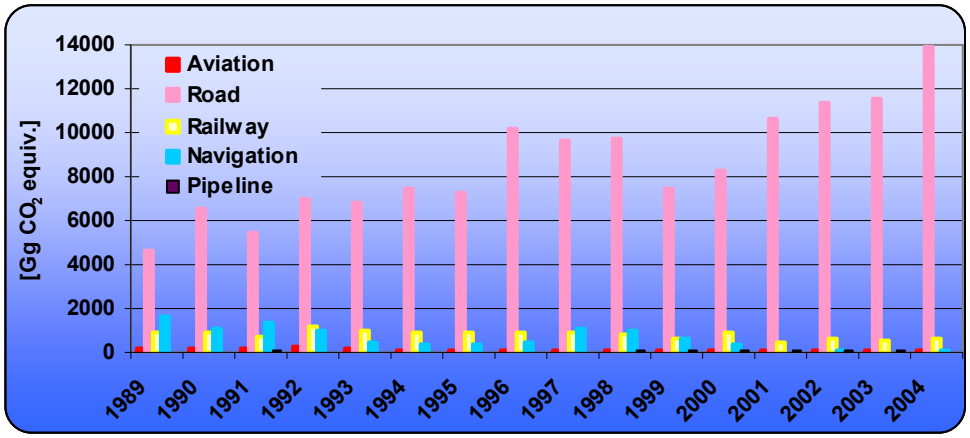
3.4.1 Description

This sector includes emissions from civil aviation, road transportation, railways, navigation and pipeline transportation. The GHGs covered are: CO_2, CH_4, N_2O, NO_x, NMVOC, CO and SO_2.

Within the fuel combustion sector, 14.3% of the CO_2 emissions correspond to 1.A.3 Transport.

While the GHG emissions resulted from the energy industries and manufacturing industries and construction are decreasing over the period, the emissions in transport sector are increasing, as a consequence of increase of mobility and number of vehicles.

Figure 3. 11 The total GHG emissions from the transport sector



3.4.2 Methodological issues

Emission data have been estimated using the amounts of fuel used in the transport sector. Previously, the only source of data was the Energy Balance where the fuel consumption is aggregately reported under the transport sector indicator. The fuel consumptions for each sub category were determined based on expert judgment.

This year, the National Institute for Statistics provided us, in addition to the Energy Balance, a complete set of each fuel used for each subcategory: road, aviation, railways, navigation and pipeline transportation. The data set is available only for the period 1993-2004. For the 1989-1992 period, only aggregate fuel consumption in transport sector is available from the Energy Balance.

According to the specifications in the Energy Balance, the transport sector indicator includes, in an aggregate way, fuel consumptions used for: road, railways, aviation, naval, internal factories transport. The indicator does not include fuel consumption for maritime activities and the fuel consumption for fisheries (included in agriculture/forestry/fisheries).

Emissions are estimated using Tier 1 method. For the period 1993-2004, the disaggregate fuel consumption data has been used. For the years 1989-1992, when only aggregate data are available, these data have been split for each fuel and for each category, based on expert judgment, following the fuel distribution in the period 1993-2004.

Based on fuel distribution in the period 1993-2004, the following estimates have been made:

- Gasoline is used: 99.8% in the road transportation and 0.2% is used for aviation
- Coal is used entirely in the railway sector
- Diesel oil is used: 75% in the road sector, 20% in the railways sector and 5% in the naval

sector

- Kerosene is used entirely for aviation and only 20% of this amount is used for domestic aviation
- Heavy oil is used entirely for navigation
- Natural gas is used: 60% for road transport and 40% for pipeline transportation

3.4.3 Uncertainties and time series consistency

There weren't performed any quantitative uncertainties, since the official statistics have not provided the uncertainty values. Time series is consistent; for the period 1989-1993, where no detailed data were available, expert judgment has been used to complete the AD set.

3.4.4 Source specific QA/QC and verification

The activities related to quality control were focused on the completeness and consistency of the estimates and on the adequate use of notation keys in the CRF Reporter.

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

1. Emissions have been recalculated for the entire time series, as detailed data on each fuel used for each transport category become available
2. In the previous submission we assumed that there are some amounts of fuels reported in the energy balance under transport sector that corresponds to mobile source used in agriculture/forestry/fisheries. According to the new inputs from the National Institute for Statistics, the fuel reported under transport sector in the Energy Balance represents the amounts of fuel used for aviation, road, railway, navigation and pipeline and the fuel consumption of mobile sources in agriculture is not included in transport indicator, it is included under Agriculture which is reported under 1.AA.4 C Agriculture/forestry/fisheries.
3. Emissions from pipeline transportation have been added in the inventory. Estimates have been made for the entire time series and reported under 1.AA.3 E Other transportation.
4. Recalculations to correct the misallocation of fuels within liquid, solid and gaseous fuel categories that happened while transferring IPCC worksheets to the CRF tables. The error was corrected for all years.

3.4.6 Source specific planned improvements

To improve the accuracy of the estimates by applying more accurate methods. To search new, more detailed AD sources.

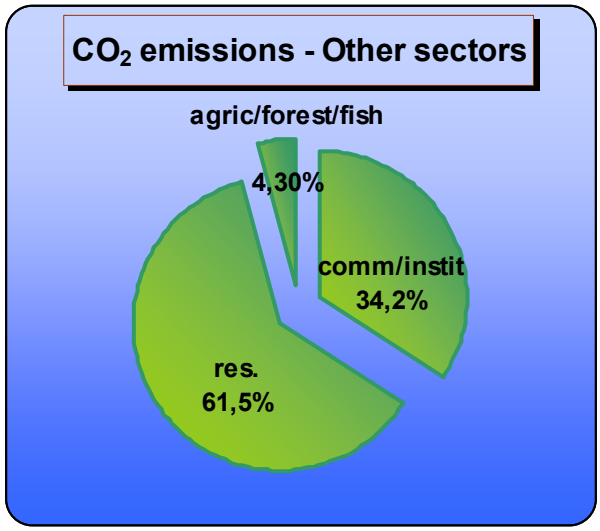
3.5 Fuel combustion, Other Sectors (CRF sector 1.A.4.)

3.5.1 Description

Within the fuel combustion sector, 11.8% of the CO_2 emissions correspond to 1.A.4 Other sectors. Other sectors include emissions from commercial/institutional, residential and agriculture/forestry/fishery sectors.

Of these other sectors, the biggest part is represented by the Residential sector emissions (61.54%), followed by the Commercial/Institutional sector with 34.16% and the Agriculture/Forestry/ Fishery sector with 4.3%.

Figure 3.12 Various sub sectors contribution in "Other sectors", in 2004 (CRF 1.A.4)



3.5.2 Methodological issues

The activity data are presented in the Romanian Energy Balance, under the categories: other economic activities (including fuel consumptions in sectors like commercial, financial, banking, assurance, hotels and restaurants, public administration, civil defense, education, health, social assistance, non-mobile

transactions, and also electricity used for public lighting), households (including fuel consumptions for heating and coking) and agriculture and forestry (including fuel consumptions in agriculture, forestry, logging, hunting, fishing). Default emissions factors were used in order to estimate emissions from these sources.

3.5.3 Uncertainties and time series consistency

There weren't performed any quantitative uncertainties, since the official statistics have not provided the uncertainty values. Activity data from the same sources, the same assumptions and the same emissions factors were used for the entire period, to assure time series consistency.

3.5.4 Source specific QA/QC and verification

Energy data from the Romanian Energy Balance have been used after multiple checking.

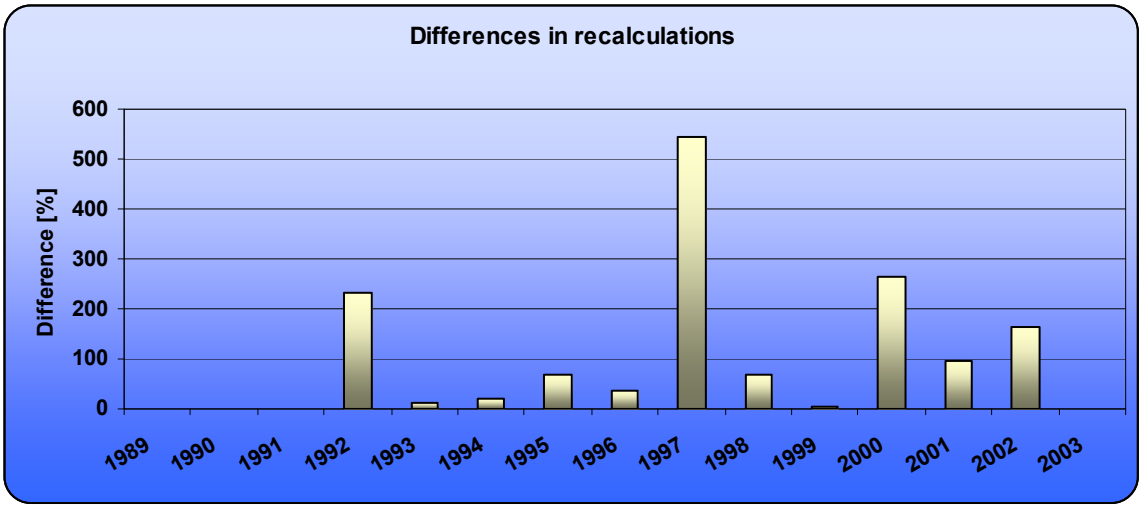
3.5.5 Source specific recalculation, including changes made in response to the review process

Recalculations to correct the misallocation of fuels within liquid, solid and gaseous fuel categories, that happened while transferring IPCC worksheets to the CRF tables (for instance refinery gas was reported under gaseous fuels category in previous submission). Some fuels skipped while transferring process, have also been added to the total fuel consumption. This error was systematically repeated in previous submissions; even the IPCC worksheets are not used anymore to transfer data into CRF tables. The error was corrected for all fuel combustion categories and all years. Correcting this issue, the problems related to higher or lower IEFs than the IPCC default are also resolved.

Also regarding the coke oven gas and blast furnace gas time series recalculations were performed for the entire 1989-2004 period, using specific EFs from the methodology; previously those two fuels were assimilated with the coke oven/gas coke regarding the EFs used.

The differences between the previous submission and the recalculated time series are presented in the next figure. These differences are calculated at an aggregated level of solid fuels.

Figure 3.13 The differences in recalculating the solid fuel time series in the energy industries, other sectors



The big differences in recalculations follows the trend of the sub-bituminous coal consumption (and the CO_2 emissions generated by this fuel) compared to the other solid fuels. Initially, this fuel was included elsewhere, not in the solid fuels category.

3.5.6 Source specific planned improvements

According to the provisions in IPCC GPG 2000, we try to collect more detailed data, to allow a Tier 2 approach.

3.6 Fugitive emissions from fuel (CRF sector 1.B.1-2)

3.6.1 Description

This category includes fugitive CH_4 emissions escaping from coal, oil and natural gas mining and handling. Emissions from fuel used in mining and handling are accounted in the Manufacturing Industry sector.

This section describes fugitive emission of greenhouse gases from coal, oil and natural gas activities. This category includes emissions from production, transport, processing, storing, and distribution of fossil fuels.

Fugitive CH_4 emissions have been decreased in the period 1989-2004, as a consequence of the production decline. The most significant decrease is in case of oil and natural gas operations.

Figure 3.14 Fugitive methane emissions variation in the period 1989-2004

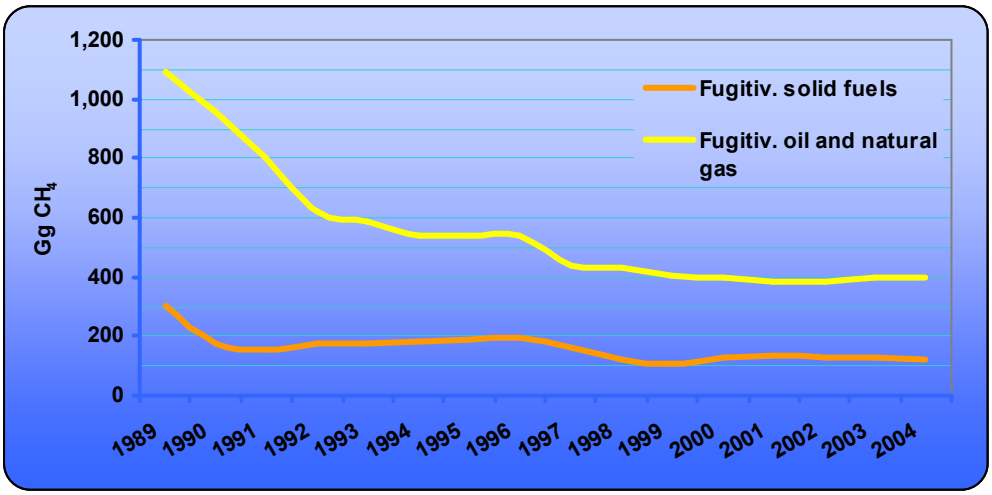
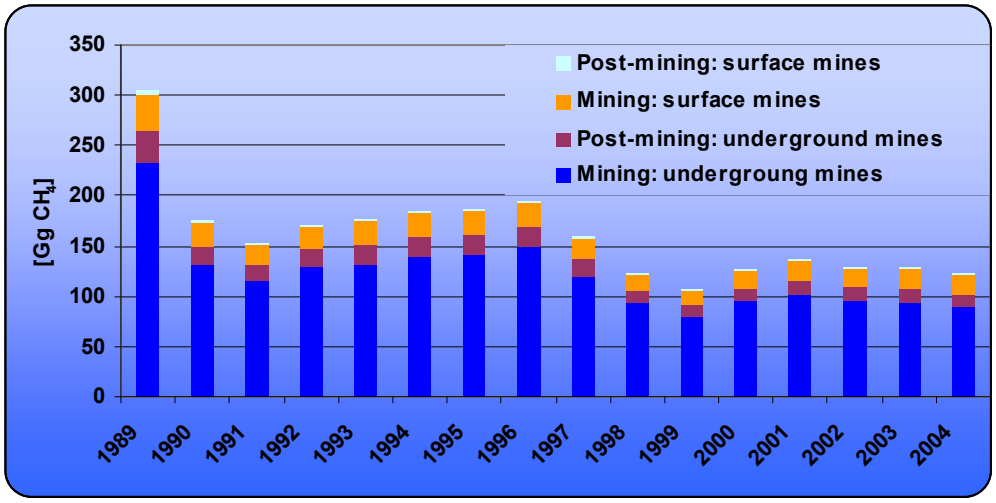


Figure 3.15 Fugitive methane emissions for the 1989-2004 period from surface and underground mines.



For the oil and natural gas fugitive emissions, for the same period, 1989-2004, the ratio is:

- variating between 97.7 and 98%, (about 98%) CH_4 emissions from natural gas,
- from 1.8 to 2%, (about 2%) from venting and flaring,
- and the rest from the oil industry (between 0.08 and 0.1%).

3.6.2 Methodological issues

***1.B.1 Coal mining and handling*:**

All underground and opencast coal mines release methane during their regular operation. After coal has been mined, small amounts of methane retained in coal are released during post-mining activities, such as coal processing, transportation and utilization. The coal in Romania is mined in surface and underground mines. The major resource is lignite (90 % of entire coal mined).
Emissions are estimated using the activity rates compiled in the Romanian Statistical Yearbook. The national statistics reports the amounts of coal extracted, by type, for the period 1989-2004.
Detailed statistical data available only for 2002 and 2003 indicates that hard coal is mined in underground mines and lignite (and brown coal) comes from surface mines (85%) and underground mines (15%). This share was used along the time series 1989-2004.
CH_4 emissions from coal mining are estimated using the IPCC Tier 1 method.

***1.B.2 Oil and natural gas*:**

This category includes fugitive emissions resulted from production of oil and natural gas, transportation and refining of oil, transport and distribution of natural gas.
CH_4 emissions are estimated using national statistics data, according to the IPCC Tier 1 method.
At the present is not possible to apply more precise methods and to consider the updated EFs included in the IPCC good practice guidance, due to the limited data and informations on oil and gas operating systems.
CH_4 emissions from Venting and Flaring are reported only for gas systems. The venting and flaring emissions from oil production are not reported, as no regional emission factor is available in the IPCC guidelines.

3.6.3 Uncertainties and time series consistency

There weren't performed any quantitative uncertainties, since the official statistics have not provided the uncertainty values. There are some inconsistencies in time series regarding the statistical data set. Activity data for missing years were estimated using the same split that is available for two years. The same emissions factors were used for the entire period**.** The emission factors and the methodology

implied for fugitive emission from fuels are consistent for the entire period.

3.6.4 Source specific QA/QC and verification

Several checks have been carried out during the inventory preparation, in order to ensure correct use of activity data and emission factors.

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

There is no specific recalculation made for this sub-sector.

3.6.6 Source specific planned improvements

To collect the necessary data, to apply a more precise method, according to the IPCC Good Practice Guidance.

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.

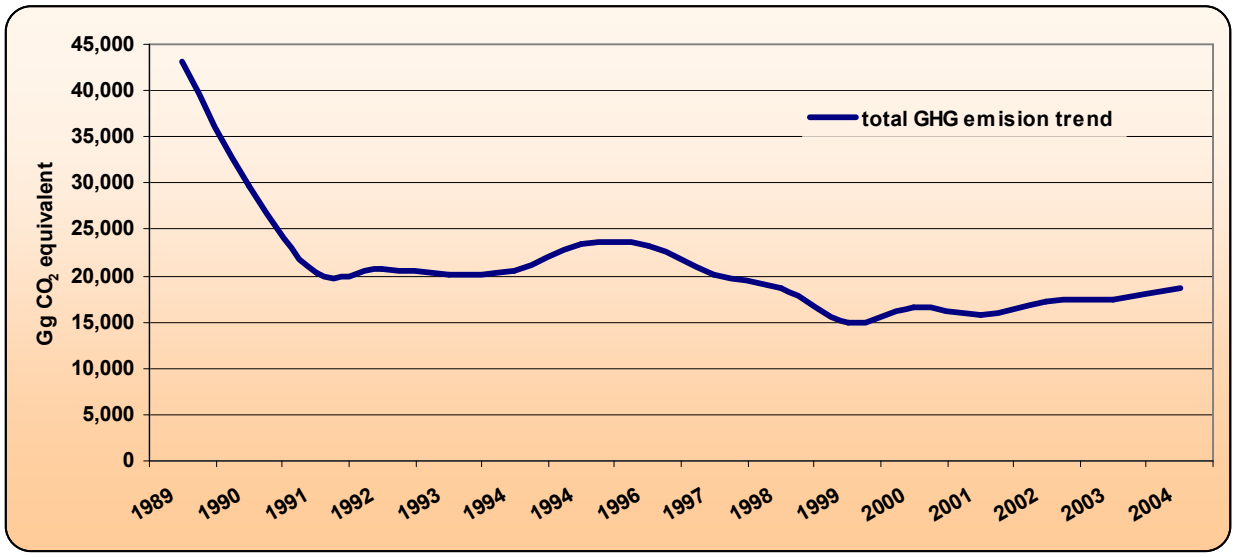
GHG emissions from industrial processes are grouped in the following sub sectors: Mineral products (CRF 2.A), Chemical industry (CRF 2.B), Metal production (CRF 2.C), Consumption of halocarbons and SF_6 (CRF 2.F) and Other production (CRF 2.D).

The GHG emissions reported in this sector are: CO_2, CH_4, N_2O, HFCs, PFCs and SF_6.
In 2004 the GHG emissions from Industrial processes contributed to 11.7% of the total GHG emissions in Romania.

Emissions from this sector estimated in 2004 decreased by 56.7% compared with 1989 and increased by 7.5 % compared with 2003. The decrease from 1990 to 2004 is caused by:

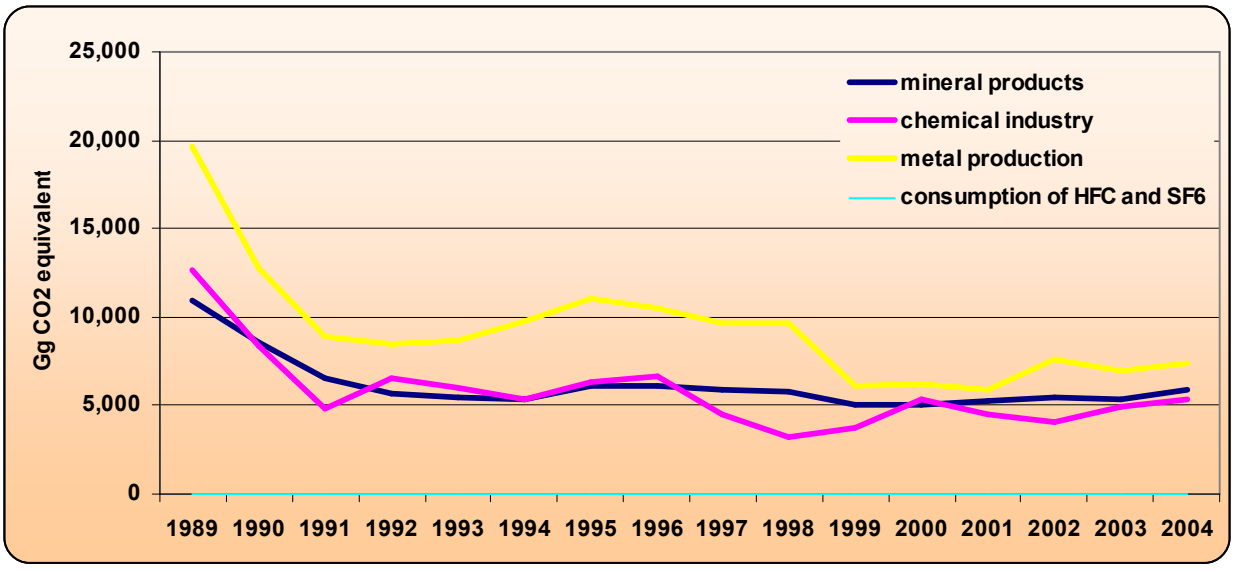
- the reduction of PFC emissions from production of aluminium due to changes in technologies;
- adipic acid is not produced anymore since 2001;
- significant decrease in the iron and steel and ammonia productions.

Figure 4.1 Total GHG emissions trend in Industrial Processes, for 1989–2004 Period.



Metal production contributes to 40% of the total GHG emissions from Industrial Processes in 2004. Mineral Product and Chemical Industry are the two other main contributing sectors with 31% and 29%, 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: 0.04%.

Figure 4.2 GHG emissions trends in Industrial Processes, by sub-sectors, for 1989–2004 period.



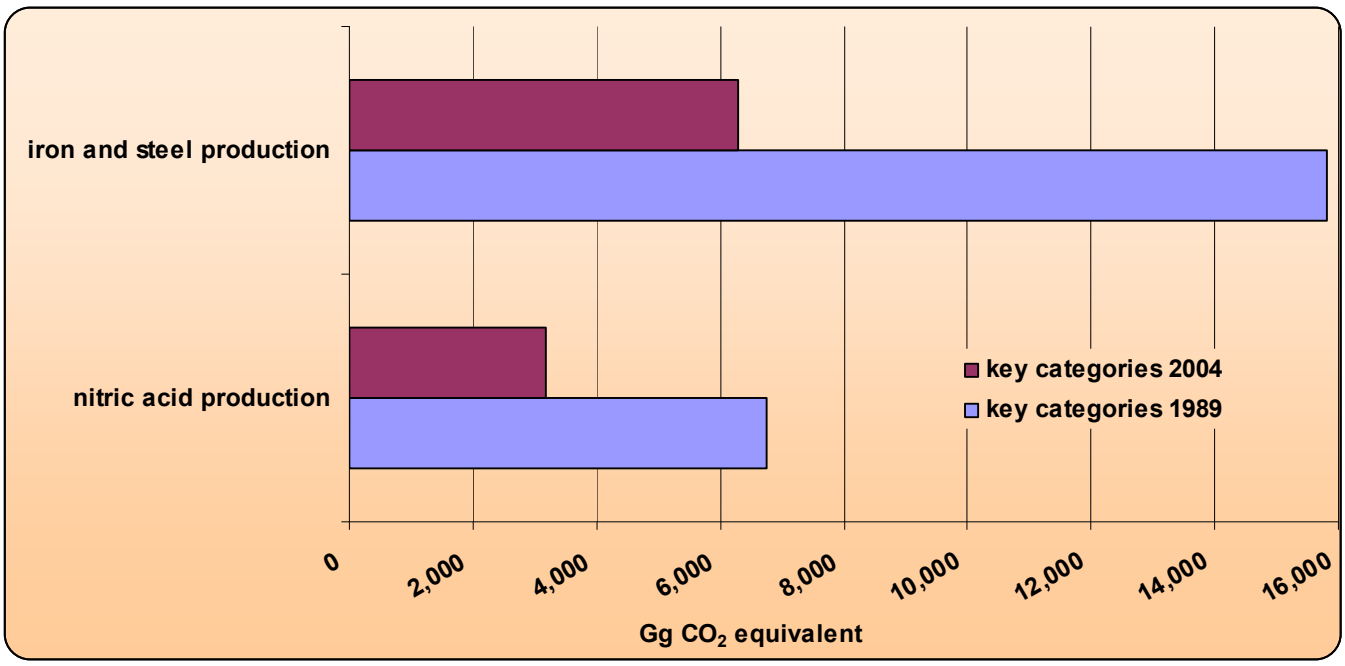
In the base year, various industrial processes sub-sectors contribution were: Mineral products 25%, Chemical industry 29%, Metal production 46%, Consumption of halocarbons and SF_6 0%.

The Tier 1 key category analysis performed for 2004 has revealed the following key categories:

Table 4.1 Key categories in industrial processes sector in 2004 **- (both level and trend)**

IPCC category	Source categories	GHG	Key	%
2 C 1	**Iron and steel production**	**CO_2**	**Yes**	**3.9**
2 B 2	**Nitric acid production**	**N_2O**	**Yes**	**2**

Figure 4.3 ***Key categories in Industrial Processes: Iron and steel Production (2C.1), Nitric acid Production*** (2B.2) **- (both level and trend)**



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

4.2.1 Source category description

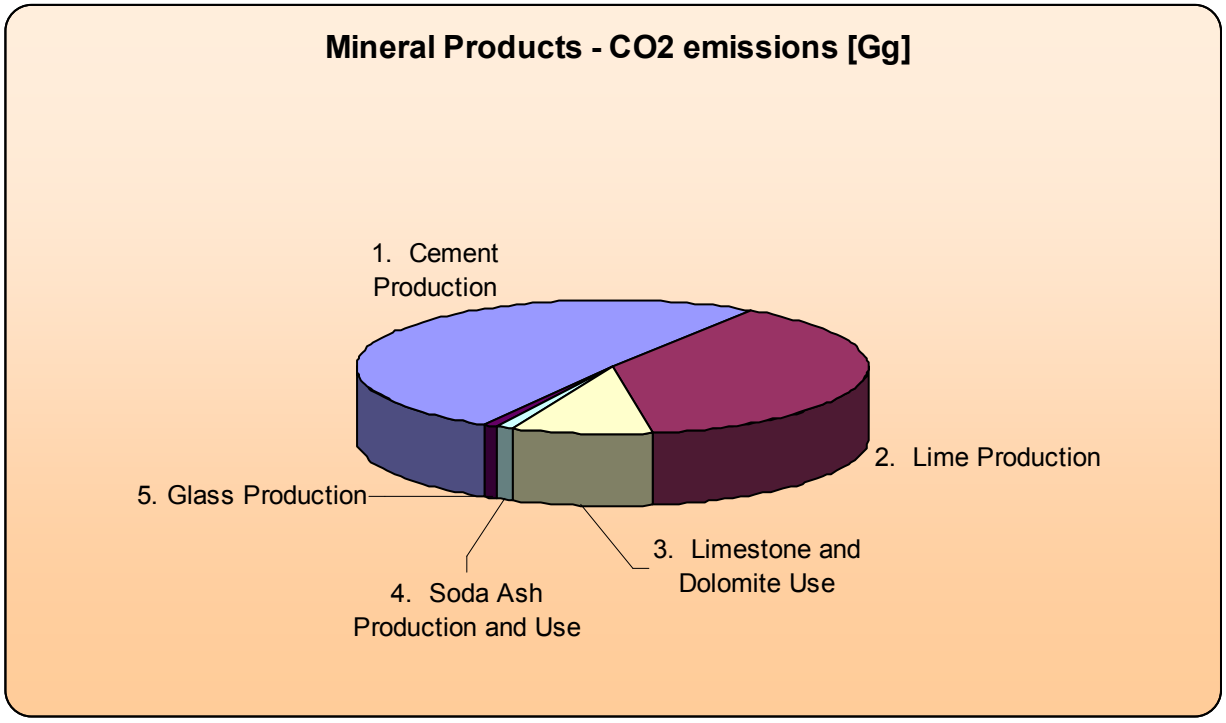
GHG emissions reported include estimates for cement production (2A1), lime production (2A2), limestone and dolomite use (2A3), soda ash production and use (2A4) and other: glass production (2A7). Emissions from asphalt roofing (2A5) and road paving with asphalt (2A6) are not estimated due to unavailability of data.

Mineral products sub-sector was responsible for 31% of the Industrial Processes sector's GHG emissions in 2004.

Table 4.2. CO_2 emissions in the Mineral products sector, in the year 2004

Sector	CO_2 emissions [Gg]
2A Mineral Products	**5862.808**
2A1 Cement Production	2972.153
2A2 Lime Production	2248.392
2A3 Limestone and Dolomite Use	532.9794
2A4 Soda Ash Production and Use	64.08387
2A7.1 Glass production	45.2

Figure 4.4 The trend of CO_2 emissions in the Mineral products sub-sector, in the year 2004.



4.2.2 Methodological issues

Cement production

There are nine cement-producing plants in Romania and all of them are covered in the inventory.

The method for calculating emissions of CO_2 from cement is in line with the Good Practice Guidance (Tier 2).

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;
- an average of 64.5% of CaO content was provided by all companies;
- an average of 2% of MgO content was provide by all companies;

- cement kiln dust (CKD) is completely recycled to the kiln. The only plant that reported **a** correction factor for discarded amounts of dust for the period 1989-2003 is completely recycling the CKD since 2004.

CO_2 emissions from clinker are estimated using a combined Tier 2 - country specific method, according to the formula:

Equation 4.1 Calculation of CO_2 emissions from clinker

Emissions = $EF_{clinker}$ x Clinker Production x CKD Correction Factor

Equation 4.2 Calculation of EF for clinker

EF for clinker is calculated based on IPCC formula:

$EF_{clinker}$ = 0.785 x CaO Content (Weight Fraction) in Clinker

IPCC neglect CO_2 from decomposition of $MgCO_3$. Discussions with companies have concluded to apply a correction for MgO content to the default IPCC EF. According to these assumptions: 64.5% CaO content and 2% MgO content in clinker, the resulted EF is 0.525 t CO_2/t clinker.
Emissions resulted from discarded cement kiln dust were calculated separately (this is the case for 1989-2003 period), taking into account its degree of calcinations and added to the CO_2 emissions resulted from calcinations. The correction factor for discarded amounts of dust for the period 1989-2003 varies between 1.06 and 1.13.

Table 4.3. Clinker production data and CO_2 emissions from clinker production in the period 1989-2004.

Years	Clinker production [kt]	Emission factor [tCO_2/t clinker]	CO_2 Emissions[Gg]
1989	10571	0.525	5572
1990	8379	0.525	4416
1991	6037	0.525	3179
1992	5488	0.525	2887
1993	5349	0.525	2815
1994	5232	0.525	2752
1995	5938	0.525	3125
1996	6038	0.525	3179
1997	5669	0.525	2985
1998	5497	0.525	2897
1999	4971	0.525	2627
2000	5006	0.525	2638
2001	5218	0.525	2750
2002	4984	0.525	2624
2003	4996	0.525	2632
2004	5661	0.525	2972

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

Equation 4.3 Calculation emissions of* SO_2 *from cement

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

The default emission factor 0.3kg SO_2/tonne cement are used**.**

Table 4.4. Cement production data and SO_2 emissions from cement production in the period 1989-2004.

Years	Cement production [kt]	Emission factor [kg SO_2 /t cement]	SO_2 Emissions[Gg]
1989	12225	0.3	3.67
1990	9468	0.3	2.84
1991	6692	0.3	2.01
1992	6271	0.3	1.88
1993	6158	0.3	1.85
1994	5998	0.3	1.8
1995	6842	0.3	2.05
1996	6956	0.3	2.09
1997	6553	0.3	1.97
1998	6577	0.3	1.97
1999	5580	0.3	1.67
2000	6058	0.3	1.82
2001	5668	0.3	1.7
2002	5680	0.3	1.7
2003	5992	0.3	1,80
2004	6239	0.3	1.87

The amount of cement produces is provided by the National Institute for Statistics and it is published in the annual statistical yearbook. The data set in case of cement production is complete.

Lime production

The ADs necessary to estimate emissions from this source category (quicklime and dolomite lime) are provided by the National Institute for Statistics. Quicklime statistics are published in the annual statistical yearbook. The data set in case of dolomite lime production is not complete; the data for 1989-1991 and 2003 – 2004 are missing.

A linear extrapolation was used to estimate dolomite lime production for 1989-1991 and 2003-2004 in

order to complete the time series.

The surrogate method used in previous submission (when dolomite lime was correlated to quicklime production) has been replaced with the linear extrapolation, considered to be more relevant.

Table 4.5. Quicklime and dolomite lime production and CO_2 emissions from lime production in the period 1989-2004.

Year	Quicklime production [kt]	Dolomite lime production [kt]	Total CO_2 emissions[Gg]
1989	3983	957	4017
1990	3028	941	3248
1991	2324	925	2677
1992	1946	782	2249
1993	1738	813	2113
1994	1621	880	2081
1995	1763	1017	2318
1996	1748	952	2247
1997	1688	973	2219
1998	1813	810	2170
1999	1623	727	1944
2000	1666	674	1930
2001	1790	673	2027
2002	1919	824	2266
2003	1936	674	2143
2004	1978	754	2248

Since no specific data for CaO and CaO*MgO contents are available, the default emission factors (0.79 tonne CO_2/t quicklime and 0.91 tonne CO_2/t dolomite lime) are used.

Limestone and dolomite use

The activity data set provided by the National Institute for Statistics is not complete. For this reason the surrogate method, used in previous submission to estimate AD for the missing years, has been replaced with a method who estimate the amount of limestone and dolomite used to produce a tonne of pig iron, for all time series.

For this reason we used the activity data from the most representative producer of iron and steel to establish the amount of limestone and dolomite used to produce a tonne of pig iron (the amount in tonnes of limestone and dolomite used/ one tonne of pig iron produced).

As a result of this calculation we get the follow:

- for a tonne of pig iron is necessary 0.233 tonnes of limestone, like average of all years series (1989-2004).
- for a tonne of pig iron is necessary 0.048 tonnes of dolomite, like average of all years series (1989-2004).

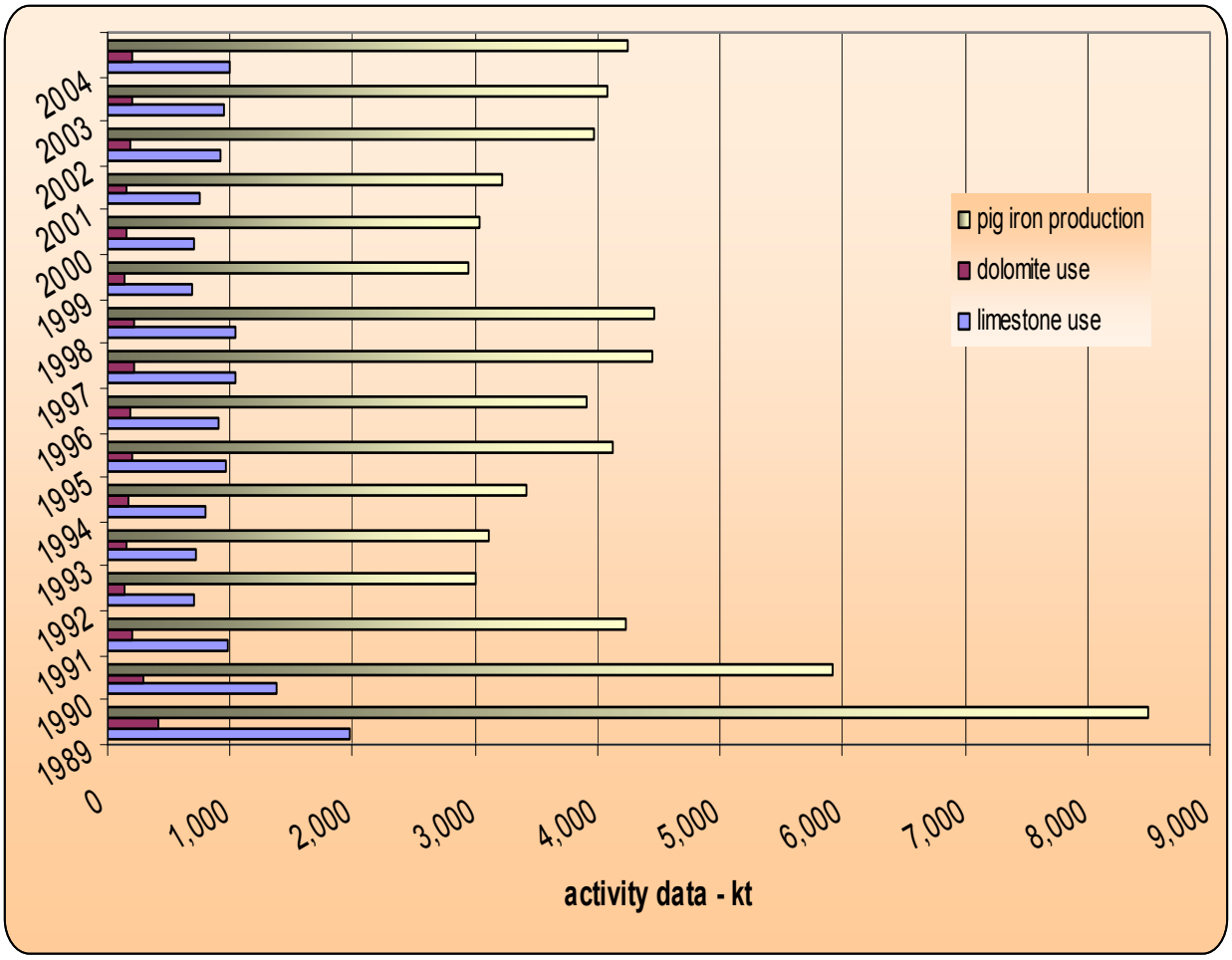
Rather to the national level we considered that to produce a tonne of pig iron is necessary 0.233 tones of limestone and 0.048 tonnes of dolomite.

The default emission factors 477 kg CO_2 / tonne dolomite and 440 kg CO_2 / tonne limestone are used.

Table: 4.6 Amount of limestone and dolomite used, related to pig iron production in the period 1989-2004

Year	Limestone use [kt]	Dolomite use[kt]	Pig iron production[kt]
1989	1981	409	8493
1990	1380	285	5914
1991	987	204	4230
1992	700	145	2999
1993	727	150	3117
1994	798	165	3420
1995	960	198	4117
1996	911	188	3905
1997	1037	214	4444
1998	1041	215	4462
1999	686	142	2942
2000	709	147	3040
2001	751	155	3220
2002	926	191	3968
2003	952	197	4081
2004	990	204	4243

Figure 4.5 Amount of limestone and dolomite used, related to pig iron production in the period 1989-2004.



Soda ash production and use

The IPCC methodology has been followed for estimating the CO_2 emissions from soda ash production. CO_2 emissions were estimated using the quantity of trona utilized. Soda ash production data are annually reported in the statistical yearbook.

Data on soda ash used are not published and The National Institute for Statistics did not provide any data for the periods 1989-1993 or 2003-2004. A surrogate method was used to determine the soda ash consumption for the missing years. This method correlates the production data to the consumption figures.

Figure 4.6 Soda ash consumption related to soda ash production in the period 1989-2004

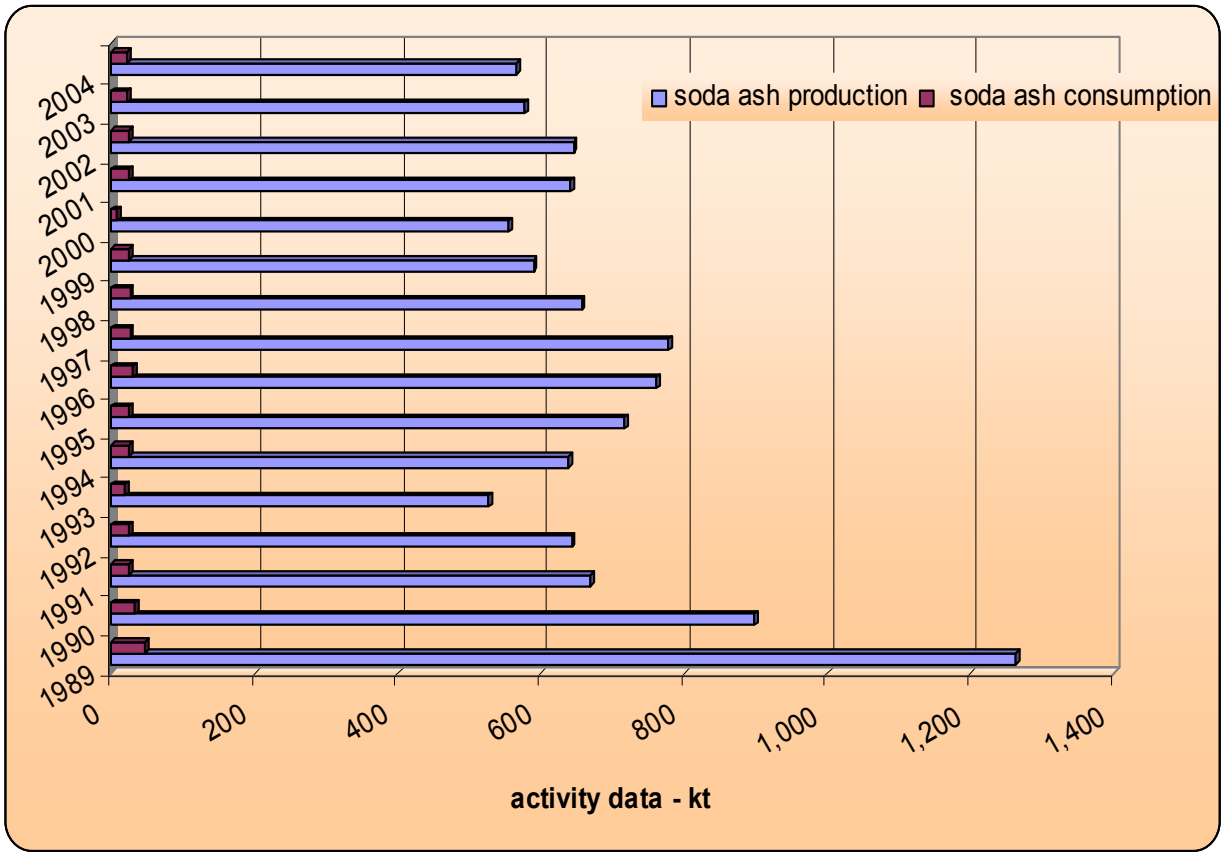


Table 4.7. Soda ash consumption related to soda ash production in the period 1989-2004.

Year	Soda ash production [kt]	Soda ash use [kt]
1989	1264	47
1990	898	34
1991	669	25
1992	642	24
1993	527	20
1994	638	24
1995	716	25
1996	762	30
1997	777	26
1998	657	26
1999	590	24
2000	556	8
2001	641	25
2002	645	25
2003	577	22
2004	566	22

The default emission factors used are 0.097 tonnes CO_2 / tonne of trona and 415 kg CO_2 / tonne of soda ash use, are used.

Others: glass production

Emissions are estimated for both container glass and flat glass, based on national statistics. Flat glass production is reported in the Statistical Yearbook in square meters. The conversion in tones was made using the thickness (2 mm) and the glass density (2.5 tones/cubic meter).

Table 4.8. Container glass and flat glass production in the period 1989-2004

Year	Container glass production [kt]	Flat glass production [kt]
1989	377	380
1990	307	285
1991	250	230
1992	206	220
1993	165	230
1994	181	190
1995	203	210
1996	216	205
1997	180	155
1998	160	155
1999	95	135
2000	129	150
2001	134	160
2002	134	210
2003	265	175
2004	152	160

The NMVOC emissions are estimated according to the revised methodology (default 4.5 kg NMVOC/ tonne of product).

The CO_2 emissions from this category are estimated for the first time and the time series is consistent. As a follow up the 2004 review, the CO_2 emissions are estimated using the EMEP/CORINAIR methodology, using: 150 kg CO_2/t of container glass and 140 kg CO_2/t of flat glass.

4.2.3 Uncertainties and time series consistency

There are inconsistencies in time series in the statistical data set for lime production, limestone and dolomite use, soda ash use. Activity data for missing years were estimated using alternative methods provided by the IPCC good practice. The same emissions factors were used for the entire period.

Cement production

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 1989-2004.
According to the IPCC GPG Table 3.2, the uncertainty for emissions using Tier 2 methodology (based on clinker production data) is 5-10%. As the applied methodology is based on plant specific data, the uncertainty of the resulting emission data is assumed to be around 5%.

Lime production

According to the IPCC GPG, the uncertainty of EF is only dependent on the composition of lime and is estimated to be 15%. The uncertainty for the activity data is expected to be higher than for the emission factors.
There are inconsistencies in time series in the statistical data set for dolomite lime production and for this reason, a linear extrapolation was used to estimate dolomite lime production for 1989-1991 and 2003-2004 in order to complete the time series.
The same emission factors were used for the entire period.

4.2.4 Source specific QA/QC and verification

Some basic QC activities were performed: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, and comparing the time series in order to obtain similar results.

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

Cement production : one cement producing company provided a modified activity data set from 1995 to 2003, as an error occurred in the data set provided last year.

Table 4.9. Recalculations of CO_2 [Gg] emissions in the cement production sector

Years	2005 submission (CO_2 emissions) [Gg]	2006 submission (CO_2 emissions) [Gg]	Differences[%]
1989	5572	5572	0
1990	4416	4416	0
1991	3179	3179	0
1992	2887	2887	0
1993	2815	2815	0
1994	2752	2752	0
1995	3028	3125	3.2
1996	2992	3179	6.2
1997	3185	2985	-6.2
1998	2696	2897	7.4
1999	2611	2627	0.6
2000	2752	2638	-4.1
2001	2579	2750	6.6
2002	2556	2624	2.6
2003	2771	2632	-4.9
2004		2972	

Lime production: the surrogate method used in previous submission (when dolomite lime was correlated to quicklime production) has been replaced to a linear extrapolation, considered to be more relevant. Recalculations were performed for 1989-1991 and 2003.

National Institute for Statistics provided the amount of dolomitic lime production for the years 2003-2004 and the AD are much the same with date obtain with the linear extrapolation.

More them for 1992 and 2002 the recalculations were made due to wrong manipulation of data.

Table 4.10 Recalculations of CO_2 [Gg] emissions in the lime production sector

Years	2005 submission (CO_2 emissions) – [Gg]	2006 submission (CO_2 emissions) – [Gg]	Differences [%]
1989	4581	4017	-12
1990	3482	3248	-6.7
1991	2681	2677	-0.1
1992	2239	2249	0.4
1993	2113	2113	0
1994	2081	2081	0
1995	2318	2318	0
1996	2247	2247	0
1997	2219	2219	0
1998	2170	2170	0
1999	1944	1944	0
2000	1930	1930	0
2001	2027	2027	0
2002	2265	2266	0.03
2003	2286	2143	-6.2
2004		2248	

Limestone and dolomite use:

Because the use of the limestone and dolomite is related with pig iron and steel production we used the trend in pig iron production to estimate the activity data for the limestone and dolomite consumption.
For this reason the surrogate method, used in previous submission to estimate AD for the missing years, has been replaced with a method who estimate the amount of limestone and dolomite used to produce a tonne of pig iron for all time series.
As a result of this calculation, to the national level we considered that to produce a tonne of pig iron is necessary 0.233 tones of limestone and 0.048 tones of dolomite.

Table 4.11. Recalculations of CO_2 [Gg] emissions in the limestone and dolomite use sector

Years	2005 submission (CO_2 emissions) [Gg]	2006 submission(CO_2 emissions) [Gg]	Differences [%]
1989	737	1067	45
1990	518	743	44
1991	346	531	53
1992	253	377	49
1993	260	392	51
1994	285	430	51
1995	321	517	61
1996	303	491	62
1997	299	558	86
1998	262	561	114
1999	189	370	95
2000	166	382	131
2001	481	405	-16
2002	458	498	9
2003	469	513	9
2004		533	

4.2.6 Source specific planned improvements

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, calcium carbide production (2B.4) and other productions (2B.5): carbon black, methanol, ethylene, etc. Chemical industry sub-sector was responsible for 29% of the total Industrial Processes sector's GHG emissions in 2004.

Table 4.12. GHG emissions from the Chemical industry sector, in 2004 (Gg)

SOURCE	CO_2	CH_4	N_2O
B. Chemical Industry	**2180.88**	**1.41**	**10.22**
2B1 Ammonia Production	2133	0	0
2B2 Nitric Acid Production	0	0	10.22
2B3 Adipic Acid Production	NA	NA	NA
2B4.2 Carbide Production	47.88	0	0
2B5 Others (ethylene, carbon black, methanol, sulphuric acid)	0	1.41	0

4.3.2 Methodological issues

Ammonia production

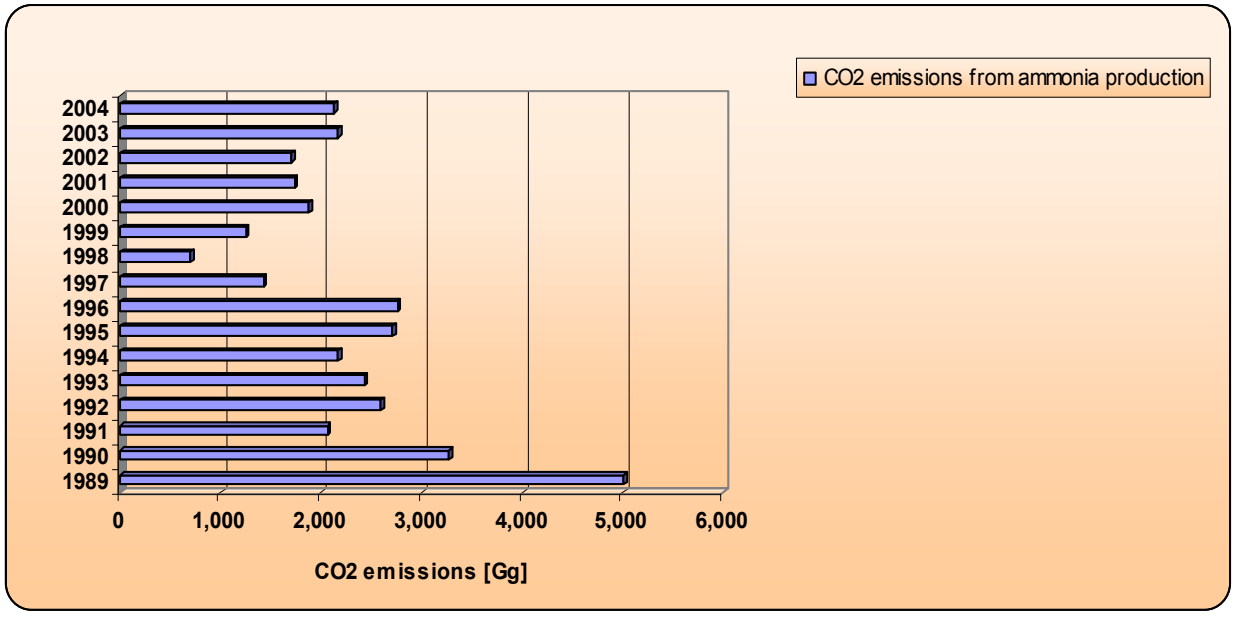
The CO_2 emissions from ammonia production are estimated according to the Tier 1b methodology, using the amount of ammonia production and the default emission factor 1.5 t/t. Although emissions from ammonia production are decreasing along the time series, this source category results in a large amount 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.

Ammonia production production data are annually reported in the statistical yearbook.

Table 4.13. Ammonia production related to the CO_2 emissions in the period 1989-2004

Year	Ammonia production[kt]	CO2 emissions [Gg]
1989	3337	5006
1990	2178	3267
1991	1375	2063
1992	1733	2600
1993	1620	2430
1994	1443	2165
1995	1809	2714
1996	1841	2762
1997	951	1427
1998	468	702
1999	834	1251
2000	1255	1883
2001	1155	1733
2002	1137	1706
2003	1445	2168
2004	1422	2133

Figure 4.7 The trend of CO_2 emissions from ammonia production in the period 1989-2004.



The CO and SO_2 emissions from ammonia production are estimated according to the revised methodology (default 7.9kg CO/ tonne of product and 0.03kg/ tonne of product).

Nitric acid production

Nitric acid production results in N_2O and NOx emissions. Emissions have been calculated by multiplying annual nitric acid production by an emission factor, which reflects the process type.

Specific questionnaires have been sent to the local EPA in order to collect information on nitric acid production. Based on this survey, 7 manufacturers of nitric acid have been identified. From these 7 factories, one stopped its production in 1990.

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.
- older (pre 1975) plants, without NSCR – this is the case of only one factory. According to IPCC Good Practice Guidance, N_2O emission factor for old plants 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 NOx/tonne nitric acid has been used to estimate NOx emissions from this factory.

The emissions have been estimated at plant level, considering the process type and the NOx abatement technology installed at each plant:

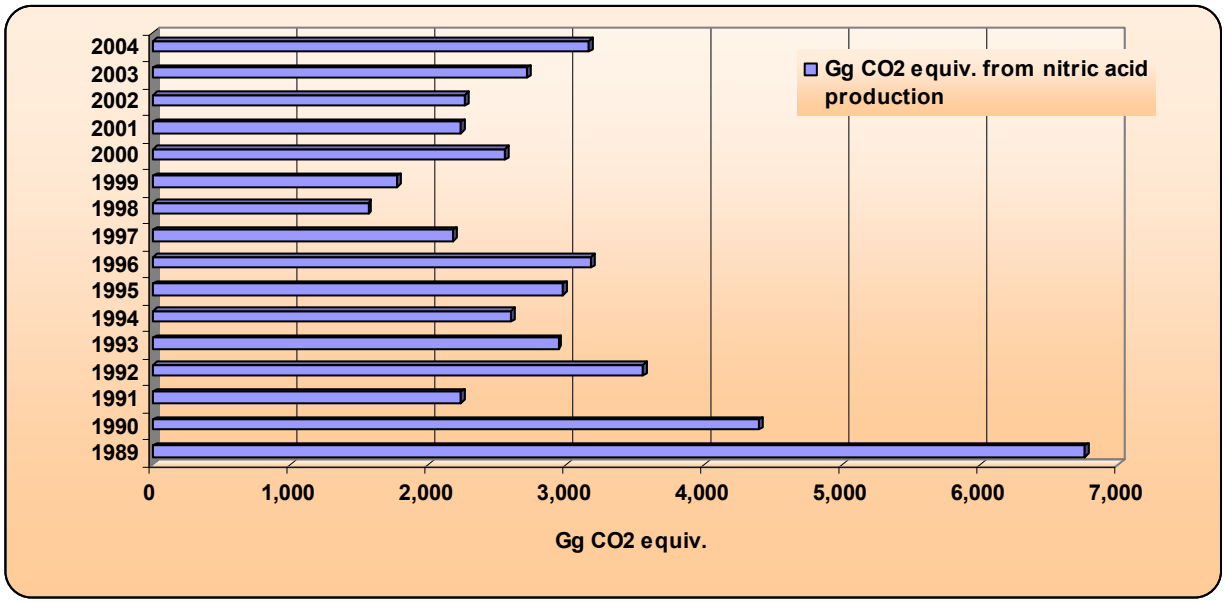
- extended absorption – used at two factories (at one plant it was used since 1997 with 86% reduction efficiency for NOx and at the other plant it was installed in 2004 with 98% reduction efficiency for NOx
- selective catalytic reduction (SCR) – used at one single plant since 2003, with 80% reduction efficiency for NOx.

These abatement techniques are used for NOx reduction and do not result is reduction of N_2O.

Table 4.14. Nitric acid production related to the N_2O and NOx emissions in the period 1989-2004.

Years	Nitric acid production[kt]	N_2O emission[Gg]	NOx emissions[Gg]
1989	2328	21.81	18.17
1990	1505	14.2	11.82
1991	773	7.22	6.01
1992	1236	11.49	9.57
1993	1014	9.49	7.9
1994	921	8.4	7
1995	1060	9.63	8.02
1996	1136	10.26	8.55
1997	774	7.02	4.99
1998	554	5.04	3.94
1999	623	5.74	4.3
2000	893	8.25	5.88
2001	776	7.23	5.4
2002	805	7.33	5.46
2003	968	8.76	2.93
2004	1095	10.22	3.14

Figure 4.8 The trend of CO_2 emissions from nitric acid production in the period 1989-2004 [Gg CO_2 equiv]



Adipic acid production

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, only one producer has been identified. The facility stopped its activity at the end of 2001. Starting 2002**,** this activity is suspended.

Table 4.15. 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

Carbide production

Methodology for estimating emissions of CO_2 from calcium carbide production is in line with the IPCC Methodolog. The default EF of 0.76 tonnes CO_2/tonne carbide was used to estimate CO_2 emissions from calcium carbide production.

National Institute for Statistics provided annually the amount of carbide production.

Table 4.16. Carbide production related to the CO_2 emissions in the period 1989-2004

Years	Carbide production[kt]	CO2 emissions[Gg]
1989	180	136.8
1990	129	98.04
1991	94	71.44
1992	87	66.12
1993	84	63.84
1994	67	50.92
1995	90	68.4
1996	106	80.56
1997	91	69.16
1998	73	55.48
1999	54	41.04
2000	55	41.8
2001	53	40.28
2002	53	40.28
2003	45	34.2
2004	63	47.88

Other production: carbon black, ethylene, methanol, sulphuric acid

SO_2, CO, NMVOC, CH_4 and NOx emissions resulted from these production processes are estimated using the default EF recommended in the methodology.

Table 4.17. EF used to estimate GHG emissions from 2B5 Other productions

EF [kg/t]	CH_4	NO_x	NMVOC	CO	SO_2
Carbon black	11	0.4	40	10	3.1
Ethylene	1		1.4		
Methanol	2				
Propylene			1.4		
Polystyrene			5.4		
Polyethylene-low density			3		
Polyethylene-high density			6.4		
Sulphuric acid					17.5

4.3.3 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 1989-2004.

4.3.4 Source specific QA/QC and verification

Some basic QC activities were performed: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, and comparing the time series in order to obtain similar results.
Due to the large fluctuation in ammonia production, AD obtained from national statistics has been checked against the data obtained from the local environmental protection agencies. The results obtained from these two sources are similar.

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

Nitric acid production

The previous national statistic data on nitric acid have been replaced with data obtained directly from the producers. The recalculations have been performed for the entire time series.
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.

Table 4.18 Recalculations of N_2O emissions in the nitric acid production subsector

Years	2005 submission (N_2O emissions) [Gg]	2006 submission (N_2O emissions) [Gg]	Differences [%]
1989	53.92	21.81	-59.5
1990	26.98	14.2	-47.3
1991	11.78	7.21	-38.7
1992	13.76	11.49	-16.4
1993	12.35	9.48	-23.2
1994	8.85	8.39	-5.1
1995	9.79	9.62	-1.7
1996	8.77	10.26	17
1997	4.7	7.02	49.3
1998	2.49	5.04	102
1999	3.81	5.73	50.4
2000	6.54	8.24	26.1
2001	4.09	7.23	76.7
2002	4.46	7.32	64.1
2003	5.47	8.76	60.2
2004		10.21	

4.3.6 Source specific planned improvements

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 40% of the total Industrial Processes sector's GHG emissions in 2004.

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 2004 CO_2 emissions from production of iron and steel contributed 4% to total greenhouse gas emissions). In the base year, these emissions accounted for 6% from the total GHG emissions.

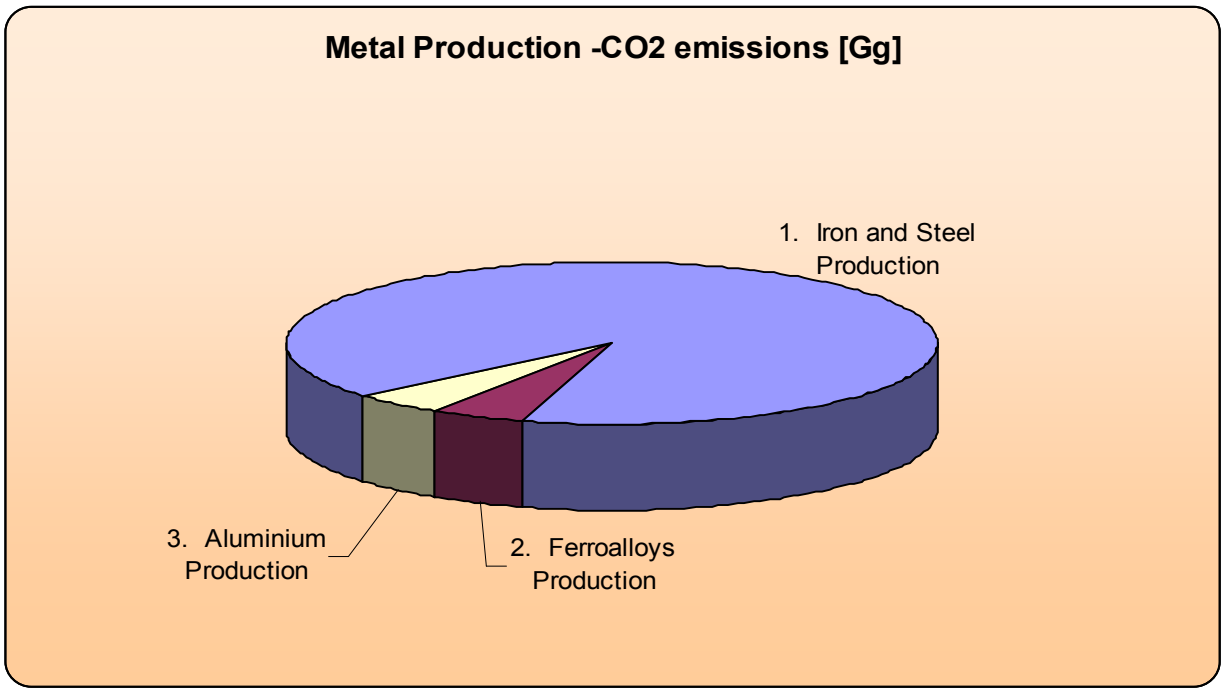
The CO_2 emissions from ferroalloys production have been included in the inventory.

Aluminum 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.

Table 4.19. GHG emissions from Metal production sub-sector, in the year 2004 [Gg CO_2 equivalent]

Sector	CO_2	PFCs
C. Metal Production	**6931.2**	**512.9**
2.C.1. Iron and Steel Production	6276.9	0
2.C.2. Ferroalloys Production	331.4	0
2.C.3. Aluminium Production	322.9	512.9

Figure 4.9 The trend of CO2 emissions from Metal production sub-sector, in the year 2004.



4.4.2 Methodological issues

Iron and steel production

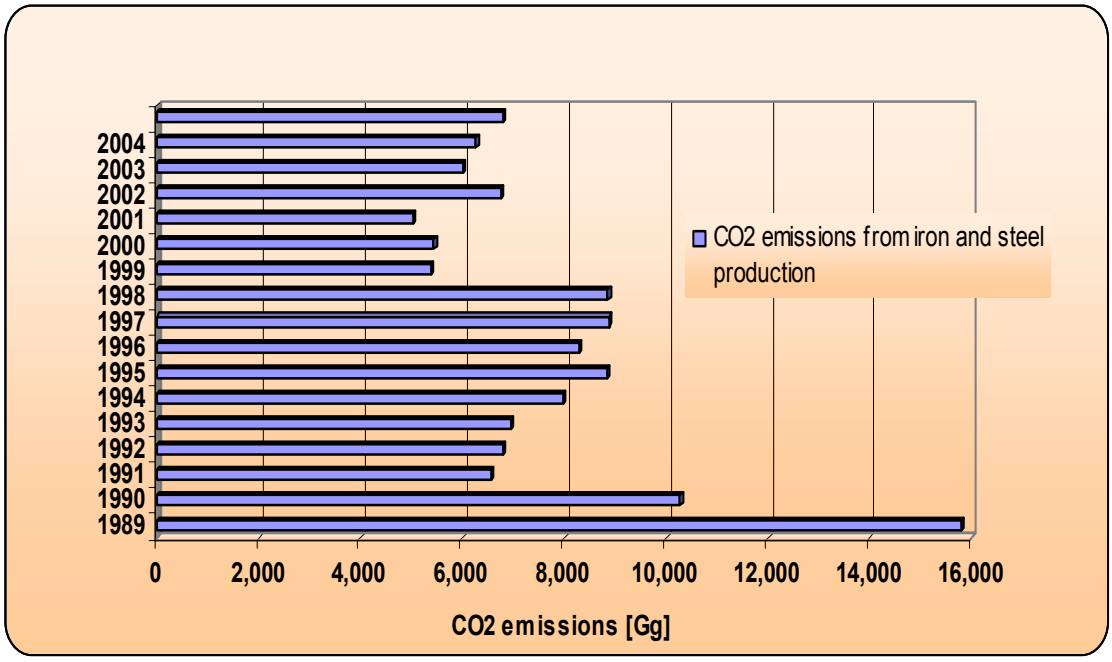
Iron and steel production sub-sector results in a large amount of CO_2 emissions, and it represents a key source within the Industrial processes sector.

Emissions figures are calculated using Tier 2 method.

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, 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).

Figure 4.10 The trend of CO_2 emissions from iron and steel production sub-sector in the period 1989- 2004.



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 4.4 Calculation of CO_2 emissions from pig iron production

$Emissions_{pig\ iron}$ = $Emission\ Factor_{reducing\ agent}$ x Mass of Reducing Agent + (Mass of Carbon in the ore – Mass of Carbon in the Ore – Mass of Carbon in the Crude Iron) x 44/12

Where:

EF reducing agent (coke oven coke) = 3.1 tone CO_2 /tone reducing agent

Mass of reducing agent: plant level data

Carbon content in ore: 0 (default value)

Carbon content in iron: 3.6% (country specific value)

CO_2 emissions from steel production

CO_2 emissions resulted from steel productions were estimated based on IPCC GPG formula*:*

Equation 4.5 Calculation of CO_2 emissions from steel production

$Emissions_{crude\ steel}$ = (Mass of Carbon in the Crude Iron used for Crude Steel Production – Mass of Carbon in the Crude Steel) x 44/12 + $Emission\ Factor_{EAF}$ x Mass of Steel Produced in EAF

Where:

Carbon content in crude iron used for crude steel: 3.6% (country specific value)

Carbon content in crude steel: 0.7 % (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

Table 4.20 The input data used to calculate emissions from iron and steel industry

Years	steel [kt]	pig iron[kt]	sinter[kt]	coke[kt]
1989	13276	8493	3525	4485
1990	8945	5914	2156	2885
1991	6469	4230	1277	1813
1992	4898	2999	879	1983
1993	4973	3117	891	2022
1994	5517	3420	944	2329
1995	6231	4117	882	2556
1996	5730	3905	1195	2393
1997	6407	4444	1348	2542
1998	6200	4462	965	2533
1999	4205	2942	544	1527
2000	4511	3040	61	1535
2001	4769	3220	103	1391
2002	5396	3968	29	1887
2003	5644	4081	195	1638
2004	6182	4243	473	1713

The NMVOC, NOx, CO, SO_2 emissions are estimated using the default emission factors applied to the first fusion raw pig iron production.

Table 4.21. Emission factors for NMVOC, NOx, CO, SO_2 from iron and steel 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

Ferroalloys production

The CO_2 emissions within the production of ferroalloys are calculated based on the production volume (Tier 1b).

The national statistics reports the ferroalloys production for the period 1992-2004. Activity rates for the beginning of the time series (1989-1991) have been determinate by applying a trend extrapolation.

Table 4.22 Ferroalloys production in the period 1989-2004

Years	Ferroalloys production	emission factor
1989	62.1	1.7
1990	66.28	1.7
1991	70.46	1.7
1992	86.4	1.7
1993	65.9	1.7
1994	98.78	1.7
1995	119.93	1.7
1996	132.22	1.7
1997	84.65	1.7
1998	62.15	1.7
1999	53.64	1.7
2000	72.62	1.7
2001	98.18	1.7
2002	84.72	1.7
2003	142.1	1.7
2004	194.95	1.7

For the most recent years, ferroalloys are reported in a disaggregate manner, by type of products: ferromanganese and silicon manganese. The main production type is silicon manganese (99% in 2004, 99.8% in 2003 and 100% in 2002).

The IPCC defaults EF for silicon manganese has been considered for estimating emissions for this source category for the entire period.

Aluminum production

Primary aluminium production is carried out in one facility, where the pre-baked process is used.

Emissions have been calculated based on activity data and technology type information provided by the plant.

From 1989 to 1996, the technology used was SWPB (Side Worked Pre-baked). Starting with 1997, the technology was changed to CWPB (Centre Worked Pre-baked).

There are no emissions measurement data available in the plant, so emissions are estimated using the default emission factors, based on IPCC Good Practice Guidance.

The quantity of CO_2 released was estimated from the production of primary aluminium**,** considering that, in case of using pre-baked anodes, approximately 1.5 tonnes of CO_2 is emitted for each tonne of

primary aluminium produced.

Table 4.23. Emission factors for NOx, CO and SO_2 from aluminiu production

Pollutant	**Process**	**Emission Factor [Kg/tonne Al produced]**
CO	Anode baking	400
SO_2	Anode baking	0,9

Emissions of CF_4 and C_2F_6 were estimated by multiplying annual primary aluminium production with the default emission factors provided by Good Practice Guidance and considering the changes in technologies over the period.

Table 4.24. EF used for the calculation of PFC emissions from aluminium production

Technology	**CF_4**	**C_2F_6**
	[Kg/tonne Al produced]	
SWPB	1.7	0.17
CWPB	0.31	0.04

Table 4.25 Aluminum production (AD) in the period 1989-2004

Years	Aluminium production [kt]
1989	266
1990	168
1991	154
1992	107
1993	112
1994	118
1995	141
1996	140
1997	164
1998	175
1999	174
2000	173
2001	180
2002	187
2003	198
2004	215

SF_6 used in aluminium and magnesium foundries

This activity is not applicable in the country.

4.4.3 Uncertainties and time series consistency

Time series is consistent; the same emission factors, the same sources of activity data and the same methods were used for the entire time series 1989-2004.

Iron and steel

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%. The uncertainty in the emission factors for the reducing agents is within 5%.

4.4.4 Source specific QA/QC and verification

Only basic QC activities were performed, such as: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain similar results.
AD on primary aluminium production obtained from national statistics has been checked against the data obtained from the local environmental protection agencies. 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.

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

Iron and steel production

Previously estimates based on national statistics have been replaced with estimates based on activity data collected at plant level. Emissions have been recalculated for the entire time series, using Tier 2 method. The time series is consistent.

For a double checking was compared the existent list of economic agents with the list of operators who are under the EU-ETS Directive.
As a result of this checking, starting with 1989 and 2001 there were identified still two new economic agents, agents which were not included in the last submission, and for this reason it is also necessary to do recalculations.

Table 4.26. Recalculations of CO_2 emissions in the iron and steel production subsector

Years	2005 submission (CO_2 emissions) [Gg]	2006 submission (CO_2 emissions) [Gg]	Differences [%]
1989	15855	15803	-0.3
1990	11038	10273	-6.9
1991	7086	6564	-7.3
1992	7971	6814	-14
1993	7207	6963	-3.4
1994	8000	7981	-0.2
1995	9515	8851	-6.9
1996	8867	8301	-6.3
1997	9338	8884	-4.8
1998	8794	8870	0.8
1999	4741	5400	13.8
2000	4547	5450	19.8
2001	3916	5044	28.8
2002	4961	6763	36.3
2003	4550	6016	32.2
2004		6277	

The figures for NMVOC, NOx, SO_2 and CO emissions have been updated based on new data inputs. The NMVOC and CO emissions have been also corrected because the figures were inverted in the previously submission (for all time series).

Ferroalloys production

Ferroalloys emissions considered under Iron and Steel production in previous submission are now reported under the appropriate IPCC category. The CO_2 emissions within the production of ferroalloys are calculated based on the production volume (Tier 1b).

Table 4.27. Recalculations of CO_2 emissions in the ferroalloys production subsector.

Years	2006 submission (CO_2 emissions) [Gg]
1989	106
1990	113
1991	120
1992	147
1993	112
1994	168
1995	204
1996	225
1997	144
1998	106
1999	91
2000	123
2001	167
2002	144
2003	242
2004	331

Aluminium production

Previously emissions estimated based on national statistics have been replaced with estimates based on activity data provided directly by the plant and considering changes in technologies over the period:

1. previously activity data set obtained from national statistic have been replaced with activity data set provided by the plant**.** There are some differences between these two data sets. National statistics figures are higher (from 0.04% until 10%). The highest differences appear in the first part of the period;

Table 4.28. Differences of aluminium production (AD) between 2005 submission and 2006 submission

Year	2005 submission Aluminium production-[kt]	2006 submission Aluminium production-[kt]	Differences[%]
1989	282	266	-5.8
1990	178	168	-5.7
1991	167	154	-7.8
1992	120	107	-10
1993	116	112	-3.6
1994	122	118	-3.1
1995	144	141	-2.3
1996	145	140	-3.2
1997	164	164	-0.1
1998	175	175	-0.1
1999	174	174	0.04
2000	181	173	-4.2
2001	183	179	-1.7
2002	190	187	-1.7
2003	205	198	-3.3
2004		215	

2. previously PFCs emission factors for CWPB technology were used to estimate emissions for the entire 1989-2003 period, but the new updated data provided by the plant showed that this not the case for the period 1989-1996, when the SWPB technology has been used. The differences in emission estimates are significant due to large differences in emission factors for those two types of technologies**;**

Table 4.29 Recalculations of CO_2, CF_4 and C_2F_6 emissions in the aluminium production subsector

Year	2005 submission			2006 submission			Differences [%]		
	emissions CF_4 [tones]	emissions C_2F_6 [tones]	emissions CO_2 [Gg]	emissions CF_4 [tones]	emissions C_2F_6 [tones]	emissions CO_2 [Gg]	emissions CF_4	emissions C_2F_6	emissions CO2
1989	105.18	11	423	451.42	45.14	398.31	329.17	310.38	-5.84
1990	66.39	7	267	285.15	28.51	251.61	329.49	307.36	-5.77
1991	62.29	6	250.5	261.73	26.17	230.94	320.18	336.23	-7.81
1992	44.76	4	180	182.22	18.22	160.79	307.12	355.57	-10.67
1993	43.26	4	174	189.94	18.99	167.60	339.01	374.87	-3.68
1994	45.51	5	183	200.94	20.09	177.30	341.57	301.88	-3.11
1995	53.71	5	216	239.02	23.90	210.90	345.00	378.04	-2.36
1996	54.09	5	217.5	238.39	23.83	210.35	340.77	376.78	-3.29
1997	61.17	6	246	50.74	6.54	245.56	-17.04	9.14	-0.18
1998	65.28	7	262.5	54.16	6.98	262.07	-17.03	-0.16	-0.16
1999	64.9	6	261	53.96	6.96	261.12	-16.85	16.05	0.05
2000	67.51	7	271.5	53.71	6.93	259.91	-20.44	-0.99	-4.27
2001	68.26	7	274.5	55.74	7.19	269.73	-18.33	2.75	-1.74
2002	70.87	7	285	57.84	7.46	279.89	-18.38	6.62	-1.79
2003	76.46	7.65	307.5	61.39	7.92	297.07	-19.71	3.60	-3.39
2004				66.72	8.61	322.89			

3. the figures for SO_2 and CO emissions have been updated based on new data inputs.

4.4.6 Source specific planned improvements

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

In the **pulp and paper production *(2.D.1)*** subsector, the emission was estimated based on the total annual production of dried pulp, provided in the Statistical Yearbook.
Emissions of NOx, NMVOC, CO and SO2 are emitted during the production of pulp and paper
The production was broken down by kraft and acid sulphite processes.
The emission factors are those indicated in the revised methodology.

In the **food and drink production *(2.D.2)*** subsector the emission was estimated based on the total annual production of the particular food and drink manufacturing process. The AD was provided by the National Institute for Statistics.
NMVOCs are emitted during the production of alcoholic beverages, bread making and other food products.
The NMVOC emission factor is indicated in the revised methodology.
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.

Table 4.30 Emission factors used to estimate emissions from CRF sector 2.D

Activity		NOx	CO	NMVOC	SO_2	Units
Pulp	**Kraft type**	**1.5**	**5.6**	**3.7**	**7**	**Kg/t**
	Sulphite type	**-**	**-**	**-**	**30**	**Kg/t**
Wine		**-**	**-**	**0.08**	**-**	**Kg/hL**
Beer		**-**	**-**	**0.035**	**-**	**Kg/hL**
Meat, fish and poultry		**-**	**-**	**0.3**	**-**	**Kg/t**
Sugar		**-**	**-**	**10**	**-**	**Kg/t**
Margarine		**-**	**-**	**10**	**-**	**Kg/t**
Cakes, biscuits		**-**	**-**	**1**	**-**	**Kg/t**
Bread		**-**	**-**	**8**	**-**	**Kg/t**

4.5.3 Uncertainties and time series consistency

There are inconsistencies in time series in the statistical data set for bread production Activity data for missing years were estimated using alternative methods provided by the IPCC good practice. The same source of activity data was used for the entire time series 1989-2004.

4.5.4 Source specific QA/QC and verification

Only basic QC activities were performed, such as: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain similar results.

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

The recalculations in the **pulp and paper production** subsector:

- In the pulp and paper production subsector, the CO emissions were inverted with NMVOC emissions, for the years 2003 and 2004, and for this reason, recalculations for both years were made.

The recalculations in the **food and drink production** subsector are due to:

- the inversion of the emission factor for bread with emission factor for crackers for all time series 1989-2004.
- Starting with 2001 the values for meal and meal preparation were wrongly used regarding the unit measure.
- In the years where there was no data regarding the bread production (1989-2000), a linear extrapolation was used, in order to complete the time series.

4.5.6 Source specific planned improvements

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 SF6 (CRF sector 2.F)

4.7.1 Source category Description

In order to estimate consumption of HFCs, PFCs and SF_6 in the period 1989-2004 two sets of questionnaires have been sent to:

- Trading companies, to identify the amounts of F gases imported/exported
- Local Environment Protection Agencies, to identify manufacturing and service companies as possible sources of handling or consumption of these compounds .

The results of the questionnaires were:

- F-gases are not produced in the country
- Export is not applicable
- There were identified few importers (there are two important economic agents in the country that imports for their own consumption and one big distributing company)
- Four types of refrigeration equipment are produced in Romania; domestic, commercial, transport and industrial. The most important economic agent is a producer for domestic refrigerators, that, starting 1995, converted the production technology to non ODS substances: HFC 134a and cyclopenthane
- Based on the response to the questionnaire, there is also air conditioning equipment produced, but the main source of F-gases is the domestic refrigeration producer.
- There are many registered services, distributed around the country, which perform servicing mainly on domestic and commercial equipment, some of these shops also service industrial equipment, but the majority of this work is done by the original equipment manufacturers, which

all operate their own service teams.

- The use of F-gases started in 1995.

4.7.2 Methodological issues

Both potential and actual emissions were estimated.

Potential emissions

Potential emissions were estimated using Tier 1a method, based on formula:

Equation 4.6 Calculation of potential emissions

Potential Emissions = Production + Imports – Exports - Destruction

where:

- production = not applicable
- imports = imported HFC/PFC in bulk (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a were identified in 2004)
- exports - not applicable
- destruction - not estimated

Potential emissions are equaled with the amount of substance imported in bulk.

Actual emissions

In 2004, the sub-sector 2F Consumption of halocarbons and SF_6 includes the following source categories and the following F-gases:

Source category	Sub-sector	HFCs/PFCs/SF_6
2F1 Refrigeration and air conditioning equipment	Domestic refrigeration	HFC-134a, HFC-143a, C5F12, C6F14
2F1 Refrigeration and air conditioning equipment	Commercial refrigeration	HFC-32, HFC-134a, HFC-143a, HFC-125, C5F12, HFC-23, HFC-43-10 mee, HFC-134, HFC-227eea
2F1 Refrigeration and air conditioning equipment	Industrial refrigeration	HFC-32, HFC-41, HFC-134a, HFC-143a, HFC-125, HFC-43-10mee, HFC-23, HFC-134, HFC-152, HFC-227ea, HFC-143, C4F10
2F1 Refrigeration and air conditioning equipment	Transport refrigeration	HFC-134a, HFC-23, C5F12
2F1 Refrigeration and air conditioning equipment	Stationary air conditioning	HFC-32, HFC-143a, HFC-125, HFC-23, HFC-134, HFC-152a, HFC-227ea, HFC-134a
2F1 Refrigeration and air conditioning equipment	Mobile air conditioning	HFC-134a, HFC-134
2F3 Fire extinguishers	Portable fire extinguishers	HFC-23
2F8 Electrical equipments	Electrical equipments	SF6

The determination of emissions of F-gases is based on a calculation of the actual emission. 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.

4.7.3 Uncertainties and time series consistency

The use of these substances started in 1995 year, serving as alternatives to ozone depleting substances (ODS) being phased out under the Montreal Protocol.

4.7.4 Source specific QA/QC and verification

Verification has been carried out by data comparison received from the importers and from the submitted questionnaires. There are high differences between these two sources. In case of HFC-125 and HFC-134a , HFC-143a, HFC-32 the ratio potential/actual emissions is very high.

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

The HFC-23 emissions from fire extinguishers have been recalculated as the data provided reconsidered the activity data set submitted last year.

The HFC-125, HFC-134a, HFC-143a. HFC-32 emissions from commercial refrigeration equipment have been recalculated because, one of the economic agent provided a modified activity data set from year 2004 , as an error occurred in the data set previded last questionary.

Also, corrections were made in the notation keys (to the production, consumption, export, import of halocarbons and SF_6).

There were some cases where probably due to a soft error it was not possible to correct the notation keys in CRF Reporter database (in case of Domestic refrigeration, Commercial refrigeration, Transport refrigeration, Industrial refrigeration, Stationary air conditioning, Mobile air conditioning).

Also the AD's regarding the HFC consumption for some of the years did not appear in the CRF Reporter database although they appeared in the CRF tables (in case of HFC-23 and HFC-134).

4.7.6 Source specific planned improvements

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

5. SOLVENTS 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 UNFCCC.

5.2 Source category:

Paint application (3A), Degreasing and Dry Cleaning (3B), Chemical Products, Manufacture and Processing (3C), Other (3D).

5.2.1 Source category Description

3 A source category includes emissions resulted from: domestic use, automobile manufacture and repairing, construction and buildings.

3 B source category refers to emissions resulted from metal degreasing, dry cleaning, electronic components manufacturing, other industrial cleaning.

3 C source category includes emissions from chemicals manufacturing or processing: polyester processing, polyvinyl chloride processing, polyurethane foam processing, rubber processing, pharmaceutical products manufacturing, paints manufacturing, glues manufacturing,

3 D source category refers to emissions resulted from other use of solvents, such as: mineral wool enduction, preservation of wood, domestic solvent use (other than paint application), underseal treatment and conservation of vehicles.

5.2.2 Methodological issues

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:

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

The AD used to calculate emissions are provided mainly by the national statistics
CO_2 emissions from solvent use were calculated from NMVOC emissions of this sector.
The following equation has been applied:

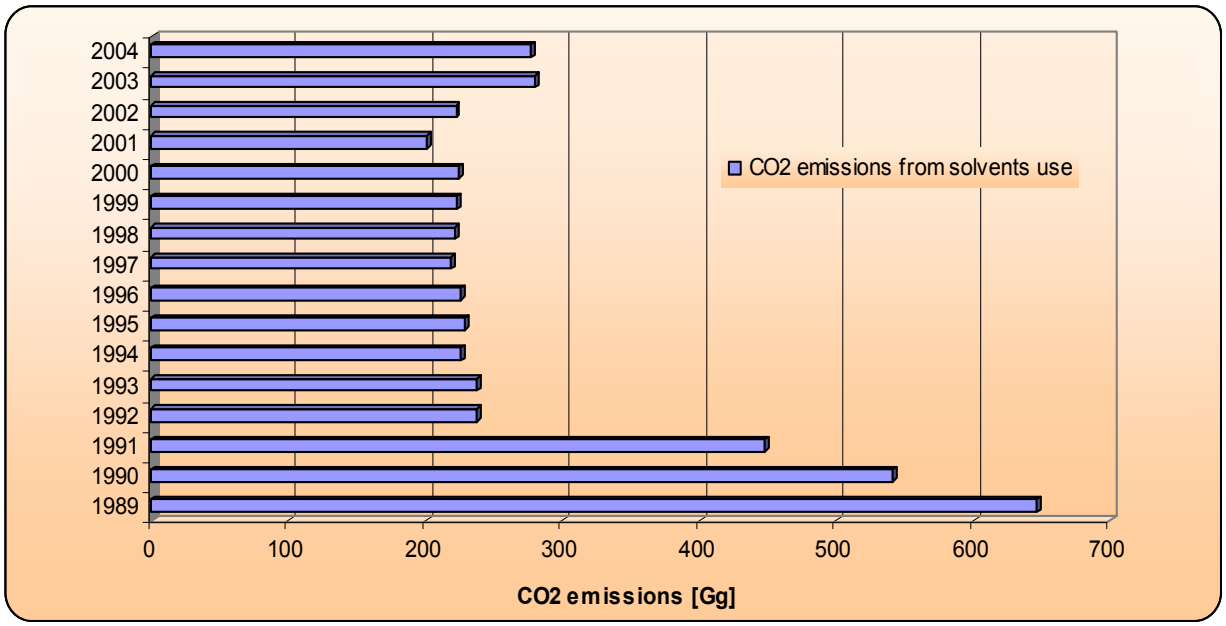
Equation 5.1 Calculation of CO_2 emissions from solvent use

CO_2 emissions = 0,85 x (44/12) x emissions of NMVOC
where 0,85 is carbon content conversion factor.

Table 5.1 CO_2 emissions resulted from Solvent and other product use

Year	3a	3b	3c	3d	total
1989	141.2	100.7	0	403.9	**645.8**
1990	111.6	88.2	0	340.7	**540.4**
1991	84.5	70.1	0	293.6	**448.2**
1992	52	31	0	154.6	**237.6**
1993	51.1	31	0	155.5	**237.6**
1994	41.5	30.9	0	153	**225.4**
1995	43.9	30.9	0	154.6	**229.4**
1996	39.6	30.9	0	154.9	**225.4**
1997	33	30.8	0	155.2	**219.1**
1998	31.5	30.8	0	159.6	**221.8**
1999	30.5	30.8	0	161.1	**222.4**
2000	32.7	30.8	0	160.8	**224.3**
2001	41.5	17.5	0	141.5	**200.4**
2002	45.5	17.8	0	159	**222.2**
2003	106.6	21.8	0	151.5	**279.9**
2004	99.8	25.8	0	151.8	**277.4**

***Figure** 5.1 The trend of CO_2 emissions resulted from Solvent and other product use sector , in the year 2004.*



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.

5.2.3 Uncertainties and time series consistency

Uncertainties are rather large due to the diverse nature of many solvent-using processes.

5.2.4 Source specific QA/QC and verification

Most general QC procedures concerning data management and the handling of data have been carried out.

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

No recalculations have been performed in this source category**.**

5.2.6 Source specific planned improvement

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 the sector

This chapter provides information on the estimation of the greenhouse gas emissions from the agriculture sector (Sectoral 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.

Figure 6.1 Total GHG emissions trend in Agriculture for 1989–2004 period

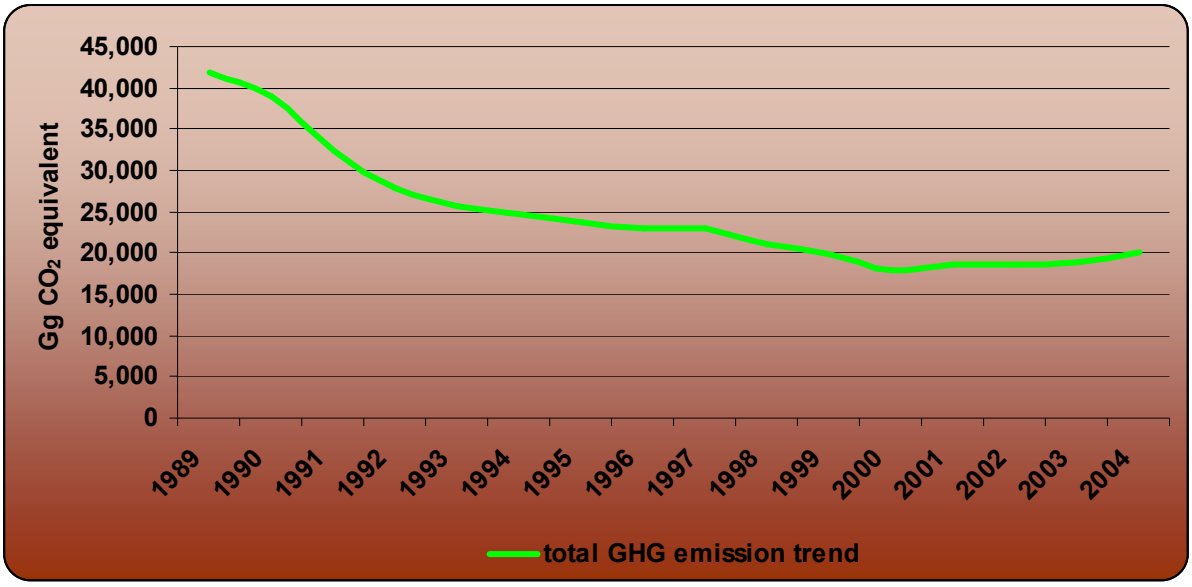
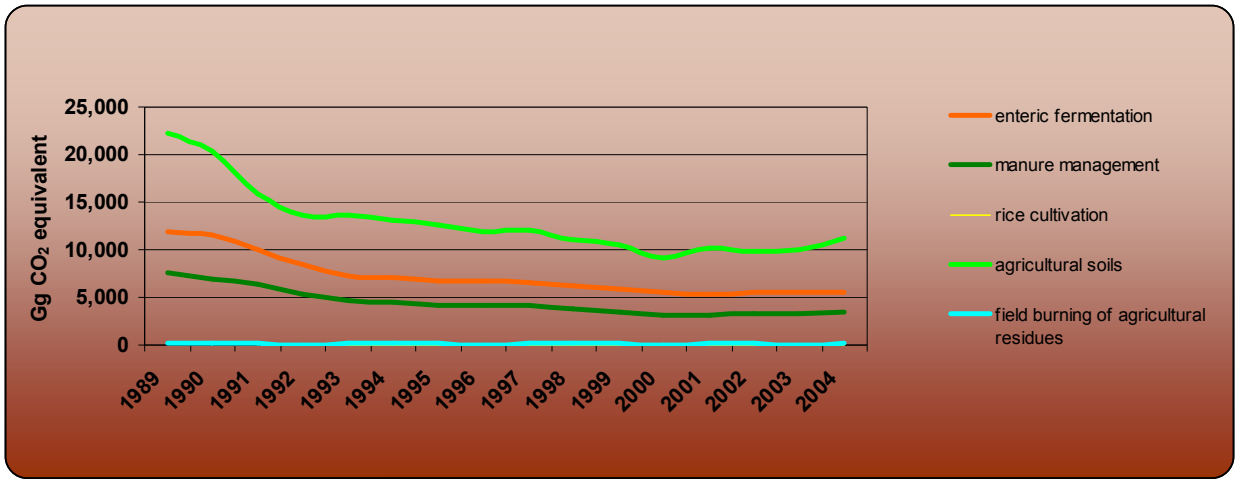


Figure 6.2 GHG emissions trends in Agriculture, by sub-sectors, for 1989–2004 period



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 emission 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 from prescribed burning of savannas do not occur in Romania.

The Agriculture sector accounted for 12.61 % of the total GHG emissions in 2004, reaching 20,182.19 Gg CO_2 equivalent (Table 6.1). Within the GHG emissions from the agriculture sector, the N_2O emissions have the largest contribution (in 2004, N_2O emissions contribution is 62.59% to the total Agriculture sector's CO_2 equivalent emissions; Figure 6.2), followed by the CH_4 emissions (that account for the remaining 37.41%).

Over the period 1989–2004, the GHG emissions resulted from agriculture sector decreased by 51.82% (Figure 6.1). In case of emissions resulted from enteric fermentation and manure management, the descending trend reflects the decrease in animal population over the period.

The rice cultivation generated in 2004 a significantly reduced emission compared to the base year 1989 (97.57% decrease comparing with the base year).

In case of agricultural soils, the emissions decreased over the period (49.54% decrease in 2004 comparing with 1989), and the evolution of emissions fluctuates, depending on the crop productions that vary from one year to another.

As presented in the Table 6.2, the Agriculture sector's CH_4 emissions decreased in 2004 with more than a half the level recorded in the base year (-54.45 %). Because the methane emissions are mainly resulted in domestic livestock, the shape of the curves shows the situation of this sector in Romania (Figure 6.2).

Table 6.3 indicates that N_2O emissions from the Agriculture sector decreased with 50.09% 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

Table 6.1 Contribution of Agriculture sector in total GHG emissions, in 1989–2004 period

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	282,467.18	41,889.74	14.83	16,578.64	39.58	25,311.09	60.42
1990	248,735.03	38,992.76	15.68	15,737.71	40.36	23,255.05	59.64
1991	196,281.84	32,369.87	16.49	13,918.51	43.00	18,451.36	57.00
1992	186,494.80	27,743.31	14.88	11,830.13	42.64	15,913.18	57.36
1993	184,334.42	25,651.17	13.92	10,194.88	39.74	15,456.29	60.26
1994	179,283.99	24,738.36	13.80	9,861.72	39.86	14,876.64	60.14
1995	186,955.81	23,677.07	12.66	9,357.26	39.52	14,319.81	60.48
1996	192,685.40	22,941.20	11.91	9,344.73	40.73	13,596.47	59.27
1997	172,844.48	23,078.23	13.35	9,220.12	39.95	13,858.11	60.05
1998	154,125.69	21,129.58	13.71	8,545.34	40.44	12,584.24	59.56
1999	135,539.84	19,873.63	14.66	7,924.23	39.87	11,949.41	60.13
2000	138,592.63	17,925.30	12.93	7,349.28	41.00	10,576.02	59.00
2001	143,000.88	18,602.33	13.01	7,154.22	38.46	11,448.10	61.54
2002	150,583.16	18,638.84	12.38	7,396.99	39.69	11,241.85	60.31
2003	157,513.90	18,925.44	12.02	7,457.72	39.41	11,467.72	60.59
2004	160,059.73	20,182.19	12.61	7,550.94	37.41	12,631.24	62.59

Table 6.2 Distribution of CH_4 emissions within Agriculture sub-sectors, in 1989–2004 period [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	789.46	563.30	211.44	9.86	NA, NE	NA	4.86
1990	749.41	546.97	190.20	7.98	NA, NE	NA	4.27
1991	662.79	476.75	177.59	4.32	NA, NE	NA	4.13
1992	563.34	404.07	153.32	3.28	NA, NE	NA	2.68
1993	485.47	345.63	133.94	2.40	NA, NE	NA	3.50
1994	469.61	336.50	128.16	0.92	NA, NE	NA	4.03
1995	445.58	324.28	115.57	1.24	NA, NE	NA	4.49
1996	444.99	323.14	117.36	1.70	NA, NE	NA	2.78
1997	439.05	315.47	118.15	0.80	NA, NE	NA	4.64
1998	406.92	296.58	106.59	0.34	NA, NE	NA	3.41
1999	377.34	278.75	94.81	0.32	NA, NE	NA	3.46
2000	349.97	262.72	84.45	0.28	NA, NE	NA	2.52
2001	340.68	255.29	80.81	0.24	NA, NE	NA	4.34
2002	352.24	262.52	86.52	0.10	NA, NE	NA	3.10
2003	355.13	265.16	87.48	0.02	NA, NE	NA	2.46
2004	359.57	258.69	95.50	0.24	NA, NE	NA	5.13

Table 6.3 Distribution of N_2O emissions within Agriculture sub-sectors, in 1989–2004 period [Gg]

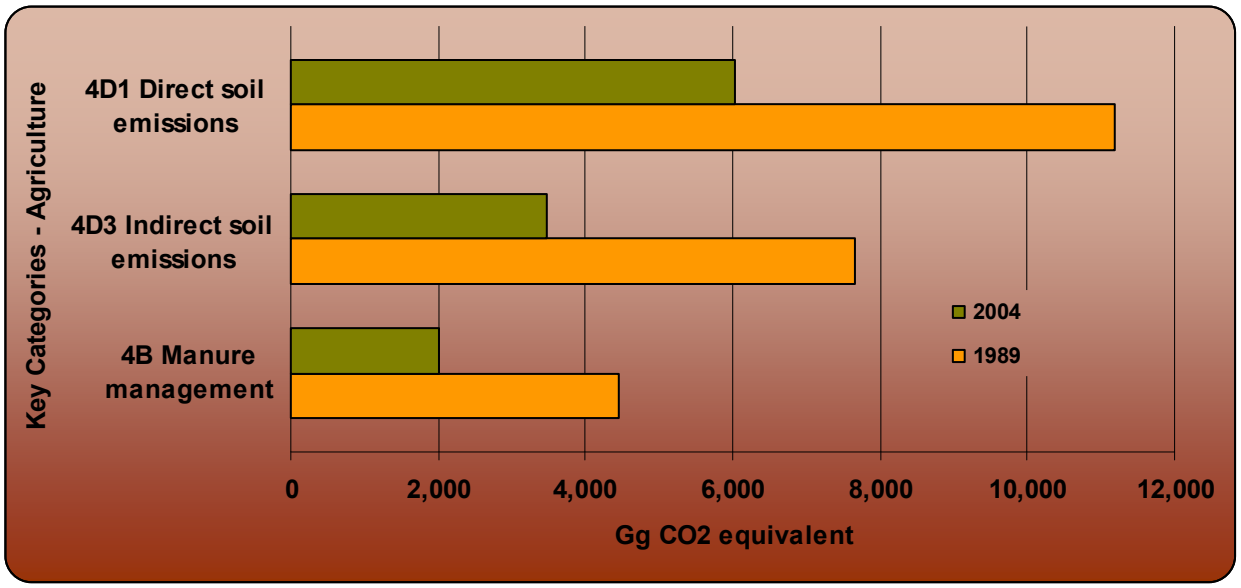
Year	Total N_2O emission - Agriculture	Enteric Fermentation	Manure Management	Rice Cultivation	Agricultural Soils	Prescribed Burning of Savannas	Field burning of agricultural residues
1989	81.65		9.99		71.54	NA	0.12
1990	75.02		9.54		65.37	NA	0.10
1991	59.52		8.44		50.97	NA	0.11
1992	51.33		7.05		44.21	NA	0.07
1993	49.86		6.02		43.75	NA	0.09
1994	47.99		5.80		42.08	NA	0.10
1995	46.19		5.50		40.58	NA	0.11
1996	43.86		5.55		38.23	NA	0.08
1997	44.70		5.47		39.12	NA	0.12
1998	40.59		5.07		35.44	NA	0.09
1999	38.55		4.72		33.73	NA	0.09
2000	34.12		4.41		29.65	NA	0.06
2001	36.93		4.29		32.54	NA	0.11
2002	36.26		4.46		31.73	NA	0.08
2003	36.99		4.49		32.43	NA	0.07
2004	40.75		4.51		36.10	NA	0.14

Table 6.4 and Figure 6.3 describe Key categories in Agriculture, both from level and trend view.

Table 6.4 Key categories overview – Agriculture, 2004

Key categories (both level and trend)	GHG	Contribution of Key categories in total GHG emissions [%]
4D1 Direct soil emissions	N_2O	3.77
4D3 Indirect soil emissions	N_2O	2.18
4B Manure management	CH_4	1.25

Figure 6.3 Key Categories in Agriculture (4D1 – Direct soil emissions, 4D3 – Indirect soil emissions, 4B – Manure management)



All improvements made, comparative to the previous submission, are described in the Sub-sector recalculation chapter and also in the Chapter 10.

A set of data requirements has been elaborated following the IPCC Tier 2 methods and it has been submitted to the National Institute for Statistics and to the Ministry of Agriculture, but the poor data received does not allow for the use of higher tier methods. The new Governmental Decision for establishment of the National System for estimating the GHG emissions underlines the need to move to higher tier methods in case of key categories and facilitates the involvement of different institution and experts from agricultural field.

6.2 Source category Enteric Fermentation (CRF sector 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 2004, CH_4 emissions from Enteric Fermentation represented 71.94% of total CH_4 emissions in the Agriculture sector);
- is the second largest source in the Agriculture sector (in 2004, CH_4 emissions from Enteric Fermentation as CO_2 equivalent represented 26.92% from Total Agriculture emissions);
- contributed with 3.39% to Total GHG emissions of Romania

Emissions from enteric fermentation are declining since 1989 due to the decrease of livestock number.

Table 6.5 Observations on source category 4A – "Enteric Fermentation"

Source indicative	Source (livestock) type	Observation	Data source
4A1	Cattle	Includes livestock data from two different cattle categories: dairy cows and non-dairy cattle.	AD: SY, NIS, 2006; expert judgment; EF: IPCC 1996, IPCC GPG 2000
4A2	Buffalo		AD: SY, NIS, 2006; EF: IPCC 1996, IPCC GPG 2000
4A3	Sheep		
4A4	Goats		AD: SY, NIS, 2006; EF: IPCC 1996, IPCC GPG 2000
4A5	Horses		
4A6	Mules and asses		AD: FAO; EF: IPCC 1996, IPCC GPG 2000
4A7	Swine		AD: SY, NIS, 2006; EF: IPCC 1996, IPCC GPG 2000
4A8	Poultry		

6.2.2 Methodological issues

Methodology

Despite the fact that Enteric fermentation 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 methane emissions from enteric fermentation, the equations 4.12 and 4.13 of IPCC GPG 2000 were used.

Emission factors

The calculation methodology took into account IPCC 1996 default emissions factors for developing countries (Tables 4-3 and 4-4 from Reference Manual). They were considered also the following:

- a temperate climate zone;
- Romania belongs to Eastern Europe;
- Romanian conditions are similar to those in developing countries

The emission factors used are presented in Table 6.6:

Table 6.6 Default emission factors used for calculation of methane emissions from Enteric fermentation

Source indicative	Livestock (source) type	Emission Factors [kg CH_4/head/year]
4A1	Cattle – Dairy cows	81
	Cattle – Non-dairy cattle	56
4A2	Buffalo	55
4A3	Sheep	5
4A4	Goats	5
4A5	Horses	18
4A6	Mules and asses	10
4A7	Swine	1
4A8	Poultry	Not estimated

Activity data

Dairy cows

Total cattle data are provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook (SY 2006) and other relevant correspondence. Beginning with 2004, NIS provides to Eurostat a more complete set of data, comprising also Dairy cows data.

By expert judgment, we extended the Dairy cows data series to 1989-2003 period, considering that 56.3% of Total cattle are Dairy cows (the percentage was obtained using the arithmetic mean of Dairy cows values for 2004 and 2005).

Non-dairy cattle

Total cattle data are provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook (SY 2006) and other relevant correspondence. Non-dairy cattle values were obtained by subtracting the Dairy cows and Buffalo values from Total cattle number.

Buffalo

Total cattle data are provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook (SY 2006) and other relevant correspondence. Beginning with 2004, NIS provides to Eurostat a more complete set of data, comprising also Buffalo data.

By expert judgment, we extended the Buffalo data series to 1989-2003 period, considering that 1.38% of Total cattle are Buffalo (the percentage was obtained using the arithmetic mean of Buffalo values for 2004 and 2005).

Mules and asses

Due to impossibility of finding data from Romanian sources we used Mules and asses data from FAO databases.

Other livestock (sheep, goats, horses, swine and poultry)

All livestock data are provided by NIS through Statistical Yearbook (SY 2006).

Livestock data series are presented in Table 6.7:

Table 6.7 Livestock data series for 1989-2004 period

Year	Livestocks data series [thousands heads]								
	Dairy cows	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Swine	Poultry
1989	3,612.21	2,715.25	88.54	16,210.00	1,078.00	702.00	36	14,351.00	127,561.00
1990	3,541.83	2,662.35	86.82	15,435.00	1,017.00	663.00	35	11,671.00	113,968.00
1991	3,029.50	2,277.24	74.26	14,062.00	1,005.00	670.00	35	12,003.00	121,379.00
1992	2,451.87	1,843.04	60.10	13,879.00	954.00	749.00	35	10,954.00	106,032.00
1993	2,073.53	1,558.65	50.83	12,079.00	805.00	721.00	34	9,852.00	87,725.00
1994	2,025.11	1,522.25	49.64	11,499.00	776.00	751.00	33	9,262.00	76,532.00
1995	1,959.80	1,473.16	48.04	10,897.00	745.00	784.00	32	7,758.00	70,157.00
1996	1,968.25	1,479.51	48.24	10,381.00	705.00	806.00	31	7,960.00	80,524.00
1997	1,933.91	1,453.69	47.40	9,663.00	654.00	816.00	30	8,235.00	78,478.00
1998	1,821.31	1,369.05	44.64	8,937.00	610.00	822.00	30.5	7,097.00	66,620.00
1999	1,717.71	1,291.18	42.10	8,121.00	558.00	858.00	31	5,848.00	69,143.00
2000	1,615.81	1,214.58	39.61	7,657.00	538.00	865.00	30	4,797.00	70,076.00
2001	1,576.40	1,184.96	38.64	7,251.00	525.00	860.00	31	4,447.00	71,413.00
2002	1,620.31	1,217.97	39.72	7,312.00	633.00	879.00	28	5,058.00	77,379.00
2003	1,631.01	1,226.01	39.98	7,447.00	678.00	897.00	28	5,145.00	76,616.00
2004	1,566.40	1,207.87	33.79	7,425.33	660.72	839.59	28	6,494.67	87,014.41

6.2.3 Uncertainties and time series consistency

There were not performed a full quantitative assessment of uncertainties, since the NIS has not provided any uncertainty values for activity data. The uncertainties associated with the emission factors specific to all livestock except cattle are estimated to be ± 20% (Table 4.3 of Reference Manual) while there are not specified default emissions factors for cattle.

According to provisions in page 4.27 of IPCC GPG 2000, emission factors estimated using the tier 1 method are unlikely to be known more accurately than ± 30% and may be uncertain to ± 50%.

Due to the fact that all activity data are provided by NIS and the same emission factors and methodologies are used for the whole period, the time series 1989-2004 is consistent.

6.2.4 Source specific QA/QC and verification

Some basic QC activities were made: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain similar results. Livestock population data were checked against the data in FAO and Eurostat databases; the data are reported at the same level of aggregation and the figures are the same.

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

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

- activity data
  - ✓ based on detailed surveys data from NIS, beginning with 2004, the old expert judgment used to spilt Total Cattle into Dairy cows, Non-dairy cows and Buffalo (46.5% Dairy cows, 49% Non-dairy cattle and 4.5 % Buffalo) was changed; we are now considering that 56.3% from Total Cattle are Dairy cows, 1.38% are Buffalo and the difference represents the number of Non-dairy cattle;
  - ✓ all previously used data, specific to all livestock types excepting Mules and asses, were supplementary checked; as a result some errors were found and corrected;
  - ✓ Mules and asses data, which were supposed to be included in Horses number, were taken from FAO databases

All the changes made at activity data level and their implications on emission estimates are described in Table 6.8.

Table 6.8 Changes made at activity data level and their effects on emission estimates

Year	Changes on livestocks data series [thousands heads]							
	NIR 2005 - Dairy cows	**NIR 2006 - Dairy cows**	NIR 2005 -Non-dairy cattle	**NIR 2006 -Non-dairy cattle**	NIR 2005 - Buffalo	**NIR 2006 - Buffalo**	NIR 2005 - Sheep	**NIR 2006 - Sheep**
1989	2,983.0	**3,612.21**	3,143.84	**2,715.25**	288.70	**88.54**	16,210	**16,210.00**
1990	2,925.3	**3,541.83**	3,082.60	**2,662.35**	283.00	**86.82**	15,435	**15,435.00**
1991	2,502.0	**3,029.50**	2,636.70	**2,277.24**	242.00	**74.26**	14,062	**14,062.00**
1992	2,025.0	**2,451.87**	2,134.00	**1,843.04**	196.00	**60.10**	13,879	**13,879.00**
1993	1,712.6	**2,073.53**	1,804.70	**1,558.65**	165.70	**50.83**	12,079	**12,079.00**
1994	1,672.6	**2,025.11**	1,762.50	**1,522.25**	161.86	**49.64**	11,499	**11,499.00**
1995	1,618.6	**1,959.80**	1,705.70	**1,473.16**	156.50	**48.04**	10,897	**10,897.00**
1996	1,625.4	**1,968.25**	1,713.00	**1,479.51**	157.30	**48.24**	10,381	**10,381.00**
1997	1,597.0	**1,933.91**	1,683.00	**1,453.69**	155.00	**47.40**	9,663	**9,663.00**
1998	1,504.0	**1,821.31**	1,585.00	**1,369.05**	145.50	**44.64**	8,937	**8,937.00**
1999	1,461.0	**1,717.71**	1,540.00	**1,291.18**	141.40	**42.10**	8,409	**8,121.00**
2000	1,418.7	**1,615.81**	1,495.00	**1,214.58**	137.30	**39.61**	8,121	**7,657.00**
2001	1,334.0	**1,576.40**	1,406.00	**1,184.96**	129.00	**38.64**	7,657	**7,251.00**
2002	1,302.0	**1,620.31**	1,372.00	**1,217.97**	126.00	**39.72**	7,251	**7,312.00**
2003	1,338.3	**1,631.01**	1,410.20	**1,226.01**	129.50	**39.98**	7,312	**7,447.00**
2004		**1,566.40**		**1,207.87**		**33.79**		**7,425.33**

Table 6.8 Changes made at activity data level and their effects on emission estimates

Year	Changes on livestocks data series [thousands heads]							
	NIR 2005 - Goats	**NIR 2006 - Goats**	NIR 2005 - Horses	**NIR 2006 - Horses**	NIR 2005 – Mules and asses	**NIR 2006 – Mules and asses**	NIR 2005 - Swine	**NIR 2006 - Swine**
1989	1,078	**1,078.00**	702	**702.00**	0	**36**	14,351	**14,351.00**
1990	1,017	**1,017.00**	663	**663.00**	0	**35**	11,671	**11,671.00**
1991	1,005	**1,005.00**	670	**670.00**	0	**35**	12,003	**12,003.00**
1992	954	**954.00**	749	**749.00**	0	**35**	10,954	**10,954.00**
1993	805	**805.00**	721	**721.00**	0	**34**	9,852	**9,852.00**
1994	776	**776.00**	751	**751.00**	0	**33**	9,262	**9,262.00**
1995	745	**745.00**	784	**784.00**	0	**32**	7,758	**7,758.00**
1996	705	**705.00**	806	**806.00**	0	**31**	7,960	**7,960.00**
1997	654	**654.00**	816	**816.00**	0	**30**	8,235	**8,235.00**
1998	610	**610.00**	822	**822.00**	0	**30.5**	7,097	**7,097.00**
1999	585	**558.00**	839	**858.00**	0	**31**	7,194	**5,848.00**
2000	558	**538.00**	858	**865.00**	0	**30**	5,848	**4,797.00**
2001	538	**525.00**	865	**860.00**	0	**31**	4,797	**4,447.00**
2002	525	**633.00**	860	**879.00**	0	**28**	4,447	**5,058.00**
2003	633	**678.00**	879	**897.00**	0	**28**	5,058	**5,145.00**
2004		**660.72**		**839.59**		**28**		**6,494.67**

Table 6.8 Changes made at activity data level and their effects on emission estimates

Year	Changes on livestocks data series [thousands heads]			Effects of changes on emission estimates		
	NIR 2005 - Poultry	**NIR 2006 - Poultry**		NIR 2005 – CH_4 emissions [Gg]	**NIR 2006 - CH_4 emissions [Gg]**	**Difference [%]**
1989	127,561	**127,561.00**		546.98	**563.30**	**2.98**
1990	113,968	**113,968.00**		531.00	**546.97**	**3.01**
1991	121,379	**121,379.00**		463.03	**476.75**	**2.96**
1992	106,032	**106,032.00**		392.91	**404.07**	**2.84**
1993	87,725	**87,725.00**		336.15	**345.63**	**2.82**
1994	76,532	**76,532.00**		327.24	**336.50**	**2.83**
1995	70,157	**70,157.00**		315.31	**324.28**	**2.84**
1996	80,524	**80,524.00**		314.13	**323.14**	**2.87**
1997	78,478	**78,478.00**		306.64	**315.47**	**2.88**
1998	66,620	**66,620.00**		288.21	**296.58**	**2.90**
1999	69,480	**69,143.00**		279.62	**278.75**	**-0.31**
2000	69,143	**70,076.00**		270.87	**262.72**	**-3.01**
2001	70,076	**71,413.00**		255.23	**255.29**	**0.02**
2002	71,413	**77,379.00**		248.03	**262.52**	**5.84**
2003	77,379	**76,616.00**		255.10	**265.16**	**3.94**
2004		**87,014.41**			**258.69**	

6.2.6 Source specific planned improvements

In respect to the IPCC GPG 2000 provisions, more detailed data which allow for using of Tier 2 method are proposed to be obtained.

6.3 Source category Manure Management (CRF sector 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 second source of CH_4 and N_2O emissions in the Agriculture sector (in 2004, CH_4 emissions from Manure Management represented 26.56% of total CH_4 emissions while N_2O accounted for 11.07% of total N_2O emissions in the Agriculture sector);
- is the third largest source in the Agriculture sector (in 2004, CH_4 and N_2O emissions from Manure Management as CO_2 equivalent represented 16.87% from Total Agriculture emissions);
- contributed with 2.13% to Total GHG emissions of Romania

Emissions from manure management are declining since 1989 due to the decrease of livestock number.

Table 6.9 Observations on source category 4B – "Manure Management"

Source indicative	Source type	Observation	Data source
Observations on source category 4B – "Manure Management – CH_4 and N_2O emissions"			
4B1	Cattle	Includes livestock data from two different cattle categories: dairy cows and non-dairy cattle.	AD: SY, NIS, 2006; expert judgment; EF: IPCC 1996, IPCC GPG 2000
4B2	Buffalo		AD: SY, NIS, 2006; EF: IPCC 1996, IPCC GPG 2000
4B3	Sheep		
4B4	Goats		AD: SY, NIS, 2006; EF: IPCC 1996, IPCC GPG 2000
4B5	Horses		
4B6	Mules and asses		AD: FAO; EF: IPCC 1996, IPCC GPG 2000
4B7	Swine		AD: SY, NIS, 2006; EF: IPCC 1996, IPCC GPG 2000
4B8	Poultry		
Observations on source category 4B – "Manure Management – N_2O emissions"			
4B9	Anaerobic lagoon		AD: IPCC 1996, IPCC GPG 2000; EF: IPCC 1996, IPCC GPG 2000
4B10	Liquid system		
4B11	Daily spread		
4B12	Solid storage and dry lot		
4B13	Pasture range and paddock		
4B14	Other AWMS		

6.3.2 Methodological issues

CH_4 emissions

Methodology

Despite the fact that CH_4 emissions from Manure Management 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 methane emissions from manure management, the equations 4.15 and 4.13 of IPCC GPG 2000 were used.

Emission factors

The calculation methodology took into account IPCC 1996 default emissions factors for developing countries (Tables 4-5 and 4-6 from Reference Manual together with Table 4-4 from Workbook). They were considered also the following:

- a temperate climate zone;
- Romania belongs to Eastern Europe;
- Romanian conditions are similar to those in developing countries

The emission factors used are presented in Table 6.10:

Table 6.10 Default emission factors used for calculation of methane emissions from Enteric fermentation

Source indicative	Livestock (source) type	Emission Factors [kg CH_4/head/year]
4B1	Cattle – Dairy cows	19
	Cattle – Non-dairy cattle	13
4B2	Buffalo	9
4B3	Sheep	0.16
4B4	Goats	0.17
4B5	Horses	1.64
4B6	Mules and asses	0.9
4B7	Swine	7
4B8	Poultry	0.018

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

Despite the fact that N_2Oemissions from Manure Management is a key category, from trend 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 nitrous oxide emissions from manure management, the equation 4.18 of IPCC GPG 2000 was used.

In respect to IPCC 1996 provisions, N_2O emissions from Daily spread and Pasture range and paddock AWMS are reported under 4D – Agricultural soils (see Chapter 6.5).

Emission factors

The calculation methodology took into account IPCC default emissions factors (Table 4-12 of IPCC GPG 2000 together with Table 4-8 of Workbook). The emission factors used are presented in Table 6.11:

Table 6.11 N_2O emission factors from animal waste per AWMS

Source indicative	AWMS (source) type	Emission factor EF_3 [kg N_2O-N/kg N excreted]
4B9	Anaerobic lagoon	0.001
4B10	Liquid system	0.001
4B11	Daily spread	0
4B12	Solid storage and dry lot	0.02
4B13	Pasture range and paddock	0.02
4B14	Other AWMS	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.

Considering that Romania belongs to Eastern Europe, default values for different parameters were taken into account as follows:

- nitrogen excretion per head of animal per region (Table 4-6 of Workbook together with Table B-1 of Reference Manual; values are presented in Table 6.12);
- percentages of manure N produced in different Animal Waste Management Systems (AWMS; Table 4-21 of Reference Manual; values are presented in Table 6.13);

Table 6.12 Default values for nitrogen excretion per head of animal

Source indicative	Livestock (source) type	Nitrogen excretion [kg N/head/year]
4B1	Cattle – Dairy cows	70
	Cattle – Non-dairy cattle	50
4B2	Buffalo	50
4B3	Sheep	16
4B4	Goats	25
4B5	Horses	25
4B6	Mules and asses	25
4B7	Swine	20
4B8	Poultry	0.6

Table 6.13 Percentages of manure N produced in different AWMS in Eastern Europe

Livestock type	Animal Waste Management Systems [%]					
	Anaerobic lagoon	**Liquid System**	**Daily spread**	**Solid storage and dry lot**	**Pasture range and paddock**	**Other system**
Non dairy cattle (includes buffalo)	8	39	0	52	0	1
Dairy cattle	0	18	1	67	13	0
Poultry	0	28	0	0	1	71
Sheep	0	0	0	0	73	27
Swine	0	29	0	0	27	45
Other animals (includes goats, horses and mules and asses)	0	0	0	0	92	8

6.3.3 Uncertainties and time series consistency

There were not performed a full quantitative assessment of uncertainties, since the NIS has not provided any uncertainty values for livestock population data. The uncertainties associated with the different default values used are:

- CH_4 emission factors specific to all livestock except cattle are estimated to be ± 20% (Table 4.5 of Reference Manual) while there are not specified default emissions factors for cattle;
- N_2O emission factors for animal waste per AWMS (EF_3) are estimated to be in range of -50% - (+100%) except Daily spread system (where uncertainty is not applicable; Table 4.12 of IPCC GPG 2000);
- uncertainties values associated to default values for nitrogen excretion per head of animal per region is ± 50% (according to the provisions in page 4.46 of IPCC GPG 2000);
- there is no uncertainty value associated with percentages of manure N produced in different Animal Waste Management Systems

Due to the fact that all activity data are provided by NIS and the same emission factors and methodologies are used for the whole period, the time series 1989-2004 is consistent.

6.3.4 Source specific QA/QC and verification

Some basic QC activities were made: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain similar results. Livestock populations data were checked against the data reported by FAO and Eurostat; the data are reported at the same level of aggregation and the figures are the same.

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

CH_4 emissions

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

- activity data
  - ✓ all changes done at livestock data level are explained in Chapter 6.2.5
- emission factors
  - ✓ all previously values used were checked for errors; as a result, the specific value for Horses was changed from 1.6 to 1.64 accordingly to the provisions of Table 4.4 of Workbook;
  - ✓ after finding new data on the livestock number of Mules and asses, the default emission factor value begun to be used (0.9 kg CH_4/head/year)

The implications of all recalculations on emissions level are described in Table 6.14:

Table 6.14 Effects of recalculations on CH_4 emission level

Year	Effects of changes on emission estimates		
	NIR 2005 – CH_4 emissions [Gg]	**NIR 2006 - CH_4 emissions [Gg]**	**Difference [%]**
1989	206.80	**211.44**	**2.24**
1990	185.65	**190.20**	**2.45**
1991	173.69	**177.59**	**2.24**
1992	150.15	**153.32**	**2.11**
1993	131.26	**133.94**	**2.05**
1994	125.53	**128.16**	**2.09**
1995	113.03	**115.57**	**2.25**
1996	114.81	**117.36**	**2.23**
1997	115.64	**118.15**	**2.17**
1998	104.22	**106.59**	**2.28**
1999	103.45	**94.81**	**-8.35**
2000	92.57	**84.45**	**-8.78**
2001	82.33	**80.81**	**-1.85**
2002	78.75	**86.52**	**9.87**
2003	84.40	**87.48**	**3.65**
2004		**95.50**	

N_2O emissions

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

- activity data
  - ✓ changes done at livestock data level, due mainly to the improvement of data quality, are explained in Chapter 6.2.5;
  - ✓ in the previously calculation of Nitrogen excretion per AWMS the number of animals was wrongly considered as thousands heads instead of heads;
  - ✓ in the previously calculation of Nitrogen excretion per AWMS fraction of manure nitrogen per AWMS was wrongly considered as percentage instead of fraction;

- ✓ due to the incorrect use of some percentage of manure N produced in different AWMS values in the previously calculation of Nitrogen excretion per AWMS, those values have been replaced as follows:
  - value specific to Swine and Liquid systems: from 28 to 29%;
  - value specific to Dairy cows and Pasture, Range and Paddock: from 14 to 13

The implications of all recalculations on emissions level are described in Table 6.15:

Table 6.15 Effects of recalculations on N_2O emission level

Year	Effects of changes on emission estimates		
	NIR 2005 – N_2O emissions [Gg]	**NIR 2006 - N_2O emissions [Gg]**	**Difference [%]**
1989	0.96	**9.99**	**941.83**
1990	0.92	**9.54**	**942.91**
1991	0.81	**8.44**	**941.47**
1992	0.68	**7.05**	**940.12**
1993	0.58	**6.02**	**939.75**
1994	0.56	**5.80**	**940.26**
1995	0.53	**5.50**	**941.20**
1996	0.53	**5.55**	**941.00**
1997	0.53	**5.47**	**940.86**
1998	0.49	**5.07**	**941.66**
1999	0.48	**4.72**	**893.00**
2000	0.45	**4.41**	**872.21**
2001	0.42	**4.29**	**913.77**
2002	0.41	**4.46**	**983.71**
2003	0.43	**4.49**	**949.75**
2004		**4.51**	

6.3.6 Source specific planned improvements

In respect to the IPCC GPG 2000 provisions, more detailed data which allow for using of Tier 2 method are proposed to be obtained.

6.4 Source category Rice Cultivation (CRF sector 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 2004, CH_4 emissions from Rice Cultivation represented 0.07% of total CH_4 emissions in the Agriculture sector);
- is the smallest source in the Agriculture sector (in 2004, CH_4 emissions from Rice Cultivation as CO_2 equivalent represented 0.02% from Total Agriculture emissions);
- contributed with 0.003% to Total GHG emissions of Romania

Emissions from rice cultivation are declining since 1989 due to the decrease of rice cultivated area (Figure 6.4).

Figure 6.4 Methane emission trend due to rice cultivation

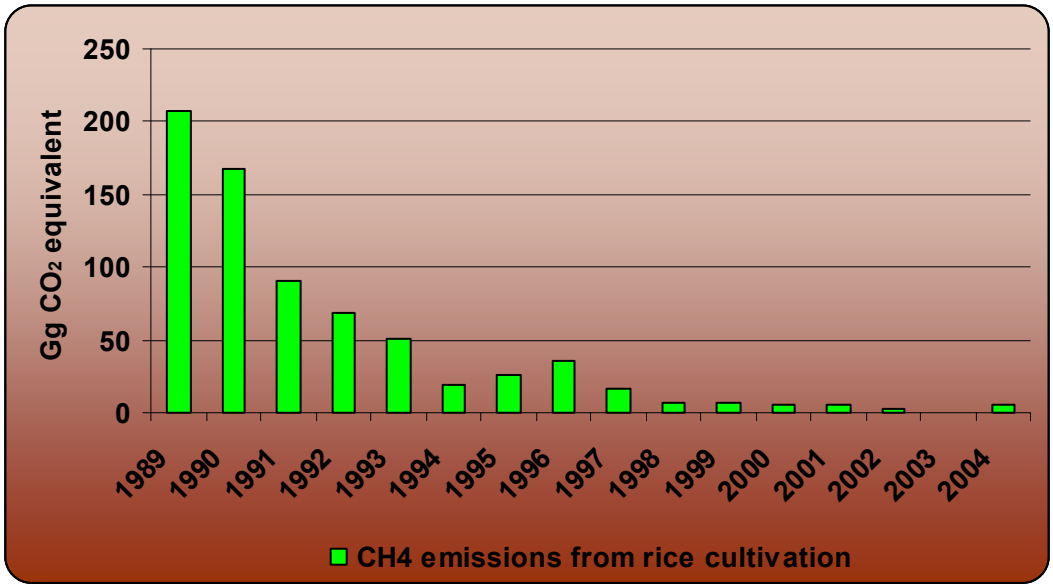


Table 6.16 Observations on source category 4C – "Rice Cultivation"

Source indicative	Source (livestock) type	Observation	Data source
4C1	Rice harvested area		AD: SY, NIS, 2006; EF: IPCC 1996, 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.

Emission factors

The calculation methodology took into account by expert judgment a default IPCC GPG 2000 seasonally integrated emission factor value for continuously flooded fields without organic amendments (20) and also default scaling factors values (1). Therefore, a value of 20 g CH_4/m^2 was considered for adjusted seasonally integrated emission factor for a particular harvested area

Activity data

Total rice cultivated area is provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook (SY 2006).
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 6.17:

Table 6.17 Harvested area data series for 1989-2004 period

Year	Harvested area [10^9 m^2]
1989	0.49
1990	0.40
1991	0.22
1992	0.16
1993	0.12
1994	0.05
1995	0.06
1996	0.09
1997	0.04
1998	0.02
1999	0.02
2000	0.01
2001	0.01
2002	0.01
2003	0.00
2004	0.01

6.4.3 Uncertainties and time series consistency

There were not performed any quantitative assessment of uncertainties, since neither NIS nor IPCC methodology have not provided any uncertainty values for activity data and for default emission factors. Due to the fact that all activity data are provided by NIS and the same emission factors and methodologies are used for the whole period, the time series 1989-2004 is consistent.

6.4.4 Source specific QA/QC and verification

Some basic QC activities were made: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain similar results. Cultivated area data were checked against the data in FAO and Eurostat databases; the data are reported at the same level of aggregation and the figures are the same.

6.4.5 Source specific recalculation, 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

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 sector 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;
  - nitrogen from animal waste;
  - biological nitrogen fixation;
  - reutilized nitrogen from crop residues;
  - 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 induced by grazing animals (Pasture, Range and Paddock Manure);
- indirect emissions take place after nitrogen is lost from the field as NO_x, 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 main source of N_2O emissions in the Agriculture sector (in 2004, N_2O Direct soil emissions represented 47.77% of total N_2O emissions in the Agriculture sector);
- is the first largest source in the Agriculture sector (in 2004, N_2O Direct soil emissions as CO_2 equivalent represented 29.9% from Total Agriculture emissions);
- contributed with 3.77% to Total GHG emissions of Romania

Pasture, Range and Paddock Manure (4D2)

Pasture, Range and Paddock Manure:

- is the third largest source of N_2O emissions in the Agriculture sector (in 2004, N_2O emissions from Pasture, Range and Paddock Manure represented 13.25% of total N_2O emissions in the Agriculture sector);
- is the fifth largest source in the Agriculture sector (in 2004, N_2O emissions from Pasture, Range and Paddock as CO_2 equivalent represented 8.29% from Total Agriculture emissions);
- contributed with 1.05% to Total GHG emissions of Romania

Indirect soil emissions (4D3)

Indirect soil emissions:

- is the second largest source of N_2O emissions in the Agriculture sector (in 2004, N_2O Indirect soil emissions represented 27.57% of total N_2O emissions in the Agriculture sector);
- is the third largest source in the Agriculture sector (in 2004, N_2O Indirect soil emissions as CO_2 equivalent represented 17.26% from Total Agriculture emissions);
- contributed with 2.18% to Total GHG emissions of Romania

Emissions from Agricultural soils are declining since 1989 (Figure 6.5) due to the decrease of the:

- amount of synthetic fertilizer applied;
- livestock populations;
- cultivated areas

Figure 6.5 N_2O emission trends – Agricultural Soils

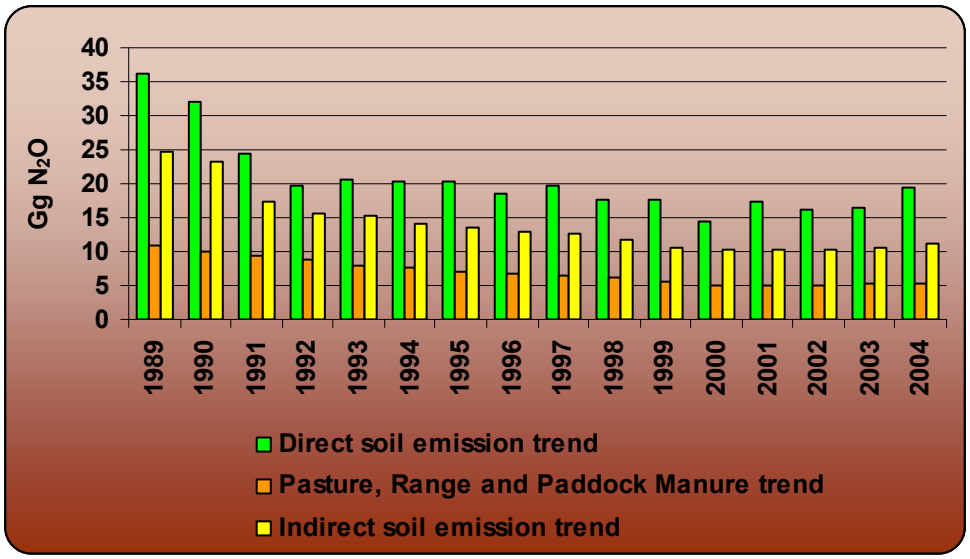


Table 6.18 Observations on source category 4D – "Agricultural Soils"

Source indicative	Source (livestock) type	Observation	Data source
4D1	Amount of N synthetic fertilizer used		AD: SY, NIS, 2006; EF: IPCC 1996, IPCC GPG 2000
4D2-4D9	Animals number by livestock	Includes data on eight different livestock types: cattle (Dairy cows and Non-dairy cattle), buffalo, sheep, goats, horses, mules and asses, swine and poultry	AD: SY, NIS, 2006; expert judgment; EF: IPCC 1996, IPCC GPG 2000
4D10-4D13	Productions of N-fixing crops	Includes data on four types of N-fixing crops: pea beans, bean, other leguminous and soybeans	AD: SY, other correspondence, NIS, 2006; EF: IPCC 1996, IPCC GPG 2000
4D14-4D39	Production of non-N fixing crops	Includes data on 26 types of non-N-fixing crops: wheat and rye, barley and two-row barley, oats, maize grains, sorghum, rice, other grains, potatoes, sugar beet, fodder roots, industrial fiber crops, sunflower, rape, flax for oil, other oilseed crops, other industrial crops, tomatoes, dry onion, dry garlic, cabbage, green peppers, water melons, melons, other vegetables, annual green fodder, perennial green fodder	

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 equation 1 from page 4.92 of IPCC 1996 Reference Manual was used.

By expert judgment, $Frac_{GRAZ}$ values were calculated for every year using the following equation:

Equation 6.1 Calculation of fraction of livestock nitrogen excreted and deposited onto soil during grazing ($Frac_{GRAZ}$)

$$\mathbf{Frac_{GRAZ} = N_{ex(Pasture\ Range\ and\ Paddock)}/N_{ex}}$$

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 1996 default emissions factors (Table 4-18 from Reference Manual):

- ✓ EF_1 = 0.0125 (fraction of N-input, kg N_2O-N/kg N);
- ✓ EF_2 = 5 (value specific to temperate zone; kg N_2O-N/ha/year)

Activity data

Data used for calculation of 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 (SY 2006).
Data series are presented in Table 6.20.

Default IPCC value of $Frac_{GASF}$ used is presented in Table 6.19.

Data used for calculation of 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_{AW})

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 ($Frac_{GRAZ}$) values are presented in Table 6.20.

Fraction of livestock nitrogen excretion contained in excrements burned for fuel ($Frac_{FUEL}$) and
fraction of livestock nitrogen excretion that volatilizes as NH_3 and NO_x ($Frac_{GASM}$) default values are presented in Table 6.19.

Data used for calculation of amount of nitrogen fixed by N-fixing crops cultivated annually (F_{BN})

Productions of pulses and soybeans data are provided by NIS through SY 2006 and are presented in Table 6.20.

According to provisions in IPCC 1996, a default value of 0.85 was used to adjust for default water content in crop productions.

Fraction of nitrogen in N-fixing crop ($Frac_{NCRBF}$) default value used is presented in Table 6.19.

Data used for calculation of amount of nitrogen in crop residues returned to soils annually (F_{CR})

Productions of non-N-fixing crops are provided by NIS through SY 2006 and specific correspondence and are presented in Table 6.20.

According to provisions in IPCC 1996, a default value of 0.85 was used to adjust for default water content in crop productions.

Fraction of nitrogen in non-N-fixing crop ($Frac_{NCR0}$), fraction of crop residue that is removed from the field as crop ($Frac_R$) and fraction of crop residue that is burned rather than left on field ($Frac_{BURN}$) default values used are presented in Table 6.19.

Table 6.19 Default IPCC 1996 values for specific fractions used (described in Table 4-19 of Reference Manual

Specific fraction	Default IPCC 1996 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)	kg N/kg crop-N
$Frac_{R}$	0.45	kg N/kg crop-N
$Frac_{FUEL}$	0	kg N/kg N excreted
$Frac_{GASF}$	0.1	kg NH_3-N + NO_x-N/kg of synthetic fertiliser 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

Due to the fact that data series provided by NIS through SY 2006 and specific correspondence are not fully consistent, we solved the inconsistency issue together with NIS representatives by correspondence, as follows:

- we considered for the whole time series Wheat and rye crop production due to lack of data disaggregated on Wheat and on Rye crop productions for 1989-1998 period;
- for 1989-2003 period we added the amount of Plants used for silage crop to Annual green fodder crop;

- for 1989-1998 period we added to the amounts of Tobacco and of Medicinal and aromatic plants crop productions the amount of Other plants crop production obtaining the value of Other industrial plants;
- for 1989-1998 period we added to the amount of Total vegetables crop production the amounts of Water melons and melons and of Fodder pumpkins crop productions. Therefore, for the same period, Water melons and Melons amounts of crop productions are comprised in Other vegetables

Area of organic soils cultivated

Although we asked for area of organic soils cultivated data we did not receive any specific data. Even they are some areas of organic soils cultivated, they are considered to be of small size; accordingly, the emissions generated are considered to have a small relevance.

Table 6.20 Activity data series used for calculation of direct soil emissions, for 1989-2004 period

Year	Amount of synthetic fertilizer applied to soil [thousands tonnes/year]	Fraction of livestock nitrogen excreted and deposited onto soil during grazing [fraction]	Production of pulses and soybeans [thousands tonnes/year]			
			Pea beans	Beans	Other leguminous	Soya beans
1989	665.3	0.3223	98.50	143.6	13.8	303.9
1990	656.0	0.3231	49.40	57.5	5.2	141.2
1991	275.0	0.3258	32.30	46.0	1.2	178.6
1992	258.0	0.3485	33.20	41.2	0.3	126.2
1993	346.0	0.3524	36.40	48.4	0.4	95.4
1994	313.0	0.3542	38.10	37.4	0.6	100.1
1995	306.0	0.3579	54.30	41.8	0.9	107.9
1996	268.0	0.3481	33.70	42.1	1.2	113.1
1997	262.0	0.3415	27.30	50.2	1.1	121.1
1998	254.0	0.3453	24.40	46.9	1.2	200.8
1999	225.0	0.3437	27.00	47.7	2.1	183.4
2000	239.0	0.3463	14.20	21.8	0.9	69.5
2001	268.0	0.3433	21.70	36.5	3.0	72.7
2002	239.0	0.3408	20.50	33.6	1.2	145.9
2003	252.0	0.3439	23.50	36.7	0.4	224.9
2004	270.0	0.3360	58.00	53.5	0.8	298.5

Table 6.20 Activity data series used for calculation of direct soil emissions, for 1989-2004 period

Year	Production of non-N-fixing crops [thousands tonnes/year]							
	Wheat and rye	Barley and two-row barley	Oats	Maize grains	Sorghum	Rice	Other grains	Potatoes
1989	7,935.2	3,436.3	167.8	6,761.8	7.6	70.1	0.5	4,420.3
1990	7,379.0	2,679.6	234.0	6,809.6	3.5	66.5	1.3	3,185.6
1991	5,558.9	2,950.7	258.2	10,497.3	6.0	31.4	4.1	1,872.8
1992	3,227.6	1,678.0	507.7	6,828.3	4.5	38.9	3.5	2,601.6
1993	5,354.5	1,552.8	553.6	7,987.5	5.5	36.4	2.8	3,708.9
1994	6,186.5	2,133.6	496.8	9,343.2	7.1	15.2	1.4	2,946.7
1995	7,709.3	1,816.3	404.4	9,923.1	4.4	24.1	1.2	3,019.9
1996	3,164.1	1,107.5	290.5	9,607.9	4.3	23.1	2.3	3,591.4
1997	7,185.6	1,889.3	325.4	12,686.7	4.8	10.7	4.8	3,206.4
1998	5,207.9	1,238.0	362.1	8,623.4	11.4	5.1	4.8	3,319.2
1999	4,682.5	1,018.6	389.6	10,934.8	2.5	3.8	5.5	3,957.1
2000	4,456.2	867.0	243.8	4,897.6	1.5	3.6	7.8	3,469.8
2001	7,763.7	1,580.0	382.4	9,119.2	5.6	1.5	18.5	3,997.1
2002	4,441.1	1,160.4	327.4	8,399.8	2.6	0.6	24.6	4,077.6
2003	2,496.5	540.8	323.1	9,577.0	5.0	0.3	21.7	3,947.2
2004	7,867.4	1,406.0	447.1	14,541.6	28.4	5.0	107.5	4,230.2

Table 6.20 Activity data series used for calculation of direct soil emissions, for 1989-2004 period

Year	Production of non-N-fixing crops [thousands tonnes/year]								
	Sugar beet	Fodder roots	Industrial fiber crops (flax for fiber, hemp for fiber)	Sunflower	Rape	Flax for oil	Other oilseed crops	Other industrial crops (tobacco, medicinal and aromatic plant)	Tomatoes
1989	6,771.1	4,094.2	241.1	655.8	18.0	48.9	7.7	90.5	1,011.3
1990	3,277.7	2,575.0	125.3	556.2	10.9	28.0	3.0	42.1	813.6
1991	4,702.7	2,139.3	73.7	612.0	8.8	22.8	1.2	41.1	692.8
1992	2,896.7	1,343.4	64.2	774.0	1.4	17.9	0.8	38.6	831.0
1993	1,776.3	1,465.1	14.6	695.8	1.4	28.0	0.2	29.2	798.9
1994	2,763.8	1,245.3	9.3	763.7	0.3	6.5	3.5	28.2	716.4
1995	2,654.6	1,332.4	13.1	932.9	0.4	4.7	9.5	36.8	730.9
1996	2,848.2	1,301.1	17.1	1,095.6	1.9	4.5	3.6	32.3	689.3
1997	2,725.5	1,247.9	11.5	858.1	11.6	4.8	6.2	36.2	463.3
1998	2,361.4	1,119.5	11.8	1,073.3	28.7	3.0	11.8	47.3	677.5
1999	1,414.9	1,174.6	8.0	1,300.9	108.2	2.8	11.3	30.0	708.6
2000	666.9	800.6	2.3	720.9	76.1	1.0	1.0	18.6	628.7
2001	875.5	1,035.2	3.2	823.5	101.8	2.0	5.5	24.4	651.7
2002	954.6	1,042.5	6.4	1,002.8	35.9	1.8	8.1	28.7	658.8
2003	764.5	985.6	3.9	1,506.4	8.1	1.5	19.5	20.4	818.9
2004	672.7	280.3	3.0	1,557.8	98.7	2.5	37.6	28.5	1,330.1

Table 6.20 Activity data series used for calculation of direct soil emissions, for 1989-2004 period

Year	Production of non-N-fixing crops [thousands tonnes/year]								
	Dry onion	Dry garlic	Cabbage	Green peppers	Water melons	Melons	Other vegetables	Annual green fodder	Perennial green fodder (lucerne, clover)
1989	412.7	46.6	877.3	253.3			1,594.4	15,801.8	18,057.0
1990	225.4	30.6	551.9	182.0			1,247.7	14,403.5	12,963.9
1991	218.5	32.2	616.5	166.8			1,519.6	11,036.2	15,228.6
1992	339.3	43.5	676.2	181.7			1,389.5	7,124.8	10,989.5
1993	344.0	48.9	853.9	176.3			1,770.1	7,001.4	11,758.2
1994	310.9	56.4	711.3	163.2			1,590.5	6,491.3	11,669.4
1995	363.0	69.5	824.4	195.6			1,685.1	6,019.5	12,209.9
1996	305.6	54.1	857.4	186.6			1,841.4	6,014.6	12,088.2
1997	337.0	63.3	761.2	167.4			1,767.4	5,344.1	13,301.2
1998	365.2	72.0	837.8	191.4			1,796.0	4,919.3	12,331.4
1999	401.1	84.5	885.4	212.3	787.9	65.3	1,220.5	5,362.9	13,509.2
2000	296.3	68.3	731.9	174.8	488.0	43.1	950.0	3,317.4	9,212.0
2001	396.5	82.9	819.2	184.8	506.7	43.9	1,162.6	3,725.6	11,535.7
2002	340.8	72.4	821.4	197.4	600.0	51.3	1,231.3	4,382.4	12,469.4
2003	350.4	76.5	1,019.2	249.1	706.3	58.3	1,405.8	4,725.3	12,613.9
2004	332.8	65.9	919.1	237.2	723.2	41.9	1,123.7	1,923.5	6,608.8

Pasture, Range and Paddock Manure emissions

Methodology

Due to the fact that Pasture, Range and Paddock Manure is not a key category neither from level, nor from trend views, a tier 1 method has been applied.
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 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

Despite the fact that Indirect 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 Indirect nitrous oxide soil emissions, the equations 4.30, 4.31 and 4.34 from IPCC GPG 2000 were used.

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 1996 default emissions factors (Table 4-23 from Reference Manual):

- ✓ 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

Default IPCC 1996 value of fraction of fertilizer and manure nitrogen that is lost through leaching and runoff, $Frac_{LEACH}$, used is considered 0.3 (Table 4.24 of Reference Manual).

All other activity data are presented in Direct soil emissions section.

6.5.3 Uncertainties and time series consistency

There were not performed a full quantitative assessment of uncertainties, since neither NIS nor IPCC methodology have not provided all uncertainty values for activity data and emission factors. However,

- uncertainty related to Nitrogen excretion per head of animal ($N_{ex(T)}$), used for calculation of N_2O Pasture, Range and Paddock emissions, is ± 50%;
- uncertainty related to N_2O emission factor for manure management system (EF_3), used for calculation of N_2O Pasture, Range and Paddock emissions, except Daily spread, is – 50% - (+100%);
- uncertainty related to emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces (EF_4) and to emission factor for N_2O emissions from leaching and runoff (EF_5) is ± 50%

Due to the fact that all activity data are provided by NIS and the same emission factors and methodologies are used for the whole period, the time series 1989-2004 is consistent.

6.5.4 Source specific QA/QC and verification

Some basic QC activities were made: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain similar results. Livestock population and crop production data were checked against the data in FAO and Eurostat databases; the data are reported at the same level of aggregation and the figures are the same.

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

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

- activity data
  - ✓ amount of synthetic N fertilizer applied to soil in 1989 has been changed from 666 to 665.3 thousands tonnes;
  - ✓ all changes made at livestock data level are presented in Chapters 6.2.5 and 6.3.5;
  - ✓ for completeness of data series we added to N-fixing plants Other leguminous crop production (obtained by subtraction of Pea beans and Beans from Total leguminous crop production);
  - ✓ for completeness of data series we added to non-N-fixing plants all crop productions in the country;
  - ✓ accordingly to the provisions of IPCC methodology, the fraction of nitrogen in N-fixing crops ($Frac_{NCRBF}$) value was changed from 0.015 to 0.03 kg N/kg of dry biomass;
  - ✓ accordingly to the provisions of IPCC methodology, the fraction of nitrogen in non-N-fixing crops ($Frac_{NCR0}$) value was changed from 0.03 to 0.015 kg N/kg of dry biomass;
  - ✓ all data series specific to fraction of livestock nitrogen excreted and deposited onto soil during grazing ($Frac_{GRAZ}$) have been recalculated as described in Equation 6.1, in respect to the IPCC 1996 provisions

Implications of changes on emission estimates are described in Table 6.21.

Table 6.21 Effects of changes made at activity data level on emission estimates

Year	Effects of changes on emission estimates		
	NIR 2005 – N_2O emissions [Gg]	**NIR 2006 – N_2O emissions [Gg]**	**Difference [%]**
1989	34.61	**71.54**	**106.70**
1990	32.43	**65.37**	**101.56**
1991	20.21	**50.97**	**152.20**
1992	16.50	**44.21**	**167.99**
1993	20.43	**43.75**	**114.13**
1994	20.32	**42.08**	**107.12**
1995	20.82	**40.58**	**94.88**
1996	16.38	**38.23**	**133.33**
1997	19.73	**39.12**	**98.21**
1998	17.00	**35.44**	**108.43**
1999	20.43	**33.73**	**65.08**
2000	14.32	**29.65**	**107.00**
2001	18.70	**32.54**	**74.01**
2002	15.46	**31.73**	**105.25**
2003	14.88	**32.43**	**118.02**
2004		**36.10**	

6.5.6 Source specific planned improvements

In respect to the IPCC GPG 2000 provisions, more detailed data which allow for using of Tier 2 method are proposed to be obtained. Data on area of cultivated organic soils are also proposed to be obtained.

6.6 Source category Prescribed Burning of Savannas (CRF sector 4.E)

Prescribed Burning of Savannas does not occur in Romania.

6.7 Source category Field Burning of Agricultural Residues (CRF sector 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.

Field Burning of Agricultural Residues:

- is the third source both of CH_4 and N_2O emissions in the Agriculture sector (in 2004, CH_4 emissions from Field Burning of Agricultural Residues represented 1.43% of total CH_4 emissions while N_2O emissions represented 0.33% of total N_2O emissions in the Agriculture sector);
- is the fourth source in the Agriculture sector (in 2004, CH_4 and N_2O emissions from Field Burning of Agricultural Residues as CO_2 equivalent represented 0.74% from Total Agriculture emissions);
- contributed with 0.09% to Total GHG emissions of Romania

Emissions from field burning of agricultural residues in 2004 are larger than emissions in 1989. Emissions trend does not describe a linear trajectory, emissions values being directly proportional to crop productions values (Figure 6.6).

Figure 6.6 Cumulative emissions trend - Field Burning of Agricultural Residues

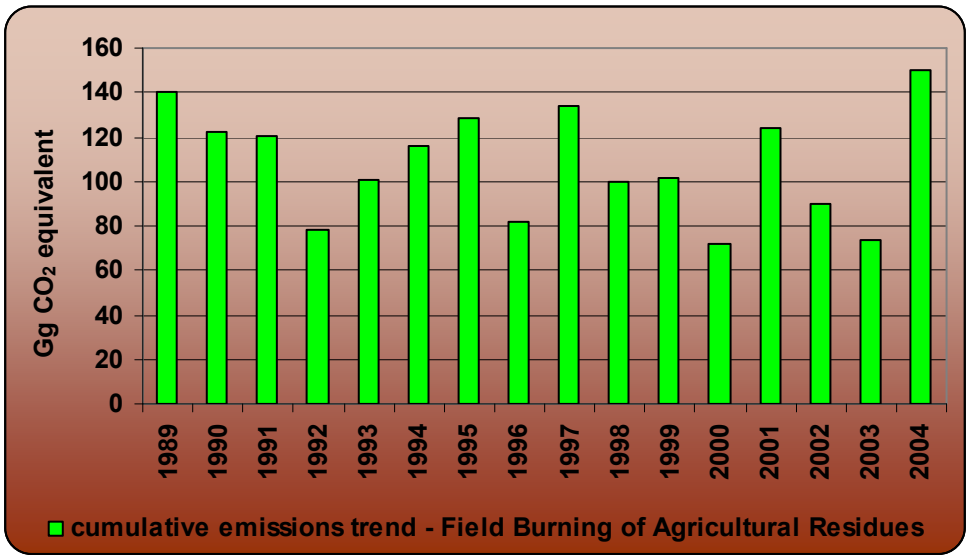


Table 6.22 Observations on source category 4F – "Field Burning of Agricultural Residues"

Source indicative	Source (livestock) type	Observation	Data source
4F1	Crop productions	Includes data on 13 types of crops productions: wheat and rye, barley and two-row barley, oats, maize grains, sorghum, rice, other grains, pea beans, bean, other leguminous, potatoes, sugar beet and soybeans.	AD: SY, other correspondence NIS, 2006; EF: IPCC 1996, IPCC GPG 2000

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.

Emission factors

The calculation methodology took into account IPCC 1996 default emissions ratios (Table 4-16 of Reference Manual). Emission ratios are presented in Table 6.23.

Table 6.23 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 data

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 6.24.

Table 6.24 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]
Wheat and rye	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
Oats	1.3	0.85	0.1	0.9	0.45	0.015
Maize grains	1	0.4	0.1	0.9	0.4709	0.02
Sorghum	1.4	0.85	0.1	0.9	0.45	0.02
Rice	1.4	0.85	0.1	0.9	0.4144	0.014
Other grains	1.3	0.85	0.1	0.9	0.4853	0.012
Pea beans	1.5	0.85	0.1	0.9	0.45	0.015
Bean	2.1	0.85	0.1	0.9	0.45	0.015
Other leguminous	2.1	0.85	0.1	0.9	0.45	0.015
Potatoes	0.4	0.45	0.1	0.9	0.4226	0.015
Sugar beet	0.2	0.15	0.1	0.9	0.4072	0.015
Soybeans	2.1	0.85	0.1	0.9	0.45	0.05

6.7.3 Uncertainties and time series consistency

There were not performed a full quantitative assessment of uncertainties, since the NIS and IPCC methodology have not provided all uncertainty values for activity data and emission factors. However, according to the provisions in page 4.90 of IPCC GPG 2000, the uncertainties related to CH_4 and N_2O emission factors in the dry season are about ± 20%.

Due to the fact that the whole crop productions data series are provided by NIS and the same default parameters, emission factors and methodologies are used for the whole period, the time series 1989-2004 is consistent.

6.7.4 Source specific QA/QC and verification

Some basic QC activities were made: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain similar results. Crop production data were checked against the data in FAO and Eurostat databases; the data are reported at the same level of aggregation and the figures are the same.

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

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

- activity data

  - ✓ for completeness of data series we took into consideration also Rye production, included into Wheat and rye crop production category;
  - ✓ for completeness of data series we added Other grains and Other leguminous crop production (obtained by subtraction of existing crop productions from Total cereal grains, respectively from Total leguminous crop production);
  - ✓ due to incorrect use, specific default values for Dry matter fraction were changed:
    - potatoes: from 0.5 to 0.45;
    - sugar beet: from 0.2 to 0.15;
    - all other crop productions except Maize grains: from 0.8 to 0.85

Implications of changes made at activity data level are presented in Table 6.25.

Table 6.25 Changes made at activity data level and their effects on emission estimates

Year	Effects of changes on emission estimates					
	NIR 2005 - CH_4 emissions [Gg]	**NIR 2006 - CH_4 emissions [Gg]**	**Difference [%]**	NIR 2005 – N_2O emissions [Gg]	**NIR 2006 - N_2O emissions [Gg]**	**Difference [%]**
1989	4.64	**4.86**	**4.78**	0.12	**0.12**	**4.42**
1990	4.09	**4.27**	**4.25**	0.10	**0.10**	**4.00**
1991	3.98	**4.13**	**3.67**	0.10	**0.11**	**3.29**
1992	2.59	**2.68**	**3.25**	0.07	**0.07**	**3.09**
1993	3.38	**3.50**	**3.53**	0.09	**0.09**	**3.27**
1994	3.89	**4.03**	**3.71**	0.10	**0.10**	**3.26**
1995	4.32	**4.49**	**3.88**	0.11	**0.11**	**3.42**
1996	2.72	**2.78**	**2.37**	0.07	**0.08**	**2.14**
1997	4.48	**4.64**	**3.50**	0.12	**0.12**	**2.96**
1998	3.30	**3.41**	**3.38**	0.09	**0.09**	**3.03**
1999	3.36	**3.46**	**2.88**	0.09	**0.09**	**2.49**
2000	2.43	**2.52**	**3.63**	0.06	**0.06**	**3.17**
2001	4.18	**4.34**	**4.00**	0.10	**0.11**	**3.98**
2002	3.00	**3.10**	**3.26**	0.08	**0.08**	**2.79**
2003	2.41	**2.46**	**2.22**	0.07	**0.07**	**2.13**
2004		**5.13**			**0.14**	

6.7.6 Source specific planned improvements

In respect to the IPCC GPG 2000 provisions, country specific values for fractions and emission ratios used in the calculations which allow for tier 2 method use are proposed to be developed.

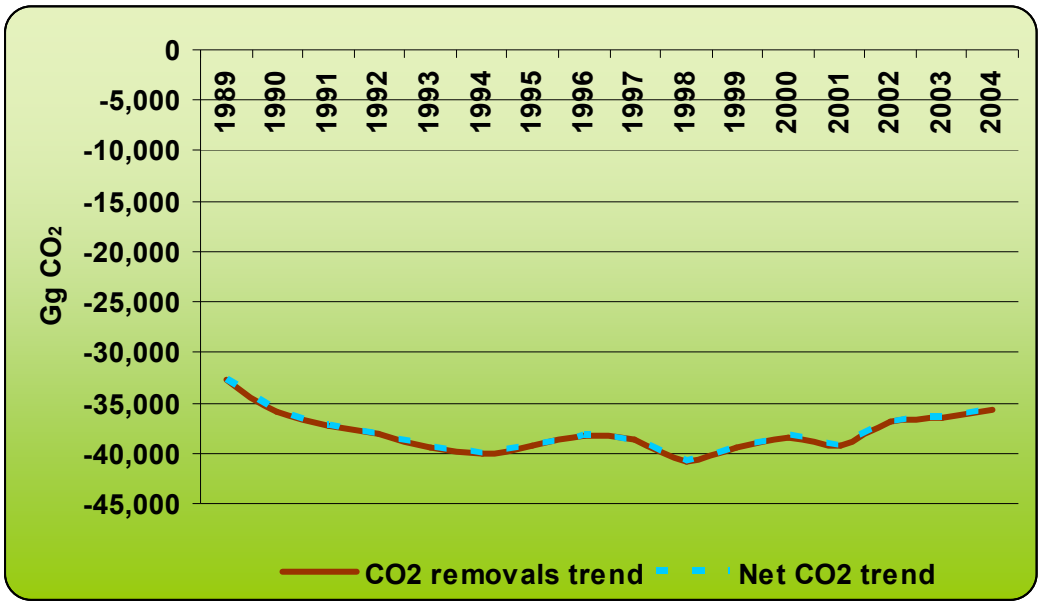
7. LULUCF (CRF SECTOR 5)

7.1 Overview of the sector

The land uses in Romania have been relatively stable over the last 16 years, even strong mutation occurred at political, economic and social levels. Due to various and spatially equilibrated forms of the relief of the Romanian national territory, as well as due to the much diversified climate the land is suitable for a large range of activities and uses.

Over the period 1989 - 2004 there is no significant variations at the removals/emissions levels. Actual submission of the inventory is based on a land use change matrix over the span.

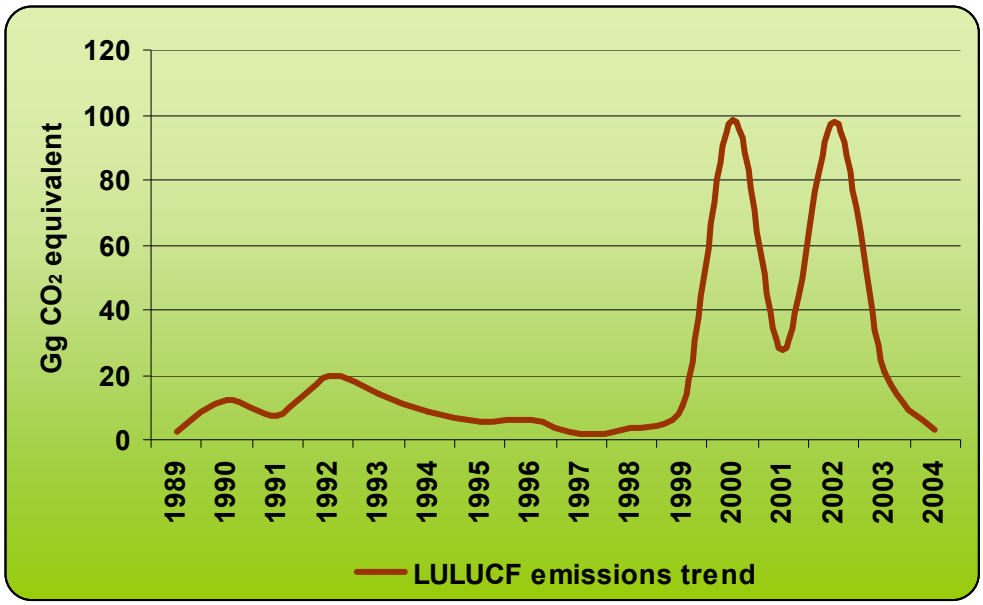
Figure 7.1 CO_2 removal trend and Net CO_2 trend - LULUCF in Romania over the last 16 years



Consequently, Romanian land use sector act as a net sink (Figure 7.1; Table 7.1), at an average uptake of 37,916.87 Gg/year, relatively stable over the last 16 years.

Emissions from LULUCF comprise CO_2, CH_4 and N_2O emissions from biomass burning. Due to the long drought in Romania, during 1999-2003 period, the area affected by wildfires increased and, as a direct consequence, levels of emissions increased (Figure 7.2).

Figure 7.2 LULUCF emissions trend



Due to the decrease trend of emissions from all other sectors, the percentage of net emissions/removals from LULUCF in total GHG emissions increased from 11.56% in 1989 to 22.35 in 2004 (Table 7.1).

Out of the national territory, agricultural land represents some 62%, forests and other wooded lands is 28%, construction and roads/railways is 4%, waters & ponds are 3.7% and other areas some 2%. Agricultural lands comprise arable lands whose areas were relatively stable to 64% over the 1989-2004, pastures and hayfields increased from 32% in 1989 to 33% in 2004. Comparatively, orchards and vineyards areas equally decreased, from 4 to 3%. Land use types strictly follow the national definitions. The estimation of GHG from LULUCF follow the methodology provided in the Good Practice Guidance for Land Use, Land use change and Forestry, IPCC, 2003.

Table 7.1 Levels in emissions and removals on 1989-2004 period

Year	Total GHG emissions [Gg CO_2 equivalent]	Net emissions/ removals from LULUCF [Gg]	Percentage of Net emissions/ removals from LULUCF in Total GHG emissions [%]	CO_2 removals [Gg]	Emissions from biomass burning [Gg CO_2 equivalent]			
					Total	CO_2	CH_4	N_2O
1989	282,467.18	-32,641.18	11.56	-32,643.72	2.54	2.30	0.21	0.02
1990	248,735.03	-35,847.13	14.41	-35,859.24	12.11	11.00	1.01	0.10
1991	196,281.84	-37,319.02	19.01	-37,326.58	7.55	6.86	0.63	0.06
1992	186,494.80	-38,124.28	20.44	-38,144.16	19.88	18.06	1.65	0.17
1993	184,334.42	-39,430.32	21.39	-39,444.45	14.13	12.83	1.18	0.12
1994	179,283.99	-40,033.65	22.33	-40,042.15	8.51	7.73	0.71	0.07
1995	186,955.81	-39,284.46	21.01	-39,290.13	5.67	5.15	0.47	0.05
1996	192,685.40	-38,292.70	19.87	-38,298.89	6.19	5.62	0.52	0.05
1997	172,844.48	-38,688.77	22.38	-38,690.62	1.85	1.68	0.15	0.02
1998	154,125.69	-40,800.87	26.47	-40,804.61	3.74	3.39	0.31	0.03
1999	135,539.84	-39,512.41	29.15	-39,522.74	10.33	9.39	0.86	0.09
2000	138,592.63	-38,288.13	27.63	-38,386.49	98.36	89.34	8.19	0.83
2001	143,000.88	-39,305.20	27.49	-39,333.02	27.81	25.26	2.32	0.23
2002	150,583.16	-36,835.44	24.46	-36,933.34	97.89	88.92	8.15	0.83
2003	157,513.90	-36,466.92	23.15	-36,487.70	20.78	18.87	1.73	0.18
2004	160,059.73	-35,768.14	22.35	-35,771.52	3.38	3.07	0.28	0.03

Information on completeness

Geographical coverage of the country is complete and consistent over time. There is no part of the territory that has not been taken into account in the inventory. For most sources the emission/uptake has been estimated. Sources not estimated or included in different other chapter:

Sinks/sources not reported (NE)		
GHG	**Sink/source category**	**Explanation**
CO_2	Cropland remaining cropland	Biomass data not available at the time of NI preparation
CO_2	Grassland remaining grassland	Biomass data not available at the time of NI preparation
CO_2	Wetland remaining wetlands	Biomass, SOM and DOM data not available at the time of NI preparation
CO_2	Settlements remaining settlements	Biomass data not available at the time of NI preparation
CO_2	Settlements	Biomass change data not available at the time of NI preparation
CO_2	Limestone/dolomite application	Data not available at the time of NI preparation
CO_2	Different conversion from one use to another	Biomass change data not available at the time of NI preparation
N_2O	Forest land, mineral soils	Emissions from N fertilizers may happen on very a small area; Data not available at the time of NI preparation
N_2O	Wetlands, organic and mineral soils	This may happen on very a small area; Data not available at the time of NI preparation
N_2O	Cropland, land use conversion to cropland	This may happen on very a small area; Data not available at the time of NI preparation
Sinks/sources reported elsewhere (IE)		
N_2O	Forest land remaining forest land	Allocation: agriculture There are no statistics on the fertilizers used in the forestry or data collection on this activity does not occur in the forest statistics

7.2. Sink/source category Forest land (CRF sector 5.A)

7.2.1. Sink/Source category description

The forest and woodlands represents some 28% from the national territory, which fits to 0.31 ha per inhabitant in 2004. Structure of forest fund in 2004 is as follows: resinous forests (29.77%), beech forests (32.08%), oaks forests (17.66%), hardwood forests (15.51%) and softwood forest (4.98%). Additionally there is an area of some 556 800 ha of woodlands. According 1985 National Forest Inventory the national forest fund was characterized by: standing wood volume of 1287.8 millions. m^3, an average volume of 227 m^3/ha and an annual average increase of 5.7 m^3/ha/yr. Stands age reflects an uneven distribution of area in the elder classes. Romanian forests grow more than it harvests, with a ratio growth to harvest of some 2. Forest management is done according a decennial management plan elaborated for every single management unit or owner, according circumstances. "Woodlands" (refers to pastoral forests, forest belts, re-growth and invasive trees on abandoned lands, etc) are not mapped and planned, compared to "forest "(refers to national forest fund). After 1990, abandoned lands (orchards, vineyards, pastures, crop fields) occasionally resulted in spontaneous forest regeneration, which is not yet assessed but it would be significant in the land use share and GHG balance.

Forest fire is not a management practice, but it may occur on very occasional and accidental base, affecting only the forest floor (litter, dead organic matter). In the structure of energy consumption pattern, the wood fire represents an important share.

Forestry sector is still in transition process, which consists in continuing of restoration of the properties and crystallization of a new administration system.

Due to lack of specific data, under Forest land only uptakes/emissions related to Forest land remaining Forest land are quantified.

Table 7.2 Observations on sink/source category 5A – "Forest land"

Sink/source indicative	Sink/source type	Observation	Data source
Observations on sink category 5.A – "Forest land" – removals			
5A1	Forest area	Includes data from five forest category species: coniferous, beech, oak, hardwood species and softwood species.	AD: SY, NIS, 2006; National Forest Fund publication, NIS, 2006; expert judgment; EF: IPCC GPG 2003
5A2	Woodland area		AD: SY, NIS, 2006; SSP, 1980; EF: IPCC GPG 2003
Observations on source category 5.A – "Forest land" - emissions			
5A3	Wood harvested volume		AD: SY, NIS, 2006; EF: IPCC GPG 2003
5A4	Wildfires affected area		AD: RNP, 2007 EF: IPCC GPG 2003
5A5	Illegal wood extracted volume		AD: RNP, 2006; EF: IPCC GPG 2003

7.2.2. Methodological issues

Removals and emissions related to Forest land remaining forest land have been calculated following the Equation 3.2.1 and 3.2.2 of IPCC GPG 2003.

According to the provisions in pages 3.34 and 3.35 of IPCC GPG 2003, we assumed by default that the average transfer rates into the dead wood pool and into the litter pool are equal to the transfer rates out of the dead organic pool and out of the litter pool so the net change is zero.

By default, according to the provisions in page 3.41 of IPCC GPG 2003, we assume that when forest remains forest the carbon stock in soil organic matter in mineral soils does not change, so the net change is zero.

Due to lack of available data, we assume by expert judgment that area of drained organic forest soils is zero so carbon dioxide emissions are zero.

Removals (annual increase in carbon stocks due to biomass growth)

Methodology

Due to lack of detailed data needed, the amount of removals from Forest land remaining forest land has been calculated both using tier 2 and tier 1 methods. For calculation of carbon removals, the equations 3.2.4 and 3.2.5 of IPCC GPG 2003 were used.

Increment rates

Different data sources have been used for different parameters took into account for average annual increment rate in total biomass (G_{TOTAL}) calculation:

- average annual net increment in volume suitable for industrial processing (I_V) - Synthesis of National Forest Inventory, ICAS-Forestry Ministry, 1984;
- basic wood density (D) – Studies and research for expansion of wood industry row material base taking into account the structure, the physical-mechanical and technological characteristics of national species, ICPIL Manuscript, 1985;
- biomass expansion factor for conversion of annual net increment (including bark) to aboveground tree biomass increment (BEF_1) – Table 3A.1.10 of IPCC GPG 2003;
- root-to-shoot ratio (R) – Table 3A.1.8 of IPCC GPG 2003

Values of parameters took into account in average annual increment rate in total biomass (G_{TOTAL}) calculation are presented in Table 7.3:

Table 7.3 Values used for average annual increment rate in total biomass (G_{TOTAL}) calculation

Type of species/Parameters	I_V [m^3/ha/year]	D [tonnes d.m./m^3]	BEF_1 [dimensionless]	R [dimensionless]
Coniferous	6.5	0.4	1.15	0.32
Beech	5.4	0.655	1.2	0.24
Oak	4.7	0.645	1.2	0.35
Hardwood species	4.7	0.6	1.2	0.43
Softwood species	7.8	0.41	1.2	0.43

According to SNFI 1984, root-to-shoot ratio values were chosen taking into consideration the following:

- a aboveground biomass density of 50-150 t/ha for coniferous species;
- a aboveground biomass density > 150 t/ha for beech species;
- a aboveground biomass density < 75 t/ha for hardwood and softwood species

Activity data

Forest areas

They were took into consideration both Forest land and Woodlands.
Forest land comprise forest areas in National Forest Fund, managed under strict forestry regime (according to provisions in Forestry Code).
Woodlands refers to pastoral forests, forest belts, re-growth and invasive trees on abandoned lands, etc.
Woodlands areas are not mapped and planned compared to Forest land.

Forest land

Forest land primary data series are provided by NIS through SY 2006 as total value and as disaggregated categories: coniferous, beech, oak and various species.
By expert judgment, taking into consideration the provisions in National Forest Fund publication, NIS, 2006, with data from 2001 to 2005 both on hardwood and softwood species, we completed the 1989-2000 series with specific data on hardwood and softwood species (average values of 0.753428 and of 0.246572 were applied to Total various species area in order to obtain the Hardwood, respectively Softwood species areas; fractions were obtained as arithmetic means of specific values for 2001-2005 period).
Activity data values are presented in Table 7.4.

For determining the area of Forest land remaining forest land a land use change matrix was built, on yearly base, as an expert judgment (land use change matrix takes also into consideration afforested and deforested areas).

In order to obtain the areas of Forest land remaining forest land for each species category, we apply to Total area of Forest land remaining forest land (obtained as a result of the land use change matrix)

different fraction values. Values were anteriorly obtained as contribution of each species on Total forest land (related to primary data from SY 2006).

Woodlands

Woodlands primary data series are provided by NIS through SY 2006 as total value (by subtracting Forest areas from Forest and other forest vegetation lands). Values are presented in Table 7.4.
For determining the area of Woodlands remaining woodlands a land use change matrix was built, on yearly base, as an expert judgment.
Taking into considerations the provisions in Synthesis of sylvo-pastoral plans, 1980, we then split the Woodlands remaining woodlands area into five category species as follows:

- coniferous – 38%;
- beech – 37%;
- oak – 7%;
- hardwood species – 16%;
- softwood species – 2%

Carbon fraction of dry matter (CF)

Default IPCC GPG 2003 value of 0.5 has been used for carbon fraction of dry matter (CF).

Table 7.4 Primary activity data used for calculation of annual increase in carbon stocks due to biomass growth

Year/Parameter	Forest land areas by species [thousands hectares]						Woodlands [thousands hectares]
	Total Forest Fund	Coniferous	Beech	Oak	Hardwood	Softwood	
1989	6,249	1,926	1,893	1,146	967.40	316.60	306.2
1990	6,252	1,929	1,896	1,145	965.89	316.11	433.1
1991	6,253	1,930	1,902	1,142	963.63	315.37	426.7
1992	6,253	1,926	1,906	1,143	962.88	315.12	428.3
1993	6,249	1,916	1,915	1,139	963.63	315.37	431.9
1994	6,246	1,913	1,909	1,144	964.39	315.61	434.4
1995	6,245	1,903	1,925	1,133	967.40	316.60	435.4
1996	6,240	1,890	1,935	1,131	967.40	316.60	450.1
1997	6,236	1,883	1,939	1,129	968.15	316.85	451.9
1998	6,227	1,868	1,942	1,127	971.92	318.08	444.9
1999	6,226	1,861	1,943	1,122	979.46	320.54	564.8
2000	6,223	1,856	1,951	1,120	976.44	319.56	234.2
2001	6,225	1,853	1,956	1,117	979.00	320.00	427.5
2002	6,239	1,856	1,973	1,117	972.00	321.00	424.3
2003	6,221	1,839	1,985	1,109	971.00	317.00	530.3
2004	6,222	1,852	1,996	1,099	965.00	310.00	556.8

Emissions (annual decrease in carbon stocks due to biomass loss)

Methodology

Due to lack of detailed data needed, the amount of emissions from Forest land remaining forest land has been calculated both using tier 2 and tier 1 methods. For calculation of carbon emissions, the equations 3.2.6-3.2.9 and 3.2.19 of IPCC GPG 2003 were used; the equations are presented below:

Equation 7.1 Annual decrease in carbon stocks due to biomass loss

$$\Delta C_{FFL} = L_{fellings} + L_{fuelwood} + L_{other\ losses}$$

where:

$L_{fellings}$ = annual carbon loss due to commercial fellings [tonnes C/year];

$L_{fuelwood}$ = annual carbon loss due to fuelwood gathering [tonnes C/year];

$L_{other\ losses}$ = annual other losses of carbon [tonnes C/year]

Equation 7.2 Annual carbon loss due to commercial fellings

$$\mathbf{L_{fellings} = H \times D \times BEF_2 \times (1 - f_{BL}) \times CF \times BEF_{Root}}$$

where:

H = annually extracted volume, roundwood [m^3/year];

BEF_2 = biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass (including bark), [dimensionless];

f_{BL} = fraction of biomass left to decay in forest, [fraction]

BEF_{Root} = biomass expansion factor used to quantify for root volume remained in soil after logging [dimensionless]

We included in commercial fellings category the amount of wood removed illegally from forest.
It is considered by default that all wood removed from forest represents an immediate emission.

$$L_{fellings\ woodland} = \sum_i A_{woodland} \times D \times CF \times RR_{woodland}$$

where:

$L_{fellings\ woodland}$ = annual carbon loss due to fellings from woodlands [tonnes C/year];

$A_{woodland}$ = woodland area by species [ha];

$RR_{woodland}$ = wood removal rate in woodland [cubic meters/year];

i = type of woodland area [coniferous, beech, oak, hardwood species and softwood species]

CO_2 emission [Gg/year] = (carbon released) [t/year] x (44/12) /1000

Equation 7.3 Annual carbon loss due to fuelwood gathering

$$\mathbf{L_{fuelwood} = FG \times D \times BEF_2 \times CF}$$

where:

FG = annual volume of fuelwood gathering [m^3/year]

Because the NIS wood harvest data could not be disaggregated into commercial fellings and fuelwood, all annual losses from volume of fuelwood gathered are presented in the commercial fellings section.

Equation 7.4 Annual other losses of carbon

$$\mathbf{L_{other\ losses} = A_{disturbance} \times B_W \times (1-f_{BL}) \times CF}$$

where:

$A_{disturbance}$ = forest areas affected by disturbances [ha/year];

B_W = average biomass stock of forest areas [tonnes d.m./ha]

Because we took into consideration as disturbance only wildfires and we assume by expert judgment that in wildfires only the forest floor (dead organic matter and litter) is affected, we took into account the following:

$$\mathbf{L_{other\ losses} = A_{wildfires} \times 6.755}$$

where:

$A_{wildfires}$ = area of forest affected by wildfires [ha/year];

6.755 = amount of C in the forest floor [tC/ha]

CO_2 emissions [Gg/year] = (carbon released) [t/year] x (44/12) /1000

CH_4 emissions [Gg/year] = (carbon released) [t/year] x (emission ratio) x (16/12) /1000

CO emissions [Gg/year] = (carbon released) [t/year] x (emission ratio) x (28/12) /1000

N_2O emissions [Gg/year] = (carbon released) [t/year] x (N/C ratio) x (emission ratio) x (44/28) /1000

NO_x emissions [Gg] = (carbon released) x [N/C ratio] x (emission ratio) x (46/14) /1000

where:

N/C ratio = nitrogen/carbon ratio of fuel burnt [fraction]

Emission ratios

Default IPCC GPG 2003 emission ratios values have been used for calculation of amounts of direct and indirect GHG released by wildfires into the atmosphere. According to the provisions in Table 3A.1.15 of IPCC GPG 2003, default values related to released gases are:

- CH_4 – 0.012;
- CO – 0.06;
- N_2O – 0.007;
- NO_x – 0.121

Activity data

Activity data related to emission of CO_2 into the atmosphere due to commercial fellings

Legal commercial felling

The amounts of wood removed from forests due to legal commercial fellings are provided by NIS through SY 2006 and are presented in Table 7.5.

Densities values (D) used are presented in Table 7.3.

According to provisions in page 3.27 of IPCC GPG 2003, default values to be used with carbon fraction of dry matter (CF) is 0.5.

By expert judgment, according to discussions with NIS and forestry experts, all bark and branches volume, is included in the annually extracted volume provided by NIS (the bark and branches volume is estimated also before wood leaves the forest as part of legally procedures). Therefore, biomass expansion factor value (BEF_2) equals zero.

By expert judgment, according to provisions in specific dendro-metrical studies, in order to have a full closed balance of carbon related to living biomass in forests, we accounted to root volume remaining in

forest soils after logging by applying a biomass expansion factor value, as follows:

- coniferous: 1.16;
- beech: 1.18;
- oak: 1.16;
- hardwood species: 1.14;
- softwood species: 1.1

According to the provisions in page 3.27 of IPCC GPG 2003, if changes in dead organic matter are not being explicitly accounted, fraction of biomass left to decay (f_{BL}) should be set to zero.

According to the provisions in Synthesis of sylvo-pastoral plans, 1980, wood removal rates values used for woodlands are as follows:

- coniferous: 8 [cubic meters/year];
- beech: 5 [cubic meters/year];
- oak: 10 [cubic meters/year];
- hardwood: 3 [cubic meters/year];
- softwood: 4 [cubic meters/year]

Illegal cutting

The amounts of wood illegally cut and removed from forests are provided by RNP and are presented in Table 7.5.

By expert judgment, we consider that the wood removed belongs equally to all categories of species (coniferous, beech, oak, hardwood species and softwood species). Therefore we used an average wood density of 0.542 (tonnes d.m./m^3; calculated as arithmetic mean of densities specific to categories of species).

By expert judgment, we use a value of 1.148 (obtained as arithmetic mean of values related to categories of species) for biomass expansion factor for account to root volume remained in forest soils.

All other values took into account correspond to the provisions in Legal commercial felling chapter.

Activity data related to emission of direct and indirect GHG into the atmosphere due to wildfires

Annually forest affected areas by wildfires are provided by RNP and are presented in Table 7.5.

By expert judgment, according to Assessment of the carbon stock in the forest soils in the monitoring network level I and II progress scientific report, ICAS, 2004, an average amount of carbon in the forest floor (corresponding to dead organic matter and litter which are affected by wildfires) of 6.755 tC/ha was taken into account.
According to the provisions in page 3.50 of IPCC GPG 2003, a default value of 0.01 was considered for nitrogen-carbon ratio.

Table 7.5 Activity data used for GHG emissions calculation

Year/Type of activity data	Legally harvested wood [thousands cubic meters/year]					Illegal logging volume [th. c.m./year]	Wildfire affected areas [ha]
	Coniferous	Beech	Oak	Hardwood species	Softwood species		
1989	6,516	6,636	1,842	2,268	2,004	83.1680	93
1990	5,813	4,958	2,045	2,071	1,762	120.7680	444
1991	4,956	4,644	1,919	2,089	1,769	186.6172	277
1992	4,418	4,629	1,739	2,109	1,524	281.5178	729
1993	4,564	4,073	1,629	1,872	1,452	157.7159	518
1994	4,285	4,037	1,651	1,741	1,228	145.8188	312
1995	4,973	4,215	1,551	1,774	1,300	122.1831	208
1996	5,751	4,266	1,658	1,876	1,252	128.7116	227
1997	5,836	4,263	1,489	1,757	1,164	136.6576	68
1998	5,195	3,635	1,276	1,491	1,045	122.2967	137
1999	5,564	4,115	1,358	1,588	1,093	130.3549	379
2000	5,346	4,509	1,333	1,731	1,366	142.8996	3,607
2001	4,915	4,260	1,288	1,673	1,274	141.0910	1,020
2002	7,166	4,439	1,495	1,805	1,478	101.9970	3,590
2003	7,139	4,748	1,532	1,823	1,450	80.8530	762
2004	6,357	5,412	1,694	2,030	1,589	70.4790	124

7.2.3. Uncertainties and time-series consistency

There were not performed a full quantitative assessment of uncertainties, since neither NIS nor RNP have not provided any uncertainty values for activity data.
According to provisions in page 3.50 of IPCC GPG 2003, emission ratios related to calculation of direct and indirect GHG from biomass burning have an associated uncertainty of 70%.
Due to the fact that all activity data are provided by NIS and RNP and the same emission factors and methodologies are used for the whole period, the time series 1989-2004 is consistent.

Main uncertainties are related to input data related to forest growth as far as there is no a recent National Forest Inventory. This is a factor that heavily limits the increase of the accuracy and certainties of estimation related to forestry sector. Another factor that limits the accuracy is limited access to some data (disaggregated illegal wood drainage volume by species, disaggregated wildfires affected areas by species). There is poor data available and consequently large uncertainties relates to the woodlands.

7.2.4. Source-specific QA/QC and verification

Some basic QC activities were made: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain similar results.
Results in different projects have been used to validate the input parameters in the GHG Inventory (ie: basic wood density measured for several species in some projects confirmed the values used in the estimation for the purpose of the inventory).

7.2.5. Source-specific recalculations, including changes made in response to the review process

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

- methodology
  - ✓ according to the provisions in IPCC GPG 2003, a land use change matrix was built based on NIS data on land uses; land use changes were made on expert judgment since no official statistics exist;

- ✓ according to the provisions of IPCC GPG 2003, biomass expansion factor for conversion of annual net increment (including bark) to aboveground tree biomass increment (BEF_1) begun to be used;
- ✓ in order to have a full closed carbon balance related to living biomass in forests, a new biomass expansion factor to account for volume of root remained in soils after logging begun to be used;

- activity data
  - ✓ errors in land use areas values have been corrected;
  - ✓ whole data series in hardwood and softwood areas have been revised taking into account new data from NIS;
  - ✓ in order to use representative national values, the values for average annual net increment in volume suitable for industrial processing (I_V) have been replaced as follows:
    - coniferous: from 8.1 to 6.5 [cubic meters/ha/year];
    - beech: from 4.1 to 5.4 [cubic meters/ha/year];
    - oak: from 3.6 to 4.7 [cubic meters/ha/year];
    - hardwood species: from 3.9 to 4.7 [cubic meters/ha/year];
    - softwood species: from 9.5 to 7.8 [cubic meters/ha/year]
  - ✓ in order to use representative national values for root-to-shoot ratios (R), according to provisions of Synthesis of National Forestry Inventory, 1984, some of specific values have been replaced as follows:
    - coniferous: from 0.46 to 0.32;
    - beech: from 0.26 to 0.24;
    - hardwood species: from 0.2 to 0.43;
    - softwood species: from 0.2 to 0.43
  - ✓ we took into account for the first time illegal logging data;
  - ✓ some errors in data series related to areas affected by wildfires have been corrected;
  - ✓ the value of nitrogen-carbon ratio used for calculation of emissions from biomass burning have been changed from 0.02 to 0.01, default IPCC GPG 2003 value

All the changes made at activity data level and their implications on emission estimates are described in Table 7.6.

Table 7.6 Implications of changes made in removals/emissions level for LULUCF

Year /Parameter	Removals/emissions level [Gg CO2 equivalent]		
	NIR 2005	NIR 2006	Difference
1989	-15,713.23	-32,641.18	**107.73**
1990	-16,993.12	-35,847.13	**110.95**
1991	-18,105.98	-37,319.02	**106.11**
1992	-18,854.07	-38,124.28	**102.21**
1993	-19,769.51	-39,430.32	**99.45**
1994	-20,263.51	-40,033.65	**97.57**
1995	-19,581.61	-39,284.46	**100.62**
1996	-18,737.61	-38,292.70	**104.36**
1997	-19,026.58	-38,688.77	**103.34**
1998	-20,732.65	-40,800.87	**96.80**
1999	-19,756.81	-39,512.41	**99.99**
2000	-18,837.07	-38,288.13	**103.26**
2001	-19,818.91	-39,305.20	**98.32**
2002	-17,460.43	-36,835.44	**110.97**
2003	-16,880.22	-36,466.92	**116.03**
2004		-35,768.14	

7.2.6. Source-specific planned improvements

In respect to the IPCC GPG 2003 provisions, more detailed data which allow for using of Tier 2 method are proposed to be obtained.

7.3. & 7.4. & 7.5. & 7.6. & 7.7 Cropland (CRF sector 5.B), Grassland (CRF sector 5.C), Wetlands (CRF sector 5.D), Settlements (CRF sector 5.E), Other land (CRF sector 5.F)

7.3.1 & 7.4.1 & 7.5.1 & 7.6.1 & 7.7.1 Description

Compared to previous submission actual submission is based upon a complete land use and land use change matrix over the entire span of reporting.

7.3.2& 7.4.2 & 7.5.2 & 7.6.2 & 7.7.2 Methodological issues

There is not improving since last year. There have not been available national data on crop biomass, particularly for some type of crops (perennial: vineyards, orchards).

7.3.3 & 7.4.3 & 7.5.3 & 7.6.3 & 7.7.3 Uncertainties and time-series consistency

Data reported relay on statistics on agricultural lands in the National Institute of Statistics and provided in annual reports. There is no computed the emissions /uptake as there is no available data on cropland and grassland biomass change.

7.3.4 & 7.4.4 & 7.5.4 & 7.6.4 & 7.7.4 Source-specific QA/QC and verification

The values used in land use change matrix have been checked for errors.

7.3.5 & 7.4.5 & 7.5.5 & 7.6.5 & 7.7.5 Source-specific recalculations, including changes made in response to the review process

The actual reporting consistently represents the agricultural land and its breakdown over the 1989-2004, as based on recently developed land use change matrix.

7.3.6 & 7.4.6 & 7.5.6 & 7.6.6 & 7.7.6 Source-specific planned improvements

In respect to the IPCC GPG 2003 provisions, more detailed data which allow for uptakes/emissions calculation are proposed to be obtained.

8. WASTE (CRF SECTOR 6)

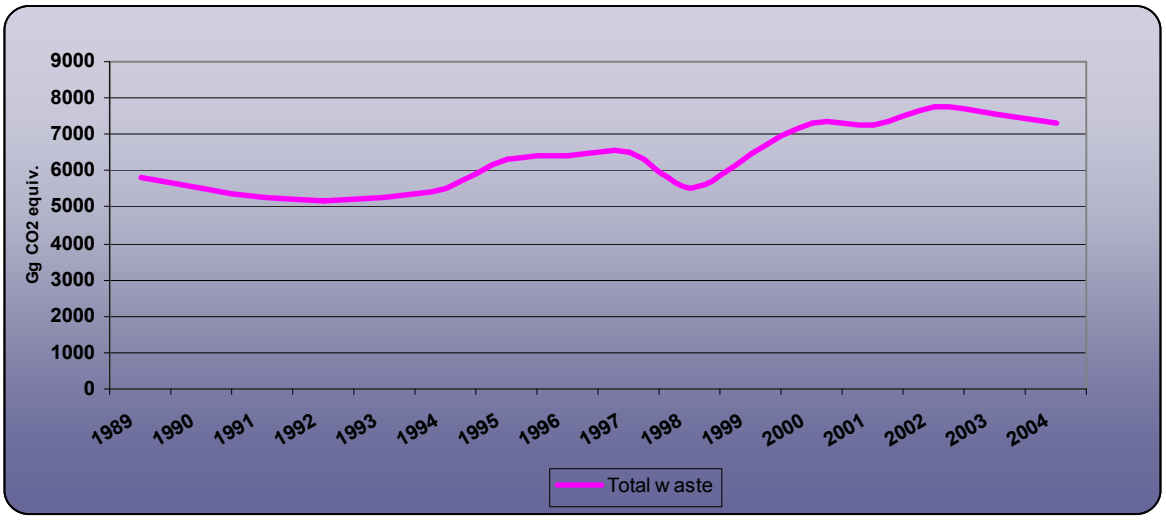
8.1 Overview of the sector

This chapter provides information on the estimation of the greenhouse gas emissions from the Waste sector.

The following source categories are quantified and reported:

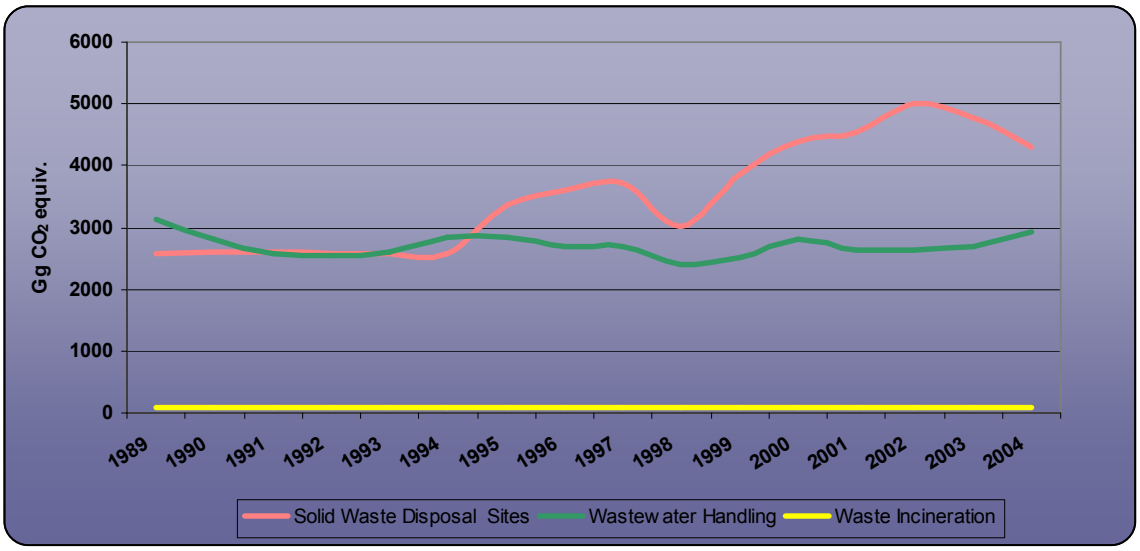
- CH_4 emissions from Solid Waste Disposal Sites
- CH_4 and N_2O emissions from Wastewater Handling
- CO_2 emissions from Waste Incineration

Figure 8.1 Total GHG emissions trend in Waste for 1989–2004 period



Over the period 1989–2004, the GHG emissions resulted from waste sector increased by 25.89% due to population consumption growth.

Figure 8.2 GHG emissions trends in Waste, by sub-sectors, for 1989–2004 period



This sector includes emissions from landfills (6.A), wastewater handling (6.B) and waste incineration (6.C). In 2004 emissions from waste sector accounted for 7.306 Tg CO_2 equivalent, which represent 4.6% of the total GHG emissions. Solid waste disposal on land (Landfills) is the main category within the waste sector, accounting for 58.90% of the sector's total emissions. Wastewater handling and waste incineration account for approximately 40.02% and 1.08% respectively. In this sector, the most important emissions of greenhouse gases are those of CH_4 from solid waste landfills and CH_4 from wastewater handling.

Table 8.1 Contribution of Waste sector in total GHG emissions, in 1989–2004 period

Year	Total GHG emissions [Gg CO_2 equivalent]	GHG emissions from Waste [Gg CO_2 equivalent]	Contribution of Waste in total GHG emissions [%]	CH_4 emissions from Waste [Gg CO_2 equivalent]	Contribution of CH_4 emissions in total GHG emissions from Waste [%]	N_2O emissions from Waste [Gg CO_2 equivalent]	Contribution of N_2O emissions in total GHG emissions from Waste [%]	CO_2 emissions from Waste [Gg]	Contribution of CO_2 emissions in total GHG emissions from Waste [%]
1989	282467.18	5803.64	2.05	5033.64	86.73	684.99	11.80	85.02	1.46
1990	248735.03	5517.25	2.22	4745.62	86.01	686.62	12.44	85.02	1.54
1991	196281.84	5268.82	2.68	4497.82	85.37	685.98	13.02	85.02	1.61
1992	186494.80	5194.43	2.79	4435.16	85.38	674.26	12.98	85.01	1.64
1993	184334.42	5272.94	2.86	4514.66	85.62	673.26	12.77	85.02	1.61
1994	179283.99	5506.45	3.07	4748.91	86.24	672.53	12.21	85.00	1.54
1995	186955.81	6304.30	3.37	5546.20	87.97	671.06	10.64	87.04	1.38
1996	192685.40	6395.20	3.32	5639.38	88.18	668.89	10.46	86.92	1.36
1997	172844.48	6506.80	3.76	5752.40	88.41	667.07	10.25	87.34	1.34
1998	154125.69	5511.79	3.58	4758.18	86.33	665.79	12.08	87.81	1.59
1999	135539.84	6462.82	4.77	5710.09	88.35	664.47	10.28	88.27	1.37
2000	138592.63	7296.04	5.26	6540.64	89.65	663.79	9.10	91.61	1.26
2001	143000.88	7258.32	5.08	6498.85	89.54	663.00	9.13	96.48	1.33
2002	150583.16	7732.53	5.14	6997.64	90.50	644.84	8.34	90.05	1.16
2003	157513.90	7574.24	4.81	6829.06	90.16	643.03	8.49	102.14	1.35
2004	160059.73	7306.02	4.56	6586.15	90.15	641.25	8.78	78.62	1.08

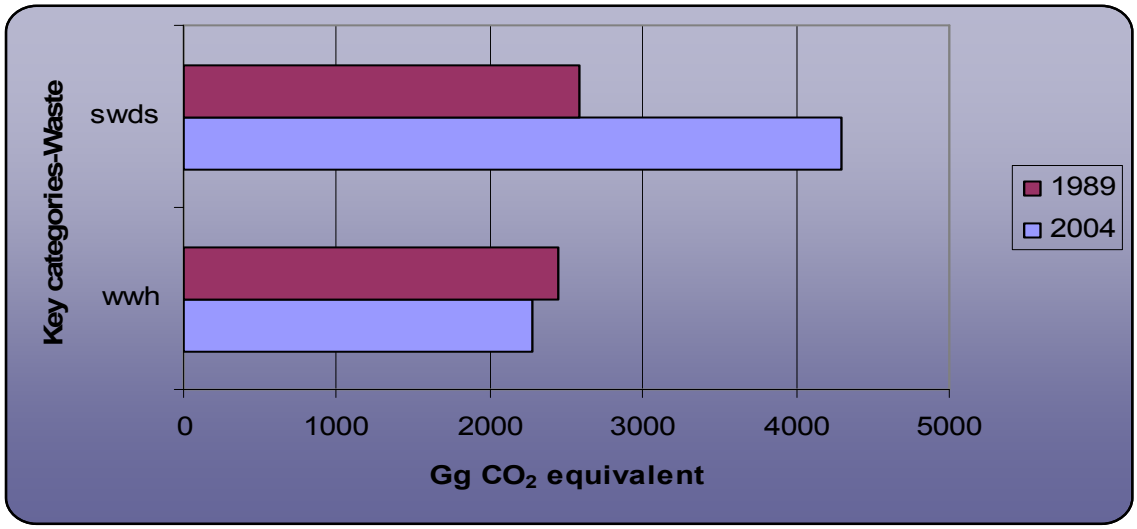
Table 8.2 and Figure 8.3 describe Key categories in Waste, both from level and trend view.

Table 8.2 Key categories overview – Waste, 2004

Key categories (both level and trend)	GHG	Contribution of Key categories in total GHG emissions [%]
6A Solid waste disposal sites	CH_4	2.7
6B Wastewater handling	CH_4	1.4

Figure 8.3 Key Categories in Waste Sector

(6.A Solid waste disposal sites, 6.B Wastewater handling)



All improvements made, comparative to the previous submission, are described in the Sub-sector recalculation chapter and also in the Chapter 10.

8.2 Source category Solid Waste Disposal on Land (CRF sector 6.A)

8.2.1 Source category description

Anaerobic decomposition of organic matter by methanogenic bacteria in Solid Waste Disposal Sites results in the release of CH_4 to the atmosphere. Municipal Solid Waste typically contains significant quantities of degradable organic matter.

The main option of waste disposal in Romania is storage method. From the total generated urban wastes, approximately 95% are annually stored. Most of the urban waste landfill is mixed (60%), which allow both urban wastes and industrial wastes for storage, usually non-hazardous. About 30% of urban landfills are simple domestic landfills, which allow for storage only waste resulted from domestic activities.

Approximately 80% of deposits are situated on relatively small areas (between 0.5 and 5 hectares), the remaining 20% are large urban deposits and lie on areas between 5 to 20 hectares.

The landfills are classified as managed and unmanaged.

From 265 urban waste deposits:

-14 managed waste landfills have free storage capacity which are in accordance with the most part of Directive 99/31 previsions.

-251 unmanaged waste landfills (11 sites have been closed in 2003, 139 sites will be closed until 2009 and 101 sites will be closed until 2017).

The percentage of domestic wastes selective collection is very low and large amounts of recyclable materials (paper, cardboard, glass, plastics, metals) are not recovered, but are finally stored with the other municipal wastes.

Figure 8.4 CH_4 emissions trends from waste disposed to managed sites, for 1995–2004 period

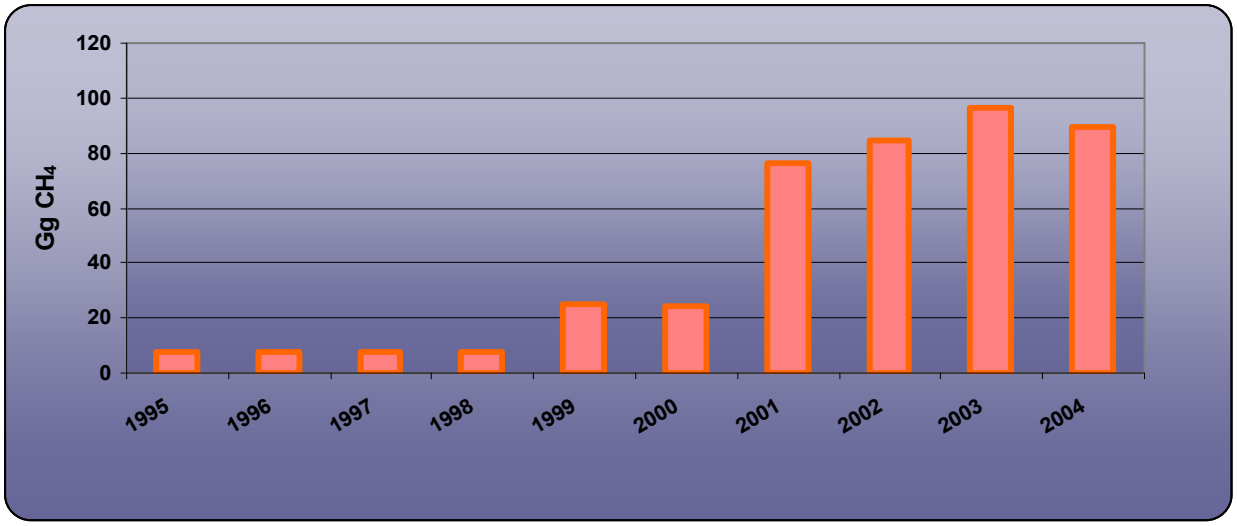
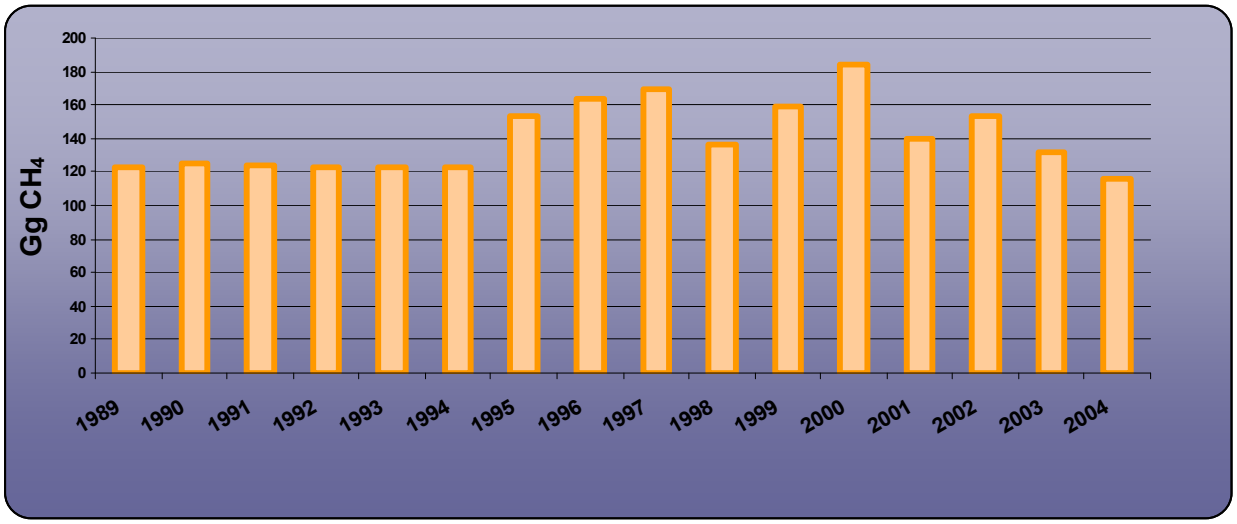


Figure 8.5 CH_4 emissions trends from waste disposed to unmanaged sites, for 1989–2004 period



8.2.2 Methodological issues

Methodology

Despite the fact that Solid Waste Disposal Sites is a key category, both from level and trend views, tier 2 method could not be applied, due to the fact that there are no sufficient historical time series to make an estimation of the collected waste. Therefore, a tier 1 method has been applied. Methane emissions from SWDS were calculated, according to the equation 5.3 from page 5.7 of IPCC GPG 2000.

Emission factors

Table 8.3 Parameters used to calculated emission factors (SWDS)

Type of site	Methane Correction Factor (IPCC 1996 Table 6-2)	Fraction of DOC which actually decrease including C (IPCC GPG 2000)	Fraction of carbon release as methane (IPCC 1996)
Managed	1	0.55	0.5
Unmanaged-deep	0.8	0.55	0.5
Unmanaged-shallow	0.4	0.55	0.5

The fraction of degradable organic carbon in MSW was calculated, according to the equation 5.4 from page 5.9 of IPCC GPG 2000, and using the percentage composition of domestic waste.

The percentage composition of domestic waste data for 2003-2004 period were provided by the Waste Directorate of NEPA. Data for 1989-2002 period were obtained using backward trend extrapolation, by expert judgment.

Table 8.4 The percentage composition of domestic waste (source: NEPA)

Year	Paper and textiles A	Garden, park waste and other non-food organic putrescibles B	Food waste C	Wood and straw D	Fraction of DOC in MSW
1989	12.63	14.62	39.51	1	0.14
1990	12.63	14.62	39.51	1	0.14
1991	12.63	14.62	39.51	1	0.14
1992	12.63	14.62	39.51	1	0.14
1993	12.63	14.62	39.51	1	0.14
1994	12.63	14.62	39.51	1	0.14
1995	12.63	14.63	39.51	1	0.14
1996	12.63	14.62	39.50	1	0.14
1997	12.64	14.64	39.52	1	0.14
1998	12.62	14.59	39.49	1	0.14
1999	12.66	14.69	39.55	1	0.14
2000	12.57	14.49	39.42	1	0.14
2001	12.75	14.89	39.68	1	0.14
2002	12.39	14.10	39.16	1	0.14
2003	13.11	15.67	40.20	1	0.14
2004	11.67	12.53	38.12	1	0.13

Activity data

The Waste Directorate of National Environment Protection Agency, which is responsible for statistical inquires on waste, provided the following information necessary for emission estimates.

- Amounts of Municipal Solid Waste (MSW) disposed to SWDS from 1998 to 2004
- Amounts of MSW that goes to managed SWDS from 1995 to 2004

- Other relevant information to support the estimates

For 1989-1997 period where no information were available, the amount of MSW was estimated based on waste generation rates: 0.8 kg/capita/day for urban areas and 0.3 kg/capita/day in rural area (parameters provided by the National Institute for Statistics), for 1995-1997 period waste generation rates data was provided by NEPA.

Table 8.5 Waste generation rate (source: NEPA)

Year	Waste generation rate in urban areas	Waste generation rate in rural areas
	Kg/capita/day	
1995	1.1	0.3
1996	1.2	0.3
1997	1.25	0.3

It was estimated that about 85% from the entire amount of wastes generated is collected, so the value used for fraction of MSW disposed to SWDSs is 0.85. In our country, almost the whole quantity of municipal wastes collected is eliminated by storage.

Amounts of MSW were calculated according to IPCC 1996, Workbook- Worksheet 6-1B.

According to the data sources used (National Institute for Statistics, Ministry of Environment and Water Management) there is no methane recovery from the unmanaged sites. The methane recovered from the managed sites is considered to be negligible.

The Amounts of MSW disposed to managed sites became available starting with 1995 and used for CH_4 emissions estimate. The emissions are reported under 6.A.1 Managed waste disposal on land; from 1989 to 1994 the emissions are reported as NA.

The Amounts of MSW disposed available for 1998 to 2004 were used for estimate the emissions reported under 6.A.2 unmanaged after subtracting the amounts disposed to managed sites. The amounts of waste disposed to Unmanaged Sites were divided in half for deep and shallow categories without having actual ratio (data were not provided).

Table 8.6 Amount of MSW disposed to Solid Disposal on Land (source: NEPA)

Year	Amount of waste disposed to managed sites [Gg]	Amount of waste disposed to unmanaged deep sites [Gg]	Amount of waste disposed to unmanaged shallow sites [Gg]
1989	NA	2032.35	2032.35
1990	NA	2057.96	2057.96
1991	NA	2052.57	2052.57
1992	NA	2019.78	2019.78
1993	NA	2021.23	2021.23
1994	NA	2021.74	2021.74
1995	150	2526.45	2526.45
1996	150	2709.86	2709.86
1997	150	2802.29	2802.29
1998	150	2247.59	2247.59
1999	490	2618.36	2618.36
2000	490	3060.49	3060.49
2001	1500	2289.50	2289.50
2002	1705	2579.83	2579.83
2003	1841	2099.61	2099.61
2004	1900	2050.60	2050.60

8.2.3 Uncertainties and time series consistency

Uncertainties are not estimated.

Due to the fact that all activity data are provided by NEPA and the same emission factors and methodologies are used for the whole period, the time series 1989-2004 is consistent.

8.2.4 Source specific QA/QC and verification

Some basic QC activities were made: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain

similar results.

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

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

- Specific data on waste were used when available (from 1995 to 2004)
- Separate emission estimates for managed and unmanaged sites (since 1995)
- Fraction of DOC in MSW and waste generation rate were updated due to new data provided by the Waste Directorate of National Environmental Protection Agency.

In the previous submission, the Fraction of DOC in MSW was calculated using the following percentage composition of domestic waste:

Table 8.7 Per cent composition of domestic waste (2005 submission)

Paper and textiles	16.46%
Garden and park waste, and other (non-food) organic putrescibles	8.42%
Food waste	50.48%
Wood and straw waste	6.35%

Table 8.8 Effects of recalculations for CH_4 emissions from SWDS

Solid Waste Disposal on Land	2005 submission	2006 submission	Difference
	CO_2 eq [Gg]		[%]
1989	3325.77	2584.73	-22.28
1990	3325.77	2617.28	-21.30
1991	3317.16	2610.46	-21.30
1992	3264.03	2568.70	-21.30
1993	3266.55	2570.67	-21.30
1994	3267.39	2571.06	-21.31
1995	3267.39	3372.55	3.22
1996	3256.05	3604.37	10.70
1997	3250.59	3724.91	14.59
1998	3240.09	3014.18	-6.97
1999	3231.06	3857.60	19.39
2000	3222.03	4392.63	36.33
2001	3219.93	4540.25	41.00
2002	3094.35	5000.41	61.60
2003	3088.68	4780.54	54.78
2004		4303.33	

8.2.6 Source specific planned improvement

In respect to the IPCC GPG 2000 provisions, will try to obtain more detailed data (amounts of MSW disposed to unmanaged deep and shallow sites) which allow for using of Tier 2 method.

8.3 Source category Wastewater Handling (CRF sector 6.B)

8.3.1 Source category description

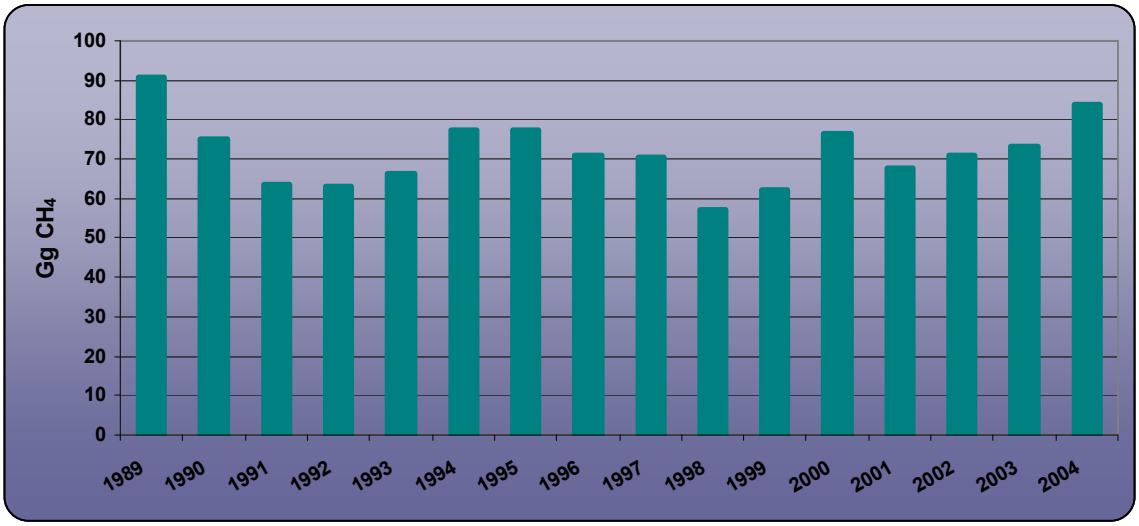
This sector includes methane emissions from domestic/industrial wastewater handling and nitrous oxide emissions from human sewage.

Methane and nitrous oxide are produced from anaerobic decomposition of organic matter by bacteria in sewage facilities, from food processing and other industrial facilities during wastewater handling. N_2O may also be released from wastewater handling and human waste.

The second biggest CH_4 source of emissions in the waste sector is wastewater handling; these emissions are key sources, both from level and trend views.

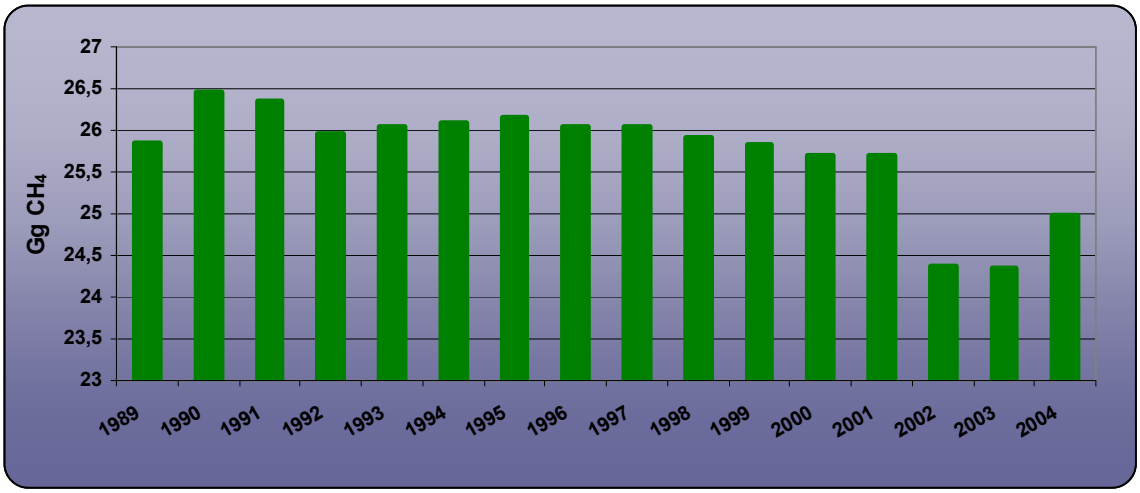
N_2O emissions from wastewater handling are not key source.

Figure 8.6 CH_4 emissions trends from industrial wastewater handling, for 1989–2004 period



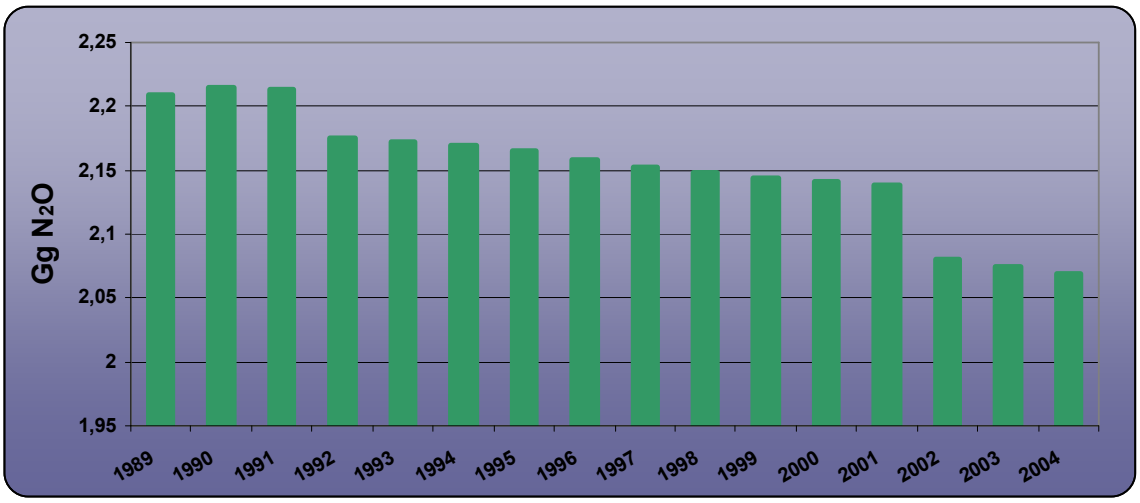
The CH_4 emission fluctuations are caused by the variation of the main industrial products in 1989-2004 period (see table 8.10).

Figure 8.7 CH_4 emissions trends from domestic/commercial wastewater, for 1989–2004 period



CH_4 emissions trend in 1989-2004 period are directly influenced by the fluctuation urban population (see table 8.13).

Figure 8.8 N_2O emissions trends from human sewage, for 1989–2004 period



N2O emissions trend in 1989-2004 period are directly influenced by the fluctuation total population (see table 8.15).

8.3.2 Methodological issues

Industrial wastewater handling

CH_4 emissions from industrial wastewater and sludge (CRF 6.B.1)

Methodology

Default method is used for calculating CH_4 emissions from industrial wastewater according to the IPCC 1966 -Reference Manual. Using Tier 1 method for CH_4 emissions from wastewater handling (key sources) does not correspond to the good practice requirements. The reasons for that is the absence of enough reliable data on the required parameters and methodology for their definition and use.

For methane emissions from industrial wastewater calculation, the equations 8, 10 and 12 of IPCC 1996 Reference Manual (Waste Chapter) were used.

Emissions factor

Table 8.9 Parameters used to calculate Emission Factor (industrial wastewater)

Fraction of Wastewater treated by the Handling System	**Methane conversion Factor for the Handling System**	**Maximum Methane Producing Capacity [kg CH_4/kg COD]**
Source: the national values	Source: IPCC 1996	Source: IPCC 1996
0.46 for anaerobic treatment and 0.54 for aerobic treatment	1 for anaerobic treatment and 0 for aerobic treatment	0.25

Activity data

Table 8.10 Production of the main industrial products (source: SY)

Year	Beer	Wine	Oil &Grease	Paper	Pulp	Petroleum Refining
	Unit [t/yr]					
1989	1151300	463200	295964	552000	574000	30615000
1990	1052700	470500	298711	427000	380000	23664000
1991	980300	500800	262493	307000	235000	15191000
1992	1001400	573900	216000	262000	171000	13299000
1993	992900	654900	213000	248000	159000	13191000
1994	904600	842500	194000	262000	163000	14744000
1995	876800	735100	224000	332000	235000	15259000
1996	811800	670900	236000	327000	203000	13426000
1997	765100	731400	246000	306000	154000	12429000
1998	998900	507100	173000	281000	129000	12520000
1999	1113300	566100	245000	276000	144000	9894000
2000	1266400	545300	253000	328000	359000	10532000
2001	1208700	509000	285000	384000	215000	10948000
2002	1160200	525200	218000	416000	243000	11906000
2003	1329200	545700	243000	457000	212000	10736000
2004	1440600	707100	258000	492000	187000	12371000

Table 8.11 Parameters used to estimate total organic industrial wastewater
(source: IPCC 1996, Reference-table 6-6)

Default Parameters	Industry type					
	Beer	Wine	Oil & Grease	Paper	Pulp	Petroleum Refining
Degradable Organic Component [kg COD/m^3ww]	17	40	0.3	5	8.5	0.3
Wastewater Produced [m^3/tonne product]	5	13	1.6	58	58	0.808
Fraction of DOC removed as sludge	0	0	0	0	0	0

CH_4 emissions from industrial sludge

CH_4 emissions from industrial sludge are reported NE because there are no data available. Data for the fraction of degradable organic component removed as sludge are unavailable ,so default value 0 has been used according to the IPCC methodology.

Domestic and commercial wastewater handling

CH_4 emissions from domestic and commercial wastewater and sludge (CRF 6.B.2)

Methodology

The method is similar to the one used for calculating methane emissions from industrial wastewater.
For calculation of methane emissions from domestic and commercial wastewater, the equations 6, 10 and 12 of IPCC 1996, Reference Manual (Waste Chapter) were used.

Emissions factor

Table 8.12 Parameters used to calculate emission factor (domestic/commercial wastewater)

Fraction of Wastewater treated by the Handling System	**Methane conversion Factor for the Handling System**	**Maximum Methane Producing Capacity [kg CH_4/kg BOD]**
Source: the national values	Source: IPCC 1996	Source: IPCC 1996
0.46 for anaerobic treatment and 0.54 for aerobic treatment	1 for anaerobic treatment and 0 for aerobic treatment	0.25

Activity data

Parameters used to estimate total domestic/commercial organic wastewater are:
DOC [kg BOD/1000 persons/y] = 18.250 kg BOD/1000 persons/yr; default value for Europe region has been used (source: IPCC 1996, Workbook table 6-5).
Fraction of degradable organic component removed as sludge = default value 0 has been used (source: IPCC 1996).

The National Institute for Statistics through the Statistical Yearbooks provided data about the number of urban population.

Table 8.13 Urban population

Year	Urban Population [Unit 1000 persons]
1989	12311.80
1990	12608.84
1991	12552.40
1992	12367.35
1993	12406.20
1994	12427.61
1995	12457.20
1996	12411.17
1997	12404.69
1998	12347.89
1999	12302.73
2000	12244.60
2001	12243.75
2002	11608.74
2003	11600.16
2004	11895.60

Methane from domestic/commercial wastewater recovered and/or flared are reported NE because there are no data available.

CH_4 emissions from domestic and commercial sludge

CH_4 emissions from domestic and commercial sludge are reported NE because there are no data available.

Nitrous Oxide emissions from Human Sewage (CRF 6.B.2)

Methodology

The IPCC default methodology only includes N_2O emissions from human sewage based on annual per capita protein intake.
For calculation of nitrous oxide emissions from human sewage, the equation 15 from page 6.28 of IPCC 1996 was used.

Emissions factor

Table 8.14 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

The National Institute for Statistics through the Statistical Yearbooks provided data about the number of total population.

Table8.15 Total population

Year	Total Population [Unit 1000 persons]
1989	23151.56
1990	23206.72
1991	23185.08
1992	22788.96
1993	22755.26
1994	22730.62
1995	22680.95
1996	22607.62
1997	22545.92
1998	22502.80
1999	22458.02
2000	22435.21
2001	22408.39
2002	21794.79
2003	21733.56
2004	21673.33

For Protein [annual per capita protein intake] have been used 37.96 kg/person/yr using the data from the Food and Agriculture Organization of the United Nations (FAO).

8.3.3 Uncertainties and time series consistency

Uncertainties are not estimated.

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

Some basic QC activities were made: checking for transcription errors in data input, checking whether the parameters and emission units were correctly recorded, comparing the time series, in order to obtain similar results.

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

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

- Emissions from industrial wastewater were recalculated for the whole time series using COD values for pulp and paper were considered as arithmetic mean of specific ranges: 2.0-15 for generic pulp and 2.0-8.0 for generic paper. In previous submission the arithmetic mean for Western Europe (paper) was used, but Romania belongs to Eastern Europe and these values are more appropriate.

Table 8.16 Effects of recalculations for CH_4 emissions from industrial wastewater handling

Year	2005 submission	2006 submission	Difference
	CO_2 eq [Gg]		[%]
1989	1151.72	1906.28	65.52
1990	1047.22	1572.62	50.17
1991	991.17	1334.13	34.60
1992	1055.60	1321.39	25.18
1993	1148.23	1397.20	21.68
1994	1371.62	1630.12	18.85
1995	1262.23	1624.62	28.71
1996	1157.91	1488.00	28.51
1997	1211.97	1480.77	22.18
1998	964.25	1199.78	24.43
1999	1063.18	1310.26	23.24
2000	1143.66	1608.35	40.63
2001	1061.86	1418.97	33.63
2002	1089.54	1485.59	36.35
2003	1152.06	1537.17	33.43
2004		1758.45	

- Emissions from human sewage were recalculated for the whole time series using data reported to FAO on protein consumption.
- Previously data on protein consumption used was lower than data reported to FAO and the N_2O emissions from human sewage were underestimated for the whole time series. For this submission, the N_2O emissions have been recalculated using the FAO data on protein consumption: 104 g/person/day.

Table 8.17 Effects of recalculations for N_2O emissions from human sewage

Year	2005 submission	2006 submission	Difference
	CO_2 eq [Gg]		[%]
1989	337.90	684.99	102.72
1990	337.90	686.62	103.20
1991	337.90	685.98	103.01
1992	331.70	674.26	103.27
1993	331.70	673.26	102.97
1994	331.70	672.53	102.75
1995	331.70	671.06	102.31
1996	331.70	668.89	101.66
1997	328.60	667.07	103.00
1998	328.60	665.79	102.61
1999	328.60	664.47	102.21
2000	328.60	663.79	102.01
2001	328.60	663.00	101.76
2002	319.30	644.84	101.96
2003	316.20	643.03	103.36
2004		641.25	

8.3.6 Source specific planned improvement

To improve the accuracy of the estimates, will try to obtain more detailed data.

8.4 Source category Waste Incineration (CRF sector 6.C)

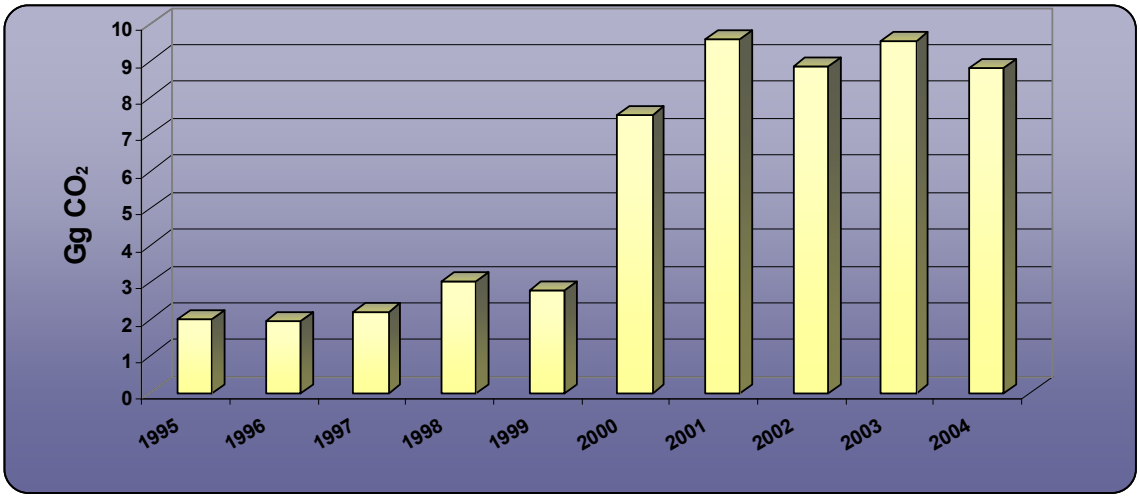
8.4.1 Source category description

Waste incineration like other types of combustion, is a source of CO_2 emissions.

Incineration is not a usual practice for municipal waste treatment/disposal in Romania. Although in the last period the weight of the combustible components have raised, the calorific power of municipal waste is still low, making inefficient the incineration process with energy recovery. Incinerated biogenic waste are reported NE.

Waste incineration includes emissions resulted from the incineration of clinical waste and hazardous waste. CO_2 emissions from waste incineration are not key source.

Figure 8.9 CO $_2$ emissions trends from clinical waste incineration, for 1995–2004 period



8.4.2 Methodological issues

Carbon dioxide emissions from the incineration of clinical waste and hazardous waste (non- biogenic waste)

Methodology

For calculation of carbon dioxide emissions from waste incineration, the equation 5.11 from page 5.25 of IPCC GPG 2000 was used.

Emissions factor

Table 8.18 Default data for estimation of CO_2 from waste incineration
(source: IPCC GPG 2000. table 5-6)

	Clinical Waste	Hazardous Waste
C content of Waste	60%	50%
Fossil Carbon as % of Total Carbon	40%	90%
Efficiency of Combustion	95%	99%

Activity data

There are no available data before 1995 and the amounts of medical waste are reported NE in the period 1989-1994.
The CO_2 emissions were estimated only for the period 1995 to 2004.

The source of data:

- National Plan for Waste Management: information regarding the generated and incinerated amounts of clinical wastes for the period 1995 to 1999. Based on these data. approximately 60% of the generated wastes is incinerated
- Public Health Institute –provided the data on amounts of clinical waste generate. The incinerated amounts were established by multiplying these amounts by 0.6

Table 8.19 Amounts of clinical waste

year	Amount of clinical waste generated	Amount of clinical waste incinerated
	Unit [Gg/yr]	
1995	3.97	2.38
1996	4.05	2.43
1997	4.96	2.98
1998	6.47	3.88
1999	7.16	4.30
2000	15.03	9.02
2001	19.06	11.44
2002	17.60	10.56
2003	18.98	11.39
2004	17.55	10.53

Hazardous waste is generated by industrial sector. Data regarding the amounts of incinerated hazardous waste were provided only for 2003-2004 period. The amounts were estimated using backward trend extrapolation for 1989-2002 period.

8.4.3 Uncertainties and time series consistency

Uncertainties are not estimated.

The time series is not consistent; data on incinerated clinical waste are available since 1995 and data about incinerated hazardous waste are available only two years 2003-2004.

8.4.4 Source specific QA/QC and verification

The input data were checked, in order to avoid the input errors.

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

The CO_2 emissions from this source category were included for the first time in the inventory.

Table 8.20 Effects of recalculations for CO_2 emissions from waste incineration

Year	2005 submission	2006 submission	Difference
	CO_2 [Gg]		[%]
1989	NE	85.02	100
1990	NE	85.02	100
1991	NE	85.02	100
1992	NE	85.01	100
1993	NE	85.02	100
1994	NE	85.00	100
1995	NE	87.04	100
1996	NE	86.92	100
1997	NE	87.34	100
1998	NE	87.81	100
1999	NE	88.27	100
2000	NE	91.61	100
2001	NE	96.48	100
2002	NE	90.05	100
2003	NE	102.14	100
2004		78.62	

8.4.6 Source specific planned improvement

In order to improve the estimation accuracy, more detailed data will be requested for the whole time series.

9. OTHER (CRF SECTOR 7)

At present, they are no greenhouse gas emissions that are calculated and could not be allocated to one of the source categories.

10. RECALCULATIONS AND IMPROVEMENTS

This chapter quantifies the changes in emissions/removals of GHG compared to the previous submission (2005). Since the last submission, recalculations have been performed for almost all sectors. The recalculation have been carried out to account for better activity data and emission factors and to correct for some errors in the calculations. The recalculations made since the previous inventory submission are also described in the sector sections.

10.1 Explanations and justifications of the recalculations

10.1.1 Recalculations in the 2006 report year, by source categories

The inventory contains improvements in the following sectors:

Energy:

- ✓ Reallocation of fuels between liquid, solid and gaseous fuel categories (1.AA);
- ✓ Recalculation of CO2 emissions from solid fuels (especially coke oven gas and blast furnace gas) in the sectoral approach (1.AA.1, 1.AA.2, 1.AA.4.A);
- ✓ Transport – pipeline has been added in the inventory, since the AD became available (1.AA.3.E)

Industrial Processes:

- ✓ Changes in activity data for the cement production subsector, because one cement producing company provided a modified activity data set from 1995 to 2003, as an error occurred in the data set provided last year. (2.A.1);
- ✓ Changes in activity data for the lime production subsector, because the surrogate method used in previous submission (when dolomite lime was correlated to quicklime production) has been replaced with a linear extrapolation, considered to be more relevant. Recalculations were performed for 1989-1991 and 2003 . For the years 1992 and 2002 the recalculations were made due to wrong manipulation of data.(2.A.2);
- ✓ Changes in activity data for the limestone and dolomite consumption subsector, because the surrogate method, used in previous submission to estimate AD for the missing years,has been replaced with a method with estimates the amount of limestone and dolomite used to produce a tonne of pig iron,for all the time series.(2.A.3);
- ✓ Changes in activity data for the nitric acid production**,** because the previous national statistic data on nitric acid have been replaced with data obtained directly from the producers. The recalculations have been performed for the entire time series.(2.B.2);

- ✓ Changes in activity data for the iron and steel production subsector, because previously estimates based on national statistics data have been replaced with estimates based on activity data collected at plant level. Emissions have been recalculated for the entire time series.(2.C.1);
- ✓ Changes in method for ferroalloys production subsector, because the ferroalloys emissions considered to be included under Iron and Steel production in previous submission are now reported under the appropriate IPCC category.(2.C.2);
- ✓ Changes in aluminium production subsector, because previously emissions estimated based on national statistics have been replaced with estimates based on activity data provided directly by the plant and considering changes in technologies over the period.(2.C.3);
- ✓ The recalculations in other production subsector were made due to wrong manipulation of data.(2.D);
- ✓ The recalculations in the Consumption of Halocarbons and SF6 subsector were made due to reconsidered the activity data set submitted last year. (2.F)

Agriculture:

- ✓ Changing livestock data series due to errors and to new data found (4.A);
- ✓ Changing livestock data series due to errors and to new data found (4.B);
- ✓ Small changes at applied emission factors level (4.B);
- ✓ Significant changes at fraction of manure nitrogen per AWMS values (4.B);
- ✓ Significant changes due to incorrect use of percentage of manure N produced in different AWMS (4.B);
- ✓ Correction of errors at amount of nitrogen fertilizer applied data series (4.D);
- ✓ Changing livestock data series due to errors and to new data found (4.D);
- ✓ Completing the N-fixing and non-N-fixing plants data series (4.D);
- ✓ Changes at specific applied fractions values level (4.D);
- ✓ Recalculation of fraction of livestock nitrogen excreted and deposited onto soil during grazing data series (4.D);
- ✓ Completing data series with Rye, Other grains and Other leguminous productions (4.F);
- ✓ Correction of error at dry matter applied values level (4.F)

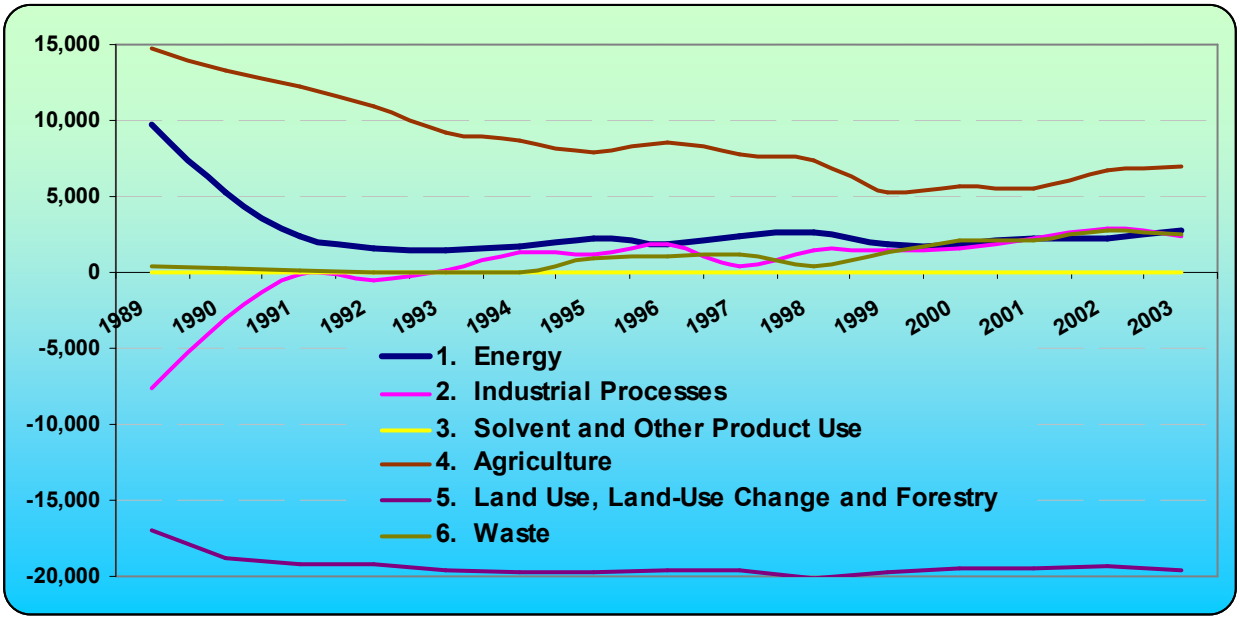
Land use, land use change and forestry:

- ✓ Building a land use change matrix (5.A);
- ✓ Beginning of use of biomass expansion factor for conversion of annual net increment to aboveground tree biomass increment (BEF_1) and of a biomass expansion factor to account for the volume of roots remaining in forests soils after logging (BEF_{root}), (5A);
- ✓ Revising and correction of activity data series (5.A);
- ✓ Changing the values related to average annual net increment in volume suitable for industrial processing (I_V) and related to root-to-shoot ratios (R) due to incorrect use (5.A);
- ✓ Taking into consideration illegal logging data (5.A);
- ✓ Correction of errors in wildfires affected areas series (5.A);
- ✓ Changing of specific value of nitrogen-carbon ratio due to incorrect use (5.A)

Waste:

- ✓ Change in the fraction of DOC for MSW (6.A.1; 6.A.2);
- ✓ Changes in activity data for the amounts of MSW, based on new facility data (6.A.1; 6.A.2);
- ✓ Use of new values for waste generation rate in 1995-1997 period (6.A.1; 6.A.2);
- ✓ Change in pulp and paper COD value for industrial wastewater (6.B.1);
- ✓ Use of specific data to FAO on protein consumption for human sewage (6.B.2);
- ✓ Beginning of calculation for emissions from waste incineration (6.C)

Figure 10.1 Source category total emissions change, for all gases, and for whole time series, in comparison to the figures in 2005 report



10.1.2 Recalculations in the 2006 report year, by gases

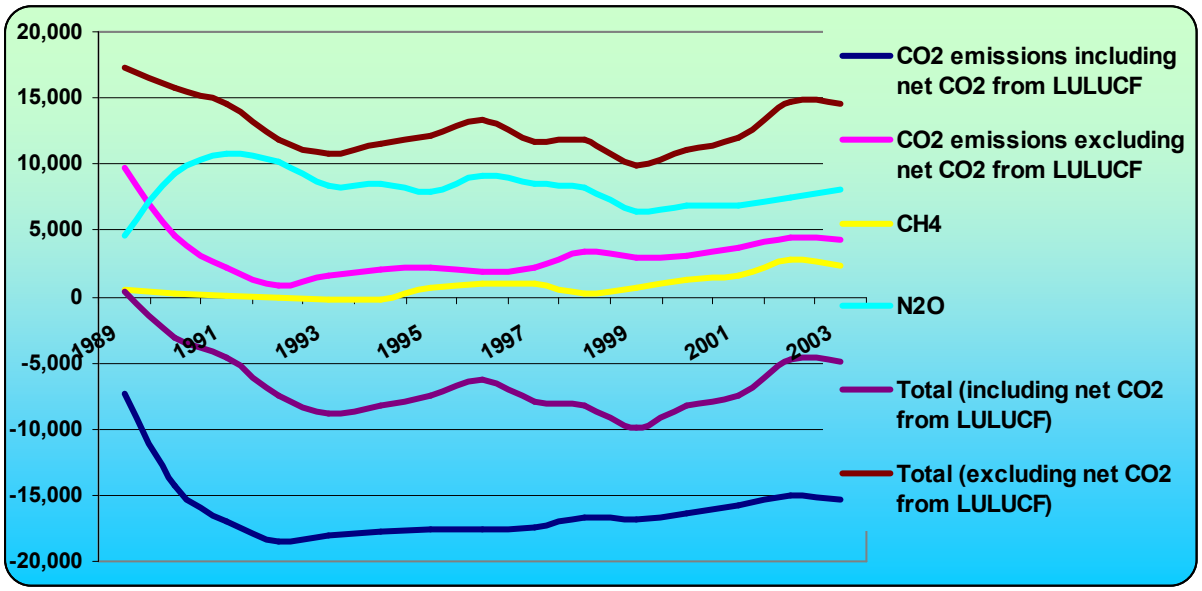
CO_2 recalculations were carried out in the following sectors:

- ✓ for the solid fuel categories (for coke oven gas and blast furnace gas in the sectoral calculations), in: Energy industries (1.AA.1), Manufacturing industries and constructions (1.AA.2) and Other sectors, in the commercial/institutional category (1.AA.4.A);
- ✓ cement production subsector (2.A.1);
- ✓ lime production subsector (2.A.2);
- ✓ limestone and dolomite consumption subsector (2.A.3);
- ✓ iron and steel production subsector (2.C.1);
- ✓ ferroalloys production subsector (2.C.2);
- ✓ aluminium production subsector (2.C.3);
- ✓ Forest land (5.A);
- ✓ Addition to emissions from waste incineration (6.C)

N_2O/CH_4 recalculations were carried out in the following sectors:

- ✓ nitric acid production (2.B.2);
- ✓ Enteric fermentation (4.A);
- ✓ Manure management (4.B);
- ✓ Agricultural soils (4.D);
- ✓ Field burning of agricultural residues (4.F);
- ✓ Forest land (5.A);
- ✓ Solid Waste Disposal Sites (6.A);
- ✓ Industrial wastewater handling (6.B.1);
- ✓ Human sewage (6.B.2)

Figure 10.2 Change in pollutant specific total emissions, for all source/absorber categories, and for the whole time series, in comparison to figures in 2005 report



10.2 Impact on emissions levels

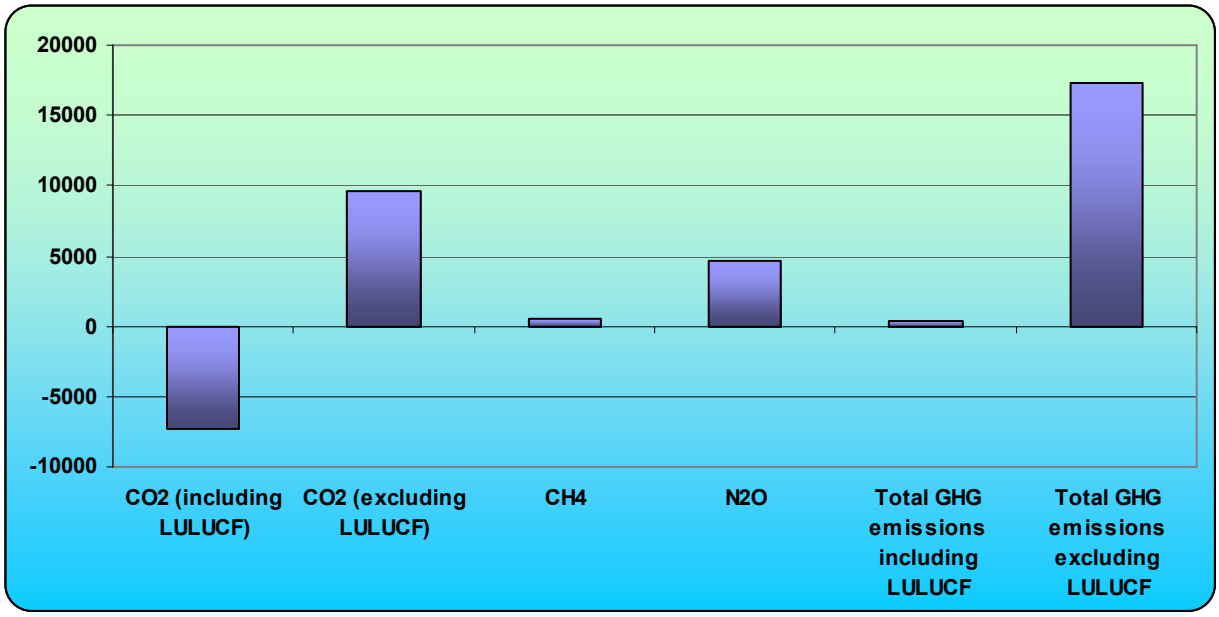
The inventory has been improved considerably with regarding to transparency and completeness.

Emissions changes due to recalculations, for 1989, by gases are described as follows:

- CO_2 including LULUCF (-4.3%), excluding LULUCF (5.25%);
- CH_4 (0.9%);
- N_2O (15.89%).

Total emissions including LULUCF increased for 1989 with (0.17%).

Figure 10.3 Effects of recalculations (presented in 2006 submission) for 1989 year, by gases



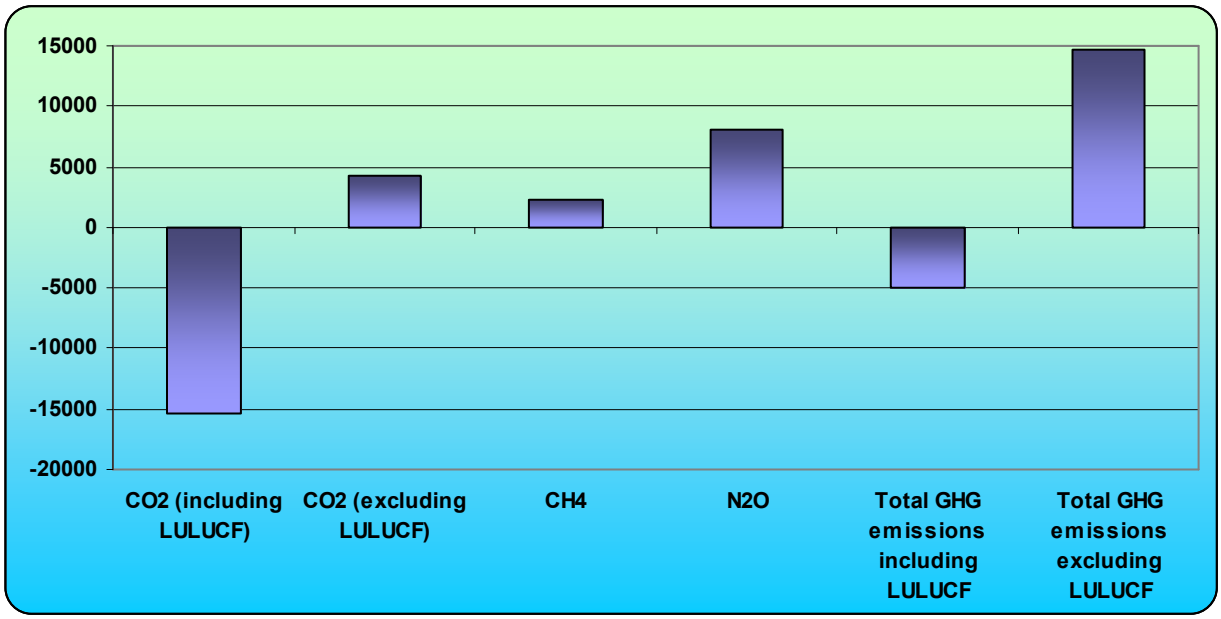
More detailed information on recalculations is available in CRF Table 8(a)s1 and 8(a)s2

Emissions changes due to recalculations, for 2003, by gases are described as follows:

- CO_2 including LULUCF (-16.2%), excluding LULUCF (3.84%);
- CH_4 (9.92%);
- N_2O (112.62%)

Total emissions including LULUCF decreased for 2003 with 3.95%.

Figure 10.4 Effects of recalculations (presented in 2006 submission) for 2003 year, by gases



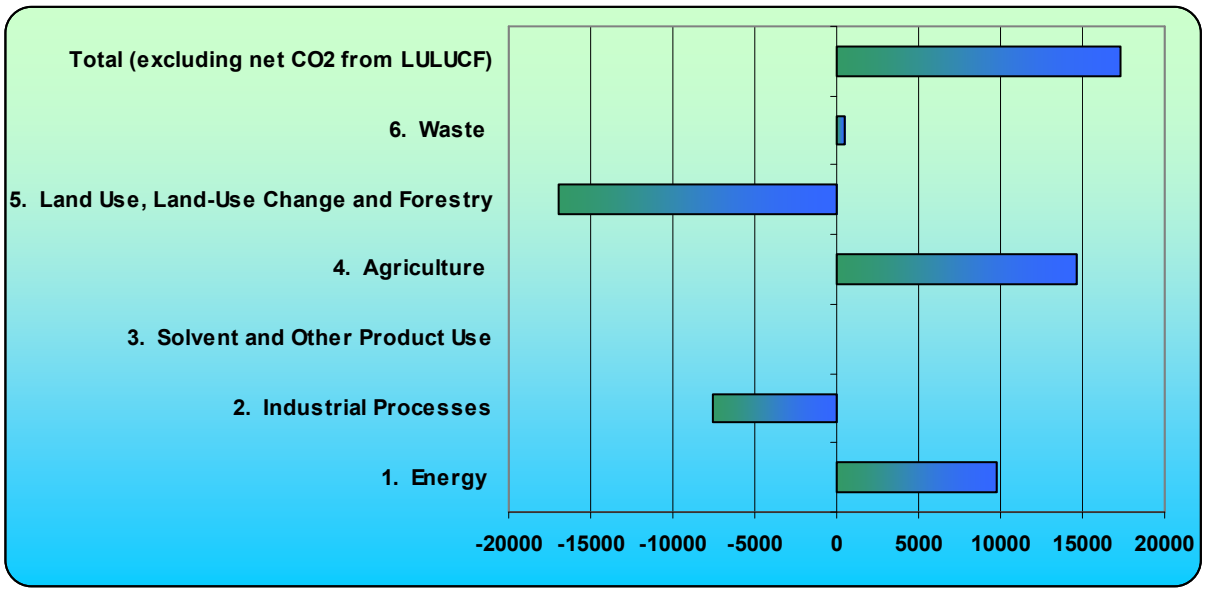
10.2.1 Impacts on 1989 emissions levels

Comparing to the 2005 submission, total emissions for 1989 not including LULUCF increased by 6.54%, mostly due to increase of emissions from Agriculture.

Table 10.1 Recalculation of total emissions, by sectors, for all gases, for 1989

Differences for 1989 emissions	Change in Gg CO_2 equiv	Differences [%]	Reported 2005 [Gg]	Reported 2006 [Gg]
1. Energy	9,799.45	5.41%	181,140.67	190,940.13
2. Industrial Processes	-7,595.65	-14.96%	50,783.30	43,187.65
3. Solvent and Other Product Use	0.00	0.00%	645.80	645.80
4. Agriculture	14,693.18	54.03%	27,196.56	41,889.74
5. Land Use, Land-Use Change and Forestry	-16,927.96	107.73%	-15,713.23	-32,641.18
6. Waste	445.62	8.32%	5,358.02	5,803.64
Total (excluding net CO_2 from LULUCF)	17,342.83	6.54%	265,124.36	282,467.18

Figure 10.5 Changes of 1989 emissions, in respect to 2005 figures



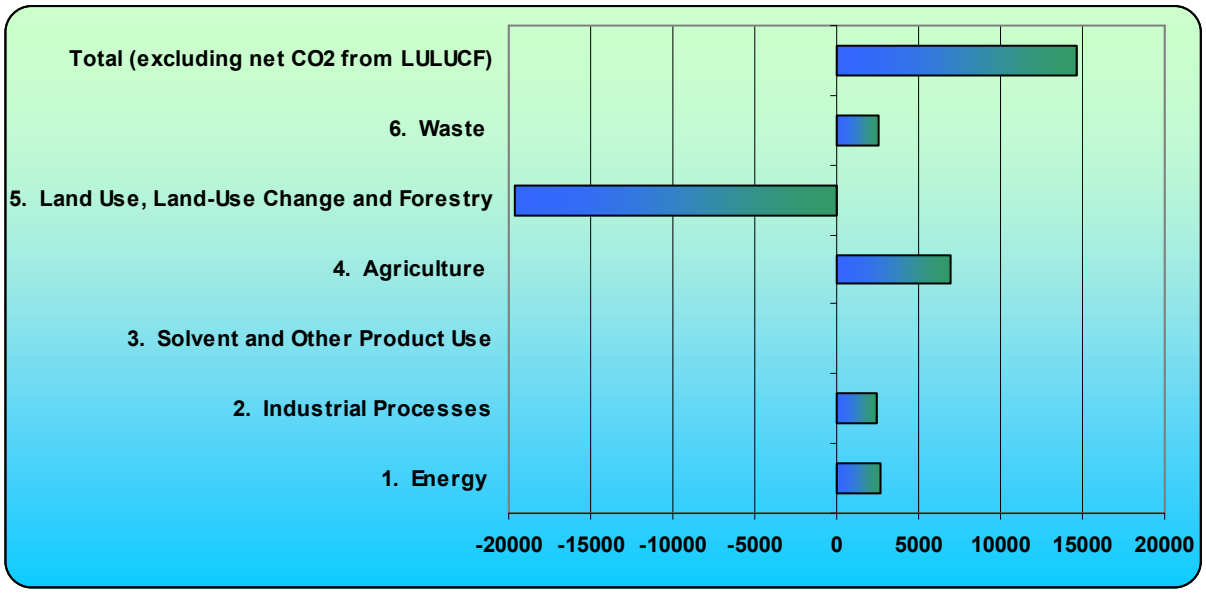
10.2.2 Impacts on 2003 emissions levels

Comparing to the 2005 submission, total emissions for 2003 not including LULUCF increased by 10.22%, mostly due to increase of emissions from Agriculture.

Table 10.2 Recalculation of total emissions, by sectors, for all gases, for 2003

Differences for 2003 emissions	Change in Gg CO_2 equiv	Differences [%]	Reported 2005 [Gg]	Reported 2006 [Gg]
1. Energy	2,735.55	2.47%	110,604.50	113,340.05
2. Industrial Processes	2,386.80	15.91%	15,005.57	17,392.37
3. Solvent and Other Product Use	0.00	0.00%	279.90	279.90
4. Agriculture	6,978.91	58.42%	11,946.54	18,925.44
5. Land Use, Land-Use Change and Forestry	-19,586.70	116.03%	-16,880.22	-36,466.92
6. Waste	2,505.95	49.44%	5,068.29	7,574.24
Total (excluding net CO_2 from LULUCF)	14,609.11	10.22%	142,904.79	157,513.90

Figure 10.6 Changes of 2003 emissions, in respect to 2005 figures



10.3 Impacts on emissions trends and on time-series consistency

As a result of recalculations, the time-series consistency has been improved.

10.4 Recalculations in response to the review process and planned inventory improvement

In response to the review process, recalculations were carried out as follows:

- Changes in activity data for the lime production subsector, because the surrogate method used in previous submission (when dolomite lime was correlated to quicklime production) has been replaced with a linear extrapolation, considered to be more relevant. Recalculations were performed for 1989-1991 and 2003 . For the years 1992 and 2002 the recalculations were made due to wrong manipulation of data.(2.A.2);
- Changes in activity data for the nitric acid production**,** because the previous national statistic data on nitric acid have been replaced with data obtained directly from the producers. The recalculations have been performed for the entire time series.(2.B.2);
- Changes in activity data for the iron and steel production subsector, because previously estimates based on national statistics data have been replaced with estimates based on activity data collected at plant level. Emissions have been recalculated for the entire time series.(2.C.1);

- Changes in method for ferroalloys production subsector, because the ferroalloys emissions considered to be included under Iron and Steel production in previous submission are now reported under the appropriate IPCC category.(2.C.2);
- Changing livestock data series due to errors and to new data found (4.A; 4.B; 4.D);
- Changes at specific applied fractions values level (4.D);
- Recalculation of fraction of livestock nitrogen excreted and deposited onto soil during grazing data series (4.D);
- Building a land use change matrix (5.A);
- Beginning of use of biomass expansion factor for conversion of annual net increment to aboveground tree biomass increment (BEF_1) and of a biomass expansion factor to account for the volume of roots remaining in forests soils after logging (BEF_{root}), (5A);
- Use of specific data to FAO on protein consumption for human sewage (6.B.2);
- Beginning of calculation for emissions from waste incineration (6.C)

Obtaining more detailed data to allow use of tier 2 methods is the major planned inventory objective.

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