

**NATIONAL ADMINISTRATION OF THE EMISSIONS TRADING SCHEME
NATIONAL EMISSION CENTRE**

Poland's National Inventory Report 1991

Submission under
the United Nations Framework
Convention on Climate Change

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Executive Summary

This report - National Inventory Report (NIR) - presents the results of the national emission inventory of greenhouse gases (GHGs) in Poland in 1991. The inventory covers the following GHGs: carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). The following GHG precursors are also reported: carbon monoxide - CO, nitrogen oxides (NO + NO₂) - NO_x, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO₂.

The national inventory and accompanying tables of Common Reporting Format (CRF), have been prepared in accordance with the UN FCCC Reporting Guidelines on Annual Inventories. Methodologies used to calculate emissions and sinks of GHGs, are in accordance with methods recommended in two basic publications of Intergovernmental Panel on Climate Change - IPCC, namely *Revised 1996 Guidelines for National Greenhouse Gas Inventories*, and *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. According to these guidelines country specific methods have been used where appropriate and give more accurate emission data. Although, national inventory reports in Polish have been compiled since early 1990s, the first Polish NIR, in English, was submitted to UN FCCC Secretariat in 2003. Here, we present and discuss the results of the GHG national inventory for the year 1991. Totals in tables may not sum due to independent rounding.

Total national GHG emissions

The GHG emissions in base year (1988/1995) and 1991, expressed as CO₂ equivalents, are presented in table ES.1 In 1991 the total national emission of GHG were about 469.79 million tones of CO₂-eq., excluding GHG emissions and sinks from category 5. (Land use change and forestry). Compared to the base year (1988/1995), the 1991 emissions have decreased by 20.0%.

Table ES.1 National emissions of greenhouse gases for the years base year (1988/1995)-1991. [Gg CO₂ eq.]

Pollutant	Base year	1991	(1991- base)/base
	Emission in CO ₂ eq. [Gg]	Emission in CO ₂ eq. [Gg]	
CO ₂ – net emission (with LUCF)	461 951.16	356 824.85	-0.23
CO ₂ – without LUCF.	494 885.88	389 359.08	-0.21
CH ₄	49 256.41	46 526.38	-0.06
N ₂ O	42 478.82	33 902.91	-0.20
HFCs	26.44	NE	NE
PFCs	250.18	NE	NE
SF ₆	13.15	NE	NE
TOTAL without CO ₂ from LUCF	586 910.88	469 788.38	-0.20
TOTAL with LUCF	553 976.16	437 254.14	-0.21

* 1995 is the base year for HFCs, PFCs and SF₆

Carbon dioxide emissions

The CO₂ emissions in 1991 were estimated as 389.36 million tones. This is 21.3% lower than in the base year. CO₂ emission was accounted for 82.9% of total GHG emissions in Poland in 1991. The main CO₂ emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO₂ emission by 95.84% in 1991. The shares of the main subcategories were as follows: *Energy industries* – 62.1%, *Manufacture Industries and Construction* – 9.5%, *Transport* – 6.9% and *Other Sectors* – 16.7%. *Industrial Processes* contributed to the total CO₂ emission by 3.9% in 1991. *Mineral Products* (especially *Cement*

Production) is the main emission source in this sector. The CO₂ removal in LUCF sector in 1991, was calculated to be approximately 32.5 million tones. It means that app. 7.4% of the total CO₂ emissions are offset by CO₂ uptake by forests.

Methane emissions

The CH₄ emission amounted to 2 215.54 Gg in 1991 i.e. 46.53 million tones of CO₂ equivalents. The contribution of CH₄ to the national total GHG emission was 9.9% in 1991. Three of main CH₄ emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture and Waste*. They contributed 37.3%, 37.8% and 23.8% to the national methane emission in 1991, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (30.0% of total CH₄ emission) and Oil and Natural Gas system (7.3% of total CH₄ emission). Waste disposal sites contributed to 10.7% of the methane emission from total CH₄ emission and Wastewater Handling contributed to 13.1% of total CH₄ emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 29.8% of total CH₄ emission in 1991.

Nitrous oxide emissions

The nitrous oxide emissions in 1991 were 109.36 Gg i.e. 33.90 million tonnes of CO₂ equivalents. The emission was app. 20.2% lower than the respective figure for the base year. The contribution of N₂O to the national total GHG emission was 7.2% in 1991. The main N₂O emission sources and its shares in total N₂O emission in 1991 are as follow: *Agricultural Soils* – 53.6%, *Manure Management* – 26.1%, *Chemical Industry* – 9.7% and *Fuel Combustion* – 6.9%.

1. Introduction

1.1 Background information on greenhouse gas inventories and climate change

The report and underlying CRF tables have been prepared according to updated reporting guidelines on annual inventories of the following GHGs: carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). The GHG precursors, in turn, are: carbon monoxide - CO, nitrogen oxides (NO + NO₂) - NO_x, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO₂ (according to document FCCC/SBSTA/2006/9 published on 18.08.2006 following the decision 14/CP.11)

The ultimate goal of the United Nations Framework Convention on Climate Change (UNFCCC) is "...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system...". The basic evidence for fulfilling UNFCCC obligations is annual inventory made by Parties to the Convention.

1.2 A description of institutional arrangement for inventory preparation

GHG inventory presented below has been compiled by the National Emission Centre (NEC) established in 2000 at the Institute of Environmental Protection in Warsaw. NEC has been commissioned by the Polish Ministry of Environment to carry out inventories for the GHGs and other air pollutants. Since 2006 NEC is located within the National Administrator of Emission Trading Scheme established also in the Institute of Environmental Protection.

When compiling the inventory, NEC have been collaborating with a number of individual experts as well as institutions. Among the latter are: Central Statistical Office (GUS), Agency of Energy Market (ARE), Institute of Ecology of Industrial Areas in Katowice (IETU), Institute of Automobile Transport (ITS) as well as Office for Forest Planning and Management (BULGiL).

1.3 Brief description of the process for inventory preparation

The GHG emission estimates are based on methodologies elaborated by the Intergovernmental Panel on Climate Change (IPCC) and recommended by the UNFCCC, while emissions of indirect gases according to methodology elaborated by UN ECE/EMEP [IPCC 1997, IPCC 2000, IPCC 2003, EEA 2004]. Wherever necessary and possible, domestic methodologies and emission factors have been developed to reflect specific national conditions. The most important features of the inventory preparation and archiving can be briefly summarized in the following way:

- activity data are mostly taken from official public statistics (GUS) or when required data are not directly available, (commissioned) research reports or expert estimates are used instead,
- emission factors for the main emission categories are mostly taken from reports on domestic research; IPCC default data are used in cases where the emission factors are highly uncertain (e.g. N₂O emissions from animal waste in agriculture, and CH₄ and N₂O emission from stationary combustion), or when particular source category contribution to national total is insignificant,
- all activity data, emission factors and resulting emission data are stored at NEC database, which is constantly updated and extended to meet the ever changing requirements for emission reporting, with respect to UNFCCC and LTRAP as well as their protocols.

1.4 General description of methodologies and data sources used

The GHG emissions and removals inventory presented in this report follow the recommended Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories [IPCC 1997], and the IPCC Good Practice Guidance and Uncertainty Management [GPG 2000]. According to these guidelines country specific methods have been used where appropriate giving more accurate emission data especially in case of key categories. For categories where emissions do not occur or are not estimated the abbreviation NE was used in tables. More detail description of methodologies used in Polish GHG inventory are given in sections 3–8.

The calculated emissions can be presented by various combinations of fuels, sources and sectors. The emissions from fuel combustion are calculated by combining the fuel consumption distributed among emission sources and economy sectors with fuel, source, sector and pollutant specific emission factors. The non-combustion emissions are estimated by combining activity data with emission factors. The emission factors are either estimated from measurements or taken from special investigations. If not available domestically, emission factors are taken first of all from IPCC guidelines or other international publications. The emissions of non-CO₂ gases are expressed in units of CO₂ equivalents, based on Global Warming Potentials (GWP), calculated for a time horizon of 100 years [IPCC 1995].

One of the main steps of emission inventorying from the 1.A. *Energy* category, is preparation of energy budgets for each energy carrier. These budgets are prepared based on the national energy balances published by Central Statistical Office and Agency of Energy Market. The tables of the national energy balance include detailed information on the ins and outs of all the energy carriers used in Poland, as well as information on their conversions to other energy carriers and on their direct consumption. The data for international bunker are also assessed.

The example of evaluation of hard coal consumption is given in table 1.1. The examples of the fuel budgets for: coking coal, brown coal (lignite), fuel oil and high-methane and nitrified natural gas are presented in Annex 2. For each fuel, balance data are given both in natural units and in common (energy) units.

Table 1.1 Steam coal consumption

Evaluation of fuel consumption in national combustion processes	Steam coal	
	10 ³ Mg	TJ
In	102 864	2 428 065
From national sources	100 535	2 365 534
1) Indigenous production	100 087	2 355 333
2) Transformation output or return	0	0
3) Stock decrease	448	10 200
Import	2 329	62 531
Out	102 864	2 428 065
National consumption	82 303	1 932 230
1) Transformation input	65 526	1 520 590
a) input for secondary fuel production	13 585	401 497
b) fuel combustion	51 941	1 119 094
2) Direct consumption	16 777	411 640
Non-energy use	1	30
Combusted directly	16 776	411 610
Combusted in Poland	68 716	1 530 704
Stock increase	407	11 963
Export	19 684	532 681
Losses and Statistical differences	471	-48 809
Net Calorific Value	MJ/kg	22.28
CO ₂ Emission Factor	kg/GJ	96.60

The data on quantity of the fuel combusted in whole country in a given year are used for calculation of the average net calorific value of the fuel. This calculated net calorific value provides then the basis for the estimation of country specific CO₂ emission factor for the given fuel. The calculations of these CO₂ emission factors for main fuels are based on empirical formulas that apply the relationship between net calorific values and elemental carbon content. The maximum (potential) CO₂ emission from combustion of a given fuel is, in turn, calculated based on the estimated emission factor. It is one of the way of checking the CO₂ emission value, estimated according to sectoral approach.

Basic information on activity data regarding IPCC categories, are usually published in various GUS statistical yearbooks. The activity data that are not available in GUS publications, have been worked out by experts based on studies commissioned by the Ministry of Environment specifically for the GHG emission inventory purposes.

Energy Statistics published by Central Statistical Office is the main source of activity data for *Energy* sector. The data on fuel consumption in *Transport* subcategory, including the fuel consumption data for various types of vehicles, are worked out routinely by experts from the Institute of Automobile Transport, as well as the emission factors for road transport.

1.5 Brief description of key source methodologies

The source categories in all sectors, are identified to be *key sources* on the basis of their contribution to the total level and/or trend uncertainty in accordance with IPCC Good Practice Guidance [IPCC 2000]. The complete tables with level and trend assessment are given in Annex 1.

1.6 Information on the QA/QC plan including verification

Comprehensive QA/QC system in Poland is still under development but general procedures are in place to ensure appropriate quality of national inventories. Activities underlying the Quality Control procedures within Polish GHG inventory system contain routine and consistent checks to ensure data integrity within entire time series, correctness as well as completeness. Potential errors and omissions are addressed through routinely checks. An extended QC procedure is carried out for higher tier methods including reviews of activity and emission factor data, and methods. Quality Assurance consisting activities aiming at external reviews are performed occasionally under the auspices of Ministry of Environment.

Generally the first draft of the inventory in form of IPCC tables and draft CRF, is usually produced 12-14 months after the end of the given year depending primarily on the availability of required activity data. The most of activity data comes from national statistics undergoing internal revision and checking process before using it in the inventory. But still extensive checks are done in form of consultations with data providers. The consultations cover both correctness of data and their proper interpretation. The most important institutional sources include: Central Statistical Office, Agency of Energy Market, and a number of collaborating individual experts and institutions. Wherever possible various different datasets are used for comparison purposes. All activity data, parameters and factors used for emission estimates for a given year are examined in comparison to entire time series to detect doubtful figures. Outliers are scrutinized in more detail. After the checking period is completed, the final CRF is prepared together with the accompanying report. The CRF Reporter is also used as one of the checking tool for detecting potential errors and omissions within domestic inventory.

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

Uncertainty evaluation made for 1991 is based on calculations and national experts judgements/estimations prepared in 2006 as well as opinions expressed by international experts under UNFCCC Secretariat during in-depth review made in 2005. Calculations includes simplified method for sector 5 and for fluorinated gases.

In Annex 5, the estimate of emission uncertainty for the year 1991 using *Tier 1* approach is given. The uncertainty figures varied significantly among various source categories. More details are included in Annexes 5.

1.8 General assessment of the completeness

The Polish GHG emission inventory includes calculation of emissions from all relevant sources that we are aware of. However, there is a number of exceptions. All of them are expected to have a minor effect on the total national GHG emissions. These exceptions are:

in *Energy* sector (*Fugitive Emission from Fuels* only):

- CO₂ and CH₄ from *Solid Fuel Transformation*
- CO₂ from *Coal Mining and Handling*
- some individual processes in *Oil and Natural Gas* systems

in *Industrial Processes*:

- CO₂ from *Asphalt Roofing*
- CO₂ from *Road Paving with Asphalt*
- CH₄ from *Ferroalloys Production*
- CH₄ from *Aluminium Production*

- CO₂ from *Food and Drink Production*
- CH₄ from *Sinter*
- some minor gaps in estimation of the emissions of HFCs, PFCs, SF₆

in *Agriculture*

- CH₄ from *Agriculture Soils*

in *LULUCF*

- N₂O from *Forest and Grassland Conversion*
- CO₂ from *Decay*

in *Waste*

- N₂O from *Industrial Wastewater*
- N₂O from *Domestic and Commercial Wastewater except Humane Sewage*
- CH₄ from *Waste Incineration*.

2. Greenhouse gas emissions and removals in 1991

2.1 GHG aggregated emissions

For carbon dioxide, net emission is calculated by subtracting from the total CO₂ emission and removals from category 5. (Land Use Change and Forestry - LUCF). According to IPCC methodology, CO₂ emissions are given with and without contributions from category 5. Also following IPCC, emission of CO₂ from biomass, is not included in the national total.

For non-CO₂ gases, the inventory results can also be presented (table 2.1) in units of CO₂ equivalents by applying values of the so called Global Warming Potentials - GWP. GWP for methane is 21, and for nitrous oxide 310. Carbon dioxide is the main GHG in Poland with the 82.9% share (in 1991), while the methane contributes with 9.9% to the national total. Nitrous oxide contribution is 7.2%.

Table 2.1 Greenhouse gas emissions in 1991 in CO₂ eq.

Pollutant	1991	
	Emission in CO ₂ eq. [Gg]	Share [%]
CO ₂ – net emission (with LUCF)	356 824.85	
CO ₂ – without LUCF.	389 359.08	82.88
CH ₄	46 526.38	9.90
N ₂ O	33 902.91	7.22
HFCs	NE	NE
PFCs	NE	NE
SF ₆	NE	NE
TOTAL without CO ₂ from LUCF	469 788.38	100.0
TOTAL with LUCF	437 254.14	

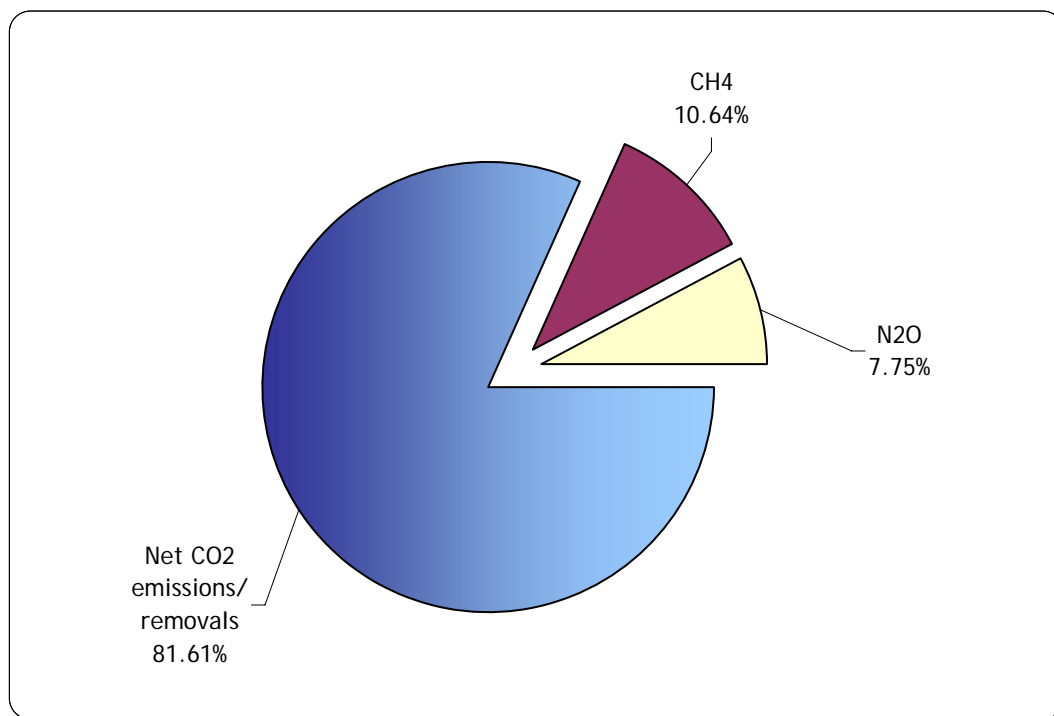


Figure 2.1 Percentage share of greenhouse gases in national total emission total in 1991

Emissions of main GHGs in 1991, disaggregated into main source sub-sectors, are given in table 2.2. Discussion of these results is given in the following section

Table 2.2 Emissions of CO₂, CH₄ and N₂O in 1991 [Gg]

[Gg]	CO ₂	CH ₄	N ₂ O
TOTAL without CO ₂ from LUCF	389 359.08	2 215.54	109.36
1. Energy	373 193.09	840.47	7.51
A. Fuel Combustion	373 142.88	13.64	7.51
1. Energy Industries	241 715.46	3.21	3.50
2. Manufacturing Industries and Construction	36 851.39	1.51	0.62
3. Transport	27 032.01	6.90	1.44
4. Other Sectors	65 125.82	1.80	1.20
5. Other	2 418.21	0.22	0.74
B. Fugitive Emissions from Fuels	50.21	826.83	NE
1. Solid Fuels	1.40	664.08	NE
2. Oil and Natural Gas	48.80	162.74	NE
2. Industrial Processes	15 268.31	10.48	10.57
A. Mineral Products	7 734.36	NE	NE
B. Chemical Industry	2 652.73	7.82	10.57
C. Metal Production	4 881.22	2.66	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	484.22	NE	0.40
4. Agriculture	NE	838.21	87.23
A. Enteric Fermentation	NE	661.33	NE
B. Manure Management	NE	175.52	28.58
D. Agricultural Soils	NE	NE	58.58
F. Field Burning of Agricultural Residues	NE	1.36	0.07
5. Land Use, Land-Use Change and Forestry	-32 534.24	0.10	0.0007
A. Forest Land	-39 328.32	NE	NE
B. Cropland	6 479.84	NE	NE
C. Grassland	3 595.49	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	-3 281.25	0.10	0.0007
F. Other Land	NE	NE	NE
6. Waste	413.46	526.29	3.65
A. Solid Waste Disposal on Land	NE	236.95	NE
B. Wastewater Handling	NE	289.34	3.60
C. Waste Incineration	413.46	NE	0.05

As a supplement to the table 2.2, table 2.3 includes percentage contributions of main source sectors to the national totals in 1991 for CO₂, CH₄ and N₂O.

Table 2.3 Percentage shares of individual source sectors in 1991 emissions

Percentage share of source sectors in biezacy emissions	Share [%]		
	CO ₂ without LUCF	CH ₄	N ₂ O
TOTAL	100.00	100.00	100.00
1. Energy	95.85	37.94	6.87
A. Fuel Combustion	95.84	0.62	6.87
1. Energy Industries	62.08	0.14	3.20
2. Manufacturing Industries and Construction	9.46	0.07	0.57
3. Transport	6.94	0.31	1.31
4. Other Sectors	16.73	0.08	1.10
5. Other	0.62	0.01	0.68
B. Fugitive Emissions from Fuels	0.01	37.32	NE
1. Solid Fuels	0.0004	29.97	NE
2. Oil and Natural Gas	0.01	7.35	NE
2. Industrial Processes	3.92	0.47	9.67
A. Mineral Products	1.99	NE	NE
B. Chemical Industry	0.68	0.35	9.67
C. Metal Production	1.25	0.12	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	0.12	NE	0.37
4. Agriculture	NE	37.83	79.76
A. Enteric Fermentation	NE	29.85	NE
B. Manure Management	NE	7.92	26.13
D. Agricultural Soils	NE	NE	53.57
F. Field Burning of Agricultural Residues	NE	0.06	0.06
5. Land Use, Land-Use Change and Forestry	NE	0.00	0.0006
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	NE	0.00	0.0006
F. Other Land	NE	NE	NE
6. Waste	0.11	23.75	3.34
A. Solid Waste Disposal on Land	NE	10.69	NE
B. Wastewater Handling	NE	13.06	3.30
C. Waste Incineration	0.11	NE	0.04

2.2 GHG emissions by gas

Carbon dioxide (CO₂)

In 1991, the net CO₂ emissions (with LULUCF) were estimated as 356.82 million tonnes, while when sector 5. *LUCF* is excluded the figure reaches 389.36 million tonnes (table 2.2). The main CO₂ emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO₂ emission by 95.84% in 1991. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 62.1%, *Manufacture Industries and Construction* – 9.5%, *Transport* – 6.9% and *Other Sectors* – 16.7%. Sector 2. *Industrial Processes* contributed to the total CO₂ emission by 3.9% in 1991. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO₂ emission/removal in LULUCF sector in 1991, was calculated to be approximately 32.5 million tonnes. It means that app. 7.4% of the total CO₂ emissions are offset by CO₂ uptake by forests.

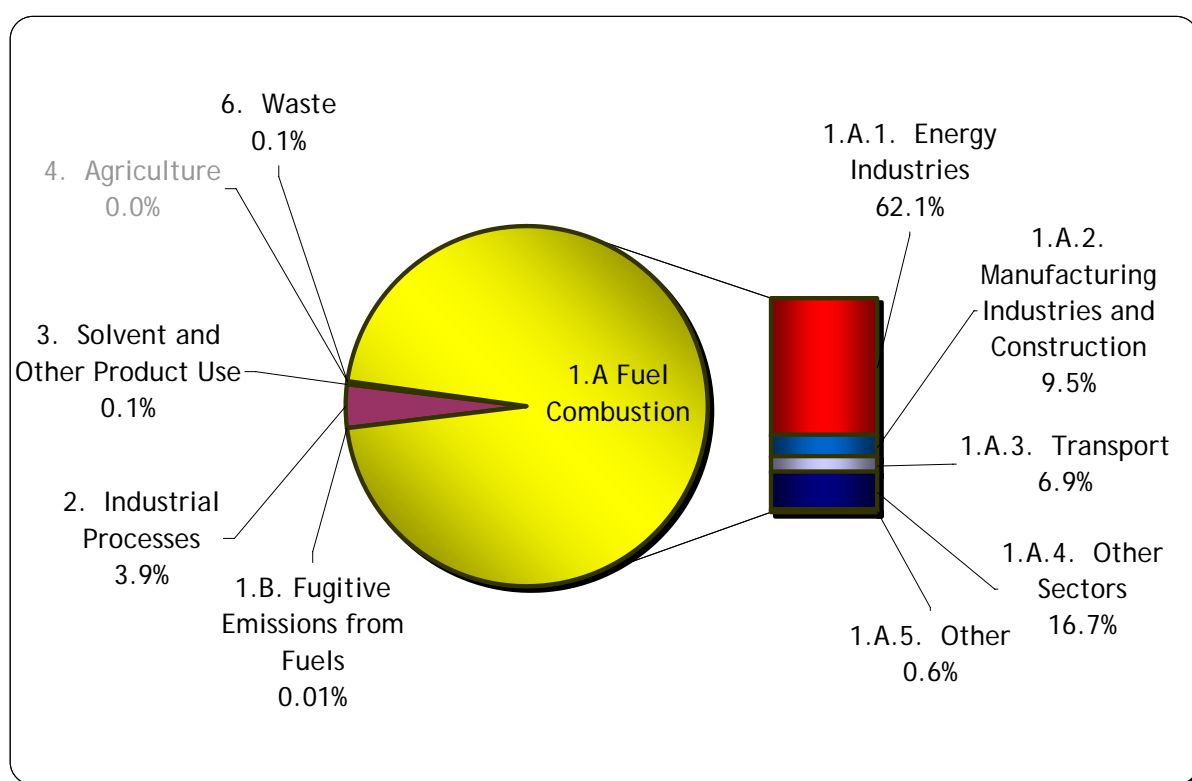


Figure 2.2 Carbon dioxide emission in 1991 by sector

Methane (CH₄)

The CH₄ emission amounted to 2 215.54 Gg in 1991 i.e. 46.53 million tones of CO₂ equivalents (table 2.2). Three of main CH₄ emission sources include the following categories: *Fugitive Emissions from Fuels*, *Agriculture* and *Waste*. They contributed to 37.3%, 37.8% and 23.8% of the national methane emission in 1991 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 30.0% of total CH₄ emission) and *Oil and Natural Gas* system (about 7.3% of total emission), *Disposal sites* contributed to 10.69% of the methane emission and *Wastewater Handling* contributed to 13.06%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 29.8% of total methane emission in 1991.

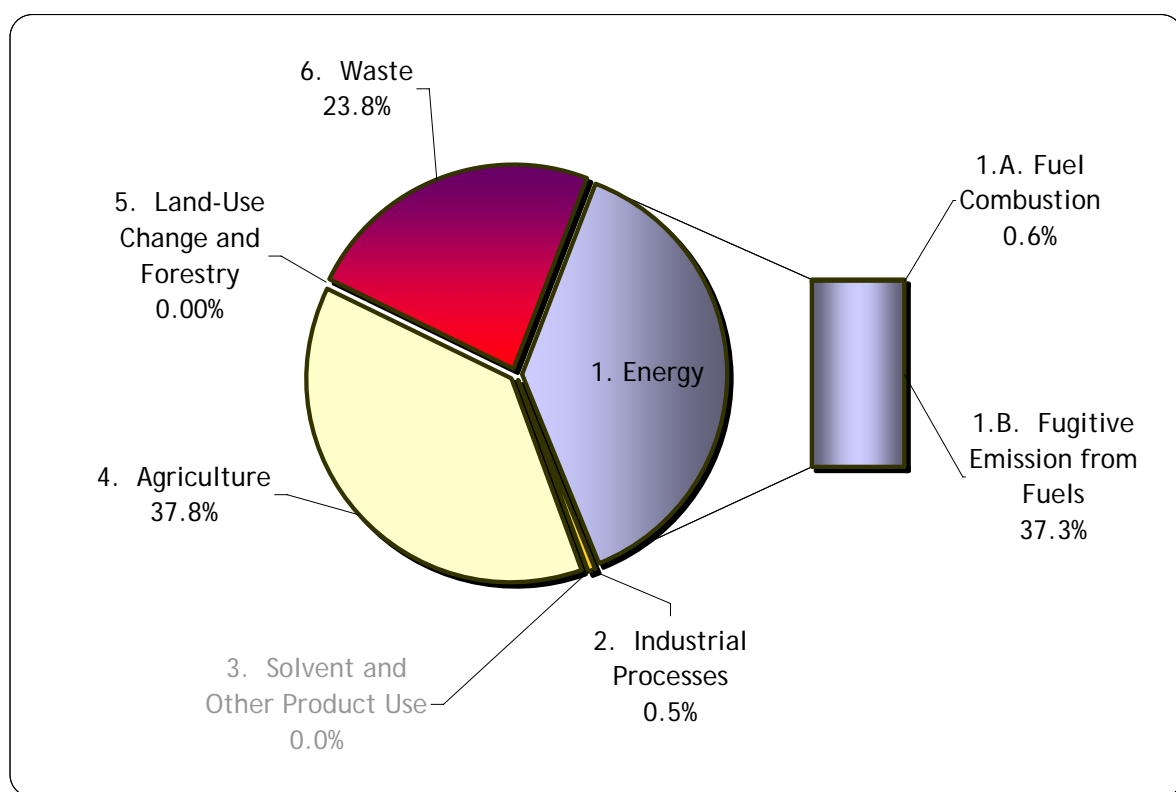


Figure 2.3 Methane emission in 1991 by sector

Nitrous oxide (N₂O)

The nitrous oxide emissions in 1991 were 109.36 Gg i.e. 33.90 million tonnes of CO₂ equivalents (table 2.2). The main N₂O emission sources and its shares in total N₂O emission in 1991 are: *Agricultural Soils* – 53.6%, *Manure Management* – 26.1%, *Chemical Industry* – 9.7% and *Fuel Combustion* – 6.9%.

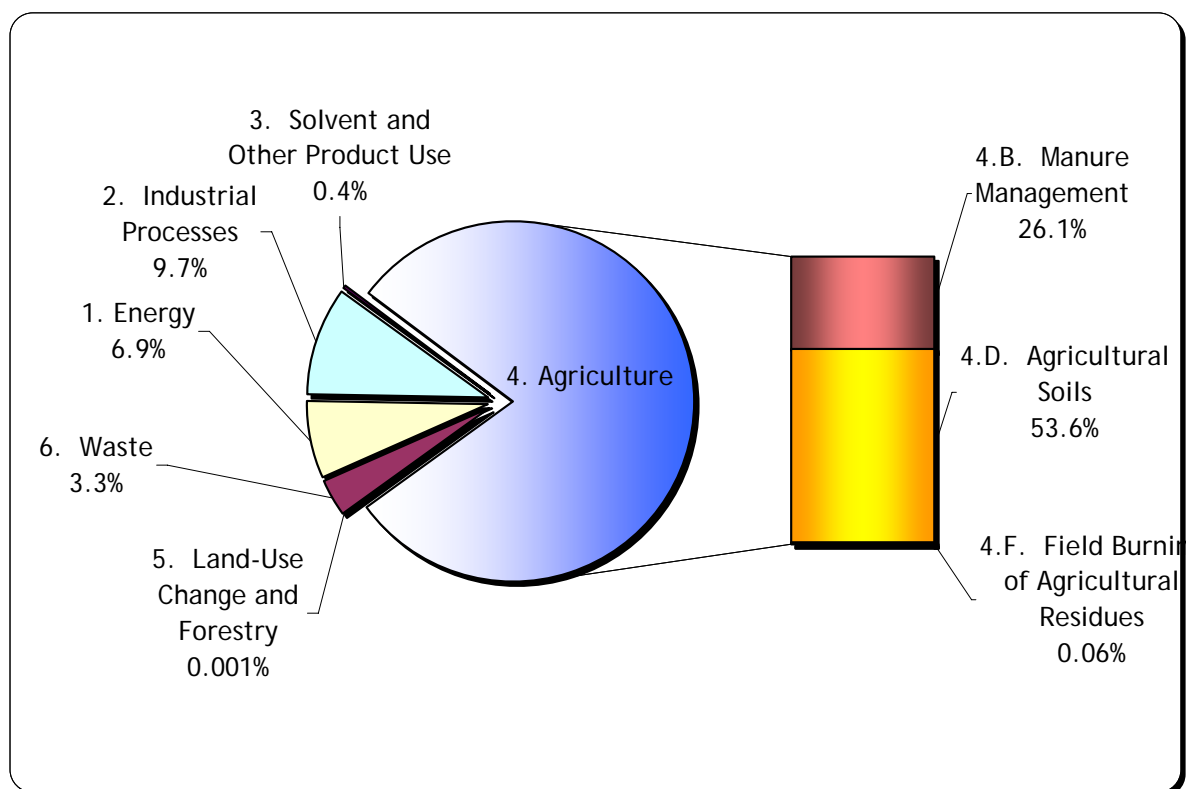


Figure 2.4 Nitrous oxide emission in 1991 by sector

2.3 GHG emissions by category

Here emissions of greenhouse gases are presented from all categories except sector 5. LULUCF described in section 7.

Table 2.4. GHG emissions according to main sectors in base year (1988/1995) and 1991

	Total [Gg eq. CO ₂]		(1991- base)/base
	Base year	1991	
TOTAL with LUCF	553 976.2	437 254.14	-0.21
TOTAL without LUCF	586 902.6	469 786.14	-0.20
1. Energy	497 964.7	393 170.76	-0.21
2. Industrial Processes	27 356.2	18 766.53	-0.31
3. Solvent and Other Product Use	1 006.5	608.22	-0.40
4. Agriculture	52 378.1	44 643.45	-0.15
5. Land-Use Change and Forestry	-32 926.5	-32 532.00	-0.01
6. Waste	8 197.2	12 597.17	0.54

2.3.1 Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 1991 was 393.2 million tons of CO₂ equivalent. CO₂ emission share exceeded 94.9% of the total GHG emissions within 1.*Energy* category (table 2.5). The most emission intensive category was 1.A.1.*Fuel combustion activities* related mostly to heavy industry sector, highly energy consuming.

Table 2.5. GHG emissions from sub-sectors in category *Energy* in 1991

GHG emission categories	GHG Emission [Tg CO ₂ -eq]	% share in the total emission from Energy	% Share in total GHG emission from a given sub-sector		
			CO ₂	CH ₄	N ₂ O
Total Energy	393 170.76	100.0	94.9	4.5	0.6
A. Fuel Combustion	375 757.20	95.6	94.9	0.1	0.6
1. Energy Industries	242 867.62	61.8	61.5	0.0	0.3
2. Manufacturing Industries and Construction	37 076.67	9.4	9.4	0.0	0.0
3. Transport	27 622.11	7.0	6.9	0.0	0.1
4. Other Sectors	65 537.05	16.7	16.6	0.0	0.1
5. Other	2 653.75	0.7	0.6	0.0	0.1
B. Fugitive Emissions from Fuels	17 413.56	4.4	0.0	4.4	0.0
1. Solid Fuels	13 947.16	3.5	0.0	3.5	0.0
2. Oil and Natural Gas	3 466.40	0.9	0.0	0.9	0.0

2.3.2 Industrial Processes and Solvent and Other Use (IPCC categories 2 and 3)

Table 2.6 shows detailed information on emissions of CO₂, CH₄ and N₂O in *Industrial Processes* sector and in *Solvent and Other Use* sector in 1991. CO₂ is dominating among GHGs – its contribution exceeds 81.4%. The main GHG emission sources in this category were: production processes of cement, nitric acid and ammonia.

The emissions of GHG from *Solvent and Other Use* sector includes N₂O emissions from anaesthesia (20.4%) and CO₂ emissions (recalculated from NMVOC) (79.6%).

Table 2.6. The emissions of CO₂, CH₄ and N₂O from sub-sectors in category *Industrial Processes* and in category *Solvents and Other Product Use* in 1991

GHG emission categories	GHG Emission [Tg CO ₂ -eq]	% share in the total emission from Industrial Processes	% Share in total GHG emission from a given sub-sector			
			CO ₂	CH ₄	N ₂ O	HFC, PFC and SF ₆
Total Industrial Processes	18 766.53	100.0	81.4	1.2	17.5	0.0
A. Mineral Products	7 734.36	41.2	41.2	0.0	0.0	NE
B. Chemical Industry	6 095.09	32.5	14.1	0.9	17.5	NE
C. Metal Production	4 937.08	26.3	26.0	0.3	0.0	NE
D. Other Production	NE	NE	NE	NE	NE	NE
F. Consumption of Halocarbons and SF ₆	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE
Total Solvent and Other Product Use	608.22	100	79.6	0.0	20.4	

2.3.3 Agriculture (IPCC category 4)

The main sources of GHG in category 4 *Agriculture* were: 4.D. *Agricultural Soils*, 4.B. *Enteric Fermentation* and 4.A. *Manure Management* (table 2.7). N₂O emission share was largest in total GHG emission from *Agriculture* in 1991 and came from both – direct (mineral and organic fertilisation) and indirect (volatilisation, leaching and runoff from applied synthetic fertiliser and animal manure) N₂O emissions from soils.

Table 2.7. GHG emissions from sub-sectors in category 4 *Agriculture* in 1991

GHG emission categories	GHG Emission [Tg CO ₂ -eq]	% share in the total emission from Agriculture	% Share in total GHG emission from a given sub-sector	
			CH ₄	N ₂ O
Total Agriculture	44 643.45	100.0	39.4	60.6
A. Enteric Fermentation	13 888.02	31.1	31.1	0.0
B. Manure Management	12 545.25	28.1	8.3	19.8
D. Agricultural Soils	18 161.07	40.7	0.0	40.7
F. Field Burning of Agricultural Residues	49.11	0.1	0.1	0.0

2.3.4 Waste (IPCC category 6)

As it can be seen in table 2.8, the emission of CH₄ dominated in this sector in 1991 (almost 87.7%). The main part of GHG emissions came from *solid waste disposal on land* and *wastewater handling*.

Table 2.8. GHG emissions from sub-sectors in category 6 *Waste* in 1991

GHG emission categories	GHG Emission [Tg CO ₂ -eq]	% share in the total emission from Waste	% Share in total GHG emission from a given sub-sector		
			CO ₂	CH ₄	N ₂ O
Total Waste	12 597.17	100	3.3	87.7	9.0
A. Solid Waste Disposal on Land	4 975.91	39.5	0.0	39.5	0.0
B. Wastewater Handling	7 193.23	57.1	0.0	48.2	8.9
C. Waste Incineration	428.03	3.4	3.3	0.0	0.1

2.4 Comparison to base year (1988/1995)

The data for the GHGs and for the national total GHG emission are given in table 2.9.

Table 2.9 Changes of greenhouse gas emissions in 1991 with respect to base year 1988/1995

Pollutant	Base year	1991	1991/base year [%]
	Emission in CO ₂ eq. [Gg]	Emission in CO ₂ eq. [Gg]	
CO ₂ – net emission (with LUCF)	461 951.16	356 824.85	77.24
CO ₂ – without LUCF.	494 885.88	389 359.08	78.68
CH ₄	49 256.41	46 526.38	94.46
N ₂ O	42 478.82	33 902.91	79.81
HFCs	26.44	NE	NE
PFCs	250.18	NE	NE
SF ₆	13.15	NE	NE
TOTAL without CO ₂ from LUCF	586 910.88	469 788.38	80.04
TOTAL with LUCF	553 976.16	437 254.14	78.93

* for industrial gases: HFC, PFC and SF₆ the base year is 1995

Carbon dioxide

CO₂ emission had decreased by app. 21.3% from the base year to 1991.

The following changes took place in the structure of fuel use:

- share in of solid fuels decreased from 85.3% in 1988 to 83.7% in 1991
- share of liquid fuels increased from 11.4% (1988) to 12.6% (1991)
- share of gaseous fuels increased from 3.3% (1988) to 3.6% (1991).

Methane

CH₄ emission had decreased by app. 5.5% from the base year to 1991. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 13.0%,
- the decrease in *Fugitive Emission* by 23.5%,
- the increase in emission from *Waste* by 71.2%.

Nitrous oxide

The nitrous oxide emissions in 1991 were app. 20.2% lower than the respective figure for the base year. The share in *Manure Management* increased from 22.0% in 1988 to 26.1% in 1991, in *Agricultural Soils* decreased from 55.6% (1988) to 53.6% (1991) and in *Chemical Industry* decreased from 11.8% in 1988 to 9.7% in 1991.

Emissions of greenhouse gases in base year (1988/1995) in CO₂ equivalent

Shares of individual GHGs to national total in base year (1988/1995) are presented in Table 2.10 and Figure 2.5 Compared to 1988/1995, the percentage share of CO₂ in 1991 decreased from 84.3% to 82.9%.

Table 2.10 Emissions of greenhouse gases in base year (1988/1995) in CO₂ equivalent

Pollutant	base year 1988 (1995)	
	Emission in CO ₂ eq. [Gg]	Share [%]
CO ₂ – net emission (with LUCF)	461 951.16	
CO ₂ – without LUCF.	494 885.88	84.3
CH ₄	49 256.41	8.4
N ₂ O	42 478.82	7.2
HFCs	26.44	0.0045
PFCs	250.18	0.0426
SF ₆	13.15	0.0022
TOTAL without CO ₂ from LUCF	586 910.88	100.0
TOTAL with LUCF	553 976.16	

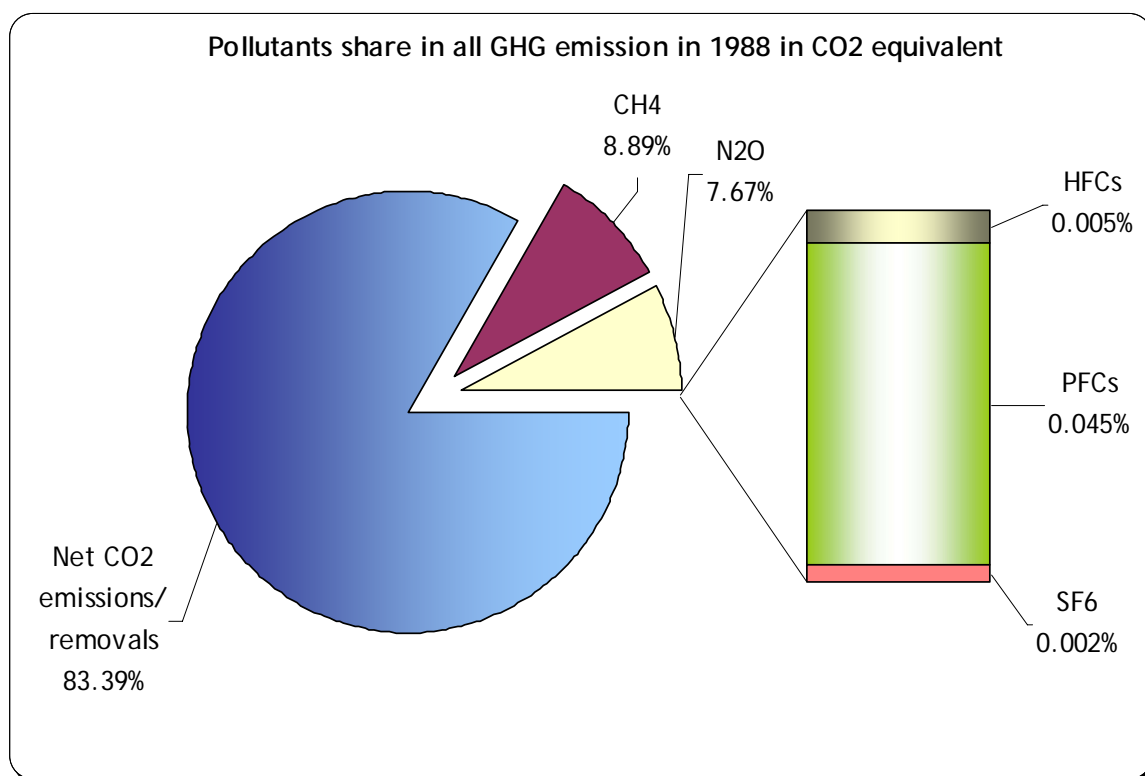


Figure 2.5 Percentage share of national greenhouse gas emissions in base year (1988/1995) including emission from sector 5.

2.5 Comparison of greenhouse gas emissions 1991 and 1990

Changes of national emissions and sinks of GHGs in 1991 compared to 1990 were:

CO ₂	- net emission fall to	97.99%
CH ₄	- emission fall to	94.42%
N ₂ O	- emission fall to	86.33%

Below results are discussed separately for each greenhouse gas with respect to 1991 emissions and change between 1991 and 1990.

Carbon dioxide (CO₂)

In 1991, the net CO₂ emissions (with LULUCF) was 2.0% lower than in 1990. The CO₂ emission in 1991 from category *Energy* was lower by 1.6% and from category *Industrial Processes* was lower by 8.7% than in 1990. In comparison to 1990 the CO₂ emission from category *Waste* in 1991 fall by 9.9%.

Table 2.11. Comparison of carbon dioxide emission in 1990 and 1991

Year	CO ₂ [Gg]		1991/1990 [%]
	1990	1991	
TOTAL without LUCF	396 860.7	389 359.1	98.1
1. Energy	379 179.0	373 193.1	98.4
A. Fuel Combustion	379 128.1	373 142.9	98.4
1. Energy Industries	245 585.4	241 715.5	98.4
2. Manufacturing Industries and Construction	44 889.1	36 851.4	82.1
3. Transport	27 344.1	27 032.0	98.9
4. Other Sectors	59 549.9	65 125.8	109.4
5. Other	1 759.6	2 418.2	137.4
B. Fugitive Emissions from Fuels	50.9	50.2	98.7
1. Solid Fuels	1.6	1.4	88.7
2. Oil and Natural Gas	49.3	48.8	99.0
2. Industrial Processes	16 717.8	15 268.3	91.3
A. Mineral Products	8 478.2	7 734.4	91.2
B. Chemical Industry	2 613.2	2 652.7	101.5
C. Metal Production	5 626.4	4 881.2	86.8
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	505.2	484.2	95.8
4. Agriculture	NE	NE	NE
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	NE	NE	NE
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	NE	NE	NE
5. Land Use, Land-Use Change and Forestry	-32 725.5	-32 534.2	99.4
A. Forest Land	-40 042.5	-39 328.3	98.2
B. Cropland	6 666.9	6 479.8	97.2
C. Grassland	3 699.3	3 595.5	97.2
D. Wetlands	NE	NE	NE
E. Settlements	-3 049.2	-3 281.3	107.6
F. Other Land	NE	NE	NE
6. Waste	458.7	413.5	90.1
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	NE	NE	NE
C. Waste Incineration	458.7	413.5	90.1

Methane (CH₄)

The emission in 1991 was lower than in 1990 by 5.6%. The main sources are *Agriculture*, *Energy* and *Waste*. Emission from *Manure Management* in the *Agriculture* sector was higher by 9.06% in 1991 and from *Waste* sector was lower by 1.3% than in 1990. *Fugitive emission* in *Energy* sector was lower by 6.5% in 1991 compared to 1990.

Table 2.12 Comparison of methane emission in 1990 and 1991

Year	CH ₄ [Gg]		1991/1990 [%]
	1990	1991	
TOTAL	2 346.54	2 215.54	94.4
1. Energy	897.32	840.47	93.7
A. Fuel Combustion	13.20	13.64	103.3
1. Energy Industries	3.26	3.21	98.5
2. Manufacturing Industries and Construction	1.93	1.51	78.1
3. Transport	6.35	6.90	108.7
4. Other Sectors	1.57	1.80	114.6
5. Other	0.10	0.22	230.1
B. Fugitive Emissions from Fuels	884.12	826.83	93.5
1. Solid Fuels	705.27	664.08	94.2
2. Oil and Natural Gas	178.85	162.74	91.0
2. Industrial Processes	10.91	10.48	96.0
A. Mineral Products	NE	NE	NE
B. Chemical Industry	7.69	7.82	101.6
C. Metal Production	3.22	2.66	82.6
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	NE	NE	NE
4. Agriculture	905.17	838.21	92.6
A. Enteric Fermentation	742.75	661.33	89.0
B. Manure Management	160.94	175.52	109.1
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	1.48	1.36	91.7
5. Land Use, Land-Use Change and Forestry	0.17	0.10	58.6
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.17	0.10	58.6
F. Other Land	NE	NE	NE
6. Waste	532.97	526.29	98.7
A. Solid Waste Disposal on Land	227.78	236.95	104.0
B. Wastewater Handling	305.19	289.34	94.8
C. Waste Incineration	NE	NE	NE

Nitrous oxide (N₂O)

The emission was lower than in 1990 (by 13.7%). The main sources of N₂O emission are *Manure Management* and *Agricultural Soils*. Emission from *Manure Management* in the *Agriculture* sector was lower by 3.2% in 1991 and from *Agricultural Soils* was lower by 20.6% than in 1990.

Table 2.13. Comparison of nitrous oxide emission in 1990 and 1991

Year	N ₂ O [Gg]		1991/1990 [%]
	1990	1991	
TOTAL	126.69	109.36	86.3
1. Energy	7.48	7.51	100.4
A. Fuel Combustion	7.48	7.51	100.4
1. Energy Industries	3.51	3.50	99.6
2. Manufacturing Industries and Construction	0.72	0.62	86.9
3. Transport	1.64	1.44	87.7
4. Other Sectors	1.10	1.20	109.8
5. Other	0.51	0.74	145.0
B. Fugitive Emissions from Fuels	NE	NE	NE
1. Solid Fuels	NE	NE	NE
2. Oil and Natural Gas	NE	NE	NE
2. Industrial Processes	11.87	10.57	89.1
A. Mineral Products	NE	NE	NE
B. Chemical Industry	11.87	10.57	89.1
C. Metal Production	NE	NE	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	0.40	0.40	100.0
4. Agriculture	103.35	87.23	84.4
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	29.52	28.58	96.8
D. Agricultural Soils	73.75	58.58	79.4
F. Field Burning of Agricultural Residues	0.08	0.07	88.3
5. Land Use, Land-Use Change and Forestry	0.0011	0.0007	58.6
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.0011	0.0007	58.6
F. Other Land	NE	NE	NE
6. Waste	3.59	3.65	101.7
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	3.54	3.60	101.9
C. Waste Incineration	0.05	0.05	89.2

2.6 Emission trends for indirect greenhouse gases (CO, NO_x and NMVOC) and SO₂

Precursors of greenhouse gases e.g. NO_x, CO and non-methane volatile organic compounds - NMVOC, through their influence on the greenhouse gases, have an indirect effect on climate. The presence of SO₂ in the atmosphere influences the climate by increasing the number of secondary aerosols, which have been found to have a cooling effect. Figures 2.6-2.9 shows trends of emissions of SO₂, NO_x, NMVOC (1980-2005) and CO (1990-2005). Emissions of SO₂ decreased by 70% between 1980 and 2005, and 62% between 1990 and 2005. Most of the reductions were caused by the decline of the heavy industry in the late 1980s and early 1990s. In late 1990s the emissions declined because of the diminished share of coal (hard and brown) among fuels used for power and heat generation.

Emissions of NO_x decreased by 33% between 1980 and 2005, and 36% between 1990 and 2005. Similar to sulphur dioxide, most of the reductions were caused by the decline of the heavy industry and lower share of coal in the late 1980s and early 1990s. Increasing emissions from road traffic contribute to the national total, and cause comparatively lower emission reductions than in case of SO₂. Emissions of NMVOC decreased by 44% between 1980 and 2002, and 30% between 1990 and 2005. In 1981, there was a drop of NMVOC emission compared to 1980, but already in 1983 emissions began to grow and reached the maximum in 1988 - 1989. In 1990, there was a significant decrease of emissions, followed by a period of fairly stable emissions until 1997. Then the emissions began to fall again until the year 2001. From 1990 to 2005 the emissions of CO have decreased by 55%, mainly because of the same reasons as the described above decline in emissions of SO₂ and NO_x.

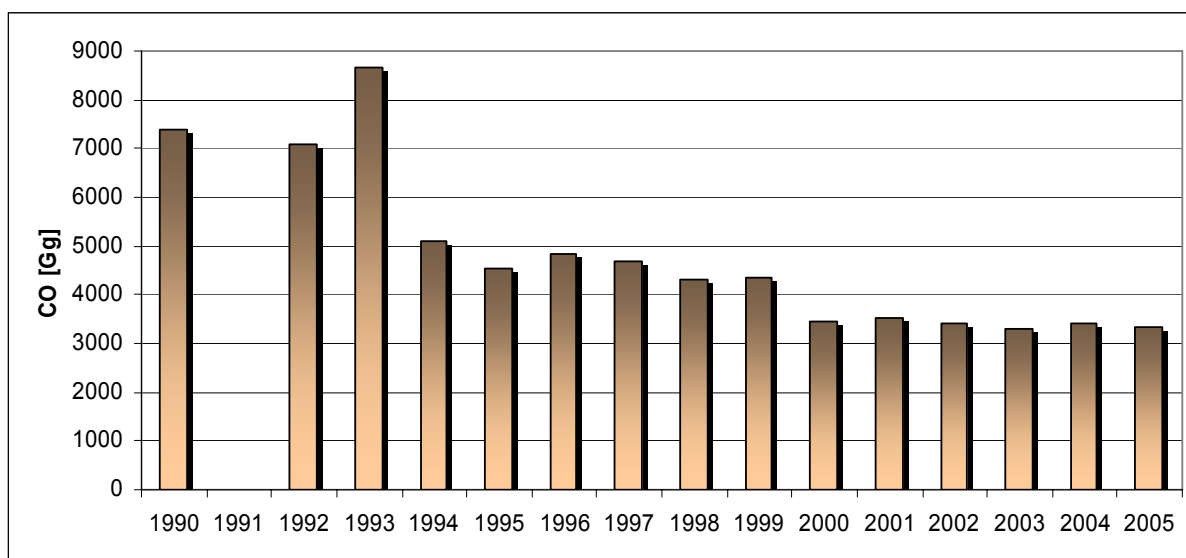


Figure 2.6 Emissions of CO (1990-2005).

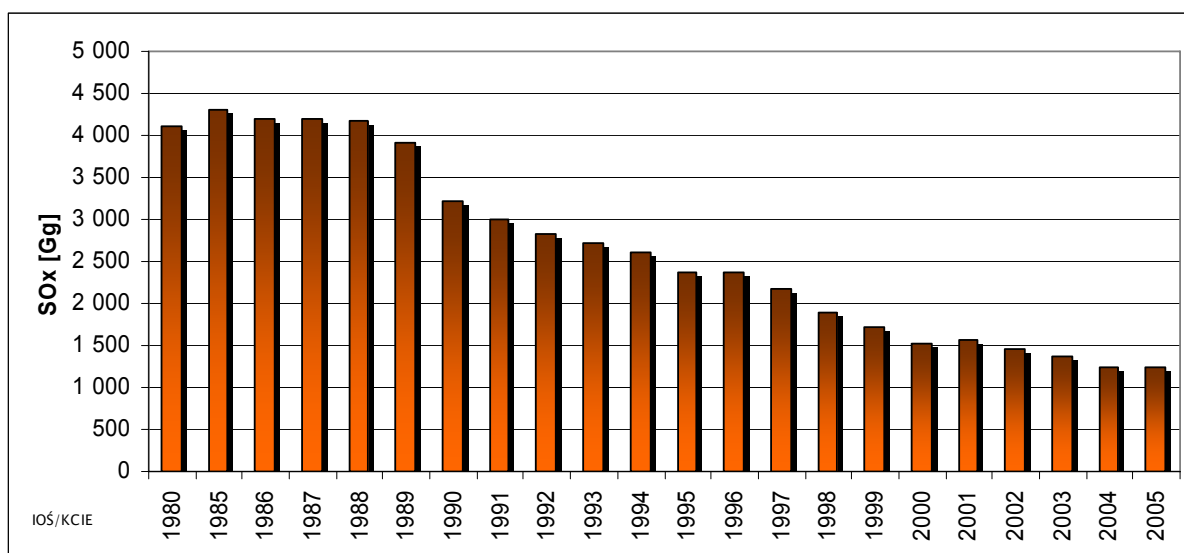


Figure 2.7 Emissions of SO_x, (1980-2005).

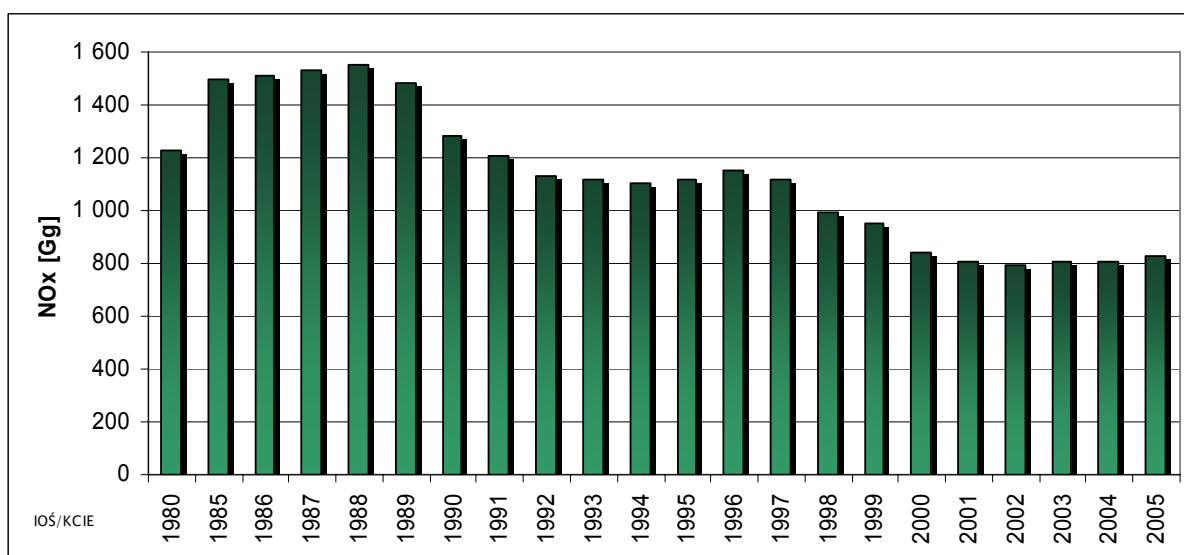


Figure 2.8 Emissions of NO_x, (1980-2005).

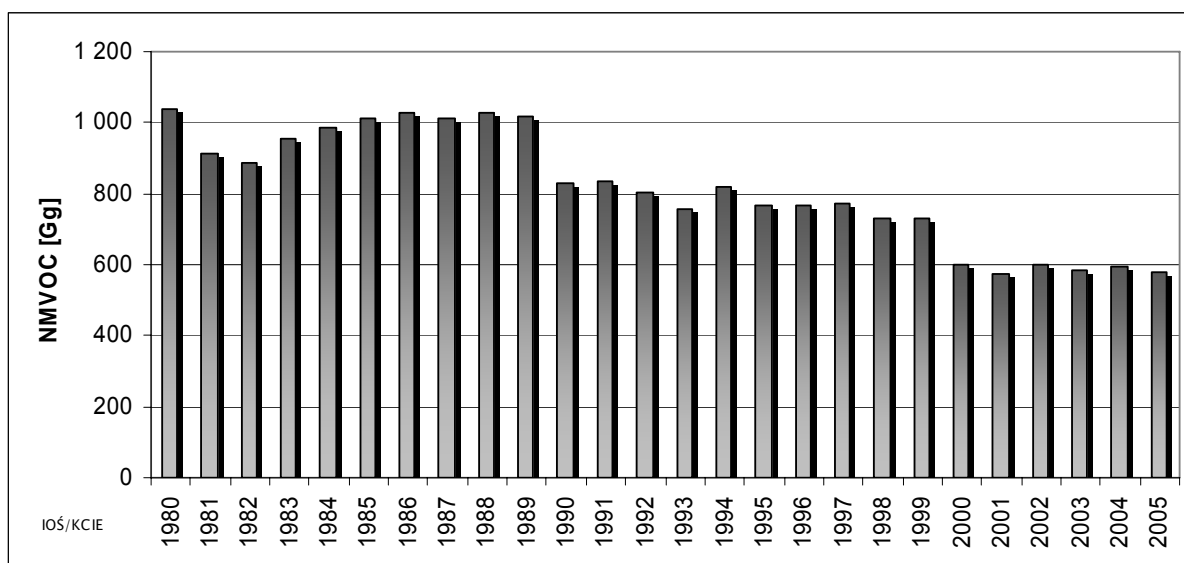


Figure 2.9 Emissions of NMVOC (1980-2005).

3. Energy (CRF sector 1)

3.1 Key categories

Following categories from sector 1 have been identified as key sources:

- 1.A.1, 1.A.2, 1.A.4, 1.A.5.a Stationary combustion of solid, liquid and gaseous fuels (CO₂ emission), share in total GHG emission 73.3%
- 1.A.3.b Transport Road Transportation (CO₂ emission), share in total GHG emission 4.4%
- 1.B.1.a. Coal Mining and Handling (CH₄ emission), share in total GHG emission 3.0%
- 1.B.2.b. Natural Gas (CH₄ emission), share in total GHG emission 0.7%

Share of these categories in total Poland's GHG emissions is 81.4%.

3.2 Methodological issues

3.2.1. Fuel combustion (CRF 1.A)

3.2.1.1. Fuel combustion – Sectoral Approach (CRF 1.A.a)

Combustion as a source of GHG emission occurs in the following category groups:

- 1.A.1. Energy industries
- 1.A.2. Manufacturing industries and construction
- 1.A.3. Transport
- 1.A.4. Other sectors:
 - a. commercial/institutional
 - b. residential
 - c. agriculture/forestry/fishing
- 1.A.5. Other:
 - a. stationary
 - b. mobile

Inventory methodology for **all stationary sources** assumes GHG emission estimation from fuel combustion on the level determined as *Tier 2* and is based on the simple formula:

$$E = \sum (EF_{abc} * A_{abc})$$

where: E - emission

EF - emission factor

A - fuel consumption

a - fuel type, b - sector, c - combustion technology

The national methodology as a primary step introduces preparation of balance spreadsheets, for each fuel. In the spreadsheet, the final calculation leads to the estimation of country specific average net calorific value (NCV) and calculation of elemental C content in the fuel - C_{max}, the maximum emission factor for CO₂. Description and examples of balance spreadsheets are given in chapter 1.4 and Annex 2.

Fraction of oxidised carbon

- gas – 0.995
- oil and oil products – 0.99
- coal – depending on technology of combustion:
 - pulverised coal - 0.984
 - travelling grate stocker – 0.946 – 0.973
 - underfeed stocker – 0.934 - 0.960
 - domestic open fire – 0.988 - 0.994
 - shallow bed AFBC (Advanced Fluidised Bed Combustion) - 0.960
 - Circulating Fluidised Bed Combustion – 0.970
 - Pressurised Fluidised Bed Combustion – 0.970

Fraction of carbon oxidised for hard coal – values for individual sub-sectors (these value have been selected basing on the estimation of share of combustion technology mentioned above):

- 0.984 for *Public thermal plants* and *Public heat plants*
- 0.973 for: *Autoproducing thermal plants*, *Non-public heat plants*, *Boilers in public thermal plants* and for fuel combustion in industry sectors
- 0.988 for *Commercial / Institutional*, *Residential*, *Agriculture / Forestry* sectors

Fraction of carbon oxidised for coke and lignite – like in the case of hard coal

Emission factors for fuel combustion in stationary sources

Maximum emission factors for elemental carbon were determined for major fuels in the form of formulas dependent on net calorific values - NCV, obtained with regression analysis of the results of country measurements. The following formulas were obtained:
the emission factor for elemental carbon from hard coal:

$$C_{hc} = 10(2.4858 \cdot NCV + 3.3132) / NCV$$

where: C_{hc} emission factor for hard coal [kg C/GJ],
NCV- net calorific value of hard coal [MJ/kg],

the emission factor for elemental carbon from brown coal (lignite):

$$C_{bc} \text{ [kg C/GJ]} = 10(1.9328 \cdot NCV + 10.067) / NCV$$

where: C_{bc} emission factor for brown coal [kg C/GJ],
NCV- net calorific value of brown coal [MJ/kg],

the emission factor for elemental carbon from coke and semi-coke:

$$C_c \text{ [kg C/GJ]} = 53.139 - 0.811 \cdot NCV$$

where: C_c emission factor for coke [kg C/GJ],
NCV- net calorific value of coke [MJ/kg],

the emission factor for elemental carbon from motor gasoline and diesel oil (this formula does not apply to mobile sources):

$$C_{gdo} [\text{kg C/GJ}] = 28.03333 - 0.192 * \text{NCV}$$

where: C_{gdo} emission factor for gasoline or diesel oil [kg C/GJ],
 NCV- net calorific value of gasoline or diesel oil [MJ/kg],

the emission factor for elemental carbon from fuel oil:

$$C_{fo} [\text{kg C/GJ}] = 39.7549 - 0.450 * \text{NCV}$$

where: C_{fo} emission factor for fuel oil [kg C/GJ],
 NCV- net calorific value of fuel oil [MJ/kg],

the emission factor for high-methane natural gas:

$$C_{hmng} [\text{kg C/GJ}] = 24.9018 - 0.2843 * \text{NCV}$$

where: C_{hmng} emission factor for high-methane natural gas [kg C/GJ],
 NCV- net calorific value of fuel oil [MJ/m³],

the emission factor for nitrified natural gas:

$$C_{nng} = 15.0 [\text{kg C/GJ}]$$

The following formula was derived for the emission factor for elemental carbon from city gas:

$$C_{cg} [\text{kg C/GJ}] = 10.678 - 0.029 * \text{NCV}$$

where: C_{cg} emission factor for city gas [kg C/GJ],
 NCV- net calorific value of city gas [MJ/m³].

Finally, following formula was derived for the emission factor for elemental carbon from blast furnace gas:

$$C_{bfg} [\text{kg C/GJ}] = 115.5 - 13.43 * \text{NCV}$$

where: C_{bfg} emission factor for blast furnace gas [kg C/GJ]
 NCV- net calorific value of blast furnace gas [MJ/m³].

Calculation of the CO₂ emission factor, when the C_{max} [kg C/GJ] is already known is done with the following formula:

$$EF_{abc} = C_{max} * 44/12 * FO_{abc} [\text{kgCO}_2/\text{GJ}]$$

where: C_{max} - maximum content of elemental carbon in fuel [kg C/GJ]
 FO_{abc} - carbon oxidation factor in combustion processes dependent on fuel type and combustion technology

CO₂ emission factors for main fuels are calculated for each sub-category basing on formulas given above. NCV of fuel, which is applied in formula, is calculated basing on statistical data for this fuel consumption expressed in TJ and in natural units. Suitable carbon oxidation

factor value for individual sub-category is selected according to information given above. In some cases aggregation of estimated emission data from detailed sub-sectors is necessary for full-filling of relevant CRF tables. For example, aggregation is needed in 1.A.1.a sub-category where emissions are calculated for each type of energy production plants separately, according to applied national methodology of inventory.

For CH₄ and N₂O applied emission factors are default factors taken from [IPCC 1997, 2006]. The emission factors for other pollutants (e.g. NO_x, CO and NMVOC) were selected from existing sets by taking into account industrial technologies and combustion conditions.

Emissions in 1.A.1 *Energy Industries* category are estimated for each fuel according to data on the year consumption value given in *Energy Statistics* published by Central Statistical Office (GUS). Calculation of emissions are carried out for detailed sub-categories as follows:

a) 1.A.1.a *Public Electricity and Heat Production*

- *Public thermal plants* – electricity generation (PKD¹ 40.1),
- *Public thermal plants* – heat generation (PKD 40.1)
- *Autoproducing thermal plants* – electricity generation (PKD 40.1)
- *Autoproducing thermal plants* – heat generation (PKD 40.1)
- *Public heat plants* (PKD 40.3)
- *Non-public heat plants* (PKD 40.3)
- *Boilers in public thermal plants* (PKD 40.3)

b) 1.A.1.b *Petroleum Refining* (PKD 23.2)

- *Manufacture of refined petroleum products* (PKD 40.3)

c) 1.A.1.c *Manufacture of Solid Fuels and Other Energy Industries*

- *Manufacture of coke oven products* (PKD 23.1)
- *other energy industries* (PKD 10.1, 10.2, 11.1, 40.1 and 40.3 – only direct consumption of fuels included)

Emissions in 1.A.2 *Energy Industries* category are estimated for each fuel in detailed sub-categories as follows:

a) *Iron and Steel* - 1.A.2.a (PKD 27 excluding activities connected with 1.A.2.b *Non-Ferrous Metals* sub-category given below)

b) *Non-Ferrous Metals* - 1.A.2.b (PKD 27.4, 27.53, 27.54)

c) *Chemicals* - 1.A.2.c (PKD 24 i 25)

d) *Pulp, Paper and Print* - 1.A.2.d (PKD 21 i 22)

e) *Food Processing, Beverages and Tobacco* - 1.A.2.e (PKD 15 and 16)

f) *Other* - 1.A.2.f:

- *construction* (PKD – section F) and *other industry branches not included elsewhere*: (PKD 13-14, 17-20, 26, 28-37, 40.2, 41)
- *off-road and other mobile machinery in industry and construction sectors*

Estimation of emissions in 1.A.3 *Transport* are carried out for each fuel in sub-categories listed below:

a) *Civil Aviation* (1.A.3.a)

b) *Road Transportation* (1.A.3.b)

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

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

e) *Other Transportation* (1.A.3.e)

¹ PKD – (Polska Klasyfikacja Działalności) – Polish Classification of Economic Activities

Emissions in 1.A.4 *Other Sectors* are estimated for each fuel in detailed sub-categories given below:

a) *Commercial/Institutional* (1.A.4.a) (PKD sections excluding sections connected with categories included elsewhere, it means excluding sections A-F and I)

b) *Residential* (1.A.4.b)

c) *Agriculture/Forestry/Fisheries* (1.A.4.c) (PKD – sections A and B)

- agriculture – stationary sources,
- agriculture – mobile sources
- fisheries.

Emissions in 1.A.5 *Other* are estimated for each fuel in detailed sub-categories as follows:

a) *stationary* (1.A.5.a) – (PKD – section I – only stationary sources from this)

b) *mobile* (1.A.4.b)

- other national aviation (not included in 1.A.3.a)
- emission from the use of motor gasoline, diesel oils and liquid gas calculated in the inventory as statistical difference between total direct consumption of these fuels given in statistic and summary results of consumption in categories 1.A.1, 1.A.2, 1.A.3 and 1.A.4.

List of fuels for which GHG emissions are estimated is as follow:

- liquid fuels: fuel oil, liquid petroleum gas (LPG), crude oil, refinery gas, non-energy products, feedstocks, other energy sources, gaseous waste fuels
- gas fuels: high – methane natural gas, coal-bed methane, nitrified natural gas
- solid fuels: hard coal, lignite, coke, coke oven gas, blast furnace gas, town gas, gas manufactured from coal, industrial wastes, municipal wastes - (non-biomass fraction)
- biomass: fuel wood, solid biomass and animal products, biogas, municipal wastes - (biomass fraction).

Sources of information

The correct inventory of GHG emissions for stationary sources, carried out by:

- precise determination of activities for categories: 1.A.1, 1.A.2, 1.A.4 and 1.A.5 and
- correct calculation or selection of emission factors for CO₂, CH₄ and N₂O

is supported by data found in the following periodic publications (annual or less frequent) or statistical yearbooks for some economy sectors:

- Electrical Power Statistics [GUS 1993a]
- Energy Balance Poland – OECD [ARE 1992]

Emission factors for stationary combustion in the sectors 1.A.1, 1.A.2, 1.A.4 and 1.A.5 are presented in the tables 3.1-3.4. Empty cells for CO₂ emission factors mean that EF is calculated based on the functions described above. Country specific EFs are estimated based on measurements or based on literature and expert opinion (not calculated based on functions connected with NCV) are marked by italic. The other factors are default values taken from [IPCC 2006].

Table 3.1. Applied EFs [kg/GJ] for 1.A.1. category

Fuel	EF CO ₂	EF CH ₄	EF N ₂ O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Rafinery Gas	51.30	0.0010	0.0001
Non-energy Products	76.50	0.0030	0.0006
Liquide and Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040

Table 3.2. Applied EFs [kg/GJ] for 1.A.2 category

Fuel	EF CO ₂	EF CH ₄	EF N ₂ O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Rafinery Gas	51.30	0.0010	0.0001
Non-energy Products	76.50	0.0030	0.0006
Liquide and Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0100	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040

Table 3.3. Applied EFs [kg/GJ] for 1.A.4 category

Fuel	EF CO ₂	EF CH ₄	EF N ₂ O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Non-energy Products	76.50	0.0030	0.0006
Liquide and Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040

Table 3.4. Applied EFs [kg/GJ] for 1.A.5 category

Fuel	EF CO ₂	EF CH ₄	EF N ₂ O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Non-energy Products	76.50	0.0030	0.0006
Liquide and Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040

As concerns sector 1.A.3 *Transport*, activity data for road transport were taken from [ITS 1995]. CO₂ emissions factors for road transport come also from [ITS 1995]. All other emission factors are default values from [IPCC 1997, 2006]. Applied emission factors are presented in the table 3.5.

Other activity data sources are as follows:

- ♦ OECD Energy Balance for Poland, [ARE 1992],
- ♦ Questionnaire/Report G-03, [GUS 1992e],
- ♦ Statistical Yearbook of The Republic of Poland [GUS 1993],
- ♦ Non-published data from Agency of Energy Market

Table 3.5 Emission factors [kg/GJ] for transport in 1991

Type of transport	Vehicle specification	EF CO ₂	EF CH ₄	EF N ₂ O
1.A.3.a.ii Civil Aviation. Domestic	1.i.PL.	70.33	0.0005	0.0022
1.A.3.a.i i International Aviation - bunker	1.i.PL.	70.33	0.0005	0.0022
1.A.5.b. Other Aviation	1.ii.BL.	72.10	0.060	0.0009
	1.ii.PL.	72.80	0.002	0.0002
1.A.3.b.i Passenger Cars without catalysts	2.i.a.BS	72.67	0.030	0.002
	2.i.a.LG	67.09	0.020	0.0002
	2.i.a.ON	73.84	0.002	0.004
	2.i.b.BS	72.67	0.020	0.001
1.A.3.b. Passenger Cars with catalysts	2.i.g.BS	72.67	0.007	0.0200
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	2.ii.a.BS	72.67	0.020	0.001
	2.ii.a.ON	73.84	0.001	0.0040
	2.ii.b.BS	72.67	0.020	0.001
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	2.ii.g.BS	72.67	0.020	0.001
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	2.iii.a.BS	72.67	0.020	0.001
	2.iii.a.ON	73.84	0.006	0.003
	2.iii.b.ON	73.84	0.006	0.003
1.A.3.b.iv Motorcycles	2.iv.BS	72.67	0.100	0.001
1.A.3.b.iv Mopeds	2.iv.BS	72.67	0.100	0.001
1.A.3.b.vi Tractors	2.vi.ON	73.84	0.004	0.0039
1.A.3.c. Railways	3.ON	73.00	0.004	0.030
	3.WK	75.00	0.006	0.002
1.A.3.d.ii Domestic Navigation - inland	4.ON	73.00	0.004	0.030
1.A.3.d.ii Domestic Navigation - marine	5.i.ON	74.10	0.007	0.002
	5.i.OP	77.60	0.007	0.002
1.A.3.d.i Domestic Navigation - bunker	5.i.ON	74.10	0.007	0.002
	5.i.OP	77.60	0.007	0.002
1.A.4.c.iii Fishery	5.ii.ON	74.10	0.007	0.002
	5.ii.OP	77.60	0.007	0.002
1.A.4.c.ii Agriculture - Off-Road Vehicles	6.i.ON	73.00	0.004	0.0039
1.A.4.c.ii Agriculture - Machines	6.ii.ON	73.00	0.004	0.030
1.A.2. Off-Road Vehicles in Industry na Other	7.i.ON	73.00	0.004	0.030
1.A.3.e.ii Other Off-Road Transport	7.ii.BS	71.00	0.120	0.002
	7.ii.LG	63.10	0.062	0.0002
	7.ii.ON	73.00	0.004	0.0300

Abbreviation explanations to table 3.5:

catal - catalytic converter

BS - motor gasoline

ON - diesel oil

LG – liquid gas

OP - fuel oil

PL - jet fuel

BL - aviation gasoline.

Domestic statistics for year 1991 do not contain division of activity data concerning consumption of non-energy products for particular economy sectors. For that reason estimation of non-energy products use for a given sector is based on total consumption of non-energy products in year 1991 [GUS 1993a] and on four-years average (from years 1996-1999) share of mentioned fuel energy consumption for this sector in total domestic consumption. Based on these calculations, the following shares of energy consumption of non-energy products have been estimated for IPCC subcategories: 1.A.1 – 10.6%, 1.A.2 – 29.9%, 1.A.4.- 21% and 1.A.5 – 1.4 %. Finally, energy consumption stands for about 63% of total consumption of non-energy products.

3.2.1.2. *Fuel combustion – Reference Approach (CRF 1.A.b)*

The CO₂ emissions from fuel combustion category was estimated also by use of reference approach characterising “top–down” approach to GHG emissions estimations. The difference between reference and sectoral approaches in CO₂ emissions is 0.98% in favour of sectoral approach [Radwański 2006a]. More data on energy consumption and CO₂ emissions for both approaches are given in annex 6, in CRF table 1.A(c).

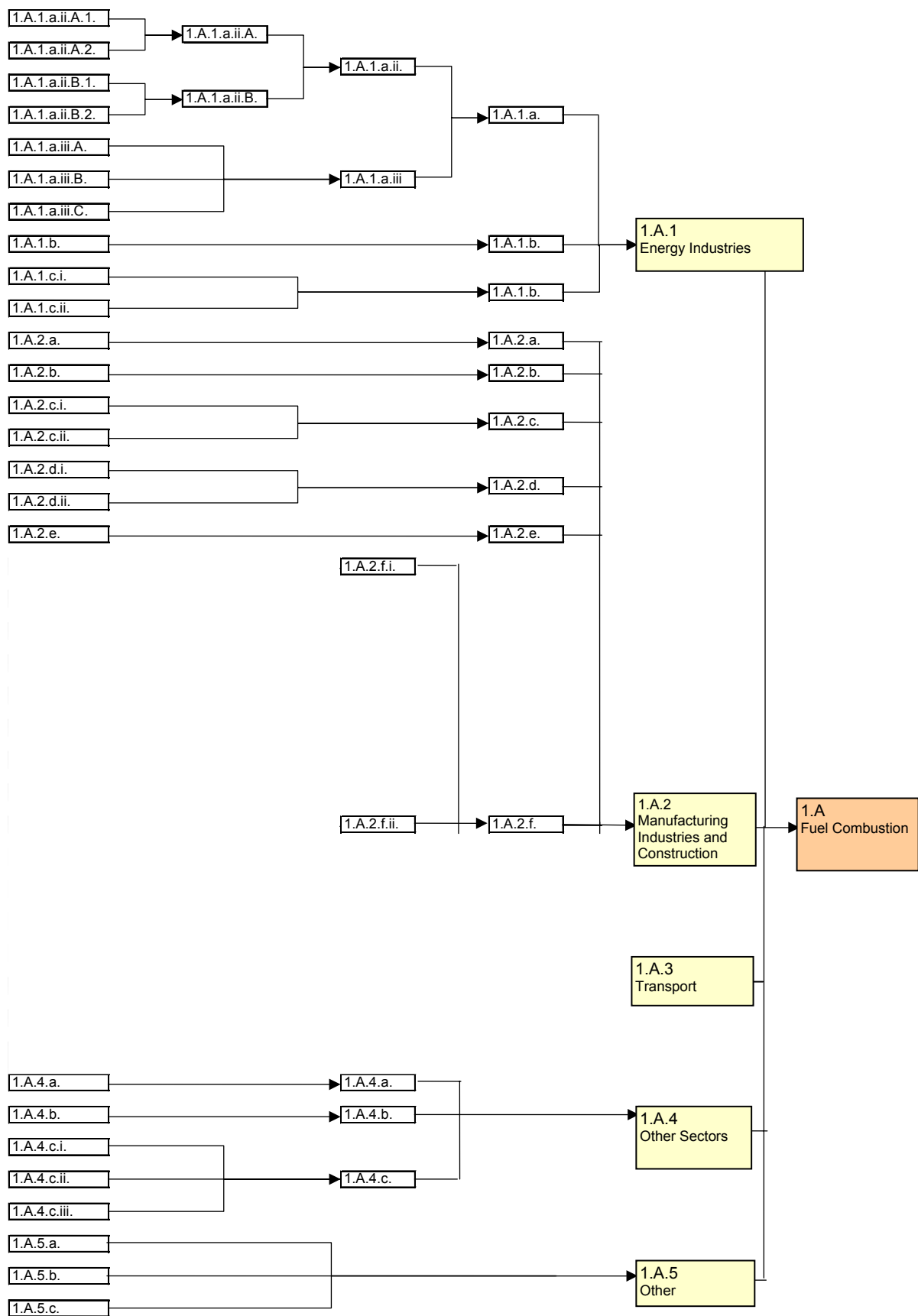


Figure 3.1. Flowchart of summing up sub-sectors in sector 1.A - Fuel Combustion

3.2.2 Fugitive emissions from fuels (CRF 1.B)

3.2.2.1 Fugitive emissions from fuels – coal mining (CRF 1.B.1.a)

Coal Mining and Handling – underground mines (CRF 1.B.1.a.i)

Based on country study [Gawlik 1994, Gawlik, 2001] domestic emission factors were estimated for the following emission sources in mines: venting systems, methane capture systems, post-mining processes and production waste. The newest emission factors were estimated by [Kwarciński 2005] based on detail data and measurements for entire period 1988–2003. For the domestic inventory purposes emissions factors were calculated for 1 tone coal mined. The set of emissions factors are presented in table 3.6.

Table 3.6. Methane emission factors analysis

Emissions sources	[Gawlik 1994]		[Gawlik 2001]		[Kwarciński 2005]	
	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal
Venting systems	6.0050	4.0234	6.4430	4.3168	5.8011	3.8868
De-methane systems			0.5962	0.3994	0.9927	0.6651
Post-mining processes	1.4810	0.9923	1.0200	0.6834	0.4288	0.2873
Production waste	0.0649	0.0435	0.0630	0.0422	0.0289	0.0194
Closed mines			0.0489	0.0328		0.0000

The following data and references for estimating emission factors for 1991 were used:

- venting processes – [Gawlik 1994]
- methane capture systems – direct data
- post-mining processes – [Kwarciński 2005]
- dumping grounds – [Kwarciński 2005]
- closed mines – not estimated

Table 3.7 contains the data on coal mining as well as methane captured and used for 1991. Emission from de-methane systems stands as a difference between methane capture and use.

Table 3.7. Data relating to coal mining and methane captured and used for 1991

Coal mining	Methane capture	Methane use	Emission from de-methane systems		
			mln m ³	mln Nm ³	Gg CH ₄
143.2	251.6	191.1	60.5	58.50	39.20

Coal Mining and Handling – surface mines (CRF 1.B.1.a.ii)

Fugitive emission of CH₄ from surface mining was estimated based on the activity data concerning lignite extraction amount from the study published by Polish Geological Institute [PIG, 1992] and country specific emission factor, which was taken from the study [Radwański 1995]. The value of these emission factors are as follow:

- Ventilation emission from coal seam – 0.007 m³ CH₄ / t of extracted coal
- Ventilation emission from surrounding rocks - 0.012 m³ CH₄ / t of extracted coal.

The conversion factor applied for recalculation of emitted methane volume upto mass of CH₄ is 0.67 kg/m³.

3.2.2.2 Fugitive emissions from fuels – coke oven gas (CRF 1.B.1.c)

Tier 1 method has been used for calculation of fugitive emissions from coke oven gas system [GPG 2000], while emission factors presented in table 3.8 have been taken from domestic case study [Steczko 1994]. Activity data come from energy statistics [GUS 1993a].

Table. 3.8. Emission factors for CO₂ and CH₄ from coke oven gas system

CO ₂ emission factors	[Gg/PJ]
gas processing	0.000194
gas transmission	0.020629
gas distribution	0.038056
CH ₄ emission factors	
gas processing	0.000546
gas transmission	0.057977
gas distribution	0.106954

3.2.2.3 Fugitive emissions from fuels – oil (CRF 1.B.2.a)

Tier 1 method has been used for calculation of fugitive emissions from oil system [GPG 2000]. Activity data come from energy statistics [GUS 1993a]:

production	PJ	6.624
distribution	Gg	11612

CO₂ and CH₄ factors used for estimation of emissions from oil production have been taken from country study [Żebrowski 1994] while for oil transmission default factors were used from [GPG 2000] (tab. 3.9).

Table 3.9. Emission factors for CO₂ and CH₄ from oil production and transmission

CO ₂ emission factors		
production	EF CO ₂ [Gg/PJ]	6.3150
transmission	EF CO ₂ [Gg/m ³]	0.0054
CH ₄ emission factors		
production	EF CH ₄ [Gg/PJ]	0.0618
transmission	EF CH ₄ [Gg/m ³]	0.00049

3.2.2.4 Fugitive emissions from fuels – natural gas (CRF 1.B.2.b)

Estimation of CO₂ and CH₄ emissions from systems of high-methane and nitrified natural gases was carried out based on *Tier 1* method [GPG 2000]. Activity data come from energy statistics [GUS 1993a] and are given in table 3.10.

Table 3.10. Activities for high-methane and nitrified natural gas systems.

Highmethane gas system		
Gas production	Gas production [PJ]	52.169
Gas processing	Gas use [PJ]	295.330
Gas transmission	Gas use [PJ]	295.330
Underground gas storage	Gas use [PJ]	295.330
Gas distribution	Gas use [PJ]	295.330
Nitrified natural gas system:		
Gas production	Gas production [PJ]	59.098
Gas processing	Gas use [PJ]	40.2919
Gas transmission	Gas use [PJ]	40.2919
Gas distribution	Gas use [PJ]	40.2919

Emission factors for both gas systems were taken from country study [Steczko K. 1994] and are listed in tables 3.11 and 3.12.

Table 3.11. Emission factors for CO₂ and CH₄ from high-methane gas system.

CO ₂ emission factors	[Gg/PJ]
Gas production	0.000402
Gas processing	0.014368
Gas transmission	0.000558
Underground gas storage	0.000011
Gas distribution	0.001234
CH ₄ emission factors	
Gas production	0.100848
Gas processing	0.000004
Gas transmission	0.140189
Underground gas storage	0.002742
Gas distribution	0.309945

Table 3.12. Emission factors for CO₂ and CH₄ from nitrified natural gas system.

CO ₂ emission factors	[Gg/PJ]
Gas production	0.000060
Gas processing	0.051321
Gas transmission	0.000192
Gas distribution	0.000558
CH ₄ emission factors	
Gas production	0.034307
Gas processing	0.101227
Gas transmission	0.109475
Gas distribution	0.317671

4. Industrial Processes (CRF sector 2)

4.1 Key categories

Following categories from sector 2 have been identified as key sources:

- 2.A.1 Cement Production (CO₂ emission), share in total GHG emission 1.1%
- 2.C.1. Iron and Steel Production (CO₂ emission), share in total GHG emission 1.0%

Share of these categories in total Poland's GHG emissions is 2.1%.

4.2 Methodological issues

4.2.1. Mineral Products (CRF 2.A)

4.2.1.1. Cement Production (CRF 2.A.1)

CO₂ emission from cement production was estimated based on data on clinker production from [GUS 1995b]. The applied emission factor is equal 525 kg / Mg clinker. This country specific emission factor is taken from [IMMB 2006].

4.2.1.2. *Lime Production* (CRF 2.A.2)

Emission of CO₂ from lime production was calculated based on data on lime production from [GUS 1995b]. The applied emission factor is equal 785 kg / Mg lime. This is default value given for quicklime (high calcium lime) production in [IPCC 1997].

4.2.1.3. *Soda Ash Production and Use* (CRF 2.A.4)

Soda Ash is produced in Poland in the Solvay Process. Emission of CO₂ from this process was assumed as 0. CO₂ emission from soda ash use was estimated based on assumption that amount of used soda ash is equal soda ash production. Data on soda ash production was taken from [GUS 1992e]. Value of emission factor taken for inventory calculation it is 415 kg CO₂/Mg of soda ash used. This emission factor is recommended in [IPCC 1997].

4.2.2. *Chemical Industry* (CRF 2.B)

4.2.2.1. *Ammonia Production* (CRF 2.B.1)

CO₂ and CH₄ emissions for ammonia production are estimated based on the data on gas and liquid ammonia production from [Radwański 2005]. The CO₂ emission factor (1.5 Mg CO₂/Mg NH₃) was taken from [IPCC 1997]. Methane emission factor is 4.9 kg CH₄ /Mg NH₃ produced was taken from [CITEPA 1992]. Emission N₂O was estimated as 0, according to the study [Kozłowski 2001].

4.2.2.2. *Nitric Acid Production* (CRF 2.B.2)

Estimation of N₂O emission from nitric acid production was based on the annual HNO₃ production data from [GUS 1995b]. The applied country specific emission factor, which is equal 6.47 kg/Mg nitric acid [Kozłowski 2001].

4.2.2.3. *Adipic Acid production* (CRF 2.B.3)

Activity data concerning adipic acid production are taken from adipic production plant. CO₂ emission factor for this category, which is equal 0.300 Mg CO₂/ Mg, was taken from [IPCC 1997].

4.2.2.4. *Carbide Production* (CRF 2.B.4)

Activity data concerning calcium carbide production are published in [GUS 1995b]. CO₂ emission factor for this category, which is equal 1.100 Mg CO₂/ Mg carbide, was taken from [IPCC 1997].

4.2.2.5. *Other* (CRF 2.B.5)

- *Carbon Black Production*

CH₄ emission from production of black carbon was estimated based on annual black carbon production from [GUS 1995b]. The emission factor, which is equal 10 kg CH₄ /Mg black carbon, was taken from [CITEPA 1992].

- *Ethylene Production*

Emission of CO₂ from ethylene production was calculated based on ethylene annual production from [GUS 1995b]. Emission factor was taken from [CITEPA 1992]. Its value is 0.3 kg CO₂ / Mg ethylene produced.

- Caprolactam Production

Data on annual caprolactam production for inventory calculation purpose was taken from [GUS 1995b]. Applied country specific emission factor of N₂O, which value is 4.74 kg N₂O / Mg caprolactam produced, was assessed based on the Polish study [Kozłowski 2001].

4.2.3. Metal Production (CRF 2.C)

4.2.3.1. *Iron and Steel Production* (CRF 2.C.1)

4.2.3.1.1. *Iron Ore Sintering* (CRF 2.C.1.a)

The value of annual iron ore sinter production was taken from [GUS 1992e]. Country specific emission factor of CO₂, which is equal 77.96 kg CO₂ / Mg iron ore sinter, was taken from [KASHUE 2006].

4.2.3.1.2. *Steel Cast Production* (CRF 2.C.1.c)

The data on steel cast production for CO₂ emission calculation was taken from [GUS 1995b]. Country specific emission factor applied for CO₂ emission estimation is from [FEWE 1994]. Its value is 62 kg CO₂ / Mg steel cast produced.

4.2.3.1.3. *Iron Cast Production* (2.C.1.d)

Annual iron cast production for CO₂ emission estimation was taken from [GUS 1995b]. Country specific emission factor applied for CO₂ emission calculation is from [FEWE 1994]. Its value is 61 kg CO₂ / Mg iron cast produced. Applied CH₄ emission factor is 0.20 kg CH₄ / Mg iron cast produced. It was taken from [Radwański 1995].

4.2.3.1.4. *Blast Furnaces Process* (CRF 2.C.1.e)

Processing emission of CO₂ from blast furnaces was estimated based on elementary carbon budget in Blast Furnaces Process.

4.2.3.1.5. *Basic Oxygen Furnace Steel* (CRF 2.C.1.f)

Basic oxygen furnace steel production was taken from [GUS 1995b]. Country specific CO₂ emission factor used for inventory report, which value is 11.26 kg CO₂ / Mg steel produced, was calculated in [FEWE 1994] based on composition of gases from basic oxygen furnaces in Polish plants.

4.2.3.1.6. *Electric Furnace Steel* (2.C.1.g)

Annual electric furnace steel production was taken from [GUS 1995b]. Applied CO₂ country specific emission factor is equal 4.30 kg CO₂ / Mg steel produced and it was calculated in [FEWE 1994] based on composition of gases from electric furnaces in Polish plants. CH₄ emission factor, which value is 0.12 kg CO₂ / Mg steel produced, is country specific as well [FEWE 1994]. Results of measurements carried out in Polish steel plants were the sources of this emission factor [Olczak 1993].

4.2.3.1.7. *Coke production* (CRF 2.C.1.j)

Processing emission of CO₂ from coking plants was estimated based on elementary carbon budget in coking plants process. CH₄ emission was estimated based on coke production volume from [GUS 1995b] and emission factor is 0.2 kg CH₄ / Mg coke produced [EEA 2004].

4.2.3.2. *Ferroalloys production* (CRF 2.C.2)

Emission of CO₂ concerning ferroalloys production was estimated based on annual ferrosilicon production taken from [GUS 1995b]. Applied emission factor, which value is 3900 kg CO₂ / Mg ferrosilicon, was taken from [IPCC 1997] for ferrosilicon – 75% Si.

4.2.3.3. *Aluminium Production* (CRF 2.C.3)

Calculation of CO₂ emission from primary aluminium production is based on the data on aluminium production published in [GUS 1995b]. The emission factor, which is equal 1.8 Mg CO₂ / Mg primary aluminium, was taken from [IPCC 1997] as value recommended for Soderberg Process.

5. Solvent and Other Product Use (CRF sector 3)

5.1 Key categories

There are no sources from sector 3, which are identified as key sources.

5.2 Methodological issues

Calculations of CO₂ emissions within Sector 3, using the common methodology, were carried out on the basis of results of NMVOC emissions [IETU 1995]. from the following activities:

- Paint application (CRF 3.A)
- Degreasing and dry cleaning (CRF 3.B)
- Other solvents use (CRF 3.D)

CO₂ emission factor was determined assuming, that carbon content in NMVOC is 85%. Then carbon content has been calculated in a stoichiometric way to CO₂. Calculations were made in accordance with formula:

$$\text{CO}_2 = 0.85 * 44/12 * \text{NMVOC}$$

where:

CO₂ – carbon dioxide emission from particular subsectors,

NMVOC – NMVOC emission from particular subsectors.

N₂O emission from anaesthesiology was taken from the case study [IOŚ 2001].

6. Agriculture (CRF sector 4)

6.1 Key categories

Following categories from sector 4 have been identified as key sources:

- 4.A. Enteric Fermentation (CH ₄ emission), share in total GHG emission	3.0%
- 4.B. Manure Management (CH ₄ emission), share in total GHG emission	0.8%
- 4.B. Manure Management (N ₂ O emission), share in total GHG emission	1.9%
- 4.D.1. Direct Soil Emissions (N ₂ O emission), share in total GHG emission	2.8%
- 4.D.3. Indirect Soil Emissions (N ₂ O emission), share in total GHG emission	0.8%

Share of these categories in total Poland's GHG emissions is 9.2%.

6.2 Methodological issues

6.2.1. Methane from Enteric Fermentation (CRF 4.A)

The emission factors for estimation of CH₄ emission from enteric fermentation were calculated based on IPCC Guidelines [IPCC 2000] as well as the national case study [Myczko 2001] and updated data on animal breeding [Walczak 2003, 2006]. The CH₄ emission factors were estimated for each livestock subcategory within cattle: dairy cows and non-dairy cattle disaggregated for: calves (under 6 months), young cattle (6–12 months) and other cattle (1 year and over). Also domestic emission factor for sheep was estimated based on disaggregating this livestock group for lambs under one year and mature sheep above one year. The emission factors for other livestock like goats, horses and swine come from [IPCC 1997].

CH₄ emissions for category 4.A Enteric fermentation for cattle and sheep were calculated using the IPCC *Tier 2* methodology. The emissions for goats, horses and swine were calculated using *Tier 1* methodology and default factors [IPCC 1997]. Activity data were obtained from national statistics [GUS 1993]. For goats population activity was taken from 1996 because of lack of data from earlier years.

The calculated Gross Energy Intake (GE) values and applied emission factors expressed in kg CH₄ per head per year, including the weighted mean for all non-dairy cattle subcategories, are given in Table 6.1.

Table 6.1. Livestock population, daily Gross Energy Intake (GE) and CH₄ emissions factors in 1991

Livestock	Population [millions]	GE Gross Energy Intake [MJ/animal/day]	EF Emission Factor [kg CH ₄ / animal / year]
4.A Enteric Fermentation	35.064	---	---
1 Cattle	8.844	---	---
a. Dairy cattle	4.577	229.145	90.176
b Non-dairy cattle	4.267	102.6464	40.395
3 Sheep	3.234	18.035	7.927
4 Goats	0.179	---	5.000
6 Horses	0.939	---	18.000
8 Swine	19.464	---	1.500

6.2.2. Methane from Manure Management (CRF 4.B)

The IPCC *Tier 2* methodology was used to establish domestic CH₄ emission factors for cattle, sheep and swine. The *Tier 1* methodology was used for estimation of default emission factors for goats, horses and poultry [IPCC 1997]. Animal population was taken from [GUS 1993]. For goats population activity was taken from 1996 because of lack of data from earlier years.

Table 6.2. Livestock population, volatile solids excreted (Vs) and CH₄ emissions factors

Livestock	Population [millions]	Vs Volatile Solids Excreted [kg dm /animal/ day]	EF Emission Factor [kg CH ₄ / animal / year]
4.B Manure Management	256.152	---	---
1 Cattle	8.844	---	---
a. Dairy cattle	4.577	4.662	5.512
b Non-dairy cattle	4.267	1.715	2.087
3 Sheep	3.234	0.360	0.167
4 Goats	0.179	0.280	0.120
6 Horses	0.939	1.720	1.390
8 Swine	21.868	0.500	5.592
9 Poultry	221.088	0.100	0.078

The factors recommended for cool climate were used. The country specific CH₄ emission factors for dairy and non-dairy cattle, sheep and swine were calculated based on:

- country specific data on the fraction of manure managed in given AWMS from [Walczak 2003, 2006] (see Table 6.3),
- B₀ (methane-producing potential) factors were taken from [IPCC 1997],
- VS (average daily volatile excreted solids) for dairy, non-dairy cattle and sheep were estimated based on country specific GE (average feed intake); VS for swine was the default value from [IPCC 1997]
- MCFs (methane conversion factors) for individual manure management systems concerning cool climate are from [IPCC 2000].

6.2.3. Nitrous oxide from Manure Management (CRF 4.B)

Livestock population for N₂O emission calculation from manure management was taken from [GUS 1993]. For goats population activity was taken from 1996 because of lack of data from earlier years.

The fractions of manure managed in given AWMS for each type of animals, taken from [Myczko 2001] and [Walczak 2003, 2006], are presented in the table 6.3.

Table 6.3. Fractions of manure managed in given AWMS for each type of animals

Livestock	Type of AWMS		
	Liquid System	Solid Storage and Drylot	Pasture Range and Paddock
Dairy cattle	0.0269	0.7678	0.2053
Non-dairy cattle	0.0507	0.7813	0.1680
Sheep	---	0.5000	0.50
Goats	---	0.9000	0.10
Horses	---	0.9000	0.10
Swine	0.2411	0.7589	---
Poultry	0.2000	0.8000	---

The default values of nitrogen excretion per head of animal for each type of animals (values for Eastern Europe) from [IPCC 1997] were used for emission calculation. Default values of N₂O emission factors for management systems from [IPCC 1997] were applied (Tables 6.4.a, 6.4.b. and 6.5).

Table 6.4.a. Emissions of nitrogen excreted in livestock manure in:

a) liquid system

Livestock	Nitrogen excreted in manure N _{ex} [kg/animal/year]	AWMS [% / 100]	Nitrogen excreted in AWMS [kg N / year / 1000]
1.a. Dairy cattle	70.0	0.0269	8618.491
1.b. Non-dairy cattle	50.0	0.0507	10816.845
3 Sheep	16.0	--	0.000
4 Goats	25.0	--	0.000
6 Horses	25.0	--	0.000
8 Swine	20.0	0.2411	105451.526
9 Poultry	0.6	0.2000	26530.534

b) solid storage and drylot

Livestock	Nitrogen excreted in manure N _{ex} [kg/animal/year]	AWMS [% / 100]	Nitrogen excreted in AWMS [kg N / year / 1000]
1.a. Dairy cattle	70.0	0.7678	245984.762
1.b. Non-dairy cattle	50.0	0.7813	166690.355
3 Sheep	16.0	0.5000	25872.000
4 Goats	25.0	0.9000	4034.610
6 Horses	25.0	0.9000	21127.500
8 Swine	20.0	0.7589	331908.474
9 Poultry	0.6	0.8000	106122.138

Table 6.5. Factors of N₂O–N emission for various manure management systems

Animal Waste Management Systems	EF Emission Factor [kg N ₂ O-N/ kg N]
10. Anaerobic lagoons	0.001
11. Liquid systems	0.001
12. Solid storage and drylot	0.020
13. Other	0.005

6.2.4. Agricultural Soils (CRF 4.D)

6.2.4.1. Direct Soil Emission (CRF 4.D.1)

6.2.4.1.1. N₂O from synthetic fertilisers (CRF 4.D.1.1)

N₂O emission from synthetic fertilisers was estimated based on the amount of synthetic fertiliser nitrogen applied to agricultural fields published in [GUS 1993]. The nitrogen fraction converted to N₂O was estimated as 0.9 (1–0.1 Frac_{gasf} – see 4.D.3) and this is default value from [IPCC 1997]. The country specific emission factor (0.008 kg N₂O-N / kg N applied) taken from [Mercik 2001] was corrected for 0.009 kg N₂O-N / kg N as the previous one included the fraction of nitrogen that is emitted as NO_x + NH₃.

6.2.4.1.2. *N₂O from animal manure applied to soils* (CRF 4.D.1.2.)

Manure nitrogen use as fertiliser was estimated according to IPCC guidelines. The total amount of nitrogen in animal excreta was calculated based on animal population taken from [GUS 1993] and the default values of nitrogen excretion per head of animal for each type of animals (values for Eastern Europe) from [IPCC 1997]. The data on fraction of manure managed in each AWMS applied in Poland are the country specific data taken from Polish studies [Myczko 2001] and [Walczak 2003, 2006]. The fractions of manure managed in given AWMS for each type of animals are given in table 6.3.

N₂O emission factors for all listed AWMS were taken from [IPCC 1997]. The fraction of nitrogen excreted during grazing was calculated based on data estimated for 4.D.2 *Pasture, range and paddock manure*. The value of the total nitrogen excretion fraction that is emitted as NO_x and NH₃ (0.2 kg NH₃-N + NO_x-N / kg of nitrogen excreted by livestock) was taken from [IPCC 1997]. The fraction of livestock nitrogen excretion contained in excrements burned was assumed as 0 in calculations.

6.2.4.1.3. *N₂O from N-fixing crops* (CRF 4.D.1.3)

N₂O emission from N-fixing crops was calculated based on the data on sown area of N-fixing crops, published in [GUS 1993]. According to study [Mercik 2001] 1% of nitrogen fixed by papilionaceous plants is denitrificated to N₂O and in this connection the used emission factor value is 0,010 N₂O-N/ kg N contained in papilionaceous plants. Most above ground plant parts is removed from fields in Poland, so only plant residues were taken into account in N₂O emission calculation. Based on the data from the study mentioned above was assumed, that nitrogen amount in plant residues is 90 kg N/ha.

6.2.4.1.4. *N₂O from crop residue* (CRF 4.D.1.4)

Emission of N₂O for non-N-fixing crop residues was calculated based on the information from [Mercik 2001], that quantity of dry residue from 1 ha of non-N-fixing crop harvested area is 2 Mg d.m. / ha and content of nitrogen in plant residues is 0.76%. The emission factor for inventory purpose was taken from this study as well. Its value is 0,010 kg N₂O-N/ kg N contained in residues. Data on sown area of other than N-fixing crops are published in [GUS 1993].

6.2.4.1.5. *N₂O from cultivation of histosols* (CRF 4.D.1.5)

The area of histosols in Poland is estimated as 1269 thousand ha [Mercik 2001] and this value was applied to entire inventory period from 1988. N₂O emission from cultivation of histosols was estimated based on default emission factor for Mid-Latitude Organic Soils from [IPCC 2000]: 8 kg N₂O-N /ha.

6.2.4.2. *N₂O from pasture, range and paddock manure* (CRF 4.D.2)

Animal population for calculation of N₂O emission from pasture range and paddock was taken from [GUS 1993]. Total amount of nitrogen in animal excreta was estimated based on the data presented in the table 6.6. The default values of nitrogen excretion per head of animal for each type of animals (values for Eastern Europe) from [IPCC 1997] were used. The data on fraction of manure related with grazing animal are the country specific data taken from

Polish studies [Myczko 2001, Walczak 2006]. N₂O emission factor (0.02) for pasture range and paddock was taken from [IPCC 1997].

Table 6.6. Fraction of manure related with grazing animal, nitrogen excreted in AWMS systems and factor of N₂O–N emission

Livestock	Nitrogen excretion N _{ex} [kg/head/yr]	Fraction of manure nitrogen per AWMS [% / 100]	Nitrogen excreted in AWMS [kg N / year / 1000]	EF Emission factor for AWMS [kg N ₂ O-N/ kg N]
1.a. Dairy cattle	70.0	0.21	65786.747	
1.b. Non-dairy cattle	50.0	0.17	35842.800	
3 Sheep	16.0	0.50	25872.000	
4 Goats	25.0	0.10	448.290	
6 Horses	25.0	0.10	2347.500	
8 Swine	--	--	--	
9 Poultry	--	--	--	
		total	130297.337	0.020

6.2.4.3. Indirect emissions (CRF 4.D.3)

The *Tier 1a* method was used for assessing indirect emissions of N₂O for 1991 in Poland. The basic equation for estimating a country's indirect N₂O emissions:

$$N_2O_{\text{indirect} \rightarrow N} = N_2O_{(G) \rightarrow N} + N_2O_{(L) \rightarrow N},$$

where:

$N_2O_{\text{indirect} \rightarrow N}$ – emissions of N₂O in units of nitrogen,

$N_2O_{(G) \rightarrow N}$ – N₂O produced from volatilisation of applied synthetic fertiliser and animal manure N, and its subsequent atmospheric deposition as nitrogen compounds (kg N/year),

$N_2O_{(L) \rightarrow N}$ – N₂O produced from leaching and runoff of applied fertiliser and animal manure N (kg N/year).

6.2.4.3.1. Atmospheric deposition (CRF 4.D.3.1)

Atmospheric deposition of nitrogen compounds fertilises soils and surface waters. It results in enhanced biogenic N₂O formation. According to this methodology the amount of N applied to soils is equal to the total amount of synthetic fertiliser nitrogen applied to soils plus the total amount of animal manure nitrogen excreted in country. Those values have to be multiplied by appropriate volatilisation factors. This sum is then multiplied by an emission factor (table 6.7). Calculations were made according to the following equation:

$$N_2O_{(G) \rightarrow N} = [(N_{\text{FERT}} * \text{Frac}_{\text{GASF}}) + (N_{\text{ex}}/1000 * \text{Frac}_{\text{GASM}})] * \text{EF},$$

where:

$N_2O_{(G) \rightarrow N}$ – N₂O produced from volatilisation of applied synthetic fertiliser and animal manure N, and its subsequent atmospheric deposition as nitrogen compounds,

N_{FERT} – total amount of synthetic nitrogen fertiliser applied to soils, this value is taken from [GUS 1993],

N_{ex} – total amount of animal manure nitrogen excreted in AWMS system (table 6.6),

$\text{Frac}_{\text{GASF}}$ – fraction of synthetic N fertiliser that volatilises to nitrogen compounds, default value,

Frac_{GASM} – fraction of animal manure N that volatilises to nitrogen compounds, default value,

EF– emission factor for N₂O emissions from atmospheric deposition of N on soils and water surfaces, default value.

Table 6.7. Estimation of indirect emissions of N₂O–N from atmospheric deposition

N _{fert} [Gg/year]	Frac _{GASF} [kg N/kg N]	N _{ex} [kgN/year/1000]	Frac _{GASM} [kg N/kg N]	EF [kgN ₂ O-N/kg N]	N ₂ O _{(g)→N} [GgN ₂ O-N]
735	0.1	130 297.34	0.2	0.01	1.00

6.2.4.3.2. Nitrogen leaching and run-off (CRF 4.D.3.2)

Part of the nitrogen is lost from agricultural soils through leaching and runoff, and gets to the groundwater, rivers and wetlands. It results in biogenic production of N₂O. To estimate the amount of applied N that leaches or runs off, the total amount of synthetic fertiliser nitrogen and the total amount of animal N excretion must be summed and then multiplied by a fraction of N input, that is lost through leaching and runoff. Then it must be multiplied by an appropriate emission factor (table 6.8). Calculations were made according to the following equation:

$$N_{2O(L)→N} = (N_{FERT} + N_{ex}/1000) * \text{Frac}_{LEACH} * EF,$$

where:

N₂O_{(L)→N} – N₂O produced from leaching and runoff of applied fertiliser and animal manure N,

N_{FERT} – total amount of synthetic nitrogen fertiliser applied to soils, this value is taken from [GUS 1993],

N_{ex} – total amount of animal manure nitrogen excreted in AWMS system (table 6.6),

Frac_{LEACH} – fraction nitrogen input to soil that is lost through leaching and runoff, default value,

EF – emission factor for N₂O emissions for leaching/runoff, default value.

The values, that were taken to calculations and emissions, are presented in table 6.8.

Table 6.8. Estimation of indirect emissions of N₂O–N from nitrogen leaching and run-off

N _{fert} [Gg/year]	N _{ex} [kgN/year /1000]	Frac _{LEACH} [kg N/kg N]	EF [kgN ₂ O-N/kg N]	N ₂ O _{(L)→N} [GgN ₂ O-N]
735	130297.34	0.3	0.025	6.490

The following equation is a conversion of N₂O→N emissions to N₂O emissions:

$$N_{2O} = N_{2O→N} * 44/28$$

6.2.5. Field Burning of Agricultural Residues (CRF 4.F)

CH₄ and N₂O emissions from burning of agricultural residues in fields were estimated based on methodology described in [IPCC 1997]. For domestic purposes there were selected 38 crops containing cereals, pulses, tuber and root, oil-bearing plants, vegetables and fruits [Łoboda *et al* 1994] which residues could be burned on fields. Activity data concerning crop production was taken from [GUS 1993]. Factors applied for emissions calculation were taken

from country study [Łoboda 1994] where experimental and literature data as well as default emission factors were used. These values are presented in the table 6.9.

Table 6.9. Factors applied for CH₄ and N₂O emission estimation from field burning of agriculture residues

Crops	Residue to crop ratio	Dry matter fraction	Fraction burned in fields	Fraction oxidised	Carbon fraction of residue	N / C	Aggregated emission factors	
							CH ₄	N ₂ O
							[Gg/Gg]	[Gg/Gg]
wheat	1.45	0.86	0.005	0.90	0.4853	0.014	0.0032	0.0001
rye	1.60	0.87	0.005	0.90	0.4800	0.011	0.0032	0.0001
barley	1.25	0.86	0.005	0.90	0.4567	0.015	0.0030	0.0001
oats	1.50	0.89	0.004	0.90	0.4700	0.016	0.0031	0.0001
triticale	1.50	0.86	0.005	0.90	0.4853	0.013	0.0032	0.0001
cereal mixed	1.40	0.87	0.004	0.90	0.4730	0.015	0.0032	0.0001
buckwheat & millet	1.70	0.86	0.002	0.90	0.4500	0.020	0.0030	0.0001
maize	1.30	0.50	0.002	0.90	0.4709	0.020	0.0031	0.0001
edible pulses	1.50	0.88	0.001	0.90	0.4500	0.040	0.0030	0.0002
feed pulses	2.00	0.85	0.001	0.90	0.4500	0.045	0.0030	0.0002
potatoes	0.30	0.25	0.100	0.85	0.4226	0.048	0.0028	0.0002
rape	2.35	0.87	0.030	0.90	0.4500	0.015	0.0030	0.0001
other oil-bearing crops	3.50	0.87	0.030	0.90	0.4500	0.015	0.0030	0.0001
flax straw	0.25	0.86	0.001	0.90	0.4500	0.016	0.0030	0.0001
tobacco	1.28	0.50	0.002	0.85	0.4500	0.040	0.0030	0.0002
hop	4.00	0.25	0.020	0.90	0.4500	0.035	0.0030	0.0002
hay from greenland	0.05	0.23	0.001	0.90	0.4500	0.044	0.0030	0.0002
hay from pulses	0.05	0.23	0.001	0.90	0.4500	0.045	0.0030	0.0002
hay from legumes	0.05	0.23	0.001	0.90	0.4500	0.061	0.0030	0.0003
tomatoes	0.60	0.15	0.050	0.85	0.4500	0.050	0.0030	0.0002
other ground veget.	0.35	0.15	0.010	0.90	0.4500	0.055	0.0030	0.0003
veget. cult. under cover	0.40	0.35	0.010	0.90	0.4500	0.060	0.0030	0.0003
apples	1.50	0.35	0.050	0.90	0.4500	0.033	0.0030	0.0002
pears & other	1.50	0.35	0.070	0.90	0.4500	0.033	0.0030	0.0002
plums	1.50	0.35	0.100	0.90	0.4500	0.033	0.0030	0.0002
cherries	1.50	0.35	0.100	0.90	0.4500	0.033	0.0030	0.0002
sweet cherries	1.50	0.35	0.100	0.90	0.4500	0.033	0.0030	0.0002
strawberries	0.50	0.18	0.010	0.90	0.4500	0.033	0.0030	0.0002
raspberries	1.20	0.30	0.250	0.90	0.4500	0.033	0.0030	0.0002
currants	1.20	0.30	0.250	0.90	0.4500	0.033	0.0030	0.0002
gooseberries & other	1.20	0.30	0.250	0.90	0.4500	0.033	0.0030	0.0002

7. Land Use Change and Forestry (CRF sector 5)

7.1 Key categories

Sector 5 is not analyzed in key source analyses.

7.2 Methodological issues

All calculations within the GHG inventory for LUCF in Poland in 1991 were prepared using the [IPCC 1997] methodology. The land use transition matrix was not available during the

inventory preparation hence the methodology suggested by GPG LULUCF could not be applied. The obtained GHG estimates were first inserted into the old CRF file, and then translated into the CRF required by GPG LULUCF. Majority of cells in the new CRF could not be filled in and those filled in were calculated by means of the transition matrix presented in table 7.2.

Reporting under the GPG LULUCF requires significant improvements in data collection and access to data on changes in land uses. The current calculations are based on net land use changes (with exception to afforestation/reforestation and deforestation for which gross data are available). This most likely underestimates the actual emissions and removals in this category. The underestimation may bias GHG estimates but direction and degree of the bias can not be easily inferred.

The inventory results for 1991 (and comparing to 1990) for LULUCF sector are presented in the following tables according to new [IPCC 2003] and previous [IPCC 1997] methodologies.

Table 7.1. Total CO₂ emissions and removals from Land Use Change and Forestry in 1990 and 1991 [IPCC 2003]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990			1991		
	Net CO ₂ emissions/ removals	CH ₄	N ₂ O	Net CO ₂ emissions/ removals	CH ₄	N ₂ O
	(Gg)			(Gg)		
5. Total Land-Use Categories	-32 725,49	0,166	0,001	-32 534,24	0,097	0,001
5A. Forest Land	-40 042,52			-39 328,32		
1. Forest Land remaining Forest Land	IE			IE		
2. Land converted to Forest Land	IE			IE		
5B. Cropland	6 666,93			6 479,84		
1. Cropland remaining Cropland	IE			IE		
2. Land converted to Cropland	IE			IE		
5C. Grassland	3 699,30			3 595,49		
1. Grassland remaining Grassland	IE			IE		
2. Land converted to Grassland	IE			IE		
5D. Wetlands	IE			IE		
1. Wetlands remaining Wetlands	IE			IE		
2. Land converted to Wetlands	IE			IE		
5E. Settlements	-3 049,21	0,166	0,001	-3 281,25	0,097	0,001
1. Settlements remaining Settlements	IE			IE		
2. Land converted to Settlements	IE			IE		
5F. Other Land	IE			IE		
1. Other Land remaining Other Land	IE			IE		
2. Land converted to Other Land	IE			IE		
5G. Other(please specify)	NE	NE	NE	NE	NE	NE
Harvested Wood Products	NE	NE	NE	NE	NE	NE

* IE – included elsewhere

* NE – not estimated

Table 7.2. Transition matrix from [IPCC 1997] to [IPCC 2003] LULUCF categories

Sector 5 - Land Use Change and Forestry		New CRF data																				
		Land Use Change and Forestry	A. Forest Land	1. Forest Land remaining Forest Land	2. Land converted to Forest Land	B. Cropland	1. Cropland remaining Cropland	2. Land converted to Cropland	C. Grassland	1. Grassland remaining Grassland	2. Land converted to Grassland	D. Wetlands	1. Wetlands remaining Wetlands	2. Land converted to Wetlands	E. Settlements	1. Settlements remaining Settlements	2. Land converted to Settlements	F. Other Land	1. Other Land remaining Other Land	2. Land converted to Other Land	G. Other <i>(please specify)</i>	Harvested Wood Products
Old IPCC data	Total Land-Use Change and Forestry	1																				
	A. Changes in Forest and Other Woody Biomass Stocks																					
	1. Tropical Forests																					
	2. Temperate Forests		1	Inc. in A	Inc. in A																	
	3. Boreal Forests																					
	4. Grasslands/Tundra																					
	5. Other <i>(please specify)</i>																					
	Harvested Wood																					
	B. Forest and Grassland Conversion																					
	1. Tropical Forests																					
	2. Temperate Forests														1	Inc. in E	Inc. in E					
	3. Boreal Forests																					
	4. Grasslands/Tundra																					
	5. Other <i>(please specify)</i>																					
	C. Abandonment of Managed Lands																					
	1. Tropical Forests																					
	2. Temperate Forests																					
	3. Boreal Forests																					
	4. Grasslands/Tundra																					
	5. Other <i>(please specify)</i>																					
	D. CO2 Emissions and Removals from Soil																					
	1. Cultivation of Mineral Soils					0.64	Inc. in B	Inc. in B	0.36	Inc. in C	Inc. in C											
	2. Cultivation of Organic Soils																					
	3. Liming of Agricultural Soils					0.64			0.36													
	4. Forest Soils		1	Inc. in A	Inc. in A																	
	5. Other Land <i>(please specify)</i>														1	Inc. in E	Inc. in E					
	E. Other <i>(please specify)</i>																					

Table 7.3. Total CO₂ emissions and removals from sector 5. Land Use Change and Forestry in 1990 and 1991 [IPCC 1997]

Greenhouse gas source and sink categories	1990					1991				
	CO ₂ emissions	CO ₂ removals	Net CO ₂ emissions/removals	CH ₄	N ₂ O	CO ₂ emissions	CO ₂ removals	Net CO ₂ emissions/removals	CH ₄	N ₂ O
	Gg					Gg				
5. Total Land-Use Change and Forestry	41 678.47	-74 403.97	-32 725.49	0.166	0.001	40 891.35	-73 425.59	-32 534.24	0.097	0.001
5A. Changes in Forest and Other Woody Biomass Stocks	33 312.92	-57 198.48	-23 885.56			32 335.55	-55 779.04	-23 443.48		
1. Tropical Forests										
2. Temperate Forests	33 312.92	-57 198.48	-23 885.56			32 335.55	-55 779.04	-23 443.48		
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
Harvested Wood										
5B. Forest and Grassland Conversion	65.64		65.64			49.10		49.10		
1. Tropical Forests										
2. Temperate Forests	65.6			0.166	0.001	49.1			0.097	0.001
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
5C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00	0.00	0.00		
1. Tropical Forests										
2. Temperate Forests										
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
5D. CO ₂ Emissions and Removals from Soil	8 299.92	-17 205.49	-8 905.57			8 506.70	-17 646.56	-9 139.85		
Cultivation of Mineral Soils	8 299.92		8 299.92			8 506.70		8 506.70		
Cultivation of Organic Soils										
Liming of Agricultural Soils		2 066.3	2 066.32				1 568.6	1 568.63		
Forest Soils		-16 156.96	-16 156.96				-15 884.84	-15 884.84		
Other Land (please specify)		-3 114.85	-3 114.85				-3 330.35	-3 330.35		
5E. Other (please specify)										

According to calculation for 1991, Sector 5. Land-Use Change and Forestry, was net CO₂ sink. Removals/emissions balance decreased from 32 725 Gg CO₂ in 1990 to 32 534 Gg CO₂ in 1991 and included results from groups given below.

7.2.1. Changes in Forest and Other Woody Biomass Stocks (old CRF 5.A)

GHG balance in this group is a net sink. In 1991 net CO₂ removals decreased to 23 443 Gg CO₂ from about 23886 Gg CO₂ in 1990. This change was caused by woody biomass decrease (about 0.1 t dm/ha) and harvest of thick decrease (about 0.57 million m³ of wood).

Increase in forest

Increase of woody biomass in forest of all owners forms was estimated based on data published in Statistical Year Book for Forestry. Source data contains also area–volume tables with age classes prepared by Forest Management and Geodesy Bureau in order of Directorate General of State Forests published in annual reports “Results of updated estimates of forestry areas and resources in state owned forests”.

Data published in statistical yearbooks are of synthetic character – (apply to all types together or separately for conifers and broadleaves only).

Estimation of actual increase (m³/ha/year) for all forests is based on data of increment in growing stock and harvest of thick. Data of harvest of thick are given as net volume of thick wood (without bark). For calculation of harvest of thick it is necessary to add estimated volume of thick bark to net harvest of thick (assume that thick bark is about 25% of thick wood without bark [Czuraj, 1991]). Increase is determined by forest type, age class and quality of forest habitats.

Harvest of thick and growing stock were converted into mass of biomass separately, using expansion ratio for timber removals and conversion for growing stocks.

Calculations were based on average values, regarded as approximation of real values. Methodology for biomass annual increase calculations should be still improved, among others for better show long and short term trends. For calculations there were used default factor describing fraction of elementary carbon in dry matter 0.5 [IPCC 1997].

7.2.2. Forest and Grassland Conversion (old CRF 5.B)

In 1991 this category was a net CO₂ emissions and accounted for about 49 Gg CO₂. Net emission in year 1991 was lower than in 1990 and it was caused by lessening forest area transmitted into non-forest tasks.

Emissions ratios for calculation CH₄, N₂O, CO and NO_x emissions from biomass burning are presented in table below.

Table 7.4. Emissions ratios for calculation CH₄, N₂O, CO and NO_x emissions from biomass burning.

Compound	Ratio		
CH ₄	0.012	default	[IPCC 1997]
CO	0.060	default	[IPCC 1997]
N ₂ O	0.007	default	[IPCC 1997]
NO _x	0.121	default	[IPCC 1997]

Ratio of carbon to nitrogen in burning biomass was taken as 0.001 and default factor of carbon fraction in aboveground biomass is equal 0.5 [IPCC 1997]. Both default factors for fraction of carbon oxidized on and off site are equal to 0.9 [IPCC 1997].

In this category emission of other than CO₂ GHGs is reported from forest fires only. Assumption is made that woody biomass is not burnt entirely during fires (only canopies and underwood are damaged) so if there is a need for moving out damaged or dead woods it is included into total wood harvest. Controlled burning of forests is not practiced in Poland.

7.2.3. Abandonment of Managed Lands (old CRF 5.C)

According to [IPCC 1997] definition, there is no anthropogenic activity on abandonment lands in Poland, so such category is not considered here. Generally agriculture lands are converted to forests or come under municipal management.

7.2.4. CO₂ Emissions and Removals from Soil (old CRF 5.D)

GHG balance in this category is a net sink.. In 1991 net CO₂ sink was about 9 139 Gg CO₂ and was higher by about 234 Gg CO₂ than in previous year. It is mainly caused by afforestation of agriculture lands.

In order to calculate carbon emissions and removals in soils, area of country was divided into forestland, cropland and other lands. Other lands are used for balance country area.

Soil types occurring in Poland are as follow.

Forests soils

Estimation of different soil types area (high activity soils, low activity soils, sandy and wetland) is based on area of forest habitat types (Table 7.5). Next the percentage fractions of all soil types in forest management were calculated (Table 7.7).

Table 7.5. Forest soils type occur in Poland.

Soil type	Forest habitat types
High Activity Soils	Fresh mixed forest, moist mixed forest, mixed upland forest, mountain mixed forest, fresh broadleaved forest, moist broadleaved forest upland forest, mountain forest
Low Activity Soils	Moist coniferous forest, mountain coniferous forest, high- mountain coniferous forest, 0,5*fresh mixed coniferous forest, moist mixed coniferous forest, upland mixed coniferous forest, mountain mixed coniferous forest
Sandy	Dry coniferous forest, fresh coniferous forest, 0,5* fresh mixed coniferous forest
Wetland	Marshy coniferous forest, boggy mountain coniferous forest, boggy mixed coniferous forest, boggy mixed forest, alder forest, ash- alder swamp forest, mountain alder forest, floodplain forest, mountain floodplain forest

Agriculture soils

Estimation of area of different soil types (high activity soils, low activity soils, sandy and wetland) is based on area of soil valuation classes (Table 7.6). Then percentage fraction of all soil types in croplands, grasslands and other lands were calculated (Table 7.7).

Table 7.6. Agricultural land by soil valuation classes

Soil type	Soil Valuation classes
High Activity Soils	I, II, III
Low Activity Soils	IV
Sandy	V
Wetland	other

Table 7.7. Percentage fraction of soil type by land use system (for time t and t–20)

Climate	Land use	Soil type (t)			
	Land-use/ management system	High Activity Soils	Low Activity Soils	Sandy	Wetland
		(%)			
Temperate	Forest management	39.6	19.0	37.2	4.2
	Grassland/Rangeland	14.6	43.1	31.5	10.7
	Agricultural crops	29.1	39.0	20.1	11.7
	Rest land	21.9	41.1	25.8	11.2
Climate	Land use	Soil type (t-20)			
	Land-use/ management system	High Activity Soils	Low Activity Soils	Sandy	Wetland
		(%)			
Temperate	Forest management	31.4	19.8	45.1	3.7
	Grassland/Rangeland	14.7	41.0	32.1	12.2
	Agricultural crops	27.8	39.3	20.6	12.3
	Rest land	21.3	40.1	26.3	12.3

Table 7.8. Area of soil type by land use system in 1991

Land-use/ management system	Soil type	Carbon in soils (Mg C/ha)	Area (Mha)
Forest management	High Activity Soils	110.0	3.522
	Low Activity Soils	70.0	1.690
	Sandy	30.0	3.309
	Wetland	230.0	0.374
Sum			8.894
Grassland/Rangeland	High Activity Soils	90.0	0.571
	Low Activity Soils	60.0	1.686
	Sandy	25.0	1.233
	Wetland	120.0	0.418
Sum			3.908
Agricultural crops	High Activity Soils	70.0	4.126
	Low Activity Soils	60.0	5.529
	Sandy	25.0	2.851
	Wetland	120.0	1.660
Sum			14.166
Other land	High Activity Soils	56.0	0.940
	Low Activity Soils	48.0	1.767
	Sandy	20.0	1.111
	Wetland	96.0	0.482
Sum			4.301
Total			31.2685

Carbon stock rates in soils were taken as default factors from [IPCC 1997] and corrected to domestic conditions by experts.

Estimation of CO₂ emissions and removals by soils is approximate and will be corrected by new methodology presented in [IPCC 2003]. Emissions and removals from soils were calculated separately, then the net emission/removal balance was estimated.

7.2.5. Carbon emissions from agricultural lime application (old CRF 5.D)

The reported annual carbon emission from agricultural lime application is calculated as:

$$C = M_{\text{limestone}} * EF_{\text{limestone}} + M_{\text{dolomite}} * EF_{\text{dolomite}}$$

where:

M_{limestone} - annual amount of sold calcic limestone [Mg/yr],

M_{dolomite} - annual amount of sold calcic dolomite [Mg/yr],

EF_{limestone} - emission factor for limestone – 0.120 [Mg C/ Mg limestone],

EF_{dolomite} - emission factor for dolomite – 0.122 [Mg C/ Mg dolomite].

Domestic statistic publications contain only data of use of lime fertilizers in pure nutrient (CaO), that it was necessary to convert these data into actual use of fertilizers [Radwański 2006b]. It was assumed that lime – magnesium fertilizers (CaMg(CO₃)₂) contains 89.1% of CaCO₃ and 10.9% of MgCO₃. Carbon (C) is converted to carbon-dioxide (CO₂) by the conversion factor 44/12.

8. Waste (CRF sector 6)

8.1 Key categories

Following categories from sector 6 have been identified as key sources:

- | | |
|---|------|
| - 6.A. Solid Waste Disposal on Land (CH ₄ emission), share in total GHG emission | 1.1% |
| - 6.B. Wastewater Handling (CH ₄ emission), share in total GHG emission | 1.3% |

Share of these categories in total Poland's GHG emissions is 2.4%.

8.2 Methodological issues

8.2.1 Solid Waste Disposal on Land (CRF 6.A)

The methane emissions from solid waste disposals in 1991 were calculated using the IPCC Waste Model published in [IPCC 2006]. The model establish multiyear series when methane is generated from organic matter decomposition in anaerobic conditions. The emission of CH₄ is diminished by recapturing of this gas.

The following indicators were used for estimation of CH₄ emissions:

- DOC – degradable organic carbon in the year of deposition (table 8.1, default value [IPCC 2006])

- DOC_f – fraction of DOC that can decompose (fraction) (table 8.1, default value [IPCC 2006])
- MCF – CH_4 correction factor for aerobic decomposition in the year of deposition (table 8.2, default value [IPCC 2006])
- OX – Oxidation Factor reflecting the amount of CH_4 from solid waste disposal sites that is oxidised in the soil or other material covering the waste (table 8.3, default value [IPCC 2006])
- k – reaction constant [Steczko 2001] (table 8.3)
- F – fraction of CH_4 by volume, in generated landfill gas (fraction) [Steczko 2001] (table 8.3).
- R – methane recovery assumed as 0.

Table 8.1. DOC and DOC_f indicators

DOC (Degradable Organic Carbon)	Range	Default	Adopted Value
Food waste	0.08-0.20	0.15	0.15
Garden	0.16-0.19	0.2	0.2
Paper	0.36-0.45	0.4	0.4
Wood and straw	0.39-0.46	0.43	0.43
Textiles	0.20-0.40	0.24	0.24
Disposable nappies	0.18-0.32	0.24	0.24
Sewage sludge	0.04-0.05	0.05	0.05
Industrial waste	0-0.54	0.15	0.15
DOC_f		0.5	0.5

Table 8.2. MCF indicators of organic carbon in disposed waste

Unmanaged, shallow	Unmanaged, deep	Managed	Managed, semiaerobic	Uncategorised
0.4	0.8	1	0.5	0.6

Table 8.3. Indicators k , F and OX assumed for calculations

Methane generation rate constant (k)	Range	Default	Value
Food waste	0.1–0.2	0.185	0.086
Garden	0.06–0.1	0.1	0.069
Paper	0.05–0.07	0.06	0.039
Wood and straw	0.02–0.04	0.03	0.023
Textiles	0.05–0.07	0.06	0.039
Disposable nappies	0.06–0.1	0.1	0.1
Sewage sludge	0.1–0.2	0.185	0.185
Industrial waste	0.08–0.1	0.09	0.09
Delay time (months)		6	6
Fraction of methane (F) in developed gas		0.5	0.618
Oxidation factor (OX)		0	0

Activities used for estimation of CH_4 emissions from solid waste disposals contain:

- Population – number of population was taken from [GUS 1993]
- Municipal Solid Wastes (MSW) – for years 1971-1973 data were interpolated on a basis of data from 1970 and 1974. The same method was used for 1976. In domestic statistics data were given in dm^3 . To recalculate data into Gg a conversion factor was used. According to GUS this conversion factor is $0.25 t/m^3$.

Table 8.4. Data sources for amount of municipal waste

1970	4113.98	[GUS 1987]
1971	4624.65	interpolacja
1972	5135.31	interpolacja
1973	5645.98	interpolacja
1974	6156.64	[GUS 1974d]
1975	6788.96	[GUS 1986d]
1976	7397.99	interpolacja
1977	8007.03	[GUS 1981d]
1978	8702.83	[GUS 1981d]
1979	9052.63	[GUS 1981d]
1980	9868.72	[GUS 1986d]
1981	10014.42	[GUS 1986d]
1982	10329.07	[GUS 1986d]
1983	10541.91	[GUS 1986d]
1984	10864.54	[GUS 1986d]
1985	11086.95	[GUS 1986d]
1986	11546.86	[GUS 1987]
1987	11877.45	[GUS 1989d]
1988	12084.18	[GUS 1989d]
1989	12000.95	[GUS 1990d]
1990	11098.28	[GUS 1996]
1991	10637.98	[GUS 1996]

The percentage of waste generated, which goes to solid waste disposal sites – according to the GUS Statistical Yearbook, Environment 1990, in 1982-1990 there was no combustion of waste and the composting was on level of 0.1% (the same in 1981 – GUS 1987). Because of the lack of data, for other years this value was assumed on level of 0.1%. Distribution of solid waste disposal sites for managed and unmanaged ones was made in accordance to elaboration [Gworek 2003].

Composition of waste (according to IPCC) was assumed on a basis of National Plan on Waste Management (table 8.5)

Table 8.5. Composition of waste

Food	Garden	Paper	Wood	Textile	Plastics, other inert
18%	2%	16%	3%	3%	57%

8.2.2 Waste Water Handling (CRF 6.B)

8.2.2.1. Industrial wastewater (CRF 6.B.1)

Methane emission from industrial wastewater was estimated based on activity data from particular industrial sectors [GUS 1992d] and fraction of treated wastewater using default factors of Biochemical Oxygen Demand (BOD). Also the default values of maximum methane producing capacity were used [IPCC 2006}. Share of anaerobic treatment of wastewater was taken from [Radwański 1995] (table 8.6).

Table 8.6. Data for CH₄ emission estimation from Industrial Wastewater Handling

Industry sectors		Degradable organic component (BOD) [kg / dm ³]	Fraction of wastewater treated by anaerobically method	Maximum methane producing capacity [Gg CH ₄ / Gg BOD]
Mining and quarrying		0.001	0.15	0.6
Iron and steel		0.001	0.15	0.6
Non-ferrous metals		0.001	0.15	0.6
Fertilizer		0.004	0.15	0.6
Food products	meat and poultry	0.003	0.15	0.6
	fish processing	0.0015	0.15	0.6
	vegetable & fruit processing	0.002	0.15	0.6
	oil & grease	0.0008	0.15	0.6
	dairy products	0.003	0.15	0.6
	sugar	0.008	0.15	0.6
	soft drinks	0.001	0.15	0.6
	beer	0.004	0.15	0.6
	other	0.004	0.15	0.6
Textiles		0.0008	0.15	0.6
Leather		0.001	0.15	0.6
Wood, wood products and pulp & paper		0.004	0.15	0.6
Energy transformation sector		0.004	0.15	0.6
Chemicals		0.002	0.15	0.6
Rubber and plastic products		0.001	0.15	0.6
Non-metallic minerals		0.001	0.15	0.6
Machinery and transportation equipment		0.001	0.15	0.6
Other		0.002	0.15	0.6

8.2.2.2. Domestic and Commercial Wastewater (6.B.2)

CH₄ emission from domestic and commercial wastewater was based on methodology [IPCC 1997]. Amounts of degradable organic components for wastewater and for sludge were estimated basing on the data on population connected to sewage treatment plants and on the rate of the each type of sewage treatment plants in municipal wastewater treatment. These data were taken from [GUS 1992d]. Default value of organic load in biochemical oxygen demand per person, which is equal to 60 g BOD/person/day [IPCC 2000], was taken for the calculations. Fraction of BOD that readily settles and is removed as sludge was estimated basing on the report [Bernacka 2006] and its value was 0.717. The emission factors calculated on the basis of the study mentioned above and applied in inventory report are:

- for wastewater: 0.060 kg CH₄ / kg BOD
- for sewage sludge: 0.383 kg CH₄ / kg BOD.

The default value (0.6 kg CH₄ / kg BOD) of maximum methane producing capacity was applied for estimation of sludge and wastewater emission factors. Fractions of wastewater and sludge anaerobically treated with and without methane recovery are estimated according to [Bernacka 2006]. These value are as follows: percentage of wastewater anaerobically treated

– 10%, fractions of sludge anareobically degraded – 63.9% of which with methane recovery – 23.7%.

N₂O emission from humane sewage was calculated according to default method [IPCC 1997]. Country population was taken from [GUS 1993]. Value of protein consumption per capita per year comes from [FAOSTAT 2006]. Default values were used for fraction of nitrogen in protein and for N₂O emission factor [IPCC 2000].

8.2.3. Waste Incineration (CRF 6.C)

Waste incineration was estimated based on IPCC methodology [IPCC 2000] and domestic case study [Wielgosiński 2003]. Emission factors as default were taken from [IPCC 2000]. For 1991 no data on municipal and sewage sludge waste incineration were available. The amount of industrial waste was calculated based on [GUS 1992d]. The activity data for incineration of medical waste was based on number of hospital beds [GUS 1992] as well as on annual mean use of hospital bed [GUS 1992]. The indicators describing amount of hospital waste produced and fraction of incinerated waste were taken from [IOS 2003].

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ANNEXES

Annex 1. Key sources

The source categories in all sectors, are identified to be *key sources* on the basis of their contribution to the total level and/or trend uncertainty in accordance with IPCC Good Practice Guidance (IPCC 2000).

From source categories which have been identified as key sources in level assessment, the most important are:

- Stationary combustion Solid Fuels,
- 1.A.3.b Transport Road Transportation,
- Stationary combustion Liquid Fuels.

Emission from these sources made up 74.8% of the total GHG emissions in Poland expressed in units of CO₂ equivalents. Combustion of solid, gaseous and liquid fuels in stationary sources, made up 73.26% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 66.3% of the total GHG emissions.

The most important source categories in level assessment are:

- Stationary combustion Solid Fuels,
- 1.A.3.b Transport Road Transportation,
- 6.B. Wastewater Handling.

Share of these sources in national total made up 72.04%.

7.A1 - 7.A3 IPCC Good Practice Guidance tables, concerning level and trend assessment are listed below.

Level Assessment

		IPCC Source Categories	Direct GHG	Current Year Estimate	Level Assessment	Cumulative Total
1	1.A.1, 2, 4, 5.a	Stationary combustion Solid Fuels	CO ₂	311565.53	0.6632	0.66
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO ₂	20794.04	0.0443	0.71
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO ₂	19094.89	0.0406	0.75
4	4.A	4.A. Enteric Fermentation	CH ₄	13888.02	0.0296	0.78
5	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH ₄	13862.87	0.0295	0.81
6	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO ₂	13507.97	0.0288	0.84
7	4.D.1	4.D.1. Direct Soil Emissions	N ₂ O	13245.18	0.0282	0.86
8	4.B	4.B. Manure Management	N ₂ O	8859.28	0.0189	0.88
9	6.B	6.B. Wastewater Handling	CH ₄	6076.13	0.0129	0.90
10	2.A.1	2.A.1 Cement Production	CO ₂	5373.38	0.0114	0.91
11	6.A	6.A. Solid Waste Disposal on Land	CH ₄	4975.91	0.0106	0.92
12	2.C1	2.C.1. Iron and Steel Production	CO ₂	4564.41	0.0097	0.93
13	4.B	4.B. Manure Management	CH ₄	3685.96	0.0078	0.94
14	4.D.3	4.D.3. Indirect Soil Emissions	N ₂ O	3646.42	0.0078	0.94
15	1.B.2.b.	1.B.2.b. Natural Gas	CH ₄	3408.86	0.0073	0.95

Trend Assessment

		IPCC Source Categories	Direct GHG	Base Year Estimate	Current Year Estimate	Level Assessment	Trend Assessment	Contribution to Trend [%]	Cumulative Total
1	1.A.1, 2, 4, 5.a	Stationary combustion Solid Fuels	CO2	400745.92	311565.53	0.6632	0.0245	22.2293	0.22
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16068.28	20794.04	0.0443	0.0211	19.1420	0.41
3	6.B	6.B. Wastewater Handling	CH4	2170.23	6076.13	0.0129	0.0115	10.4708	0.52
4	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	26824.08	19094.89	0.0406	0.0063	5.7348	0.58
5	1.A.5.b	1.A.5.b Other Mobile	CO2	5049.93	1942.50	0.0041	0.0056	5.0671	0.63
6	6.A	6.A. Solid Waste Disposal on Land	CH4	4284.31	4975.91	0.0106	0.0041	3.7321	0.66
7	4.B	4.B. Manure Management	N2O	9335.10	8859.28	0.0189	0.0037	3.3471	0.70
8	4.D.3	4.D.3. Indirect Soil Emissions	N2O	6276.40	3646.42	0.0078	0.0037	3.3243	0.73
9	1.A.3.d	1.A.3.d Transport Navigation	CO2	2334.06	3009.94	0.0064	0.0030	2.7550	0.76
10	4.A	4.A. Enteric Fermentation	CH4	15954.36	13888.02	0.0296	0.0030	2.6964	0.78
11	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	15562.17	13507.97	0.0288	0.0028	2.5368	0.81
12	4.B	4.B. Manure Management	CH4	3435.39	3685.96	0.0078	0.0025	2.2590	0.83
13	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18455.82	13862.87	0.0295	0.0024	2.1962	0.85
14	2.A.2	2.A.2. Lime Production	CO2	3477.55	1894.21	0.0040	0.0024	2.1463	0.88
15	1.A.3.c	1.A.3.c Transport Railways	CO2	3355.49	1910.20	0.0041	0.0021	1.8719	0.90
16	2.C1	2.C.1. Iron and Steel Production	CO2	6556.09	4564.41	0.0097	0.0018	1.6492	0.91
17	4.D.1	4.D.1. Direct Soil Emissions	N2O	15747.10	13245.18	0.0282	0.0017	1.5455	0.93
18	2.B.2	2.B.2. Nitric Acid Production	N2O	4386.47	2884.60	0.0061	0.0017	1.5120	0.94
19	2.B.1.	2.B.1. Ammonia Production	CO2	3516.60	2341.35	0.0050	0.0013	1.1427	0.95

Annex 2. 1991 Energy balance data for main fuels

Energy balances in 1991 for several main fuels: brown coal, diesel oil, fuel oil, high-methane and nitrified natural gas and coke, are given below. Similar balance data for hard coal are presented in Chapter 1.4.

Brown coal consumption

Evaluation of fuel consumption In national combustion processes	Brown coal	
	10 ³ Mg	TJ
In	69 406	589 632
From national sources	69 406	589 632
1) Indigenous production	69 406	589 632
2) Transformation output or return	0	0
3) Stock decrease	0	0
Import	0	0
Out	69 406	589 632
National consumption	67 948	566 144
1) Transformation input	67 906	565 761
a) input for secondary fuel production	269	2 609
b) fuel combustion	67 637	563 152
2) Direct consumption	42	383
Non-energy use	2	15
Combusted directly	40	368
Combusted in Poland	67 677	563 520
Stock increase	183	1 479
Export	1 275	11 476
Losses	0	0
Statistical differences		10 533
Net calorific value	MJ/kg	8.33
CO ₂ Emission Factor	kg/GJ	115.20

Diesel oil consumption

Evaluation of fuel consumption In national combustion processes	Diesel oil	
	10 ³ Mg	TJ
In	5 168	220 660
From national sources	3 809	162 632
1) Indigenous production	0	0
2) Transformation output or return	3 695	157 762
3) Stock decrease	114	4 870
Import	1 359	58 028
Out	5 168	220 659
National consumption	4 918	210 012
1) Transformation input	26	1 106
a) input for secondary fuel production	1	54
b) fuel combustion	25	1 052
2) Direct consumption	4 892	208 906
Non-energy use	5	234
Combusted directly	4 887	208 672
Combusted in Poland	4 912	209 724
Stock increase	0	0
Export	246	10 493
Losses	4	154
Statistical differences		0
Net calorific value	MJ/kg	42.70
CO ₂ Emission Factor	kg/GJ	72.73

Fuel oil consumption

Evaluation of fuel consumption In national combustion processes	Fuel oil	
	10 ³ Mg	TJ
In	4 393	178 174
From national sources	3 480	141 394
1) Indigenous production	0	0
2) Transformation output or return	3 480	141 394
3) Stock decrease	0	0
Import	913	36 780
Out	4 392	178 175
National consumption	3 392	136 741
1) Transformation input	1 757	71 108
a) input for secondary fuel production	132	5 429
b) fuel combustion	1 625	65 679
2) Direct consumption	1 635	65 633
Non-energy use	15	581
Combusted directly	1 620	65 052
Combusted in Poland	3 245	130 731
Stock increase	13	539
Export	1 099	44 290
Losses	0	2
Statistical differences	-112	-3 397
Net calorific value	MJ/kg	40.29
CO ₂ Emission Factor	kg/GJ	79.29

High-methane natural gas consumption

Evaluation of fuel consumption In national combustion processes	High-methane natural gas	
	10 ⁶ m ³	TJ
In	8 677	292 536
From national sources	2 062	69 932
1) Indigenous production	1 444	47 972
2) Transformation output or return	618	21 960
3) Stock decrease	0	0
Import	6 615	222 604
Out	8 679	292 536
National consumption	8 232	279 892
1) Transformation input	824	28 930
a) input for secondary fuel production	398	13 860
b) fuel combustion	426	15 071
2) Direct consumption	7 408	250 962
Non-energy use	1 808	63 697
Combusted directly	5 600	187 265
Combusted in Poland	6 026	202 335
Stock increase	40	1 409
Export	1	21
Losses	406	11 214
Statistical differences		0
Net calorific value	MJ/m ³	33.58
CO ₂ Emission Factor	kg/GJ	56.31

Nitrified natural gas consumption

Evaluation of fuel consumption In national combustion processes	Nitrified natural gas	
	10 ⁶ m ³	TJ
In	2 716	66 438
From national sources	2 716	66 438
1) Indigenous production	2 504	59 098
2) Transformation output or return	212	7 340
3) Stock decrease	0	0
Import	0	0
Out	2 716	66 438
National consumption	2 537	62 072
1) Transformation input	1 099	28 178
a) input for secondary fuel production	1 081	27 712
b) fuel combustion	18	466
2) Direct consumption	1 438	33 894
Non-energy use	0	0
Combusted directly	1 438	33 894
Combusted in Poland	1 456	34 360
Stock increase	0	0
Export	0	0
Losses	179	4 366
Statistical differences		0
Net calorific value	MJ/m ³	23.61
CO ₂ Emission Factor	kg/GJ	55

Coke consumption

Evaluation of fuel consumption In national combustion processes	Coke	
	10 ³ Mg	TJ
In	11 411	320 764
From national sources	11 411	320 764
1) Indigenous production	0	0
2) Transformation output or return	11 411	320 764
3) Stock decrease	0	0
Import	0	0
Out	11 412	320 764
National consumption	7 936	224 118
1) Transformation input	2 270	62 894
a) input for secondary fuel production	1 534	43 737
b) fuel combustion	736	19 157
2) Direct consumption	5 666	161 224
Non-energy use	172	4 330
Combusted directly	5 494	156 894
Combusted in Poland	6 230	176 051
Stock increase	9	200
Export	3 467	96 446
Losses	0	0
Statistical differences		0
Net calorific value	MJ/kg	28.26
CO ₂ Emission Factor	kg/GJ	110.81

Annex 3. National energy balance 1991 [GUS, 1993a]

CZĘŚĆ I. ZBIORCZY BILANS PRZYCHODU I ROZDYSPONOWANIA ENERGII

TABL. 1. PODSTAWOWY (SYNTETYCZNY) BILANS ENERGII

PART I. BASIC ENERGY SUPPLY AND USE BALANCE

TABLE 1. BASIC (SYNTHETIC) ENERGY BALANCE

LP	NAZWA NOŚNIKA ENERGII	ROK	JEDNOSTKA MIARY	POZYSKANIE	IMPORT	- W TYM BUNKIER	EKSPORT	ZMIANA ZAPASÓW
	SPECIFICATION	YEAR	UNIT OF MEASURE	INDIGENOUS PRODUCTION	IMPORT	AMONG WHICH BUNKER	EXPORT	STOCK CHANGE
1	ENERGIA OGÓŁEM TOTAL ENERGY	1991	TJ	3972830	895834	52170	705969	38263
		1992		3915950	908437	40808	696153	30693
2	ENERGIA PIERWOTNA PRIMARY ENERGY	1991	TJ	3972830	705281	-	501615	46694
		1992		3915950	762002	-	551319	36519
3	WĘGIEL KAMIENNY HARD COAL	1991	tys.ton	140376	54	-	19534	2061
		1992	10 ³ ton	131597	126	-	19602	916
		1991	TJ	3207921	1584	-	490118	48600
		1992		3154316	3659	-	542979	21928
4	WĘGIEL BRUNATNY LIGNITE	1991	tys.ton	69406	-	-	1275	183
		1992	10 ³ ton	66852	18	-	978	415
		1991	TJ	589632	-	-	11476	1479
		1992		579841	152	-	8234	3509
5	ROPA NAFTOWA CRUDE OIL	1991	tys.ton	158	11454	-	-	-114
		1992	10 ³ ton	200	12769	-	-	136
		1991	TJ	6624	481052	-	-	-4795
		1992		8322	532585	-	-	5674
6	GAZ ZIEMNY WYSOKOMETANOWY HIGH - METHANE NATURAL GAS	1991	mln m ³	1644	6615	-	1	40
		1992	10 ⁶ m ³	1509	6247	-	3	152
		1991	TJ	52196	222604	-	21	1409
		1992		47616	225527	-	106	5408
7	GAZ ZIEMNY ZAAZOTOWANY NITRIFIED NATURAL GAS	1991	mln m ³	2504	-	-	-	-
		1992	10 ⁶ m ³	2519	-	-	-	-
		1991	TJ	59098	-	-	-	-
		1992		60640	-	-	-	-
8	TORF I DREWNO PEAT AND WOOD	1991	tys. m ³	3030	-	-	-	-
		1992	10 ³ m ³	3509	-	-	-	-
		1991	TJ	28785	-	-	-	-
		1992		33336	-	-	-	-
9	ENERGIA WODY I WIATRU HYDRO AND WOOD ENERGY	1991	TJ	5131	-	-	-	-
		1992		5427	-	-	-	-
10	PALIWA ODPADOWE STAŁE SOLID WASTE FUEL	1991	TJ	23442	41	-	-	-
		1992		26451	80	-	-	-
11	ENERGIA POCHODNA DERIVED ENERGY	1991	TJ	-	190553	52170	204354	-8431
		1992		-	146435	40808	144835	-5826
12	BRYKIETY Z WĘGLA KAMIENNEGO HARD COAL BRIQUETTES	1991	tys.ton	-	-	-	10	-26
		1992	10 ³ ton	-	-	-	2	-9
		1991	TJ	-	-	-	230	-602
		1992		-	-	-	64	-218
13	BRYKIETY Z WĘGLA BRUNATNEGO LIGNITE BRIQUETTES (BKB)	1991	tys.ton	-	-	-	82	33
		1992	10 ³ ton	-	-	-	-	87
		1991	TJ	-	-	-	1465	643
		1992		-	-	-	-	1570
14	KOKS I PÓLKOKS COKE AND SEMI-COKE	1991	tys.ton	-	-	-	3467	9
		1992	10 ³ ton	-	1	-	2566	-158
		1991	TJ	-	-	-	96446	200
		1992		-	14	-	71818	-4412

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETY- CZNE	STRATY TRANSPORTU I MAGA- ZYNOWANIA	RÓŻNICE BILANSOWE	LP
GLOBAL CONSUMPTION OR EXCHANGE BALANCES	TRANSFORMA- TIONS OUTPUT OR RETURNS	TOTAL CONSUMPTION	TRANSFORMA- TIONS INPUT	DIRECT CONSUMPTION	AMONG WHICH NON-ENERGY USE	LOSSES OF TRANSPORT AND STORAGE	STATISTICAL DIFFERENCE	
4124432	2314276	x	3434265	2928570	91583	68803	7071	1
4097541	2273022	x	3352358	2931558	85680	72026	14621	
4129802	29301	x	3240698	892293	67376	15580	10532	2
4090115	26724	x	3143092	931360	61722	15496	26890	
118835	-	118835	94843	23991	22	-	-	3
111204	-	111204	88244	22960	19	-	-	
2670788	-	2670788	2097498	573290	718	-	-	
2593068	-	2593068	1989153	603915	555	-	-	
67947	-	67947	67906	42	2	-	-	4
65477	-	65477	65455	22	1	-	-	
576676	-	576676	565761	383	15	-	10533	
568250	-	568250	551796	197	8	-	16257	
11725	-	11725	11725	-	-	-	-	5
12832	-	12832	12579	-	-	-	253	
492471	-	492471	492471	-	-	-	-1	
535233	-	535233	524600	-	-	-	10633	
8219	618	8837	961	7471	1808	406	-	6
7601	591	8193	706	7063	1638	423	-	
273370	21960	295330	31933	252183	63697	11214	-	
267629	21048	288678	23172	253946	57760	11559	-	
2504	212	2716	1099	1438	-	179	-	7
2519	166	2684	1028	1497	-	159	-	
59098	7340	66438	28178	33894	-	4366	-	
60640	5676	66316	26318	36061	-	3937	-	
3030	-	3030	98	2932	-	-	-	8
3509	-	3509	130	3379	-	-	-	
28785	-	28785	928	27857	-	-	-	
33336	-	33336	1237	32099	-	-	-	
5131	-	5131	5131	-	-	-	-	9
5427	-	5427	5427	-	-	-	-	
23483	-	23483	18797	4686	2945	-	-	10
26531	-	26531	21388	5143	3399	-	-	
-5371	2284976	x	181029	2048815	10725	53222	-3461	11
7426	2246298	x	198765	2010699	9999	56530	-12269	
16	1	17	15	2	-	-	-	12
7	-	7	7	1	-	-	-	
372	13	385	342	51	-	-	-9	
154	-	154	152	13	-	-	-11	
-115	124	9	6	5	-	-	-3	13
-87	95	9	5	4	-	-	-	
-2108	2255	146	110	92	-	-	-56	
-1570	1725	155	83	68	-	-	4	
-3476	11411	7935	2270	5666	172	-	-	14
-2408	11094	8687	2131	6555	126	-	-	
-96646	320764	224118	62894	161224	4330	-	-	
-67391	312424	245032	57891	187141	3199	-	-	

LP	NAZWA NOŚNIKA ENERGII	ROK	JEDNOSTKA MIARY	POZYSKANIE	IMPORT	- W TYM BUNKIER	EKSPORT	ZMIANA ZAPASÓW
	<i>SPECIFICATION</i>	<i>YEAR</i>	<i>UNIT OF MEASURE</i>	<i>INDIGENOUS PRODUCTION</i>	<i>IMPORT</i>	<i>AMONG WHICH BUNKER</i>	<i>EXPORT</i>	<i>STOCK CHANGE</i>
15	GAZ CIEKŁY	1991	tys.ton	-	-	-	-	-
	LIPUEFIED PETROLEUM GAS (LPG)	1992	10 ³ ton	-	-	-	-	0
		1991	TJ	-	-	-	-	-
		1992		-	-	-	-	0
16	BENZYNY	1991	tys. ton	-	1602	101	31	-129
	GASOLINE	1992	10 ³ ton	-	1554	88	13	-8
		1991	TJ	-	69370	4373	1352	-5589
		1992		-	67285	3793	544	-362
17	OLEJE NAPĘDOWE	1991	tys. ton	-	1359	269	246	-114
	DIESEL OIL	1992	10 ³ ton	-	677	132	32	-53
		1991	TJ	-	58028	11486	10493	-4870
		1992		-	28913	5621	1383	-2275
18	OLEJE OPAŁOWE	1991	tys. ton	-	913	901	1099	13
	FUEL OIL	1992	10 ³ ton	-	780	779	876	-2
		1991	TJ	-	36780	36310	44290	539
		1992		-	31451	31394	35308	-99
19	PRODUKTY NIEENERGETYCZNE	1991	TJ	-	2035	-	16505	1248
	NON-ENERGY PRODUCTS	1992		-	465	-	3082	-29
20	GAZ RAFINERYJNY	1991	tys. ton	-	-	-	-	-
	REFINERY GAS	1992	10 ³ ton	-	-	-	-	-
		1991	TJ	-	-	-	-	-
		1992		-	-	-	-	-
21	GAZ KOKSOWNICZY	1991	mln m ³	-	-	-	-	-
	COKE OVEN GAS	1992	10 ⁶ m ³	-	-	-	-	-
		1991	TJ	-	-	-	-	-
		1992		-	-	-	-	-
22	GAZ MIEJSKI	1991	mln m ³	-	12	-	-	-
	TOWN GAS	1992	10 ⁶ m ³	-	12	-	-	-
		1991	TJ	-	192	-	-	-
		1992		-	186	-	-	-
23	GAZ CZADNICOWY I WYTLEWNY	1991	mln m ³	-	-	-	-	-
	BLAST FURNACE GAS	1992	10 ⁶ m ³	-	-	-	-	-
		1991	TJ	-	-	-	-	-
		1992		-	-	-	-	-
24	GAZ WIELKOPIECOWY	1991	mln m ³	-	-	-	-	-
	GAS MANUFACTURED FROM COAL	1992	10 ⁶ m ³	-	-	-	-	-
		1991	TJ	-	-	-	-	-
		1992		-	-	-	-	-
25	ENERGIA ELEKTRYCZNA	1991	GWh	-	6708		9326	-
	ELECTRICITY	1992		-	5034		9066	-
		1991	TJ	-	24148		33572	-
		1992		-	18121		32636	-
26	CIEPŁO	1991	TJ	-	-	-	-	-
	HEAT	1992		-	-	-	-	-
27	ENERGIA Z ODZYSKU	1991	TJ	-	-	-	-	-
	ENERGY FROM RETURNS	1992		-	-	-	-	-
28	PALIWA ODPAD. CIEKŁE I GAZOWE	1991	TJ	-	-	-	-	-
	LIQUID AND GASEOUS WASTE FUELS	1992		-	-	-	-	-
29	CIEPŁO Z ODZYSKU	1991	TJ	-	-	-	-	-
	HEAT FROM RETURNS	1992		-	-	-	-	-

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETY- CZNE	STRATY TRANSPORTU I MAGA- ZYNOWANIA	RÓŻNICE BILANSOWE	LP
GLOBAL CONSUMPTION OR EXCHANGE BALANCES	TRANSFORMA- TIONS OUTPUT OR RETURNS	TOTAL CONSUMPTION	TRANSFORMA- TIONS INPUT	DIRECT CONSUMPTION	AMONG WHICH NON-ENERGY USE	LOSSES OF TRANSPORT AND STORAGE	STATISTICAL DIFFERENCE	
-	144	144	10	134	107	0	-	15
0	159	159	8	151	105	0	-	
-	6571	6571	445	6124	4918	2	-	
0	7263	7263	383	6879	4784	1	-	
1700	2400	4100	168	3926	15	6	-	16
1550	3201	4750	642	4097	18	11	-	
73606	103920	177526	6945	170340	661	241	-	
67104	138589	205692	27819	177390	771	483	-	
1227	3695	4922	26	4892	5	4	-	17
698	4437	5135	202	4929	5	4	-	
52405	157762	210167	1106	208906	234	154	-	
29805	189472	219277	8602	210498	201	176	-	
-200	3480	3281	1757	1635	15	0	-112	18
-93	2982	2889	1567	1618	26	0	-296	
-8049	141394	133345	71108	65633	581	2	-3397	
-3759	120358	116599	63743	65021	1044	1	-12165	
-15718	99220	83502	576	82903	-	23	-	19
-2588	99727	97139	1003	96062	-	74	-	
-	239	239	15	224	-	-	-	20
-	295	295	20	275	-	-	-	
-	11844	11844	764	11080	-	-	-	
-	15142	15142	1040	14102	-	-	-	
-	5056	5056	449	4476	0	131	-	21
-	4881	4881	507	4296	0	78	-	
-	89809	89809	7965	79448	0	2396	-	
-	86666	86666	9041	76235	1	1390	-	
12	87	100	1	95	-	4	-	22
12	63	75	1	73	-	1	-	
192	1812	2004	18	1920	-	65	-	
186	1238	1424	13	1395	-	15	-	
-	924	924	39	886	-	-	0	23
-	648	648	43	612	-	-	-7	
-	5446	5446	250	5195	-	-	0	
-	3852	3852	328	3621	-	-	-97	
-	12499	12499	3762	8736	-	-	-	24
-	11895	11895	3952	7942	-	-	-	
-	42811	42811	12961	29849	-	-	-	
-	40802	40802	13606	27196	-	-	-	
-2618	134715	132097	2747	115367	-	13983	-	25
-4032	132750	128719	2825	110785	-	15108	-	
-9424	484973	475549	9888	415321	-	50339	-	
-14515	477901	463387	10172	398826	-	54389	-	
-	816383	816383	5655	810728	-	-	-	26
-	751140	751140	4888	746252	-	-	-	
-	90450	x	12538	77912	13483	-	-	27
-	92480	x	10501	81979	13958	-	-	
-	53693	53693	12538	41155	13483	-	-	28
-	54606	54606	10501	44105	13958	-	-	
-	36757	36757	-	36757	-	-	-	29
-	37874	37874	-	37874	-	-	-	

Annex 4. National energy balance 1991 – OECD

Poland : 1991

PRODUCTION AND USES OF ENERGY	Coal (TJ)							Gas (TJ)	
	Hard Coal	Brown Coal	Oven Coke and Gas Coke	Patent Fuel	BKB	Fuel Wood	Other Non- commercial Fuels	Natural Gas	Gas Works Gas
Indigenous Production	3200602.2	589631.7	320764.1	12.6	2254.5	28785.0	22839.0	113720.4	6834.2
From Other Sources	7319.2							8703.4	449.5
Imports	1584.3							244864.0	211.1
Exports	490117.5	11475.9	96446.4	229.7	1465.2			23.2	
International Marine Bunkers									
Stock Changes	-48600.0	-1479.4	-200.0	601.8	-643.0			-1550.1	
DOMESTIC SUPPLY	2670788.2	576676.4	224117.7	384.7	146.3	28785.0	22839.0	365714.5	7494.8
Returns to Supply							50099.9		
Transfers								-2617.6	700.1
Total Requirements	2670788.2	576676.4	224117.7	384.7	146.3	28785.0	72938.9	363096.9	8194.9
Statistical Difference	0.0	10532.5	0.0	-8.6	-4.1	0.0	0.0		0.3
TRANSFORMATION SECTOR	1994587.6	564079.6	59811.2	245.9	50.8	272.2	23025.6	24238.2	141.7
Patent Fuel Plants	11.1	2398.8							
Coke Ovens	448531.5		557.9					1834.6	
Gas Works	10558.4	210.1	369.0					4441.6	
Blast Furnaces			47091.6						
Oil Refineries									
Autoproducers of Electricity	267098.9	1293.3	34.2				18482.8	2296.1	
Public Plants for CHP	871686.4	557346.0					1476.5	278.4	
Heating Plants	396701.3	2831.4	11758.5	245.9	50.8	272.2	3066.3	15387.5	141.7
Non-Specified									
ENERGY SECTOR	7807.2	129.8	498.1	0.0	10.0	5.0	271.7	12768.3	198.2
Coal Mines	5359.7	127.4	118.1		10.0	0.3		230.8	140.8
Oil and Gas Extraction	53.3		14.9					5418.5	
Patent Fuel Plants	0.4								
Coke Ovens			37.5					18.0	
Gas Works	73.4		204.9			0.2		5391.4	50.7
Oil Refineries	20.3	2.4	0.1				271.7	1693.2	
Electric Plants									
Pumped Storage									
Non-Specified	2300.1		122.6			4.5		16.4	6.7
Distribution Losses								17138.5	72.0
FINAL CONSUMPTION	668393.4	1934.5	163808.4	147.4	89.6	28507.8	49641.6	308951.9	7782.7
INDUSTRY SECTOR	155265.2	792.0	109983.6	37.3	53.7	568.9	21853.9	85424.3	5796.5
Iron and Steel	1270.3	18.2	80110.7				6755.8	35522.7	1607.8
Chemical	6723.6	40.2	1850.6	0.3		26.7	9033.0	4773.8	210.6
<i>of which: Petrochemical</i>	6.2		2.3				6855.1		
Non-Ferrous Metals	568.4		4957.3				483.4	5051.0	6.7
Non-Metallic Minerals	72908.3	141.3	10496.5	0.9	13.7	9.2	468.5	24975.0	3450.4
Transport Equipment	4223.0	5.9	950.2	0.7		3.2	3.5	1969.0	4.2
Machinery	11771.5	43.2	5697.5	3.8	0.3	32.9	28.3	7415.7	444.0
Mining and Quarrying	3129.5	5.4	706.5		38.5	0.5	124.7	2968.5	
Food and Tobacco	36334.5	17.8	2828.9	0.5	0.8	78.7	37.1	2183.0	15.1
Paper, Pulp and Print	1804.6	1.1	266.5	30.3				67.8	1.9
Wood and Wood Products	5324.0	116.1	262.7	0.1	0.1	376.5	4774.5	225.8	
Constructions	4595.1	13.5	1261.1	0.7	0.3	34.4	26.7	69.4	51.5
Textiles and Leather	6160.0	387.8	436.1			0.6	61.7	166.6	4.1
Non-specified	452.4	1.5	159.0			6.2	56.7	36.0	0.2
TRANSPORT SECTOR	14139.9	30.4	3754.4	5.9	30.9	2.1	0.2	143.9	30.7
Air Transport	6.5								
Road Transport	1945.6	14.0	665.9	5.9	0.1	2.1	0.2	29.3	7.7
Railways	12149.6	16.4	3062.2		30.8			114.4	20.5
Internal Navigation	38.2		26.3					0.2	2.5
OTHER SECTORS	498269.9	1097.1	45740.2	104.2	5.0	27936.8	11359.4	153316.6	1955.5
Agriculture	23916.2	1063.4	1079.0	60.8	1.7	236.7	41.7	302.6	0.3
Commerce and Public		4.0							
Residential									
Non-Specified	474353.7	29.7	44661.2	43.4	3.3	27700.1	11317.7	153014.0	1955.2
NON-ENERGY USE	718.4	15.0	4330.2				16428.1	70067.1	
in Industry	424.4	15.0	3998.2				6862.4	70067.1	

Poland : 1991

PRODUCTION AND USES OF ENERGY						Oil (TJ)				
	Coke Oven Gas	Blast Furnace Gas	Electricity		Heat	Crude Oil + Feedstocks + Other Inputs	Crude Oil + NGL	Feed- stocks	Other Inputs	Refinery Gas
			Total	of which Hydro						
Indigenous Production	93217.4	42810.5	477823.0	5131.1	734220.8	7230.9	6624.0		606.9	11507.6
From Other Sources	3290.7		7150.0	71150.0	3473.1					
Imports			24148.0			483344.5	481052.0	2252.3	40.2	
Exports			33572.2							
International Marine Bunkers										
Stock Changes						4795.0	4795.0			
DOMESTIC SUPPLY	96508.1	42810.5	475548.8	76281.1	737693.9	495370.4	492471.0	2252.3	647.1	11507.6
Returns to Supply					36757.4	4606.6		4606.6		
Transfers	1917.5									
Total Requirements	98425.6	42810.5	475548.8	12281.1	774451.3	499977.0	492471.0	6858.9	647.1	11507.6
Statistical Difference	0.0	0.0			0.0			0.0	0.0	0.1
TRANSFORMATION SECTOR	8309.2	12961.5	0.0	0.0	5655.0	499977.0	492471.0	6858.9	647.1	934.1
Patent Fuel Plants										
Coke Ovens		164.0								
Gas Works										
Blast Furnaces										
Oil Refineries										
Autoproducers of Electricity	6144.6	11170.4			4984.8	499977.0	492471.0	6858.9	647.1	934.1
Public Plants for CHP	2.9				670.2					
Heating Plants	2161.7	1627.1								
Non-Specified										
ENERGY SECTOR	42340.3	1831.2	103385.0	0.0	84871.2	0.0	0.0	0.0	0.0	7236.7
Coal Mines	4.1		31763.9		22032.0					
Oil and Gas Extraction			368.8		203.0					
Patent Fuel Plants			9.4		342.7					
Coke Ovens	42226.2	1831.2	2432.4		13439.0					
Gas Works	106.8		683.7		1367.4					
Oil Refineries			1336.1		12150.2					7236.7
Electric Plants			33891.5		4273.2					
Pumped Storage			9889.2							
Non-Specified	3.2		23010.0		31063.7					
Distribution Losses	2635.5		50339.1							
FINAL CONSUMPTION	45140.6	28017.8	321824.7		683925.1	0.0	0.0	0.0	0.0	3336.7
INDUSTRY SECTOR	28295.8	28017.8	135780.9	0.0	374222.8	0.0	0.0	0.0	0.0	6673.4
Iron and Steel	24299.7	27902.1	22889.0		39659.8					
Chemical	573.8	9.9	31477.5		115136.3					3336.7
of which: Petrochemical			3075.4		22107.1					3336.7
Non-Ferrous Metals	195.8		7720.5		4039.1					
Non-Metallic Minerals	2002.6	105.8	10766.9		11363.6					
Transport Equipment	37.5		5133.6		15437.5					
Machinery	950.6		15339.3		31883.0					
Mining and Quarrying	15.0		11367.3		34245.6					
Food and Tobacco	138.3		10788.5		46871.0					
Paper, Pulp and Print	2.7		7119.6		31317.3					
Wood and Wood Products	1.1		3520.3		9554.2					
Constructions	57.5		3574.4		10876.7					
Textiles and Leather	21.2		5711.5		23127.6					
Non-specified			372.5		711.1					
TRANSPORT SECTOR	9.7	0.0	21103.0	0.0	6714.6	0.0	0.0	0.0	0.0	0.0
Air Transport			24.7		108.0					
Road Transport	4.8		3148.3		3560.6					
Railways	4.9		17683.4		2567.4					
Internal Navigation			246.6		478.6					
OTHER SECTORS	16834.8	0.0	164940.8	0.0	302987.7	0.0	0.0	0.0	0.0	0.0
Agriculture	1.7		29958.9		9279.2					
Commerce and Public										
Residential			72742.1							
Non-Specified	16833.1	0.0	62239.8	0.0	293708.5		0.0			
NON-ENERGY USE	0.3									
in Industry	0.3									

Poland : 1991

PRODUCTION AND USES OF ENERGY	Oil (TJ)		Petroleum Products (TJ)						
	Liquified Petroleum Gases	Motor Gasoline	Aviation Gasoline	Jet Fuel	Kerosene	Gas/Diesel Oil	Residual Fuel Oil	Naphta	Other Petroleum Products
Indigenous Production	6741.8	97316.3		6041.9	157.5	159237.2	139884.7	34800.3	38010.8
From Other Sources									
Imports		59465.9	1917.4	3469.1	47233.4	470.3			534.6
Exports		560.0		833.8	9685.0	41921.6			5426.1
International Marine Bunkers					3085.3	4501.6			
Stock Changes		7055.8	13.4	1253.0	8.8	4944.3	-538.6		1209.8
DOMESTIC SUPPLY	6741.8	163278.0	1930.8	9930.2	34629.4	118228.6	139346.1	34800.3	34329.1
Returns to Supply									
Transfers	75.7	113.7	-4.5	-878.4	-4.4	866.7			-168.8
Total Requirements	6817.5	163391.8	1926.3	9051.7	161.9	199511.2	93393.1	34800.3	34160.3
Statistical Difference	0.0	0.0	0.0	0.0	0.0	0.0	-5711.5		0.0
TRANSFORMATION SECTOR	463.6	0.0	0.0	0.0	0.0	658.7	66929.8	0.0	0.0
Patent Fuel Plants									
Coke Ovens									
Gas Works	463.6								
Blast Furnaces									
Oil Refineries						56.3	5305.5		
Autoproducers of Electricity						143.0	39598.4		
Public Plants for CHP						138.7	7371.4		
Heating Plants						320.7	14654.5		
Non-Specified									
ENERGY SECTOR	94.6	98.6	0.0	0.0	0.0	2110.3	10052.4	0.0	0.0
Coal Mines		35.8				1434.3			
Oil and Gas Extraction						281.7			
Patent Fuel Plants									
Coke Ovens						4.3			
Gas Works	4.7	9.0				17.3			
Oil Refineries	80.4					13.0	10000.1		
Electric Plants									
Pumped Storage									
Non-Specified	9.5	53.8				359.7	52.3		
Distribution Losses		246.4		4.5		156.0	4.0		20.1
FINAL CONSUMPTION	6259.3	163046.7	1926.3	9047.3	34625.0	116170.3	68071.4	34800.3	34140.2
INDUSTRY SECTOR	165.6	1823.6	0.0	0.0	0.0	11786.7	17841.7	0.0	0.0
Iron and Steel	9.5	13.4				143.0	7849.7		
Chemical		143.4				875.3	1905.2		
<i>of which: Petrochemical</i>						4.3	265.3		
Non-Ferrous Metals		4.5				34.7	819.9		
Non-Metallic Minerals	14.2	300.2				819.0	2797.5		
Transport Equipment	23.7	327.0				654.3	184.9		
Machinery	47.3	246.4				758.3	72.3		
Mining and Quarrying		26.9				1391.0	305.5		
Food and Tobacco	28.4	98.6				1009.7	1483.1		
Paper, Pulp and Print	33.1	9.0				73.7	1221.9		
Wood and Wood Products		26.9				156.0	1028.9		
Constructions	4.7	564.5				5494.7	112.5		
Textiles and Leather	4.7	31.4				164.7	60.3		
Non-specified		31.4				212.3			
TRANSPORT SECTOR	4.7	160537.7	1926.3	9047.2	0.0	132344.5	1716.2	0.0	0.0
Air Transport		10187.2	1926.3	9047.2		43.3			
Road Transport		150050.3				117927.5	8.0		
Railways	4.7	291.2				13684.7			
Internal Navigation		9.0				689.0	1708.2		
OTHER SECTORS	1031.5	0.0	0.0	0.0	34463.1	-28199.2	47927.5	0.0	0.0
Agriculture	4.7					52216.7	1973.5		
Commerce and Public									
Residential									
Non-Specified	1026.8	0.0	0.0		34463.1	-80415.9	45954.0	0.0	0.0
NON-ENERGY USE	5057.5	685.4			161.9	238.3	586.0	34800.3	34140.2
in Industry	5057.5	685.4			161.9	134.3	12.0	34800.3	34140.2

Annex 5. Uncertainty estimation of the 1991 inventory

Uncertainty analysis for the year 1991 was performed with Tier1 methodology. This simplified methodology is based on the assumptions listed below:

- every value is independent (there is no correlation between values)
- probability distribution is symmetric (probability of underestimation and overestimation is the same)

Conclusions from the 2005 in-depth review of the Polish GHG emission inventory were taken into account and additional analyses were made in *Agriculture* sector. For sector 5. *LUCF* due to lack of appropriate information, uncertainty estimates were made directly to emission values.

First step of the analysis was to assign uncertainty to each activity and emission factor. Next step was to estimate error propagation and its influence of total results. To estimate error propagation from activity and emission factor to emission values, formula (1) was used.

$$U_{\text{emission}} = \text{square root } (U_{\text{act}}^2 + U_{\text{EF}}^2) \quad (1)$$

where: U_{emission} – uncertainty of emission value
 U_{act} – uncertainty of activity value
 U_{ef} – uncertainty of emission factor value

To estimate error propagation from sectoral emissions to national total, formula (2) was used

$$U_{\text{emission}} = \text{square root } (\Sigma (\text{Emission} * U_{\text{emission}})^2) / \Sigma \text{Emission} \quad (2)$$

where: U_{emission} – uncertainty of emission value in sector
Emission – emission from sector

As the base bottom level of analysis the following sectors were chosen:

- sector 1: levels 1.A.1, 1.A.2, 1.A.3., 1.A.4, 1.A.5 with disaggregation by fuel type (liquid, solid, gaseous, biomass etc.)
- sector 2: levels 2.A.1, 2.A.2 2.C.3. (no estimates of emission from 2.D and 2.E)
- sector 4: 4.A.1, 4.A.2 4.F.5
- sector 6: 6.A.1, 6.A.2; 6.B with disaggregation according to wastewater types and 6.C with disaggregation according to waste types.

To estimate uncertainty of input data, the results of research made in 2000 for the 1998 GHG emission inventory were used. These data were assigned for emission factors for CH₄ and N₂O in sector 1. *Energy*, 4. *Agriculture* and partly in 6. *Waste*. Another source of data on uncertainties was analysis of 2002 GHG Inventory of Scandinavian countries. Conclusions were applied to activities in sector 1. *Energy* and for activities and emission factors in sector 2. *Industrial processes*. Other uncertainties for activities and factors were estimated with expert's opinion in National Emission Centre in Warsaw (CO₂ emission factors in sector 1. *Energy*; and activities and factors in 6.C Waste/Waste Incineration).

Results of analysis of error propagation of uncertainty of national totals are shown below:

CO ₂ – 6.2%	CH ₄ – 19.6%	N ₂ O – 52.8%
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Activities

Most uncertain values of activity were assigned in category *4.F Agriculture/Field Burning of Agricultural Residues* and in *6.B Waste/Domestic and Commercial Wastewater* (30%). Lowest uncertainty values were assigned to *1.B Fugitive emission from fuels* (2%) and in *1.A.1 Energy/ Fuel Combustion/ Energy Industries* (3%).

CO₂ emission factors

Most uncertain values for CO₂ emission factors were assigned in sector *6.C Waste incineration* (50%), *2.A. Cement Production* (15%) and *2.C Metal Production* (10%), the most precise values were in *1.A Fuel Combustion* (1-2%).

Low level of uncertainty of national total of CO₂ (6.2%) comes from the fact, that major part of emission comes from sector *1.A Fuel Combustion* where data for activities and factors are most precise (relatively 2-5% and 1-2%).

CH₄ emission factors

Most uncertain values for CH₄ emission factors were assigned in sector *6.A Solid Waste Disposal on Land* (100%), and *6.B. Wastewater Handling* (100%), *4.A. Enteric Fermentation* and *4.B Manure Management* (50%), *1.A.3 Transport* (50%), and for liquid fuels in *1.A Fuel Combustion* (41.8%), the most precise values were in *1.B.2 Fugitive emission from fuels/ Oil and natural gas* (8.1%).

Uncertainty of CH₄ emission is app. 19.6% which is result of share of agriculture and waste sectors in national totals – emission factors in those sectors have high uncertainty.

N₂O emission factors

Most uncertain values for N₂O emission factors were assigned in sector *4.B.11 and 4.B.12 Manure management* (150%), *4.D Agricultural Soils* (150%) and in *4.F Agriculture/Field Burning of Agricultural Residues* (150%), most precise values were for Natural gas combustion in *1.A.3 Transport* (2.3%) and *1.A Fuel Combustion* (3.8%).

Highest value of uncertainty of national total occurred in N₂O (52.8%) and is a result of high uncertainty of the emission factors in sector of *Agriculture* (*4.B.11 Liquid systems*, *4.B.12 Solid Storage and Dry Lot*, *4.D Agricultural Soils* and *4.Field Burning of Agricultural residues* – 150%).

The uncertainty assessment of GHG Inventory for 1990 was made on the basis of calculations and experts opinions made in 2006 (during compiling inventories for years 2000-2004) and recommendations of the UNFCCC expert review team. The calculations were extended to cover simplified approach for LULUCF.

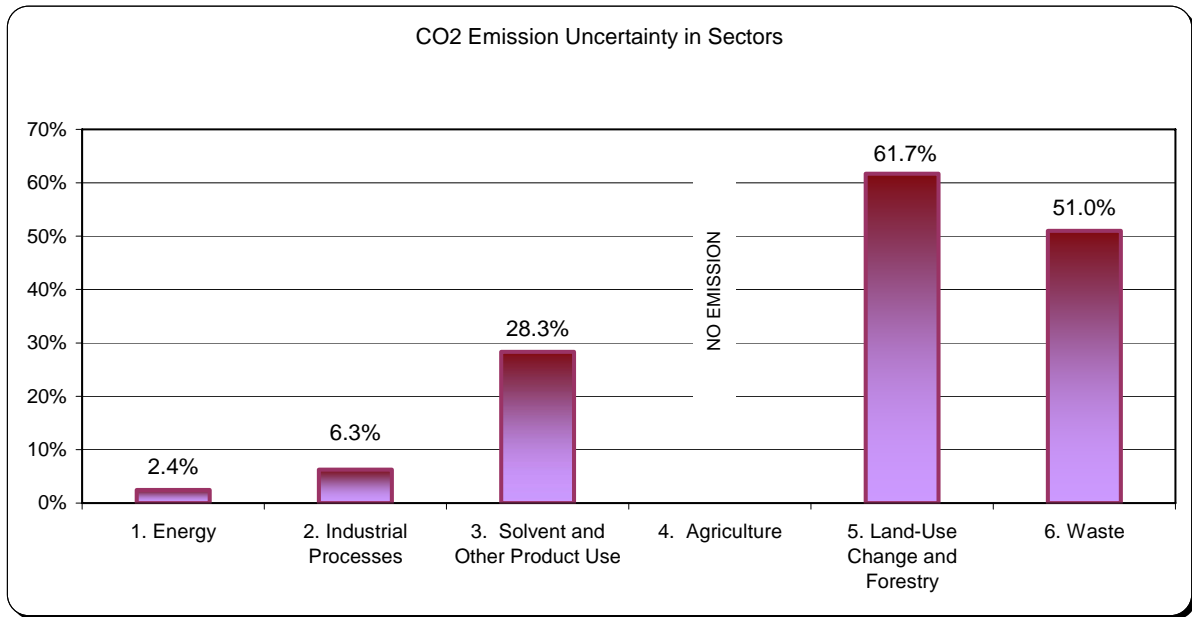
Sector *3. Solvents and Other Products Use* was included in calculations with high sectoral uncertainty 28.3%. Emission from this sector is small compared to total CO₂ and high uncertainty have very little influence on uncertainty of values of total national CO₂ emission.

GHG inventory 1991 – Uncertainty analysis, part 1, sectors 1-2

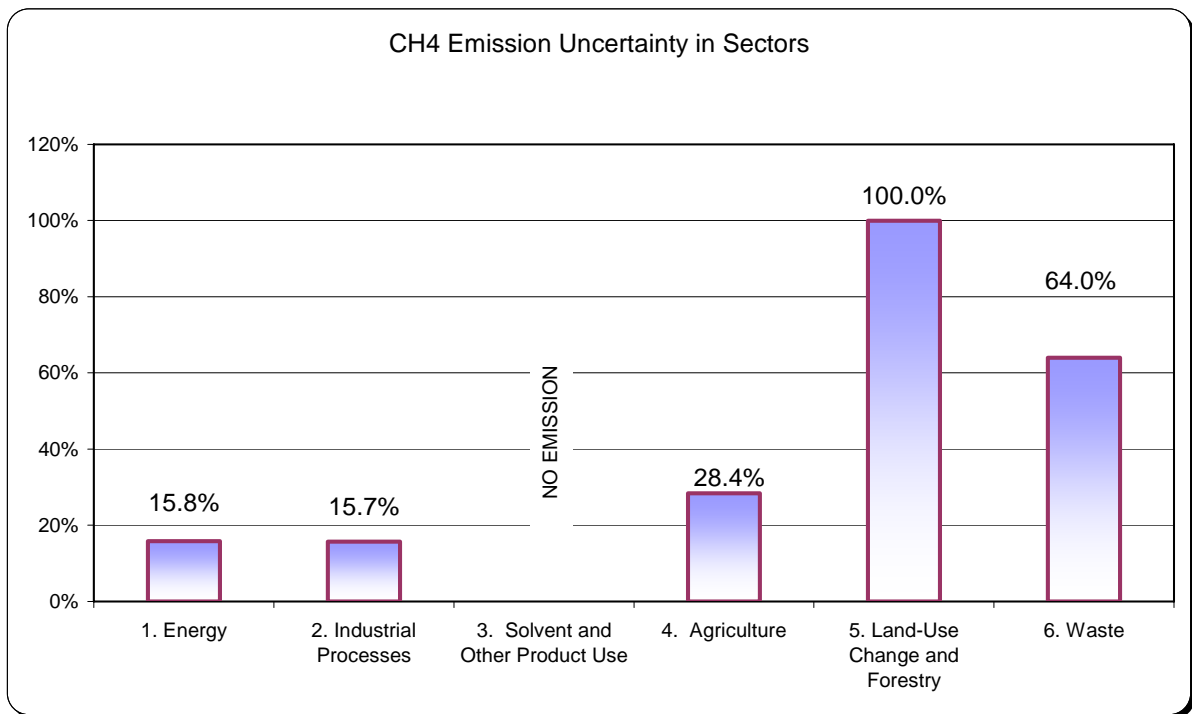
1991	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
TOTAL									356 824.85	2 215.54	109.36	6.2%	19.6%	52.8%	22 077.85	433.16	57.79
1. Energy									373 193.09	840.47	7.51	2.4%	15.8%	2.6%	9129.83	132.84	0.19
A. Fuel Combustion									373 142.88	13.64	7.51	2.4%	7.0%	2.6%	9129.83	0.96	0.19
1. Energy Industries									241 715.46	3.21	3.50	3.4%	12.9%	3.5%	8328.94	0.41	0.12
Liquid Fuels	134 601	3.0%	70.13	2.39	0.53	1.0%	41.8%	3.8%	9 440.21	0.32	0.07	3.2%	41.9%	3.2%	298.53	0.13	0.00
Solid Fuels	2 307 392	3.0%	100.05	1.23	1.48	2.0%	13.5%	11.7%	230 850.42	2.83	3.42	3.2%	13.8%	3.6%	8323.43	0.39	0.12
Gaseous Fuels	25 501	3.0%	55.87	1.00	0.10	2.0%	17.0%	20.0%	1 424.82	0.03	0.00	3.6%	17.3%	3.6%	51.37	0.00	0.00
Biomass	928	3.0%				0.0%	24.0%	37.0%	103.96	0.03	0.00	3.0%	24.2%	3.0%		0.01	0.00
2. Manufacturing Industries and Construction									36 851.39	1.51	0.62	4.2%	13.0%	6.7%	1546.50	0.20	0.04
Liquid Fuels	62 095.08	5.0%	73.58	2.93	5.30	1.0%	41.8%	3.8%	4 568.68	0.18	0.33	5.1%	42.1%	6.3%	232.96	0.08	0.02
Solid Fuels	244 006.86	5.0%	115.07	5.10	1.18	2.0%	13.5%	11.7%	28 076.78	1.24	0.29	5.4%	14.4%	12.7%	1511.98	0.18	0.04
Gaseous Fuels	76 479.08	5.0%	54.99	1.00	0.10	2.0%	17.0%	20.0%	4 205.94	0.08	0.01	5.4%	17.7%	20.6%	226.50	0.01	0.00
Biomass	118.48	5.0%	112.00	30.00	4.00	0.0%	24.0%	37.0%	13.27	0.00	0.00	5.0%	24.5%	37.3%		0.00	0.00
3. Transport									27 032.01	6.90	1.44	6.8%	11.2%	5.4%	1848.14	0.78	0.08
Liquid Fuels	331 183.96	5.0%	78.87	20.62	4.26	5.0%	10.2%	2.3%	26 120.79	6.83	1.41	7.1%	11.4%	5.5%	1847.02	0.78	0.08
Solid Fuels	12 149.60	5.0%	75.00	6.00	NE	5.0%	13.5%	11.7%	91.22	0.07	0.02	7.1%	14.4%	12.7%	64.43	0.01	0.00
Biomass	NE	5.0%	0.00	0.00	0.00	0.0%	24.0%	37.0%	0.00	0.00	0.00	5.0%	24.5%	37.3%	0.00	0.00	0.00
Other Fuels	NE	5.0%	0.00	0.00	0.00	0.0%	50.0%	50.0%	0.00	0.00	0.00	5.0%	50.2%	50.2%	0.00	0.00	0.00
4. Other Sectors									65 125.82	1.80	1.20	4.4%	13.9%	9.3%	2857.30	0.25	0.11
Liquid Fuels	67 165.03	5.0%	74.40	4.08	4.08	1.0%	41.8%	3.8%	4 997.40	0.27	0.27	5.1%	42.1%	6.3%	254.82	0.12	0.02
Solid Fuels	552 530.10	5.0%	94.58	1.00	1.46	2.0%	13.5%	11.7%	52 257.91	0.55	0.80	5.4%	14.4%	12.7%	2814.17	0.08	0.10
Gaseous Fuels	138 967.60	5.0%	56.64	1.00	0.10	2.0%	17.0%	20.0%	7 870.52	0.14	0.01	5.4%	17.7%	20.6%	423.84	0.02	0.00
Biomass	27 922.70	5.0%	112.00	30.00	4.00		24.0%	37.0%	3 127.34	0.84	0.11	5.0%	24.5%	37.3%		0.21	0.04
5. Other									2 418.21	0.22	0.74	4.4%	98.5%	6.2%	105.57	0.22	0.05
Liquid Fuels	27 801.07	5.0%	73.06	7.83	26.61	1.0%	100.0%	3.8%	2 031.10	0.22	0.74	5.1%	100.1%	6.3%	103.57	0.22	0.05
Solid Fuels	3 447.99	5.0%	110.33	1.00	1.49	2.0%	80.0%	11.7%	380.43	0.00	0.01	5.4%	80.2%	12.7%	20.49	0.00	0.00
Gaseous Fuels	121.00	5.0%	55.21	1.00	0.10	2.0%	90.0%	20.0%	6.68	0.00	0.00	5.4%	90.1%	20.6%	0.36	0.00	0.00
Biomass	1.00	5.0%	112.00	30.00	4.00	0.0%	95.0%	37.0%	0.11	0.00	0.00	5.0%	95.1%	37.3%		0.00	0.00
B. Fugitive Emissions from Fuels									50.21	826.83	0.00	5.6%	16.1%		2.81	132.84	0.00
1. Solid Fuels									1.40	664.08	0.00	6.6%	20.0%		0.09	132.51	0.00
1. B. 1. a. Coal Mining and Handling															0.00	0.00	0.00
i. Underground Mines [Activity in Mt, EF in kg/t]	143.20	2.0%		4.60378			20.0%			659.26			20.1%		0.00	132.51	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	68.72	2.0%		0.01273			20.0%			0.87			20.1%		0.00	0.18	0.00
1. B. 1. c. Other [CO2 Emission from Coking Gas Subsystem]	0.68	2.0%	2 060 765	5 791 695.00			20.0%		1.40	3.95		6.6%	15.0%		0.09	0.59	
2. Oil and Natural Gas									48.80	162.74	0.00	5.7%	5.7%		2.80	9.35	0.00
1. B. 2. a. Oil															0.00	0.00	0.00
ii. Production [Activity in PJ, EFs in kg/PJ]	6.62	0.5%	6 315 000	61 800.00		6.6%	8.1%		41.83	0.41		6.6%	8.1%		2.77	0.03	0.00
iii. Transport [Activity in Gg]	11 612.00	0.5%	NE	NE		6.6%	8.1%		0.07	0.01		6.6%	8.1%		0.00	0.00	0.00
1. B. 2. b. Natural Gas															0.00	0.00	0.00
i. Production / Processing [Activity in PJ, EFs in kg/PJ]	111.27	0.5%	56 940.87	102 172.47		6.6%	8.1%		6.34	11.37		6.6%	8.1%		0.42	0.92	0.00
ii. Transmission [Activity in PJ, EFs in kg/PJ]	335.62	0.5%	514.06	136 501.74		6.6%	8.1%		0.17	45.81		6.6%	8.1%		0.01	3.72	0.00
ii. Distribution [Activity in PJ, EFs in kg/PJ]	335.62	0.5%	1 162.52	313 285.34		6.6%	8.1%		0.39	105.15		6.6%	8.1%		0.03	8.53	0.00
2. Industrial Processes									15268.31	10.48	10.57		15.7%	26.5%	956.43	1.65	2.80
A. Mineral Products									7734.36		0	11.5%			892.06	0.00	0.00
1. Cement Production [Activity in kt, EF in t/t]	10 235.00	5.0%	0.525			15.0%			5373.38			15.8%			849.61	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	2 413.00	10.0%	0.785			10.0%			1894.21			14.1%			267.88	0.00	0.00
4. Soda Ash (production) [Activity in kt, EF in t/t]	1 124.76	10.0%	0.415			0.0%			466.78			10.0%			46.68	0.00	0.00
7. Other (Limestone) [Activity in kt, EF in t/t]	0.00	5.0%	0			5.0%			0.00			7.1%			0.00	0.00	0.00
B. Chemical Industry									2652.73	7.82	10.57	6.3%	20.2%	26.5%	167.02	1.58	2.80
1. Ammonia Production [Activity in kt, EF in t/t]	1 560.90	5.0%	1.5	0.0049		5.0%	20.0%		2341.35	7.65		7.1%	20.6%		165.56	1.58	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	1 438.20	2.0%			0.01			30.0%			9.31			30.1%	0.00	0.00	2.80
3. Adipic Acid Production [Activity in kt, EF in t/t]	2.59	5.0%			0.00			10.0%	NE		0.78			11.2%			
4. Carbide Production (calcium carbide) [Activity in kt, EF in t/t]	283.00	5.0%	1.1			5.0%			311.30			7.1%			22.01	0.00	0.00
5. Other (Carbon Black) [Activity in kt, EF in t/t]	17.14	5.0%		0.01			20.0%			0.17			20.6%		0.00	0.04	0.00
5. Other (Ethylene) [Activity in kt, EF in t/t]	271.36	5.0%	0.0003			5.0%			0.08			7.1%			0.01	0.00	0.00
5. Other (N2O for Medical Use) [Activity in kt, EF in t/t]	IE	5.0%		IE				20.0%			IE				0.00	0.00	IE
5. Other (Urea production) [Activity in kt, EF in t/t]	664.30	5.0%	0			5.0%						7.1%			0.00	0.00	0.00
5. Other (Caprolactam) [Activity in kt, EF in t/t]	103.65	5.0%			0.0047			20.0%		0.49				20.6%	0.00	0.00	0.10
C. Metal Production									4881.22	2.66	0	6.2%	17.9%		301.81	0.48	0.00
1. Iron and Steel Production															0.00	0.00	0.00
Sinter [Activity in kt, EF in t/t]	8 612.67	5.0%	0.08			10.0%			671.44			11.2%			75.07	0.00	0.00
Coke [Activity in kt, EF in t/t]	11 468.07	5.0%	0.13	0.000200		10.0%	20.0%		1532.50	2.29		11.2%	20.6%		171.34	0.47	0.00
Open-heart Steel [Activity in kt, EF in t/t]	2 637.70	5.0%	0.052			10.0%			137.16			11.2%		NE			
Electric Furnace Steel [Activity in kt, EF in t/t]	2 047.50	5.0%	0.00430	0.000120		10.0%	20.0%		8.80	0.25		11.2%	20.6%		0.98	0.05	0.00
Pig Iron [Activity in kt, EF in t/t]	6 501.54	5.0%	0.32404			10.0%			2106.78			11.2%			235.55	0.00	0.00
Iron Cast [Activity in kt, EF in t/t]	603.20	5.0%	0.061	0.000200		10.0%	20.0%		36.80	0.12		11.2%	20.6%		4.11	0.02	0.00
Steel Cast [Activity in kt, EF in t/t]	100.40	5.0%	0.062			10.0%			6.22			11.2%			0.70	0.00	0.00
Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]	5 745.50	5.0%	0.01126			10.0%			64.69			11.2%			7.23	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	60.10	5.0%	3.9			5.0%			234.39			7.1%			16.57	0.00	0.00
3. Aluminium Production [Activity in kt, EF in t/t]	45.79	5.0%	1.8			5.0%			82.43			7.1%			5.83	0.00	0.00
D. Other Production															0.00	0.00	0.00
G. Other															0.00	0.00	0.00

GHG inventory 1991 – Uncertainty analysis, part 2, sector 3-6

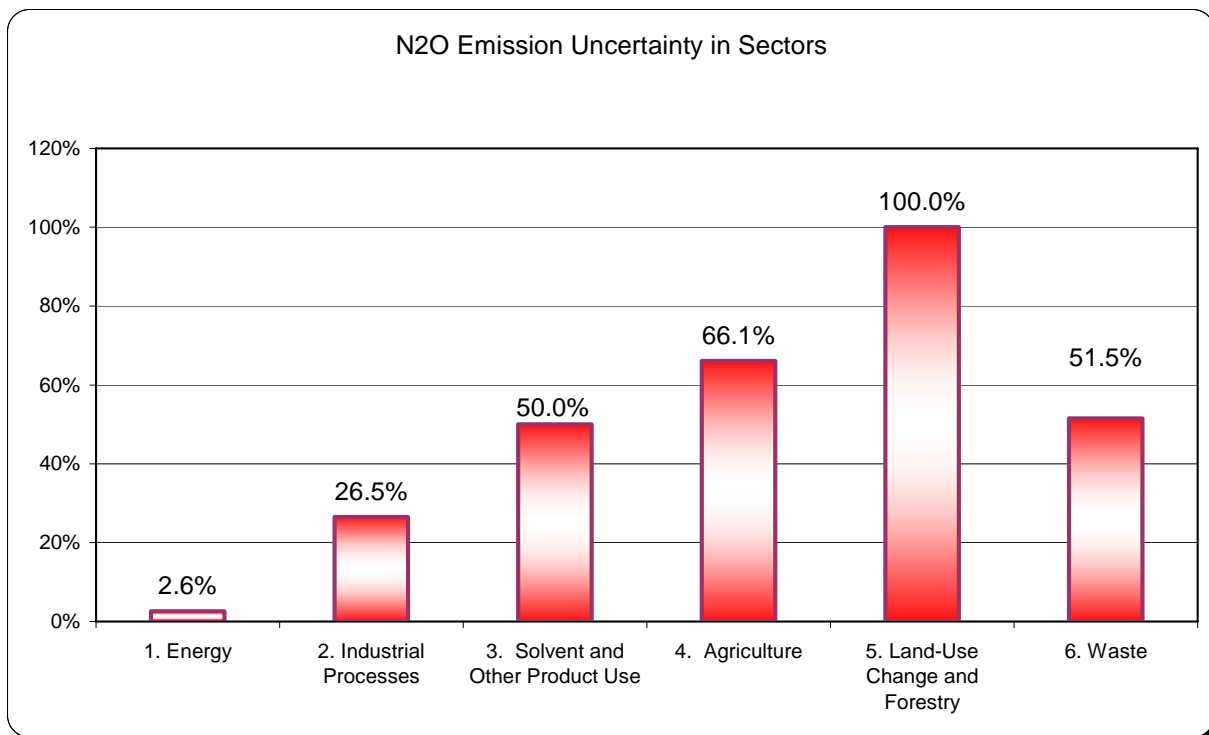
1991	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
3. Solvent and Other Product Use	151.43		NA						484.22		0.40	28.3%		50.0%	137.03	0.00	0.20
4. Agriculture										838.21	87.23		28.4%	66.1%	0.00	237.75	57.69
A. Enteric Fermentation										661.33			34.2%		0.00	225.89	0.00
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	4 577.0	5.0%		90.18			50.0%			412.73			50.2%		0.00	207.40	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	4 267.0	5.0%		40.39			50.0%			172.36			50.2%		0.00	86.61	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	3 234.0	5.0%		7.93			50.0%			25.64			50.2%		0.00	12.88	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	179.3	5.0%		5.00			50.0%			0.90			50.2%		0.00	0.45	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	939.0	5.0%		18.00			50.0%			16.90			50.2%		0.00	8.49	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	21 868.0	5.0%		1.50			50.0%			32.80			50.2%		0.00	16.48	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	221 087.8	5.0%		0.00			50.0%			0.00			50.2%		0.00	0.00	0.00
B. Manure Management										175.52	28.58		42.2%	148.8%	0.00	74.15	42.54
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	4 577	5.0%		5.51			50.0%			25.23			50.2%		0.00	12.68	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	4 267	5.0%		2.09			50.0%			8.90			50.2%		0.00	4.47	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	3 234	5.0%		0.17			50.0%			0.54			50.2%		0.00	0.27	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	173	5.0%		0.12			50.0%			0.02			50.2%		0.00	0.01	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	939	5.0%		1.39			50.0%			1.31			50.2%		0.00	0.66	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	21 868	5.0%		5.59			50.0%			122.28			50.2%		0.00	61.44	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	221 088	5.0%		0.08			50.0%			17.24			50.2%		0.00	8.67	0.00
11. Liquid Systems [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.001000			150.0%			0.24			150.1%	0.00	0.00	0.36
12. Solid Storage and Dry Lot [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.020000			150.0%			28.34			150.1%	0.00	0.00	42.53
D. Agricultural Soils											58.58			66.5%	0.00	0.00	38.97
1. Direct Soil Emissions															0.00	0.00	0.00
Synthetic Fertilizers [Activity in kg N, EF in kg N2O-N/kg N]	661 500 000	5.0%			0.01			150.0%			9.24			150.1%	0.00	0.00	13.87
Animal Wastes Applied to Soils [Activity in kg N, EF in kg N2O-N/kg N]	816 466 321	5.0%			0.01			150.0%			12.83			150.1%	0.00	0.00	19.26
N-fixing Crops [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	101 610 000	5.0%			0.01			150.0%			1.80			150.1%	0.00	0.00	2.40
Crop Residue [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	197 676 000	5.0%			0.01			150.0%			3.11			150.1%	0.00	0.00	4.66
Cultivation of Histosols [Activity in ha, EF in kg N2O-N/ha]	1 269 000	5.0%			8.00			150.0%			15.95			150.1%	0.00	0.00	23.94
2. Animal Production [Activity in kg N, EF in kg N2O-N/kg N]	130 297 337	5.0%			0.02			150.0%			4.10			150.1%	0.00	0.00	6.15
3. Indirect Emissions [Activity in kg N/yr, EF in kg N2O/kg N]	99 559 467	20.0%			1.181470071			150.0%			11.76			151.3%	0.00	0.00	17.80
F. Field Burning of Agricultural Residues										1.36	0.07		20.5%	107.5%	0.00	0.28	0.07
1. Cereals															0.00	0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	9 270 000	30.0%		0.1816	0.0004		20.0%	150.0%		0.17	0.00		36.1%	153.0%	0.00	0.06	0.01
Barley [Activity in t of crop production, EF in kg/t dm]	4 257 000	30.0%		0.1473	0.0004		20.0%	150.0%		0.06	0.00		36.1%	153.0%	0.00	0.02	0.00
Maize [Activity in t of crop production, EF in kg/t dm]	340 000	30.0%		0.0367	0.0001		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
Oats [Activity in t of crop production, EF in kg/t dm]	1 873 000	30.0%		0.1506	0.0004		20.0%	150.0%		0.03	0.00		36.1%	153.0%	0.00	0.01	0.00
Rye [Activity in t of crop production, EF in kg/t dm]	5 900 000	30.0%		0.2004	0.0004		20.0%	150.0%		0.12	0.00		36.1%	153.0%	0.00	0.04	0.00
Other Cereals [Activity in t of crop production, EF in kg/t dm]	6 171 000	30.0%		0.1576	0.0004		20.0%	150.0%		0.10	0.00		36.1%	153.0%	0.00	0.04	0.00
2 Pulses (Other non-specified)	680 000	30.0%		0.0439	0.0003		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
3 Tuber and Root															0.00	0.00	0.00
Potatoes [Activity in t of crop production, EF in kg/t dm]	29 038 000	30.0%		0.1796	0.0014		20.0%	150.0%		0.52	0.04		36.1%	153.0%	0.00	0.19	0.06
Sugar Beet [Activity in t of crop production, EF in kg/t dm]	0	30.0%		0.0000	0.0000		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
Other Tuber and Root [Activity in t of crop production, EF in kg/t dm]	0	30.0%		0.0000	0.0000		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
5 Other															0.00	0.00	0.00
Fruits, Veget., Rape, Tobacco, Hop, Hey [Activity in t of crop prod., EF in kg/ t of crop]	31 120 700	30.0%		0.0114	0.0005		20.0%	150.0%		0.35	0.01		36.1%	153.0%	0.00	0.13	0.02
5. Land-Use Change and Forestry									-32534.24	0.10	0.00	61.7%	100.0%	100.0%	-20077.35	0.10	0.00
A. Forest Land									-38328.32			50.0%			-19664.16	0.00	0.00
B. Cropland									6479.84			50.0%			3239.92	0.00	0.00
C. Grassland									3595.49			50.0%			1797.75	0.00	0.00
D. Wetlands									0.00			50.0%			0.00	0.00	0.00
E. Settlements									-3281.25	0.10	0.0007	50.0%	100.0%	100.0%	-1640.63	0.10	0.001
F. Other Land									0.00	0.00	0.0000	50.0%	100.0%	100.0%	0.00	0.00	0.00
6. Waste									413.46	526.29	3.65	51.0%	64.0%	51.5%	210.83	336.83	1.88
A. Solid Waste Disposal on Land										236.95			102.6%		0.00	243.13	0.00
1 Managed Waste Disposal on Land [Activity in Gg, EF in t/t MSW]							100.0%						100.0%		0.00	0.00	0.00
2 Unmanaged Waste Disposal Sites - deep (>5 m) [Activity in Gg, EF in t/t MSW]															0.00	0.00	0.00
3 Other - Total Waste Disposal on Land (Draft Guidelines 2006) [Activity in Gg, EF in t/t MSW]	10 627.34	23.0%					100.0%			236.95	3.60		102.6%		0.00	243.13	0.00
B. Wastewater Handling										289.34			80.6%	52.2%	0.00	233.11	1.88
Industrial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	2 470.88			0.09			100.0%			222.38			100.0%		0.00	222.38	0.00
Domestic and Commercial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	295.27	30.0%		0.226782464			100.0%			66.96			104.4%		0.00	69.91	0.00
sewage N produced]	38 309.00	15.0%			0.0000941			50.0%			3.60			52.2%	0.00	0.00	1.88
C. Waste Incineration									413.46		0.05	51.0%			210.83	0.00	0.01
biogenic [Activity in Gg, EF in kg/t waste]		10.0%					50.0%			109.94		51.0%			56.06	0.00	0.00
plastics and other non-biogenic waste [Activity in Gg, EF in kg/t waste]		10.0%					50.0%			413.46		51.0%			210.83	0.00	0.01



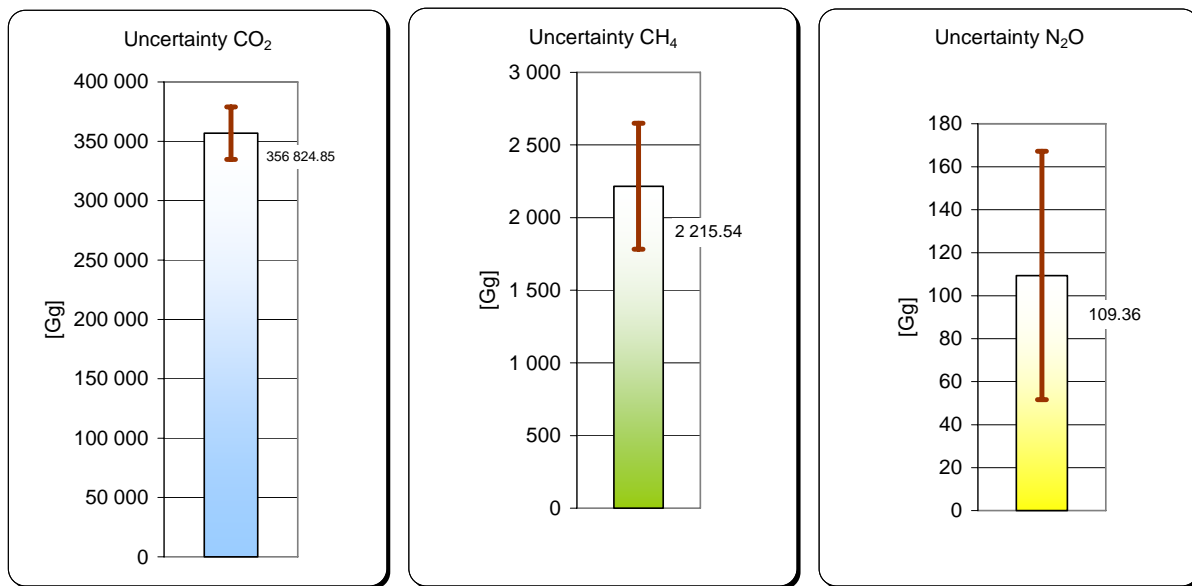
Results of uncertainty analysis in percents for CO₂ with sectoral split.



Results of uncertainty analysis in percents for CH₄ with sectoral split.



Results of uncertainty analysis in percents for N₂O with sectoral split



Emission results with uncertainties bars.