

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

Poland's National Inventory Report 1993

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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 1993. 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 1993. Totals in tables may not sum due to independent rounding.

Total national GHG emissions

The GHG emissions in base year (1988/1995) and 1993, expressed as CO₂ equivalents, are presented in table ES.1 In 1993 the total national emission of GHG were about 438.77 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 1993 emissions have decreased by 25.2%.

Table ES.1 National emissions of greenhouse gases for the years base year (1988/1995)-1993. [Gg CO₂ eq.]

Pollutant	Base year	1993	(1993-base)/base
	Emission in CO ₂ eq. [Gg]	Emission in CO ₂ eq. [Gg]	
CO ₂ – net emission (with LUCF)	461 951.16	329 933.89	-0.29
CO ₂ – without LUCF.	494 885.88	365 280.13	-0.26
CH ₄	49 256.41	42 242.03	-0.14
N ₂ O	42 478.82	31 242.85	-0.26
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	438 765.01	-0.25
TOTAL with LUCF	553 976.16	403 418.77	-0.27

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

Carbon dioxide emissions

The CO₂ emissions in 1993 were estimated as 365.28 million tones. This is 26.2% lower than in the base year. CO₂ emission was accounted for 83.3% of total GHG emissions in Poland in 1993. The main CO₂ emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO₂ emission by 95.60% in 1993. The shares of the main subcategories were as follows: *Energy industries* – 56.9%, *Manufacture Industries and Construction* – 10.0%, *Transport* – 7.3% and *Other Sectors* – 21.0%. *Industrial Processes* contributed to the total CO₂ emission by 4.2% in 1993. *Mineral Products* (especially *Cement*

Production) is the main emission source in this sector. The CO₂ removal in LUCF sector in 1993, was calculated to be approximately 35.3 million tones. It means that app. 8.8% of the total CO₂ emissions are offset by CO₂ uptake by forests.

Methane emissions

The CH₄ emission amounted to 2 011.53 Gg in 1993 i.e. 42.24 million tones of CO₂ equivalents. The contribution of CH₄ to the national total GHG emission was 9.6% in 1993. Three of main CH₄ emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture and Waste*. They contributed 38.4%, 35.3% and 25.1% to the national methane emission in 1993, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (29.9% of total CH₄ emission) and Oil and Natural Gas system (8.5% of total CH₄ emission). Waste disposal sites contributed to 12.5% of the methane emission from total CH₄ emission and Wastewater Handling contributed to 12.6% of total CH₄ emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 27.4% of total CH₄ emission in 1993.

Nitrous oxide emissions

The nitrous oxide emissions in 1993 were 100.78 Gg i.e. 31.24 million tonnes of CO₂ equivalents. The emission was app. 26.5% lower than the respective figure for the base year. The contribution of N₂O to the national total GHG emission was 7.1% in 1993. The main N₂O emission sources and its shares in total N₂O emission in 1993 are as follow: *Agricultural Soils* – 53.0%, *Manure Management* – 24.3%, *Chemical Industry* – 11.8% 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 1993 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 1993 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 1993

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 83.3% share (in 1993), while the methane contributes with 9.6% to the national total. Nitrous oxide contribution is 7.1%.

Table 2.1 Greenhouse gas emissions in 1993 in CO₂ eq.

Pollutant	1993	
	Emission in CO ₂ eq. [Gg]	Share [%]
CO ₂ – net emission (with LUCF)	329 933.89	
CO ₂ – without LUCF.	365 280.13	83.25
CH ₄	42 242.03	9.63
N ₂ O	31 242.85	7.12
HFCs	NE	NE
PFCs	NE	NE
SF ₆	NE	NE
TOTAL without CO ₂ from LUCF	438 765.01	100.0
TOTAL with LUCF	403 418.77	

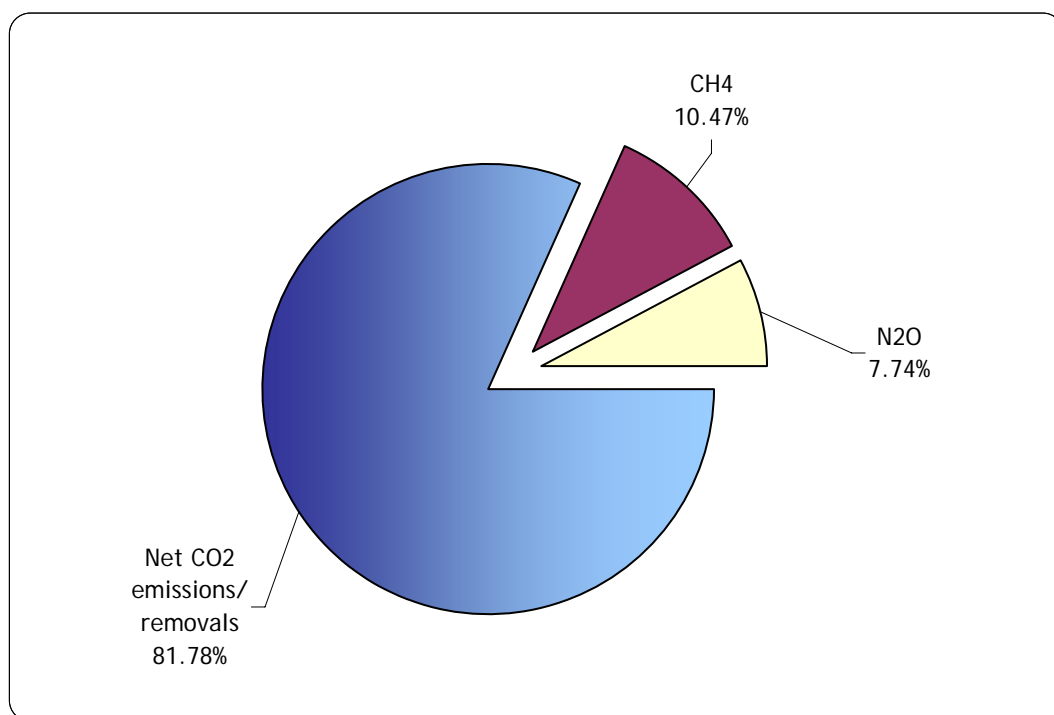


Figure 2.1 Percentage share of greenhouse gases in national total emission total in 1993

Emissions of main GHGs in 1993, 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 1993 [Gg]

[Gg]	CO ₂	CH ₄	N ₂ O
TOTAL without CO ₂ from LUCF	365 280.13	2 011.53	100.78
1. Energy	349 276.57	786.43	6.91
A. Fuel Combustion	349 206.28	13.64	6.91
1. Energy Industries	207 792.86	2.69	2.99
2. Manufacturing Industries and Construction	36 611.96	1.75	0.62
3. Transport	26 555.77	6.69	1.34
4. Other Sectors	76 597.20	2.43	1.48
5. Other	1 648.50	0.08	0.48
B. Fugitive Emissions from Fuels	70.29	772.79	NE
1. Solid Fuels	1.01	602.29	NE
2. Oil and Natural Gas	69.27	170.50	NE
2. Industrial Processes	15 217.94	10.68	11.85
A. Mineral Products	7 554.64	NE	NE
B. Chemical Industry	2 644.88	8.26	11.85
C. Metal Production	5 018.43	2.43	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	395.36	NE	0.40
4. Agriculture	NE	709.56	78.01
A. Enteric Fermentation	NE	552.04	NE
B. Manure Management	NE	156.10	24.52
D. Agricultural Soils	NE	NE	53.41
F. Field Burning of Agricultural Residues	NE	1.41	0.08
5. Land Use, Land-Use Change and Forestry	-35 346.24	0.15	0.0011
A. Forest Land	-41 683.87	NE	NE
B. Cropland	5 428.49	NE	NE
C. Grassland	3 012.13	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	-2 102.99	0.15	0.0011
F. Other Land	NE	NE	NE
6. Waste	390.26	504.70	3.61
A. Solid Waste Disposal on Land	NE	252.20	NE
B. Wastewater Handling	NE	252.50	3.57
C. Waste Incineration	390.26	NE	0.04

As a supplement to the table 2.2, table 2.3 includes percentage contributions of main source sectors to the national totals in 1993 for CO₂, CH₄ and N₂O.

Table 2.3 Percentage shares of individual source sectors in 1993 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	95.62	39.10	6.86
A. Fuel Combustion	95.60	0.68	6.86
1. Energy Industries	56.89	0.13	2.97
2. Manufacturing Industries and Construction	10.02	0.09	0.61
3. Transport	7.27	0.33	1.33
4. Other Sectors	20.97	0.12	1.47
5. Other	0.45	0.00	0.48
B. Fugitive Emissions from Fuels	0.02	38.42	NE
1. Solid Fuels	0.0003	29.94	NE
2. Oil and Natural Gas	0.02	8.48	NE
2. Industrial Processes	4.17	0.53	11.76
A. Mineral Products	2.07	NE	NE
B. Chemical Industry	0.72	0.41	11.76
C. Metal Production	1.37	0.12	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	0.11	NE	0.40
4. Agriculture	NE	35.27	77.40
A. Enteric Fermentation	NE	27.44	NE
B. Manure Management	NE	7.76	24.33
D. Agricultural Soils	NE	NE	52.99
F. Field Burning of Agricultural Residues	NE	0.07	0.08
5. Land Use, Land-Use Change and Forestry	NE	0.01	0.0011
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	NE	0.01	0.0011
F. Other Land	NE	NE	NE
6. Waste	0.11	25.09	3.58
A. Solid Waste Disposal on Land	NE	12.54	NE
B. Wastewater Handling	NE	12.55	3.54
C. Waste Incineration	0.11	NE	0.04

2.2 GHG emissions by gas

Carbon dioxide (CO₂)

In 1993, the net CO₂ emissions (with LULUCF) were estimated as 329.93 million tonnes, while when sector 5. *LUCF* is excluded the figure reaches 365.28 million tones (table 2.2). The main CO₂ emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO₂ emission by 95.60% in 1993. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 56.9%, *Manufacture Industries and Construction* – 10.0%, *Transport* – 7.3% and *Other Sectors* – 21.0%. Sector 2. *Industrial Processes* contributed to the total CO₂ emission by 4.2% in 1993. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO₂ emission/removal in LULUCF sector in 1993, was calculated to be approximately 35.3 million tones. It means that app. 8.8% of the total CO₂ emissions are offset by CO₂ uptake by forests.

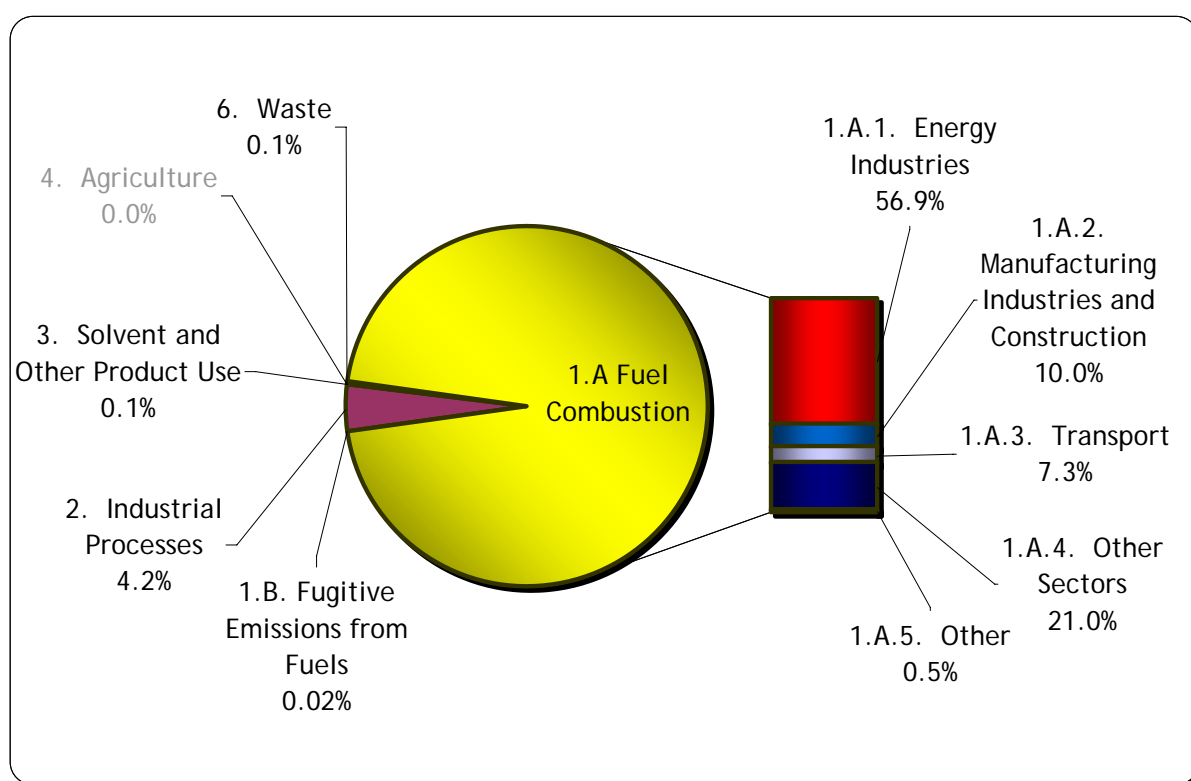


Figure 2.2 Carbon dioxide emission in 1993 by sector

Methane (CH₄)

The CH₄ emission amounted to 2 011.53 Gg in 1993 i.e. 42.24 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 38.4%, 35.3% and 25.1% of the national methane emission in 1993 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 29.9% of total CH₄ emission) and *Oil and Natural Gas* system (about 8.5% of total emission), *Disposal sites* contributed to 12.54% of the methane emission and *Wastewater Handling* contributed to 12.55%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 27.4% of total methane emission in 1993.

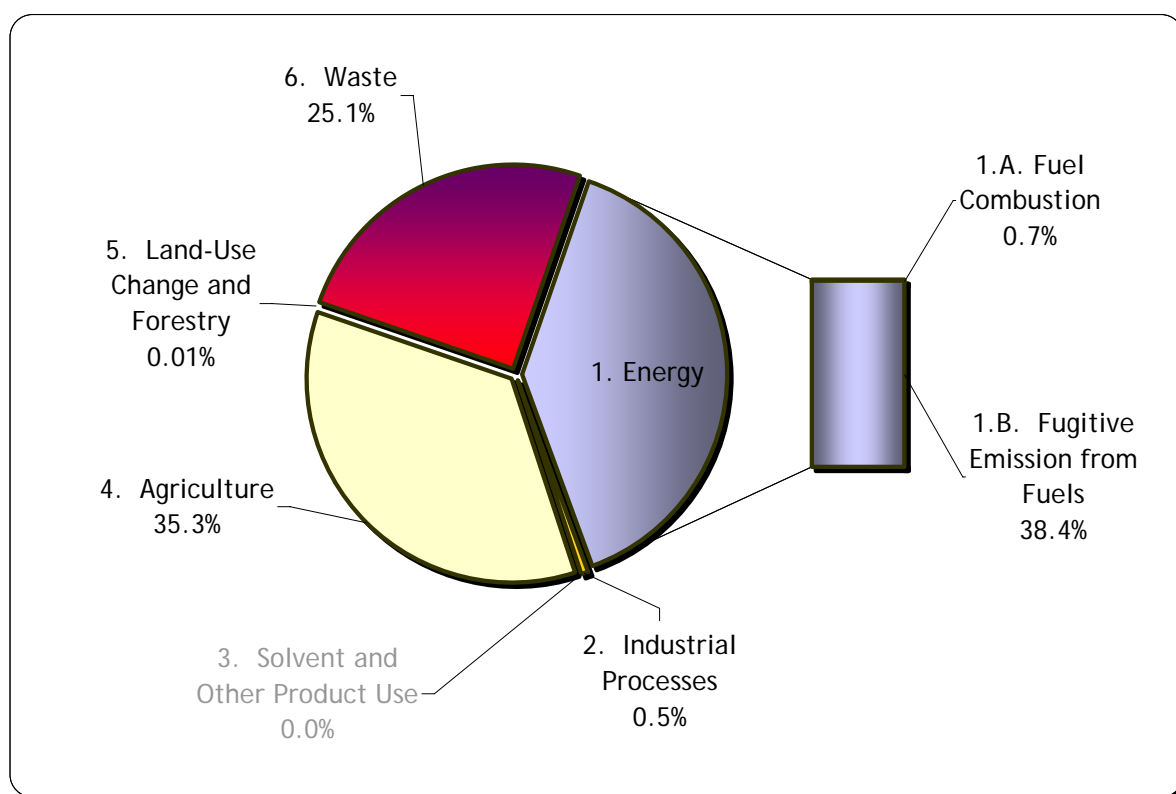


Figure 2.3 Methane emission in 1993 by sector

Nitrous oxide (N₂O)

The nitrous oxide emissions in 1993 were 100.78 Gg i.e. 31.24 million tonnes of CO₂ equivalents (table 2.2). The main N₂O emission sources and its shares in total N₂O emission in 1993 are: *Agricultural Soils* – 53.0%, *Manure Management* – 24.3%, *Chemical Industry* – 11.8% and *Fuel Combustion* – 6.9%.

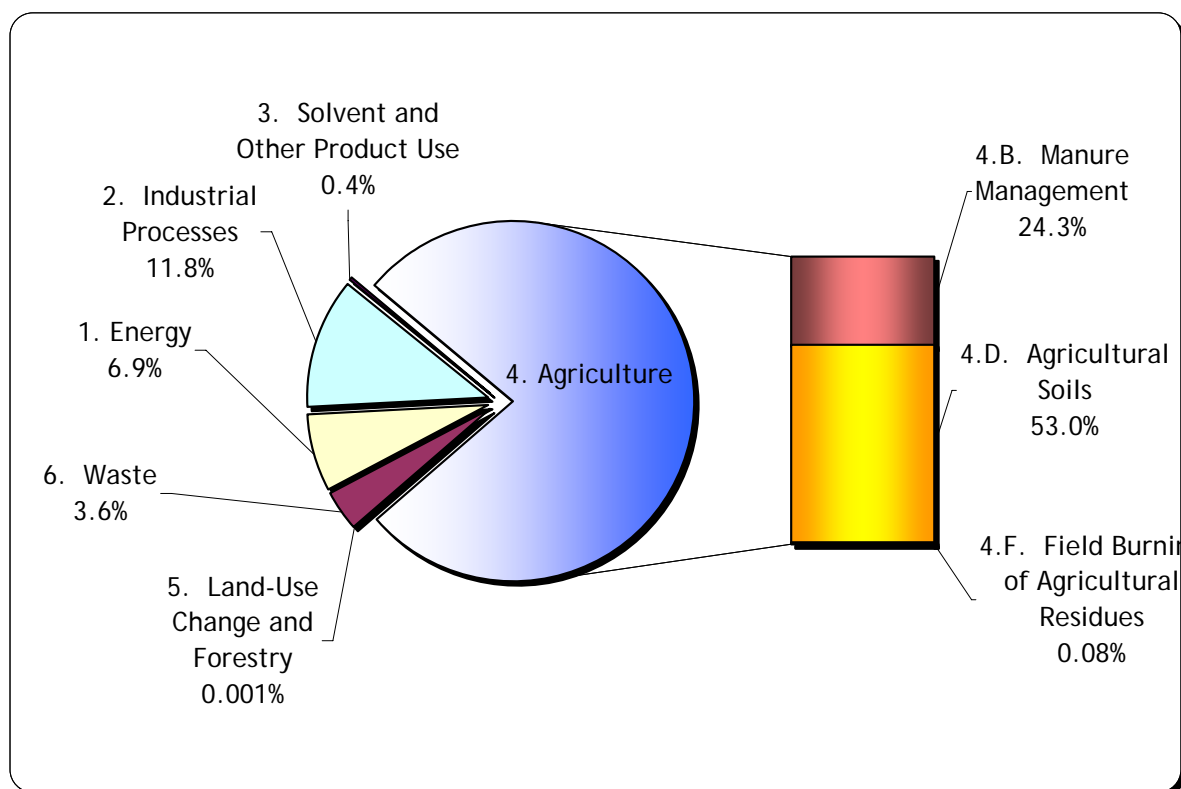


Figure 2.4 Nitrous oxide emission in 1993 by sector

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 1993

	Total [Gg eq. CO ₂]		(1993-base)/base
	Base year	1993	
TOTAL with LUCF	553 976.2	403 418.77	-0.27
TOTAL without LUCF	586 902.6	438 761.43	-0.25
1. Energy	497 964.7	367 934.38	-0.26
2. Industrial Processes	27 356.2	19 116.30	-0.30
3. Solvent and Other Product Use	1 006.5	519.36	-0.48
4. Agriculture	52 378.1	39 082.43	-0.25
5. Land-Use Change and Forestry	-32 926.5	-35 342.67	0.07
6. Waste	8 197.2	12 108.96	0.48

2.3.1 Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 1993 was 367.9 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 1993

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	367 934.38	100.0	94.9	4.5	0.6
A. Fuel Combustion	351 635.56	95.6	94.9	0.1	0.6
1. Energy Industries	208 775.87	56.7	56.5	0.0	0.3
2. Manufacturing Industries and Construction	36 839.72	10.0	10.0	0.0	0.1
3. Transport	27 112.53	7.4	7.2	0.0	0.1
4. Other Sectors	77 107.41	21.0	20.8	0.0	0.1
5. Other	1 800.03	0.5	0.4	0.0	0.0
B. Fugitive Emissions from Fuels	16 298.82	4.4	0.0	4.4	0.0
1. Solid Fuels	12 649.10	3.4	0.0	3.4	0.0
2. Oil and Natural Gas	3 649.72	1.0	0.0	1.0	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 1993. CO₂ is dominating among GHGs – its contribution exceeds 79.6%. 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 (23.9%) and CO₂ emissions (recalculated from NMVOC) (76.1%).

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 1993

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	19 116.30	100.0	79.6	1.2	19.2	0.0
A. Mineral Products	7 554.64	39.5	39.5	0.0	0.0	NE
B. Chemical Industry	6 492.27	34.0	13.8	0.9	19.2	NE
C. Metal Production	5 069.39	26.5	26.3	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	519.36	100	76.1	0.0	23.9	

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 1993 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 1993

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	39 082.43	100.0	38.1	61.9
A. Enteric Fermentation	11 592.94	29.7	29.7	0.0
B. Manure Management	10 879.29	27.8	8.4	19.4
D. Agricultural Soils	16 556.62	42.4	0.0	42.4
F. Field Burning of Agricultural Residues	53.57	0.1	0.1	0.1

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 1993 (almost 87.5%). 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 1993

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	12 108.96	100	3.2	87.5	9.2
A. Solid Waste Disposal on Land	5 296.21	43.7	0.0	43.7	0.0
B. Wastewater Handling	6 408.81	52.9	0.0	43.8	9.1
C. Waste Incineration	403.93	3.3	3.2	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 1993 with respect to base year 1988/1995

Pollutant	Base year	1993	1993/base year [%]
	Emission in CO ₂ eq. [Gg]	Emission in CO ₂ eq. [Gg]	
CO ₂ – net emission (with LUCF)	461 951.16	329 933.89	71.42
CO ₂ – without LUCF.	494 885.88	365 280.13	73.81
CH ₄	49 256.41	42 242.03	85.76
N ₂ O	42 478.82	31 242.85	73.55
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	438 765.01	74.76
TOTAL with LUCF	553 976.16	403 418.77	72.82

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

Carbon dioxide

CO₂ emission had decreased by app. 26.2% from the base year to 1993.

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

- share in of solid fuels decreased from 85.3% in 1988 to 82.7% in 1993
- share of liquid fuels increased from 11.4% (1988) to 13.5% (1993)
- share of gaseous fuels increased from 3.3% (1988) to 3.8% (1993).

Methane

CH₄ emission had decreased by app. 14.2% from the base year to 1993. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 27.3%,
- the decrease in *Fugitive Emission* by 28.5%,
- the increase in emission from *Waste* by 64.2%.

Nitrous oxide

The nitrous oxide emissions in 1993 were app. 26.5% lower than the respective figure for the base year. The share in *Manure Management* increased from 22.0% in 1988 to 24.3% in 1993, in *Agricultural Soils* decreased from 55.6% (1988) to 53.0% (1993) and in *Chemical Industry* increased from 11.8% in 1988 to 11.8% in 1993.

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 1993 decreased from 84.3% to 83.3%.

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	

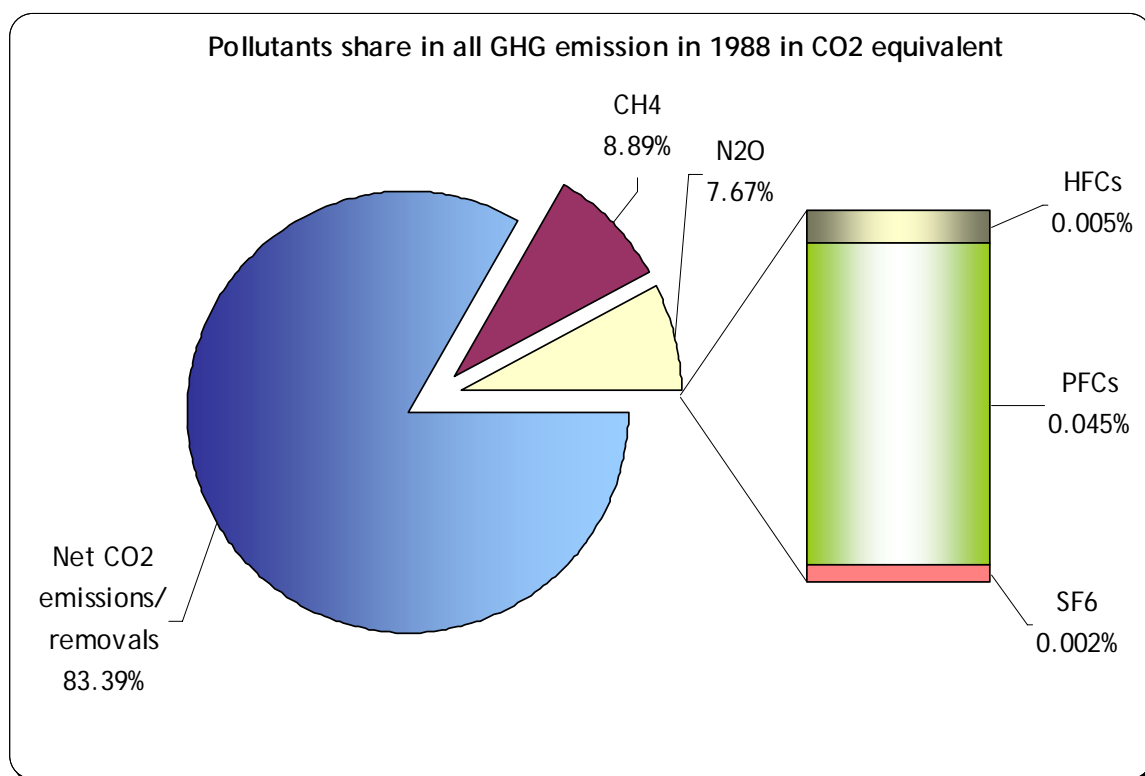


Figure 2.5 Percentage share of national greenhouse gas emissions in base year (1988/1995) including emission from sector 5.

2.5 Comparison of greenhouse gas emissions 1993 and 1992

Changes of national emissions and sinks of GHGs in 1993 compared to 1992 were:

CO ₂	- net emission fall to	95.41%
CH ₄	- emission fall to	97.05%
N ₂ O	- emission fall to	98.15%

Below results are discussed separately for each greenhouse gas with respect to 1993 emissions and change between 1993 and 1992.

Carbon dioxide (CO₂)

In 1993, the net CO₂ emissions (with LULUCF) was 4.6% lower than in 1992. The CO₂ emission in 1993 from category *Energy* was lower by 4.4% and from category *Industrial Processes* was lower by 2.6% than in 1992. In comparison to 1992 the CO₂ emission from category *Waste* in 1993 fall by 0.8%.

Table 2.11. Comparison of carbon dioxide emission in 1992 and 1993

Year	CO ₂ [Gg]		1993/1992 [%]
	1992	1993	
TOTAL without LUCF	381 944.8	365 280.1	95.6
1. Energy	365 494.7	349 276.6	95.6
A. Fuel Combustion	365 434.1	349 206.3	95.6
1. Energy Industries	229 447.9	207 792.9	90.6
2. Manufacturing Industries and Construction	35 442.1	36 612.0	103.3
3. Transport	26 476.9	26 555.8	100.3
4. Other Sectors	72 316.0	76 597.2	105.9
5. Other	1 751.2	1 648.5	94.1
B. Fugitive Emissions from Fuels	60.5	70.3	116.1
1. Solid Fuels	1.1	1.0	93.3
2. Oil and Natural Gas	59.5	69.3	116.5
2. Industrial Processes	15 622.0	15 217.9	97.4
A. Mineral Products	7 937.1	7 554.6	95.2
B. Chemical Industry	2 464.2	2 644.9	107.3
C. Metal Production	5 220.7	5 018.4	96.1
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	434.6	395.4	91.0
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	-36 150.9	-35 346.2	97.8
A. Forest Land	-42 688.2	-41 683.9	97.6
B. Cropland	5 592.9	5 428.5	97.1
C. Grassland	3 103.3	3 012.1	97.1
D. Wetlands	NE	NE	NE
E. Settlements	-2 158.9	-2 103.0	97.4
F. Other Land	NE	NE	NE
6. Waste	393.6	390.3	99.2
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	NE	NE	NE
C. Waste Incineration	393.6	390.3	99.2

Methane (CH₄)

The emission in 1993 was lower than in 1992 by 2.9%. The main sources are *Agriculture*, *Energy* and *Waste*. Emission from *Manure Management* in the *Agriculture* sector was lower by 11.0% in 1993 and from *Waste* sector was higher by 1.7% than in 1992. *Fugitive emission* in *Energy* sector was lower by 0.4% in 1993 compared to 1992.

Table 2.12 Comparison of methane emission in 1992 and 1993

Year	CH ₄ [Gg]		1993/1992 [%]
	1992	1993	
TOTAL	2 072.58	2 011.53	97.1
1. Energy	789.08	786.43	99.7
A. Fuel Combustion	13.51	13.64	101.0
1. Energy Industries	3.15	2.69	85.4
2. Manufacturing Industries and Construction	1.51	1.75	116.1
3. Transport	6.65	6.69	100.6
4. Other Sectors	2.12	2.43	114.7
5. Other	0.08	0.08	98.6
B. Fugitive Emissions from Fuels	775.58	772.79	99.6
1. Solid Fuels	615.82	602.29	97.8
2. Oil and Natural Gas	159.76	170.50	106.7
2. Industrial Processes	10.07	10.68	106.1
A. Mineral Products	NE	NE	NE
B. Chemical Industry	7.51	8.26	109.9
C. Metal Production	2.55	2.43	95.1
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	NE	NE	NE
4. Agriculture	777.04	709.56	91.3
A. Enteric Fermentation	600.45	552.04	91.9
B. Manure Management	175.47	156.10	89.0
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	1.12	1.41	125.6
5. Land Use, Land-Use Change and Forestry	0.14	0.15	107.9
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.14	0.15	107.9
F. Other Land	NE	NE	NE
6. Waste	496.25	504.70	101.7
A. Solid Waste Disposal on Land	244.78	252.20	103.0
B. Wastewater Handling	251.47	252.50	100.4
C. Waste Incineration	NE	NE	NE

Nitrous oxide (N₂O)

The emission was lower than in 1992 (by 1.9%). The main sources of N₂O emission are *Manure Management* and *Agricultural Soils*. Emission from *Manure Management* in the *Agriculture* sector was lower by 9.6% in 1993 and from *Agricultural Soils* was lower by 0.9% than in 1992.

Table 2.13. Comparison of nitrous oxide emission in 1992 and 1993

Year	N ₂ O [Gg]		1993/1992 [%]
	1992	1993	
TOTAL	102.69	100.78	98.1
1. Energy	7.16	6.91	96.5
A. Fuel Combustion	7.16	6.91	96.5
1. Energy Industries	3.33	2.99	89.7
2. Manufacturing Industries and Construction	0.58	0.62	107.0
3. Transport	1.33	1.34	101.3
4. Other Sectors	1.39	1.48	106.7
5. Other	0.54	0.48	89.3
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	10.40	11.85	113.9
A. Mineral Products	NE	NE	NE
B. Chemical Industry	10.40	11.85	113.9
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	81.07	78.01	96.2
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	27.13	24.52	90.4
D. Agricultural Soils	53.88	53.41	99.1
F. Field Burning of Agricultural Residues	0.06	0.08	134.7
5. Land Use, Land-Use Change and Forestry	0.0010	0.0011	107.9
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.0010	0.0011	107.9
F. Other Land	NE	NE	NE
6. Waste	3.65	3.61	99.0
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	3.60	3.57	99.0
C. Waste Incineration	0.04	0.04	98.9

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.

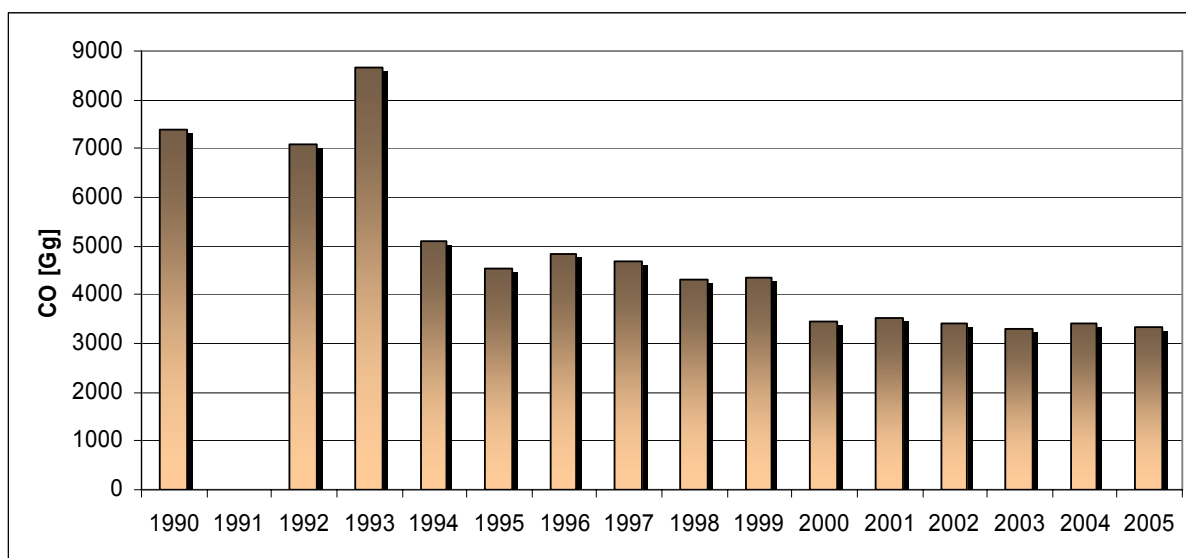


Figure 2.6 Emissions of CO (1990-2005).

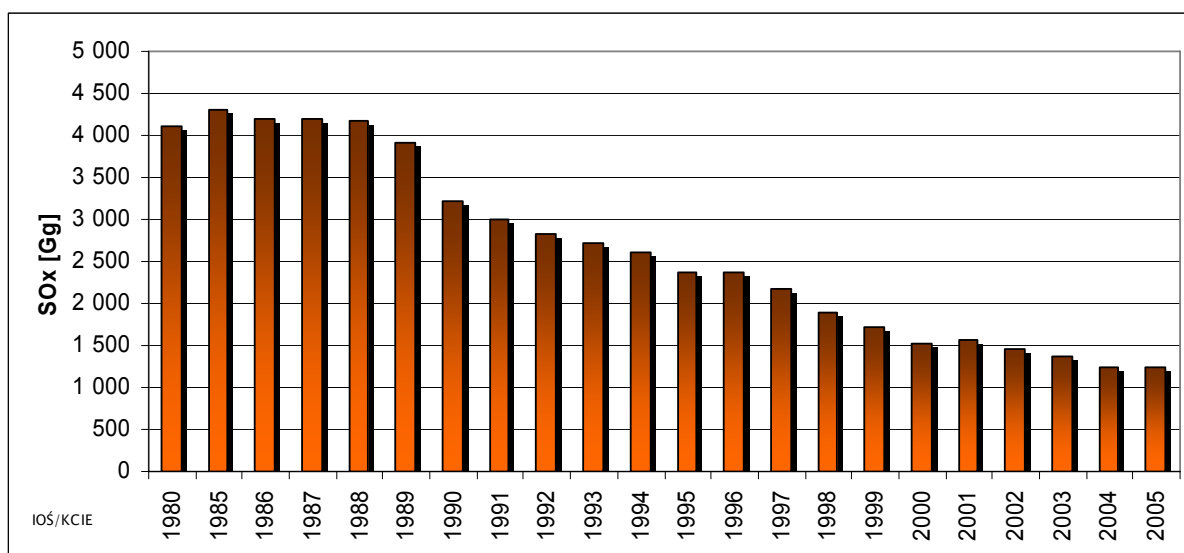


Figure 2.7 Emissions of SO_x, (1980-2005).

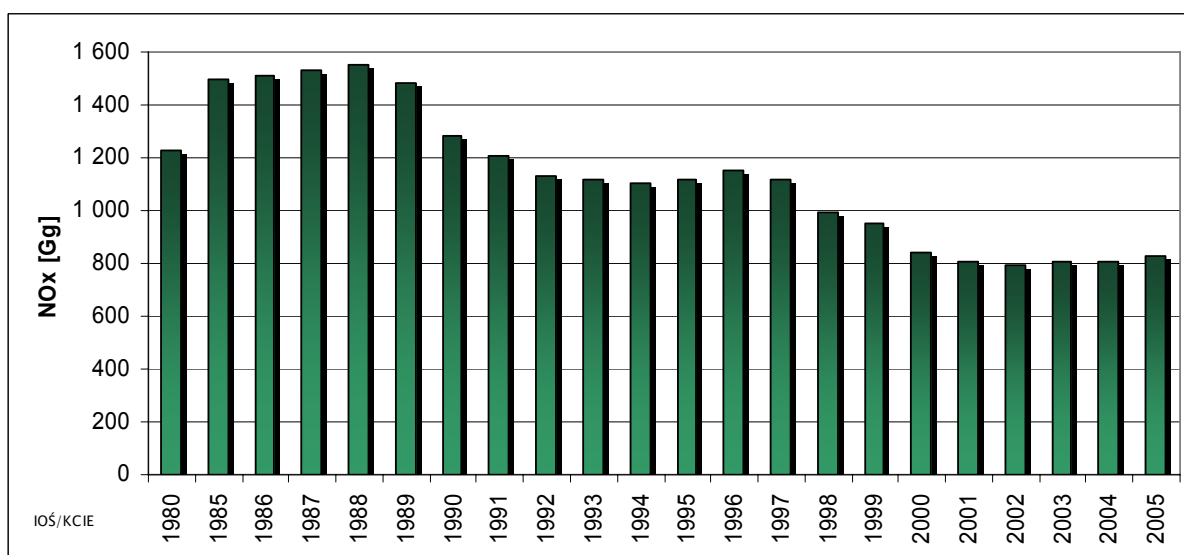


Figure 2.8 Emissions of NO_x, (1980-2005).

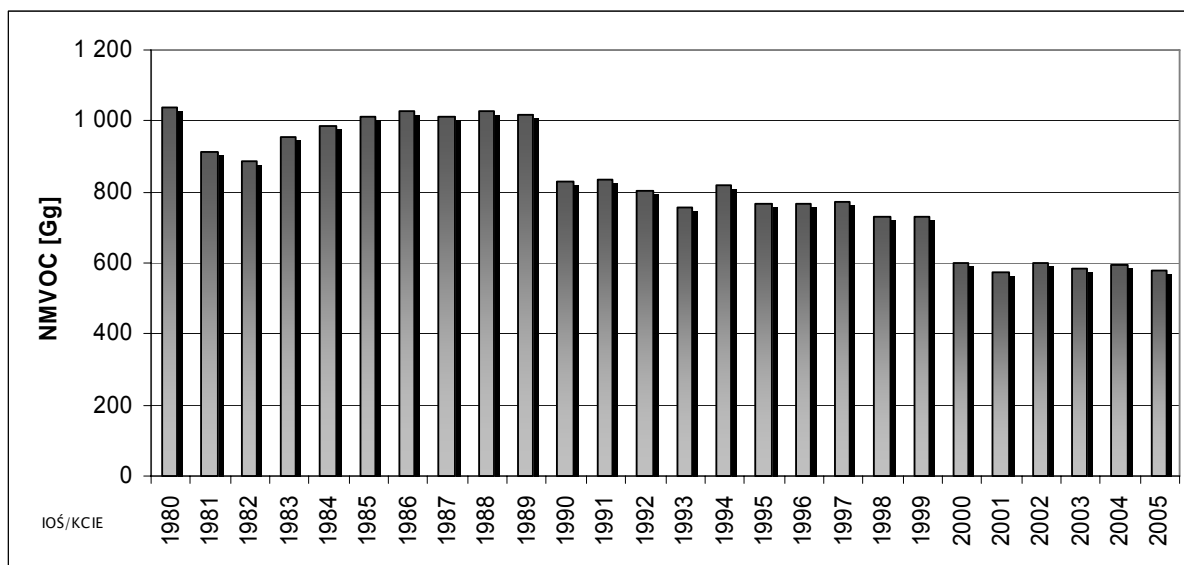


Figure 2.9 Emissions of NMVOC (1980-2005).

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 5.0%
- 1.B.1.a. Coal Mining and Handling (CH₄ emission), share in total GHG emission 2.9%
- 1.B.2.b. Natural Gas (CH₄ emission), share in total GHG emission 0.8%

Share of these categories in total Poland's GHG emissions is 82.0%.

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 1995a]
- Energy Balance Poland – OECD [ARE 1994]

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 1994],
- ♦ Questionnaire/Report G-03, [GUS 1994e],
- ♦ Statistical Yearbook of The Republic of Poland [GUS 1995],
- ♦ unpublished data from Agency of Energy Market

Table 3.5 Emission factors [kg/GJ] for transport in 1993

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.	70.88	0.0005	0.0023
1.A.3.a.i i International Aviation - bunker	1.i.PL.	70.88	0.0005	0.0023
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	72,80	0.030	0.002
	2.i.a.LG	65,45	0.020	0.0002
	2.i.a.ON	73,84	0.002	0.004
	2.i.b.BS	72,80	0.020	0.001
1.A.3.b. Passenger Cars with catalysts	2.i.g.BS	72,80	0.007	0.0200
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	2.ii.a.BS	72,80	0.020	0.001
	2.ii.a.ON	73,84	0.001	0.0040
	2.ii.b.BS	72,80	0.020	0.001
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	2.ii.g.BS	72,80	0.020	0.001
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	2.iii.a.BS	72,80	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	72,80	0.100	0.001
1.A.3.b.iv Mopeds	2.iv.BS	72,80	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 1993 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 1993 [GUS 1995a] 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 4.05% in favour of reference 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).

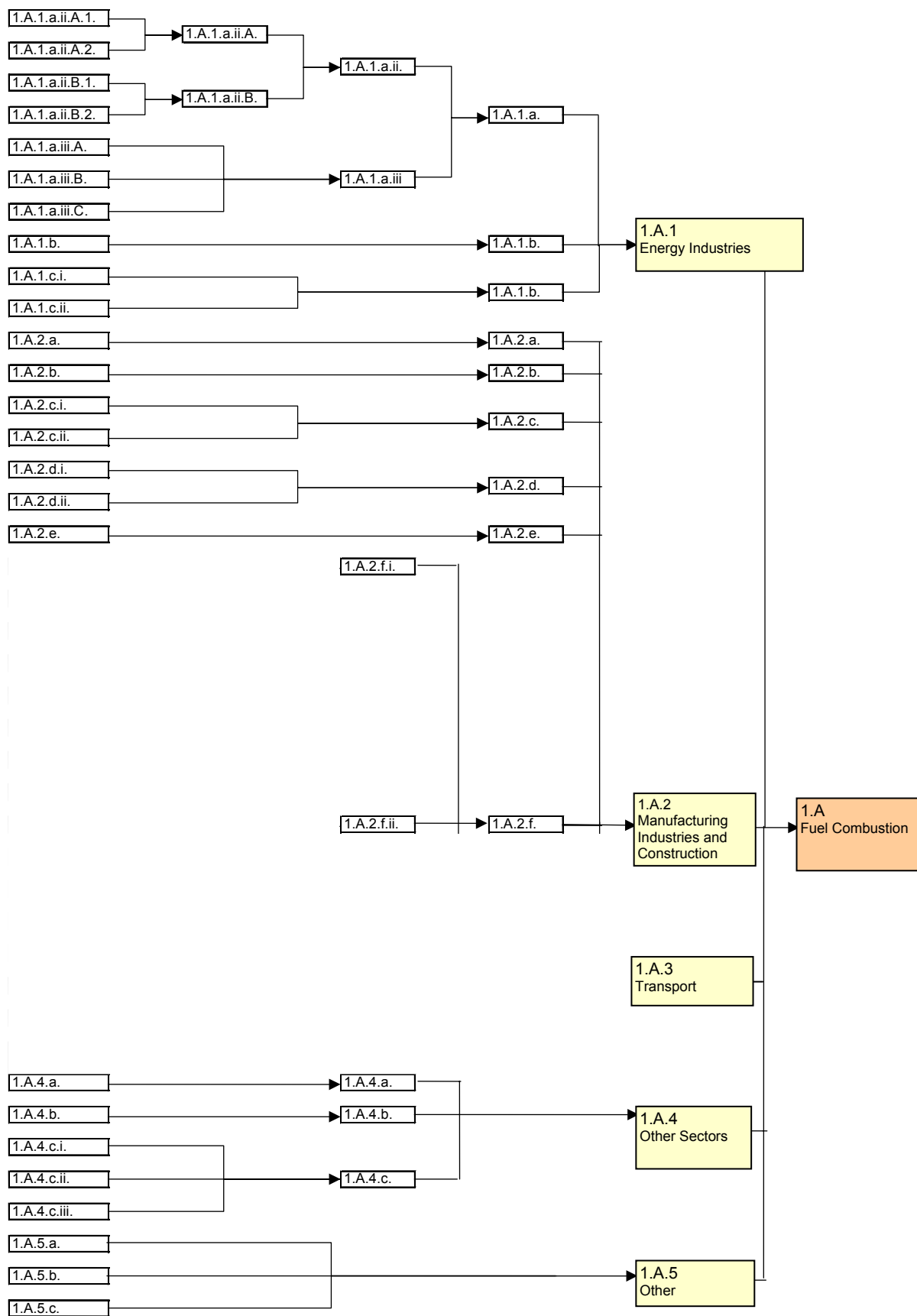


Figure 3.1. Flowchart of summing up sub-sectors in sector 1.A - Fuel Combustion

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 1993 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 1993. 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 1993

Coal mining	Methane capture	Methane use	Emission from de-methane systems		
			mln m ³	mln Nm ³	Gg CH ₄
131.4	213.3	167.6	45.7	44.19	29.61

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, 1994] 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 1995a].

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 1995a]:

production	PJ	9.803
distribution	Gg	13909

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 1995a] 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]	70.038
Gas processing	Gas use [PJ]	301.000
Gas transmission	Gas use [PJ]	301.000
Underground gas storage	Gas use [PJ]	301.000
Gas distribution	Gas use [PJ]	301.000
Nitrified natural gas system:		
Gas production	Gas production [PJ]	68.293
Gas processing	Gas use [PJ]	45.7266
Gas transmission	Gas use [PJ]	45.7266
Gas distribution	Gas use [PJ]	68.293

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 1.2%
- 2.C.1. Iron and Steel Production (CO₂ emission), share in total GHG emission 1.1%

Share of these categories in total Poland's GHG emissions is 2.3%.

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 1994e]. 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 1994e]. Country specific emission factor of CO₂, which is equal 74.68 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 1996].

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	2.6%
- 4.B. Manure Management (CH ₄ emission), share in total GHG emission	0.7%
- 4.B. Manure Management (N ₂ O emission), share in total GHG emission	1.7%
- 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	0.7%

Share of these categories in total Poland's GHG emissions is 8.7%.

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 1995]. 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 1993

Livestock	Population [millions]	GE Gross Energy Intake [MJ/animal/day]	EF Emission Factor [kg CH ₄ / animal / year]
4.A Enteric Fermentation	28.791	---	---
1 Cattle	7.643	---	---
a. Dairy cattle	3.983	226.036	88.952
b Non-dairy cattle	3.660	99.3685	39.105
3 Sheep	1.268	18.384	8.124
4 Goats	0.179	---	5.000
6 Horses	0.841	---	18.000
8 Swine	18.860	---	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 1995]. 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	227.143	---	---
1 Cattle	7.643	---	---
a. Dairy cattle	3.983	4.554	5.008
b Non-dairy cattle	3.660	1.645	1.827
3 Sheep	1.268	0.367	0.170
4 Goats	0.179	0.280	0.120
6 Horses	0.841	1.720	1.390
8 Swine	18.860	0.500	5.970
9 Poultry	198.352	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 1995]. 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 AWSM		
	Liquid System	Solid Storage and Drylot	Pasture Range and Paddock
Dairy cattle	0.0230	0.7863	0.1907
Non-dairy cattle	0.0440	0.8000	0.1560
Sheep	---	0.5000	0.50
Goats	---	0.9000	0.10
Horses	---	0.9000	0.10
Swine	0.2592	0.7408	---
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	0.0230	6412.630
1.b. Non-dairy cattle	50.0	0.0440	8052.000
3 Sheep	16.0	--	0.000
4 Goats	25.0	--	0.000
6 Horses	25.0	--	0.000
8 Swine	20.0	0.2592	97764.781
9 Poultry	0.6	0.2000	23802.187

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	0.7863	219237.597
1.b. Non-dairy cattle	50.0	0.8000	146400.000
3 Sheep	16.0	0.5000	10144.000
4 Goats	25.0	0.9000	4034.610
6 Horses	25.0	0.9000	18922.500
8 Swine	20.0	0.7408	279435.219
9 Poultry	0.6	0.8000	95208.748

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 1995]. 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 1995] 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 1995]. 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 1995].

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 1995]. 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 Nex [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	0.19	53159.773	
1.b. Non-dairy cattle	50.0	0.16	28548.000	
3 Sheep	16.0	0.50	10144.000	
4 Goats	25.0	0.10	448.290	
6 Horses	25.0	0.10	2102.500	
8 Swine	--	--	--	
9 Poultry	--	--	--	
		total	94402.563	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 1993 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:

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

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 1995],

Nex – total amount of animal manure nitrogen excreted in AWMS system (table 6.6),

Frac_{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]
683	0.1	94 402.56	0.2	0.01	0.87

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:

N_{2O(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 1995],

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]
683	94402.56	0.3	0.025	5.831

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 1995]. 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 1993 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 1993 (and comparing to 1992) 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 1992 and 1993 [IPCC 2003]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1992			1993		
	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	-36 150.88	0.143	0.001	-35 346.24	0.155	0.001
5A. Forest Land	-42 688.20			-41 683.87		
1. Forest Land remaining Forest Land	IE			IE		
2. Land converted to Forest Land	IE			IE		
5B. Cropland	5 592.87			5 428.49		
1. Cropland remaining Cropland	IE			IE		
2. Land converted to Cropland	IE			IE		
5C. Grassland	3 103.34			3 012.13		
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	-2 158.88	0.143	0.001	-2 102.99	0.155	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 1992 and 1993 [IPCC 1997]

Greenhouse gas source and sink categories	1992					1993				
	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	46 121.04	-82 271.92	-36 150.88	0.143	0.001	45 086.21	-80 432.46	-35 346.24	0.155	0.001
5A. Changes in Forest and Other Woody Biomass Stocks	38 679.50	-64 991.70	-26 312.20			37 869.02	-63 358.59	-25 489.56		
1. Tropical Forests										
2. Temperate Forests	38 679.50	-64 991.70	-26 312.20			37 869.02	-63 358.59	-25 489.56		
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
Harvested Wood										
5B. Forest and Grassland Conversion	58.66		58.66			59.60		59.60		
1. Tropical Forests										
2. Temperate Forests	58.7			0.143	0.001	59.6			0.155	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	7 382.88	-17 280.22	-9 897.33			7 157.59	-17 073.87	-9 916.28		
Cultivation of Mineral Soils	7 382.88		7 382.88			7 157.59		7 157.59		
Cultivation of Organic Soils										
Liming of Agricultural Soils		1 313.3	1 313.32				1 283.0	1 283.03		
Forest Soils		-16 376.00	-16 376.00				-16 194.31	-16 194.31		
Other Land (please specify)		-2 217.54	-2 217.54				-2 162.59	-2 162.59		
5E. Other (please specify)										

According to calculation for 1993, Sector 5. Land-Use Change and Forestry, was net CO₂ sink. Removals/emissions balance decreased from 36 151 Gg CO₂ in 1992 to 35 346 Gg CO₂ in 1993 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 1993 net CO₂ removals decreased to 25 490 Gg CO₂ from about 26 312 Gg CO₂ in 1992. This change was caused by woody biomass decrease (about 0.11 t dm/ha) and harvest of thick decrease (about 0.47 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 1993 this category was a net CO₂ emissions and accounted for about 60 Gg CO₂. Net emission in year 1993 was similar to previous year.

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. It is mainly caused by afforestation of agriculture lands. In 1993 net CO₂ sink was about 9 916 Gg CO₂ and was higher by about 19 Gg CO₂ than in previous year.

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 1993

Land-use/ management system	Soil type	Carbon in soils (Mg C/ha)	Area (Mha)
Forest management	High Activity Soils	110.0	3.531
	Low Activity Soils	70.0	1.694
	Sandy	30.0	3.317
	Wetland	230.0	0.375
Sum			8.917
Grassland/Rangeland	High Activity Soils	90.0	0.572
	Low Activity Soils	60.0	1.690
	Sandy	25.0	1.236
	Wetland	120.0	0.419
Sum			3.917
Agricultural crops	High Activity Soils	70.0	4.114
	Low Activity Soils	60.0	5.513
	Sandy	25.0	2.843
	Wetland	120.0	1.655
Sum			14.125
Other land	High Activity Soils	56.0	0.942
	Low Activity Soils	48.0	1.771
	Sandy	20.0	1.113
	Wetland	96.0	0.483
Sum			4.310
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:

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

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

$EF_{\text{limestone}}$ - 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 | 1.2% |
| - 6.B. Wastewater Handling (CH ₄ emission), share in total GHG emission | 1.2% |

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 1993 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 1995]
- 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]
1992	10621.00	[GUS 1996]
1993	10644.66	[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 1994d] 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 1994d]. 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 0.739. 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 anaerobically 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 1995]. 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 1993 no data on municipal and sewage sludge waste incineration were available. The amount of industrial waste was calculated based on [GUS 1994d]. The activity data for incineration of medical waste was based on number of hospital beds [GUS 1994] as well as on annual mean use of hospital bed [GUS 1994]. The indicators describing amount of hospital waste produced and fraction of incinerated waste were taken from [IOS 2003].

References

- ARE (1994). Fuel balance according to OECD structure. Agency of Energy Market, Warsaw, 1994.
- Bernacka (2006). Bernacka J., Pawłowska L. Elaboration and analysis of data regarding GHG emissions from municipal wastewater management. Institute of Environmental Protection, 2006 (in Polish).
- BULiGL (1992). Results of updating forest area and woody biomass in State Forests At 1 January 1992. Office for Forest Planning and Management. Warsaw. 1992. (in Polish)
- CITEPA (1992). Default Emission Factors Handbook, CORINAIR INVENTORY, CITEPA, Paris, 1992.
- Czuraj M. (1991). Tables of log volume of butt end and standing trees. PWRiL. Warsaw. 1991 (in Polish).
- EEA (1996). EMEP/CORINAIR The Atmospheric Emission Inventory Guidebook. 1996.
- EEA (2002). EMEP/CORINAR. The Atmospheric Emission Inventory Guidebook. 3rd Ed., European Environmental Agency. 2002.
- EEA (2004). EMEP/CORINAIR Emission Inventory Guidebook. 2004.
- FAOSTAT (2006). FAOSTAT data base, 2006,
<http://faostat.fao.org/site/502/DesktopDefault.asp1990?PageID=502>.
- FEWE (1994). Determination of GHG emission factors from fuel combustion in industrial technology processes. Foundation on Effective Energy Use – FEWE, 1994. (in Polish).
- Fudała (1994). Fudała J., Hławiczka S., Cenowski M., Butniewicz K. Establishment of a list of sources of the emission of greenhouse gases (in surface industrial activities). determination of emission factors for these sources and calculation of emission for the last year, as well as submission of a methodology for the updating of information. 1994. (in Polish).
- Gawlik (1994). Gawlik L. et al. (1994). Establishment of GHG sources related to handling of coal (hard and brown coal) system and estimation of emission factors in emission system sources; emission calculation for the last year applying OECD/IPCC methodology and current methodology information actualisation. Cracow 1994. (in Polish).
- Gawlik (2001). Gawlik. L., Grzybek I. Study on GHG fugitive emission from the hard coal system. 2001. (in Polish).
- Górka (1991). Górka W., Zajączkowski K., Zajączkowska B. Estimation of wood stock in stand density in Poland. Forest Research Institute. 1991. (in Polish).
- GUS (1974). Statistical Yearbook of The Republic of Poland 1974. GUS, Warsaw, 1974.
- GUS (1981d). Environmental Protection. GUS, Warsaw, 1981.
- GUS (1985). Statistical Yearbook of The Republic of Poland 1985. GUS, Warsaw, 1985.
- GUS (1987). Statistical Yearbook of The Republic of Poland 1987. GUS, Warsaw, 1987.
- GUS (1989d). Environmental Protection. GUS, Warsaw, 1989.
- GUS (1990d). Environmental Protection. GUS, Warsaw, 1990.
- GUS (1993z). Use of mineral and lime fertilisers in 1992/1993. GUS, Warsaw, 1993
- GUS (1994). Statistical Yearbook of The Republic of Poland 1994. GUS, Warsaw, 1994.

GUS (1994a). Energy Statistics 1992-1993, GUS, Warsaw, 1994.

GUS (1994d). Environmental Protection 1994. GUS, Warsaw, 1994.

GUS (1994e). Questionnaire/Report G-03. Selected data from energy statistic system. Central Statistical Office – GUS 1994.

GUS (1995). Statistical Yearbook of The Republic of Poland 1995. GUS, Warsaw, 1995.

GUS (1995a). Energy Statistics 1993-1994, GUS, Warsaw, 1995.

GUS (1995b). Production of industrial products, Central Statistical Office – GUS, Warsaw, 1995.

GUS (1995c). Forestry 1995. GUS, Warsaw, 1995.

GUS (1996). Statistical Yearbook of The Republic of Poland 1996. GUS, Warsaw, 1996.

GUS (1996c). Forestry. GUS, Warsaw, 1996.

GUS (1996d). Environmental Protection. GUS, Warsaw, 1996.

GUS (2000c). Forestry 2000. GUS, Warsaw, 2000.

GUS (2002d). Environmental Protection. GUS, Warsaw, 2002.

GUS (2003c). Forestry 2003. GUS, Warsaw, 2003.

Gworek (2003). Gworek B., Barański A., Czarnomski K., Bojanowicz A. GHG emission from waste disposal sites, Institute of Environmental Protection, 2003.

IETU (1995). Report on NMVOC emission in Poland for the year 1994. Institute for Ecology of Industrial Areas, Katowice, 1995. (in Polish).

IMMB (2006). Cement sector in Poland. Allocation plan of CO₂ allowances in frames of NAP for 2008-2012. Institute for Mineral Building Materials, Opole, 2006.

IOŚ (2001). Strategy of reduction of GHG emission until 2020 in the division into separate gases (N₂O, HFCs, PFCs i SF₆) and sectors. IOŚ, 2001 (in Polish)

IOŚ (2002). Emission Inventory of SO₂, N₂O, NH₃, CO, PMs, HMs, MNVOCs and POPs in Poland in 2000, IOŚ, 2002

IPCC (1995). Third Assessment Report. IPCC 1995.

IPCC (1997). Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories - Vol. 1. Reporting Instructions, Vol. 2. Workbook, Vol. 3. Reference Manual. Intergovernmental Panel on Climate Change - IPCC, 1997.

IPCC (2000). Good Practice Guidance and Uncertainty Management in National GHG Inventories, Intergovernmental Panel on Climate Change -IPCC, 2000.

IPCC (2006). Draft IPCC Guidelines for National Greenhouse Gas Inventories, Intergovernmental Panel on Climate Change -IPCC 2006.

ITS (1995). Estimation of emissions of pollutants introduced to the atmosphere from combustion engines in 1991-1994. Motor Transport Institute. Warsaw, 1995.

KASHUE (2006). Database of National Administration of Emission Trading Scheme. Institute of Environmental Protection. Warsaw, 2006.

Kozłowski (2001). Kozłowski K. Strategy of reduction of N₂O emission in industry processes. (Part of the report: Radwański E. et al. - Strategy of reduction of GHG emission until 2020 in the division into separate gases (N₂O, HFCs, PFCs i SF₆) and sectors up to 2020. (in Polish) 2001.

- Krzysik (1975). Krzysik S. Wood science (in Polish). PWN Warsaw 1975.
- Kwarciański (2005). Kwarciański et al. Estimation of actual methane emissions caused by coal production. Polish Geological Institute, Sosnowiec, 2005.
- Łoboda (1994). Łoboda T., Pietkiewicz S. Estimation of amount of CH₄, CO, N₂O and NO_x released to atmosphere from agricultural residues burning in 1992, Warsaw Agricultural University, 1994 (in Polish).
- Mercik (2001). Mercik S., Moskal S., Study on GHG emission and sinks from arable land soils (in Polish). 2001.
- Myczko (2001). Myczko A., Karłowski J., Szulc R. Study on GHG emissions from enteric fermentation and animal manure in 1999 (in Polish). 2001.
- Olczak (1993). Olczak Cz. et al. Elaboration of quantitative and qualitative measurement profile for volatile organic compounds emitted from iron and steel production processes. (in Polish). Opole, 1993.
- Ordinance of Council of Ministers No. 219 from 29 October 2002 - Ordinance of Council of Ministers No. 219 from 29 October 2002 on National Plan on Waste Management.
- PIG (1994): Balance of mineral resources and underground water in Poland. Polish Geological Institute. Warsaw, 1994 (in Polish)
- Radwański (1995). Radwański E. National Study on sources and sinks of GHG. National Foundation of Environmental Protection, 1995 (in Polish).
- Radwański (2005). Radwański E. Proposal of the ammonia production value for verification of CO₂ emission in 2 IPCC category in GHG emission inventory for 1988-2003, Warsaw, 2005 (in Polish)
- Radwański E. 2006a. Estimation of emissions of C-CO₂ according to Reference Approach. Warsaw, 2006. (in Polish).
- Radwański E. 2006b. Estimation of carbon content in liming of agricultural and forest soils. Warsaw, 2006. (in Polish).
- Steczko (1994). Steczko K. i in. „Establishment of emission sources of GHG associated with the operation of the (high-methane and nitrified) natural gas system and the system involving other network gases, together with the determination of emission factors for emission sources in the system, the calculation of emission for the last year using the OECD/IPCC methodology for the continuous updating of information”. Cracow, 1994.
- Steczko (2001). Steczko K. Studies on GHG emissions and removals for 1999 within solid waste disposals sector. (in Polish). IGNiG, Cracow, 2001.
- Walczak (2003). Walczak J. Correction of N₂O emissions in agriculture, in: Realization of tasks of National Emission Centre in the emission inventory. Institute of Environmental Protection, (in Polish) 2003.
- Walczak (2006). Walczak J. Elaboration of activity data and GHG emission factors in Polish agriculture. National Research Institute of Animal Production, Cracow, 2006.
- Wielgosiński (2003). Wielgosiński G. Estimation of data and update of methodology for pollutants emissions inventory from waste combustion. Łódź, 2003.
- Żebrowski M. 1994. Emission inventory of GHG from crude oil system. Cracow, 1994

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 identify 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 75.3% 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 73.27% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 65.7% 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 71.92%.

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	288118.65	0.6567	0.66
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO ₂	22148.15	0.0505	0.71
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO ₂	19934.01	0.0454	0.75
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO ₂	13409.85	0.0306	0.78
5	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH ₄	12588.37	0.0287	0.81
6	4.D.1	4.D.1. Direct Soil Emissions	N ₂ O	12371.88	0.0282	0.84
7	4.A	4.A. Enteric Fermentation	CH ₄	11592.94	0.0264	0.87
8	4.B	4.B. Manure Management	N ₂ O	7601.22	0.0173	0.88
9	6.B	6.B. Wastewater Handling	CH ₄	5302.54	0.0121	0.90
10	6.A	6.A. Solid Waste Disposal on Land	CH ₄	5296.21	0.0121	0.91
11	2.A.1	2.A.1 Cement Production	CO ₂	5108.25	0.0116	0.92
12	2.C1	2.C.1. Iron and Steel Production	CO ₂	4765.85	0.0109	0.93
13	1.B.2.b.	1.B.2.b. Natural Gas	CH ₄	3567.56	0.0081	0.94
14	4.B	4.B. Manure Management	CH ₄	3278.07	0.0075	0.95
15	4.D.3	4.D.3. Indirect Soil Emissions	N ₂ O	3264.99	0.0074	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	288118.65	0.6567	0.0350	27.0255	0.27
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16068.28	22148.15	0.0505	0.0309	23.8728	0.51
3	6.B	6.B. Wastewater Handling	CH4	2170.23	5302.54	0.0121	0.0112	8.6678	0.60
4	1.A.5.b	1.A.5.b Other Mobile	CO2	5049.93	1188.00	0.0027	0.0079	6.0938	0.66
5	6.A	6.A. Solid Waste Disposal on Land	CH4	4284.31	5296.21	0.0121	0.0064	4.9304	0.71
6	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	15562.17	13409.85	0.0306	0.0054	4.1825	0.75
7	4.D.3	4.D.3. Indirect Soil Emissions	N2O	6276.40	3264.99	0.0074	0.0044	3.3615	0.78
8	1.A.3.c	1.A.3.c Transport Railways	CO2	3355.49	1274.00	0.0029	0.0038	2.9077	0.81
9	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18455.82	12588.37	0.0287	0.0037	2.8475	0.84
10	4.B	4.B. Manure Management	CH4	3435.39	3278.07	0.0075	0.0022	1.6718	0.86
11	4.B	4.B. Manure Management	N2O	9335.10	7601.22	0.0173	0.0019	1.4660	0.87
12	4.D.1	4.D.1. Direct Soil Emissions	N2O	15747.10	12371.88	0.0282	0.0018	1.4121	0.88
13	2.A.2	2.A.2. Lime Production	CO2	3477.55	2028.44	0.0046	0.0017	1.3457	0.90
14	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4111.13	3567.56	0.0081	0.0015	1.1638	0.91
15	1.A.3.d	1.A.3.d Transport Navigation	CO2	2334.06	2148.21	0.0049	0.0012	0.9499	0.92
16	4.A	4.A. Enteric Fermentation	CH4	15954.36	11592.94	0.0264	0.0010	0.7875	0.93
17	1.A.5.b	1.A.5.b Other Mobile	N2O	603.67	148.09	0.0003	0.0009	0.7141	0.93
18	1.A.3.e	1.A.3.e Transport Other	CO2	1661.49	962.57	0.0022	0.0009	0.6584	0.94
19	4.D.2	4.D.2. Animal Production	N2O	1575.89	919.75	0.0021	0.0008	0.6085	0.95
20	6.B	6.B. Wastewater Handling	N2O	1142.28	1106.28	0.0025	0.0008	0.5943	0.95

Annex 2. 1993 Energy balance data for main fuels

Energy balances in 1993 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	68 130	583 525
From national sources	68 129	583 517
1) Indigenous production	68 105	583 315
2) Transformation output or return	0	0
3) Stock decrease	24	202
Import	1	8
Out	68 130	583 524
National consumption	67 221	558 340
1) Transformation input	66 614	552 991
a) input for secondary fuel production	226	2 195
b) fuel combustion	66 388	550 796
2) Direct consumption	607	5 349
Non-energy use	1	7
Combusted directly	606	5 342
Combusted in Poland	66 994	556 138
Stock increase	0	0
Export	909	7 535
Losses and statistical differences		17 649
Net calorific value	MJ/kg	8.30
CO ₂ Emission Factor	kg/GJ	115.34

Diesel oil consumption

Evaluation of fuel consumption In national combustion processes	Diesel oil	
	10 ³ Mg	TJ
In	5 576	238 083
From national sources	5 001	213 543
1) Indigenous production	0	0
2) Transformation output or return	4 998	213 417
3) Stock decrease	3	126
Import	575	24 540
Out	5 576	238 082
National consumption	5 571	237 849
1) Transformation input	512	21 780
a) input for secondary fuel production	502	21 365
b) fuel combustion	10	416
2) Direct consumption	5 059	216 069
Non-energy use	3	136
Combusted directly	5 056	215 933
Combusted in Poland	5 066	216 349
Stock increase	0	0
Export	3	142
Losses and statistical differences	2	91
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	4 034	162 517
From national sources	3 341	134 577
1) Indigenous production	0	0
2) Transformation output or return	3 341	134 577
3) Stock decrease	0	0
Import	693	27 940
Out	4 034	162 518
National consumption	3 215	129 882
1) Transformation input	1 572	63 743
a) input for secondary fuel production	194	7 992
b) fuel combustion	1 378	55 751
2) Direct consumption	1 643	66 139
Non-energy use	25	1 011
Combusted directly	1 618	65 128
Combusted in Poland	2 996	120 879
Stock increase	4	160
Export	1 045	42 105
Losses and statistical differences	-230	-9 629
Net calorific value	MJ/kg	40.35
CO ₂ Emission Factor	kg/GJ	79.19

High-methane natural gas consumption

Evaluation of fuel consumption In national combustion processes	High-methane natural gas	
	10 ⁶ m ³	TJ
In	8 282	295 682
From national sources	2 796	97 622
1) Indigenous production	1 834	64 173
2) Transformation output or return	710	24 459
3) Stock decrease	252	8 990
Import	5 486	198 060
Out	8 281	295 683
National consumption	7 479	273 649
1) Transformation input	257	9 055
a) input for secondary fuel production	226	7 953
b) fuel combustion	32	1 101
2) Direct consumption	7 221	264 595
Non-energy use	1 499	53 226
Combusted directly	5 722	211 369
Combusted in Poland	5 754	212 470
Stock increase	0	0
Export	16	548
Losses and statistical differences	786	21 486
Net calorific value	MJ/m ³	36.93
CO ₂ Emission Factor	kg/GJ	52.81

Nitrified natural gas consumption

Evaluation of fuel consumption In national combustion processes	Nitrified natural gas	
	10 ⁶ m ³	TJ
In	2 928	71 723
From national sources	2 928	71 723
1) Indigenous production	2 821	68 293
2) Transformation output or return	107	3 430
3) Stock decrease	0	0
Import	0	0
Out	2 928	71 723
National consumption	2 752	67 413
1) Transformation input	1 173	27 074
a) input for secondary fuel production	1 164	26 850
b) fuel combustion	9	224
2) Direct consumption	1 579	40 339
Non-energy use	0	0
Combusted directly	1 579	40 339
Combusted in Poland	1 588	40 563
Stock increase	0	0
Export	0	0
Losses and statistical differences	176	4 310
Net calorific value	MJ/m ³	25.55
CO ₂ Emission Factor	kg/GJ	55

Coke consumption

Evaluation of fuel consumption In national combustion processes	Coke	
	10 ³ Mg	TJ
In	10 428	292 509
From national sources	10 425	292 432
1) Indigenous production	0	0
2) Transformation output or return	10 282	288 428
3) Stock decrease	143	4 004
Import	3	77
Out	10 427	292 510
National consumption	8 535	239 531
1) Transformation input	1 823	52 034
a) input for secondary fuel production	1 512	43 889
b) fuel combustion	311	8 145
2) Direct consumption	6 712	187 497
Non-energy use	166	4 213
Combusted directly	6 546	183 284
Combusted in Poland	6 857	191 429
Stock increase	0	0
Export	1 892	52 979
Losses and statistical differences	0	0
Net calorific value	MJ/kg	27.92
CO ₂ Emission Factor	kg/GJ	111.83

Annex 3. National energy balance 1993 [GUS, 1995a]

CZĘŚĆ II. ZBIORCZY BILANS PRZYCHODU I ROZDYSPONOWANIA ENERGII

TABL. 1(4). SYNTETYCZNY BILANS ENERGII

PART II. BASIC ENERGY SUPPLY AND USE BALANCE

TABLE 1(4). 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	1993 1994	TJ	4050054 4051859	907456 910035	36467 31384	769182 902578	-56349 23684
2	ENERGIA PIERWOTNA PRIMARY ENERGY	1993 1994	TJ	4050954 4051859	773029 772515	- -	642459 744583	-53230 29053
3	WĘGIEL KAMIENNY ENERGETYCZNY STEAM COAL	1993 1994 1993 1994	tys. ton 103 ton TJ	104071 107416 2371159 2432111	 429 10622	- - - -	10139 17002 254637 421248	-2875 2279 -64629 50913
4	WĘGIEL KAMIENNY KOKSOWY COKING COAL	1993 1994 1993 1994	tys. ton 103 ton TJ	26408 26517 779127 756377	129 616 3768 18224	- - - -	12829 10693 379740 316535	-69 77 -2028 2191
5	WĘGIEL BRUNATNY LIGNITE	1993 1994 1993 1994	tys. ton 103 ton TJ	68105 66770 583315 553658	1 1 8 12	- - - -	909 719 7535 5963	-24 18 -202 147
6	ROPA NAFTOWA CRUDE OIL	1993 1994 1993 1994	tys. ton 103 ton TJ	235 284 9803 11828	13674 12721 570400 529809	- - - -	- - - -	543 -443 22619 -18464
7	GAZ ZIEMNY WYSOKOMETANOWY HIGH - METHANE NATURAL GAS	1993 1994 1993 1994	mln m3 106 m3 TJ	2129 1997 70038 65813	5486 5816 198060 209323	- - - -	16 24 548 837	-252 -163 -8990 -5737
8	GAZ ZIEMNY ZAAZOTOWANY NITRIFIED NATURAL GAS	1993 1994 1993 1994	mln m3 106 m3 TJ	2821 2638 68293 63950	- - - -	- - - -	- - - -	- - - -
9	TORF I DREWNO PEAT AND WOOD	1993 1994 1993 1994	tys. m3 103 m3 TJ	14419 14301 136979 135860	- - - -	- - - -	- - - -	- 0 - 3
10	ENERGIA WODY I WIATRU HYDRO AND WOOD ENERGY	1993 1994	TJ	5357 6219	- -	- -	- -	- -
11	PALIWA ODPADOWE STAŁE SOLID WASTE FUEL	1993 1994	TJ	26884 26042	793 4526	- -	- -	- -
12	ENERGIA POCHODNA DERIVED ENERGY	1993 1994	TJ	- -	134428 137520	36467 31384	126723 157995	-3119 -5380
13	BRYKIETY Z WĘGLA KAMIENNEGO HARD COAL BRIQUETTES	1993 1994 1993 1994	tys. ton 103 ton TJ	- - - -	1 0 14 0	- - - -	9 282 208 6544	-19 -318 -449 -7365
14	BRYKIETY Z WĘGLA BRUNATNEGO LIGNITE BRIQUETTES (BKB)	1993 1994 1993 1994	tys. ton 103 ton TJ	- - - -	- - - -	- - - -	- - - -	8 -2 144 -31
15	KOKS I PÓLKOKS COKE AND SEMI-COKE	1993 1994 1993 1994	tys. ton 103 ton TJ	- - - -	3 27 77 761	- - - -	1892 3105 52979 86940	-143 60 -4004 1671
16	GAZ CIEKŁY LIPUEFIED PETROLEUM GAS (LPG)	1993 1994 1993 1994	tys. ton 103 ton TJ	- - - -	89 180 4058 8208	- - - -	- - - -	0 0 -1 6
17	BENZYNY SILNIKOWE MOTOR GASOLINE	1993 1994 1993 1994	tys. ton 103 ton TJ	- - - -	1083 982 46889 42526	- - - -	0 3 3 118	39 7 1669 310

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETY- CZNE	STRATY I 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 AND STATISTICAL DIFFERENCE	
4245578	2157642	x	3143483	3163671	77618	96066	1
4035632	2183803	x	3148521	3077758	100486	-6844	
4234755	27890	x	2924412	1294788	56958	43444	2
4050738	25919	x	2903160	1226189	73948	-52691	
96807	-	96807	63309	33498	25	-	3
88565	-	88565	60780	31741	18	-3956	
2181152	-	2181152	1349749	831402	742	-	
1970572	-	1970572	1299628	757311	492	-86367	
13777	-	13777	13777	-	-	-	4
16363	-	16363	15324	2		1036	
405183	-	405183	405183	-	-	-	
455874	-	455874	436609	47	-	19218	
67221	-	67221	66614	607	1		5
66035	-	66035	65405	717	-	-88	
575989	-	575989	552991	5349	7	17649	
547561	-	547561	541216	7237	-	-892	
13367	-	13367	13367	-	-	-	6
13448	-	13448	13448	-	-	-	
557584	-	557584	557584	-	-	-	
560102	-	560102	560102	-	-	-	
7851	710	8561	350	7424	1499	786	7
7951	688	8640	241	7778	1951	621	
276540	24459	301000	10835	268679	53226	21486	
280037	23475	303512	7677	278963	69592	16872	
2821	107	2927	1173	1579	-	176	8
2638	81	2719	1158	1483	-	78	
68293	3430	71723	27074	40339	-	4310	
63950	2444	66394	31341	36575	-	-1522	
14419	-	14419	31	14388	-	-	9
14301	-	14301	17	14284	-	-	
136979	-	136979	297	136682	-	-	
135857	-	135857	158	135699	-	-	
5357	-	5357	5357	-	-	-	10
6219	-	6219	6219	-	-	-	
27677	-	27677	15341	12336	2984	-	11
30568	-	30568	20211	10357	3864	-	
10823	2129752	x	210271	1877682	10286	52622	12
-15094	2157884	x	236212	1860718	9625	45859	
11	-	11	2	9	-	0	13
36	-	36	2	35	-	-	
255	-	255	46	212	-	-3	
821	-	821	36	785	-	-	
-8	102	94	0	94	-	-	14
2	92	94	0	94	-	-	
-144	1838	1693	2	1691	-	-	
31	1647	1678	1	1678	-	-	
-1746	10282	8535	1823	6712	166	-	15
-3137	11456	8318	2035	6283	168	-	
-48897	288428	239531	52034	187497	4213	-	
-87849	321007	233157	58107	175050	4275	-	
89	171	260	8	252	90	0	16
180	197	377	6	371	72	0	
4059	7789	11849	356	11491	4096	1	
8202	8991	17193	273	16916	3252	5	
1044	3486	4530	610	3909	19	10	17
972	3773	4746	433	4302	16	10	
45217	150924	196141	26428	169272	829	440	
42098	163384	205482	18740	186295	670	447	

TABL. 1(4). SYNTETYCZNY BILANS ENERGII (dok.)

TABLE 1(4). BASIC (SYNTHETIC) ENERGY BALANCE (end)

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
18	BENZYNY LOTNICZE AVIATION GASOLINE	1993	tys. ton	-	8	-	-	2
		1994	103 ton	-	9	-	-	-2
		1993	TJ	-	353	-	-	81
		1994		-	378	-	-	-68
19	PALIWA ODRZUTOWE JET FUEL	1993	tys. ton	-	198	79	14	-1
		1994	103 ton	-	390	70	16	6
		1993	TJ	-	8573	3412	614	-47
		1994		-	16884	3052	707	255
20	OLEJE NAPĘDOWE DIESEL OIL	1993	tys. ton	-	575	120	3	-3
		1994	103 ton	-	695	146	2	-1
		1993	TJ	-	24540	5115	142	-126
		1994		-	29656	6235	90	-35
21	OLEJE OPALOWE FUEL OIL	1993	tys. ton	-	693	693	1045	4
		1994	103 ton	-	559	548	894	-1
		1993	TJ	-	27940	27940	42105	160
		1994		-	22534	22097	36013	-39
22	PRODUKTY NIEENERGETYCZNE NON-ENERGY PRODUCTS	1993	TJ	-	1656	-	1833	-545
		1994		-	77	-	1511	-84
23	GAZ RAFINERYJNY REFINERY GAS	1993	tys. ton	-	-	-	-	-
		1994	103 ton	-	-	-	-	-
		1993	TJ	-	-	-	-	-
		1994		-	-	-	-	-
24	GAZ KOKSOWNICZY COKE OVEN GAS	1993	mln m3	-	-	-	-	-
		1994	106 m3	-	-	-	-	-
		1993	TJ	-	-	-	-	-
		1994		-	-	-	-	-
25	GAZ WIELKOPIECOWY GAS MANUFACTURED FROM COAL	1993	mln m3	-	-	-	-	-
		1994	106 m3	-	-	-	-	-
		1993	TJ	-	-	-	-	-
		1994		-	-	-	-	-
26	GAZ MIEJSKI TOWN GAS	1993	mln m3	-	11	-	-	-
		1994	106 m3	-	5	-	-	-
		1993	TJ	-	166	-	-	-
		1994		-	69	-	-	-
27	GAZ CZADNICOWY I WYTLEWNY BLAST FURNACE GAS	1993	mln m3	-	-	-	-	-
		1994	106 m3	-	-	-	-	-
		1993	TJ	-	-	-	-	-
		1994		-	-	-	-	-
28	ENERGIA ELEKTRYCZNA ELECTRICITY	1993	GWh	-	5600	-	8011	-
		1994		-	4563	-	7242	-
		1993	TJ	-	20160	-	28840	-
		1994		-	16427	-	26071	-
29	CIEPŁO HEAT	1993	TJ	-	-	-	-	-
		1994		-	-	-	-	-
30	ENERGIA Z ODZYSKU ENERGY FROM RETURNS	1993	TJ	-	-	-	-	-
		1994		-	-	-	-	12
31	PALIWA ODPAD. GAZOWE GASEOUS WASTE FUELS	1993	TJ	-	-	-	-	-
		1994		-	-	-	-	12
32	CIEPŁO Z ODZYSKU HEAT FROM RETURNS	1993	TJ	-	-	-	-	-
		1994		-	-	-	-	-

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETY- CZNE	STRATY I RÓŻNICE BILANSOWE	LP
<i>GLOBAL CONSUMPTION OR EXCHANGE BALANCES</i>	<i>TRANSFORMA- TIONS OUTPUT OR RETURNS</i>	<i>TOTAL CONSUMPTION</i>	<i>TRANSFORMA- TIONS INPUT</i>	<i>DIRECT CONSUMPTION</i>	<i>AMONG WHICH NON-ENERGY USE</i>	<i>LOSSES AND STATISTICAL DIFFERENCE</i>	
6	0	6	2	4	-	-	18
10	5	15	5	9	-	0	
272	0	273	94	179	-	-	
447	197	644	233	410	-	2	
185	258	443	60	384	-	-	19
368	447	814	230	584	-	1	
8006	11190	19196	2584	16613	-	-	
15923	19342	35265	9943	25297	-	25	
574	4998	5572	512	5059	3	2	20
693	5088	5781	807	4960	3	15	
24524	213417	237941	21780	216069	136	91	
29601	217247	246848	34437	211790	110	620	
-355	3341	2985	1572	1643	25	-230	21
-334	3260	2927	1579	1770	25	-422	
-14325	134577	120252	63743	66139	1011	-9629	
-13440	131097	117657	63721	70800	1003	-16865	
368	101998	102367	8652	93679	-	35	22
-1350	98702	97352	6266	91055	-	30	
-	294	294	17	276	-	-	23
-	240	240	25	215	-	-	
-	14837	14837	870	13968	-	-	
-	12129	12129	1241	10888	-	-	
-	4435	4435	468	3922	-	46	24
-	4911	4911	761	4146	17	4	
-	78094	78094	8226	69051	-	817	
-	84950	84950	13280	71722	316	-52	
-	11247	11247	3160	8087	-	-	25
-	12847	12847	3914	8934	-	-1	
-	38157	38157	10510	27648	-	-	
-	44162	44162	13335	30832	-	-5	
11	38	48	0	60	-	-12	26
5	15	19	-	50	-	-31	
166	799	966	1	917	-	49	
69	347	416	-	1056	-	-641	
-	554	554	14	554	-	-14	27
-	399	399	6	392	-	-	
-	3252	3252	84	3292	-	-124	
-	2345	2345	37	2307	-	-	
-2411	133867	131456	2879	111648	-	16929	28
-2679	135348	132669	2868	112497	-	17303	
-8680	481921	473241	10363	401934	-	60945	
-9644	487231	477587	10326	404970	-	62291	
-	602530	602530	4498	598031	-	-	29
-	565105	565105	6236	558869	-	-	
-	75748	x	8800	66948	10374	-	30
-12	82187	x	9149	73038	16913	-12	
-	36901	36901	8800	28101	10374	-	31
-12	41661	41649	9149	32512	16913	-12	
-	38847	38847	-	38847	-	-	32
-	40526	40526	-	40526	-	-	

Annex 4. National energy balance 1993 – OECD

Poland 1993

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	3139940.3	583314.7	288427.9		1837.7	136979.4	144775.3	3640.4	84169.6
From Other Sources	10345.4						7388.6	354.8	1308.7
Imports	3768.1	7.6	77.4	13.5			217865.8	183.1	
Exports	634376.4	7534.9	52978.7	207.5			602.4		
International Marine Bunkers									
Stock Changes	66657.3	201.7	4004.0	449.5	-144.4		9889.3		
DOMESTIC SUPPLY	2586334.8	575989.1	239530.6	255.4	1693.3	136979.4	379316.7	4178.3	85478.3
Returns to Supply									
Transfers							-616.6	188.5	425.4
TOTAL REQUIREMENTS	2586334.8	575989.1	239530.6	255.4	1693.3	136979.4	378700.0	4366.7	85903.6
Statistical Difference		17648.6		-2.6				53.4	
TRANSFORMATION SECTOR	1754932.4	552991.3	52034.0	45.8	1.8	297.3	8050.3	92.8	9048.9
Patent Fuel Plants		1984.2							
Coke Ovens	405183.3		1687.0				2779.3		
Gas Works	4507.7	210.4	228.8				1854.5		
Blast Furnaces			41973.2						
Oil Refineries									
Autoproducers of Electricity	255652.7	1171.5	8.0				2288.8		8571.6
Public Plants for CHP	835914.0	548700.1					222.0		
Heating Plants	253674.7	925.2	8137.0	45.8	1.8	297.3	905.8	92.8	477.2
Non-Specified									
ENERGY SECTOR	24472.4	315.7	486.6		33.2	8.1	20680.6	132.7	38449.3
Coal Mines	20969.4	303.4	164.4		33.2	0.4	1452.3	128.9	577.9
Oil and Gas Extraction	7.8	0.0	8.8				2354.2		
Patent Fuel Plants									
Coke Ovens	44.8						295.8		37835.4
Gas Works	778.1		64.9			0.0	14728.0	3.8	35.7
Oil Refineries	221.0		0.1				1768.9		
Electric Plants									
Pumped Storage									
Non-Specified	2451.5	12.3	248.5			7.6	81.4		0.3
Distribution Losses							28375.1		898.2
FINAL CONSUMPTION	806930.0	5033.5	187010.1	212.2	1658.3	136674.0	321594.0	4087.8	37507.2
INDUSTRY SECTOR	242016.0	1231.1	113990.3	170.9	42.0	852.3	85706.7	3504.0	27787.8
Iron and Steel	9288.3		86407.7			16.2	25337.3	680.8	24004.9
Chemical	13061.8	43.7	1747.2			3.2	11081.6	140.1	1720.1
<i>of which: Petrochemical</i>	8.5		1.0						
Non-Ferrous Metals	1898.0		2698.5			0.7	1880.3		47.9
Non-Metallic Minerals	78745.0	153.0	9913.1	0.0	0.1	32.9	24185.1	2657.6	1371.4
Transport Equipment	12121.7	0.7	580.2		6.1	0.9	1775.3	0.1	11.2
Machinery	23855.6	74.0	2998.8		0.1	22.3	8928.9	19.7	497.0
Mining and Quarrying	8677.6	2.2	4209.0		35.4	0.8	7855.7		8.6
Food and Tobacco	56413.3	372.7	3122.3	167.0		133.1	3488.1	1.1	113.1
Paper, Pulp and Print	4529.3	1.6	293.7	0.1		0.1	66.9	0.3	2.9
Wood and Wood Products	9965.6	54.7	199.3			442.4	377.3	0.1	2.2
Constructions	7568.0	18.3	1200.0	2.6	0.4	49.0	323.3	3.2	4.6
Textiles and Leather	15228.1	510.3	560.6	1.1		56.4	376.8	1.0	4.0
Non-specified	663.6		60.0			94.2	30.1	0.0	
TRANSPORT SECTOR	6783.0	4.3	2892.2		15.0				
Air Transport									
Road Transport									
Railways	6759.0	4.3	2878.8		15.0				
Internal Navigation	24.0		13.4						
OTHER SECTORS	557388.9	3791.5	65915.1	41.3	1601.2	135821.7	177339.2	583.8	9719.4
Agriculture	15301.6	841.1	509.5	31.4	6.1	12736.8	121.3	1.6	0.6
Commerce and Public									
Residential	472500.0	2931.0	31500.0			123082.0	152020.1	479.2	8009.1
Non-Specified	69587.3	19.3	33905.6	9.9	1595.2	2.9	25197.8	103.0	1709.7
NON-ENERGY USE	742.0	6.7	4212.5				58548.1		
in Industry	551.9	6.7	4212.3				58548.1		

[illegible]

Poland 1993

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	8027.2	142085.4		10193.7	525.4	214723.0	134265.0	38252.5	35359.7
From Other Sources									
Imports	4210.7	28923.8	365.7	4318.3		19712.5			2454.3
Exports		3.4		632.2		144.6	40385.5		1816.1
International Marine Bunkers						2600.7	1673.0		
Stock Changes	0.9	-1726.5	-83.8	48.6	-2.1	128.3	-159.4		515.2
DOMESTIC SUPPLY	12238.7	169279.4	281.9	13928.4	523.2	231818.5	92047.1	38252.5	36513.1
Returns to Supply									
Transfers	32.1	5900.6	-97.0	-334.8	-9.6	-19879.8	-7802.2		-4707.4
TOTAL REQUIREMENTS	12270.9	175180.0	184.8	13593.6	513.6	211938.7	84244.9	38252.5	31805.7
Statistical Difference							-18529.7		-771.1
TRANSFORMATION SECTOR	350.2					427.2	55364.2		
Patent Fuel Plants									
Coke Ovens									
Gas Works	350.0								
Blast Furnaces									
Oil Refineries									
Autoproducers of Electricity						103.7	40190.0		
Public Plants for CHP						109.8	6073.6		
Heating Plants	0.2					213.7	9100.5		
Non-Specified									
ENERGY SECTOR	35.2	169.8				4527.9	13024.1		
Coal Mines	0.0	35.8				2733.1	754.3		
Oil and Gas Extraction		4.4				147.3	28.2		
Patent Fuel Plants									
Coke Ovens		0.4				3.9	243.4		
Gas Works	1.8	33.0				1180.6	4.9		
Oil Refineries	29.0	2.2				96.2	11866.5		
Electric Plants									
Pumped Storage									
Non-Specified	4.3	94.0				366.8	126.9		
Distribution Losses	1.4	455.6	1.8	9.9	0.4	92.7	1.4		33.9
FINAL CONSUMPTION	11884.1	174554.7	183.0	13583.7	513.2	206890.9	34384.9	38252.5	32542.9
INDUSTRY SECTOR	199.8	1379.1				10951.3	19766.9		
Iron and Steel	4.0	17.8				362.2	4303.3		
Chemical	48.9	298.1				717.2	2499.2		
<i>of which: Petrochemical</i>	23.5	1.2				34.7	10.0		
Non-Ferrous Metals	0.0	4.4				100.0	21.7		
Non-Metallic Minerals	23.3	16.3				756.3	3975.4		
Transport Equipment	27.1	277.1				693.3	258.2		
Machinery	28.4	173.1				578.8	531.4		
Mining and Quarrying		13.5				1571.4	940.2		
Food and Tobacco	26.5	139.3				1189.5	3301.8		
Paper, Pulp and Print	30.4	6.1				23.6	1549.3		
Wood and Wood Products	0.1	21.2				172.4	1364.2		
Constructions	3.6	392.1				4695.2	638.1		
Textiles and Leather	7.2	18.7				89.0	377.0		
Non-specified	0.2	1.3				2.5	7.2		
TRANSPORT SECTOR	1167.8	172312.5	183.0	13583.7		120140.9	132.9		
Air Transport			183.0	13583.7		25.1			
Road Transport	1143.7	171963.1				108894.8	124.3		
Railways	24.1	347.0				10508.0	8.6		
Internal Navigation		2.4				713.0			
OTHER SECTORS	6247.5	0.0	0.0			75660.1	13466.8		
Agriculture	2.5					63266.7	13466.8		
Commerce and Public									
Residential	6245.0					12393.3			
Non-Specified		0.0	0.0			0.0	0.0		
NON-ENERGY USE	4268.9	863.0			513.2	138.5	1018.3	38252.5	32542.9
in Industry	4268.9	860.4			513.2	63.0	6.1	38252.5	32542.9

Annex 5. Uncertainty estimation of the 1993 inventory

Uncertainty analysis for the year 1993 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 – 6.9%	CH ₄ – 19.9%	N ₂ O – 51.2%
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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 (6.9%) 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. 19.9% 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 (51.2%) 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.

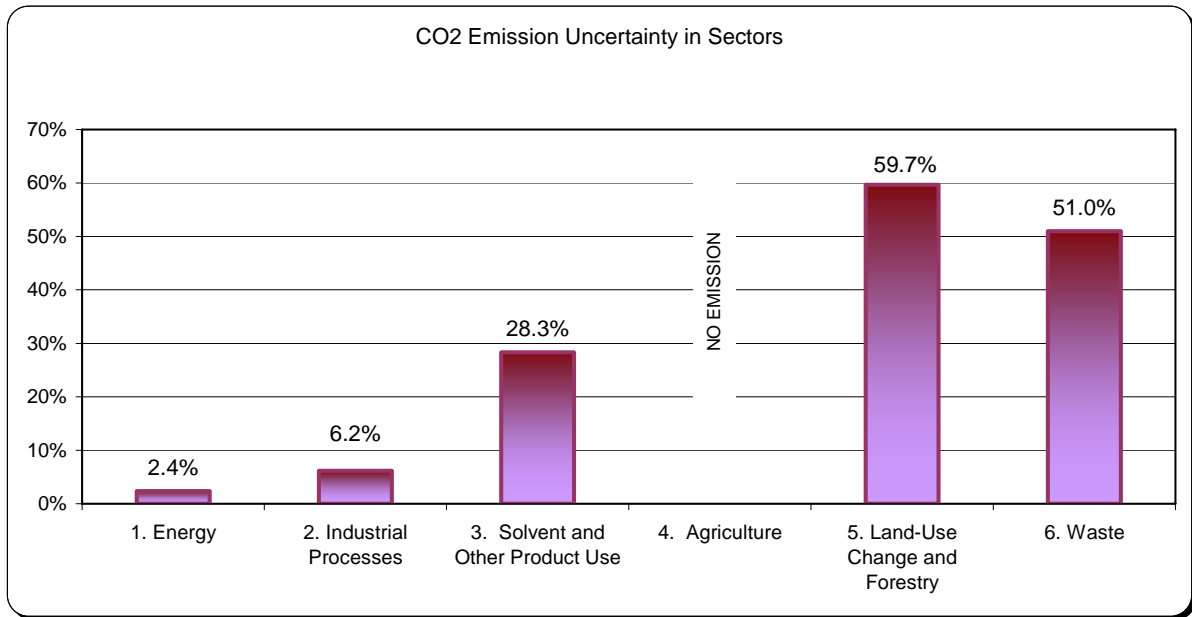
Sector *3. Solvents and Other Products Use* was included in calculations with high sectoral uncertainty 28.3%. Emission from this sector is small compared to total CO₂ and high uncertainty have very little influence on uncertainty of values of total national CO₂ emission.

GHG inventory 1993 – Uncertainty analysis, part 1, sectors 1-2

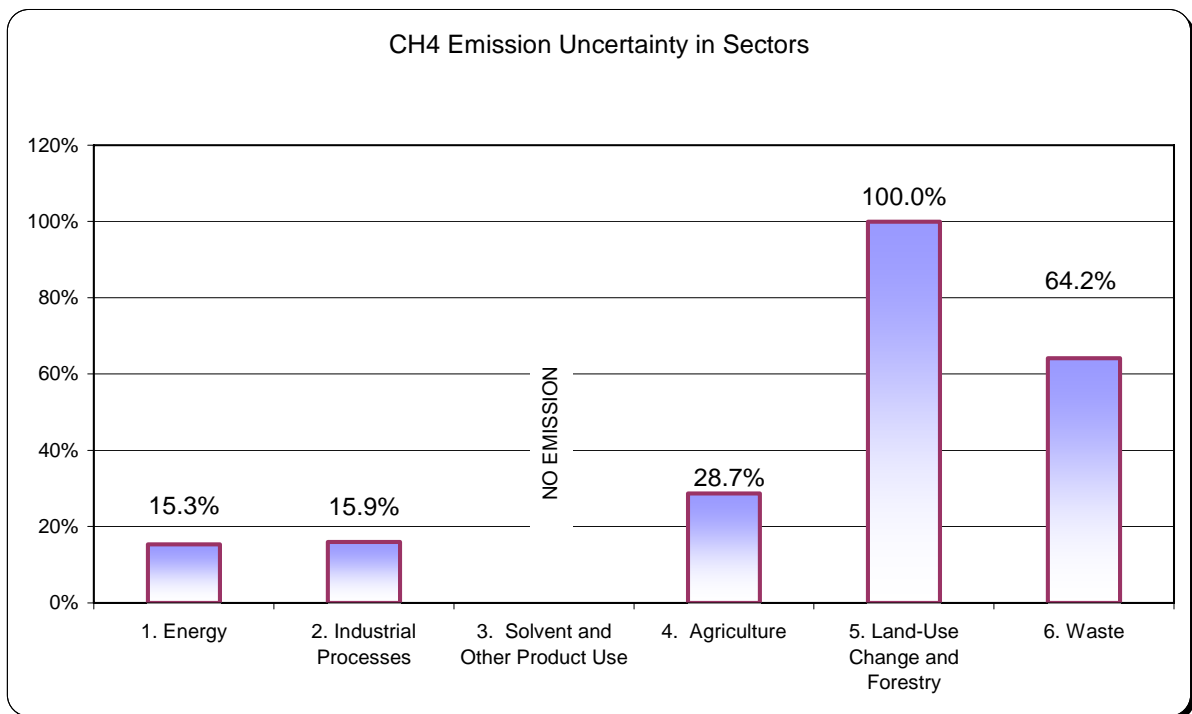
1993	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
TOTAL									329 933.89	2 011.53	100.78	6.9%	19.9%	51.2%	22 681.12	401.27	51.58
1. Energy									349 276.57	786.43	6.91	2.4%	15.3%	2.8%	8268.78	120.71	0.20
A. Fuel Combustion									349 206.28	13.64	6.91	2.4%	6.9%	2.8%	8268.78	0.94	0.20
1. Energy Industries									207 792.85	2.69	2.99	3.5%	13.0%	3.5%	7180.13	0.35	0.11
Liquid Fuels	112 005	3.0%	71.46	2.49	0.52	1.0%	41.8%	3.8%	8 004.32	0.28	0.06	3.2%	41.9%	3.2%	253.12	0.12	0.00
Solid Fuels	1 979 994	3.0%	100.51	1.21	1.48	2.0%	13.5%	11.7%	199 015.61	2.39	2.93	3.6%	13.8%	3.6%	7175.61	0.33	0.11
Gaseous Fuels	13 426	3.0%	57.57	1.00	0.10	2.0%	17.0%	20.0%	772.93	0.01	0.00	3.6%	17.3%	3.6%	27.87	0.00	0.00
Biomass	300	3.0%				0.0%	24.0%	37.0%	33.65	0.01	0.00	3.0%	24.2%	3.0%		0.00	0.00
2. Manufacturing Industries and Construction									36 611.96	1.75	0.62	4.2%	13.0%	7.2%	1544.12	0.23	0.04
Liquid Fuels	60 610.34	5.0%	74.16	2.96	4.79	1.0%	41.8%	3.8%	4 495.10	0.18	0.29	5.1%	42.1%	6.3%	229.21	0.08	0.02
Solid Fuels	246 014.33	5.0%	114.08	6.06	1.29	2.0%	13.5%	11.7%	28 064.88	1.49	0.32	5.4%	14.4%	12.7%	1511.34	0.21	0.04
Gaseous Fuels	72 936.90	5.0%	55.55	1.00	0.10	2.0%	17.0%	20.0%	4 051.98	0.07	0.01	5.4%	17.7%	20.6%	218.21	0.01	0.00
Biomass	182.87	5.0%	112.00	30.00	4.00	0.0%	24.0%	37.0%	20.48	0.01	0.00	5.0%	24.5%	37.3%		0.00	0.00
3. Transport									26 555.77	6.69	1.34	6.9%	11.3%	5.4%	1842.28	0.76	0.07
Liquid Fuels	330 831.85	5.0%	78.74	20.11	4.02	5.0%	10.2%	2.3%	26 048.85	6.65	1.33	7.1%	11.4%	5.5%	1841.93	0.76	0.07
Solid Fuels	6 759.00	5.0%	75.00	6.00	NE	5.0%	13.5%	11.7%	506.93	0.04	0.01	7.1%	14.4%	12.7%	35.85	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
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
4. Other Sectors									76 597.20	2.43	1.48	4.3%	14.8%	9.3%	3321.97	0.36	0.14
Liquid Fuels	98 942.28	5.0%	74.06	3.67	3.60	1.0%	41.8%	3.8%	7 327.60	0.36	0.36	5.1%	42.1%	6.3%	373.64	0.15	0.02
Solid Fuels	635 161.73	5.0%	95.56	1.00	1.48	2.0%	13.5%	11.7%	60 693.11	0.64	0.94	5.4%	14.4%	12.7%	3268.42	0.09	0.12
Gaseous Fuels	165 322.00	5.0%	51.88	1.00	0.10	2.0%	17.0%	20.0%	8 576.48	0.17	0.02	5.4%	17.7%	20.6%	461.86	0.03	0.00
Biomass	42 252.81	5.0%	112.00	30.00	4.00		24.0%	37.0%	4 732.31	1.27	0.17	5.0%	24.5%	37.3%		0.31	0.06
5. Other									1 648.50	0.08	0.48	4.2%	96.2%	6.2%	68.60	0.08	0.03
Liquid Fuels	17 678.31	5.0%	73.25	4.46	27.07	1.0%	100.0%	3.8%	1 294.99	0.08	0.48	5.1%	100.1%	6.3%	66.03	0.08	0.03
Solid Fuels	3 131.00	5.0%	110.20	1.00	1.50	2.0%	80.0%	11.7%	345.05	0.00	0.00	5.4%	80.2%	12.7%	18.58	0.00	0.00
Gaseous Fuels	153.00	5.0%	55.27	1.00	0.10	2.0%	90.0%	20.0%	8.46	0.00	0.00	5.4%	90.1%	20.6%	0.46	0.00	0.00
Biomass	NE	5.0%	0.00	0.00	0.00	0.0%	95.0%	37.0%	0.00	0.00	0.00	5.0%	95.1%	37.3%		0.00	0.00
B. Fugitive Emissions from Fuels									70.29	772.79	0.00	5.9%	15.6%		4.13	120.70	0.00
1. Solid Fuels									1.01	602.29	0.00	6.6%	20.0%		0.07	120.31	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]	131.40	2.0%		4.55539			20.0%			598.58			20.1%		0.00	120.31	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	68.20	2.0%		0.01273			20.0%			0.87			20.1%		0.00	0.17	0.00
1. B. 1. c. Other [CO2 Emission from Coking Gas Subsystem]	0.49	2.0%	2 060 765	5 791 695.00			20.0%		1.01	2.84		6.6%	15.0%		0.07	0.43	
2. Oil and Natural Gas									69.27	170.50	0.00	6.0%	5.7%		4.13	9.68	0.00
1. B. 2. a. Oil															0.00	0.00	0.00
ii. Production [Activity in PJ, EFs in kg/PJ]	9.80	0.5%	6 315 000	61 800.00		6.6%	8.1%		61.91	0.61		6.6%	8.1%		4.10	0.05	0.00
iii. Transport [Activity in Gg]	13 909.00	0.5%	NE	NE		6.6%	8.1%		0.09	0.01		6.6%	8.1%		0.01	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]	138.33	0.5%	48 461.70	101 467.43		6.6%	8.1%		6.70	14.04		6.6%	8.1%		0.44	1.14	0.00
ii. Transmission [Activity in PJ, EFs in kg/PJ]	346.73	0.5%	509.73	136 138.41		6.6%	8.1%		0.18	47.20		6.6%	8.1%		0.01	3.83	0.00
ii. Distribution [Activity in PJ, EFs in kg/PJ]	346.73	0.5%	1 154.40	313 344.29		6.6%	8.1%		0.40	108.64		6.6%	8.1%		0.03	8.82	0.00
2. Industrial Processes									15217.94	10.68	11.85	6.2%	15.9%	26.4%	938.71	1.70	3.13
A. Mineral Products									7554.64		0	11.4%			858.13	0.00	0.00
1. Cement Production [Activity in kt, EF in t/t]	9 730.00	5.0%	0.525			15.0%			5108.25			15.8%			807.69	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	2 584.00	10.0%	0.785			10.0%			2028.44			14.1%			286.86	0.00	0.00
4. Soda Ash (production) [Activity in kt, EF in t/t]	1 007.10	10.0%	0.415			0.0%			417.95			10.0%			41.79	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									2644.88	8.26	11.85	6.6%	20.0%	26.4%	173.55	1.65	3.13
1. Ammonia Production [Activity in kt, EF in t/t]	1 630.90	5.0%	1.5	0.0049		5.0%	20.0%		2446.35	7.99		7.1%	20.6%		172.98	1.65	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	1 607.60	2.0%			0.01			30.0%			10.40			30.1%	0.00	0.00	3.13
3. Adipic Acid Production [Activity in kt, EF in t/t]	3.21	5.0%			0.00			10.0%	NE		0.96			11.2%			
4. Carbide Production (calcium carbide) [Activity in kt, EF in t/t]	180.40	5.0%	1.1			5.0%			198.44			7.1%			14.03	0.00	0.00
5. Other (Carbon Black) [Activity in kt, EF in t/t]	28.43	5.0%		0.01			20.0%			0.26			20.6%		0.00	0.05	0.00
5. Other (Ethylene) [Activity in kt, EF in t/t]	289.08	5.0%	0.0003			5.0%			0.09			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]	528.80	5.0%	0			5.0%						7.1%			0.00	0.00	0.00
5. Other (Caprolactam) [Activity in kt, EF in t/t]	103.17	5.0%			0.0047			20.0%			0.49			20.6%	0.00	0.00	0.10
C. Metal Production									5018.43	2.43	0	6.7%	17.6%		338.63	0.43	0.00
1. Iron and Steel Production															0.00	0.00	0.00
Sinter [Activity in kt, EF in t/t]	7 628.23	5.0%	0.07			10.0%			569.68			11.2%			63.69	0.00	0.00
Coke [Activity in kt, EF in t/t]	10 281.73	5.0%	0.13	0.000200		10.0%	20.0%		1341.94	2.06		11.2%	20.6%		150.03	0.42	0.00
Open-heart Steel [Activity in kt, EF in t/t]	1 660.30	5.0%	0.052			10.0%			86.34			11.2%		NE			
Electric Furnace Steel [Activity in kt, EF in t/t]	2 114.50	5.0%	0.00430	0.000120		10.0%	20.0%		9.09	0.25		11.2%	20.6%		1.02	0.05	0.00
Pig Iron [Activity in kt, EF in t/t]	6 292.90	5.0%	0.42104			10.0%			2649.59			11.2%			296.23	0.00	0.00
Iron Cast [Activity in kt, EF in t/t]	583.20	5.0%	0.061	0.000200		10.0%	20.0%		35.58	0.12		11.2%	20.6%		3.98	0.02	0.00
Steel Cast [Activity in kt, EF in t/t]	68.50	5.0%	0.062			10.0%			4.25			11.2%			0.47	0.00	0.00
Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]	6 162.00	5.0%	0.01126			10.0%			69.38			11.2%			7.76	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	43.10	5.0%	3.9			5.0%			168.09			7.1%			11.89	0.00	0.00
3. Aluminium Production [Activity in kt, EF in t/t]	46.94	5.0%	1.8			5.0%			84.50			7.1%			5.97	0.00	0.00
D. Other Production															0.00	0.00	0.00
G. Other															0.00	0.00	0.00

GHG inventory 1993 – Uncertainty analysis, part 2, sector 3-6

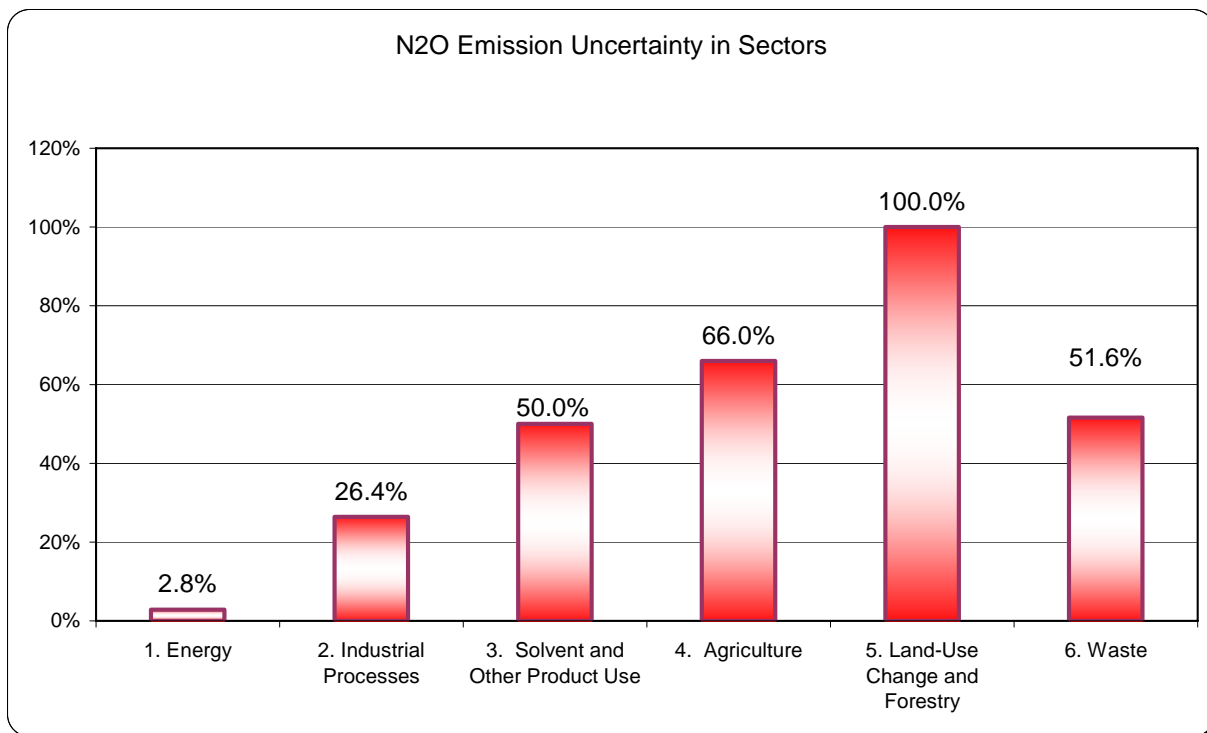
1993	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
3. Solvent and Other Product Use	119.65		NA						395.36		0.40	28.3%		50.0%	111.89	0.00	0.20
4. Agriculture										709.56	78.01	28.7%	28.7%	66.0%	0.00	203.93	51.45
A. Enteric Fermentation									552.04			34.9%			0.00	192.75	0.00
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 983.0	5.0%		88.95			50.0%			354.30		50.2%	50.2%		0.00	178.03	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 660.0	5.0%		39.10			50.0%			143.12		50.2%	50.2%		0.00	71.92	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	1 268.0	5.0%		8.12			50.0%			10.30		50.2%	50.2%		0.00	5.18	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	179.3	5.0%		5.00			50.0%			0.90		50.2%	50.2%		0.00	0.45	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	841.0	5.0%		18.00			50.0%			15.14		50.2%	50.2%		0.00	7.61	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	18 860.0	5.0%		1.50			50.0%			28.29		50.2%	50.2%		0.00	14.22	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	198 351.6	5.0%		0.00			50.0%			0.00		50.2%	50.2%		0.00	0.00	0.00
B. Manure Management									156.10	24.52		42.7%	42.7%	148.8%	0.00	66.59	36.48
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 983	5.0%		5.01			50.0%			19.95		50.2%	50.2%		0.00	10.02	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 660	5.0%		1.83			50.0%			6.69		50.2%	50.2%		0.00	3.36	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	1 268	5.0%		0.17			50.0%			0.22		50.2%	50.2%		0.00	0.11	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	179	5.0%		0.12			50.0%			0.02		50.2%	50.2%		0.00	0.01	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	841	5.0%		1.39			50.0%			1.17		50.2%	50.2%		0.00	0.59	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	18 860	5.0%		5.97			50.0%			112.59		50.2%	50.2%		0.00	56.57	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	198 352	5.0%		0.08			50.0%			15.47		50.2%	50.2%		0.00	7.77	0.00
11. Liquid Systems [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.001000			150.0%			0.21			150.1%	0.00	0.00	0.32
12. Solid Storage and Dry Lot [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.020000			150.0%			24.31			150.1%	0.00	0.00	36.48
D. Agricultural Soils											53.41			67.9%	0.00	0.00	36.28
1. Direct Soil Emissions															0.00	0.00	0.00
Synthetic Fertilizers [Activity in kg N, EF in kg N2O-N/kg N]	614 700 000	5.0%			0.01			150.0%			8.59			150.1%	0.00	0.00	12.89
Animal Wastes Applied to Soils [Activity in kg N, EF in kg N2O-N/kg N]	708 650 905	5.0%			0.01			150.0%			11.14			150.1%	0.00	0.00	16.71
N-fixing Crops [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	78 930 000	5.0%			0.01			150.0%			1.24			150.1%	0.00	0.00	1.86
Crop Residue [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	190 501 600	5.0%			0.01			150.0%			2.99			150.1%	0.00	0.00	4.49
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]	94 402 563	5.0%			0.02			150.0%			2.97			150.1%	0.00	0.00	4.45
3. Indirect Emissions [Activity in kg N/yr, EF in kg N2O/kg N]	87 180 513	20.0%			1.208093834			150.0%			10.53			151.3%	0.00	0.00	15.94
F. Field Burning of Agricultural Residues									1.41	0.08		22.0%	22.0%	112.8%	0.00	0.31	0.09
1. Cereals															0.00	0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	8 243 000	30.0%		0.1816	0.0004		20.0%	150.0%		0.15	0.00		36.1%	153.0%	0.00	0.05	0.01
Barley [Activity in t of crop production, EF in kg/t dm]	3 255 000	30.0%		0.1473	0.0004		20.0%	150.0%		0.05	0.00		36.1%	153.0%	0.00	0.02	0.00
Maize [Activity in t of crop production, EF in kg/t dm]	290 000	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]	1 493 000	30.0%		0.1506	0.0004		20.0%	150.0%		0.02	0.00		36.1%	153.0%	0.00	0.01	0.00
Rye [Activity in t of crop production, EF in kg/t dm]	4 992 000	30.0%		0.2004	0.0004		20.0%	150.0%		0.10	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]	5 144 000	30.0%		0.1559	0.0004		20.0%	150.0%		0.08	0.00		36.1%	153.0%	0.00	0.03	0.00
2 Pulses (Other non-specified)	411 000	30.0%		0.0432	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]	36 270 000	30.0%		0.1796	0.0014		20.0%	150.0%		0.65	0.05		36.1%	153.0%	0.00	0.23	0.08
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]	27 270 400	30.0%		0.0131	0.0006		20.0%	150.0%		0.36	0.02		36.1%	153.0%	0.00	0.13	0.03
5. Land-Use Change and Forestry									-35346.24	0.15	0.00	59.7%	100.0%	100.0%	0.00	0.00	0.00
A. Forest Land									-41683.97			50.0%	50.0%	100.0%	-21098.04	0.15	0.01
B. Cropland									5428.49			50.0%	50.0%	100.0%	-20841.94	0.00	0.00
C. Grassland									3012.13			50.0%	50.0%	100.0%	2714.25	0.00	0.00
D. Wetlands									0.00			50.0%	50.0%	100.0%	0.00	0.00	0.00
E. Settlements									-2102.99	0.15	0.0011	50.0%	100.0%	100.0%	-1051.50	0.15	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									390.26	504.70	3.61	51.0%	64.2%	51.6%	198.99	323.81	1.86
A. Solid Waste Disposal on Land									252.20			102.6%	102.6%	100.0%	0.00	258.79	0.00
1 Managed Waste Disposal on Land [Activity in Gg, EF in t/t MSW]							100.0%					100.0%	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]	10 551.85	23.0%					100.0%			252.20	3.57		102.6%		0.00	258.79	0.00
B. Wastewater Handling									252.50				77.1%	52.2%	0.00	194.64	1.86
Industrial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	1 986.37			0.09			100.0%			178.77			100.0%		0.00	178.77	0.00
Domestic and Commercial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	318.03	30.0%		0.231829724			100.0%			73.73			104.4%		0.00	76.97	0.00
sewage N produced]	38 505.00	15.0%			0.0000927			50.0%			3.57			52.2%	0.00	0.00	1.86
C. Waste Incineration									390.26		0.04	51.0%	51.0%	100.0%	198.99	0.00	0.01
biogenic [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			106.33		0.00	51.0%	51.0%	30.0%	54.22	0.00	0.00
plastics and other non-biogenic waste [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			390.26		0.04	51.0%	51.0%	30.0%	198.99	0.00	0.01



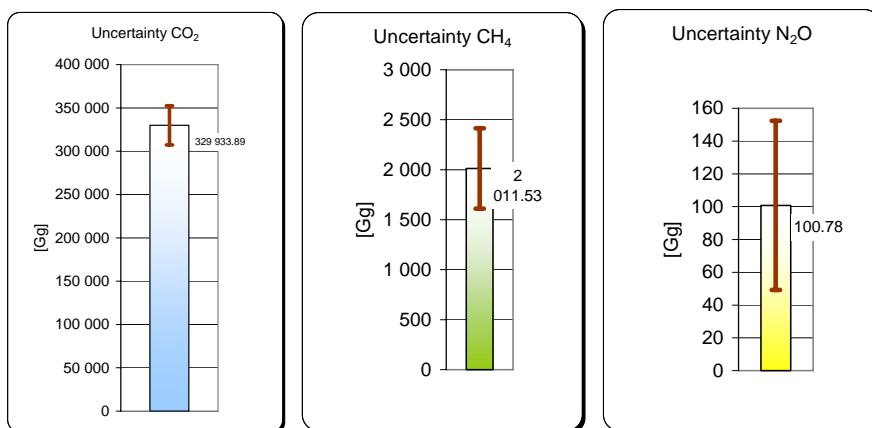
Results of uncertainty analysis in percents for CO₂ with sectoral split.



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.