NATIONAL ADMINISTRATION OF THE EMISSIONS TRADING SCHEME
NATIONAL EMISSION CENTRE

Poland's
National Inventory Report 1992

Submission under

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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 1992. The inventory covers the following GHGs: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The following GHG precursors are also reported: carbon monoxide - CO, nitrogen oxides ($NO + NO_2$) - NO_X, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO_2.

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 1992. Totals in tables may not sum due to independent rounding.

Total national GHG emissions

The GHG emissions in base year (1988/1995) and 1992, expressed as CO_2 equivalents, are presented in table ES.1 In 1992 the total national emission of GHG were about 457.30 million tones of CO_2-eq., excluding GHG emissions and sinks from category 5. (Land use change and forestry). Compared to the base year (1988/1995), the 1992 emissions have decreased by 22.1%.

Table ES.1 National emissions of greenhouse gases for the years base year (1988/1995)-1992. [Gg CO_2 eq.]

Pollutant	Base year	1992	(1992-base)/base
	Emission in CO_2 eq. [Gg]	Emission in CO_2 eq. [Gg]	
CO_2 – net emission (with LUCF)	461 951.16	345 793.91	-0.25
CO_2 – without LUCF.	494 885.88	381 944.79	-0.23
CH_4	49 256.41	43 524.24	-0.12
N_2O	42 478.82	31 832.39	-0.25
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	457 301.42	-0.22
TOTAL with LUCF	553 976.16	421 150.54	-0.24

* 1995 is the base year for HFCs, PFCs and SF_6

Carbon dioxide emissions

The CO_2 emissions in 1992 were estimated as 381.94 million tones. This is 22.8% lower than in the base year. CO_2 emission was accounted for 83.5% of total GHG emissions in Poland in 1992. The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission by 95.68% in 1992. The shares of the main subcategories were as follows: *Energy industries* – 60.1%, *Manufacture Industries and Construction* – 9.3%, *Transport* – 6.9% and *Other Sectors* – 18.9%. *Industrial Processes* contributed to the total CO_2 emission by 4.1% in 1992. *Mineral Products* (especially *Cement*

Production) is the main emission source in this sector. The CO_2 removal in LUCF sector in 1992, was calculated to be approximately 36.2 million tones. It means that app. 8.6% of the total CO_2 emissions are offset by CO_2 uptake by forests.

Methane emissions

The CH_4 emission amounted to 2 072.58 Gg in 1992 i.e. 43.52 million tones of CO_2 equivalents. The contribution of CH_4 to the national total GHG emission was 9.5% in 1992. Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed 37.4%, 37.5% and 23.9% to the national methane emission in 1992, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (29.7% of total CH_4 emission) and Oil and Natural Gas system (7.7% of total CH_4 emission). Waste disposal sites contributed to 11.8% of the methane emission from total CH_4 emission and Wastewater Handling contributed to 12.1% of total CH_4 emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 29.0% of total CH_4 emission in 1992.

Nitrous oxide emissions

The nitrous oxide emissions in 1992 were 102.69 Gg i.e. 31.83 million tonnes of CO_2 equivalents. The emission was app. 25.1% lower than the respective figure for the base year. The contribution of N_2O to the national total GHG emission was 7.0% in 1992. The main N_2O emission sources and its shares in total N_2O emission in 1992 are as follow: *Agricultural Soils* – 52.5%, *Manure Management* – 26.4%, *Chemical Industry* – 10.1% and *Fuel Combustion* – 7.0%.

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 (CO_2), methane (CH_4) and nitrous oxide (N_2O). The GHG precursors, in turn, are: carbon monoxide - CO, nitrogen oxides ($NO + NO_2$) - NO_X, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO_2 (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. N_2O emissions from animal waste in agriculture, and CH_4 and N_2O 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-CO_2 gases are expressed in units of CO_2 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 CO_2 emission factor for the given fuel. The calculations of these CO_2 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) CO_2 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 CO_2 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 1992 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 1992 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):

- CO_2 and CH_4 from *Solid Fuel Transformation*
- CO_2 from *Coal Mining and Handling*
- some individual processes in *Oil and Natural Gas* systems

in *Industrial Processes*:

- CO_2 from *Asphalt Roofing*
- CO_2 from *Road Paving with Asphalt*
- CH_4 from *Ferroalloys Production*
- CH_4 from *Aluminium Production*

- CO_2 from *Food and Drink Production*
- CH_4 from *Sinter*
- some minor gaps in estimation of the emissions of HFCs, PFCs, SF_6

in *Agriculture*

- CH_4 from *Agriculture Soils*

in *LULUCF*

- N_2O from *Forest and Grassland Conversion*
- CO_2 from *Decay*

in *Waste*

- N_2O from *Industrial Wastewater*
- N_2O from *Domestic and Commercial Wastewater except Humane Sewage*
- CH_4 from *Waste Incineration.*

2. Greenhouse gas emissions and removals in 1992

2.1 GHG aggregated emissions

For carbon dioxide, net emission is calculated by subtracting from the total CO_2 emission and removals from category 5. (Land Use Change and Forestry - LUCF). According to IPCC methodology, CO_2 emissions are given with and without contributions from category 5. Also following IPCC, emission of CO_2 from biomass, is not included in the national total.

For non-CO_2 gases, the inventory results can also be presented (table 2.1) in units of CO_2 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 83.5% share (in 1992), while the methane contributes with 9.5% to the national total. Nitrous oxide contribution is 7.0%.

Table 2.1 Greenhouse gas emissions in 1992 in CO_2 eq.

Pollutant	1992	
	Emission in CO_2 eq. [Gg]	Share [%]
CO_2 – net emission (with LUCF)	345 793.91	
CO_2 – without LUCF.	381 944.79	83.52
CH_4	43 524.24	9.52
N_2O	31 832.39	6.96
HFCs	NE	NE
PFCs	NE	NE
SF_6	NE	NE
TOTAL without CO_2 from LUCF	457 301.42	100.0
TOTAL with LUCF	421 150.54	

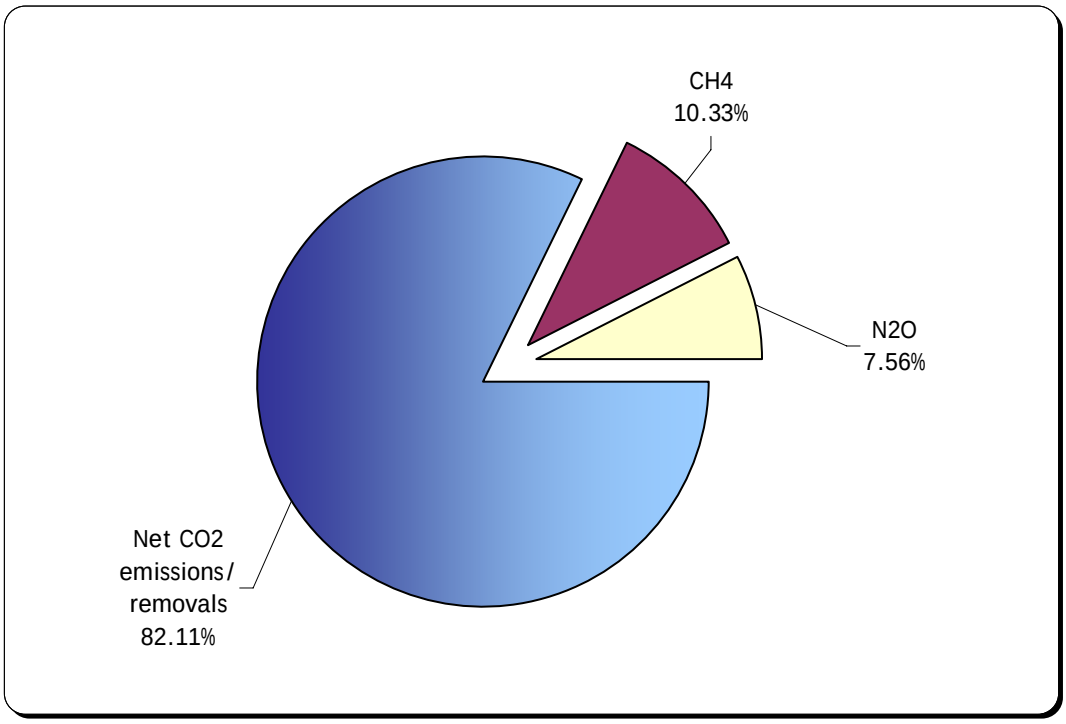


Figure 2.1 Percentage share of greenhouse gases in national total emission total in 1992

Emissions of main GHGs in 1992, 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 CO_2, CH_4 and N_2O in 1992 [Gg]

[Gg]	CO_2	CH_4	N_2O
TOTAL without CO_2 from LUCF	381 944.79	2 072.58	102.69
1. Energy	365 494.68	789.08	7.16
A. Fuel Combustion	365 434.14	13.51	7.16
1. Energy Industries	229 447.92	3.15	3.33
2. Manufacturing Industries and Construction	35 442.08	1.51	0.58
3. Transport	26 476.89	6.65	1.33
4. Other Sectors	72 316.03	2.12	1.39
5. Other	1 751.22	0.08	0.54
B. Fugitive Emissions from Fuels	60.54	775.58	NE
1. Solid Fuels	1.08	615.82	NE
2. Oil and Natural Gas	59.46	159.76	NE
2. Industrial Processes	15 621.97	10.07	10.40
A. Mineral Products	7 937.06	NE	NE
B. Chemical Industry	2 464.16	7.51	10.40
C. Metal Production	5 220.75	2.55	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	434.57	NE	0.40
4. Agriculture	NE	777.04	81.07
A. Enteric Fermentation	NE	600.45	NE
B. Manure Management	NE	175.47	27.13
D. Agricultural Soils	NE	NE	53.88
F. Field Burning of Agricultural Residues	NE	1.12	0.06
5. Land Use, Land-Use Change and Forestry	-36 150.88	0.14	0.0010
A. Forest Land	-42 688.20	NE	NE
B. Cropland	5 592.87	NE	NE
C. Grassland	3 103.34	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	-2 158.88	0.14	0.0010
F. Other Land	NE	NE	NE
6. Waste	393.57	496.25	3.65
A. Solid Waste Disposal on Land	NE	244.78	NE
B. Wastewater Handling	NE	251.47	3.60
C. Waste Incineration	393.57	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 1992 for CO_2, CH_4 and N_2O.

Table 2.3 Percentage shares of individual source sectors in 1992 emissions

Percentage share of source sectors in biezacy emissions	Share [%]		
	CO_2 without LUCF	CH_4	N_2O
TOTAL	100.00	100.00	100.00
1. Energy	95.69	38.07	6.98
A. Fuel Combustion	95.68	0.65	6.98
1. Energy Industries	60.07	0.15	3.24
2. Manufacturing Industries and Construction	9.28	0.07	0.56
3. Transport	6.93	0.32	1.29
4. Other Sectors	18.93	0.10	1.35
5. Other	0.46	0.00	0.53
B. Fugitive Emissions from Fuels	0.02	37.42	NE
1. Solid Fuels	0.0003	29.71	NE
2. Oil and Natural Gas	0.02	7.71	NE
2. Industrial Processes	4.09	0.49	10.13
A. Mineral Products	2.08	NE	NE
B. Chemical Industry	0.65	0.36	10.13
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	0.39
4. Agriculture	NE	37.49	78.95
A. Enteric Fermentation	NE	28.97	NE
B. Manure Management	NE	8.47	26.43
D. Agricultural Soils	NE	NE	52.47
F. Field Burning of Agricultural Residues	NE	0.05	0.06
5. Land Use, Land-Use Change and Forestry	NE	0.01	0.0010
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	0.0010
F. Other Land	NE	NE	NE
6. Waste	0.10	23.94	3.55
A. Solid Waste Disposal on Land	NE	11.81	NE
B. Wastewater Handling	NE	12.13	3.51
C. Waste Incineration	0.10	NE	0.04

2.2 GHG emissions by gas

Carbon dioxide (CO_2)

In 1992, the net CO_2 emissions (with LULUCF) were estimated as 345.79 million tonnes, while when sector 5. *LUCF* is excluded the figure reaches 381.94 million tones (table 2.2). The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission by 95.68% in 1992. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 60.1%, *Manufacture Industries and Construction* – 9.3%, *Transport* – 6.9% and *Other Sectors* – 18.9%. Sector 2. *Industrial Processes* contributed to the total CO_2 emission by 4.1% in 1992. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO_2 emission/removal in LULUCF sector in 1992, was calculated to be approximately 36.2 million tones. It means that app. 8.6% of the total CO_2 emissions are offset by CO_2 uptake by forests.

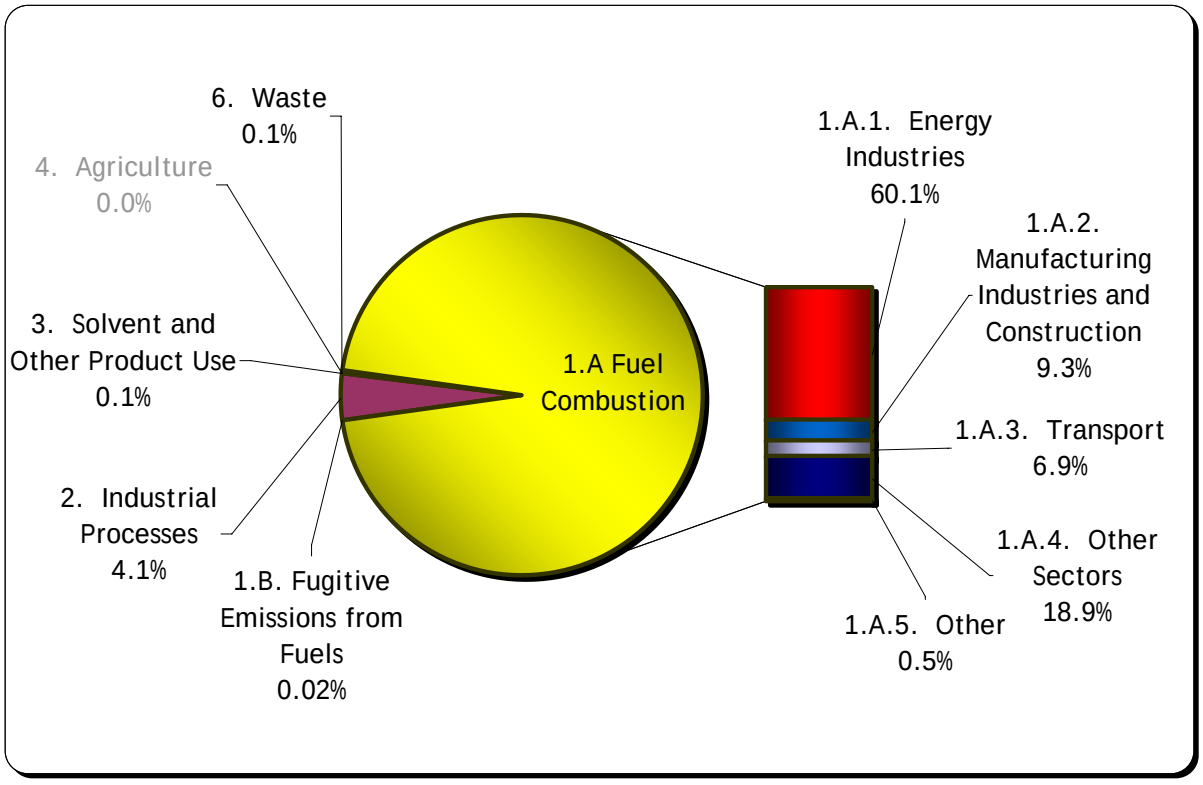


Figure 2.2 Carbon dioxide emission in 1992 by sector

Methane (CH_4)

The CH_4 emission amounted to 2 072.58 Gg in 1992 i.e. 43.52 million tones of CO_2 equivalents (table 2.2). Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed to 37.4%, 37.5% and 23.9% of the national methane emission in 1992 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 29.7% of total CH_4 emission) and *Oil and Natural Gas* system (about 7.7% of total emission), *Disposal sites* contributed to 11.81% of the methane emission and *Wastewater Handling* contributed to 12.13%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 29.0% of total methane emission in 1992.

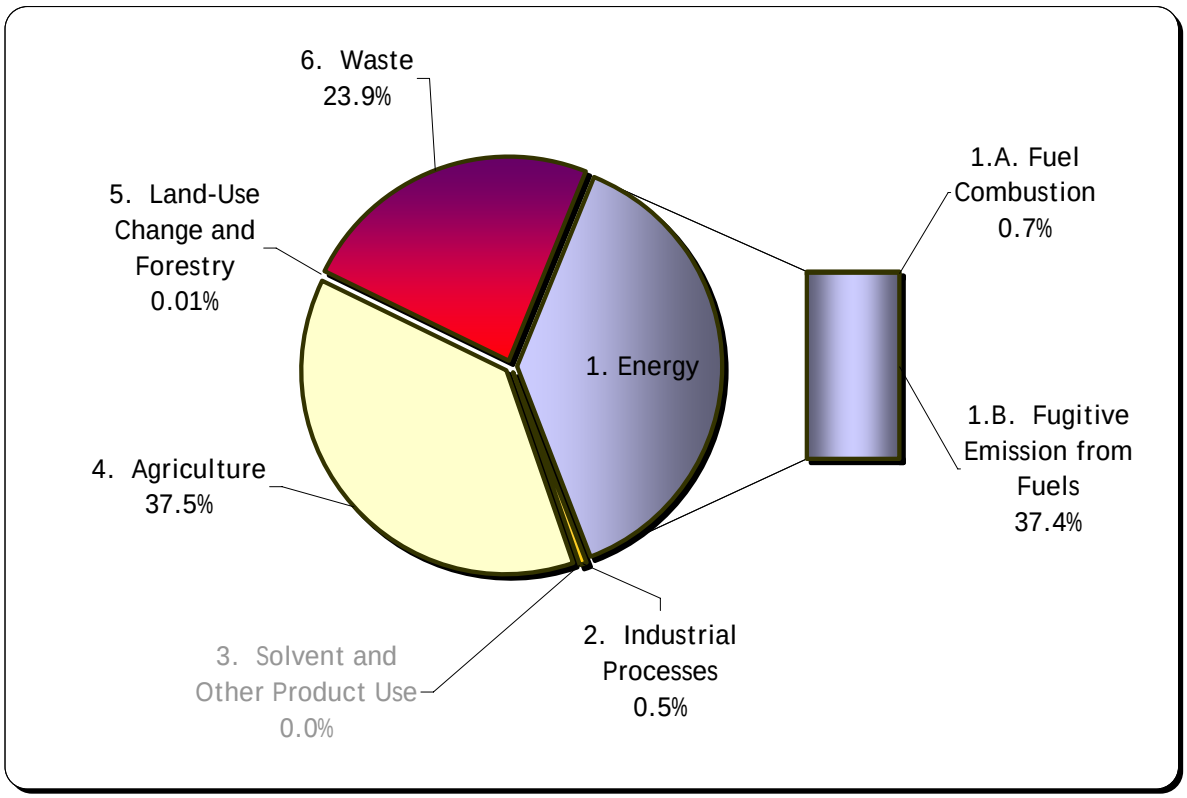


Figure 2.3 Methane emission in 1992 by sector

Nitrous oxide (N_2O)

The nitrous oxide emissions in 1992 were 102.69 Gg i.e. 31.83 million tonnes of CO_2 equivalents (table 2.2). The main N_2O emission sources and its shares in total N_2O emission in 1992 are: *Agricultural Soils* – 52.5%, *Manure Management* – 26.4%, *Chemical Industry* – 10.1% and *Fuel Combustion* – 7.0%.

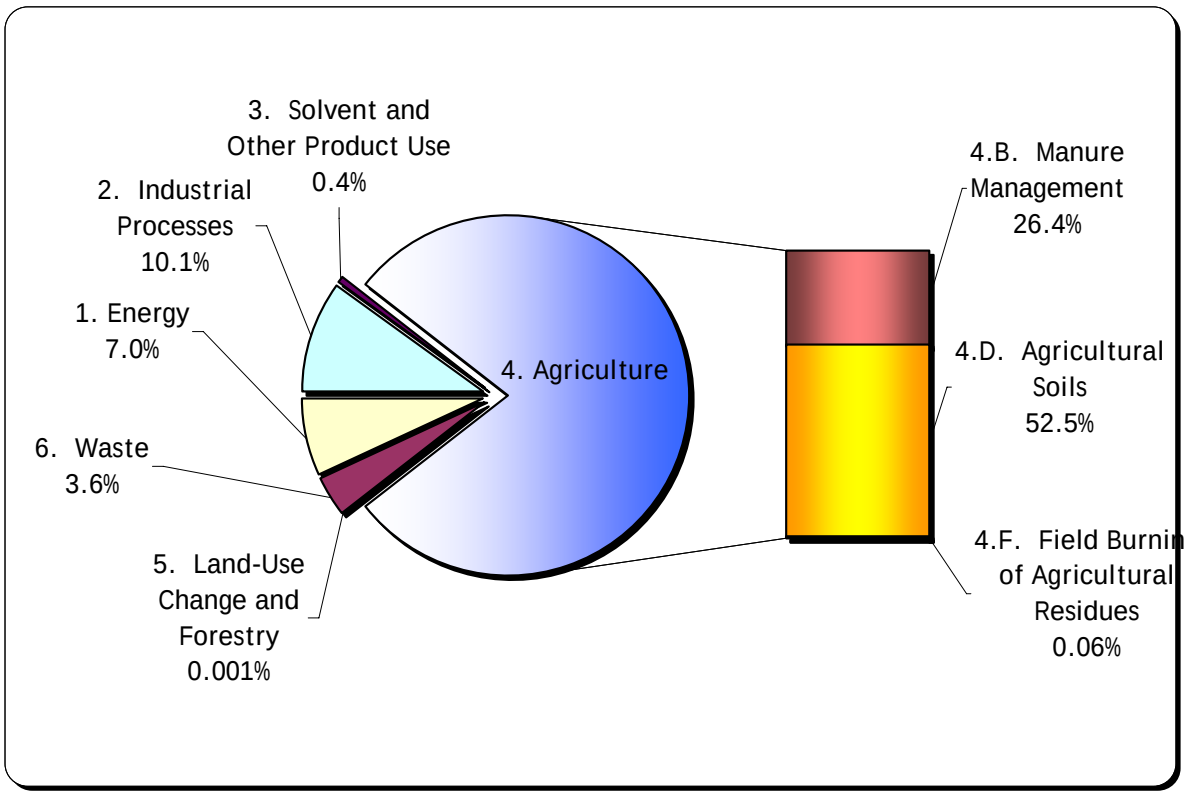


Figure 2.4 Nitrous oxide emission in 1992 by sector

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 1992

	Total [Gg eq. CO_2]		(1992-base)/base
	Base year	1992	
TOTAL with LUCF	553 976.2	421 150.54	-0.24
TOTAL without LUCF	586 902.6	457 298.10	-0.22
1. Energy	497 964.7	384 285.77	-0.23
2. Industrial Processes	27 356.2	19 058.78	-0.30
3. Solvent and Other Product Use	1 006.5	558.57	-0.45
4. Agriculture	52 378.1	41 449.40	-0.21
5. Land-Use Chpole and Forestry	-32 926.5	-36 147.57	0.10
6. Waste	8 197.2	11 945.59	0.46

2.3.1 Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 1992 was 384.3 million tons of CO_2 equivalent. CO_2 emission share exceeded 95.1% 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 1992

GHG emission categories	GHG Emission [Tg CO2-eq]	% share in the total emission from Energy	% Share in total GHG emission from a given sub-sector		
			CO_2	CH_4	N_2O
Total Energy	384 285.77	100.0	95.1	4.3	0.6
A. Fuel Combustion	367 938.08	95.7	95.1	0.1	0.6
1. Energy Industries	230 546.60	60.0	59.7	0.0	0.3
2. Manufacturing Industries and Construction	35 652.25	9.3	9.2	0.0	0.0
3. Transport	27 027.46	7.0	6.9	0.0	0.1
4. Other Sectors	72 791.03	18.9	18.8	0.0	0.1
5. Other	1 920.74	0.5	0.5	0.0	0.0
B. Fugitive Emissions from Fuels	16 347.69	4.3	0.0	4.2	0.0
1. Solid Fuels	12 933.21	3.4	0.0	3.4	0.0
2. Oil and Natural Gas	3 414.48	0.9	0.0	0.9	0.0

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

Table 2.6 shows detailed information on emissions of CO_2, CH_4 and N_2O in *Industrial Processes* sector and in *Solvent and Other Use* sector in 1992. CO_2 is dominating among GHGs – it's contribution exceeds 82.0%. 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 N_2O emissions from anaesthesia (22.2%) and CO_2 emissions (recalculated from NMVOC) (77.8%).

Table 2.6. The emissions of CO_2, CH_4 and N_2O from sub-sectors in category *Industrial Processes* and in category *Solvents and Other Product Use* in 1992

GHG emission categories	GHG Emission [Tg CO2-eq]	% share in the total emission from Industrial Processes	% Share in total GHG emission from a given sub-sector			
			CO_2	CH_4	N_2O	HFC, PFC and SF6
Total Industrial Processes	19 058.78	100.0	82.0	1.1	16.9	0.0
A. Mineral Products	7 937.06	41.6	41.6	0.0	0.0	NE
B. Chemical Industry	5 847.40	30.7	12.9	0.8	16.9	NE
C. Metal Production	5 274.32	27.7	27.4	0.3	0.0	NE
D. Other Production	NE	NE	NE	NE	NE	NE
F. Consumption of Halocarbons and SF6	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE
Total Solvent and Other Product Use	558.57	100	77.8	0.0	22.2	

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). N_2O emission share was largest in total GHG emission from *Agriculture* in 1992 and came from both – direct (mineral and organic fertilisation) and indirect (volatilisation, leaching and runoff from applied synthetic fertiliser and animal manure) N_2O emissions from soils.

Table 2.7. GHG emissions from sub-sectors in category 4.*Agriculture* in 1992

GHG emission categories	GHG Emission [Tg CO2-eq]	% share in the total emission from Agriculture	% Share in total GHG emission from a given sub sector	
			CH_4	N_2O
Total Agriculture	41 449.40	100.0	39.4	60.6
A. Enteric Fermentation	12 609.47	30.4	30.4	0.0
B. Manure Management	12 096.55	29.2	8.9	20.3
D. Agricultural Soils	16 702.01	40.3	0.0	40.3
F. Field Burning of Agricultural Residues	41.37	0.1	0.1	0.0

2.3.4 Waste (IPCC category 6)

As it can be seen in table 2.8, the emission of CH_4 dominated in this sector in 1992 (almost 87.2%). The main part of GHG emissions came from s*olid waste disposal on land* and *wastewater handling*.

Table 2.8. GHG emissions from sub-sectors in category 6.*Waste* in 1992

GHG emission categories	GHG Emission [Tg CO2-eq]	% share in the total emission from Waste	% Share in total GHG emission from a given sub-sector		
			CO_2	CH_4	N_2O
Total Waste	11 945.59	100	3.3	87.2	9.5
A. Solid Waste Disposal on Land	5 140.33	43.0	0.0	43.0	0.0
B. Wastewater Handling	6 397.85	53.6	0.0	44.2	9.4
C. Waste Incineration	407.41	3.4	3.3	0.0	0.1

2.4 Comparison to base year (1988/1995)

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

Table 2.9 Changes of greenhouse gas emissions in 1992 with respect to base year 1988/1995

Pollutant	Base year	1992	1992/base year [%]
	Emission in CO_2 eq. [Gg]	Emission in CO_2 eq. [Gg]	
CO_2 – net emission (with LUCF)	461 951.16	345 793.91	74.86
CO_2 – without LUCF.	494 885.88	381 944.79	77.18
CH_4	49 256.41	43 524.24	88.36
N_2O	42 478.82	31 832.39	74.94
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	457 301.42	77.92
TOTAL with LUCF	553 976.16	421 150.54	76.02

* for industrial gases: HFC, PFC and SF_6 the base year is 1995

Carbon dioxide
CO_2 emission had decreased by app. 22.8% from the base year to 1992.
The following changes took place in the structure of fuel use:

- share in of solid fuels decreased from 85.3% in 1988 to 83.8% in 1992
- share of liquid fuels increased from 11.4% (1988) to 12.6% (1992)
- share of gaseous fuels increased from 3.3% (1988) to 3.6% (1992).

Methane
CH_4 emission had decreased by app. 11.6% from the base year to 1992. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 21.0%,
- the decrease in *Fugitive Emission* by 28.3%,
- the increase in emission from *Waste* by 61.5%.

Nitrous oxide
The nitrous oxide emissions in 1992 were app. 25.1% lower than the respective figure for the base year. The share in *Manure Management* increased from 22.0% in 1988 to 26.4% in 1992, in *Agricultural Soils* decreased from 55.6% (1988) to 52.5% (1992) and in *Chemical Industry* decreased from 11.8% in 1988 to 10.1% in 1992.

Emissions of greenhouse gases in base year (1988/1995) in CO_2 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 CO_2 in 1992 decreased from 84.3% to 83.5%.

Table 2.10 Emissions of greenhouse gases in base year (1988/1995) in CO_2 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_2O	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	

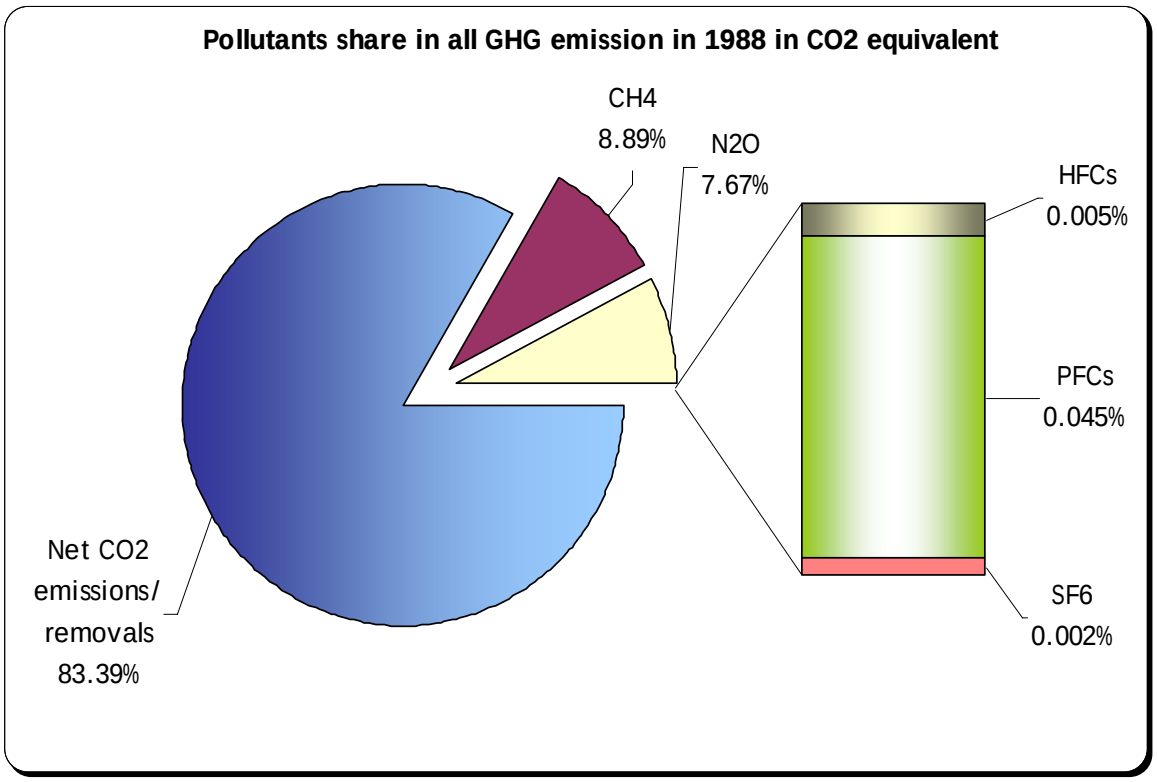


Figure 2.5 Percentage share of national greenhouse gas emissions in base year (1988/1995) including emission from sector 5.

2.5 Comparison of greenhouse gas emissions 1992 and 1991

Changes of national emissions and sinks of GHGs in 1992 compared to 1991 were:

CO_2	- net emission fall to	96.91%
CH_4	- emission fall to	93.55%
N_2O	- emission fall to	93.89%

Below results are discussed separately for each greenhouse gas with respect to 1992 emissions and change between 1992 and 1991.

Carbon dioxide (CO_2)

In 1992, the net CO_2 emissions (with LULUCF) was 3.1% lower than in 1991. The CO_2 emission in 1992 from category *Energy* was lower by 2.1% and from category *Industrial Processes* was higher by 2.3% than in 1991. In comparison to 1991 the CO_2 emission from category *Waste* in 1992 fall by 4.8%.

Table 2.11. Comparison of carbon dioxide emission in 1991 and 1992

Year	CO_2 [Gg]		1992/1991 [%]
	1991	1992	
TOTAL without LUCF	389 359.1	381 944.8	98.1
1. Energy	373 193.1	365 494.7	97.9
A. Fuel Combustion	373 142.9	365 434.1	97.9
1. Energy Industries	241 715.5	229 447.9	94.9
2. Manufacturing Industries and Construction	36 851.4	35 442.1	96.2
3. Transport	27 032.0	26 476.9	97.9
4. Other Sectors	65 125.8	72 316.0	111.0
5. Other	2 418.2	1 751.2	72.4
B. Fugitive Emissions from Fuels	50.2	60.5	120.6
1. Solid Fuels	1.4	1.1	77.2
2. Oil and Natural Gas	48.8	59.5	121.8
2. Industrial Processes	15 268.3	15 622.0	102.3
A. Mineral Products	7 734.4	7 937.1	102.6
B. Chemical Industry	2 652.7	2 464.2	92.9
C. Metal Production	4 881.2	5 220.7	107.0
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	484.2	434.6	89.7
4. Agriculture	NE	NE	NE
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	NE	NE	NE
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	NE	NE	NE
5. Land Use, Land-Use Change and Forestry	-32 534.2	-36 150.9	111.1
A. Forest Land	-39 328.3	-42 688.2	108.5
B. Cropland	6 479.8	5 592.9	86.3
C. Grassland	3 595.5	3 103.3	86.3
D. Wetlands	NE	NE	NE
E. Settlements	-3 281.3	-2 158.9	65.8
F. Other Land	NE	NE	NE
6. Waste	413.5	393.6	95.2
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	NE	NE	NE
C. Waste Incineration	413.5	393.6	95.2

Methane (CH_4)

The emission in 1992 was lower than in 1991 by 6.5%. The main sources are *Agriculture*, *Energy* and *Waste.* Emission from *Manure Management* in the *Agriculture* sector was lower by 0.03% in 1992 and from *Waste* sector was lower by 5.7% than in 1991. *Fugitive emission* in *Energy* sector was lower by 6.2% in 1992 compared to 1991.

Table 2.12 Comparison of methane emission in 1991 and 1992

Year	CH_4 [Gg]		1992/1991 [%]
	1991	1992	
TOTAL	2 215.54	2 072.58	93.5
1. Energy	840.47	789.08	93.9
A. Fuel Combustion	13.64	13.51	99.0
1. Energy Industries	3.21	3.15	98.0
2. Manufacturing Industries and Construction	1.51	1.51	100.0
3. Transport	6.90	6.65	96.4
4. Other Sectors	1.80	2.12	117.5
5. Other	0.22	0.08	37.7
B. Fugitive Emissions from Fuels	826.83	775.58	93.8
1. Solid Fuels	664.08	615.82	92.7
2. Oil and Natural Gas	162.74	159.76	98.2
2. Industrial Processes	10.48	10.07	96.1
A. Mineral Products	NE	NE	NE
B. Chemical Industry	7.82	7.51	96.1
C. Metal Production	2.66	2.55	95.9
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	NE	NE	NE
4. Agriculture	838.21	777.04	92.7
A. Enteric Fermentation	661.33	600.45	90.8
B. Manure Management	175.52	175.47	99.97
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	1.36	1.12	83.0
5. Land Use, Land-Use Change and Forestry	0.10	0.14	147.6
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.10	0.14	147.6
F. Other Land	NE	NE	NE
6. Waste	526.29	496.25	94.3
A. Solid Waste Disposal on Land	236.95	244.78	103.3
B. Wastewater Handling	289.34	251.47	86.9
C. Waste Incineration	NE	NE	NE

Nitrous oxide (N_2O)

The emission was lower than in 1991 (by 6.1%). The main sources of N_2O emission are *Manure Management* and *Agricultural Soils*. Emission from *Manure Management* in the *Agriculture* sector was lower by 5.1% in 1992 and from *Agricultural Soils* was lower by 8.0% than in 1991.

Table 2.13. Comparison of nitrous oxide emission in 1991 and 1992

Year	N_2O [Gg]		1992/1991 [%]
	1991	1992	
TOTAL	109.36	102.69	93.9
1. Energy	7.51	7.16	95.4
A. Fuel Combustion	7.51	7.16	95.4
1. Energy Industries	3.50	3.33	95.2
2. Manufacturing Industries and Construction	0.62	0.58	92.2
3. Transport	1.44	1.33	92.3
4. Other Sectors	1.20	1.39	115.3
5. Other	0.74	0.54	72.7
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	10.57	10.40	98.4
A. Mineral Products	NE	NE	NE
B. Chemical Industry	10.57	10.40	98.4
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	87.23	81.07	92.9
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	28.58	27.13	94.9
D. Agricultural Soils	58.58	53.88	92.0
F. Field Burning of Agricultural Residues	0.07	0.06	85.9
5. Land Use, Land-Use Change and Forestry	0.0007	0.0010	147.6
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.0007	0.0010	147.6
F. Other Land	NE	NE	NE
6. Waste	3.65	3.65	99.9
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	3.60	3.60	100.0
C. Waste Incineration	0.05	0.04	95.0

2.6 Emission trends for indirect greenhouse gases (CO, NO_x and NMVOC) and SO_2

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 SO_2 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 SO_2, NO_x, NMVOC (1980-2005) and CO (1990-2005). Emissions of SO_2 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 SO_2. 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 SO_2 and NO_x.

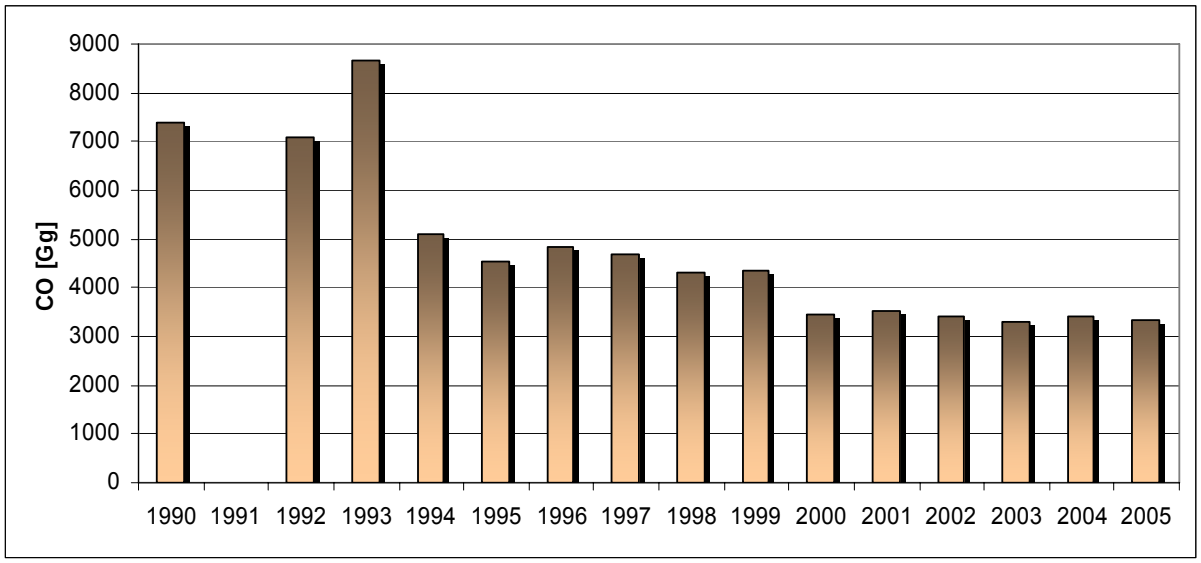


Figure 2.6 Emissions of CO (1990-2005).

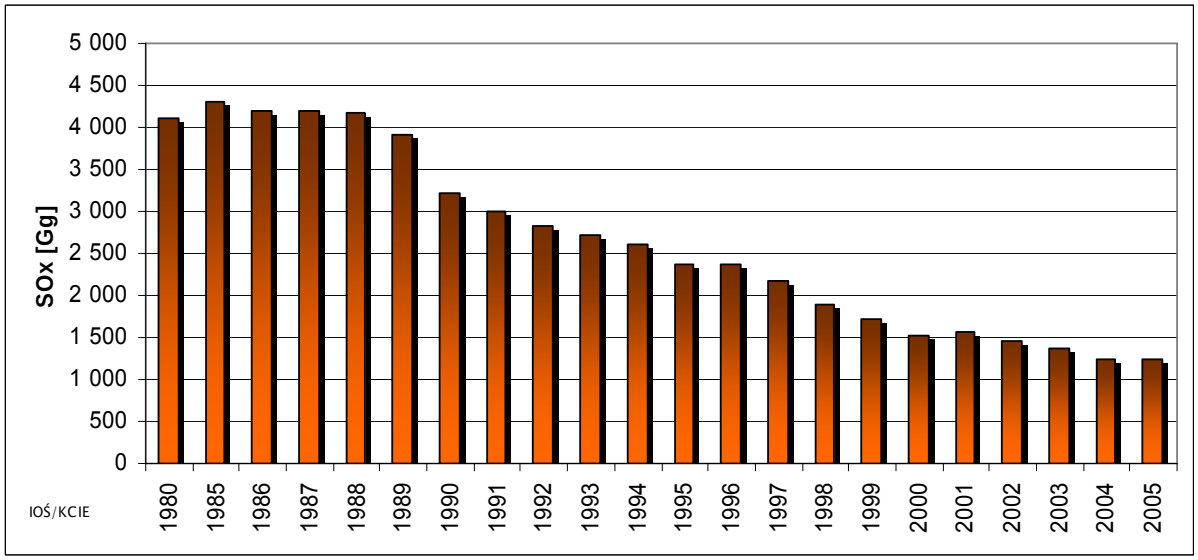


Figure 2.7 Emissions of SO_x, (1980-2005).

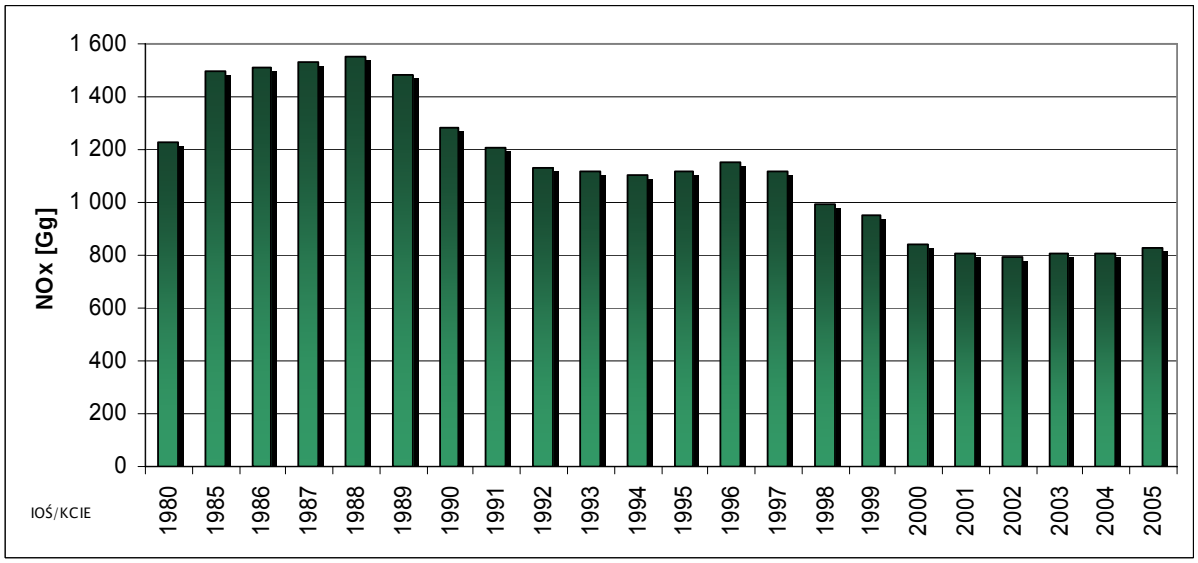


Figure 2.8 Emissions of NO_x (1980-2005).

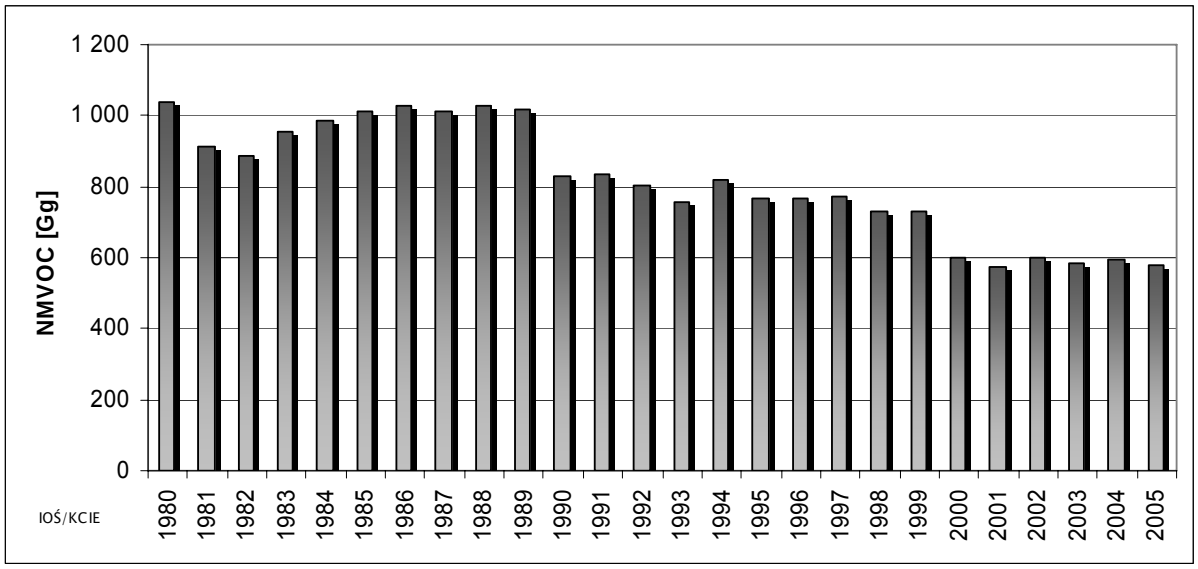


Figure 2.9 Emissions of NMVOC (1980-2005).

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 (CO_2 emission), share in total GHG emission 73.8%
- 1.A.3.b Transport Road Transportation (CO2 emission), share in total GHG emissior 4.7%
- 1.B.1.a. Coal Mining and Handling (CH4 emission), share in total GHG emission 2.8%
- 1.B.2.b. Natural Gas (CH4 emission), share in total GHG emission 0.7%

Share of these categories in total Poland's GHG emissions is 82.1%.

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 CO_2. 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:

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

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):

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

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:

$$C_c\ [kg\ C/GJ] = 53.139 - 0.811*\ NCV$$

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):

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

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:

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

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:

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

where: C_{hmng} emission factor for high-methane natural gas [kg C/GJ],
NCV- net calorific value of fuel oil [MJ/m^3],

the emission factor for nitrified natural gas:

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

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

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

where: C_{cg} emission factor for city gas [kg C/GJ],
NCV- net calorific value of city gas [MJ/m^3].

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

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

where: C_{bfg} emission factor for blast furnace gas [kg C/GJ]
NCV- net calorific value of blast furnace gas [MJ/m^3].

Calculation of the CO_2 emission factor, when the Cmax [kg C/GJ] is already known is done with the following formula:

$$EF_{abc} = C_{max} * 44/12 * FO_{abc}\ [kgCO_2/GJ]$$

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

CO_2 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 CH_4 and N_2O 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 (PKD[1] 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 CO_2, CH_4 and N_2O

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 1994a]
- 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 CO_2 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_2O
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_2O
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_2O
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_2O
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]. CO_2 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 1994],
- unpublished data from Agency of Energy Market

Table 3.5 Emission factors [kg/GJ] for transport in 1992

Type of transport	Vehicle specification	EF CO_2	EF CH_4	EF N_2O
1.A.3.a.ii Civil Aviation. Domestic	1.i.PL.	70.33	0.0005	0.0022
1.A.3.a.i i International Aviation - bunker	1.i.PL.	70.33	0.0005	0.0022
1.A.5.b. Other Aviation	1.ii.BL.	72.10	0.060	0.0009
	1.ii.PL.	72.80	0.002	0.0002
1.A.3.b.i Passenger Cars without catalysts	2.i.a.BS	72.82	0.030	0.002
	2.i.a.LG	64.83	0.020	0.0002
	2.i.a.ON	73.82	0.002	0.004
	2.i.b.BS	72.82	0.020	0.001
1.A.3.b. Passenger Cars with catalysts	2.i.g.BS	72.82	0.007	0.0200
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	2.ii.a.BS	72.82	0.020	0.001
	2.ii.a.ON	73.82	0.001	0.0040
	2.ii.b.BS	72.82	0.020	0.001
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	2.ii.g.BS	72.82	0.020	0.001
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	2.iii.a.BS	72.82	0.020	0.001
	2.iii.a.ON	73.82	0.006	0.003
	2.iii.b.ON	73.82	0.006	0.003
1.A.3.b.iv Motorcycles	2.iv.BS	72.82	0.100	0.001
1.A.3.b.iv Mopeds	2.iv.BS	72.82	0.100	0.001
1.A.3.b.vi Tractors	2.vi.ON	73.82	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 1992 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 1992 [GUS 1994a] 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 CO_2 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 CO_2 emissions is 0.27% in favour of reference approach [Radwański 2006a]. More data on energy consumption and CO_2 emissions for both approaches are given in annex 6, in CRF table 1.A(c).

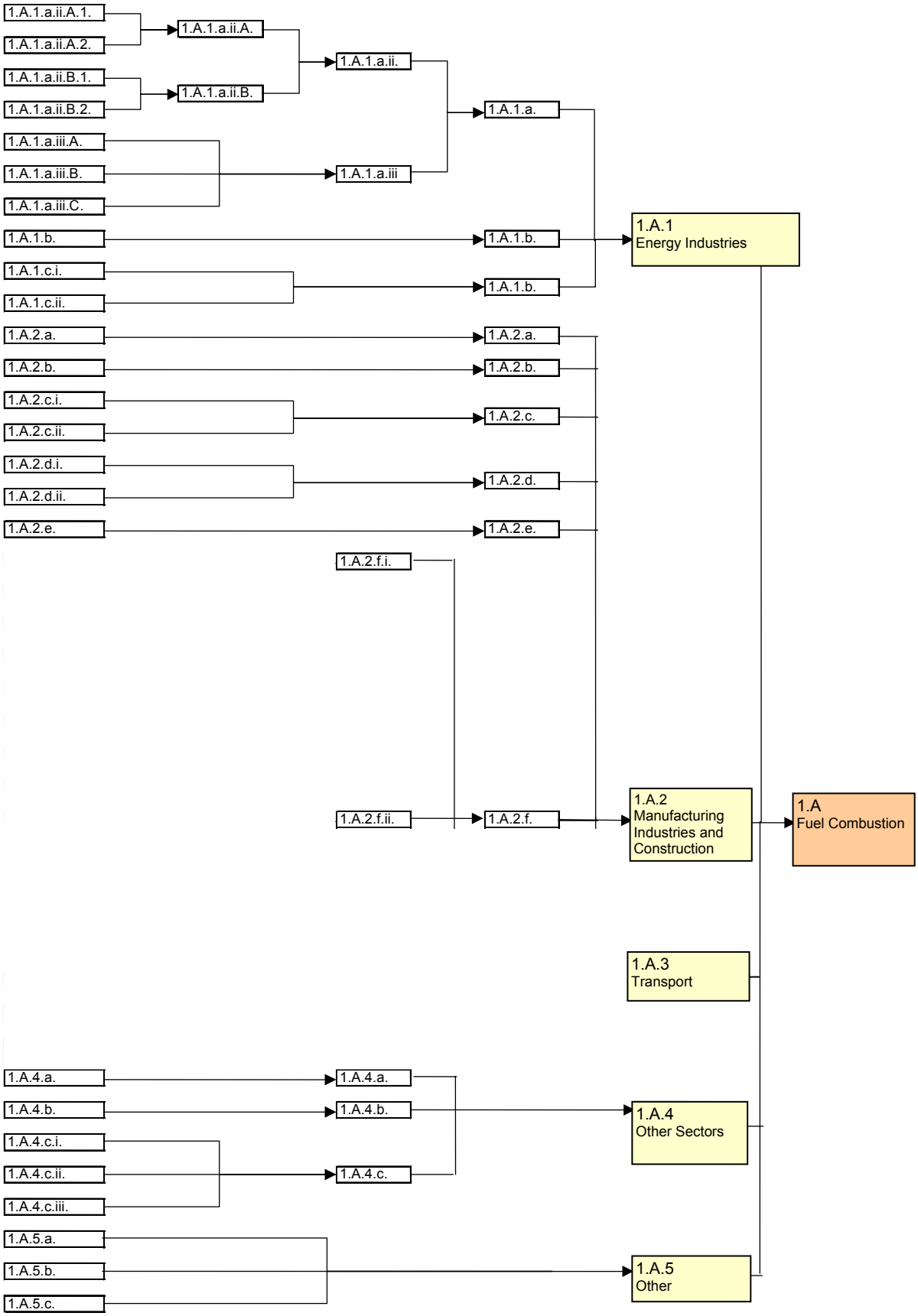


Figure 3.1. Flowchart of summing up sub-sectors in sector 1.A - Fuel Combustion

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	Nm3 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 1992 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 1992. 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 1992

Coal mining	Methane capture	Methane use	Emission from de-methane systems		
mln Mg	mln m^3	mln m^3	mln m^3	mln Nm^3	Gg CH_4
132.7	232.9	175.3	57.6	55.70	37.32

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

Fugitive emission of CH_4 from surface mining was estimated based on the activity data concerning lignite extraction amount from the study published by Polish Geological Institute [PIG, 1993] 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 m^3 CH_4 / t of extracted coal
- Ventilation emission from surrounding rocks - 0.012 m^3 CH_4 / t of extracted coal.

The conversion factor applied for recalculation of emitted methane volume upto mass of CH_4 is 0.67 kg/m^3.

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 1994a].

Table. 3.8. Emission factors for CO_2 and CH_4 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 1994a]:

production	PJ	8.322
distribution	Gg	12969

CO_2 and CH_4 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 CO_2 and CH_4 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 CO_2 and CH_4 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 1994a] 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]	47.616
Gas processing	Gas use [PJ]	288.678
Gas transmission	Gas use [PJ]	288.678
Underground gas storage	Gas use [PJ]	288.678
Gas distribution	Gas use [PJ]	288.678
Nitrified natural gas system:		
Gas production	Gas production [PJ]	60.64
Gas processing	Gas use [PJ]	40.923
Gas transmission	Gas use [PJ]	40.923
Gas distribution	Gas use [PJ]	40.923

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 CO_2 and CH_4 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 CO_2 and CH_4 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)
CO_2 emission from cement production was estimated based on data on clinker production from [GUS 1994b]. 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 CO_2 from lime production was calculated based on data on lime production from [GUS 1994b]. 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 CO_2 from this process was assumed as 0. CO_2 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 CO_2/ 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)
CO_2 and CH_4 emissions for ammonia production are estimated based on the data on gas and liquid ammonia production from [Radwański 2005]. The CO_2 emission factor (1.5 Mg CO_2/Mg NH_3 was taken from [IPCC 1997]. Methane emission factor is 4.9 kg CH_4 /Mg NH_3 produced was taken from [CITEPA 1992]. Emission N_2O was estimated as 0, according to the study [Kozłowski 2001].

4.2.2.2. *Nitric Acid Producti*on (CRF 2.B.2)
Estimation of N_2O emission from nitric acid production was based on the annual HNO_3 production data from [GUS 1994b]. 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. CO_2 emission factor for this category, which is equal 0.300 Mg CO_2/ 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 1994b]. CO_2 emission factor for this category, which is equal 1.100 Mg CO_2/ Mg carbide, was taken from [IPCC 1997].

4.2.2.5. *Other* (CRF 2.B.5)
- *Carbon Black Production*
CH_4 emission from production of black carbon was estimated based on annual black carbon production from [GUS 1994b]. The emission factor, which is equal 10 kg CH_4 /Mg black carbon, was taken from [CITEPA 1992].

- *Ethylene Production*
Emission of CO_2 from ethylene production was calculated based on ethylene annual production from [GUS 1994b]. Emission factor was taken from [CITEPA 1992]. Its value is 0.3 kg CO_2 / Mg ethylene produced.

- *Caprolactam Production*
Data on annual caprolactam production for inventory calculation purpose was taken from [GUS 1994b]. Applied country specific emission factor of N_2O, which value is 4.74 kg N_2O / 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 CO_2, which is equal 71.76 kg CO_2 / 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 CO_2 emission calculation was taken from [GUS 1994b]. Country specific emission factor applied for CO_2 emission estimation is from [FEWE 1994]. Its value is 62 kg CO_2 / Mg steel cast produced.

4.2.3.1.3. *Iron Cast Production* (2.C.1.d)
Annual iron cast production for CO_2 emission estimation was taken from [GUS 1994b]. Country specific emission factor applied for CO_2 emission calculation is from [FEWE 1994]. Its value is 61 kg CO_2 / Mg iron cast produced. Applied CH_4 emission factor is 0.20 kg CH_4 / 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 CO_2 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 1994b]. Country specific CO_2 emission factor used for inventory report, which value is 11.26 kg CO_2 / 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 1994b]. Applied CO_2 country specific emission factor is equal 4.30 kg CO_2 / Mg steel produced and it was calculated in [FEWE 1994] based on composition of gases from electric furnaces in Polish plants. CH_4 emission factor, which value is 0.12 kg CO_2 / 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 CO_2 from coking plants was estimated based on elementary carbon budget in coking plants process. CH_4 emission was estimated based on coke production volume from [GUS 1994b] and emission factor is 0.2 kg CH_4 / Mg coke produced [EEA 1996].

4.2.3.2. *Ferroalloys production* (CRF 2.C.2)
Emission of CO_2 concerning ferroalloys production was estimated based on annual ferrosilicon production taken from [GUS 1994b]. Applied emission factor, which value is 3900 kg CO_2 / Mg ferrosilicon, was taken from [IPCC 1997] for ferrosilicon – 75% Si.

4.2.3.3. *Aluminium Production* (CRF 2.C.3)
Calculation of CO_2 emission from primary aluminium production is based on the data on aluminium production published in [GUS 1994b]. The emission factor, which is equal 1.8 Mg CO_2 / 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 CO_2 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)

CO_2 emission factor was determined assuming, that carbon content in NMVOC is 85%. Then carbon content has been calculated in a stoichiometric way to CO_2. Calculations were made in accordance with formula:

$$CO_2 = 0.85 * 44/12 * NMVOC$$

where:
CO_2 – carbon dioxide emission from particular subsectors,
NMVOC – NMVOC emission from particular subsectors.

N_2O 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 (CH4 emission), share in total GHG emission 2.8%
- 4.B. Manure Management (CH4 emission), share in total GHG emission 0.8%
- 4.B. Manure Management (N2O emission), share in total GHG emission 1.8%
- 4.D.1. Direct Soil Emissions (N2O emission), share in total GHG emission 2.8%

Share of these categories in total Poland's GHG emissions is 8.2%.

6.2 Methodological issues

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

The emission factors for estimation of CH_4 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 CH_4 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].

CH_4 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 1994]. 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 CH_4 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 CH_4 emissions factors in 1992

Livestock	Population [millions]	GE Gross Energy Intake [MJ/animal/day]	EF Emission Factor [kg CH_4 / animal / year]
4.A Enteric Fermentation	33.256	---	---
1 Cattle	8.221	---	---
a. Dairy cattle	4.257	226.833	89.266
b Non-dairy cattle	3.964	99.3197	39.085
3 Sheep	1.870	18.479	8.175
4 Goats	0.179	---	5.000
6 Horses	0.900	---	18.000
8 Swine	22.086	---	1.500

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

The IPCC *Tier 2* methodology was used to establish domestic CH_4 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 1994]. 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 CH_4 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	236.629	---	---
1 Cattle	8.221	---	---
a. Dairy cattle	4.257	4.592	5.286
b Non-dairy cattle	3.964	1.644	1.977
3 Sheep	1.870	0.369	0.171
4 Goats	0.179	0.280	0.120
6 Horses	0.900	1.720	1.390
8 Swine	22.086	0.500	5.781
9 Poultry	203.373	0.100	0.078

The factors recommended for cool climate were used. The country specific CH_4 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),
- B_o (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 N_2O emission calculation from manure management was taken from [GUS 1994]. 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	0.0253	0.7767	0.1980
Non-dairy cattle	0.0498	0.7882	0.1620
Sheep	---	0.5000	0.50
Goats	---	0.9000	0.10
Horses	---	0.9000	0.10
Swine	0.2501	0.7499	---
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 N_2O 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 Nex [kg/animal/year]	AWMS [% / 100]	Nitrogen excreted in AWMS [kg N / year / 1000]
1.a. Dairy cattle	70.0	0.0253	7539.147
1.b. Non-dairy cattle	50.0	0.0498	9870.360
3 Sheep	16.0	--	0.000
4 Goats	25.0	--	0.000
6 Horses	25.0	--	0.000
8 Swine	20.0	0.2501	110495.097
9 Poultry	0.6	0.2000	24404.718

b) solid storage and drylot

Livestock	Nitrogen excreted in manure Nex [kg/animal/year]	AWMS [% / 100]	Nitrogen excreted in AWMS [kg N / year / 1000]
1.a. Dairy cattle	70.0	0.7767	231448.833
1.b. Non-dairy cattle	50.0	0.7882	156221.240
3 Sheep	16.0	0.5000	14960.000
4 Goats	25.0	0.9000	4034.610
6 Horses	25.0	0.9000	20250.000
8 Swine	20.0	0.7499	331224.903
9 Poultry	0.6	0.8000	97618.870

Table 6.5. Factors of N_2O–N emission for various manure management systems

Animal Waste Management Systems	EF Emission Factor [kg N2O-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. *N_2O from synthetic fertilisers* (CRF 4.D.1.1)

N_2O emission from synthetic fertilisers was estimated based on the amount of synthetic fertiliser nitrogen applied to agricultural fields published in [GUS 1994]. The nitrogen fraction converted to N_2O 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 N_2O-N / kg N applied) taken from [Mercik 2001] was corrected for 0.009 kg N_2O-N / kg N as the previous one included the fraction of nitrogen that is emitted as $NO_x + NH_3$.

6.2.4.1.2. *N_2O 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 1994] 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.

N_2O 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 NH_3 (0.2 kg NH_3-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. *N_2O from N-fixing crops* (CRF 4.D.1.3)

N_2O emission from N-fixing crops was calculated based on the data on sown area of N-fixing crops, published in [GUS 1994]. According to study [Mercik 2001] 1% of nitrogen fixed by papilionaceous plants is denitrificated to N_2O and in this connection the used emission factor value is 0,010 N_2O-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 N_2O 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. *N_2O from crop residue* (CRF 4.D.1.4)

Emission of N_2O 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 N_2O-N/ kg N contained in residues. Data on sown area of other than N-fixing crops are published in [GUS 1994].

6.2.4.1.5. *N_2O 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. N_2O emission from cultivation of histosols was estimated based on default emission factor for Mid-Latitude Organic Soils from [IPCC 2000]: 8 kg N_2O-N /ha.

6.2.4.2. *N_2O from pasture, range and paddock manure* (CRF 4.D.2)

Animal population for calculation of N_2O emission from pasture range and paddock was taken from [GUS 1994]. 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]. N_2O 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 N_2O–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 N2O-N/ kg N]
1.a. Dairy cattle	70.0	0.20	59002.020	
1.b. Non-dairy cattle	50.0	0.16	32108.400	
3 Sheep	16.0	0.50	14960.000	
4 Goats	25.0	0.10	448.290	
6 Horses	25.0	0.10	2250.000	
8 Swine	--	--	--	
9 Poultry	--	--	--	
		total	108768.710	0.020

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

The *Tier 1a* method was used for assessing indirect emissions of N_2O for 1992 in Poland. The basic equation for estimating a country's indirect N_2O emissions:

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

where:
$N_2O_{indirect} \rightarrow N$ – emissions of N_2O in units of nitrogen,
$N_2O_{(G)} \rightarrow N$ – N_2O produced from volatilisation of applied synthetic fertiliser and animal manure N, and its subsequent atmospheric deposition as nitrogen compounds (kg N/year),
$N_2O_{(L)} \rightarrow N$ –N_2O produced form 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 N_2O 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:

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

where:
$N_2O_{(G)} \rightarrow N$ – N_2O 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 1994],
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 N_2O emissions from atmospheric deposition of N on soils and water surfaces, default value.

Table 6.7. Estimation of indirect emissions of N_20–N from atmospheric deposition

N_{fert} [Gg/year]	$Frac_{GASF}$ [kg N/kgN]	N_{ex} [kgN/year/1000]	$Frac_{GASM}$ [kg N/kg N]	EF [kgN_2O-N/kg N]	$N_2O_{(G)}\rightarrow N$ [GgN_2O-N]
619	0.1	108 768.71	0.2	0.01	0.84

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, an d gets to the groundwater, rivers and wetlands. It results in biogenic production of N_2O. 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:

$$N_2O_{(L)}\rightarrow N = (N_{FERT} + Nex/1000) * Frac_{LEACH} * EF,$$

where:
$N_2O_{(L)}\rightarrow N$ – N_2O produced form 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 1994],
Nex – 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 N_2O emissions for leaching/runoff, default value.

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

Table 6.8. Estimation of indirect emissions of N_20–N from nitrogen leaching and run-off

N_{fert} [Gg/year]	N_{ex} [kgN/year /1000]	$Frac_{LEACH}$ [kg N/kg N]	EF [kgN_2O-N/kg N]	$N_2O_{(L)}\rightarrow N$ [GgN_2O-N]
619	108768.71	0.3	0.025	5.458

The following equation is a conversion of $N_2O\rightarrow N$ emissions to N_2O emissions:

$$N_2O = N_2O\rightarrow N * 44/28$$

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

CH_4 and N_2O 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 *at al* 1994] which residues could be burned on fields. Activity data concerning crop production was taken from [GUS 1994]. 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 CH_4 and N_2O 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_2O
							[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 1992 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 easy inferred.

The inventory results for 1992 (and comparing to 1991) for LULUCF sector are presented in the following tables according to new [IPCC 2003] and previous [IPCC 1997] methodologies.

Table 7.1. Total CO_2 emissions and removals from Land Use Change and Forestry in 1991 and 1992 [IPCC 2003]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1991			1992		
	Net CO_2 emissions/ removals	CH_4	N_2O	Net CO_2 emissions/ removals	CH_4	N_2O
	(Gg)			(Gg)		
5. Total Land-Use Categories	-32 534.24	0.097	0.001	-36 150.88	0.143	0.001
5A. Forest Land	-39 328.32			-42 688.20		
1. Forest Land remaining Forest Land	IE			IE		
2. Land converted to Forest Land	IE			IE		
5B. Cropland	6 479.84			5 592.87		
1. Cropland remaining Cropland	IE			IE		
2. Land converted to Cropland	IE			IE		
5C. Grassland	3 595.49			3 103.34		
1. Grassland remaining Grassland	IE			IE		
2. Land converted to Grassland	IE			IE		
5D. Wetlands	IE			IE		
1. Wetlands remaining Wetlands	IE			IE		
2. Land converted to Wetlands	IE			IE		
5E. Settlements	-3 281.25	0.097	0.001	-2 158.88	0.143	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 *(please specify)*	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 *(please specify)*																					
	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 *(please specify)*																					
	C. Abandonment of Managed Lands																					
	1. Tropical Forests																					
	2. Temperate Forests																					
	3. Boreal Forests																					
	4. Grasslands/Tundra																					
	5. Other *(please specify)*																					
	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	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 *(please specify)*														1	Inc. in E	Inc. in E					
	E. Other *(please specify)*																					

Table 7.3. Total CO_2 emissions and removals from sector 5. Land Use Change and Forestry in 1991and 1992 [IPCC 1997]

Greenhouse gas source and sink categories	1991					1992				
	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O
	Gg					Gg				
5. Total Land-Use Change and Forestry	40 891.35	-73 425.59	-32 534.24	0.097	0.001	46 121.04	-82 271.92	-36 150.88	0.143	0.001
5A. Changes in Forest and Other Woody Biomass Stocks	32 335.55	-55 779.04	-23 443.48			38 679.50	-64 991.70	-26 312.20		
I. Tropical Forests										
2. Temperate Forests	32 335.55	-55 779.04	-23 443.48			38 679.50	-64 991.70	-26 312.20		
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
Harvested Wood										
5B. Forest and Grassland Conversion	49.10		49.10			58.66		58.66		
1. Tropical Forests										
2. Temperate Forests	49.1			0.097	0.001	58.7			0.143	0.001
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
5C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00	0.00	0.00		
1. Tropical Forests										
2. Temperate Forests										
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
5D. CO_2 Emissions and Removals from Soil	8 506.70	-17 646.56	-9 139.85			7 382.88	-17 280.22	-9 897.33		
Cultivation of Mineral Soils	8 506.70		8 506.70			7 382.88		7 382.88		
Cultivation of Organic Soils										
Liming of Agricultural Soils		1 568.6	1 568.63				1 313.3	1 313.32		
Forest Soils		-15 884.84	-15 884.84				-16 376.00	-16 376.00		
Other Land (please specify)		-3 330.35	-3 330.35				-2 217.54	-2 217.54		
5E. Other *(please specify)*										

According to calculation for 1992, Sector 5. Land-Use Change and Forestry, was net CO_2 sink. Removals/emissions balance increased from 32 534 Gg CO_2 in 1991 to 36 151 Gg CO_2 in 1992 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 1992 net CO_2 removals increased to 26 312 Gg CO_2 from about 23 443 Gg CO_2 in 1991. This change was caused by woody biomass increase (about 0.56 t dm/ha) and harvest of thick increase (about 3.68 million m^3 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 (m^3/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 1992 this category was a net CO_2 emissions and accounted for about 59 Gg CO_2. Net emission in year 1992 was higher than in 1991 and it was caused by lessening forest area transmitted into non-forest tasks.

Emissions ratios for calculation CH_4, N_2O, CO and NO_x emissions from biomass burning are presented in table below.

Table 7.4. Emissions ratios for calculation CH_4, N_2O, CO and NO_x emissions from biomass burning.

Compound	Ratio		
CH_4	0.012	default	[IPCC 1997]
CO	0.060	default	[IPCC 1997]
N_2O	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 CO_2 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. *CO_2 Emissions and Removals from Soil* (old CRF 5.D)

GHG balance in this category is a net sink. In 1992 net CO_2 sink was about 9 897 Gg CO_2 and was higher by about 757 Gg CO_2 than in previous year. It is mainly caused by afforestation of agriculture lands.

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

Soil types occurring in Poland are as follow.

Forests soils

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

Table 7.5. Forest soils type occur in Poland.

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

Agriculture soils

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

Table 7.6. Agricultural land by soil valuation classes

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

Table 7.7. Percentage fraction of soil tape 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 1992

Land-use/ management system	Soil type	Carbon in soils (Mg C/ha)	Area (Mha)
Forest management	High Activity Soils	110.0	3.527
	Low Activity Soils	70.0	1.692
	Sandy	30.0	3.313
	Wetland	230.0	0.374
Sum			8.906
Grassland/Rangeland	High Activity Soils	90.0	0.572
	Low Activity Soils	60.0	1.689
	Sandy	25.0	1.235
	Wetland	120.0	0.419
Sum			3.914
Agricultural crops	High Activity Soils	70.0	4.121
	Low Activity Soils	60.0	5.523
	Sandy	25.0	2.848
	Wetland	120.0	1.658
Sum			14.150
Other land	High Activity Soils	56.0	0.940
	Low Activity Soils	48.0	1.766
	Sandy	20.0	1.111
	Wetland	96.0	0.482
Sum			4.299
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 CO_2 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:

$$C = M_{limestone} * EF_{limestone} + Md_{olomite} * EF_{dolomite}$$

where:
$M_{limestone}$ - annual amount of sold calcic limestone [Mg/yr],
$M_{dolomite}$ - annual amount of sold calcic dolomite [Mg/yr],
$EF_{limestone}$ - emission factor for limestone – 0.120 [Mg C/ Mg limestone],
$EF_{dolomite}$ - emission factor for dolomite – 0.122 [Mg C/ Mg dolomite].

Domestic statistic publications contain only data of use of lime fertilizers in pure nutrient (CaO), that it was necessary to convert these data into actual use of fertilizers [Radwański 2006b]. It was assumed that lime – magnesium fertilizers ($CaMg(CO_3)_2$) contains 89.1% of $CaCO_3$ and 10.9% of $MgCO_3$. Carbon (C) is converted to carbon-dioxide (CO_2) 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 (CH4 emission), share in total GHG emission 1.1%
- 6.B. Wastewater Handling (CH4 emission), share in total GHG emission 1.2%

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

8.2 Methodological issues

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

The methane emissions from solid waste disposals in 1992 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 CH_4 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
DOCf		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 1994]
– Municipial 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 dam^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]

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 1993d] 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)

CH_4 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 1993d]. 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 0.730. The emission factors calculated on the basis of the study mentioned above and applied in inventory report are:

- for wastewater: 0.060 kg CH_4 / kg BOD
- for sewage sludge: 0.383 kg CH_4 / kg BOD.

The default value (0.6 kg CH_4 / kg BOD) of maximum methane producing capacity was applied for estimation of sludge and wastewater emission factors. Fractions of wastewater and sludge anareobically treated with and without methane recovery are estimated according to [Bernacka 2006]. These value are as follows: percentage of wastewater anareobically treated

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

N_2O emission from humane sewage was calculated according to default method [IPCC 1997]. Country population was taken from [GUS 1994]. Value of protein consumption per capita per year comes from [FAOSTAT 2006]. Default values were used for fraction of nitrogen in protein and for N_2O 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 1992 no data on municipal and sewage sludge waste incineration were available. The amount of industrial waste was calculated based on [GUS 1993d]. The activity data for incineration of medical waste was based on number of hospital beds [GUS 1993] as well as on annual mean use of hospital bed [GUS 1993]. The indicators describing amount of hospital waste produced and fraction of incinerated waste were taken from [IOS 2003].

References

ARE (1993). Fuel balance according to OECD structure. Agency of Energy Market, Warsaw, 1993.

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 (1973). Statistical Yearbook of The Republic of Poland 1973. GUS, Warsaw, 1973.

GUS (1974). Statistical Yearbook of The Republic of Poland 1974. GUS, Warsaw, 1974.

GUS (1985). Statistical Yearbook of The Republic of Poland 1985. GUS, Warsaw, 1985.

GUS (1986d). Environmental Protection. GUS, Warsaw, 1986.

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 (1992). Statistical Yearbook of The Republic of Poland 1992. GUS, Warsaw, 1992.

GUS (1992c). Forestry. Central Statistical Office - GUS, Warsaw, 1992.

GUS (1992z). Use of mineral and lime fertilisers in 1991/1992. GUS, Warsaw, 1992

GUS (1993). Statistical Yearbook of The Republic of Poland 1993. GUS, Warsaw, 1993.

GUS (1993a). Energy Statistics 1991-1992, Central Statistical Office - GUS, Warsaw, 1993.

GUS (1993d). Environmental Protection. GUS, Warsaw, 1993.

GUS (1993e). Questionnaire/Report G-03. Selected data from energy statistic system. Central Statistical Office – GUS, Warsaw, 1993

GUS (1994). Statistical Yearbook of The Republic of Poland 1994. GUS, Warsaw, 1994.

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

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

GUS (1995c). Forestry. Central Statistical Office - GUS, Warsaw, 1995.

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

GUS (1996c). Forestry. Central Statistical Office - GUS, Warsaw, 1996.

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

GUS (2000c). Forestry. Central Statistical Office - GUS, Warsaw, 2000.

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

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 2008-20012. 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.

Kwarciński (2005). Kwarciński 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 NOx 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 voletail 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 (1993): Balance of mineral resources and underground water in Poland. Polish Geological Institute. Warsaw, 1993 (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 75.7% of the total GHG emissions in Poland expressed in units of CO_2 equivalents. Combustion of solid, gaseous and liquid fuels in stationary sources, made up 73.83% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 66.9% of the total GHG emissions.

The most important source categories in level assessment are:
- 1.A.3.b Transport Road Transportation,
- Stationary combustion Solid Fuels,
- 6.B. Wastewater Handling.

Share of these sources in national total made up 72.76%.

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	CO2	305807.92	0.6687	0.67
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	21657.12	0.0474	0.72
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	18774.46	0.0411	0.76
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	13051.90	0.0285	0.79
5	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	12868.14	0.0281	0.81
6	4.A	4.A. Enteric Fermentation	CH4	12609.47	0.0276	0.84
7	4.D.1	4.D.1. Direct Soil Emissions	N2O	12575.83	0.0275	0.87
8	4.B	4.B. Manure Management	N2O	8411.73	0.0184	0.89
9	2.A.1	2.A.1 Cement Production	CO2	5496.23	0.0120	0.90
10	6.B	6.B. Wastewater Handling	CH4	5280.85	0.0115	0.91
11	6.A	6.A. Solid Waste Disposal on Land	CH4	5140.33	0.0112	0.92
12	2.C1	2.C.1. Iron and Steel Production	CO2	5001.43	0.0109	0.93
13	4.B	4.B. Manure Management	CH4	3684.82	0.0081	0.94
14	1.B.2.b.	1.B.2.b. Natural Gas	CH4	3344.07	0.0073	0.95

Trend Assessment

		IPCC Source Categories	Direct GHG	Base Year Estimate	Current Year Estimate	Level Assessment	Trend Assessment	Contribution to Trend [%]	Cumulative Total
1	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16068.28	21657.12	0.0474	0.0256	23.4033	0.23
2	1.A.1, 2, 4, 5.a	Stationary combustion Solid Fuels	CO2	400745.92	305807.92	0.6687	0.0181	16.5003	0.40
3	6.B	6.B. Wastewater Handling	CH4	2170.23	5280.85	0.0115	0.0101	9.1948	0.49
4	1.A.5.b	1.A.5.b Other Mobile	CO2	5049.93	1322.97	0.0029	0.0073	6.6896	0.56
5	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	26824.08	18774.46	0.0411	0.0060	5.4457	0.61
6	4.D.3	4.D.3. Indirect Soil Emissions	N2O	6276.40	3066.47	0.0067	0.0051	4.6717	0.66
7	6.A	6.A. Solid Waste Disposal on Land	CH4	4284.31	5140.33	0.0112	0.0051	4.6158	0.71
8	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18455.82	12868.14	0.0281	0.0042	3.8730	0.74
9	1.A.3.c	1.A.3.c Transport Railways	CO2	3355.49	1290.96	0.0028	0.0037	3.3900	0.78
10	4.B	4.B. Manure Management	N2O	9335.10	8411.73	0.0184	0.0032	2.9150	0.81
11	4.B	4.B. Manure Management	CH4	3435.39	3684.82	0.0081	0.0028	2.5820	0.83
12	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	15562.17	13051.90	0.0285	0.0026	2.3725	0.86
13	2.A.2	2.A.2. Lime Production	CO2	3477.55	1982.91	0.0043	0.0020	1.8613	0.88
14	1.A.3.d	1.A.3.d Transport Navigation	CO2	2334.06	2482.73	0.0054	0.0019	1.7010	0.89
15	2.B.2	2.B.2. Nitric Acid Production	N2O	4386.47	2784.51	0.0061	0.0018	1.6221	0.91
16	2.B.1.	2.B.1. Ammonia Production	CO2	3516.60	2221.20	0.0049	0.0015	1.3289	0.92
17	4.D.1	4.D.1. Direct Soil Emissions	N2O	15747.10	12575.83	0.0275	0.0009	0.7841	0.93
18	1.A.5.b	1.A.5.b Other Mobile	N2O	603.67	166.18	0.0004	0.0009	0.7791	0.94
19	1.A.3.e	1.A.3.e Transport Other	CO2	1661.49	1023.61	0.0022	0.0008	0.6941	0.94
20	6.B	6.B. Wastewater Handling	N2O	1142.28	1117.00	0.0024	0.0006	0.5813	0.95

Annex 2. 1992 Energy balance data for main fuels

Energy balances in 1992 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	**66 870**	**579 993**
From national sources	66 852	579 841
1) Indigenous production	66 852	579 841
2) Transformation output or return	0	0
3) Stock decrease	0	0
Import	18	152
Out	**66 870**	**579 993**
National consumption	65 477	551 993
1) Transformation input	65 455	551 796
a) input for secondary fuel production	214	2 084
b) fuel combustion	65 241	549 712
2) Direct consumption	22	197
Non-energy use	1	8
Combusted directly	21	189
Combusted in Poland	**65 262**	**549 901**
Stock increase	415	3 509
Export	978	8 234
Losses	0	0
Statistical differences		16 257
Net calorific value	MJ/kg	8.43
CO_2 Emission Factor	kg/GJ	114.68

Diesel oil consumption

Evaluation of fuel consumption In national combustion processes	Diesel oil	
	10^3 Mg	TJ
In	**5 167**	**220 660**
From national sources	4 490	191 747
1) Indigenous production	0	0
2) Transformation output or return	4 437	189 472
3) Stock decrease	53	2 275
Import	677	28 913
Out	**5 167**	**220 659**
National consumption	5 131	219 100
1) Transformation input	202	8 602
a) input for secondary fuel production	178	7 568
b) fuel combustion	25	1 034
2) Direct consumption	4 929	210 498
Non-energy use	5	202
Combusted directly	4 924	210 296
Combusted in Poland	**4 949**	**211 330**
Stock increase	0	0
Export	32	1 383
Losses	4	176
Statistical differences		0
Net calorific value	MJ/kg	42.71
CO_2 Emission Factor	kg/GJ	72.72

Fuel oil consumption

Evaluation of fuel consumption In national combustion processes	Fuel oil	
	10^3 Mg	TJ
In	**3 764**	**151 908**
From national sources	2 984	120 457
1) Indigenous production	0	0
2) Transformation output or return	2 982	120 358
3) Stock decrease	2	99
Import	780	31 451
Out	**3 765**	**151 908**
National consumption	3 195	129 152
1) Transformation input	1 577	64 131
a) input for secondary fuel production	112	4 618
b) fuel combustion	1 465	59 513
2) Direct consumption	1 618	65 021
Non-energy use	26	1 044
Combusted directly	1 592	63 977
Combusted in Poland	**3 057**	**123 490**
Stock increase	0	0
Export	876	35 308
Losses	0	1
Statistical differences	-306	-12 553
Net calorific value	MJ/kg	40.40
CO_2 Emission Factor	kg/GJ	79.11

High-methane natural gas consumption

Evaluation of fuel consumption In national combustion processes	High-methane natural gas	
	10^6 m^3	TJ
In	**8 032**	**287 754**
From national sources	1 785	62 227
1) Indigenous production	1 194	41 179
2) Transformation output or return	591	21 048
3) Stock decrease	0	0
Import	6 247	225 527
Out	**8 033**	**287 754**
National consumption	7 455	270 681
1) Transformation input	591	20 860
a) input for secondary fuel production	338	11 849
b) fuel combustion	253	9 011
2) Direct consumption	6 863	249 822
Non-energy use	1 638	57 760
Combusted directly	5 225	192 062
Combusted in Poland	**5 479**	**201 072**
Stock increase	152	5 408
Export	3	106
Losses	423	11 559
Statistical differences		0
Net calorific value	MJ/m^3	36.70
CO_2 Emission Factor	kg/GJ	53.05

Nitrified natural gas consumption

Evaluation of fuel consumption In national combustion processes	Nitrified natural gas	
	10^6 m^3	TJ
In	**2 685**	**66 316**
From national sources	2 685	66 316
1) Indigenous production	2 519	60 640
2) Transformation output or return	166	5 676
3) Stock decrease	0	0
Import	0	0
Out	**2 684**	**66 316**
National consumption	2 525	62 379
1) Transformation input	1 028	26 318
a) input for secondary fuel production	1 013	25 935
b) fuel combustion	15	383
2) Direct consumption	1 497	36 061
Non-energy use	0	0
Combusted directly	1 497	36 061
Combusted in Poland	**1 512**	**36 444**
Stock increase	0	0
Export	0	0
Losses	159	3 937
Statistical differences		0
Net calorific value	MJ/m^3	24.10
CO_2 Emission Factor	kg/GJ	55

Coke consumption

Evaluation of fuel consumption In national combustion processes	Coke	
	10^3 Mg	TJ
In	**11 253**	**316 850**
From national sources	11 252	316 836
1) Indigenous production	0	0
2) Transformation output or return	11 094	312 424
3) Stock decrease	158	4 412
Import	1	14
Out	**11 253**	**316 851**
National consumption	8 687	245 033
1) Transformation input	2 132	57 902
a) input for secondary fuel production	1 493	41 056
b) fuel combustion	640	16 846
2) Direct consumption	6 555	187 131
Non-energy use	126	3 199
Combusted directly	6 429	183 932
Combusted in Poland	**7 069**	**200 778**
Stock increase	0	0
Export	2 566	71 818
Losses	0	0
Statistical differences		0
Net calorific value	MJ/kg	28.40
CO_2 Emission Factor	kg/GJ	110.38

Annex 3. National energy balance 1992 [GUS, 1994a]

CZĘŚĆ I. ZBIORCZY BILANS PRZYCHODU I ROZDYSPONOWANIA ENERGII
TABL. 1. PODSTAWOWY (SYNTETYCZNY) BILANS ENERGII

PART I. BASIC ENERGY SUPPLY AND USE BALANCE
TABLE 1. BASIC (SYNTHETIC) ENERGY BALANCE

LP	NAZWA NOŚNIKA ENERGII *SPECIFICATION*	ROK *YEAR*	JEDNOSTKA MIARY *UNIT OF MEASURE*	POZYSKANIE *INDIGENOUS PRODUCTION*	IMPORT *IMPORT*	- W TYM BUNKIER *AMONG WHICH BUNKER*	EKSPORT *EXPORT*	ZMIANA ZAPASÓW *STOCK CHANGE*
1	***ENERGIA OGÓŁEM***	1992	***TJ***	***3918648***	***908437***	***40808***	***696153***	***29897***
	TOTAL ENERGY	1993		***3945040***	***903398***	***36467***	***769182***	***-54761***
2	***ENERGIA PIERWOTNA***	1992	***TJ***	***3918648***	***762002***	-	***551319***	***35620***
	PRIMARY ENERGY	1993		***3945040***	***773029***	-	***642459***	***-53230***
3	WĘGIEL KAMIENNY	1992	tys.ton	131620	126	-	19602	939
	HARD COAL	1993	10^3 ton	130479	129	-	22968	-2944
		1992	TJ	3154869	3659	-	542979	22481
		1993		3150286	3768	-	634376	-66657
4	WĘGIEL BRUNATNY	1992	tys.ton	66852	18	-	978	415
	LIGNITE	1993	10^3 ton	68105	1	-	909	-24
		1992	TJ	579841	152	-	8234	3509
		1993		583315	8	-	7535	-202
5	ROPA NAFTOWA	1992	tys.ton	200	12769	-	-	106
	CRUDE OIL	1993	10^3 ton	235	13674	-	-	542
		1992	TJ	8322	532585	-	-	4423
		1993		9803	570400	-	-	22619
6	GAZ ZIEMNY WYSOKOMETANOWY	1992	mln m^3	1509	6247	-	3	152
	HIGH - METHANE NATURAL GAS	1993	10^6 m^3	2129	5486	-	16	-252
		1992	TJ	47616	225527	-	106	5408
		1993		70038	198060	-	548	-8990
7	GAZ ZIEMNY ZAAZOTOWANY	1992	mln m^3	2519	-	-	-	-
	NITRIFIED NATURAL GAS	1993	10^6 m^3	2821	-	-	-	-
		1992	TJ	60640	-	-	-	-
		1993		68293	-	-	-	-
8	TORF I DREWNO	1992	tys. m^3	3727	-	-	-	-
	PEAT AND WOOD	1993	10^3 m^3	3270	-	-	-	-
		1992	TJ	35407	-	-	-	-
		1993		31065	-	-	-	-
9	ENERGIA WODY I WIATRU	1992	TJ	5427	-	-	-	-
	HYDRO AND WOOD ENERGY	1993		5357	-	-	-	-
10	PALIWA ODPADOWE STAŁE	1992	TJ	26525	80	-	-	-
	SOLID WASTE FUEL	1993		26884	793	-	-	-
11	***ENERGIA POCHODNA***	1992	***TJ***	-	***146435***	***40808***	***144835***	***-5923***
	DERIVED ENERGY	1993		-	***130369***	***36467***	***126723***	***-1530***
12	BRYKIETY Z WĘGLA KAMIENNEGO	1992	tys.ton	-	-	-	2	-9
	HARD COAL BRIQUETTES	1993	10^3 ton	-	1	-	9	-19
		1992	TJ	-	-	-	64	-218
		1993		-	14	-	208	-449
13	BRYKIETY Z WĘGLA BRUNATNEGO	1992	tys.ton	-	-	-	-	81
	LIGNITE BRIQUETTES (BKB)	1993	10^3 ton	-	-	-	-	96
		1992	TJ	-	-	-	-	1473
		1993		-	-	-	-	1733
14	KOKS I PÓŁKOKS	1992	tys.ton	-	1	-	2566	-158
	COKE AND SEMI-COKE	1993	10^3 ton	-	3	-	1892	-143
		1992	TJ	-	14	-	71818	-4412
		1993		-	77	-	52979	-4004

ZUŻYCIE GLOBALNE LUB SALDO WYM. *GLOBAL CONSUMPTION OR EXCHANGE BALANCES*	UZYSK Z PRZEMIAN LUB ODZYSK *TRANSFORMA-TIONS OUTPUT OR RETURNS*	ZUŻYCIE OGÓŁEM *TOTAL CONSUMPTION*	ZUŻYCIE NA WSAD PRZEMIAN *TRANSFORMA-TIONS INPUT*	ZUŻYCIE BEZPOŚREDNIE *DIRECT CONSUMPTION*	- W TYM ZUŻYCIE NIEENERGETY-CZNE *AMONG WHICH NON-ENERGY USE*	STRATY TRANSPORTU I MAGA-ZYNOWANIA *LOSSES OF TRANSPORT AND STORAGE*	RÓŻNICE BILANSOWE *STATISTICAL DIFFERENCE*	LP
4101034	***2276252***	***x***	***3356656***	***2933121***	***85691***	***72021***	***15487***	1
4134016	***2323413***	***x***	***3377446***	***2983477***	***81809***	***88126***	***8380***	
4093510	***26724***	***x***	***3146380***	***930217***	***61732***	***15496***	***28141***	2
4128840	***27890***	***x***	***3142307***	***970979***	***56958***	***25796***	***17649***	
111204	-	111204	88395	22810	19	-	-	3
110584	-	110584	86172	24413	25	-	-	
2593068	-	2593068	1992272	600796	565	-	-	
2586335	-	2586335	1953877	632458	742	-	-	
65477	-	65477	65455	22	1	-	-	4
67221	-	67221	66865	356	1	-	-	
568250	-	568250	551796	197	8	-	16257	
575989	-	575989	555313	3027	7	-	17649	
12862	-	12862	12579	-	-	-	283	5
13367	-	13367	13367	-	-	-	-	
536485	-	536485	524600	-	-	-	11884	
557584	-	557584	557584	-	-	-	-	
7601	591	8193	709	7061	1638	423	-	6
7851	710	8561	594	7181	1499	786	-	
267629	21048	288678	23267	253851	57760	11559	-	
276540	24459	301000	18741	260773	53226	21486	-	
2519	166	2684	1028	1497	-	159	-	7
2821	107	2927	1192	1559	-	176	-	
60640	5676	66316	26318	36061	-	3937	-	
68293	3430	71723	27566	39848	-	4310	-	
3727	-	3727	130	3597	-	-	-	8
3270	-	3270	139	3131	-	-	-	
35407	-	35407	1237	34170	-	-	-	
31065	-	31065	1322	29743	-	-	-	
5427	-	5427	5427	-	-	-	-	9
5357	-	5357	5357	-	-	-	-	
26604	-	26604	21461	5143	3399	-	-	10
27677	-	27677	22546	5131	2984	-	-	
7524	***2249528***	***x***	***199438***	***2013742***	***10001***	***56525***	***-12654***	***11***
5176	***2295524***	***x***	***226315***	***2021323***	***10226***	***62331***	***-9269***	
7	-	7	7	1	-	-	-	12
11	-	11	11	0	-	-	0	
154	-	154	152	13	-	-	-11	
255	-	255	255	2	-	-	-2	
-81	95	14	10	4	-	-	-	13
-96	102	6	2	3	-	-	-	
-1473	1725	253	177	68	-	-	8	
-1733	1838	105	43	62	-	-	-	
-2408	11094	8687	2132	6555	126	-	-	14
-1746	10282	8535	1942	6593	166	-	-	
-67391	312424	245032	57902	187131	3199	-	-	
-48897	288428	239531	54843	184688	4213	-	-	

LP	NAZWA NOŚNIKA ENERGII *SPECIFICATION*	ROK *YEAR*	JEDNOSTKA MIARY *UNIT OF MEASURE*	POZYSKANIE *INDIGENOUS PRODUCTION*	IMPORT *IMPORT*	- W TYM BUNKIER *AMONG WHICH BUNKER*	EKSPORT *EXPORT*	ZMIANA ZAPASÓW *STOCK CHANGE*
15	GAZ CIEKŁY	1992	tys.ton	-	-	-	-	0
	LIPUEFIED PETROLEUM GAS (LPG)	1993	10^3 ton	-	-	-	-	0
		1992	TJ	-	-	-	-	0
		1993		-	-	-	-	-1
16	BENZYNY	1992	tys. ton	-	1554	88	13	-8
	GASOLINE	1993	10^3 ton	-	1289	79	14	39
		1992	TJ	-	67285	3793	544	-362
		1993		-	55816	3412	617	1703
17	OLEJE NAPĘDOWE	1992	tys. ton	-	677	132	32	-53
	DIESEL OIL	1993	10^3 ton	-	575	120	3	-3
		1992	TJ	-	28913	5621	1383	-2275
		1993		-	24540	5115	142	-126
18	OLEJE OPAŁOWE	1992	tys. ton	-	780	779	876	-2
	FUEL OIL	1993	10^3 ton	-	693	693	1045	4
		1992	TJ	-	31451	31394	35308	-99
		1993		-	27940	27940	42105	160
19	PRODUKTY NIEENERGETYCZNE	1992	TJ	-	465	-	3082	-29
	NON-ENERGY PRODUCTS	1993		-	1656	-	1833	-545
20	GAZ RAFINERYJNY	1992	tys. ton	-	-	-	-	-
	REFINERY GAS	1993	10^3 ton	-	-	-	-	-
		1992	TJ	-	-	-	-	-
		1993		-	-	-	-	-
21	GAZ KOKSOWNICZY	1992	mln m^3	-	-	-	-	-
	COKE OVEN GAS	1993	10^6 m^3	-	-	-	-	-
		1992	TJ	-	-	-	-	-
		1993		-	-	-	-	-
22	GAZ MIEJSKI	1992	mln m^3	-	12	-	-	-
	TOWN GAS	1993	10^6 m^3	-	11	-	-	-
		1992	TJ	-	186	-	-	-
		1993		-	166	-	-	-
23	GAZ CZADNICOWY I WYTLEWNY	1992	mln m^3	-	-	-	-	-
	BLAST FURNACE GAS	1993	10^6 m^3	-	-	-	-	-
		1992	TJ	-	-	-	-	-
		1993		-	-	-	-	-
24	GAZ WIELKOPIECOWY	1992	mln m^3	-	-	-	-	-
	GAS MANUFACTURED FROM COAL	1993	10^6 m^3	-	-	-	-	-
		1992	TJ	-	-	-	-	-
		1993		-	-	-	-	-
25	ENERGIA ELEKTRYCZNA	1992	GWh	-	5034	-	9066	-
	ELECTRICITY	1993		-	5600	-	8011	-
		1992	TJ	-	18121	-	32636	-
		1993		-	20160	-	28840	-
26	CIEPŁO	1992	TJ	-	-	-	-	-
	HEAT	1993		-	-	-	-	-
27	***ENERGIA Z ODZYSKU***	1992	TJ	-	-	-	-	-
	ENERGY FROM RETURNS	1993		-	-	-	-	-
28	PALIWA ODPAD. CIEKŁE I GAZOWE	1992	TJ	-	-	-	-	-
	LIQUID AND GASEOUS WASTE FUELS	1993		-	-	-	-	-
29	CIEPŁO Z ODZYSKU	1992	TJ	-	-	-	-	-
	HEAT FROM RETURNS	1993		-	-	-	-	-

ZUŻYCIE GLOBALNE LUB SALDO WYM. *GLOBAL CONSUMPTION OR EXCHANGE BALANCES*	UZYSK Z PRZEMIAN LUB ODZYSK *TRANSFORMA-TIONS OUTPUT OR RETURNS*	ZUŻYCIE OGÓŁEM *TOTAL CONSUMPTION*	ZUŻYCIE NA WSAD PRZEMIAN *TRANSFORMA-TIONS INPUT*	ZUŻYCIE BEZPOŚREDNIE *DIRECT CONSUMPTION*	- W TYM ZUŻYCIE NIEENERGETY-CZNE *AMONG WHICH NON-ENERGY USE*	STRATY TRANSPORTU I MAGA-ZYNOWANIA *LOSSES OF TRANSPORT AND STORAGE*	RÓŻNICE BILANSOWE *STATISTICAL DIFFERENCE*	LP
0	159	159	8	151	105	0	-	15
0	259	259	8	251	90	0	-	
0	7263	7263	383	6879	4784	1	-	
1	11749	11750	358	11391	4096	1	-	
1550	3213	4763	655	4097	18	11	-	16
1235	3744	4979	672	4297	18	10	-	
67104	139133	206237	26363	177390	771	483	-	
53496	162114	215610	29106	186063	767	440	-	
698	4437	5135	202	4929	5	4	-	17
574	4998	5572	529	5041	3	2	-	
29805	139472	219277	8602	210498	202	176	-	
24524	213417	237941	22556	215294	138	91	-	
-93	2982	2889	1577	1616	26	0	-306	18
-355	3341	2985	1800	1403	25	0	-218	
-3759	120358	116599	64131	65021	1044	1	-12553	
-14325	134577	120252	72926	56498	1011	1	-9173	
-2588	99766	97178	1003	96101	-	74	-	19
368	101977	102345	8652	93657	-	35	-	
-	295	295	13	282	-	-	-	20
-	294	294	17	276	-	-	-	
-	15142	15142	676	14466	-	-	-	
-	14837	14837	870	13968	-	-	-	
-	4881	4881	507	4296	0	78	-	21
-	4435	4435	533	3857	-	46	-	
-	86666	86666	9041	76235	1	1390	-	
-	78094	78094	9384	67894	-	817	-	
12	63	75	1	73	-	1	-	22
11	38	48	18	28	-	-	2	
186	1238	1424	13	1400	-	11	-	
156	799	966	298	638	-	-	31	
-	670	670	43	634	-	-	-7	23
-	554	554	32	536	-	-	-14	
-	3977	3977	328	3746	-	-	-97	
-	3252	3252	235	3141	-	-	-124	
-	11895	11895	3952	7942	-	-	-	24
-	11247	11247	3484	7762	-	-	-	
-	40802	40802	13606	27196	-	-	-	
-	38157	38157	11928	26230	-	-	-	
-4032	132750	128719	2825	110785	-	15108	-	25
-2411	133867	131456	2879	111648	-	16929	-	
-14515	477901	463387	10172	398826	-	54389	-	
-8680	481921	473241	10363	401934	-	60945	-	
-	753661	753661	4888	748773	-	-	-	26
-	764363	764363	4498	759865	-	-	-	
-	77310	x	10838	66473	13958	-	-	*27*
-	75372	x	8824	66547	14625	-	-	
-	39436	39436	10838	28599	13958	-	-	28
-	36479	36479	8824	27555	14625	-	-	
-	37874	37874	-	37674	-	-	-	29
-	38892	38892	-	38892	-	-	-	

Annex 4. National energy balance 1992 – OECD

POLAND: 1992

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	3148419.9	579841.1	312423.8		1725.4	35406.5	111308.2	4998.4	91452.0
From Other Sources	6448.9						7774.1	406.4	2978.3
Imports	3658.8	151.8	14.2				248079.5	204.4	
Exports	542979.0	8234.1	71817.9	63.6			116.1		
International Marine Bunkers									
Stock Changes	-22480.6	-3508.7	4412.3	217.9	-1472.6		-5949.3		
DOMESTIC SUPPLY	**2593067.9**	**568250.2**	**245032.4**	**154.4**	**252.8**	**35406.5**	**361096.4**	**5609.2**	**94430.3**
Returns to Supply									
Transfers							-1168.6	331.2	837.4
TOTAL REQUIREMENTS	**2593067.9**	**568250.2**	**245032.4**	**154.4**	**252.8**	**35406.5**	**359927.8**	**5940.3**	**95267.8**
Statistical Difference		16257.1		-10.9	7.6			-107.0	
TRANSFORMATION SECTOR	**1910021.8**	**550646.3**	**52951.4**	**86.6**	**166.7**	**497.5**	**16735.1**	**372.5**	**9847.9**
Patent Fuel Plants		1861.3							
Coke Ovens	438573.6		1796.7				2300.5		
Gas Works	7185.0	222.7	329.0				3917.2		
Blast Furnaces			40801.9						
Oil Refineries									
Autoproducers of Electricity	254340.8	1129.3	2.9				1802.4		7949.3
Public Plants for CHP	845706.0	544835.5					275.1		0.9
Heating Plants	364216.5	2597.5	10020.9	86.6	166.7	497.5	8439.9	372.5	1897.7
Non-Specified									
ENERGY SECTOR	**6268.8**	**70.3**	**262.3**		**5.4**	**3.7**	**16620.8**	**10.8**	**42937.7**
Coal Mines	3606.3	70.3	132.7		5.4		367.9		0.4
Oil and Gas Extraction	45.2		8.5				5481.1		
Patent Fuel Plants									
Coke Ovens							199.1		42771.7
Gas Works	54.0		23.9			0.1	8882.9	10.8	164.6
Oil Refineries	13.7		0.1				1658.4		
Electric Plants									
Pumped Storage									
Non-Specified	2549.5		97.1			3.6	31.5		0.9
Distribution Losses							17046.1	11.6	1528.7
FINAL CONSUMPTION	**676777.2**	**1276.5**	**191818.7**	**78.6**	**73.0**	**34905.2**	**309525.8**	**5652.5**	**40953.5**
INDUSTRY SECTOR	**139548.4**	**324.1**	**110853.5**	**6.1**	**39.6**	**458.0**	**75312.3**	**4190.6**	**28218.4**
Iron and Steel	1541.0		83316.6				26923.1	797.6	25075.0
Chemical	4594.2	30.3	1731.9			10.4	4875.1	147.5	489.0
of which: Petrochemical	8.4		1.3						
Non-Ferrous Metals	815.9		2177.3				1299.8		206.8
Non-Metallic Minerals	69903.8	94.5	10316.7			42.2	24470.6	3006.6	1490.2
Transport Equipment	2901.4	4.4	544.3	0.1		4.7	1885.1	1.3	17.2
Machinery	9745.4	15.9	4641.1	0.3	0.5	31.5	6656.9	175.0	758.1
Mining and Quarrying	2367.0	7.2	3809.6		35.4	1.0	5994.5		12.5
Food and Tobacco	32732.5	12.7	2545.4	1.0	0.0	71.7	2573.3	1.3	138.1
Paper, Pulp and Print	1413.0	0.8	245.2			0.1	29.1	1.7	2.1
Wood and Wood Products	5111.1	66.3	190.0	2.3	0.1	252.9	263.4	0.0	0.2
Constructions	3023.2	14.6	859.3	2.1	3.6	24.2	97.1	57.4	5.2
Textiles and Leather	5031.7	76.2	361.0	0.3		7.8	223.0	2.1	23.9
Non-specified	368.1	1.2	115.3			11.5	21.4	0.0	
TRANSPORT SECTOR	**8749.2**	**18.8**	**3212.8**	**0.3**	**21.6**	**3.5**	**182.1**	**11.9**	**8.9**
Air Transport	0.4								
Road Transport	1905.9	15.9	551.4	0.3	1.8	3.4	31.3	2.4	6.8
Railways	6805.2	2.9	2629.4		19.8		150.7	9.0	2.1
Internal Navigation	37.7		31.9			0.0	0.2	0.5	
OTHER SECTORS	**527915.1**	**925.5**	**74553.8**	**72.2**	**11.8**	**34443.8**	**170495.1**	**1450.1**	**12725.4**
Agriculture	15071.0	923.2	611.0	66.9	11.8	476.7	60.5	0.3	0.4
Commerce and Public									
Residential							155333.4	820.6	12702.1
Non-Specified	512844.0	2.3	73942.7	5.2	0.0	33967.1	15101.2	629.2	22.9
NON-ENERGY USE	**564.6**	**8.2**	**3198.7**				**63536.2**		**0.9**
in Industry	346.4	8.2	3198.1				63536.2		0.9

POLAND: 1992

PRODUCTION AND USES OF ENERGY	Gas (TJ)					Oil (TJ)				
	Coke Oven Gas	Blast Furnace Gas	Electricity Total	Electricity of which Hydro	Heat	Crude Oil + Feedstocks + Other Inputs	Crude Oil + NGL	Feed-stocks	Other Inputs	Rafinery Gas
Indigenous Production	25801.9	40801.9	470476.2	5427.4	685451.1	9048.8	8322.3		726.5	14227.5
From Other Sources			7425.2	7425.2	3530.3					
Imports			18121.3			552965.7	532584.9	20300.8	79.9	
Exports			32636.0							
International Marine Bunkers										
Stock Changes						-4422.7	-4422.7			
DOMESTIC SUPPLY	**25801.9**	**40801.9**	**463386.7**	**12852.6**	**688981.4**	**557591.7**	**536484.6**	**20300.8**	**806.4**	**14227.5**
Returns to Supply	36497.0				37874.0	3839.7		3839.7		
Transfers										
TOTAL REQUIREMENTS	**62298.9**	**40801.9**	**463386.7**	**12852.6**	**726855.4**	**561431.4**	**536484.6**	**24140.5**	**806.4**	**14227.5**
Statistical Difference						11884.1	11884.1			
TRANSFORMATION SECTOR	**24146.2**	**13605.8**			**4888.3**	**549547.3**	**524600.5**	**24140.5**	**806.4**	**635.3**
Patent Fuel Plants										
Coke Ovens		228.0								
Gas Works										
Blast Furnaces										
Oil Refineries						549547.3	524600.5	24140.5	806.4	
Autoproducers of Electricity	18928.2	12107.1			3863.4					635.3
Public Plants for CHP	1172.9				1024.9					
Heating Plants	4045.1	1270.7								
Non-Specified										
ENERGY SECTOR	**682.0**	**1201.7**	**100873.2**		**78051.2**					**8272.5**
Coal Mines			30596.7		20354.1					
Oil and Gas Extraction			392.8		216.5					
Patent Fuel Plants			9.1		260.7					
Coke Ovens		1201.7	2341.6		9809.0					
Gas Works			588.4		987.1					
Oil Refineries	682.0		1445.0		11939.7					8272.5
Electric Plants			32901.1		4700.5					
Pumped Storage			10171.7							
Non-Specified			22426.7		29783.5					
Distribution Losses			54389.2							
FINAL CONSUMPTION	**37470.7**	**25994.4**	**308124.3**		**643916.0**					**5319.7**
INDUSTRY SECTOR	**19711.7**	**25994.4**	**130824.4**		**336207.5**					**5319.7**
Iron and Steel	6497.0	25909.1	21718.7		37576.1					
Chemical	7645.4	5.7	30318.5		111761.2					5319.7
of which: Petrochemical	5430.7		3284.2		21983.5					5319.7
Non-Ferrous Metals	514.3		7053.9		2400.1					
Non-Metallic Minerals	267.1	79.6	10486.7		9946.2					
Transport Equipment			4653.9		13658.8					
Machinery	15.4		15170.5		27693.0					
Mining and Quarrying	47.2		12032.9		24793.8					
Food and Tobacco	31.4		10386.8		41051.9					
Paper, Pulp and Print			7029.6		28888.1					
Wood and Wood Products	4679.7		3657.0		9610.0					
Constructions	14.1		2778.1		7506.7					
Textiles and Leather			5362.6		21061.3					
Non-specified			175.2		260.3					
TRANSPORT SECTOR			**18894.5**		**6299.0**					
Air Transport			22.1		109.3					
Road Transport			2861.0		2916.2					
Railways			15766.1		2868.3					
Internal Navigation			245.3		405.3					
OTHER SECTORS	**402.0**	**0.0**	**158405.4**		**301409.5**					**0.0**
Agriculture	112.2		28683.4		6289.1					
Commerce and Public										
Residential			68210.2							
Non-Specified	289.8	0.0	61511.9		295120.3					0.0
NON-ENERGY USE	**17357.0**									
in Industry	7962.7									

POLAND: 1992

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	7477.1	131401.5		5719.0	323.8	190698.8	119876.5	35093.5	36944.2
From Other Sources									
Imports		38614.7	208.7	5440.0		23636.8	56.8		524.5
Exports				560.3		1007.0	33731.1		3034.3
International Marine Bunkers						4230.3	7756.1		
Stock Changes	0.4	693.0	-0.6	-320.4	0.4	2308.8	98.6		19.0
DOMESTIC SUPPLY	**7477.4**	**170709.2**	**208.1**	**10278.3**	**324.2**	**211407.2**	**78544.7**	**35093.5**	**34453.4**
Returns to Supply									
Transfers	58.1	-368.0	-129.8	-82.0	9.4	485.9	2.1		9.6
TOTAL REQUIREMENTS	**7535.6**	**170341.2**	**78.4**	**10196.3**	**333.6**	**211893.1**	**78546.8**	**35093.5**	**34463.0**
Statistical Difference							-13243.9		
TRANSFORMATION SECTOR	**400.9**					**7160.0**	**61172.6**		
Patent Fuel Plants									
Coke Ovens									
Gas Works	400.8								
Blast Furnaces									
Oil Refineries						6595.3	4506.3		
Autoproducers of Electricity						118.5	38748.8		
Public Plants for CHP						125.0	6249.1		
Heating Plants	0.1					321.1	11668.4		
Non-Specified									
ENERGY SECTOR	**97.6**	**81.7**				**2204.2**	**11374.1**		
Coal Mines	0.0	32.8				1614.3	1.7		
Oil and Gas Extraction						194.9			
Patent Fuel Plants									
Coke Ovens		0.4				11.1			
Gas Works	0.1	10.3				24.2			
Oil Refineries	93.2	1.4				26.1	11310.8		
Electric Plants									
Pumped Storage									
Non-Specified	4.2	36.8				333.7	61.5		
Distribution Losses	1.3	500.1	2.5	2.5	0.2	178.4	1.2		69.3
FINAL CONSUMPTION	**7035.8**	**169759.4**	**75.9**	**10193.8**	**333.3**	**202350.5**	**19242.8**	**35093.5**	**34393.7**
INDUSTRY SECTOR	**156.8**	**931.1**				**10203.8**	**16485.7**		
Iron and Steel	8.2	8.2				187.8	5293.5		
Chemical	2.0	1.1				786.9	1798.7		
of which: Petrochemical		1.1				42.2	156.4		
Non-Ferrous Metals	0.1	2.0				110.3	16.9		
Non-Metallic Minerals	18.4	12.6				795.6	3559.8		
Transport Equipment	23.1	230.7				520.8	150.2		
Machinery	39.1	135.7				607.4	373.5		
Mining and Quarrying		22.7				1547.6	1295.6		
Food and Tobacco	25.5	59.1				929.6	1313.9		
Paper, Pulp and Print	32.2	8.1				54.6	1310.5		
Wood and Wood Products	0.0	24.9				121.9	1241.1		
Constructions	5.5	394.0				4340.4	105.1		
Textiles and Leather	2.5	17.0				163.4	25.3		
Non-specified	0.1	15.1				37.6	1.7		
TRANSPORT SECTOR	**7.9**	**167999.5**	**75.9**	**10193.8**		**130842.9**	**1234.1**		
Air Transport		7966.4	75.9	10193.8		32.6			
Road Transport	0.1	159762.4				119310.7	17.7		
Railways	7.8	263.9				10693.4			
Internal Navigation		6.8				806.2	1216.4		
OTHER SECTORS	**1896.7**	**0.0**	**0.0**			**61100.1**	**470.9**		
Agriculture	1.3					61100.1	470.9		
Commerce and Public									
Residential									
Non-Specified	1895.4	0.0	0.0			0.0			
NON-ENERGY USE	**4974.4**	**828.8**			**333.3**	**203.8**	**1052.1**	**35093.5**	**34393.7**
in Industry	4964.6	795.1			333.3	72.7	3.9	35093.5	34393.7

Annex 5. Uncertainty estimation of the 1992 inventory

Uncertainty analysis for the year 1992 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.

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

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

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

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 CH_4 and N_2O 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 (CO_2 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 – 6.8%	CH_4 – 19.6%	N_2O – 53.1%

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%).

CO_2 emission factors
Most uncertain values for CO_2 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 CO_2 (6.8%) 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%).

CH_4 emission factors
Most uncertain values for CH_4 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 CH_4 emission is app. 19.6% which is result of share of agriculture and waste sectors in national totals – emission factors in those sectors have high uncertainty.

N_2O emission factors
Most uncertain values for N_4O 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 N_2O (53.1%) 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.

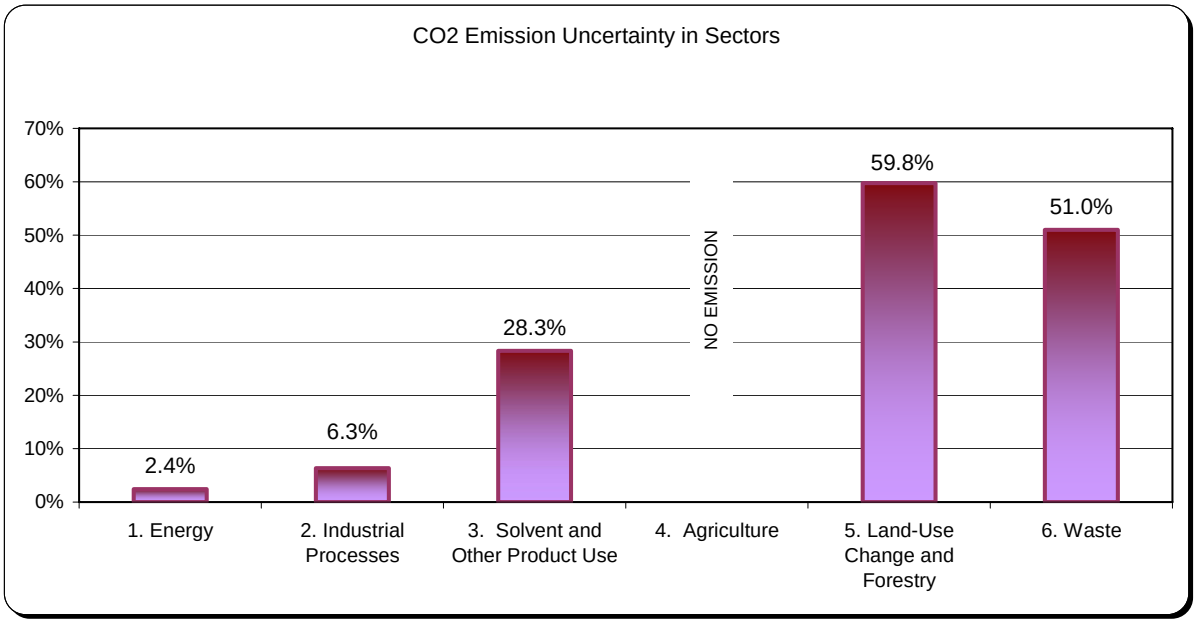
Sector *3. Solvents and Other Products Use* was included in calculations with high sectoral uncertainty 28.3%. Emission from this sector is small compared to total CO_2 and high uncertainty have very little influence on uncertainty of values of total national CO_2 emission.

GHG inventory 1992 – Uncertainty analysis, part 1, sectors 1-2

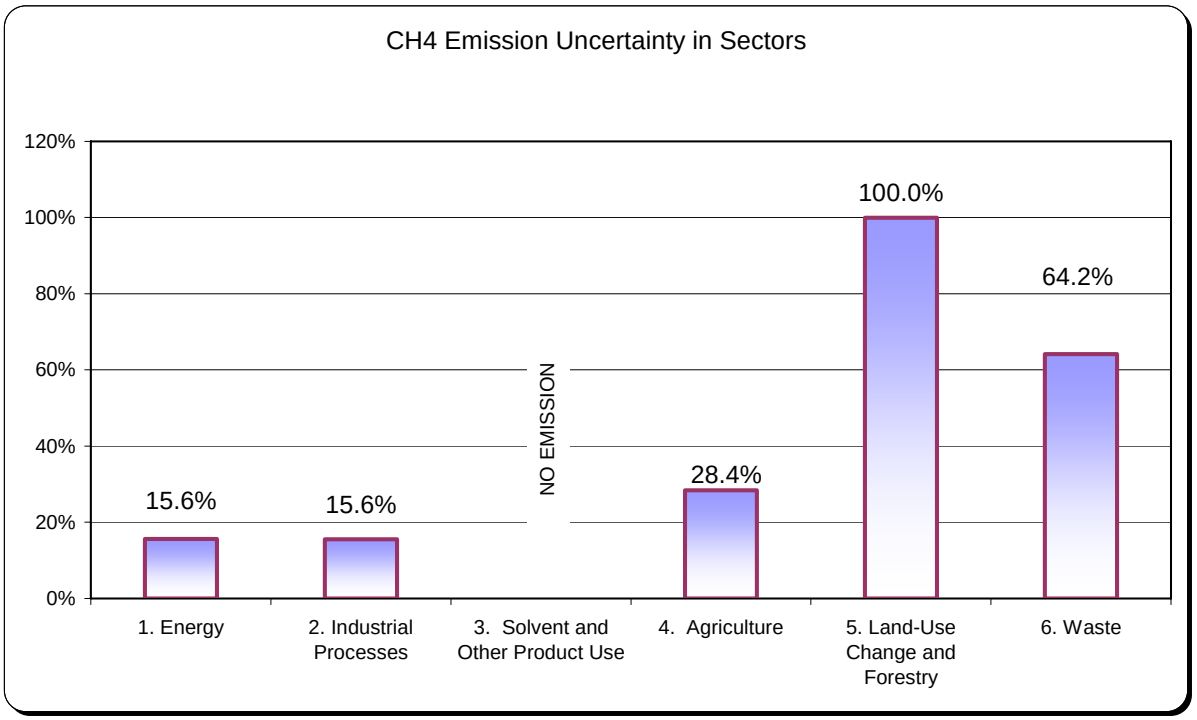
1992	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
TOTAL									345 793.91	2 072.58	102.69	6.8%	19.6%	53.1%	23 382.67	406.58	54.48
1. Energy									**365 494.68**	**789.08**	**7.16**	2.4%	15.6%	2.7%	**8874.11**	**123.34**	**0.20**
A. Fuel Combustion									**365 434.14**	**13.51**	**7.16**	2.4%	6.9%	2.7%	8874.11	0.93	0.20
1. Energy Industries									229 447.92	3.15	3.33	3.5%	12.9%	3.5%	7935.63	0.41	0.12
Liquid Fuels	115 241	3.0%	71.39	2.49	0.51	1.0%	41.8%	3.8%	8 226.61	0.29	0.06	3.2%	41.9%	3.2%	260.15	0.12	0.00
Solid Fuels	2 200 728	3.0%	99.95	1.27	1.48	2.0%	13.5%	11.7%	219 972.96	2.80	3.26	3.6%	13.8%	3.6%	7931.24	0.39	0.12
Gaseous Fuels	22 260	3.0%	56.08	1.00	0.10	2.0%	17.0%	20.0%	1 248.35	0.02	0.00	3.6%	17.3%	3.6%	45.01	0.00	0.00
Biomass	1 238	3.0%				0.0%	24.0%	37.0%	138.63	0.04	0.00	3.0%	24.2%	3.0%		0.01	0.00
2. Manufacturing Industries and Construction									35 442.08	1.51	0.58	4.2%	13.0%	7.0%	1492.27	0.20	0.04
Liquid Fuels	62 686.06	5.0%	73.72	2.91	4.59	1.0%	41.8%	3.8%	4 621.17	0.18	0.29	5.1%	42.1%	6.3%	235.63	0.08	0.02
Solid Fuels	236 013.29	5.0%	114.87	5.31	1.19	2.0%	13.5%	11.7%	27 110.40	1.25	0.28	5.4%	14.4%	12.7%	1459.94	0.18	0.04
Gaseous Fuels	66 733.56	5.0%	55.60	1.00	0.10	2.0%	17.0%	20.0%	3 710.50	0.07	0.01	5.4%	17.7%	20.6%	199.82	0.01	0.00
Biomass	138.19	5.0%	112.00	30.00	4.00	0.0%	24.0%	37.0%	15.48	0.00	0.00	5.0%	24.5%	37.3%		0.00	0.00
3. Transport									26 476.89	6.65	1.33	6.9%	11.3%	5.4%	1836.46	0.75	0.07
Liquid Fuels	330 165.03	5.0%	78.65	20.02	3.97	5.0%	10.2%	2.3%	25 966.51	6.61	1.31	7.1%	11.4%	5.5%	1836.11	0.75	0.07
Solid Fuels	6 805.00	5.0%	75.00	6.00	NE	5.0%	13.5%	11.7%	510.38	0.04	0.01	7.1%	14.4%	12.7%	36.09	0.01	0.00
Biomass	NE	5.0%	0.00	0.00	0.00	0.0%	24.0%	37.0%	0.00	0.00	0.00	5.0%	24.5%	37.3%	0.00	0.00	0.00
Other Fuels	NE	5.0%	0.00	0.00	0.00	0.0%	50.0%	50.0%	0.00	0.00	0.00	5.0%	50.2%	50.2%	0.00	0.00	0.00
4. Other Sectors									72 316.03	2.12	1.39	4.4%	14.2%	9.2%	3189.14	0.30	0.13
Liquid Fuels	78 594.43	5.0%	74.12	4.03	4.23	1.0%	41.8%	3.8%	5 825.69	0.32	0.33	5.1%	42.1%	6.3%	297.05	0.13	0.02
Solid Fuels	614 018.07	5.0%	95.12	1.00	1.47	2.0%	13.5%	11.7%	58 406.67	0.61	0.90	5.4%	14.4%	12.7%	3145.30	0.09	0.11
Gaseous Fuels	154 874.00	5.0%	52.20	1.00	0.10	2.0%	17.0%	20.0%	8 083.67	0.15	0.02	5.4%	17.7%	20.6%	435.32	0.03	0.00
Biomass	34 437.71	5.0%	112.00	30.00	4.00		24.0%	37.0%	3 857.02	1.03	0.14	5.0%	24.5%	37.3%		0.25	0.05
5. Other									1 751.22	0.08	0.54	4.3%	96.5%	6.2%	74.60	0.08	0.03
Liquid Fuels	19 445.76	5.0%	73.23	4.13	27.61	1.0%	100.0%	3.8%	1 423.96	0.08	0.54	5.1%	100.1%	6.3%	72.61	0.08	0.03
Solid Fuels	2 890.00	5.0%	109.99	1.00	1.49	2.0%	80.0%	11.7%	317.88	0.00	0.00	5.4%	80.2%	12.7%	17.12	0.00	0.00
Gaseous Fuels	170.00	5.0%	55.17	1.00	0.10	2.0%	90.0%	20.0%	9.38	0.00	0.00	5.4%	90.1%	20.6%	0.51	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									**60.54**	**775.58**	**0.00**	5.8%	15.9%		3.51	123.34	0.00
1. Solid Fuels									1.08	615.82	0.00	6.6%	20.0%		0.07	122.99	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]	132.70	2.0%		4.61128			20.0%			611.92			20.1%		0.00	122.99	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	66.90	2.0%		0.01273			20.0%			0.85			20.1%		0.00	0.17	0.00
1. B. 1. c. Other [CO2 Emisson from Coking Gas Subsystem]	0.53	2.0%	2 060 765	5 791 695.00			20.0%		1.08	3.05		6.6%	15.0%		0.07	0.46	
2. Oil and Natural Gas									59.46	159.76	0.00	5.9%	5.7%		3.51	9.18	0.00
1. B. 2. a. Oil															0.00	0.00	0.00
ii. Production [Activity in PJ, EFs in kg/PJ]	8.32	0.5%	6 315 000	61 800.00		6.6%	8.1%		52.55	0.51		6.6%	8.1%		3.48	0.04	0.00
iii. Transport [Activity in Gg]	12 969.00	0.5%	NE	NE		6.6%	8.1%		0.08	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]	108.26	0.5%	57 924.78	101 851.18		6.6%	8.1%		6.27	11.03		6.6%	8.1%		0.42	0.89	0.00
ii. Transmission [Activity in PJ, EFs in kg/PJ]	329.60	0.5%	512.56	136 375.59		6.6%	8.1%		0.17	44.95		6.6%	8.1%		0.01	3.65	0.00
ii. Distribution [Activity in PJ, EFs in kg/PJ]	329.60	0.5%	1 159.70	313 305.81		6.6%	8.1%		0.38	103.27		6.6%	8.1%		0.03	8.38	0.00
2. Industrial Processes									**15621.97**	**10.07**	**10.40**	6.3%	15.6%	26.0%	990.09	1.57	2.70
A. Mineral Products									7937.06		0	11.5%			914.30	0.00	0.00
1. Cement Production [Activity in kt, EF in t/t]	10 469.00	5.0%	0.525			15.0%			5496.23			15.8%			869.03	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	2 526.00	10.0%	0.785			10.0%			1982.91			14.1%			280.43	0.00	0.00
4. Soda Ash (production) [Activity in kt, EF in t/t]	1 103.43	10.0%	0.415			0.0%			457.92			10.0%			45.79	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									2464.16	7.51	10.40	6.4%	19.9%	26.0%	158.00	1.50	2.70
1. Ammonia Production [Activity in kt, EF in t/t]	1 480.80	5.0%	1.5	0.0049		5.0%	20.0%		2221.20	7.26		7.1%	20.6%		157.06	1.50	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	1 388.30	2.0%			0.01			30.0%			8.98			30.1%	0.00	0.00	2.70
3. Adipic Acid Production [Activity in kt, EF in t/t]	3.09	5.0%			0.00			10.0%	NE		0.93			11.2%			
4. Carbide Production (calcium carbide) [Activity in kt, EF in t/t]	220.80	5.0%	1.1			5.0%			242.88			7.1%			17.17	0.00	0.00
5. Other (Carbon Black) [Activity in kt, EF in t/t]	25.88	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]	283.13	5.0%	0.0003			5.0%			0.08			7.1%			0.01	0.00	0.00
5. Other (N2O for Medical Use) [Activity in kt, EF in t/t]	IE	5.0%			IE			20.0%			IE				0.00	0.00	IE
5. Other (Urea production) [Activity in kt, EF in t/t]	635.00	5.0%	0			5.0%						7.1%			0.00	0.00	0.00
5. Other (Caprolactam) [Activity in kt, EF in t/t]	104.68	5.0%			0.0047			20.0%			0.50			20.6%	0.00	0.00	0.10
C. Metal Production									5220.75	2.55	0	6.6%	18.1%		345.48	0.46	0.00
1. Iron and Steel Production															0.00	0.00	0.00
Sinter [Activity in kt, EF in t/t]	8 621.68	5.0%	0.07			10.0%			618.69			11.2%			69.17	0.00	0.00
Coke [Activity in kt, EF in t/t]	11 128.39	5.0%	0.15	0.000200		10.0%	20.0%		1618.80	2.23		11.2%	20.6%		180.99	0.46	0.00
Open-heart Steel [Activity in kt, EF in t/t]	1 820.40	5.0%	0.052			10.0%			94.66			11.2%			NE		
Electric Furnace Steel [Activity in kt, EF in t/t]	1 797.40	5.0%	0.00430	0.000120		10.0%	20.0%		7.73	0.22		11.2%	20.6%		0.86	0.04	0.00
Pig Iron [Activity in kt, EF in t/t]	6 462.03	5.0%	0.39514			10.0%			2553.40			11.2%			285.48	0.00	0.00
Iron Cast [Activity in kt, EF in t/t]	549.60	5.0%	0.061	0.000200		10.0%	20.0%		33.53	0.11		11.2%	20.6%		3.75	0.02	0.00
Steel Cast [Activity in kt, EF in t/t]	69.00	5.0%	0.062			10.0%			4.28			11.2%			0.48	0.00	0.00
Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]	6 247.70	5.0%	0.01126			10.0%			70.35			11.2%			7.87	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	36.10	5.0%	3.9			5.0%			140.79			7.1%			9.96	0.00	0.00
3. Aluminium Production [Activity in kt, EF in t/t]	43.63	5.0%	1.8			5.0%			78.53			7.1%			5.55	0.00	0.00
D. Other Production															0.00	0.00	0.00
G. Other															0.00	0.00	0.00

GHG inventory 1992 – Uncertainty analysis, part 2, sector 3-6

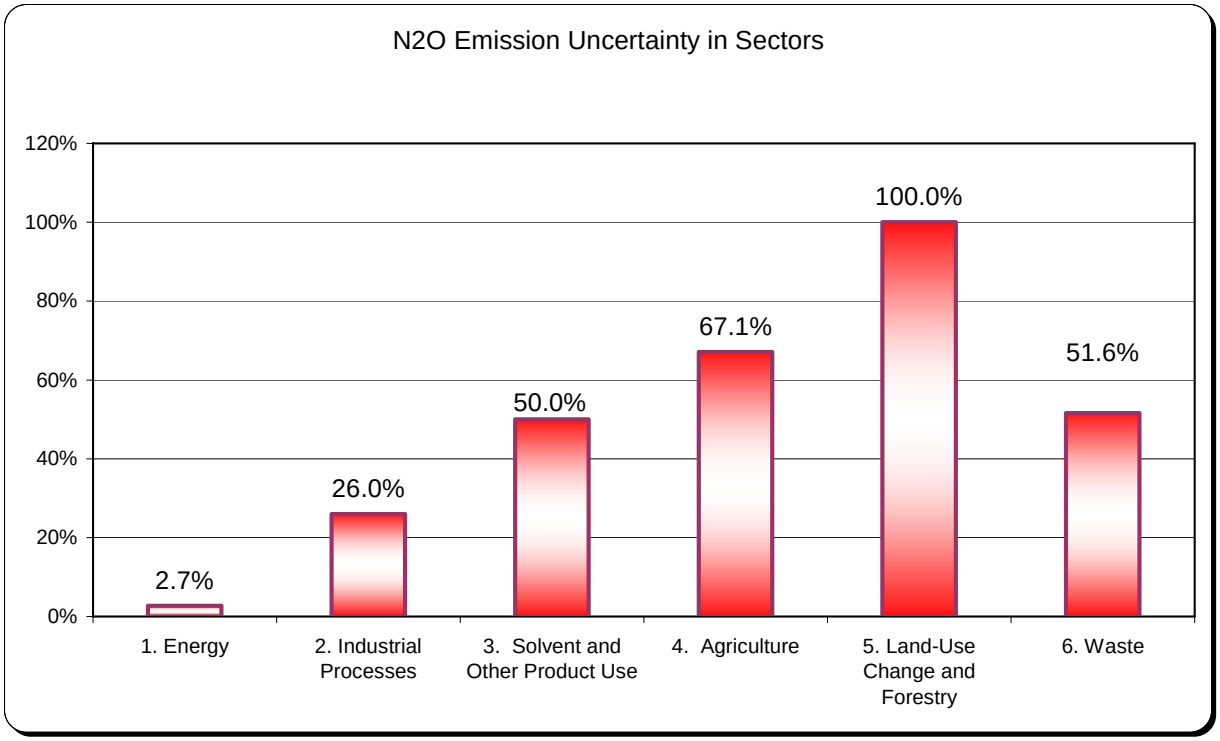
1992	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
3. Solvent and Other Product Use	**132.44**		**NA**						**434.57**		**0.40**	28.3%		50.0%	122.98	0.00	0.20
4. Agriculture										**777.04**	**81.07**		28.4%	67.1%	0.00	220.49	54.38
A. Enteric Fermentation										600.45			34.5%		0.00	207.18	0.00
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	4 257.0	5.0%		89.27			50.0%			380.00			50.2%		0.00	190.95	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 964.0	5.0%		39.09			50.0%			154.93			50.2%		0.00	77.85	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	1 870.0	5.0%		8.17			50.0%			15.29			50.2%		0.00	7.68	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	179.3	5.0%		5.00			50.0%			0.90			50.2%		0.00	0.45	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	900.0	5.0%		18.00			50.0%			16.20			50.2%		0.00	8.14	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	22 086.0	5.0%		1.50			50.0%			33.13			50.2%		0.00	16.65	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	203 372.6	5.0%		0.00			50.0%			0.00			50.2%		0.00	0.00	0.00
B. Manure Management										175.47	27.13		43.0%	148.8%	0.00	75.42	40.37
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	4 257	5.0%		5.29			50.0%			22.50			50.2%		0.00	11.31	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 964	5.0%		1.98			50.0%			7.84			50.2%		0.00	3.94	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	1 870	5.0%		0.17			50.0%			0.32			50.2%		0.00	0.16	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	179	5.0%		0.12			50.0%			0.02			50.2%		0.00	0.01	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	900	5.0%		1.39			50.0%			1.25			50.2%		0.00	0.63	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	22 086	5.0%		5.78			50.0%			127.67			50.2%		0.00	64.15	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	203 373	5.0%		0.08			50.0%			15.86			50.2%		0.00	7.97	0.00
11. Liquid Systems [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.001000			150.0%			0.24			150.1%	0.00	0.00	0.36
12. Solid Storage and Dry Lot [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.020000			150.0%			26.90			150.1%	0.00	0.00	40.37
D. Agricultural Soils											53.88			67.6%	0.00	0.00	36.44
1. Direct Soil Emissions															0.00	0.00	0.00
Synthetic Fertilizers [Activity in kg N, EF in kg N2O-N/kg N]	557 100 000	5.0%			0.01			150.0%			7.78			150.1%	0.00	0.00	11.68
Animal Wastes Applied to Soils [Activity in kg N, EF in kg N2O-N/kg N]	784 700 480	5.0%			0.01			150.0%			12.33			150.1%	0.00	0.00	18.51
N-fixing Crops [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	96 660 000	5.0%			0.01			150.0%			1.52			150.1%	0.00	0.00	2.28
Crop Residue [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	189 787 200	5.0%			0.01			150.0%			2.98			150.1%	0.00	0.00	4.48
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]	108 768 710	5.0%			0.02			150.0%			3.42			150.1%	0.00	0.00	5.13
3. Indirect Emissions [Activity in kg N/yr, EF in kg N2O/kg N]	83 653 742	20.0%			1.182473449			150.0%			9.89			151.3%			14.97
F. Field Burning of Agricultural Residues										1.12	0.06		21.1%	105.1%	0.00	0.24	0.06
1. Cereals															0.00	0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	7 368 000	30.0%		0.1816	0.0004		20.0%	150.0%		0.13	0.00		36.1%	153.0%	0.00	0.05	0.00
Barley [Activity in t of crop production, EF in kg/t dm]	2 819 000	30.0%		0.1473	0.0004		20.0%	150.0%		0.04	0.00		36.1%	153.0%	0.00	0.01	0.00
Maize [Activity in t of crop production, EF in kg/t dm]	206 000	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]	1 229 000	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]	3 981 000	30.0%		0.2004	0.0004		20.0%	150.0%		0.08	0.00		36.1%	153.0%	0.00	0.03	0.00
Other Cereals [Activity in t of crop production, EF in kg/t dm]	4 359 000	30.0%		0.1572	0.0004		20.0%	150.0%		0.07	0.00		36.1%	153.0%	0.00	0.02	0.00
2 Pulses (Other non-specified)	380 000	30.0%		0.0433	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]	23 388 000	30.0%		0.1796	0.0014		20.0%	150.0%		0.42	0.03		36.1%	153.0%	0.00	0.15	0.05
Sugar Beat [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, Tabacco, Hop, Hey [Activity in t of crop prod., EF in kg/ t of crop]	23 180 300	30.0%		0.0155	0.0007		20.0%	150.0%		0.36	0.02		36.1%	153.0%	0.00	0.13	0.02
													0.0%	0.0%	0.00	0.00	0.00
5. Land-Use Change and Forestry									**-36150.88**	**0.14**	**0.00**	59.8%	100.0%	100.0%	-21609.34	0.14	0.001
A. Forest Land									-42688.20			50.0%			-21344.10	0.00	0.000
B. Cropland									5592.87			50.0%			2796.43	0.00	0.000
C. Grassland									3103.34			50.0%			1551.67	0.00	0.000
D. Wetlands									0.00			50.0%			0.00	0.00	0.000
E. Settlements									-2158.88	0.14	0.0010	50.0%	100.0%	100.0%	-1079.44	0.14	0.001
F. Other Land									0.00	0.00	0.0000	50.0%	100.0%	100.0%	0.00	0.00	0.000
6. Waste									**393.57**	**496.25**	**3.65**	51.0%	64.2%	51.6%	200.68	318.56	1.88
A. Solid Waste Disposal on Land										244.78			102.6%		0.00	251.17	0.00
1 Managed Waste Disposal on Land [Activity in Gg, EF in t/t MSW]							100.0%						100.0%		0.00	0.00	0.00
2 Unmanaged Waste Disposal Sites - deep (>5 m) [Activity in Gg, EF in t/t MSW]															0.00	0.00	0.00
3 Other - Total Waste Disposal on Land (Draft Guidlines 2006) [Activity in Gg, EF in t/t MSW]	10 610.38	23.0%					100.0%			244.78			102.6%		0.00	251.17	0.00
B. Wastewater Handling										251.47	3.60		77.9%	52.2%	0.00	195.94	1.88
Industrial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	2 022.70			0.09			100.0%			182.04			100.0%		0.00	182.04	0.00
Domestic and Commercial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	302.29	30.0%		0.229668821			100.0%			69.43			104.4%		0.00	72.48	0.00
sewage N produced]	38 418.00	15.0%			0.0000938			50.0%			3.60			52.2%	0.00	0.00	1.88
C. Waste Incineration									393.57		0.04	51.0%		27.2%	200.68	0.00	0.01
biogenic [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			105.82		0.00	51.0%		30.0%	53.96	0.00	0.00
plastics and other non-biogenic waste [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			393.57		0.04	51.0%		30.0%	200.68	0.00	0.01



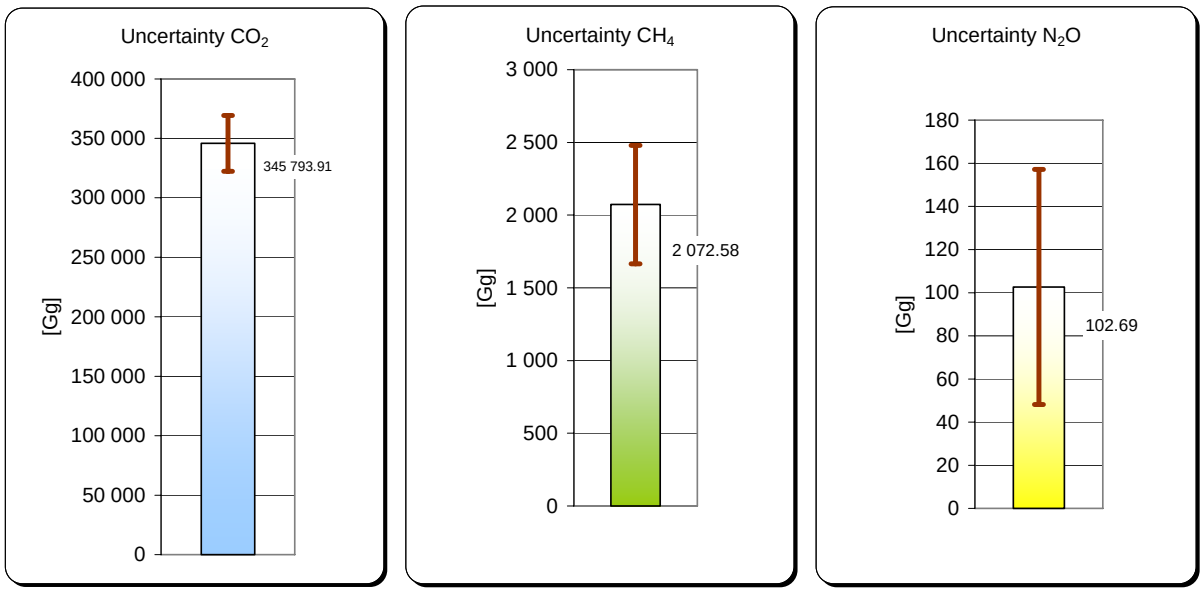
Results of uncertainty analysis in percents for CO_2 with sectoral split.



Results of uncertainty analysis in percents for CH_4 with sectoral split.



Results of uncertainty analysis in percents for N_2O with sectoral split



Emission results with uncertainties bars.