KASHUE

INSTYTUT OCHRONY ŚRODOWISKA
INSTITUTE OF ENVIRONMENTAL PROTECTION

NATIONAL ADMINISTRATION OF THE EMISSIONS TRADING SCHEME

NATIONAL EMISSION CENTRE

Poland's
National Inventory Report 2006

Submission under
the United Nations Framework
Convention on Climate Change
and the Kyoto Protocol

**Krzysztof Olendrzyński, Iwona Kargulewicz, Jacek Skośkiewicz,
Bogusław Dębski, Joanna Cieślińska, Anna Olecka,
Monika Kanafa, Katarzyna Kania**

April 2008

Table of contents

Executive Summary

ES.1 Background information on greenhouse gas inventories and climate change

This report - National Inventory Report (NIR) - presents the results of the national emission inventory of greenhouse gases (GHGs) in Poland in 2006. The inventory covers the following GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons - HFCs (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, HCF227ea), perfluorocarbons - PFCs (perfluoromethane (CF_4), perfluoroethane (C_2F_6), perfluorobutane (C_4F_{10}), and sulphur hexafluoride (SF_6). The following GHG precursors are also reported: carbon monoxide - CO, nitrogen oxides (NO + NO_2) - NO_X, non-methane volatile organic compounds - NMVOC and sulphur dioxide - SO_2.

The national inventory and accompanying tables of Common Reporting Format (CRF), have been prepared in accordance with the UNFCCC reporting guidelines on annual inventories (FCCC/SBSTA/2006/9). 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 giving more accurate emission data.

ES.2 National GHG emissions and trends

The GHG emissions in base year 1988 (and 1995 for industrial gases) and 2006, expressed as CO_2 equivalents, are presented in table ES.1 In 2006 the total national emission of GHG were about 400.46 million tones of CO_2-eq., excluding GHG emissions and sinks from category 5 (Land use, land use change and and forestry). Compared to the base year (1988/1995), the 2006 emissions have decreased by 28.9%.

Table ES.1 National emissions of greenhouse gases for the base year 1988/1995 and 2006. [Gg CO_2 eq.]

Pollutant	Base year	2006	(2006-base)/base [%]
	Emission in CO_2 eq. [Gg]	Emission in CO_2 eq. [Gg]	
CO2 – net emission (with LULUCF)	436 209.10	287 641.12	-34.06
CO2 – without LULUCF.	469 143.82	330 523.56	-29.55
CH4 - net emission (with LULUCF)	53 672.51	39 584.34	-26.25
CH4 - without LULUCF	53 665.03	37 209.50	-30.66
N2O - net emission (with LULUCF)	40 334.29	29 585.79	-26.65
N2O - without LULUCF	40 333.53	29 582.98	-26.65
HFCs	26.44	2 843.53	10654.10
PFCs	250.18	269.75	7.82
SF_6	23.77	30.02	26.33
TOTAL net emission (with LULUCF)	530 516.30	359 954.55	-32.15
TOTAL without LULUCF	563 442.77	400 459.34	-28.93

Trend of aggregated greenhouse gases emissions follows the trend of emissions CO_2 alone which is a primary greenhouse gas emitted in Poland. The GHGs trend for entire inventoried period indicate dramatic decrease between 1988 and 1990 triggered by significant economical changes, especially in heavy industry, related to political transformation from centralized to market economy. This drop in emissions continued up to 1993 and then emissions started to rise with peak in 1996 as a result of modernization processes implemented in heavy industry and other sectors and dynamic economic growth. The succeeding years characterise slow decline in emissions up to 2002, when still energy efficiency policies and measures were implemented, and then slight increase up to 2006 again caused by animated economic development (figure ES.1).

Table S.2 National emissions of greenhouse gases for 1988–2006 according to gases [Gg CO_2 eq.]

GHG	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]
CO2 – net emission (with LULUCF)	436 209.10	411 428.65	343 491.15	336 752.52	329 182.45	342 161.83	337 815.05	343 170.39	350 524.52	342 678.42
CO2 – without LULUCF.	469 143.82	446 920.74	368 678.29	368 172.99	359 597.18	366 036.20	361 535.23	366 096.76	374 856.68	368 565.72
CH4 - net emission (with LULUCF)	53 672.51	52 648.93	49 864.38	48 290.86	46 093.39	45 849.82	45 998.27	45 840.66	45 319.41	45 506.48
CH4 - without LULUCF	53 665.03	52 645.05	47 708.93	46 129.61	43 907.39	43 668.12	43 806.05	43 642.25	43 110.10	43 274.99
N2O - net emission (with LULUCF)	40 334.29	41 799.48	37 194.34	31 769.50	29 746.14	29 384.90	29 715.38	30 566.42	30 109.64	30 436.48
N2O - without LULUCF	40 333.53	41 799.09	37 187.29	31 763.36	29 736.64	29 379.16	29 710.03	30 561.90	30 104.73	30 432.76
HFCs	26.44							26.44	96.82	153.56
PFCs	250.18							250.18	235.68	248.89
SF6	23.77							30.53	24.93	24.02
TOTAL net emission (with LULUCF)	**530 516.30**	**505 877.06**	**430 549.87**	**416 812.87**	**405 021.97**	**417 396.54**	**413 528.70**	**419 884.62**	**426 311.02**	**419 047.85**
TOTAL without LULUCF	**563 442.77**	**541 364.88**	**453 574.52**	**446 065.97**	**433 241.21**	**439 083.48**	**435 051.32**	**440 608.05**	**448 428.94**	**442 699.93**

GHG	1998	1999	2000	2001	2002	2003	2004	2005	2006
	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]	CO2 eq. [Gg]
CO2 – net emission (with LULUCF)	314 794.54	302 216.83	293 868.12	290 634.51	273 513.69	283 519.30	280 436.90	279 944.40	287 641.12
CO2 – without LULUCF.	340 612.11	328 877.12	320 365.45	316 821.50	305 578.05	316 690.93	316 872.77	317 669.35	330 523.56
CH4 - net emission (with LULUCF)	44 575.10	44 182.45	41 253.43	40 218.23	39 493.42	40 001.97	39 159.80	39 392.14	39 584.34
CH4 - without LULUCF	42 352.93	41 943.42	38 995.85	37 941.88	37 209.37	37 682.23	36 827.62	37 043.59	37 209.50
N2O - net emission (with LULUCF)	30 181.54	29 293.99	29 287.96	29 380.88	27 969.43	28 072.61	27 786.49	28 343.23	29 585.79
N2O - without LULUCF	30 178.53	29 291.01	29 285.10	29 378.39	27 966.75	28 068.13	27 783.95	28 340.44	29 582.98
HFCs	167.02	206.44	594.67	1 073.35	1 519.44	1 816.23	2 413.78	3 015.46	2 843.53
PFCs	251.20	239.79	224.40	269.95	286.50	278.34	285.05	259.95	269.75
SF6	25.08	24.64	24.18	23.96	24.42	21.72	23.43	28.09	30.02
TOTAL net emission (with LULUCF)	**389 994.48**	**376 164.14**	**365 252.76**	**361 600.88**	**342 806.90**	**353 710.15**	**350 105.44**	**350 983.28**	**359 954.55**
TOTAL without LULUCF	**413 586.87**	**400 582.42**	**389 489.65**	**385 509.03**	**372 584.54**	**384 557.58**	**384 206.59**	**386 356.89**	**400 459.34**

Table S.3 National emissions of greenhouse gases for 1988–2006 according to IPCC categories [Gg CO_2 eq.]

IPCC sector	1988 CO2 eq. [Gg]	1989 CO2 eq. [Gg]	1990 CO2 eq. [Gg]	1991 CO2 eq. [Gg]	1992 CO2 eq. [Gg]	1993 CO2 eq. [Gg]	1994 CO2 eq. [Gg]	1995 CO2 eq. [Gg]	1996 CO2 eq. [Gg]	1997 CO2 eq. [Gg]
1. Energy	470 309.06	446 900.54	369 656.97	372 035.02	363 081.92	371 271.08	365 483.73	368 761.33	379 144.78	371 494.14
2. Industrial Processes	32 832.19	31 694.48	24 324.20	20 599.48	19 980.46	19 944.13	21 394.41	23 849.77	22 437.70	23 352.75
3. Solvent and Other Product Use	1 006.46	946.14	629.23	608.22	558.57	519.36	521.05	524.80	547.11	542.72
4. Agriculture	50 893.90	53 347.89	49 358.66	42 912.49	39 640.18	37 264.74	37 584.80	37 487.20	36 234.78	37 026.25
5. Land-Use, Land-Use Change and Forestry	-32 926.48	-35 487.83	-23 024.65	-29 253.10	-28 219.24	-21 686.94	-21 522.61	-20 723.44	-22 117.93	-23 652.08
6. Waste	8 401.16	8 475.83	9 605.45	9 910.76	9 980.07	10 084.17	10 067.33	9 984.95	10 064.57	10 284.07
TOTAL net emission (with LULUCF)	**530 516.30**	**505 877.06**	**430 549.87**	**416 812.87**	**405 021.97**	**417 396.54**	**413 528.70**	**419 884.62**	**426 311.02**	**419 047.85**

IPCC sector	1998 CO2 eq. [Gg]	1999 CO2 eq. [Gg]	2000 CO2 eq. [Gg]	2001 CO2 eq. [Gg]	2002 CO2 eq. [Gg]	2003 CO2 eq. [Gg]	2004 CO2 eq. [Gg]	2005 CO2 eq. [Gg]	2006 CO2 eq. [Gg]
1. Energy	344 178.25	333 441.91	321 960.66	320 195.48	309 094.81	319 011.45	318 824.56	318 945.90	329 839.89
2. Industrial Processes	20 875.61	19 820.25	22 990.69	21 083.75	19 622.82	22 562.15	23 804.26	25 344.85	27 217.63
3. Solvent and Other Product Use	543.39	535.04	616.09	637.21	664.25	647.39	704.67	705.75	705.75
4. Agriculture	37 416.23	36 099.72	34 327.69	33 963.89	33 562.14	32 794.26	32 157.22	32 743.59	34 291.22
5. Land-Use, Land-Use Change and Forestry	-23 592.39	-24 418.28	-24 236.89	-23 908.15	-29 777.64	-30 847.42	-34 101.15	-35 373.61	-40 504.79
6. Waste	10 573.40	10 685.49	9 594.53	9 628.70	9 640.52	9 542.33	8 715.87	8 616.80	8 404.85
TOTAL net emission (with LULUCF)	**389 994.48**	**376 164.14**	**365 252.76**	**361 600.88**	**342 806.90**	**353 710.15**	**350 105.44**	**350 983.28**	**359 954.55**

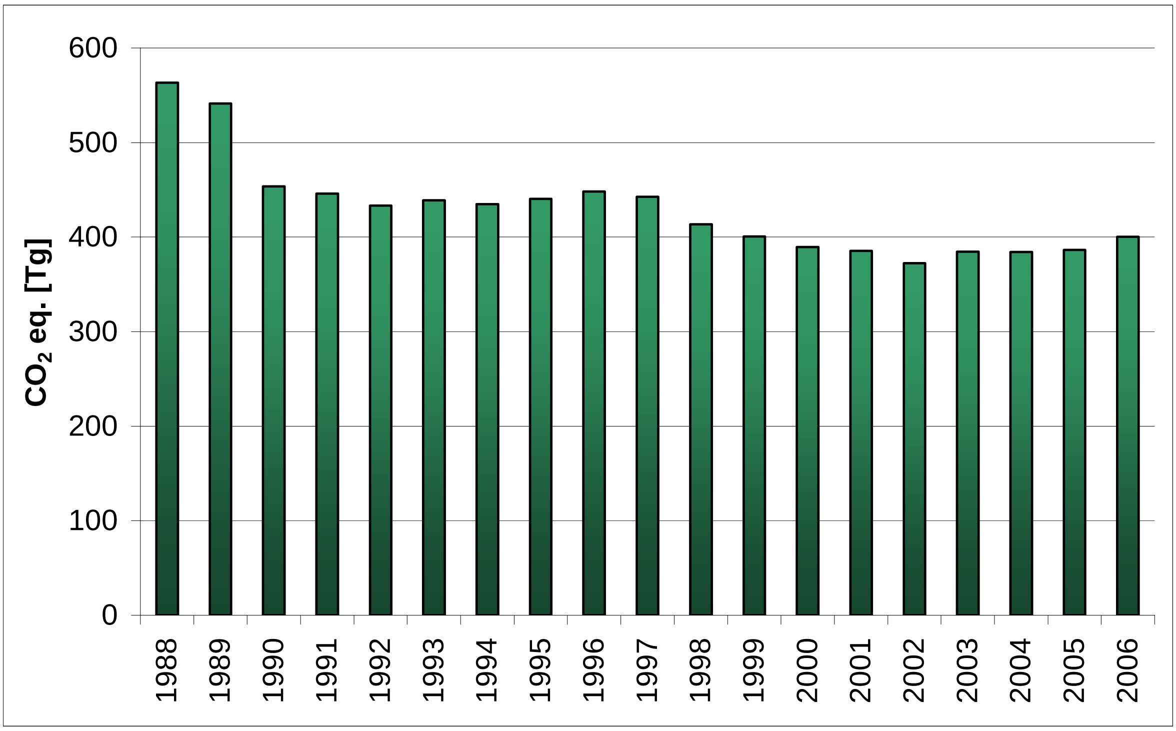


Figure ES.1. Trend of aggregated GHGs emissions excluding category 5 for 1988–2006 [Tg CO_2 eq.]

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

Carbon dioxide emissions

The CO_2 emissions (excluding category 5) in 2006 were estimated as 330.52 million tones. This is 29.5% lower than in the base year. CO_2 emission (excluding category 5) was accounted for 82.5% of total GHG emissions in Poland in 2006. The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission by 93.89% in 2006. The shares of the main subcategories were as follows: *Energy industries* – 56.7%, *Manufacture Industries and Construction* – 10.2%, *Transport* – 11.3% and *Other Sectors* – 15.7%. *Industrial Processes* contributed to the total CO_2 emission by 5.8% in 2006. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO_2 removal in LULUCF sector in 2006, was calculated to be approximately 42.9 million tones. It means that app. 10.7% of the total CO_2 emissions are offset by CO_2 uptake by forests.

Methane emissions

The CH_4 emission (including category 5) amounted to 1 884.97 Gg in 2006 i.e. 39.58 million tones of CO_2 equivalents. The contribution of CH_4 to the national total GHG emission was 11.0% in 2006. Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed 34.4%, 32.7% and 18.5% to the national methane emission in 2006, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (23.4% of total CH_4 emission) and Oil and Natural Gas system (1.0% of total CH_4 emission). Waste disposal sites contributed to 15.9% of the methane emission from total CH_4 emission and Wastewater Handling contributed to 2.6% of total CH_4 emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 23.2% of total CH_4 emission in 2006.

Nitrous oxide emissions

The nitrous oxide emissions (including category 5) in 2006 were 95.44 Gg i.e. 29.59 million tonnes of CO_2 equivalents. The emission was app. 26.6% lower than the respective figure for the base year. The contribution of N_2O to the national total GHG emission was 8.2% in 2006. The main N_2O emission sources and its shares in total N_2O emission in 2006 are as follow: *Agricultural Soils* – 51.6%, *Manure Management* – 20.6%, *Chemical Industry* – 15.7% and *Fuel Combustion* – 9.1%.

Hydrofluorocarbons (HFCs) emissions

The total emission of HFCs in 2006 was 2.84 million tones CO_2 equivalents. The contribution of HFCs to the national total GHG emission in 2006 was relatively low and has been estimated at 0.79%. The emissions of HFCs-gases had increased 108 times between the base year (1995) and 2006. This significant growth in HFCs emission is mainly due to the increase of emission from refrigeration and air conditioning equipment.

Perfluorocarbons (PFCs) emissions

The total emission of PFCs in 2006 was 0.27 million tonnes of CO_2 equivalents. The contribution of PFCs to the national total GHG emission in 2006 was 0.07%. The emission of PFCs had fluctuated to a limited extend, and followed the trends in aluminium production-its main source. The emission changes between 2006 and the preceding years depend on the aluminium production levels (main PFC source) and the use of C_4F_{10} in fire extinguishers

Sulphur hexafluoride emissions

The total emission of SF_6 in 2006 was 0.03 million tones of CO_2 equivalents. The contribution of SF_6 to the national total GHG emission is insignificant, and in 2006 amounted to app. 0.008%. SF_6 emissions in 2006 were by 1.3 times higher than in 1995. Leakage from electrical equipment during its use and production is the main SF_6 emission source.

ES.4 Indirect greenhouse gases emissions

Generally emissions of all GHG precursors (CO, NO_x, NMLZO and SO_2) have decreased since 1980 (and since 1990 for CO). The biggest drop characterises emissions of SO_2, which decreased by about 71% between 1980 and 2006, and 63% between 1990 and 2006. Most of the reductions were caused by the decline of 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 about 28% between 1980 and 2006, and 30% between 1990 and 2006. Similar to sulphur dioxide, most of the reductions were triggered by the decline of the heavy industry in the late 1980s and early 1990s and lower share of coal in late 1990s. Increasing emissions from road traffic contribute to the national total, and cause comparatively lower emission reductions than in case of SO_2. Similarly emissions of NMVOC decreased by 42% between 1980–2006 and by 27% between 1990–2006 and CO emissions drop by about 62% between 1990–2006

1. Introduction

1.1 Background information on greenhouse gas inventories and climate change

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 of greenhouse gases of anthropogenic origin made by Parties to the Convention. The report has been prepared according to updated reporting guidelines on annual inventories contained in the document FCCC/SBSTA/2006/9 on 18.08.2006 (following incorporation of the provisions of decision 14/CP.11).

The report and underlying CRF tables have been prepared of the following GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons - HFCs (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, HCF227ea, HFC-365mfc and HFC-245fa), perfluorocarbons - PFCs (perfluoromethane (CF_4), perfluoroethane (C_2F_6), perfluorobutane (C_4F_{10}), and sulphur hexafluoride (SF_6). The GHG precursors, in turn, are: carbon monoxide - CO, nitrogen oxides (NO + NO_2) - NO_X, non-methane volatile organic compounds - NMVOC and sulphur dioxide - SO_2.

1.2 A description of institutional arrangement for inventory preparation

GHG inventory is compiled annually by the National Emission Centre (NEC) located in the Institute of Environmental Protection in Warsaw. Since 2000 the NEC has been commissioned by the Ministry of Environment (MoE) on a yearly basis contracts to carry out national emission inventories for the GHGs and other air pollutants. Since 2006 NEC is located within the National Administrator of Emission Trading Scheme (NAETS) established also in the Institute of Environmental Protection based on *Ordinance of 13 September 2005* to the *Act of 22 December 2004 on emission allowance trading system for greenhouse gases and other substances*. The tasks of the NEC as compiling and submitting GHG inventories are defined in the agreement with the Ministry of Environment and National Fund for Environmental Protection and Water Management in Warsaw signed in 2000 and updated in analogous agreement signed in 2006.

The emission calculation, choices of activity data, emission factors and methodology are performed by the NEC staff. The NEC is also collaborating with a number of individual experts as well as institutions when compiling inventories. 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). These institutions are mainly involved in providing activity data for inventory estimates. The NEC, as a subunit of the NAETS, has access to the individual data of entities participating in the European Union Emission Trading Scheme (EU-ETS). This ensures availability of data for major sources in emissions from stationary combustion sectors (1.A.1, 1.A.2) as well as from specific industrial processes. Such data are successively included into GHG inventory where possible after verification.

Prior to submission the elaborated inventories undergo internal process for the official consideration and approval. The responsibility for approval GHG inventories lies on the Ministry of Environment.

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 abbreviations NO and NE were used in tables. More detail description of methodologies used in Polish GHG inventory is 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: brown coal (lignite), natural gas, coke-oven gas and blast furnace 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 Hard coal consumption

Evaluation of fuel consumption in national combustion processes	Hard coal - Eurostat	
	10^3 Mg	TJ
In	100 494	2 438 377
From national sources	95 223	2 302 016
1) Indigenous production	94 407	2 282 289
2) Transformation output or return	816	19 727
3) Stock decrease	0	0
Import	5 271	136 361
Out	100 494	2 438 377
National consumption	83 694	2 028 323
1) Transformation input	65 915	1 577 397
a) input for secondary fuel production	12 798	378 744
b) fuel combustion	53 117	1 198 653
2) Direct consumption	17 779	450 925
Non-energy use	21	495
Combusted directly	17 758	450 431
Combusted in Poland	70 875	1 649 084
Stock increase	-2 371	-57 319
Export	16 735	464 513
Losses and statistical differences	2 436	2 860
Net calorific value	MJ/kg lub MJ/m3	23.27

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 (coal and lignite). 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 ways 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 Eurostat database and 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.

Eurostat database containing domestic data transferred by GUS is the main source of activity data for *Energy* sector (Annex 3). 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

The programme for Quality Assurance and Quality Control has been elaborated to improve and assure high quality of the Polish annual greenhouse gas inventory. It has been elaborated in line with the *IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories* (2000). The QA/QC programme contains tasks, responsibilities as well as time schedule for performance of the QA/QC procedures. More detailed information on the QA/QC plan and activities is described in Annex 4. Therefore no additional information on QA/QC within particular sectors is given.

The Polish inventory is generated in two main steps. First calculations are produced around 9–11 months after the end of the inventoried year (n–1) depending primarily on the availability of required activity data. Initial check of activity data and estimation procedures is then done. When the official statistics are available the revision of data is made and final inventory is produced up 12 months after given year. Additionally the recalculations of the previous inventories for selected categories are performed because of methodological changes and improvements.

Based on recommendations of the *IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories* the following elements of the Quality Assurance and Quality Control system has been addressed:

- Inventory agency responsible for coordinating QA/QC activities,
- QA/QC plan,
- General QC procedures (Tier 1),
- Source category-specific QC procedures (Tier 2),
- QA review procedures,
- Reporting, documentation and archiving procedures.

The national entity – National Emission Centre (NEC) – which is responsible for preparation of GHG inventories (see Chapter 1.2), is also responsible for coordination and implementing the QA/QC activities. QA/QC Plan elaborated by NEC was approved by the Ministry of Environment in 2007.

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

Uncertainty evaluation made for 2006 is based on calculations and national expert's judgements/estimations as well as opinions expressed by international experts under UNFCCC Secretariat during in-depth review made in 2007. Calculations include simplified method for sector 5 and for fluorinated gases.

In Annex 5, the estimate of emission uncertainty for the year 2006 using *Tier 1* approach is given. The uncertainty figures varied significantly among various source categories. More details, including sectoral information on uncertainty ranges, are given in Annex 5, so no additional information is presented within sectoral chapters.

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 are 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 from *Coal Mining and Handling* (CRF 1.B.1.a)
- CO_2 and CH_4 from *Solid Fuel Transformation* (CRF 1.B.1.b)
- some individual processes in *Oil and Natural Gas* systems (CRF 1.B.2.a i b)

in *Industrial Processes*:

- *CO_2 from Asphalt Roofing* (CRF 2.A.5)
- CO_2 from *Road Paving with Asphalt* (CRF 2.A.6)
- CH_4 from *Aluminium Production* (CRF 2.C.3)
- CO_2 from *Food and Drink Production* (CRF 2.D.2)
- some minor gaps in estimation of the emissions of HFCs, PFCs, SF_6 (CRF 2.F)

in *Agriculture*

- CH_4 from *Agriculture Soils* (CRF 4.D)

in *Waste*

- N_2O from *Industrial Wastewater* (CRF 6.B.1)
- CH_4 from *Waste Incineration* (CRF 6.C)

1.9 Assigned amount information for the Kyoto Protocol purpose

According to the Kyoto Protocol Poland is obliged to reduce its greenhouse gases emissions in 2008–1012 by 6% comparing to the base year, 1988 (and 1995 year for industrial gases). Following decision 13/CMP.1 Poland submitted its Initial Report in December 2006 containing, among others, assigned amount calculated in accordance with Article 3 paragraphs 7 and 8 of the Kyoto Protocol. After revision of the Initial Report and GHGs inventories for 1988–2004 by the Expert Review Team in 2007 and after applying recommended amendments and improvements for the base year 1988/1995 (as well as for entire series) **Poland's assigned amount for 2008–2012 is 2,648,181.038 tonnes CO_2 eq.** [IRR 2007].

1.10 Registry information

One of the main responsibilities of the National Administrator of Emission Trading Scheme established in the Institute of Environmental protection in 2006 is to create and maintain the national registry to track Polish holdings and transactions of the Kyoto Protocol units.

As the registering system, the French software SERINGAS has been chosen, created by computer science department of Caisse des Dépôts et Consignations. Tests connected with accreditation of the National Registry took place in May 2006, and on 16 May the National Administrator received a Certificate of Conformity i.e. the system is fully compliant with CITL. Initialization test in frames of the Kyoto Protocol was completed on 28 November 2007.

More detailed description of the National Registry can be found in Annex B to the *Poland's Initial Report* available at the UNFCCC website. Technical assessment of the national registry, including results of standardized testing, is described in the *Independent Assessment Report of the national registry of Poland* [IAR 2007]. Expert Review Team reviewing Polish Initial report in 2007 concluded that **Poland's national registry is fully compliant with the registry requirements** as defined by decisions 13/CMP.1 and 5/CMP.1.

In 2006 – 2007 Polish National Registry has not issued, held, acquired, cancelled, retired or transferred any AAU, RMU, ERU or CER units.

2. Greenhouse gas emissions and removals in 2006

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, Land Use Change and Forestry - LULUCF). 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 79.9% (including category 5) share (in 2006), while the methane contributes with 11.0% (including category 5) to the national total. Nitrous oxide contribution is 8.2% (including category 5) and all industrial GHG together contribute 0.9%.

Table 2.1 Greenhouse gas emissions in 2006 in CO_2 eq.

Pollutant	2006	
	Emission in CO_2 eq. [Gg]	Share [%]
CO2 – net emission (with LULUCF)	287 641.12	79.91
CO2 – without LULUCF.	330 523.56	82.54
CH4 - net emission (with LULUCF)	39 584.34	11.00
CH4 - without LULUCF	37 209.50	9.29
N2O - net emission (with LULUCF)	29 585.79	8.22
N2O - without LULUCF	29 582.98	7.39
HFCs	2 843.53	0.79
PFCs	269.75	0.07
SF_6	30.02	0.01
TOTAL net emission (with LULUCF)	359 954.55	100.00
TOTAL without LULUCF	400 459.34	100.00

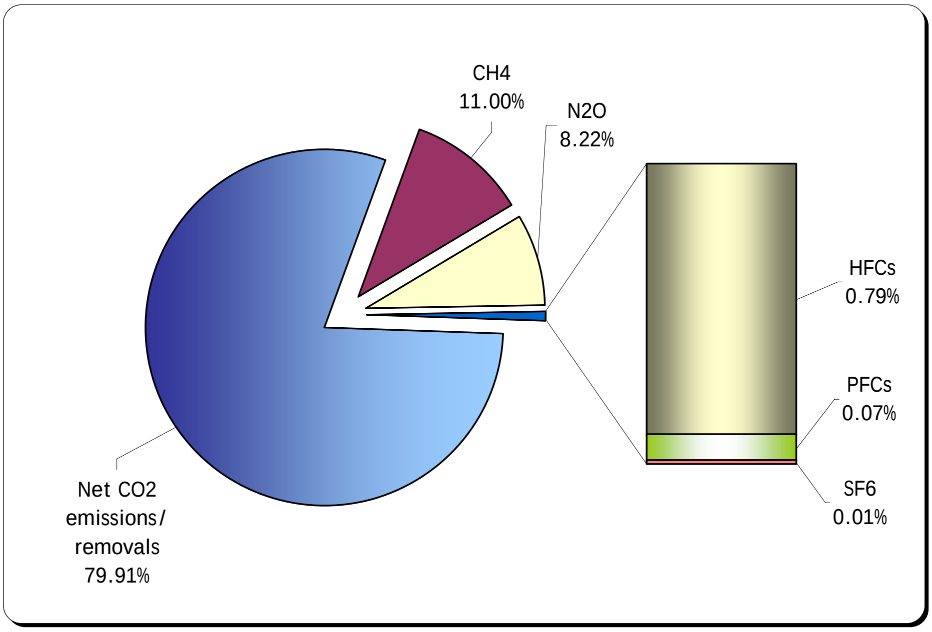


Figure 2.1. Percentage share of greenhouse gases in national total emission total in 2006 (including category 5)

Emissions of main GHGs in 2006, disaggregated into main source sub-sectors, are given in table 2.2. Respective values for the industrial gases are presented in table 2.3. Discussion of these results is given in the following section

Table 2.2 Emissions of CO_2, CH_4 and N_2O in 2006 [Gg]

[Gg]	CO_2	CH_4	N_2O
TOTAL without LULUCF	330 523.56	1 771.88	95.43
1. Energy	310 592.29	788.34	8.69
A. Fuel Combustion	310 341.40	139.30	8.69
1. Energy Industries	187 500.65	2.91	2.77
2. Manufacturing Industries and Construction	33 724.50	3.70	0.68
3. Transport	37 381.40	5.48	3.63
4. Other Sectors	51 734.87	127.22	1.61
5. Other	NA, NO	NA, NO	NA, NO
B. Fugitive Emissions from Fuels	250.88	649.04	NE
1. Solid Fuels	1.34	441.54	NE
2. Oil and Natural Gas	249.55	207.50	NE
2. Industrial Processes	19 040.21	18.35	15.00
A. Mineral Products	9 147.39	NE	NE
B. Chemical Industry	4 276.75	12.35	15.00
C. Metal Production	4 471.88	6.00	NE
D. Other Production	0.05	NE	NE
G. Other	1 144.14	NE	NE
3. Solvent and Other Product Use	581.75	NE	0.40
4. Agriculture	NE	615.68	68.91
A. Enteric Fermentation	NE	436.56	NE
B. Manure Management	NE	178.02	19.66
D. Agricultural Soils	NE	NE	49.21
F. Field Burning of Agricultural Residues	NE	1.10	0.04
5. Land Use, Land-Use Change and Forestry	-42 882.45	113.09	0.009
A. Forest Land	-54 266.11	0.14	0.002
B. Cropland	8 237.09	NE	NE
C. Grassland	130.54	0.12	0.00001
D. Wetlands	3 090.49	112.83	0.007
E. Settlements	-74.45	NE	NE
F. Other Land	NE	NE	NE
6. Waste	309.32	349.51	2.44
A. Solid Waste Disposal on Land	NE	300.24	NE
B. Wastewater Handling	NE	49.27	2.34
C. Waste Incineration	309.32	NE	0.09

Table 2.3 Emissions of industrial gases: HFCs, PFCs and SF_6 in 2006 [eq. Gg]

2006	HFCs	PFCs	SF_6	Total in eq. CO_2
Total Industrial gases [Gg eq. CO_2]	2 843.53	269.75	30.02	3 143.30
C. Metal Production	NE	253.19	1.30	254.49
3. Aluminium Production	NE	253.19	1.30	254.49
F. Consumption of Halocarbons and SF_6	2 843.53	16.56	28.72	2 888.81
1. Refrigeration and Air Conditioning Equipment	2 195.75	NE	NE	2 195.75
2. Foam Blowing	290.78	NE	NE	290.78
3. Fire Extinguishers	11.48	16.56	NE	28.04
4. Aerosols	345.51	NE	NE	345.51
8. Electrical Equipment	NE	NE	28.72	28.72

As a supplement to the tables 2.2 and 2.3, table 2.4 includes percentage contributions of main source sectors to the national totals in 2006 for CO_2, CH_4 and N_2O.

Table 2.4 Percentage shares of individual source sectors in 2006 emissions

Percentage share of emissions of source sectors in current year	Share [%]		
	CO2 with LULUCF	CH4 with LULUCF	N2O with LULUCF
TOTAL	100.00	100.00	100.00
1. Energy	107.98	41.82	9.10
A. Fuel Combustion	107.89	7.39	9.10
1. Energy Industries	65.19	0.15	2.90
2. Manufacturing Industries and Construction	11.72	0.20	0.71
3. Transport	13.00	0.29	3.80
4. Other Sectors	17.99	6.75	1.69
5. Other	NE	NE	NE
B. Fugitive Emissions from Fuels	0.09	34.43	NE
1. Solid Fuels	NE	23.42	NE
2. Oil and Natural Gas	0.09	11.01	NE
2. Industrial Processes	6.62	0.97	15.71
A. Mineral Products	3.18	NE	NE
B. Chemical Industry	1.49	0.65	15.71
C. Metal Production	1.55	0.32	NE
D. Other Production	0.00	NE	NE
G. Other	0.40	NE	NE
3. Solvent and Other Product Use	0.20	NE	0.42
4. Agriculture	NE	32.66	72.20
A. Enteric Fermentation	NE	23.16	NE
B. Manure Management	NE	9.44	20.60
D. Agricultural Soils	NE	NE	51.56
F. Field Burning of Agricultural Residues	NE	0.06	0.05
5. Land Use, Land-Use Change and Forestry	-14.91	6.00	0.010
A. Forest Land	-18.87	0.01	0.002
B. Cropland	2.86	NE	NE
C. Grassland	0.05	0.01	0.00001
D. Wetlands	1.07	5.99	0.007
E. Settlements	-0.03	NE	NE
F. Other Land	NE	NE	NE
6. Waste	0.11	18.54	2.55
A. Solid Waste Disposal on Land	NE	15.93	NE
B. Wastewater Handling	NE	2.61	2.46
C. Waste Incineration	0.11	NE	0.10

Trend of aggregated greenhouse gases emissions follows the trend of emissions CO_2 alone which is a primary greenhouse gas emitted in Poland. The GHGs trend for entire inventoried period indicate dramatic decrease between 1988 and 1990 triggered by significant economical changes, especially in heavy industry, related to political transformation from centralized to market economy. This drop in emissions continued up to 1993 and then emissions started to rise with peak in 1996 as a result of modernization processes implemented in heavy industry and other sectors and dynamic economic growth. The succeeding years characterise slow decline in emissions up to 2002, when still energy efficiency policies and measures were implemented, and then slight increase up to 2006 again caused by animated economic development (figure 2.2 and tables 2.5 and 2.6).

Table 2.5. National emissions of greenhouse gases for 1988–2006 according to gases [Gg CO_2 eq.]

GHG	1988 CO2 eq. [Gg]	1989 CO2 eq. [Gg]	1990 CO2 eq. [Gg]	1991 CO2 eq. [Gg]	1992 CO2 eq. [Gg]	1993 CO2 eq. [Gg]	1994 CO2 eq. [Gg]	1995 CO2 eq. [Gg]	1996 CO2 eq. [Gg]	1997 CO2 eq. [Gg]
CO2 – net emission (with LULUCF)	436 209.10	411 428.65	343 491.15	336 752.52	329 182.45	342 161.83	337 815.05	343 170.39	350 524.52	342 678.42
CO2 – without LULUCF.	469 143.82	446 920.74	368 678.29	368 172.99	359 597.18	366 036.20	361 535.23	366 096.76	374 856.68	368 565.72
CH4 - net emission (with LULUCF)	53 672.51	52 648.93	49 864.38	48 290.86	46 093.39	45 849.82	45 998.27	45 840.66	45 319.41	45 506.48
CH4 - without LULUCF	53 665.03	52 645.05	47 708.93	46 129.61	43 907.39	43 668.12	43 806.05	43 642.25	43 110.10	43 274.99
N2O - net emission (with LULUCF)	40 334.29	41 799.48	37 194.34	31 769.50	29 746.14	29 384.90	29 715.38	30 566.42	30 109.64	30 436.48
N2O - without LULUCF	40 333.53	41 799.09	37 187.29	31 763.36	29 736.64	29 379.16	29 710.03	30 561.90	30 104.73	30 432.76
HFCs	26.44							26.44	96.82	153.56
PFCs	250.18							250.18	235.68	248.89
SF6	23.77							30.53	24.93	24.02
TOTAL net emission (with LULUCF)	**530 516.30**	**505 877.06**	**430 549.87**	**416 812.87**	**405 021.97**	**417 396.54**	**413 528.70**	**419 884.62**	**426 311.02**	**419 047.85**
TOTAL without LULUCF	**563 442.77**	**541 364.88**	**453 574.52**	**446 065.97**	**433 241.21**	**439 083.48**	**435 051.32**	**440 608.05**	**448 428.94**	**442 699.93**

GHG	1998 CO2 eq. [Gg]	1999 CO2 eq. [Gg]	2000 CO2 eq. [Gg]	2001 CO2 eq. [Gg]	2002 CO2 eq. [Gg]	2003 CO2 eq. [Gg]	2004 CO2 eq. [Gg]	2005 CO2 eq. [Gg]	2006 CO2 eq. [Gg]
CO2 – net emission (with LULUCF)	314 794.54	302 216.83	293 868.12	290 634.51	273 513.69	283 519.30	280 436.90	279 944.40	287 641.12
CO2 – without LULUCF.	340 612.11	328 877.12	320 365.45	316 821.50	305 578.05	316 690.93	316 872.77	317 669.35	330 523.56
CH4 - net emission (with LULUCF)	44 575.10	44 182.45	41 253.43	40 218.23	39 493.42	40 001.97	39 159.80	39 392.14	39 584.34
CH4 - without LULUCF	42 352.93	41 943.42	38 995.85	37 941.88	37 209.37	37 682.23	36 827.62	37 043.59	37 209.50
N2O - net emission (with LULUCF)	30 181.54	29 293.99	29 287.96	29 380.88	27 969.43	28 072.61	27 786.49	28 343.23	29 585.79
N2O - without LULUCF	30 178.53	29 291.01	29 285.10	29 378.39	27 966.75	28 068.13	27 783.95	28 340.44	29 582.98
HFCs	167.02	206.44	594.67	1 073.35	1 519.44	1 816.23	2 413.78	3 015.46	2 843.53
PFCs	251.20	239.79	224.40	269.95	286.50	278.34	285.05	259.95	269.75
SF6	25.08	24.64	24.18	23.96	24.42	21.72	23.43	28.09	30.02
TOTAL net emission (with LULUCF)	**389 994.48**	**376 164.14**	**365 252.76**	**361 600.88**	**342 806.90**	**353 710.15**	**350 105.44**	**350 983.28**	**359 954.55**
TOTAL without LULUCF	**413 586.87**	**400 582.42**	**389 489.65**	**385 509.03**	**372 584.54**	**384 557.58**	**384 206.59**	**386 356.89**	**400 459.34**

Table 2.6. National emissions of greenhouse gases for 1988–2006 according to IPCC categories [Gg CO_2 eq.]

IPCC sector	1988 CO2 eq. [Gg]	1989 CO2 eq. [Gg]	1990 CO2 eq. [Gg]	1991 CO2 eq. [Gg]	1992 CO2 eq. [Gg]	1993 CO2 eq. [Gg]	1994 CO2 eq. [Gg]	1995 CO2 eq. [Gg]	1996 CO2 eq. [Gg]	1997 CO2 eq. [Gg]
1. Energy	470 309.06	446 900.54	369 656.97	372 035.02	363 081.92	371 271.08	365 483.73	368 761.33	379 144.78	371 494.14
2. Industrial Processes	32 832.19	31 694.48	24 324.20	20 599.48	19 980.46	19 944.13	21 394.41	23 849.77	22 437.70	23 352.75
3. Solvent and Other Product Use	1 006.46	946.14	629.23	608.22	558.57	519.36	521.05	524.80	547.11	542.72
4. Agriculture	50 893.90	53 347.89	49 358.66	42 912.49	39 640.18	37 264.74	37 584.80	37 487.20	36 234.78	37 026.25
5. Land-Use, Land-Use Change and Forestry	-32 926.48	-35 487.83	-23 024.65	-29 253.10	-28 219.24	-21 686.94	-21 522.61	-20 723.44	-22 117.93	-23 652.08
6. Waste	8 401.16	8 475.83	9 605.45	9 910.76	9 980.07	10 084.17	10 067.33	9 984.95	10 064.57	10 284.07
TOTAL net emission (with LULUCF)	**530 516.30**	**505 877.06**	**430 549.87**	**416 812.87**	**405 021.97**	**417 396.54**	**413 528.70**	**419 884.62**	**426 311.02**	**419 047.85**

IPCC sector	1998 CO2 eq. [Gg]	1999 CO2 eq. [Gg]	2000 CO2 eq. [Gg]	2001 CO2 eq. [Gg]	2002 CO2 eq. [Gg]	2003 CO2 eq. [Gg]	2004 CO2 eq. [Gg]	2005 CO2 eq. [Gg]	2006 CO2 eq. [Gg]
1. Energy	344 178.25	333 441.91	321 960.66	320 195.48	309 094.81	319 011.45	318 824.56	318 945.90	329 839.89
2. Industrial Processes	20 875.61	19 820.25	22 990.69	21 083.75	19 622.82	22 562.15	23 804.26	25 344.85	27 217.63
3. Solvent and Other Product Use	543.39	535.04	616.09	637.21	664.25	647.39	704.67	705.75	705.75
4. Agriculture	37 416.23	36 099.72	34 327.69	33 963.89	33 562.14	32 794.26	32 157.22	32 743.59	34 291.22
5. Land-Use, Land-Use Change and Forestry	-23 592.39	-24 418.28	-24 236.89	-23 908.15	-29 777.64	-30 847.42	-34 101.15	-35 373.61	-40 504.79
6. Waste	10 573.40	10 685.49	9 594.53	9 628.70	9 640.52	9 542.33	8 715.87	8 616.80	8 404.85
TOTAL net emission (with LULUCF)	**389 994.48**	**376 164.14**	**365 252.76**	**361 600.88**	**342 806.90**	**353 710.15**	**350 105.44**	**350 983.28**	**359 954.55**

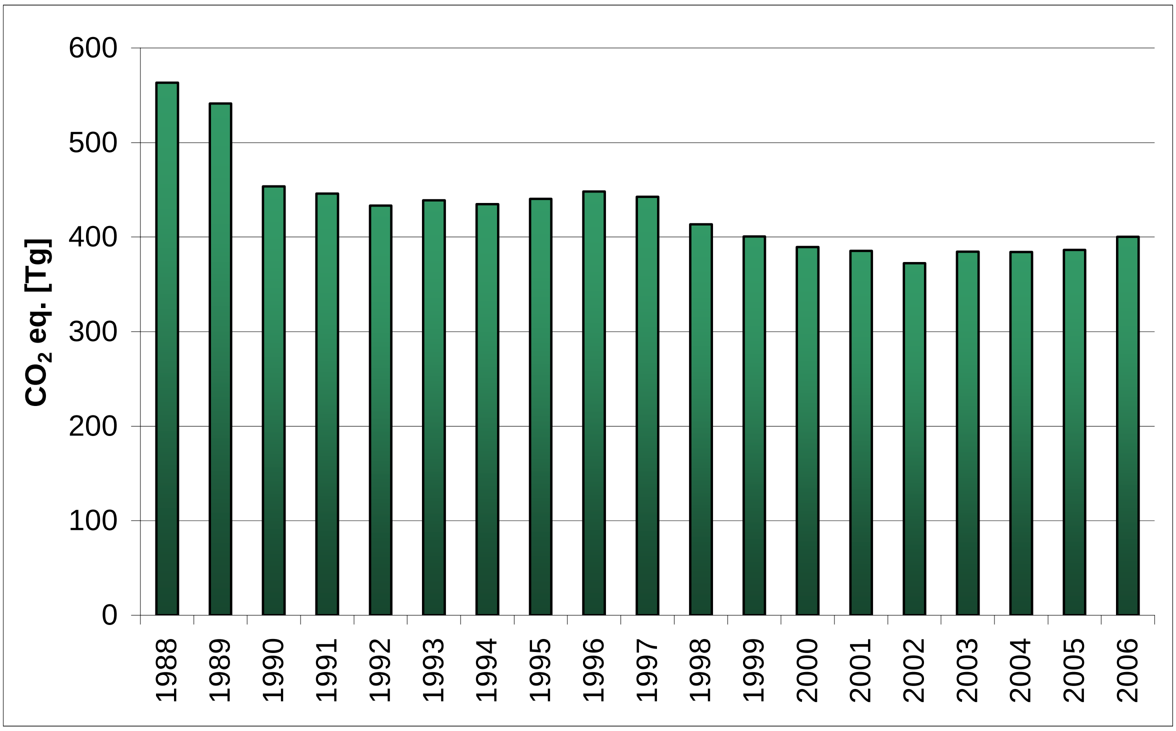


Figure 2.2. Trend of aggregated GHGs emissions excluding category 5 for 1988–2006 [Tg CO_2 eq.]

2.2 GHG emissions by gas

Carbon dioxide (CO_2)

In 2006, the net CO_2 emissions (with LULUCF) were estimated as 287.64 million tonnes, while when sector 5. *LULUCF* is excluded the figure reaches 330.52 million tones (table 2.1). The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission by 94.0% in 2006. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 56.7%, *Manufacture Industries and Construction* – 10.2%, *Transport* – 11.3% and *Other Sectors* – 15.7%. Sector 2. *Industrial Processes* contributed to the total CO_2 emission by 5.8% in 2006. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO_2 emission/removal in LULUCF sector in 2006, was calculated to be approximately 42.9 million tones. It means that app. 10.7% of the total CO_2 emissions are offset by CO_2 uptake by forests.

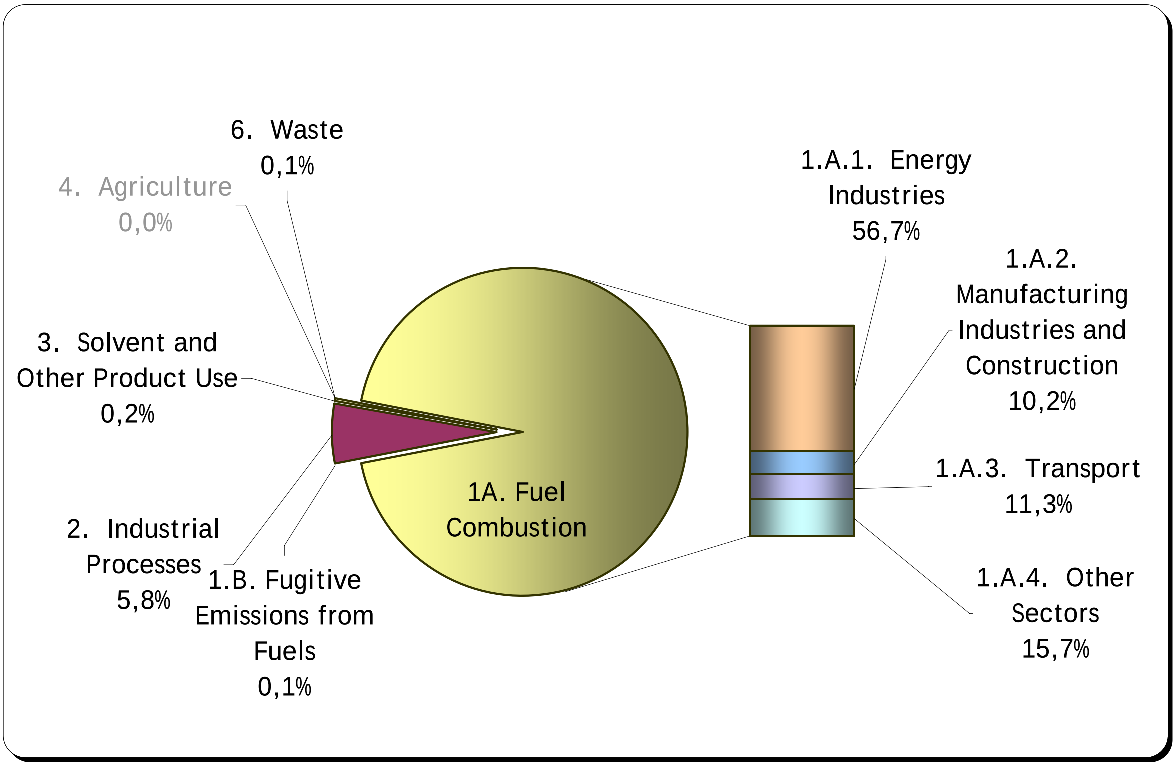


Figure 2.3 Carbon dioxide emission in 2006 by sector

Methane (CH_4)

The CH_4 emission amounted to 1 884.97 Gg in 2006 i.e. 39.58 million tones (including category 5) of CO_2 equivalents (table 2.1). Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed to 34.4%, 32.7% and 18.5% of the national methane emission in 2006 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 23.4% of total CH_4 emission) and *Oil and Natural Gas* system (about 11.0% of total emission). *Disposal sites* contributed to 15.9% of the methane emission and *Wastewater Handling* contributed to 2.6%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 23.2% of total methane emission in 2006.

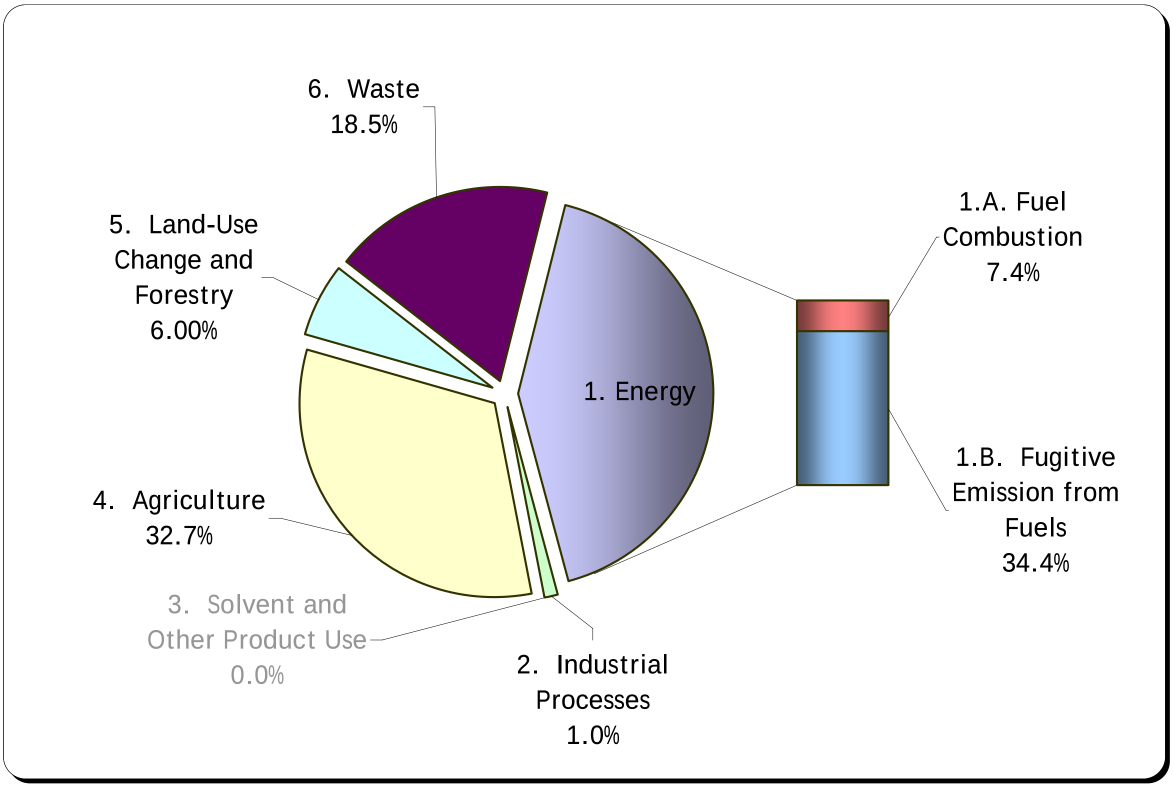


Figure 2.4 Methane emission in 2006 by sector

Nitrous oxide (N_2O)

The nitrous oxide emissions (including category 5) in 2006 were 95.44 Gg i.e. 29.59 million tonnes of CO_2 equivalents (table 2.2). The main N_2O emission sources and its shares in total N_2O emission in 2006 are: *Agricultural Soils* – 51.6%, *Manure Management* – 20.6%, *Chemical Industry* – 15.7% and *Fuel Combustion* – 9.1%.

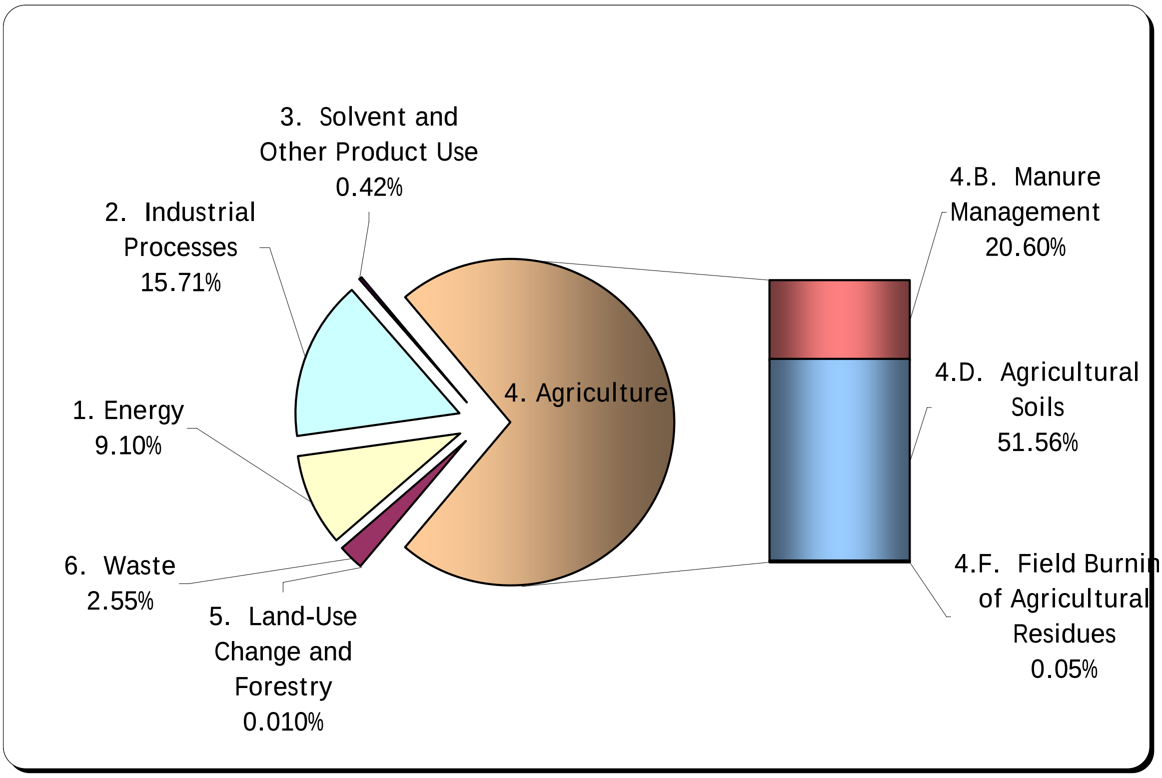


Figure 2.5 Nitrous oxide emission in 2006 by sector

Industrial gases

The total emission of HFCs in 2006 was 2.84 million tones of CO_2 equivalents. The emissions of HFCs-gases had increased 108 times between the base year (1995) and 2006. This significant growth of HFCs emission in recent years is mainly due to the increase of emission from refrigeration and air conditioning equipment.

The total emission of PFCs in 2006 was 0.27 million tonnes of CO_2 equivalents. The emissions of PFCs-gases had increased by 7.8% between the base year (1995) and 2006. It is due to the growth in aluminium production and in the use of C_4H_{10} for manufacturing of fire extinguishers. The emission of PFCs had fluctuated to a limited extend in recent years, and basically followed the trends in aluminium production - its main source.

The total emission of SF_6 in 2006 was 0.03 million tones of CO_2 equivalents. SF_6 emissions in 2006 were by 1.3 time higher than in 1995. Leakage from electrical equipment is the main SF_6 emission source. Insignificant emission of SF_6 occurs during production of soundproof windows.

Large percentage increase of industrial F-gas emissions, compared to the base year, does not influence significantly the national total GHG emission trend, because all the industrial gases together contributed merely 0.9% to national total in 2006.

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 2.5. GHG emissions according to main sectors in base year (1988/1995) and 2006

	Total [Gg eq. CO_2]		(2006-base)/base [%]
	Base year	2006	
TOTAL with LULUCF	530 516.3	359 954.55	-32.15
TOTAL without LULUCF	563 442.8	400 459.34	-28.93
1. Energy	470 309.1	329 839.89	-29.87
2. Industrial Processes	32 832.2	27 217.63	-17.10
3. Solvent and Other Product Use	1 006.5	705.75	-29.88
4. Agriculture	50 893.9	34 291.22	-32.62
5. Land-Use Change and Forestry	-32 926.5	-40 504.79	23.02
6. Waste	8 401.2	8 404.85	0.04

2.3.1 Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 2006 was 329.8 million tons of CO_2 equivalent. CO_2 emission share exceeded 94.2% of the total GHG emissions within 1.*Energy* category (table 2.6). The most emission intensive category was 1.A.1.*Fuel combustion activities* related mostly to heavy industry sector, highly energy consuming.

Table 2.6. GHG emissions from sub-sectors in category *Energy* in 2006

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	329 839.89	100.0	94.2	5.0	0.8
A. Fuel Combustion	315 959.17	95.8	94.1	0.9	0.8
1. Energy Industries	188 420.43	57.1	56.8	0.0	0.3
2. Manufacturing Industries and Construction	34 012.27	10.3	10.2	0.0	0.1
3. Transport	38 620.49	11.7	11.3	0.0	0.3
4. Other Sectors	54 905.98	16.6	15.7	0.8	0.2
5. Other	0.00	0.0	0.0	0.0	0.0
B. Fugitive Emissions from Fuels	13 880.72	4.2	0.1	4.1	0.0
1. Solid Fuels	9 273.67	2.8	0.0	2.8	0.0
2. Oil and Natural Gas	4 607.06	1.4	0.1	1.3	0.0

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

Table 2.7 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 2006. CO_2 is dominating among GHGs – it's contribution exceeds 70.0%. 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 (17.6%) and CO_2 emissions (recalculated from NMVOC) (82.4%).

Table 2.7. 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 2006

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	27 217.63	100.0	70.0	1.4	17.1	11.5
A. Mineral Products	9 147.39	33.6	33.6	0.0	0.0	
B. Chemical Industry	9 184.82	33.7	15.7	1.0	17.1	
C. Metal Production	4 851.12	17.8	16.4	0.5	0.0	0.9
D. Other Production	0.05	0.0	0.0	0.0	0.0	
F. Consumption of Halocarbons and SF6	2 888.81	10.6				10.6
G. Other	1 144.14	4.2	4.2	0.0	0.0	
Total Solvent and Other Product Use	705.75	100	82.4	0.0	17.6	

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 2.8). N_2O emission share was largest in total GHG emission from *Agriculture* in 2006 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 2.8. GHG emissions from sub-sectors in category 4.*Agriculture* in 2006

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	34 291.22	100.0	37.7	62.3
A. Enteric Fermentation	9 167.79	26.7	26.7	0.0
B. Manure Management	9 832.35	28.7	10.9	17.8
D. Agricultural Soils	15 254.23	44.5	0.0	44.5
F. Field Burning of Agricultural Residues	36.84	0.1	0.1	0.0

2.3.4 Waste (IPCC category 6)

As it can be seen in table 2.9, the emission of CH_4 dominated in this sector in 2006 (almost 87.3%). The main part of GHG emissions came from s*olid waste disposal on land* and *wastewater handling*.

Table 2.9. GHG emissions from sub-sectors in category 6.*Waste* in 2006

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	8 404.85	100	3.7	87.3	9.0
A. Solid Waste Disposal on Land	6 305.08	75.0	0.0	75.0	0.0
B. Wastewater Handling	1 761.27	21.0	0.0	12.3	8.6
C. Waste Incineration	338.49	4.0	3.7	0.0	0.3

2.4 Comparison to base year (1988/1995)

The data for the GHGs share and for the national total GHG emission in the base year are given in table 2.10 and at figure 2.6.

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 [%]
CO2 – net emission (with LULUCF)	436 209.10	82.2
CO2 – without LULUCF.	469 143.82	83.3
CH4 - net emission (with LULUCF)	53 672.51	10.1
CH4 - without LULUCF	53 665.03	9.5
N2O - net emission (with LULUCF)	40 334.29	7.6
N2O - without LULUCF	40 333.53	7.2
HFCs	26.44	0.005
PFCs	250.18	0.047
SF_6	23.77	0.004
TOTAL net emission (with LULUCF)	530 516.30	100.0
TOTAL without LULUCF	563 442.77	100.0

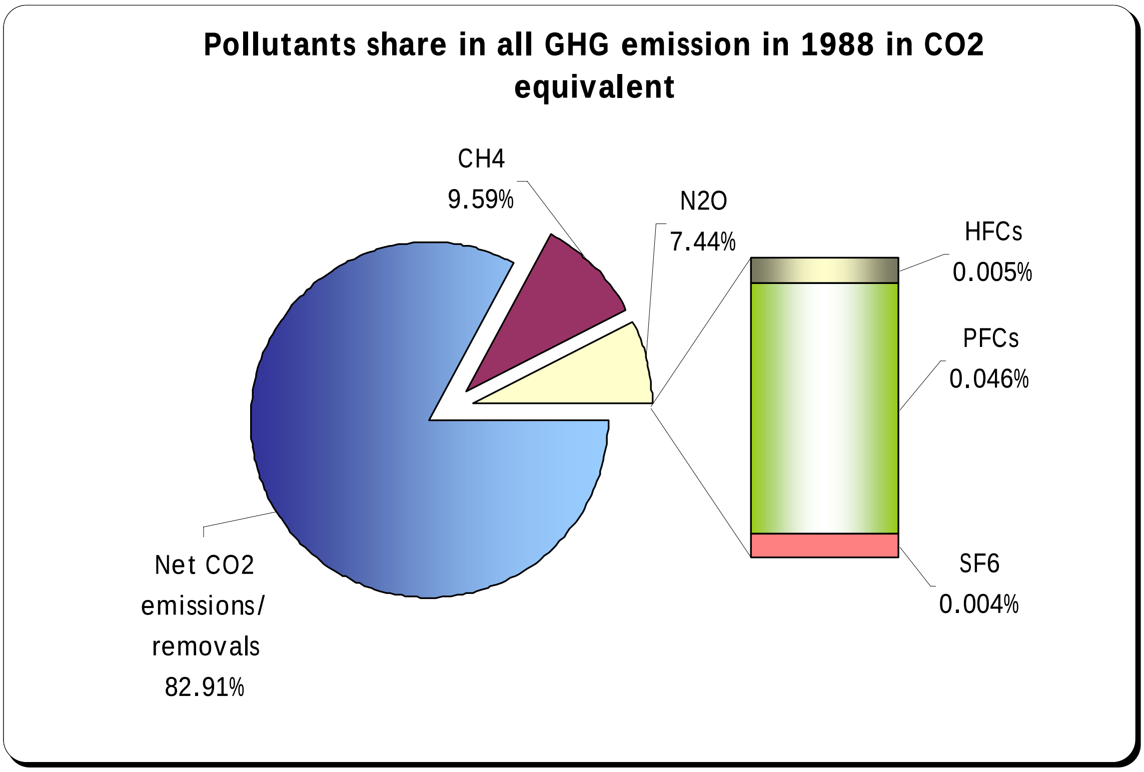


Figure 2.6 Percentage share of national greenhouse gas emissions in base year (1988/1995) including emission from sector 5.

Inventory results for 2006 are presented in table 2.11 and comparison to the base year is described below according to specific gases.

Table 2.11. Changes of greenhouse gas emissions in 2006 with respect to base year 1988/1995

Pollutant	Base year Emission in CO_2 eq. [Gg]	2006 Emission in CO_2 eq. [Gg]	2006/base year [%]
CO2 – net emission (with LULUCF)	436 209.10	287 641.12	65.94
CO2 – without LULUCF.	469 143.82	330 523.56	70.45
CH4 - net emission (with LULUCF)	53 672.51	39 584.34	73.75
CH4 - without LULUCF	53 665.03	37 209.50	69.34
N2O - net emission (with LULUCF)	40 334.29	29 585.79	73.35
N2O - without LULUCF	40 333.53	29 582.98	73.35
HFCs	26.44	2 843.53	10754.10
PFCs	250.18	269.75	107.82
SF_6	23.77	30.02	126.33
TOTAL net emission (with LULUCF)	530 516.30	359 954.55	67.85
TOTAL without LULUCF	563 442.77	400 459.34	71.07

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

Carbon dioxide

CO_2 emission (excluding category 5) had decreased by app. 29.5% from the base year to 2006.
The following changes took place in the structure of fuel use:

- share in of solid fuels from 87.7% in 1988 to 73.5% in 2006
- share of liquid fuels from 8.7% (1988) to 18.8% (2006)
- share of gaseous fuels increased from 3.6% (1988) to 7.7% (2006).

Methane

CH_4 emission (including category 5) had decreased by app. 26.2% from the base year to 2006.
The reasons for that are as follow:

- the in emission from *Enteric Fermentation* by 41.6%
- the in *Fugitive Emission* by 40.0%
- the increase in emission from *Waste* by 10.2%.

Nitrous oxide

The nitrous oxide emissions (including category 5) in 2006 were app. 26.6% lower than the respective figure for the base year. The share in *Manure Management* decreased from 23.1% in 1988 to 20.6% in 2006, in *Agricultural Soils* decreased from 55.5% (1988) to 51.6% (2006) and in *Chemical Industry* increased from 12.4% in 1988 to 15.7% in 2006.

Industrial gases: HFCs, PFCs and SF_6

HFCs emissions in 2006 were 108 times higher than in 1995. This significant growth in HFCs emission is mainly due to the increase in emission from refrigeration and air conditioning equipment.

PFCs emissions in 2006 were 7.8% higher than in base year (1995). The PFCs emission changes between 2006 and the preceding years depend on the aluminium production levels (main PFC source) and the use of C4F10 in fire extinguishers.

SF_6 emissions in 2006 were about than 1.3 times higher than in 1995. Leakage from electrical equipment during its use and production is the main SF_6 emission. Large percentage increase of industrial gases emissions, compared to the base year, does not influence significantly the national total GHG emission trend, because all the industrial gases together contribute merely app. 0.9% to the national total in 2006.

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 2.11 and Figure 2.6. Compared to 1988/1995, the percentage share of CO_2 (excluding category 5) in 2006 decreased from 83.3% to 82.5%.

2.5 Comparison of greenhouse gas emissions 2006 and 2005

Changes of national emissions and sinks of GHGs in 2006 compared to 2005 were:

CO2 (without LULUCF)	- emission rise to	104.05%
CH4 (without LULUCF)	- emission rise to	100.49%
N2O (without LULUCF)	- emission rise to	104.38%
HFC	- actual emission fall to	94.30%
PFC	- actual emission rise to	103.77%
SF_6	- actual emission rise to	106.87%

Below results are discussed separately for each greenhouse gas with respect to 2006 emissions and change between 2006 and 2005.

Carbon dioxide (CO_2)

In 2006, the net CO_2 emissions (with LULUCF) was 2.7% higher than in 2005. The CO_2 emission in 2006 from category *Energy* was higher by 3.6% and from category *Industrial Processes* was higher by 12.2% than in 2005. In comparison to 2005 the CO_2 emission from category *Waste* in 2006 fall by 2.8%.

Table 2.12. Comparison of carbon dioxide emission in 2005 and 2006

Year	CO_2 [Gg]		2006/2005 [%]
	2005	2006	
TOTAL without LULUCF	317 669.3	330 523.6	104.0
1. Energy	299 798.1	310 592.3	103.6
A. Fuel Combustion	299 567.0	310 341.4	103.6
1. Energy Industries	180 011.6	187 500.6	104.2
2. Manufacturing Industries and Construction	34 380.5	33 724.5	98.1
3. Transport	35 357.5	37 381.4	105.7
4. Other Sectors	49 817.4	51 734.9	103.8
5. Other	NE	NE	NE
B. Fugitive Emissions from Fuels	231.1	250.9	108.6
1. Solid Fuels	1.0	1.3	130.4
2. Oil and Natural Gas	230.0	249.5	108.5
2. Industrial Processes	16 971.2	19 040.2	112.2
A. Mineral Products	8 039.9	9 147.4	113.8
B. Chemical Industry	4 502.5	4 276.7	95.0
C. Metal Production	3 474.5	4 471.9	128.7
D. Other Production	0.1	0.0	62.3
G. Other	NE	NE	NE
3. Solvent and Other Product Use	581.8	581.8	100.0
4. Agriculture	NE	NE	NE
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	NE	NE	NE
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	NE	NE	NE
5. Land Use, Land-Use Change and Forestry	-37 725.0	-42 882.4	113.7
A. Forest Land	-49 226.5	-54 266.1	110.2
B. Cropland	8 521.7	8 237.1	96.7
C. Grassland	-5.8	130.5	-2255.4
D. Wetlands	3 057.7	3 090.5	101.1
E. Settlements	-72.0	-74.5	103.4
F. Other Land	NE	NE	NE
6. Waste	318.4	309.3	97.2
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	NE	NE	NE
C. Waste Incineration	318.4	309.3	97.2

Methane (CH_4)

The emission (including category 5) in 2006 was higher than in 2005 by 0.5%. The main sources are *Agriculture*, *Energy* and *Waste*. Emission from *Manure Management* in the *Agriculture* sector was higher by 4.4% in 2006 and from *Waste* sector was lower by 2.4% than in 2005. *Fugitive emission* in *Energy* sector was lower by 2.3% in 2006 compared to 2005.

Table 2.13 Comparison of methane emission in 2005 and 2006

Year	CH_4 [Gg]		2006/2005 [%]
	2005	2006	
TOTAL with LULUCF	1 875.82	1 884.97	100.5
1. Energy	789.81	788.34	99.8
A. Fuel Combustion	125.58	139.30	110.9
1. Energy Industries	2.69	2.91	108.1
2. Manufacturing Industries and Construction	3.29	3.70	112.5
3. Transport	5.27	5.48	103.9
4. Other Sectors	114.33	127.22	111.3
5. Other	NE	NE	NE
B. Fugitive Emissions from Fuels	664.23	649.04	97.7
1. Solid Fuels	458.59	441.54	96.3
2. Oil and Natural Gas	205.64	207.50	100.9
2. Industrial Processes	18.29	18.35	100.3
A. Mineral Products	NE	NE	NE
B. Chemical Industry	12.99	12.35	95.0
C. Metal Production	5.30	6.00	113.4
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	NE	NE	NE
4. Agriculture	597.77	615.68	103.0
A. Enteric Fermentation	426.09	436.56	102.5
B. Manure Management	170.54	178.02	104.4
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	1.15	1.10	95.8
5. Land Use, Land-Use Change and Forestry	111.84	113.09	101.1
A. Forest Land	0.15	0.14	92.5
B. Cropland	NE	NE	NE
C. Grassland	0.05	0.12	216.5
D. Wetlands	111.63	112.83	101.1
E. Settlements	NE	NE	NE
F. Other Land	NE	NE	NE
6. Waste	358.11	349.51	97.6
A. Solid Waste Disposal on Land	309.55	300.24	97.0
B. Wastewater Handling	48.56	49.27	101.5
C. Waste Incineration	NE	NE	NE

Nitrous oxide (N_2O)

The emission (including category 5) was higher than in 2005 (by 4.4%). The main sources of N_2O emission are *Manure Management* and *Agricultural Soils*. Emission from *Manure Management* in the *Agriculture* sector was higher by 4.0% in 2006 and from *Agricultural Soils* was higher by 6.5% than in 2005.

Table 2.14. Comparison of nitrous oxide emission in 2005 and 2006

Year	N_2O [Gg]		2006/2005 [%]
	2005	2006	
TOTAL with LULUCF	91.43	95.44	104.4
1. Energy	8.26	8.69	105.1
A. Fuel Combustion	8.26	8.69	105.1
1. Energy Industries	2.63	2.77	105.2
2. Manufacturing Industries and Construction	0.63	0.68	107.2
3. Transport	3.41	3.63	106.2
4. Other Sectors	1.58	1.61	101.7
5. Other	NE	NE	NE
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	15.12	15.00	99.2
A. Mineral Products	NE	NE	NE
B. Chemical Industry	15.12	15.00	99.2
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	65.13	68.91	105.8
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	18.90	19.66	104.0
D. Agricultural Soils	46.18	49.21	106.5
F. Field Burning of Agricultural Residues	0.05	0.04	96.3
5. Land Use, Land-Use Change and Forestry	0.0090	0.0091	100.9
A. Forest Land	0.0021	0.0022	103.5
B. Cropland	NE	NE	NE
C. Grassland	0.0000	0.0000	216.5
D. Wetlands	0.0068	0.0068	100.0
E. Settlements	NE	NE	NE
F. Other Land	NE	NE	NE
6. Waste	2.51	2.44	97.1
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	2.42	2.34	97.0
C. Waste Incineration	0.09	0.09	99.9

Industrial gases

The total emission of HFCs in 2006 was by 5.7% lower than in 2005. PFCs emissions in 2006 were by app. 3.8% higher than in 2005. SF_6 emissions in 2006 were by 6.9% higher than in 2005.

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

Precursors of greenhouse gases like 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 2.7-2.10 shows trends of emissions of SO_2, NO_x, NMVOC (1980-2006) and CO (1990-2006). Emissions of SO_2 decreased by about 71% between 1980 and 2006, and 63% between 1990 and 2006. 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 about 28% between 1980 and 2006, and 30% between 1990 and 2006. Similar to sulphur dioxide, most of the reductions were triggered by the decline of the heavy industry in the late 1980s and early 1990s and lower share of coal in 1990s. Increasing emissions from road traffic contribute to the national total, and cause comparatively lower emission reductions than in case of SO_2. Similarly emissions of NMVOC decreased by 42% between 1980–2006 and by 27% between 1990–2006 and CO emissions drop by about 62% between 1990–2006. The main reasons are the same as those described regarding to emissions of SO_2 and NO_x.

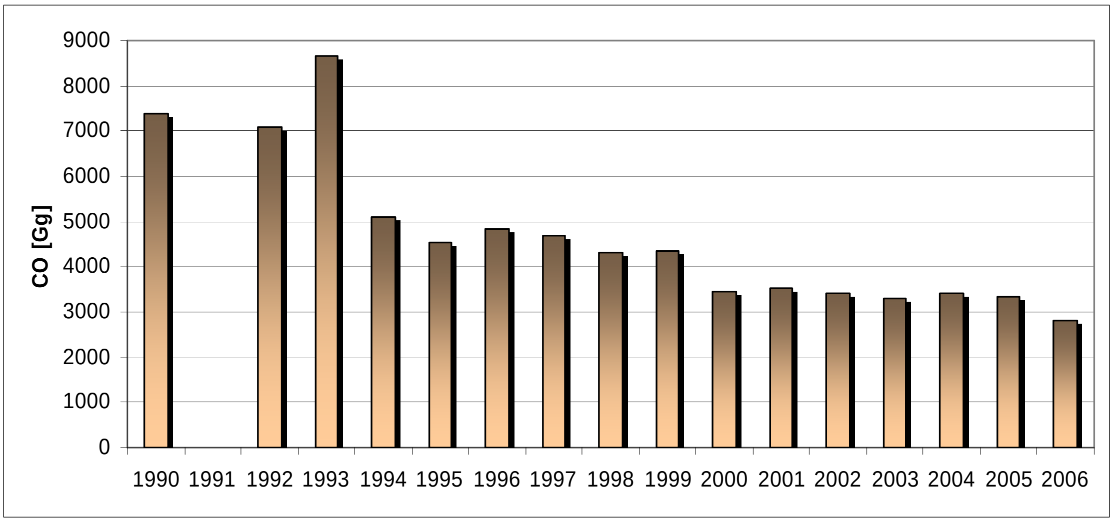


Figure 2.7 Emissions of CO (1990-2006).

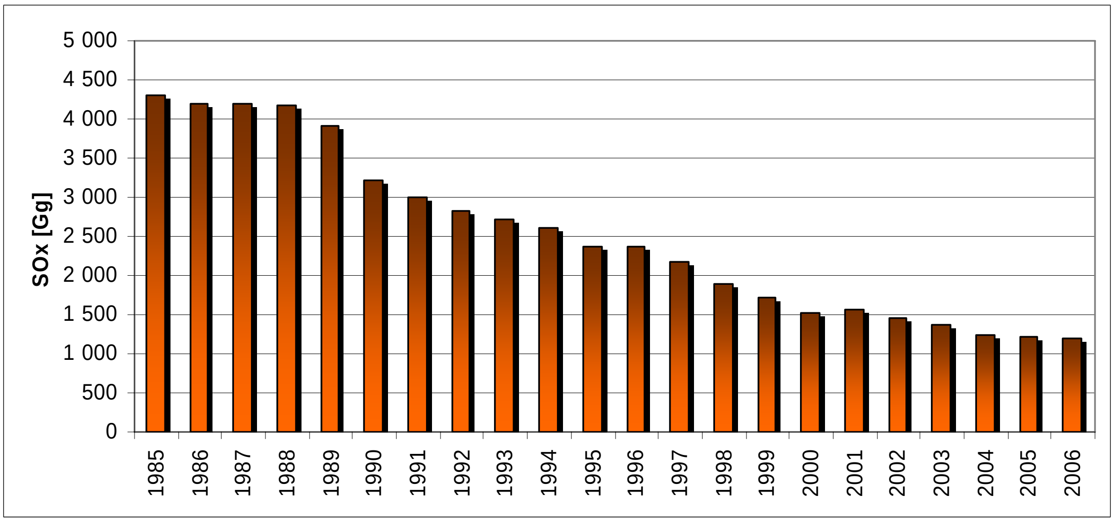


Figure 2.8 Emissions of SO_2, (1980-2006).

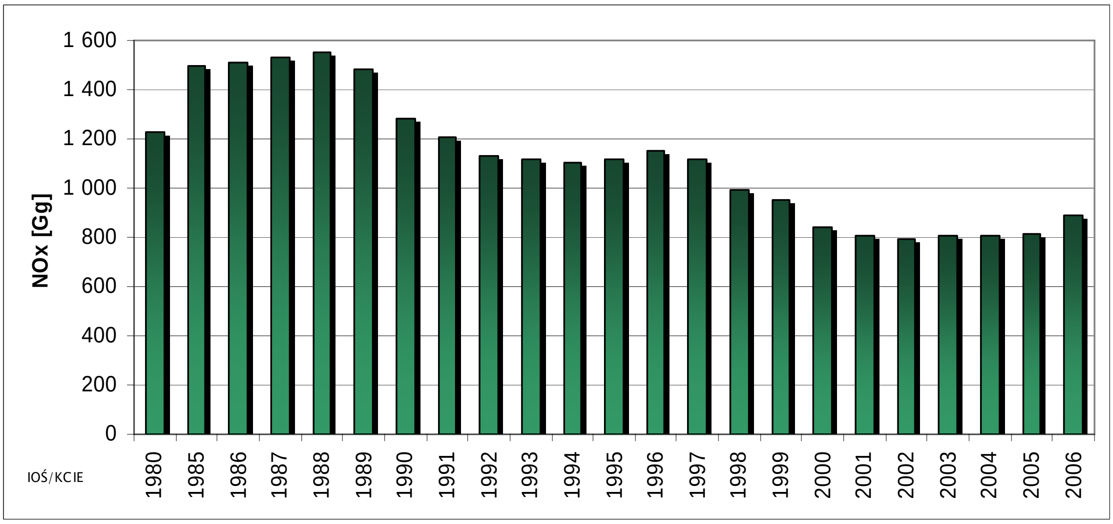


Figure 2.9 Emissions of NO_x (1980-2006).

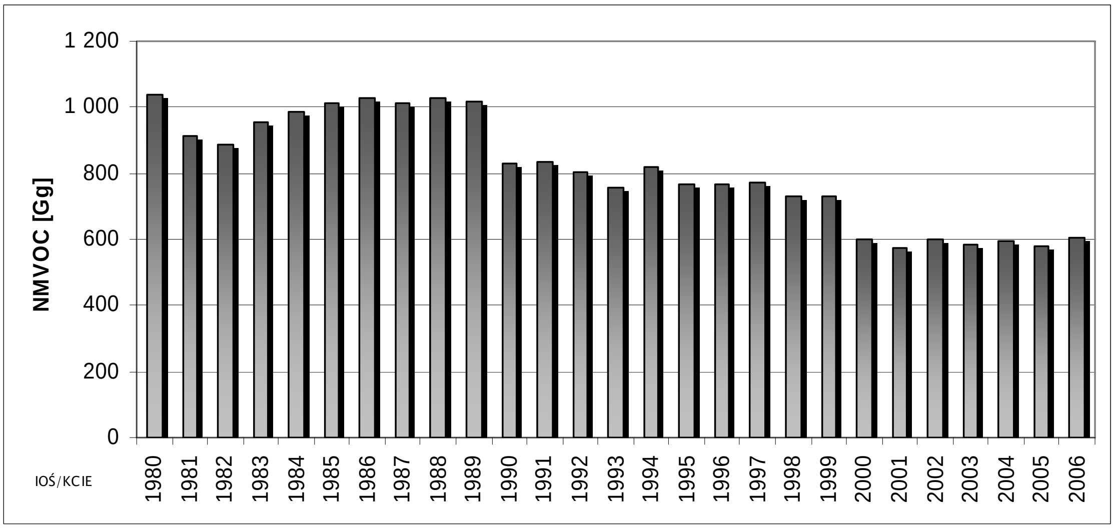


Figure 2.10 Emissions of NMVOC (1980-2006).

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 Stationary combustion of solid, liquid and gaseous fuels (CO_2 emission), share in total GHG emission 58.2%
- 1.A.3.b Transport Road Transportation (CO_2 emission), share in total GHG emission 7.7%
- 1.B.1.a. Coal Mining and Handling (CH_4 emission), share in total GHG emission 2.0%
- 1.B.2.b. Natural Gas (CH_4 emission), share in total GHG emission 0.9%

Share of these categories in total Poland's GHG emissions is 68.9%.

3.2 Sector overview and methodological issues

3.2.1 *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

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

a) 1.A.1.a *Public Electricity and Heat Production*
- *Public thermal plants* – electricity and heat generation (PKD[1] 40.1),
- *Autoproducing thermal plants* – electricity and heat generation (PKD 40.1)
- *Public and non-public heat plants* (PKD 40.3)

b) 1.A.1.b *Petroleum Refining* (PKD 23.2)
- Manufacture of refined petroleum products

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 – hard coal mining and enrichment; 10.2 lignite mining and enrichment; 11.1 natural gas and oil extraction; 60.3 oil and gas pipeline transport; 40.1 and 40.3 – production and distribution of electrical energy and heat – only direct consumption of fuels is included)

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

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

a) *Iron and Steel* - 1.A.2.a (PKD 27 excluding activities included in 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)
d) *Pulp, Paper and Print* - 1.A.2.d (PKD 21 and 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 vehicles and other machinery in industry and construction sub-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)

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 included elsewhere, that 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.

Stationary sources

Data on CO_2 emissions from fuel combustion in installations covered by the Community Emission Trading Scheme (EU ETS) were taken directly from the annual verification reports and then aggregated to the corresponding IPCC source categories. Emissions of CO_2 for installations covered by the EU ETS are estimated following the Ordinance of the Minister of Environment of 12 January 2006 on the way of monitoring of emission amounts of substances covered by the Community Emission Trading Scheme. The ordinance transposes to the Polish law the UE Monitoring and Reporting Guidelines for ETS (Commission Decision 2004/156/EC). The amount of CO_2 emissions from stationary sources outsider the EU ETS is estimated on the level determined as IPCC *Tier 2* and is based on the following equation:

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

where: E - emission
EF - emission factor
A - fuel consumption
a - fuel type, b - sector

The amount of combusted fuel in sources outside the EU ETS was calculated on the basis of the difference between national energy related use of the given fuel included in the energy balance sheets submitted by GUS to Eurostat and the fuel consumption reported by the installations covered by the EU ETS that are included in the given IPCC source category.

List of combusted fuels for which GHG emissions are estimated based upon selected or calculated emission factors is as follow:

- liquid fuels: fuel oil, diesel oil, liquid petroleum gas (LPG), crude oil, motor gasoline, jet kerosene, refinery gas, feedstocks, gaseous waste fuels, other petroleum products and petroleum coke
- gaseous fuels: natural gas
- solid fuels: hard coal, lignite, coke, hard coal briquettes, lignite briquettes coke oven gas, blast furnace gas, industrial wastes, municipal waste - (non-biogenic fraction)
- biomass: fuel wood and wood waste, biogas, municipal waste – biogenic fraction, biofuels: bioethanol and biodiesel

The emission factors for CO_2 emission estimation for fuel combustion in stationary sources are the following:

- domestic emission factors for hard coal and lignite;
the EFs are based on empirical functions (regression method based on measured NCV values), that link the amount of elemental carbon in fuel with the corresponding net calorific value, the empirical functions are the following:

for hard coal:

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

where: C_{hc} emission factor/elemental carbon content for hard coal [kg C/GJ],
NCV- net calorific value of hard coal [MJ/kg] in the given sub-category calculated based upon hard coal combusted expressed in both physical and energy units,

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

$$C_{bc} = 10(1.9272*NCV + 9.3856)/NCV$$

where: C_{bc} emission factor for brown coal [kg C/GJ],
NCV- net calorific value of lignite [MJ/kg] in the given sub-category calculated based upon lignite combusted expressed in both physical and energy units

- default emission factors [IPCC 2006] for biomass and waste (fuel wood and wood waste, biogas, industrial and municipal waste)

- default emission factors [IPCC 1997] for all other fuels i.e.: natural gas, coke, hard coal briquettes, lignite briquettes, coke oven gas, blast furnace gas, fuel oil, diesel oil, LPG, crude oil, motor gasoline, jet kerosene, refinery gas, feedstocks, gaseous waste fuels, other petroleum products and petroleum coke

The values for fraction of oxidized carbon for the given fuel types were taken following the IPPC guidelines [IPCC 1997].

The following values are used:

- gaseous fuels – 0.995
- liquid fuels – 0.990
- solid fuels – 0.980 (in IPCC guidelines this value is recommended for hard coal; the same values was applied for all other solid fuels due to lack of respective default values)

Emissions of CH_4 and N_2O from fuel combustion in stationary sources is based on fuel quantities submitted by GUS to Eurostat (Eurostat database) and the corresponding emission factors [IPCC 2006].

Trend of fuel use and methodology over the years 1988-2006

Estimation of CO_2 emissions for the years 1988-2005 is based on methodology used for the year 2006 for fuel combustion for stationary sources outside the EU ETS. For the years: 1990-2005 the data from the Eurostat database were applied. The Eurostat database does not cover fuel use data for Poland for the years before 1990. Therefore, fuel use data for the period: 1988-1989 were taken from the GUS publication [GUS 1989a-1990a]. In the latter case, the fuel list is more disaggregated e.g. natural gas is divided into high-methane gas, nitrified gas and coal-bed methane from hard coal. All emission factors for GHGs for fuel combustion in stationary sources, with the exception of CO_2 EFs for hard coal and lignite, are the IPCC default EFs – the same for the entire time series (references for the EFs have been described above when describing the inventory methodology for the year 2006). Emission factors for CO_2 for hard coal and lignite for the entire time series: 1988-2005 are based on the same empirical functions as for 2006. The values of CO2 EFs changed over the years following the changes of the respective net calorific values for hard coal and lignite.

Below the time series of fuel use and GHG emissions for the main subsectors are presented in the source category 1.A *Fuel combustion*

1.A.1.a *Production of electric energy and heat*

Table 3.1 presents the structure and amounts of fuel used in the sub-category 1.A.1.a *Production of electric energy and heat* for the years 1988-2006 together with the estimation of the share of the installations covered by the UE ETS in 2006.

Table 3.1. Fuel consumption in 1988-2006 in subcategory 1.A.1.a [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	75.465	72.994	66.952	62.622	57.600	56.354	57.231
Gaseous Fuels	21.274	21.900	21.641	16.329	9.562	3.107	4.094
Solid Fuels	2449.580	2419.961	2131.211	2130.563	2054.985	1937.053	1882.447
Biomass	16.699	15.129	14.585	14.384	17.289	13.783	14.057
TOTAL	2563.017	2529.984	2234.389	2223.898	2139.436	2010.297	1957.829
	1995	1996	1997	1998	1999	2000	2001
Liquid Fuels	26.229	28.863	28.976	19.307	18.515	15.490	16.455
Gaseous Fuels	4.738	7.157	7.949	10.768	16.210	21.627	28.242
Solid Fuels	1760.900	1820.506	1773.038	1709.529	1666.951	1645.374	1659.729
Biomass	1.447	2.793	3.381	3.877	3.747	3.904	5.449
TOTAL	1793.314	1859.319	1813.344	1743.481	1705.423	1686.395	1709.875
	2002	2003	2004	2005	2006	ETS in 2006	ETS share [%]
Liquid Fuels	15.308	14.123	11.460	9.615	9.102	7.658	84.1
Gaseous Fuels	38.700	45.496	53.667	57.039	52.808	50.726	96.1
Solid Fuels	1605.372	1683.512	1659.101	1663.636	1756.489	1697.757	96.7
Biomass	5.424	6.533	10.198	19.320	23.201	13.705	59.1
TOTAL	1664.804	1749.664	1734.426	1749.610	1841.600	1769.847	96.1*

*) value in the last cell is the weighted mean of four values given above. It‘s a percent share of total fuels combusted in 2006 from installations included in ETS, in total account of fuels combusted in this subcategory in 2006 in specific IPCC subcategory (this also concerns all further tables which includes consumption of fuels and ETS share)

The data in table 3.1 show that the use of solid fuels is dominant in 1.A.1.a – mainly hard coal and lignite. In 2006, the use of hard coal was almost 1200 PJ i.e. app. 65% of the entire energy of all fuels used in that sub-sector. Lignite made up 29% of the energy, accordingly. Despite the significant share of solid fuels (over 95%) in the total energy related fuel use in 1.A.1.a, a slow decreasing trend can be noticed since the late 1990s (from app. 98.1% in 1998 till 95.4% in 2006). At the same time, the share of grows as well as the share of biomass. Table 3.1 also shows that in 2006 almost entire fuel used in sub-category 1.A.1.a (over 96%) took place in installations covered by EU ETS.

Figure 3.1 shows CO_2 emission changes over the period 1988-2006. A significant emission decrease took place over the years 1988-1995 followed by a period of emission stabilization. Data for the year 2006 show that over 97% of CO_2 emission in 1.A.1.a originated in EU ETS installations.

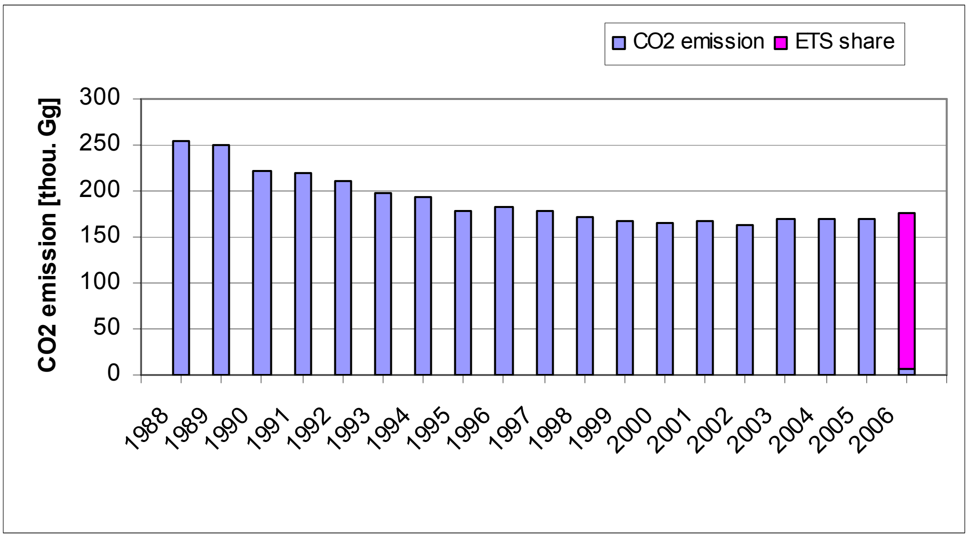


Figure 3.1. CO_2 emission for 1.A.1.a category in 1988-2006

Figure 3.2 shows emission trends for CH_4 i N_2O between the base year and 2006. Similarly to CO_2 a significant emission decrease for these gases happened in the period 1988-1995.

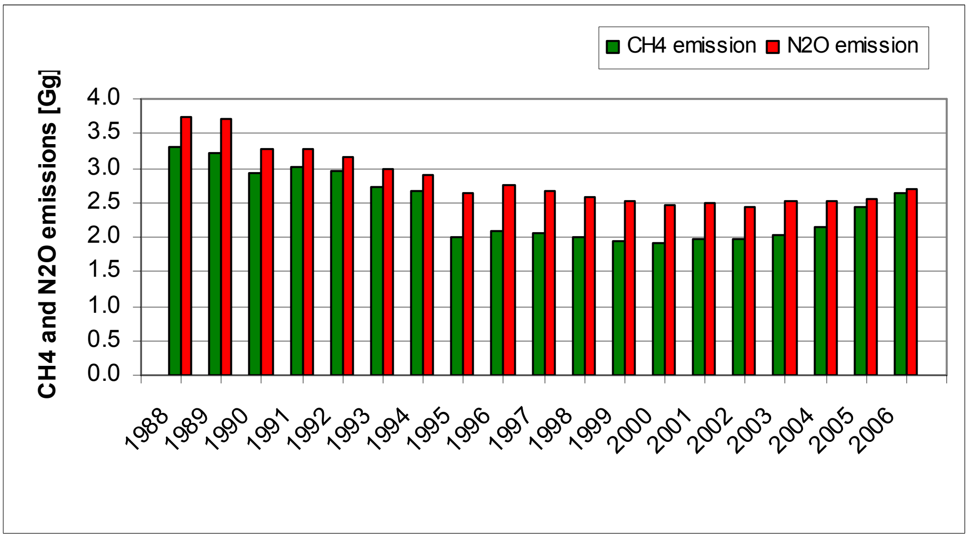


Figure 3.2. CH_4 and N_2O emissions for 1.A.1.a category in 1988-2006

1.A.1.b *Petroleum Refining*

Table 3.2 shows fuel consumption data in sub-category 1.A.1. b *Petroleum Refining* for the years 1988-2006 together with estimation of the share of EU ETS installations.

Tabel 3.2. Fuel consumption in 1988-2006 in subcategory 1.A.1.b [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	23.490	22.919	19.032	18.394	24.452	22.281	19.548
Gaseous Fuels	2.395	2.396	1.671	1.539	1.508	1.608	1.591
Solid Fuels	7.865	7.627	5.268	0.363	0.754	0.268	0.330
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	33.750	32.941	25.971	20.296	26.714	24.157	21.469
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	44.804	50.129	43.568	47.617	43.782	47.114	53.241
Gaseous Fuels	1.562	1.749	3.931	13.946	14.918	20.076	19.281
Solid Fuels	3.915	1.837	1.557	1.171	0.965	0.504	0.072
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	50.281	53.715	49.056	62.734	59.665	67.694	72.594
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	53.632	54.304	56.645	53.890	63.844	58.697	91.9
Gaseous Fuels	18.941	20.506	23.099	23.040	24.808	0.934	3.8
Solid Fuels	0.024	0.176	0.221	0.285	0.224	0.012	5.5
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	-
TOTAL	72.597	74.986	79.965	77.215	88.876	59.643	67.1

Figure 3.3 shows CO_2 emission changes in 1988-2006 in sub-category 1.A.1.b. Since mid-1990s emission grow in that sub-category. The share of EU ETS installations in 2006 CO_2 emission was over 72%.

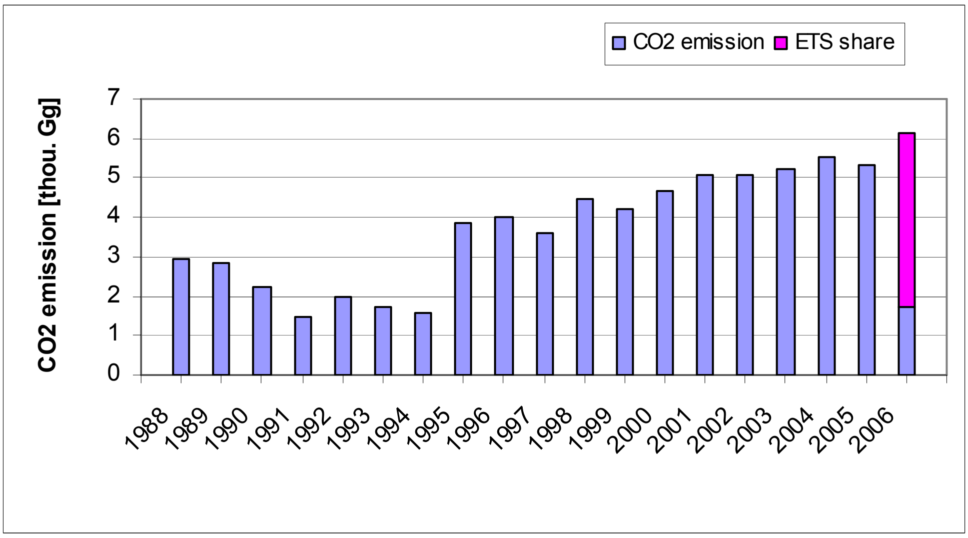


Figure 3.3. CO_2 emission for 1.A.1.b category in 1988-2006

Figure 3.4 shows the corresponding CH_4 and N_2O emission in that source sub-category between the base year and 2006.

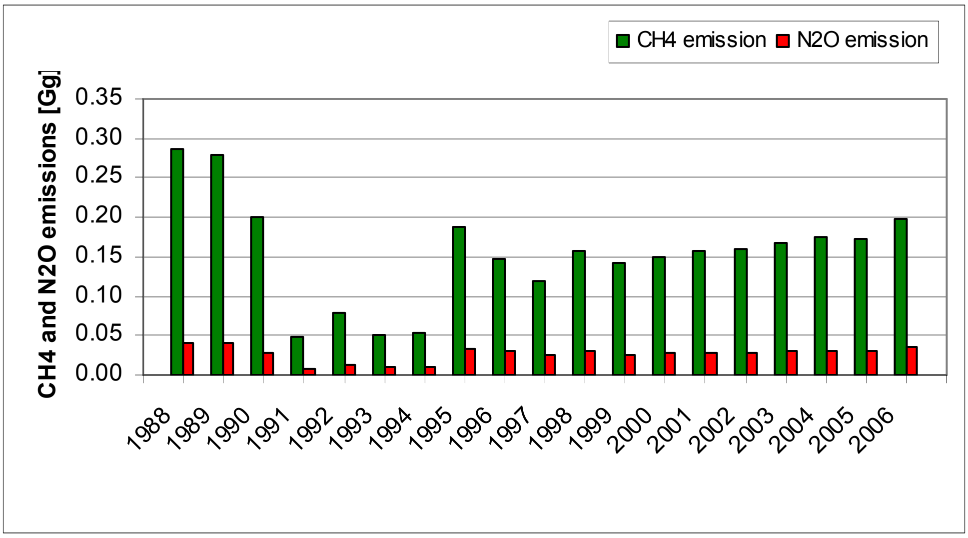


Figure 3.4. CH_4 and N_2O emissions for 1.A.1.b category in 1988-2006

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

Table 3.3 shows the fuel use data in the sub-category 1.A.1.c over the period: 1988-2006. The table also shows the share of EU ETS installations in that sub-category in 2006 (coke plants).

Tabel 3.3. Fuel consumption in 1988-2006 in subcategory 1.A.1.c [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	2.592	2.218	1.998	2.286	2.495	4.893	4.142
Gaseous Fuels	13.736	15.364	12.371	12.432	14.665	12.354	17.402
Solid Fuels	70.511	66.331	58.619	49.200	47.158	63.171	105.149
Biomass	0.018	0.001	0.006	0.000	0.004	0.008	0.011
TOTAL	86.857	83.914	72.994	63.918	64.322	80.426	126.704
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	4.278	3.652	3.103	2.967	2.169	2.164	1.689
Gaseous Fuels	14.858	23.294	21.181	17.802	19.479	21.988	16.249
Solid Fuels	103.711	98.633	99.436	93.850	80.096	72.597	73.611
Biomass	0.004	0.014	0.031	0.026	0.027	0.033	0.051
TOTAL	122.851	125.593	123.751	114.645	101.771	96.782	91.600
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	2.101	2.184	1.925	2.162	1.427	0.000	0.0
Gaseous Fuels	16.016	14.169	17.386	18.704	26.549	0.000	0.0
Solid Fuels	61.728	71.036	67.751	59.370	51.987	36.291	69.8
Biomass	0.047	0.135	0.004	0.014	0.025	0.000	0.0
TOTAL	79.892	87.524	87.066	80.250	79.989	36.291	45.4

The emission trends of CO_2, CH_4 and N_2O in the 1988-2006 period are shown in figures 3.5 and 3.6.
The share of EU ETS installations in 2006 CO_2 emissions in that sub-category was app. 35%.

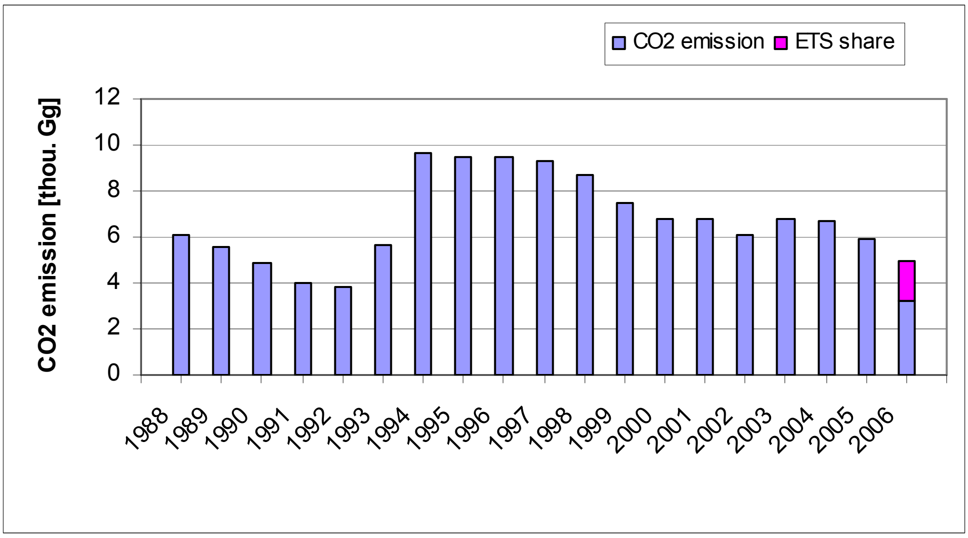


Figure 3.5. CO_2 emission for 1.A.1.c category in 1988-2006

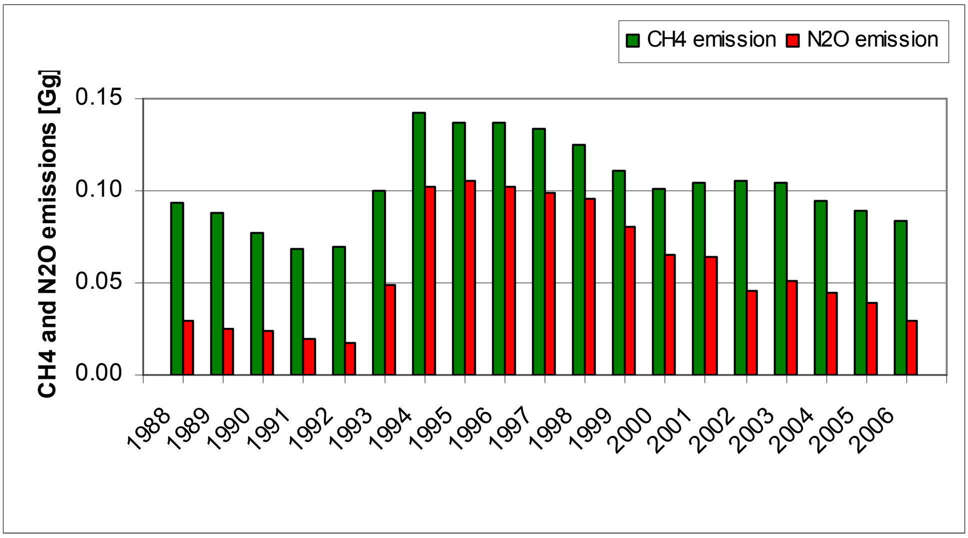


Figure 3.6. CH_4 and N_2O emissions for 1.A.1.c category in 1988-2006

1.A.2.a *Iron and Steal*

Table 3.4. shows the fuel use data in the sub-category 1.A.2.a *Iron and Steal* for the period: 1988-2006 and the estimated share of EU ETS installations in the overall fuel use in 2006 in that sub-category. Solid fuels is the dominant fuel type in that sub-category.

Tabel 3.4. Fuel consumption in 1988-2006 in subcategory 1.A.2.a [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	18.338	15.604	11.169	7.927	5.449	4.618	3.510
Gaseous Fuels	73.507	63.332	51.839	32.306	24.476	23.036	24.152
Solid Fuels	98.404	88.673	76.494	79.979	83.677	93.515	96.334
Biomass	0.000	0.000	0.000	0.000	0.000	0.016	0.014
TOTAL	190.249	167.610	139.502	120.212	113.602	121.185	124.010
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	2.801	1.848	5.270	1.896	2.184	1.861	0.993
Gaseous Fuels	23.163	24.055	26.915	23.119	20.699	21.482	17.261
Solid Fuels	116.887	109.348	111.626	97.501	79.250	87.325	70.252
Biomass	0.005	0.006	0.004	0.006	0.004	0.003	0.006
TOTAL	142.856	135.257	143.815	122.522	102.137	110.671	88.512
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	0.357	0.311	0.265	0.085	0.127	0.003	2.3
Gaseous Fuels	14.652	14.637	19.696	19.991	20.503	4.473	21.8
Solid Fuels	61.068	64.277	68.389	46.146	52.874	39.414	74.5
Biomass	0.003	0.004	0.004	0.002	0.001	0.000	0.0
TOTAL	76.080	79.229	88.354	66.224	73.505	43.890	59.7

Figure 3.7 shows CO_2 emissions in the 1988-2006 period. Emissions of CH_4 and N_2O in the same time period are shown in figure 3.8. Emission trends for all three gases follow closely the trends in fuel use.

Over 73% of CO_2 emissions in 2006 in the sub-category 1.A.2.a came from installations covered by the EU ETS.

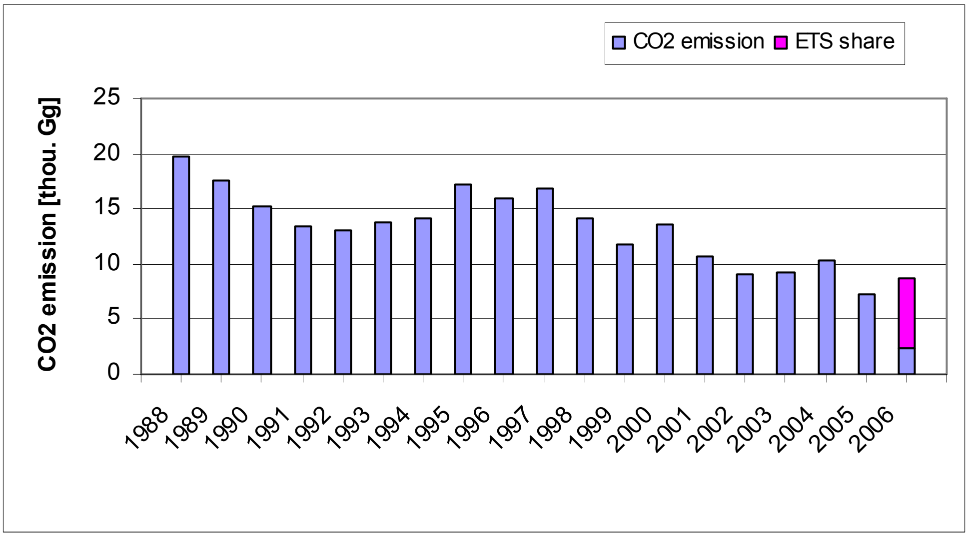


Figure 3.7. CO_2 emission for 1.A.2.a category in 1988-2006

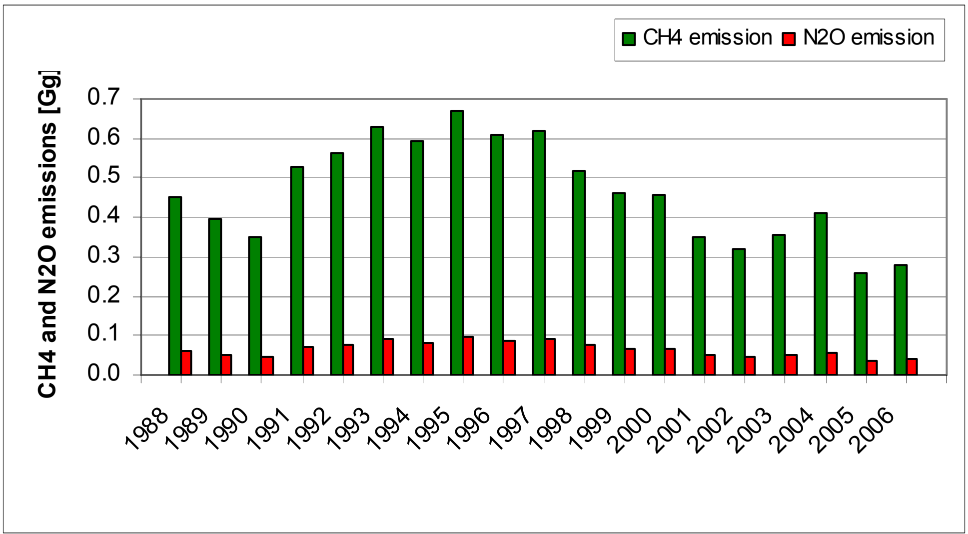


Figure 3.8. CH_4 and N_2O emissions for 1.A.2.a category in 1988-2006

1.A.2.b *Non-Ferrous Metals*

The data on fuel type use in the sub-category 1.A.2.b *Non-Ferrous Metals* over the 1988-2006 period are presented in table 3.5.

Tabel 3.5. Fuel consumption in 1988-2006 in subcategory 1.A.2.b [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	0.686	0.807	0.802	0.842	0.927	0.845	0.927
Gaseous Fuels	5.638	5.470	4.599	4.633	1.213	1.745	5.321
Solid Fuels	12.871	11.551	6.769	6.192	3.617	5.394	8.899
Biomass	0.000	0.000	0.000	0.000	0.000	0.001	0.001
TOTAL	19.195	17.827	12.170	11.667	5.757	7.985	15.148
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	0.889	0.938	0.852	0.774	0.729	0.860	0.781
Gaseous Fuels	5.447	5.108	5.424	5.639	5.660	5.814	5.700
Solid Fuels	12.503	13.082	12.820	11.733	10.958	11.197	12.051
Biomass	0.000	0.149	0.042	0.026	0.010	0.011	0.005
TOTAL	18.839	19.277	19.138	18.172	17.357	17.882	18.537
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	0.615	0.493	0.615	0.615	0.615	-	-
Gaseous Fuels	5.589	5.868	6.405	6.468	6.884	-	-
Solid Fuels	11.233	10.464	8.672	6.494	6.973	-	-
Biomass	0.001	0.000	0.000	0.000	0.000	-	-
TOTAL	17.438	16.825	15.692	13.577	14.472	-	-

Emissions of the main greenhouse gases in 1.A.2.b between the base year and 2006 are shown in figures: 3.10 and 3.11.

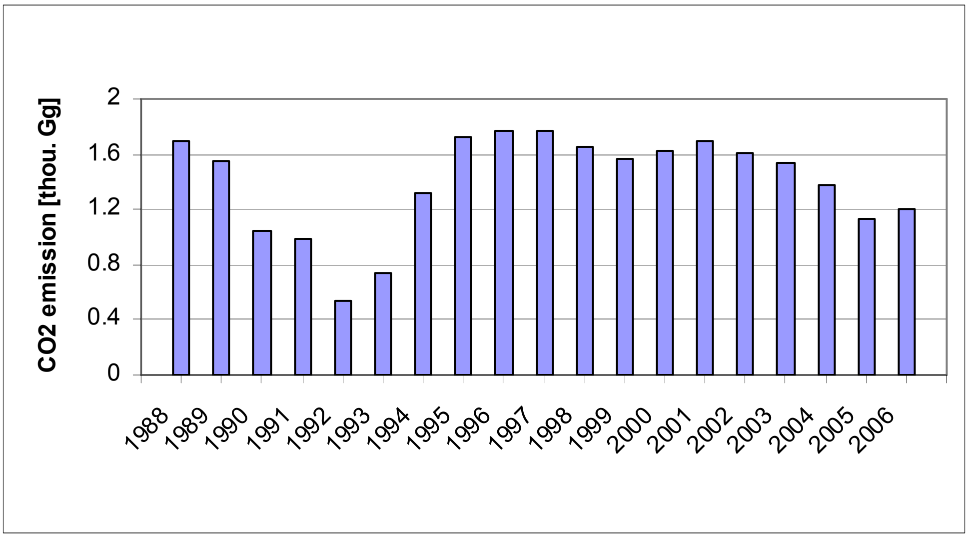


Figure 3.10. CO_2 emission for 1.A.2.b category in 1988-2006

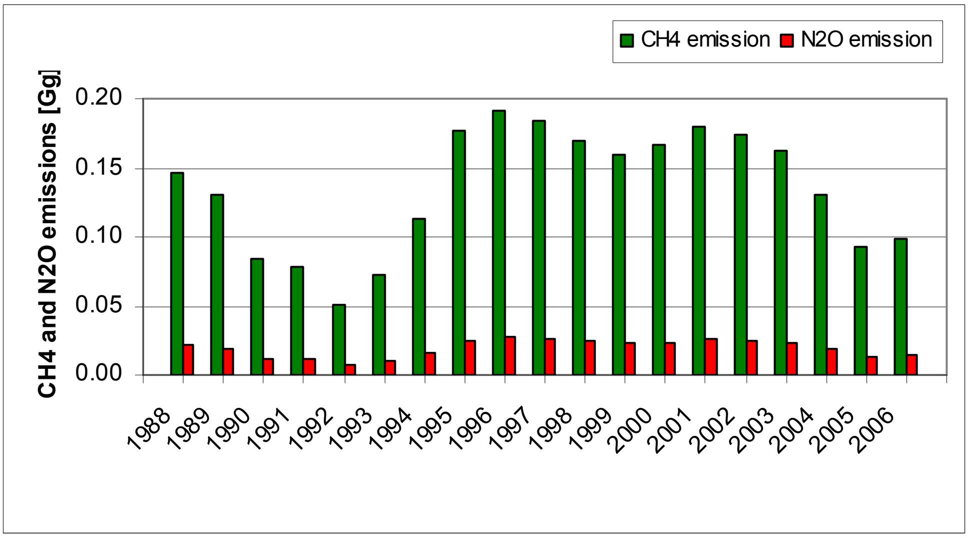


Figure 3.11. CH_4 and N_2O emissions for 1.A.2.b category in 1988-2006

1.A.2.c *Chemicals*

The data on fuel type use in the sub-category 1.A.2.c *Chemicals* over the 1988-2006 period are presented in table 3.6. For the year 2006, the share of EU ETS installations was estimated at 63.9%.

Tabel 3.6. Fuel consumption in 1988-2006 in subcategory 1.A.2.c [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	11.054	9.414	4.093	7.100	8.771	7.788	7.919
Gaseous Fuels	6.409	6.244	5.289	4.340	4.432	10.075	4.507
Solid Fuels	24.661	29.901	27.332	27.719	23.892	34.585	32.760
Biomass	0.345	0.390	0.118	0.039	0.010	0.003	0.035
TOTAL	42.469	45.949	36.832	39.198	37.105	52.451	45.221
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	10.949	19.322	22.500	40.322	38.724	41.481	37.764
Gaseous Fuels	6.356	6.191	11.024	9.408	9.041	9.464	8.481
Solid Fuels	95.757	86.947	80.691	65.766	62.196	62.070	61.248
Biomass	0.007	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	113.069	112.460	114.215	115.496	109.961	113.015	107.493
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	37.309	37.306	37.131	29.112	33.704	23.063	68.4
Gaseous Fuels	7.199	6.457	7.498	8.104	9.053	0.986	10.9
Solid Fuels	57.538	41.224	40.319	39.003	38.928	28.169	72.4
Biomass	0.001	0.153	0.102	0.165	0.000	0.000	-
TOTAL	102.047	85.140	85.050	76.384	81.685	52.218	63.9

Figure 3.12 shows CO_2 emissions in the sub-category 1.A.2.c in the 1988-2006 period. Emissions of CH_4 and N_2O, in turn, are shown in figure 3.13. In 2006, almost 63% of CO_2 emissions in that sub-category came from installations covered by the EU ETS.

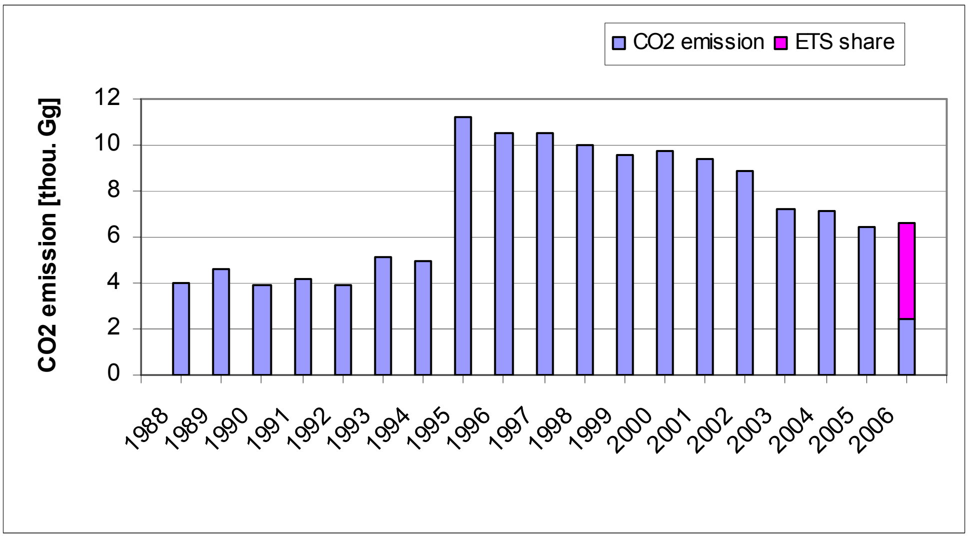


Figure 12. CO_2 emission for 1.A.2.c category in 1988-2006

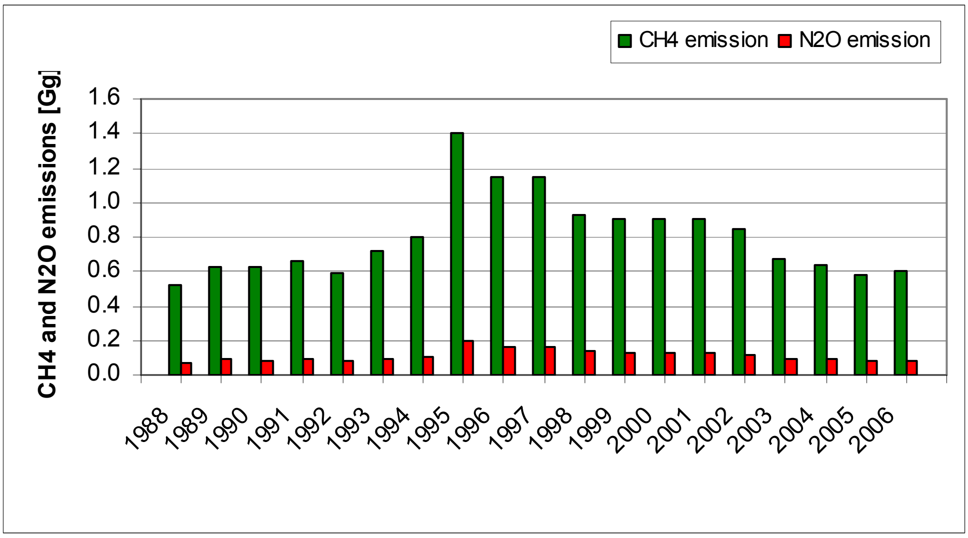


Figure 13. CH_4 and N_2O emissions for 1.A.2.c category in 1988-2006

1.A.2.d *Pulp, Paper and Print*

The data on fuel type use in the sub-category 1.A.2.d *Pulp, Paper and Print* over the 1988-2006 period are presented in table 3.7. Characteristic for that sub-sector is relatively large share of biomass in the total fuel use.
For the year 2006, the share of EU ETS installations was estimated for each fuel type and for the sum of fuels (40.5 %).

Tabel 3.7. Fuel consumption in 1988-2006 in subcategory 1.A.2.d [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	1.380	1.300	1.368	1.331	1.408	1.648	1.531
Gaseous Fuels	0.103	0.162	0.101	0.061	0.026	0.061	0.250
Solid Fuels	1.976	2.192	1.799	2.022	1.632	4.833	4.116
Biomass	0.352	0.205	0.001	0.000	0.000	1.585	1.610
TOTAL	3.811	3.858	3.269	3.414	3.066	8.127	7.507
	1995	1996	1997	1998	1999	2000	2001
Liquid Fuels	2.533	1.678	2.105	2.604	2.216	2.090	2.037
Gaseous Fuels	0.232	0.455	1.096	0.563	1.007	1.211	1.445
Solid Fuels	22.596	22.487	24.220	19.024	17.532	15.733	15.619
Biomass	15.437	16.243	16.472	16.476	15.545	15.938	15.138
TOTAL	40.798	40.863	43.893	38.667	36.300	34.972	34.239
	2002	2003	2004	2005	2006	ETS in 2006	ETS share [%]
Liquid Fuels	2.029	2.111	2.237	1.984	2.073	1.609	77.6
Gaseous Fuels	1.461	2.094	2.657	2.288	2.976	2.411	81.0
Solid Fuels	14.455	14.813	14.174	13.588	11.743	5.170	44.0
Biomass	16.622	17.950	18.957	18.611	30.369	9.919	32.7
TOTAL	34.567	36.968	38.025	36.471	47.161	19.109	40.5

Figures 3.14 and 3.15 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.2.d in the period: 1988-2006. The calculations show that in 2006 opp. 51% of CO_2 emissions in the sub-category 1.A.2.d came from installations covered by the EU ETS.

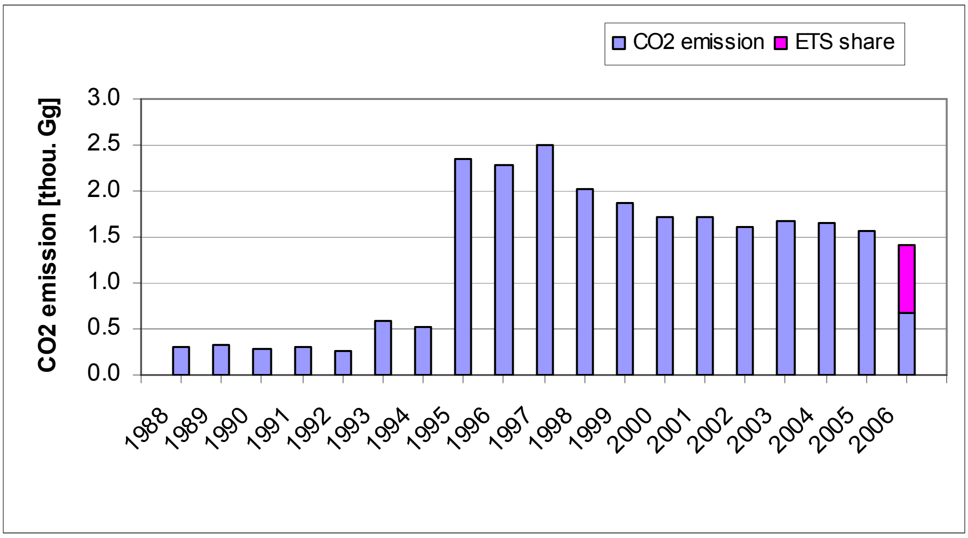


Figure 3.14. CO_2 emission for 1.A.2.d category in 1988-2006

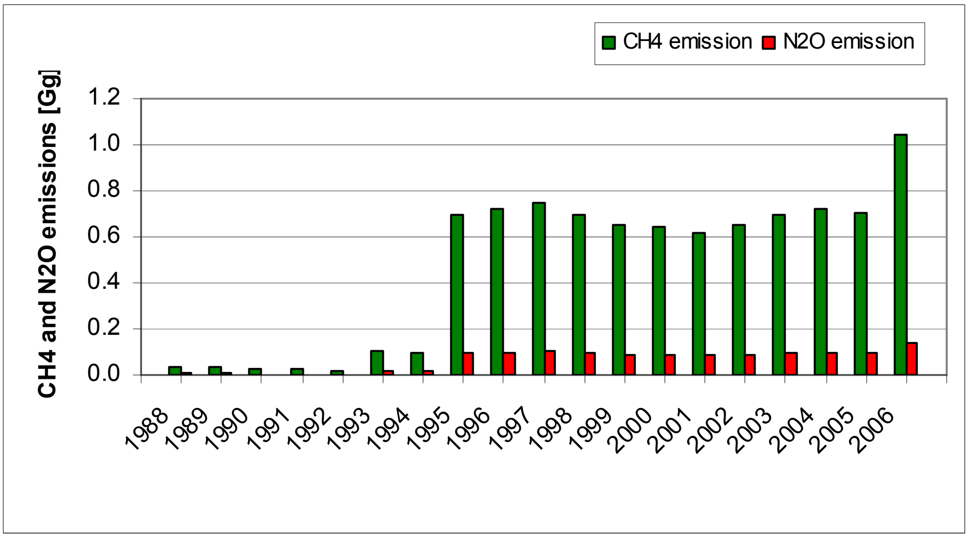


Figure 3.15. CH_4 and N_2O emissions for 1.A.2.d category in 1988-2006

1.A.2.e *Food, Beverages and Tobacco*

The data on fuel type use in the sub-category 1.A.2.e *Food, Beverages and Tobacco* over the 1988-2006 period are presented in table 3.8. For the year 2006, the share of EU ETS installations was estimated for each fuel type and for the sum of fuels (46.6 %).

Tabel 3.8. Fuel consumption in 1988-2006 in subcategory 1.A.2.e [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	4.468	3.524	3.045	2.629	2.386	4.686	5.202
Gaseous Fuels	1.965	1.910	1.970	1.985	2.339	3.171	7.180
Solid Fuels	29.282	35.544	35.341	38.979	35.485	59.312	56.661
Biomass	0.114	0.105	0.091	0.094	0.072	0.151	0.056
TOTAL	35.829	41.084	40.447	43.687	40.282	67.320	69.099
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	7.408	8.452	7.746	9.770	10.144	10.575	10.787
Gaseous Fuels	3.839	15.051	12.927	10.694	9.255	10.494	11.363
Solid Fuels	75.820	92.292	81.575	67.020	48.239	45.192	41.526
Biomass	0.082	0.094	0.075	0.104	0.089	0.112	0.104
TOTAL	87.149	115.889	102.323	87.588	67.727	66.373	63.780
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	11.242	11.276	10.935	9.960	8.602	1.876	21.8
Gaseous Fuels	12.490	15.075	16.164	17.456	18.623	4.680	25.1
Solid Fuels	43.498	42.156	37.932	36.919	31.779	21.023	66.2
Biomass	0.097	0.386	0.447	0.282	0.311	0.033	10.7
TOTAL	67.327	68.893	65.478	64.617	59.314	27.612	46.6

Figures 3.16 and 3.17 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.2.e in the period: 1988-2006. The calculations show that in 2006 opp. 50% of CO_2 emissions in the sub-category 1.A.2.e came from installations covered by the EU ETS.

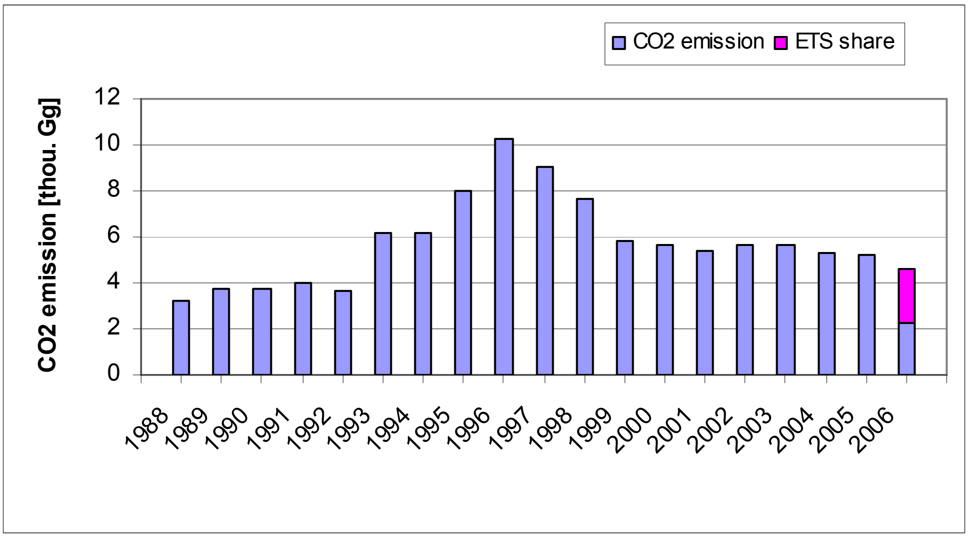


Figure3.16. CO_2 emission for 1.A.2.e category in 1988-2006

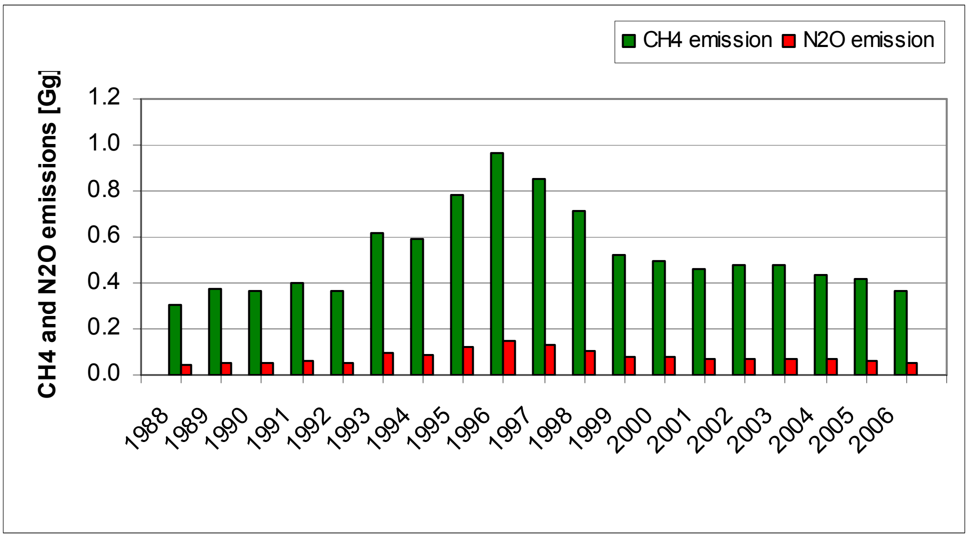


Figure 3.17. CH_4 and N_2O emissions for 1.A.2.e category in 1988-2006

1.A.2.f *Other* (stationary sources)

The data on fuel type use in stationary sources in the sub-category 1.A.2.f *Other* over the 1988-2006 period are presented in table 3.9. For the year 2006, the share of EU ETS installations was estimated for each fuel type and for the sum of fuels (63.7 %).

Tabel 3.9. Fuel consumption in 1988-2006 in subcategory 1.A.2.f [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	29.047	27.157	18.810	15.526	14.843	16.759	16.792
Gaseous Fuels	52.767	50.455	40.220	34.460	36.058	39.907	38.844
Solid Fuels	210.857	196.647	146.425	137.977	126.581	184.462	180.218
Biomass	10.113	9.468	6.981	5.973	5.077	5.028	3.414
TOTAL	302.785	283.728	212.436	193.936	182.559	246.156	239.268
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	22.437	28.218	30.730	28.386	24.622	22.343	21.430
Gaseous Fuels	40.695	40.861	41.717	44.737	40.269	46.522	50.178
Solid Fuels	182.268	213.838	188.250	147.860	124.043	106.244	83.509
Biomass	4.980	6.530	8.200	8.240	8.606	10.111	10.991
TOTAL	250.380	289.447	268.897	229.223	197.540	185.220	166.108
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	22.191	31.446	30.127	39.467	23.890	5.890	24.7
Gaseous Fuels	52.506	56.740	60.828	62.287	65.056	29.009	44.6
Solid Fuels	70.563	69.117	66.150	60.594	63.261	58.607	92.6
Biomass	12.592	12.006	12.458	12.370	11.987	11.076	92.4
TOTAL	157.852	169.309	169.563	174.717	164.194	104.582	63.7

Figures 3.18 and 3.19 show emissions of CO_2 and CH_4 and N_2O, respectively in the sub-category 1.A.2.f in the period: 1988-2006. The calculations show that in 2006 opp. 65% of CO_2 emissions in the sub-category 1.A.2.f came from installations covered by the EU ETS.

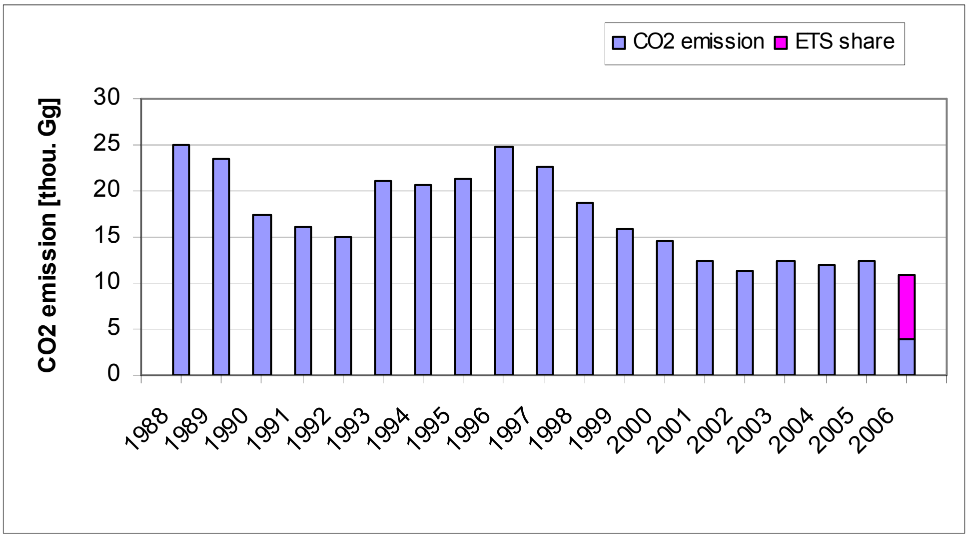


Figure 3.18. CO_2 emission for 1.A.2.f category in 1988-2006

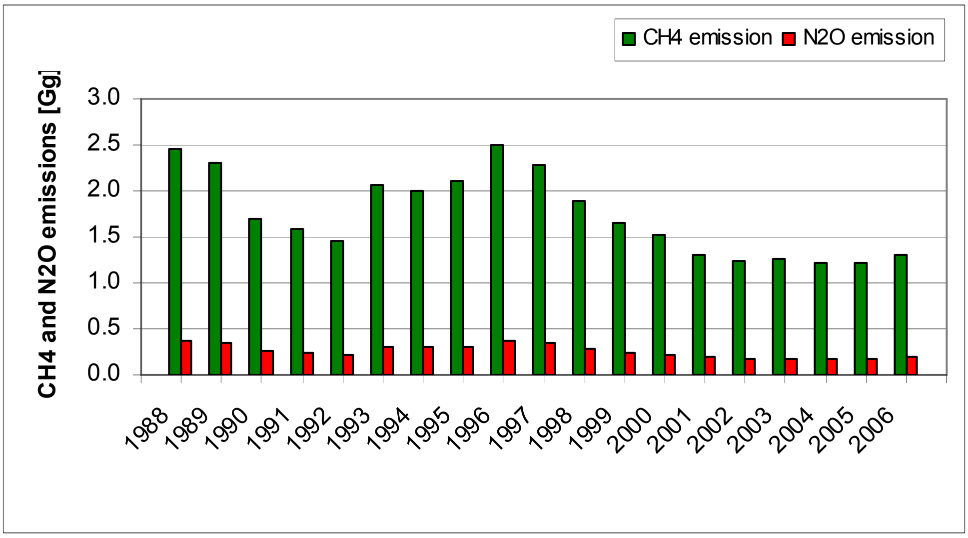


Figure 3.19. CH_4 and N_2O emissions for 1.A.2.f category in 1988-2006

The mobile source classified in the sub-category 1.A.2.f (i.e. machinery in industry and construction) are described below in a separate sub-chapter.

1.A.4.a *Other Sectors – Commercial/Institutional*

The data on fuel type use in stationary sources in the sub-category 1.A.4.a *Other Sectors – Commercial/Institutional* over the 1988-2006 period are presented in table 3.10. For the year 2006, the share of EU ETS installations was estimated for each fuel type and for the sum of fuels (1.9%).

Tabel 3.10. Fuel consumption in 1988-2006 in subcategory 1.A.4.a [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	0.000	0.000	0.000	0.000	0.000	0.000	1.334
Gaseous Fuels	13.079	12.601	13.787	10.977	11.190	11.548	9.573
Solid Fuels	299.156	244.760	118.908	141.592	131.701	99.412	65.944
Biomass	0.084	0.123	0.379	0.187	0.206	2.610	0.249
TOTAL	312.319	257.484	133.074	152.756	143.097	113.570	77.100
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	0.782	1.755	6.058	7.698	10.079	16.115	20.490
Gaseous Fuels	13.260	18.771	24.256	32.769	37.697	38.567	49.971
Solid Fuels	64.505	51.281	48.785	30.075	29.023	23.089	18.635
Biomass	11.983	10.625	9.627	9.085	9.216	9.212	6.596
TOTAL	90.530	82.432	88.726	79.627	86.015	86.982	95.692
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	18.908	29.649	26.591	19.255	14.772	0.004	0.0
Gaseous Fuels	61.001	67.057	69.570	70.224	62.941	0.141	0.2
Solid Fuels	31.628	30.637	27.355	28.054	32.148	2.075	6.5
Biomass	6.440	6.463	6.614	6.514	5.085	0.000	0.0
TOTAL	117.976	133.806	130.130	124.047	114.946	2.219	1.9

Figures 3.20 and 3.21 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.4.a in the period: 1988-2006. The calculations show that in 2006 opp. 3% of CO_2 emissions in the sub-category 1.A.4.a came from installations covered by the EU ETS.

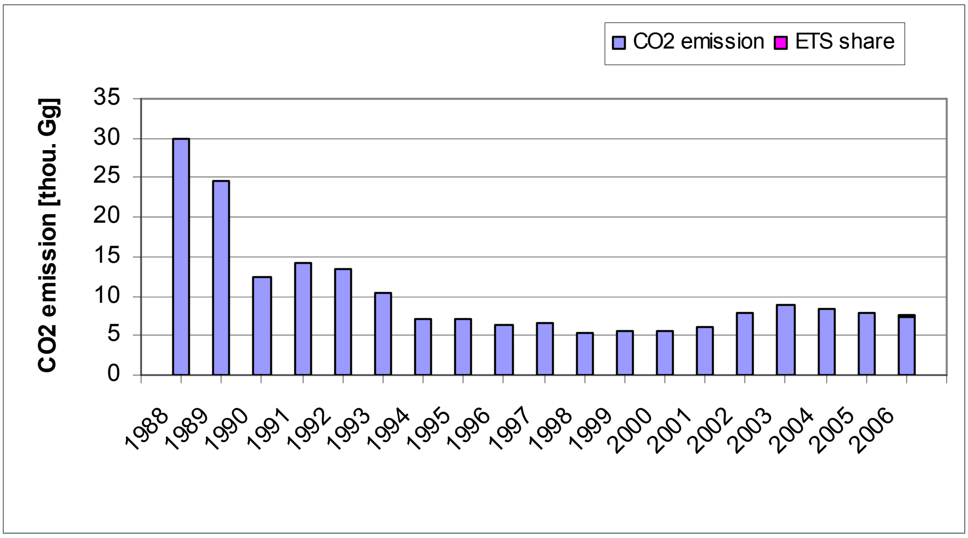


Figure 3.20. CO_2 emission for 1.A.4.a category in 1988-2006

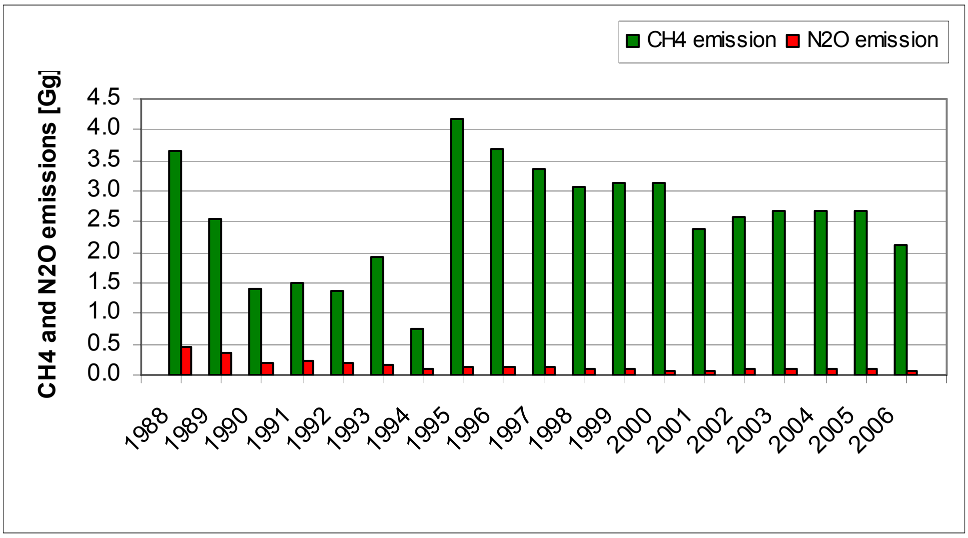


Figure 3.21. CH_4 and N_2O emissions for 1.A.4.a category in 1988-2006

1.A.4.b *Residential*

The data on fuel type use in stationary sources in the sub-category 1.A.4.b *Residential* over the 1988-2006 period are presented in table 3.11. Sources in that sub-category are not covered by the EU ETS.

Tabel 3.11. Fuel consumption in 1988-2006 in subcategory 1.A.4.b [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	6.955	7.664	1.702	1.012	1.840	6.072	8.970
Gaseous Fuels	102.581	107.619	122.204	133.674	141.212	141.590	151.671
Solid Fuels	617.865	546.681	285.135	355.892	373.615	439.866	367.015
Biomass	33.615	32.351	34.335	27.721	33.969	123.084	123.154
TOTAL	761.015	694.315	443.376	518.299	550.636	710.612	650.810
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	12.834	18.215	24.745	26.860	28.964	37.160	41.850
Gaseous Fuels	159.559	143.057	150.022	138.268	135.995	127.611	133.737
Solid Fuels	365.396	353.171	323.771	245.509	261.444	192.778	216.059
Biomass	105.000	101.000	100.000	100.700	95.000	95.000	104.500
TOTAL	642.789	615.443	598.538	511.337	521.403	452.549	496.146
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	44.021	47.931	48.565	44.335	33.390	-	-
Gaseous Fuels	127.093	127.629	126.376	135.111	138.686	-	-
Solid Fuels	196.036	181.505	176.814	208.626	242.148	-	-
Biomass	104.500	103.075	103.360	100.700	104.500	-	-
TOTAL	471.650	460.140	455.115	488.772	518.723	-	-

Figure 3.22 show emissions of CO_2 in 1.A.4.b in the 1988-2006 period while CH_4 and N_2O, emissions in the same sub-category are shown in figure 3.23.

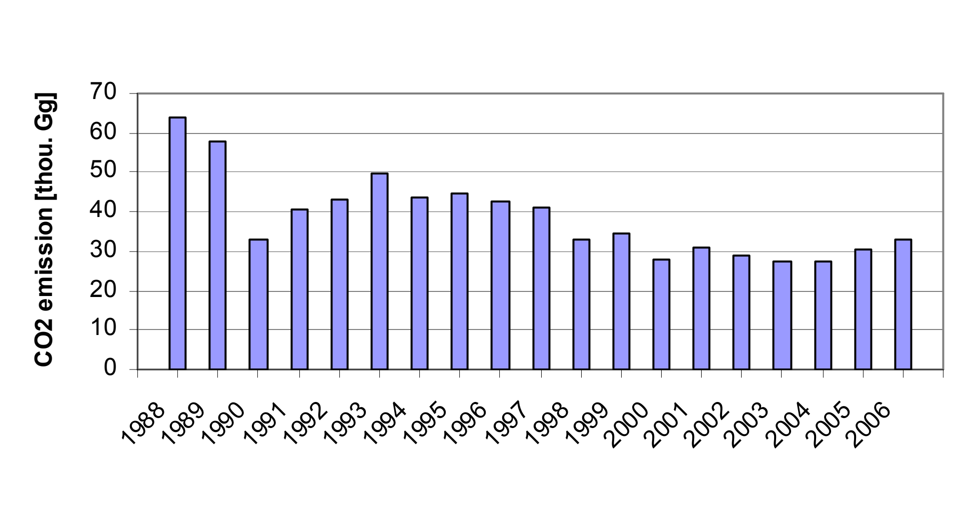


Figure 3.22. CO_2 emission for 1.A.4.b category in 1988-2006

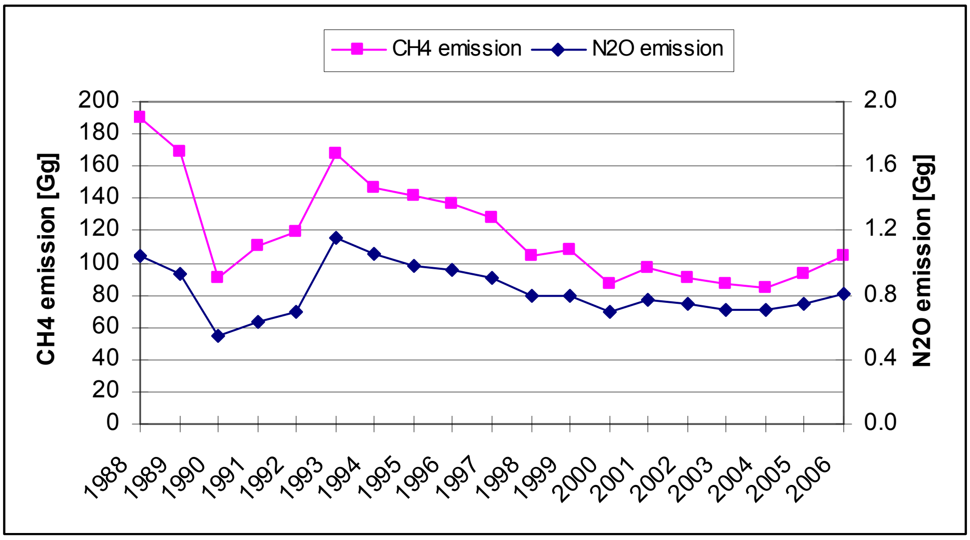


Figure 3.23. CH_4 and N_2O emissions for 1.A.4.b category in 1988-2006

1.A.4.c *Agriculture/Forestry/Fisheries – stationary sources*

The data on fuel type use in stationary sources in the sub-category 1.A.4.c Agriculture/Forestry/Fisheries over the 1988-2006 period are presented in table 3.12. For the year 2006, the share of EU ETS installations was estimated for each fuel type and for the sum of fuels (1.2%).

Tabel 3.12. Fuel consumption in 1988-2006 in subcategory 1.A.4.c [PJ]

	1988	1989	1990	1991	1992	1993	1994
Liquid Fuels	2.733	2.613	2.760	2.000	0.480	14.060	18.280
Gaseous Fuels	0.507	0.445	0.448	0.275	0.055	0.132	0.212
Solid Fuels	42.690	42.027	29.795	47.496	56.902	57.993	70.315
Biomass	0.039	0.113	0.039	0.278	0.583	12.737	11.647
TOTAL	45.969	45.198	33.042	50.049	58.020	84.922	100.454
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Liquid Fuels	10.510	6.250	9.128	8.160	8.410	8.804	8.464
Gaseous Fuels	0.243	0.428	0.571	0.869	0.476	0.536	0.777
Solid Fuels	69.299	67.002	61.955	55.247	59.368	40.330	45.464
Biomass	18.500	17.567	17.000	17.100	17.100	17.100	19.043
TOTAL	98.552	91.247	88.654	81.376	85.354	66.770	73.748
	2002	**2003**	**2004**	**2005**	**2006**	**ETS in 2006**	**ETS share [%]**
Liquid Fuels	6.904	9.528	8.560	10.804	4.088	0.754	18.4
Gaseous Fuels	0.914	1.197	1.182	1.084	1.493	0.115	7.7
Solid Fuels	37.594	35.305	34.452	38.978	45.961	0.003	0.0
Biomass	19.010	19.017	19.878	19.038	19.977	0.000	0.0
TOTAL	64.422	65.047	64.072	69.904	71.519	0.872	1.2

Figures 3.24 and 3.25 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.4.c in the period: 1988-2006. The calculations show that in 2006 opp. 1% of CO_2 emissions in the sub-category 1.A.4.c came from installations covered by the EU ETS.

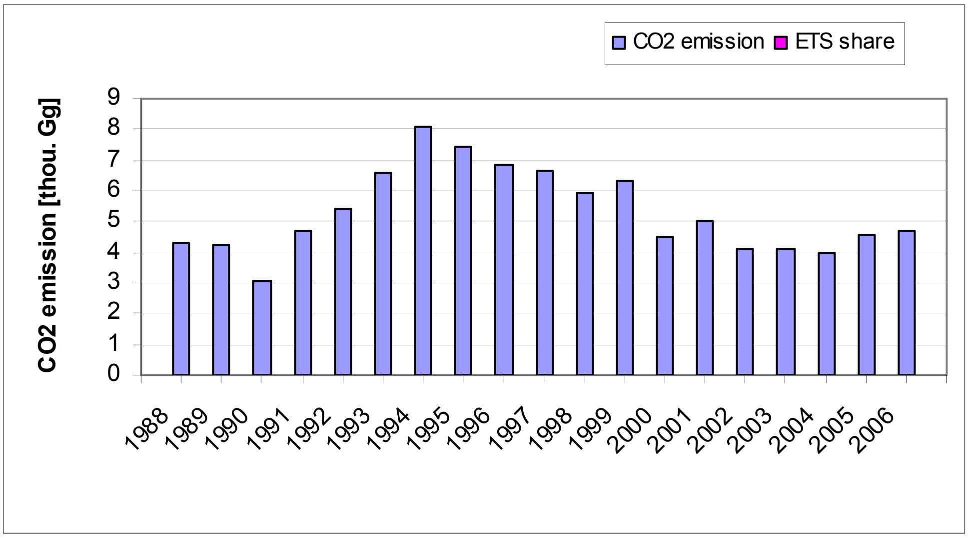


Figure 3.24. CO_2 emission for 1.A.4.c category in 1988-2006

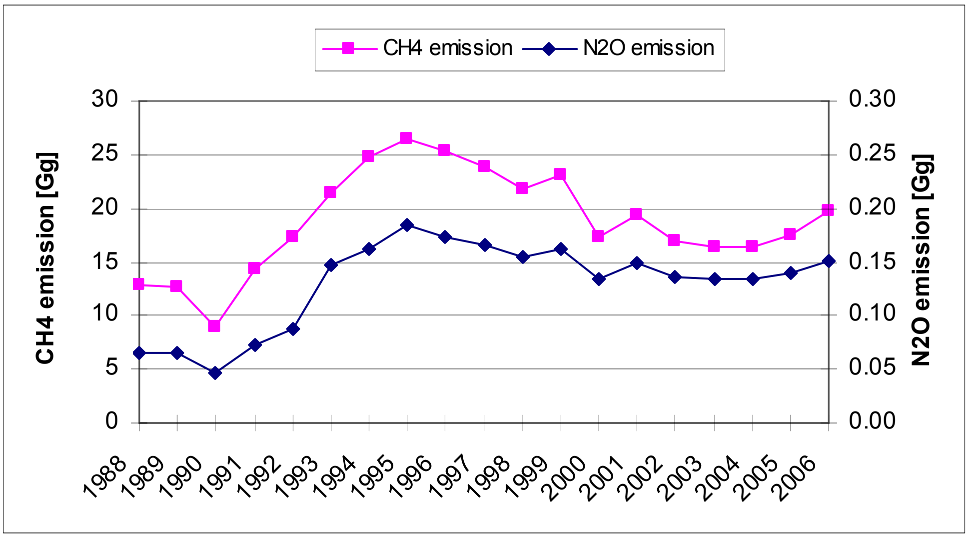


Figure 3.25. CH_4 and N_2O emissions for 1.A.4.c category in 1988-2006

The mobile source classified in the sub-category 1.A.2.c (i.e. machinery and off-road vehicles in agriculture) are described below.

<u>Mobile sources</u>

For the source category 1.A.3 and for other mobile sources the following data sources were used to estimate the fuel use:

- report of the Motor Transport Institute [ITS 2007] – activity data in road transport
- Eurostat database – use of fuels in the following sub-categories: 1.A.3.a – *Civil Aviation*, 1.A.3.c – *Railways*, in part of the sub-category 1.A.3.d – *Navigation – i.e. inland water navigation*, in part of the sub-category 1.A.4.c – vehicles and machinery in agriculture, use of fuels included in the international maritime bunker
- GUS reports G-03 – selected aggregated data from the energy balance statistics [GUS 2007e] – used for estimation of fuel use for part of the sub-category 1.A.3.d – *Navigation* - for maritime shipping
- „Fuel-Energy Economy" [GUS 2007a] – publication used as a source for fuel use estimation in the sub-category 1.A.2.f.ii – machinery and off-road vehicles In industry and in 1.A.3.e – other off-road vehicles
- Statistical Yearbook [GUS 2007] – data on fishing used for fuel use estimation in the sub-category 1.A.4.c. iii - Fishing
- report [ITS 2001] – data used for fuel use estimation in the sub-category 1.A.2.f.ii – machinery in industry and construction, 1.A.3.e – other off-road vehicles, 1.A.4.c. iii – Fishing

For calculation of CO_2 emissions in road transport (1.A.3.b) domestic emission factors estimated each year by ITS were used [ITS 2007]. For other means of transport (including mobile source outside the category 1.A.3) default emission factors were used for CO_2 [IPCC 1997, 2006].
Estimation of CH_4 and N_2O emissions for all mobile sources (source categories: 1.A.3 and mobile sources in 1.A.2.f and 1.A.4.c) were based on the default emission factors [IPCC 1997, 2006]. Table 3.13 shows the values of the emission factors for mobile sources used in the national inventory.

Tabel. 3.13. Emission factors [kg/GJ] for transport types in 2006

Type of transport	Category code	EF CO_2	EF CH_4	EF N_2O
1.A.3.a.i i International Aviation - bunker	1.i.PL.	73.26	0.0005	0.0023
1.A.3.a.ii Civil Aviation. Domestic	1.i.PL.	73.26	0.0005	0.0023
	1.i.BL.	72.10	0.0600	0.0009
1.A.3.b.i Passenger Cars without catalysts	2.i.a.BS	70.75	0.03	0.002
	2.i.a.LG	63.11	0.02	0.0002
	2.i.a.ON	73.16	0.002	0.004
	2.i.b.BS	70.75	0.02	0.001
1.A.3.b. Passenger Cars with catalysts	2.i.g.BS	70.31	0.007	0.02
	2.i.g.LG	63.11	0.02	0.0002
	2.i.g.ON	73.16	0.002	0.004
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	2.ii.a.BS	70.75	0.02	0.001
	2.ii.a.LG	63.11	0.03	0.0002
	2.ii.a.ON	73.16	0.001	0.004
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	2.ii.g.BS	70.31	0.02	0.001
	2.ii.g.LG	63.11	0.01	0.0002
	2.ii.g.ON	73.16	0.001	0.004
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	2.iii.a.ON	73.16	0.006	0.003
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. with catalysts	2.iii.g.ON	73.16	0.006	0.003
1.A.3.b.iii Autobusy	2.iii.a.ON	73.16	0.0039	0.0013
	2.iii.g.ON	73.16	0.0039	0.0013
1.A.3.b.iv Motorcycles	2.iv.BS	70.75	0.1	0.001
1.A.3.b.iv Mopeds	2.iv.BS	70.75	0.1	0.001
1.A.3.b.vi Tractors	2.vi.ON	73.16	0.004	0.0039
1.A.3.b - different types of vehicles	biodiesel	70.80	0.003	0.0006
1.A.3.b - different types of vehicles	bioethanol	70.80	0.003	0.0006
1.A.3.c. Railways	3.ON	75.00	0.005	0.0006
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.f.ii Off-Road Vehicles in Industry, 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:
catalyst - catalytic converter; BS - motor gasoline; ON - diesel oil; LG – liquid gas; OP - fuel oil; PL - jet fuel; BL - aviation gasoline.

Trends of fuel use and methodology over the period: 1988-2006

The methodology used for estimation of GHG emissions in the national inventory for mobile sources for the entire time series: 1988-2006 is factor based – data on fuel used are multiplied by the corresponding emission factors.
Domestic emission factors for mobile sources include: CO_2 emission factors for road transport which are taken from annual reports of Motor Transport Institute and CO_2 emission factors for hard coal combustion in railway transport (concerns the period till 1998) – here the EF is calculated based upon an empirical function described above for stationary sources.
All other emission factors for mobile sources were taken from IPCC guidelines and have constant values over the entire time series 1988-2006. The values of the EFs are those in table 3.13. The values of EFs which are expressed in g/kg in the original references may differ from year to year compared to values in table 3.13 following the fluctuations of NCVs and subsequent unit conversions. This applies - inter alia - to CO_2 and CH_4 emission factors for jet fuel.

1.A.3.a *Civil Aviation*

Data on fuel use in domestic aviation are show in figure 3.26. When assessing the amount of fuel used for civil aviation, it was assumed that 5% of the jet fuel and the entire amount of aviation kerosene in the national aviation transport statistics is used in domestic aviation.

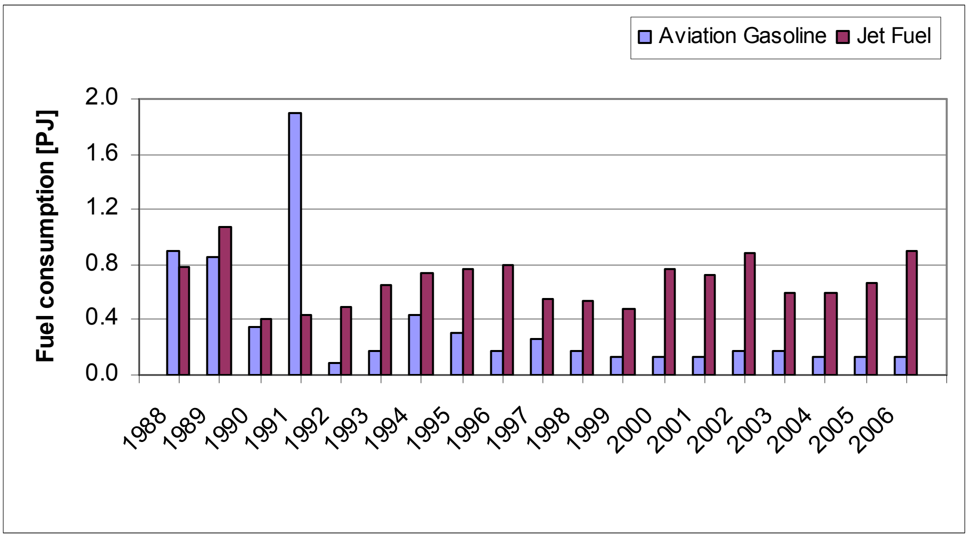


Figure 3.26. Fuel consumption in 1.A.3.a category for 1988-2006

Figures 3.27 and 3.28 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.3.a in the period: 1988-2006.

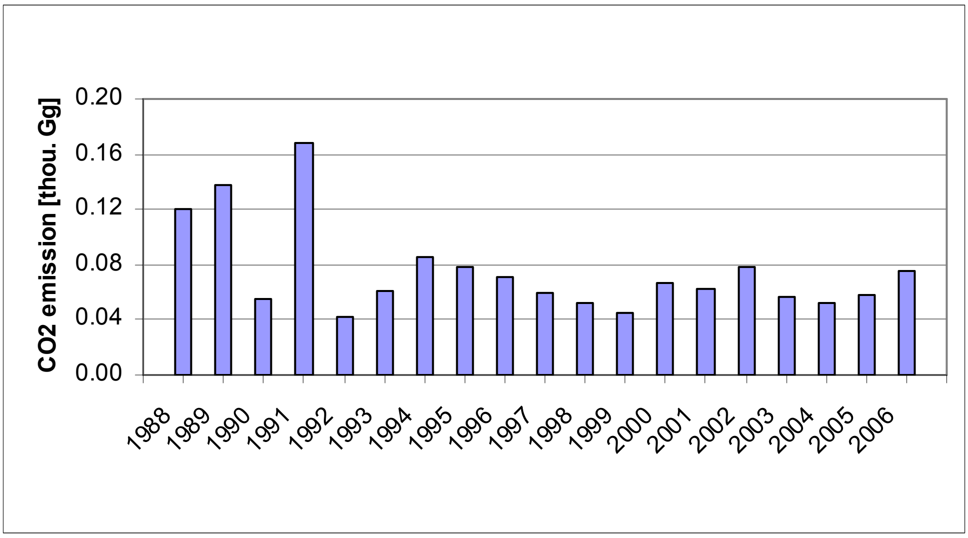


Figure 3.27. CO_2 emission for 1.A.3.a category in 1988-2006

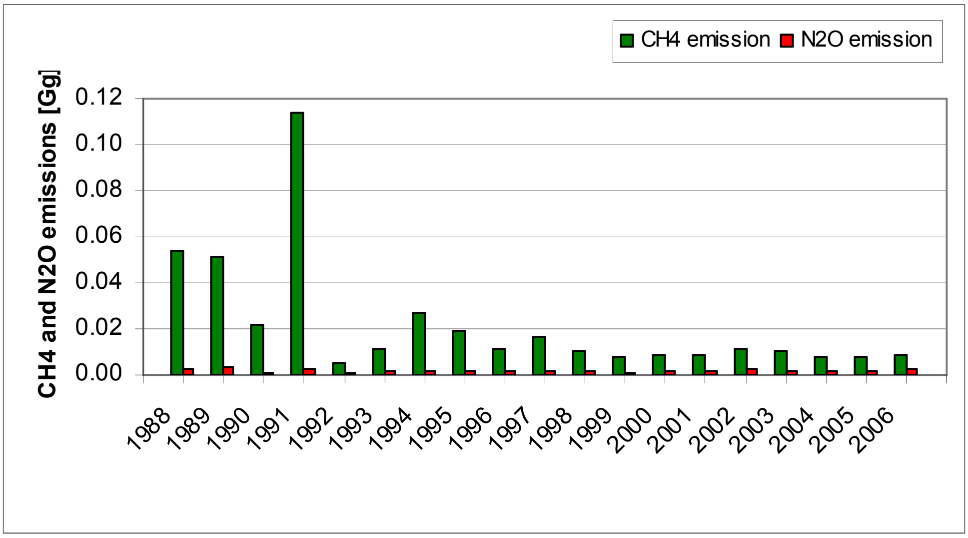


Figure 3.28. CH_4 and N_2O emissions for 1.A.3.a category in 1988-2006

1.A.3.b *Road Transportation*

Consumption of main fuels in road transport (gasoline, diesel oil and LPG) in the 1988-2006 period is shown in figure 3.29.

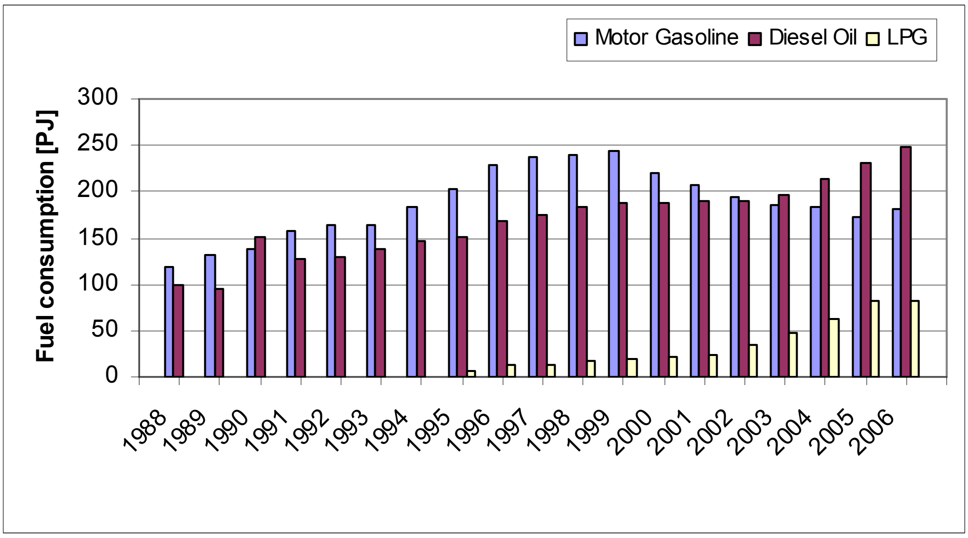


Figure 3.29. Fuel consumption in 1.A.3.b category for 1988-2006

There is a growing trend of consumption of biofuels in road transport. In 2005 and 2006 the following amounts of biofuel was used:

- biodiesel 0.510 PJ in 2005 and 1.122PJ in 2006
- bioethanol 1.802 PJ and 2.924PJ in 2005 and 2006, respectively.

As the consumption of biofuels in 1.A.3.b is not significant compared to consumption of other fuels, it is not shown in the above figure.

Figure 3.30 shows CO_2 emissions in sub-category 1.A.3.b in the period: 1988-2006. Emissions of CH_4 and N_2O in the same sub-category are shown in figure 3.31.

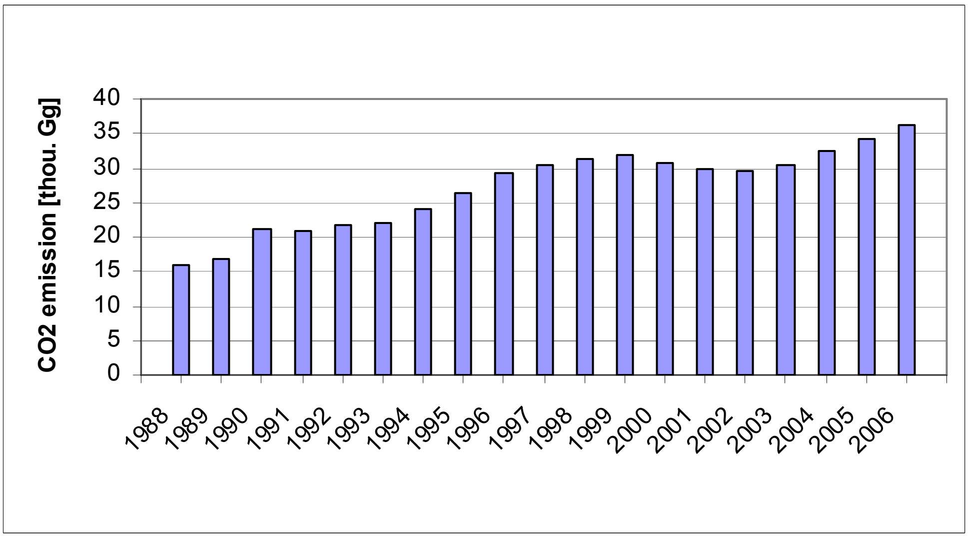


Figure 3.30. CO_2 emission for 1.A.3.b category in 1988-2006

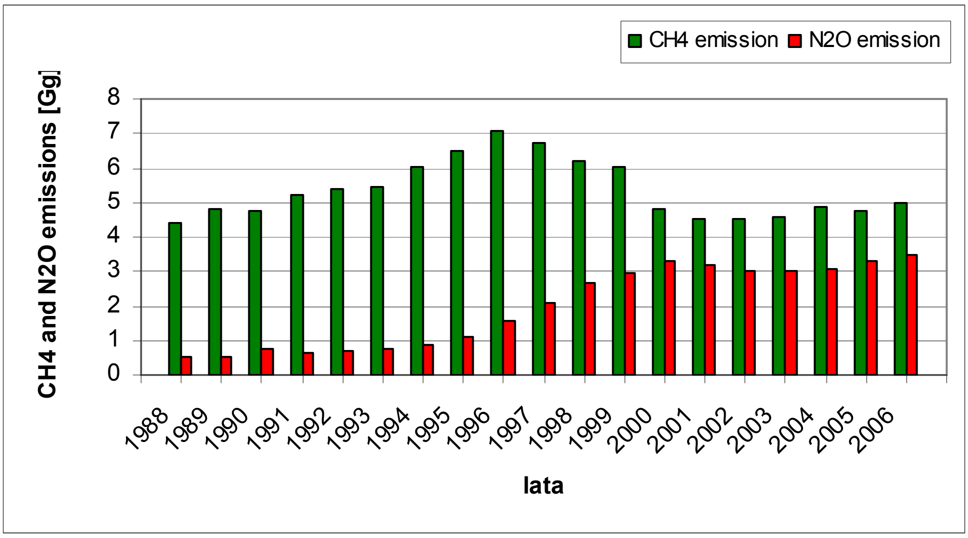


Figure 3.31. CH_4 and N_2O emissions for 1.A.3.b category in 1988-2006

1.A.3.c *Railways*

The amounts of fuels used in railway transport in the 1988-2006 period are shown in figure 3.32.

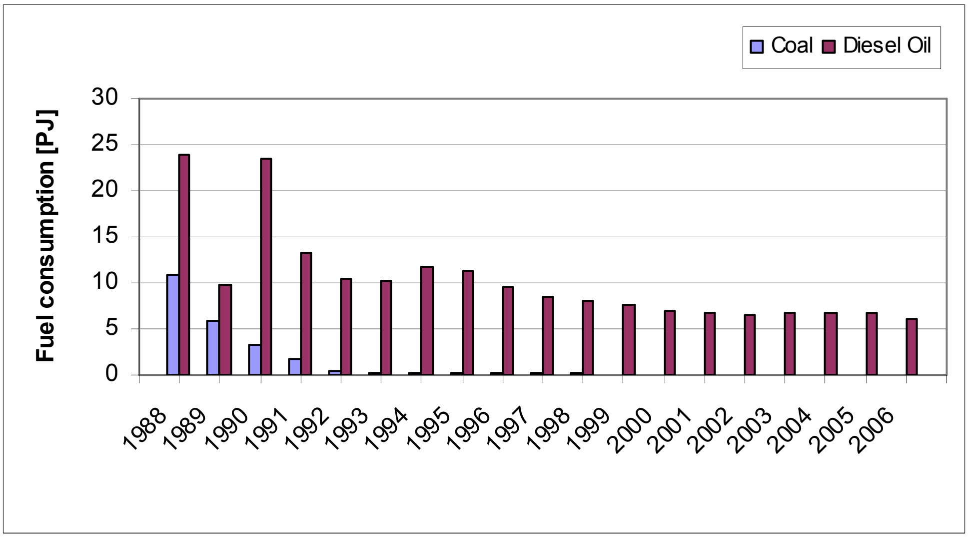


Figure 3.32. Fuel consumption in 1.A.3.c category for 1988-2006

Figures 3.33 and 3.34 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.3.c for the entire time series beginning in the base year.

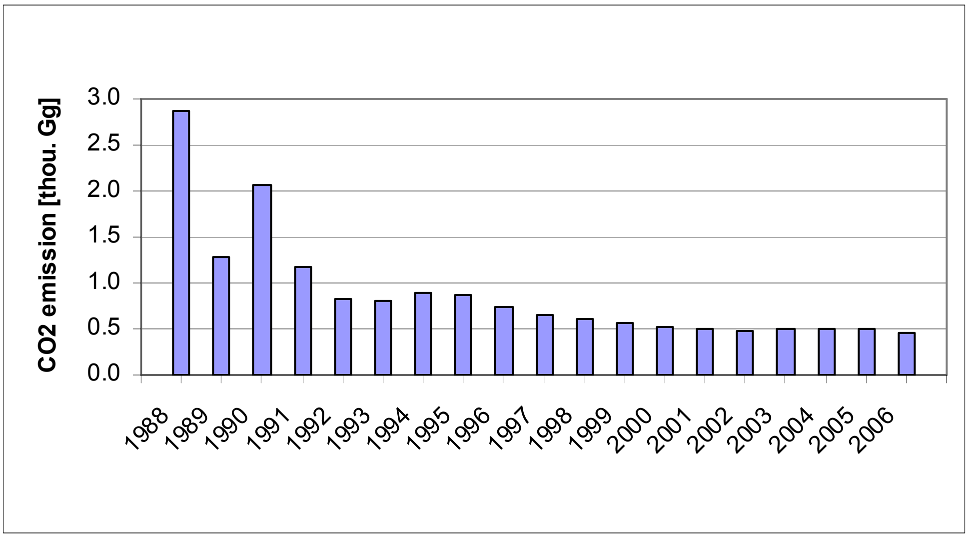


Figure 3.33. CO_2 emission for 1.A.3.c category in 1988-2006

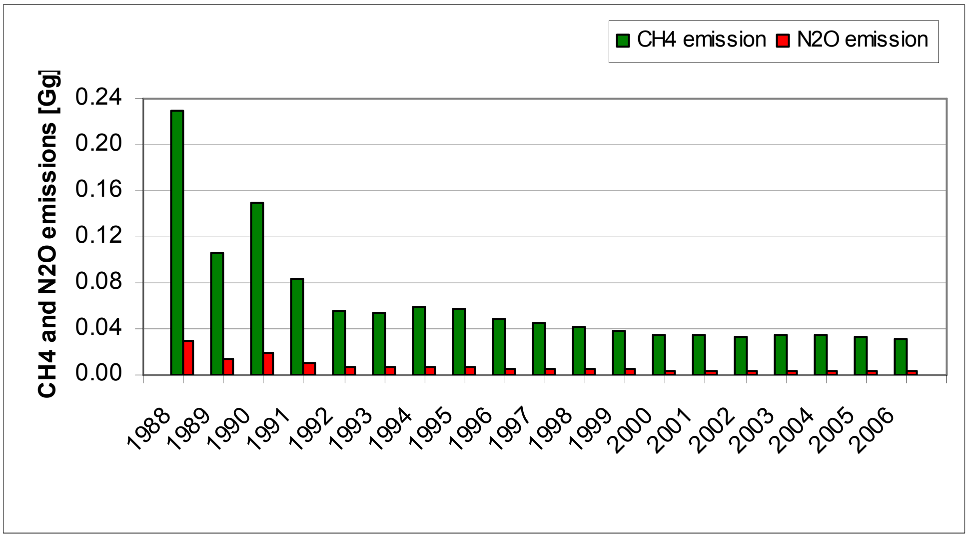


Figure 3.34. CH_4 and N_2O emissions for 1.A.3.c category in 1988-2006

1.A.3.d *Navigation*

The amounts of fuels (diesel and fuel oil) used in both inland water and maritime navigation in the 1988-2006 period are shown in figure 3.35.

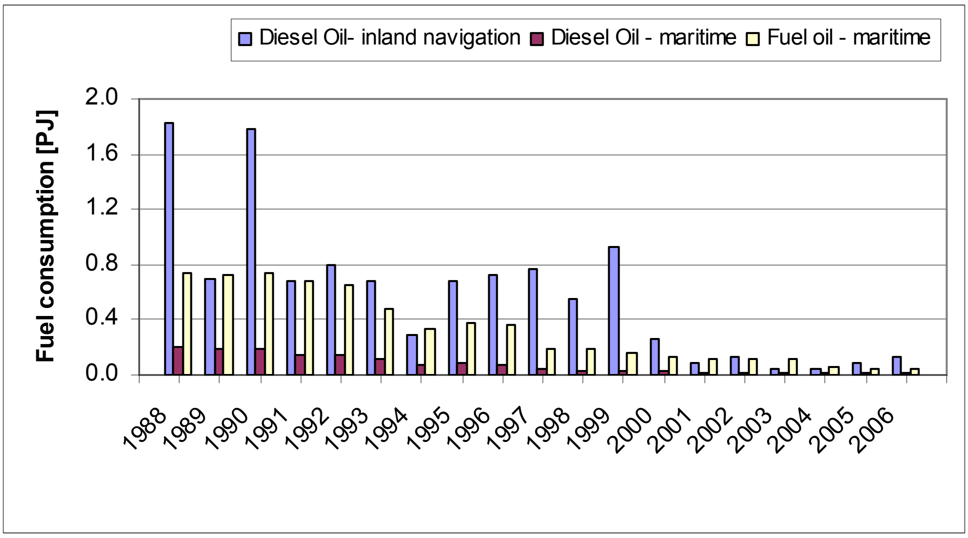


Figure 3.35. Fuel consumption in 1.A.3.d category for 1988-2006

Figures 3.36 and 3.37 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.3.d for the entire time series 1988-2006.

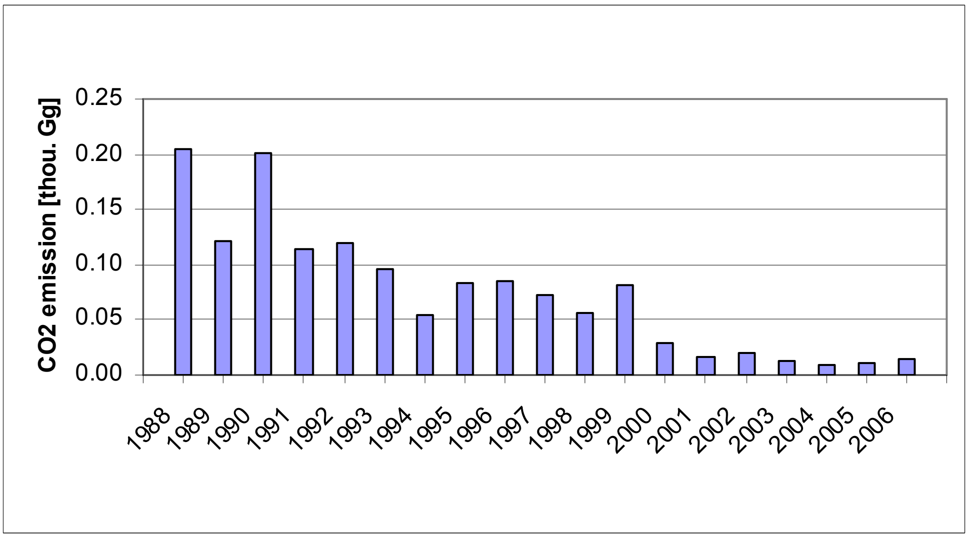


Figure 3.36. CO_2 emission for 1.A.3.d category in 1988-2006

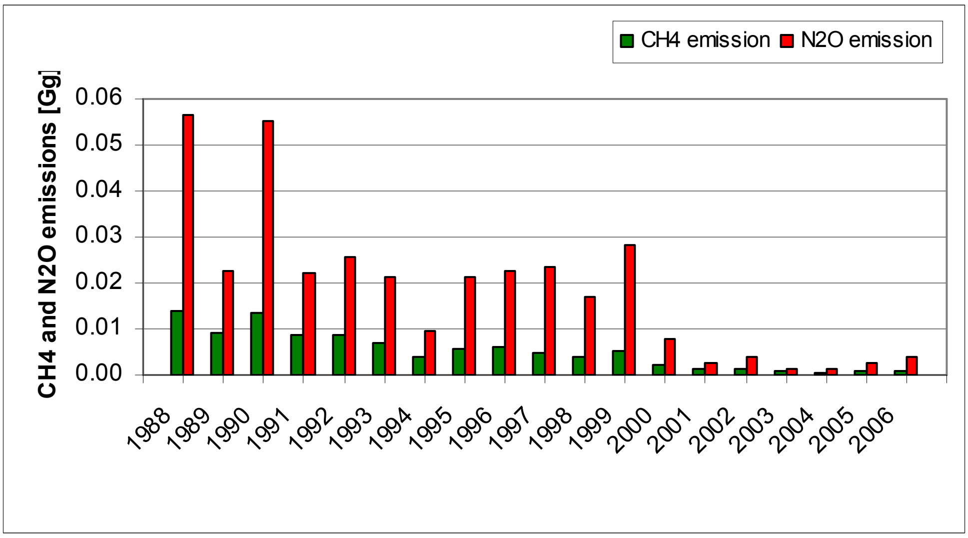


Figure 3.37. CH_4 and N_2O emissions for 1.A.3.d category in 1988-2006

1.A.3.e *Other Transportation*

The amounts of fuels (gasoline, diesel oil and LPG) used in the sub-category 1.A.3. in the 1988-2006 period are shown in figure 3.38.

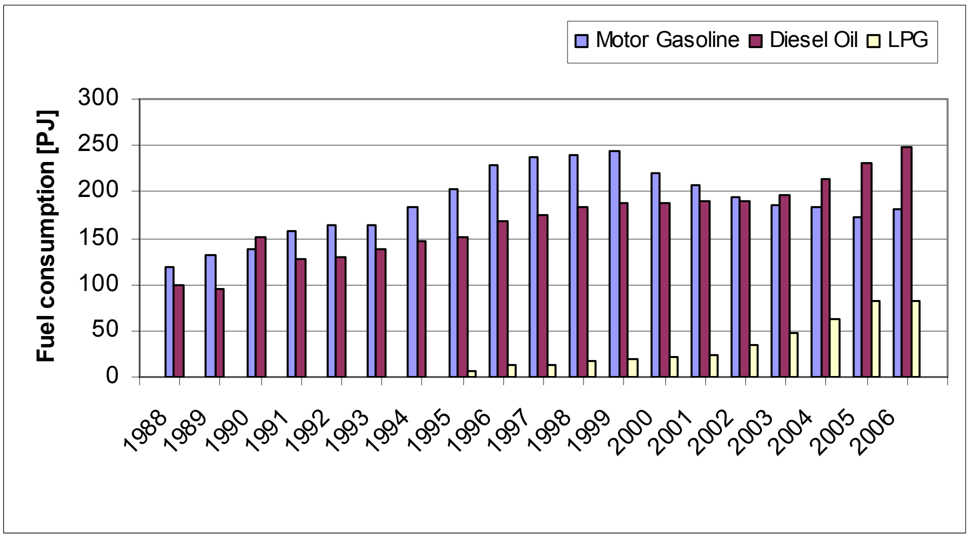


Figure 3.38. Fuel consumption in 1.A.3.e category for 1988-2006

Figures 3.39 and 3.40 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.3.e for the entire time series 1988-2006.

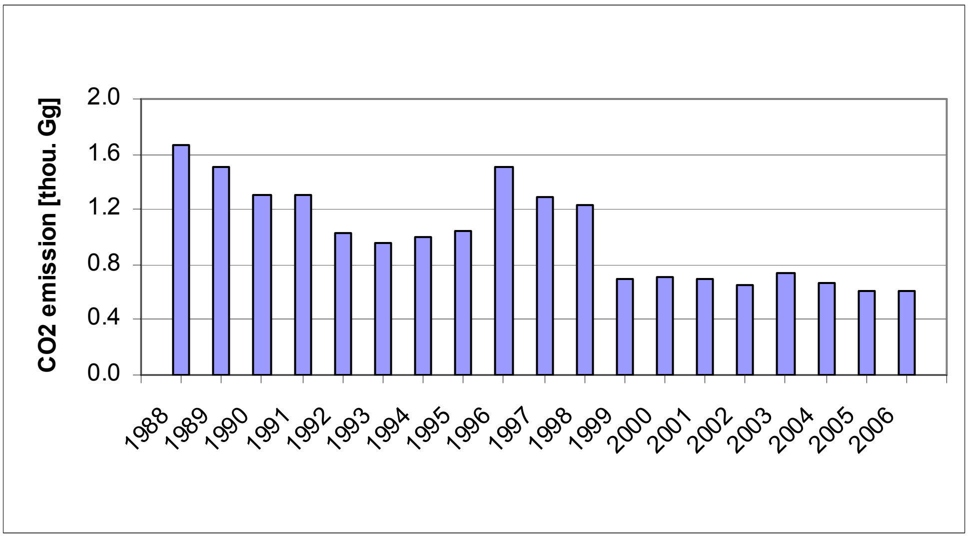


Figure 3.39. CO_2 emission for 1.A.3.e category in 1988-2006

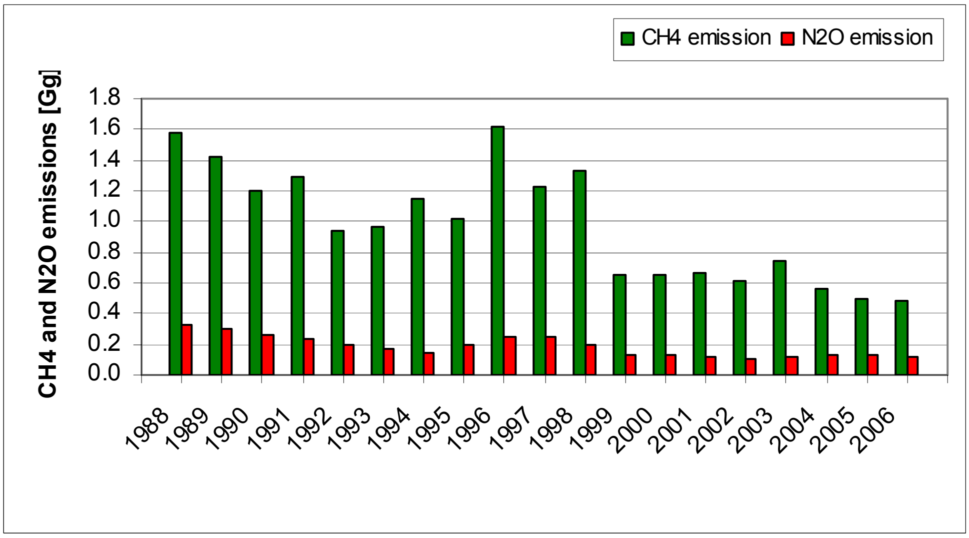


Figure 3.40. CH_4 and N_2O emissions for 1.A.3.e category in 1988-2006

Other mobile sources outside of the source category 1.A.3

Other mobile sources included in the national inventory in sub-categories other than 1.A.3 include:

- machinery and off-road transport in agriculture (sub-category 1.A.4.c.ii) – classified in source category 1.A.4
- fishery (sub-category 1.A.4.c.iii) - classified in source category 1.A.4
- machinery and off-road transport in industry and construction (sub-category 1.A.2.f.ii) - classified in source category 1.A.2

The amounts of fuels used in the above listed sub-categories in the 1988-2006 period are presented in table 3.14. The amounts of corresponding emissions of CO_2, CH_4 and N_2O are shown in tables 3.15–3.17.

Tabel 3.14. Fuel consumption [PJ] in 1988-2006 in mobile sources in subcategories other than 1.A.3

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
ON-1.A.4.c.i	50.27	48.72	36.81	36.15	44.67	59.47	65.24	68.72	74.69	90.51	80.33	85.09	96.10	88.73	88.43	89.75	91.56	93.92	87.65
ON-1.A.4.c.ii	4.55	4.15	3.43	3.30	3.44	2.82	3.22	3.16	2.60	2.70	1.95	1.96	1.73	1.83	1.79	1.44	1.62	1.38	1.30
OP-1.A.4.c.ii	7.54	6.87	5.67	5.46	5.69	4.67	5.33	5.24	4.24	4.41	3.18	3.19	2.83	2.98	2.93	2.36	2.65	2.25	2.13
ON-1.A.2.f.ii	13.70	12.43	10.96	9.92	8.52	8.64	7.23	8.29	10.21	10.51	7.88	5.71	5.63	4.89	4.80	4.93	5.67	5.37	5.28

ON - diesel oil, OP - fuel oil

Tabel 3.15. CO_2 emission [thous. Gg] in 1988-2006 in mobile sources in subcategories other than 1.A.3

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1.A.4.c.i	3.669	3.556	2.687	2.639	3.261	4.341	4.763	5.016	5.453	6.607	5.864	6.211	7.016	6.478	6.456	6.552	6.684	6.856	6.399
1.A.4.c.ii	0.923	0.840	0.694	0.668	0.697	0.571	0.652	0.641	0.522	0.543	0.391	0.393	0.348	0.367	0.360	0.290	0.325	0.277	0.261
1.A.2.f.ii	1.000	0.907	0.800	0.724	0.622	0.631	0.528	0.605	0.745	0.767	0.575	0.417	0.411	0.357	0.350	0.360	0.414	0.392	0.385

Tabel 3.16. CH_4 emission [Gg] in 1988-2006 in mobile sources in subcategories other than 1.A.3

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1.A.4.c.i	0.201	0.195	0.147	0.145	0.179	0.238	0.261	0.275	0.299	0.362	0.321	0.340	0.384	0.355	0.354	0.359	0.366	0.376	0.351
1.A.4.c.ii	0.085	0.077	0.064	0.061	0.064	0.052	0.060	0.059	0.048	0.050	0.036	0.036	0.032	0.034	0.033	0.027	0.030	0.025	0.024
1.A.2.f.ii	0.055	0.050	0.044	0.040	0.034	0.035	0.029	0.033	0.041	0.042	0.032	0.023	0.023	0.020	0.019	0.020	0.023	0.021	0.021

Tabel 3.17. N_2O emission [Gg] in 1988-2006 in mobile sources in subcategories other than 1.A.3

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1.A.4.c.i	0.327	0.317	0.240	0.235	0.291	0.387	0.425	0.447	0.486	0.589	0.523	0.554	0.626	0.578	0.576	0.584	0.596	0.611	0.571
1.A.4.c.ii	0.024	0.022	0.018	0.018	0.018	0.015	0.017	0.017	0.014	0.014	0.010	0.010	0.009	0.010	0.009	0.008	0.009	0.007	0.007
1.A.2.f.ii	0.411	0.373	0.329	0.298	0.256	0.259	0.217	0.249	0.306	0.315	0.236	0.171	0.169	0.147	0.144	0.148	0.170	0.161	0.158

3.2.2. *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 IPCC Reference Approach is based on determining carbon dioxide emissions from domestic consumption of fuels (e.g. hard and brown coal, crude oil, natural gas). Apparent consumption is calculated as:

apparent consumption = production + imports – exports – stock change

Data about production, imports, exports and stock change based on Eurostat database.

Total apparent consumption was corrected by subtracting non-energy consumption and feedstocks. Calculations of CO_2 emissions based on country specific factors for hard and brown coals and average carbon emission factors from subcategory 1A. for Gasoline, Jet Kerosene, Gas/Diesel Oil, Residual Fuel Oil and LPG.

The difference between reference and sectoral approaches in CO_2 emissions are low and in 2006 it was about 0.9%. Comparison of both methods is given in table below.

Year	Reference approach [Gg]	Sectoral approach [Gg]	Difference [%]
2006	313 178	310 341	0.91
2005	305 416	299 567	1.95
2004	301 569	299 479	0.70
2003	302 412	299 813	0.87
2002	293 572	290 501	1.06
2001	297 914	300 644	-0.91
2000	298 149	301 700	-1.18
1999	313 941	312 430	0.48
1998	324 112	323 130	0.30
1997	349 920	348 943	0.28
1996	355 437	356 294	-0.24
1995	343 402	346 126	-0.79
1994	333 459	343 296	-2.87
1993	354 695	349 223	1.57
1992	350 967	342 261	2.54
1991	357 052	350 221	1.95
1990	357 922	347 366	3.04

3.2.3 *International bunker*

1990-2006 fuel use data for fuels classified to the international marine bunker were taken from the Eurostat database. For the years 1988-1989, the respective data were waken from the database of the International Energy Agency (IEA).

For the estimation of GHG emissions from bunker fuels, the same IPCC default emission factors were assumed as those used for maritime navigation: for CO_2 and diesel oil 74.10 kg/GJ, for fuel oil 77.60 kg/GJ. The emission factors for CH_4 and N_2O for the two fuels are: 0.007 kg/GJ and 0.002 kg/GJ, respectively. The fuel use data and the corresponding emission estimates of CO_2, CH_4 and N_2O for international marine bunker for the 1988-2006 period are presented in table 3.18.

The amounts of fuels for the aviation international bunker were estimated under the assumption that 95% of fuel used for aviation in Poland (expert estimate) is used for international traffic i.e. constitutes the international aviation bunker. For the years: 1990-2006 aviation fuel data are those of the Eurostat database, while for the base year and 1989 are those of the IEA database.

For the estimation of GHG emissions from aviation bunker fuels, the same IPCC default emission factors for jet fuel were assumed as those used for emission estimation for domestic aviation: for CO_2 : 3150 g/kg, for CH_4 0.0005 kg/GJ and for N_2O 0.1 g/kg.
The fuel use data and the corresponding emission estimates of CO_2, CH_4 and N_2O for international aviation marine bunker for the 1988-2006 period are presented in table 3.18.

Tabel 3.18. Fuel consumption and CO_2, CH_4 and N_2O emissions in international aviation and navigation bunker in 1988-2006

	1988	1989	1990	1991	1992	1993	1994	1995	1996
AVIATION BUNKER									
Fuel consumption – jet fuel [Gg]	331.55	456.00	181.45	192.85	216.60	289.75	327.75	342.00	351.50
Fuel consumption – jet fuel [PJ]	14.784	20.333	7.802	8.293	9.314	12.459	14.093	14.706	15.115
Calorific value [MJ/kg]	44.59	44.59	43.00	43.00	43.00	43.00	43.00	43.00	43.00
CO_2 potential emission factor [g/kg]	3150	3150	3150	3150	3150	3150	3150	3150	3150
CO_2 potential emission factor [kg/GJ]	70.64	70.64	73.26	73.26	73.26	73.26	73.26	73.26	73.26
CO_2 potential emission factor [Gg]	1044.38	1436.40	571.57	607.48	682.29	912.71	1032.41	1077.30	1107.23
CH_4 emission factor [kg/GJ]	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
CH_4 emission [Gg]	0.007	0.010	0.004	0.004	0.005	0.006	0.007	0.007	0.008
N_2O emission factor [g/kg]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O emission factor [kg/GJ]	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023
N_2O emission [Gg]	0.033	0.046	0.018	0.019	0.022	0.029	0.033	0.034	0.035
NAVIGATION BUNKER									
Fuel consumption – diesel oil [PJ]	14.473	11.353	6.387	3.003	4.145	2.538	0.635	2.073	1.565
Fuel consumption - diesel oil [PJ]	9.043	20.740	11.280	4.480	7.720	1.680	3.000	5.840	7.520
CO_2 potential emission - ON [Gg]	1072.48	841.28	473.28	222.52	307.14	188.07	47.05	153.61	115.97
CO_2 potential emission - OP [Gg]	701.77	1609.40	875.33	347.65	599.07	130.37	232.80	453.18	583.55
Total CO_2 potential emission [Gg]	1774.25	2450.69	1348.60	570.17	906.22	318.43	279.85	606.79	699.52
CH_4 emission - ON [Gg]	0.101	0.079	0.045	0.021	0.029	0.018	0.004	0.015	0.011
CH_4 emission - OP [Gg]	0.063	0.145	0.079	0.031	0.054	0.012	0.021	0.041	0.053
Total CH_4 potential emission [Gg]	0.165	0.225	0.124	0.052	0.083	0.030	0.025	0.055	0.064
N_2O emission - ON [Gg]	0.029	0.023	0.013	0.006	0.008	0.005	0.001	0.004	0.003
N_2O emission - OP [Gg]	0.018	0.041	0.023	0.009	0.015	0.003	0.006	0.012	0.015
Total N_2O potential emission [Gg]	0.047	0.064	0.035	0.015	0.024	0.008	0.007	0.016	0.018

Tabel 3.18. (cont.). Fuel consumption and CO_2, CH_4 and N_2O emissions in international aviation and navigation bunker in 1988-2006

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AVIATION BUNKER										
Fuel consumption – jet fuel [Gg]	241.30	237.50	209.95	341.05	321.10	391.40	265.05	260.30	295.45	394.25
Fuel consumption – jet fuel [PJ]	10.376	10.213	9.028	14.665	13.807	16.830	11.397	11.193	12.704	16.953
Calorific value [MJ/kg]	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00
CO_2 potential emission factor [g/kg]	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150
CO_2 potential emission factor [kg/GJ]	73.26	73.26	73.26	73.26	73.26	73.26	73.26	73.26	73.26	73.26
CO_2 potential emission factor [Gg]	760.10	748.13	661.34	1074.31	1011.47	1232.91	834.91	819.95	930.67	1241.89
CH_4 emission factor [kg/GJ]	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
CH_4 emission [Gg]	0.005	0.005	0.005	0.007	0.007	0.008	0.006	0.006	0.006	0.008
N_2O emission factor [g/kg]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O emission factor [kg/GJ]	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023
N_2O emission [Gg]	0.024	0.024	0.021	0.034	0.032	0.039	0.027	0.026	0.030	0.039
NAVIGATION BUNKER										
Fuel consumption – diesel oil [PJ]	0.719	2.834	4.695	1.861	0.931	1.819	1.946	1.650	4.907	3.680
Fuel consumption - diesel oil [PJ]	5.480	8.080	17.600	9.920	9.800	9.320	9.800	8.800	8.480	8.560
CO_2 potential emission - ON [Gg]	53.28	210.00	347.90	137.90	68.99	134.79	144.20	122.27	363.61	272.70
CO_2 potential emission - OP [Gg]	425.25	627.01	1365.76	769.79	760.48	723.23	760.48	682.88	658.05	664.26
Total CO_2 potential emission [Gg]	478.53	837.01	1713.66	907.69	829.47	858.02	904.68	805.15	1021.66	936.95
CH_4 emission - ON [Gg]	0.005	0.020	0.033	0.013	0.007	0.013	0.014	0.012	0.034	0.026
CH_4 emission - OP [Gg]	0.038	0.057	0.123	0.069	0.069	0.065	0.069	0.062	0.059	0.060
Total CH_4 potential emission [Gg]	0.043	0.076	0.156	0.082	0.075	0.078	0.082	0.073	0.094	0.086
N_2O emission - ON [Gg]	0.001	0.006	0.009	0.004	0.002	0.004	0.004	0.003	0.010	0.007
N_2O emission - OP [Gg]	0.011	0.016	0.035	0.020	0.020	0.019	0.020	0.018	0.017	0.017
Total N_2O potential emission [Gg]	0.012	0.022	0.045	0.024	0.021	0.022	0.023	0.021	0.027	0.024

3.2.2 *Fugitive emissions from fuels* (CRF 1.B)

3.2.2.1 *Fugitive emissions from fuels – coal mining* (CRF 1.B1.a)

Coal Mining and Handling – u*nderground 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. For the year 1999 annual emissions for one of closed mines were estimated what allowed to calculate emission factor from this source relating to coal mined.

Emission factors for 2004 and 2005 were estimated by [Kwarciński 2005] based on detail data and measurements made in 2003. For the domestic inventory purposes emissions factors were calculated for 1 tone coal mined. The set of Polish emissions factors are presented in table 3.18.

Table 3.18. Methane emission factors analysis

Emissions sources	[Gawlik et al. 1994]		[Gawlik i Grzybek 2001]		[Kwarciński et al 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

Finally the following data and references for estimating emission factors were used:
– venting processes – [Kwarciński et al. 2005]
– methane capture systems – direct data
– post-mining processes – [Kwarciński et al. 2005]
– dumping grounds – [Kwarciński et al. 2005]
– closed mines – [Gawlik 2001].

Coal Mining and Handling – s*urface 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, 2006] 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 up to 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 [IPCC 2000], while emission factors presented in table 3.19 have been taken from domestic case study [Steczko 1994]. Activity data come from [EUROSTAT].

Table. 3.19. 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 [IPCC 2000]. Activity data come from [EUROSTAT].

Tabela 3.20. Activity data for emission from oil system

	Extraction	Extraction	Import	Transport	Input to oil refineries
	PJ	Gg	Gg	Gg	PJ
1988	6.58	159	14992	15151	618.69
1989	6.48	157	14725	14882	628.44
1990	6.68	160	13126	13286	536.04
1991	6.61	158	11454	11612	490.50
1992	8.40	200	13052	13252	552.32
1993	9.88	235	13674	13909	561.78
1994	11.87	284	12721	13005	561.96
1995	12.14	292	12957	13249	558.83
1996	13.21	317	14026	14343	608.10
1997	12.12	289	14713	15002	624.11
1998	15.11	360	15367	15727	672.68
1999	18.26	434	16022	16456	703.40
2000	27.50	653	18002	18655	769.51
2001	32.33	767	17558	18325	757.12
2002	30.50	728	17942	18670	745.00
2003	32.14	765	17448	18213	733.44
2004	37.26	886	17316	18202	761.84
2005	35.70	848	17912	18760	764.68
2006	33.50	796	19813	20609	843.67

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 and refining default factors were used from [IPCC 2000] (tab. 3.21).

Table 3.21. Emission factors for CO_2 and CH_4 from oil production and transmission

CO2 emission factors		
production	EF CO2 [Gg/PJ]	6.3150
transmission	EF CO2 [Gg/m^3]	0.00049
CH4 emission factors		
production	EF CH4 [Gg/PJ]	0.0618
transmission	EF CH4 [Gg/m^3]	0.0054
refining	EF CO2 [Gg/PJ]	0.0007

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 [IPCC 2000]. Activity data come from [EUROSTAT] and are given in table 3.22.

Table 3.22. Activities for natural gas system [TJ].

year	Extraction	Total consumption
1990	99559	374206
1991	111294	348944
1992	107174	324987
1993	136948	341385
1994	129763	343987
1995	132689	376592
1996	131473	395454
1997	134150	394289
1998	136013	398345
1999	129883	387833
2000	138724	416993
2001	146204	434447
2002	149433	423419
2003	151197	471462
2004	164428	497416
2005	162630	512234
2006	162463	518052

Emission factors for both gas systems were taken from country study [Steczko K. 1994] for production, processing and distribution and from [Steczko 2003] for transmission and underground storage (only CH4) and are listed in tables 3.23 and 3.24.

Table 3.23. Emission factors for CO_2 and CH_4 from high-methane gas system.

CO_2 emission factors	[Gg/PJ]
Gas extraction	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	0.055135
Underground gas storage	0.001433
Gas distribution	0.309945

Table 3.24. Emission factors for CO2 and CH4 from nitrified natural gas system.

CO2 emission factors	[Gg/PJ]
Gas production	0.000060
Gas processing	0.051321
Gas transmission	0.000192
Gas distribution	0.000558
CH4 emission factors	
Gas production	0.034307
Gas processing	0.101227
Gas transmission	0.035733
Gas distribution	0.317671

3.3 Uncertainties

Uncertainty analysis for this IPCC sector was prepared with use of *Tier 1* methodology defined in the IPCC Good Practice Guidance. Summary results of the analysis are presented in the table below, more detailed information for this and other sectors can be found in annex 5 of this report.

2006	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]
1. Energy	310,592.29	788.34	8.69	1.8%	6.1%	2.9%	5,646.89	48.42	0.25
A. Fuel Combustion	310,341.40	139.30	8.69	1.8%	11.1%	2.9%	5,646.87	15.45	0.25
1. Energy Industries	187,500.65	2.91	2.77	2.7%	11.0%	2.7%	4,983.45	0.32	0.07
2. Manufacturing Industries and Construction	33,724.50	3.70	0.68	2.6%	11.8%	11.0%	861.12	0.44	0.07
3. Transport	37,381.40	5.48	3.63	5.4%	10.4%	3.0%	2,013.05	0.57	0.11
4. Other Sectors	51,734.87	127.22	1.61	2.9%	12.1%	12.6%	1,502.80	15.43	0.20
5. Other									
B. Fugitive Emissions from Fuels	250.88	649.04		6.5%	7.1%		16.22	45.89	
1. Solid Fuels	1.34	441.54		6.6%	10.1%		0.09	44.57	
2. Oil and Natural Gas	249.55	207.50		6.5%	5.3%		16.22	10.93	

3.4 Recalculations

1.A. Fuel combustion

Fuel combustion in stationary sources

- for the year 2006, fuel use and the corresponding CO_2 emission data for the installations (plants) covered by the EU ETS were used; the data come from verification reports for the individual installations covered by the Emission Trading Scheme (concerns individual sub-categories in 1.A. excluding 1.A.3)
- for the years 1990-2006 a new data source for fuel use was assumed – data submitted by Poland to Eurostat were used in place of activity data in the annual GUS publication: "Gospodarka Paliwowo-Energetyczna"; a slight modification of the fuel list followed the change of data source (inter alia aggregation of natural gas)
- for the entire time series 1988-2006, CO_2 emission factors were changed for a number of fuels: for lignite a new empirical function was derived that links elemental carbon content with net calorific value, based upon a greater number of documented measurements, which enabled verification of former EFs for that fuel; for natural gas, coke, fuel oil, blast-furnace gas and diesel oil, default EFs were assumed in

accordance with IPCC guidelines [IPCC 1997] – previously for these fuels CO_2 emission factors were estimated based on domestically derived empirical functions

- for CH_4 and N_2O in a number of sub-categories, updated default emission factors were applied from *2006 IPCC Guidelines* (concerns all the years in the 1988-2006 period)
- for all years oxidation factors were changed for hard coal and lignite combustion – for combustion of solid fuels a default oxidation factor is used recommended by IPCC [IPCC 1997]
- fuel use and the corresponding GHG emissions reported formerly in sub-category 1.A.5, were moved to other sub-categories (aviation fuels to 1.A.3.a *Domestic Civil Aviation*, while other fuels included in transport sector (according to Gospodarka Paliwowo-Energetyczna, use of which was associated with heating of railway stations, and warehouses was moved to sub-category 1.A.4.a Other sectors - Commercial/Institutional

<u>Fuel combustion in mobile sources</u>

- fuel use data for the years: 1990-2006 in the sub-categories: 1.A.3.*a Civil Aviation*, 1.A.3.*c Railways*, 1.A.3.d *Navigation* (concerns inland navigation), Machinery and off-road vehicles in agriculture (from sub-category 1.A.4.c.) and within the international marine bunker were estimated based on the Eurostat database
- for all years, emission factors were verified in sub-category 1.A.3.c *Railway*s - EFs for fuel oil in railway transport were taken from [IPCC 1997], domestic EF for CO_2 for hard coal were estimated based on the empirical function used for determination of EF for hard coal combustion processes in stationary sources, and EFs for CH_4 and N_2O for hard coal were also taken based on IPCC [IPCC 1997] (tables 1-7 and 1-8 in the *Reference Manual,* respectively)
- activity data for the domestic maritime navigation for the entire time series were updated – it was assumed that merely 1-2% of fuel use reported in the energy statistics questionnaire G-03 is actually used for the needs of the domestic maritime transport
- for all years: 1988-2006 consumption of aviation fuels (aviation gasoline and jet fuel) and the corresponding GHG emissions reported formerly under *Other Aviation* in the sub-category 1.A.5, was moved to sub-category 1.A.3.a
- in the sub-category 1.A.3.b *Road Transportation* activity data for 1990 and 1999 for diesel oil were corrected
- activity data in the sub-category 1.A.4.c.ii *Fisheries* for the years 1990-2005 were corrected , based upon the correction of NCV for fuel oil
- for the year 2005 the use of bifuels was taken into consideration in the sub-category 1.A.3.b *Road Transportation* (AD for 2005 and 2006 were estimated based on the Eurostat database)
- 1999 CO_2 emissions for diesel oil consumption in the sub-category 1.A.3.b *Road Transportation* were corrected (CO_2 EF in the sub-category 1.A.3.iii for: *heavy duty vehicles over 3.5 tonnes without catalytic converters, old type,* was supplemented)

1.B Fugitive emissions

Activity data used for estimation of emissions from the systems of: natural gas, coke-oven gas and oil previously based on public statistics, were replaced by the respective data from the Eurostat database [EUROSTAT]. GHG emissions from oil refining was estimated based on the default emission factors [IPCC 2000].

Emission factors for the distribution and underground storage of natural gas were updated. New emission factors are based on [Steczko K. 2003]. Former emission factors were based upon an older publication [Steczko 1994].

3.5 Planned improvements

1.A. Fuel combustion

- in the 2005 and subsequent GHG emission inventories, explicit inclusion of individual data in the sub-categories in 1.A.1, 1.A.2 and 1.A.4, coming from verfification reports on CO_2 emissions from installations covered by the EU ETS (similarly to the 2006 data)
- verification and updating of data on off-road transport (both for the sub-category 1.A.3 jas well as for mobile source in other sub-sectors (1.A.4.c – *Machinery and off road vehicles in agriculture*, *Fisheries* and 1.A.2.f. – mobile sources in industry)

1.B Fugitive emissions

Domestic emission factors for the systems of coke-oven gas, natural gas and oil are based on a publication from year 1994. New studies are needed to update these data.

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 1.3%
- 2.B.1. Ammonia Production (CO2 emission), share in total GHG emission 0.9%
- 2.B.2. Nitric Acid Production (N2O emission), share in total GHG emission 0.9%
- 2.C.1. Iron and Steel Production (CO2 emission), share in total GHG emission 0.9%

Share of these categories in total Poland's GHG emissions is 4.0%.

4.2 Sector overview and methodological issues

For the 2006, in sector 2. *Industrial Processes,* there were used data concerning CO_2 process emissions from installations which take part in emission trading scheme. Emission based on such data were estimated in the following subcategories:

- subcategory 2.A. *Mineral Products*: 2.A.1. *Clinker Production*, 2.A.3. *Limestone and Dolomite Use* and from subcategory 2.A.7. *Other*: *Glass Production*, *Ceramics materials production*
- subcategory 2.C. *Metal Production*: processes included into *Iron and Steel Production* (2.C.1) such as: sinter production, pig iron production, steel production in basic oxygen process, steel production in electric arc furnace process, coke production
- subcategory 2.D. *Other Production*: 2.D.1. *Pulp and Paper*
- subcategory 2.G. *Other* – this subcategory includes data containing CO_2 process emissions from installations which take part in emission trading scheme that cannot be included in subcategory 2.A-2.F; for example emissions from refineries (process emissions, discharges and flaring or CO_2 from fire equipments which is given in reports)

4.2.1. *Mineral Products* (CRF 2.A)

4.2.1.1. *Clinker Production* (CRF 2.A.1)

CO_2 emission from clinker production is the sum of the process emissions given in the verified reports for 2006 for installation of clinker production, which participate in the emission trading scheme [KASHUE 2008]. This emission was estimated as 5983.7 Gg CO_2. Data on clinker production was taken from [GUS 2007b].

The clinker production in period 1988-2006 is shown on figure 4.1. Data on clinker production for entire inventoried period was taken from [GUS 1989b-2007b].

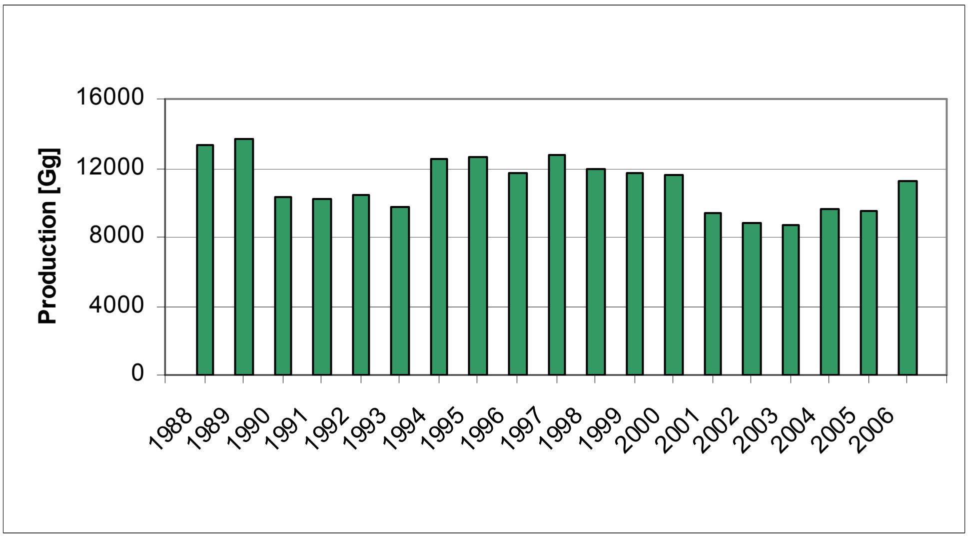


Figure 4.1. Clinker production in 1988-2006

CO_2 emission from clinker production was taken from the verified reports for 2005 and 2006 for installations which participate in the emission trading scheme. For other years emissions were estimated based on clinker production and emission factors. Emission factors which were used to estimate CO_2 process emissions from subcategory 2.A.1 are given bellow:

- for years 1988-1989 – default factor from IPCC – 525 kg/t of clinker
- for years 1990-2000 – emission factor equal 529 kg CO_2/ t of clinker – average from country specific factors for years 2001-2004 (2001 – 531 kg CO/t, 2002 – 530 kg CO2/t, 2003 – 528 kg CO2/t, 2004 – 527 kg CO2/t)
- for years 2001-2004 - country specific factors from [IMMB 2006].

CO_2 emissions from clinker production in period 1988-2006 are shown on figure 4.2.

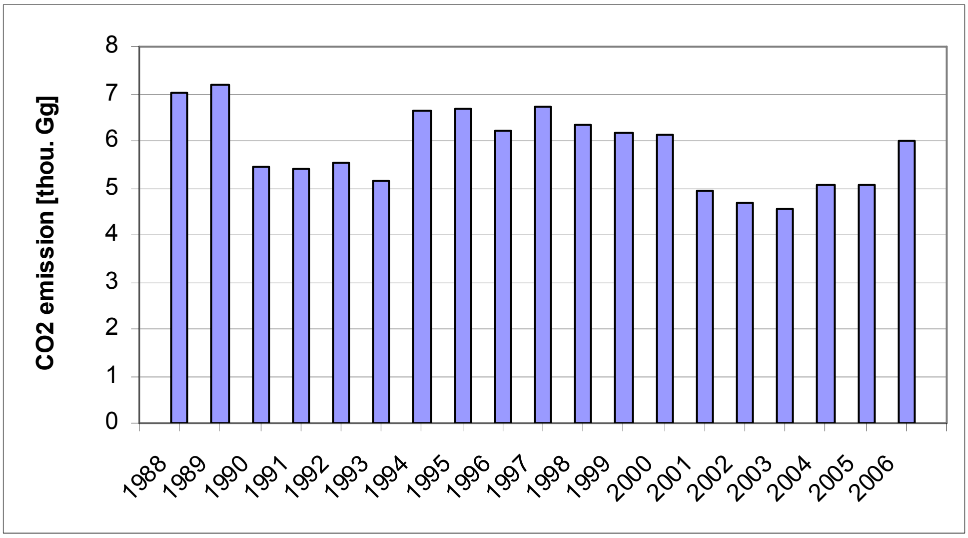


Figure 4.2. CO_2 process emission for clinker production in 1988-2006

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 2007b]. The applied emission factor is equal 785 kg / Mg lime. This is default value given for this subcategory in [IPCC 1997].

Emission for period 1988-2006 was estimated based on emission factors. Data about production was taken from statistical yearbooks [GUS 1989b-2007b] (figure 4.3). Default emission factor was used for all years – 785 kg CO_2/t of lime). CO_2 emissions in period 1988-2006 are shown on figure 4.4.

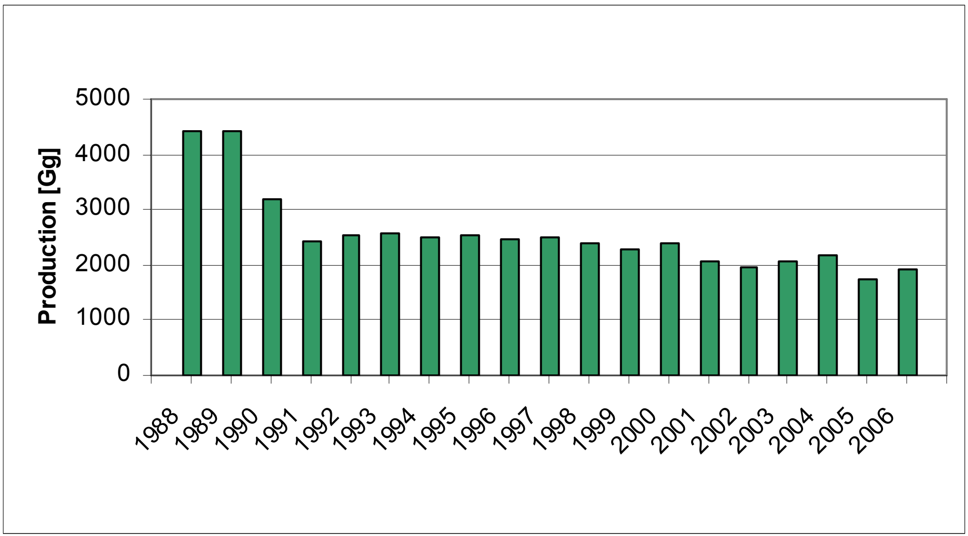


Figure 4.3. Lime production in 1988-2006

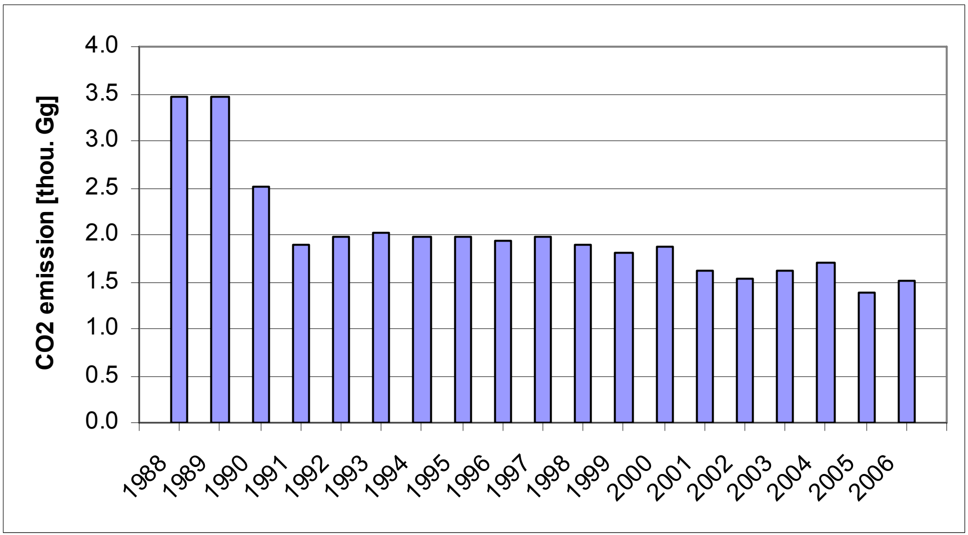


Figure 4.4. CO_2 process emission for lime production in 1988-2006

4.2.1.3. *Limestone and Dolomite Use* (CRF 2.A.3)

In this subcategory there were used only emissions from limestone and dolomite use in sulphur removal installations in power industry, which participate in emission trading scheme. It was assumed that CO_2 process emission given in reports for installations producing energy and heat (type E1) comes from limestone and dolomite use in sulphur removal process. Emissions for this subcategory in GHG inventory correspond to emissions from verified reports. For 2006 it was 617.8 Gg CO_2, and for 2005 it was 568.5 Gg CO_2. This emission constitutes only part of total emission from limestone and dolomite use. The rest of it was included into other categories where these minerals are used, for example: metal production (iron ore sinter production, pig iron in blast furnace, steel production, casting), mineral industry (glass and ceramics production), subcategory of sector 5.B IPCC – *Agriculture lime application*.

4.2.1.4. *Soda Ash Production and Use* (CRF 2.A.4)
In Poland soda ash is produced 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 soda ash used is equal to soda ash production. Data on soda ash production was taken from [GUS 2007e]. 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].
For entire period 1988-2006 were used data about soda ash production from G03 reports and default emission factor 415 kg CO2/t soda ash for CO_2 emission estimations.

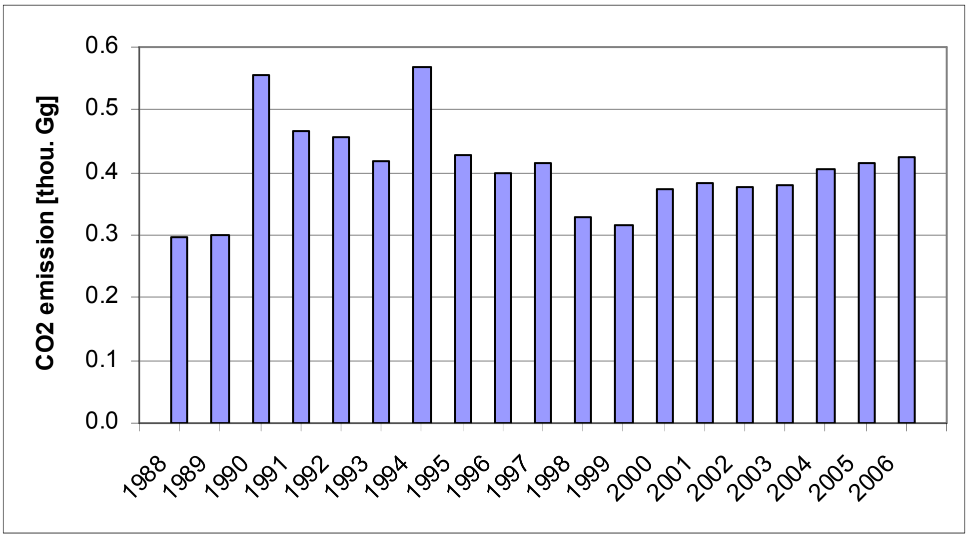


Figure 4.5. CO_2 emission for soda ash use and production in 1988-2006

4.2.1.5. *Other* (CRF 2.A.7)

- *Glass production*

CO_2 emission from glass production was taken from the verified reports for 2006 for installation of glass and glass wool production, which participate in the emission trading scheme [KASHUE 2008]. In 2006 this emission amounted for 339.2 Gg CO_2. In 2005 emission taken from the verified reports for 2005 for installations participating in the emission trading scheme was 343.5 Gg CO_2. For years 1988-2004 this emission was not estimated.

- *Ceramics materials production*

CO_2 emission from production of ceramics materials was calculated based on the verified reports for 2006 for installation of ceramics production, which participate in the emission trading scheme [KASHUE 2008]. This emission value was equal 260.9 Gg CO_2. In 2005 emission also taken from the verified reports for 2005 for installation participating in the emission trading scheme was 284.7 Gg CO_2. For years 1988-2004 this emission was not estimated.

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

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

CO_2 emissions for ammonia production are estimated based on the data on natural gas use in this process [GUS 2007e]. To estimate carbon content in natural gas was used factor 0.525 kg C/m3 from IPCC [IPCC 1997]. Process emission was calculated using the following equation:

$$E_{CO2} = Z_{\text{natural gas}} * 0.525*44/12$$

where:

E_{CO2} – CO_2 process emission from ammonia production [Mg]

$Z_{\text{natural gas}}$ – natural gas use [thousands m^3]

This method was used for all years 1988-2006. In years 1989-1990 for ammonia production was also used coke-oven gas. For coke-oven gas consumption was taken in energy units – also based on G03 reports – and factor of carbon content from IPCC.

CO_2 process emissions in period 1988-2006 are shown on figure 4.6

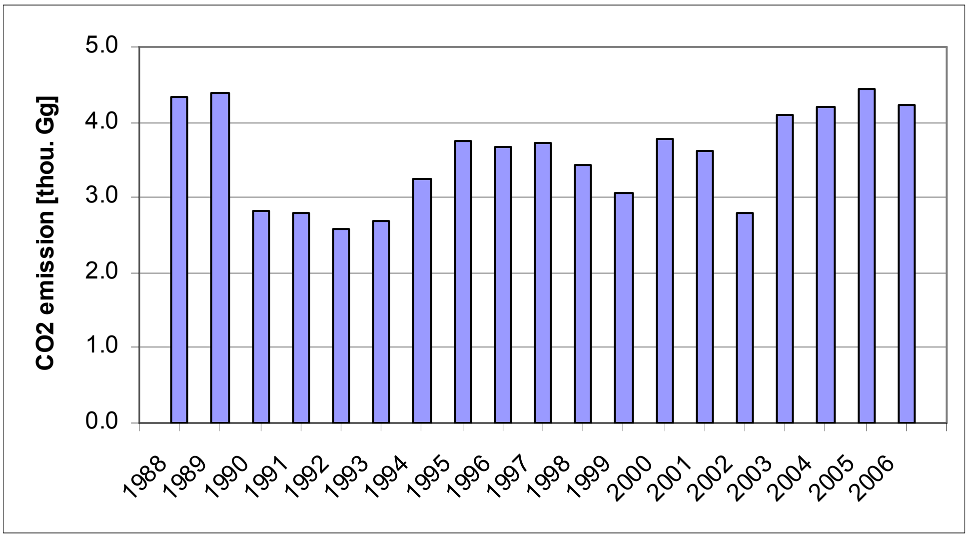


Figure 4.6. CO_2 process emission for ammonia production in 1988-2006

CH_4 process emissions for ammonia production were estimated for all years based on data on ammonia production from G03 reports (figure 4.7) and emission factor 4.9 kg CH_4/Mg NH_3 [CITEPA 1992].

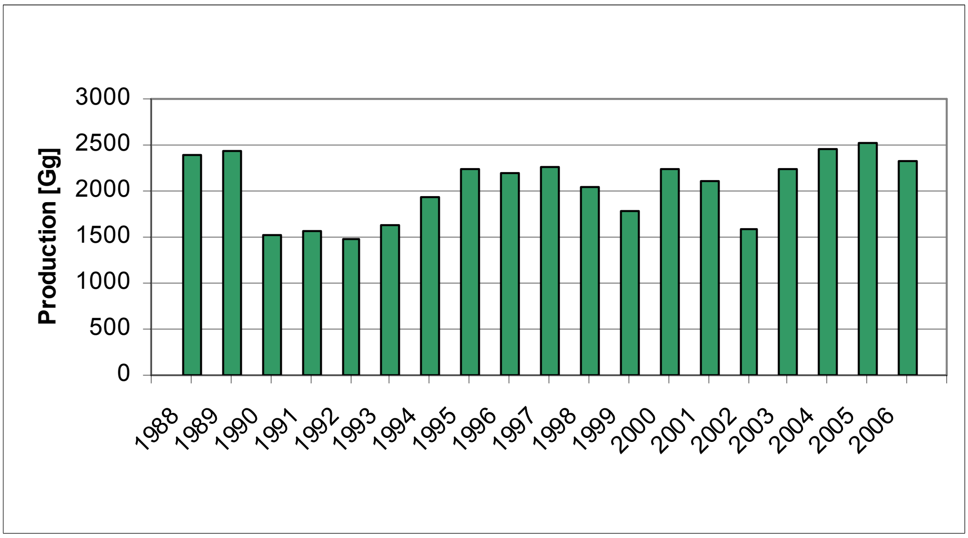


Figure 4.7. Production of ammonia in 1988-2006

Process of ammonia production is not a source of N_2O emission [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 2007b]. The applied country specific emission factor, which is equal 6.47 kg/Mg nitric acid [Kozłowski 2001].

Nitrous oxide emissions for entire period was calculated based on the same emissions factor and data on production from [GUS 1989b-2007b]. The amount of production and N_2O emissions from nitric acid production are shown at figures 4.8 and 4.9.

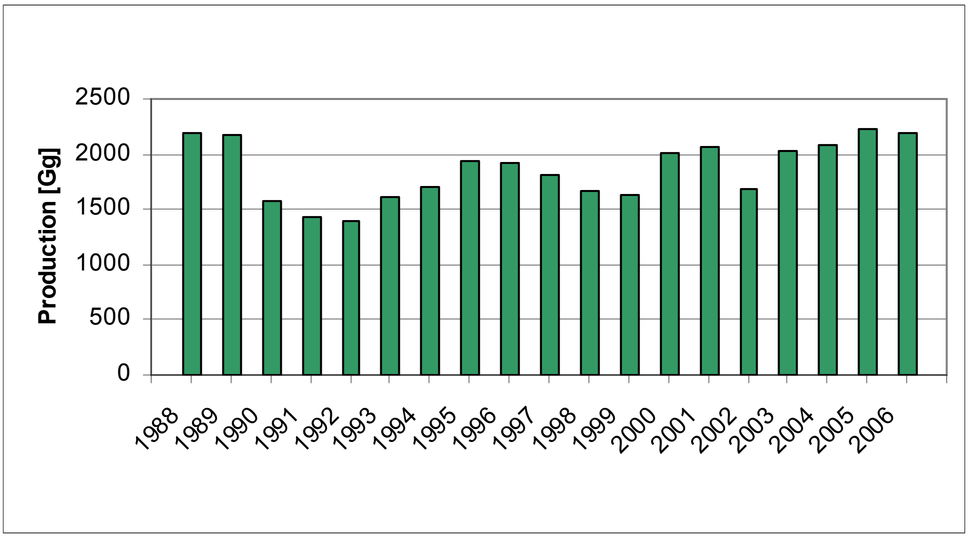


Figure 4.8. Production of nitric acid in 1988-2006

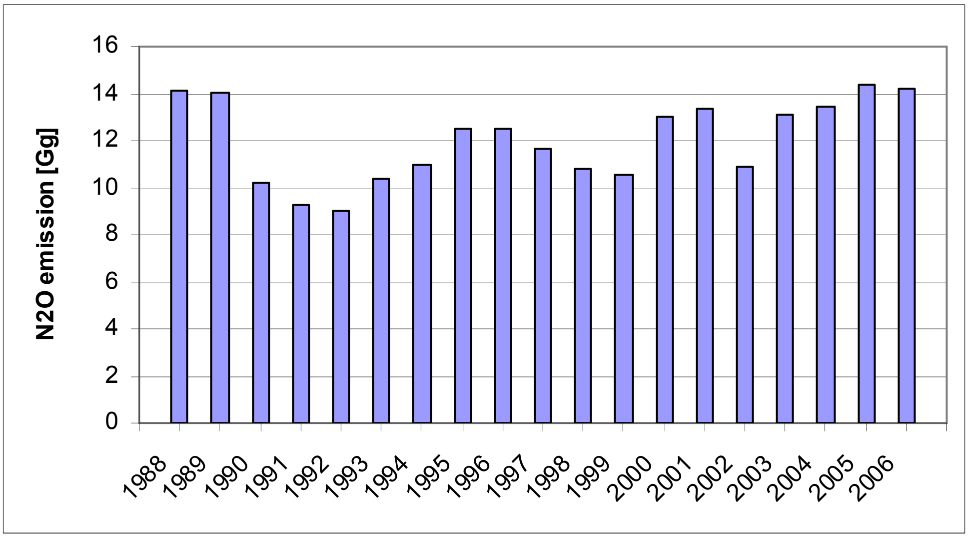


Figure 4.9. N_2O process emission for nitric acid production in 1988-2006

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

Activity data concerning calcium carbide production are published in [GUS 2007b]. CO_2 emission factor for this category, which is equal 2190 kg CO_2/ Mg carbide (1090 kg CO_2/ Mg carbide from production + 1100 kg CO_2/ Mg carbide from use), was taken from [IPCC 1997].

For all inventoried years, starting from the base year, the same data source was used from national statistics [GUS 1989b-2007b]; since 1990 the same emission factor was applied to assess CO2 process emissions from carbide production and use: 2190 kg CO_2/Mg carbide z [IPCC 1997].

For 1988-1989 the emission factor of 1100 kg CO_2/Mg carbide was used for emission estimation in subcategory 2.B.4 which corresponds to emissions from carbide use only.

4.2.2.4. *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 2007e]. The emission factor, which is equal 11 kg CH_4/Mg black carbon, was taken from [CITEPA 1992].

For the entire inventoried period the activity data on carbon black production was taken from [GUS 1989e-2007e]. The emission factor of 11 kg CH_4/Mg was applied for emission calculation since 1990, for 1988 and 1989 the lower EF was used: 10 kg CH_4/Mg [CITEPA 1992].

- *Ethylene Production*

Emission of CO_2 from ethylene production was calculated based on ethylene annual production from [GUS 2007b]. Emission factor was taken from [CITEPA 1992]. Its value is 0.3 kg CO_2 / Mg ethylene produced.

For 1988-2006 the activity data for ethylene production and emission factor are the same.

Additionally in 1990-2006 the methane emissions from ethylene production were calculated. The default EF was applied from [IPCC 1997] amounting of 1 kg CH_4/ Mg ethylene.

- *Caprolactam Production*

Data on annual caprolactam production for inventory calculation purpose was taken from [GUS 2007b]. 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].

For entire series the same activity data source – GUS publications [GUS 1989b-2007b] and the same emission factor were applied.

- *Methanol Production*

For 1990-2006 methane emissions from methanol production were estimated for the first time. For all years the same emission factor was used of 2 kg CH_4/ Mg methanol [IPCC 1997] as well as data on methanol production taken from national statistics [GUS 1991b-2007b].

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)

Carbon dioxide process emissions from iron ore sinter production for 2006 come from verified reports on annual emissions of CO_2 from iron ore sinter installations elaborated for the emission trading scheme [KASHUE 2008]. The value of annual iron ore sinter production was taken according to production amount indicated in these reports.

Based on verified reports of CO_2 emissions elaborated for the purpose of emission trading scheme, also emissions and production within this subcategory for 2005 were estimated. Emissions for 1988-2004 were calculated (using carbon balance method) based on data (amount of feedstock material and output from production process) from questionnaires regarding to installations included into emission trading scheme collected by the National Administration of Emission Trading Scheme [KASHUE 2008].

The activity data for iron ore sinter production for 2001-2004 were taken according to information reported in earlier mentioned questionnaires and for 1988-2000 data from G-03 was used.
For entire period 1988-2006 emissions of CH_4 were also estimated from iron ore sinter production. Activity data applied for calculations (amount of iron ore sinter production) is presented in table 4.1. The default emission factor for CH_4 (0.07 kg/t), was taken from [IPCC 2006].

Table 4.1. Iron ore sinter production [Gg] and CO_2 emissions from in years 1988-2006 [Gg]

	1988	1989	1990	1991	1992	1993	1994	1995	1996
Production	14107.3	12992.5	11779.4	8612.7	8621.7	7628.2	8787.4	8646.6	8318.6
CO_2 emissions	1069.2	735.8	834.0	671.4	618.7	569.7	631.2	677.4	652.2

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
8980.8	6882.1	6475.9	8078.7	7352.8	7616.9	7732.2	8590.6	6168.4	6907.8
662.7	492.4	522.0	619.8	516.5	545.5	636.6	645.5	244.7	283.5

4.2.3.1.2. *Steel Cast Production* (CRF 2.C.1.c)
The data on CO_2 process emissions from steel cast production as well as on amount of cast steel was taken from [Holtzer 2007]. CO_2 emission estimated in mentioned study concerns only melt process of alloy since this is main sources of process emission. CO_2 emission occurring at pouring into moulding sands is not included. Estimation of emission in [Holtzer 2007] was based on following assumption:
- metal yield for particular years from period 1988-2006 equals 41.7-46.1% (cast steel production was calculated based on the yield value and steel cast production published every year in [*Modern Casting*])
- in electric arc furnaces 97% steel for cast steel is melted and in induction furnace only 3%.
- average consumption of electrodes in electric arc furnace was assumed as 8 kg/Mg of liquid steel (according to information from Polish foundries 6 – 12 kg/Mg liquid steel).
- during melting of steel in electric arc furnace average 0.5% of carbon burns out (this is 5 kg/Mg liquid steel).
Data applied for estimation of CO_2 process emission from steel casts and CO_2 emissions values for entire period 1988-2006 were presented in table 4.2.

Table 4.2. CO2 process emission from melting of steel in electric arc furnace in years 1988-2006

Year	Liquid steel Mg	Liquid steel melted in electric arc furnace, Mg	Liquid steel melted in induction furnace, Mg	Electrode consumption, Mg	CO2 emission from burning out of electrodes, Mg	Amount of carbon burn out, Mg	CO2 emission from burn out of carbon, Mg	Total CO2 emission from melting of steel, Gg
1988	641 892	622 635	19 257	4 981	18 264	3 113	11 415	29 .679
1989	538 289	522 140	16 149	4 177	15 316	2 611	9 573	24 .889
1990	434 685	421 644	13 041	3 373	12 368	2 108	4 216	16 .584
1991	225 968	219 189	6 779	1 754	6 430	1 096	4 018	10 .448
1992	165 766	160 793	4 973	1 286	4 717	804	2 948	7 .665
1993	150 473	145 959	4 514	1 168	4 281	730	2 676	6 .957
1994	159 910	155 113	4 797	1 241	4 550	776	2 844	7 .394
1995	175 901	170 624	5 277	1 365	5 005	853	3 128	8 .133
1996	193 919	188 101	5 818	1 505	5 518	941	3 450	8 .968
1997	178 378	173 027	5 351	1 384	5 075	865	3 172	8 .247
1998	140 090	135 887	4 203	1 087	3 986	679	2 491	6 .477
1999	123 874	120 158	3 716	961	3 525	601	2 203	5 .728
2000	124 775	121 032	3 743	968	3 550	605	2 218	5 .768
2001	122 748	119 066	3 682	953	3 493	595	2 183	5 .676
2002	109 009	105 739	3 270	846	3 102	529	1 939	5 .041
2003	111 511	108 166	3 345	865	3 173	541	1 983	5 .156
2004	117 354	113 833	3 521	911	3 339	569	2 087	5 .426
2005	133 187	129 191	3 996	1 034	3 790	666	2 442	6 .232
2006	132 747	128 765	3 982	1 062	3 894	664	2 435	6.329

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

The data on CO_2 process emissions from iron cast production as well as on amount of cast iron was taken from [Holtzer 2007]. Estimation of CO_2 emissions concerns only melt process of alloy since this is main sources of process emission. CO_2 emission occurring at pouring into moulding sands was not taken into consideration. Carbon dioxide emission values for particular years were estimated based on following assumption [Holtzer 2007]:

- metal yield values for given types of cast iron in period 1988-2006 were as follow: 67-72% for gray iron, 47.9-50.7% for ductile cast iron, 32.3-34.5% for malleable cast iron (total amount of melted cast iron for particular year was calculated based on iron cast production [*Modern Casting*] and metal yield value);
- part of coke in charge is 15% (150 kg / Mg metal charge).
- part of $CaCO_3$ in charge is 25% of coke addition (3.75% of metal charge).
- yield of liquid metal from cupola is 95% (melting loss 5%).
- part of cast iron melted in cupola was assumed as follow: for 1988 – 1998 - 80%, for 1999 66.7% , since 2000 was significant drop of share of cast iron melted in cupola in total cast iron production – from 77.3% in 2000 to 38.2% in 2006
- C content in coke for charge was 85-90%.

Data applied for calculation of CO_2 process emission from iron casting production and CO_2 process emission value for 1988-2006 were presented in the table 4.3.

CH_4 emission for entire period 1988-2006 was estimation based on EF = 0.20 kg CH_4 / Mg. This EF was taken from [Radwański 1995].

Table 4.3. CO2 process emission from cast iron production in years 1988-2006

Year	Liquid cast iron Mg	Liquid cast iron melted in cupola, Mg	Metal charge into cupola Mg	Coke consumption Mg	$CaCO_3$ consumption Mg	CO2 emission from $CaCO_3$ break down Mg
1988	2 185 633	1 748 506	1 840 533	276 080	69 020	30 .369
1989	1 855 655	1 484 524	1 562 657	234 399	58 560	25 .784
1990	1 525 676	1 220 541	1 284 780	192 717	48 179	21 .199
1991	1 039 006	831 205	874 952	131 243	32 811	14 .437
1992	1 013 144	810 405	653 058	127 959	31 990	14 .075
1993	1 005 974	804 779	847 136	127 070	31 768	13 .978
1994	1 057 558	846 046	890 575	133 586	33 397	14 .694
1995	1 137 438	909 950	957 842	143 676	35 919	15 .804
1996	1 073 413	858 730	903 927	135 589	33 897	14 .915
1997	1 054 730	843 784	888 194	133 229	33 307	14 .655
1998	904 220	723 376	761 448	114 217	28 554	12 .564
1999	882 894	589 000	620 000	93 000	23 250	10 .230
2000	982 735	760 000	800 000	120 000	30 000	13 .200
2001	984 608	519 334	546 667	82 000	20 500	9 .020
2002	876 968	456 000	480 000	72 000	18 000	7 .920
2003	865 238	412 934	434 667	65 200	16 300	7 .172
2004	893 865	395 200	416 000	62 400	15 600	6 .864
2005	914 745	369 835	389 300	58 400	14 600	6 .424
2006	962 163	367 334	386 667	58 000	14 500	6 .380

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

CO_2 emission from pig iron production was taken according to verified reports prepared by installations included into emission trading scheme. Additional data for separation blast furnace process and steel production in integrated steel plants were received directly from plants. CO_2 process emission value from pig iron production for 2006 was equal 620.1 Gg. CO_2 process emission from pig iron production for 1988-2005 was based on carbon balance in blast furnace process. Values concerning input and output for this balance were taken from statistical data (pig iron production for entire period from [GUS 1989e-2007e], BF gas production for 1888-1989 from [GUS 1989a-1990a] and for 1990-2005 from [Eurostat], coke input for 1988-2005 – corrected data from Energy Market Agency (ARE). For sinter assumed that use in the BF process relates to sinter production. Amounts of limestone, dolomites and iron ore for BF carbon balance were estimated based on technological factors taken from literature [Szargut J. 1978]. C contents in components of charge and output were calculated base on C EF from IPCC guidelines (for BF gas and coke from [IPCC 1997], for pig iron from [IPCC 2000], for limestone and dolomites from [IPCC 2006]) and country specific values for iron ore [Szargut J. 1978] and sinter (data from plants). Pig iron production for entire period was taken from [GUS 1989e-2007e]. This value for 2006 equal 5 543.4 Gg. CO_2 emission values and data concerning BF process applied in C balance for period 1988-2005 were presented in table 4.4.

Table 4.4. Carbon balance for blast furnace process in years 1988-2005

	1988	1989	1990	1991	1992	1993	1994	1995	1996
CHARGE - Technological indicators [kg/kg of steel]									
Rousted ore	0.1880	0.1880	0.1880	0.1880	0.1880	0.1880	0.1880	0.1880	0.1880
Dolomite	0.088454	0.088454	0.088454	0.088454	0.088454	0.088454	0.088454	0.088454	0.088454
Limestone	0.0974	0.0974	0.0974	0.0974	0.0974	0.0974	0.0974	0.0974	0.0974
Manganese ore	0.0716	0.0716	0.0716	0.0716	0.0716	0.0716	0.0716	0.0716	0.0716
CHARGE -amount used in process in given year									
Sinter [Gg]	14 107.3	12 992.5	11 779.4	8 612.7	8 621.7	7 628.2	8 787.4	8 646.6	8 318.6
Rousted ore [Gg]	1 929.3	1 783.7	1 627.5	1 222.3	1 214.9	1 183.1	1 331.3	1 399.4	1 233.6
Dolomite [Gg]	907.7	839.2	765.7	575.1	571.6	556.6	626.4	658.4	580.4
Limestone [Gg]	999.6	924.1	843.2	633.3	629.4	612.9	689.7	725.0	639.1
Manganese ore [Gg]	734.8	679.3	619.8	465.5	462.7	450.6	507.0	533.0	469.8
Coke [TJ]	186 338	179 462	157 424	107 026	102 005	95 394	110 405	113 863	97 656
CHARGE - C content									
Sinter [kg/kg]	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
Rousted ore [kg/kg]	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113
Dolomite [kg/kg]	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300
Limestone [kg/kg]	0.1200	0.1200	0.1200	0.1200	0.1200	0.1200	0.1200	0.1200	0.1200
Manganese ore [kg/kg]	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262
Coke [kg/GJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
CHARGE -total C content [Gg]									
Sinter	15.5	14.3	13.0	9.5	9.5	8.4	9.7	9.5	9.2
Rousted ore	21.7	20.1	18.3	13.8	13.7	13.3	15.0	15.8	13.9
Dolomite	118.0	109.1	99.5	74.8	74.3	72.4	81.4	85.6	75.5
Limestone	119.9	110.9	101.2	76.0	75.5	73.6	82.8	87.0	76.7
Manganese ore	19.2	17.8	16.2	12.2	12.1	11.8	13.3	13.9	12.3
Coke	5 497.0	5 294.1	4 644.0	3 157.3	3 009.1	2 814.1	3 256.9	3 359.0	2 880.8
C IN CHARGE - SUM	5 791.4	5 566.3	4 892.2	3 343.4	3 194.2	2 993.5	3 459.1	3 570.8	3 068.3
OUTPUT IN GIVEN YEAR									
Pig iron [Gg]	**10 262.4**	**9 487.6**	**8 656.7**	**6 501.5**	**6 462.0**	**6 292.9**	**7 081.2**	**7 443.5**	**6 561.9**
Blast furnace gas [TJ]	74 535	71 785	62 970	42 811	40 802	38 157	44 162	45 545	39 062
OUTPUT - C content									
Pig iron [kg/kg]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Blast furnace gas [kg/GJ]	66	66	66	66	66	66	66	66	66
OUTPUT - total C content [Gg]									
Pig iron	410.5	379.5	346.3	260.1	258.5	251.7	283.2	297.7	262.5
Blast furnace gas	4 919.3	4 737.8	4 156.0	2 825.5	2 692.9	2 518.4	2 914.7	3 006.0	2 578.1
C IN OUTPUT - SUM	5 329.8	5 117.3	4 502.3	3 085.6	2 951.4	2 770.1	3 197.9	3 303.7	2 840.6
DIFFERENCE BETWEEN C IN INPUT and C IN OUTPUT [Gg]	461.6	449.0	389.9	257.9	242.8	223.4	261.1	267.0	227.8
CO2 EMISSIN[Gg]	**1 693**	**1 646**	**1 430**	**945**	**890**	**819**	**957**	**979**	**835**
CO2 EMOSSION FACTOR [kg/Mg]	**165**	**174**	**165**	**145**	**138**	**130**	**135**	**132**	**127**

Table 4.4. (cont.) Carbon balance for blast furnace process in years 1988-2005

	1997	1998	1999	2000	2001	2002	2003	2004	2005
CHARGE - Technological indicators [kg/kg of steel]									
Rousted ore	0.1880	0.1880	0.1880	0.1880	0.1880	0.1880	0.1880	0.1880	0.1880
Dolomite	0.088454	0.088454	0.088454	0.088454	0.088454	0.088454	0.088454	0.088454	0.088454
Limestone	0.0974	0.0974	0.0974	0.0974	0.0974	0.0974	0.0974	0.0974	0.0974
Manganese ore	0.0716	0.0716	0.0716	0.0716	0.0716	0.0716	0.0716	0.0716	0.0716
CHARGE -amount used in process in given year									
Sinter [Gg]	8 980.8	6 882.1	6 475.9	8 078.7	7 352.8	7 616.9	7 732.2	8 590.6	6 168.4
Rousted ore [Gg]	1 394.6	1 180.5	993.1	1 223.0	1 023.3	995.7	1 061.4	1 208.3	842.5
Dolomite [Gg]	656.2	555.4	467.2	575.4	481.4	468.5	499.4	568.5	396.4
Limestone [Gg]	722.5	611.6	514.5	633.6	530.1	515.9	549.9	626.0	436.5
Manganese ore [Gg]	531.1	449.6	378.2	465.8	389.7	379.2	404.2	460.2	320.9
Coke [TJ]	103 297	85 722	70 447	92 633	79 759	71 879	77 578	84 590	58 614
CHARGE - C content									
Sinter [kg/kg]	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
Rousted ore [kg/kg]	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113
Dolomite [kg/kg]	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300
Limestone [kg/kg]	0.1200	0.1200	0.1200	0.1200	0.1200	0.1200	0.1200	0.1200	0.1200
Manganese ore [kg/kg]	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262
Coke [kg/GJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
CHARGE -total C content [Gg]									
Sinter	9.9	7.6	7.1	8.9	8.1	8.4	8.5	9.4	6.8
Rousted ore	15.7	13.3	11.2	13.8	11.5	11.2	12.0	13.6	9.5
Dolomite	85.3	72.2	60.7	74.8	62.6	60.9	64.9	73.9	51.5
Limestone	86.7	73.4	61.7	76.0	63.6	61.9	66.0	75.1	52.4
Manganese ore	13.9	11.8	9.9	12.2	10.2	9.9	10.6	12.0	8.4
Coke	3 047.3	2 528.8	2 078.2	2 732.7	2 352.9	2 120.4	2 288.6	2 495.4	1 729.1
C IN CHARGE - SUM	3 258.7	2 707.0	2 228.9	2 918.4	2 508.9	2 272.8	2 450.5	2 679.5	1 857.7
OUTPUT IN GIVEN YEAR									
Pig iron [Gg]	**7 418.0**	**6 279.4**	**5 282.3**	**6 505.3**	**5 442.8**	**5 296.4**	**5 645.9**	**6 426.9**	**4 481.2**
Blast furnace gas [TJ]	41 319	34 289	28 179	37 053	31 904	28 752	31 031	33 836	23 446
OUTPUT - C content									
Pig iron [kg/kg]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Blast furnace gas [kg/GJ]	66	66	66	66	66	66	66	66	66
UZYSK -ilość C dla danego składnika w danym roku [Gg]									
Surówka	296.7	251.2	211.3	260.2	217.7	211.9	225.8	257.1	179.2
Gaz wielkopiecowy	2 727.1	2 263.1	1 859.8	2 445.5	2 105.7	1 897.6	2 048.0	2 233.2	1 547.4
C IN OUTPUT - SUM	3 023.8	2 514.3	2 071.1	2 705.7	2 323.4	2 109.5	2 273.9	2 490.3	1 726.7
DIFFERENCE BETWEEN C IN INPUT and C IN OUTPUT [Gg]	235.0	192.8	157.8	212.7	185.5	163.3	176.6	189.3	131.0
CO2 EMISSIN[Gg]	**862**	**707**	**578**	**780**	**680**	**599**	**648**	**694**	**480**
CO2 EMOSSION FACTOR [kg/Mg]	**116**	**113**	**110**	**120**	**125**	**113**	**115**	**108**	**107**

4.2.3.1.5. *Basic Oxygen Furnace Steel* (CRF 2.C.1.f)
Amount of CO_2 process emission from basic oxygen furnace steel production in 2006 was taken from verified reports from steel plants participating in ETS. Specification of information and excluding data on steel production from total balance was needed to use data from verified reports. Additional data, taken directly from plants, enabled this kind of operation and estimation of emission from basic oxygen furnace steel production. CO_2 process emission from basic oxygen furnace steel production in 2006 was 755 Gg (except of process emission this includes also emission from continuous steel casting in basic oxygen steel plants). In 2006 basic oxygen steel production was accounted to 5766.4 Gg [GUS 2007b]. For years 1988-2005 CO_2 process emission from basic oxygen furnace steel production was estimated on the basis of carbon balances (table 4.5) prepared by Polish Steel Association (HIPH) [HIPH 2007]. In these balances amount of steel production for separate years were taken from CIBEH S.A. In frames of national statistics program (Annex to Ordinance of Council of Ministers of 2004) CIBEH provides specialised statistical researches for iron and steel industry (since 2004 data published by national statistics (GUS) are coherent with data given by CIBEH). Technological factors for consumption of pig iron in oxygen furnace process are also taken from CIBEH (data were available only for 1988-1999, for further years amount from 1999 was taken).

Factors for consumption of scrap were calculated on the basis of data from MG-08 questionnaire – consumption of raw materials used in production of metallurgy products (because the obligation of fulfilling the questionnaire is since 1999, full data series is available from 1998; for previous year (1988-1997) value from 1998 was taken into account). Because of the lack of data in national statistics, the output of oxygen furnace gas was assumed on the basis of produced oxygen furnace gas amount rate to amount of produced steel. It was based on steel plants reports included in ETS.

CO_2 process emission from basic oxygen furnace steel production for 2006, which was estimated on the basis of reports from plants was higher, than values estimated on the basis of balances. It was mainly due to factor of C content in pig iron used (in HIPH balances for 1988-2005 the value was default and amounted to 4%, the same values for 2006 in steel plants reports, which have BOF steel installations, were amounted to 4.72% and 5%).

4.2.3.1.6. *Electric Furnace Steel* (2.C.1.g)
Process emissions of CO_2 from steel production in electric furnaces in 2006 were taken from verified reports prepared by installations included into emission trading scheme. The amount of emissions for 2006 was estimated for 361.5 Gg CO_2. This emission contain, additionally to process emissions from electric furnaces, emission from continuous steel casting and from off-furnace steel treatment. Annual electric furnace steel production was taken from [GUS 2007b] and amounted for 4225.3 Gg in 2006. Activity data on steel production in electric furnaces and on CO_2 emissions related to this process in 1988-2005 are presented in table 4.6 and come from [HIPH 2007]. Activity data come from CIBEH S.A. and are compatible with national statistic publications (GUS).

Table 4.5. Carbon balance for steel production in basic oxygen process in years 1988-2005

	1988	1989	1990	1991	1992	1993	1994	1995	1996
CHARGE									
Pig iron [Mg]	6 437 194	6 274 714	6 212 430	4 835 755	5 279 309	5 205 226	5 873 001	6 440 439	5 669 525
Scrap [Mg]	1 895 954	1 841 725	1 840 367	1 468 313	1 595 404	1 573 016	1 796 072	1 962 554	1 725 579
Coke-carbon pick-up [Mg]	0	0	0	0	0	0	0	0	0
Technological indicator [Mg/Mg of steel]									
Pig iron	0.867	0.870	0.862	0.841	0.845	0.845	0.835	0.838	0.839
Scrap	0.2554	0.2554	0.2554	0.2554	0.2554	0.2554	0.2554	0.2554	0.2554
Coke	0	0	0	0	0	0	0	0	0
Material-specific carbon content									
Pig iron [Mg C/Mg]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Scrap [Mg C/Mg]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Coke [Mg C/TJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Carbon contents in charge components [Mg C]									
Pig iron	257 488	250 989	248 497	193 430	211 172	208 209	234 920	257 618	226 781
Steel scrap	7 584	7 367	7 361	5 873	6 382	6 292	7 184	7 850	6 902
Coke	0	0	0	0	0	0	0	0	0
Carbon contents in charge – SUM [Mg]	265 072	258 355	255 859	199 303	217 554	214 501	242 104	265 468	233 683
OUTPUT									
Steel [Mg]	**7 424 676**	**7 212 315**	**7 206 995**	**5 750 006**	**6 247 703**	**6 160 031**	**7 033 534**	**7 685 488**	**6 757 479**
BOF Gas [thous. m3]	259 384	251 965	251 779	200 878	218 266	215 203	245 719	268 495	236 075
Technological indicator									
BOF Gas [thous. m3/Mg og steel]	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349
Material-specific carbon content									
Steel [Mg C/Mg]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
BOF Gas [Mg C/TJ]	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9
Carbon content in products [Mg C]									
Steel	29 699	28 849	28 828	23 000	24 991	24 640	28 134	30 742	27 030
BOF Gas	118 824	115 425	115 340	92 022	99 988	98 584	112 564	122 998	108 146
Carbon content in products - SUM [Mg]	148 522	144 274	144 168	115 022	124 978	123 225	140 698	153 740	135 176
C emission from steel production [Mg]	116 549	114 081	111 691	84 281	92 576	91 277	101 406	111 728	98 507
CO2 process emission from steel production [Gg]	**427.386**	**418.336**	**409.570**	**309.058**	**339.475**	**334.711**	**371.857**	**409.707**	**361.227**
CO2 EMOSSION FACTOR [kg CO2/Mg of steel]	**57.56**	**58.00**	**56.83**	**53.75**	**54.34**	**54.34**	**52.87**	**53.31**	**53.46**

Table 4.5. (cont.) Carbon balance for steel production in basic oxygen process in years 1988-2005

	1997	1998	1999	2000	2001	2002	2003	2004	2005
CHARGE									
Pig iron [Mg]	6 311 208	5 233 149	4 640 291	6 491 867	5 440 047	5 296 410	5 629 786	6 304 253	4 538 670
Scrap [Mg]	1 923 174	1 588 976	1 303 910	1 657 053	1366064,9	1 360 557	1 424 125	1 608 909	1 147 906
Coke-carbon pick-up [Mg]	0	0	0	0	1 201	2 645	4 286	1 689	1 205
Technological indicator [Mg/Mg of steel]									
Pig iron	0.838	0.841	0.851	1.047	1.070	1.095	1.078	1.088	1.078
Scrap	0.2554	0.2554	0.2391	0.2437	0.2346	0.2346	0.2346	0.2346	0.2346
Coke	0	0	0	0	0.0002	0.0005	0.0007	0.0002	0.0002
Material-specific carbon content									
Pig iron [Mg C/Mg]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Scrap [Mg C/Mg]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Coke [Mg C/TJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Carbon contents in charge components [Mg C]									
Pig iron	252 448	209 326	185 612	259 675	217 602	211 856	225 191	252 170	181 547
Steel scrap	7 693	6 356	5 216	6 628	5 464	5 442	5 696	6 436	4 592
Coke	0	0	0	0	992	2 184	3 539	1 395	995
Carbon contents in charge – SUM [Mg]	260 141	215 682	190 827	266 303	224 058	219 483	234 427	260 000	187 133
OUTPUT									
Steel [Mg]	**7 531 274**	**6 222 532**	**5 452 751**	**6 799 681**	**5 822 518**	**5 799 042**	**6 069 985**	**6 857 583**	**4 892 671**
BOF Gas [thous. m3]	263 108	217 386	190 494	237 549	203 412	202 592	212 057	239 572	170 927
Technological indicator									
BOF Gas [thous. m3/Mg og steel]	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349
Material-specific carbon content									
Steel [Mg C/Mg]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
BOF Gas [Mg C/TJ]	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9
Carbon content in products [Mg C]									
Steel	30 125	24 890	21 811	27 199	23 290	23 196	24 280	27 430	19 571
BOF Gas	120 530	99 585	87 265	108 821	93 183	92 807	97 143	109 748	78 302
Carbon content in products - SUM [Mg]	150 655	124 475	109 076	136 020	116 473	116 003	121 423	137 178	97 872
C emission from steel production [Mg]	109 486	91 207	81 751	130 283	107 585	103 479	113 004	122 822	89 261
CO2 process emission from steel production [Gg]	**401.486**	**334.456**	**299.781**	**477.747**	**394.514**	**379.458**	**414.384**	**450.388**	**327.320**
CO2 EMOSSION FACTOR [kg CO2/Mg of steel]	**53.31**	**53.75**	**54.98**	**70.26**	**67.76**	**65.43**	**68.27**	**65.68**	**66.90**

Table 4.6 Carbon balance for steel production in electric arc furnace in years 1988-2005

	1988	1989	1990	1991	1992	1993	1994	1995	1996
CHARGE									
Steel scrap [Mg]	2 980 592	2 623 615	2 674 982	2 260 467	2 001 450	2 368 569	2 743 833	2 991 568	3 068 664
EAF carbon electrodes[Mg]	5 402	4 755	4 848	4 097	3 627	4 293	4 973	5 422	5 562
Ferroalloys [Mg]	6 688	5 887	6 002	5 072	4 491	5 315	6 157	6 713	6 886
Coke -carbon pick-up [Mg]	2 800	4 100	4 180	3 000	1 000	4 300	3 900	1 365	1 400
Calcium and magnesium carbonate [Mg]	29 806	26 236	26 750	22 605	20 014	23 686	27 438	29 916	30 687
Anthracite carbon pick-up [Mg]	17 884	15 742	16 050	13 563	12 009	14 211	16 463	17 949	18 412
Technological indicators									
Scrap [Mg/Mg of steel]	1.1587	1.1587	1.1587	1.1587	1.1587	1.1587	1.1587	1.1587	1.1587
EAF carbon electrodes [Mg/Mg of steel]	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
Ferroalloys [Mg/Mg of steel]	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
Coke -carbon pick-up [Mg/Mg of steel]	0.0011	0.0018	0.0018	0.0015	0.0006	0.0021	0.0016	0.0005	0.0005
Calcium and magnesium carbonate [Mg/Mg scrap]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Anthracite carbon pick-up [Mg/Mg scrap]	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Material-specific carbon content									
Scrap [Mg C/Mg]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
EAF carbon electrodes [Mg C/Mg]	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Ferroalloys [Mg C/Mg]	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Coke -carbon pick-up [Mg C/TJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Calcium and magnesium carbonate [Mg C/Mg]	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Anthracite carbon pick-up [Mg C/TJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Carbon contents in charge components [Mg C]									
Steel scrap	11 922	10 494	10 700	9 042	8 006	9 474	10 975	11 966	12 275
EAF carbon electrodes	4 430	3 899	3 975	3 359	2 974	3 520	4 078	4 446	4 561
Ferroalloys	17	15	16	13	12	14	16	17	18
Coke -carbon pick-up	2 312	3 385	3 452	2 477	826	3 551	3 220	1 127	1 156
Calcium and magnesium carbonate	3 877	3 413	3 480	2 940	2 603	3 081	3 569	3 891	3 992
Anthracite carbon pick-up	12 108	10 658	10 866	9 182	8 130	9 621	11 146	12 152	12 465
Carbon contents in charge – SUM [Mg]	34 666	31 865	32 488	27 014	22 551	29 261	33 004	33 600	34 466
OUTPUT									
Steel [Mg]	**2 572 388**	**2 264 300**	**2 308 632**	**1 950 887**	**1 727 343**	**2 044 184**	**2 368 054**	**2 581 861**	**2 648 398**
Material-specific carbon content									
Steel [Mg C/Mg]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Carbon content in products [Mg C]									
Steel	10 290	9 057	9 235	7 804	6 909	8 177	9 472	10 327	10 594
Carbon content in products - SUM [Mg]	10 290	9 057	9 235	7 804	6 909	8 177	9 472	10 327	10 594
C emission from steel production [Mg]	24 377	22 807	23 254	19 211	15 642	21 084	23 532	23 273	23 873
CO2 process emission from steel production [Gg]	**89.389**	**83.635**	**85.272**	**70.446**	**57.359**	**77.317**	**86.292**	**85.341**	**87.541**
CO2 EMOSSION FACTOR [kg CO2/Mg steel]	**34.75**	**36.94**	**36.94**	**36.11**	**33.21**	**37.82**	**36.44**	**33.05**	**33.05**

Table 4.6. (cd.) Bilans węgla pierwiastkowego dla procesu produkcji stali w piecach elektrycznych dla lat 1988-2005

	1997	1998	1999	2000	2001	2002	2003	2004	2005
CHARGE									
Steel scrap [Mg]	3 367 519	3 611 532	2 660 359	3 538 030	3 024 402	2 872 406	2 178 588	4 177 197	3 926 662
EAF carbon electrodes[Mg]	6 103	6 546	5 933	6 896	5 899	5 378	6 125	7 814	7 231
Ferroalloys [Mg]	7 556	8 104	7 345	8 538	7 304	6 659	7 583	9 674	8 952
Coke -carbon pick-up [Mg]	1 536	4 500	4 800	16 774	14 348	13 082	18 319	20 299	8 704
Calcium and magnesium carbonate [Mg]	33 675	36 115	26 604	35 380	30 244	28 724	21 786	41 772	39 267
Anthracite carbon pick-up [Mg]	20 205	21 669	15 962	21 228	18 146	17 234	19 607	37 595	35 340
Technological indicators									
Scrap [Mg/Mg of steel]	1.1587	1.1587	0.9417	1.0774	1.0767	1.1215	0.7470	1.1226	1.1404
EAF carbon electrodes [Mg/Mg of steel]	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
Ferroalloys [Mg/Mg of steel]	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
Coke -carbon pick-up [Mg/Mg of steel]	0.0005	0.0014	0.0017	0.0051	0.0051	0.0051	0.0063	0.0055	0.0025
Calcium and magnesium carbonate [Mg/Mg scrap]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Anthracite carbon pick-up [Mg/Mg scrap]	0.006	0.006	0.006	0.006	0.006	0.006	0.009	0.009	0.009
Material-specific carbon content									
Scrap [Mg C/Mg]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
EAF carbon electrodes [Mg C/Mg]	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Ferroalloys [Mg C/Mg]	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Coke -carbon pick-up [Mg C/TJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Calcium and magnesium carbonate [Mg C/Mg]	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Anthracite carbon pick-up [Mg C/TJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Carbon contents in charge components [Mg C]									
Steel scrap	13 470	14 446	10 641	14 152	12 098	11 490	8 714	16 709	15 707
EAF carbon electrodes	5 005	5 367	4 865	5 655	4 837	4 410	5 022	6 407	5 929
Ferroalloys	20	21	19	22	19	17	20	25	23
Coke -carbon pick-up	1 269	3 716	3 963	13 850	11 847	10 802	15 126	16 761	7 187
Calcium and magnesium carbonate	4 380	4 698	3 461	4 602	3 934	3 736	2 834	5 434	5 108
Anthracite carbon pick-up	13 679	14 671	10 807	14 372	12 286	11 668	13 275	25 453	23 926
Carbon contents in charge – SUM [Mg]	37 823	42 919	33 756	52 654	45 021	42 124	44 991	70 789	57 880
OUTPUT									
Steel [Mg]	**2 906 324**	**3 116 918**	**2 825 084**	**3 283 944**	**2 809 078**	**2 561 171**	**2 916 596**	**3 720 899**	**3 443 227**
Material-specific carbon content									
Steel [Mg C/Mg]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Carbon content in products [Mg C]									
Steel	11 625	12 468	11 300	13 136	11 236	10 245	11 666	14 884	13 773
Carbon content in products - SUM [Mg]	11 625	12 468	11 300	13 136	11 236	10 245	11 666	14 884	13 773
C emission from steel production [Mg]	26 197	30 451	22 456	39 518	33 785	31 879	33 325	55 905	44 107
CO2 process emission from steel production [Gg]	**96.066**	**111.664**	**82.345**	**144.912**	**123.888**	**116.900**	**122.202**	**205.004**	**161.740**
CO2 EMOSSION FACTOR [kg CO2/Mg steel]	**33.05**	**35.83**	**29.15**	**44.13**	**44.10**	**45.64**	**41.90**	**55.10**	**46.97**

Table 4.7. Carbon balance for coke production in years 1988-2006

	1988	1989	1990	1991	1992	1993	1994	1995	1996
INPUT [TJ]									
Coaking coal	658115	639140	534118	448516	438558	405168	436596	451761	403902
High Methane Natural Gas		1239	1012	1668	2092	2526	1335	1076	1842
Coke	1077	1486	947	534	1746	1543	2354	2283	1784
Blast furnace gas		152	0	0	0	0	0	0	0
Tar	390	306	619	330	157	115	82	194	
Industrial waste		2							
NCV [MJ/kg]									
Coking coal	29.48	29.47	29.33	29.44	29.47	29.41	28.49	29.36	29.36
INPUT - Material-specific carbon content [kg C/GJ]									
Coking coal	25.98	25.98	25.99	25.98	25.98	25.98	26.02	25.99	25.99
High Methane Natural Gas	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Coke	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Blast furnace gas	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0
Tar	22	22	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Industrial waste	39	39	39.0	39.0	39.0	39.0	39.0	39.0	39.0
INPUT - Carbon contents in charge components [Gg]									
Coking coal	17099.2	16606.2	13880.4	11654.0	11394.7	10528.1	11360.6	11739.7	10495.9
High Methane Natural Gas	0.0	18.9	15.5	25.5	32.0	38.6	20.4	16.5	28.2
Coke	31.8	43.8	27.9	15.8	51.5	45.5	69.4	67.3	52.6
Blast furnace gas	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tar	8.6	6.7	13.6	7.3	3.5	2.5	1.8	4.3	0.0
Industrial waste	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carbon contents in charge – SUM [Gg]	17139.5	16685.8	13937.5	11702.6	11481.7	10614.8	11452.3	11827.8	10576.7
OUTPUT [TJ]									
Coke	466962	452889	380655	320752	312418	288431	321009	322383	288300
Coke-Oven Gas	115366	114320	100628	89478	85741	77314	84100	84769	76036
Tar	27580	27429	22885	20268	20648	19071	21147	21265	19832
Benzol	7702	7231	6167	5151	5646	5159	6011	6057	5447
OUTPUT - Material-specific carbon content [kg C/GJ]									
Coke	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Coke-Oven Gas	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Tar	22	22	22	22	22	22	22	22	22
Benzol	23	23	23	23	23	23	23	23	23
OUTPUT - Carbon content in products [Gg]									
Coke	13775.4	13360.2	11229.3	9462.2	9216.3	8508.7	9469.8	9510.3	8504.9
Coke-Oven Gas	1499.8	1486.2	1308.2	1163.2	1114.6	1005.1	1093.3	1102.0	988.5
Tar	606.8	603.4	503.5	445.9	454.3	419.6	465.2	467.8	436.3
Benzol	177.5	163.4	141.8	118.5	129.9	118.7	138.2	139.3	125.3
Carbon content in products - SUM [Gg]	16059.4	15613.2	13182.8	11189.8	10915.1	10052.0	11166.5	11219.4	10054.9
C process emission[Gg]	1080.1	1072.6	754.7	512.8	566.6	562.8	285.8	608.4	521.8
CO2 process emission[Gg]	**3960.4**	**3932.8**	**2767.1**	**1880.3**	**2077.6**	**2063.6**	**1047.8**	**2230.6**	**1913.4**
Coke output [Gg]	**16795**	**16323**	**13671**	**11411**	**11094**	**10282**	**11456**	**11579**	**10340**
EF [kg CO2/Mg of coke]	**236**	**241**	**202**	**165**	**187**	**201**	**91**	**193**	**185**

Table 4.7. (cont.) Carbon balance for coke production in years 1988-2006

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
INPUT [TJ]										
Coking coal	420825	373917	334582	363260	359331	351567	406805	401491	331593	378744
High Methane Natural Gas	1364	874	741	542	1067	811	190	274	469	505
Coke	1669	1975	1429	1896	982	1642	1435	1505	1926	2076
Blast furnace gas	0	0	0	0	0	0	0	0	0	0
Tar		15								
Industrial waste										
NCV [MJ/kg]										
Coking coal	29.45	29.54	29.48	29.62	29.53	29.53	29.56	29.55	29.51	29.59
INPUT - Material-specific carbon content [kg C/GJ]										
Coking coal	25.98	25.98	25.98	25.98	25.98	25.98	25.98	25.98	25.98	25.98
High Methane Natural Gas	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Coke	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Blast furnace gas	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0
Tar	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Industrial waste	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0
INPUT - Carbon contents in charge components [Gg]										
Coking coal	10934.3	9714.2	8693.1	9436.2	9335.5	9133.7	10568.3	10430.4	8615.0	9838.8
High Methane Natural Gas	20.9	13.4	11.3	8.3	16.3	12.4	2.9	4.2	7.2	7.7
Coke	49.2	58.3	42.2	55.9	29.0	48.4	42.3	44.4	56.8	61.3
Blast furnace gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tar	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industrial waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carbon contents in charge – SUM [Gg]	11004.4	9786.2	8746.6	9500.5	9380.8	9194.5	10613.6	10479.0	8679.0	9907.8
OUTPUT [TJ]										
Coke	298053	266064	237065	254374	252286	246207	285907	285927	237152	270125
Coke-Oven Gas	79286	73457	62989	68849	69008	65570	75091	72947	61947	71712
Tar	19600	17950	16265	17003	17233	16463	18188	17421	14603	16219
Benzol	5429	4857	4525	2499	4789	4475	5253	5358	4403	3804
OUTPUT - Material-specific carbon content [kg C/GJ]										
Coke	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Coke-Oven Gas	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Tar	22	22	22	22	22	22	22	22	22	22
Benzol	23	23	23	23	23	23	23	23	23	23
OUTPUT - Carbon content in products [Gg]										
Coke	8792.6	7848.9	6993.4	7504.0	7442.4	7263.1	8434.3	8434.8	6996.0	7968.7
Coke-Oven Gas	1030.7	954.9	818.9	895.0	897.1	852.4	976.2	948.3	805.3	932.3

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Tar	431.2	394.9	357.8	374.1	379.1	362.2	400.1	383.3	321.3	356.8
Benzol	124.9	111.7	104.1	57.5	110.1	102.9	120.8	123.2	101.3	87.5
Carbon content in products - SUM [Gg]	10379.3	9310.4	8274.2	8830.6	8828.8	8580.6	9931.4	9889.7	8223.8	9345.2
C process emission[Gg]	625.0	475.8	472.4	669.9	552.0	613.9	682.2	589.3	455.2	562.6
CO2 process emission[Gg]	**2291.8**	**1744.4**	**1732.3**	**2456.2**	**2023.9**	**2251.0**	**2501.2**	**2160.7**	**1669.1**	**2062.8**
Coke output [Gg]	**10536**	**9747**	**8368**	**8972**	**8946**	**8723**	**10112**	**10097**	**8404**	**9613**
EF [kg CO2/Mg of coke]	**218**	**179**	**207**	**274**	**226**	**258**	**247**	**214**	**199**	**215**

Data used in budgets (table 4.5) on graphite electrodes used, ferroalloys, limestones and anthracite are taken directly from steel plants (installations under Polish Steel Association). Data on steel scrap and coke use come from CIBEH S.A. (scrap use was estimated based on MG-08 questionnaires like for BOF steel; because of lack of detail data up to 1997, scrap use factor from 1998 was applied for 1988-1997).

CH_4 emission from steel production in electric furnaces was assessed for entire time series 1988-2006 based on country specific emission factor of 0.12 kg CH_4/Mg steel produced [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 in period 1988-2006 was estimated based on elementary carbon budget in coking plants process (tab. 4.7). Activity data concerning input and output based on statistical yearbooks (in 1988-1989 [GUS 1989a-1990a], in 1990-2006 [Eurostat] and [GUS 1991a-2007a]).Amount of carbon in input and output's components was calculated based on IPCC factors [IPCC 1997, IPCC 2006].

CH_4 emission in period 1990-2006 was estimated based on coke production volume from [Eurostat] and emission factor is 0.5 kg CH_4 / Mg coke produced [IPCC 1997]. CH_4 emission for years 1988-1989 was estimated based on activity data published in statistical yearbooks [GUS 1989b-1990b] and emission factor is 0.1 g CH_4 / Mg [IPCC 2006].

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 2007b]. Applied emission factor, which value is 3900 kg CO_2 / Mg ferrosilicon, was taken from [IPCC 1997] for ferrosilicon – 75% Si.

CH_4 emission was estimated based on emission factors from [IPCC 2006] which is equal 1 kg CH_4/Mg ferrosilicon – 75% Si.

In period 1988-2006 CO_2 and CH_4 process emission from ferroalloys production was estimated based on annual ferrosilicon production taken from [GUS 1989b-2007b] (figure 4.10) and emission factors as in year 2006.

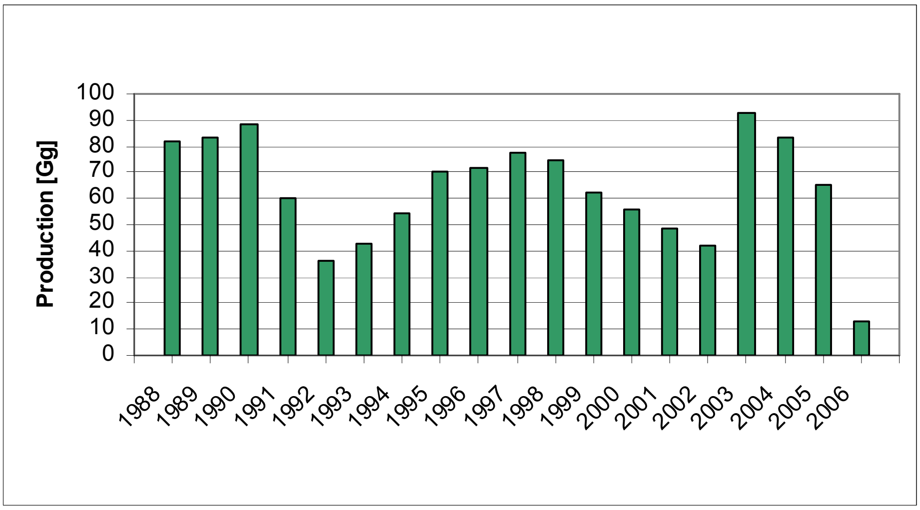


Figure 4.10. Production of ferrosilicon in 1988-2006
.
4.2.3.3. *Aluminium Production* (CRF 2.C.3)
Calculation of CO_2 emission from primary aluminium production for 2006 is based on the data on aluminium production published in [GUS 2007b]. The emission factor, which is equal 1.8 Mg CO_2 / Mg primary aluminium, was taken from [IPCC 1997] as the value recommended for Soderberg Process.

CO_2 process emissions from aluminium production for 1988-2006 was estimated based on according to above mentioned description. The amount of emissions for entire trend is shown at figure 4.11.

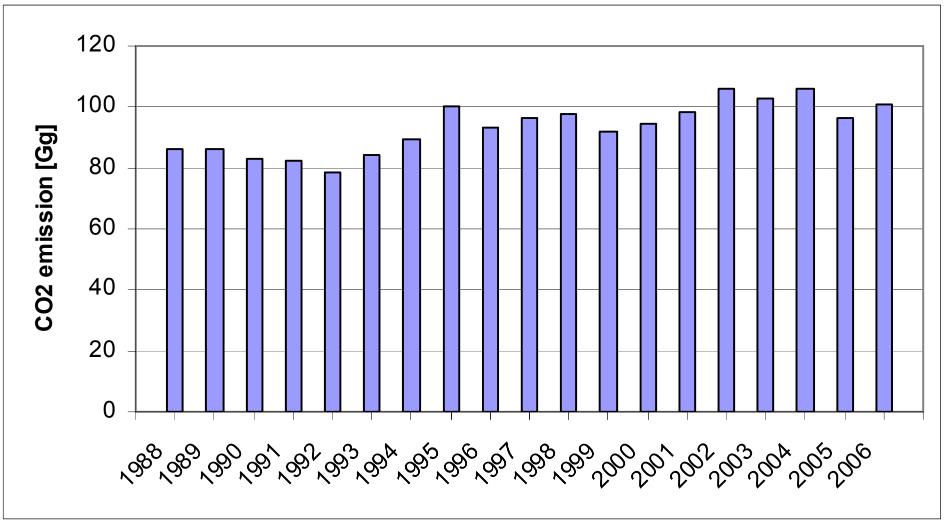


Figure 4.11. CO_2 process emission for aluminium production in 1988-2006

4.2.3.4. *Zinc production*

Process emission of CO_2 from zinc production was estimated based on annual zinc production taken from GUS [GUS 2007b]. Emission factor come from [IPCC 2006] – table 4.24 and amount of 1.72 Mg CO_2/ Mg zinc.

For entire period 1988-2006 data source on zinc production as well as emission factor are the same. Trend of process emissions from zinc production is given at figure 4.12.

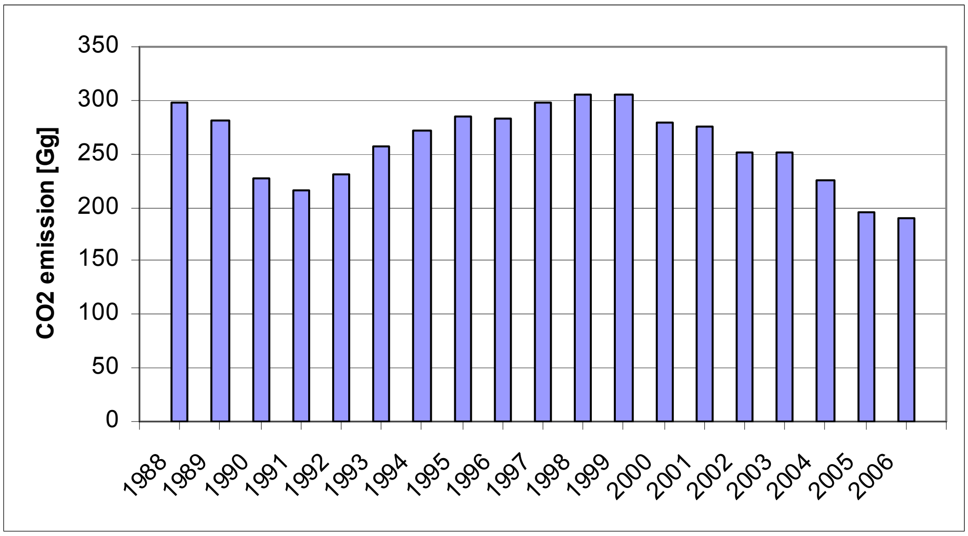


Figure 4.12. CO_2 process emission for zinc production in 1988-2006

4.2.3.5. *Lead production*

Process emission of CO_2 from lead production was estimated based on annual lead production taken from GUS [GUS 2007b]. The default emission factor of 0.52 Mg CO_2/ Mg lead from [IPCC 2006] – table 4.21 was applied.

For entire period 1988-2006 the same emission factor was used. Data source on lead production come from [GUS 1989b-2007b]. Trend of process emissions from lead production is given at figure 4.13.

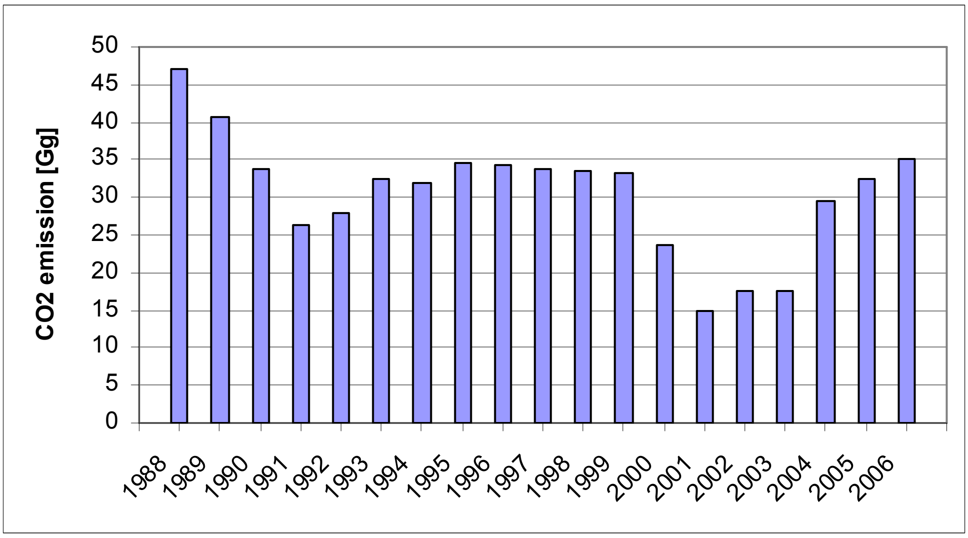


Figure 4.13. CO_2 process emission for lead production in 1988-2006

4.2.4. *Other production* (CRF 2.D)

4.2.4.1. *Pulp and paper production* (CRF 2.D.1)
CO_2 process emission from pulp and paper production for 2005 and 2006 was taken from the verified reports for installations of paper and cardboard production, which participate in the emission trading scheme [KASHUE 2008]. This emission value was equal 48 Mg CO_2 for 2006 and 77 Mg CO_2 for 2005.

4.2.5. *Other* (CRF 2.G)

4.2.5.1. *Refinery processes*
CO_2 emission value estimated as process emission of CO_2 from the verified reports for refineries, which participate in the emission trading scheme was included in this sub-category [KASHUE 2008]. Values of process emissions amounted for 1144.1 Gg CO_2 in 2006 and 954.3 Gg CO_2 in 2005. This part of refinery emission mainly resulted from the following processes: hydrogen production, regeneration of catalysts and after-burning gases from asphalt production.

4.2.6 *Consumption of Halocarbons and SF_6* (CRF 2.F)

Emissions of HFC, PFCs and SF_6 are based on activity data available at public statistics data and data collected by surveys among importers and exporters of CFCs and F-gases. In case of refrigeration and air-conditioning equipment containing HFCs, some information concerning e.g. amounts of gas used, are collected by experts among main domestic producers and importers/exporters. The main emission factors for HFC-134a [IPCC 2000] are given in table 4.8.

Table 4.8. Main HFC-134a emission factors

Emission sources	Emission factor
Transport refrigeration – product life factor	30 %
Commercial refrigeration (window refrigerators and chamber freezers) – product life factor	20 %
Commercial refrigeration (window refrigerators and chamber freezers) – product manufacturing factor	3 %

The main source of emission of PFC gases in Poland is aluminium production Activities on aluminium production were taken from [GUS 2007b]. *Tier 1* method and the following emission factors as in [IPCC 2000] were used for estimation of PFC emissions:
for CF_4 EF = 0.61 kg/Mg aluminium produced
for C_2F_6 EF = 0.061 kg/Mg aluminium produced

As concerns SF_6 – the only sources estimated in Poland are electrical equipment and sound-proof windows. Values on use of SF_6 (marked as underlined) were estimated based on mass balance analysis. The following emission factors [IPCC 2000] were used for calculation of SF_6 emission:
Equipment manufacturing – EF = 0.06 Mg/Mg of SF_6 used
Equipment use – EF = 0.05 Mg/Mg SF6 in use (1995), EF = 0.02 Mg/Mg (since 1996)

Table 4.9. Activity data used for estimation of PFC and SF_6 emissions

Activity characteristic for the source sector	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2.C. Metal production												
3. Aluminium Production [Gg]	55.278	51.924	53.614	54.168	50.981	46.941	54.606	58.777	57.237	58.931	53.582	55.939
2.F Consumption of HFC, PFC and SF_6												
2.F.8. Electrical equipment – amount of SF_6 in use [Mg]	11.000	14.024	17.048	20.072	23.096	26.120	28.702	32.039	33.748	36.446	40.567	44.606
2.F.8 Electrical equipment – amount of imported SF_6 [Mg]	0.000	0.600	0.600	2.000	2.330	2.660	3.303	4.160	2.500	3.588	5.160	5.160

4.3 Uncertainties

Uncertainty analysis for this IPCC sector was prepared with use of *Tier 1* methodology defined in the IPCC Good Practice Guidance. Summary results of the analysis are presented in the table below, more detailed information for this and other sectors can be found in annex 5 of this report.

2006	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]
2. Industrial Processes	19,040.21	18.35	15.00	5.5%	14.1%	28.6%	1,052.50	2.59	4.28
A. Mineral Products	9,147.39			10.6%			973.13		
B. Chemical Industry	4,276.75	12.35	15.00	7.0%	19.1%	28.6%	299.15	2.35	4.28
C. Metal Production	4,471.88	6.00		5.8%	18.1%		260.79	1.09	
D. Other Production	0.05			5.0%			0.00		
G. Other	1,144.14			5.0%			57.21		

4.4 Recalculations

- In subcategory 2.A.1 *Clinker production* – CO_2 emission factor was corrected for 1990-2000 (mean value for 2001-2004 for domestic emission factors was taken); CO_2 emissions for 2005 were corrected based on verified reports from installations, which participate in the emission trading scheme.

- In subcategory 2.A.3 *Limestone and Dolomite Use* data on CO_2 emissions for 2005 relates to limestone use in sulfur removal processes in energy and heat production (other limestone and dolomite use was included in other categories).
- In subcategory 2.B.1 *Ammonia production* the methodology of CO_2 emissions estimation was changed – for entire period 1988-2006 process emission was estimated based on carbon content in feedstock used for production (in natural and coke oven gases relatively); the source of activity data on ammonia production was also changed – for entire time series data from G03 reports was taken.
- In subcategory 2.B.4 *Carbide production,* for 1990-2005, CO_2 emission factor was verified; earlier EF related only to carbide use, not carbide production.
- In subcategory 2.C.1 *Iron Ore sintering*, in 2005, CO_2 emissions were corrected based on information from verified reports from installations included into emission trading scheme.
- The methodology for CO_2 process emission estimation from steel production (BFP, BOF and EFS) as well as from steel cast and iron cast production was changed – for time series 1988-2005 calculation was based on carbon balance.
- data on the production of pig iron and coke for the years 1988-2005 were updated – data on input to and output from processes in each year were corrected based on data in the Eurostat database (recalculated coke input data for pig iron production were taken from ARE, as these data have not been corrected in Eurostat) and for the main input and output components for the coke and blast-furnace processes emission factors for hard coal were taken from IPCC guidelines [IPCC 1997]
- for all years estimation of CO_2 emissions from production of zinc an lead were added
- process CO_2 emissions for ceramics production were verified based on data in the verification reports for installations covered by EU ETS
- for all years estimation of CH_4 emissions from sinter production were added
- for all years 1988-2006 CH_4 emissions were estimated for the ferroalloys production (ferrosilicon)
- for the years: 1990-2005 a new source of data for coke production was used (data on coke output in the Eurostat database were used)
- emission factors for CH_4 for coke production were changed – EFs from IPCC [IPCC 2006] for 1988 and 1989 and for: 1990-2006 [IPCC 1997])
- CH_4 process emissions from methanol production were added for the period 1990-2006
- process emission factors for CH_4 for soot production for the period: 1990-2005 were changed (EF from [IPCC 1997] was taken, EF = 11 kg/Mg of produced soot, in place of the former EF = 10 kg/Mg)
- for the years: 1990-2006 estimation of process emissions from ethylene production was added

4.5 Planned improvements

- verification and updating of emission factors for process emissions of N_2O from nitric acid z production (sub-category 2.B.2)
- to distinguish CO_2 emissions from limestone and dolomite use among various sub-categories in source sector 2. and estimation of total CO_2 emission in the sub-category 2.A.3 Limestone and Dolomite Use
- taking into consideration in the 2005 GHG emission inventory, data on CO_2 process emission from verification reports from installations covered by the EU ETS (similarly to the use of analogous data for the year 2006 in some of the sub-categories in category 2.)

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 Sector overview and 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 2006]. 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.

Additionally, N_2O emissions form anesthesiology were estimated in sub-sector 3.D.

5.3 Uncertainties

Uncertainty analysis for this IPCC sector was prepared with use of *Tier 1* methodology defined in the IPCC Good Practice Guidance. Summary results of the analysis are presented in the table below, more detailed information for this and other sectors can be found in annex 5 of this report.

2006	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	581.75		0.40	15.0%		50.0%	87.26		0.20

5.4 Recalculations

No recalculations of GHG emissions were carried our in this category.

5.5 Planned improvements

Experts study is found to be helpful within searching the detail data on N_2O use in anesthesiology.

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	2.0%
- 4.B. Manure Management (CH4 emission), share in total GHG emission	0.8%
- 4.B. Manure Management (N2O emission), share in total GHG emission	1.3%
- 4.D.1. Direct Soil Emissions (N2O emission), share in total GHG emission	2.3%
- 4.D.3. Indirect Soil Emissions (N2O emission), share in total GHG emission	0.9%

Share of these categories in total Poland's GHG emissions is 7.2%.

6.2 Sector overview and methodological issues

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

In order to calculate CH_4 emission factors from enteric fermentation and manure management the Gross Energy Intake (GE) was calculated [IPCC 2000, equation 4.11] for dairy cattle and for and non-dairy cattle disaggregated for: calves under 1 year, young cattle 1-2 years and other matured cattle (over 2 years). Country specific parameters like pregnancy [GUS R1 2007], milk production (table 6.1), percent of fat in milk [GUS R 2007] come from national statistics. Digestible energy (DE – expressed as a percent of gross energy) was estimated by [Walczak 2006] and change from 58.6% in 1988 through 60% in 1995 up to 62.8% in 2004 and after for dairy cattle what was caused by diet improving. As concerns non-dairy cattle, DE values are as following: young cattle up to 1 year – 68.6%, bovines between 1–2 years and older cows – 62.4%, other matured cattle – 59.1%.

Above mentioned parameters were used for calculation GE factor (and further emission factor), for dairy cattle for entire trend 1988–2006 (table 6.1) which fluctuates following changes in milk production and other parameters. So methane emission factor for dairy cattle vary from 88.8 up to 94.3 kg CH_4/animal/year, following GE changes, and is slightly higher then IPCC default one (81 kg CH_4/animal/year) because of using country specific parameters for calculations. For non–dairy cattle GE factor was calculated for every subcategory based on country specific parameters like mean mass and daily weight gain [Walczak 2006]. Methane emission factors for entire trend for non-dairy cattle in form of weighted mean values are presented in table 6.2. The values of EFs vary from 39.1 up to 48.5 kg CH_4/animal/year. Relatively low EF (IPCC default is 56 kg CH_4/animal/year) depends on big share of youngest cattle within this category. For sheep GE factor was calculated for two subcategories: lambs 1 year and mature sheep above 1 year Parameters for sheep are presented in table 6.3. Weighted mean emission factors for sheep for 1988–2006 oscillate around IPCC default value of 8 kg CH_4/animal/year (7.8–8.3 kg CH_4/animal/year). The characteristics like mean mass or daily mass gain of animals come from country case study [Walczak 2006], wool production come from national statistics [GUS R 2007].

Methane emissions from enteric fermentation of cattle and sheep were based on *Tier 2* method [IPCC 2000, equations 4.1–4.14]. In case of goats, horses and swine the *Tier 1* method and default Emission Factors for CH_4 was applied [IPCC 1997]. Activity data comes from national statistics [GUS 2007].

Table 6.1. Dairy cattle population, milk production, daily Gross Energy Intake (GE), CH_4 emissions factors and CH_4 emissions in 1988–2006

Years	Population [thousands]	Milk production [kg/day/cow]	GE Gross Energy Intake [MJ/cow/day]	EF Emission Factor [kg CH_4 / animal / year]	CH4 Emission [Gg CH4]
1988	4806	8.9	235.237	92.573	444.91
1989	4994	9.2	236.590	93.105	464.97
1990	4919	8.9	232.836	91.628	450.72
1991	4577	8.7	229.198	90.196	412.83
1992	4257	8.5	225.947	88.917	378.52
1993	3983	8.7	225.881	88.891	354.05
1994	3863	8.8	226.560	89.158	344.42
1995	3579	8.9	225.712	88.825	317.90
1996	3461	9.2	227.696	89.605	310.12
1997	3490	9.5	229.767	90.420	315.57
1998	3542	9.9	229.602	90.355	320.04
1999	3418	9.9	228.373	89.872	307.18
2000	3098	10.4	230.791	90.824	281.37
2001	3005	10.8	234.447	92.262	277.25
2002	2873	11.0	234.819	92.409	265.49
2003	2897	11.2	235.931	92.846	268.98
2004	2796	11.5	237.233	93.359	261.03
2005	2795	11.7	238.822	93.984	262.69
2006	2824	11.9	239.649	94.309	266.33

Table 6.2. Non–dairy cattle population, weighted mean mass, daily Gross Energy Intake (GE), CH_4 emissions factors and CH_4 emissions in 1988–2006

Years	Population [thousands]	Weighted mean mass [kg]	GE Gross Energy Intake (Weighted mean) [MJ/animal/day]	EF Emission Factor (Weighted mean) [kg CH_4 / animal / year]	CH4 Emission (Weighted mean) [Gg CH4]
1988	5516	248	101.074	39.776	219.40
1989	5739	257	104.437	41.099	235.87
1990	5130	259	104.856	41.264	211.68
1991	4267	254	102.646	40.395	172.36
1992	3964	245	99.320	39.085	154.93
1993	3660	245	99.369	39.105	143.12
1994	3833	242	98.205	38.647	148.13
1995	3727	246	99.805	39.276	146.38
1996	3675	244	99.279	39.070	143.58
1997	3817	256	103.591	40.766	155.60
1998	3413	309	120.933	47.591	162.43
1999	3137	311	120.480	47.413	148.73
2000	2985	308	121.123	47.666	142.28
2001	2729	305	119.830	47.157	128.69
2002	2660	303	123.221	48.491	128.99
2003	2592	311	120.608	47.463	123.02
2004	2557	315	120.878	47.569	121.63
2005	2688	307	120.384	47.375	127.34
2006	2782	312	121.827	47.943	133.38

Table 6.3. Sheep population, daily Gross Energy Intake (GE), CH_4 emissions factors and CH_4 emissions in 1988–2006

Years	Population [thousands]	GE Gross Energy Intake (Weighted mean) [MJ/animal/day]	EF Emission Factor (Weighted mean) [kg CH_4 / animal / year]	CH4 Emission [Gg CH4]
1988	4377	17.933	7.863	34.41
1989	4409	18.128	7.972	35.15
1990	4159	18.192	8.011	33.32
1991	3234	18.035	7.927	25.64
1992	1870	18.479	8.175	15.29
1993	1268	18.384	8.124	10.30

Years	Population [thousands]	GE Gross Energy Intake (Weighted mean) [MJ/animal/day]	EF Emission Factor (Weighted mean) [kg CH_4 / animal / year]	CH4 Emission [Gg CH4]
1994	870	18.552	8.216	7.15
1995	713	18.527	8.205	5.85
1996	552	18.578	8.231	4.54
1997	491	18.668	8.279	4.06
1998	453	18.466	8.173	3.70
1999	392	18.544	8.212	3.22
2000	362	18.474	8.167	2.96
2001	343	18.873	8.383	2.88
2002	345	17.901	7.838	2.70
2003	338	17.858	7.823	2.64
2004	318	18.458	8.174	2.60
2005	316	18.285	8.112	2.56
2006	301	17.719	7.831	2.36

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]. The factors recommended for cool climate were used. Animal population was taken from [GUS 2007].

Due to inconsistency in time series in poultry population there was a need for recalculation for 1988–2001 based on original data for 2002. The reason for this was change in national statistics in accounting for poultry. Up to 2001 only chicken living above six months were taken into account in national statistics. Since 2002 the methodology has changed and also younger chicken, above two weeks, were accounted. The year 2002 was the only one where both statistics of poultry (chicken) accounting were available in GUS database so that data was applied to estimate comparable poultry population for earlier years, 1988–2001. The main criteria for approximation was share of "older" poultry population in the "younger" population which is about 27% for 2002. The poultry population data, original from GUS and approximated, are presented at figure 6.1.

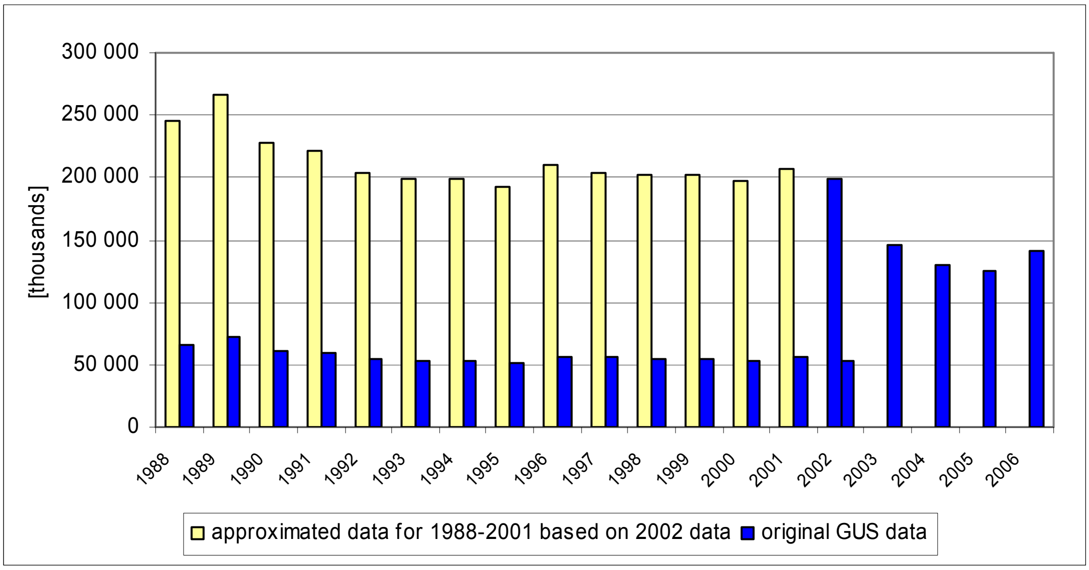


Figure 6.1. Poultry population trend for 1988–2006

Due to lack of data in goats population before 1996 the number of animals from 1996 was used for years 1988–1995. Additionally the population of goats for 1997 was interpolated using 1996 and 1998 numbers. The population of horses, coming from national statistics (GUS), and goats is presented in table 6.4.

Table 6.4. Horses and goats population trend for 1988–2006 [thousands]

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
horses	1051	973	941	939	900	841	622	636	569	558	561	551	550	546	330	333	321	312	307
goats	179	179	179	179	179	179	179	179	179	182	186	181	177	172	193	192	176	142	130

The country specific CH_4 emission factors for manure management 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] (table 6.7),
- B_o (methane-producing potential) factors were taken from [IPCC 1997, tables B–3,4,6,7],
- Vs (average daily volatile excreted solids) for dairy, non-dairy cattle and sheep were estimated based on country specific GE; VS for swine was the default value from [IPCC 1997, tables B–6],
- MCFs (methane conversion factors) for individual manure management systems concerning cool climate are from [IPCC 2000, table 4.10].

Examples of above mentioned indicators and emission factors for livestock for 2006 are shown in table 6.5. Entire trend of CH_4 emission factors for cattle, swine and sheep are presented in table 6.6

Table 6.5. Methane-producing potential (B_o), volatile solids excreted (Vs) and CH_4 emission factors for manure management in 2006

Livestock	B_o methane-producing potential [m^3 CH_4/kg Vs]	Vs Volatile Solids Excreted [kg dm /animal/ day]	EF Emission Factor [kg CH_4 / animal / year]
4.B Manure Management	---	---	---
1 Cattle	---	---	---
a. Dairy cattle	0.24	4.450	9.361
b Non-dairy cattle	0.17	2.097	5.974
3 Sheep	0.19	0.353	0.164
4 Goats	0.17	0.280	0.120
6 Horses	0.33	1.720	1.390
8 Swine	0.45	0.500	6.536
9 Poultry	0.32	0.100	0.078

Table 6.6. Methane emission factors [kg CH_4/head/year] and emissions [Gg CH_4] trends for 1988–2006 for manure management of cattle, swine and sheep

Years	Dairy cattle		Non–dairy cattle		Swine		Sheep	
	EF	Emission	EF	Emission	EF	Emission	EF	Emission
1988	5.86	28.17	2.00	11.05	5.21	102.21	0.17	0.73
1989	5.91	29.51	2.60	14.91	5.21	98.20	0.17	0.74
1990	5.63	27.69	1.61	8.28	5.40	105.16	0.17	0.70
1991	5.51	25.24	2.09	8.90	5.59	122.28	0.17	0.54
1992	5.27	22.42	1.98	7.84	5.78	127.67	0.17	0.32
1993	5.00	19.93	1.83	6.69	5.97	112.59	0.17	0.22
1994	5.02	19.37	1.75	6.72	6.16	119.88	0.17	0.15
1995	4.99	17.87	1.68	6.25	6.35	129.60	0.17	0.12
1996	4.78	16.53	2.13	7.84	6.54	117.42	0.17	0.10
1997	5.06	17.67	1.55	5.90	6.54	118.54	0.17	0.08
1998	4.73	16.76	1.96	6.71	6.54	125.29	0.17	0.08
1999	5.85	20.00	3.93	12.33	6.54	121.17	0.17	0.07
2000	6.22	19.27	3.91	11.66	6.54	111.92	0.17	0.06
2001	6.28	18.87	3.87	10.57	6.54	111.81	0.17	0.06
2002	9.32	26.79	6.03	16.03	6.54	121.77	0.17	0.06
2003	9.29	26.92	5.91	15.31	6.54	121.61	0.17	0.06
2004	9.27	25.91	5.93	15.16	6.54	111.04	0.17	0.05
2005	9.33	26.07	5.88	15.81	6.54	118.39	0.17	0.05
2006	9.36	26.44	5.97	16.62	6.54	123.42	0.16	0.05

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 2007]. The fractions of manure managed in given AWMS for each type of animals, taken from [Walczak 2006], are presented in the table 6.7.

Table 6.7. Fractions of manure managed in given AWMS for each type of animals in 2006

Livestock	Type of AWSM		
	Liquid System	Solid Storage and Drylot	Pasture Range and Paddock
Dairy cattle	0.0680	0.8220	0.11
Non-dairy cattle	0.1540	0.7560	0.09
Sheep	---	0.5000	0.50
Goats	---	0.9000	0.10
Horses	---	0.9000	0.10
Swine	0.2863	0.7137	---
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, table 4–20] were used for emission calculation. Default values of N_2O emission factors for management systems from [IPCC 2000, table 4.12] were applied (tables 6.8 and 6.9).

Table 6.8. Emissions of nitrogen excreted in livestock manure in 2006 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	0.0680	13308.960
1.b. Non-dairy cattle	50.0	0.1540	19688.900
3 Sheep	16.0	--	0.000
4 Goats	25.0	--	0.000
6 Horses	25.0	--	0.000
8 Swine	20.0	0.2863	97273.288
9 Poultry	0.6	0.2000	15634.680

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	0.8220	160881.840
1.b. Non-dairy cattle	50.0	0.7560	96654.600
3 Sheep	16.0	0.5000	2540.800
4 Goats	25.0	0.9000	3954.578
6 Horses	25.0	0.9000	7222.500
8 Swine	20.0	0.7137	242486.712
9 Poultry	0.6	0.8000	62538.720

Table 6.9. Factors of N_2O–N emission for various manure management systems [IPCC 2000]

Animal Waste Management Systems	EF Emission Factor [kg N2O-N/ kg N]
Liquid systems	0.001
Solid storage and drylot	0.020

Methane emissions from enteric fermentation (436.6 Gg CH_4 in 2006) as well as methane and nitrous oxide emissions from manure management (178.0 Gg CH_4 and 19.7 Gg N_2O in 2006) are closely related to livestock population. So in 2006 CH_4 emissions were slightly higher than in 2005 and much lower than in 1988. There is a general trend of decreasing livestock population since late 1980-ties in Poland, stabilizing in 2000–2006.

6.2.4 *Agricultural Soils* (CRF 4.D)

Nitrous oxide emissions from agricultural soils dramatically decreased after 1989 and then stabilized up till now (figure 6.2). There are a few main driving forces influencing emissions variability during entire inventoried period: nitrogen fertilizers use, livestock population, area of N–fixing crops and cultivated histosols.

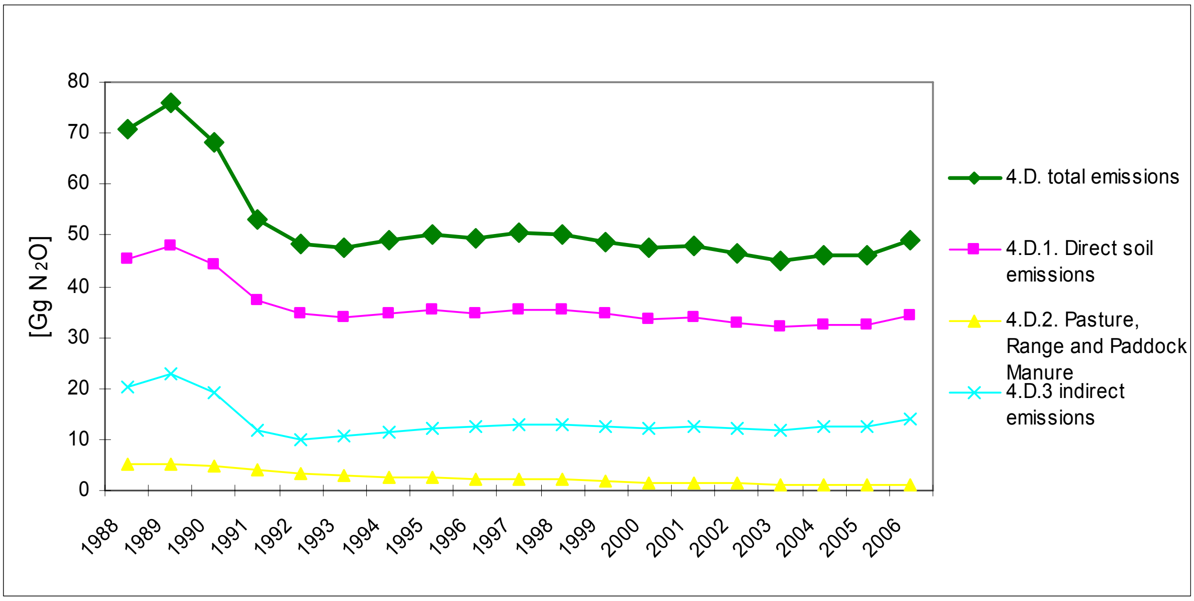


Figure 6.2. N_2O emissions from agricultural soils for 1988–2006

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 2007]. 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. Activity data concerning consumption of nitrogen fertilizers in terms of pure ingredient amounted for 996 Gg [GUS 2007].

Table 6.10. Nitrogen fertilizers use in 1988–2006 in Poland

	1988	1989	1990	1991	1992	1993	1994	1995	1996
Nitrogen fertilizers use [Gg]	1335	1520	1274	735	619	683	758	836	852
1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
890	891	862	861	895	862	832	895	895	996

Nitrous oxide emissions regarding synthetic fertilizers use in 2006 was about 12.5 Gg N_2O and comparing to 2005 emissions was higher because of increased use of nitrogen fertilizers by about 101 Gg. General trend in N_2O emissions follows nitrogen fertilizers use which decreases from 1335 Gg N in 1988 to 832 Gg N in 2003 and then slightly increases up to 996 Gg N in 2006 (table 6.10).

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 2007] 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 [Walczak 2003, 2006]. The fractions of manure managed in given AWMS for each type of animals are given in table 6.7.

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.

Nitrous oxide emissions from animal manure applied to soils in 2006 was about 9.8 Gg N_2O and was higher than in 2005 because of increase of cattle and swine population, but lower than in base year 1988. This is caused by general decreasing trend of livestock population, mainly cattle and sheep after 1989 (see table 6.1).

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 2007]. 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. Data on sown area of N-fixing crops are published in [GUS 2007].

Emission from N–fixing crops in 2006 was about 0.3 Gg N_2O and has stabilized for the last 5 years. But comparing to 1988 the sawn area of N–fixing crops has decreased sixfold following general trend of decreasing area of agricultural land in Poland as well as decreasing livestock population (significant part of papilionaceous plants are used as forage).

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 2007].

Emissions from crop residue in 2006 amounted for 2.7 Gg N_2O and have been at the same level since 2002. But general trend of emissions and area sawn since 1988 is decreasing.

6.2.4.1.5 *N_2O from cultivation of histosols* (CRF 4.D.1.5)

The area of cultivated histosols in Poland was estimated as a case study for the purposes if national inventory [Oświecimska–Piasko 2008]. Based on information collected from Computer database on Peatlands in Poland "TORF" as well as from system of Spatial Information on Wetlands in Poland the area of histosols was assessed for mid–1970s and mid–1990s. The area from which N_2O emissions were calculated covers histosols as agricultural lands cultivated and/or irrigated. So the area of such area was 882.6 thousand ha in mid–1970–ties and 769 thousand ha in mid–1990–ties. Estimation of cultivated histosols area for entire time series was made using an interpolation for the 1975–1995 and extrapolation after 1995. 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.

Nitrous oxide emissions from cultivated histosols in Poland in 2006 was about 8.9 Gg N_2O and is lower than in 2005 and in 1988 because of continuous progress of mineralization of organic matter as well as increasing area of histosols occupied by forest and scrub communities following cultivation termination of these areas.

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 2007]. Total amount of nitrogen in animal excreta was estimated based on the data presented in the table 6.11. 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 case study [Walczak 2006]. N_2O emission factor for pasture range and paddock was taken from [IPCC 1997].

Table 6.11. 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	0.11	21529.200	
1.b. Non-dairy cattle	50.0	0.09	11506.500	
3 Sheep	16.0	0.50	2540.800	
4 Goats	25.0	0.10	439.398	
6 Horses	25.0	0.10	802.500	
8 Swine	--	--	--	
9 Poultry	--	--	--	
		total	36818.398	0.020

Emissions in 2006 from pasture, range and paddock manure were 1.2 Gg N_2O and has stabilized since 2002, but this value is much lower than in 1988 what was caused by decreasing livestock population as well as decreasing percentage of livestock grazed.

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

The *Tier 1a* method was used for assessing indirect emissions of N_2O 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 6.12). 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 2007],
Nex – total amount of animal manure nitrogen excreted in AWMS system (table 6.7),
$Frac_{GASF}$ – 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 6.12. Estimation of indirect emissions of N_20–N from atmospheric deposition

N_{FERT} [Gg/year]	$Frac_{GASF}$ [kg N/kgN]	Nex [kgN/year/1000]	$Frac_{GASM}$ [kg N/kg N]	EF [kgN_2O-N/kg N]	$N_2O_{(G)} \rightarrow N$ [GgN_2O-N]
996	0.1	37 764.30	0.2	0.01	1.07

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 6.12). 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 2007],
Nex – total amount of animal manure nitrogen excreted in AWMS system (table 6.7),
$Frac_{LEACH}$ – 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.

Table 6.13. Estimation of indirect emissions of N_20–N from nitrogen leaching and run-off

N_{FERT} [Gg/year]	Nex [kgN/year /1000]	$Frac_{LEACH}$ [kg N/kg N]	EF [kgN_2O-N/kg N]	$N_2O_{(L)}$ [GgN_2O-N]
996	37 764.30	0.3	0.025	7.753

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

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

Indirect emission in 2006 was about 13.9 Gg N_2O and was higher than in 2005 and lower than in 1988. The main reason for this was change in nitrogen fertilizers use in particular years (see table 6.10).

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

CH_4 and N_2O emissions from burning of agricultural residues in fields in 2006 were estimated based on methodology described in [IPCC 1997]. For domestic purposes 43 crops were selected for which residues can potentially be burned [Łoboda *at al* 1994]. Within this group certain plants were excluded for which residues can be composted or used as forage. So finally there were selected 38 crops containing cereals, pulses, tuber and root, oil-bearing plants, vegetables and fruits which residues could be burned on fields. Activity data concerning crop production was taken from [GUS 2007]. 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 6.14.

Greenhouse gas emissions in 2006 from field burning of agricultural residues amounted for 1.10 Gg CH_4 and 0.04 Gg N_2O. These values are lower than in the base year 1988 and in 2005 what was caused by reduced crop production. Additionally since 1988 the area sawn systematically decreases, although in 2005–2006 it slightly increased. But drought that occurred in spring and summer months of 2006 in many regions of Poland triggered dramatic low yields of almost all crops. Only oil-bearing plants, vegetables under cover and some fruits (apples, cherries and plums) had higher production than in 2005.

Table 6.14. 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 [Gg/Gg]	N_2O [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

6.3 Uncertainties

Uncertainty analysis for this IPCC sector was prepared with use of *Tier 1* methodology defined in the IPCC Good Practice Guidance. Summary results of the analysis are presented in the table below, more detailed information for this and other sectors can be found in annex 5 of this report.

2006	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]
4. Agriculture		615.68	68.91		27.3%	65.8%		168.23	45.33
A. Enteric Fermentation		436.56	0.00		34.4%	0.0%		150.38	0.00
B. Manure Management		178.02	19.66		42.4%	148.2%		75.41	29.13
D. Agricultural Soils		0.00	49.21			70.6%			34.73
F. Field Burning of Agricultural Residues		1.10	0.04		23.4%	99.9%		0.26	0.04

6.4 Recalculations

- Data on milk production has been homogenized for entire series 1988–2006 based on national statistics (GUS). Earlier data for 1988–1989 came from the Institute of Animal Production. This change caused decrease in methane emission factor for dairy cattle as well as emissions of CH_4 from enteric fermentation in 1988-1989.
- Emissions of N_2O from cultivated histosols have been updated for entire time series based on new case study [Oświecimska–Piasko, 2008] where areas of histosols soils were estimated for the purpose of GHG inventory. This change resulted in decrease of N_2O emissions in entire inventoried period.
- N_2O emissions from the animal manure have been recalculated based on updated methodology [IPCC 2000, equation 4.23] for entire series. This revision resulted in increase in N_2O emissions by 1–4% in 1988-2006.

6.5 Planned improvements

- Due to change in non–dairy cattle livestock age characterization since 1998 there is a need for estimation of consistent series for entire trend.
- There is a need of elaboration of more specific AWMS division for subcategories for non–dairy cattle to apply fully the *Tier 2* methodology in estimating CH_4 emissions for this category of livestock.

7. Land use, land use change and forestry (CRF sector 5)

7.1 Key categories

Following categories from sector 5 have been identified as key sources:

- 5.A.1 Forest Land remaining Forest Land (CO2 emission), share in total GHG emission 10.8%
- 5.A.2 Land converted to Forest Land (CO2 emission), share in total GHG emission 0.7%
- 5.B.1 Cropland remaining Cropland (CO2 emission), share in total GHG emission 1.8%

Share of these categories in total Poland's GHG emissions is 13.3%.

7.2 Sector overview and methodological issues

The inventory for 2006 for land use, land use change and forestry sector were estimated according to new [IPCC 2003] methodology and results are presented in table 7.1.

Table 7.1. Total CO_2 emissions and removals from LULUCF sector in 2006

Greenhouse gas source and sink categories	2006		
	Net CO_2 emissions/ removals	CH_4	N_2O
	(Gg)		
5. Total Land-Use Categories	-42 882.45	113.08	0.009
5A. Forest Land	-54 266.11	0.141	0.002
1. Forest Land remaining Forest Land	-50 835.30	0.141	0.002
2. Land converted to Forest Land	-3 430.81	IE	IE
5B. Cropland	8 237.09	IE	IE
1. Cropland remaining Cropland	8 237.09	IE	IE
2. Land converted to Cropland	0.00	IE	IE
5C. Grassland	130.54	0.117	0.000
1. Grassland remaining Grassland	130.54	0.117	0.000
2. Land converted to Grassland	0.00	IE	IE
5D. Wetlands	3 090.49	112.83	0.006
1. Wetlands remaining Wetlands	3 090.49	112.83	0.006
2. Land converted to Wetlands	0.007	NO	NO
5E. Settlements	-74.45	NO	NO
1. Settlements remaining Settlements	-74.45	NO	NO
2. Land converted to Settlements	0.00	NO	NO
5F. Other Land	0.00	0.00	0.00
1. Other Land remaining Other Land	0.00	0.00	0.00
2. Land converted to Other Land	0.00	0.00	0.00
5G. Other(please specify)	NO	NO	NO
Harvested Wood Products	NO	NO	NO

IE – included elsewhere, NO – not occurring

The country area balance by geodesic status and directions of land use, consistent with IPCC 2003 guidelines, is presented below in table 7.2.

Table 7.2. Country area balance in 2006

Year	2006
Greenhouse gas source and sink categories	Area [ha]
5. Total Land-use categories	
5A. Forest Land	9 229 000.0
total organic soils area at forest area	238 380.0
total mineral soils area at forest area	8 990 620.0
5.A.1. Forest Land remaining Forest Land	8 847 000.0
organic soils	229 284.4
mineral soils	8 617 715.6
5.A. 2. Land converted to Forest Land	382 000.0
organic soils	9 095.6
mineral soils	372 904.4
5B. Cropland	12 741 000.0
5B1. Cropland remaining Cropland	12 741 000.0
drained organic soils	558 150.8
mineral soils	12 182 849.2
5.B.1A Other Cropland remaining Cropland (temporarily not in use)	0.0
5.B.2. Land converted to Cropland	0.0
5C. Grassland	3 216 000.0
5C1. Grassland remaining Grassland	3 216 000.0
drained organic soils	142 405.2
mineral soils	3 073 594.8
5.C.2. Land converted to Grassland	0.0
5D. Wetlands	873 200.0
5D1. Wetlands remaining Wetlands	872 200.0
Area of nutrient rich organic soils managed for peat extraction, including abandoned areas in which drainage is still present	1 028.1
Area of nutrient poor organic soils managed for peat extraction, including abandoned areas in which drainage is still present	171.9
Total flooded surface area, including flooded land, flooded lake and flooded river surface area	871 000.0
5.D.2. Land converted to Wetlands	1 000.0
Area of land converted annually to flooded land	1 000.0
Area of land converted annually to peat extraction	0.0
Area of nutrient poor organic soils converted to peat extraction	0.0
5E. Settlements	2 024 000.0
5E1. Settlements remaining Settlements	2 010 000.0
5E2. Land converted to Settlements	14 000.0
5F. Other Land	3 185 800.0
5G. Other(please specify)	NO
Harvested Wood Products	NO
Area balance	31 269 000.0

Generally Sector 5. Land Use, Land-Use Change and Forestry in 2006 was a net CO_2 sink. Detail results of inventory made according to subcategories are given below.

7.2.1. Forest Land (CRF 5.A)

GHG balance in this category is a net sink. In 2006 net CO_2 sink was about 54 266 Gg CO_2 .

Area of Forest lands in Poland in year 2006.

According to data on December 31, 2006 forest land in Poland equals 9,026,000 ha. This is equivalent to 28.9% of the forest cover [Raport 2006]. The forest cover varies among particular provinces and ranges from 248,500 ha in Opolskie Province to 799,200 ha in West

Pomerania (Zachodniopomorskie). The highest level of forest cover appears in Lubuskie Province (41.7%), the lowest – in Łódzkie Province (20.7%), The forest cover in Poland is presented in figure bellow:

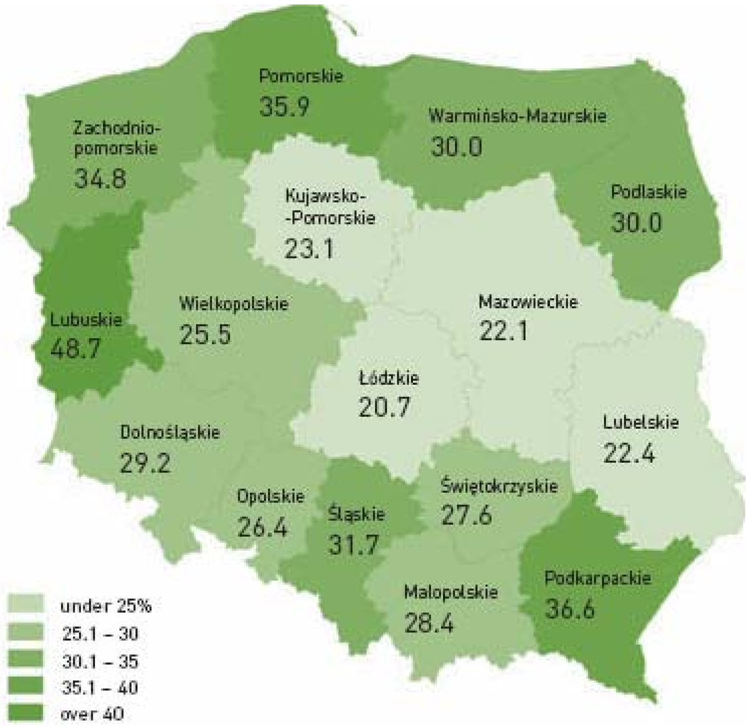


Figure 7.1. Forest cover by provinces
Source: Forests in Poland 2007. Centrum Informacyjne Lasów Państwowych. Lasy Państwowe.

In 2006, comparing with 2005, forest cover increased by 26,000 ha. Since 1990 forest cover in Poland has expanded to 332,000 ha. The forest cover in this period has increased over 1.1%. [Raport 2006].

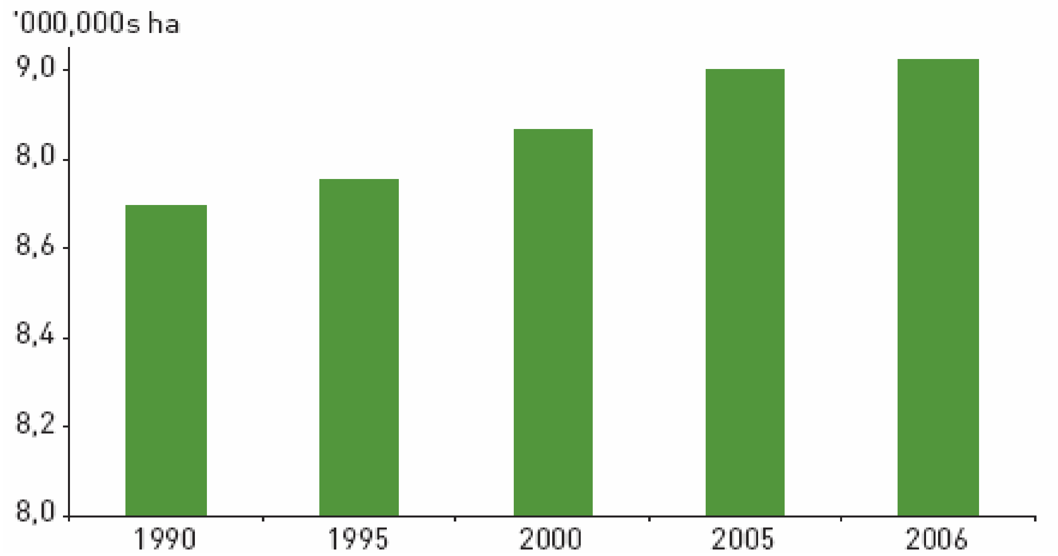


Figure 7.2. Forest area in Poland between 1990–2006
Source: Forests in Poland 2007. Centrum Informacyjne Lasów Państwowych. Lasy Państwowe.

Ownership structure

The structure of ownership in Poland is predominated by public owned forests – 82.2% of the area, including the forests under the State Forests NFH management – 78.2%. The area of the forests in private hands equals 17.8% of the total area.

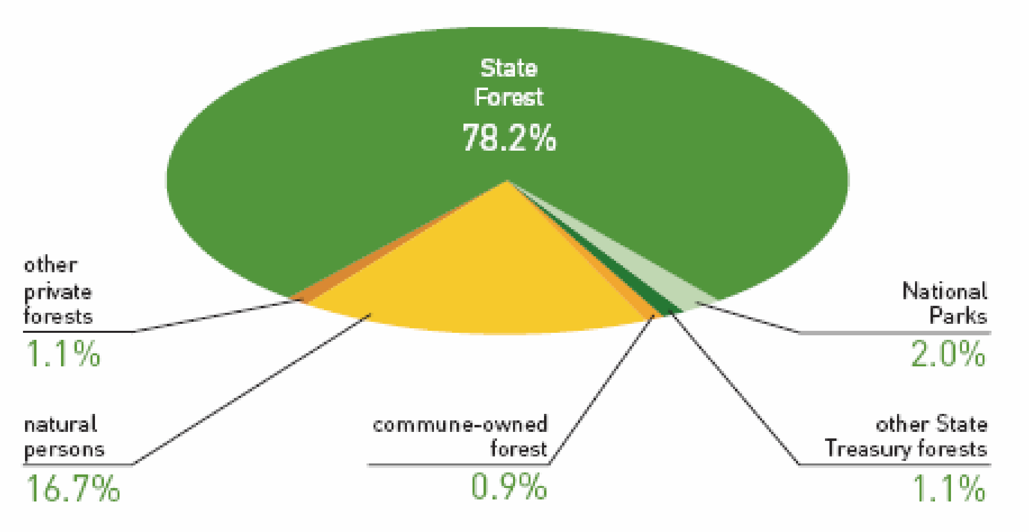


Figure 7.3. Structure of forest ownership in Poland
Source: Forests in Poland 2007. Centrum Informacyjne Lasów Państwowych. Lasy Państwowe.

In the whole post-war period the ownership structure remained almost unchanged. The year 1990 saw an increase by 0.8% of the forests in private hands and the share of public-owned forests has decreased by the same value. There has been a notable rise in the share of forests from the second group within the national parks area – from 1.3% in 1990 up to 2.0% in 2006. [Raport 2006].

Wood reserves

According to the last "Forest Area and Wood Reserves Revision", updated on January 1, 2006 by the Forest Management and Geodesy Bureau and the State Forests NFH, the wood reserves in forests managed by the State Forests NFH gained 1,629,300 m^3 of gross merchantable timber. On the other hand, Forest Management and Geodesy Bureau's data (status on January 1, 1999), concerning reserves in the private and commune-owned forests, note 188,600,000 m3 of gross merchantable timber. Last information regarding the whole country wood reserves (by Central Statistical Office) refers to 1997. The comparison of the resources managed by the State Forests NFH and of forests in other forms of ownership (experts' estimation updated on January 1, 2006) reveals that their total value was approximately 1,909,000 m3 of gross merchantable timber at that time.
Since 1967, when the first wood reserves' updating was carried out in the State Forests NFH, their constant increase has been noted. In years 1967–2006 they increased by 75%. [Raport 2006].

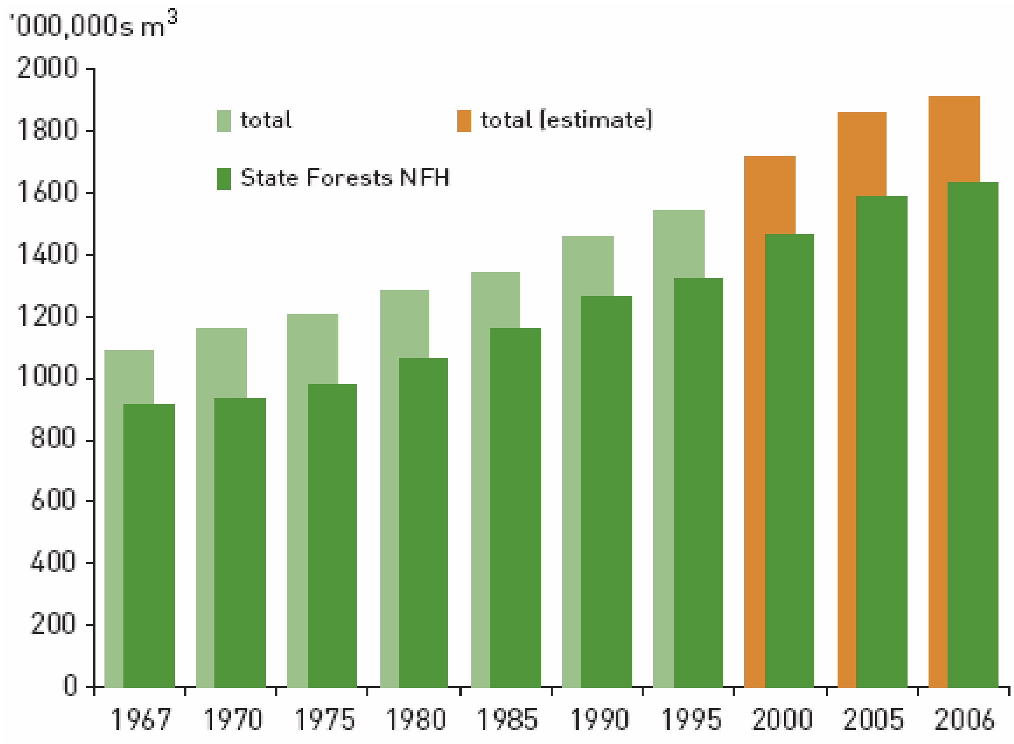


Figure 7.4. Wood resources in forests of Poland in 1967–2006, calculated in mln m3 of gross merchantable timber
Source: Forests in Poland 2007. Centrum Informacyjne Lasów Państwowych. Lasy Państwowe.

Species structure

Species structure in forests in Poland is presented bellow:

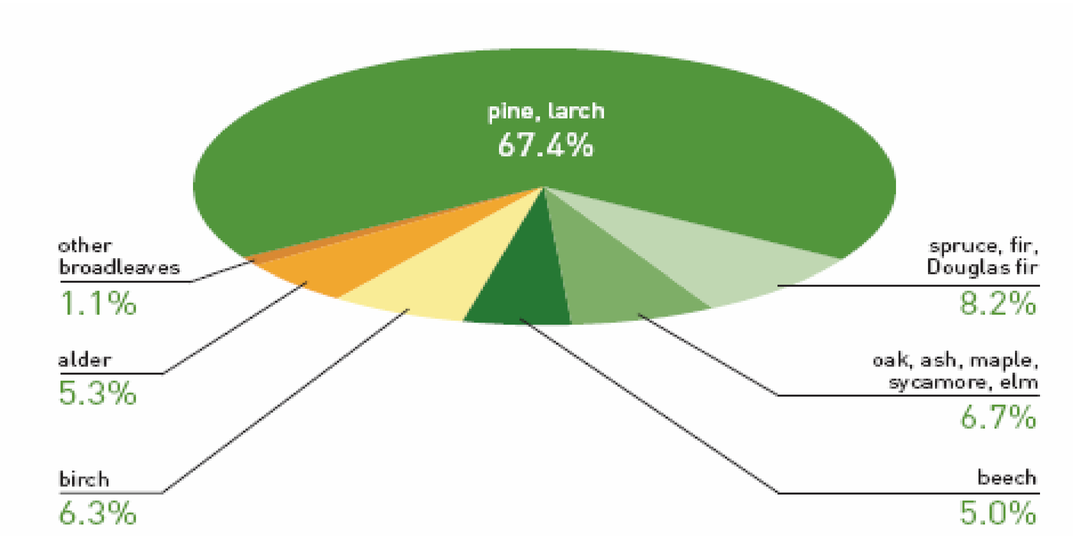


Figure 7.5. Total share of dominant species in the area of the State Forest NFH, National Parks, private and commune – owned stands
Source: Forests in Poland 2007. Centrum Informacyjne Lasów Państwowych. Lasy Państwowe.

In approximately 75.6% of the forest area in Poland coniferous species prevail. Pine (accounting for 67.4% along withlarch) finds the advantageous climatic and site conditions in Poland within its Euro-Asiatic natural range, thus being capable of developing a number of important ecotypes (e. g. The Taborska pine or Augustowska pine). Moreover, coniferous species have been favoured by the wood processing industry since the 19th century which added up to their considerable share in the species structure. [Raport 2006].

Age structure

Stands in age classes III and IV (41–80 years old) prevail in the area of the State Forests – 24 and 19%. In private and commune-owned forests (data on 1999) 60% of the area is overgrown by stands in the age of 21–60 (II and III class), of which almost 35% falls to II age class (21–40 years old). Stands older than 100 years, including stands in the restocking class (KO), stands in the class for restocking (KDO) and in the clearing structure (SP) account for 14% of the State Forests NFH area. The volume of these stands is roughly 2% in the private and commune-owned forests. Non-afforested area in the private and commune-owned forests equals approx. 5%, slightly over 1% – in the States Forests NFH.
In 1999 the average age of the stands in private forests reached 40 years in 1999, in the State Forests NFH – 57 years, but in 2006 – 60 years.

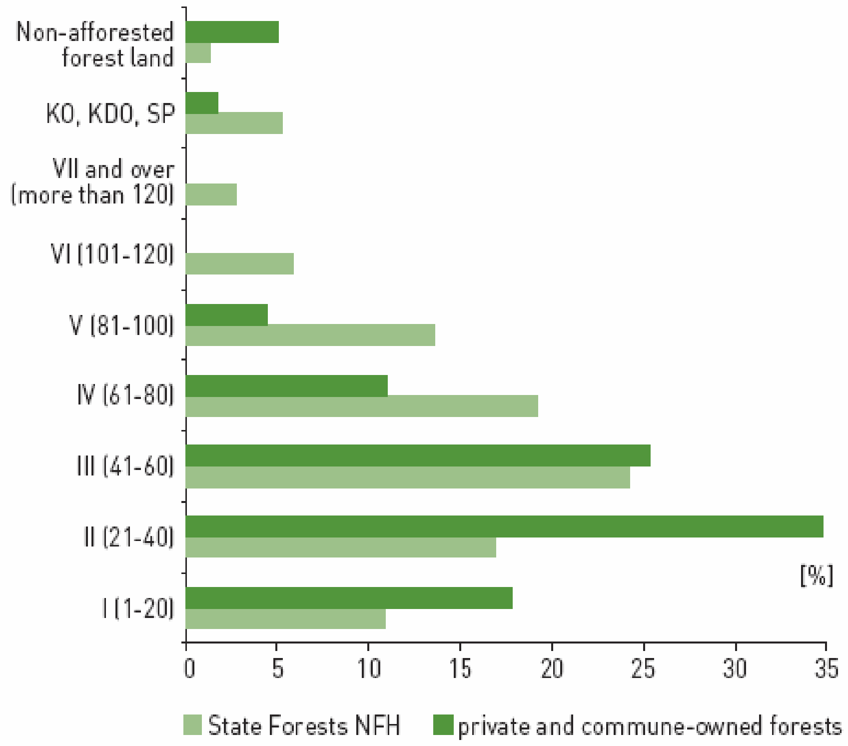


Figure 7.6. Area share of stands by age class in the States Forests NFH, private and commune forests
Source: Forests in Poland 2007. Centrum Informacyjne Lasów Państwowych. Lasy Państwowe.

Over 51% of the wood reserves in the State Forests NFH falls to the age stands being 41–80 years old (III and IV class). 2/3 of the reserves in the private and commune-owned forests are found in the II and III class stands (21–60 years old). The tree volume of the stands older than 100 years, along with the restocking class (KO), the class for restocking (KDO) and the clearing structure (SP) reaches 18% in the State Forests, whereas in private and commune-owned forests – 3%.

Structure of stand volume

According to the statistics on January 1, 2006, with regard to the forest area (except for land associated with forestry), the average stands volume in forests managed by the State Forests NFH was at the level of 231 m3/ha. In private and commune-owned forests – 119 m3/ha according to the data provided on January 1, 1999.
Since 1967, when the first inventory of timber reserves took place, a constant growth has been observed both in the State Forests and the private and commune-owned forests

Annual increment of the timber resources

The gross merchantable timber increment is estimated on the basis of the difference in volume by the end and beginning of the year, considering harvest in a given year. The values of the current net growth (increasing standing timber resources) and gross growth (after taking into account harvest and so-called loses in bucking) in the recent 20 years in the State Forests NFH are presented bellow:

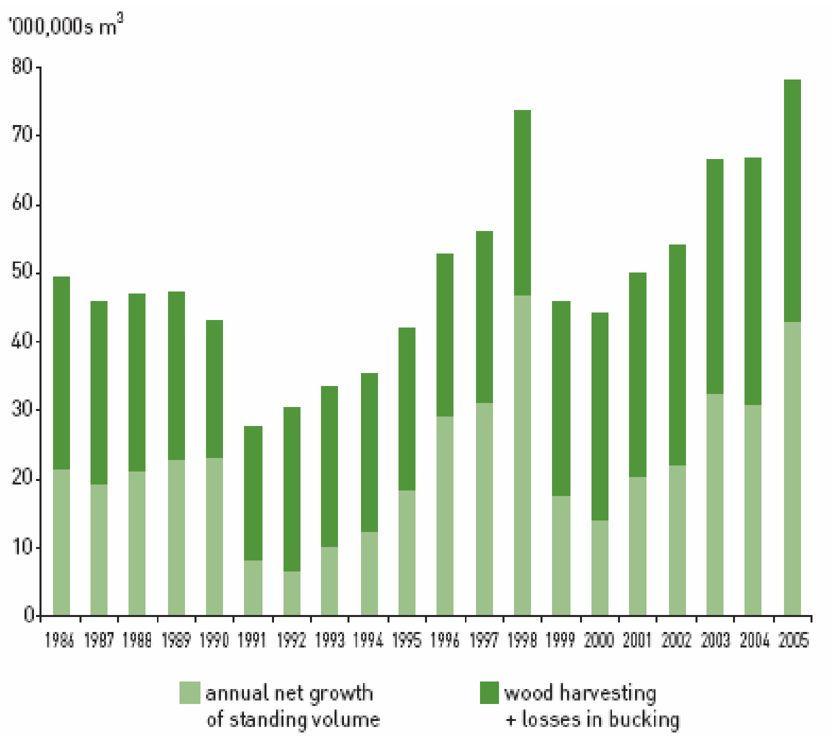


Figure 7.7. Current net growth of timber resources and the value of gross merchantable timber (plus the loses in production) in forests managed by the State Forests NFH in the period 1986–2005 calculated in mln m3 (Central Statistical Office, Forest Management and Geodesy Bureau).
Source: Forests in Poland 2007. Centrum Informacyjne Lasów Państwowych. Lasy Państwowe.

From January 1986 to January 2006 gross merchantable timber increment in the forests managed by the State Forests NFH amounted to about 989,000 m3. During this period 536,000 m3 of gross merchantable timber was harvested which means that 453,000 m3 of gross merchantable timber representing about 46% of total increment increased the standing volume.

The current annual increment in tree volume of gross merchantable timber is 7.2 m3/ha. It was estimated for the last 20 years (1986–2005) on the basis of the difference in volume by the end (January 2006) and beginning of the period (January 1986), including harvest and calculation per hectare of forestland administrated by the State Forests NFH. In turn, the average annual increment in gross merchantable timber calculated over the last five years amounts to 9.0 m3/ha. [Raport 2006].

Accompanying infrastructure

According to the Forest Act, forestlands also include lands related to the forestry, occupied by the buildings intended for the forestry use, drainage appliances, special division lines in forest, forest routes, areas situated under power lines, nurseries, timber – stocking spots, forest parking spaces and tourist appliances.
Soil area related to the forestry in Poland, according to the state on 31.12.2006, reached 203,000 ha, including 196,000 ha in the State Forests. According to the Central Statistical Office the soil area grew by 10,000 ha, including 6,000 ha in the State
Forests, in the last 10 years' time.

7.2.1.1. Forest Land remaining Forest Land (CRF 5.A.1)

GHG balance in this category is a net sink. In 2006 net CO_2 sink was about 50 830 Gg CO_2.

This subcategory includes entire land with woody vegetation consistent with tresholds used to define forest land in the national GHG inventory:

- minimum area: 0.1 hectare,
- minimum width of forest land area: 10 m
- minimum tree crown cover: 10% with trees having a potential to reach a minimum height of 2 metres at maturity in situ. Young stands and all plantations that have yet to reach a crown density of 10 percent or a tree height of 2 metres are included under forest. Areas normally forming part of the forest area that are temporarily un-stocked as a result of human intervention, such as harvesting or natural causes such as wind-throw, but which are expected to revert to forest are also included.

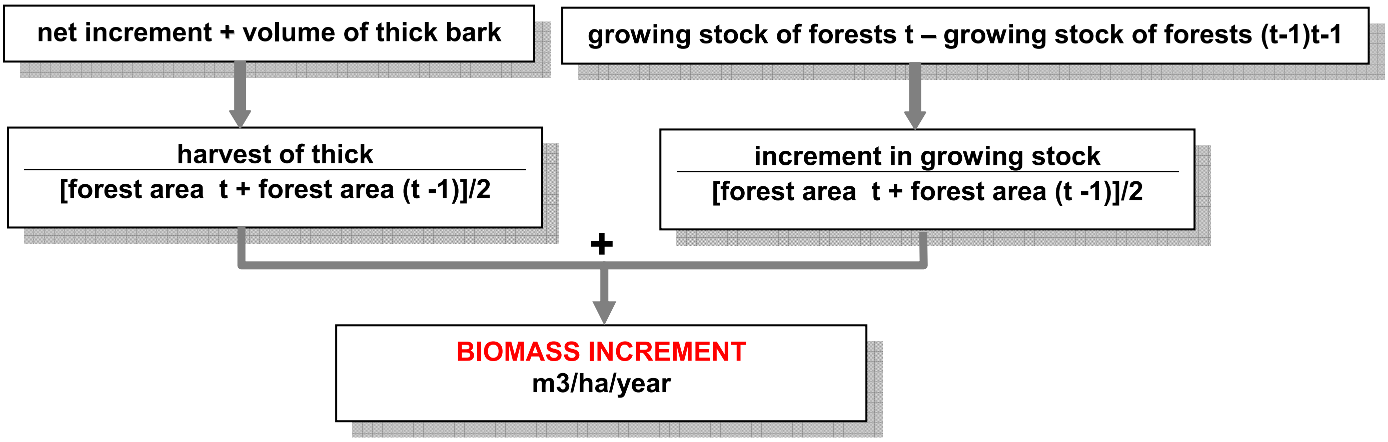
Increase in forest

Increase of woody biomass in forest of all owners forms was estimated based on data published in Statistical Year Book for Forestry [GUS 2006c]. 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" [BULiGL 2006 and 2007].

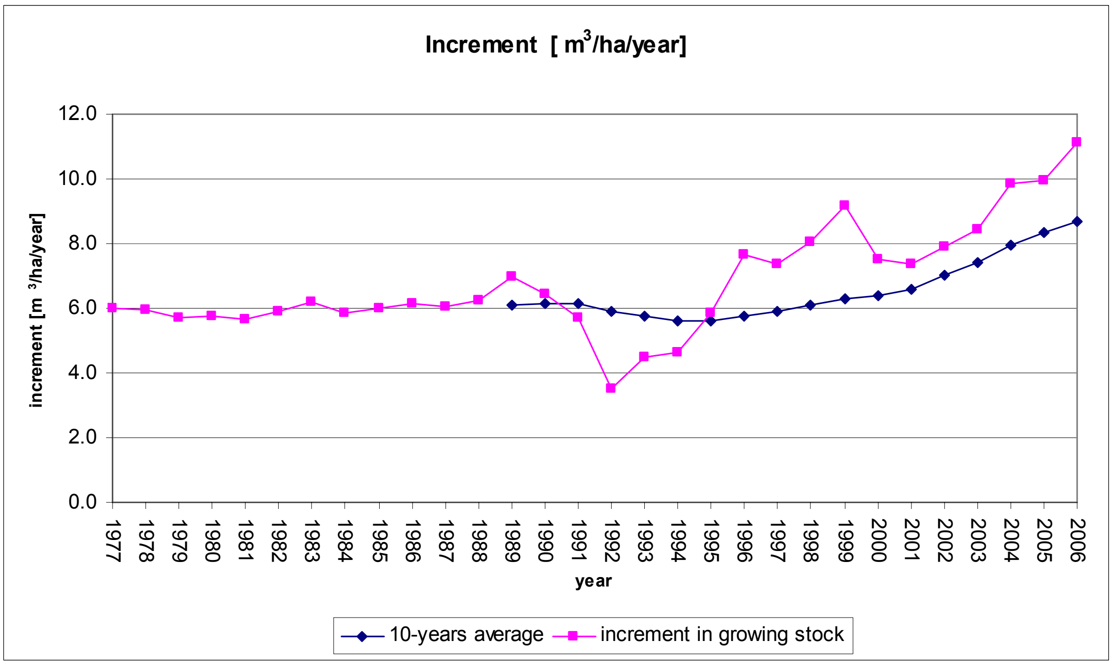
Data published in statistical yearbooks are of synthetic character – (apply to all types together or separately for conifers and broadleaves only).
Estimation of actual increase (m3/ha/year) for all forests is based on data of increment in growing stock and harvest of thick. Data of harvest of thick are given as net volume of thick wood (without bark). For calculation of harvest of thick it is necessary to add estimated volume of thick bark to net harvest of thick (assume that thick bark is about 25% of thick

wood without bark [Czuraj, 1991]). Share of roots in harvest of thick was also estimated. Default ratio from guidelines AFOLU [IPCC 2006] was used – 0.17 (page 4.49, table 4.4). Increase is determined by forest type, age class and quality of forest habitats.

Scheme for calculation of increase in biomass in forests is presented bellow:



Calculations of annual increment are based on forest area and growing stock of forests [GUS 2007]. Because of big differences between succeeding years, ten-year average of increment in growing stock were used for calculations. Forest management cycle in Poland is 10 years, and ten-years average better demonstrates long term trends in increment. The results are presented at the graph bellow:



Methodology for biomass annual increase calculations should be still improved, among others for better estimation of long and short term trends.

Basic wood density

Basic wood density was calculated based on weighted mean wood density by wood species (national ratio), and is presented in table below:

Table 7.3. Scheme for weighted mean wood density calculation, by wood species in Poland based on data from Forest Management and Geodesy Bureau (2007.01.01)

Species	Air-dry wood density [t/m3]	Volume of thick [thous. m3]	Share of each species in weighted mean wood density [t/m3]
	A	B	E=A*B/ΣBi
Pine	0.46	1150892.1	0.3253
Spruce	0.41	102908.1	0.0259
Fir	0.40	43518.8	0.0107
Beech	0.60	95033.0	0.0350
Oak	0.60	108746.4	0.0401
Hornbeam	0.67	4442.3	0.0018
Birch	0.56	69505.0	0.0239
Alder	0.46	63777.5	0.0180
Poplar	0.39	2002.2	0.0005
Aspen	0.39	3702.3	0.0009
Sum	-	1644527.7	-
Weighted mean wood density			0.482

Harvest of thick and growing stock were converted into mass of biomass separately, using expansion ratio for converting volumes of extracted roundwood BEF_2 (national factor – table 7.4.) and conversion of annual net increment (including bark) BEF_1 (default factor [IPCC 2003]).

Table 7.4. Scheme for calculation of expansion factors for harvest of thick BEF2 by data from Forest Management and Geodesy Bureau. (2007.01.01)

Species	Volume of thick in age classes V-VII*	Wood density	Dry matter	Dry matter with thin wood and underbrush destroyed during filling	Biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass (including bark) BEF_2
	[thous. m3]	[t/m3]	[thous. t]	[thous. t]	[t/m3]
Pine	349809.0	0.89	311330.01	438352.7	-
Spruce	41127.5	0.68	27966.7	39377.11	-
Fir	19681.5	0.75	14761.125	20783.66	-
Beech	45153.4	0.91	41089.594	57854.15	-
Oak	56939.1	0.96	54661.536	76963.44	-
Hornbeam	1153.6	0.86	992.096	1396.871	-
Birch	4708	0.83	3907.64	5501.957	-
Alder	13058.4	0.64	8357.376	11767.19	-
Poplar	44.8	0.56	25.088	35.3239	-
Aspen	970.7	0.44	427.108	601.3681	-
Sum	532646	-	-	652634	1.22

* Age class – conventional period, usually 20 years long, which allows grouping of forest stands by their age. First age class contains forest stands up to 20 years, Second age class contains forest stands in age between 21 – 40 years etc. To calculate the biomass expansion factor BEF_2 for converting volumes of extracted roundwood into total aboveground biomass (including bark), there were used the data only for trees from V, VI and VII age classes, because in Poland only wood from these classes
is logged

Methodology for calculation of expansion factors should be still improved, among others for better estimation of long and short term trends.

For calculations there were used default factors as below:

- fraction of elementary carbon in dry matter 0.5 [IPCC 2003],
- fraction of biomass left in forest to decay 0.1 [IPCC 2003].

Average belowground to aboveground biomass ratio is equal 0.307. It was calculated by use of volume of thick for conifers and broadleaves and multiplying it by adequate factors (conifers – 0.23, broadleaves – 0.32 [IPCC 2003]).

Dead organic matter

Assumed that carbon stock change in dead organic matter (dead wood and litter) is equal zero.

Forests soils

Mineral 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 7.6).

Table 7.5. Forest habitant types in Poland by IPCC soils types.

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

Table 7.6. Percentage share of soil types by land use system (for time t and t–20)

Soil types by IPCC	2006 (t)	1986 (t-20)
High Activity Soils	39.6	31.4
Low Activity Soils	19.0	19.8
Sandy	37.3	45.1
Wetland	4.2	3.7
Sum	100.0	100.0

Carbon stock rates in forest soils were taken as default factors from [IPCC 2003] and corrected to domestic conditions by experts (Table 7.7). For calculations there were used default factors as below:

- adjustment factor reflecting the effect of a change from the native forest to the forest type in state i, j 1.0 [IPCC 2003],

- adjustment factor reflecting the effect of management intensity or practices on forest in state i, j 1.0 [IPCC 2003],

- adjustment factor reflecting the effect of a change in the disturbance regime to state i, j with respect to the native forest 1.0 [IPCC 2003].

Table 7.7. Soil organic carbon content by land use system and soil types.

Land-use/ management system	Soil types by IPCC	Carbon in soils (Mg C/ha)	
		Default IPCC	Default IPCC
Forest management	High Activity Soils	50 lub 95	110.0
	Low Activity Soils	33 lub 85	70.0
	Sandy	34 lub 71	30.0
	Wetland	87	230.0

Organic soils

The area of cultivated histosols in Poland was estimated as a case study for the purposes if national inventory [Oświecimska–Piasko 2008]. Based on information collected from Computer database on Peatlands in Poland "TORF" as well as from system of Spatial Information on Wetlands in Poland the area of histosols was assessed for mid–1970s and mid–1990s. Estimation of cultivated histosols area for entire time series was made using an interpolation for the 1975–1995 and extrapolation after 1995.

Total organic soils area in 2006 was estimated for 238 380 ha, with the following split for subcategories: forest land remaining forest land – 229 285 ha, land converted to forest land – 90 956 ha.

Since 1970-ties area of histosols occupied by forest and scrub communities is increasing. In 1970-ties it was equal 170 800 ha, in 1990-ties – 214 400 ha. Also proportion of and scrub communities at organic soils is increasing, from 12% at the beginning of 1970-ties to 16,5 % in 1990-ties.

Emissions from organic soils at forest land was not estimated because in Poland only cultivated organic soils are drained.

<u>CH_4, N_2O, CO and NOx emissions from forest fires</u>

CH_4, N_2O, CO and NOx emissions from forest fires were calculated using following equation (IPCC 2003, page 3.49, equation 3.2.20):

$$L_{fire} = A*B*C*D*10^{-6}$$

where:
Lfire – quantity of GHG released due to fire, [tonnes of GHG] - (equation 3.2.20 page 3.49 IPCC 2003)
A – area burnt [ha],
B – mass of 'available' fuel [kg d.m./ha],

C – combustion efficiency – equal 0.03 [IPCC],
D – emission factor [g/hg d.m] – see table 7.8

Table 7.8. Emissions ratios for calculation CH4, N2O, CO and NOx emissions from forests fires.

Compound	Ratio [g/kg d.m]		
CH_4	7.1	default	[IPCC 2003]
CO	112.0	default	[IPCC 2003]
N_2O	0.11	default	[IPCC 2003]
NO_x	0.6	default	[IPCC 2003]

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

7.2.1.2. Land converted to Forest Land (CRF 5.A.2)

GHG balance in this category is a net sink. In 2006 net CO_2 sink was about 3 431 Gg CO_2. Calculations for this subcategory are analogical to calculations for subcategory 5.A.1.

CH_4, N_2O, CO and NOx emissions from forest fires were calculated in subcategory 5.A.1.

7.2.2. Cropland (CRF 5.B.)

This category includes arable and tillage land, and agro-forestry systems (orchards) where vegetation character is not consistent with the selected of national definitions for forest land category.
In 2005 this category was a net CO_2 emissions and accounted for about 8 117 Gg CO_2.

7.2.2. Cropland remaining Cropland (CRF 5.B.1.)

Living organic matter

Annual carbon stock change in living biomass was calculated based on cropland area covered by perennial woody biomass (orchards). Annual growth rate for perennial woody biomass was calculated as 0.18 [t C/ha*year].

GHG balance in this category is a net sink. In 2006 net CO_2 sink was about 200 Gg CO_2.

Agriculture soils

Mineral 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 7.9). Then percentage fraction of all soil types in croplands were calculated.

Table 7.9. Agricultural land by soil valuation classes in Poland.

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

Valuation classes of agricultural land describe the quality of land in terms of value to agricultural production. Class I corresponds to the highest agricultural value and class VI to the lowest.

Carbon stock rates in agriculture soils were taken as default factors from [IPCC 2003] and corrected to domestic conditions by experts (Table 7.10).

Table. 7.10. Soil organic carbon by land use system and soil types.

Land-use/ management system	Soil types by IPCC	Carbon in soils (Mg C/ha)	
		Default IPCC	Country specific factors
Agricultural crops	High Activity Soils	50 or 95	51.5
	Low Activity Soils	33 or 85	44.1
	Sandy	34 or 71	18.4
	Wetland	87	88.2

For calculations there were used default factors as below:

- stock change factor for land use or land-use change type in the beginning of inventory year - $F_{LU}(0\text{-}T) = 0.80$, [IPCC 2003 tab. 3.3.4. page 3.77],
- stock change factor for management regime in the beginning of inventory year - $F_{MG}(0\text{-}T)=1.00$ [IPCC 2003 tab. 3.3.4. page 3.77],
- Stock change factor for input of organic matter in the beginning of inventory year - $F_I(0\text{-}T)=1.1$ [IPCC 2003 tab. 3.3.4. page. 3.77],
- Stock change factor for land use or land-use change type in current inventory year - $F_{LU}(0)= 0.81$[IPCC 2003 tab. 3.3.4. page 3.77],
- Stock change factor for management regime in current inventory year -$F_{MG}(0)=1.05$, [IPCC 2003 tab. 3.3.4. page 3.77],
- Stock change factor for input of organic matter in current inventory year - $F_I(0) = 1.1$[IPCC 2003 tab. 3.3.4. page 3.77].

Organic soils

The area of cultivated histosols in Poland was estimated as a case study for the purposes if national inventory [Oświecimska–Piasko 2008]. Based on information collected from Computer database on Peatlands in Poland “TORF” as well as from system of Spatial Information on Wetlands in Poland the area of histosols was assessed for mid–1970–ties and mid–1990–ties. The area from which CO_2 and N_2O emissions were calculated covers agricultural lands cultivated and/or irrigated. So the area of such area was 882.6 thousand ha in mid–1970–ties and 769 thousand ha in mid–1990–ties. Estimation of cultivated histosols area for entire time series was made using an interpolation for the 1975–1995 and extrapolation after 1995. N_2O emission from cultivation of histosols was estimated based on default emission factor for Mid-Latitude Organic Soils from [IPCC 2000]: 8 kg N2O-N /ha. N_2O emission is reported in sector 4. Agriculture in subcategory 4.D.1.5.

To estimate CO_2 emission from cultivated organic soils were used default emission factor for cold temperate climate – 1.0 tC/ha*year [tab. 3.3.5 page 3.79 IPCC 2003] and equation 3.3.5 page 3.79 IPCC 2003.

Carbon emissions from agricultural lime application

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

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

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.

Annual CO_2 emission in 2006 from agricultural lime application was 560.6 Gg CO_2. Emission from lime application is decreasing. Emission from agricultural lime application is reported together with lime application in Grassland.

CH_4, N_2O, CO and NOx emissions from cropland fires are reported in subcategory 5.C.1.

7.2.2.2. Land converted to Cropland (CRF 5.B.2.)

Emissions/ removals from this subcategory was not estimated, because in Poland cropland area is decreasing. Only in years 2002 and 2004 area was increasing – converted from grassland.

7.2.3. Grassland (CRF 5.C1)

This category includes rangelands and pasture land that are not considered as croplands. In Poland there is no perennial woody biomass on area of grassland.

GHG balance in this category is a net sink. In 2006 net CO_2 sink was over 130.5 Gg CO_2.

7.2.3.1. Grassland remaining Grassland (CRF 5.C.1)

Living organic matter

Emissions/ removals from this subcategory was not estimated, because in Poland there is no perennial woody biomass.

Soils

Organic soils

The area of cultivated histosols in Poland was estimated as a case study for the purposes if national inventory [Oświecimska–Piasko 2008].

To estimate CO_2 emission from cultivated organic soils the default emission factor was used for cold temperate – 0.25 tC/ha*year [tab. 3.3.6 page 3.118 IPCC 2003] and equation 3.4.10 page 3.114 IPCC 2003.

Carbon emission from lime application

Carbon emission from grassland lime application is reported together with cropland lime application in subcategory 5.B.1.

CH_4, N_2O, CO and NOx emissions from fires

CH_4, N_2O, CO and NOx emissions from fires were calculated using following equation (IPCC 2003, page 3.49, equation 3.2.20):

$$L_{fire} = A*B*C*D*10^{-6}$$

where:
Lfire – quantity of GHG released due to fire, [tonnes of GHG] - (equation 3.2.20 page 3.49 IPCC 2003)
A – area burnt [ha],
B – mass of 'available' fuel 3.6 [kg d.m./ha],
C – combustion efficiency – equal 0.9 (90%) [IPCC 2003],
D – emission factor [g/hg d.m] – see table 7.9

In this subcategory non-CO_2 emission from crop area, meadows and stubbles fires is reported. In Poland there is no controlled burning of grasslands.

7.2.3.2. Land converted to Grassland (CRF 5.C.2)

Living organic matter.

Emissions/ removals from this subcategory was not estimated, because in Poland only croplands without perennial woody biomass are converted to grasslands.

Soils

Mineral soils

Carbon stock rates in grassland soils were taken as default factors from [IPCC 2003] and corrected to domestic conditions by experts (Table 7.11).

Table 7.11. Soil organic carbon by land use system and soil types..

Land-use/ management system	Soil types by IPCC	Carbon in soils (Mg C/ha)	
		Default IPCC	Country specific factors
Grassland/Rangeland	High Activity Soils	50 or 95	99.0
	Low Activity Soils	33 or 85	66.0
	Sandy	34 or 71	27.5
	Wetland	87	132.0

For calculations there were used default factors as below:

- stock change factor for land use or land-use change type in the beginning of inventory year $F_{LU(0-T)}$ = 0.82 [IPCC 2003 tab. 3.3.4. page 3.77],
- stock change factor for management regime in the beginning of inventory year $F_{MG(0-T)}$ = 1.00 [IPCC 2003 tab. 3.3.4. page 3.77],
- stock change factor for input of organic matter in the beginning of inventory year $F_{I(0-T)}$ = 1.2 [IPCC 2003 tab. 3.3.4. page 3.77].
- stock change factor for land use or land-use change type in the current of inventory year $F_{LU(0)}$ = 0.81 [IPCC 2003 tab. 3.3.4. page 3.77],
- stock change factor for management regime in the beginning of current year $F_{MG(0)}$ = 1.00 [IPCC 2003 tab. 3.3.4. page 3.77],
- stock change factor for input of organic matter in the beginning of current year $F_{I(0)}$ = 1.2 [IPCC 2003 tab. 3.3.4. page 3.77].

Organic solis

CO2 emission from cultivated organic soils converted to grassland is reported in subcategory 5.C.1.

CH_4, N_2O, CO and NOx emissions from fires

CH_4, N_2O, CO and NOx emissions from crop areas, meadows and stubbles fires are reported in subcategory 5.C.1.

7.2.4. Wetlands (CRF 5.D.)

This category includes land that is covered or saturated by water for all or part of the year and that does not fall into the forestland, cropland, grassland or settlements categories. It includes reservoirs as a managed subcategory and natural rivers and lakes as unmanaged subcategory.

7.2.4.1 Wetlands remaning wetlands (CRF 5.D.1.)

According to IPCC 2003 wetlands are divided into organic soils managed for peat extraction and flooded lands. Area of organic soils managed for peat extraction in 2006 was 1 200 ha and area of flooded land was 873 200 ha.

Area of organic soils managed for peat extraction was estimated based on literature data and is presented in table 7.12:

Table 7.12. Area of organic soils managed for peat extraction in Poland.

Year	1960[1]	1985[2]	1999[2]
Area of organic soils managed for peat extraction [ha]	78 341	4931	1200
in it:			
nutrient rich organic soils, in it:	67 120		
low peat deposit	67 120		
nutrient poor organic solis, in it:	11 220		
transition peat deposit	2 116		
high peat deposit	5 136		
mix-typical peat deposit	3 055		
other peat deposit	913		
data sources:			
[1] "Characteristic of peat deposit in Poland" IMUZ Falenty 1996			
[2]: „Peat lands and peat", Publication of Agricurtural Academy in Poznań, Ilnicki P., Poznań 2002.			

CO_2 and N_2O emissions are estimated from organic soils managed for peat extraction. This area was 78 341 ha in 1960-ties and 1 200 ha at the end of 1990-ties. Area of organic soils managed for peat extraction between years 1960-1999 was calculated using interpolation, and because of lack of data, for years 2000-2006 value from year 1999 was taken.

Emission calculations are based on equation 3.5.5, page 3.138 IPCC 2003.

For calculations there were used default emission factors for cold climate as below:

Symbol	Unit	Emission factor	Source
$EF_{peatNrich}$	[t C/ha*year]	1.1	table 3A.3.2. page 3.280 IPCC 2003
$EF_{peatNpoor}$	[t C/ha*year]]	0.2	

Symbol	Unit	Emission factor	Source
$EF_{peatNrich}$	[kgN2O/ha*year]	1.8	table 3A.3.4. page 3.284 IPCC 2003
$EF_{peatNpoor}$	[kgN2O/ha*year]	0.1	

Area of flooded lands was estimated based on statistical yearbook of Environmental Protection [GUS 2007d]. Area of flooded land include:
- land under internal marine waters,
- land under surface flowing waters, which covers land under waters flowing in rivers, mountain streams, channels, and other water courses, permanently or seasonally and their sources as well as land under lakes and artificial water reservoirs, from or to which the water course flow,
- land under surface lentic water, which covers land under water in lakes and reservoirs other than those described above,
- land under ponds including water reservoirs (excluding lakes and dam reservoirs for water level adjustment) including ditches and areas adjacent and related to ponds,
- land under ditches including open ditches acting as land improvement facilities for land used in agricultural production.

Emission calculations are based on equation 3.a.3.8, page 3. 287, IPCC 2003.
For calculations there were used default emission factors for cold climate as below:

Symbol	Unit	Emission factor	Source
$E(CO_2)diff$	[kg CO_2/ha*day]	9.3	table 3A.3.5. page 3.290 IPCC 2003
$E(CO_2)diff$	[Gg CO_2/ha*day]	0.0000093	

Emission calculations are based on equation 3.a.3.9, page 3. 287, IPCC 2003.
For calculations there were used default emission factors for cold climate as below:

Symbol	Unit	Emission factor	Source
$E(CH_4)diff$	[kg CH_4/ha*day]	0.2	table 3A.3.5. page 3.290 IPCC 2003
$E(CH_4)diff$	[Gg CH_4/ha*day]	0.0000002	
$E(CH_4)diff$	[kg CH_4/ha*day]	0.14	table 3A.3.5. page 3.290 IPCC 2003
$E(CH_4)diff$	[Gg CH_4/ha*day]	0.00000014	

CH_4 emission from flooded land was not estimated because there is no domestic emission factor for average daily diffusive emissions. Also in IPCC 2003 this factor is sign as „not measured" [IPCC 2003 page 3.290 tab. 3.A.3.5.]

7.2.4.1 Land converted to Wetlands (CRF 5.D.2.)
In 2006 annual carbon stock change in living biomass was estimated on 0.007 Gg CO_2.
Calculations are based on equation 3.5.6, page 3. 140, IPCC 2003.
For calculations were used default emission factors as below:

- carbon fraction of dry matter CF=0.5, [IPCC 2003, page 3.140]
- Living biomass in land immediately before conversion to flooded land B_{Before} =0.0036 t dm/ha [CENOWSKI factor used in EMEP inventory]
- Living biomass immediately following conversion to flooded land B_{After}=0 t dm/ha [IPCC 2003, page 3.140]

Emission from organic soils managed for peat extraction was not estimated because in Poland area of these lands is decreasing.

7.2.5. Settlements (CRF 5.E.)

This category includes all developed lands, including transportion infrastructure and human settlements refers to:

- residential areas include land not used for agricultural and forest production, put under dwelling buildings, devices functionally related to dwelling buildings (yards, drives, passages, playgrounds adjacent to houses), as well as gardens adjacent to houses.
- industrial areas include land put under buildings and devices serving the purpose of industrial production,
- other built-up areas include land put under buildings and devices related to administration, not listed under residential and industrial areas.
- undeveloped urbanised areas include land that is not built over, allocated in spatial management plans to building development and excluded from agricultural and forest production
- recreational and resting areas comprise the following types of land not put under buildings:
  - areas of recreational centres, children playgrounds, beaches, arranged parks, squares, lawns (outside street lanes);
  - areas of historical significance: ruins of castles, strongholds, etc.
  - sport grounds: stadiums, football fields, ski-jumping take-offs, toboggan-run, sports rifle-ranges, public baths etc.
  - area for entertainment purposes: amusement, grounds, funfairs etc.,
  - zoological and botanical gardens;
  - areas of non-arranged greenery, not listed under woodlands or land planted with trees or shrubbery
- transport areas including land put under:
  - roads: national roads; voivodeship roads; poviat roads; communal roads; roads within housing estates; access roads to agricultural land and woodlands and to facilities of public utility; stopping and manoeuvring yards next to railway stations, bus stations and airports, maritime and river ports and other ports, as well as universal accesses to unloading platforms and storage yards.
  - railway grounds,
  - other transport grounds

7.2.5.1. Settlements remaining Settlements (CRF 5.E.1.)

GHG balance in this category is a net sink. In 2006 net CO_2 sink was about 75 Gg CO_2.

Living organic matter

Calculations for carbon stock changes in living biomass were based on crown cower area method (urban green area - GUS 2007 Environmental Protection table 50(268), page 318).
Carbon stock changes in living biomass was calculated based on equation 3.a.4.1., page 3.295 [IPCC 2003,].
For calculations were used default crown cover area-based growth rate CRF=1.8t C/ha crown cover*yaer [IPCC 2003, page 3.297]

7.2.5.2. Land converted to Settlements (CRF 5.E.2.)

Emissions/ removals from this subcategory was not estimated. Forest lands in Poland are not converted to any other lands. Forest land after deforestation remain forest land, because in future these lands are reforested.

7.2.6. Other land (CRF 5.F)

Carbon pools would not need to be assessed for this category, but it is included for checking overall consistency of land area. this category includes bare soil, rock and all unmanaged land areas do not fall into any of the other categories.

Emissions/ removals from this subcategory was not estimated.

7.3 Uncertainties

Uncertainty analysis for this IPCC sector was prepared with use of *Tier 1* methodology defined in the IPCC Good Practice Guidance. Summary results of the analysis are presented in the table below, more detailed information for this and other sectors can be found in annex 5 of this report.

2006	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]
5. Land-Use Change and Forestry	-42,882.45	113.09	0.01	32.0%	99.8%	79.3%	-13,701.96	112.83	0.01
A. Forest Land	-54,266.11	0.14	0.00	25.0%	100.0%	100.0%	-13,566.53	0.14	0.00
B. Cropland	8,237.09			25.0%			2,059.27		
C. Grassland	130.54	0.12	0.00	25.0%	100.0%	100.0%	0.00	0.12	0.00
D. Wetlands	3,090.49	112.83	0.01	25.0%	100.0%	100.0%	772.62	112.83	0.01
E. Settlements	-74.45			25.0%			-18.61		
F. Other Land	0.00			50.0%			0.00		

7.4 Recalculations

According to recommendations of Experts Review Team all calculations within the GHG inventory for LULUCF for period 1990 -2004 were prepared using IPCC 2003 „Good Practice Guidance for Land Use, Land Use Change and Forestry". Previous GHG inventory for LULUCF for period 1988-2004 were prepared using [IPCC 1997].

Inventory results for period 1990 – 2006, based on IPCC 2003 methodology are presented in table 7.3.

The following changes were made in GHG inventory for sector 5. in comparison to inventory for year 2005:

- roots of trees biomass used in harvest of thick were estimated,
- growing stock in private forests was estimated using interpolation,
- CH_4 and N_2O emissions from crop area, meadows and stubbles fires were estimated
- emissions from area of organic soils were estimated – according to IPCC 2003,
- emissions from organic soils managed for peat extraction and flooded lands were estimated (5.D).

In calculations made for period 1990-2004 by IPCC 2003 methodology, taking into account above changes and for all years the same Biomass expansion factor was used for converting volumes of extracted roundwood to total aboveground biomass (including bark) – BEF2.

7.5 Planned improvements

- In Poland in 2005, in the forests of all the ownership categories, including the forests which are not the property of the State Treasury, throughout the country, a large area inventory of the national forests of all the ownership categories began – in a five-year cycle (the years 2005-2009).
- The aim of this study is to identify and then to monitor the forest status as well as the rate and trend of the change taking place in forests. The inventory results will be used for statistical purposes; in addition to the provision of data on Polish forests for national and international reporting purposes, they will also serve for the formulation, implementation and assessment of the National Forest Policy.
- It is planned to analyze and use large inventory results for emissions end removal estimations in sector 5 LULUCF including activities under article 3.3 and 3.4 of Kyoto Protocol.

Table 7.13. CO_2 emissions and removals from sector 5. Land use, land use change and forestry in period 1990-2006 [Gg CO_2]

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997
5. Total Land-Use Categories	-25 187.14	-31 420.48	-30 414.74	-23 874.37	-23 720.18	-22 926.37	-24 332.16	-25 887.30
5A. Forest Land	-38 791.64	-44 562.86	-43 237.07	-36 661.29	-36 359.15	-35 896.26	-36 626.05	-38 714.85
1. Forest Land remaining Forest Land	-35 948.13	-41 909.49	-40 286.70	-33 853.52	-33 343.17	-33 094.89	-33 791.34	-35 741.00
2. Land converted to Forest Land	-2 843.51	-2 653.38	-2 950.37	-2 807.77	-3 015.99	-2 801.37	-2 834.71	-2 973.86
5B. Cropland	10 773.06	10 232.29	9 938.90	9 874.12	9 745.79	10 012.18	9 787.52	9 852.87
1. Cropland remaining Cropland	10 773.06	10 232.29	9 938.90	9 874.12	9 745.79	10 012.18	9 787.52	9 852.87
2. Land converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C. Grassland	77.39	146.94	110.80	127.96	96.11	142.57	-318.97	140.38
1. Grassland remaining Grassland	148.03	146.94	145.85	144.75	143.66	142.57	141.47	140.38
2. Land converted to Grassland	-70.65	0.00	-35.04	-16.80	-47.54	0.00	-460.45	0.00
5D. Wetlands	2 813.28	2 822.39	2 831.85	2 844.07	2 856.30	2 863.08	2 875.37	2 887.33
1. Wetlands remaining Wetlands	2 813.28	2 822.38	2 831.84	2 844.06	2 856.30	2 863.07	2 875.35	2 887.33
2. Land converted to Wetlands	0.005	0.005	0.011	0.011	0.000	0.011	0.013	0.000
5E. Settlements	-59.23	-59.23	-59.23	-59.23	-59.23	-47.93	-50.02	-53.02
1. Settlements remaining Settlements	-59.23	-59.23	-59.23	-59.23	-59.23	-47.93	-50.02	-53.02
2. Land converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5F. Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Other Land remaining Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Land converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5G. Other(please specify)	NO	NO	NO	NO	NO	NO	NO	NO
Harvested Wood Products	NO	NO	NO	NO	NO	NO	NO	NO

NO – not occurring

Greenhouse gas source and sink categories	1998	1999	2000	2001	2002	2003	2004	2005	2006
5. Total Land-Use Categories	-25 817.57	-26 660.30	-26 497.32	-26 186.99	-32 058.32	-33 171.63	-36 429.57	-37 724.95	-42 876.14
5A. Forest Land	-38 511.09	-39 049.04	-38 723.04	-38 263.94	-44 108.17	-44 993.94	-47 666.55	-49 226.53	-54 266.11
1. Forest Land remaining Forest Land	-35 612.16	-35 922.86	-36 150.71	-35 490.28	-41 207.25	-42 055.60	-44 636.74	-45 994.65	-50 835.30
2. Land converted to Forest Land	-2 898.93	-3 126.18	-2 572.33	-2 773.66	-2 900.92	-2 938.34	-3 029.81	-3 231.88	-3 430.81
5B. Cropland	9 718.49	9 398.80	9 207.25	9 044.09	9 004.98	8 745.12	8 726.06	8 521.71	8 243.39
1. Cropland remaining Cropland	9 718.49	9 398.80	9 207.25	9 044.09	8 998.93	8 745.12	8 719.75	8 521.71	8 237.09
2. Land converted to Cropland	0.00	0.00	0.00	0.00	6.05	0.00	6.31	0.00	6.31
5C. Grassland	139.29	138.19	137.10	136.01	134.91	133.82	-453.60	-5.79	130.54
1. Grassland remaining Grassland	139.29	138.19	137.10	136.01	134.91	133.82	132.72	131.63	130.54
2. Land converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	-586.32	-137.42	0.00
5D. Wetlands	2 894.15	2 913.48	2 941.12	2 960.48	2 973.99	3 009.97	3 035.54	3 057.70	3 090.49
1. Wetlands remaining Wetlands	2 894.12	2 913.44	2 941.10	2 960.47	2 973.94	3 009.94	3 035.51	3 057.65	3 090.49
2. Land converted to Wetlands	0.024	0.038	0.022	0.011	0.053	0.033	0.026	0.046	0.007
5E. Settlements	-58.41	-61.73	-59.75	-63.63	-64.03	-66.60	-71.02	-72.04	-74.45
1. Settlements remaining Settlements	-58.41	-61.73	-59.75	-63.63	-64.03	-66.60	-71.02	-72.04	-74.45
2. Land converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5F. Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Other Land remaining Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Land converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5G. Other(please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Harvested Wood Products	NO	NO	NO	NO	NO	NO	NO	NO	NO

NO – not occurring

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 1.3%

Share of this category in total Poland's GHG emissions is 1.3%.

8.2 Methodological issues

The methane emissions from solid waste disposals in 2004 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 [IPCC 2006] (table 8.3)
- F – fraction of CH_4 by volume, in generated landfill gas (fraction) [IPCC 2006] (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
Sewage sludge	0.04-0.05	0.05	0.05
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	0.185
Garden	0.06–0.1	0.1	0.1
Paper	0.05–0.07	0.06	0.06
Wood and straw	0.02–0.04	0.03	0.03
Textiles	0.05–0.07	0.06	0.06
Sewage sludge	0.1–0.2	0.185	0.185
Delay time (months)		6	6
Fraction of methane (F) in developed gas		0.5	0.5
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 2007]
– 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]
1993	10644.66	[GUS 1996]
1994	11014.64	[GUS 1996]
1995	10985.00	[GUS 2005d]
1996	11621.22	[GUS 1997d]
1997	12183.44	[GUS 1998d]
1998	12275.77	[GUS 1999d]
1999	12316.90	[GUS 2000d]
2000	12226.00	[GUS 2005d]
2001	11109.00	[GUS 2005d]

2002	10508.70	[GUS 2005d]
2003	9925.00	[GUS 2005d]
2004	9759.00	[GUS 2005d]
2005	9354.30	[GUS 2006d]
2006	9473.00	[GUS 2007d]

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%. The percentage of waste going to SWDS for the years 1970-1976 was assumed as in 1977 – 96%. Distribution of solid waste disposal sites for managed and unmanaged ones was made in accordance to elaboration [Gworek 2003].

Composition of waste was made on the basis of publication [Rosik-Dulewska Cz. 2000] and on the basis of publication by [Rzeczyński B. 1996]. From the first publication composition of waste in 1985 was taken:

Food	30%
Garden	3%
Paper	14%
Wood	5%
Textile	2%
Plastics, other inert	46%

From the second publication, information on change in composition of metals and plastics during 20 years was taken (11.8% decrease from 1992 to 1972).
Composition from [Rosik-Dulewska Cz. 2000].

Based on those data and on data from [KPGO 2003] for 2001 interpolation for the other years was made (table 8.5).

Table 8.5. Composition of waste

Year	Food	Garden	Paper	Wood	Textile	Plastics, and other inert
1970	32%	5%	16%	6%	4%	39%
1971	32%	5%	16%	6%	4%	39%
1972	32%	5%	16%	6%	4%	39%
1973	31%	5%	15%	6%	3%	39%
1974	31%	4%	15%	6%	3%	40%
1975	31%	4%	15%	6%	3%	41%
1976	31%	4%	15%	6%	3%	41%
1977	31%	4%	15%	6%	3%	42%
1978	31%	4%	15%	6%	3%	42%
1979	31%	4%	15%	5%	3%	43%
1980	31%	4%	15%	5%	3%	43%
1981	30%	4%	14%	5%	2%	44%
1982	30%	4%	14%	5%	2%	44%
1983	30%	3%	14%	5%	2%	45%
1984	30%	3%	14%	5%	2%	45%
1985	30%	3%	14%	5%	2%	46%

Year	Food	Garden	Paper	Wood	Textile	Plastics, and other inert
1986	29%	3%	14%	5%	2%	47%
1987	29%	3%	14%	5%	2%	47%
1988	28%	3%	14%	4%	2%	48%
1989	27%	3%	15%	4%	2%	49%
1990	26%	3%	15%	4%	2%	49%
1991	26%	3%	15%	4%	2%	50%
1992	25%	3%	15%	4%	2%	51%
1993	24%	3%	15%	4%	2%	52%
1994	24%	3%	15%	4%	2%	52%
1995	23%	3%	15%	4%	2%	53%
1996	22%	3%	16%	4%	2%	54%
1997	21%	2%	16%	4%	2%	54%
1998	21%	2%	16%	3%	3%	55%
1999	20%	2%	16%	3%	3%	56%
2000	19%	2%	16%	3%	3%	56%
2001	18%	2%	16%	3%	3%	57%
2002	18%	2%	16%	3%	3%	57%
2003	18%	2%	16%	3%	3%	57%
2004	18%	2%	16%	3%	3%	57%
2005	18%	2%	16%	3%	3%	57%
2006	18%	2%	16%	3%	3%	57%

Recovery of methane was assumed on the basis of [GUS 2007e] for 2006 it was 23.7 Gg of methane.

8.2.1.2 Industrial Waste

Methodology is based on 2006 IPCC Guidelines [IPCC 2006]. Estimations were made using the IPCC Waste Model in MS Excel. Because the model originally doesn't calculate the emission from industrial waste for each type of waste (there is only possibility to put total amount of waste), so the emission from industrial waste was calculated in the same way as municipal waste (according to IPCC Guidelines it is correct). So the waste model was used two times – once to calculate municipal waste and second time to calculate industrial waste.

Activity data

According to IPCC Guidelines there is CH4 emission only from few types of industrial waste:

- paper and cardboard,
- textiles,
- food,
- wood,
- tobacco,
- rubber (only synthetic).

In national inventory activity data were taken from Central Statistical Office annuals – Environment Protection . Time series is 1975-2006. Before year 1975 there were no data on industrial waste.

Table 8.6. Composition of industrial wastes [Gg]

Gg	Food	Paper	Wood	Textile	Rubber	Plastics, other inert	Total	Source of activity data
1975	2 671.2	226.1	78.0	67.2	0.0	0.0	3 042.5	[GUS 1975d]
1976	3 390.7	173.6	79.5	51.5	0.0	0.0	3 695.3	[GUS 1976d]
1977	4 226.3	216.6	107.3	110.3	0.0	0.0	4 660.5	[GUS 1977d]
1978	4 841.5	163.1	87.2	201.0	0.0	0.0	5 292.8	[GUS 1978d]
1979	4 551.0	164.9	94.9	87.6	0.0	0.0	4 898.4	[GUS 1979d]
1980	3 727.0	198.4	88.1	93.2	0.0	0.0	4 106.7	[GUS 1981d]
1981	4 337.8	161.4	47.9	79.2	0.0	0.0	4 626.3	[GUS 1982d]
1982	3 741.9	273.5	47.7	82.4	0.0	0.0	4 145.5	[GUS 1983d]
1983	3 519.6	380.0	60.7	66.4	0.0	0.0	4 026.7	[GUS 1984d]
1984	3 373.1	319.2	50.7	78.8	0.0	0.0	3 821.8	[GUS 1985d]
1985	3 483.9	295.9	61.5	81.5	0.0	0.0	3 922.8	[GUS 1986d]
1986	1 273.3	347.2	102.2	144.9	0.0	0.0	1 867.6	[GUS 1987d]
1987	1 258.9	381.4	123.6	87.5	0.0	0.0	1 851.4	[GUS 1988d]
1988	1 498.3	409.2	106.0	137.8	0.0	0.0	2 151.3	[GUS 1989d]
1989	1 235.3	492.9	108.5	70.2	0.0	0.0	1 906.9	[GUS 1990d]
1990	1 211.5	408.2	90.9	42.2	0.0	0.0	1 752.8	[GUS 1991d]
1991	1 385.1	407.0	65.6	40.1	0.0	0.0	1 897.8	[GUS 1992d]
1992	938.9	363.2	23.9	53.4	81.4	11.5	1 472.3	[GUS 1993d]
1993	1 058.9	339.0	17.6	34.0	36.1	13.1	1 498.7	[GUS 1994d]
1994	855.3	277.1	19.1	21.6	21.2	10.4	1 204.7	[GUS 1995d]
1995	705.3	240.3	35.2	25.9	19.2	17.5	1 043.4	[GUS 1996d]
1996	791.0	266.9	30.9	29.2	19.5	12.1	1 149.6	[GUS 1997d]
1997	624.3	258.2	23.0	24.7	17.5	13.3	961.0	[GUS 1998d]
1998	612.3	464.5	20.9	21.3	8.2	27.9	1 155.1	[GUS 1999d]
1999	467.5	729.1	24.5	12.5	5.2	30.1	1 268.9	[GUS 2000d]
2000	430.6	446.3	21.7	6.9	3.3	31.7	940.5	[GUS 2001d]
2001	330.9	363.0	13.5	2.8	2.8	23.4	736.4	[GUS 2002d]
2002	295.7	356.5	15.3	1.7	0.9	16.3	686.4	[GUS 2003d]
2003	275.6	275.2	13.6	1.2	0.6	18.2	584.4	[GUS 2004d]
2004	294.3	186.2	10.1	1.9	0.7	0.7	493.9	[GUS 2005d]
2005	314.4	144.5	7.6	4.5	0.7	0.6	472.3	[GUS 2006d]
2006	244,1	119,4	3,9	2,0	0,3	1,9	371,6	[GUS 2007d]

For years 1977 and 1978 in annual there were no data on amount of industrial waste from separate industries, but there were data on waste amount from resorts. But the data were aggregated – in textile resort there were data for textiles and leather products, in forests and wood resort there were data on wood and on pulp and paper. Disaggregating of these data was made on the basis of adequate data from years 1976 and 1979. Also the percentages of food waste in a food resort were taken from 1976 and 1979.

The percentage of waste which goes to sewage sludge was taken from Environmental Protection annual for 1981 [GUS 1981d].

Food	Paper	Wood	Textile
98%	42%	1%	0%

On the basis of waste amount from each industry sector and the percent of waste which goes to sewage sludge the composition of waste was made.

Table 8.7. Composition of industrial wastes [%]

Year	Food	Paper	Wood	Textile	Rubber	Plastics, other inert
	%	%	%	%	%	%
1975	16%	40%	23%	20%	0%	0%
1976	23%	34%	26%	17%	0%	0%
1977	20%	29%	25%	26%	0%	0%
1978	20%	20%	18%	42%	0%	0%
1979	25%	26%	26%	24%	0%	0%
1980	20%	31%	24%	25%	0%	0%
1981	28%	30%	15%	26%	0%	0%
1982	21%	44%	13%	23%	0%	0%
1983	17%	53%	14%	16%	0%	0%
1984	18%	49%	13%	21%	0%	0%
1985	18%	45%	16%	21%	0%	0%
1986	5%	43%	21%	31%	0%	0%
1987	6%	48%	27%	19%	0%	0%
1988	6%	47%	21%	27%	0%	0%
1989	5%	59%	22%	14%	0%	0%
1990	6%	60%	23%	11%	0%	0%
1991	8%	64%	18%	11%	0%	0%
1992	5%	53%	6%	13%	20%	3%
1993	7%	62%	5%	11%	11%	4%
1994	7%	64%	8%	9%	8%	4%
1995	6%	56%	14%	10%	8%	7%
1996	6%	59%	12%	11%	7%	5%
1997	5%	62%	9%	10%	7%	6%
1998	3%	75%	6%	6%	2%	8%
1999	2%	84%	5%	2%	1%	6%
2000	3%	78%	6%	2%	1%	10%
2001	3%	81%	5%	1%	1%	9%
2002	2%	84%	6%	1%	0%	7%
2003	3%	80%	7%	1%	0%	9%
2004	5%	85%	8%	1%	1%	1%
2005	6%	81%	7%	4%	1%	1%

Emission factors

All of the input parameters are default based on 2006 IPCC Guidelines [IPCC 2006].

Table 8.8. DOC and DOC_f indicators

DOC (Degradable Organic Carbon)	Range	Default	Adopted Value
Food waste	0.08-0.20	0.15	0.15
Garden	0.36-0.45	0.4	0.4
Paper	0.39-0.46	0.43	0.43
Wood and straw	0.20-0.40	0.24	0.24
Textiles	0.39	0.39	0.39
Rubber	0.08-0.20	0.15	0.15
DOCf		0.5	0.5

Table 8.9. 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 8.10. Indicators k, F and OX assumed for calculations

Methane generation rate constant (k)	Range	Default	Value
Food waste	0.1–0.2	0.185	0.185
Garden	0.05–0.07	0.06	0.06
Paper	0.02–0.04	0.03	0.03
Wood and straw	0.20-0.40	0.24	0.24
Textiles	0.02–0.04	0.03	0.03
Rubber	0.1–0.2	0.185	0.185
Delay time (months)		6	6
Fraction of methane (F) in developed gas		0.5	0.5
Oxidation factor (OX)		0	0

8.2.2 *Waste Water Handling* (CRF 6.B)

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

Data on amount of industrial wastewater from separate branches and on biological treatment of organic wastewater were taken from national statistics [GUS 2007d]. Data on employment and production from some branches were taken from [GUS 2007].

Table 8.11. Amount of industrial wastewater in [million m^3]

		1988	1989	1990	1991	1992	1993	1994	1995	1996
Mining and quarying	[mln m3]	548.1	426.5	518.7	469.5	452.8	391.6	382	377.7	361.9
Iron and steel	[mln m3]	94.2	119.6	99.8	73.1	51.4	47	45.8	44.4	43
Non-iron metals	[mln m3]	48.7	86.1	39.7	67.8	66.2	59.7	127.9	133.6	142.2
Synthetic fertilizers	[mln m3]	123.2	118.3	92.5	58.4	53.5	48.5	51.3	41.5	48.5
Food products: Meat & Poultry	[mln m3]	3.3	3	2.7	3.2	5.4	4.6	3.9	4	4.2
Food products: Fish Processing	[mln m3]	1.6	1.5	1.3	1.2	1.1	0.9	0.8	0.3	0.4
Food products: Vegatables & Fruits	[mln m3]	14.2	12	10	8.5	7.4	8	7.4	8.3	7.8
Food products: Vegetable Oils	[mln m3]	3.7	2.5	1.5	1	0.5	2.1	1.2	1	3.6
Food products: Dairy Products	[mln m3]	19.5	20.6	19.7	17.7	16.2	15.3	14.2	13.2	12.5
Food products: Sugar	[mln m3]	23.7	21	20.4	13.9	10	11	7.9	7.7	6.5
Food products: Soft Drinks	[mln m3]	4.1	4.2	4.3	5	5.8	2.3	2.6	2.4	2.6
Food products: Beer & Malt	[mln m3]	4	4	4.3	4	4	3.6	2.7	2.1	1.7
Food products: Other	[mln m3]	2.7	5.72	3.7	2.6	0.6	1.5	1.6	1.5	0.9
Textiles	[mln m3]	14.2	13.86	11.1	8.2	9	7.8	7.3	6.4	5.7
Leathers	[mln m3]	6.3	5.666	4.7	4.2	3	2.6	1.7	1.6	1.3
Wood and Paper	[mln m3]	195.2	199.08	184.3	167.7	146	131.7	128.9	120.9	116.8
Petroleum Refineries	[mln m3]	43.2	43.384	38.7	40	36.6	33.6	32.6	33.2	28.1
Organic Chemicals	[mln m3]	125.6	224.1	107.3	120.4	107.8	97.7	101	98.6	94.3
Plastics & Resins	[mln m3]	17.4		17.6	15.8	15.7	15.1	14.6	12.6	6.7
Other non-metallic	[mln m3]	58.2	59.6	53.3	43.9	31	28	29.6	29.3	28.8
Manufacturing of Machinery and Transport Equipment	[mln m3]	53.6	54.6	50.3	42.1	32.6	30.7	29.5	27	25.9
Other	[mln m3]	90.9	91.316	95.2	89.8	79.8	82.7	103.5	94.5	115

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Mining and quarying	[mln m3]	340.4	336.2	362.3	349.6	331.6	293.4	271.6	261.2	266.9	272.4
Iron and steel	[mln m3]	43.9	25.3	13.2	14.2	14.8	13.3	9.6	8.2	6.5	7.4
Non-iron metals	[mln m3]	172.4	188.1	184.8	183.9	187.4	183.7	155.4	134.9	131.9	132.2
Synthetic fertilizers	[mln m3]	51.9	52.3	52.6	51.7	49.7	50.3	46	49.4	48.6	50.7
Food products: Meat & Poultry	[mln m3]	4.2	3.9	4	3.6	3.4	3.4	3.5	4.1	4.3	4.6
Food products: Fish Processing	[mln m3]	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0	0
Food products: Vegatables & Fruits	[mln m3]	7.7	9.4	7.5	7.5	7.2	6.4	7.8	6.8	6.6	7
Food products: Vegetable Oils	[mln m3]	4.8	2.5	3.2	2.4	0.7	0.3	0.2	0.3	0.3	0.4
Food products: Dairy Products	[mln m3]	12.2	12.3	11.4	11.3	11.7	11.3	11.5	13	13.5	13.8
Food products: Sugar	[mln m3]	5.7	6.1	4.9	4	2.9	2.7	2.7	2.2	1.8	1.4
Food products: Soft Drinks	[mln m3]	2.9	2.7	2.6	2.5	2.1	2.2	3.1	2	2.1	2.1
Food products: Beer & Malt	[mln m3]	1.7	1.6	1.4	1.3	1.3	1.4	1.2	1.2	1.3	1.7
Food products: Other	[mln m3]	1.1	2.5	0.5	0.8	0.7	0.7	0.8	3.3	2.8	2.3
Textiles	[mln m3]	5.2	4.7	3.1	2.6	2.1	1.7	1.6	1.5	1.6	1.3
Leathers	[mln m3]	1.1	0.7	0.7	1.1	1.2	0.9	0.8	0.6	0.7	0.6
Wood and Paper	[mln m3]	113.5	106.4	90.3	81.7	76.9	77.1	71.5	70.9	68.9	69.7
Petroleum Refineries	[mln m3]	25.1	24.3	20.3	17.8	18.1	16.8	17.4	19.6	19.3	20.7
Organic Chemicals	[mln m3]	81.5	63.1	55.9	47.7	42.4	42	38.3	36	38.4	38.6
Plastics & Resins	[mln m3]	9.2	10.3	8.4	7.8	4.7	2.7	2.5	2.5	2.4	2.2
Other non-metallic	[mln m3]	32.9	27.9	29.8	32.3	34.2	38	31.9	37.4	36.3	43.2
Manufacturing of Machinery and Transport Equipment	[mln m3]	26.5	25.1	22	12	10.4	9.1	8.1	6.8	7	4.4
Other	[mln m3]	110.4	160.8	116.7	120.9	129.5	125.5	120.2	128.8	128.2	128.2

Table 8.12. Emission factors on wastewater and sludge

	COD concentration in organic wastewater	Methane correction factor from wastewater	Maximum CH4 producing capacity form wastewater	Methane emission factor for wastewater	Methane correction factor from sludge	Maximum CH4 producing capacity form sludge	Methane emission factor for sludge
	kg/m3		kg CH4/ kg ChZT	kg CH4/ kg ChZT		kg CH4/ kg ChZT	kg CH4/ kg ChZT
Mining and quarying	0.60	0.10	0.25	0.030	0.32	0.25	0.080
Iron and steel	0.75	0.10	0.25	0.030	0.32	0.25	0.080
Non-iron metals	0.67	0.10	0.25	0.030	0.32	0.25	0.080
Synthetic fertilizers	0.82	0.10	0.25	0.030	0.32	0.25	0.080
Food products: Meat & Poultry	3.00	0.20	0.25	0.050	0.36	0.34	0.120
Food products: Fish Processing	2.50	0.15	0.25	0.040	0.68	0.34	0.231
Food products: Vegatables & Fruits	2.82	0.20	0.25	0.050	0.35	0.29	0.102
Food products: Vegetable Oils	0.79	0.34	0.25	0.090	0.65	0.34	0.221
Food products: Dairy Products	2.88	0.16	0.25	0.040	0.32	0.34	0.109
Food products: Sugar	2.51	0.52	0.25	0.130	0.38	0.34	0.129
Food products: Soft Drinks	1.49	0.10	0.25	0.030	0.2	0.34	0.068
Food products: Beer & Malt	3.81	0.10	0.25	0.030	0.20	0.34	0.068
Food products: Other	2.77	0.22	0.25	0.060	0.39	0.34	0.133
Textiles	0.90	0.12	0.25	0.030	0.24	0.25	0.060
Leathers	3.31	0.29	0.25	0.070	0.24	0.25	0.060
Wood and Paper	2.71	0.11	0.25	0.030	0.12	0.25	0.030
Petroleum Refineries	0.37	0.15	0.25	0.040	0.08	0.25	0.020
Organic Chemicals	3.00	0.15	0.25	0.040	0.08	0.25	0.020
Plastics & Resins	3.70	0.15	0.25	0.040	0.08	0.25	0.020
Other non-metallic	2.50	0.10	0.25	0.030	0.32	0.25	0.080
Manufacturing of Machinery and Transport Equipment	4.97	0.10	0.25	0.030	0.32	0.25	0.080
Other	0.77	0.10	0.25	0.030	0.32	0.25	0.080

Data on share of aerobic and anaerobic wastewater treatment method was taken from expert opinion [Przewłocki, 2007].
Methodology is consistent with Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Workbook [IPCC 1997] and publication [Przewłocki, 2007], and based on COD default emission factors. For some branches, were the COD EF was not available country specific data were used [Rueffer, 1998].

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 2007d] Activity datafor yera 1988-2006 are presented in table.. 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 2005] and its value was 0.953 (for this estimation the country specific value of BOD = 369 g O_2/m^3 was used). The emission factors calculated on the basis of the study mentioned above and applied in inventory report are:

- for wastewater: 0.030 kg CH_4 / kg BOD
- for sewage sludge: 0.488 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 2005]. These value are as follows: percentage of wastewater anareobically treated – 5%, fractions of sludge anareobically degraded – 81.3% of which with methane recovery – 83.5%.

Tabel 8.13. Activity data for domestic and commercial wastewater.

Year	Municipal waste discharged into collection system	% treated wastewater
	mln m3	%
1988	2478.1	52.75
1989	2443.5	54.79
1990	2313.9	60.11
1991	2166.1	62.91
1992	2075.3	64.08
1993	1981.4	64.68
1994	1999.2	63.81
1995	1852.4	67.89
1996	1751.8	71.04
1997	1691.9	75.32
1998	1655.5	79.21
1999	1589.9	81.31
2000	1494.0	83.23
2001	1425.3	86.12
2002	1353.1	88.01
2003	1323.7	87.56
2004	1293.6	89.07
2005	1273.6	89.51
2006	1265.2	91.33

N_2O emission from humane sewage was calculated according to default method [IPCC 1997]. Country population and value of protein consumption per capita per year were taken from [GUS 2007]. 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 for CO2 from incineration of municipal waste were taken from [Background Papers, IPCC]. The rest of emission factors as default were taken from [IPCC 2000]. Biogenic and non-biogenic content of waste for municipal waste was assumed on a basis of national case study [Wielgosiński 2003]. For industrial, medical waste and sewage sludge this content was taken from [IPCC 2000]. The activity data for all types of wastes were taken from [Wielgosiński G. 2008].

Table 8.14. Activity data in [Gg]

municipal waste incinerated	41.27
industrial waste incinerated	159.55
medical waste incinerated	22.11
sewage sludge incinerated	75.3

Table 8.15. Biogenic and non-biogenic content of waste

non-biogenic content of waste	
municipal waste incinerated	0.7
industrial waste incinerated	0.9
medical waste incinerated	0.4
biogenic content of waste (1-non-biogenic)	
municipal waste incinerated	0.3
industrial waste incinerated	0.1
medical waste incinerated	0.6
sewage sludge incinerated	1

Table 8.16. Emission factors

Incineration of municipal waste	
CO2 [Gg CO2/Gg of waste]	1
N2O [kg N2O / Gg]	8
Incineration of industrial waste (incl. hazardous waste)	
CO2 [Gg CO2/Gg of waste]	
C Content of Waste	0.5
Efficiency of Combustion	0.995
N2O [kg N2O / Gg]	210
Incineration of medical waste	
CO2 [Gg CO2/Gg of waste]	
C Content of Waste	0.6
Efficiency of Combustion	0.95
Incineration of sewage sludge	
CO2 [Gg CO2/Gg of waste]	
C Content of Waste	0.3
Efficiency of Combustion	0.95
N2O [kg N2O / Gg]	800

Waste combusted for energy purposes are included in Energy sector and treated as a fuel. Information on EFs used is included in NIR report under the Energy sector methodology description part (chapter 3.2.1.1).

8.3 Uncertainties

Uncertainty analysis for this IPCC sector was prepared with use of *Tier 1* methodology defined in the IPCC Good Practice Guidance. Summary results of the analysis are presented in the table below, more detailed information for this and other sectors can be found in annex 5 of this report.

2006	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]
6. Waste	309.32	349.51	2.44	0.51	0.89	0.50	157.72	311.04	1.22
A. Solid Waste Disposal on Land		300.24			1.03			308.08	
B. Wastewater Handling		49.27	2.34		0.87	0.52		42.80	1.22
C. Waste Incineration	309.32		0.09	0.51		0.23	157.72		0.02

8.4 Recalculations

Solid Waste Disposal Sites

- In municipal waste category two indicators were changed from country specific to default data. It is k – reaction constant and F – fraction of CH_4 by volume, in generated landfill gas. The reason for this is the lack of background for the former values.
- Also in municipal waste the composition of waste was diversified using two additional publications [Rosik-Dulewska Cz. 2000], [Rzeczyński B. 1996]. Former values were constant during whole time period and taken from only one publication National Plan on Waste Management [KPGO 2003].
- The percentage of municipal waste going to SWDS for the years 1970-1976 was changed to 96%, because there was no background to use the former value (which was 99%).
- The recovery of methane was added on the basis of [GUS 2007e].
- Emission from industrial waste was added.

Wastewater Handling

- Whole methodology for calculating industrial wastewater was recalculated for the whole time period.

Waste Incineration

- Activity data for all types of waste in 2005 were changed from statistical data to expert study [Wielgosiński 2008].

8.5 Planned improvements

- In Solid Waste Disposal Sites all emission factors are default. There is a need to conduct some research to determine country specific emission factors.
- In Domestic and Commercial Wastewater sub-sector the activity data (consumption of animal and vegetable proteins) set for calculating N2O from human sewage is inconsistent, because for period 1988-2003 data are taken from FAO database and from 2004 data are taken from national statistics. The reason for this is that FAO is rebuilding their database and data from 2004 are not available by now. There is a need to input data from FAO to inventory for years 2004-2006 as soon as it will be available.

Abbreviations

AWMS	Animal waste management system
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CRF	Common reporting format
DOC	Degradable organic component
GHG	Greenhouse Gases
IE	Included elsewhere
LULUCF	Land use, land-use change and forestry
MCF	Methane correction factor (Waste)
MCF	Methane Conversion Factor (Agriculture)
MSW	Municipal solid waste
NA	Not applicable
NE	Not estimated
NO	Not occurring
SWDS	Solid waste disposal site

References

Background Papers, IPCC Expert Meetings on Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories; http://www.ipcc-nggip.iges.or.jp/public/gp/gpg-bgp.htm

Bernacka (2005), Bernacka J., Pawłowska L. Elaboration and analysis of data regarding GHG emissions from municipal wastewater management. Institute of Environmental Protection, 2007 (in Polish).

BULiGL (2006). Results of updating forest area and woody biomass In State Forests At 1 January 2006. Office for Forest Planning and Management. Warszawa. 2006. (in Polish)

BULiGL (2007). Results of updating forest area and woody biomass In State Forests At 1 January 2007. Office for Forest Planning and Management. Warszawa. 2007. (in Polish)

CITEPA 1992. Default Emission Factors Handbook, CORINAIR INVENTORY, CITEPA, Paris, 1992.

Czuraj (1991). Tables of log volume of butt end and standing trees. PWRiL. Warszawa. 1991 (in Polish).

EUROSTAT, EUROSTAT database

FEWE (1994). Determination of GHG emission factors from fuel combustion in industrial technology processes. Foundation on Effective Energy Use – FEWE, 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. Kraków 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 (1974d), Environmental Protection 1974. Warsaw, 1974.

GUS (1975d), Environmental Protection 1975. Warsaw, 1975.

GUS (1976d), Environmental Protection 1976. Warsaw, 1976.

GUS (1977d), Environmental Protection 1977. Warsaw, 1977.

GUS (1978d), Environmental Protection 1978. Warsaw, 1978.

GUS (1979d), Environmental Protection 1979. Warsaw, 1979.

GUS (1981d), Environmental Protection 1981. Warsaw, 1981.

GUS (1982d), Environmental Protection 1982. Warsaw, 1982.

GUS (1983d), Environmental Protection 1983. Warsaw, 1983.

GUS (1984d), Environmental Protection 1984. Warsaw, 1984.

GUS (1985d), Environmental Protection 1985. Warsaw, 1985.

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

GUS (1987), Statistical Yearbook of The Republic of Poland 1987. GUS. Warsaw, 1987

GUS (1987d), Environmental Protection 1987. Warsaw, 1987.

GUS (1988d), Environmental Protection 1988. Warsaw, 1988.

GUS (1989-2006). Statistical Yearbook of The Republic of Poland 1988-2005. GUS, 1989-2006.

GUS (1989a-2007a). Energy Statistics from 1988-1989 up to 2006-2007, Central Statistical Office - GUS, 1989-2007.

GUS (1989b-2007b). Statistical Yearbook of Industry 1989-2007, Central Statistical Office – GUS, 1989-2007.B62

GUS (1989d), Environmental Protection 1989. Warsaw, 1989.

GUS (1990d), Environmental Protection 1990. Warsaw, 1990.

GUS (1991d), Environmental Protection 1991. Warsaw, 1991.

GUS (1992d), Environmental Protection 1992. Warsaw, 1992.

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

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

GUS (1995d), Environmental Protection 1995. Warsaw, 1995.

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

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

GUS (1997d), Environmental Protection 1997. Warsaw, 1997.

GUS (1998d), Environmental Protection 1998. Warsaw, 1998.

GUS (1999d), Environmental Protection 1999. Warsaw, 1999.

GUS (2000d), Environmental Protection 2000. Warsaw, 2000.

GUS (2001d), Environmental Protection 2001. Warsaw, 2001.

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

GUS (2003d), Environmental Protection 2003. Warsaw, 2003.

GUS (2004d), Environmental Protection 2004. Warsaw, 2004.

GUS (2005d), Environmental Protection 2005. Warsaw, 2005.

GUS (2006c). Forestry. Central Statistical Office - GUS, 2007.

GUS (2006d), Environmental Protection 2006. Warsaw, 2006.

GUS (2007), Statistical Yearbook of The Republic of Poland 2007. GUS. Warsaw, 2007

GUS (2007d), Environmental Protection 2007. Warsaw, 2007.

GUS (2007e), Questionnaire/Report G-03. Selected data from energy statistic system. GUS 2007.

GUS R (2007).2007 Statistical yearbook of agriculture and rural areas. GUS, Warszawa. 2007.

GUS R1 (2006). Livestock in 2006. GUS, Warszawa. 2006.

GUS R2 (2006). Land use, sawn area and livestock population in 2006. GUS, Warszawa, 2006.

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

HIPH (2007). CO_2 emissions from iron and steel making operations. HIPH 2007.

Holtzer (2007). Defining the CO_2 process emission from foundring processes for 1988–2005 based on carbon balance. Modern Casting nr 12 dla lat 1991 do 2001 i dla 1989.

IAR 2007. Independent assessment report of the national registry of Poland. Reg_IAR_PL_2007_1. 6/12/2007.

IETU (2006), Emissions of NMVOC and heavy metals for 2005. Institute for Ecology of Industrial Areas. Katowice, 2006

IMMB (2006). Cement sector in Poland. Allocation plan of CO2 allowances in frames of NAP for 20+B7208-20012. Instytut Mineralnych Materiałów Budowlanych, 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. Institute of Environmental Protection, 2001 (in Polish)

IOŚ (2007). National programme for Quality Assurance and uality Control of the Polish Greenhouse gas inventory. ver. 1.3. National Emission Centre. Institute of Environmental Protection. Warszawa, 2007.

IPCC (1995).Third Assesement Report. (IPCC 1995).

IPCC (1997), Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. IPCC 1997.

IPCC (2000), Good Practice Guidance and Uncertainty Management in National GHG Inventories. IPCC 2000.

IPCC (2003), Good Practice Guidance for Land Use, Land use Chcnge and Forestry. IPCC, 2003.

IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

IRR 2007. Report of the review of the initial report of Poland. FCCC/IRR/2007/POL. 14 December 2007.

ITS (2001). Preparation of database regarding to emissions of pollutants introduced to the atmosphere from transport in 2000 r. Warszawa 2001

ITS (2007). Estimation of emissions of selected pollutants introduced to the atmosphere from combustion engines in 2007. Instytut Transportu Samochodowego. Warszawa, 2007.

KASHUE (2008). Database of National Administration of Emission Trading Scheme containing information on instalations included into emission trading scheme and data from verified reports on annual CO2 emissions. Instytut Ochrony Środowiska. Warszawa, 2008.

Kozłowski (2001). Kozłowski K. Strategy of reduction of N_2O 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 (N_2O, HFCs, PFCs i SF_6) and sectors up to 2020. (in Polish) 2001.

KPGO (2003), 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

Krzysik (1975). Krzysik S. Wood science (In Polish). PWN Warszawa 1975.

Kwarciński (2005). Kwarciński et al. Estimation of actual methane emissions caused by coal production. Państwowy Instytut Geologiczny, Sosnowiec, 2005.

Łoboda (1994). Łoboda T., Pietkiewicz S. Estimation of amount of CH_4, CO, N_2O 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.

Modern Casting (1989; 1991 - 2007). Nr 12 for: 1989; 1991 - 2007

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.

Oświecimska–Piasko Z. (2008). Assessment of area of cultivated histosols in Poland for the purpose of GHG emissions monitoring in Poland. (in Polish) Falenty.

Przewłocki (2007), Methodology of estimation of methan emission in industrial wastewter treatment processes in Poland in 1988-2004, Wrocław, 2007.

Radwański (1995). Radwański E. National Study on sources and sinks of GHG. National Foundation of Environmental Protection, 1995 (in Polish).

Radwański E. 2006b. Estimation of carbon content in liming of agricultural and forest soils. Warszawa, 2006. (In Polish).

Radwański E.(2006a). Estimation of emissions of C–CO_2 according to Reference Approach. Warszawa, 2006. (In Polish).

Raport (2006). Forests in Poland 2006. Centrum Informacyjne Lasów Państwowych. Warszawa, październik 2007 r.

Rosik-Dulewska Cz. (2000), The basics of waste management, PWN, Warsaw 2000

Rueffer (1998), Rueffer H., Rosewinkel K.-H. Industrial wastewater treatment. Guidebook. Projprzem-EKO, 1998.

Rzeczyński B. (1996), Solid municipal wastes trademarks, Eko-problemy, No 1, 1996

Steczko (1994), Steczko K. et al., 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 K. (2003) Analysis of unaccounted quantities of natural gas and reasons for losses occurring in the gas distribution system of PGNIG. Stage II: Inventory of methane emission from Polish gas transmission system based on available reported data and emission factors”). Instytut Górnictwa Naftowego i Gazownictwa (Oil and Gas Institute), Kraków 2003

Szargut J. (1978). Heat engineeing in metallurgy. Wydawnictwo Śląsk, Katowice,1978 (in Polish)

Walczak (2003). Walczak J. Correction of N_2O 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 (praca niepublikowana). Instytut Zootechniki, Kraków, 2006.

Wielgosiński G. (2003), Estimation of data and update of methodology for pollutants emissions inventory from waste combustion. Łódź, 2003

Wielgosiński G. (2008), Information on waste incinerated in Poland in 2005 and 2006, Łódź, 2008

Żebrowski M. (1994), Emission inventory of GHG from crude oil system. Cracow, 1994

ANNEXES

Annex 1. Key categories in 2006

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 assessment. The methodology of reporting key categories is based on IPCC Good Practice Guidance (IPCC 2000), Tier 1. Poland's key category analysis guides the inventory preparation and is used to set priorities for the development of more advanced methodologies.

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 Gaseous Fuels.

Emission from these sources made up 72.0% 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 68.16% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 57.0% of the total GHG emissions.

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

Share of these sources in national total made up 72.00%.

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

Level Assessment without category 5

		IPCC Source Categories	Direct GHG	Emission in 2006	Level Assessment	Cumulative Total
1	1.A.1, 2, 4	Stationary combustion Solid Fuels	CO2	228 215.19	0.5699	0.57
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	36 225.73	0.0905	0.66
3	1.A.1, 2, 4	Stationary combustion Gaseous Fuels	CO2	23 883.13	0.0596	0.72
4	1.A.1, 2, 4	Stationary combustion Liquid Fuels	CO2	20 861.69	0.0521	0.77
5	4.D.1	4.D.1. Direct Soil Emissions	N2O	10 587.38	0.0264	0.80
6	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	9 193.40	0.0230	0.82
7	4.A	4.A. Enteric Fermentation	CH4	9 167.79	0.0229	0.84
8	6.A	6.A. Solid Waste Disposal on Land	CH4	6 305.08	0.0157	0.86
9	4.B	4.B. Manure Management	N2O	6 093.84	0.0152	0.88
10	2.A.1	2.A.1 Cement Production	CO2	5 983.74	0.0149	0.89
11	2.B.2	2.B.2. Nitric Acid Production	N2O	4 414.15	0.0110	0.90
12	4.D.3	4.D.3. Indirect Soil Emissions	N2O	4 298.92	0.0107	0.91
13	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4 298.12	0.0107	0.92
14	2.B.1.	2.B.1. Ammonia Production	CO2	4 230.42	0.0106	0.93
15	2.C1	2.C.1. Iron and Steel Production	CO2	4 095.65	0.0102	0.94
16	4.B	4.B. Manure Management	CH4	3 738.51	0.0093	0.95

Level Assessment with category 5

		IPCC Source Categories	Direct GHG	Emission in 2006	Absolut Value of Current Year Estimate	Level Assessment	Cumulative Total
1	1.A.1, 2, 4	Stationary combustion Solid Fuels	CO2	228 215.19	228 215.19	0.4870	0.49
2	5.A.1	5.A.1 Forest Land remaining Forest Land	CO2	-50 835.30	50 835.30	0.1085	0.60
3	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	36 225.73	36 225.73	0.0773	0.67
4	1.A.1, 2, 4	Stationary combustion Gaseous Fuels	CO2	23 883.13	23 883.13	0.0510	0.72
5	1.A.1, 2, 4	Stationary combustion Liquid Fuels	CO2	20 861.69	20 861.69	0.0445	0.77
6	4.D.1	4.D.1. Direct Soil Emissions	N2O	10 587.38	10 587.38	0.0226	0.79
7	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	9 193.40	9 193.40	0.0196	0.81
8	4.A	4.A. Enteric Fermentation	CH4	9 167.79	9 167.79	0.0196	0.83
9	5.B.1	5.B.1 Cropland remaining Cropland	CO2	8 237.09	8 237.09	0.0176	0.85
10	6.A	6.A. Solid Waste Disposal on Land	CH4	6 305.08	6 305.08	0.0135	0.86
11	4.B	4.B. Manure Management	N2O	6 093.84	6 093.84	0.0130	0.87
12	2.A.1	2.A.1 Cement Production	CO2	5 983.74	5 983.74	0.0128	0.89
13	2.B.2	2.B.2. Nitric Acid Production	N2O	4 414.15	4 414.15	0.0094	0.90
14	4.D.3	4.D.3. Indirect Soil Emissions	N2O	4 298.92	4 298.92	0.0092	0.91
15	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4 298.12	4 298.12	0.0092	0.91
16	2.B.1.	2.B.1. Ammonia Production	CO2	4 230.42	4 230.42	0.0090	0.92
17	2.C1	2.C.1. Iron and Steel Production	CO2	4 095.65	4 095.65	0.0087	0.93
18	4.B	4.B. Manure Management	CH4	3 738.51	3 738.51	0.0080	0.94
19	5.A.2	5.A.2 Land converted to Forest Land	CO2	-3 430.81	3 430.81	0.0073	0.95

Trend Assessment without category 5

		IPCC Source Categories	Direct GHG	Base Year Estimate	Emission in 2006	Level Assessment	Trend Assessment	Contribution to Trend [%]	Cumulative Total
1	1.A.1, 2, 4	Stationary combustion Solid Fuels	CO2	384 148.28	228 215.19	0.5699	0.1574	35.89211	0.36
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16 068.28	36 225.73	0.0905	0.0872	19.86741	0.56
3	1.A.1, 2, 4	Stationary combustion Gaseous Fuels	CO2	15 813.67	23 883.13	0.0596	0.0444	10.12679	0.66
4	1.A.1, 2, 4	Stationary combustion Liquid Fuels	CO2	18 580.41	20 861.69	0.0521	0.0269	6.13185	0.72
5	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18 455.82	9 193.40	0.0230	0.0138	3.14271	0.75
6	2.C1	2.C.1. Iron and Steel Production	CO2	10 888.61	4 095.65	0.0102	0.0128	2.91802	0.78
7	6.A	6.A. Solid Waste Disposal on Land	CH4	4 934.38	6 305.08	0.0157	0.0098	2.24103	0.80
8	1.A.3.c	1.A.3.c Transport Railways	CO2	3 853.56	460.01	0.0011	0.0080	1.82520	0.82
9	2.F.1	2.F.1. Refrigeration and Air Conditioning Equipment	HFC	10.52	2 195.75	0.0055	0.0077	1.75266	0.84
10	4.A	4.A. Enteric Fermentation	CH4	15 706.86	9 167.79	0.0229	0.0070	1.59838	0.85
11	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4 111.11	4 298.12	0.0107	0.0048	1.10224	0.87
12	4.B	4.B. Manure Management	CH4	3 419.72	3 738.51	0.0093	0.0046	1.04761	0.88
13	2.B.2	2.B.2. Nitric Acid Production	N2O	4 386.47	4 414.15	0.0110	0.0046	1.03843	0.89
14	1.A.1, 2, 4	Stationary combustion Solid Fuels	CH4	4 460.68	1 907.48	0.0048	0.0044	1.01149	0.90
15	2.G	2.G. Other	CO2	0.00	1 144.14	0.0029	0.0040	0.91637	0.91
16	2.B.1.	2.B.1. Ammonia Production	CO2	4 347.41	4 230.42	0.0106	0.0040	0.91351	0.92
17	2.A.1	2.A.1 Cement Production	CO2	7 028.18	5 983.74	0.0149	0.0035	0.79177	0.92
18	1.A.3.b	1.A.3.b Transport Road Transportation	N2O	153.15	1 083.23	0.0027	0.0034	0.78041	0.93
19	2.A.2	2.A.2. Lime Production	CO2	3 477.55	1 519.76	0.0038	0.0033	0.76238	0.94
20	4.D.2	4.D.2. Animal Production	N2O	1 575.89	367.93	0.0009	0.0026	0.60239	0.94
21	1.A.1, 2, 4	Stationary combustion Biomass	CH4	213.46	853.34	0.0021	0.0025	0.56195	0.95

Trend Assessment with category 5

		IPCC Source Categories	Direct GHG	Base Year Estimate	Absolut Value of Base Year Estimate	Emission in 2006	Absolut Value of Current Year Estimate	Level Assessment	Trend Assessment	Contribution to Trend [%]	Cumulative Total
1	1.A.1, 2, 4	Stationary combustion Solid Fuels	CO2	384 148.28	384 148.28	228 215.19	228 215.19	0.4870	0.1736	34.7211	0.35
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16 068.28	16 068.28	36 225.73	36 225.73	0.0773	0.0683	13.6549	0.48
3	5.A.1	5.A.1 Forest Land remaining Forest Land	CO2	-42 705.20	42 705.20	-50 835.30	50 835.30	0.1085	0.0528	10.5594	0.59
4	1.A.1, 2, 4	Stationary combustion Gaseous Fuels	CO2	15 813.67	15 813.67	23 883.13	23 883.13	0.0510	0.0339	6.7747	0.66
5	1.A.1, 2, 4	Stationary combustion Liquid Fuels	CO2	18 580.41	18 580.41	20 861.69	20 861.69	0.0445	0.0194	3.8830	0.70
6	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18 455.82	18 455.82	9 193.40	9 193.40	0.0196	0.0134	2.6709	0.72
7	2.C1	2.C.1. Iron and Steel Production	CO2	10 888.61	10 888.61	4 095.65	4 095.65	0.0087	0.0116	2.3279	0.75
8	5.A.2	5.A.2 Land converted to Forest Land	CO2	0.00	0.00	-3 430.81	3 430.81	0.0073	0.0097	1.9427	0.77
9	5.C.1	5.C.1 Grassland remaining Grassland	CO2	4 530.69	4 530.69	130.54	130.54	0.0003	0.0093	1.8597	0.78
10	5.D.1	5.D.1 Wetlands remaining Wetlands	CO2	0.00	0.00	3 090.49	3 090.49	0.0066	0.0087	1.7500	0.80
11	4.A	4.A. Enteric Fermentation	CH4	15 706.86	15 706.86	9 167.79	9 167.79	0.0196	0.0076	1.5122	0.82
12	6.A	6.A. Solid Waste Disposal on Land	CH4	4 934.38	4 934.38	6 305.08	6 305.08	0.0135	0.0073	1.4643	0.83
13	1.A.3.c	1.A.3.c Transport Railways	CO2	3 853.56	3 853.56	460.01	460.01	0.0010	0.0069	1.3841	0.85
14	5.D.2	5.D.2 Land converted to Wetlands	CH4	0.00	0.00	2 369.42	2 369.42	0.0051	0.0067	1.3417	0.86
15	2.F.1	2.F.1. Refrigeration and Air Conditioning Eq	HFC	10.52	10.52	2 195.75	2 195.75	0.0047	0.0062	1.2388	0.87
16	5.E.1	5.E.1 Settlements remaining Settlements	CO2	-2 925.46	2 925.46	-74.45	74.45	0.0002	0.0060	1.2064	0.88
17	5.B.1	5.B.1 Cropland remaining Cropland	CO2	8 165.26	8 165.26	8 237.09	8 237.09	0.0176	0.0059	1.1794	0.89
18	1.A.1, 2, 4	Stationary combustion Solid Fuels	CH4	4 460.68	4 460.68	1 907.48	1 907.48	0.0041	0.0041	0.8236	0.90
19	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4 111.11	4 111.11	4 298.12	4 298.12	0.0092	0.0034	0.6792	0.91
20	4.B	4.B. Manure Management	CH4	3 419.72	3 419.72	3 738.51	3 738.51	0.0080	0.0033	0.6574	0.92
21	2.G	2.G. Other	CO2	0.00	0.00	1 144.14	1 144.14	0.0024	0.0032	0.6479	0.92
22	2.B.2	2.B.2. Nitric Acid Production	N2O	4 386.47	4 386.47	4 414.15	4 414.15	0.0094	0.0031	0.6274	0.93
23	2.A.2	2.A.2. Lime Production	CO2	3 477.55	3 477.55	1 519.76	1 519.76	0.0032	0.0031	0.6236	0.94
24	1.A.3.b	1.A.3.b Transport Road Transportation	N2O	153.15	153.15	1 083.23	1 083.23	0.0023	0.0027	0.5480	0.94
25	2.B.1.	2.B.1. Ammonia Production	CO2	4 347.41	4 347.41	4 230.42	4 230.42	0.0090	0.0027	0.5401	0.95
26	4.B	4.B. Manure Management	N2O	9 335.10	9 335.10	6 093.84	6 093.84	0.0130	0.0027	0.5334	0.95

	IPCC Source Categories	Direct GHG	Level Assessement - L, Trend Assessment - T	
	ENERGY			
1.A.1, 2, 4	Stationary combustion Liquid Fuels	CO_2	L	T
1.A.1, 2, 4	Stationary combustion Solid Fuels	CO_2	L	T
1.A.1, 2, 4	Stationary combustion Gaseous Fuels	CO_2	L	T
1.A.1, 2, 4	Stationary combustion Liquid Fuels	CH_4		
1.A.1, 2, 4	Stationary combustion Solid Fuels	CH_4		T
1.A.1, 2, 4	Stationary combustion Gaseous Fuels	CH_4		
1.A.1, 2, 4	Stationary combustion Biomass	CH_4		
1.A.1, 2, 4	Stationary combustion Liquid Fuels	N_2O		
1.A.1, 2, 4	Stationary combustion Solid Fuels	N_2O		
1.A.1, 2, 4	Stationary combustion Gaseous Fuels	N_2O		
1.A.1, 2, 4	Stationary combustion Biomass	N_2O		
1.A.3.a	1.A.3.a Transport Civil Aviation	CO_2		
1.A.3.b	1.A.3.b Transport Road Transportation	CO_2	L	T
1.A.3.c	1.A.3.c Transport Railways	CO_2		T
1.A.3.d	1.A.3.d Transport Navigation	CO_2		
1.A.3.e	1.A.3.e Transport Other	CO_2		
1.A.3.a	1.A.3.a Transport Civil Aviation	CH_4		
1.A.3.b	1.A.3.b Transport Road Transportation	CH_4		
1.A.3.c	1.A.3.c Transport Railways	CH_4		
1.A.3.d	1.A.3.d Transport Navigation	CH_4		
1.A.3.e	1.A.3.e Transport Other	CH_4		
1.A.3.a	1.A.3.a Transport Civil Aviation	N_2O		
1.A.3.b	1.A.3.b Transport Road Transportation	N_2O		T
1.A.3.c	1.A.3.c Transport Railways	N_2O		
1.A.3.d	1.A.3.d Transport Navigation	N_2O		
1.A.3.e	1.A.3.e Transport Other	N_2O		
1.A.5.b	1.A.5.b Other Mobile	CO_2		
1.A.5.b	1.A.5.b Other Mobile	CH_4		
1.A.5.b	1.A.5.b Other Mobile	N_2O		
1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH_4	L	T
1.B.1.c.	1.B.1.c. Other	CO_2		
1.B.1.c.	1.B.1.c. Other	CH_4		
1.B.2.a.	1.B.2.a. Oil	CO_2		
1.B.2.a.	1.B.2.a. Oil	CH_4		
1.B.2.b.	1.B.2.b. Natural Gas	CO_2		
1.B.2.b.	1.B.2.b. Natural Gas	CH_4	L	T
	INDUSTRIAL PROCESSES			
2.A.1	2.A.1 Cement Production	CO_2	L	
2.A.2	2.A.2. Lime Production	CO_2		T
2.A.3	2.A.3. Limestone and Dolomite Use	CO_2		
2.A.4	2.A.4. Soda Ash (production)	CO_2		
2.A.7	2.A.7. Other (ETS Data; Bricks, Tiles And Ceramics Materials production)	CO_2		
2.B.1.	2.B.1. Ammonia Production	CO_2	L	T
2.B.1.	2.B.1. Ammonia Production	CH_4		
2.B.2	2.B.2. Nitric Acid Production	N_2O	L	T
2.B.3	2.B.3. Adipic Acid Production	N_2O		
2.B.4	2.B.4. Carbide Production (calcium carbide)	CO_2		
2.B.5	2.B.5. Other	CO_2		
2.B.5	2.B.5. Other	CH_4		
2.B.5	2.B.5. Other	N_2O		
2.C1	2.C.1. Iron and Steel Production	CO_2	L	T
2.C1	2.C.1. Iron and Steel Production	CH_4		
2.C2	2.C.2. Ferroalloys Production	CO_2		
2.C2	2.C.2. Ferroalloys Production	CH_4		
2.C3	2.C.3. Aluminium Production	CO_2		
2.C3	2.C.3. Aluminium Production	PFC		

	IPCC Source Categories	Direct GHG	Level Assessement - L, Trend Assessment - T	
2.C4	2.C.4. SF6 Used in Aluminium and Magnesium Foundries	SF_6		
2.C5	2.C.5. Other	CO_2		
2.D	2.D. Other Production	CO_2		
2.G	2.G. Other	CO_2		T
2.F.1	2.F.1. Refrigeration and Air Conditioning Equipment	HFC		T
2.F.2	2.F.2. Foam Blowing	HFC		
2.F.3	2.F.3. Fire Extinguishers	HFC		
2.F.3	2.F.3. Fire Extinguishers	PFC		
2.F.4	2.F.4. Aerosols/ Metered Dose Inhalers	HFC		
2.F.8	2.F.8. Electrical Equipment	SF_6		
	SOLVENT AND OTHER PRODUCT USE			
3.A	3.A. Paint Application	CO_2		
3.B	3.B. Degreasing and Dry Cleaning	CO_2		
3.C	3.C. Chemical Products, Manufacture and Processing	CO_2		
3.D	3.D. Other	CO_2		
3.D	3.D. Other	N_2O		
	AGRICULTURE			
4.A	4.A. Enteric Fermentation	CH_4	L	T
4.B	4.B. Manure Management	CH_4	L	T
4.B	4.B. Manure Management	N_2O	L	T
4.D.1	4.D.1. Direct Soil Emissions	N_2O	L	
4.D.2	4.D.2. Animal Production	N_2O		
4.D.3	4.D.3. Indirect Soil Emissions	N_2O	L	
4.F	4.F. Field Burning of Agricultural Residues	CH_4		
4.F	4.F. Field Burning of Agricultural Residues	N_2O		
	LAND USE CHANGE AND FORESTRY			
5.A.1	5.A.1 Forest Land remaining Forest Land	CO_2	L	T
5.A.1	5.A.1 Forest Land remaining Forest Land	CH_4		
5.A.1	5.A.1 Forest Land remaining Forest Land	N_2O		
5.A.2	5.A.2 Land converted to Forest Land	CO_2	L	T
5.B.1	5.B.1 Cropland remaining Cropland	CO_2	L	T
5.C.1	5.C.1 Grassland remaining Grassland	CO_2		T
5.C.1	5.C.1 Grassland remaining Grassland	CH_4		
5.C.1	5.C.1 Grassland remaining Grassland	N_2O		
5.D.1	5.D.1 Wetlands remaining Wetlands	CO_2		T
5.D.2	5.D.2 Land converted to Wetlands	CO_2		
5.D.2	5.D.2 Land converted to Wetlands	CH_4		T
5.D.2	5.D.2 Land converted to Wetlands	N_2O		
5.E.1	5.E.1 Settlements remaining Settlements	CO_2		T
5.E.2	5.E.2 Land converted to Settlements	CH_4		
5.E.2	5.E.2 Land converted to Settlements	N_2O		
	WASTE			
6.A	6.A. Solid Waste Disposal on Land	CH_4	L	T
6.B	6.B. Wastewater Handling	CH_4		
6.B	6.B. Wastewater Handling	N_2O		
6.C	6.C. Waste Incineration	CO_2		
6.C	6.C. Waste Incineration	N_2O		

Annex 2. 2006 Energy balance data for main fuels

Energy balances in 2006 for several main fuels: brown coal, natural gas, coke oven gas and blast furnace gas 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 - Eurostat	
	10^3 Mg	TJ
In	60 849	527 317
From national sources	60 844	527 274
1) Indigenous production	60 844	527 274
2) Transformation output or return	0	0
3) Stock decrease	0	0
Import	5	43
Out	60 849	527 317
National consumption	60 800	531 553
1) Transformation input	60 231	526 599
a) input for secondary fuel production	0	0
b) fuel combustion	60 231	526 599
2) Direct consumption	569	4 953
Non-energy use	0	0
Combusted directly	569	4 953
Combusted in Poland	60 800	531 553
Stock increase	49	425
Export	0	0
Losses and statistical differences	0	-4 660
Net calorific value	MJ/kg lub MJ/m3	8,74

Natural gas consumption

Evaluation of fuel consumption in national combustion processes	Natural gas - Eurostat
	TJ
In	536 625
From national sources	162 463
1) Indigenous production	162 463
2) Transformation output or return	0
3) Stock decrease	0
Import	374 162
Out	536 625
National consumption	511 732
1) Transformation input	53 313
a) input for secondary fuel production	505
b) fuel combustion	52 808
2) Direct consumption	458 419
Non-energy use	80 848
Combusted directly	377 571
Combusted in Poland	430 379
Stock increase	18 607
Export	1 570
Losses and statistical differences	4 716

Coke oven gas consumption

Evaluation of fuel consumption in national combustion processes	Coke oven gas - Eurostat
	TJ
In	71 712
From national sources	71 712
1) Indigenous production	0
2) Transformation output or return	71 712
3) Stock decrease	0
Import	0
Out	71 712
National consumption	69 576
1) Transformation input	18 322
a) input for secondary fuel production	0
b) fuel combustion	18 322
2) Direct consumption	51 254
Non-energy use	0
Combusted directly	51 254
Combusted in Poland	69 576
Stock increase	0
Export	0
Losses and statistical differences	2 136

Blast furnace gas consumption

Evaluation of fuel consumption in national combustion processes	Blast furnace gas - Eurostat
	TJ
In	28 948
From national sources	28 948
1) Indigenous production	0
2) Transformation output or return	28 948
3) Stock decrease	0
Import	0
Out	28 948
National consumption	28 903
1) Transformation input	8 323
a) input for secondary fuel production	0
b) fuel combustion	8 323
2) Direct consumption	20 580
Non-energy use	0
Combusted directly	20 580
Combusted in Poland	28 903
Stock increase	45
Export	0
Losses and statistical differences	0

Annex 3. National energy balance 2006 – EUROSTAT

Solid Fuels and Gases	Total all fuels	All fuels ex.biomass	Hard coal	Anthracite	Coking coal	Bitumenus coal	Subbitum. coal	Patent fuels	Coke	Total lignite	Lignite ancien	Lignite redent	Peat	Brown coal briquettes	Tar, benzol	Cokeoven gas	Blastfurn. gas	Gasworks gas	Derived Gas	Natural gas
.200600.87..										ktoe										
Primary production	**76 855**	**71 996**	**54 512**		**10 282**	**44 230**				**12 594**		**12 594**								**3 068**
Redovered products	1 711	1 711	471			452														
Imports	39 589	39 587	3 257		1 005	2 252			64	1		1		2						8 937
Stock change	330	332	1 369		411	991			368	10		10								406
Exports	19 874	19 805	11 095		2 553	8 542		3	4 235											38
Bunkers	292	292																		
Gross inland consumption	**98 317**	**93 528**	**48 514**		**9 145**	**39 383**		**3**	**3 802**	**12 585**		**12 585**		**2**						**12 373**
Transformation input	**76 193**	**75 639**	**37 675**		**9 105**	**27 518**			**734**	**12 578**		**12 578**				**438**	**199**		**636**	**1 273**
Classic thermal Power Stations	39 522	39 011	24 575			24 575				12 571		12 571				410	199		609	964
Public thermal power stations	37 232	36 911	23 128			23 128				12 552		12 552				225			225	860
Autoprod. thermal power stations	2 271	2 081	1 447			1 447										185	199		384	104
Nuclear power stations																				
Patent fuel and briquetting plants																				
Coke-oven plants	9 108	9 108	9 046		9 046				50											12
Blast-furnace plants	681	681							681											
Gas works	3	3																		
Refineries	22 397	22 397																		
District heating plants	4 483	4 440	4 055		59	2 943			4	7		7				27			27	297
Transformation output	**51 785**	**51 785**							**6 452**							**1 713**	**691**	**3**	**2 407**	
Classic thermal Power Stations	18 901	18 901																		
Public thermal power stations	17 158	17 158																		
Autoprod. thermal power stations	1 743	1 743																		
Nuclear power stations																				
Patent fuel and briquetting plants																				
Coke-oven plants	8 165	8 165							6 452							1 713			1 713	
Blast-furnace plants	691	691															691		691	
Gas works	3	3																3	3	
Refineries	21 151	21 151																		
District heating plants	2 874	2 874																		
Exchanges and transfers, returns	**26**	**26**																		
Interproduct transfers																				
Products transferred	0	0																		
Returns from petrochem. industry	26	26																		
Consumption of the energy branch	**7 859**	**7 858**	**338**		**104**	**255**				**5**		**5**				**871**	**27**	**0**	**898**	**1 227**
Production and distribution of electricity	1 442	1 442	70			70														
Pumping stations	36	36																		
Extraction and agglo. of solid fuels	885	885	185			185				5		5				3			3	9
Coke-oven and gas works plants	1 311	1 311	83		104	1										867		0	867	132
Oil and Nat. Gat extraction plants	175	175																		167
Oleducs and Gazeducs	360	360																		322
Oil refineries	2 256	2 256																		593
Nuclear fuel fabrication plants																				
Distribution losses	**1 369**	**1 369**														**51**			**51**	**113**
Available for final consumption	**64 655**	**60 421**	**10 500**		**63**	**11 610**		**3**	**1 916**	**2**		**2**		**2**		**353**	**466**	**2**	**822**	**9 761**
Final non-energy consumption	**4 886**	**4 886**	**12**			**12**			**44**											**1 931**
Chemical industry	3 146	3 146																		1 931
Other sectors	1 740	1 740	12			12			44											
Final energy consumption	**60 012**	**55 782**	**10 420**			**10 420**		**1**	**1 791**	**113**		**113**		**2**		**353**	**465**	**2**	**820**	**7 791**
Industry	17 252	16 214	3 062			3 062		1	1 614	2		2		1		353	465		818	2 940
Iron & steel industry	3 536	3 536	203			203			1 325							304	465		768	490
Non-ferrous metal industry	719	719	1			1			142											164
Chemical industry	3 883	3 883	661			661			34							13			13	216
Glass, pottery & building mat. industry	2 569	2 527	753			753			72					1		35			35	986
Ore-extraction industry	302	302	15			15			1											25
Food, drink & tobacco industry	1 864	1 857	737			737			20	2		2								445
Textile, leather & clothing industry	230	230	51			51			1											56
Paper and printing	1 471	746	277			277			1											71
Engineering & other metal industry	1 203	1 202	126			126			9							1			1	301
Other industries	1 491	1 228	238			238			9	0		0								185
Ajustment	16	17						1												
Transport	13 393	13 296																		
Railways	415	415																		
Road transport	12 545	12 448																		
Air transport	429	429																		
Inland navigation	3	3																		
Households, commerce, pub. auth., etc.	29 367	26 273	7 358			7 358			178	111		111		1				2	2	4 851
Households	19 175	16 679	5 653			5 653			77	52		52						2	2	3 312
Agriculture	4 284	3 807	1 005			1 005			33	59		59								36
Fisheries																				
Services	5 906	5 784	700			700			67									0	0	1 503
Other	2	2												1						
Statistical difference	**243**	**247**	**68**		**63**	**1 178**		**4**	**80**	**111**		**111**		**0**			**1**	**0**	**1**	**38**

Annex 4. Main elements of the QA/QC plan addressed to the Polish GHG inventories

Introduction

Effective development and use of QA/QC procedures required elaboration of plan which describes tasks and responsibilities of specialists engaged in the inventory preparation and check as well as timeframes for preparing and controlling entire inventory process. Below the selected basic elements of QA/QC plan are presented, which is implemented and co-ordinated by the National Emission Centre responsible for Polish GHG inventory preparation are presented. It follows the *IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories* (2000) recommendations.

General timeframes of annual inventory preparation (including checking procedures), approval and submission are presented in the table 1. The dates for particular stages are established based on country specific availability of statistical data as well as international obligations.

Table 1. Timetable for inventory preparation and check for the year n-2 (n – submission year)

Timing	Activity
May to October (year n–1)	Data and emission factors collection (estimation) Check for consistency data Initial calculations of emissions
November up to mid December (year –-1)	Final preparation and check of inventory results
Up to10 January (year n–2)	Approval of inventory by the Ministry of Environment
11-15 January (year n–2)	Submission of PL GHG inventory for the year n-2 and elements of NIR to the European Commission (required by dec. 280/2004//EC)
January-March (year n–2)	Additional checks and final corrections to the inventory, preparation of NIR and CRF tables
15 March (year n–2)	Submission of complete National Inventory Report to the European Commission (required by dec. 280/2004//EC)
15 March – 10 April (year n–2)	Official approval of NIR and CRF tables by the Ministry of Environment
10-15 April (year n–2)	Submission of PL GHG inventory for the year n-2 to the UNFCCC Secretariat (CRF and NIR) (required by dec. 18/CP.8)

Each IPCC sector undergoes detail QC procedure which is carried out firstly by performer for given category/subcategory and additional check is to be made by additional NEC expert. As a part of QA activity a list of specialists from different institutes, associations and individual experts is established for verification.

Depending on methodology used for emission estimation within categories Tier 1 or Tier 2 check procedures are carried out. The extended QC procedure for checking the correctness of emissions estimations is used for these categories where country specific emission factors are established. This concerns the key categories especially for such sectors like: fuel combustion (1.A), transport (1.A.3), cement production (2.A.1), enteric fermentation (4.A), manure management (4.B), agricultural soils (4.D) and others. In these cases checklist presented in table 5 is used. Where the Tier 1 methodology is used for emission calculation, the checklist for quality control indicated in table 4 is used. The scheme for QC check list made for specific categories is presented below in Table 3. The categorisation of IPCC inventory sectors for Tier 1 and Tier 2 quality control procedures is shown in table 2.

For some GHG sources that are key categories, where Tier 1 methodology is used for their estimations, are checked also using Tier 1 QC procedure. But suitable steps are undertaken to develop country specific inventory methods where recommended by guidelines to improve GHG emissions inventory in Poland.

Table 2. Categorisation of IPCC sectors for Quality Control Tier 1 and Tier 2 procedures

Categories checked following the Tier 1 procedure (according to table 4)	Categories checked following the Tier 2 procedure (according to table 5)
1.A.1,2,4,5.a stationary combustion (solid, liquid and gaseous fuels) (CH_4, N_2O) **1.A.3** transport (except 1.A.3.b) (CO_2, CH_4, N_2O) **1.A.3.b** road transport (CH_4, N_2O)	**1.A.1,2,4,5.a** stationary combustion (solid, liquid and gaseous fuels) (CO_2) **1.A.3.b** road transport (CO_2)
1.B.1.c other (except 1.B.1.a) **1.B.2** oil and natural gas (except of 1.B.2.b) (CO_2, CH_4)	**1.B.1.a** coal mining and handling (CH_4) **1.B.2.b** natural gas (CH_4)
2.A.4 soda ash prod. (CO_2) **2.B.4** carbide prod. (CO_2) **2.B.5** other (CO_2, CH_4, N_2O) **2.C** Metal production (except 2.C.1) (CO_2, CH_4) **2.E+2.F** production and consumption of halocarbons and SF_6	**2.A.1** cement production (CO_2) **2.A.2** lime production (CO_2). **2.B.1** ammonia production (CO_2) **2.B.2** nitric acid production (N_2O) **2.C.1** iron and steel production (CO_2)
3. Solvent and other product use	
4.B manure management (N_2O) **4.D.2** pasture, range and paddock manure (N_2O) **4.D.3** indirect soil emissions (N_2O) **4.F** field burning of agricultural residues (CH4, N_2O)	**4.A** enteric fermentation (CH_4) **4.B** manure management (CH_4) **4.D.1** direct soil emissions (N_2O)
5. LULUCF (except of 5.A) (CO_2, CH_4, N_2O)	**5.A** forest land (CO_2)
6.B wastewater handling (CH4, N_2O) **6.C** waste incineration (CO2, N_2O)	**6.A** solid waste disposal on land (CH_4)

General Quality Control procedures (Tier 1)

Source of activity data used for estimation of GHG emissions and removals come mostly from the Central Statistical Office (GUS) and Agency of Energy Market (ARE) undergoing internal revision and checking process of published data. If necessary specific data are collected from collaborating individual experts and research institutions.

Specific attention is made for the key categories but for all categories and gases, general procedures of Quality Control following Tier 1 method listed in Table 8.1 of the *IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories* are performed at different levels of detail elaborated specifically in the national QA/QC Programme [IOŚ 2007].

Source category–specific QC procedures Tier 2

Additionally to QC procedures conducted as part of Tier 1 for all IPCC categories an extended QC procedure is carried out (Tier 2 methods) for the key categories within such sectors like energy, industrial processes, agriculture and waste. Source category–specific QC procedures include expert personal reviews of activity and emission factor data, and methods especially extensively used for the energy sector responsible for majority of CO_2 emissions in Poland.

Specific case studies have been conducted in Poland for the last years (and are still updated if necessary) for different source categories to assess best estimates for national circumstances and a rational for the selected emission factors applied in the inventory. Then the emission factors and/or indicators used for country specific factors come from direct measurements and domestic literature based usually on experiments and statistics.

Specific information on source category–specific QC procedures is to be given in National Inventory Reports in Chapters characterising categories.

Quality Assurance procedures

As a first part of QA procedures external reviewers from R&D Institutes, Branch Associations, Industrial Chambers, individual plants as well as independent experts verify the inventory assumptions and results (table 2). The direct contact is initiated for exchanging comments and setting the proper data.

As an additional QA procedure the broader participation of academic circles in reviewing the overall inventory is planned. For the time being such review was conducted occasionally.

The post submission reviews and verifications made within the European Community members inventory checks as well as by the UNFCCC Secretariat are also treated as the part of QA procedures. Within the due time the full response to the comments made by inventory categories compilers is prepared, checked by the Head of Unit and within acceptance of Ministry of Environment is sent back.

The final approval of Polish GHG inventory is made by the Department Global Environmental Problems and Climate Change in the Ministry of Environment what includes official seminar with ministry and external experts invited. After potential correction of submitted report official protocol of approval is signed. Then the Ministry of Environment initiates formal governmental acceptance of National Inventory Report which is next sent to the UNFCCC Secretariat in line with official submission (CRF Reporter). The same inventory data and elements of NIR are sent to the European Commission.

Verification of emissions data

Additional verification for entire inventory results is made using CRF-Reporter as well as NIR files. For instance information contained in CRF tables is used for detection of omissions and errors as well as correct emission and emission factors estimations. The NEC team also elaborated automatic National Inventory Report preparation where additional calculating procedures are employed for estimation of sectoral and total emission results for comparison against CRF tables and experts estimations.

Documentation, archiving and reporting

Effective management with the preparation of GHG inventory requires sufficient archiving procedures collecting internal documentation associated with particular aspects of inventory preparation, check and reporting.

Therefore the *Data Management Manual* has been elaborated in National Emission Centre for the purpose of efficient governance with all important information containing databases, software, worksheets, final reports as well as QA/QC documentation regarding to inventory process.

References:
IOŚ 2007 - *National programme for Quality Assurance and Quality Control of the Polish Greenhouse Gas inventory*. Ver. 1.3.National Emission Center, Instutite of Environmental Protection. Warszawa, 2007.

Oil	Crude oil	Feedstocks	Total pet. products	Refinery gas	LPG	Motor spirit	Kerosenes , jet fuels	Naphtha	Gas / diesel oil	Residual fuel oil	Other pet. products	White spirit	Lubrificants	Bitumen	Petroleum coke
.200600.87..	ktoe														
Primary production	**300**														
Redovered products		616	43										43		
Imports	19 918	893	6 104		2 382	634			2 567	79	71	35	107	152	76
Stock change	278		711		9	67	3		549	75	4		12	2	
Exports	283		2 795		38	673	451	61	316	747	56	30	190	232	
Bunkers			292						88	204					
Gross inland consumption	**20 156**	**1 509**	**2 349**		**2 335**	**106**	**448**	**61**	**1 614**	**948**	**11**	**4**	**52**	**78**	**76**
Transformation input	**20 151**	**2 246**	**221**		**3**				**27**	**190**					
Classic thermal Power Stations			168						3	165					
Public thermal power stations			145						3	142					
Autoprod. thermal power stations			23							23					
Nuclear power stations															
Patent fuel and briquetting plants															
Coke-oven plants															
Blast-furnace plants															
Gas works			3		3										
Refineries	20 151	2 246													
District heating plants			49						24	25					
Transformation output			**21 151**	**1 028**	**310**	**4 374**	**877**	**1 487**	**8 422**	**2 698**	**274**	**55**	**231**	**1 395**	
Classic thermal Power Stations															
Public thermal power stations															
Autoprod. thermal power stations															
Nuclear power stations															
Patent fuel and briquetting plants															
Coke-oven plants															
Blast-furnace plants															
Gas works															
Refineries			21 151	1 028	310	4 374	877	1 487	8 422	2 698	274	55	231	1 395	
District heating plants															
Exchanges and transfers, returns		**737**	**763**	**201**	**37**			**398**	**33**		**49**		**43**		
Interproduct transfers															
Products transferred		44	43										43		
Returns from petrochem. industry		693	719	201	37			398	33		49				
Consumption of the energy branch			**1 379**	**313**	**1**				**48**	**997**	**9**		**1**	**10**	
Production and distribution of eledtricity			9						8	1					
Pumping stations															
Extraction and agglo. of solid fuels			18						18						
Coke-oven and gas works plants															
Oil and Nat. Gat extraction plants			4						4						
Oleducs and Gazeducs			1						1						
Oil refineries			1 345	313					17	996	8		1	10	
Nuclear fuel fabrication plants															
Distribution losses															
Available for final consumption	**5**		**21 138**	**515**	**2 603**	**4 268**	**429**	**1 028**	**9 927**	**563**	**228**	**59**	**135**	**1 307**	**76**
Final non-energy consumption			**2 899**					**1 020**			**269**	**59**	**243**	**1 307**	
Chemical industry			1 215					1 020			166	23	6		
Other sedtors			1 684								104	36	237	1 307	
Final energy consumption			**18 348**	**515**	**2 713**	**4 268**	**429**		**9 927**	**409**	**4**				**84**
Industry			1 648	515	170	6	3		523	343	4				84
Iron & steel industry			3						3						
Non-ferrous metal industry			15		1				4	10					
Chemical industry			805	515	100				96	94	1				
Glass, pottery & building mat. industry			206		9				44	69					84
Ore-extraction industry			60		1				59						
Food, drink & tobacco industry			205		29	1			106	70					
Textile, leather & clothing industry			15		3				11	1					
Paper and printing			50		2				9	38					
Engineering & other metal industry			69		14	2	3		43	6					
Other industries			238		11	3			148	56	20				
Ajustment			17								17				
Transport			13 027		1 868	4 254	426		6 479						
Railways			146						146						
Road transport			12 448		1 868	4 251			6 330						
Air transport			429			3	426								
Inland navigation			3						3						
Households, commerce, pub. auth., etc.			3 673		675	7			2 925	66					
Households			798		494				303						
Agriculture			2 522		55	7			2 425	35					
Fisheries															
Services			353		125				197	31					
Other															
Statistical difference	**5**		**109**		**110**			**7**		**154**	**45**		**108**		**7**

Annex 5. Uncertainty assessment of the 2006 inventory

Uncertainty analysis for the year 2006 was performed with Tier1 methodology described in IPCC Good Practice Guidance. This simplified methodology is based on the assumptions that every value is independent (there is no correlation between values) and 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* and *Industrial gases* (HFC, PFC, SF6) due to lack of appropriate information, uncertainty estimates were made directly to emission values.

First step of the Tier1 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 was literature describing details of uncertainty analysis of Scandinavian countries for 2002 GHG inventory. After investigation of socio-economic parameters literature data was 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 help 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 is shown below:

CO_2 – 5,2%	CH_4 –19,9%	N_2O - 47,7%
HFC - 43,7%	PFC - 20,0%	SF6 - 100,0%

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

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. 19,9% 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 (47,7%) 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%).

Industrial Gases

Simplified analysis were made for industrial gases HFC, PFC and SF6 – uncertainty estimates were applied directly to emission values of each pollutant. Results are HFC – 43,7%, PFC – 20,0%, SF6 – 100,0%. Due to lack of information, additional analysis need to be done for these gases.

The uncertainty assessment of GHG Inventory for 2006 was made on the basis of calculations and experts opinions made in 2007 (during compiling inventories for years 1988-2005) and recommendations of the UNFCCC expert review team. The calculations were extended to cover simplified approach for LULUCF sector and industrial gases.

Sector *3. Solvents and Other Products Use* was included in calculations with high sectoral uncertainty 15,0%. 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 2006 – Uncertainty analysis, part 1, sectors 1-2

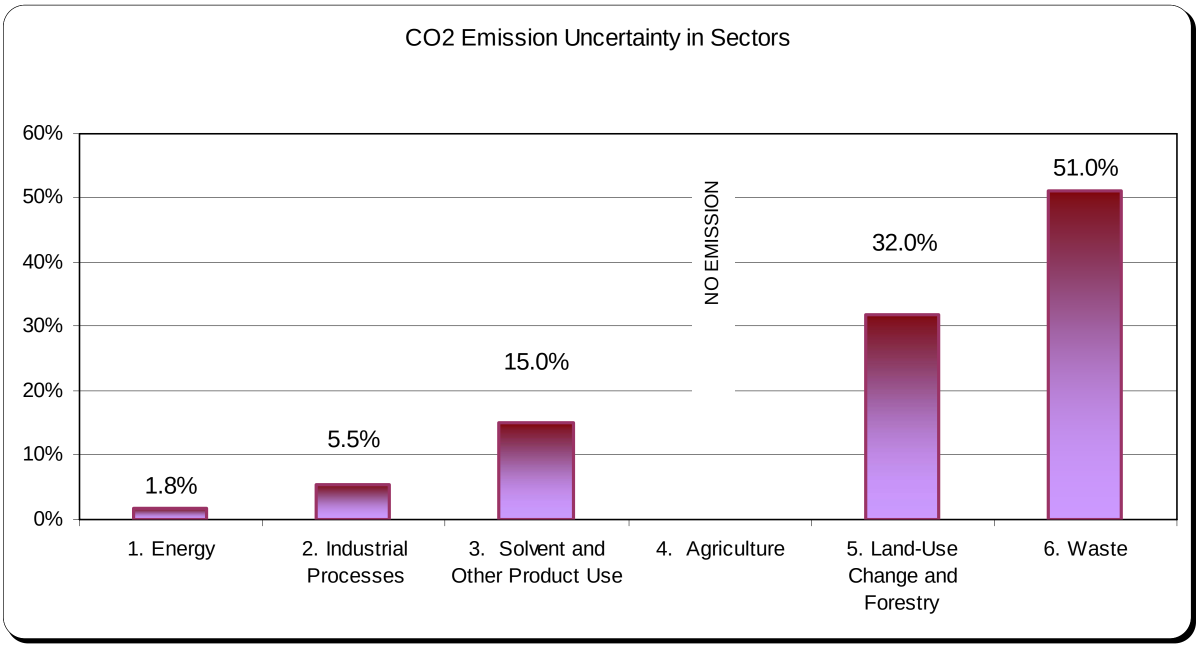
2006	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
TOTAL									**287,641.12**	**1,884.97**	**95.44**	**5.2%**	**19.9%**	**47.7%**	14,858.38	374.34	45.55
1. Energy									**310,592.29**	**788.34**	**8.69**	1.8%	6.1%	2.9%	**5646.89**	**48.42**	**0.25**
A. Fuel Combustion									**310,341.40**	**139.30**	**8.69**	1.8%	11.1%	2.9%	5646.87	15.45	0.25
1. Energy Industries									187,500.65	2.91	2.77	2.7%	11.0%	2.7%	4983.45	0.32	0.07
Liquid Fuels	74,374	2.0%	74.40	2.65	0.51	1.0%	41.8%	3.8%	5,533.49	0.20	0.04	2.2%	41.8%	2.2%	123.73	0.08	0.00
Solid Fuels	1,808,700	2.0%	97.33	1.09	1.46	2.0%	13.5%	11.7%	176,037.42	1.97	2.64	2.8%	13.6%	2.8%	4979.09	0.27	0.07
Gaseous Fuels	104,165	2.0%	56.93	1.00	0.10	2.0%	17.0%	20.0%	5,929.74	0.10	0.01	2.8%	17.1%	2.8%	167.72	0.02	0.00
Biomass	23,226	3.0%				0.0%	24.0%	37.0%	2,436.42	0.64	0.08	3.0%	24.2%	3.0%		0.15	0.00
2. Manufacturing Industries and Construction									33,724.50	3.70	0.68	2.6%	11.8%	11.0%	861.12	0.44	0.07
Liquid Fuels	74,286.46	3.0%	69.14	2.16	2.49	1.0%	41.8%	3.8%	5,136.38	0.16	0.19	3.2%	41.9%	4.8%	162.43	0.07	0.01
Solid Fuels	205,556.94	3.0%	106.89	10.41	1.51	2.0%	13.5%	11.7%	21,972.08	2.14	0.31	3.6%	13.8%	12.1%	792.21	0.30	0.04
Gaseous Fuels	123,094.80	4.0%	53.75	1.00	0.10	2.0%	17.0%	20.0%	6,616.03	0.12	0.01	4.5%	17.5%	20.4%	295.88	0.02	0.00
Biomass	42,668.50	4.0%	109.44	29.95	3.99	0.0%	24.0%	37.0%	4,669.65	1.28	0.17	4.0%	24.3%	37.2%		0.31	0.06
3. Transport									37,381.40	5.48	3.63	5.4%	10.4%	3.0%	2013.05	0.57	0.11
Liquid Fuels	529,402.84	2.0%	70.61	10.33	6.84	5.0%	10.2%	2.3%	37,381.40	5.47	3.62	5.4%	10.4%	3.0%	2013.05	0.57	0.11
Solid Fuels	NE,NO	3.0%	NA	NA	NA	5.0%	13.5%	11.7%				5.8%	13.8%	12.1%	0.00	0.00	0.00
Biomass	NE,NO	4.0%	55.82	0.00	0.00	0.0%	24.0%	37.0%	NE,NO	0.00	0.00	4.0%	24.3%	37.2%		0.00	0.00
Other Fuels	4,046.00	4.0%	0.00	0.00	0.00	0.0%	50.0%	50.0%	286.46	0.01	0.00	4.0%	50.2%	50.2%	11.46	0.01	0.00
4. Other Sectors									51,734.87	127.22	1.61	2.9%	12.1%	12.6%	1502.80	15.43	0.20
Liquid Fuels	143,330.54	4.0%	71.11	5.27	4.15	1.0%	41.8%	3.8%	10,191.81	0.76	0.59	4.1%	42.0%	5.5%	420.22	0.32	0.03
Solid Fuels	320,256.23	4.0%	94.32	270.80	1.50	2.0%	13.5%	11.7%	30,205.69	86.72	0.48	4.5%	14.1%	12.4%	1350.84	12.21	0.06
Gaseous Fuels	203,119.20	4.0%	55.82	5.00	0.10	2.0%	17.0%	20.0%	11,337.37	1.02	0.02	4.5%	17.5%	20.4%	507.02	0.18	0.00
Biomass	129,562.00	4.0%	109.54	298.85	3.98		24.0%	37.0%	14,192.73	38.72	0.52	4.0%	24.3%	37.2%		9.42	0.19
5. Other									0.00	0.00	0.00	0.0%	0.0%	0.0%	0.00	0.00	0.00
Liquid Fuels	NO	4.0%	NA	NA	NA	1.0%	100.0%	3.8%	IE	IE	IE	4.1%	100.1%	5.5%	0.00	0.00	0.00
Solid Fuels	IE	4.0%	NA	NA	NA	2.0%	80.0%	11.7%	IE	IE	IE	4.5%	80.1%	12.4%	0.00	0.00	0.00
Gaseous Fuels	IE	4.0%	NA	NA	NA	2.0%	90.0%	20.0%	IE	IE	IE	4.5%	90.1%	20.4%	0.00	0.00	0.00
Biomass	IE	4.0%	NA	NA	NA	0.0%	95.0%	37.0%	IE	IE	IE	4.0%	95.1%	37.2%	0.00	0.00	0.00
B. Fugitive Emissions from Fuels									**250.88**	**649.04**	**0.00**	6.5%	7.1%		16.22	45.89	0.00
1. Solid Fuels									1.34	441.54	0.00	6.6%	10.1%		0.09	44.57	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]	89.34	2.0%		4.89139			10.0%			437.01			10.2%		0.00	44.57	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	60.85	2.0%		0.01273			10.0%			0.77			10.2%		0.00	0.08	0.00
1. B. 1. c. Other [CO2 Emisson from Coking Gas Subsystem]	0.65	2.0%	2,060,765	5,791,695.00			10.0%		1.34	3.76		6.6%	15.0%		0.09	0.56	
2. Oil and Natural Gas									249.55	207.50	0.00	6.5%	5.3%		16.22	10.93	0.00
1. B. 2. a. Oil															0.00	0.00	0.00
ii. Production [Activity in PJ, EFs in kg/PJ]	33.50	0.5%	7,315,000	61,800.00		6.6%	8.1%		245.07	2.07		6.6%	8.1%		16.22	0.17	0.00
iii. Transport [Activity in Gg]	20,609.00	0.5%	NE	NE		6.6%	8.1%		0.01	0.13		6.6%	8.1%		0.00	0.01	0.00
iv. Refining/storage [Gg]	843.67	0.5%		745.00		6.6%	8.1%		NA	0.63			8.1%			0.05	
1. B. 2. b. Natural Gas															0.00	0.00	0.00
i. Production / Processing [Activity in PJ, EFs in kg/PJ]	162.46	0.5%	22,022.39	94,970.12		6.6%	8.1%		3.58	15.43		6.6%	8.1%		0.24	1.25	0.00
ii. Transmission [Activity in PJ, EFs in kg/PJ]	518.05	0.5%	524.08	53,336.79		6.6%	8.1%		0.27	27.63		6.6%	8.1%		0.02	2.24	0.00
iv. Distribution [Activity in PJ, EF in kg/PJ]	518.05	0.5%	1,171.36	310,660.93		6.6%	8.1%		0.61	160.94		6.6%	8.1%		0.04	13.06	0.00
v. Other Leakage [Activity in PJ, EFs in kg/PJ]	518.05	0.5%	9.98	2,487.91		6.6%	8.1%		0.01	0.67		6.6%	8.1%		0.00	0.05	
2. Industrial Processes									**19040.21**	**18.35**	**15.00**	5.5%	14.1%	28.6%	1052.50	2.59	4.28
A. Mineral Products									9147.39		0	10.6%			973.13	0.00	0.00
1. Cement Production [Activity in kt, EF in t/t]	11,219.90	5.0%	0.53331509			15.0%			5983.74			15.8%			946.11	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	1,936.00	10.0%				10.0%			1519.76			14.1%			214.93	0.00	0.00
3. Limestone and dolomite Use [activitz in kt, EFs in t/t]	IE		NA	NA	NA				617.81			10.0%					
4. Soda Ash (production) [Activity in kt, EF in t/t]	1,026.31	10.0%	0.415			0.0%			425.92			10.0%			42.59	0.00	0.00
7. Other (ETS Data; Bricks, Tiles, Ceramic Materials and Glass production) [emission data only]									600.16			1.0%			6.00	0.00	0.00
B. Chemical Industry									4276.75	12.35	15.00	7.0%	19.1%	28.6%	299.15	2.35	4.28
1. Ammonia Production [Activity in kt, EF in t/t]	2,326.62	5.0%	1.81826904	0.0049		5.0%	20.0%		4230.42	11.40		7.1%	20.6%		299.14	2.35	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	2,200.80	2.0%			0.01			30.0%			14.24			30.1%	0.00	0.00	4.28
3. Adipic Acid Production [Activity in kt, EF in t/t]	NO	5.0%			0.00			10.0%	NO		NO						
4. Carbide Production (calcium carbide) [Activity in kt, EF in t/t]	21.07	5.0%	2.19			5.0%			46.15			7.1%			3.26	0.00	0.00
5. Other (Carbon Black) [Activity in kt, EF in t/t]	31.97	5.0%		0.01			20.0%			0.35			20.6%		0.00	0.07	0.00
5. Other (Ethylene) [Activity in kt, EF in t/t]	592.78	5.0%	0.0003	0.001		5.0%	20.0%		0.18	0.592781		7.1%	20.6%		0.01	0.12	0.00
5. Other (N2O for Medical Use) [Activity in kt, EF in t/t]	NA	5.0%			IE			20.0%			IE				0.00	0.00	IE
5. Other (Methanol) [Activity in kt, EF in t/t]	0.07	5.0%		0.002			20.0%			0.000148			20.6%		0.00	0.00	0.00
5. Other (Caprolactam) [Activity in kt, EF in t/t]	159.71	5.0%			0.0047			20.0%			0.76			20.6%	0.00	0.00	0.16
C. Metal Production									4471.88	6.00	0	5.8%	18.1%		260.79	1.09	0.00
1. Iron and Steel Production															0.00	0.00	0.00
Sinter [Activity in kt, EF in t/t]	6,907.82	5.0%	0.04			10.0%	20.0%		283.52	0.48		11.2%			31.70	0.00	0.00
Coke [Activity in kt, EF in t/t]	9,613.00	5.0%	0.21	0.000500		10.0%	20.0%		2062.78	4.81		11.2%	20.6%		230.63	0.99	0.00
Open-heart Steel [Activity in kt, EF in t/t]	NO	5.0%															
Electric Furnace Steel [Activity in kt, EF in t/t]	4,225.25	5.0%	0.08557	0.000120		10.0%	20.0%		361.54	0.51		11.2%	20.6%		40.42	0.10	0.00
Pig Iron [Activity in kt, EF in t/t]	5,543.35	5.0%	0.11187			10.0%			620.11			11.2%			69.33	0.00	0.00
Iron Cast [Activity in kt, EF in t/t]	962.16	5.0%	0.007	0.000200		10.0%	20.0%		6.38	0.19		11.2%	20.6%		0.71	0.04	0.00
Steel Cast [Activity in kt, EF in t/t]	132.75	5.0%	0.048			10.0%			6.33			11.2%			0.71	0.00	0.00
Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]	5,766.39	5.0%	0.13093			10.0%			754.99			11.2%			84.41	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	13.03	5.0%	3.9			5.0%	20.0%		50.83	0.01		7.1%			3.59	0.00	0.00
3. Aluminium Production [Activity in kt, EF in t/t]	55.94	5.0%	1.8			5.0%			100.69			7.1%			7.12	0.00	0.00
5. Other (Zinc Production) [Activity in kt, EF w t/t]	110.30	5.0%	1.7			5.0%			189.72			7.1%			13.41		
5. Other (Lead Production) [Activity in kt, EF w t/t]	67.30	5.0%	0.5			5.0%			34.99			7.1%			2.47		
D. Other Production									0.05			5.0%			0.00	0.00	0.00
G. Other									1,144.14			5.0%			57.21	0.00	0.00

GHG inventory 2006 – Uncertainty analysis, part 2, sector 3-6

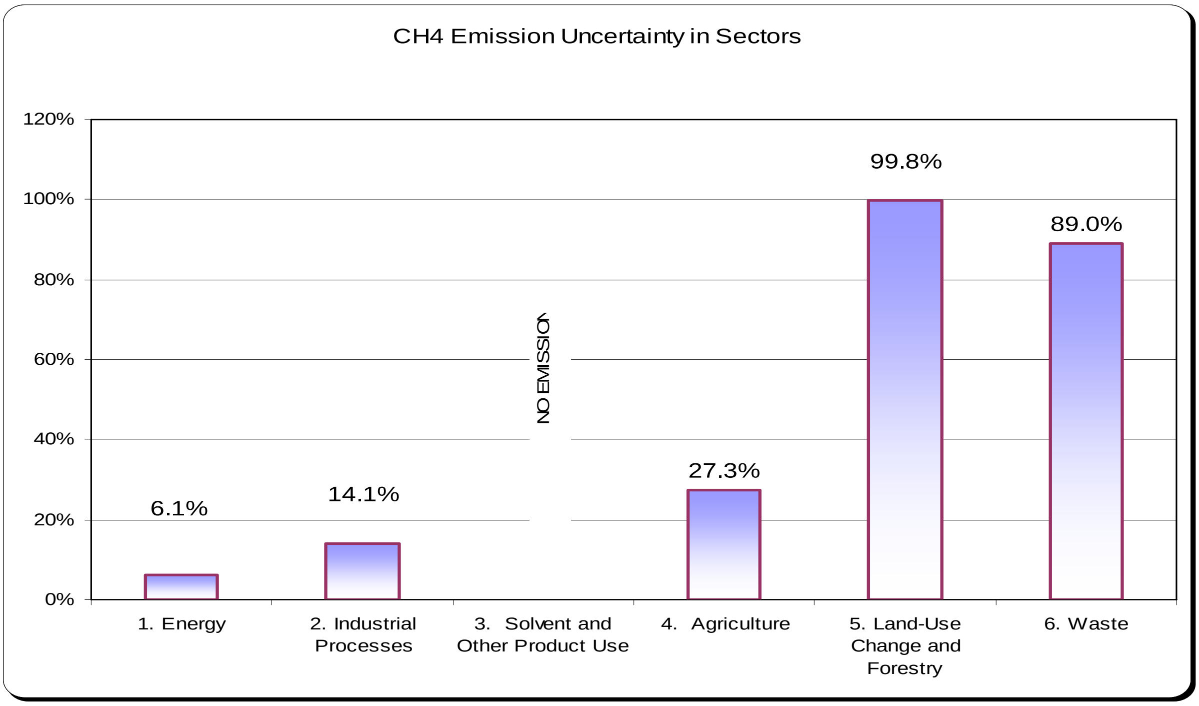
2006	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
3. Solvent and Other Product Use	**169.19**		**NA**						**581.75**		**0.40**	15.0%		50.0%	87.26	0.00	0.20
4. Agriculture										**615.68**	**68.91**		27.3%	65.8%	0.00	168.23	45.33
A. Enteric Fermentation										436.56			34.4%		0.00	150.38	0.00
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2,824.0	5.0%		94.31			50.0%			266.33			50.2%		0.00	133.83	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2,782.0	5.0%		47.94			50.0%			133.38			50.2%		0.00	67.02	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	301.0	5.0%		7.83			50.0%			2.36			50.2%		0.00	1.18	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	130.0	5.0%		5.00			50.0%			0.65			50.2%		0.00	0.33	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	307.0	5.0%		18.00			50.0%			5.53			50.2%		0.00	2.78	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	18,881.0	5.0%		1.50			50.0%			28.32			50.2%		0.00	14.23	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	141,808.0	5.0%		0.00			50.0%			0.00			50.2%		0.00	0.00	0.00
B. Manure Management										178.02	19.66		42.4%	148.2%	0.00	75.41	29.13
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2,824	5.0%		9.36			50.0%			26.44			50.2%		0.00	13.28	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2,782	5.0%		5.97			50.0%			16.62			50.2%		0.00	8.35	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	301	5.0%		0.16			50.0%			0.05			50.2%		0.00	0.02	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	130	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]	307	5.0%		1.39			50.0%			0.43			50.2%		0.00	0.21	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	18,881	5.0%		6.54			50.0%			123.42			50.2%		0.00	62.02	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	141,808	5.0%		0.08			50.0%			11.06			50.2%		0.00	5.56	0.00
11. Liquid Systems [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.001000			150.0%			0.25			150.1%	0.00	0.00	0.38
12. Solid Storage and Dry Lot [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.020000			150.0%			19.41			150.1%	0.00	0.00	29.13
0																	
D. Agricultural Soils											49.21			70.6%	0.00	0.00	34.73
1. Direct Soil Emissions															0.00	0.00	0.00
Synthetic Fertilizers [Activity in kg N, EF in kg N2O-N/kg N]	896,400,000	5.0%			0.01			150.0%			12.52			150.1%	0.00	0.00	18.79
Animal Wastes Applied to Soils [Activity in kg N, EF in kg N2O-N/kg N]	621,969,200	5.0%			0.01			150.0%			9.77			150.1%	0.00	0.00	14.67
N-fixing Crops [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	18,180,000	5.0%			0.01			150.0%			0.29			150.1%	0.00	0.00	0.43
Crop Residue [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	171,197,600	5.0%			0.01			150.0%			2.69			150.1%	0.00	0.00	4.04
Cultivation of Histosols [Activity in ha, EF in kg N2O-N/ha]	706,520	5.0%			8.00			150.0%			8.88			150.1%	0.00	0.00	13.33
2. Animal Production [Activity in kg N, EF in kg N2O-N/kg N]	37,764,300	5.0%			0.02			150.0%			1.19			150.1%	0.00	0.00	1.78
3. Indirect Emissions [Activity in kg N/yr, EF in kg N2O/kg N]	107,152,860	20.0%			1.29417743			150.0%			13.87			151.3%			20.99
F. Field Burning of Agricultural Residues										1.10	0.04		23.4%	99.9%	0.00	0.26	0.04
1. Cereals															0.00	0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	7,060,000	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]	3,161,000	30.0%		0.1473	0.0004		20.0%	150.0%		0.05	0.00		36.1%	153.0%	0.00	0.02	0.00
Maize [Activity in t of crop production, EF in kg/t dm]	1,261,000	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]	1,035,000	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]	2,622,000	30.0%		0.2004	0.0004		20.0%	150.0%		0.05	0.00		36.1%	153.0%	0.00	0.02	0.00
Other Cereals [Activity in t of crop production, EF in kg/t dm]	6,635,000	30.0%		0.1616	0.0004		20.0%	150.0%		0.11	0.00		36.1%	153.0%	0.00	0.04	0.00
2 Pulses (Other non-specified)	206,000	30.0%		0.0429	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]	8,982,000	30.0%		0.1796	0.0014		20.0%	150.0%		0.16	0.01		36.1%	153.0%	0.00	0.06	0.02
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 cro	20,586,000	30.0%		0.0282	0.0011		20.0%	150.0%		0.58	0.02		36.1%	153.0%	0.00	0.21	0.04
0													0.0%	0.0%	0.00	0.00	0.00
5. Land-Use Change and Forestry									**-42882.45**	**113.09**	**0.01**	32.0%	99.8%	79.3%	-13701.96	112.83	0.007
A. Forest Land									-54266.11	0.141361	0.002222	25.0%	100.0%	100.0%	-13566.53	0.14	0.002
B. Cropland									8237.09			25.0%			2059.27	0.00	0.000
C. Grassland									130.54	0.116925	6.41E-06	25.0%	100.0%	100.0%	0.00	0.12	0.000
D. Wetlands									3090.49	112.8293	0.006849	25.0%	100.0%	100.0%	772.62	112.83	0.007
E. Settlements									-74.45			25.0%			-18.61	0.00	0.000
F. Other Land									0.00			50.0%			0.00	0.00	0.000
6. Waste									**309.32**	**349.51**	**2.44**	51.0%	89.0%	50.2%	157.72	311.04	1.22
A. Solid Waste Disposal on Land										300.24			102.6%		0.00	308.08	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	9,069.20	23.0%					100.0%			300.24			102.6%		0.00	308.08	0.00
B. Wastewater Handling										49.27	2.34		86.9%	52.2%	0.00	42.80	1.22
Industrial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	337.15			0.02			100.0%			9.24			100.0%		0.00	9.24	0.00
Domestic and Commercial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	512.42	30.0%		0.078113794			100.0%			40.03			104.4%		0.00	41.79	0.00
N2O from human sewage [Activity in 1000s of population, EF in kg N2O-N/kg sewage N produced]	38,125.50	15.0%			0.0000615			50.0%			2.34			52.2%	0.00	0.00	1.22
C. Waste Incineration									309.32		0.09	51.0%		22.5%	157.72	0.00	0.02
biogenic [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			147.90		0.06	51.0%		30.0%	75.42	0.00	0.02
plastics and other non-biogenic waste [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			309.32		0.03	51.0%		30.0%	157.72	0.00	0.01

Industrial gases inventory 2006 – Uncertainty analysis for HFC, PFC and SF_6.

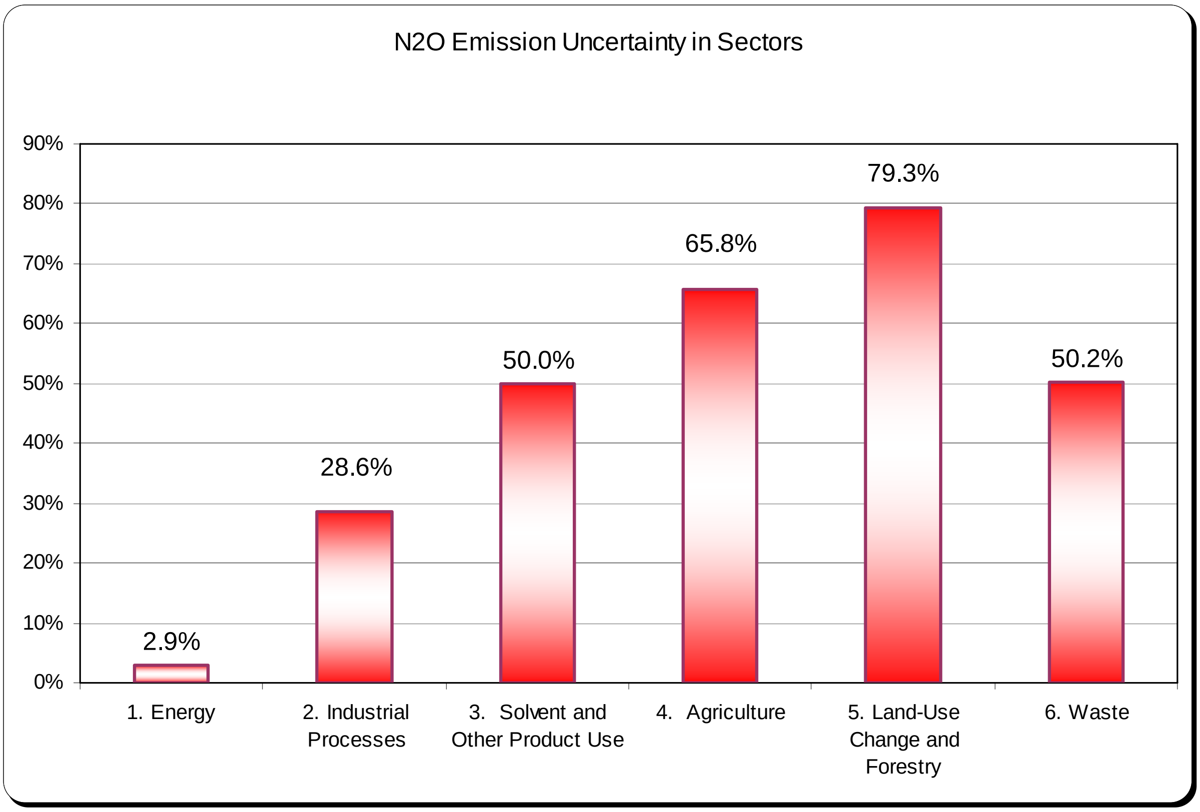
	HFC Emission [Gg of CO2 eq.]	PFC Emission [Gg of CO2 eq.]	SF_6 Emission [Gg of CO2 eq.]	HFC Emission uncertainty [%]	PFC Emission uncertainty [%]	SF6 Emission uncertainty [%]	HFC Emission absolute uncertainty [Gg of CO2 eq.]	PFC Emission absolute uncertainty [Gg of CO2 eq.]	SF6 Emission absolute uncertainty [Gg of CO2 eq.]
TOTAL	2,843.53	269.75	30.02	43.7%	20.0%	100.0%	1,243.58	53.95	30.02
2. Industrial Processes	**2,843.53**	**269.75**	**30.02**	**43.7%**	**20.0%**	**100.0%**	**1,243.58**	**50.64**	**30.02**
C. Metal Production		253.19			20.0%			50.64	
3. Aluminium Production		253.19			20.0%			50.64	
F. Consumption of Halocarbons and SF6	2,843.53	16.56	30.02	43.7%		100.0%	1243.58	0.00	30.02
1. Refrigeration and Air Conditioning Equipment	2,195.75			50.0%			1097.88		
2. Foam Blowing	290.78			50.0%				0.00	
3. Fire Extinguishers	11.48	16.56		50.0%	20.0%				
4. Aerosols/ Metered Dose Inhalers	345.51			50.0%			172.76		
8. Electrical Equipment			30.02			100.0%			30.02



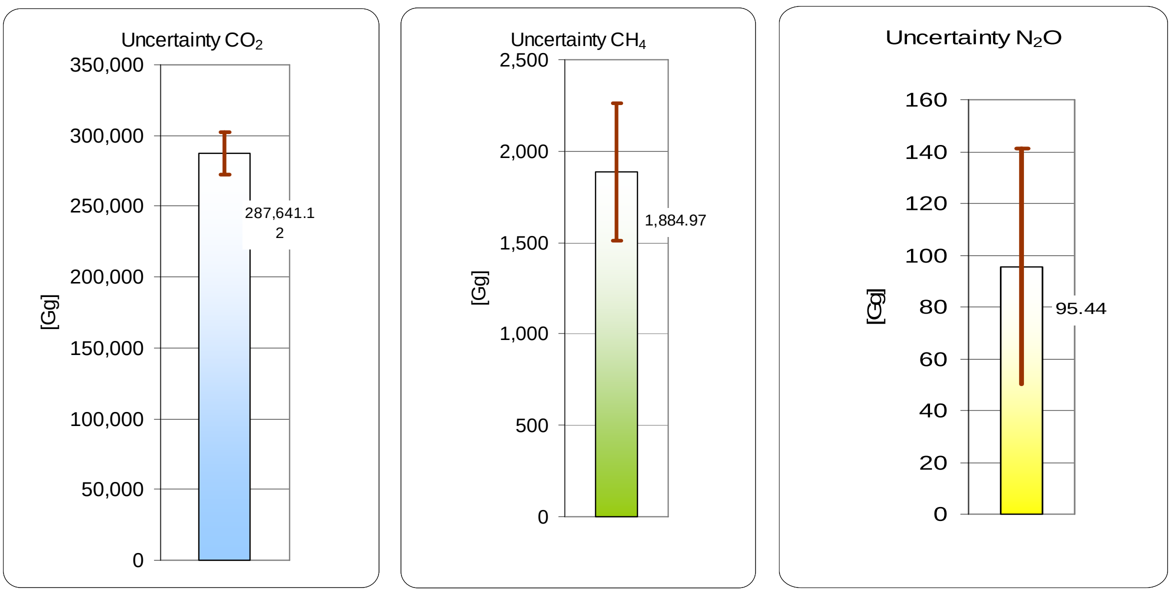
Results of uncertainty analysis in percents for CO_2 with sectoral split.



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.