KOBiZE Krajowy Ośrodek Bilansowania i Zarządzania Emisjami

POLAND'S NATIONAL INVENTORY REPORT 2015

Greenhouse Gas Inventory
for 1988-2013

Submission under
the UN Framework Convention on Climate Change

Warszawa, October 2015

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Reporting entity:

National Centre for Emission Management (KOBiZE)
at the Institute of Environmental Protection – National Research Institute

Warszawa
October 2015

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Działalność KOBiZE jest finansowana ze środków
Narodowego Funduszu Ochrony Środowiska i Gospodarki Wodnej

EXECUTIVE SUMMARY

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

Poland has been the signatory to the United Nations Framework Convention on Climate Change (UNFCCC) since 1994 and to its Kyoto Protocol since 2002 thus joining the international efforts aiming at combat climate change. One of the main obligations resulting from ratification of the Kyoto Protocol by Poland is to reduce the greenhouse gas emissions by 6% in 2008-2012 in relation to the base year and by 20% in 2013−2020 jointly with the European Union.

According to the provisions of Article 4.6 of the UNFCCC and decision 9/CP.2 Poland uses 1988 as the base year for the estimation and reporting of GHG inventories. For groups of gases: HFCs, PFCs and for sulphur hexafluoride (SF_6) the year 1995 was established as the base one and for the nitrogen trifluoride (NF_3) – the year 2000 is adopted as the base year.

The underlying report presenting the results of national greenhouse gas inventory for 2013, in line with the trend since 1988, is prepared according to the *Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention* contained in the decision 24/CP.19.

The national inventory covers the following GHGs and groups of gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3) i and are reported in five categories: 1. Energy, 2. Industrial Processes and Product Use (IPPU), 3. Agriculture, 4. Land Use, Land Use Change and Forestry (LULUCF) and 5. Waste. Information on emissions of sulphur dioxide (SO_2) and the following GHG precursors is also reported: carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC).

Methodologies used to calculate emissions and sinks of GHGs are those published by the Intergovernmental Panel on Climate Change (IPCC) in 2006, namely *Revised2006 Guidelines for National Greenhouse Gas Inventories* what is in accordance with the provisions of the decision 24/CP.19. According to these guidelines country specific methods have been used where appropriate giving more accurate emission data.

At the same time the underlying report has been elaborated for the for the purpose of Poland's obligations resulting from Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC as well Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council.

The unit responsible for compiling the GHG inventory for the purpose of the European Union and the UNFCCC, according to the provisions of the Act of 17 July 2009 on the system to manage the emissions of greenhouse gases and other substances *(Journal of laws Nr 130, position 1070 with further changes)*, is the National Centre for Emissions Management (KOBiZE) in the Institute of Environmental Protection National Research Institute, supervised by the Minister of Environment.

S.2. Summary of national emission and removal related trends

The GHG emissions for the base year (see chapter S.1) and the year 2013, expressed as CO_2 equivalents, are presented in table S.1. In 2013 the total national emission of GHG was 394.89 million tonnes of CO_2 eq., excluding GHG emissions and removals from category 4 (*Land use, land use change and forestry* – LULUCF). Compared to the base year, the 2013 emissions have decreased by 32.0%.

Table S.1. National emissions of greenhouse gases for the base year and 2013

Pollutant	Emission in CO_2 eq. [kt]		(2013-base)/base [%]
	Base year	2013	
CO_2 (with LULUCF)	460 160.19	285 272.89	-38.01
CO_2 (without LULUCF)	474 657.36	322 900.21	-31.97
CH_4 (with LULUCF)	77 294.20	42 134.12	-45.49
CH_4 (without LULUCF)	77 250.07	42 097.14	-45.51
N_2O (with LULUCF)	28 852.52	20 236.95	-29.86
N_2O (without LULUCF)	28 841.35	20 233.61	-29.85
HFCs	97.34	9 606.78	97.34
PFCs	171.97	14.64	-91.49
Unspecified mix of HFCs and PFCs	NA	NA	NA
SF_6	29.12	39.15	29.12
NF_3	NA	NA,NO	NA,NO
TOTAL net emission (with LULUCF)	566 478.88	357 304.53	-36.93
TOTAL without LULUCF	580 920.74	394 891.52	-32.02

Carbon dioxide is the main GHG in Poland with the share of 81.8% in national emissions in 2013, the share of methane and nitrous oxide contributes respectively with: 10.7% and 5.1%. All F-gases contribute to 2.4% of total GHG emissions. Percentage share of GHG in national total emissions (excluding category 4. LULUCF) in 2013 is presented at figure S.1.

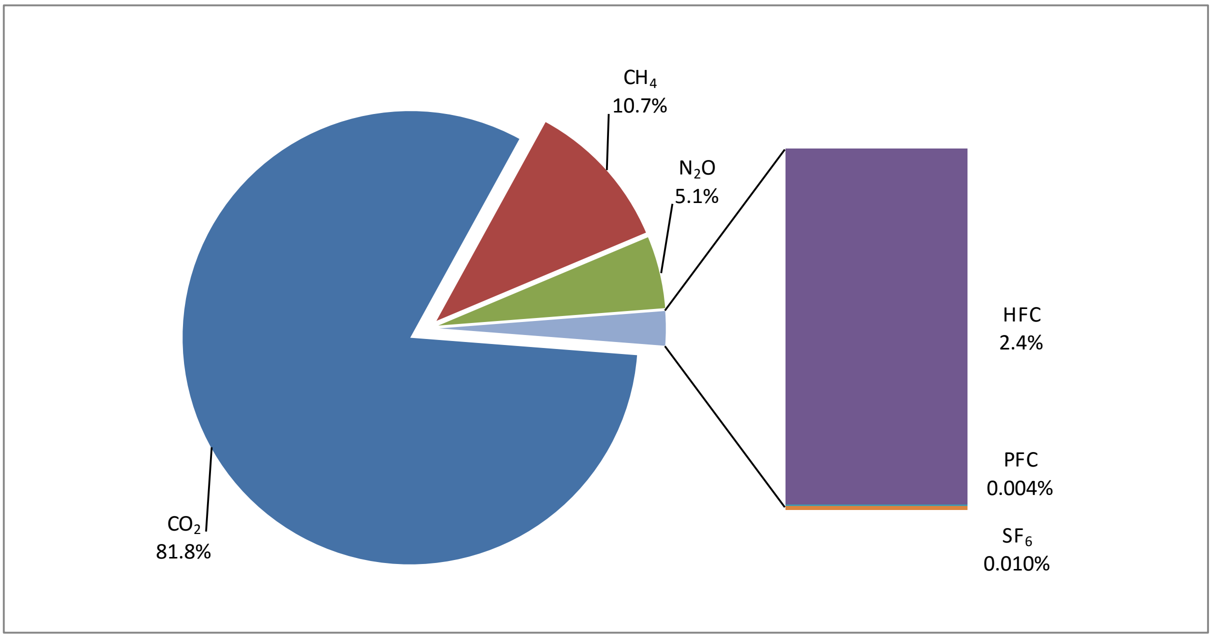

Figure S.1. Percentage share of greenhouse gases in national total emission in 2013 (excluding category 4. LULUCF)

Trend of aggregated greenhouse gases emissions follows the trend of emissions CO_2 alone which is the primary greenhouse gas emitted in Poland. The GHGs trend for period between 1988 and 1990 indicates dramatic decrease 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 a peak in 1996 as a result of development in heavy industry and other sectors and dynamic economic growth. The succeeding years characterize slow decline in emissions up to 2002, when still energy efficiency policies and measures were implemented, and then slight increase up to 2007 caused by animated economic development. Since 2008 stabilisation in emissions has been noted with distinct decrease in 2009 related to world economic slow-down (table S.2 and figure S.2). Since 2010 GHG emissions in Poland gradually decreases.

Since 2005 Poland takes part in the European Union's Emission Trading System, being one of the flexible mechanism supporting measures for limiting the greenhouse gas emissions. The share of emissions related to installations covered by EU ETS in the national emissions in 2005–2013 amounted to about 50% on average (from 49% in 2009–2010 up to 52% in 2013). One should notice that since 2013 the scope of the EU ETS has expanded with new industries (like production of selected chemicals) and greenhouse gases (nitrous oxide) (Fig. S.2).

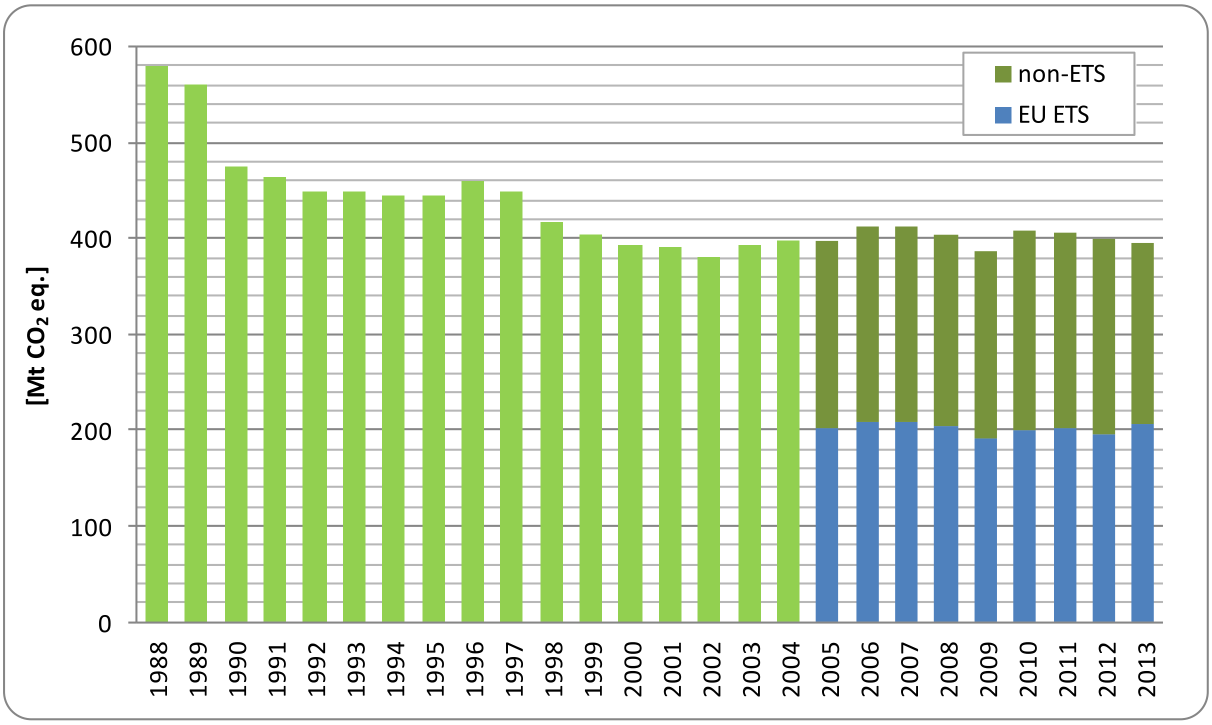

Figure S.2. Trend of aggregated GHGs emissions excluding category 4 for 1988–2013

Table S.2. National emissions of greenhouse gases for 1988–2013 according to gases [kt CO_2 eq.]

GHG	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (with LULUCF)	460 160.19	434 672.34	352 503.13	356 469.99	370 450.85	362 837.21	358 040.22	348 448.09	344 253.18	335 298.88	300 260.35	283 720.28	288 498.87
CO_2 (without LULUCF)	474 657.36	454 416.20	379 464.82	376 496.13	366 413.10	366 726.68	362 432.48	363 900.96	377 676.61	368 543.24	339 469.55	329 870.26	319 482.57
CH_4 (with LULUCF)	77 294.20	74 995.11	67 479.63	64 470.58	61 084.54	60 020.43	59 392.81	58 448.56	57 837.31	57 012.35	53 166.14	51 770.51	49 204.39
CH_4 (without LULUCF)	77 250.07	74 951.07	67 435.57	64 425.59	61 040.03	59 978.22	59 351.88	58 402.66	57 800.92	56 974.41	53 131.81	51 733.41	49 171.84
N_2O (with LULUCF)	28 852.52	30 192.03	27 759.56	22 441.99	20 960.10	21 904.61	21 764.52	22 747.56	22 914.47	22 809.33	22 554.55	21 843.19	22 214.48
N_2O (without LULUCF)	28 841.35	30 180.86	26 866.85	22 435.84	20 909.08	21 892.86	21 752.25	22 738.14	22 897.95	22 800.06	22 548.47	21 832.39	22 205.75
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	97.34	228.41	373.93	462.23	673.38	1 739.19
PFCs	147.26	147.51	141.87	141.31	134.63	144.86	152.78	171.97	161.07	173.36	174.86	168.71	176.68
Unspecified mix of HFCs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SF_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	13.27	29.12	23.80	22.91	23.94	23.50	23.07
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
TOTAL (with LULUCF)	**566 454.17**	**540 006.98**	**447 884.19**	**443 523.87**	**452 630.12**	**444 907.11**	**439 363.60**	**429 942.65**	**425 418.24**	**415 690.76**	**376 642.06**	**358 199.57**	**361 856.67**
TOTAL (without LULUCF)	**580 896.03**	**559 695.64**	**473 909.11**	**463 498.88**	**448 496.84**	**448 742.62**	**443 702.65**	**445 340.19**	**458 788.75**	**448 887.92**	**415 810.85**	**404 301.66**	**392 799.10**

Table S.2. (cont.) National emissions of greenhouse gases for 1988–2013 according to gases [kt CO_2 eq.]

GHG	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CO_2 (with LULUCF)	292 787.16	275 634.32	286 793.86	279 317.04	279 010.67	276 744.28	305 305.23	298 537.94	286 803.12	308 474.02	298 872.40	292 423.36	285 272.89
CO_2 (without LULUCF)	315 509.06	307 790.64	320 487.58	324 514.92	323 586.36	337 065.77	336 707.74	329 704.52	316 191.13	336 695.02	333 947.03	326 969.55	322 900.21
CH_4 (with LULUCF)	49 916.25	47 897.98	47 855.66	47 120.62	47 015.34	46 956.37	45 555.41	44 585.31	43 047.11	43 546.82	42 304.59	42 758.38	42 134.12
CH_4 (without LULUCF)	49 883.67	47 863.26	47 818.75	47 086.36	46 981.85	46 917.29	45 525.71	44 550.67	43 017.27	43 515.17	42 273.51	42 726.61	42 097.14
N_2O (with LULUCF)	22 372.57	21 263.48	21 500.97	22 002.96	22 356.38	22 696.43	23 521.32	23 974.79	19 832.83	19 546.80	19 887.18	19 835.40	20 236.95
N_2O (without LULUCF)	22 367.29	21 256.07	21 477.45	21 996.94	22 168.36	22 687.42	23 487.23	22 950.33	19 826.93	19 542.95	19 882.64	19 826.27	20 233.61
HFCs	2 323.03	3 137.01	4 059.79	4 335.11	5 317.72	6 074.69	6 993.20	7 415.19	8 366.72	8 304.03	8 992.69	9 234.01	9 606.78
PFCs	197.34	207.33	201.08	205.07	187.41	193.58	184.63	163.12	17.97	17.07	16.22	15.41	14.64
Unspecified mix of HFCs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SF_6	22.86	23.29	20.72	22.36	26.80	33.20	31.16	32.87	37.60	35.37	39.02	40.13	39.15
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
TOTAL (with LULUCF)	**367 619.22**	**348 163.41**	**360 432.08**	**353 003.16**	**353 914.31**	**352 698.54**	**381 590.96**	**374 709.21**	**358 105.34**	**379 924.10**	**370 112.09**	**364 306.67**	**357 304.53**
TOTAL (without LULUCF)	**390 303.26**	**380 277.60**	**394 065.37**	**398 160.76**	**398 268.49**	**412 971.94**	**412 929.67**	**404 816.70**	**387 457.61**	**408 109.60**	**405 151.11**	**398 811.96**	**394 891.52**

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

Total GHG emissions presented in CO_2 equivalents for the base year and for 2013 together with change between 2013 and 1988 according to main categories are given in table S.3. In all categories emission reduction has been observed while in LULUCF sector increase in carbon sink has been noted. The highest drop in emissions has occurred in *3.Agriculture* (by nearly 38%) what was caused by significant structural and economic changes after 1989 in this sector, including diminishing animal and crop production (i.e. cattle population drop from 10.7 million up to 5.7 or sheep population from 4.4 million up to 223 thousands in 1988-2013). Next category with high emission reduction in 1988-2013 is *1.Energy* (by about 32%) what was caused by transformation of heavy industry in Poland as well as by decreasing coal use and mining and energy efficiency measures implemented.

Table S 3. GHG emissions according to main sectors in base year (1988) and 2013

	Total [kt eq. CO2]		(2013-base)/base [%]
	Base year	2013	
TOTAL with LULUCF	566 454.17	357 304.53	-36.9
TOTAL without LULUCF	580 896.03	394 891.52	-32.0
1. Energy	483 466.81	323 470.71	-33.1
2. Industrial Processes	34 248.55	30 290.96	-11.6
3. Agriculture	48 438.01	30 100.41	-37.9
4. Land-Use, Land-Use Change and Forestry	-14 441.86	-37 586.99	160.3
5. Waste	14 742.65	11 029.45	-25.2

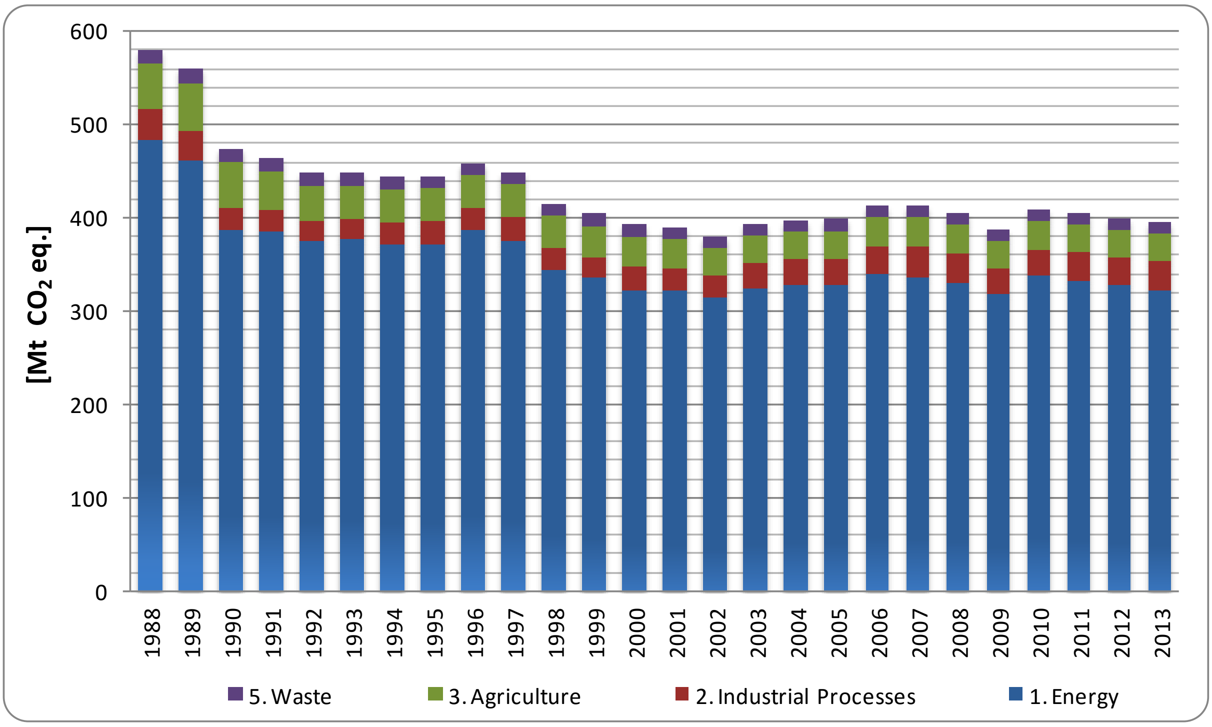

Figure S.3. Trend of aggregated GHGs emissions (excluding category 4) for 1988–2013 according to source categories

Table S.4. National emissions of greenhouse gases for 1988–2013 according to source categories [kt CO_2 eq.]

IPCC sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy	483 466.81	461 231.72	386 536.68	386 344.92	376 329.65	378 288.32	371 703.39	372 445.51	387 356.19	376 404.40	344 976.27	336 225.23	322 702.24
2. Industrial Processes	34 248.55	33 067.80	25 372.91	22 064.63	21 087.87	21 212.39	23 471.35	25 019.47	24 135.04	24 939.16	23 256.48	22 116.60	25 788.57
3. Agriculture	48 438.01	50 711.41	47 608.57	40 917.81	37 093.27	35 483.29	35 150.91	34 720.57	34 339.01	34 671.46	34 681.52	33 144.30	31 347.23
4. Land-Use, Land-Use Change and Forestry	-14 441.86	-19 688.65	-26 024.92	-19 975.01	4 133.29	-3 835.52	-4 339.05	-15 397.54	-33 370.52	-33 197.16	-39 168.79	-46 102.09	-30 942.43
5. Waste	14 742.65	14 684.71	14 390.95	14 171.52	13 986.04	13 758.62	13 376.99	13 154.63	12 958.51	12 872.90	12 896.58	12 815.52	12 961.06
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
TOTAL (with LULUCF)	**566 454.17**	**540 006.98**	**447 884.19**	**443 523.87**	**452 630.12**	**444 907.11**	**439 363.60**	**429 942.65**	**425 418.24**	**415 690.76**	**376 642.06**	**358 199.57**	**361 856.67**
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Table S.4. (cont.) National emissions of greenhouse gases for 1988–2013 according to source categories [kt CO_2 eq.]

IPCC sector	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1. Energy	322 624.91	314 258.63	325 444.38	328 765.16	328 523.40	339 722.69	336 303.38	329 833.73	318 421.23	338 562.43	332 755.32	327 734.72	323 470.71
2. Industrial Processes	24 165.98	23 139.90	26 418.37	27 798.64	27 947.50	30 591.97	33 529.53	32 314.72	26 972.63	28 038.05	30 966.26	30 000.45	30 290.96
3. Agriculture	30 865.16	30 267.98	29 698.28	29 617.04	29 860.99	30 912.87	31 353.43	31 184.76	30 470.72	29 962.73	30 305.15	30 086.67	30 100.41
4. Land-Use, Land-Use Change and Forestry	-22 684.05	-32 114.20	-33 633.29	-45 157.60	-44 354.18	-60 273.40	-31 338.71	-30 107.49	-29 352.27	-28 185.50	-35 039.02	-34 505.29	-37 586.99
5. Waste	12 647.21	12 611.10	12 504.34	11 979.92	11 936.60	11 744.42	11 743.33	11 483.49	11 593.03	11 546.40	11 124.39	10 990.11	11 029.45
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
TOTAL (with LULUCF)	**367 619.22**	**348 163.41**	**360 432.08**	**353 003.16**	**353 914.31**	**352 698.54**	**381 590.96**	**374 709.21**	**358 105.34**	**379 924.10**	**370 112.09**	**364 306.67**	**357 304.53**
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Carbon dioxide emissions

The CO_2 emissions (excluding category 4) in 2013 were estimated as 322.90 million tonnes. This is 32.0% lower than in the base year. CO_2 emission (excluding category 5) accounted for 81.8% of total GHG emissions in Poland in 2013. The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission by 92.4% in 2013. The shares of the main subcategories were as follows: *Energy industries* – 52.4%, *Manufacture Industries and Construction* – 9.2%, *Transport* – 13.4% and *Other Sectors* – 17.3%. *Industrial Processes* contributed to the total CO_2 emission by 6.0% in 2013. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO_2 removal in LULUCF sector in 2013, was calculated to be approximately 37.6 million tonnes. It means that app. 11.7% of the total CO_2 emissions are offset by CO_2 uptake by forests.

Methane emissions

The CH_4 emission (excluding category 4) amounted to 1 683.89 kt in 2013 i.e. 42.10 million tonnes of CO_2 equivalents. Compared to the base year, the emission in 2013 was lower by 45.5%. The contribution of CH_4 to the national total GHG emission was 10.7% in 2013. Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed 35.4%, 32.3% and 22.7% to the national methane emission in 2013, respectively. The emission from the first mentioned sector was covered by emission from underground mines (29.6% of total CH_4 emission) and Oil and Natural Gas system (5.8% of total CH_4 emission). The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 27.8% of total CH_4 emission in 2013. Waste disposal sites contributed to 20.3% of the methane emission from total CH_4 emission and Wastewater Handling contributed to 2.1% of total CH_4 emission.

Nitrous oxide emissions

The nitrous oxide emissions (excluding category 4) in 2013 were 67.90 kt i.e. 20.23 million tonnes of CO_2 equivalents. The emission was app. 29.8% lower than the respective figure for the base year. The contribution of N_2O to the national total GHG emission was 5.1% in 2013. The main N_2O emission sources and its shares in total N_2O emission in 2013 are as follow: *Agricultural Soils* – 67.3%*, Manure Management* – 9.9%, *Chemical Industry* – 5.5% and *Fuel Combustion* – 12.2%.

Emissions of Fluorinated gases

The total emission of industrial gases (HFCs, PFCs and SF_6) in 2013 was 9 660.57 kt CO_2 eq. what accounts for 2.4% of total GHG emissions share in 2013. Industrial gases emissions were about 6460.3% higher comparing to the base year (table S.2). This significant growth in HFCs emission is mainly due to the increase in emission from refrigeration and air conditioning equipment. Share of HFCs, PFCs and SF_6 in total 2013 emissions was respectively as follows: 2.43%, 0.004% and 0.010%. NF_3 emissions did not occur.

S.4. Trends of indirect greenhouse gases and SO_2

Emissions of all GHG precursors have significantly diminished since 1990. In case of SO_2 emissions, which amounted to 846.8 kt in 2013, the decrease was noted by about 70% between 1990 and 2013 what was 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 and lignite among fuels used for power and heat generation. Wider application of flue gases desulphurisation installations had the essential impact for ongoing SO_2 emissions decrease.

Emissions of NO_X in 2013 amounted 798.2 kt and significantly decreased between 1990 and 2013. Similar to sulphur dioxide, most of the reductions were triggered by the decline of the heavy industry in the late 1980s and early 1990s as well as the lower share of hard coal and lignite in fuel used in 1990s. Limited rate of reduction of NO_X emissions results from increased activities of various economy sectors, including transport, as well as from technological consequences related to reduction of emissions of other air pollutants, especially CO_2, SO_2, not combusted hydrocarbons and particulate matter. CO emissions in 2013 amounted to 2876.4 kt and dropped by more than 60% between 1990 - 2013 triggered by the same reasons as given for SO_2 and NO_X. Emissions of NMVOC were about 635.8 kt in 2013 and dropped by approximately 24% between 1990 and 2013.

1. INTRODUCTION

1.1. Background information on greenhouse gas inventories and climate change

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Methodologies used to calculate emissions and sinks of GHGs are those published by the Intergovernmental Panel on Climate Change (IPCC) in 2006, namely *Revised2006 Guidelines for National Greenhouse Gas Inventories* what is in accordance with the provisions of the decision 24/CP.19. According to these guidelines country specific methods have been used where appropriate giving more accurate emission data

At the same time the underlying report has been elaborated for the for the purpose of Poland's obligations resulting from Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC as well Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council.

The unit responsible for compiling the GHG inventory for the purpose of the European Union and the UNFCCC, according to the provisions of the Act of 17 July 2009 on the system to manage the emissions of greenhouse gases and other substances *(Journal of laws Nr 130, position 1070 with further changes)*, is the National Centre for Emissions Management (KOBiZE) in the Institute of Environmental Protection National Research Institute, supervised by the Minister of Environment.

1.2. A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management

The ***Act on 17 July 2009 on the system to manage the emissions of greenhouse gases and other substances*** (*Journal of Laws No 130 item 1070 with further changes)* established a legal base to manage the national emissions cap for greenhouse gases or other substances in a way that should ensure that Poland complies with EU and international commitments and will allow for cost-effective reductions of pollutant emission. The area of work specified in the act, carried out by the National Centre for Emissions Management (Krajowy Ośrodek Bilansowania i Zarządzania Emisjami – KOBiZE) established in the Institute of Environmental Protection – National Research Institute in Warsaw, includes:

- carry out tasks associated with functioning of the national system to balance and forecast emissions, including managing a national database on greenhouse gas emissions and other substances,
- elaborate methodologies to estimate emissions for individual types of installations or activities and methodologies to estimate emission factors per unit of produced good, fuel used or raw material applied,
- elaborate emission reports and projections for GHG and air pollutants,
- manage the national registry for Kyoto Protocol units,
- administration of Emission Trading Scheme.

The Minister responsible for issues related to the environment supervises the carrying out of tasks by the National Centre for Emissions Management.

According to Article 11 of above mentioned Act the National Centre prepare and submit to the Minister of Environment, 30 days before the deadlines of the provisions of European Union law or international environmental agreements, annual greenhouse gas inventories carried out in accordance with the guidelines of the UNFCCC and the substances listed in the Convention on Longrange Transboundary Air Pollution (UNECE CLRTAP). Prior to the submission the elaborated inventories undergo internal process for the official consideration and approval implemented by the Ministry of Environment.

The emission calculation, choices of activity data, emission factors and methodology are performed by the Emission Inventory Unit in the National Centre for Emissions Management. The national Centre is 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), Motor Transport Institute (ITS), Polish Geological Institute National Research Institute (PIG PIB), State Mining Authority (WUG) as well as Office for Forest Planning and Management (BULGiL). These institutions are mainly involved in providing activity data for inventory estimates. The experts of the National Centre have access to the individual data of entities participating in the European Union Emission Trading Scheme (EU-ETS). This verified data is included in GHG inventory for some IPCC subcategories (e.g. in some subsectors in industrial processes).

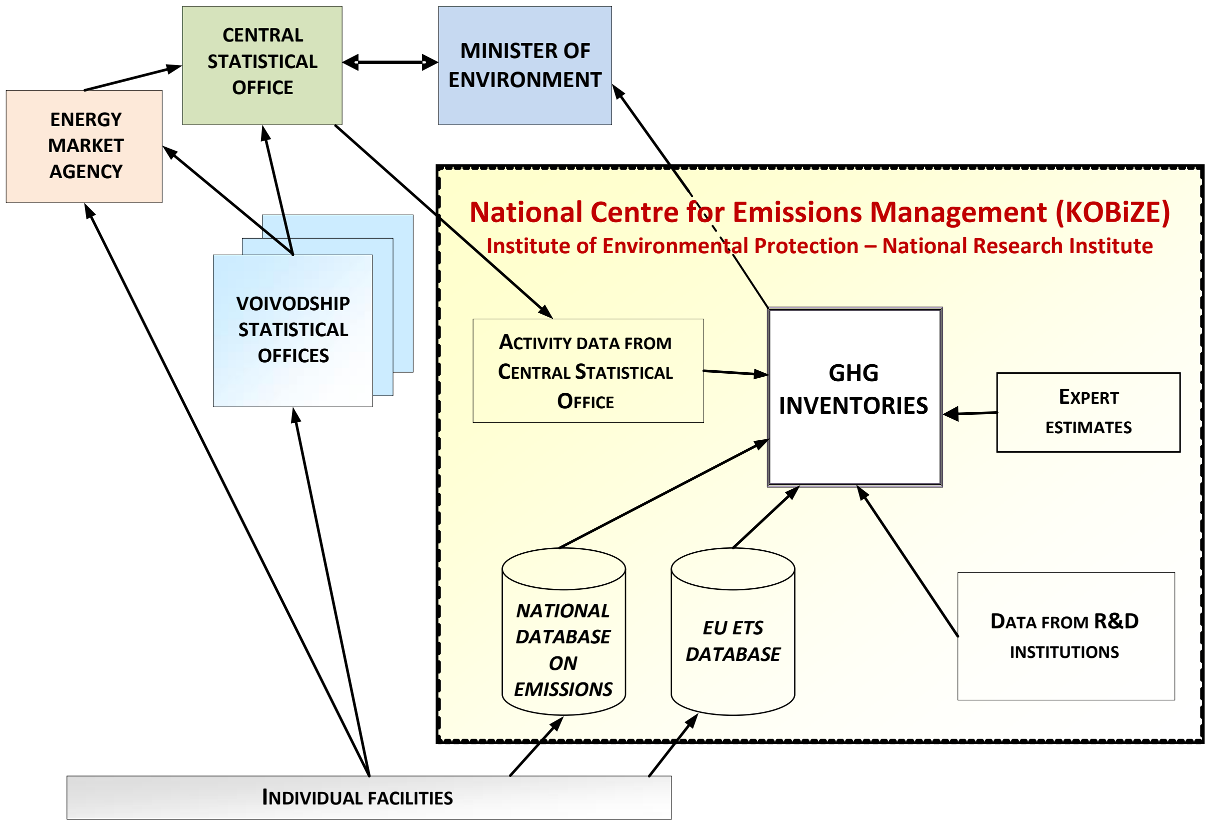

Figure 1.1. National GHG emissions inventory system scheme

The National Centre for Emissions Management, as the unit directly responsible for GHG inventory preparation, is also in charge of co-ordination and implementation of QA/QC procedures within inventory. The QA/QC programme has been elaborated in line with the *IPCC Guidelines* to assure high quality of the Polish annual greenhouse gas inventory. The QA/QC programme contains tasks, responsibilities as well as time schedule for performance of the QA/QC procedures. 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* method),
- Source category-specific QC procedures (*Tier 2*),
- QA review procedures,
- Reporting, documentation and archiving procedures.

For more detailed information see Annex 5.

1.3. Inventory preparation and data collection, processing and storage

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 UNECE/EMEP. Wherever necessary and possible, domestic methodologies and emission factors have been developed to reflect country specific 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, EUROSTAT) 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. 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 database in the KOBIZE, 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.

It should be mentioned here that Poland has made every effort to fill CRF reporting tables according to "UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention", however late delivery of the mandatory software for reporting (CRF Reporter) and encountered problems with functionality, may result in fact that some inventory data is missing or settled in incorrect cells. To make inconveniences of above situation minimized most important issues identified in CRF tables are presented below:

- Table 3s1 – redundant and misplaced information about N_2O emission from 3.B is displayed in 3.A (dairy cattle, goats and horses)
- Table 10s2 – table contains information about CO_2 emission, but in rows 67-70 are filled with information on all GHG recalculated to CO_2 equivalent. Empty cells with total emission including indirect CO_2 emission.
- Table NIR-2 – sum for "Total area at the end of the current inventory year" and "Total area at the end of the previous inventory year" is calculated incorrectly.
- Notation key explanations (NE, IE) and documentation boxes are not transferred to CRF tables or reported in wrong localization.

Submission 2015 of Poland was prepared with CRF Reporter v5.10.1, that was assessed as functional enough to fulfil UNFCCC Convention reporting requirements. Regard reporting under Kyoto Protocol of the Convention – in common decision of EU Members, number of problems identified in the CRF Reporter, does not allow to create KP tables and proceed with reporting process.

1.4. Brief general description of methodologies and data sources used

The GHG emissions and removals inventory presented in this report follow the recommended by decision 24/CP.19 the *2006 IPCC Guidelines for national inventories* [IPCC 2006]. 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 3–7.

The non-CO_2 GHG emissions from fuel combustion (1.A. category) were estimated based on fuel consumption estimates and respective emission factors. Data on fuel consumption for stationary sources with disaggregation into fuel type and source category come from fuel balances elaborated by Central Statistical Office and reported to Eurostat.

One of the steps of emission inventorying from the 1.A. *Energy* category is preparation of energy budgets for main fuels (energy carriers). 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: lignite, natural gas, coke-oven gas and blast furnace gas are presented in Annex 4.

The data on quantity of coal combusted in whole country in a given year (tab. 1.1) is used for calculation of the average net calorific value of this fuel. This calculated net calorific value provides then the basis for the estimation of country specific CO_2 emission factor based on empirical formula that apply the relationship between net calorific value and elemental carbon content in fuel (see chapter 3.1.1). This factor can be used for estimation of the potential CO_2 emission from coal combustion. The amount of fuel combusted in given year, calculated in fuel budget, can be compared with total consumption of this fuel in all sectors. It is one of the ways of verifying of sectoral approach.

Basic information on activity data regarding IPCC categories comes from Eurostat databases and Central Statistical Office. The activity data that are not available in the GUS has been worked out in frames of experts studies commissioned specifically for the GHG emission inventory purposes.

Table 1.1. Hard coal consumption in 2013

National fuel balance	Hard coal - Eurostat	
	kt	TJ
In	87 532	2 105 316
From national sources	77 017	1 842 979
1) Indigenous production	76 466	1 830 379
2) Transformation output or return	551	12 600
3) Stock decrease	0	0
Import	10 515	262 337
Out	87 532	2 105 316
National consumption	77 583	1 842 170
1) Transformation input	58 568	1 365 099
a) input for secondary fuel production	12 548	371 333
b) fuel combustion	46 020	993 766
2) Direct consumption	19 015	477 071
Non-energy use	157	3 669
Combusted directly	18 858	473 402
Combusted in Poland	64 878	1 467 168
Stock increase	-2 097	-51 491
Export	10 846	295 990
Losses and statistical differences	1 200	18 647

Net calorific value	MJ/kg	22.61

Eurostat database containing domestic data transferred by GUS is the main source of activities for *Energy* sector (Annex 4). The data on fuel consumption in *Road Transportation* subcategory was also taken from Eurostat database and next disaggregated on individual vehicle types based on methodology developed in the Motor Transport Institute.

1.5. Brief description of key categories

The source/sink categories in all sectors are identified to be *key categories* on the basis of their contribution to the total level and/or trend uncertainty established in accordance with 2006 IPCC GLs following Approach 1. In 2013, 25 sources were identified as Poland's key categories excluding LULUCF and 29 including LULUCF while in 1988 respectively: 22 and 25. For about 71% of GHG emissions in 2013 is responsible combustion of fuels, both in stationary and mobile sources. Those categories are of significant influence on a country's total GHG emissions in terms of both: level and trend of emissions. In table 1.2 the general information on identified key categories in the national inventory for 2013 are presented. The complete tables with level and trend assessments are given in Annex 1.

Table 1.2. Key category analysis results in 2013 (without LULUCF)

	IPCC Category Code	IPCC Source Categories	Classification	Greenhouse Gas	Identification criteria (Level, Trend, Qualitative)			Comments
1	1.A.1	Energy Industries	Solid Fuels	CO2	L	T		
2	1.A.3.b	Road Transportation	Fossil Fuels	CO2	L	T		
3	1.A.4	Other Sectors	Solid Fuels	CO2	L	T		
4	1.A.2	Manufacturing Industries and Construction	Solid Fuels	CO2	L	T		
5	1.B.1	Solid Fuels	Operation	CH4	L	T		
6	1.A.4	Other Sectors	Gaseous Fuels	CO2	L	T		
7	3.A	Enteric Fermentation	Farming	CH4	L	T		
8	3.D	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	L	T		
9	2.F.1	Refrigeration and Air conditioning	no classification	Aggregate F-gases	L	T		
10	1.A.4	Other Sectors	Liquid Fuels	CO2	L	T		
11	5.A	Solid Waste Disposal	Waste	CH4	L	T		
12	1.A.2	Manufacturing Industries and Construction	Gaseous Fuels	CO2	L	T		
13	2.A.1	Cement Production	no classification	CO2	L	T		
14	1.A.1	Energy Industries	Gaseous Fuels	CO2	L	T		
15	2.B.1	Ammonia Production	no classification	CO2	L			
16	1.A.1	Energy Industries	Liquid Fuels	CO2	L	T		
17	1.A.2	Manufacturing Industries and Construction	Liquid Fuels	CO2	L			
18	3.D	Agricultural Soils	Farming	N2O	L			
19	1.A.4	Other Sectors	Solid Fuels	CH4	L			
20	1.A.2	Manufacturing Industries and Construction	Other Fossil Fuels	CO2	L			
21	3.B	Manure Management	Farming	CH4	L			
22	1.B.1	Solid Fuels	Operation	CO2	L			
23	2.D	Non-energy Products from Fuels and Solvent Use	no classification	CO2	L			
24	1.A.2.a	Iron and Steel Production	no classification	CO2	L	T		
25	2.A.4	Other Process Uses of Carbonates	no classification	CO2	L	T		
26	2.B.2	Nitric Acid Production	no classification	N2O		T		
27	1.B.2	Other emissions from energy production	Operation	CO2		T		
28	1.A.3.c	Railways	Fossil Fuels	CO2		T		
29	3.G	Liming	Farming	CO2		T		
30	1.A.4	Other Sectors	Biomass	CH4		T		
31	5.D	Wastewater Treatment and Discharge	Wastewater	CH4		T		
32	1.B.2.c	Venting and Flaring	Operation	CH4		T		
33	2.B.1	Ammonia Production	no classification	CO2		T		

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

Uncertainty evaluation made for 2013 is based on calculations and national expert's judgments/ estimations as well as opinions expressed by international experts during the review lead by UNFCCC Secretariat in the years 2007-2012. Calculations include simplified method for sector 4 and for fluorinated industrial gases.

The estimate of emission uncertainty for the year 2013 was made using *Tier 1* approach. The uncertainty ranges varied significantly among various source categories and are presented within sectoral chapters 3-7. More details, including sectoral information on uncertainty ranges, are given in Annex 6.

1.7. General assessment of the completeness

The Polish GHG emission inventory includes calculation of emissions from all relevant sources recommended by the mandatory guidelines. Only CO_2 from *Coal Mining and Handling* (1.B.1.a) is not considered due to the lack of data at this level of aggregation.

2. Trends in greenhouse gas emissions

2.1. Description and interpretation of emission trends for aggregated greenhouse gas emissions

For carbon dioxide, net emission is calculated by subtracting from the total CO_2 emission – the emissions and removals from category 4. *Land Use, Land Use Change and Forestry* (LULUCF). According to the IPCC methodology, CO_2 emissions are given with and without contributions from category 4. 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 81.8% (excluding category 4) share in 2013, while the methane contributes with 10.7% (excluding category 4) to the national total. Nitrous oxide contribution is 5.1% (excluding category 4) and all industrial GHG together contribute 100.0%. Percentage share of GHG in national total emissions in 2013 is presented at figure 2.1.

Table 2.1. Greenhouse gas emissions in 2013 in CO_2 eq.

Pollutant	2013	
	Emission in CO_2 eq. [kt]	Share [%]
CO_2 (with LULUCF)	285 272.89	79.84
CO_2 (without LULUCF)	322 900.21	81.77
CH_4 (with LULUCF)	42 134.12	11.79
CH_4 (without LULUCF)	42 097.14	10.66
N_2O (with LULUCF)	20 236.95	5.66
N_2O (without LULUCF)	20 233.61	5.12
HFCs	9 606.78	2.43
PFCs	14.64	0.00
Mix HFC i PFC	NA	NA
SF_6	39.15	0.01
NF_3	NA,NO	NA,NO
TOTAL net emission (with LULUCF)	357 304.53	100.00
TOTAL without LULUCF	394 891.52	100.00

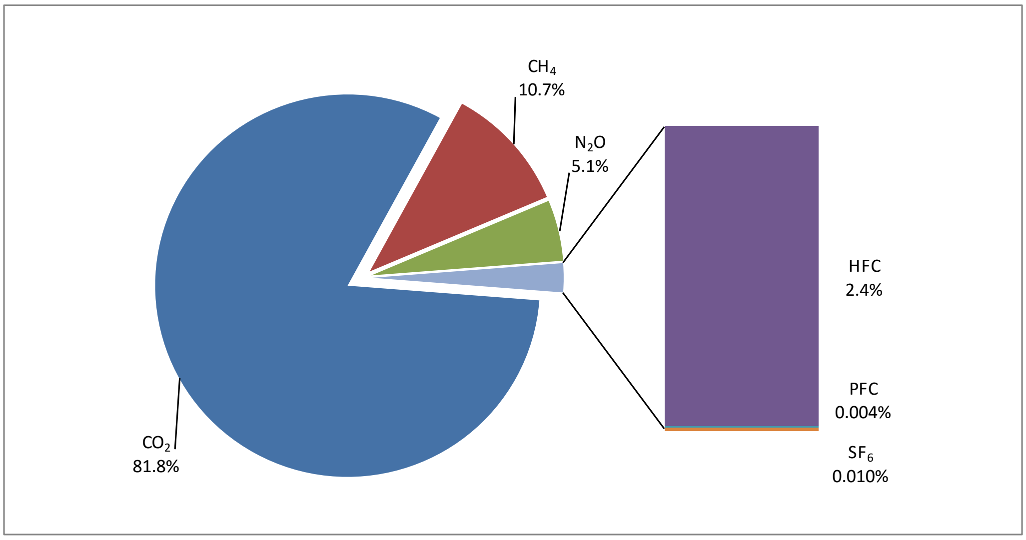

Figure 2.1. Percentage share of greenhouse gases in national total emission in 2013 (excluding category 4)

Emissions of main GHGs in 2013, disaggregated into main source sub-sectors, are given in table 2.2. Respective values for the fluorinated industrial gases are presented in table 2.3. Discussion of these results is given in the following sections.

Table 2.2. Emissions of CO_2, CH_4 and N_2O in 2013 [kt]

[kt]	CO_2	CH_4	N_2O
TOTAL without LULUCF	322 900.21	1 683.89	67.90
TOTAL with LULUCF	285 272.89	1 685.36	67.91
1. Energy	302 125.95	755.01	8.29
A. Fuel Combustion	298 208.54	158.80	8.29
1. Energy Industries	169 172.05	4.49	2.70
2. Manufacturing Industries and Construction	29 820.43	4.09	0.57
3. Transport	43 351.76	4.12	1.80
4. Other Sectors	55 864.29	146.09	3.22
5. Other	IE, NO	IE, NO	IE, NO
B. Fugitive Emissions from Fuels	3 917.41	596.21	0.002
1. Solid Fuels	1 899.61	497.95	NA
2. Oil and Natural Gas	2 017.80	98.26	0.00
2. Industrial Processes and Product Use	19 337.72	2.55	4.12
A. Mineral Products	9 255.14	NA	NA
B. Chemical Industry	5 517.45	1.99	3.72
C. Metal Production	2 434.45	0.55	NA
D. Other Production	2 130.68	NE	NE
G. Other	NO	NO	0.4
3. Agriculture	883.46	543.51	52.45
A. Enteric Fermentation	NE	468.50	NE
B. Manure Management	NE	74.04	6.69
D. Agricultural Soils	NE	NA	45.72
F. Field Burning of Agricultural Residues	NE	0.97	0.04
G. Liming	438.83	NA	NA
H. Urea application	444.63	NA	NA
4. Land Use, Land-Use Change and Forestry	-37 627.32	1.48	0.01
A. Forest Land	-41 421.75	1.39	0.0098
B. Cropland	-435.68	IE, NO	0.0000
C. Grassland	-348.42	0.09	0.00141
D. Wetlands	4 316.31	0.00	0.0000
E. Settlements	262.23	NA, NO	NA, NO
F. Other Land	NA, NO	NA, NO	NA, NO
5. Waste	553.08	382.82	3.04
A. Solid Waste Disposal	NO,NA	341.89	NO,NA
B. Biological Treatment of Solid Waste	NO,NA	5.49	0.41
C. Incineration and Open Burning of Waste	553.08	0.00	0.15
D. Wastewater Treatment and Discharge	NO,NA	35.44	2.48

Table 2.3. Emissions of industrial gases: HFCs, PFCs and SF_6 in 2013 [kt eq. CO_2]

2013	HFCs	PFCs	SF_6	Total in eq. CO_2
Total Industrial gases [kt eq. CO_2]	9 606.78	14.64	0.00	9 660.57
C. Metal Production	NE	NO	0.00	4.15
4. Magnesium production	NE	NO	0.00	4.15
F. Consumption of Halocarbons and SF_6	9 606.78	14.64	0.00	9 621.41
1. Refrigeration and Air Conditioning Equipment	9 278.77	NO	NO	9 278.77
2. Foam Blowing	141.24	NO	NO	141.24
3. Fire Extinguishers	61.41	14.64	NA	76.04
4. Aerosols	124.95	NA	NA	124.95
G. Other product manufacture and use	NO	NO	0.00	35.01
1. Electrical equipment	NO	NO	0.00	35.01

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 2013 for CO_2, CH_4 and N_2O.

Trend of aggregated greenhouse gases emissions follows the trend of emissions CO_2 alone which is the primary greenhouse gas emitted in Poland. The GHGs trend for period between 1988 and 1990 indicate dramatic decrease triggered by significant economic 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 development in heavy industry and other sectors and dynamic economic growth. The succeeding years characterize slow decline in emissions up to 2002, when still energy efficiency policies and measures were implemented, and then slight increase up to 2007 caused by animated economic development. Since 2008 stabilisation in emissions has been noted with distinct decrease in 2009 related to world economic slow-down (figure 2.2 and tables 2.5 and 2.6). Since 2010 GHG emissions in Poland gradually decreases.

Since 2005 Poland takes part in the European Union's Emission Trading System, being one of the flexible mechanism supporting measures for limiting the greenhouse gas emissions. The share of emissions related to installations covered by EU ETS in the national emissions in 2005−2013 amounted about 50% on average (from 49% in 2009−2010 up to 52% in 2013). One should notice that since 2013 the scope of the EU ETS has expanded with new industries (like production of selected chemicals) and greenhouse gases (nitrous oxide) (Fig. S.2).

Table 2.4. Percentage shares of individual source sectors in 2013 emissions

Percentage share of emissions of source sectors in current year without LULUCF	Share [%]		
	CO_2	CH_4	N_2O
TOTAL	100.00	100.00	100.00
1. Energy	93.57	44.84	12.21
A. Fuel Combustion	92.35	9.43	12.20
1. Energy Industries	52.39	0.27	3.97
2. Manufacturing Industries and Construction	9.24	0.24	0.84
3. Transport	13.43	0.24	2.65
4. Other Sectors	17.30	8.68	4.74
5. Other	IE, NO	IE, NO	IE, NO
B. Fugitive Emissions from Fuels	1.21	35.41	0.00
1. Solid Fuels	0.59	29.57	NA
2. Oil and Natural Gas	0.62	5.84	0.00
2. Industrial Processes and Product Use	5.99	0.15	6.07
A. Mineral Products	2.87	NA	NA
B. Chemical Industry	1.71	0.12	5.49
C. Metal Production	0.75	0.03	NA
D. Other Production	0.66	NE	NE
G. Other	NO	NO	0.59
3. Agriculture	0.27	32.28	77.24
A. Enteric Fermentation	NE	27.82	NE
B. Manure Management	NE	4.40	9.85
D. Agricultural Soils	NE	NA	67.34
F. Field Burning of Agricultural Residues	NE	0.06	0.06
G. Liming	0.14	NA	NA
H. Urea application	0.14	NA	NA
4. Land Use, Land-Use Change and Forestry	-	-	-
A. Forest Land	-	-	-
B. Cropland	-	-	-
C. Grassland	-	-	-
D. Wetlands	-	-	-
E. Settlements	-	-	-
F. Other Land	-	-	-
5. Waste	0.17	22.73	4.48
A. Solid Waste Disposal	NO,NA	20.30	NO,NA
B. Biological Treatment of Solid Waste	NO,NA	0.33	0.61
C. Incineration and Open Burning of Waste	0.17	0.00	0.22
D. Wastewater Treatment and Discharge	NO,NA	2.10	3.65

Table 2.5. National emissions of greenhouse gases for 1988–2013 according to gases [kt CO_2 eq.]

GHG	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (with LULUCF)	460 160.19	434 672.34	352 503.13	356 469.99	370 450.85	362 837.21	358 040.22	348 448.09	344 253.18	335 298.88	300 260.35	283 720.28	288 498.87
CO_2 (without LULUCF)	474 657.36	454 416.20	379 464.82	376 496.13	366 413.10	366 726.68	362 432.48	363 900.96	377 676.61	368 543.24	339 469.55	329 870.26	319 482.57
CH_4 (with LULUCF)	77 294.20	74 995.11	67 479.63	64 470.58	61 084.54	60 020.43	59 392.81	58 448.56	57 837.31	57 012.35	53 166.14	51 770.51	49 204.39
CH_4 (without LULUCF)	77 250.07	74 951.07	67 435.57	64 425.59	61 040.03	59 978.22	59 351.88	58 402.66	57 800.92	56 974.41	53 131.81	51 733.41	49 171.84
N_2O (with LULUCF)	28 852.52	30 192.03	27 759.56	22 441.99	20 960.10	21 904.61	21 764.52	22 747.56	22 914.47	22 809.33	22 554.55	21 843.19	22 214.48
N_2O (without LULUCF)	28 841.35	30 180.86	26 866.85	22 435.84	20 909.08	21 892.86	21 752.25	22 738.14	22 897.95	22 800.06	22 548.47	21 832.39	22 205.75
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	97.34	228.41	373.93	462.23	673.38	1 739.19
PFCs	147.26	147.51	141.87	141.31	134.63	144.86	152.78	171.97	161.07	173.36	174.86	168.71	176.68
Unspecified mix of HFCs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SF_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	13.27	29.12	23.80	22.91	23.94	23.50	23.07
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
TOTAL (with LULUCF)	**566 454.17**	**540 006.98**	**447 884.19**	**443 523.87**	**452 630.12**	**444 907.11**	**439 363.60**	**429 942.65**	**425 418.24**	**415 690.76**	**376 642.06**	**358 199.57**	**361 856.67**
TOTAL (without LULUCF)	**580 896.03**	**559 695.64**	**473 909.11**	**463 498.88**	**448 496.84**	**448 742.62**	**443 702.65**	**445 340.19**	**458 788.75**	**448 887.92**	**415 810.85**	**404 301.66**	**392 799.10**

Table 2.5. (cont.) National emissions of greenhouse gases for 1988–2013 according to gases [kt CO_2 eq.]

GHG	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CO_2 (with LULUCF)	292 787.16	275 634.32	286 793.86	279 317.04	279 010.67	276 744.28	305 305.23	298 537.94	286 803.12	308 474.02	298 872.40	292 423.36	285 272.89
CO_2 (without LULUCF)	315 509.06	307 790.64	320 487.58	324 514.92	323 586.36	337 065.77	336 707.74	329 704.52	316 191.13	336 695.02	333 947.03	326 969.55	322 900.21
CH_4 (with LULUCF)	49 916.25	47 897.98	47 855.66	47 120.62	47 015.34	46 956.37	45 555.41	44 585.31	43 047.11	43 546.82	42 304.59	42 758.38	42 134.12
CH_4 (without LULUCF)	49 883.67	47 863.26	47 818.75	47 086.36	46 981.85	46 917.29	45 525.71	44 550.67	43 017.27	43 515.17	42 273.51	42 726.61	42 097.14
N_2O (with LULUCF)	22 372.57	21 263.48	21 500.97	22 002.96	22 356.38	22 696.43	23 521.32	23 974.79	19 832.83	19 546.80	19 887.18	19 835.40	20 236.95
N_2O (without LULUCF)	22 367.29	21 256.07	21 477.45	21 996.94	22 168.36	22 687.42	23 487.23	22 950.33	19 826.93	19 542.95	19 882.64	19 826.27	20 233.61
HFCs	2 323.03	3 137.01	4 059.79	4 335.11	5 317.72	6 074.69	6 993.20	7 415.19	8 366.72	8 304.03	8 992.69	9 234.01	9 606.78
PFCs	197.34	207.33	201.08	205.07	187.41	193.58	184.63	163.12	17.97	17.07	16.22	15.41	14.64
Unspecified mix of HFCs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SF_6	22.86	23.29	20.72	22.36	26.80	33.20	31.16	32.87	37.60	35.37	39.02	40.13	39.15
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
TOTAL (with LULUCF)	**367 619.22**	**348 163.41**	**360 432.08**	**353 003.16**	**353 914.31**	**352 698.54**	**381 590.96**	**374 709.21**	**358 105.34**	**379 924.10**	**370 112.09**	**364 306.67**	**357 304.53**
TOTAL (without LULUCF)	**390 303.26**	**380 277.60**	**394 065.37**	**398 160.76**	**398 268.49**	**412 971.94**	**412 929.67**	**404 816.70**	**387 457.61**	**408 109.60**	**405 151.11**	**398 811.96**	**394 891.52**

Table 2.6. National emissions of greenhouse gases for 1988–2013 according to IPCC categories [kt CO_2 eq.]

IPCC sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy	483 466.81	461 231.72	386 536.68	386 344.92	376 329.65	378 288.32	371 703.39	372 445.51	387 356.19	376 404.40	344 976.27	336 225.23	322 702.24
2. Industrial Processes	34 248.55	33 067.80	25 372.91	22 064.63	21 087.87	21 212.39	23 471.35	25 019.47	24 135.04	24 939.16	23 256.48	22 116.60	25 788.57
3. Agriculture	48 438.01	50 711.41	47 608.57	40 917.81	37 093.27	35 483.29	35 150.91	34 720.57	34 339.01	34 671.46	34 681.52	33 144.30	31 347.23
4. Land-Use, Land-Use Change and Forestry	-14 441.86	-19 688.65	-26 024.92	-19 975.01	4 133.29	-3 835.52	-4 339.05	-15 397.54	-33 370.52	-33 197.16	-39 168.79	-46 102.09	-30 942.43
5. Waste	14 742.65	14 684.71	14 390.95	14 171.52	13 986.04	13 758.62	13 376.99	13 154.63	12 958.51	12 872.90	12 896.58	12 815.52	12 961.06
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
TOTAL (with LULUCF)	**566 454.17**	**540 006.98**	**447 884.19**	**443 523.87**	**452 630.12**	**444 907.11**	**439 363.60**	**429 942.65**	**425 418.24**	**415 690.76**	**376 642.06**	**358 199.57**	**361 856.67**
TOTAL (without LULUCF)	**580 896.03**	**559 695.64**	**473 909.11**	**463 498.88**	**448 496.84**	**448 742.62**	**443 702.65**	**445 340.19**	**458 788.75**	**448 887.92**	**415 810.85**	**404 301.66**	**392 799.10**

Table 2.6. (cont.) National emissions of greenhouse gases for 1988–2013 according to IPCC categories [kt CO_2 eq.]

IPCC sector	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1. Energy	322 624.91	314 258.63	325 444.38	328 765.16	328 523.40	339 722.69	336 303.38	329 833.73	318 421.23	338 562.43	332 755.32	327 734.72	323 470.71
2. Industrial Processes	24 165.98	23 139.90	26 418.37	27 798.64	27 947.50	30 591.97	33 529.53	32 314.72	26 972.63	28 038.05	30 966.26	30 000.45	30 290.96
3. Agriculture	30 865.16	30 267.98	29 698.28	29 617.04	29 860.99	30 912.87	31 353.43	31 184.76	30 470.72	29 962.73	30 305.15	30 086.67	30 100.41
4. Land-Use, Land-Use Change and Forestry	-22 684.05	-32 114.20	-33 633.29	-45 157.60	-44 354.18	-60 273.40	-31 338.71	-30 107.49	-29 352.27	-28 185.50	-35 039.02	-34 505.29	-37 586.99
5. Waste	12 647.21	12 611.10	12 504.34	11 979.92	11 936.60	11 744.42	11 743.33	11 483.49	11 593.03	11 546.40	11 124.39	10 990.11	11 029.45
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
TOTAL (with LULUCF)	**367 619.22**	**348 163.41**	**360 432.08**	**353 003.16**	**353 914.31**	**352 698.54**	**381 590.96**	**374 709.21**	**358 105.34**	**379 924.10**	**370 112.09**	**364 306.67**	**357 304.53**
TOTAL (without LULUCF)	**390 303.26**	**380 277.60**	**394 065.37**	**398 160.76**	**398 268.49**	**412 971.94**	**412 929.67**	**404 816.70**	**387 457.61**	**408 109.60**	**405 151.11**	**398 811.96**	**394 891.52**

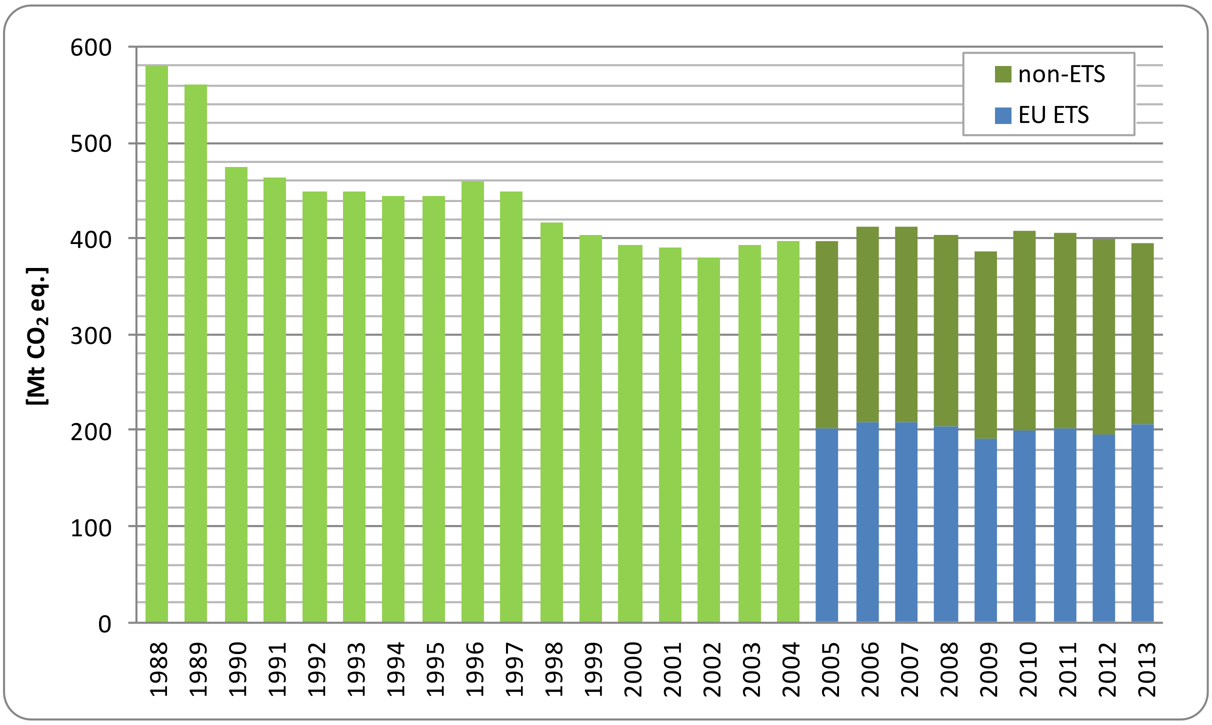

Figure 2.2. Trend of aggregated GHGs emissions (excluding category 4) for 1988–2013

2.2. Description and interpretation of emission trends by gas

Carbon dioxide (CO_2)

In 2013, the CO_2 emissions (without LULUCF) were estimated as 322.90 million tonnes, while when sector 4. LULUCF is included the figure reaches 285.27 million tonnes (table 2.1). CO_2 share in total GHG emissions in 2013 amounted to 81.8%. The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission (without LULUCF) by 92.4% in 2013 (fig. 2.3). The shares of the main subcategories in 1.A were as follows: *Energy industries* - 52.4%, *Manufacture Industries and Construction* – 9.2%, *Transport* – 13.4% and *Other Sectors* – 17.3%. Sector 2. *Industrial Processes* contributed to the total CO_2 emission by 6.0% in 2013. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO_2 emission/removal in LULUCF sector in 2013, was calculated to be approximately 37.6 million tonnes. It means that app. 11.7% of the total CO_2 emissions are offset by CO_2 uptake by forests.

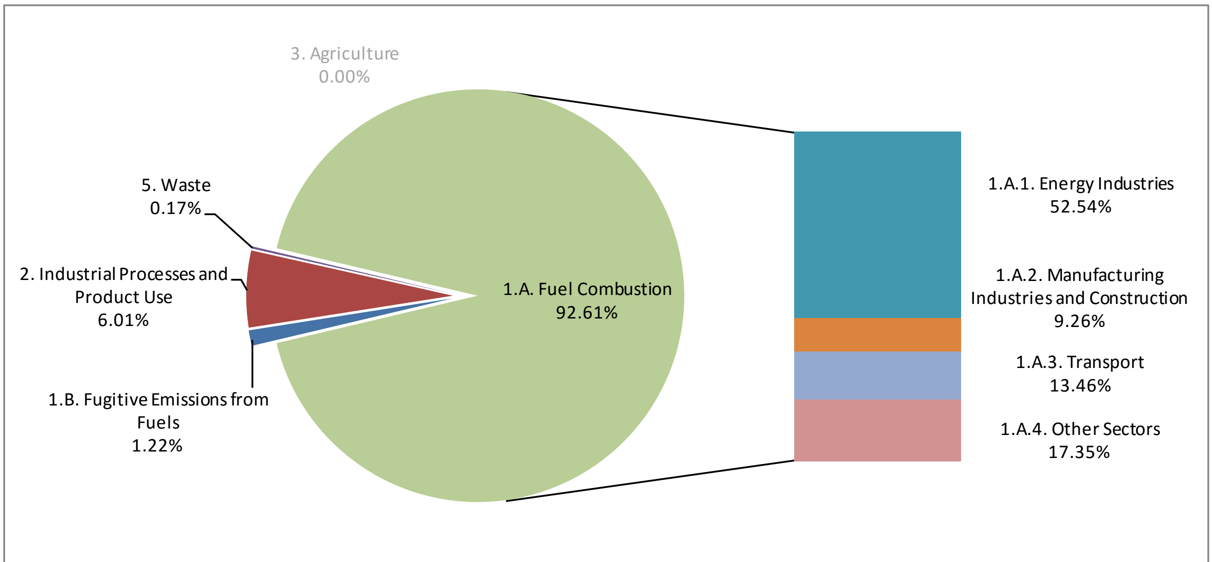

Figure 2.3. Carbon dioxide emission (excluding category 4) in 2013 by sector

Methane (CH_4)

The CH_4 emission (excluding category 4) amounted to 1 683.89 kt in 2013 i.e. 42.10 million tonnes of CO_2 equivalents (table 2.1). CH_4 share in total GHG emissions in 2013 amounted to 10.7%. Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed to 35.4%, 32.3% and 22.7% of the national methane emission in 2013, respectively (fig. 2.4). The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 29.6% of total CH_4 emission) and *Oil and Natural Gas* system (about 5.8% of total emission). The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 27.8% of total methane emission in 2013. *Disposal sites* contributed to 20.3% of the methane emission.22.7

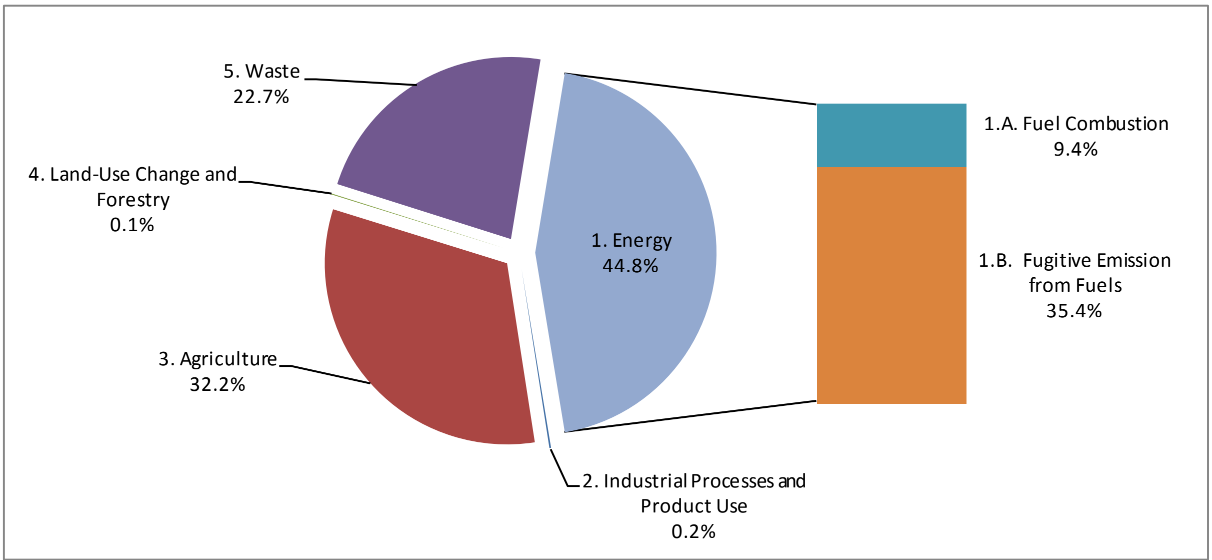

Figure 2.4. Methane emission (excluding category 4) in 2013 by sector

Nitrous oxide (N_2O)

The nitrous oxide emissions (excluding category 4) in 2013 were 67.90 kt i.e. 20.23 million tonnes of CO_2 equivalents (table 2.2). N_2O share in total GHG emissions in 2013 amounted to 5.1%. The main N_2O emission sources and its shares in total N_2O emission in 2013 are: *Agricultural Soils* – 67.3%, *Manure Management* – 9.9%, *Chemical Industry* – 6.1% and *Fuel Combustion* – 12.2% (fig. 2.5).

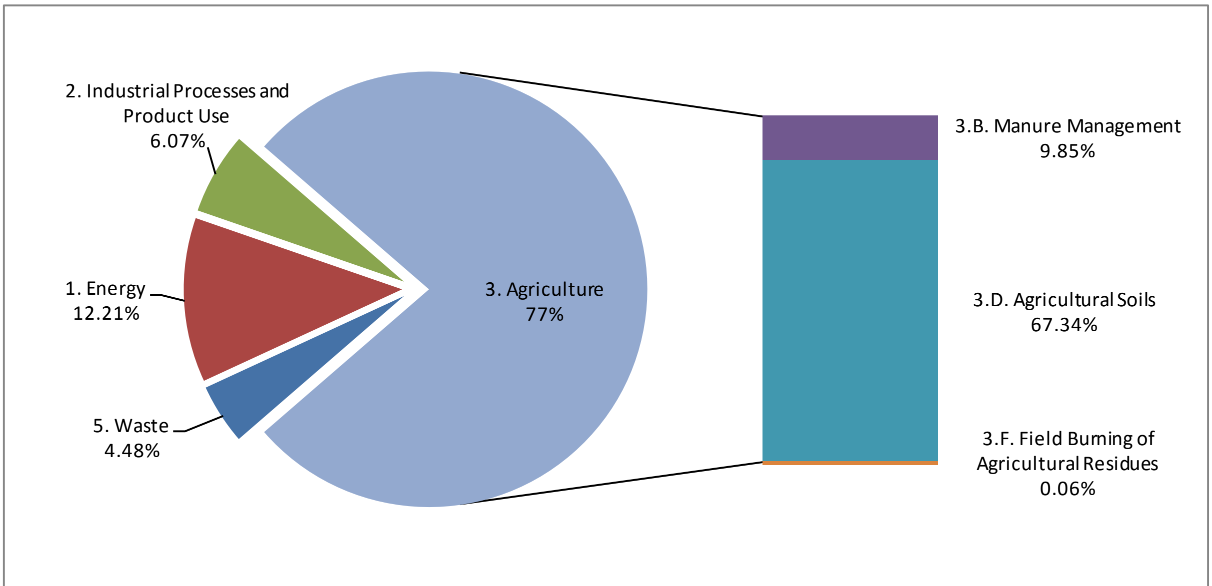

Figure 2.5. Nitrous oxide emission (excluding category 4) in 2013 by sector

Industrial gases

The total emission of industrial gases (HFCs, PFCs SF_6 and NF_3) in 2013 was 9 660.57 kt CO_2 equivalent what accounts for 2.4% of total GHG emissions share in 2013. This significant growth in HFCs emission is mainly due to the increase in emission from refrigeration and air conditioning equipment. Shares of HFCs, PFCs and SF_6 in total 2013 GHG emissions was respectively as follows: 2.43%, 0.004% and 0.010%. NF_3 emissions did not occur.

The total emissions in 2013 according to groups of industrial gases are as follows: HFCs –9.61 million tonnes of CO_2 equivalents, PFCs – 0.01 million tonnes of CO_2 equivalents and SF_6 – 0.04 million tonnes of CO_2 equivalents.

Comparison of GHG emissions to the base year

Percentage share of individual GHGs to national total in the base year (1988/1995) is presented at figure 2.6. Compared to the base year, the percentage share of CO_2 (excluding category 4) in 2013 increased from 81.7% to 81.8%.

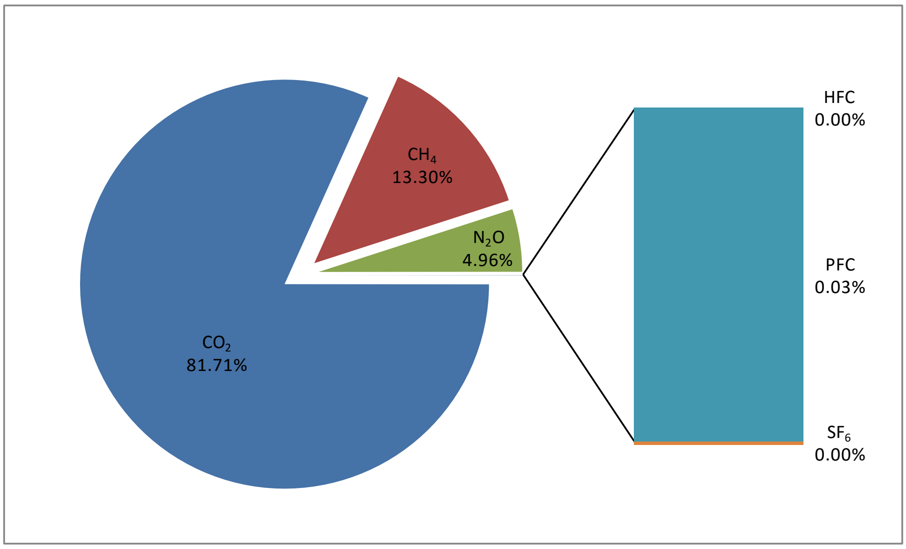

Figure 2.6. Percentage share of national greenhouse gas emissions in base year excluding emission from category 4

Table 2.7. Greenhouse gas emissions in 2013 with respect to base year

Pollutant	Emission in CO_2 eq. [kt]		2013/base year [%]
	Base year	2013	
CO_2 (with LULUCF)	460 160.19	285 272.89	61.99
CO_2 (without LULUCF)	474 657.36	322 900.21	68.03
CH_4 (with LULUCF)	77 294.20	42 134.12	54.51
CH_4 (without LULUCF)	77 250.07	42 097.14	54.49
N_2O (with LULUCF)	28 852.52	20 236.95	70.14
N_2O (without LULUCF)	28 841.35	20 233.61	70.15
HFCs	97.34	9 606.78	9868.94
PFCs	171.97	14.64	8.51
Unspecified mix of HFCs and PFCs	NA	NA	NA
SF_6	29.12	39.15	134.45
NF_3	NA	NA,NO	NA
TOTAL net emission (with LULUCF)	566 478.88	357 304.53	63.07
TOTAL without LULUCF	580 920.74	394 891.52	67.98

Comparison of GHG emissions in 2013 and the base year is given in table 2.8 and indicates significant drop in all gases, except HFCs and SF_6, especially in methane emissions where decrease number amounted to 45% in 1988-2013. This was mainly caused by serious drop in coal mining as well as significant drop in livestock population.

Carbon dioxide

CO_2 emission (excluding category 4) had decreased by app. 32.0% from the base year (1988) to 2013. The following changes took place in the structure of fuel use:

- share of solid fuels decreased from 80.1% in the base year to 56.7% in 2013,
- share of liquid fuels increased from 11.7% in the base year to 21.6% in 2013,
- share of gaseous fuels increased from 6.2% in the base year to 12.5% in 2013.

Methane

CH_4 emission (excluding category 4) had decreased by app. 45.5% from the base year (1988) to 2013. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 46.6%,
- the decrease in *Fugitive Emission* by 55.3%,
- the decrease in emission from *Waste* by 29.3%.

Nitrous oxide

The nitrous oxide emissions (excluding category 4) in 2013 were app. 29.8% lower than the respective figure for the base year (1988). The share in *Manure Management* decreased from 11.5% in the base year 1988 to 10.2% in 2013, in *Agricultural Soils* increased from 63.3% in the base year 1988 to 70.0% in 2013 and in *Chemical Industry* decreased from 17.3% in the base year 1988 to 5.7% in 2013.

Industrial gases: HFCs, PFCs, NF_3 and SF_6

HFCs emissions in 2013 were 98.7 times higher than in base year (1995). This significant growth in HFCs emission is mainly due to the increase in emission from refrigeration and air conditioning equipment. PFCs emissions in 2013 were 91.5% lower than in base year (1995). The PFCs emission changes between 2013 and the preceding years depend on the aluminium production levels (main PFC source) and the use of C_4F_{10} in fire extinguishers.

SF_6 emissions in 2013 were about 29.1% higher than in base year (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 (1995), does not influence significantly the national total GHG emission trend, because all the fluorinated industrial gases together contributed merely app. 2.4% to the national total in 2013. NF_3 emissions did not occur.

2.3. Description and interpretation of emission trends by category

Table 2.8 includes emissions of greenhouse gases from all categories for the base year and for year 2013 according to main categories. In 2013 total GHG emissions accounted for 394.89 million tons CO_2 eq. excluding sector 4. LULUCF. Comparing to the fixed base year emissions in 2013 decreased by 32.0%.

Table 2.8. GHG emissions according to main sectors in base year and 2013

	Total [kt eq. CO_2]		(2013-base)/base [%]
	Base year	2013	
TOTAL with LULUCF	566 478.88	357 304.53	-36.9
TOTAL without LULUCF	580 920.74	394 891.52	-32.0
1. Energy	483 466.81	323 470.71	-33.1
2. Industrial Processes and Product Use	34 273.26	30 290.96	-11.6
3. Agriculture	48 438.01	30 100.41	-37.9
4. Land-Use, Land-Use Change and Forestry	-14 441.86	-37 586.99	160.3
5. Waste	14 742.65	11 029.45	-25.2

2.3.1. Energy

The emission of GHGs from *Energy* sector in 2013 was 323.5 million tons of CO_2 equivalent. CO_2 emission share exceeded 93.4% of the total GHG emissions within 1. *Energy* category (table 2.9). The most emission intensive category was 1.A.1. *Fuel combustion activities* related mostly to heavy industry sector, highly energy consuming.

Table 2.9. GHG emissions from sub-sectors in category 1. *Energy* in 2013

GHG emission categories	GHG emission [kt CO_2 eq.]	% share in the total emission from Energy	% share in total GHG emission from a given subsector		
			CO_2	CH_4	N_2O
1. TOTAL ENERGY	323 470.71	100.0	93.4	5.8	0.8
A. Fuel Combustion	304 647.50	94.2	92.2	1.2	0.8
1. Energy Industries	170 088.03	52.6	52.3	0.0	0.2
2. Manufacturing Industries and Construction	30 093.08	9.3	9.2	0.0	0.1
3. Transport	43 990.35	13.6	13.4	0.0	0.2
4. Other Sectors	60 476.04	18.7	17.3	1.1	0.3
5. Other	0.00	0.0	0.0	0.0	0.0
B. Fugitive Emissions from Fuels	18 823.21	5.8	1.2	4.6	0.0
1. Solid Fuels	14 348.47	4.4	0.6	3.8	0.0
2. Oil and Natural Gas and other emissions from energy production	4 474.74	1.4	0.6	0.8	0.0

2.3.2. Industrial Processes and Product Use

Table 2.10 shows detailed information on emissions of CO_2, CH_4, N_2O as well as HFCs, PFCs, SF_6 in 2. *Industrial Processes and Product Use* sector in 2013. CO_2 is dominating among GHGs – it's contribution exceeds 63.8%. The main GHG emission sources in this category were: production processes of cement, nitric acid and ammonia.

Table 2.10. The emissions of CO_2, CH_4 and N_2O from *Industrial Processes and Product Use* in 2013

GHG emission categories	GHG emission [kt CO_2 eq.]	% share in the total emission from sector 2.	% share in total GHG emission from a given subsector			
			CO_2	CH_4	N_2O	HFC, PFC and SF_6
2. TOTAL INDUSTRIAL PROCESSES AND PRODUCT USE	30 290.96	100.0	63.8	0.2	4.1	31.9
A. Mineral Products	9 255.14	30.6	30.6	0.0	0.0	0.0
B. Chemical Industry	6 677.09	22.0	18.2	0.2	3.7	0.0
C. Metal Production	2 452.43	8.1	8.0	0.0	0.0	0.0
D. Non-energy products from fuels and solvent use	2 130.68	7.0	7.0	0.0	0.0	0.0
F. Product uses as substitutes for ODS	9621.41	31.8	0.0	0.0	0.0	31.8
G. Other product manufacture and use	154.21	0.5	0.0	0.0	0.4	0.1

2.3.3. Agriculture

The main sources of GHG in category 3. *Agriculture* were: 3.D. *Agricultural Soils,* 3.A. *Enteric Fermentation* and 3.B. *Manure Management* (table 2.11). N_2O emission share was the largest in total GHG emission from 3. *Agriculture* in 2013 and came from both – direct (mineral and organic fertilization) and indirect (volatilization, leaching and runoff from applied synthetic fertilizer and animal manure) N_2O emissions from soils.

Table 2.11. GHG emissions from *Agriculture* in 2013

GHG emission categories	GHG emission [kt CO_2 eq.]	% share in the total emission from Agriculture	% share in total GHG emission from a given subsector	
			CH_4	N_2O
3. TOTAL AGRICULTURE	30 100.41	100.0	45.1	51.9
A. Enteric Fermentation	11 712.49	38.9	38.9	0.0
B. Manure Management	3 844.55	12.8	6.1	6.6
D. Agricultural Soils	13 624.47	45.3	0.0	45.3
F. Field Burning of Agricultural Residues	35.44	0.1	0.1	0.0
G. Liming	438.83	1.5	0.0	0.0
H. Urea application	444.63	1.5	0.0	0.0

2.3.4. Waste

As it can be seen in table 2.12, the emission of CH_4 dominated in this sector in 2013 (almost 86.8%). The main part of GHG emissions came from 6.A. *Solid waste disposal*.

Table 2.12. GHG emissions from *Waste* in 2013

GHG emission categories	GHG emission [kt CO_2 eq.]	% share in the total emission from Waste	% share in total GHG emission from a given subsector		
			CO_2	CH_4	N_2O
5. TOTAL WASTE	11 029.45	100	5.0	86.8	8.2
A. Solid Waste Disposal	8 547.27	77.5	0.0	77.5	0.0
B. Biological Treatment of Solid Waste	260.01	2.4	0.0	1.2	1.1
C. Incineration and Open Burning of Waste	597.57	5.4	5.0	0.0	0.4
D. Wastewater Treatment and Discharge	1 624.60	14.7	0.0	8.0	6.7

2.4. Emission trends for SO_2 and indirect greenhouse gases

Emissions of all GHG precursors have significantly diminished since 1990. In case of SO_2 emissions, which amounted to 846.8 kt in 2013, the decrease was noted by about 70% between 1990 and 2013 what was 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 and lignite among fuels used for power and heat generation. Wider application of flue gases desulphurisation installations had the essential impact for ongoing SO_2 emissions decrease.

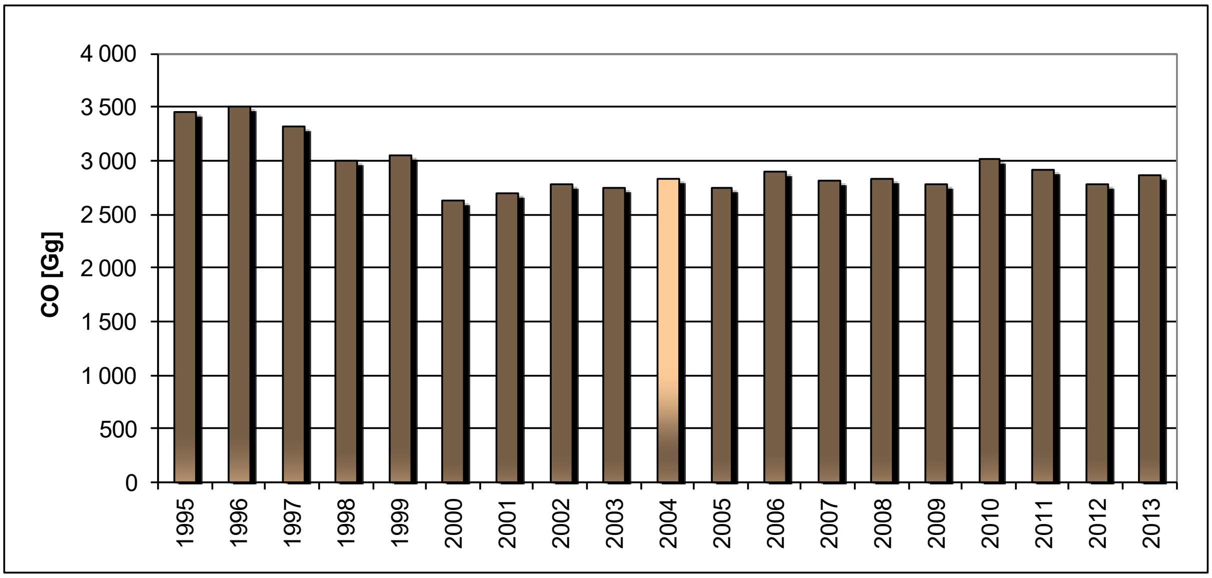

Figure 2.7. Emissions of CO in 1995-2013

Emissions of NO_X in 2013 amounted 798.2 kt and significantly decreased between 1990 and 2013. Similar to sulphur dioxide, most of the reductions were triggered by the decline of the heavy industry in the late 1980s and early 1990s as well as the lower share of hard coal and lignite in fuel used in 1990s. Increasing emissions from road transport cause comparatively lower (36%) total emission reductions than in case of SO_2 (*ca.* 70%).

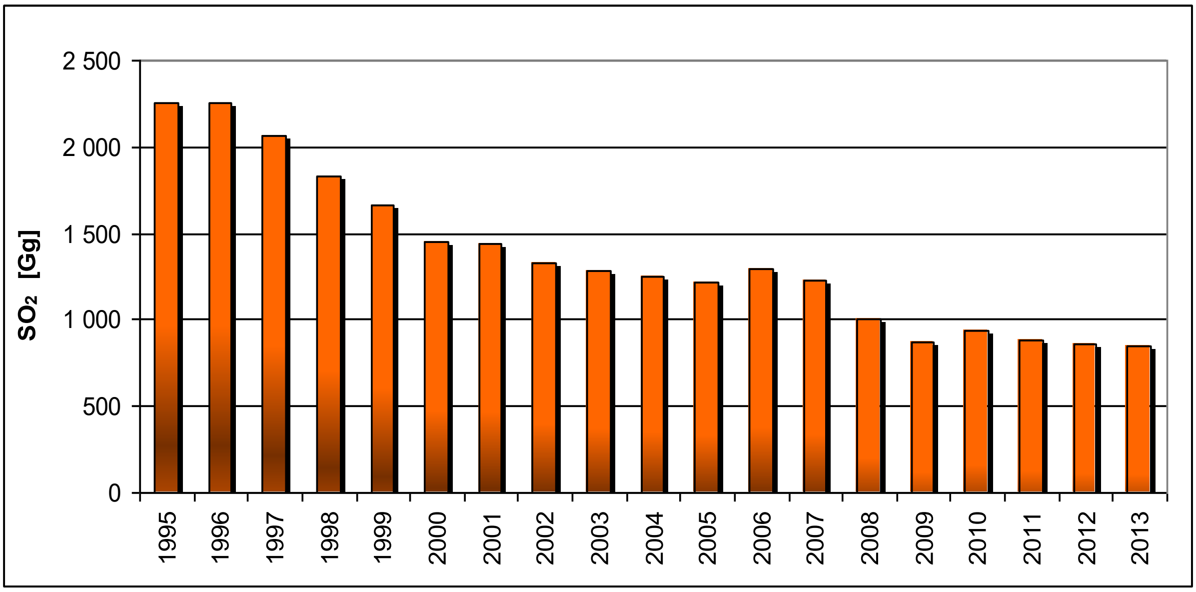

Figure 2.8. Emissions of SO_2 in 1995-2013

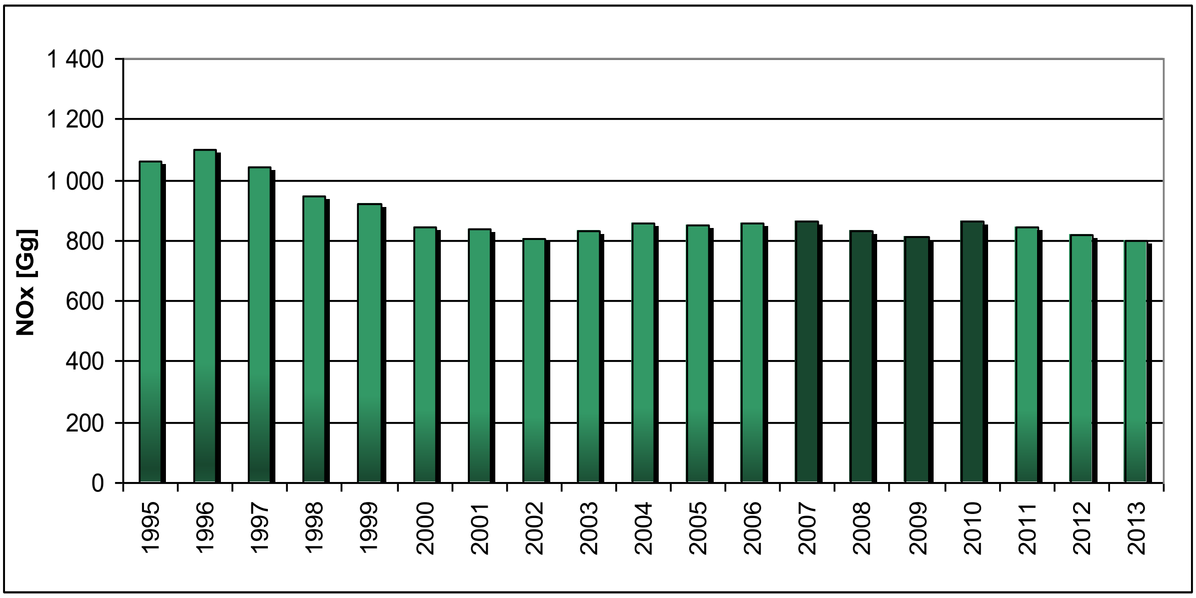

Figure 2.9. Emissions of NO_x in 1995-2013

CO emissions in 2013 amounted to 2876.4 kt and dropped by more than 60% between 1990 - 2013 triggered by the decrease of fuel used in non-industrial combustion sector (services households and agricultural combustion sources), also road transport. Emissions of NMVOC were about 635.8 kt in 2013 and dropped by approximately 24% between 1990 and 2013 due to decreases in: road transport (*ca* 48%), non-industrial combustion and industrial combustion.

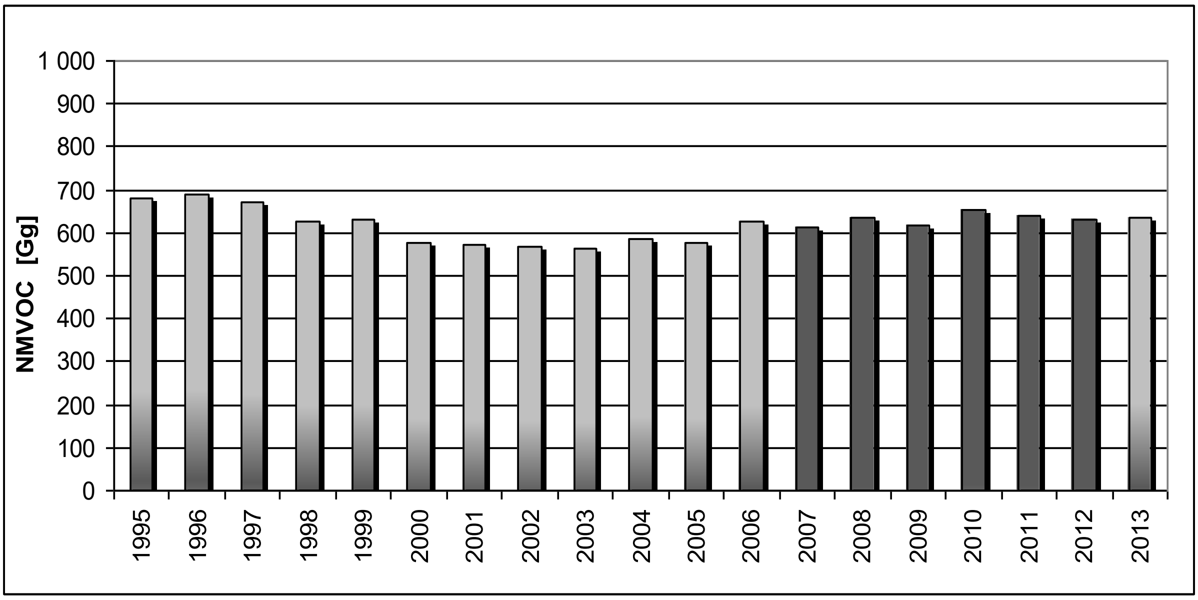

Figure 2.10. Emissions of NMVOC in 1995-2013

3. ENERGY (CRF SECTOR 1)

3.1. Overview of sector

Following categories from sector 1 have been identified as key sources (excluding LULUCF):

IPCC Category Code	IPCC Source Categories	Greenhouse Gas	Level Assessment	Trend Assessment
1.A.1	Energy Industries	CO_2	42.80%	
1.A.2	Manufacturing Industries and Construction	CO_2	7.60%	
1.A.2.a	Iron and Steel Production	CO_2	0.50%	
1.A.3.b	Road Transportation	CO_2	10.60%	
1.A.4	Other Sectors	CO_2	14.70%	
1.B.1	Solid Fuels	CH_4	3.20%	
1.B.1	Solid Fuels	CO_2	0.50%	
1.B.2	Other emissions from energy production	CO_2		+
1.B.2.c	Venting and Flaring	CH_4		+

Share of these categories in total Poland's GHG emissions is ca. 79.90%

Figure 3.3.1 shows emission trend in *Energy* sector while figure 3.1.2 shows emission trend according to subcategories 1.A. *Fuel combustion* and 1.B. *Fugitive emission*. Emission from subcategory 1.A. *Fuel combustion* is the largest contributor to emissions from sector 1. *Energy* – in 2013 over 94%.

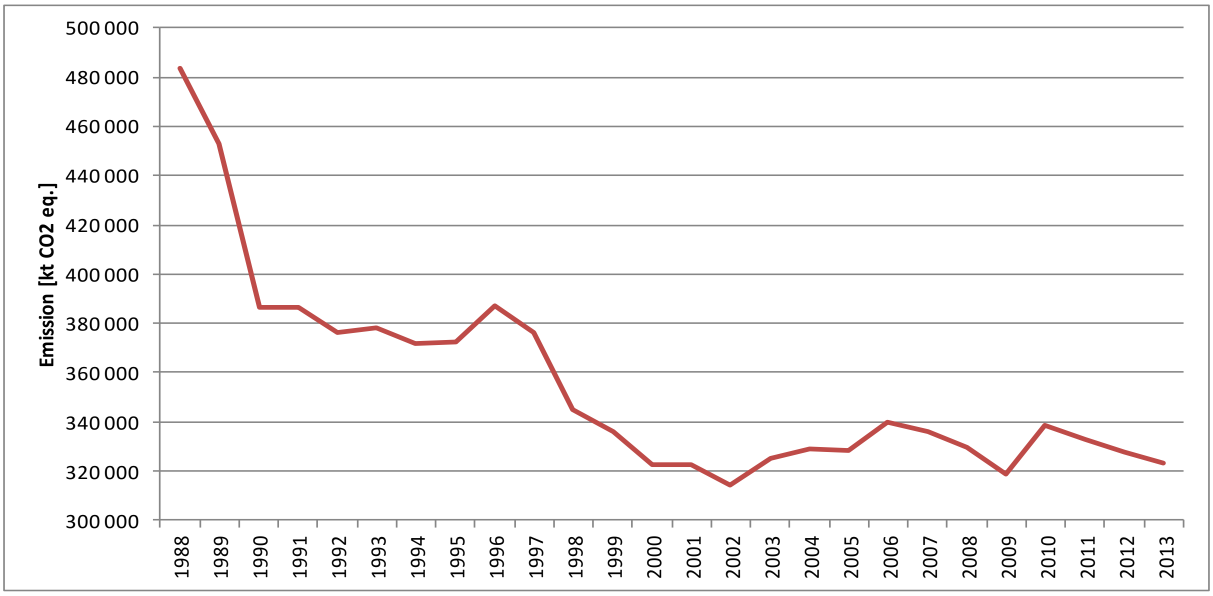

Figure 3.1.1. GHG emission trend in period 1988 – 2013 in sector *Energy*

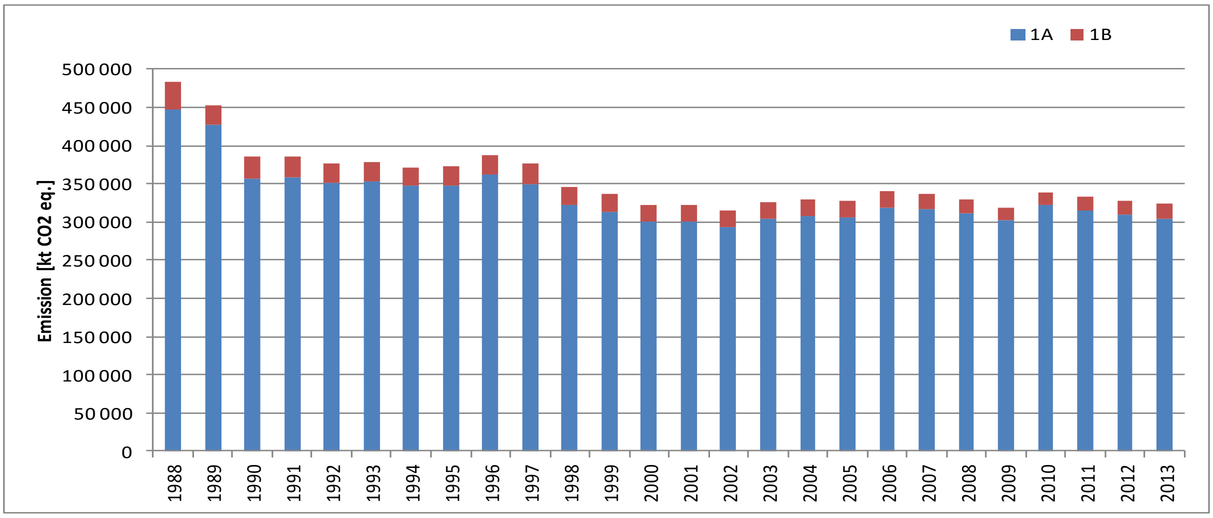

Figure 3.1.2. GHG emission trend in period 1988 - 2013 in subsectors 1.A and 1.B

3.1.1 Fuel combustion (CRF sector 1.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*

Share of that sector in total GHG emission in 2013 is over 77%. Subsector 1.A.1. *Energy Industries* is by far the largest contributor to emissions from fuel combustion (see figure 3.1.3).

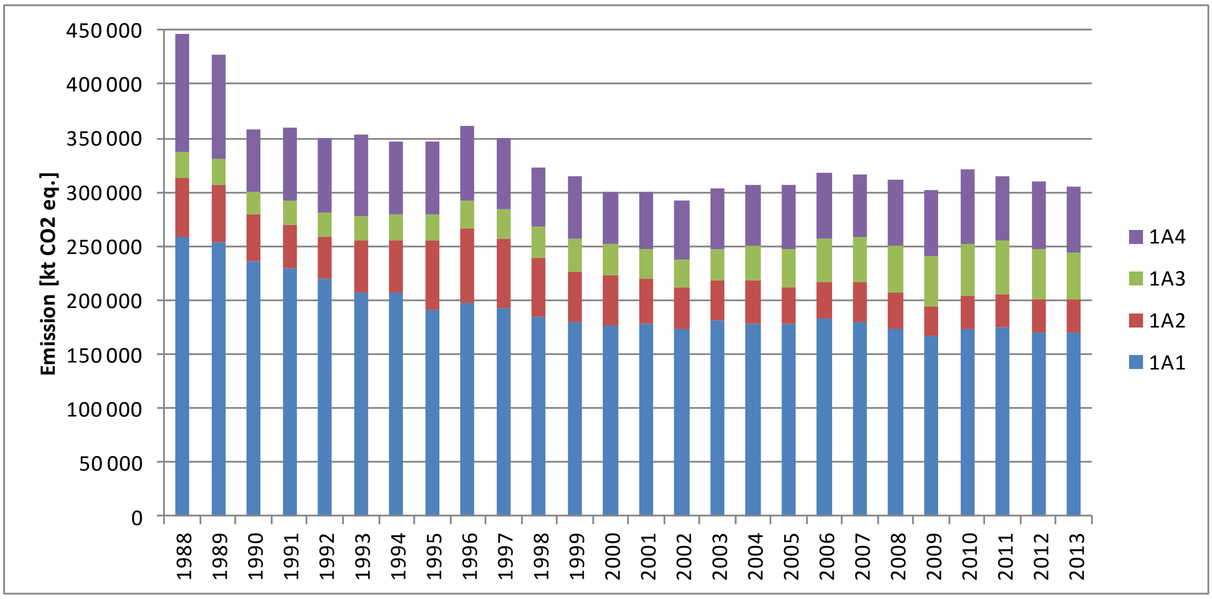

Figure 3.1.3. GHG emissions from fuel combustion in 1988-2013 according to subcategories

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 power plants
- autoproducing thermal power plants (CHP)
- heat plants

b) 1.A.1.b *Petroleum Refining*
c) 1.A.1.c *Manufacture of Solid Fuels and Other Energy Industries*
- *manufacture of solid fuels* (coke-oven plants, gas-works plants, mines, patent fuel/briquetting plants)
- *oil and gas extraction*
- *other energy industries* (own use in Electricity, CHP and heat plants)

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
b) *Non-Ferrous Metals* - 1.A.2.b
c) *Chemicals* - 1.A.2.c
d) *Pulp, Paper and Print* - 1.A.2.d
e) *Food Processing, Beverages and Tobacco* - 1.A.2.e
f) *Non-metallic minerals* - 1.A.2.f
g) *Other* - 1.A.2.g:
- *Manufacturing of machinery*
- *Manufacturing of transport equipment*
- *Mining (excluding fuels) and quarrying*
- *Wood and wood products*
- *Construction*
- *Textile and leather*
- *Off-road vehicles and other machinery*
- *Other* - other industry branches not included elsewhere

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)
b) *Residential* (1.A.4.b)
c) *Agriculture/Forestry/Fishing* (1.A.4.c)
- agriculture – stationary sources,
- agriculture – mobile sources: off-road vehicles and other machinery
- fishing.

The amount of CO_2 emissions from fuel combustion in stationary sources were estimated on the level determined as IPCC *Tier 2 or Tier 1 depending on EF type (country specific or default).* In this case the calculation was 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 was accepted according to data included in the energy balance submitted by GUS to Eurostat [EUROSTAT].

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

- liquid fuels: fuel oil, diesel oil, liquid petroleum gas (LPG), crude oil, motor gasoline, jet kerosene, refinery gas, feedstocks, 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, gas works gas,
- other fuels: industrial wastes, municipal waste (non-biogenic fraction)
- biomass: fuel wood and wood waste, biogas, municipal waste – biogenic fraction.

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

- country specific emission factors for hard coal and lignite;

the EFs are based on empirical functions, that link the amount of carbon in fuel with the corresponding net calorific value, the empirical functions are the following:

- for hard coal:

$$C_{hc} = 10(2.4898*NCV + 3.3132)/NCV$$

where:

C_{hc} - emission factor/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,

- for lignite:

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

where:

C_{bc} - emission factor for lignite [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 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, other petroleum products, petroleum coke, biomass (fuel wood and wood waste, biogas), waste (industrial and municipal waste) and gas works gas.

For coal and lignite, where the CS EFs were used, the oxidation factor was assumed as 0.980. In other cases oxidation factor assumed to be 1, because it is included in default emission factor value in accordance with 2006 IPCC GLs.

Emissions of CH_4 and N_2O from fuel combustion in stationary sources are 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 1988-2013

Estimation of CO_2 emission from fuel combustion in stationary sources for the years 1988-2012 is based on methodology corresponding to methodology applied for 2013 (that methodology is presented above). For the years: 1990-2012 fuel consumptions 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 IEA database [IEA]. Amounts of particular fuel consumptions in individual subsectors: 1.A.1, 1.A.2 and 1.A.4 were presented in the tables 1-13 (Annex 2). CO_2 emission factors from fuel combustion in stationary sources for hard coal and lignite are the country specific EFs. These EFs for the entire time series are based on the same empirical functions described above.
The values of CO_2 EFs changed over the years following the changes of the respective net calorific values for hard coal and lignite (Annex 2 -table 14-26). GHG emission factors for other fuels are the IPCC default EFs [IPCC 2006]. Values of applied emission factors were tabulated in annex 2 (emission factors of CO_2, CH_4 and N_2O for particular fuel are presented in tables 27-29 of this annex).

The time series of fuel use and GHG emissions for the main subsectors of 1.A *Fuel combustion* are presented below (in the following chapters). Detailed data on particular fuel consumption in the main subcategories of 1.A IPCC category for entire period 1988-2013 and GHG EFs for individual fuels are presented in Annex 2 .

3.1.2. Fugitive emissions (CRF sector 1.B)

The GHG emission sources in fugitive emissions sector cover: fugitive emission from solid fuels (CO_2 and CH_4) and fugitive emission from oil and gas (CO_2, CH_4 and N_2O).

Total emission of GHGs as carbon dioxide equivalent in 1.B. subcategory amounted to 18 823 kt in 2013 and decreased since 1988 by 49%. Table 3.1. shows emissions from 1.B.1 and 1.B.2 subcategories in period 1988-2013.

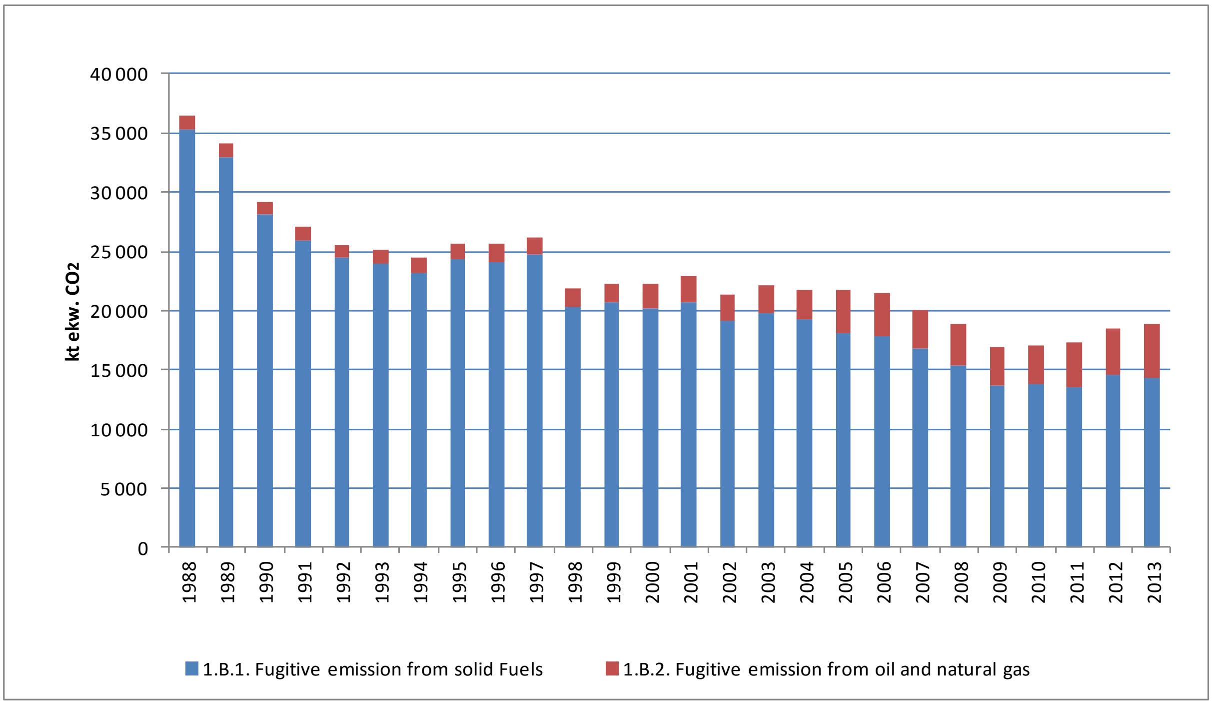

Figure 3.1. GHG emissions from 1.B.1 and 1.B.2 subcategories in 1988-2013.

3.2. Fuel combustion (CRF 1.A)

3.2.1. Comparison of the sectoral approach with the reference approach

The Reference Approach is a top-down approach, using a country's energy supply data to calculate the emissions of CO_2 from combustion of mainly fossil fuels. Comparability between the sectoral and reference approaches continues to allow a country to produce a second independent estimate of CO_2 emissions from fuel combustion. It allow to compare the results of these two independent estimates and indicate possible problems with the activity data, net calorific values, carbon content, carbon stored calculation, etc.

The Reference Approach is designed to calculate the emissions of CO_2 from fuel combustion, starting from high level energy supply data. The Reference Approach does not distinguish between different source categories within the energy sector and only estimates total CO_2 emissions from Source category 1.A. *Fuel Combustion*. The IPCC Reference Approach is based on determining carbon dioxide emissions from domestic consumption of fuels (e.g. hard coal and lignite, crude oil, natural gas). Apparent consumption of fuels is calculated as:

Apparent Consumption = Production +Imports – Exports – International Bunkers – Stock Change

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

CO_2 emissions were estimated based on adjusted fuel consumption data and default oxidation and emission factors. For hard coal and lignite national emission factors were assumed, for fuels in transport average emission factors were used from subcategories of 1A, and for other fuels default emission factors were applied. Total apparent consumption was corrected by subtracting the amount of carbon which does not lead to fuel combustion emission (carbon which is emitted in another sector of the inventory or is stored in a product manufactured from the fuel). The main sources of such carbon are those used as non-energy products and feedstocks. As the use of energy products for non energy purposes can lead to emissions Poland has calculated these emission and report them under category 2D3 *Other*.

The Reference Approach and the Sectoral Approach often have different results which may be caused by:

- statistical differences - is the difference between energy available for final consumption covering the energy placed at the disposal of final users and final energy consumption covering energy supplied to the final consumer's door for all energy uses (see figure 3.2.1);
- distribution loses - losses due to transport or distribution of natural gas;
- differences in NCVs used in reference and sectoral approaches, especially for hard and brown coal, where NCV affects emission factors;
- part of emission from solid fuel use was included in sector Industrial processes (2.C.1: production of sinter, pig iron and steel).

Correlation between difference in solid fuel apparent consumption in reference and sectoral approach and statistical differences for hard coal (which is predominant fuel among solid fuels) is shown on figure below.

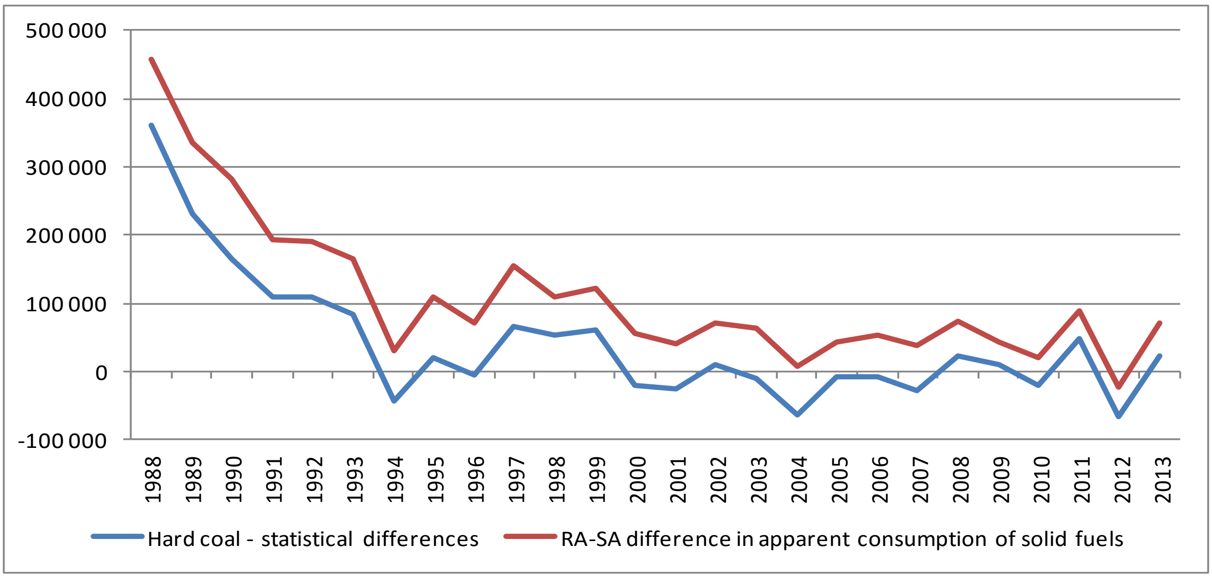

Figure 3.2.1. Correlation between statistical differences and differences between RA and SA for solid fuels [TJ] in period 1988 - 2013

Calculating CO_2 emissions with the two approaches can lead to different results. In 2013 the difference between reference and sectoral approaches in CO_2 emissions is equal 1.06%. Comparison of both methods is given in table 3.2.1.

Table 3.2.1. Differences between CO_2 emissions in sectoral and reference approach

Year	Reference approach [kt]	Sectoral approach [kt]	Difference [%]
2013	301 373	298 209	1.06
2012	296 640	302 605	-1.97
2011	312 587	308 986	1.17
2010	312 213	314 551	-0.74
2009	293 786	295 315	-0.52
2008	306 936	304 859	0.68
2007	307 160	310 363	-1.03
2006	312 370	312 098	0.09
2005	301 727	300 807	0.31
2004	299 966	301 253	-0.43
2003	302 272	297 777	1.51
2002	293 440	287 375	2.11
2001	296 438	294 185	0.77
2000	294 203	295 183	-0.33
1999	313 374	307 947	1.76
1998	321 271	317 203	1.28
1997	349 797	343 515	1.83
1996	355 250	354 577	0.19
1995	341 557	339 907	0.49
1994	332 454	340 362	-2.32
1993	355 318	345 789	2.76
1992	357 091	344 731	3.59
1991	367 331	353 411	3.94
1990	370 796	352 127	5.30
1989	438 404	419 877	4.41
1988	470 930	439 046	7.26

3.2.2. International bunker fuels

1990-2013 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 taken 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 1988-2013 period are presented in table 3.6.1.

For the years 1990-2013 data related to aviation gasoline and jet kerosene are those of the Eurostat database, while for the base year and 1989 – those of the IEA database. As there was no split on international and domestic jet kerosene use in those statistics, the amounts of domestic fuels use in years 2005 – 2013 were calculated based on Eurocontrol data on fuel share of jet kerosene used for international aviation in Poland. Due to the lack of Eurocontrol data for the years before 2005, the share for years 1988-2004 was assumed as a 5-years average from Eurocontrol data for years 2005-2009.

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 bunker for the 1988-2013 period are presented in table 3.2.2.

Table 3.2.2. Fuel consumption and CO_2, CH_4 and N_2O emissions in international aviation and navigation bunker in 1988-2013

AVIATION BUNKER													
	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Fuel consumption – jet fuel [kt]	327.47	450.40	201.74	208.31	226.14	225.20	228.01	245.84	289.00	258.98	263.67	235.52	250.53
Fuel consumption – jet fuel [PJ]	14.08	19.37	8.67	8.96	9.72	9.68	9.80	10.57	12.43	11.14	11.34	10.13	10.77
Calorific value [MJ/kg]	44.58	44.58	43.00	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	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	73.26	73.26	73.26	73.26
CO_2 potential emission factor [kt]	1 032	1 419	635	656	712	709	718	774	910	816	831	742	789
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	0.0005	0.0005	0.0005
CH_4 emission [kt]	0.007	0.010	0.004	0.004	0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.005	0.005
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	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	0.0023	0.0023	0.0023	0.0023
N_2O emission [kt]	0.033	0.045	0.020	0.021	0.023	0.023	0.023	0.025	0.029	0.026	0.026	0.024	0.025
NAVIGATION BUNKER													
	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Fuel consumption – diesel oil [PJ]	14.23	11.16	6.01	2.70	3.18	2.45	1.29	1.20	1.76	2.53	2.87	4.42	1.89
Fuel consumption - diesel oil [PJ]	9.00	9.37	10.48	3.76	6.76	3.16	4.24	4.60	5.08	6.28	8.08	10.80	9.92
CO_2 potential emission - ON [kt]	1054	827	445	200	235	181	95	89	130	188	213	327	140
CO_2 potential emission - OP [kt]	698	727	813	292	525	245	329	357	394	487	627	838	770
Total CO_2 potential emission [kt]	1753	1554	1258	492	760	426	424	446	525	675	840	1166	910
CH_4 emission - ON [kt]	0.100	0.078	0.042	0.019	0.022	0.017	0.009	0.008	0.012	0.018	0.020	0.031	0.013
CH_4 emission - OP [kt]	0.063	0.066	0.073	0.026	0.047	0.022	0.030	0.032	0.036	0.044	0.057	0.076	0.069
Total CH_4 potential emission [kt]	0.163	0.144	0.115	0.045	0.070	0.039	0.039	0.041	0.048	0.062	0.077	0.107	0.083
N_2O emission - ON [kt]	0.028	0.022	0.012	0.005	0.006	0.005	0.003	0.002	0.004	0.005	0.006	0.009	0.004
N_2O emission - OP [kt]	0.018	0.019	0.021	0.008	0.014	0.006	0.008	0.009	0.010	0.013	0.016	0.022	0.020
Total N_2O potential emission [kt]	0.046	0.041	0.033	0.013	0.020	0.011	0.011	0.012	0.014	0.018	0.022	0.030	0.024

Table 3.2.2. (cont.) Fuel consumption and CO_2, CH_4 and N_2O emissions in international aviation and navigation bunker in 1988-2013

AVIATION BUNKER													
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Fuel consumption – jet fuel [kt]	246.78	242.09	261.79	257.10	288.35	387.70	405.75	491.26	443.88	465.13	452.90	486.75	480.71
Fuel consumption – jet fuel [PJ]	10.61	10.41	11.26	11.06	12.40	16.67	17.45	21.12	19.09	20.00	19.47	20.93	20.67
Calorific value [MJ/kg]	43.00	43.00	43.00	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	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	73.26	73.26	73.26
CO_2 potential emission factor [kt]	777	763	825	810	908	1 221	1 278	1 547	1 398	1 465	1 427	1 533	1 514
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	0.0005	1.0005	2.0005
CH_4 emission [kt]	0.005	0.005	0.006	0.006	0.006	0.008	0.009	0.011	0.010	0.010	0.010	0.010	0.010
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	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	0.0023	0.0023	0.0023
N_2O emission [kt]	0.025	0.024	0.026	0.026	0.029	0.039	0.041	0.049	0.044	0.047	0.045	0.049	0.048
NAVIGATION BUNKER													
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Fuel consumption – diesel oil [PJ]	0.94	1.85	1.97	1.67	4.98	3.73	2.15	2.10	2.77	2.34	2.90	2.86	3.29
Fuel consumption – diesel oil [PJ]	9.80	9.32	9.80	8.80	8.48	8.56	8.16	9.32	7.60	6.68	4.24	3.20	2.60
CO_2 potential emission - ON [kt]	70	137	146	124	369	277	159	156	205	173	215	212	244
CO_2 potential emission - OP [kt]	760	723	760	683	658	664	633	723	590	518	329	248	202
Total CO_2 potential emission [kt]	830	860	907	807	1027	941	792	879	795	692	544	460	446
CH_4 emission - ON [kt]	0.007	0.013	0.014	0.012	0.035	0.026	0.015	0.015	0.019	0.016	0.020	0.020	0.023
CH_4 emission - OP [kt]	0.069	0.065	0.069	0.062	0.059	0.060	0.057	0.065	0.053	0.047	0.030	0.022	0.018
Total CH_4 potential emission [kt]	0.075	0.078	0.082	0.073	0.094	0.086	0.072	0.080	0.073	0.063	0.050	0.042	0.041
N_2O emission - ON [kt]	0.002	0.004	0.004	0.003	0.010	0.007	0.004	0.004	0.006	0.005	0.006	0.006	0.007
N_2O emission - OP [kt]	0.020	0.019	0.020	0.018	0.017	0.017	0.016	0.019	0.015	0.013	0.008	0.006	0.005
Total N_2O potential emission [kt]	0.021	0.022	0.024	0.021	0.027	0.025	0.021	0.023	0.021	0.018	0.014	0.012	0.012

3.2.3. Feedstocks and non-energy use of fuels

As the use of energy products for non-energy purposes can lead to emissions, Poland has calculated such emissions and report them under category 2D *Non-energy products from fuels and solvent use*. For more description see chapter 4.5

3.2.4. CO_2 capture from flue gases and subsequent CO_2 storage

Not applicable in Poland.

3.2.5. Country-specific issues

Information on country specific fuel structure, important for national emission level and CO_2 emission factors for coal (main fuel in Polish economy), is presented in chapters 3.1.1., 3.2.6-3.2.9 and in annex 2.

3.2.6. Energy Industries (CRF sector 1.A.1.)

3.2.6.1. Source category description

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 power plants
- autoproducing thermal power plants (CHP)
- heat plants

b) 1.A.1.b *Petroleum Refining*

c) 1.A.1.c *Manufacture of Solid Fuels and Other Energy Industries*
- *manufacture of solid fuels* (coke-oven plants, gas-works plants, mines, patent fuel/briquetting plants)
- *oil and gas extraction*
- *other energy industries* (own use in Electricity, CHP and heat plants)

Subsector 1.A.1.a *Public Electricity and Heat Production* is by far the largest contributor to emissions from this category (see figure 3.2.6.1) – about 95% in 2013.

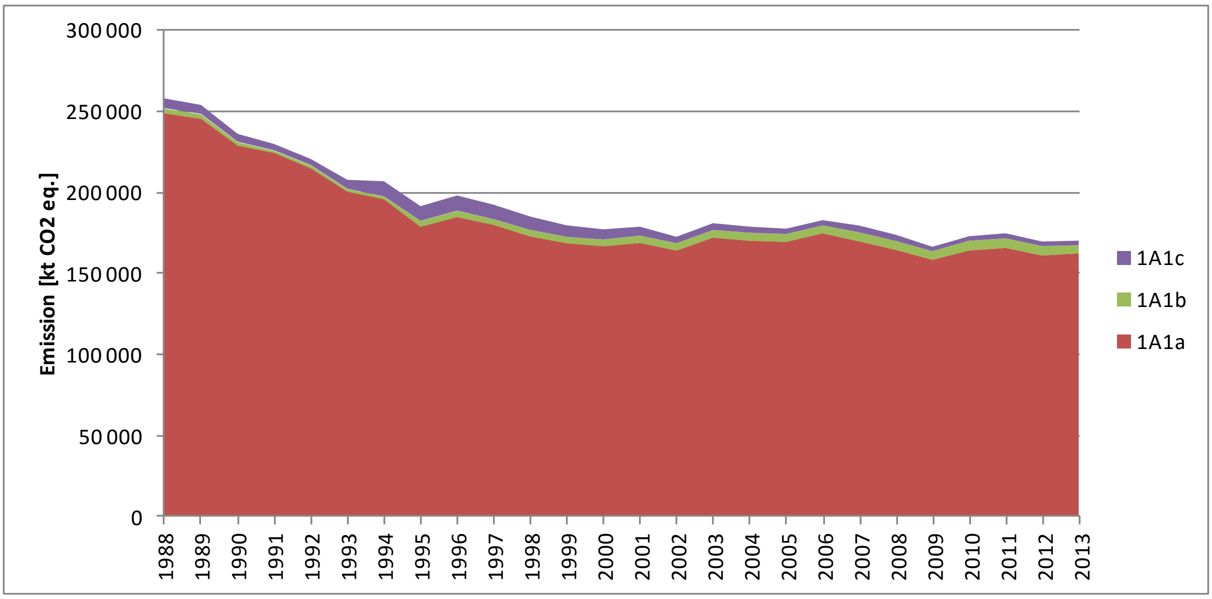

Figure 3.2.6.1. GHG emissions from *Energy Industries* in years 1988-2013 according to subcategories

3.2.6.2. Methodological issues

Methodology of emission estimation in 1.A.1 subcategory corresponds with methodology described for fuel combustion in stationary sources. Detailed information on fuel consumption and applied emission factors for subcategories mentioned below are presented in Annex 2.

3.2.6.2.1. Public electricity and heat production (CRF sector 1.A.1.a)

Table 3.2.6.1 presents the structure and amounts of fuel used in the sub-category 1.A.1.a *Public Electricity and Heat Production* for the years 1988-2013.

Table 3.2.6.1. Fuel consumption for the years 1988-2013 in 1.A.1.a subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	75.134	72.672	66.951	62.623	57.602	56.351	57.225	26.233
Gaseous Fuels	21.274	21.900	21.641	16.329	9.561	3.107	4.094	4.738
Solid Fuels	2374.674	2346.290	2197.782	2169.776	2086.989	1942.858	1890.625	1760.175
Biomass	3.741	3.873	5.265	8.914	7.354	6.658	6.876	3.878
Other Fuels	16.699	15.129	14.585	14.387	17.289	13.783	14.057	1.447
TOTAL	**2491.522**	**2459.864**	**2306.224**	**2272.029**	**2178.795**	**2022.757**	**1972.877**	**1796.471**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	28.878	29.000	19.329	18.538	15.837	16.923	15.701	14.154
Gaseous Fuels	7.156	7.949	10.768	16.210	21.627	28.242	38.700	45.496
Solid Fuels	1824.672	1776.913	1715.015	1671.753	1648.958	1665.608	1611.570	1690.270
Other Fuels	3.393	3.267	0.550	0.575	0.883	1.031	1.520	0.372
Biomass	2.793	3.381	3.877	3.747	3.904	5.449	5.424	6.642
TOTAL	**1866.892**	**1820.510**	**1749.539**	**1710.823**	**1691.209**	**1717.253**	**1672.915**	**1756.934**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	11.585	9.281	9.119	8.010	8.215	7.661	8.326	8.070
Gaseous Fuels	53.667	57.039	52.808	49.653	51.052	51.828	52.230	58.031
Solid Fuels	1664.247	1663.495	1717.390	1676.924	1614.359	1554.386	1608.667	1604.967
Other Fuels	0.407	0.483	0.427	0.386	0.584	0.645	0.793	0.861
Biomass	10.198	19.320	23.201	27.739	41.289	58.206	69.772	81.917
TOTAL	**1740.104**	**1749.618**	**1802.945**	**1762.712**	**1715.499**	**1672.726**	**1739.788**	**1753.846**

	2012	2013
Liquid Fuels	7.174	6.469
Gaseous Fuels	61.963	53.395
Solid Fuels	1550.077	1568.382
Other Fuels	0.791	0.718
Biomass	109.804	92.581
TOTAL	**1729.809**	**1721.545**

The data in table 3.2.6.1 shows that the use of solid fuels is dominant in 1.A.1.a – mainly hard coal and lignite. In 2013, the use of hard coal was app. 994 PJ i.e. about 58% of the entire energy of all fuels used in that sub-sector. Lignite made app. 31% of the energy, accordingly. Despite the significant share of solid fuels (app. 91%) 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% in 1998 till 91% in 2013). At the same time in last decade increased the share of gas as well as the share of biomass. Detailed data concerning individual fuel consumptions in 1.A.1.a subcategory for the entire period 1988-2013 was presented in Annex 2 (tab. 1).

Figure 3.2.6.2 shows CO_2 emission changes over the period 1988-2013. A significant emission decrease took place over the years 1988-1995 followed by a period of emission stabilization.

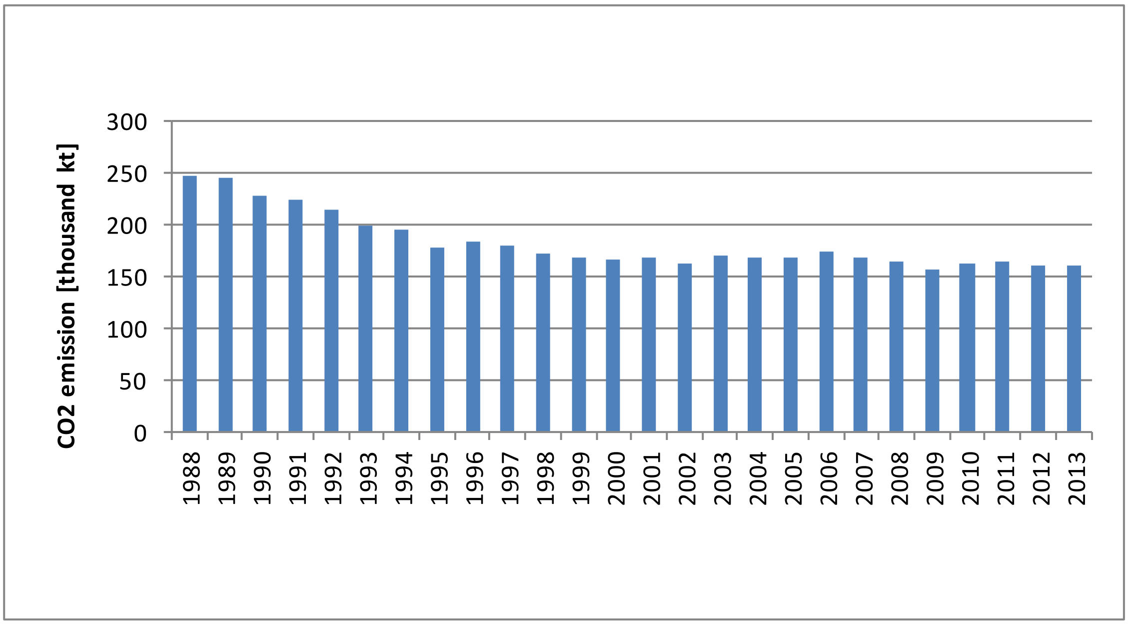

Figure 3.2.6.2. CO_2 emission for 1.A.1.a category in 1988-2013

Figure 3.2.6.3 shows emission trends for CH_4 and N_2O between the base year and 2013. Similarly to CO_2 a significant emission decrease for these gases happened in the period 1988-1995. Since 2002 is noticeable increase of CH_4 emission connected with a growth of biomass consumption. That emission increase is the result of relatively high value of CH_4 EF for solid biomass.

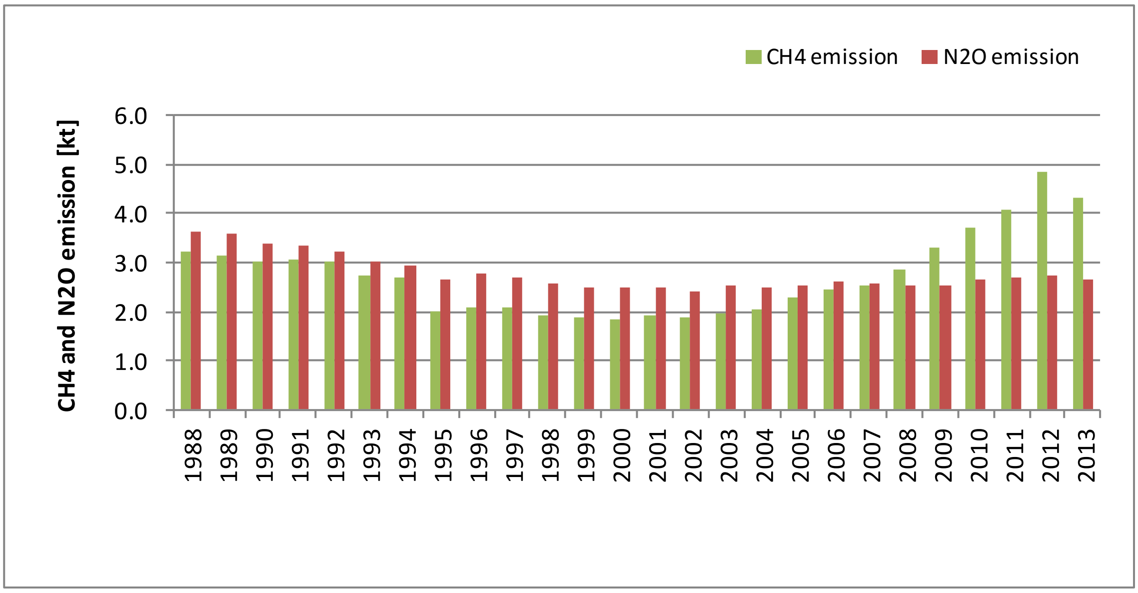

Figure 3.2.6.3. CH_4 and N_2O emissions for 1.A.1.a category in 1988-2013

3.2.6.2.2. Petroleum Refining (CRF sector 1.A.1.b)

Table 3.2.6.2 shows fuel consumption data in sub-category 1.A.1.b *Petroleum Refining* for the years 1988-2013. Detailed data on fuel consumptions in 1.A.1.b subcategory for the entire period 1988-2013 was presented in Annex 2 (table 2).

Table 3.2.6.2. Fuel consumption in 1988-2013 in 1.A.1.b subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	23.660	23.106	18.957	18.226	24.274	22.142	22.490	44.600
Gaseous Fuels	2.395	2.396	1.671	1.539	1.508	1.608	1.591	1.562
Solid Fuels	0.142	0.140	0.046	0.118	0.069	0.245	0.068	1.302
Other Fuels	7.724	7.487	5.222	0.272	0.682	0.002	0.259	1.919
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	**33.921**	**33.129**	**25.896**	**20.155**	**26.533**	**23.997**	**24.408**	**49.383**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	50.172	43.737	47.441	43.546	47.002	53.150	53.552	54.178
Gaseous Fuels	1.749	2.529	8.244	10.832	12.110	11.354	10.124	12.770
Solid Fuels	1.451	1.349	0.710	0.637	0.277	0.140	0.023	0.000
Other Fuels	0.350	0.163	0.000	0.310	0.219	0.095	0.253	0.176
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	**53.722**	**47.778**	**56.395**	**55.325**	**59.608**	**64.739**	**63.952**	**67.124**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	55.859	53.915	55.858	61.194	62.085	60.695	70.009	61.677
Gaseous Fuels	15.454	14.482	14.900	20.816	18.816	17.381	19.232	27.399
Solid Fuels	0.000	0.000	0.000	0.000	0.000	0.023	0.023	0.141
Other Fuels	0.221	0.285	0.224	0.000	0.000	0.000	0.000	0.000
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	**71.534**	**68.682**	**70.982**	**82.010**	**80.901**	**78.099**	**89.264**	**89.217**
	2012	**2013**						
Liquid Fuels	61.108	44.315						
Gaseous Fuels	30.638	34.779						
Solid Fuels	0.113	0.176						
Other Fuels	0.000	0.000						
Biomass	0.000	0.000						
TOTAL	**91.859**	**79.270**						

Figure 3.2.6.4 shows CO_2 emission changes in 1988-2013 in sub-category 1.A.1.b.

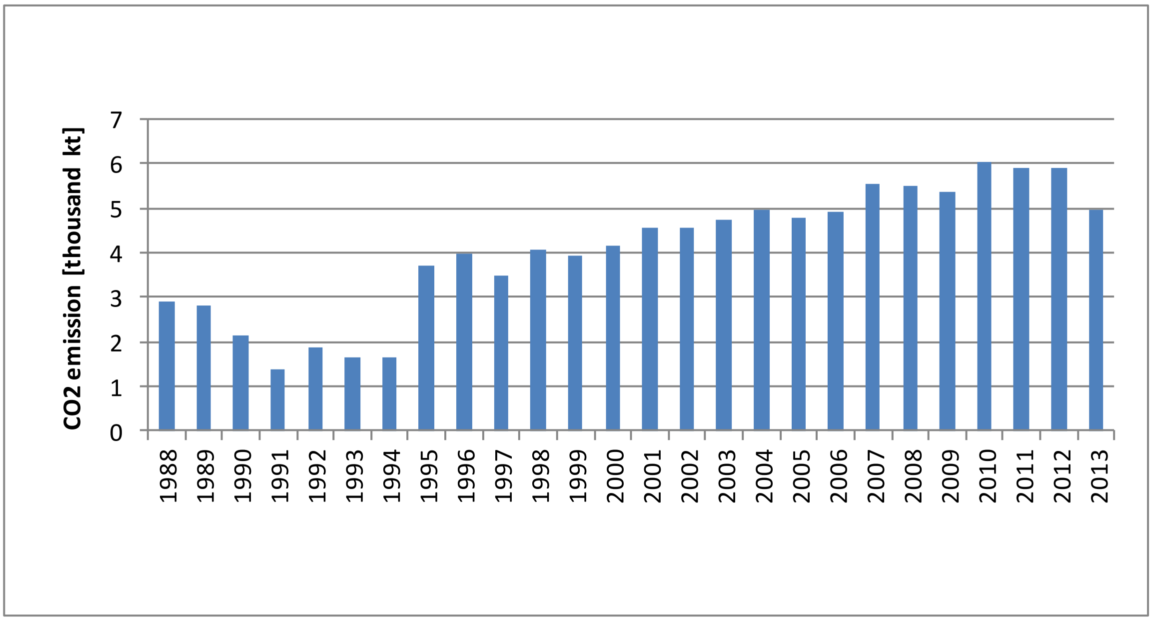

Figure 3.2.6.4. CO_2 emission for 1.A.1.b category in 1988-2013

Figure 3.2.6.5 shows the corresponding CH_4 and N_2O emission in that source sub-category between the base year and 2013.

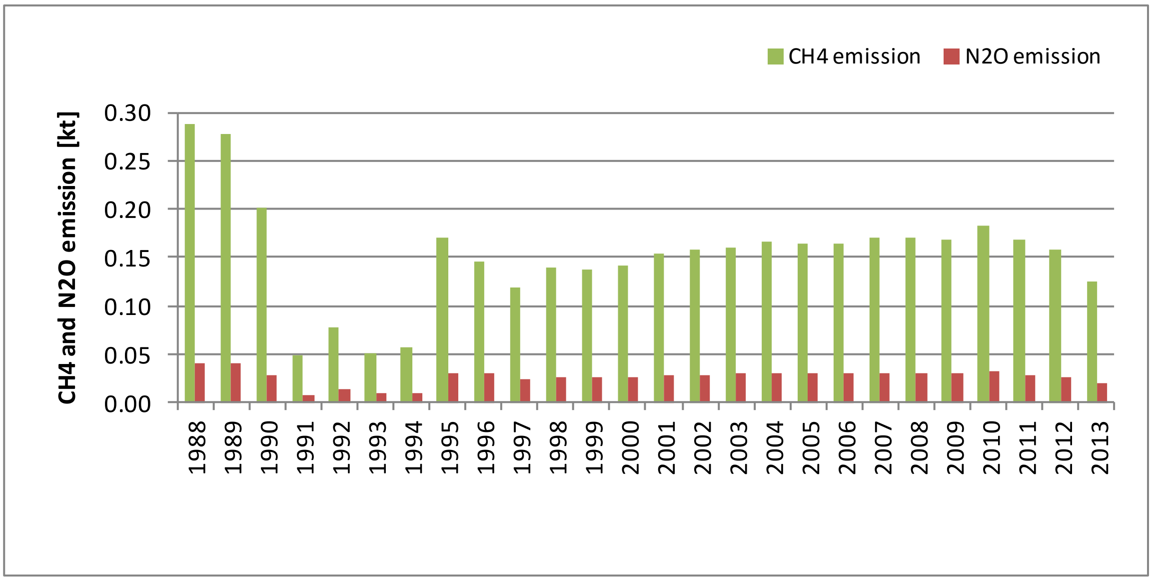

Figure 3.2.6.5. CH_4 and N_2O emissions for 1.A.1.b category in 1988-2013

3.2.6.2.3. Manufacture of Solid Fuels and Other Energy Industries (CRF sector 1.A.1.c)

Table 3.2.6.3 shows the fuel use data in the sub-category 1.A.1.c over the period: 1988-2013. Particular fuel consumptions in 1.A.1.c subcategory for the entire period 1988-2013 were tabulated in Annex 2 (table 3).

Table 3.2.6.3. Fuel consumption in 1988-2013 in 1.A.1.c subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	2.550	2.180	2.067	2.367	2.536	5.004	4.201	4.250
Gaseous Fuels	13.736	15.364	12.371	12.432	14.665	12.354	17.401	14.850
Solid Fuels	70.465	66.330	58.694	49.265	47.123	61.209	102.119	98.936
Other Fuels	0.046	0.001	0.000	0.000	0.000	0.311	0.235	0.184
Biomass	0.018	0.001	0.006	0.000	0.004	0.008	0.011	0.004
TOTAL	**86.815**	**83.875**	**73.138**	**64.064**	**64.328**	**78.886**	**123.967**	**118.224**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	3.716	3.164	2.965	2.216	2.208	1.712	1.730	1.652
Gaseous Fuels	23.269	21.155	17.779	19.458	19.491	12.986	12.515	9.741
Solid Fuels	97.647	95.586	89.237	76.215	68.737	66.257	49.936	56.476
Other Fuels	0.158	0.138	0.000	0.000	0.014	0.008	0.005	0.013
Biomass	0.014	0.031	0.026	0.027	0.037	0.052	0.047	0.026
TOTAL	**124.804**	**120.074**	**110.007**	**97.916**	**90.487**	**81.015**	**64.233**	**67.908**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	1.441	1.690	1.413	1.490	1.445	1.631	1.755	2.179
Gaseous Fuels	11.190	10.106	10.363	9.680	9.239	8.858	10.321	9.804
Solid Fuels	50.943	45.375	46.205	58.783	54.457	36.427	42.000	47.538
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
Biomass	0.020	0.014	0.026	0.085	0.037	0.137	0.349	0.162
TOTAL	**63.594**	**57.185**	**58.007**	**70.038**	**65.178**	**47.053**	**54.425**	**59.693**
	2012	**2013**						
Liquid Fuels	1.574	1.891						
Gaseous Fuels	11.205	12.013						
Solid Fuels	41.981	42.667						
Other Fuels	0.001	0.002						
Biomass	0.160	0.122						
TOTAL	**54.921**	**56.695**						

The emission trends of CO_2, CH_4 and N_2O in the 1988-2013 period are shown in figures 3.2.6.6 and 3.2.6.7.

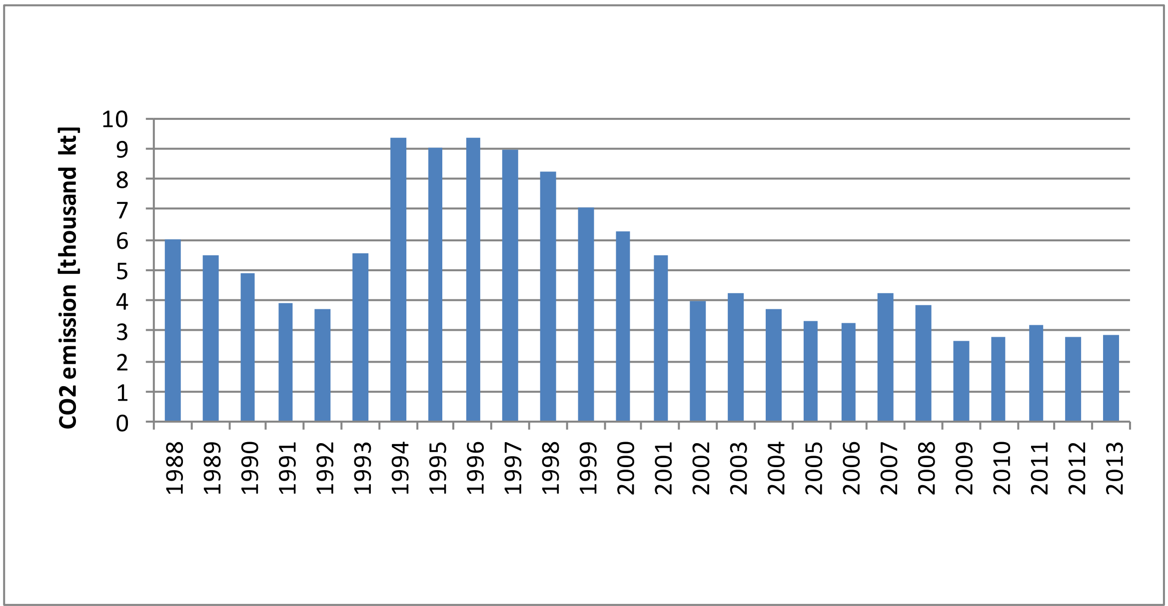

Figure 3.2.6.6. CO_2 emission for 1.A.1.c category in 1988-2013

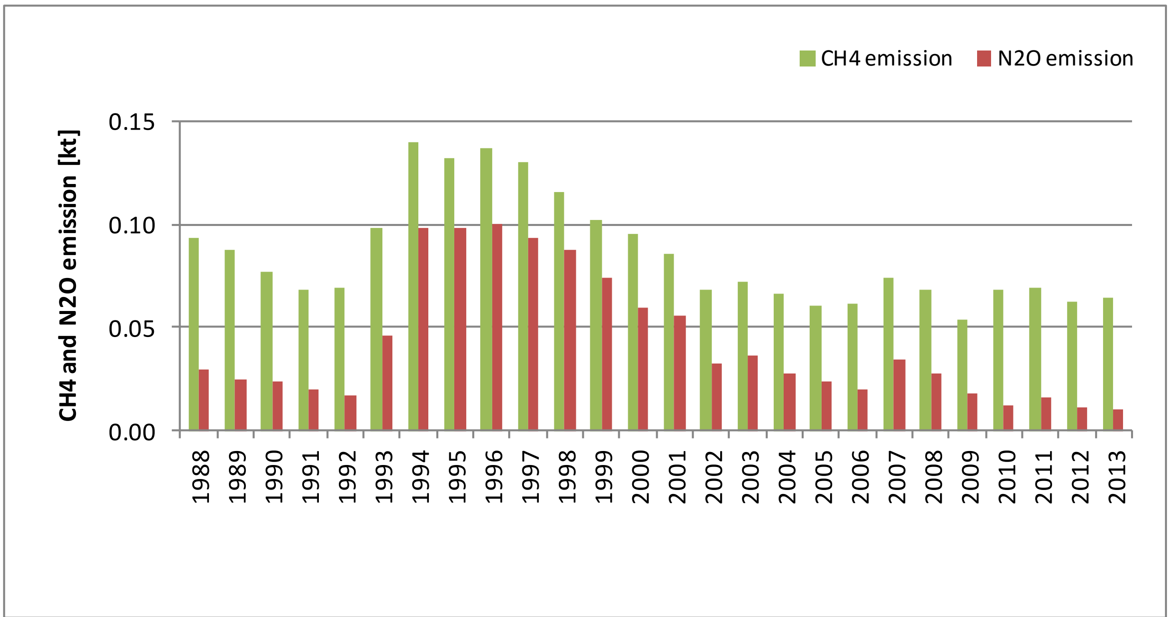

Figure 3.2.6.7. CH_4 and N_2O emissions for 1.A.1.c category in 1988-2013

3.2.6.3. Uncertainties and time-series consistency

Uncertainty analysis for the revised year 2013 for IPCC sector *1.Energy* was estimated with use of approach 1 described in 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Simplified approach was based on the assumptions that every value is independent and probability distribution is symmetric. Results of the sectoral uncertainty analysis are given below. More details on uncertainty assessment of whole inventory are given in annex 8.
Recalculation of data for years 1988-2012 ensured consistency for whole time-series.

2013	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 Emission uncertainty [%]	CH_4 Emission uncertainty [%]	N_2O Emission uncertainty [%]
1. Energy	**302,125.95**	**755.01**	**8.29**	1.9%	29.1%	12.6%
A. Fuel Combustion	**298,208.54**	**158.80**	**8.29**	1.9%	11.4%	12.6%
1. Energy Industries	169,172.05	4.49	2.70	2.7%	16.1%	30.5%
2. Manufacturing Industries and Construction	29,820.43	4.09	0.57	2.4%	11.2%	23.4%
3. Transport	43,351.76	4.12	1.80	5.7%	10.2%	20.0%
4. Other Sectors	55,864.29	146.09	3.22	4.3%	12.4%	16.0%
5. Other						
B. Fugitive Emissions from Fuels	**3,917.41**	**596.21**	**0.00**	8.5%	36.7%	71.8%
1. Solid Fuels	1,899.61	497.95		15.0%	43.9%	
2. Oil and Natural Gas	2,017.80	98.26	0.00	8.7%	16.0%	71.8%

3.2.6.4. Source-specific QA/QC and verification

Activity data used in the GHG inventory concerning energy sector come from Eurostat Database which is fed by the Central Statistical Office (GUS). GUS is responsible for QA/QC of collected and published data. Activity data applied in GHG inventory are regularly checked and updated if necessary according to adjustments made in Eurostat Database.
One of the elements of quality control of activity data correction is fuel balances prepared for the purpose of national GHG inventories (see Annex 4). For the main fuels (i.e. coal, lignite) calorific values are analysed for avoiding significant errors. Close cooperation is developed between inventory experts and institutions responsible for energy data. Any doubtful fuel consumption values are systematically verified - it is often required to obtain additional confirmation of data by installations/entities submitting the energy questionnaire. In case of any doubts energy data are also validated based on Central Statistical Office's Energy Statistics published annually.
Natural verification of data in an energy sector is comparison of sectoral and reference approaches within the GHG inventory.
Calculations in energy sector were examined with focus on formulas, units and trends consistency. Generally QC procedures follow QA/QC plan presented in Annex 7.

3.2.6.5. Source-specific recalculations

- fuel consumptions for the years 1990-2012 were updated according to current Eurostat database,
- default CO_2 emission factors from 1996 IPCC GLs were replaced with EFs recommended in 2006 GLs
- emission was estimated in more detailed split of sub-categories than previously (in accordance with 2006 GLs)

Table.3.2.6.4. Changes of GHG emission values in 1.A.1 subcategory as a result of recalculations

Changes	1988	1989	1990	1991	1992	1993	1994	1995
				CO2				
kt	551.22	483.03	408.05	181.40	162.18	110.08	131.66	-26.48
%	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0
				CH4				
kt	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				N2O				
kt	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Changes	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
				CO2				
kt	-45.04	-70.63	-429.53	-306.95	-291.95	-296.95	-363.24	-317.06
%	0.0	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
				CH4				
kt	0.000	0.000	-0.112	-0.077	-0.069	-0.068	-0.090	-0.075
%	0.0	0.0	-4.9	-3.5	-3.2	-3.0	-4.1	-3.3
				N2O				
kt	0.000	0.000	-0.015	-0.010	-0.009	-0.009	-0.012	-0.010
%	0.0	0.0	-0.6	-0.4	-0.4	-0.4	-0.5	-0.4
Changes	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
				CO2				
kt	-408.10	-537.28	-509.38	-575.90	-0.57	46.08	-7.83	-161.98
%	-0.2	-0.3	-0.3	-0.3	0.0	0.0	0.0	-0.1
				CH4				
kt	-0.105	-0.137	-0.139	-0.129	-0.020	-0.014	-0.017	-0.038
%	-4.4	-5.2	-5.0	-4.4	-0.6	-0.4	-0.4	-0.9
				N2O				
kt	-0.014	-0.018	-0.019	-0.017	-0.003	-0.002	-0.002	-0.008
%	-0.5	-0.7	-0.7	-0.7	-0.1	-0.1	-0.1	-0.3

Changes	2012
CO2	
kt	-408.10
%	0.0
CH4	
kt	-0.024
%	-0.5
N2O	
kt	-0.004
%	-0.2

3.2.6.6. Source-specific planned improvements

- analysis of the possibility of country specific EF elaboration for the gaseous fuels in Polish fuel structure

3.2.7. Manufacturing Industries and Construction (CRF sector 1.A.2)

3.2.7.1. Source category description

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
b) *Non-Ferrous Metals* - 1.A.2.b
c) *Chemicals* - 1.A.2.c
d) *Pulp, Paper and Print* - 1.A.2.d
e) *Food Processing, Beverages and Tobacco* - 1.A.2.e
f) *Non-metallic minerals* - 1.A.2.f
g) *Other* - 1.A.2.g:

- *Manufacturing of machinery*
- *Manufacturing of transport equipment*
- *Mining (excluding fuels) and quarrying*
- *Wood and wood products*
- *Construction*
- *Textile and leather*
- *Off-road vehicles and other machinery*
- *Other* - other industry branches not included elsewhere

Subsector 1.A.2.f *Non-metallic minerals, 1.A.2.c Chemicals and 1.A.2.a Iron and Steel are* the largest contributors to emissions from this category (see figure 3.2.7.1) – respectively 24.3%, 23.9% and 19.4% in 2013.

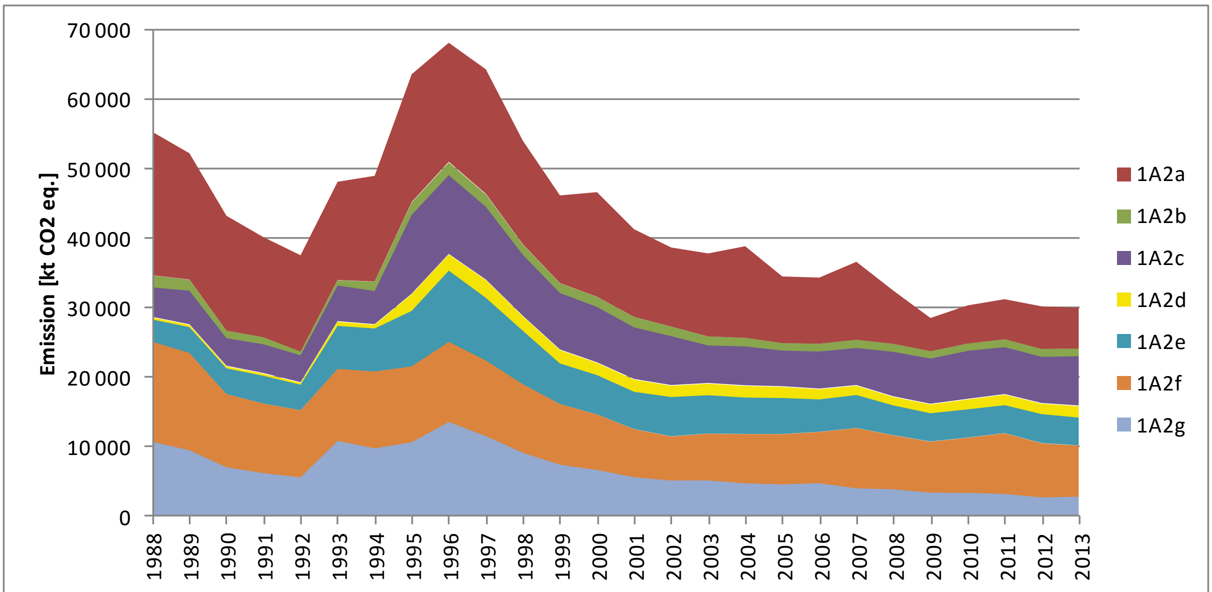

Figure 3.2.7.1. Emissions from *Manufacturing Industries and Construction* category in years 1988-2013 according to subcategories

3.2.7.2. Methodological issues

Methodology of emission estimation in 1.A.2 subcategory corresponds with methodology described for fuel combustion in stationary sources. Detailed information on fuel consumption and applied emission factors for subcategories listed below are presented in Annex 2.

3.2.7.2.1. Iron and Steel (CRF sector 1.A.2.a)

Table 3.3.7.1 shows the fuel use data in the sub-category 1.A.2.a *Iron and Steel* for the period: 1988-2013. As you can see in the table solid fuels is the dominant fuel type in that sub-category. Detailed data on fuel consumptions in 1.A.2.a subcategory for the entire period 1988-2013 was presented in Annex 2 (table 4).

Table 3.3.7.1. Fuel consumption in 1988-2013 in 1.A.2.a subcategory [PJ]

	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Liquid Fuels	18.248	15.528	11.172	7.929	5.452	4.623	3.518	2.812
Gaseous Fuels	73.507	63.332	52.851	33.974	26.568	25.562	25.487	24.239
Solid Fuels	95.323	82.955	76.433	75.020	78.771	85.990	95.465	117.273
Other Fuels	3.158	3.344	4.079	6.756	6.497	4.272	3.757	2.941
Biomass	0.000	0.000	0.000	0.000	0.000	0.016	0.014	0.005
TOTAL	**190.236**	**165.159**	**144.535**	**123.679**	**117.288**	**120.463**	**128.241**	**147.270**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	1.861	5.324	1.900	2.189	1.739	0.996	0.359	0.313
Gaseous Fuels	25.898	28.278	23.993	21.440	22.024	18.328	15.463	14.827
Solid Fuels	112.053	112.843	99.056	81.401	93.750	80.328	73.817	78.273
Other Fuels	0.498	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.006	0.004	0.006	0.004	0.003	0.006	0.003	0.004
TOTAL	**140.316**	**146.449**	**124.955**	**105.034**	**117.516**	**99.658**	**89.642**	**93.417**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	0.267	0.086	0.129	0.086	0.132	0.132	0.132	0.132
Gaseous Fuels	19.969	20.460	21.008	22.724	20.401	16.597	16.922	17.209
Solid Fuels	84.874	60.078	57.003	61.573	40.309	25.077	30.107	33.944
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.004	0.002	0.001	0.001	0.001	0.001	0.000	0.000
TOTAL	**105.114**	**80.626**	**78.141**	**84.384**	**60.843**	**41.807**	**47.161**	**51.285**
	2012	**2013**						
Liquid Fuels	0.135	0.089						
Gaseous Fuels	16.905	16.242						
Solid Fuels	37.578	36.116						
Other Fuels	0.000	0.000						
Biomass	0.000	0.001						
TOTAL	**54.618**	**52.448**						

Blast furnaces transformation efficiency in Eurostat energy balance is very high and it is the reason, that there is too little amount of coke use in „Transformation input in Blast Furnaces" compared with real technological demand. Because of that, some part of coke, classified in *Final energy consumption – Iron and Steel* in Eurostat database (1.A.2.a IPCC subcategory) was reallocated into blast furnace input and use in C mass balance prepared in 2 IPCC sector for pig iron production.

Amounts of coke [PJ] moved from 1.A2.a to 2.C.1 subcategory for individual years were as follow:

1988	12.050	1997	62.244	2006	36.611
1989	14.549	1998	45.989	2007	45.225
1990	95.533	1999	37.609	2008	36.044
1991	64.926	2000	51.008	2009	19.582
1992	61.701	2001	42.717	2010	21.640
1993	57.678	2002	36.571	2011	23.479
1994	66.679	2003	40.206	2012	23.177
1995	68.741	2004	43.660	2013	25.064
1996	58.875	2005	28.440		

CO_2 emission from reallocated coke was included in emission from 2.C.1 subcategory. Emissions of CH_4 and N_2O were included in 1.A.2.a category.

Figure 3.3.7.2 shows CO_2 emissions in the 1988-2013 period. Emissions of CH_4 and N_2O in the same time period are shown in figure 3.3.7.3. Emission trends for all three gases follow closely the trends in fuel use.

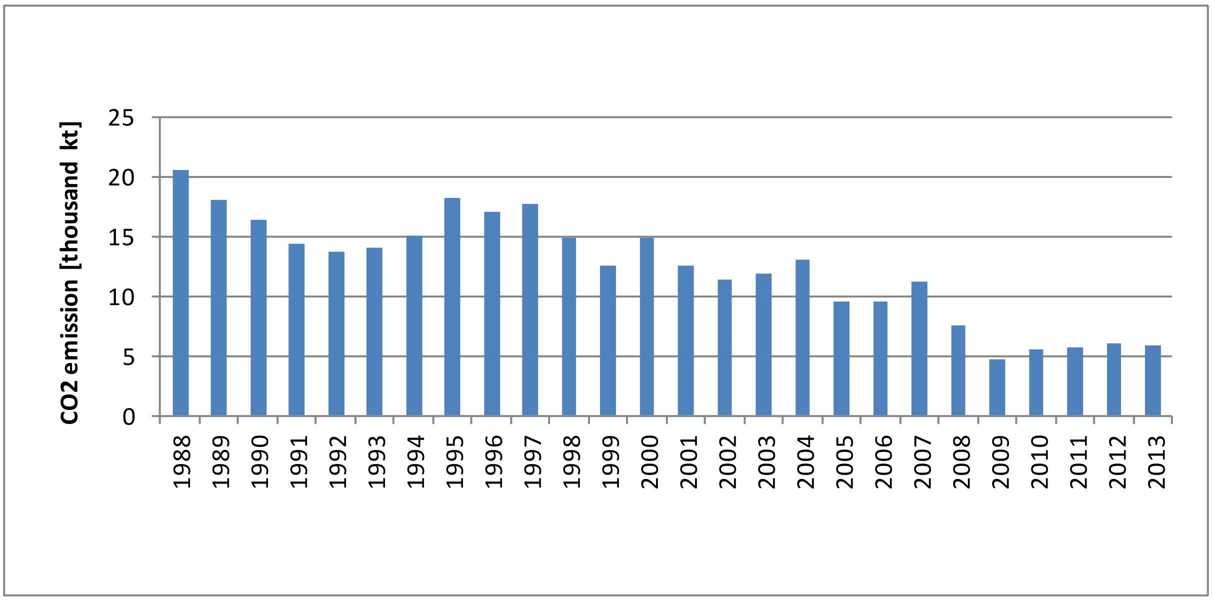

Figure 3.3.7.2. CO_2 emission for 1.A.2.a category in 1988-2013

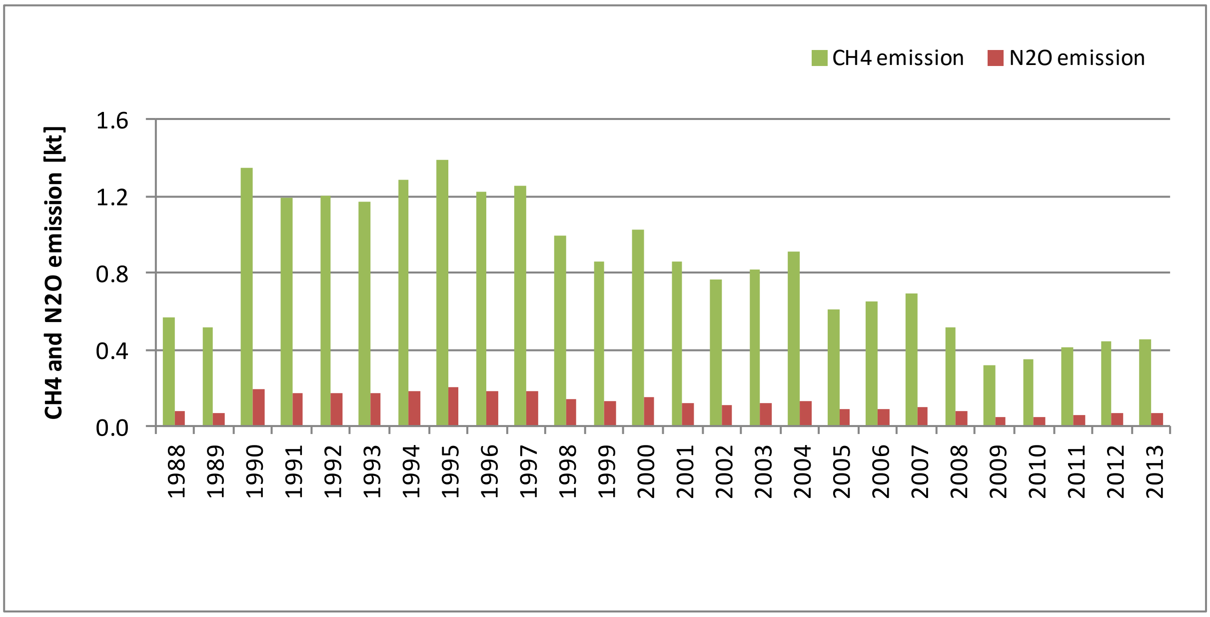

Figure 3.3.7.3. CH_4 and N_2O emissions for 1.A.2.a category in 1988-2013

3.2.7.2.2. Non-Ferrous Metals (CRF sector 1.A.2.b)

The data on fuel type use in the sub-category 1.A.2.b *Non-Ferrous Metals* over the 1988-2013 period are presented in table 3.3.7.2. More detailed data concerning fuel consumptions was tabulated in Annex 2 (table 5).

Table 3.3.7.2. Fuel consumption in 1988-2013 in 1.A.2.b subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	0.683	0.803	0.803	0.843	0.929	0.846	0.929	0.892
Gaseous Fuels	5.638	5.470	4.599	4.633	1.213	1.745	5.321	5.447
Solid Fuels	12.001	10.832	6.908	5.965	3.316	4.752	8.183	10.499
Other Fuels	0.870	0.719	0.439	0.483	0.514	0.729	0.823	2.150
Biomass	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
TOTAL	**19.191**	**17.823**	**12.749**	**11.924**	**5.972**	**8.073**	**15.257**	**18.988**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	0.940	0.854	0.777	0.732	0.863	0.784	0.618	0.495
Gaseous Fuels	5.108	5.424	5.638	5.660	5.814	5.700	5.589	5.868
Solid Fuels	10.897	10.491	11.879	11.115	11.446	12.497	11.455	10.582
Other Fuels	2.411	2.361	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.149	0.042	0.026	0.010	0.011	0.005	0.001	0.000
TOTAL	**19.505**	**19.172**	**18.320**	**17.517**	**18.134**	**18.986**	**17.663**	**16.945**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	0.658	0.618	0.618	0.378	0.378	0.379	0.382	0.339
Gaseous Fuels	6.405	6.468	6.884	6.743	6.542	5.852	6.048	6.670
Solid Fuels	8.848	6.841	7.070	7.993	7.892	7.389	7.036	7.470
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	**15.911**	**13.927**	**14.572**	**15.114**	**14.812**	**13.620**	**13.466**	**14.479**
	2012	**2013**						
Liquid Fuels	0.293	0.293						
Gaseous Fuels	6.890	6.703						
Solid Fuels	7.469	7.488						
Other Fuels	0.000	0.000						
Biomass	0.000	0.000						
TOTAL	**14.652**	**14.484**						

Emissions of the main greenhouse gases in 1.A.2.b between the base year and 2013 are shown in figures 3.3.7.4 and 3.3.7.5.

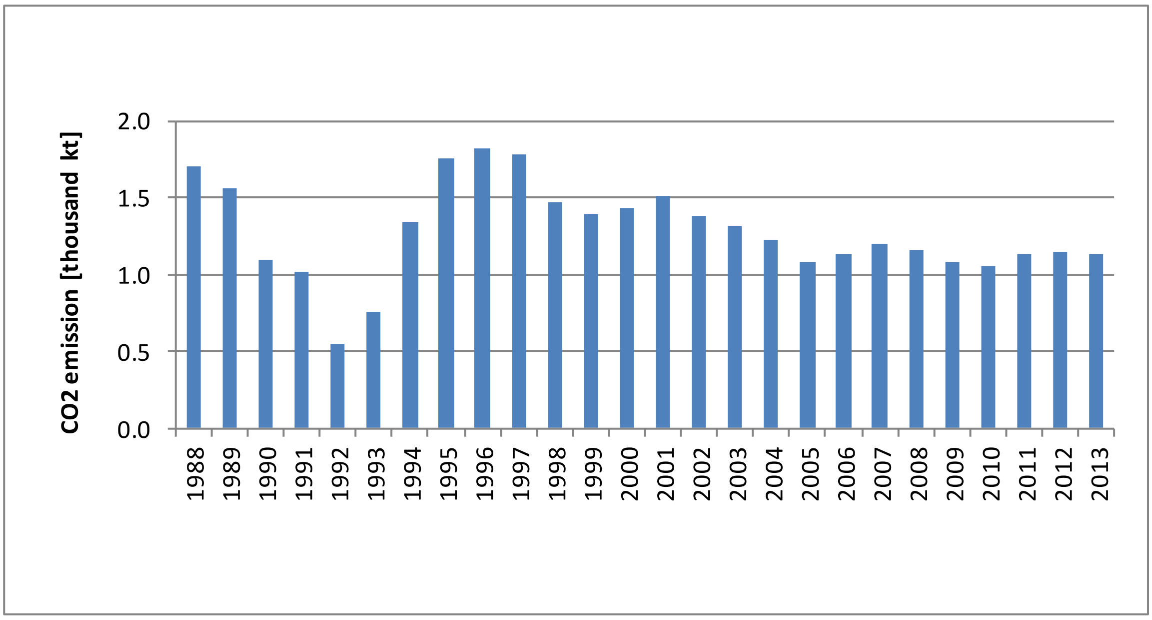

Figure 3.3.7.4. CO_2 emission for 1.A.2.b category in 1988-2013

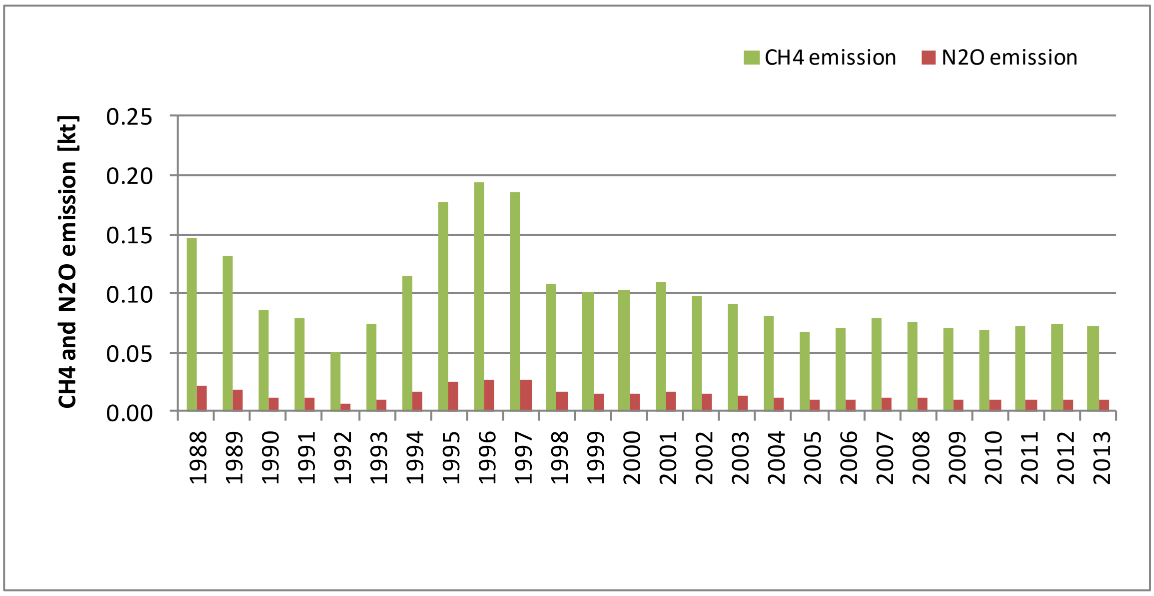

Figure 3.3.7.5. CH_4 and N_2O emissions for 1.A.2.b category in 1988-2013

3.2.7.2.3. Chemicals (CRF sector 1.A.2.c)

Detailed data on fuel consumptions in 1.A.2.c subcategory for the entire period 1988-2013 was presented in Annex 2 (table 6).
The data on fuel type use in the sub-category 1.A.2.c *Chemicals* over the 1988-2013 period are presented in table 3.3.7.3.

Table 3.3.7.3. Fuel consumption in 1988-2013 in 1.A.2.c subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	14.825	13.968	4.103	6.203	8.977	7.710	4.527	10.688
Gaseous Fuels	6.409	6.244	5.289	4.340	4.432	10.075	4.507	6.356
Solid Fuels	12.407	14.986	10.896	9.351	7.008	16.738	10.312	74.948
Other Fuels	12.255	14.915	16.712	18.586	17.039	18.003	22.591	21.546
Biomass	0.345	0.390	0.118	0.039	0.010	0.003	0.035	0.007
TOTAL	**46.241**	**50.503**	**37.118**	**38.519**	**37.466**	**52.529**	**41.972**	**113.545**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	19.576	22.964	40.929	39.132	38.344	33.144	32.907	33.483
Gaseous Fuels	6.191	11.024	9.408	9.041	9.464	8.481	7.199	6.457
Solid Fuels	75.455	65.909	57.138	52.421	51.772	50.353	47.485	30.174
Other Fuels	17.374	14.356	0.672	0.582	0.607	0.618	0.567	0.875
Biomass	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.153
TOTAL	**118.596**	**114.253**	**108.148**	**101.176**	**100.187**	**92.596**	**88.159**	**71.142**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	33.648	26.001	29.370	29.805	23.485	26.781	22.154	20.430
Gaseous Fuels	7.498	8.104	9.053	8.771	8.037	9.762	12.043	13.887
Solid Fuels	31.215	32.175	31.194	31.381	47.901	45.428	51.159	49.660
Other Fuels	1.122	0.628	0.721	0.761	0.518	0.621	0.777	0.732
Biomass	0.102	0.165	0.000	0.121	0.000	0.058	0.058	0.053
TOTAL	**73.585**	**67.073**	**70.338**	**70.839**	**79.941**	**82.650**	**86.191**	**84.762**
	2012	**2013**						
Liquid Fuels	17.491	22.566						
Gaseous Fuels	13.568	14.696						
Solid Fuels	50.527	50.495						
Other Fuels	0.581	1.092						
Biomass	0.131	0.050						
TOTAL	**82.298**	**88.899**						

Figure 3.3.7.6 shows CO_2 emissions in the sub-category 1.A.2.c in the 1988-2013 period. Emissions of CH_4 and N_2O, in turn, are shown in figure 3.3.7.7.

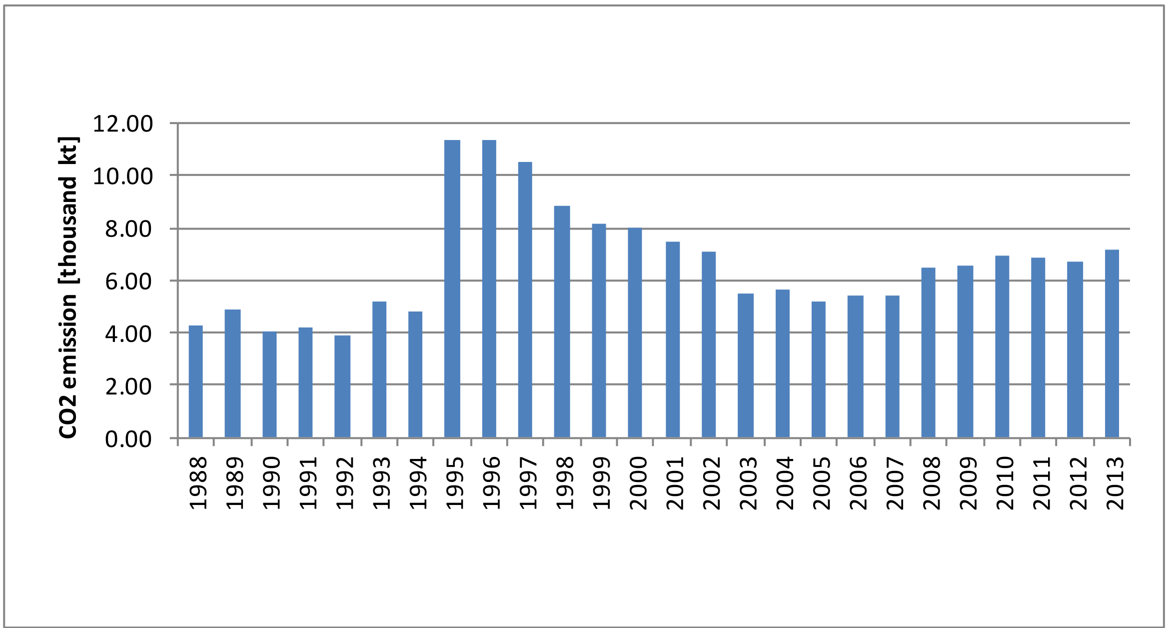

Figure 3.3.7.6. CO_2 emission for 1.A.2.c category in 1988-2013

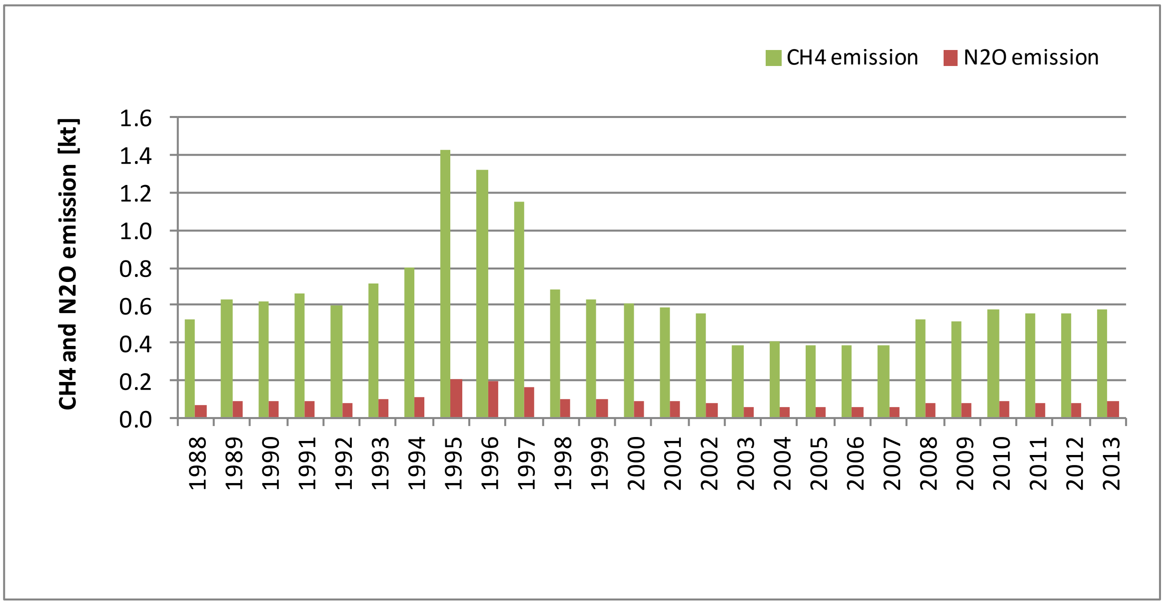

Figure 3.3.7.7. CH_4 and N_2O emissions for 1.A.2.c category in 1988-2013

3.2.7.2.4. Pulp, Paper and Print (CRF sector 1.A.2.d)

The data on fuel type use in the sub-category 1.A.2.d *Pulp, Paper and Print* over the 1988-2013 period are presented in table 3.3.7.4. Characteristic for that sub-sector is relatively large share of biomass in the total fuel use. Detailed data on fuel consumptions in 1.A.2.d subcategory was presented in Annex 2 (table 7).

Table 3.3.7.4. Fuel consumption in 1988-2013 in 1.A.2.d subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	1.371	1.291	1.369	1.332	1.409	1.649	1.532	2.535
Gaseous Fuels	0.103	0.162	0.101	0.061	0.026	0.061	0.250	0.232
Solid Fuels	1.976	2.192	1.810	2.043	1.639	4.841	4.123	22.605
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.352	0.205	0.001	0.000	0.000	1.585	1.610	15.437
TOTAL	**3.803**	**3.850**	**3.281**	**3.436**	**3.074**	**8.136**	**7.515**	**40.809**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	1.687	2.119	2.619	2.227	2.099	2.044	2.035	2.208
Gaseous Fuels	0.455	1.096	0.563	1.007	1.210	1.445	1.461	2.094
Solid Fuels	22.494	24.121	19.022	17.528	15.724	15.592	14.345	14.107
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	16.243	16.472	16.476	15.545	15.938	15.138	16.622	17.950
TOTAL	**40.879**	**43.808**	**38.680**	**36.307**	**34.971**	**34.219**	**34.463**	**36.359**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	2.244	2.029	2.118	2.333	1.986	1.995	1.992	1.988
Gaseous Fuels	2.657	2.288	2.976	4.087	4.822	4.834	5.030	4.587
Solid Fuels	13.825	13.458	11.620	9.480	7.878	8.515	9.978	11.096
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	18.957	18.611	19.379	18.644	19.729	19.189	19.166	19.475
TOTAL	**37.683**	**36.386**	**36.093**	**34.544**	**34.415**	**34.533**	**36.166**	**37.146**
	2012	**2013**						
Liquid Fuels	1.785	1.872						
Gaseous Fuels	5.535	6.271						
Solid Fuels	10.643	11.460						
Other Fuels	0.000	0.037						
Biomass	20.441	27.243						
TOTAL	**38.404**	**46.883**						

Figures 3.3.7.8 and 3.3.7.9 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.2.d in the period: 1988-2013.

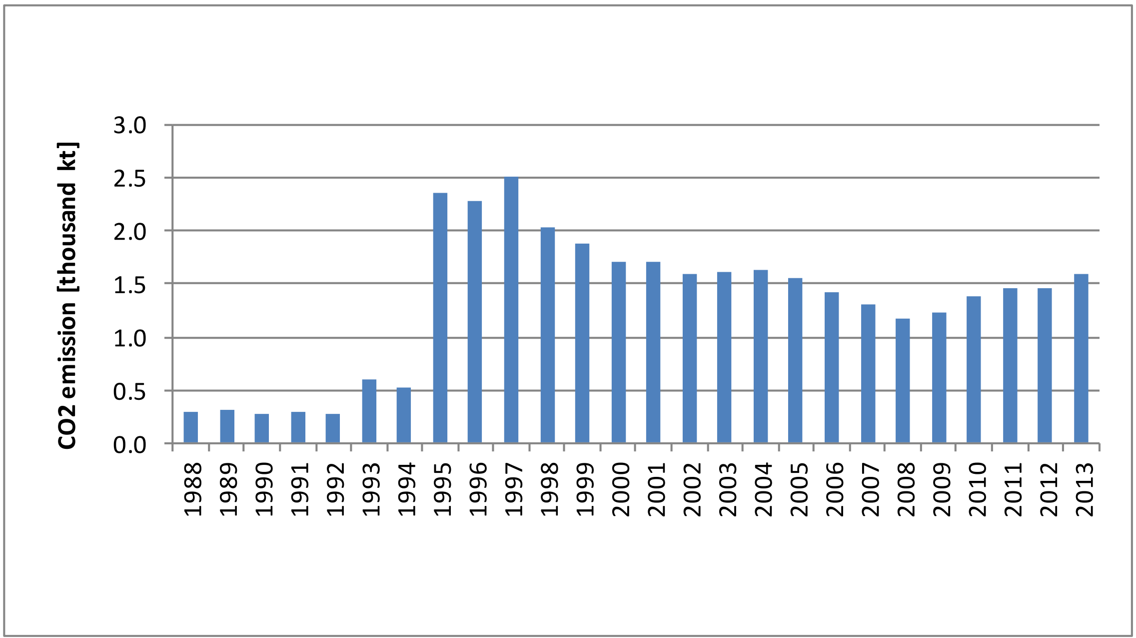

Figure 3.3.7.8. CO_2 emission for 1.A.2.d category in 1988-2013

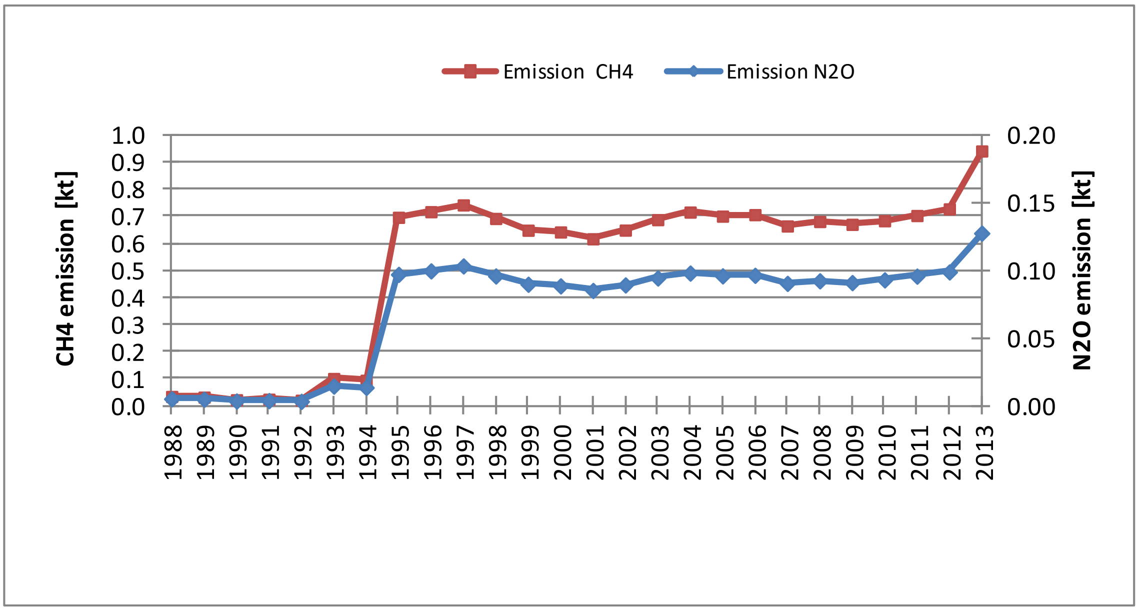

Figure 3.3.7.9. CH_4 and N_2O emissions for 1.A.2.d category in 1988-2013

3.2.7.2.5. Food Processing, Beverages and Tobacco (CRF sector 1.A.2.e)

The data on fuel type use in the sub-category 1.A.2.e *Food Processing, Beverages and Tobacco* over the 1988-2012 period are presented in table 3.3.7.5. Detailed data on fuel consumption was tabulated in Annex 2 (table 8).

Table 3.3.7.5. Fuel consumption in 1988-2013 in 1.A.2.e subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	4.413	3.484	3.065	2.646	2.402	4.707	5.219	7.339
Gaseous Fuels	1.965	1.910	1.970	1.984	2.339	3.171	7.180	3.839
Solid Fuels	29.280	35.542	35.468	39.034	35.517	59.569	56.912	75.938
Other Fuels	0.003	0.002	0.000	0.000	0.031	0.003	0.003	0.000
Biomass	0.114	0.105	0.091	0.094	0.072	0.151	0.056	0.082
TOTAL	**35.775**	**41.043**	**40.594**	**43.758**	**40.361**	**67.601**	**69.370**	**87.198**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	8.612	7.900	9.907	10.250	10.681	10.889	11.340	11.374
Gaseous Fuels	15.051	12.927	10.694	9.255	10.494	11.363	12.490	15.075
Solid Fuels	92.385	81.307	67.056	48.274	45.232	41.557	43.534	40.545
Other Fuels	0.000	0.000	0.000	0.000	0.001	0.014	0.000	0.000
Biomass	0.094	0.075	0.104	0.089	0.112	0.104	0.097	0.386
TOTAL	**116.142**	**102.209**	**87.761**	**67.868**	**66.520**	**63.927**	**67.461**	**67.380**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	11.022	10.036	8.665	7.801	7.561	5.612	5.014	4.524
Gaseous Fuels	16.164	17.456	18.623	20.614	20.725	20.950	21.610	22.128
Solid Fuels	37.450	36.955	31.793	32.077	27.434	26.470	26.534	26.156
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.447	0.282	0.311	0.248	0.459	0.301	0.542	0.679
TOTAL	**65.083**	**64.729**	**59.392**	**60.740**	**56.179**	**53.333**	**53.700**	**53.487**
	2012	**2013**						
Liquid Fuels	4.994	3.900						
Gaseous Fuels	23.704	24.475						
Solid Fuels	26.486	25.094						
Other Fuels	0.000	0.000						
Biomass	0.635	0.866						
TOTAL	**55.819**	**54.335**						

Figures 3.3.7.10 and 3.3.7.11 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.2.e in the period: 1988-2013.

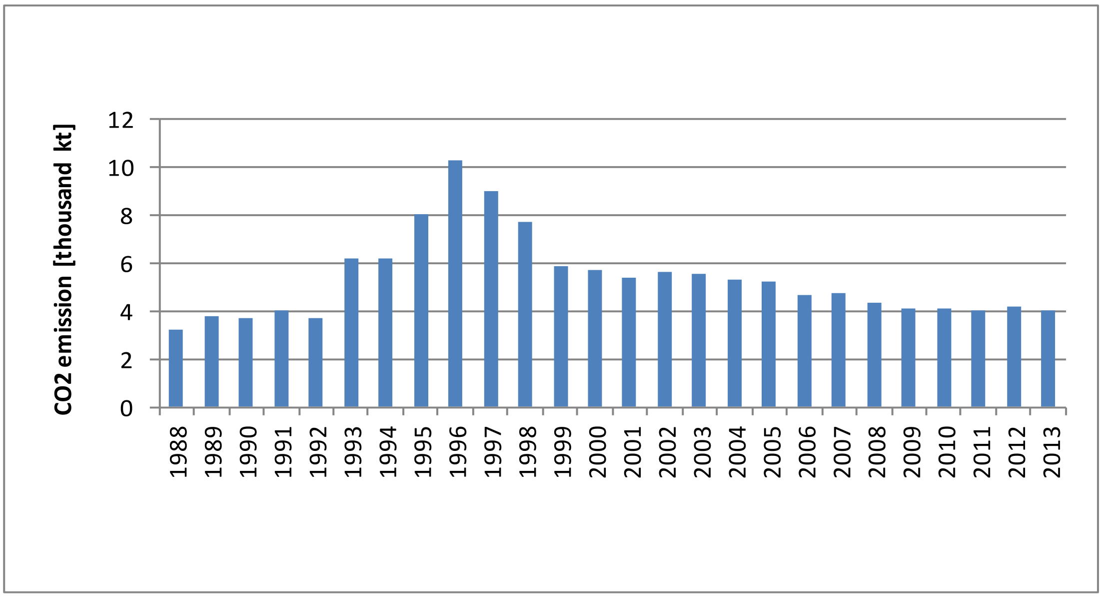

Figure 3.3.7.10. CO_2 emission for 1.A.2.e category in 1988-2013

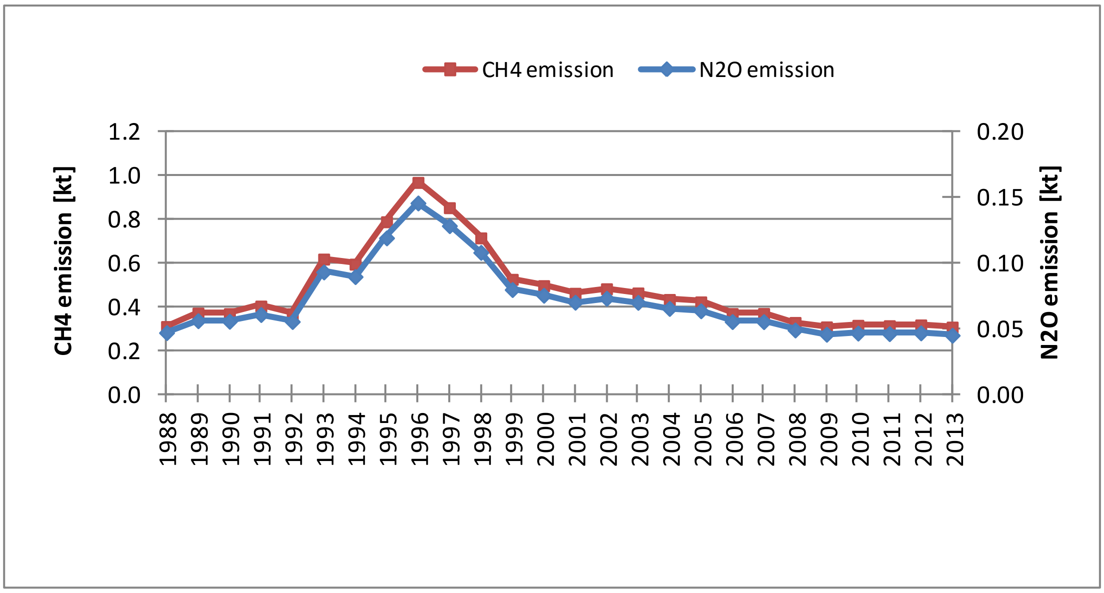

Figure 3.3.7.11. CH_4 and N_2O emissions for 1.A.2.e category in 1988-2013

3.2.7.2.6. Non-metallic minerals (CRF sector 1.A.2.f)

The data on fuel type use in the sub-category 1.A.2.f *Non-metallic minerals* in the 1988-2013 period are presented in table 3.3.7.6. Detailed data concerning total fuel consumption in 1.A.2.f subcategory was tabulated in Annex 2 (table 9).

Table 3.3.7.6. Fuel consumption in 1988-2013 in 1.A.2.f subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	7.321	7.828	5.104	3.615	4.332	4.732	5.356	7.548
Gaseous Fuels	28.729	28.108	24.574	22.704	22.246	21.986	21.506	25.518
Solid Fuels	128.357	123.387	92.221	89.061	84.226	91.535	98.135	92.655
Other Fuels	0.382	0.446	0.068	0.023	0.267	0.250	0.145	0.197
Biomass	1.778	1.924	1.155	0.455	0.042	0.033	0.004	0.010
TOTAL	**166.566**	**161.692**	**123.122**	**115.858**	**111.113**	**118.536**	**125.146**	**125.928**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	5.608	8.535	10.126	8.358	6.016	7.029	8.355	12.590
Gaseous Fuels	26.650	25.655	27.097	23.917	27.976	31.858	33.233	35.584
Solid Fuels	99.819	91.341	78.249	69.195	60.767	46.906	39.208	35.992
Other Fuels	0.144	0.047	0.207	0.529	0.472	0.524	0.508	1.474
Biomass	0.010	0.005	0.006	0.002	0.006	0.275	0.292	0.102
TOTAL	**132.231**	**125.583**	**115.685**	**102.001**	**95.237**	**86.592**	**81.596**	**85.742**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	12.156	14.214	8.720	5.855	6.108	7.209	6.038	4.410
Gaseous Fuels	38.233	38.963	41.283	42.473	39.708	41.422	42.894	44.492
Solid Fuels	38.551	35.210	36.102	50.026	41.303	29.982	32.422	39.231
Other Fuels	1.831	3.418	6.663	7.737	7.778	12.134	14.981	16.746
Biomass	0.261	0.110	0.139	0.117	0.224	0.314	0.422	1.686
TOTAL	**91.032**	**91.915**	**92.907**	**106.208**	**95.121**	**91.061**	**96.757**	**106.565**
	2012	**2013**						
Liquid Fuels	3.556	3.274						
Gaseous Fuels	42.349	40.911						
Solid Fuels	31.510	27.253						
Other Fuels	16.083	16.515						
Biomass	1.767	1.889						
TOTAL	**95.265**	**89.842**						

Figures 3.3.7.12 and 3.3.7.13 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.2.f in the period: 1988-2013.

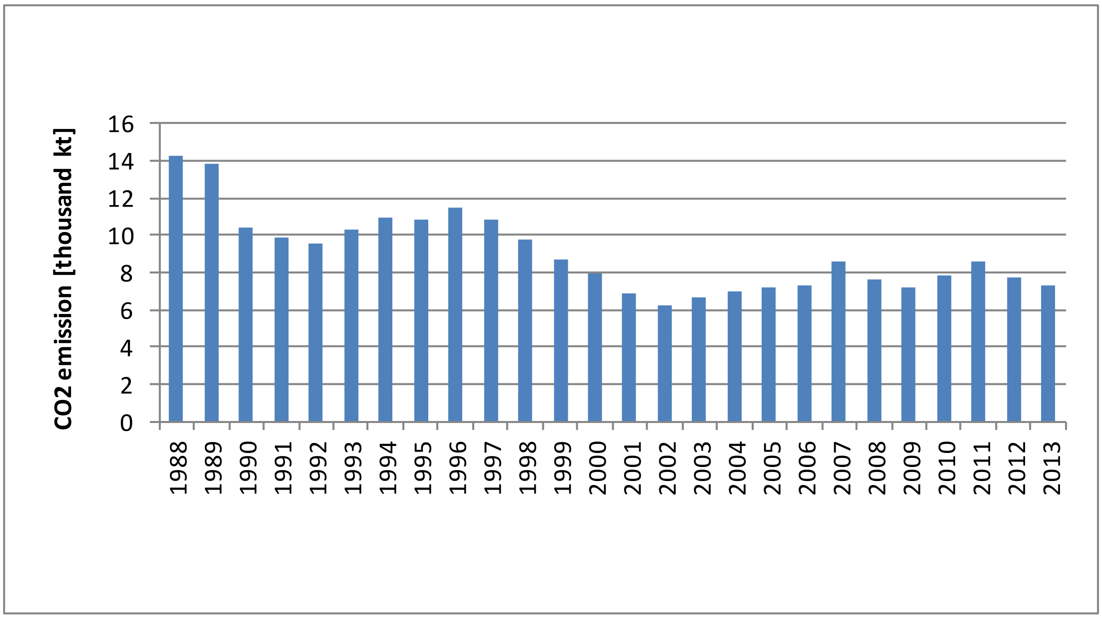

Figure 3.3.7.12. CO_2 emission from 1.A.2.f category in 1988-2013

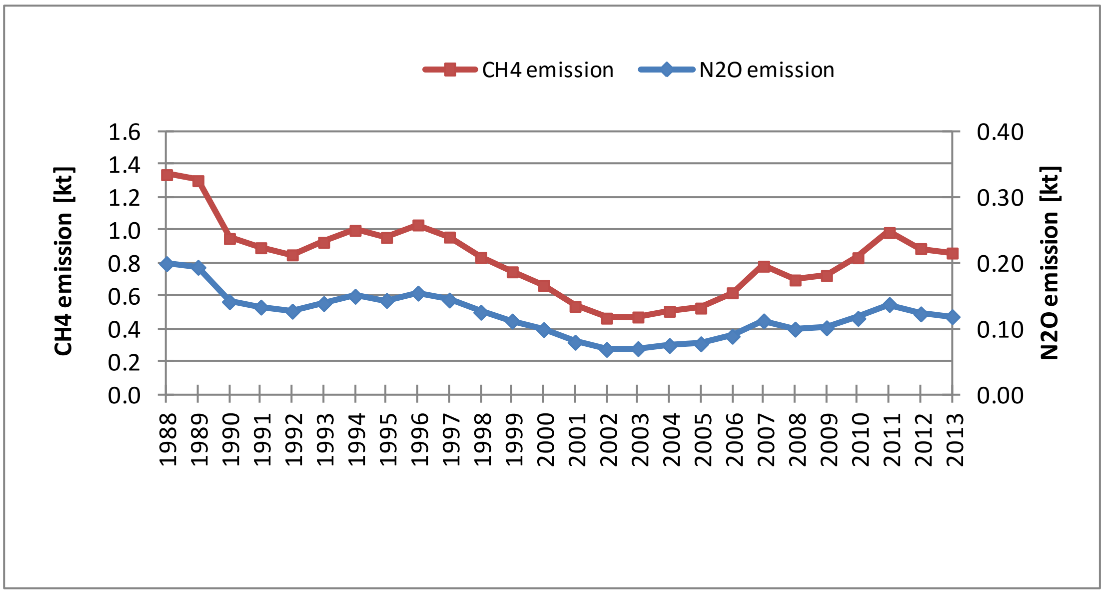

Figure 3.3.7.13. CH_4 and N_2O emissions from 1.A.2.f category in 1988-2013

3.2.7.2.7. Other (1.A.2.g)

The GHG emission was estimated for sub-categories as follows:

- *Manufacturing of machinery*
- *Manufacturing of transport equipment*
- *Mining (excluding fuels) and quarrying*
- *Wood and wood products*
- *Construction*
- *Textile and leather*
- *Off-road vehicles and other machinery*
- *Other* - other industry branches not included elsewhere

The data on fuel type use in stationary sources in the category 1.A.2.g *Other* over the 1988-2013 period are presented in table 3.3.7.7. Detailed data concerning total fuel consumption in 1.A.2.g subcategory was tabulated in Annex 2 (table 10).

Table 3.3.7.7. Fuel consumption in 1988-2013 in stationary sources of 1.A.2.g subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	19.848	18.040	13.846	12.029	10.684	12.077	11.560	14.398
Gaseous Fuels	24.039	22.347	15.645	11.755	13.811	17.922	17.336	15.176
Solid Fuels	82.038	72.062	54.022	48.748	41.858	92.328	80.329	87.356
Other Fuels	0.082	0.058	0.022	0.012	0.134	0.298	1.593	2.294
Biomass	8.335	7.545	5.826	5.518	5.035	4.995	3.410	4.970
TOTAL	**134.342**	**120.051**	**89.361**	**78.062**	**71.522**	**127.620**	**114.228**	**124.194**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	22.621	21.909	18.803	16.603	16.480	14.357	13.982	14.478
Gaseous Fuels	14.210	16.060	17.640	16.354	18.545	18.319	19.273	21.156
Solid Fuels	111.430	92.492	67.610	53.094	43.187	34.504	28.893	26.985
Other Fuels	2.675	1.133	2.080	1.482	2.075	1.802	2.078	2.503
Biomass	6.520	8.195	8.233	8.604	10.105	10.716	12.300	11.897
TOTAL	**157.456**	**139.789**	**114.366**	**96.137**	**90.392**	**79.698**	**76.526**	**77.019**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	14.166	15.025	15.380	12.883	11.811	11.545	11.694	11.647
Gaseous Fuels	22.595	23.325	23.290	23.543	26.267	22.863	24.984	23.876
Solid Fuels	23.495	20.805	18.958	17.446	14.889	11.734	11.918	10.953
Other Fuels	1.661	1.700	3.789	0.938	1.154	1.392	0.069	0.052
Biomass	12.184	11.918	11.030	12.919	13.777	13.753	17.460	20.051
TOTAL	**74.101**	**72.773**	**72.447**	**67.729**	**67.898**	**61.287**	**66.125**	**66.579**
	2012	**2013**						
Liquid Fuels	9.210	8.445						
Gaseous Fuels	23.019	26.036						
Solid Fuels	8.173	7.973						
Other Fuels	0.069	0.098						
Biomass	20.854	24.842						
TOTAL	**61.325**	**67.394**						

Figures 3.3.7.14 and 3.3.7.15 show emissions of CO_2, CH_4 and N_2O, respectively in the 1.A.2.g category in the period: 1988-2013.

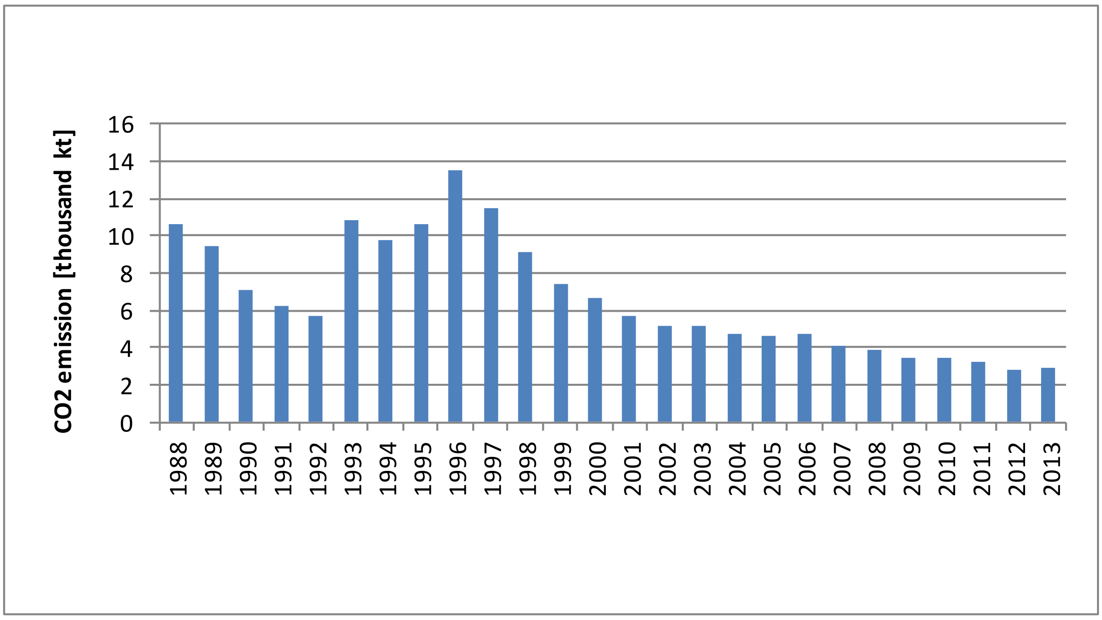

Figure 3.3.7.14. CO_2 emission from 1.A.2.g category in 1988-2013

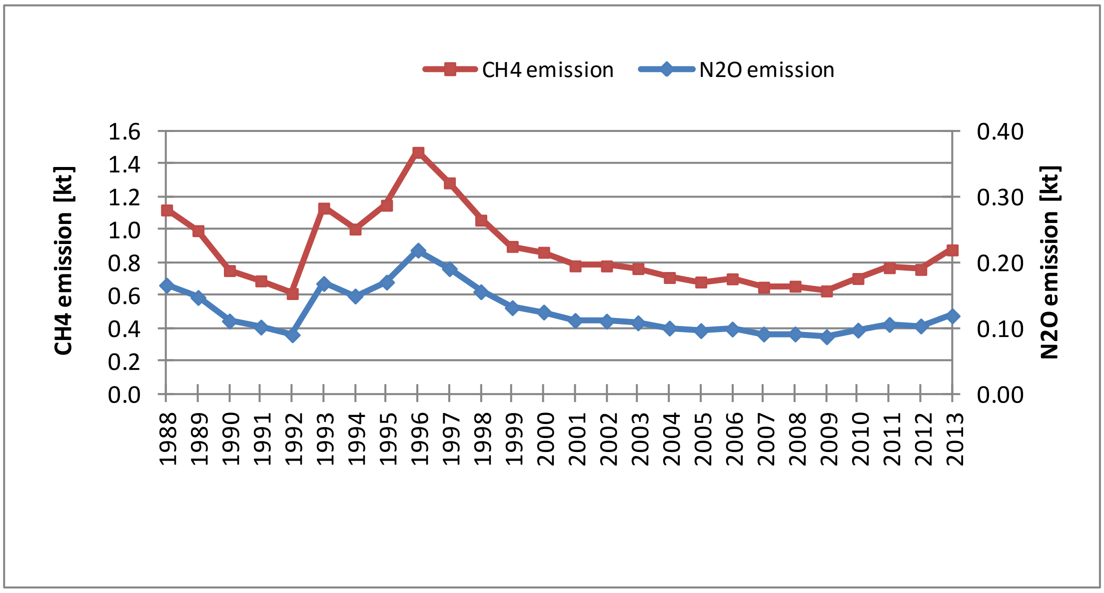

Figure 3.3.7.15. CH_4 and N_2O emissions from 1.A.2.g category in 1988-2013

3.2.7.3. Uncertainties and time-series consistency

See chapter 3.2.6.3.

3.2.7.4. Source-specific QA/QC and verification

See chapter 3.2.6.4.

3.2.7.5. Source-specific recalculations

- fuel consumptions for the years 1990-2012 were updated according to current Eurostat database;
- default CO_2 emission factors from 1996 IPCC GLs were replaced with EFs recommended in 2006 GLs;
- emission was estimated in more detailed split of sub-categories than previously (in accordance with 2006 GLs);

Table. 3.2.7.8. Changes in GHG emissions in 1.A.2 subsector as a result of recalculations

Changes	1988	1989	1990	1991	1992	1993	1994	1995
				CO2				
kt	904.55	850.34	779.57	604.20	534.54	535.87	648.75	745.88
%	1.7	1.7	1.8	1.5	1.5	1.1	1.3	1.2
				CH4				
kt	-0.562	-0.510	-0.420	-0.318	-0.283	-0.323	-0.327	-0.326
%	-12.2	-11.4	-9.2	-7.5	-7.1	-6.4	-6.3	-4.7
				N2O				
kt	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Changes	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
				CO2				
kt	673.13	634.36	-1015.28	-1142.60	-1123.24	-1333.08	-1341.80	-1284.22
%	1.0	1.0	-1.9	-2.4	-2.4	-3.1	-3.4	-3.3
				CH4				
kt	-0.376	-0.405	-0.768	-0.733	-0.789	-0.827	-0.834	-0.851
%	-5.1	-5.9	-13.1	-14.3	-15.2	-17.3	-18.0	-18.8
				N2O				
kt	0.000	-0.001	-0.053	-0.052	-0.055	-0.060	-0.062	-0.061
%	0.0	-0.1	-6.6	-7.5	-7.9	-9.5	-10.1	-10.2

Changes	2004	2005	2006	2007	2008	2009	2010	2011
				CO2				
kt	-1031.44	-826.38	-956.43	-702.07	-632.54	-973.59	-837.51	-419.02
%	-2.6	-2.3	-2.7	-1.9	-1.9	-3.3	-2.7	-1.3
				CH4				
kt	-0.859	-0.785	-0.839	-0.839	-0.720	-0.738	-0.750	-0.686
%	-18.6	-18.8	-19.4	-18.8	-17.1	-18.6	-17.6	-15.2
				N2O				
kt	-0.055	-0.043	-0.047	-0.044	-0.028	-0.033	-0.031	-0.020
%	-9.2	-8.1	-8.6	-7.8	-5.4	-6.7	-5.9	-3.6

Changes	2012
CO2	
kt	-588.45
%	-1.9
CH4	
kt	-0.717
%	-16.0
N2O	
kt	-0.025
%	-4.5

3.2.7.6. Source-specific planned improvements

- analysis of the possibility of country specific EF elaboration for the gaseous fuels in Polish fuel structure

3.2.8. Transport (CRF sector 1.A.3)

3.2.8.1. Source category description

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)

Share of that sector in total GHG emission in 2013 is about 11.1%. Road transport is by far the largest contributor to transport emissions (see figure 3.2.8.1) - in year 2013 about 97%.

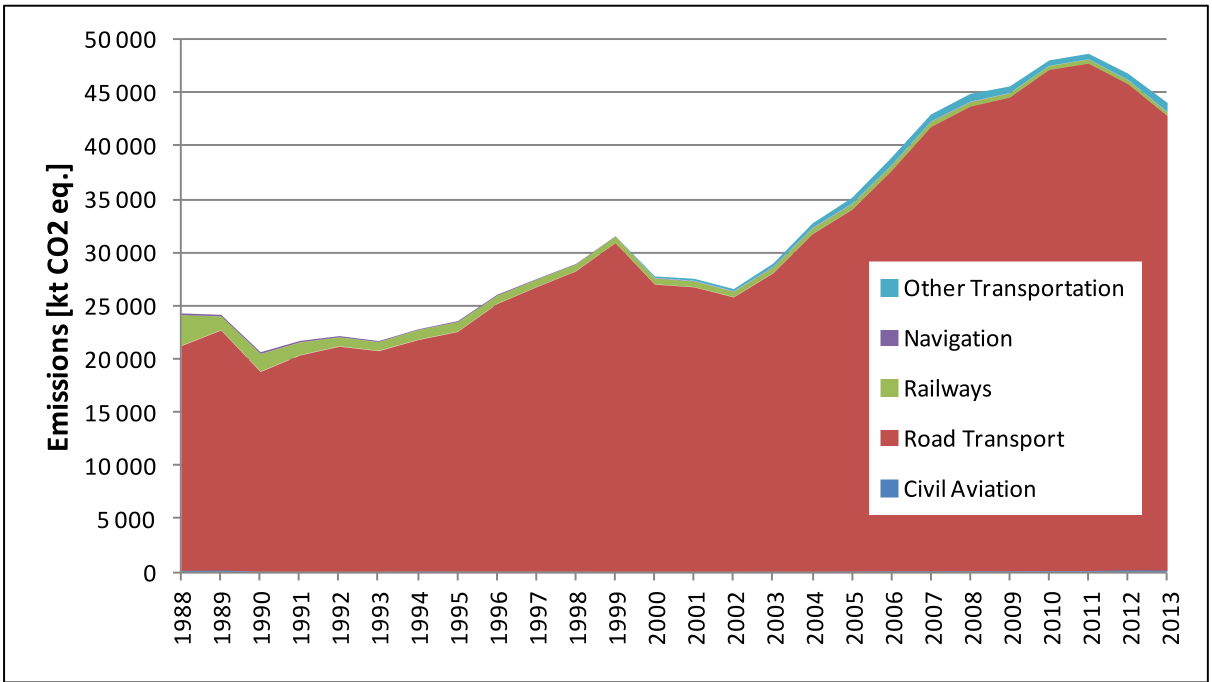

Figure 3.2.8.1. Emissions from transport in years 1988-2013

3.2.8.2. Methodological issues

The methodology used for estimation of GHG emissions in the national inventory for mobile sources for the entire time series 1988-2013 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 (chapter 3.1.1).

Origin of CO_2 emission factors in Road transportation

CO_2 emission factors for road transport have been elaborated by the Motor Transport Institute based on research, analysis and literature. The values of EFs may differ from year to year compared to values in table 3.2.8.1 which is caused by different issues explained below.
ITS published CO_2 EFs in g/kg units which must be converted into kg/GJ to be used in inventory calculation. To conversion NCVs are used, which may differ from year to year and that is why CO_2 EFs

are not constant for period 1988-2011. Since 1996 NCV comes from "Energy Statistic" published by Central Statistical Office (GUS) these are standard calorific values and are mostly constant (it fluctuate only ±0,01MJ/kg and from 2004 all NCV are constant). Before 1996 Poland use real calorific value based on statistical data of fuel consumption given in TJ and kt units.

Moreover, CO_2 EFs depend on carbon content in fuel. There is visible change between years 1995 and 1996 for CO_2 EF for gasoline. The change in IEF for gasoline in 1996 was caused by introducing the new EFs based on the newer country study applying, among others, analysis of gasoline content. EFs used before 1996 were based on study completed in early 1990-ties. The EFs were derived based on C content in different fuel types as well as on the data containing information on vehicle park and mobility. The specific car models were analyzed for elaboration of EFs.

To estimate amount of carbon in motor gasoline it was assumed by ITS that hydrogen carbon ratio is equal 1.85 [Directive 93/116]. It was taken into account that gasoline, except hydrocarbons, include:
- ethyl fluid,
- sulphur (average content in 1992 was about 0.06%),
- additives,
- oxygen (due to the addition of oxygenates).

Content of substances other than carbon and hydrogen was assumed as about 0.7% of mass. Due to this carbon content was about 88.0% of mass (99.3/13.85x12).

In 1993 and 1994 gasoline content significantly changed, e.g. the amount of oxygenates was higher. In some gasoline types oxygen content was almost 3% of mass. In this case new analyses were made. In one of Warsaw petrol stations there were taken 2 samples of each type of gasoline: E94, E98, E94EA (leaded petrol with ethyl alcohol) , B95 and B98. For each samples content of carbon and hydrogen was measured. Analyses were made in Institute of Organic Chemistry – Polish Academy of Sciences. Results of carbon content are presented below (average value from 2 samples):
E94 – 86.8%
E98 – 86.4%
E94EA – 85.2%
B95 – 85.9%
B98 – 85.3%
Weighted average carbon content in motor gasoline in 1994 is then equal 86.45%. Total error of estimation of above analysis is assumed as 0.6%, therefore the value of carbon content which was assumed in previous estimation (equal 86.0%) is in the limit of error. For that reason for all calculation the amount of 86.0% was taken.

In case of diesel oil it was assumed that hydrogen carbon ratio is equal 1.86. Taken into account that diesel oil, except hydrogen and carbon, contain also sulphur, additives, oxygen and water, it was assumed that carbon content is similar to gasoline – 86.0%.

The LPG content is constantly changing, that is why literature value was taken at 81.4%.

IEF contain information on different EFs derived for various engine types, including two-stroke ones. In 1990-ties large change in vehicles number and structure was observed. The share of two-stroke engines extremely dropped in 1990-ties.

The other issue is that characteristics of gasoline used in Poland changed over time. The regular petrol (leaded) was used in 1980-ties and early 1990-ties like: regular petrol 86, 94, 98. Presently only lead-free petrol 95 and 98 is sold/used. For instance consumption of regular petrol 86 drop from 526.8 kt in 1991 to 88.1 kt in 1994 and was withdrawn from production in 1994 following decreasing demand.

Origin of other emission factors

All other emission factors for mobile sources were taken from IPCC guidelines and have constant values over the entire time series 1988-2013. The values of the EFs in 2012 are those in table 3.2.8.1. Exception is N_2O emission factor from gasoline for passenger cars with catalyst, which is based on COPERT IV (following recommendation made by ERT).

Table 3.2.8.1. Emission factors [kg/GJ] for transport types (means) in 2013

Type of transport	Category code	EF CO_2	EF CH_4	EF N_2O
1.A.3.a.ii International Aviation - bunker	PL	73.26	0.0005	0.0023
1.A.3.a.ii Civil Aviation. Domestic	PL	73.26	0.0005	0.0023
	BL	72.10	0.0600	0.0009
1.A.3.b.i Passenger Cars without catalysts	α.BS	70.04	0.03	0.002
	α.LG	62.48	0.02	0.0002
	α.ON	72.43	0.002	0.004
	β.BS	70.04	0.02	0.001
1.A.3.b.i Passenger Cars with catalysts	γ.BS	69.60	0.007	0.003
	γ.LG	62.48	0.02	0.0002
	γ.ON	72.43	0.002	0.004
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	α.BS	70.04	0.02	0.001
	α.LG	62.48	0.03	0.0002
	α.ON	72.43	0.001	0.004
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	γ.BS	69.60	0.02	0.001
	γ.LG	62.48	0.01	0.0002
	γ.ON	72.43	0.001	0.004
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	α.ON	72.43	0.006	0.003
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. with catalysts	γ.ON	72.43	0.006	0.003
1.A.3.b.iii Buses	α.ON	72.43	0.0039	0.0013
	γ.ON	72.43	0.0039	0.0013
1.A.3.b.iv Motorcycles	BS	70.04	0.1	0.001
1.A.3.b.iv Mopeds	BS	70.04	0.1	0.001
1.A.3.b.vi Tractors	ON	72.43	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	ON	75.00	0.005	0.0006
1.A.3.d.ii Domestic Navigation - inland	ON	73.00	0.004	0.030
1.A.3.d.ii Domestic Navigation - marine	ON	74.10	0.007	0.002
	OP	77.60	0.007	0.002
1.A.3.d.i Domestic Navigation - bunker	ON	74.10	0.007	0.002
	OP	77.60	0.007	0.002
1.A.4.c.iii Fishery	ON	74.10	0.007	0.002
	OP	77.60	0.007	0.002
1.A.4.c.ii Agriculture - Off-Road Vehicles	ON	73.00	0.004	0.0039
1.A.4.c.ii Agriculture - Machines	ON	73.00	0.004	0.030
1.A.2.f.ii Off-Road Vehicles in Industry, Other	ON	73.00	0.004	0.030
1.A.3.e.ii Other Off-Road Transport	BS	71.00	0.120	0.002
	LG	63.10	0.062	0.0002
	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; α – 4-stroke, old generation; β - 2-stroke, old generation; γ – new generation (Euro).

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

- Eurostat database – use of fuels (according to Energy Market Agency fuel used is equal to fuel sold) in the following sub-categories: 1.A.3.a – *Civil Aviation*, 1.A.3.b. -*Road Transportation*, 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,

- report of the Motor Transport Institute [ITS 2014],
- GUS G-03 reports – selected aggregated data from the energy balance statistics [GUS 2014e] – used for estimation of fuel use for part of the sub-category 1.A.3.d – *Navigation* - for maritime shipping,
- Statistical Yearbook [GUS 2014] – 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.4.c. iii – Fishing.

3.2.8.2.1. Civil Domestic Aviation (CRF sector 1.A.3.a)

This category include emissions from passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.). Exclude use of fuel at airports for ground transport, fuel for stationary combustion at airports.

For the years 1990-2013 data related to aviation gasoline and jet kerosene are those of the Eurostat database, while for the base year and 1989 – those of the IEA database. As there was no split on international and domestic jet kerosene use in those statistics, the amounts of domestic fuels use in years 2005 – 2013 were calculated based on Eurocontrol data on fuel share of jet kerosene used for domestic aviation in Poland. Due to the lack of Eurocontrol data for the years before 2005, the share for years 1988-2004 was assumed as a 5-years average from Eurocontrol data for years 2005-2009.

Emissions from aviation come from the combustion of jet fuel and aviation gasoline. Data on fuel use in domestic aviation are shown in table 3.2.8.2 and figure 3.2.8.2. Figures 3.2.8.3 and 3.2.8.4 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.3.a in the period 1988-2013.

Table 3.2.8.2. Fuel consumption and GHG emission in years 1988 - 2013

		1988	1989	1990	1991	1992	1993	1994	1995	1996
Aviation gasoline	TJ	879.98	836.02	352.00	220.00	88.00	176.00	440.00	308.00	176.00
Jet fuel	TJ	925.58	1273.01	570.20	588.77	639.16	636.50	644.46	694.85	816.85
CO2 emission	kt	131.25	153.53	67.15	58.99	53.17	59.32	78.93	73.11	72.53
CH4 emission	kt	0.053	0.051	0.021	0.013	0.006	0.011	0.027	0.019	0.011
N2O emission	kt	0.003	0.004	0.002	0.002	0.002	0.002	0.002	0.002	0.002
		1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Aviation gasoline	TJ	264.00	176.00	132.00	132.00	132.00	176.00	176.00	132.00	132.00
Jet fuel	TJ	731.98	745.24	665.68	708.11	697.50	684.24	739.94	726.68	973.83
CO2 emission	kt	72.66	67.28	58.28	61.39	60.61	62.81	66.89	62.75	80.86
CH4 emission	kt	0.016	0.011	0.008	0.008	0.008	0.011	0.011	0.008	0.008
N2O emission	kt	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
Aviation gasoline	TJ	132.00	176.00	132.00	176.00	176.00	220.00	220.00	176.00	
Jet fuel	TJ	1173.82	1128.82	1192.61	1123.22	1284.33	1380.17	2160.64	1861.29	
CO2 emission	kt	95.51	95.38	96.88	94.97	106.77	116.97	174.14	149.04	
CH4 emission	kt	0.009	0.011	0.009	0.011	0.011	0.014	0.014	0.011	
N2O emission	kt	0.003	0.003	0.003	0.003	0.003	0.003	0.005	0.004	

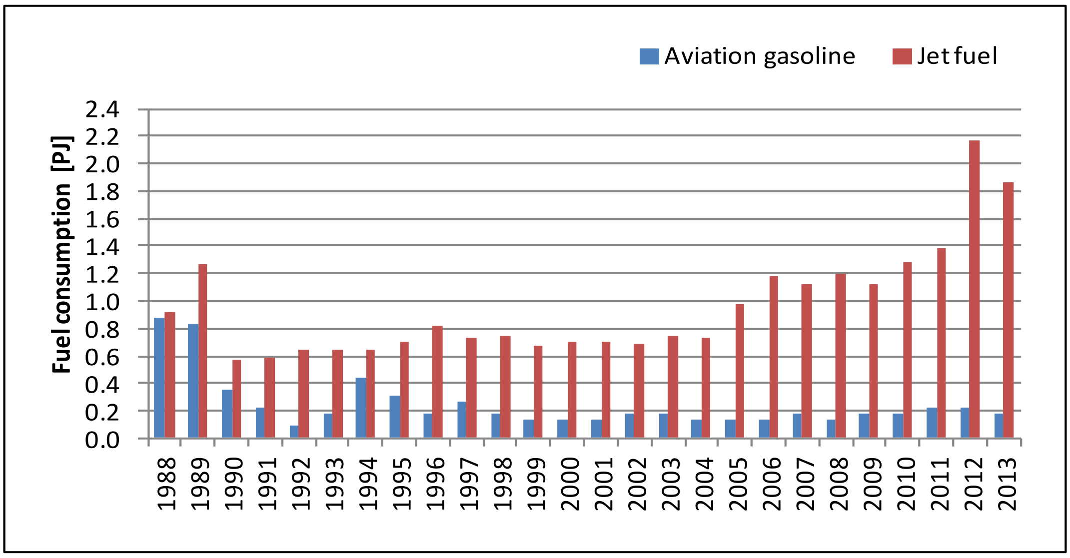

Figure 3.2.8.2. Fuel consumption in 1.A.3.a category for 1988-2013

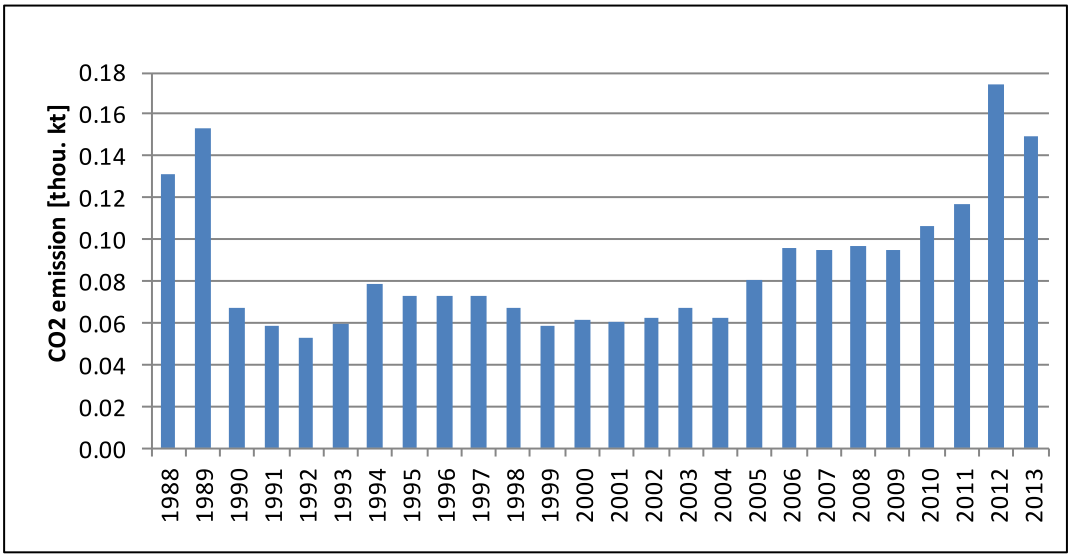

Figure 3.2.8.3. CO_2 emission for 1.A.3.a category in 1988-2013

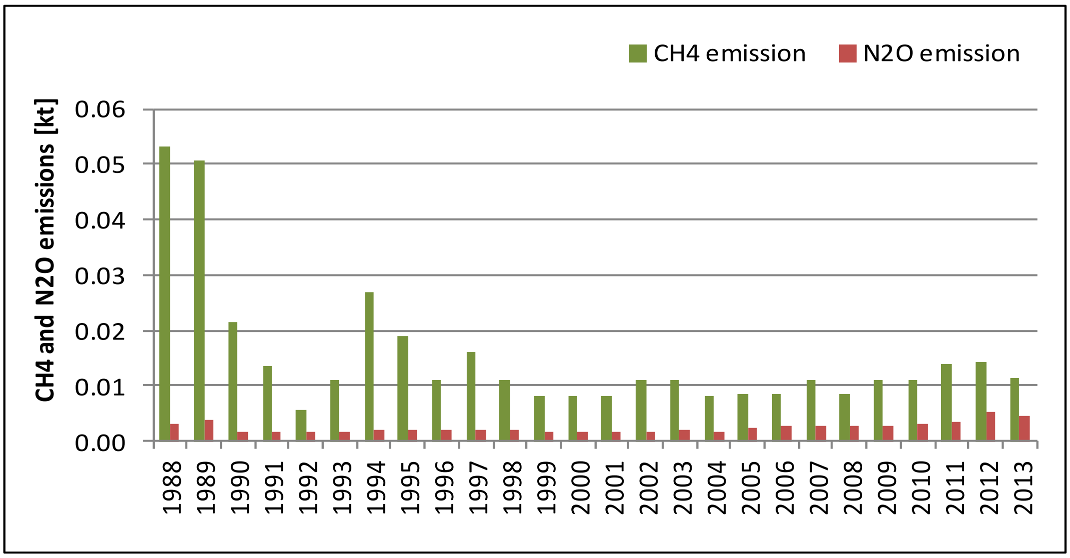

Figure 3.2.8.4. CH_4 and N_2O emissions for 1.A.3.a category in 1988-2013

3.2.8.2.2. Road Transportation (CRF sector 1.A.3.b)

Emission estimates from this category are based on fuel consumed by different vehicle types – including passenger cars, light and heavy duty vehicles, buses, tractors, motorcycles and mopeds. Data on fuel consumption for years 1990-2013 comes from Eurostat database, and for years 1988-1989 from IEA. Consumption of each type of fuel (used in road transport) in statistics is given without distinguishing on individual vehicle type. Therefore, for the purpose of this report fuel consumption was disaggregated based on ITS report [ITS 2014]. Table 3.2.8.3 shows fuel consumption and GHG emissions in 2013 by vehicle categories.

Table 3.2.8.3. Fuel consumption and GHG emissions in 2013 by vehicle categories.

Vehicle category	Oznaczenie paliwa	Ilość zużytego paliwa [TJ]	Emisja CO_2 [kt]	Emisja CH_4 [kt]	Emisja N_2O [kt]
1.A.3.b.i Passenger Cars without catalysts	α.BS	7.560	529.55	0.227	0.015
	α.LPG	9.671	604.19	0.193	0.002
	α.ON	4.647	336.58	0.009	0.019
	β.BS	0.000	0.00	0.000	0.000
1.A.3.b.i Passenger Cars with catalysts	γ.BS	133.885	9318.78	0.937	0.402
	γ.LPG	52.280	3266.31	1.046	0.010
	γ.ON	154.309	11176.27	0.309	0.617
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	α.BS	0.747	52.34	0.015	0.001
	α.LPG	1.150	71.82	0.034	0.000
	α.ON	2.748	199.04	0.003	0.011
	β.BS	0.000	0.00	0.000	0.000
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	γ.BS	9.450	657.76	0.189	0.009
	γ.LPG	10.177	635.85	0.102	0.002
	γ.ON	83.089	6017.99	0.083	0.332
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	α.BS	0.000	0.00	0.000	0.000
	α.ON	23.469	1699.82	0.141	0.070
	β.ON	0.000	0.00	0.000	0.000
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. with catalysts	γ.ON	65.596	4751.00	0.394	0.197
1.A.3.b.iii Buses	α.ON	4.171	302.12	0.016	0.005
	γ.ON	19.921	1442.86	0.078	0.026
1.A.3.b.iv Motorcycles	BS	1.099	76.97	0.110	0.001
1.A.3.b.iv Mopeds	BS	0.483	33.87	0.048	0.000
1.A.3.b.vi Tractors	ON	11.484	831.79	0.046	0.045

catalyst - catalytic converter; BS - motor gasoline; ON - diesel oil; LG – liquid gas; α – 4-stroke, old generation; β - 2-stroke, old generation; γ – new generation (Euro).

The amount of vehicles according to categories in 2013 [GUS T 2014] is given in table below.

Table 3.2.8.4. Amount of vehicles according to categories in 2013

Category	Amount [thous. pcs.]
Passenger cars	19 389
Trucks	2 962
Buses	103
Motorcycles	1 153
Mopeds	1163
Tractors	1 632

Consumption of main fuels in road transport (gasoline. diesel oil and LPG) and GHG emissions in 1988-2013 period is shown in table 3.2.8.5.

Table 3.2.8.5. Fuel consumption and GHG emission in years 1988 - 2013

		1988	1989	1990	1991	1992	1993	1994	1995	1996
Motor gasoline	PJ	130.33	144.36	136.14	158.81	168.42	172.06	190.42	193.03	201.78
Diesel oil	PJ	155.40	161.03	117.85	116.77	118.15	107.85	101.42	104.89	136.47
LPG	PJ	0	0	0	0	0	1.10	3.27	8.10	11.64
Biodiesel	PJ	0	0	0	0	0	0	0	0	0
Bioethanol	PJ	0	0	0	0	0	0	0	0	0
CO2 emission	kt	20 771	22 179	18 429	19 961	20 776	20 356	21 354	22 108	24 683
CH4 emission	kt	4.580	5.014	4.549	5.198	5.433	5.550	6.109	6.049	6.177
N2O emission	kt	0.713	0.755	0.603	0.637	0.662	0.646	0.676	0.712	0.855
		1997	1998	1999	2000	2001	2002	2003	2004	2005
Motor gasoline	PJ	217.90	222.17	247.13	222.70	206.59	189.16	180.68	183.42	177.04
Diesel oil	PJ	139.25	155.34	162.08	134.79	140.58	134.84	164.18	200.99	229.82
LPG	PJ	15.46	16.10	21.48	19.55	26.96	38.13	49.22	61.69	71.25
Biodiesel	PJ	0	0	0	0	0	0	0	0	0.65
Bioethanol	PJ	0	0	0	0	0	0	1.18	0.56	1.42
CO2 emission	kt	26 234	27 717	30 341	26 519	26 270	25 343	27 567	31 200	33 433
CH4 emission	kt	6.130	5.655	6.032	4.566	4.383	4.269	4.385	4.779	4.610
N2O emission	kt	0.922	1.014	1.108	0.967	0.948	0.894	0.975	1.111	1.206
		2006	2007	2008	2009	2010	2011	2012	2013	
Motor gasoline	PJ	181.62	181.35	179.20	179.78	177.66	168.03	160.83	153.23	
Diesel oil	PJ	268.77	323.21	352.55	365.97	402.82	421.92	401.95	369.44	
LPG	PJ	78.20	80.50	79.07	76.04	76.36	73.97	73.88	73.28	
Biodiesel	PJ	1.46	1.02	12.88	19.57	29.22	31.60	28.01	25.26	
Bioethanol	PJ	2.30	3.00	5.31	8.15	7.90	7.48	6.44	6.03	
CO2 emission	kt	37 008	41 073	42 957	43 780	46 322	46 883	44 928	42 005	
CH4 emission	kt	4.956	5.036	5.043	5.007	5.093	4.813	4.457	4.073	
N2O emission	kt	1.351	1.548	1.666	1.744	1.881	1.954	1.893	1.784	

The decrease in fuel consumption (especially petrol and LPG) for road transport in recent years may be due to the economic downturn, rising of fuel prices and rationalization of transportation by transport companies. There is a growing trend of consumption of biofuels in road transport – share in 2013 was about 5%. Amounts of biofuels used in years 2005 - 2013 are given in table 3.1.8.3. 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.

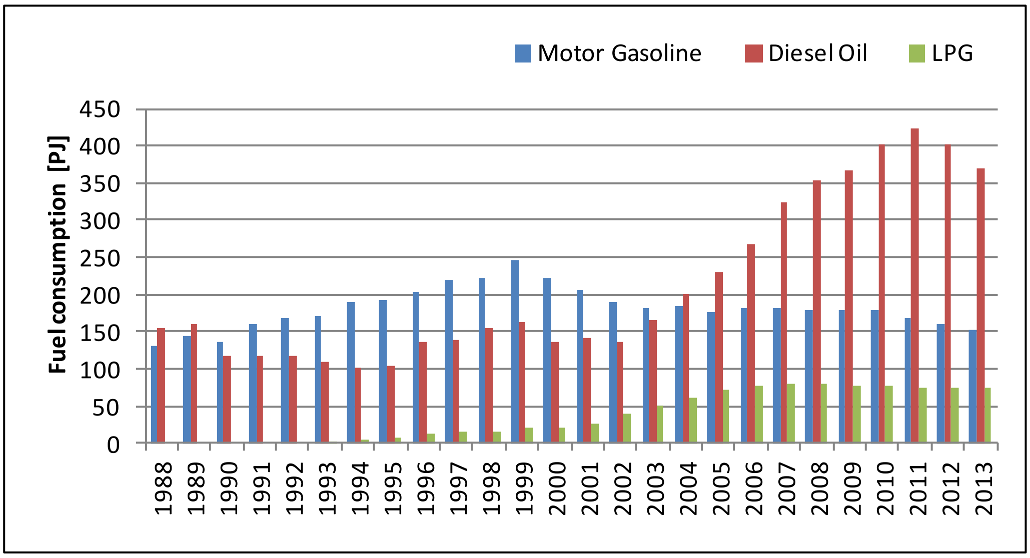

Figure 3.2.8.5. Fuel consumption in 1.A.3.b category for 1988-2013

Figure 3.2.8.6 shows CO_2 emissions in sub-category 1.A.3.b in period 1988-2013. Emissions of CH_4 and N_2O in the same sub-category are shown in figure 3.2.8.7.

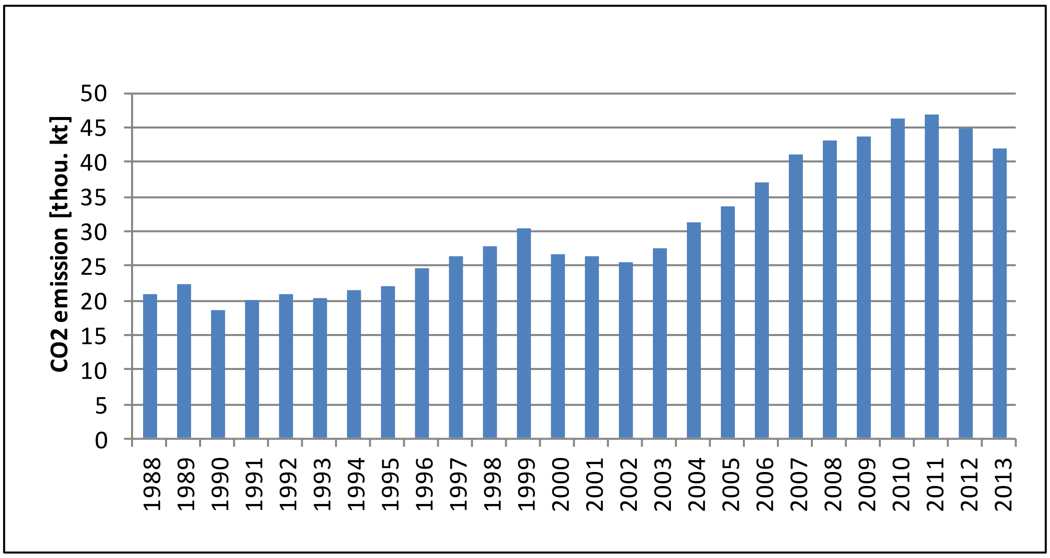

Figure 3.2.8.6. CO_2 emission for 1.A.3.b category in 1988-2013

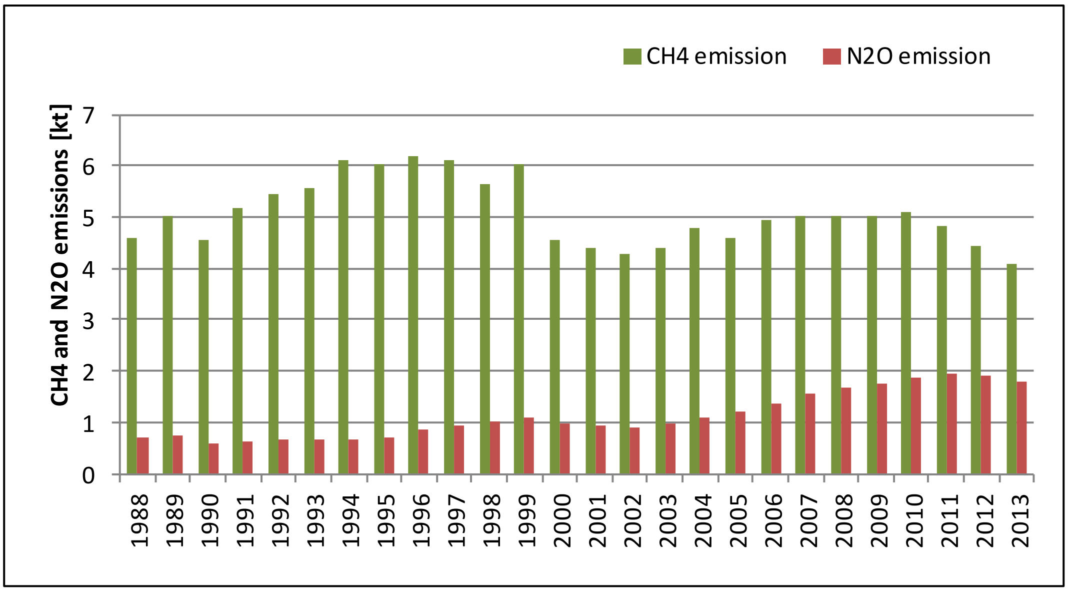

Figure 3.2.8.7. CH_4 and N_2O emissions for 1.A.3.b category in 1988-2013

3.2.8.2.3. Railways (CRF sector1.A.3.c)

Category include emissions from railway transport for both freight and passenger traffic routes. Railway locomotives used in Poland are diesel and electric. Up to year 1998 coal was used in steam locomotives. Electric locomotives are powered by electricity generated at stationary power plants as well as other sources. The corresponding emissions are covered under the Stationary Combustion sector. The amounts of fuels used in railway transport in the 1988-2013 period are shown table 3.2.8.6 and in figure 3.2.8.8.

Table 3.2.8.6. Fuel consumption and GHG emission in years 1988 - 2013

		1988	1989	1990	1991	1992	1993	1994	1995	1996
Hard coal	TJ	10 972	5 785	3 169	1 686	350	293	156	132	192
Diesel oil	TJ	23 600	9 585	17 761	13 556	10 596	10 425	11 798	11 497	9 652
CO2 emission	kt	2 829	1 277	1 638	1 179	828	810	900	875	742
CH4 emission	kt	0.228	0.106	0.120	0.085	0.056	0.055	0.061	0.059	0.050
N2O emission	kt	0.030	0.014	0.015	0.010	0.007	0.007	0.007	0.007	0.006
		1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Hard coal	TJ	181	138	0	0	0	0	0	0	0
Diesel oil	TJ	8 666	8 151	7 722	7 078	6 907	6 564	6 907	6 907	6 778
CO2 emission	kt	667	625	579	531	518	492	518	518	508
CH4 emission	kt	0.045	0.042	0.039	0.035	0.035	0.033	0.035	0.035	0.034
N2O emission	kt	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.004
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
Hard coal	TJ	0	0	0	0	0	0	0	0	
Diesel oil	TJ	6 220	6 135	5 362	5 196	4 806	4 980	4 633	4 287	
CO2 emission	kt	467	460	402	390	360	374	347	322	
CH4 emission	kt	0.031	0.031	0.027	0.026	0.024	0.025	0.023	0.021	
N2O emission	kt	0.004	0.004	0.003	0.003	0.003	0.003	0.003	0.003	

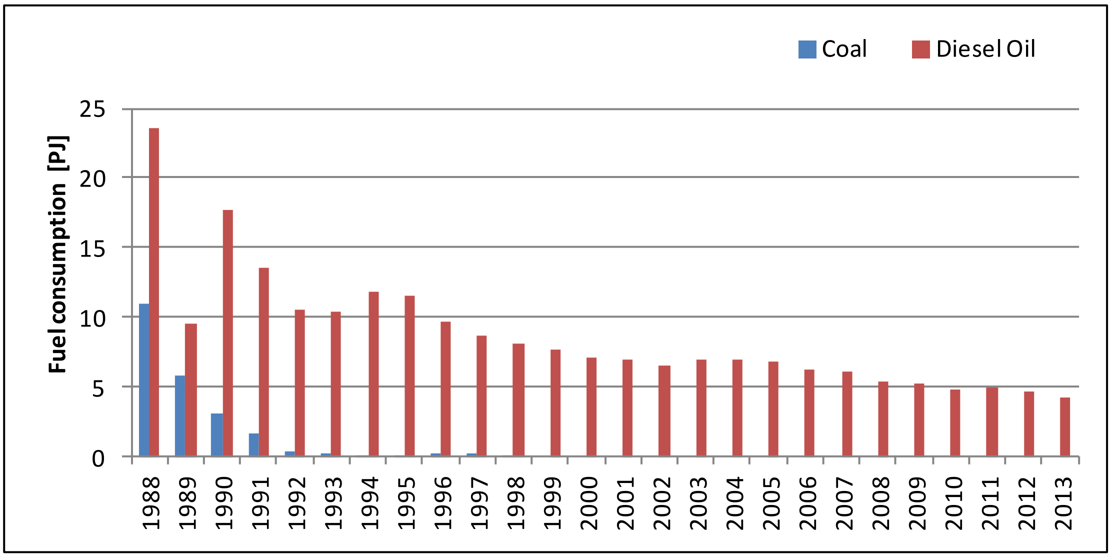

Figure 3.2.8.8. Fuel consumption in 1.A.3.c category for 1988-2013

Figures 3.2.8.9 and 3.2.8.10 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.3.c for the entire time series beginning in the base year.

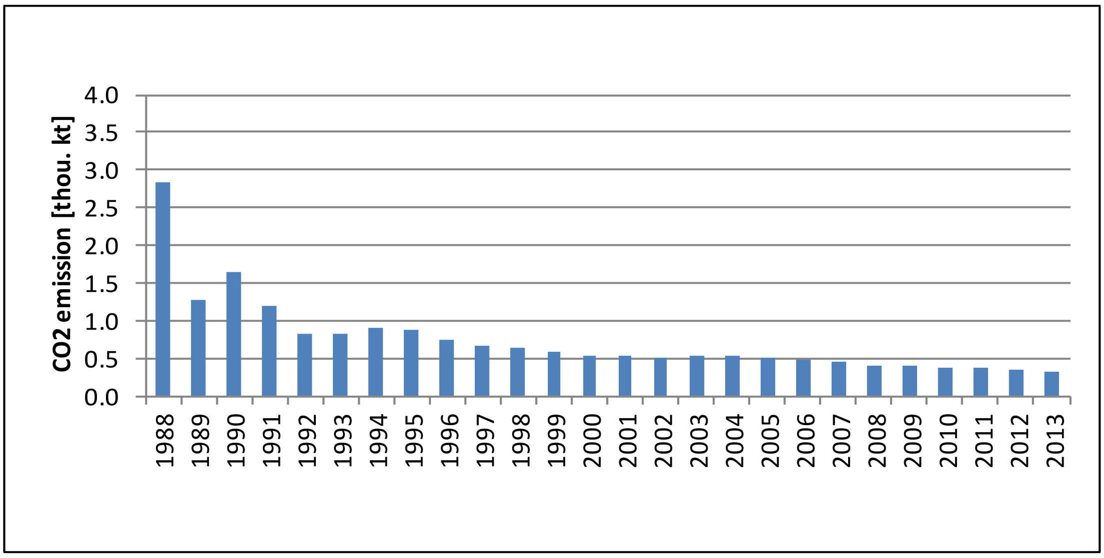

Figure 3.2.8.9. CO_2 emission for 1.A.3.c category in 1988-2013

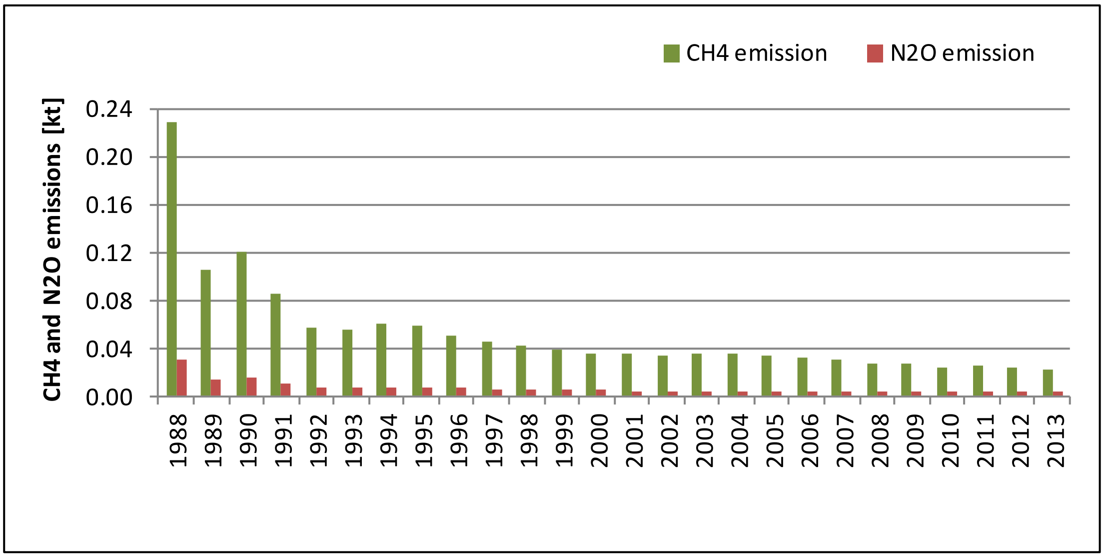

Figure 3.2.8.10. CH_4 and N_2O emissions for 1.A.3.c category in 1988-2013

3.2.8.2.4. Domestic Navigation (CRF sector 1.A.3.d)

Category relates to inland and marine domestic navigation and include emissions from fuels used by vessels of all flags that depart and arrive in the same country. Exclude fishing, which should be reported under 1 A 4 c iii.

The structure of fuels used in Navigation has been recalculated based on G-03 questionnaires and statistical data on levels of international vs. domestic shipping activity (table 3.2.8.7). The amounts of fuels (diesel and fuel oil) used in both inland water and maritime navigation in the 1988-2013 period are shown in table 3.2.8.8 and figure 3.2.8.11.

Table3.2.8.7. Cargo traffic at Polish seaports.

Cargo traffic	Unit	1990	1991	1992	1993	1994	1995	1996	1997
International	kt	45 901	40 671	43 558	49 814	51 148	48 179	47 925	50 630
Domestic	kt	1 138	1 009	744	711	1 327	1 142	1 068	355
Share of domestic	%	2.4	2.4	1.7	1.4	2.5	2.3	2.2	0.7
		1998	1999	2000	2001	2002	2003	2004	2005
International	kt	50 564	49 227	47 334	47 220	48 404	51 020	56 011	58 489
Domestic	kt	432	453	537	534	562	866	907	990
Share of domestic	%	0.8	0.9	1.1	1.1	1.1	1.7	1.6	1.7
		2006	2007	2008	2009	2010	2011	2012	2013
International	kt	59 137	51 604	47 806	44 250	58 613	56 609	57 728	62 898
Domestic	kt	1 182	830	1 027	829	893	1 129	1 098	1 206
Share of domestic	%	2.0	1.6	2.1	1.8	1.5	2.0	1.9	1.9

Table 3.2.8.8. Fuel consumption and GHG emission in years 1988 – 2013.

		1988	1989	1990	1991	1992	1993	1994	1995	1996
Diesel oil-inland navigation	TJ	968.83	681.61	858.00	686.00	815.00	686.00	300.00	686.00	686.00
Diesel oil - maritime	TJ	239.59	236.54	232.96	183.59	119.30	82.08	97.98	93.40	72.68
Fuel oil - maritime	TJ	894.34	878.75	900.55	825.50	546.35	340.58	425.53	428.31	399.10
CO2 emission	kt	157.88	135.48	149.78	127.74	110.73	82.59	62.18	90.24	86.43
CH4 emission	kt	0.012	0.011	0.011	0.010	0.008	0.006	0.005	0.006	0.006
N2O emission	kt	0.031	0.023	0.028	0.023	0.026	0.021	0.010	0.022	0.022
		1997	1998	1999	2000	2001	2002	2003	2004	2005
Diesel oil-inland navigation	TJ	644.00	386.00	300.00	257.00	257.00	214.00	300.00	257.00	214.00
Diesel oil - maritime	TJ	27.93	27.25	25.20	24.52	19.76	19.60	31.67	22.84	30.42
Fuel oil - maritime	TJ	127.94	156.91	142.74	138.76	133.80	133.37	182.04	85.41	60.55
CO2 emission	kt	59.01	42.37	34.84	31.35	30.61	27.42	38.37	27.08	22.57
CH4 emission	kt	0.004	0.003	0.002	0.002	0.002	0.002	0.003	0.002	0.001
N2O emission	kt	0.020	0.012	0.009	0.008	0.008	0.007	0.009	0.008	0.007
		2006	2007	2008	2009	2010	2011	2012	2013	
Diesel oil-inland navigation	TJ	257.00	214.00	214.00	130.00	0.00	130.00	130.00	130.00	
Diesel oil - maritime	TJ	31.48	24.15	26.70	16.49	9.22	10.46	10.14	13.39	
Fuel oil - maritime	TJ	80.26	65.28	63.97	38.21	12.78	14.79	11.06	23.32	
CO2 emission	kt	27.32	22.48	22.56	13.68	1.68	11.41	11.10	12.29	
CH4 emission	kt	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.001	
N2O emission	kt	0.008	0.007	0.007	0.004	0.000	0.004	0.004	0.004	

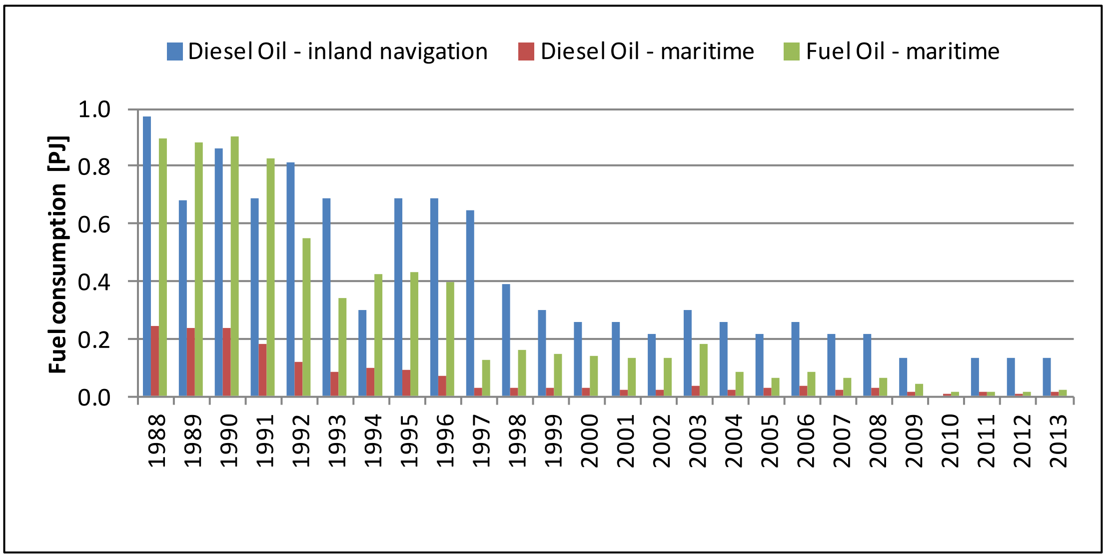

Figure 3.2.8.11. Fuel consumption in 1.A.3.d category for 1988-2013

Figures 3.2.8.12 and 3.2.8.13 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.3.d for the entire time series 1988-2013.

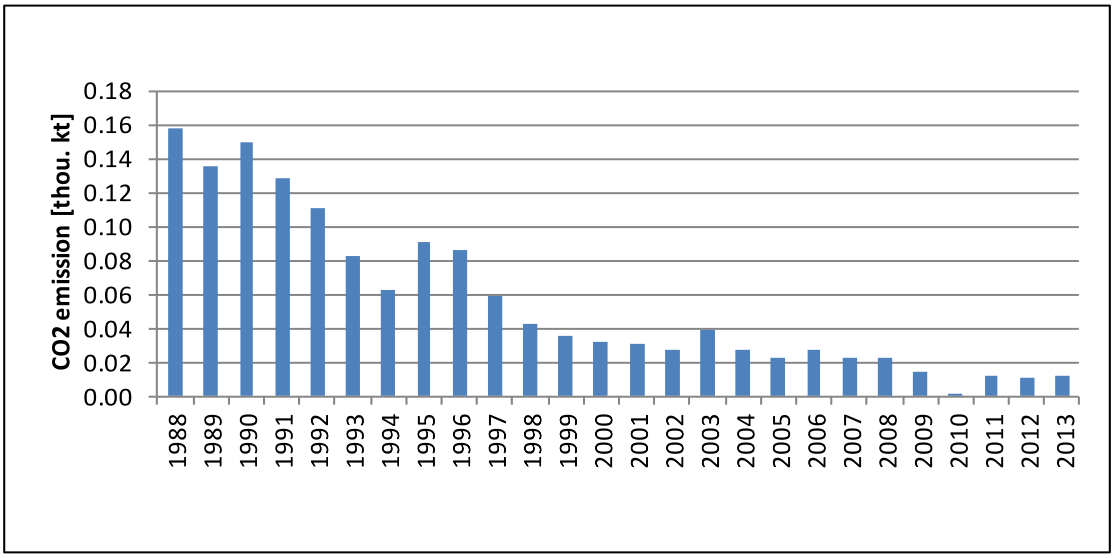

Figure 3.2.8.12. CO_2 emission for 1.A.3.d category in 1988-2013

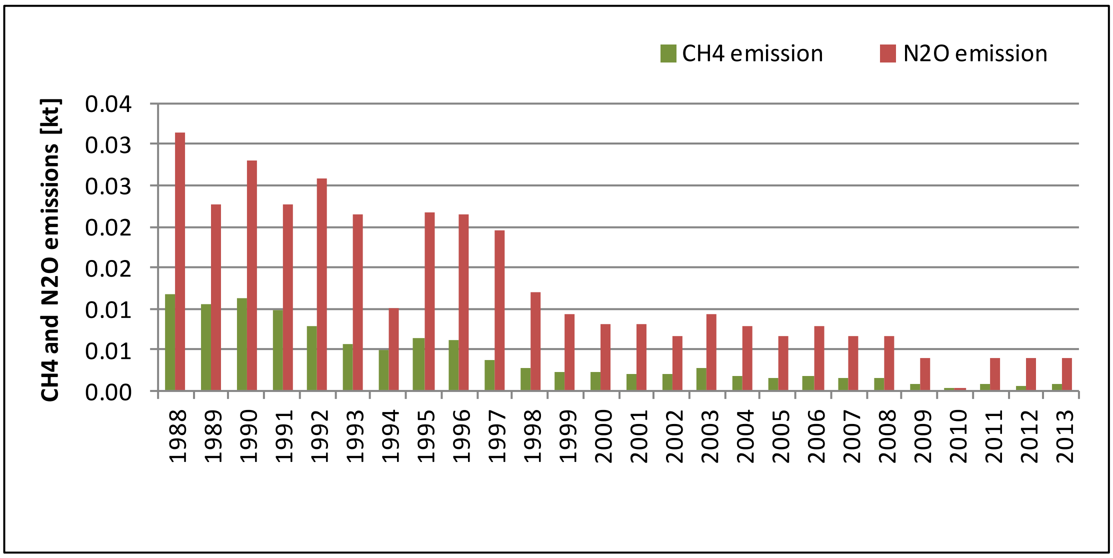

Figure 3.2.8.13. CH_4 and N_2O emissions for 1.A.3.d category in 1988-2013

3.2.8.2.5. Other transportation (CRF sector 1.A.3.e)

Pipeline transport contains combustion related emissions from the operation of pump stations and maintenance of pipelines. From year 2000, when gas pipeline Jamal was completed, the amount of this fuel increased sharply from 21 TJ in 1999 to 2498 TJ in 2000.

The amounts of fuels consumption in the sub-category 1.A.3.e.i. *Pipelines transport* in the 1988-2013 period are shown in table 3.2.8.9. Natural gas consumption is shown on figure 3.2.8.14.

Table 3.2.8.9. Fuel consumption and GHG emission in years 1988 - 2013

		1988	1989	1990	1991	1992	1993	1994	1995	1996
Gasoline	TJ	0	0	0	0	0	0	0	0	0
Diesel oil	TJ	0	0	0	0	0	0	0	0	0
Natural gas	TJ	0	0	0	0	0	0	1	7	24
CO2 emission	kt	0	0	0	0	0	0	0.06	0.39	1.34
CH4 emission	kt	0	0	0	0	0	0	0.000001	0.000007	0.000024
N2O emission	kt	0	0	0	0	0	0	0.000000	0.000001	0.000002
		1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Gasoline	TJ	0	0	0	0	45	45	45	45	45
Diesel oil	TJ	0	0	0	43	43	0	43	43	43
Natural gas	TJ	26	23	21	2 498	3 262	3 502	5 257	7 381	9 866
CO2 emission	kt	1.45	1.28	1.17	142.59	188.32	198.57	299.68	418.24	556.96
CH4 emission	kt	0.000026	0.000023	0.000021	0.002627	0.003526	0.003637	0.005521	0.007645	0.010130
N2O emission	kt	0.000003	0.000002	0.000002	0.000276	0.000379	0.000377	0.000579	0.000791	0.001039
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
Gasoline	TJ	0	45	0	45	0	0	0	0	
Diesel oil	TJ	43	43	43	43	43	43	43	43	
Natural gas	TJ	12 912	11 828	13 442	11 084	9 269	9 299	10 806	15 422	
CO2 emission	kt	723.89	666.47	742.79	619.04	513.43	522.22	606.34	864.00	
CH4 emission	kt	0.013041	0.012092	0.013571	0.011348	0.009398	0.009428	0.010935	0.015551	
N2O emission	kt	0.001317	0.001236	0.001370	0.001161	0.000953	0.000956	0.001106	0.001568	

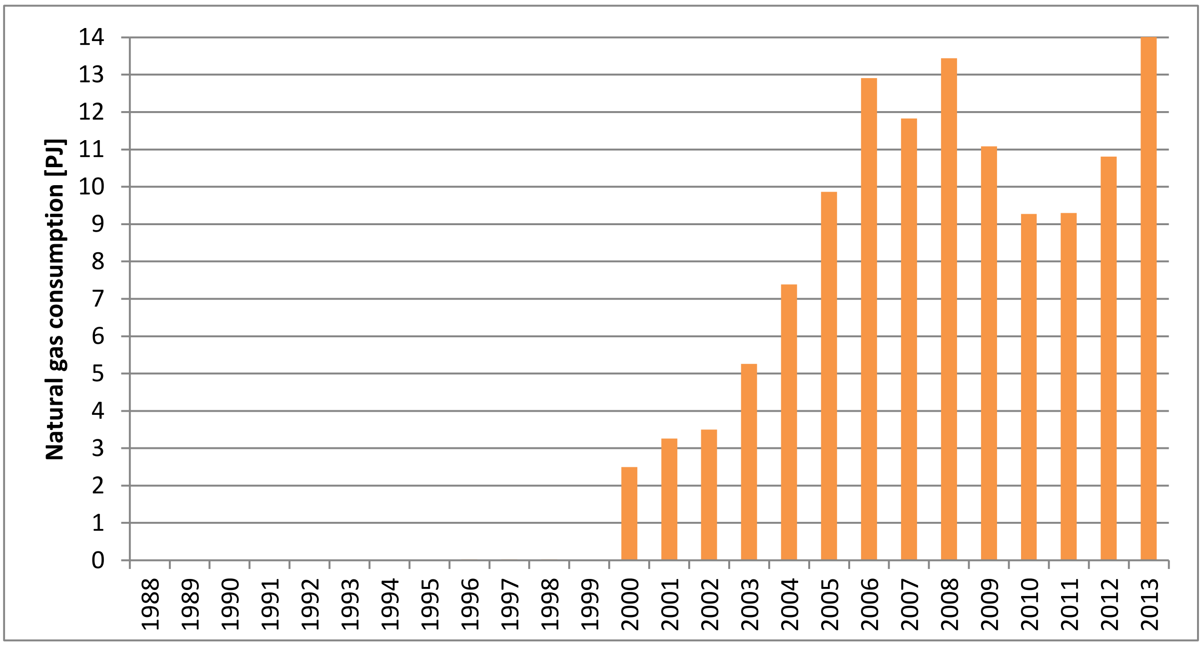

Figure 3.2.8.14. Natural gas consumption in *Pipelines transport* category for 1988- 2013

Figures 3.2.8.15 and 3.2.8.16 show respectively emissions of CO_2, CH_4 and N_2O, in the sub-category 1.A.3.e from Pipelines for the entire time series 1988-2013.

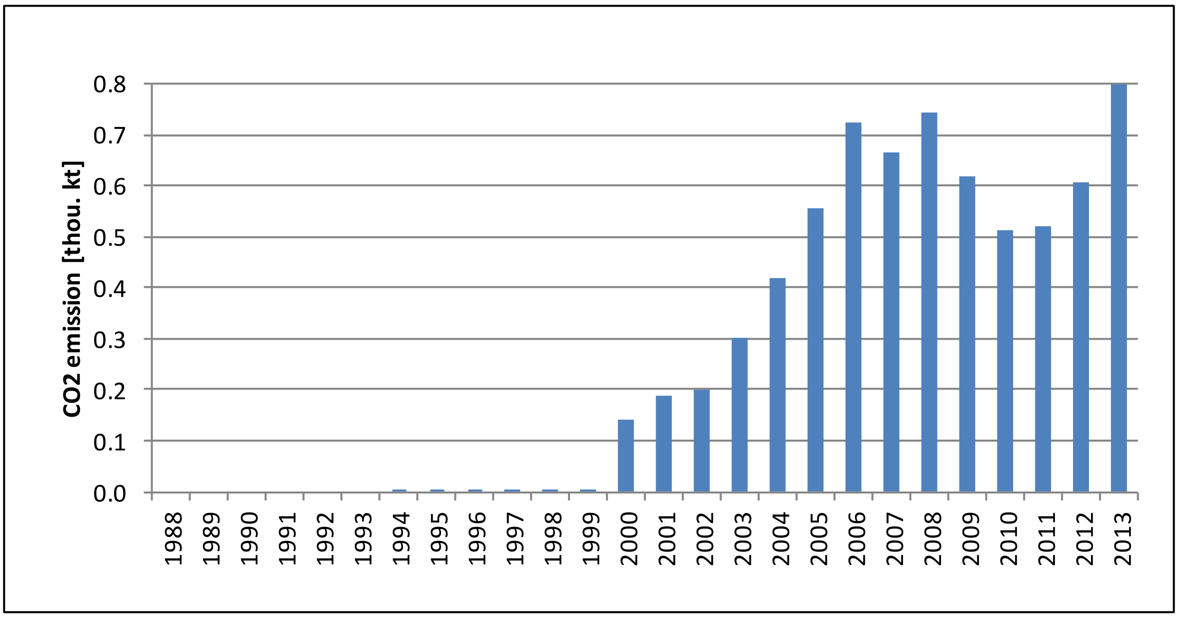

Figure 3.2.8.15. CO_2 emission from Pipelines category in 1988-2013

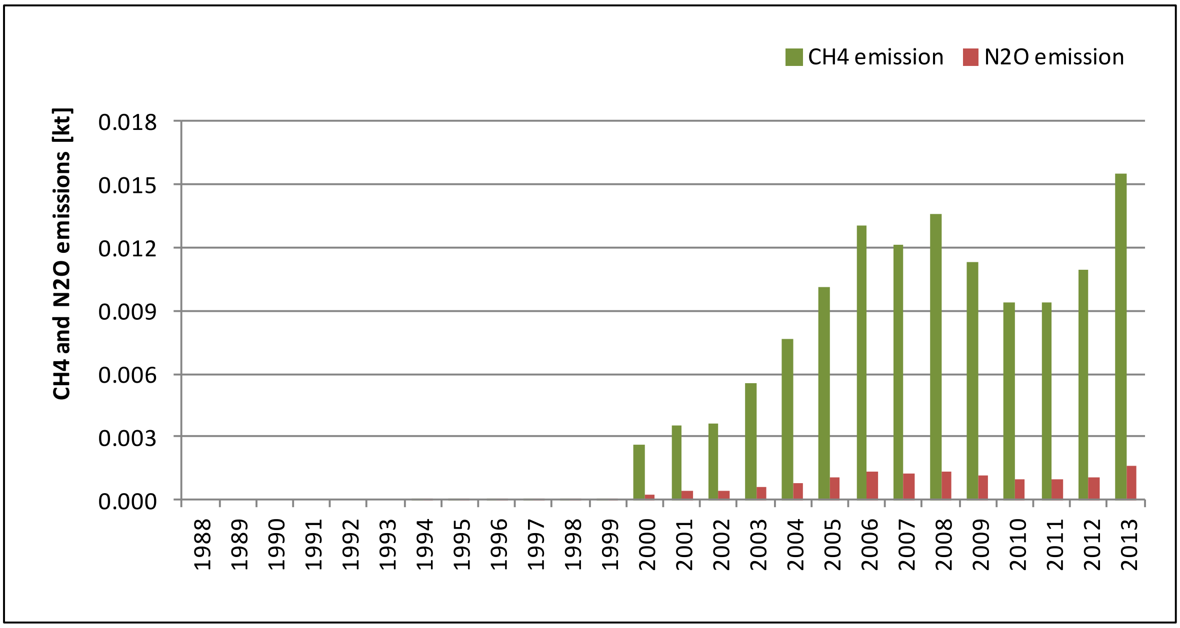

Figure 3.2.8.16. CH_4 and N_2O emissions from Pipelines category in 1988-2013

3.2.8.2.6. 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

The amounts of fuels used in the above listed sub-categories in the 1988-2013 period are presented in table 3.2.8.10 and figure 3.2.8.17. The amounts of corresponding emissions of CO_2, CH_4 and N_2O are shown in tables 3.2.8.11–3.2.8.12 and figures 3.2.8.18 and 3.2.8.19.

Table 3.2.8.10. Fuel consumption in 1988-2013 in mobile sources in subcategories other than 1.A.3

		1988	1989	1990	1991	1992	1993	1994	1995	1996
ON-1.A.4.c.ii	PJ	49.42	47.82	50.54	48.70	57.22	72.17	78.16	82.29	91.78
ON-1.A.4.c.iii	PJ	4.55	4.15	3.43	3.30	3.44	2.82	3.22	3.16	2.60
OP-1.A.4.c.iii	PJ	7.54	6.87	5.67	5.46	5.69	4.67	5.33	5.24	4.24
		1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
ON-1.A.4.c.ii	PJ	106.78	97.15	99.50	110.24	102.76	102.45	103.66	105.59	108.01
ON-1.A.4.c.iii	PJ	2.70	1.95	1.96	1.73	1.83	1.79	1.44	1.62	1.38
OP-1.A.4.c.iii	PJ	4.41	3.18	3.19	2.83	2.98	2.93	2.36	2.65	2.25
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
ON-1.A.4.c.ii	PJ	80.21	73.73	73.78	71.68	71.89	72.49	73.03	71.39	
ON-1.A.4.c.iii	PJ	1.30	1.35	1.30	1.93	1.59	1.64	1.66	1.78	
OP-1.A.4.c.iii	PJ	2.13	2.20	2.11	3.14	2.60	2.67	2.71	2.91	

Table 3.2.8.11. GHG emission in 1988-2013 in subcategory 1.A.4.c.ii.

1.A.4.c.ii		1988	1989	1990	1991	1992	1993	1994	1995	1996
CO2 emission	kt	3 662	3 544	3 745	3 609	4 240	5 348	5 792	6 098	6 801
CH4 emission	kt	0.205	0.198	0.210	0.202	0.237	0.300	0.324	0.342	0.381
N2O emission	kt	1.413	1.368	1.446	1.393	1.637	2.064	2.235	2.354	2.625
1.A.4.c.ii		**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CO2 emission	kt	7 912	7 199	7 373	8 168	7 615	7 592	7 681	7 824	8 004
CH4 emission	kt	0.443	0.403	0.413	0.457	0.426	0.425	0.430	0.438	0.448
N2O emission	kt	3.054	2.778	2.846	3.153	2.939	2.930	2.965	3.020	3.089
1.A.4.c.ii		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
CO2 emission	kt	5 943	5 463	5 467	5 312	5 327	5 372	5 412	5 290	
CH4 emission	kt	0.333	0.306	0.306	0.297	0.298	0.301	0.303	0.296	
N2O emission	kt	2.294	2.109	2.110	2.050	2.056	2.073	2.089	2.042	

Table 3.2.8.12. GHG emission in 1988-2013 in subcategory 1.A.4.c.iii.

1.A.4.c.iii		1988	1989	1990	1991	1992	1993	1994	1995	1996
CO2 emission	kt	921	839	693	667	695	570	651	640	521
CH4 emission	kt	0.085	0.077	0.064	0.061	0.064	0.052	0.060	0.059	0.048
N2O emission	kt	0.024	0.022	0.018	0.018	0.018	0.015	0.017	0.017	0.014
1.A.4.c.iii		**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CO2 emission	kt	542	391	392	347	366	359	289	325	277
CH4 emission	kt	0.050	0.036	0.036	0.032	0.034	0.033	0.027	0.030	0.025
N2O emission	kt	0.014	0.010	0.010	0.009	0.010	0.009	0.008	0.009	0.007
1.A.4.c.iii		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
CO2 emission	kt	261	270	260	386	319	328	332	357	
CH4 emission	kt	0.024	0.025	0.024	0.035	0.029	0.030	0.031	0.033	
N2O emission	kt	0.007	0.007	0.007	0.010	0.008	0.009	0.009	0.009	

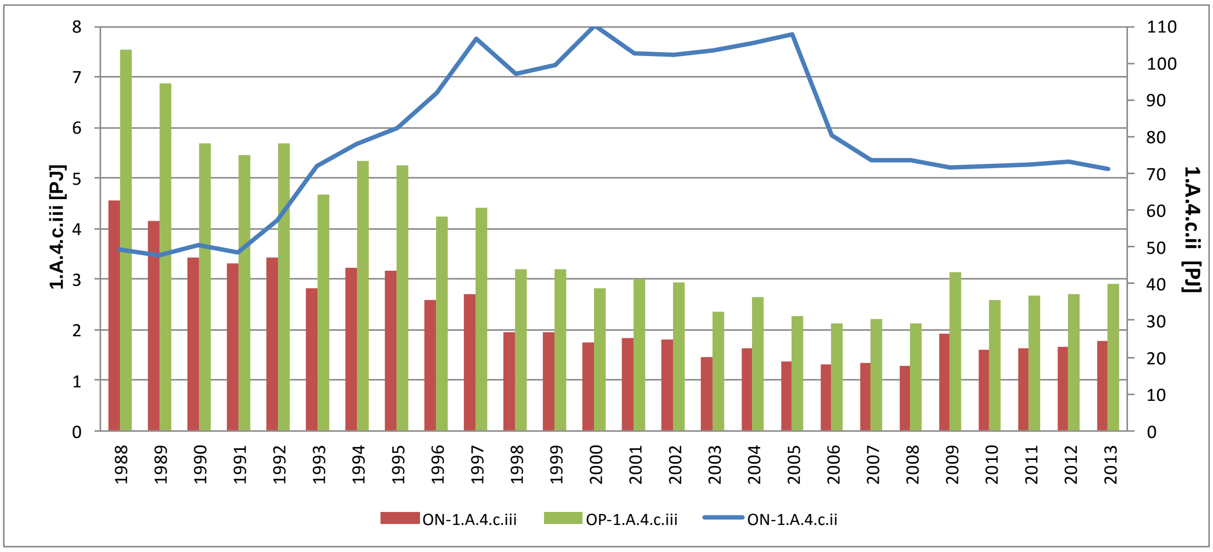

Figure 3.2.8.17. Fuel consumption in 1988-2013 in mobile sources in subcategories other than 1.A.3

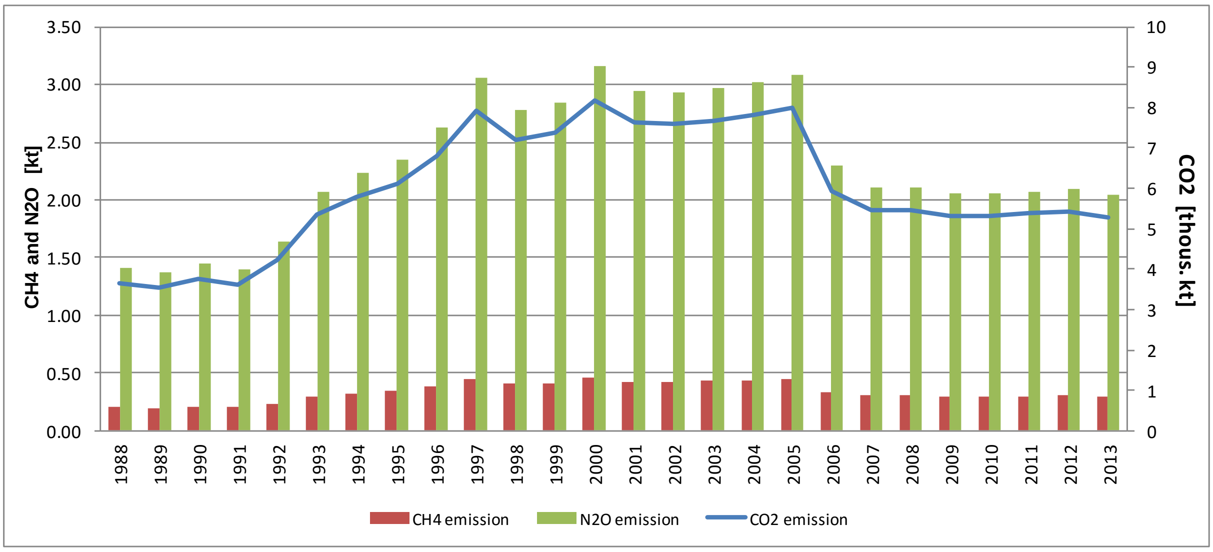

Figure 3.2.8.18. GHG emission in 1988-2013 in subcategory 1.A.4.c.ii.

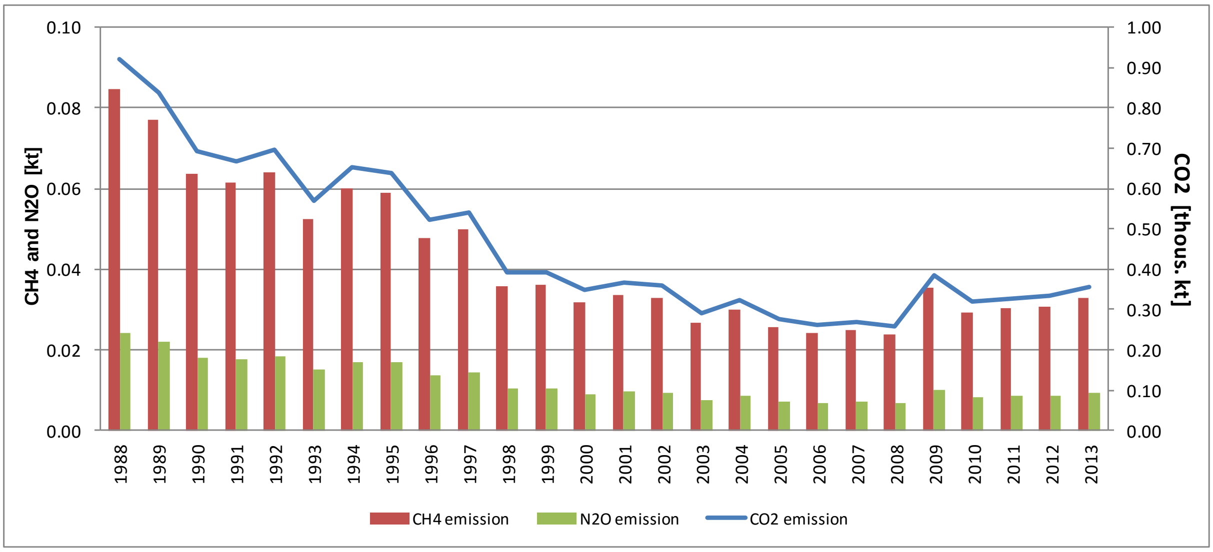

Figure 3.2.8.19. GHG emission in 1988-2013 in subcategory 1.A.4.c.iii.

3.2.8.3. Uncertainties and time-series consistency

See chapter 3.2.6.3

3.2.8.4. Source-specific QA/QC and verification

See chapter 3.2.6.4

3.2.8.5. Source-specific recalculations

- fuel consumption in 1988 and 1989 were updated based on IEA database and in period 1990-2011 on actual Eurostat (table 3.2.8.3);
- in sector 1.A.3.a *Domestic aviation,* domestic vs. international split of jet fuel was based on Eurocontrol data(table 3.2.8.14-16);

Table 3.2.8.13. Changes in CO2 emission resulting from recalculations.

Difference	1988	1989	1990	1991	1992	1993	1994	1995	1996
kt	12.84	17.66	7.91	8.17	8.86	8.83	8.94	9.64	11.33
%	0.05	0.07	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Difference	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
kt	10.15	10.34	9.23	9.82	6.54	6.35	7.19	6.94	19.22
%	0.04	0.04	0.03	0.04	0.02	0.02	0.03	0.02	0.06
Difference	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**		
kt	20.63	11.52	5.62	281.54	316.44	362.95	-80.72		
%	0.05	0.03	0.01	0.63	0.67	0.76	-0.17		

Table 3.2.8.14. Changes in CO_2 emission in subsector 1.A.3.a. *Domestic aviation* resulting from recalculations.

Difference	1988	1989	1990	1991	1992	1993	1994	1995	1996
kt	12.84	17.66	7.91	8.17	8.86	8.83	8.94	9.64	11.33
%	10.84	12.99	13.35	16.07	20.01	17.48	12.77	15.18	18.51
Difference	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
kt	10.15	10.34	9.23	9.82	9.67	9.49	10.26	10.08	22.36
%	16.24	18.15	18.82	19.04	18.99	17.80	18.12	19.13	38.22
Difference	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**		
kt	20.63	14.65	5.62	8.26	16.12	24.72	117.33		
%	27.55	18.15	6.16	9.52	17.78	26.79	206.52		

Table 3.2.8.15. Changes in CH_4 emission in subsector 1.A.3.a. *Domestic aviation* resulting from recalculations.

Difference	1988	1989	1990	1991	1992	1993	1994	1995	1996
kt	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
%	0.16	0.24	0.25	0.41	1.09	0.56	0.23	0.35	0.71
Difference	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
kt	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
%	0.43	0.65	0.77	0.82	0.80	0.60	0.64	0.84	1.85
Difference	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**		
kt	0.0001	0.0001	0.0000	0.0001	0.0001	0.0002	0.0008		
%	1.68	0.91	0.45	0.51	0.99	1.23	5.94		

Table 3.2.8.16. Changes in N_2O emission in subsector 1.A.3.a. *Domestic aviation* resulting from recalculations.

Difference	1988	1989	1990	1991	1992	1993	1994	1995	1996
kt	0.0004	0.0006	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004
%	16.06	17.78	18.04	19.82	21.91	20.63	17.61	19.27	21.18
Difference	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
kt	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0007
%	19.92	20.99	21.33	21.45	21.42	20.80	20.97	21.49	42.40
Difference	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**		
kt	0.0007	0.0005	0.0002	0.0003	0.0005	0.0008	0.0037		
%	29.85	20.06	6.58	10.45	19.44	29.92	248.65		

3.2.8.6. Source-specific planned improvements

- developing a methodology to split domestic and international aviation bunker fuels and estimating emissions from aviation;
- improving the methodology of estimating emissions from road transport.

3.2.9. Other sectors (CRF sector 1.A.4)

3.2.9.1. Source category description

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)
b) *Residential* (1.A.4.b)
c) *Agriculture/Forestry/Fishing* (1.A.4.c)
   - agriculture – stationary sources,
   - agriculture – mobile sources: off-road vehicles and other machinery,
   - fishing.

Subsector 1.A.4.b *Residential* is by far the largest contributor to emissions from this category (see figure 3.2.9.1) – about 67 % in 2013.

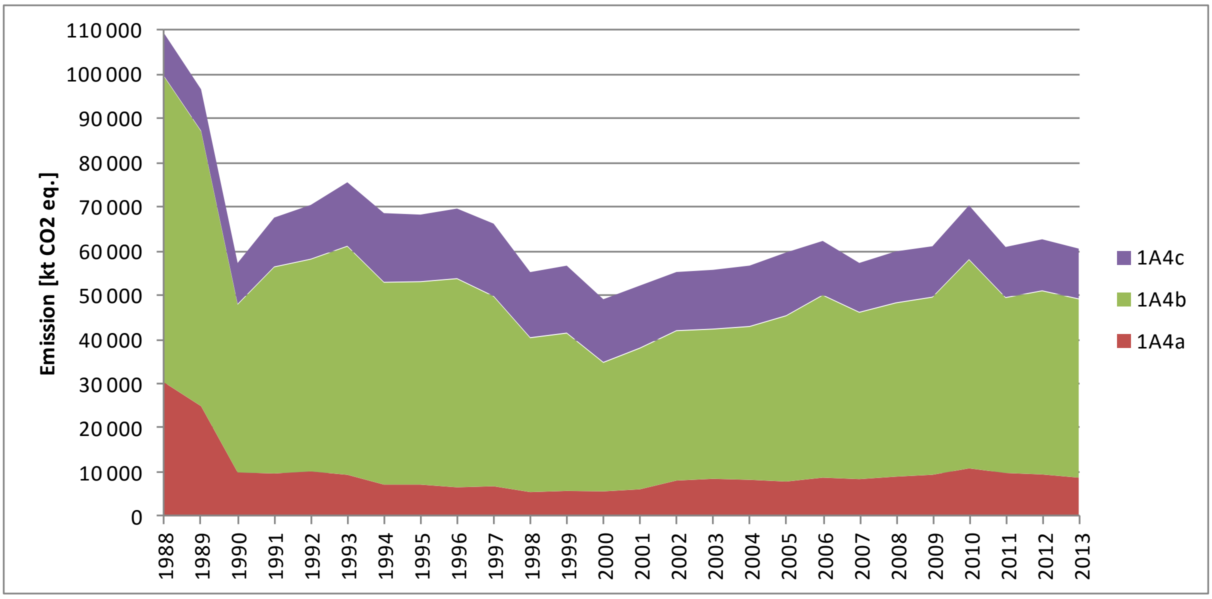

Figure 3.2.9.1. GHG emissions from 1.A.4. *Other sectors* in years 1988-2013 according to subcategories

3.2.9.2. Methodological issues

Methodology of emission estimation in 1.A.4 subcategory corresponds with methodology described for fuel combustion in stationary sources. Detailed information on fuel consumption and applied emission factors for subsectors included in 1.A.4 subcategory are presented in Annex 2.

3.2.9.2.1. Other Sectors – Commercial/Institutional (1.A.4.a)

The data on fuel type use in the sub-category 1.A.4.a *Other Sectors – Commercial/Institutional* over the 1988-2013 period are presented in table 3.5.9.1. Detailed data concerning fuel consumption in 1.A.4.a subcategory was tabulated in Annex 2 (table 11).

Table 3.5.9.1. Fuel consumption in 1988-2013 in 1.A.4.a subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	0.000	0.000	0.000	0.000	0.000	0.000	1.334	0.782
Gaseous Fuels	13.079	12.601	13.787	10.977	11.190	11.548	9.573	13.260
Solid Fuels	297.025	244.614	91.215	92.072	95.735	86.052	64.046	62.499
Other Fuels	2.135	0.144	0.504	0.081	0.011	0.352	0.089	0.000
Biomass	0.084	0.123	4.880	3.132	0.206	12.374	11.968	11.983
TOTAL	**312.322**	**257.481**	**110.386**	**106.262**	**107.142**	**110.326**	**87.010**	**88.524**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	1.769	6.118	7.784	10.346	16.522	21.281	22.808	24.014
Gaseous Fuels	18.771	24.256	32.769	37.696	38.567	49.971	61.001	67.057
Solid Fuels	52.142	48.086	29.849	27.864	22.004	17.283	29.822	29.723
Other Fuels	0.124	0.000	0.003	0.004	0.024	0.091	0.101	0.071
Biomass	10.625	9.627	9.085	9.216	9.211	6.596	6.440	6.466
TOTAL	**83.431**	**88.087**	**79.490**	**85.126**	**86.328**	**95.222**	**120.172**	**127.331**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	21.300	17.813	28.496	27.788	27.328	25.682	30.953	28.986
Gaseous Fuels	69.570	68.410	63.517	65.488	71.250	75.746	83.433	78.278
Solid Fuels	28.433	28.087	32.202	27.900	30.862	33.550	40.119	33.638
Other Fuels	0.002	0.022	0.000	0.000	0.037	0.123	0.024	0.046
Biomass	6.599	6.544	5.113	5.802	5.896	7.946	8.923	9.781
TOTAL	**125.904**	**120.876**	**129.328**	**126.978**	**135.373**	**143.047**	**163.452**	**150.729**
	2012	**2013**						
Liquid Fuels	22.450	18.007						
Gaseous Fuels	80.888	76.501						
Solid Fuels	34.142	31.724						
Other Fuels	0.037	0.421						
Biomass	9.113	9.560						
TOTAL	**146.630**	**136.213**						

Figures 3.5.9.2 and 3.5.9.3 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.4.a in the period 1988-2013.

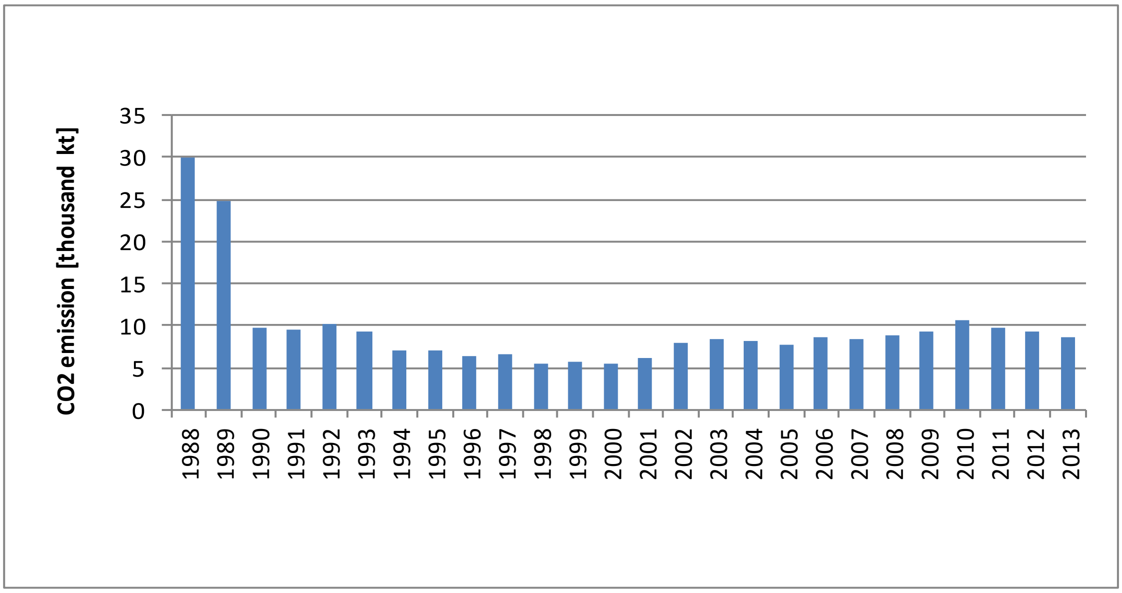

Figure 3.5.9.2. CO_2 emission for 1.A.4.a category in 1988-2013

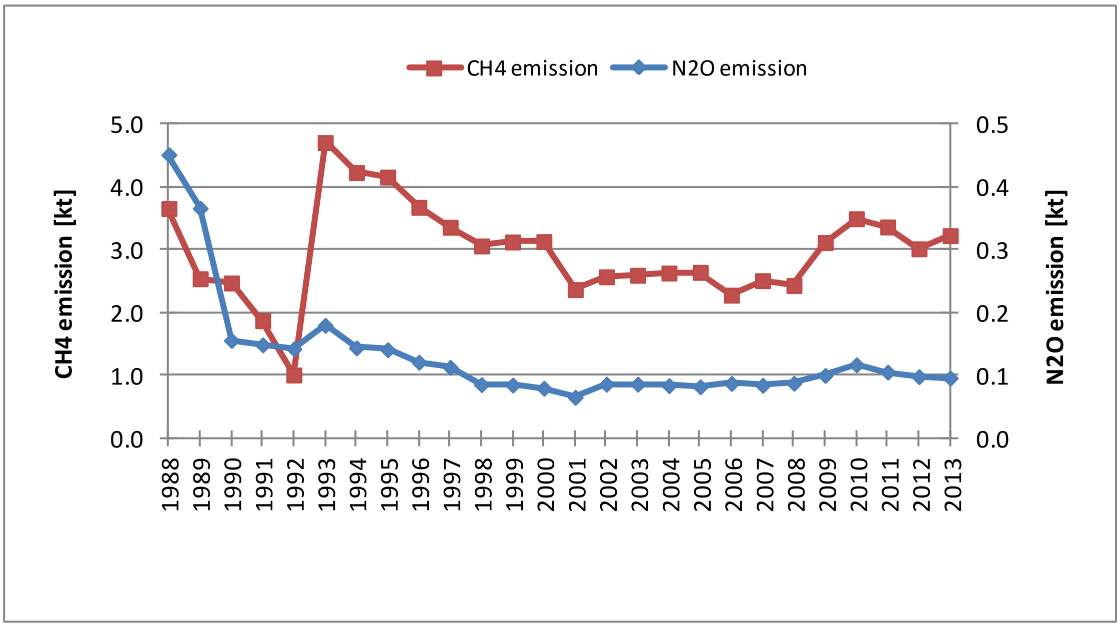

Figure 3.5.9.3. CH_4 and N_2O emissions for 1.A.4.a category in 1988-2013

3.2.9.2.2. Residential (CRF sector 1.A.4.b)

The data on fuel type use in stationary sources in the sub-category 1.A.4.b *Residential* over the 1988-2013 period are presented in table 3.5.2. Detailed information on fuel consumption for 1.A.4.b subcategory are presented in Annex 2 (table 12).

Table 3.5.2. Fuel consumption in 1988-2013 in 1.A.4.b subcategory [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	6.762	7.452	1.702	1.012	1.840	6.072	8.970	12.834
Gaseous Fuels	102.581	107.619	122.204	133.674	141.212	141.590	151.671	159.559
Solid Fuels	617.874	546.675	307.564	385.686	390.347	413.265	346.089	339.463
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	33.615	32.351	34.335	27.721	33.969	106.000	104.715	105.000
TOTAL	**760.831**	**694.097**	**465.805**	**548.093**	**567.368**	**666.927**	**611.445**	**616.856**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	18.245	24.835	26.980	29.101	37.400	42.150	44.342	48.252
Gaseous Fuels	143.057	150.022	138.268	135.995	127.611	133.737	127.093	127.629
Solid Fuels	358.593	307.562	235.470	243.304	179.024	198.224	219.937	217.497
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	101.000	100.000	100.700	95.000	95.000	104.500	104.500	103.075
TOTAL	**620.895**	**582.419**	**501.418**	**503.400**	**439.035**	**478.611**	**495.872**	**496.453**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	45.370	42.305	42.305	39.364	35.963	33.264	29.386	27.763
Gaseous Fuels	126.376	135.111	138.686	132.622	131.450	134.857	148.427	135.471
Solid Fuels	228.811	255.087	290.173	260.866	279.849	288.024	352.789	285.169
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	103.360	100.700	104.500	102.000	102.500	102.500	112.746	115.000
TOTAL	**503.917**	**533.203**	**575.664**	**534.852**	**549.762**	**558.645**	**643.348**	**563.403**
	2012	**2013**						
Liquid Fuels	26.767	25.084						
Gaseous Fuels	141.397	143.187						
Solid Fuels	301.038	289.812						
Other Fuels	0.000	0.000						
Biomass	116.850	116.850						
TOTAL	**586.052**	**574.933**						

Figure 3.5.9.4 show emissions of CO_2 in 1.A.4.b in the 1988-2013 period while CH_4 and N_2O, emissions in the same sub-category are shown in figure 3.5.9.5.

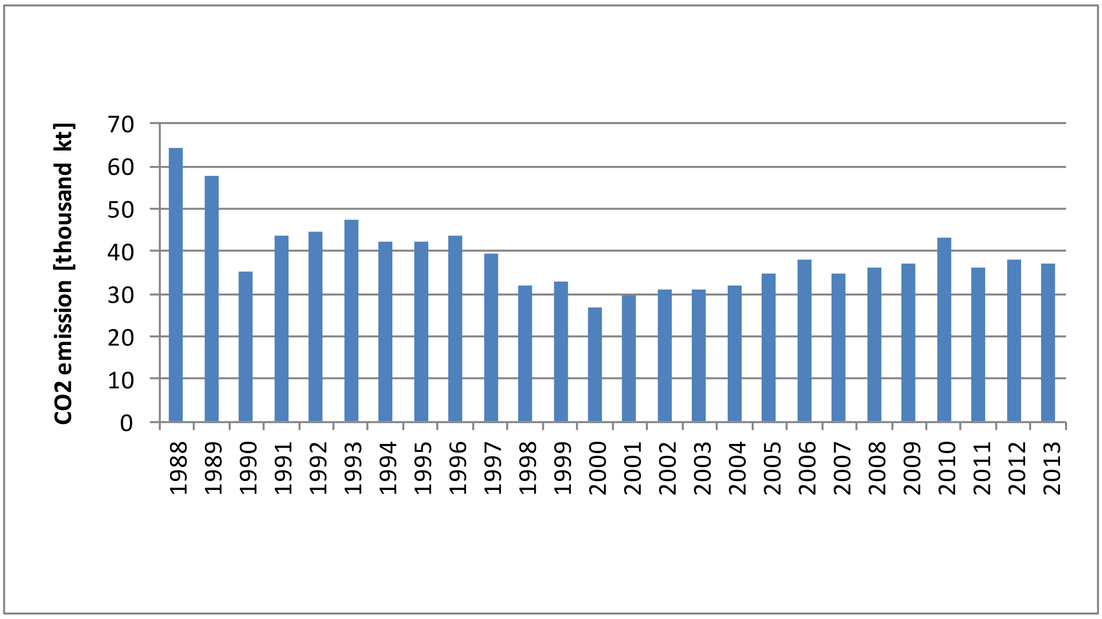

Figure 3.5.9.4. CO_2 emission for 1.A.4.b category in 1988-2013

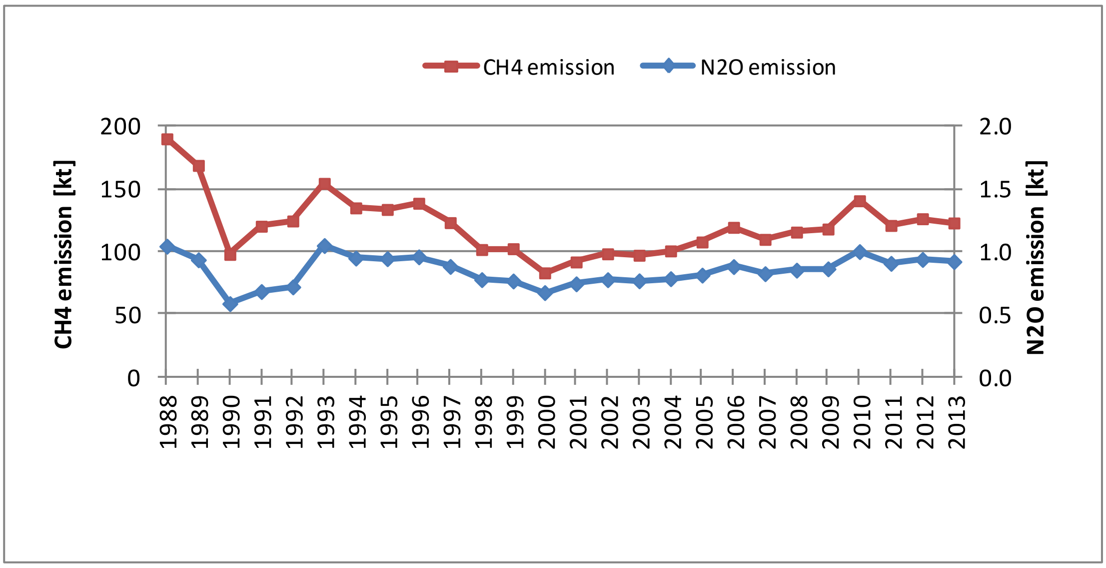

Figure 3.5.9.5. CH_4 and N_2O emissions for 1.A.4.b category in 1988-2013

3.2.9.2.3. Agriculture/Forestry/Fishing – stationary sources (CRF sector 1.A.4.c)

The data on fuel type use in stationary sources in the sub-category 1.A.4.c Agriculture/Forestry/Fishing over the 1988-2013 period are presented in table 3.5.9.3. Detailed data concerning total fuel consumption in 1.A.4.c subcategory (including fuel consumption related to off-road vehicles and other machinery in agriculture and fuel use in fishing) was tabulated in Annex 2 (table 13).

Table 3.5.9.3. Fuel consumption in stationary sources in 1.A.4.c subcategory for years 1988-2013 [PJ]

	1988	1989	1990	1991	1992	1993	1994	1995
Liquid Fuels	2.720	2.600	3.560	2.720	1.440	14.074	18.302	10.532
Gaseous Fuels	0.507	0.445	0.448	0.275	0.055	0.132	0.212	0.243
Solid Fuels	42.691	42.026	39.465	59.710	64.662	63.946	66.261	64.299
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.039	0.113	0.039	0.278	0.583	20.057	18.367	18.500
TOTAL	**45.956**	**45.185**	**43.512**	**62.983**	**66.740**	**98.209**	**103.142**	**93.574**
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels	6.272	9.152	8.182	8.437	8.832	8.483	6.909	9.374
Gaseous Fuels	0.428	0.571	0.868	0.476	0.536	0.777	0.914	1.197
Solid Fuels	68.014	58.905	53.170	55.389	37.590	41.916	35.065	34.071
Other Fuels	0.000	0.000	0.000	0.006	0.012	0.011	0.000	0.000
Biomass	17.567	17.000	17.100	17.106	17.113	19.053	19.010	19.017
TOTAL	**92.281**	**85.628**	**79.320**	**81.414**	**64.083**	**70.240**	**61.898**	**63.659**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	9.404	10.689	4.334	3.724	3.930	3.495	3.265	3.671
Gaseous Fuels	1.182	1.084	1.492	1.840	1.900	1.577	1.486	1.531
Solid Fuels	35.838	39.001	46.028	40.728	45.335	44.947	53.241	43.882
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	19.878	19.038	19.977	19.060	19.024	19.030	21.088	24.154
TOTAL	**66.302**	**69.812**	**71.831**	**65.352**	**70.189**	**69.049**	**79.080**	**73.238**
	2012	**2013**						
Liquid Fuels	3.705	2.905						
Gaseous Fuels	1.796	1.501						
Solid Fuels	45.552	44.603						
Other Fuels	0.000	0.000						
Biomass	21.200	21.223						
TOTAL	**72.253**	**70.232**						

Figures 3.5.9.6 and 3.5.9.7 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.4.c in the period: 1988-2013.

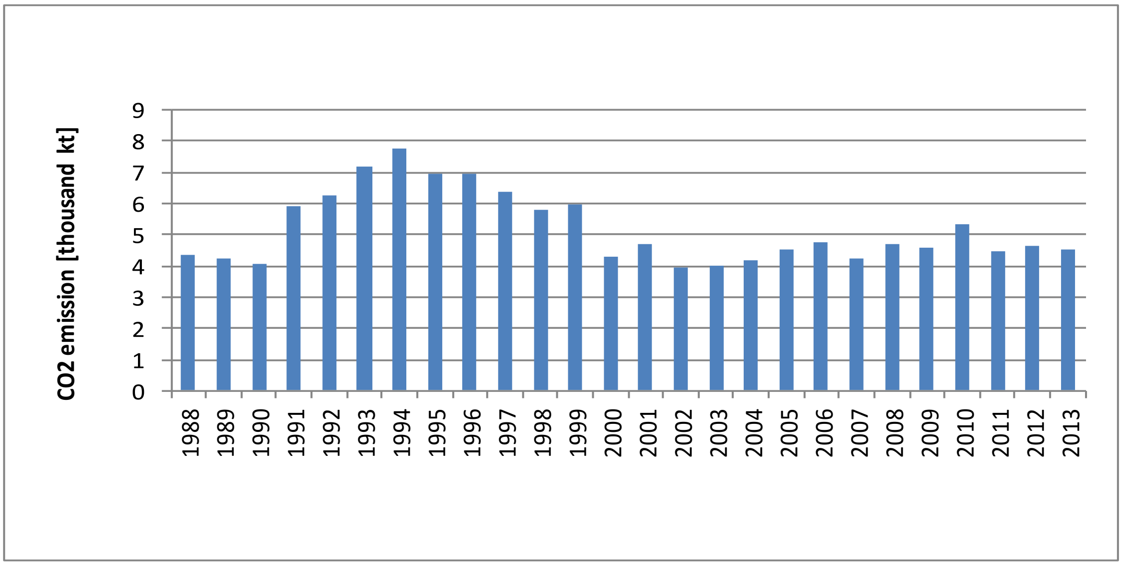

Figure 3.5.9.6. CO_2 emission for stationary sources in 1.A.4.c category in 1988-2013

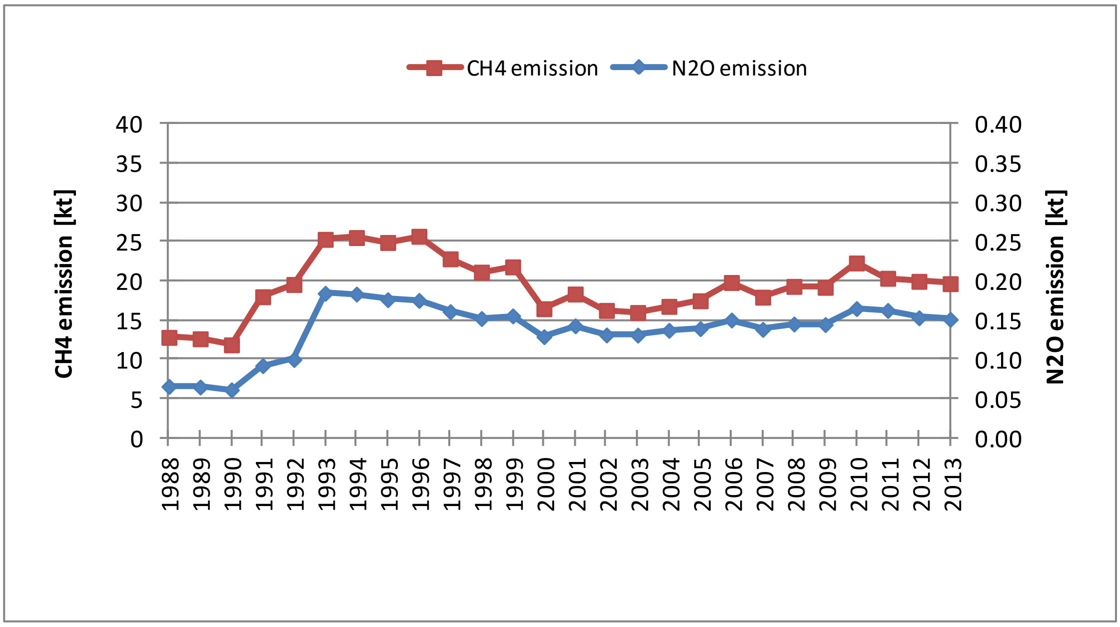

Figure 3.5.9.7. CH_4 and N_2O emissions for stationary sources in 1.A.4.c category in 1988-2013

The mobile sources classified in the sub-category 1.A.4.c (i.e. off-road vehicles and other machinery in agriculture and fishing) are described in chapter 3.2.8.2.6.

3.2.9.3. Uncertainties and time-series consistency

See chapter 3.2.6.3

3.2.9.4. Source-specific QA/QC and verification

See chapter 3.2.6.4

3.2.9.5. Source-specific recalculations

- activity data on fuel consumption for years 1990-2012 were updated according to current Eurostat database.
- default CO_2 emission factors from 1996 IPCC GLs were replaced with EFs recommended in 2006 GLs;

Table. 3.2.9.4. Changes in GHG emissions in 1.A.4 subsector as a result of recalculations

Changes	1988	1989	1990	1991	1992	1993	1994	1995
				CO2				
kt	284.29	196.14	111.54	94.03	138.07	189.38	208.76	184.58
%	0.3	0.2	0.2	0.1	0.2	0.3	0.3	0.3
				CH4				
kt	0.007	0.007	0.008	0.007	0.009	0.011	0.012	0.008
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				N2O				
kt	1.092	1.056	1.116	1.076	1.264	1.594	1.727	1.818
%	57.2	62.2	97.1	85.5	93.5	84.0	95.8	100.2
Changes	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
				CO2				
kt	183.40	138.20	78.96	96.61	113.78	190.93	3823.11	4277.84
%	0.3	0.2	0.2	0.2	0.3	0.4	8.1	9.0
				CH4				
kt	0.008	-0.002	-0.006	-0.004	-0.001	0.009	11.430	12.841
%	0.0	0.0	0.0	0.0	0.0	0.0	10.8	12.4
				N2O				
kt	2.027	2.358	2.145	2.197	2.434	2.270	2.320	2.354
%	108.6	126.3	129.3	131.8	151.1	139.2	143.8	146.8
Changes	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
				CO2				
kt	4386.12	4602.41	4715.87	4052.26	4123.74	4597.54	5649.36	4494.34
%	9.1	9.1	8.9	8.3	8.0	8.8	9.5	8.7
				CH4				
kt	13.195	13.937	14.401	12.302	12.565	13.863	17.268	13.525
%	12.3	12.2	11.3	10.4	10.0	10.9	11.6	10.3
				N2O				
kt	2.398	2.456	1.844	1.690	1.693	1.657	1.679	1.673
%	146.6	146.6	117.0	114.7	112.1	109.7	100.6	105.7

Changes	2012
CO2	
kt	4893.61
%	9.2
CH4	
kt	14.549
%	10.8
N2O	
kt	1.682
%	104.8

3.2.9.6. Source-specific planned improvements

- analysis of the possibility of country specific EF elaboration for the gaseous fuels in Polish fuel structure.

3.3. Fugitive emissions (CRF sector 1.B)

3.3.1. Fugitive emission from solid fuels (CRF sector 1.B.1)

3.3.1.1. Source category description

Fugitive emission from solid fuels involves emission from coal mining and handling (CH_4) and emission from coke oven gas subsystem (CO_2 and CH_4).

The biggest share of emission in 1.B category comes from coal mining and handling. The hard coal and lignite extraction are presented at the graph bellow (Figure 3.3.1). The main reason for the decreasing coal extraction since late 1980s was the declining demand for coal and lignite in economy.

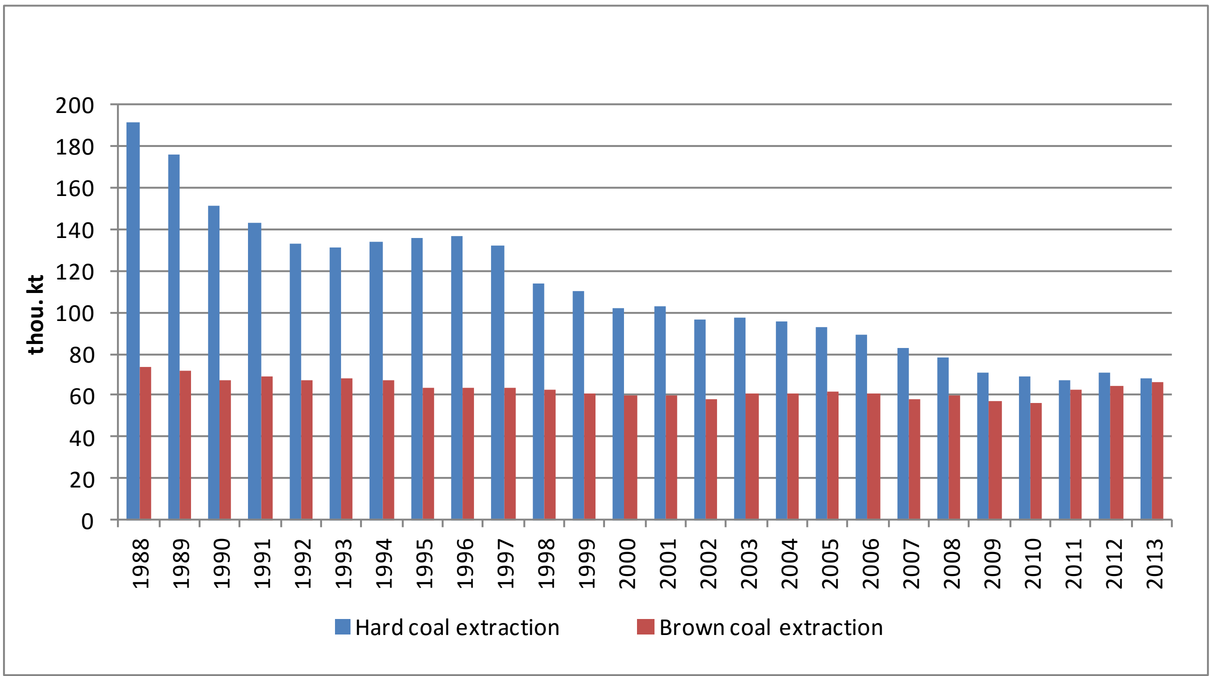

Figure 3.3.1. Hard coal and lignite extraction in 1988-2013.

3.3.1.2. Methodological issues

<u>3.3.1.2.1 Fugitive emissions from fuels – coal mining (CRF sector 1.B.1.a.)</u>

<u>Coal Mining and Handling – underground mines (1.B.1.a.i.)</u>

Coal production in 2013 was to 68 399 kt and compared to the previous year, was lower by 2 940 kt [Polish Geological Institute (PIG) 2014].
Tier 1 method has been used for calculation of fugitive emissions from coal mining and post-mining [IPCC 2006, page 4.11-4.12]

Fugitive emission of CH_4 from coal mining and post-mining was estimated based on the activity data concerning hard coal extraction amount from the study published by Polish Geological Institute [PIG. 2013] and emission factors presented in table 3.3.1. have been taken from IPCC 2006.

Table 3.3.1. CH_4 Emission factor for calculation mining and post-mining emission from coal mines

CH_4 emission factor	
Mining	6.80 [$m^3 CH_4/t$; IPCC 1996, table I-54 str.1.105]
Post -Mining	2.50 [$m^3 CH_4/t$; IPCC 2006, page 4.12]

Tier 1 method was used used for calculation of fugitive emissions from abandoned underground mines, [IPCC 2006, page 4.21 equation 4.1.9.] Fugitive emission of CH_4 from coal mining and post-mining was estimated based on number of abandoned underground mines from the data provided by State Mining Authority [SMA- 2014] and emission factors from IPCC 2006 – table 4.1.5, 4.1.6, and 4.1.7.

Table 3.3.2 shows data on hard coal extraction, total methane emissions from coal mines and emission from abandoned underground mines, in 1988-2013 .

Table 3.3.2. Hard coal extraction, total methane emissions from coal mines and abandoned underground mines, in 1988-2013 .

Year	Hard coal extraction [kt]	CH_4 Emissions [kt]	Emission from abandoned underground mines [kt CH_4]
1988	191 624	1 194.01	10.46
1989	175 947	1 096.33	10.46
1990	151 321	942.88	10.46
1991	143 131	891.85	8.94
1992	132 730	827.04	12.26
1993	131 400	818.75	7.18
1994	134 078	835.44	6.62
1995	135 523	844.44	6.17
1996	136 272	849.11	5.80
1997	132 576	826.08	5.48
1998	113 859	709.46	5.21
1999	109 986	685.32	4.98
2000	102 081	636.07	4.78
2001	102 477	638.53	49.95
2002	96 160	599.17	20.88
2003	97 274	606.11	15.35
2004	95 623	595.83	12.66
2005	93 006	579.52	11.02
2006	89 342	556.69	9.87
2007	82 779	515.80	9.01
2008	77 989	485.95	8.35
2009	70 500	439.29	7.80
2010	69 186	431.12	7.36
2011	67 637	421.45	6.98
2012	71 339	444.51	6.65
2013	68 399	426.19	6.36

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

Tier 1 method was used for calculation of fugitive emissions from coal mining and post-mining [IPCC 2006, page 4.18-4.19]
Fugitive emission of CH_4 from coal mining and post-mining was estimated based on the activity data concerning lignite extraction amount from the study published by Polish Geological Institute [PIG. 2014] and emission factors from IPCC 2006. (table 3.3.3.).

Table 3.3.3 CH_4 Emission factor for calculation mining and post-mining emission from surface coal mining.

CH_4 emission factor	
Mining	1.20 [$m^3 CH_4/t$; IPCC 2006, table I-54 str.4.18]
Post -Mining	0.1 [$m^3 CH_4/t$; IPCC 2006, page 4.19]

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

In table 3.3.3 are shown data on lignite extraction and total related methane emissions in 1988-2013.

Table 3.3.3. Lignite extraction and total methane emissions from lignite mines in 1988-2013.

Year	Lignite extraction [kt]	CH_4 Emissions [kt]
1988	73 970 000	64.43
1989	72 000 000	62.71
1990	67 680 000	58.95
1991	68 720 000	59.86
1992	66 900 000	58.27
1993	68 200 000	59.40
1994	66 780 000	58.17
1995	63 550 000	55.35
1996	63 850 000	55.61
1997	63 200 000	55.05
1998	62 880 000	54.77
1999	60 860 000	53.01
2000	59 490 000	51.82
2001	59 550 000	51.87
2002	58 240 000	50.73
2003	60 920 000	53.06
2004	61 190 000	53.30
2005	61 610 000	53.66
2006	60 850 000	53.00
2007	57 700 000	50.26
2008	59 500 000	51.82
2009	57 060 000	49.70
2010	56 520 000	49.23
2011	62 890 000	54.78
2012	64 297 000	56.00
2013	66 139 000	57.61

3.3.1.2.2. Fugitive emission from solid fuel transformation (1.B.1.b.)

Processing emission of CO_2 from coking plants in the period 1990-2013 was estimated based on carbon budgets in the coking plants (tab. 3.3.4). Data concerning input and output are based on [Eurostat] and [GUS 1991a-2013a]. Coke productions for 1990-2013 were applied according to data in Eurostat [Eurostat].

The Eurostat database does not cover energy balances for Poland for the years before 1990 so data on input and output in coking plants (i.e. coke output) applied for C balance in coke production process for the period: 1988-1989 were taken from IEA database [IEA].

The amounts of carbon in the input and output components used in C balances for entire period were calculated based on IPCC factors [IPCC 1997. IPCC 2006].

Fuels given as the input in C balance for coke production process (tab. 3.3.5) did not include the fuels for energy purpose of the process. Emission from coke production given in 1.A.1.c subcategory was related to the fuel consumption for energy purpose of the coke plants. so double counting should not be the case in GHG inventory.

CO_2 emission from coke production in Polish GHG inventory is split between two sub-categories and is reported under following sub-sectors:

- 1.A.1.c – includes the emission estimated based on fuel use. given in Eurostat database as *Consumption of the energy branch – Coke-oven and gas-works plants* (it means based on fuel consummated for own energy purpose)

- 2.C.1 – includes the emission calculated based on C balance (i.e. carbon emission = carbon content in transformation output – carbon content in transformation input)

CH_4 emission in the period 1990-2013 was estimated based on coke production volume from [Eurostat] while for 1988 and 1989 from [IEA]. For the entire period emission factor equal 0.5 kg CH_4/Mg coke produced [IPCC 1997; Workbook table 2-9] was applied.

Table 3.3.5. Carbon balance for coke production in years 1988-2013.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
INPUT [TJ]													
Coking coal	**656592**	**637742**	**535538**	**448105**	**437665**	**405168**	**436596**	**451761**	**403902**	**423800**	**377787**	**338208**	**366814**
High Methane Natural Gas	0	1239	0	0	0	0	0	0	0	0	0	0	0
Coke			969	542	1767	1568	2394	2337	1824	1682	2109	1482	2024
Blast furnace gas	0	152	0	0	0	0	0	0	0	0	0	0	0
Tar	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial waste	7	0	0										
NCV [MJ/kg]													
Coking coal	29.41	29.41	29.41	29.41	29.41	29.41	28.49	29.36	29.36	29.45	29.54	29.48	29.62
INPUT – Material-specific carbon content [kg C/GJ]													
Coking coal	26.02	26.02	26.02	26.02	26.02	26.02	26.06	26.03	26.03	26.02	26.02	26.02	26.02
High Methane Natural Gas	15.3	15.3	15.3	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	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	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	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	39.0	39.0	39.0
INPUT – Carbon contents in charge components [kt]													
Coking coal	17087.6	16597.0	13937.2	11661.8	11390.1	10544.3	11378.1	11757.8	10512.1	11028.5	9829.9	8800.9	9543.2
High Methane Natural Gas	0.0	19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke	0.0	0.0	28.6	16.0	52.1	46.3	70.6	68.9	53.8	49.6	62.2	43.7	59.7
Blast furnace gas	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industrial waste	0.3	0.0	0.0	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 [kt]	**17087.8**	**16626.0**	**13965.7**	**11677.7**	**11442.2**	**10590.6**	**11448.7**	**11826.7**	**10565.9**	**11078.2**	**9892.1**	**8844.6**	**9602.9**
OUTPUT [TJ]													
Coke	**471501.8**	**455831.8**	385206.0	323646.0	315381.0	292838.0	326468.0	329973.0	294662.0	300248.0	277761.0	238488.0	255702.0
Coke-Oven Gas	**118914.6**	**117040.4**	96832.0	84743.0	82307.0	75753.0	84002.0	84767.0	76036.0	79286.0	73457.0	62989.0	68849.0
Tar	27580.0	27429.3	22885.3	20268.2	20648.1	19071.4	21146.6	21265.0	19831.9	19600.4	17949.6	16264.8	17003.0
Benzol	7701.5	7230.9	6166.9	5150.7	5646.2	5159.1	6010.6	6056.5	5446.7	5428.6	4856.9	4524.7	2498.5
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	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	13.0	13.0	13.0
Tar	22	22	22	22	22	22	22	22	22	22	22	22	22
Benzol	23	23	23	23	23	23	23	23	23	23	23	23	23
OUTPUT – Carbon content in products [kt]													
Coke	13909.3	13447.0	11363.6	9547.6	9303.7	8638.7	9630.8	9734.2	8692.5	8857.3	8193.9	7035.4	7543.2
Coke-Oven Gas	1545.9	1521.5	1258.8	1101.7	1070.0	984.8	1092.0	1102.0	988.5	1030.7	954.9	818.9	895.0
Tar	606.8	603.4	503.5	445.9	454.3	419.6	465.2	467.8	436.3	431.2	394.9	357.8	374.1
Benzol	177.1	166.3	141.8	118.5	129.9	118.7	138.2	139.3	125.3	124.9	111.7	104.1	57.5
Carbon content in products – SUM [kt]	**16239.1**	**15738.3**	**13267.7**	**11213.6**	**10957.9**	**10161.7**	**11326.3**	**11443.3**	**10242.6**	**10444.1**	**9655.5**	**8316.1**	**8869.8**
C process emission[kt]	**848.8**	**887.7**	**698.0**	**464.2**	**484.3**	**428.8**	**122.4**	**383.4**	**323.3**	**634.1**	**236.6**	**528.4**	**733.2**
CO_2 process emission[kt]	**3112.1**	**3254.8**	**2559.5**	**1701.9**	**1775.9**	**1572.4**	**448.8**	**1405.9**	**1185.5**	**2324.9**	**867.5**	**1937.6**	**2688.3**
Coke output [kt]	17007	16499	13516	11356	11066	10275	11455	11578	10339	10535	9746	8368	8972
EF [kg CO_2/Mg of coke]	**183**	**197**	**189**	**150**	**160**	**153**	**39**	**121**	**115**	**221**	**89**	**232**	**300**

Table 3.3.5. (cont.) Carbon balance for coke production in years 1988-2013.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
INPUT [TJ]													
Coking coal	362 343	353 752	410 854	405 806	335 694	383 094	405 666	392 453	277 057	383 177	364 348	350 150	371 333
High Methane Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke	1055	1710	1568	1710	2138	2366	2651	3050	1938	3021	2 964	2 366	1 710
Blast furnace gas	0	0	0	0	0	0	0	0	0	0	0	0	0
Tar	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial waste										3.5	0	0	0
NCV [MJ/kg]													
Coking coal	29.53	29.53	29.56	29.55	29.51	29.59	29.50	29.57	29.56	29.49	29.52	29.60	29.59
INPUT – Material-specific carbon content [kg C/GJ]													
Coking coal	26.02	26.02	26.02	26.02	26.02	26.02	26.02	26.02	26.02	26.02	26.0	26.0	26.0
High Methane Natural Gas	15.3	15.3	15.3	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	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	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	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	39.0	39.0	39.0
INPUT – Carbon contents in charge components [kt]													
Coking coal	9428.2	9204.6	10689.9	10558.7	8735.0	9967.2	10555.8	10211.0	7208.7	9970.8	9480.5	9110.0	9661.2
High Methane Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke	31.1	50.4	46.3	50.4	63.1	69.8	78.2	90.0	57.2	89.1	87.4	69.8	50.4
Blast furnace gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tar	0.0	0.0	0.0	0.0	0.0	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	0.1	0.0	0.0	0.0
Carbon contents in charge – SUM [kt]	**9459.3**	**9255.1**	**10736.2**	**10609.1**	**8798.1**	**10037.0**	**10634.0**	**10301.0**	**7265.9**	**10060.1**	**9567.9**	**9179.8**	**9711.6**
OUTPUT [TJ]													
Coke	254961.0	248606.0	288192.0	287765.0	239514.0	273971.0	289788.0	287138.0	202094.0	280554.0	267244.0	253450.0	266760.0
Coke-Oven Gas	69008.0	65570.0	75091.0	72947.0	61947.0	71712.0	76950.0	73935.0	53376.0	73008.0	69440.0	65321.0	68844.0
Tar	17232.6	16462.6	18188.1	17417.0	14590.0	16211.0	17342.0	15721.0	11838.0	16475.0	15268.0	14175.0	14854.0
Benzol	4788.6	4474.8	5253.3	5358.3	4403.2	3803.7	5315.6	4711.9	3373.4	4892.6	4518.8	4125.1	4465.4
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	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	13.0	13.0	13.0
Tar	22	22	22	22	22	22	22	22	22	22	22	22	22
Benzol	23	23	23	23	23	23	23	23	23	23	23	23	23
OUTPUT – Carbon content in products [kt]													
Coke	7521.3	7333.9	8501.7	8489.1	7065.7	8082.1	8548.7	8470.6	5961.8	8276.3	7883.7	7476.8	7869.4
Coke-Oven Gas	897.1	852.4	976.2	948.3	805.3	932.3	1000.4	961.2	693.9	949.1	902.7	849.2	895.0
Tar	379.1	362.2	400.1	383.2	321.0	356.6	381.5	345.9	260.4	362.5	335.9	311.9	326.8
Benzol	110.1	102.9	120.8	123.2	101.3	87.5	122.3	108.4	77.6	112.5	103.9	94.9	102.7
Carbon content in products – SUM [kt]	**8907.7**	**8651.4**	**9998.8**	**9943.8**	**8293.2**	**9458.5**	**10052.9**	**9886.0**	**6993.7**	**9700.4**	**9226.2**	**8732.7**	**9193.9**
C process emission[kt]	**551.6**	**603.7**	**737.4**	**665.3**	**504.9**	**578.4**	**581.2**	**415.0**	**272.2**	**359.7**	**341.6**	**447.1**	**517.8**
CO_2 process emission[kt]	**2022.6**	**2213.4**	**2703.8**	**2439.6**	**1851.2**	**2120.9**	**2130.9**	**1521.8**	**998.1**	**1318.7**	**1252.7**	**1639.3**	**1898.4**
Coke output [kt]	8946	8723	10112	10097	8404	9613	10168	10075.0	7091	9844	9 845	9 846	9 847
EF [kg CO_2/Mg of coke]	**226**	**254**	**267**	**242**	**220**	**221**	**210**	**151**	**141**	**134**	**127**	**166**	**193**

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

Tier 1 method has been used for calculation of fugitive emissions from coke oven gas system [IPCC 2006] while emission factors presented in table 3.3.5. have been taken from domestic case study [Steczko 1994]. Activity data for 1990-2013 come from [EUROSTAT]. For years: 1988-1989 the activity data come from [IEA] database.

Table 3.3.6. Emission factors for CO_2 and CH_4 from coke oven gas system.

Gas system emission factor [Kt/PJ]	**CO_2**	**CH_4**
gas processing	0.000194	0.000546
gas transmission	0.020629	0.057977
gas distribution	0.038056	0.106954

For coke-oven gas subsystem there is no possibility to add activity data in PJ in the CRF Reporter database, but only in kt. This conversion into kt was done only for CRF Reporter purposes (emission is estimated on the PJ activity data basis) the mentioned change has no impact on emissions.

3.3.1.3. Uncertainties and time-series consistency

See chapter 3.2.6.3

3.3.1.4. Source-specific QA/QC and verification

QA/QC and verification are integral parts of the inventory and has been elaborated in line with the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* and *2006 IPCC Guidelines for National Greenhouse Gas Inventories(2006)*.
Activity data used in the GHG inventory concerning sector 1.B.1 come from Eurostat database which is fed by the Central Statistical Office (GUS) and from Polish Geological Institute - National Research Institute (PIG-PIB). GUS and PIG-PIB are responsible for QA/QC of collected and published data. Activity data applied in GHG inventory are regularly checked and updated if necessary according to adjustments made in Eurostat database.
Generally QC procedures follow QA/QC plan presented in Annex 7.

3.3.1.5. Source-specific recalculations

Recalculations for the years 1988-2012 was made. Recent recalculations constituting the result of implementation of 2006 IPCC guidelines. Emission changes for subcategory 1.B.2 are presented in table below. Emission changes for subcategory 1.B.1 are presented in table below.

Tabele 3.3.7. Emission changes for subcategory 1.B.1. Fugitive emissions from fuels.

Difference	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
Kt eq CO_2	-15 353	-14 018	-12 261	-11 703	-11 000	-10 695
%	77	74	77	82	82	81
	1994	**1995**	**1996**	**1997**	**1998**	**1999**
Kt eq CO_2	-10 272	-10 117	-9 994	-9 301	-7 896	-6 949
%	80	71	71	60	64	51
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Kt eq CO_2	-6 384	-7 898	-6 920	-6 884	-6 733	-6 553
%	46	62	56	53	54	57
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
Kt eq CO_2	**-6 318**	**-5 878**	**-5 643**	**-5 165**	**-5 082**	**-4 887**
%	55	54	58	61	59	57
	2012					
Kt eq CO_2	-5 092					
%	54					

3.3.1.6. Source-specific planned improvements

Analysis for possibility of updating the emission factors for the systems of coke-oven gas.

3.3.2. Fugitive emissions from oil and natural gas (CRF sector 1.B.2)

3.3.2.1. Source category description

Fugitive emission from oil and natural gas include fugitive emissions from extraction, transport and refining of oil, from production, processing, transmission, distribution and underground storage of gas as well as from venting and flaring of gas and oil.

3.3.2.2. Methodological issues

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

Tier 1 method has been used for calculation of fugitive emissions from oil system [IPCC 2006]. Activity data come from [EUROSTAT]. For years: 1988-1989 the activity data come from [IEA] database. Activity data for 1990-2013 come from Eurostat (table 3.3.8)

Table 3.3.8. Activity data for emission from oil system.

Year	Production [kJ]	Production [kt]	Import [kt]	Transport [kt]	Input to oil refineries [PJ]
1988	6.58	155.51	14 681.42	14 836.92	618.67
1989	6.48	153.19	14 422.39	14 575.59	628.44
1990	6.59	160.00	13 126.00	13 286.00	528.78
1991	6.45	158.00	11 454.00	11 612.00	478.33
1992	7.98	200.00	13 052.00	13 252.00	524.72
1993	9.49	235.00	13 674.00	13 909.00	539.96
1994	10.97	284.00	12 721.00	13 005.00	519.25
1995	11.28	292.00	12 957.00	13 249.00	519.06
1996	12.70	317.00	14 026.00	14 343.00	584.98
1997	11.92	289.00	14 713.00	15 002.00	613.70
1998	14.88	360.00	15 367.00	15 727.00	662.31
1999	18.03	434.00	16 022.00	16 456.00	694.72
2000	26.55	653.00	18 002.00	18 655.00	742.97
2001	31.64	767.00	17 558.00	18 325.00	740.95
2002	29.72	728.00	17 942.00	18 670.00	726.13
2003	32.59	765.00	17 448.00	18 213.00	743.69
2004	37.33	886.00	17 316.00	18 202.00	763.30
2005	35.17	848.00	17 912.00	18 760.00	753.40
2006	32.85	796.00	19 813.00	20 609.00	827.25
2007	30.29	721.00	20 885.00	21 606.00	844.88
2008	31.20	755.00	20 787.00	21 542.00	859.60
2009	28.83	687.00	20 098.00	20 785.00	852.11
2010	28.54	687.00	22 688.00	23 375.00	949.08
2011	25.43	617.00	23 792.00	24 409.00	989.25
2012	27.96	681.00	24 633.00	25 314.00	1 032.82
2013	40.06	962.00	23 347.00	24 309.00	1 011.91

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 2006] (tab. 3.3.9).

Table 3.3.9. Emission factors for CO_2 and CH_4 from oil production and transmission.

Oil system	Emission factors	Source
	CO_2	
production [kt/PJ]	6.3150	country specific
transmission [kt/m^3]	0.00049	IPCC 2006
	CH_4	
production [kt/PJ]	0.0618	country specific
transmission [kt/m^3]	0.0054	IPCC 2006
refining [kt/PJ]	0.0007	IPCC 2006

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

Estimation of CO_2 and CH_4 emissions from natural gas was carried out based on *Tier 1* method [IPCC 2006]. Activity data for 1990-2013 come from [EUROSTAT]. For years 1988-1989 activity data come from [IEA] database. Activity data are given in table 3.3.10.

Table 3.3.10. Activities for natural gas system [TJ]

Year	Production [TJ]	Total consumption [TJ]
1988	156.57	350.71
1989	144.98	342.97
1990	99.56	374.21
1991	111.29	348.94
1992	107.17	324.99
1993	136.95	341.39
1994	129.76	343.99
1995	132.69	376.59
1996	131.47	395.45
1997	134.15	394.29
1998	136.01	398.34
1999	129.88	387.83
2000	138.72	416.99
2001	146.20	434.45
2002	149.43	423.42
2003	151.20	471.46
2004	164.43	497.42
2005	162.63	512.23
2006	162.46	526.76
2007	163.15	523.12
2008	154.49	526.11
2009	153.98	505.03
2010	154.62	536.11
2011	161.19	537.43
2012	163.57	572.77
2013	160.07	574.67

Emission factors gas system for production, processing, transmission, underground storage and distribution was taken from IPCC 2006. Emission factor listed in table 3.3.11.

Table 3.3.11. Emission factors for CO_2 and CH_4 from natural gas system.

Emission factors [kt/10^{6}m^3]	CO_2	CH_4
Gas production	0.000082	0.0023
Gas processing	0.00032	0.00103
Gas transmission	0.00000088	0.00048
Underground gas storage	0.00000011	0.000025
Gas distribution	0.000051	0.0011

3.3.2.2.3 Fugitive emissions from fuels – Venting and Flaring (CRF sector 1.B.2.c)

Venting and Flaring in oil subsystem

CO_2 and CH_4 emission from venting and CO_2, CH_4 and N_2O emission from flaring were calculated in oil subsystem. Emission factors for both emissions were taken default from [IPCC 2006].

CO_2 EF from venting: 0.000095 kt/10^{3}m^3
CH_4 EF from venting: 0.00072 kt/10^{3}m^3

CO_2 from flaring: 0.00002500 kt/10^{3}m^3
CH_4 from flaring: 0.04100000 kt/10^{3}m^3
N_2O from flaring: 0.00000064 kt/10^{3}m^3

Extraction of oil is used as activity data and is in accordance with whole oil subsystem. Other emissions from venting and flaring in oil subsystem are included in 1.B.2.a.

CO_2 process emission from refineries and flaring was included into sub-category 1.B.2.C.2. This emission were estimated based on the verified reports for refineries which participate in EU ETS [KOBiZE 2013]. These values amounted to: 1701.7kt for 2013, 1671.1 kt for 2012, 1553.6 kt for 2011, 991.9 kt for 2010, 1093.0 kt for 2009, 1091.6 kt for 2008, 956.5 kt for 2007, 1143.1 kt CO_2 in 2006 and 1082.3 kt CO_2 in 2005 respectively. CO_2 emission from refineries reported as process emission mainly resulted from the following processes: hydrogen production, regeneration of catalysts and after-burning gases from asphalt production.

Flaring in natural gas subsystem

CO_2, CH_4 and N_2O emissions from flaring in gas extraction and consumption were calculated in natural gas subsystem. Emission factors for those emissions were taken default from [IPCC 2006].

CO_2 EF from flaring in gas extraction:	0.000000760	kt /$10^6 m^3$
CH_4 EF from flaring in gas extraction:	0.0012	kt/$10^6 m^3$
N_2O EF from flaring in gas extraction:	0.000000021	kt/$10^6 m^3$
CO_2 EFfrom flaring in gas consumption:	0.00360	kt/$10^6 m^3$
CH_4 EF from flaring in gas consumption:	0.00000002	kt/$10^6 m^3$
N_2O EF from flaring in gas consumption:	0.00000005	kt/$10^6 m^3$

Extraction and consumption of natural gas are used as activity data and are in accordance with whole natural gas subsystem. Other emissions from venting and flaring in natural gas subsystem are included in 1.B.2.b.

3.3.2.3. Uncertainties and time-series consistency

See chapter 3.2.6.3

3.3.2.4. Source-specific QA/QC and verification

See chapter 3.3.1.4.

3.3.2.5. Source-specific recalculations

Recalculations for the years 1988-2012 was made. Recent recalculations constituting the result of implementation of 2006 IPCC guidelines. Emission changes for subcategory 1.B.2 are presented in table below.

Tabele 3.3.12. Emission changes for subcategory 1.B.2. Fugitive emissions from oil and natural gas.

Difference	1988	1989	1990	1991	1992	1993
Kt eq CO_2	2 190	2 160	2 077	1 905	1 700	1 727
%	-64	-65	-66	-64	-61	-58
	1994	**1995**	**1996**	**1997**	**1998**	**1999**
Kt eq CO_2	1 682	1 881	1 977	1 995	1 937	1 773
%	-56	-58	-58	-59	-56	-52
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Kt eq CO_2	1 696	1 666	1 630	1 881	1 891	2 033
%	-46	-43	-43	-45	-42	-36
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
Kt eq CO_2	2 185	2 253	2 244	2 191	2 365	2 465
%	-38	-41	-39	-40	-42	-40
	2012					
Kt eq CO_2	2 583					
%	-39					

3.3.2.6. Source-specific planned improvements

Any improvements are planned at the moment

4. INDUSTRIAL PROCESSES AND PRODUCT USE (CRF SECTOR 2)

4.1. Source category description

Following categories from sector 2 have been identified as key sources (excluding LULUCF):

IPCC Category Code	IPCC Source Categories	Greenhouse Gas	Level Assessment	Trend Assessment
2.A.1	Cement Production	CO_2	1.50%	
2.A.4	Other Process Uses of Carbonates	CO_2	0.50%	
2.B.1	Ammonia Production	CO_2	1.10%	
2.B.1	Ammonia Production	CO_2		+
2.B.2	Nitric Acid Production	N_2O		+
2.D	Non-energy Products from Fuels and Solvent Use	CO_2	0.50%	
2.F.1	Refrigeration and Air conditioning	Aggregate F-gases	2.30%	

Share of these categories in total Poland's GHG emissions is ca. 5.90%

Figure bellow shows GHG emission trend in *Industrial processes* sector.

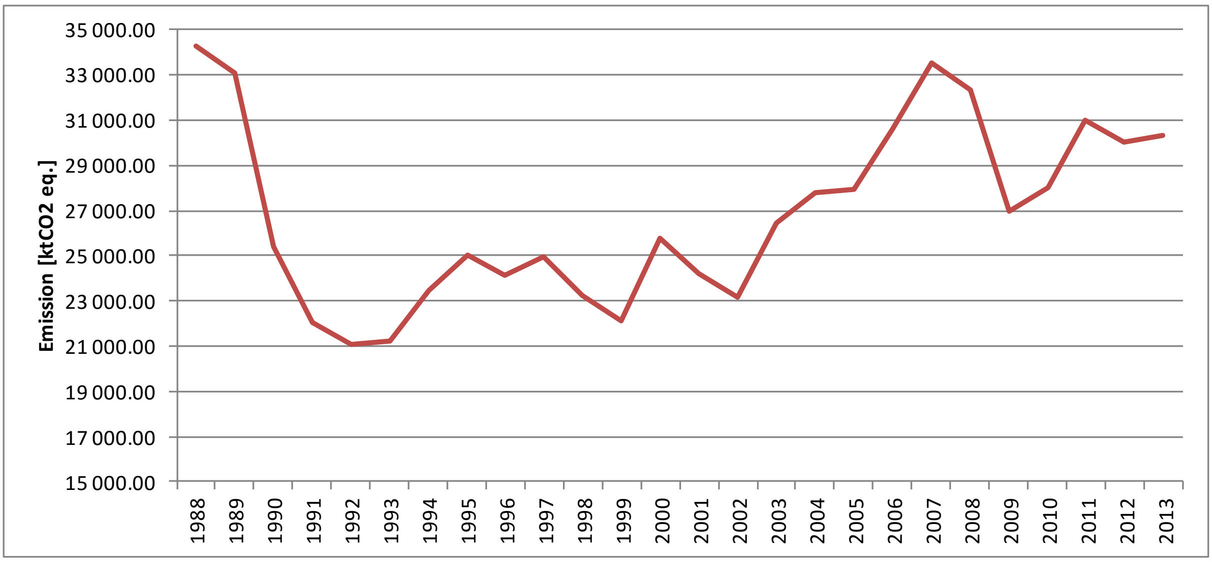

Figure 4.1.1. Emission trend in *Industrial processes* sector in period 1988 – 2013

Figure 4.1.2 shows GHG emissions according to subcategories of sector 2:

- 2.A. Mineral Products
- 2.B. Chemical Industry
- 2.C. Metal Production
- 2.D. Non-energy products from fuels and solvent use
- 2.E. Electronics industry
- 2.F. Product uses as substitutes for ODS
- 2.G. Other product manufacture and use
- 2.H. Other.

For estimation of the 2013 emission in sector 2. *Industrial Processes and product use* some data from EU ETS installation reports was applied in the following subcategories:

- 2.A. *Mineral Products*: 2.A.1. *Clinker Production*, 2.A.4.a. *Other process uses of carbonates - ceramics*
- 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.

Emissions in individual subcategories in period 1988 – 2013 are shown in figure 4.1.2

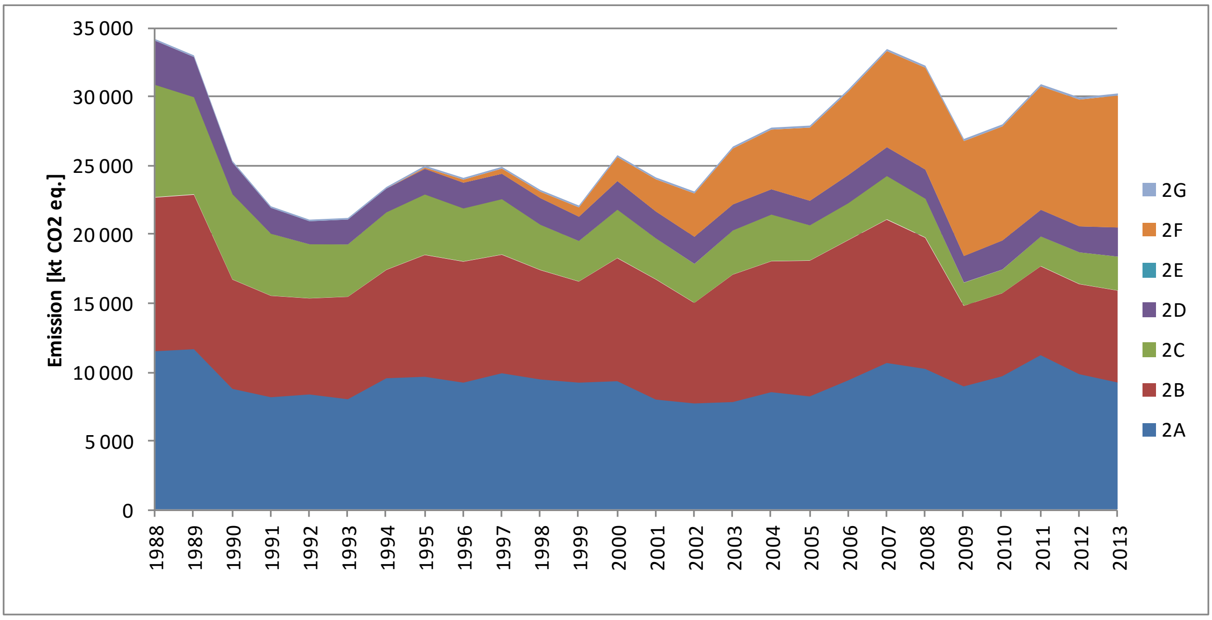

Figure 4.1.2. GHG emissions from *Industrial processes* in 1988-2013 according to subcategories

4.2. Mineral Products (CRF sector 2.A)

4.2.1. Source category description

Estimation of emissions in 2.A. *Mineral products* is carried out in sub-categories listed below:

a) *Cement Production* (2.A.1)
b) *Lime Production* (2.A.2)
c) *Glass production* (2.A.3)
d) *Other process uses of carbonates* (2.A.4)

- *Ceramics*
- *Other uses of soda ash*
- *Non-metallurgical magnesium production*
- *Other*

Subsector 2.A.1. *Cement Production* is by far the largest contributor to emissions from this category (see figure 4.2.1) – over 63% in 2013.

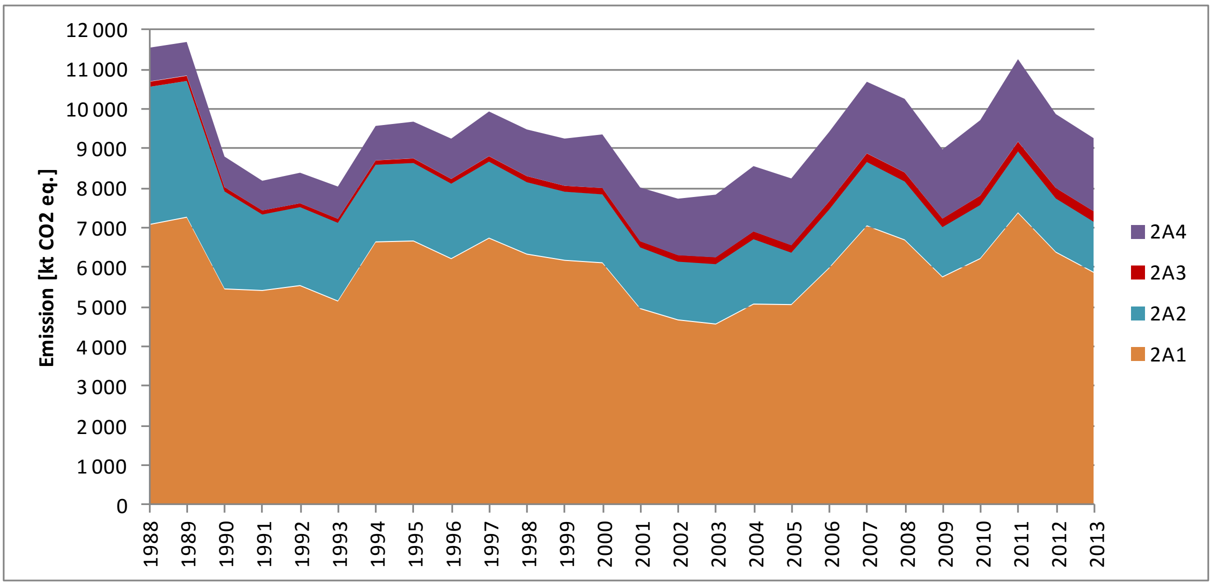

Figure 4.2.1. Emissions from *Mineral Products* sector in years 1988-2013 according to subcategories.

4.2.2. Methodological issues

4.2.2.1. Cement Production (CRF sector 2.A.1)

CO_2 emission from clinker production is the sum of the process emissions given in the verified reports for 2013 for installation of clinker production, which participate in the EU ETS [KOBiZE 2014]. This emission was estimated as 5874.2 kt CO_2. Data on clinker production was taken from [GUS 2014b].

The clinker production in period 1988-2013 is shown on figure 4.2.2. Data on clinker production for the entire inventoried period was taken from [GUS 1989b-2014b].

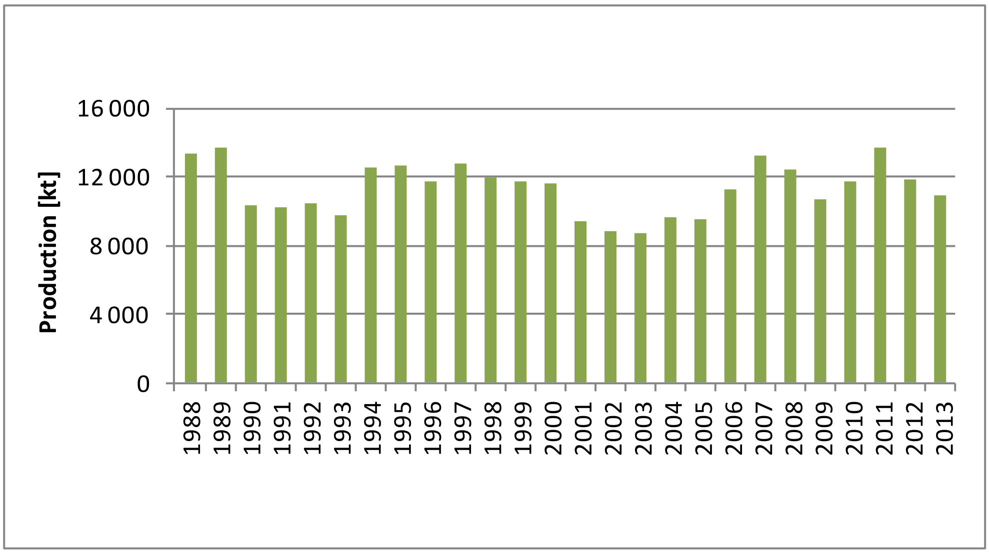

Figure 4.2.2. Clinker production in 1988-2013

CO_2 emission from clinker production was taken from the verified reports for the years: 2005-2013 for installations which participate in EU ETS. 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: 1988-2000 – emission factor equal 529 kg CO_2/t of clinker – average from country specific factors for years: 2001-2004 (2001 – 531 kg CO_2/t, 2002 – 530 kg CO_2/t, 2003 – 528 kg CO_2/t, 2004 – 527 kg CO_2/t)
- for years: 2001-2004 - country specific factors (given above) from [IMMB 2006].

CO_2 emissions from clinker production in period 1988-2013 are shown in figure 4.2.3.

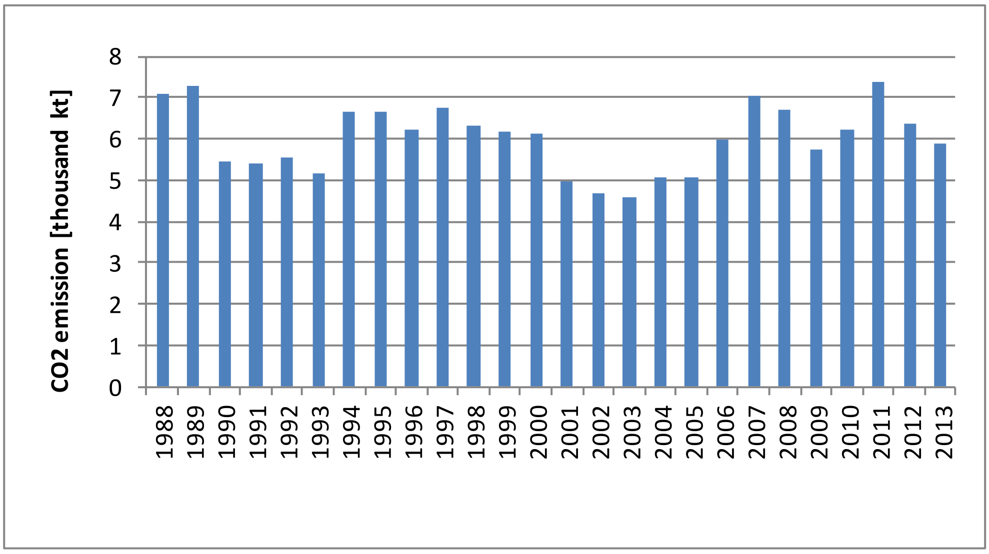

Figure 4.2.3. CO_2 process emission for clinker production in 1988-2013

4.2.2.2. Lime Production (CRF sector 2.A.2)

Emission of CO_2 from lime production was calculated based on lime production data from Central Statistical Office. Since 2000 activity data divided into quicklime, hydrated lime and hydraulic lime has been applied and emission has been estimated for each type of lime separately using default emission factors for high calcium lime and hydraulic lime from IPCC 2006 GLs (tab. 2.4. p. 2.22). For hydrated lime appropriate correction was considered. Due to the lack of the disaggregated lime production data for the years before 2000, the IEFs (average emission factor from the years 2000-2013) and total lime production was used for CO_2 emission estimation.
Dolomite lime production is given separately in the Polish statistical yearbook, as calcined and sintered dolomite. Emission from production of this type of lime was estimated based on dolomite consumption in production process according to the study [Galos 2013]. Emission from dolomite lime production was added to the emission from production of other lime types.

The figure 4.2.4 presents data concerning lime production (including dolomite lime) for the entire period. CO_2 emissions in period 1988-2013 are shown in the figure 4.2.5.

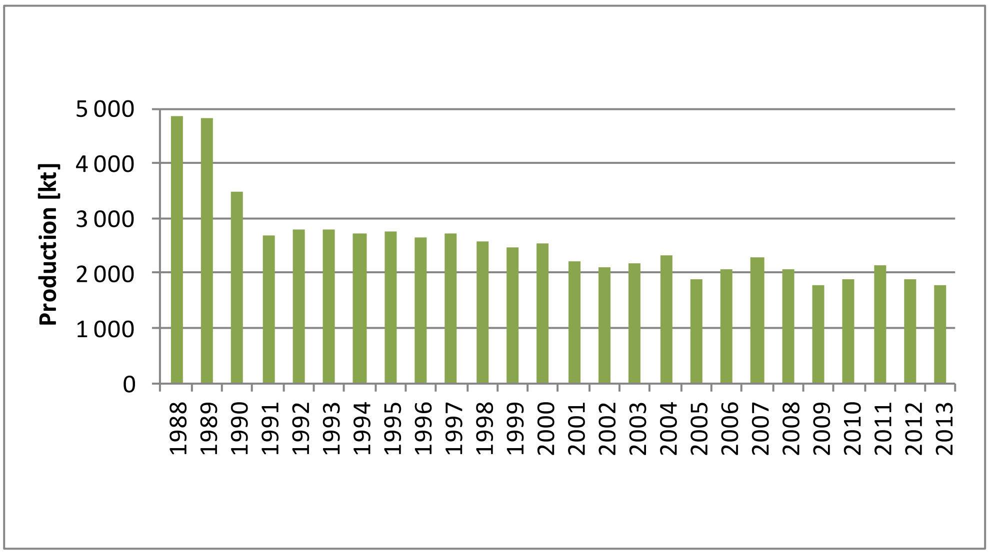

Figure 4.2.4. Lime (including dolomite lime) production in 1988-2013

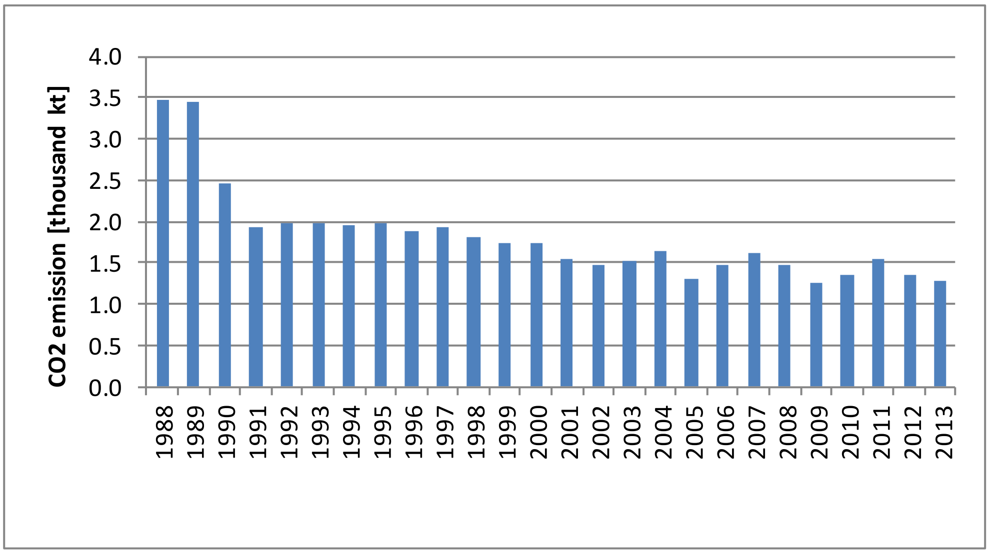

Figure 4.2.5. CO_2 process emission for lime production in 1988-2013

4.2.2.3. Glass production (CRF sector 2.A.3)

Emission of CO_2 from lime production was calculated based on glass production data from Central Statistical Office. Default CO_2 emission factor amounted to 0.1 tonnes CO_2/tonne glass was applied for emission estimation in entire period, according to IPCC 2006 GLs – equation 2.13 p. 2.29 and assumption on default cullet ratio of 50% (recommendation from p.2.30, IPCC 2006 GLs).

Glass production and CO_2 emission values from that process in period 1988-2013 are shown in the figures 4.2.6 and 4.2.7 respectively.

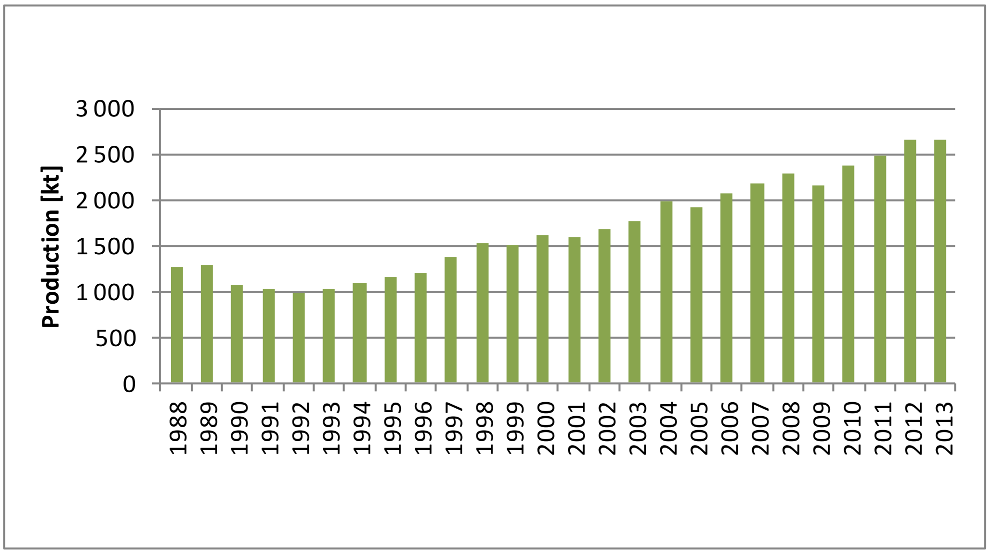

Figure 4.2.6. Glass production in 1988-2013

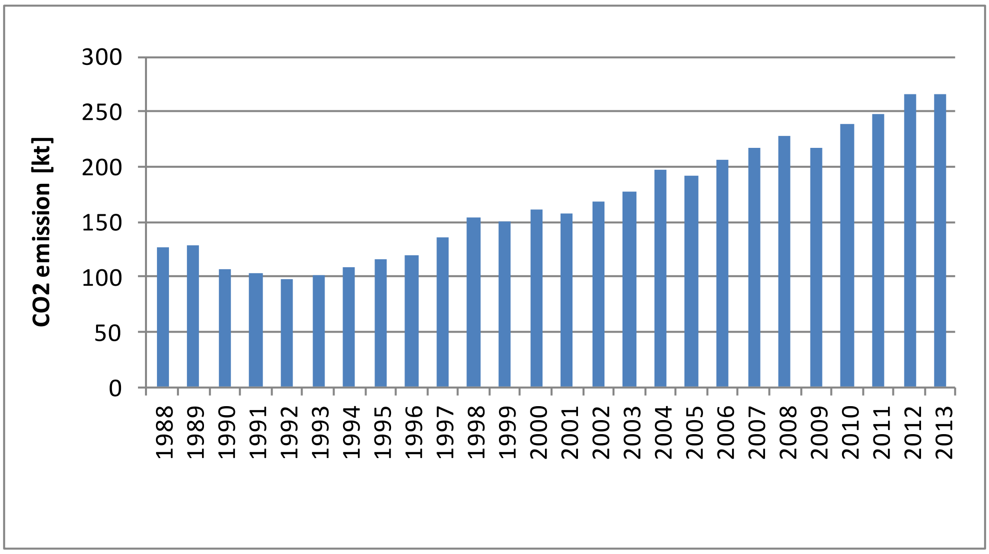

Figure 4.2.7. CO_2 process emission for glass production in 1988-2013

4.2.2.4. Other processes uses of carbonates (CRF sector 2.A.4)

This category includes CO_2 emission from sources as follows:

a) ceramics
b) other uses of soda ash
c) non-metallurgical magnesium production
d) other

2.A.4.a. Ceramics

Estimation of CO_2 emission from ceramics was based on ceramics production data from Central Statistical Office (Fig. 4.2.8). CO_2 emission factors for the years 2005-2013 was grounded on the verified reports for ceramic installation covered by EU ETS [KOBiZE 2014].

EFs values, expressed in kg CO_2/t of ceramics, were following:

2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
56.69	48.20	54.30	53.88	48.52	51.44	48.77	49.41	49.86

For the years before 2005 average value of EFs from 2005-2013, amounted to 51.23 kg CO_2/t of ceramics, was applied.

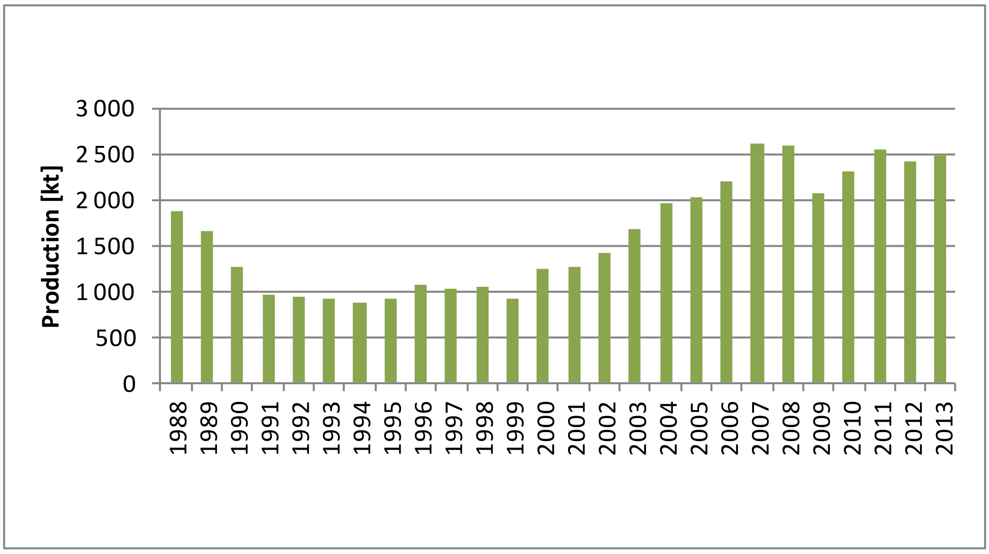

Figure 4.2.8. Ceramic production in 1988-2013

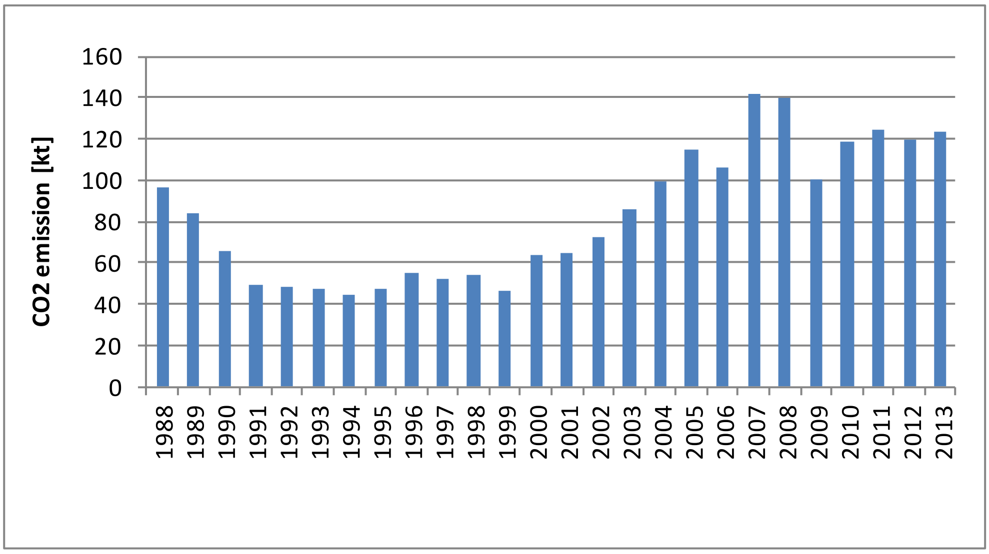

Figure 4.2.9. CO_2 process emission from ceramics in 1988-2013

<u>2.A.4.b. Other uses of soda ash</u>

CO_2 emission from soda ash use was estimated based on annually consumption of soda ash, which was published in GUS yearbook: *Materials Management in 2013* [GUS 2014f]. Additionally to assumed that half of soda ash use was consumed in glass and ceramics production and that amount was subtracted from AD because it was included in 2.A.3 and 2.A.4.a subcategories respectively.

EF amounting to 415 kg CO_2/t of soda ash used was taken for inventory calculation for the entire period.

CO_2 emission for the years 1992-2013 was estimated based on data concerning soda ash consumption taken from *Materials Management* [GUS 1994f-2014f]. For years before 1992, due to lack of the published statistical data, the assumption was made, that total soda ash consumption amounts to 50% of soda ash production. That assumption was based on the analysis, which considered production [GUS 1998e-2000e] and use of soda ash in the period 1992-1999.

CO_2 emission values from soda ash use in 2.A.4.b subcategories, for entire period 1988-2013, were presented in the figure 4.2.10.

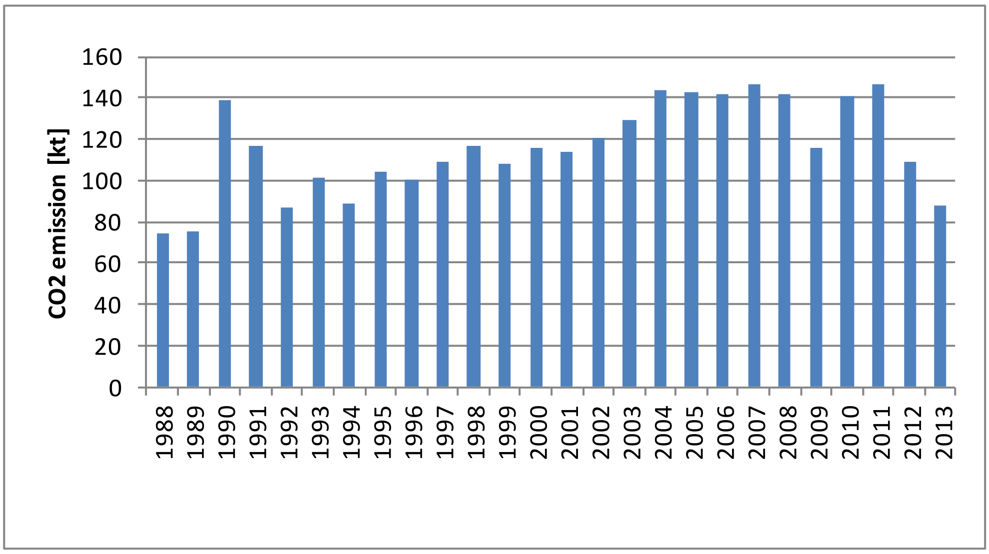

Figure 4.2.10. CO_2 emission values from soda ash use in 2.A.4.b subcategory in the years 1988-2013

2.A.4.c. Non-metallurgical magnesium production

Magnesium has not been produced in Poland [PIG-PIB 2014].

2.A.4.d. Other

CO_2 emission from limestone use as a sorbent in lime wet flue-gas desulfurization, FGD in FBB (fluid bad boiler) and other method of flue gas desulfurization was considered under this subcategory. Estimation of emission was based on study [Galos 2013]. The results were presented in figure 4.2.11. Details concerning calculations of CO_2 emission for 2.A.4.d category were provided in the Annex 3.1.

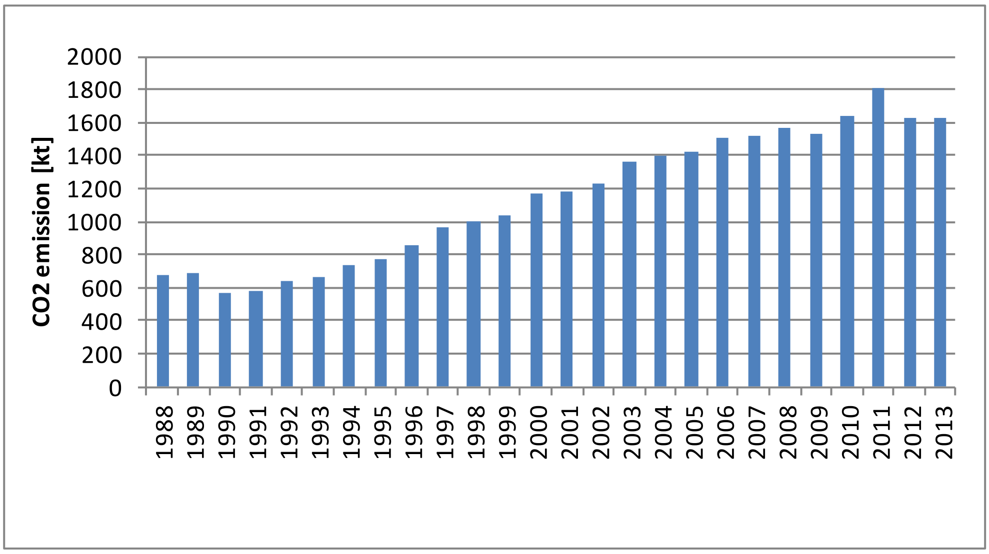

Figure 4.2.11. CO_2 emission from carbonate use in 2.A.4.d subcategory for 1988-2013

4.2.3. Uncertainties and time-series consistency

Uncertainty analysis for the revised year 2013 for IPCC sector *2.Industrial processes* was estimated with use of approach 1 described in 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Simplified approach was based on the assumptions that every value is independent and probability distribution is symmetric. Results of the sectoral uncertainty analysis are given below. More details on uncertainty assessment of whole inventory are given in annex 8.
Recalculation of data for years 1988-2012 ensured consistency for whole time-series.

2013	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 Emission uncertainty [%]	CH_4 Emission uncertainty [%]	N_2O Emission uncertainty [%]
2. Industrial processes and product use	**19,337.72**	**2.55**	**4.12**	5.3%	29.2%	44.7%
A. Mineral Products	9,255.14			10.3%		
B. Chemical Industry	5,517.45	1.99	3.72	4.4%	37.0%	49.4%
C. Metal Production	2,434.45	0.55	0.00	4.9%	18.1%	0.0%
D. Non-energy Products from Fuels and Solvent Use	2,130.68			12.2%		
G. Other			0.40			40.3%

4.2.4. Source-specific QA/QC and verification

Activity data used in the GHG inventory concerning industry sector come from yearbooks published by the Central Statistical Office (GUS). GUS is responsible for QA/QC of collected and published data. Data on selected production is compared to data collected from installations/entities covered by the EUETS. Depending on type of emission factor and *Tier* method applied in the GHG inventory, EF is compared with plant specific emission factor or the default one, respectively.

Data relating to EUETS installations are verified by independent reviewers and by verification unit established in the National Centre for Emissions Management (KOBiZE). Additionally data on industrial production is compared with public statistics in case where entire sector is covered by EUETS.
Calculations in industry sector were examined with focus on formulas, units and trends consistency. Generally QC procedures follow QA/QC plan presented in Annex 7.

4.2.5. Source-specific recalculations

- estimation of CO_2 emission in accordance with emission source categories included in IPCC 2006 GLs;
- complementation of emission for some categories, where was lack of data for years before 2005 (glass and ceramic production);
- change of methodology from T1 to T2 for lime production by consideration of type of line produced in Poland.

Table. 4.2.2. Changes of GHG emission values in 2.A. subcategory as a result of recalculations

Change	1988	1989	1990	1991	1992	1993	1994	1995
CO2								
kt	-287.4	-299.2	-295.2	-234.0	-214.8	-234.5	-218.9	-231.6
%	-2.4	-2.5	-3.2	-2.8	-2.5	-2.8	-2.2	-2.3
Change	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO2								
kt	-215.8	-231.9	-228.8	-220.5	-292.1	-207.9	-206.2	-195.1
%	-2.3	-2.3	-2.4	-2.3	-3.0	-2.5	-2.6	-2.4
Change	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
CO2								
kt	-190.0	-444.3	-443.6	-353.0	-404.7	-296.6	-291.9	-270.2
%	-2.2	-5.1	-4.5	-3.2	-3.8	-3.2	-2.9	-2.3
Change	**2012**							
CO2								
kt	-203.1							
%	-2.0							

4.2.6. Source-specific planned improvements

No improvements are planned at the moment.

4.3. Chemical Industry (CRF sector 2.B)

4.3.1. Source category description

Estimation of emissions in 2.B. *Chemical Industry* are carried out in sub-categories listed below:

a) *Ammonia production* (2.B.1)
b) *Nitric acid production* (2.B.2)
c) *Adipic acid production* (2.B.3)
d) Caprolactam, glyoxal and glyoxylic acid production (2.B.4)
e) *Carbide production* (2.B.5)
f) Titanium dioxide production (2.B.6)
g) Soda ash production (2.B.7)
h) Petrochemical and carbon black production (2.B.8)

Subsectors 2.B.1. *Ammonia production* is the largest contributors to emissions from this category (see figure 4.3.1) – almost 66% in 2013. Adipic acid was produced up to 1994.

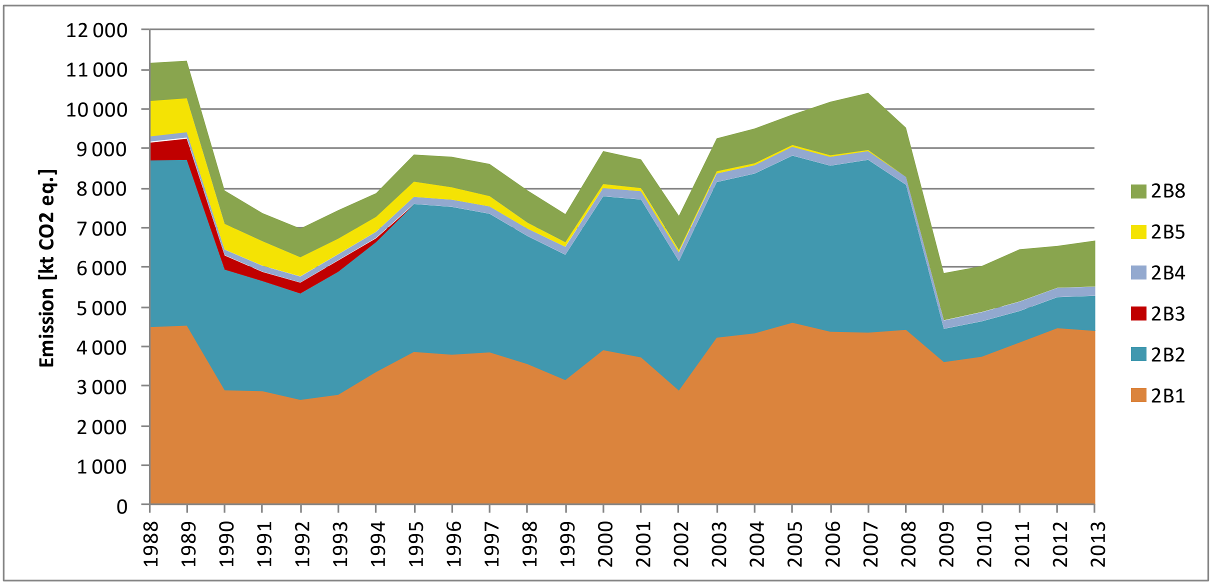

Figure 4.3.1. Emissions from *Chemical Industry* category in years 1988-2013 according to subcategories

4.3.2. Methodological issues

4.3.2.1. Ammonia production (CRF sector 2.B.1)

CO_2 emissions for ammonia production are estimated based on the data on natural gas use in this process (natural gas consumption for the years 1988-2013 was presented in Annex 3.2). The amount of natural gas consumption expressed in volume units was taken from [GUS 2014e]. To estimate carbon content in natural gas, the country specific emission factor 0.544 kg C/m^3 was used. Applied factor was elaborated base on the data from verified EU ETS reports concerning ammonia production installations [KOBiZE 2014]. Accounting above-mentioned information, the CO_2 process emission from ammonia production was calculated using the following formula:

$$E_{CO2} = Z_{natural\ gas} * 0.544*44/12$$

where:

E_{CO2} – CO_2 process emission from ammonia production [t]
$Z_{natural\ gas}$ – natural gas use [thousands m^3]

This method was used for all years: 1988-2013. In years 1989-1990, also coke-oven gas was used for ammonia production and this fact was reflected in the inventory calculations (Annex 3.2). The coke-oven gas consumption was taken in energy units – also based on G-03 reports – and the carbon content factor is taken from IPCC [IPCC 2006].

CO_2 process emissions in the period: 1988-2013 are shown in figure 4.3.2 while the ammonia production values [GUS 1989e-2014e] are presented in figure 4.3.3.

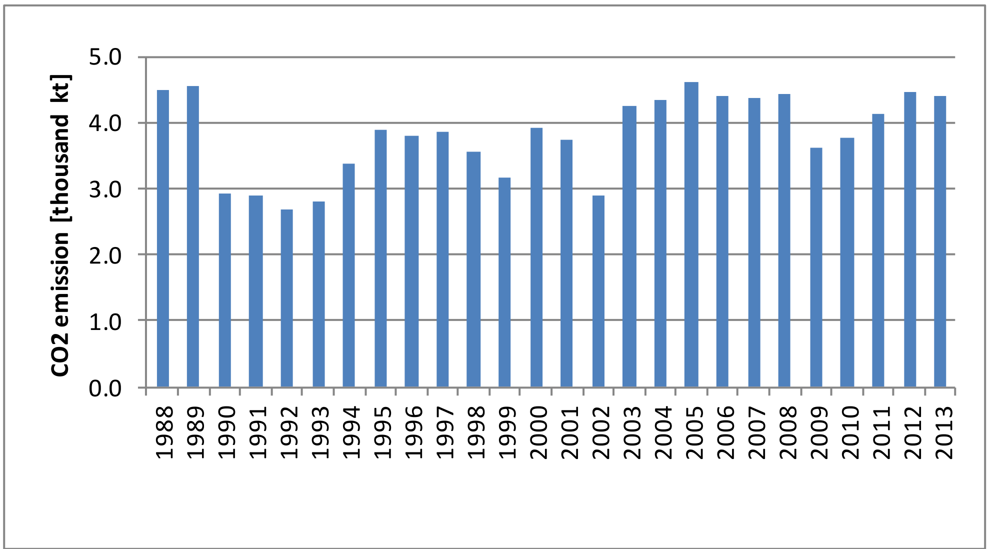

Figure 4.3.2. CO_2 process emission for ammonia production in 1988-2013

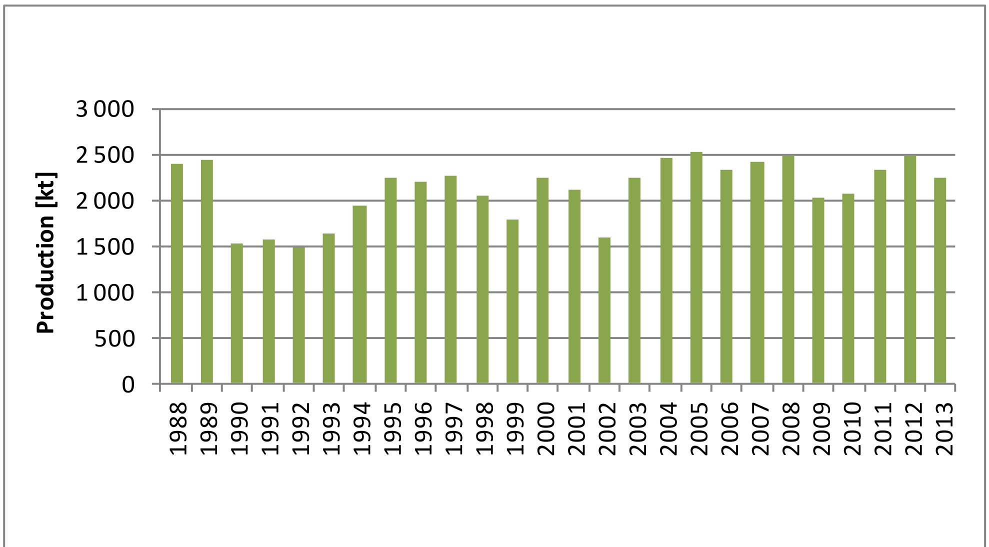

Figure 4.3.3. Production of ammonia in 1988-2013

4.3.2.2. Nitric acid production (CRF sector 2.B.2)

Estimation of N_2O emission from nitric acid production for 2013 was based on annual HNO_3 production data from [GUS 2014b]. The applied country specific emission factor for 2013: 1.30 kg/t nitric acid was estimated based on the reports from all producers of HNO_3 [KOBiZE 2014]. The N_2O emission factors for years 2005-2012 were calculated also based on mentioned reports provided by installations of nitric acid production.

The values of N_2O EFs applied for the years 2005-2013, expressed in kg CO_2/t HNO_3, were as follows:

2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
6.36	6.37	6.43	5.40	1.31	1.35	1.23	1.13	1.30

Emission factors mentioned above were estimated as weighted average of plant specific emission factors obtained from all nitric acid producers (from 5 installations located in 4 enterprises).

Decrease of the N_2O EF value from nitric acid production in 2008 and its significant drop in 2009 - 2011 are the result of the implementation of the JI projects. N_2O catalytic decompose inside the oxidation ammonia reactor is the abatement technology applied in these installations.
Individual data obtained from nitric acid producers is confidential, so was not published in the NIR (it could be available for ERT review purpose only).

For the period 1988-2004, N_2O EF amounted to 6.47 kg/t nitric acid was applied. This country specific emission factor was taken from [Kozłowski 2001].

Activity data (i.e. HNO_3 production) for estimation of nitrous oxide emissions in 2.B.2 subcategory were taken from [GUS 1989b-2014b] for the entire period 1988-2013. The amount of production and N_2O emissions from nitric acid production are shown in figures 4.3.4 and 4.3.5, respectively.

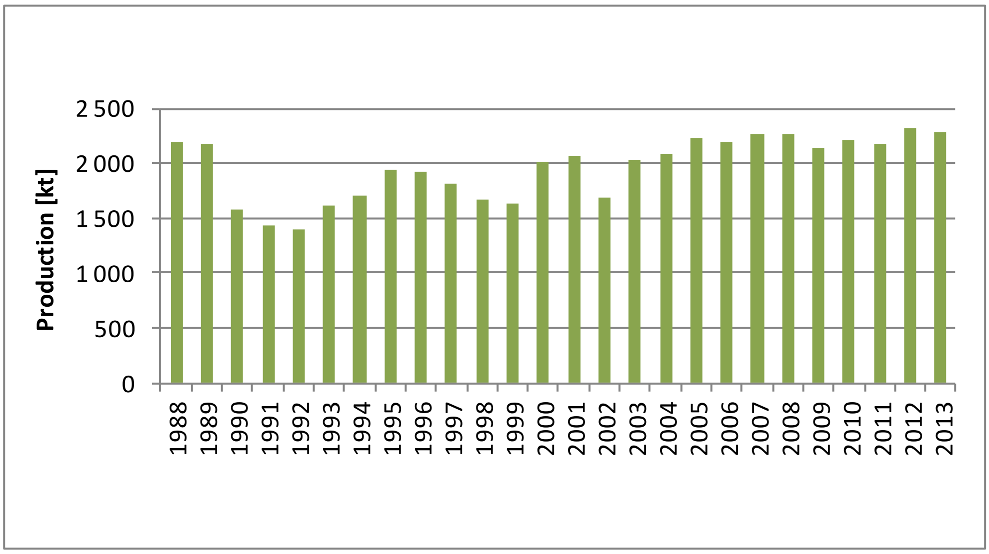

Figure 4.3.4. Production of nitric acid in 1988-2013

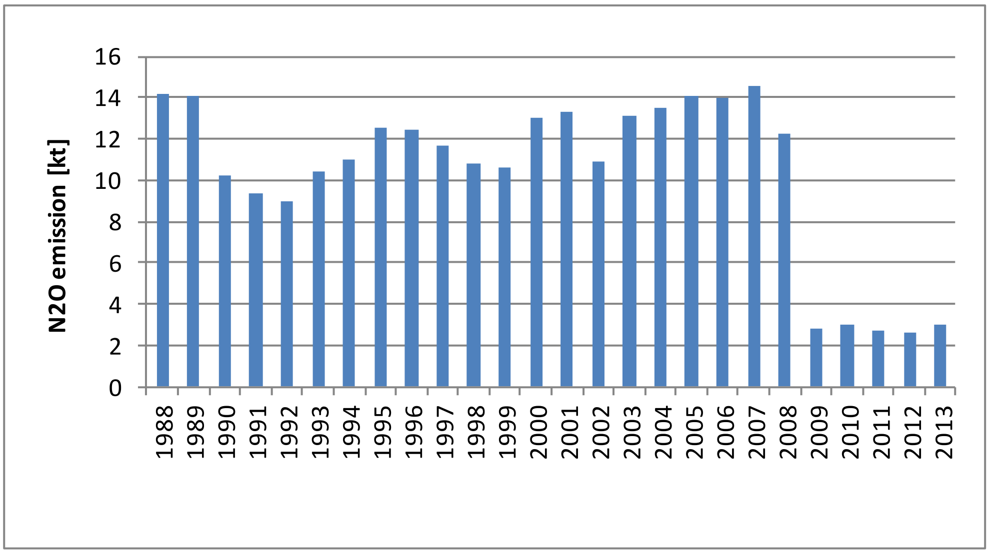

Figure 4.3.5. N_2O process emission for nitric acid production in 1988-2013

4.3.2.3. Adipic acid production (CRF sector 2.B.3)

Production of adipic acid was continued up to 1994. Activity data concerning adipic acid production was taken from the only adipic production plant.
CO2 emission factor for this category, which is equal 300 kg CO2/ t, was taken from table 3.4, p. 3.30, 2006 IPCC GLs [IPCC 2006].

4.3.2.4. Caprolactam, glyoxal and glyoxylic acid production (CRF sector 2.B.4)

Caprolactam Production

Data on annual caprolactam production for inventory calculation purpose was taken from [GUS 2014b]. Applied country specific emission factor of N_2O, which value is 4.74 kg N_2O/t caprolactam produced, was assessed based on the Polish study [Kozłowski 2001].
For the entire time series the same activity data source – GUS publications [GUS 1989b-2014b] and the same emission factor were applied.

Glyoxal and glyoxylic acid production

Glyoxal and glyoxylic acid have not been produced in Poland.

4.3.2.5. Carbide production (CRF sector 2.B.5)

CO_2 emission from calcium carbide category was estimated for years 1988-2007 based on annual production amounts taken from [GUS 1989b-2008b]. Starting from 2008 carbide is no longer produced in Poland.
EF equal 2190 kg CO2/t of carbide (i.e.: 1090 kg CO_2/t carbide from production + 1100 kg CO_2/t carbide from use) was applied for CO_2 emission estimation in entire period 1988-2007. The factors given above were taken from tab. 3.8, 2006 IPCC GLs [IPCC 2006].

Silicon carbide has not been produced in Poland.

4.3.2.6. Titanium dioxide production (CRF sector 2.B.6)

Titanium dioxide is produced in Poland in sulphate route process, so it was assumed, that the GHG emission is insignificant from TiO_2 production (in accordance with 2006 IPCC GLs (Chapter 3.7, p. 3.47)

4.3.2.7. Soda ash production (CRF sector 2.B.7)

In Poland, soda ash is produced in the Solvay process. Emission of CO_2 from this process was assumed as 0 as coke consumption in soda ash production process is included in fuel use in *Final Energy Consumption - Chemical and Petrochemical* category in Polish energy balance and CO_2 emission is accounted in 1.A.2.c IPCC sector.

4.3.2.8. Petrochemical and carbon black production (CRF sector 2.B.8)

a. Methanol production

Process emissions of CO_2 and CH_4 from methanol production for the entire period 1988-2013 were estimated based on data on annual production from [GUS 1989b-2014b]. CO_2 EF equal 670 kg CO_2/t from tab. 3.12 of 2006 IPCC GLs [IPCC 2006] was applied. CH_4 emission values were calculated based on CH_4 EF equal 2.3 kg CH_4/t [IPCC 2006].

b. Ethylene production

CO_2 and CH_4 process emissions related to ethylene production were estimated for the entire period 1988-2013 based on the data on annual production amounts taken from [GUS 1989b-2014b]. CO_2 EF equal 1903 kg CO_2/t was applied. It is value of CO_2 EF (for default feedstock) given in tab. 3.14 of 2006 IPCC GLs adjusted by recommended regional factor (110% in case of Eastern Europe; tab. 3.15) [IPCC 2006]. CH_4 emission values were calculated based on CH_4 EF equal 3.0 kg CH_4/t according to the table 3.16 [IPCC 2006].

c. Ethylene dichloride and vinyl chloride monomer production

CO_2 and CH_4 emission in this IPCC category was estimated based on vinyl chloride monomer production. Activity data for the years 2002-2013 was taken from Central Statistical Office. Data for the years 1988-2001 come directly from VCM producer. CO_2 EF amounted to 294.3 kg CO2/t VCM produced, recommended for balanced process (default process) in the table 3.17 of 2006 IPCC GLs [IPCC 2006], was applied for emission estimation in entire period. CH_4 emission was calculated using EF=0.0226 kg/t VCM produced (tab. 3.19, 2006 IPCC GLs).

d. Ethylene oxide production

Ethylene oxide production amounts from Central Statistical Office were used for estimation of CO_2 and CH_4 emissions. Default EFs for both CO_2 and CH_4 were applied in order to calculation of emissions. Utilized EF values were as follow: CO_2 EF = 863 kg CO_2/tonne ethylene oxide (tab. 3.20, 2006 GLs), CH_4 EF = 1.79 kg CH_4/tonne ethylene oxide (tab. 3.21, 2006 GLs).

e. Acrylonitrile production

According to data from Central Statistical Office production of acrylonitrile in Poland was in the years: 1988-1990 and 1996-2003. Emission of CO_2 and CH_4 from this production was estimated according to 2006 IPCC GLs. CO_2 EF = 1000 kg CO_2/tonne acrylonitrile produced (tab. 3.22, 2006 GLs) and CH_4 EF = 0.18 kg CH_4/tonne acrylonitrile produced (p. 3.79, 2006 GLs) were applied for GHG inventory purpose.

f. Carbon black production

CO_2 and CH_4 emissions from production of carbon black was estimated based on annual carbon black production taken from [GUS 1989b-2000b] and [GUS 2001e-2014e] respectively. CO_2 EF equal to 2620 kg CO_2/tonne carbon black produced (tab. 3.23, 2006 GLs) and CH_4 EF = 0.06 kg CH_4/tonne carbon black produced (tab. 3.24, 2006 GLs) were used.

g. Other

- Styrene Production

Data on styrene production applied for emission estimation was obtained from [GUS 1996e-2014e] for the years 1995-2013 and directly from the only styrene producer for previous years (1988-1994). Methane emissions values for the entire period 1988-2013 were estimated by applying the same emission factor of 4 kg CH_4/t styrene produced [IPCC 1997].

4.3.3. Uncertainties and time-series consistency

See chapter 4.2.3

4.3.4. Source-specific QA/QC and verification

See chapter 4.2.4

4.3.5. Source-specific recalculations

- estimation of CO_2 emission in accordance with emission source categories included in IPCC 2006 GLs (new emission sources, new EFs);
- change in emission calculation from ammonia production (applied CS data on C content in natural gas consumed in NH3 production process)

Table. 4.3.1. Changes of GHG emission values in 2.B. subcategory as a result of recalculations

Change	1988	1989	1990	1991	1992	1993	1994	1995
				CO2				
kt	1064.0	1058.0	905.2	782.4	791.9	789.9	691.8	789.8
%	20.2	20.1	26.1	23.0	25.9	25.5	19.1	19.1
				CH4				
kt	-11.4	-11.7	-7.1	-7.2	-6.9	-7.7	-9.3	-10.7
%	-86.8	-87.2	-81.5	-85.1	-85.0	-86.5	-89.7	-89.1
Change	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
				CO2				
kt	872.0	914.0	907.2	792.7	936.1	823.1	932.4	945.7
%	21.9	22.9	25.2	25.0	24.1	22.3	32.6	22.8
				CH4				
kt	-10.3	-10.6	-9.6	-8.3	-10.4	-9.8	-7.2	-10.5
%	-88.1	-88.0	-86.8	-86.6	-87.6	-87.9	-82.2	-87.8

Change	2004	2005	2006	2007	2008	2009	2010	2011
				CO_2				
kt	993.7	898.1	1451.3	1540.2	1348.6	1267.3	1243.2	1408.4
%	23.4	19.9	33.9	36.3	31.5	36.3	34.3	35.5
				CH_4				
kt	-11.7	-12.0	-10.5	-11.0	-11.4	-9.1	-9.4	-10.7
%	-88.3	-89.6	-82.1	-82.2	-84.6	-81.2	-82.2	-82.8

Change	2012
	CO_2
kt	1168.9
%	27.1
	CH_4
kt	-11.4
%	-85.9

4.3.6. Source-specific planned improvements

No improvements are planned at the moment.

4.4. Metal Production (CRF sector 2.C)

4.4.1. Source category description

Estimation of emissions in 2.C. *Metal Production* are carried out in sub-categories listed below:

1. *Iron and steel production* (2.C.1)
    a. *Steel* (2.C.1.a)
    b. *Pig iron* (2.C.1.b)
    c. *Direct reduced iron* (2.C.1.c)
    d. *Sinter* (2.C.1.d)
    e. *Pellet* (2.C.1.e)
    f. *Other* (2.C.1.f)
2. *Ferroalloys production* (2.C.2)
3. *Aluminium production* (2.C.3)
4. *Magnesium production* (2.C.4)
5. *Lead production* (2.C.5)
6. *Zinc production* (2.C.6)
7. *Other* (2.C.7)

Subsector 2.C.1. *Iron and Steel Production* is by far the largest contributor to emissions from this category (see figure 4.4.1) – over 76% in 2013.

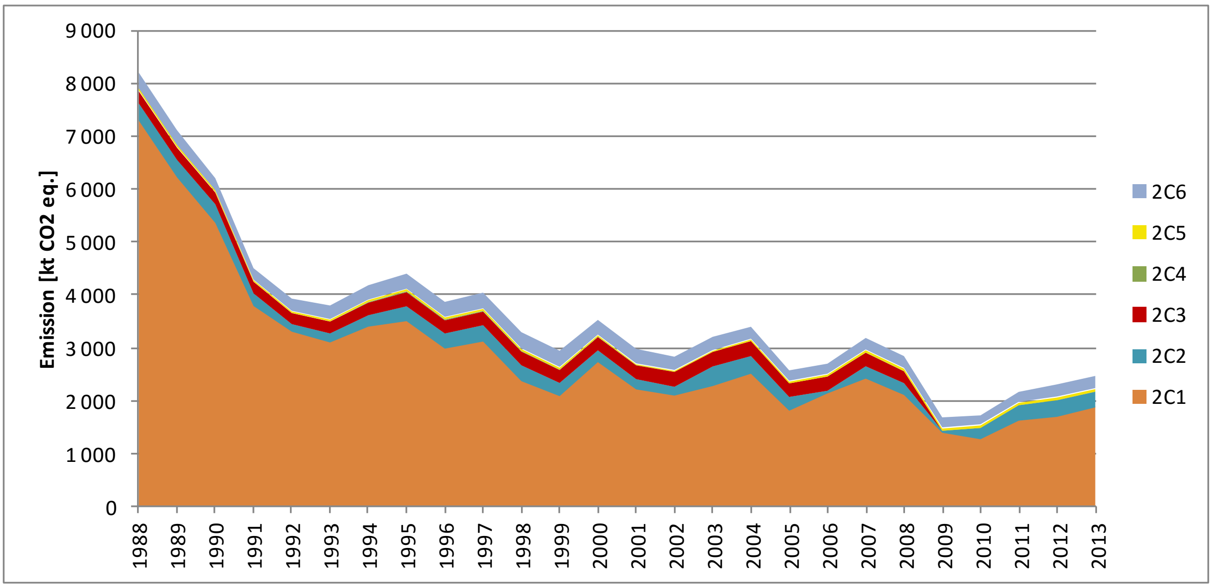

Figure 4.4.1. Emissions from *Metal Production* sector in years 1988-2013 according to subcategories

4.4.2. Methodological issues

4.4.2.1. Iron and steel production (CRF sector 2.C.1)

<u>4.4.2.1.a. Steel (CRF sector 2.C.1.a)</u>

<u>Basic oxygen furnace steel production</u>

Amount of CO_2 process emission from steel production in basic oxygen furnace was estimated based on the carbon balance in converter process (table 4.4.1). For the years 1988-2006 the Polish Steel Association (HIPH) study [HIPH 2007] was the main source of data for C balance purpose. The HIPH

Table 4.4.1. Carbon balance for steel production in basic oxygen process in years 1988-2013

	1988	1989	1990	1991	1992	1993	1994	1995	1996
CHARGE									
Pig iron [t]	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 [t]	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
Carbon pick-up agent [t]	0	0	0	0	0	0	0	0	0
Ferroalloys [t]	61 135	58 311	57 193	45 416	48 066	46 278	53 217	57 027	51 883
Dolomite [t]	187 960	182 054	189 020	144 459	155 741	144 853	163 776	177 073	156 867
Technological indicator [t/t 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
Carbon pick-up agent	0	0	0	0	0	0	0	0	0
Ferroalloys	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.007	0.008
Dolomite	0.025	0.025	0.026	0.025	0.025	0.024	0.023	0.023	0.023
Material-specific carbon content									
Pig iron [t C/t]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Scrap [t C/t]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Carbon pick-up agent [t C/TJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Ferroalloys [t C/t]	0.033	0.033	0.033	0.033	0.032	0.033	0.033	0.033	0.032
Dolomite [t C/t]	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130
Carbon contents in charge components [t 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
Carbon pick-up agent	0	0	0	0	0	0	0	0	0
Ferroalloys	2 019	1 936	1 868	1 481	1 557	1 518	1 741	1 862	1 686
Dolomite	24 435	23 667	24 573	18 780	20 246	18 831	21 291	23 019	20 393
Carbon contents in charge – SUM [t]	**291 526**	**283 959**	**282 299**	**219 564**	**239 357**	**234 850**	**265 136**	**290 349**	**255 762**
OUTPUT									
Steel [t]	**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**
Material-specific carbon content									
Steel [t C/t]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Carbon content in products [t C]									
Steel	29 699	28 849	28 828	23 000	24 991	24 640	28 134	30 742	27 030
Carbon content in products – SUM [t]	**29 699**	**28 849**	**28 828**	**23 000**	**24 991**	**24 640**	**28 134**	**30 742**	**27 030**
C emission from steel production [t]	261 827	255 109	253 471	196 564	214 366	210 210	237 002	259 607	228 732
CO_2 process emission from steel production [kt]	**960.033**	**935.401**	**929.394**	**720.734**	**786.009**	**770.769**	**869.006**	**951.893**	**838.684**
CO_2 EMISSION FACTOR [kg CO_2/t of steel]	**129.30**	**129.69**	**128.96**	**125.34**	**125.81**	**125.12**	**123.55**	**123.86**	**124.11**

Table 4.4.1. Carbon balance (cont.) for steel production in basic oxygen process in years 1988-2013

	1997	1998	1999	2000	2001	2002	2003	2004	2005
CHARGE									
Pig iron [t]	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 [t]	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
Carbon pick-up agent [t]	0	0	0	0	1 201	2 645	4 286	1 689	1 205
Ferroalloys [t]	59 896	50 915	45 285	57 840	50 035	49 610	48 197	57 157	56 566
Dolomite [t]	188 810	157 145	141 317	174 301	156 426	161 404	127 127	162 673	191 374
Technological indicator [t/t 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
Carbon pick-up agent	0	0	0	0	0.0002	0.0005	0.0007	0.0002	0.0002
Ferroalloys	0.008	0.008	0.008	0.009	0.009	0.009	0.008	0.008	0.012
Dolomite	0.025	0.025	0.026	0.026	0.027	0.028	0.021	0.024	0.039
Material-specific carbon content									
Pig iron [t C/t]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Scrap [t C/t]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Carbon pick-up agent [t C/TJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Ferroalloys [t C/t]	0.033	0.033	0.032	0.033	0.032	0.032	0.032	0.033	0.031
Dolomite [t C/t]	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130
Carbon contents in charge components [t 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
Carbon pick-up agent	0	0	0	0	992	2 184	3 539	1 395	995
Ferroalloys	1 951	1 659	1 466	1 905	1 623	1 598	1 560	1 860	1 779
Dolomite	24 545	20 429	18 371	22 659	20 335	20 983	16 527	21 147	24 879
Carbon contents in charge – SUM [t]	**286 637**	**237 769**	**210 665**	**290 867**	**246 016**	**242 063**	**252 514**	**283 008**	**213 791**
OUTPUT									
Steel [t]	**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**
Material-specific carbon content									
Steel [t C/t]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Carbon content in products [t C]									
Steel	30 125	24 890	21 811	27 199	23 290	23 196	24 280	27 430	19 571
Carbon content in products – SUM [t]	**30 125**	**24 890**	**21 811**	**27 199**	**23 290**	**23 196**	**24 280**	**27 430**	**19 571**
C emission from steel production [t]	256 512	212 879	188 854	263 668	222 726	218 867	228 234	255 578	194 220
CO_2 process emission from steel production [kt]	**940.545**	**780.557**	**692.464**	**966.782**	**816.662**	**802.513**	**836.857**	**937.119**	**712.141**
CO_2 EMISSION FACTOR [kg CO_2/t of steel]	**124.89**	**125.44**	**126.99**	**142.18**	**140.26**	**138.39**	**137.87**	**136.65**	**145.55**

Table 4.4.1. (cont.) Carbon balance for steel production in basic oxygen process in years 1988-2013

	2006	2007	2008	2009	2010	2011	2012	2013
CHARGE								
Pig iron [t]	5 338 401	5 723 961	4 892 172	2 988 979	3 599 854	3 942 754	3 934 606	3 951 192
Scrap [t]	1 352 895	1 414 926	1 105 439	727 586	965 296	1 106 613	912 706	925 533
Carbon pick-up agent [t]	1 036	753	8 270	12 826	16 033	24 905	8 845	9 044
Ferroalloys [t]	68 765	71 480	65 149	40 273	53 926	59 738	53 477	57 253
Dolomite [t]	35 776	37 149	18 930	10 786	16 375	14 220	15 560	20 627
Technological indicator [t/t of steel]								
Pig iron	1.080	0.924	0.936	0.924	0.901	0.891	0.908	0.874
Scrap	0.2346	0.228	0.212	0.225	0.242	0.250	0.211	0.205
Carbon pick-up agent	0.0002	0.000	0.002	0.004	0.004	0.006	0.002	0.002
Ferroalloys	0.012	0.012	0.012	0.012	0.013	0.014	0.012	0.013
Dolomite	0.006	0.006	0.004	0.003	0.004	0.003	0.004	0.005
Material-specific carbon content								
Pig iron [t C/t]	0.04	0.042	0.042	0.043	0.042	0.042	0.043	0.043
Scrap [t C/t]	0.004	0.003	0.008	0.008	0.009	0.009	0.008	0.008
Carbon pick-up agent [t C/t]	0.826	0.899	0.820	0.845	0.823	0.806	0.823	0.833
Ferroalloys [t C/t]	0.029	0.032	0.035	0.035	0.033	0.028	0.031	0.031
Dolomite [t C/t]	0.130	0.130	0.124	0.125	0.125	0.125	0.126	0.125
Carbon contents in charge components [t C]								
Pig iron	213 536	239 730	207 333	127 337	150 438	165 971	167 334	168 816
Steel scrap	5 412	4 297	8 457	5 785	9 109	9 865	7 292	6 999
Carbon pick-up agent	855	677	6 783	10 839	13 198	20 075	7 277	7 538
Ferroalloys	2 021	2 288	2 249	1 427	1 761	1 673	1 681	1 769
Dolomite	4 649	4 829	2 341	1 345	2 047	1 780	1 960	2 586
Carbon contents in charge – SUM [t]	**226 474**	**251 821**	**227 163**	**146 733**	**176 553**	**199 365**	**185 544**	**187 708**
OUTPUT								
Steel [t]	**5 766 375**	**6 197 910**	**5 225 075**	**3 235 666**	**3 994 650**	**4 423 604**	**4 333 168**	**4 520 358**
Material-specific carbon content								
Steel [t C/t]	0.004	0.003	0.008	0.008	0.010	0.009	0.008	0.003
Carbon content in products [t C]								
Steel	23 066	18 304	41 662	25 760	38 441	40 780	34 990	11 919
Carbon content in products – SUM [t]	**23 066**	**18 304**	**41 662**	**25 760**	**38 441**	**40 780**	**34 990**	**11 919**
C emission from steel production [t]	203 408	233 516	185 501	120 974	138 111	158 585	150 554	175 789
CO_2 process emission from steel production [kt]	**745.831**	**856.227**	**680.171**	**443.570**	**506.409**	**581.478**	**552.032**	**644 561**
CO_2 EMISSION FACTOR [kg CO_2/t of steel]	**129.34**	**138.15**	**130.17**	**137.09**	**126.77**	**131.45**	**127.40**	**142.59**

data was supplemented for the years 1988-2004 with the information from questionnaires collected by the National Centre for Emissions Management (KOBiZE) for installations covered by EU ETS and starting from 2005 with the data from verified reports concerning CO_2 emission, prepared as part of EU ETS. Based on mentioned verified reports, C balances for basic oxygen steel plants were prepared for the years not included in the HIPH study, it means for the period 2007-2013. Steel production amounts applied in the C balance were in accordance with data published in GUS yearbook [2005b-2014b].

Electric furnace steel production

Process emissions of CO_2 from steel production in electric furnaces for particular years in the period 1988-2006 were estimated based on the data from Polish Steel Association study [HIPH 2007]. For the last years information from verified reports, prepared as part of EU ETS, was applied for emission calculation. Steel production amounts was taken from Central Statistical Office yearbook [GUS 2008b-2014b].

Results of CO_2 emission estimation, AD and emission factors applied for calculation are presented in the table 4.4.2.

Table 4.4.2. Values of steel production in electric furnace [kt] as well as CO_2 emission factors [kg/t of steel] and CO_2 emission [**kt**] connected with that process for the years 1988-2013.

	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Production	2572.4	2264.3	2308.6	1950.9	1727.3	2044.2	2368.1	2581.9	2648.4	2906.3
CO_2 emission factor	34.75	36.94	36.94	36.11	33.21	37.82	36.44	33.05	33.05	33.05
CO_2 emission	89.38	83.63	85.27	70.45	57.36	77.32	86.29	85.34	87.54	96.07
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Production	3116.9	2825.1	3283.9	2809.1	2561.2	2916.6	3720.9	3443.2	4225.3	4432.8
CO_2 emission factor	35.83	29.15	44.13	44.10	45.64	41.90	55.10	46.97	48.88	44.76
CO_2 emission	111.66	82.35	144.91	123.89	116.90	122.20	205.00	161.74	206.53	198.41
	2008	**2009**	**2010**	**2011**	**2012**	**2013**				
Production	4502.3	3892.8	4001.4	4352.9	4209.3	3679.0				
CO_2 emission factor	53.44	52.84	50.70	54.98	52.70	61.26				
CO_2 emission	240.58	205.68	202.88	239.30	221.84	225.38				

Open-hearth furnace steel production

Steel production in open-hearth furnaces was continued up to 2002. CO_2 process emissions from this source was estimated according to case study prepared by the Polish Steel Association (HIPH) [HIPH 2007]. CO_2 emission was calculated based on carbon balance developed for steel production process in mentioned furnaces.

4.4.2.1.b. Pig iron (CRF sector 2.C.1.b)

CO_2 process emission from pig iron production for the years 1988-2013 was estimated based on carbon balance in blast furnace process. Balances for individual years were founded on the statistical data for main components of input and output. Pig iron production values for entire period were accepted according to G-03 questioners [GUS 1989e-2014e]. Output of blast furnace gas was taken from IEA database [IEA] for the years 1988-1989. For the period 1990-2013 this data came from Eurostat database. In case of coke input source of data was derived respectively: for the years 1988-1989 – data from the *Energy statistic* [GUS 1989a-1990a] corrected by Energy Market Agency (ARE), for the period 1990-2013 – IEA database [IEA]. (Data from Eurostat database was not applied to C balance for process of pig iron production, because of blast furnaces transformation efficiency in Eurostat energy balance is very high and it is the reason, that there is too little amount of coke use in „Transformation input in Blast Furnaces" compared with real technological demand. This problem was also mentioned in chapter 3.2.7.2.1. *Iron and steel* (1.A.2.a)). Amounts of other components were estimated according to technological factors taken from literature [Szargut J. 1978]. These coefficients enabled to estimate amounts i.a.: dolomite (0,0885 kg/kg pig iron), limetone (0,0974 kg/kg pig iron) and iron ore (0,188 kg roasted ore/kg pig iron 0,0716 manganese ore/kg pig iron). In case of iron ore sinter was assumed (in accordance with data from steel plants), that total annual sinter production is consumed in given year for pig iron production. Carbon contents in components of charge and output were calculated base on C EFs from IPCC guidelines (BF gas, coke, pig iron, limestone and dolomites) and country specific values for iron ore [Szargut J. 1978] and sinter (data from plants).

Carbon balance for blast furnace process for the years 1988-2013 and estimated emissions for entire period were presented in the table 4.4.3.

Table 4.4.3. Carbon balance for blast furnace process in years: 1988-2013

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
CHARGE – amount used in process in given year										
Sinter [kt]	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	8 980.8
Roasted ore [kt]	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	1 394.6
Dolomite [kt]	907.7	839.2	765.7	575.1	571.6	556.6	626.4	658.4	580.4	656.2
Limestone [kt]	999.6	924.1	843.2	633.3	629.4	612.9	689.7	725.0	639.1	722.5
Manganese ore [kt]	734.8	679.3	619.8	465.5	462.7	450.6	507.0	533.0	469.8	531.1
Coke [TJ]	186 338	179 462	157 399	106 999	101 994	95 370	110 384	113 854	97 640	103 274
Coking coal [TJ]										
CHARGE – C content										
Sinter [kg/kg]	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
Roasted ore [kg/kg]	0.0113	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	0.1300
Limestone [kg/kg]	0.1200	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	0.0262
Coke [kg/GJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Coking coal [kg/GJ]										
CHARGE – total C content [kt]										
Sinter	15.5	14.3	13.0	9.5	9.5	8.4	9.7	9.5	9.2	9.9
Roasted ore	21.7	20.1	18.3	13.8	13.7	13.3	15.0	15.8	13.9	15.7
Dolomite	118.0	109.1	99.5	74.8	74.3	72.4	81.4	85.6	75.5	85.3
Limestone	119.9	110.9	101.2	76.0	75.5	73.6	82.8	87.0	76.7	86.7
Manganese ore	19.2	17.8	16.2	12.2	12.1	11.8	13.3	13.9	12.3	13.9
Coke	5 497.0	5 294.1	4 643.3	3 156.5	3 008.8	2 813.4	3 256.3	3 358.7	2 880.4	3 046.6
Coking coal										
C IN CHARGE – SUM	5 791.4	5 566.3	4 891.5	3 342.6	3 193.9	2 992.8	3 458.5	3 570.5	3 067.9	3 258.0
OUTPUT IN GIVEN YEAR										
Pig iron [kt]	**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**	**7 418.0**
Blast furnace gas [TJ]	74 521	71 771	62 970	42 811	40 802	38 157	44 162	45 545	39 062	41 319
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	0.04
Blast furnace gas [kg/GJ]	66	66	66	66	66	66	66	66	66	66
OUTPUT – total C content [kt]										
Pig iron	410.5	379.5	346.3	260.1	258.5	251.7	283.2	297.7	262.5	296.7
Blast furnace gas	4 918.4	4 736.9	4 156.0	2 825.5	2 692.9	2 518.4	2 914.7	3 006.0	2 578.1	2 727.1
C IN OUTPUT – SUM	5 328.9	5 116.4	4 502.3	3 085.6	2 951.4	2 770.1	3 197.9	3 303.7	2 840.6	3 023.8
DIFFERENCE BETWEEN C IN INPUT and C IN OUTPUT [kt]	462.5	449.9	389.2	257.0	242.5	222.7	260.5	266.8	227.3	234.3
CO_2 EMISSION [kt]	**1 696**	**1 650**	**1 427**	**942**	**889**	**817**	**955**	**978**	**833**	**859**
CO_2 EMISSION FACTOR [kg/t]	**165**	**174**	**165**	**145**	**138**	**130**	**135**	**131**	**127**	**116**

Table 4.4.3. (cont.) Carbon balance for blast furnace process in years: 1988-2013

	1998	1999	2000	2001	2002	2003	2004	2005	2006
CHARGE – amount used in process in given year									
Sinter [kt]	6 882.1	6 475.9	8 078.7	7 352.8	7 616.9	7 732.2	8 590.6	6 168.4	6 907.8
Roasted ore [kt]	1 180.5	993.1	1 223.0	1 023.3	995.7	1 061.4	1 208.3	842.5	1 042.1
Dolomite [kt]	555.4	467.2	575.4	481.4	468.5	499.4	568.5	396.4	490.3
Limestone [kt]	611.6	514.5	633.6	530.1	515.9	549.9	626.0	436.5	539.9
Manganese ore [kt]	449.6	378.2	465.8	389.7	379.2	404.2	460.2	320.9	396.9
Coke [TJ]	85 714	70 423	92 603	79 737	71 875	77 563	84 581	58 590	72 356
Coking coal [TJ]									
CHARGE – C content									
Sinter [kg/kg]	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
Roasted 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
Coking coal [kg/GJ]									
CHARGE – total C content [kt]									
Sinter	7.6	7.1	8.9	8.1	8.4	8.5	9.4	6.8	7.6
Roasted ore	13.3	11.2	13.8	11.5	11.2	12.0	13.6	9.5	11.7
Dolomite	72.2	60.7	74.8	62.6	60.9	64.9	73.9	51.5	63.7
Limestone	73.4	61.7	76.0	63.6	61.9	66.0	75.1	52.4	64.8
Manganese ore	11.8	9.9	12.2	10.2	9.9	10.6	12.0	8.4	10.4
Coke	2 528.5	2 077.5	2 731.8	2 352.3	2 120.3	2 288.1	2 495.1	1 728.4	2 134.5
Coking coal									
C IN CHARGE – SUM	2 706.8	2 228.2	2 917.5	2 508.3	2 272.6	2 450.1	2 679.3	1 857.0	2 292.8
OUTPUT IN GIVEN YEAR									
Pig iron [kt]	**6 279.4**	**5 282.3**	**6 505.3**	**5 442.8**	**5 296.4**	**5 645.9**	**6 426.9**	**4 481.2**	**5 543.4**
Blast furnace gas [TJ]	34 289	28 179	37 053	31 904	28 752	31 031	33 836	23 446	28 948
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 [kt]									
Pig iron	251.2	211.3	260.2	217.7	211.9	225.8	257.1	179.2	221.7
Blast furnace gas	2 263.1	1 859.8	2 445.5	2 105.7	1 897.6	2 048.0	2 233.2	1 547.4	1 910.6
C IN OUTPUT – SUM	2 514.3	2 071.1	2 705.7	2 323.4	2 109.5	2 273.9	2 490.3	1 726.7	2 132.3
DIFFERENCE BETWEEN C IN INPUT and C IN OUTPUT [kt]	192.5	157.1	211.8	184.9	163.1	176.2	189.0	130.3	160.4
CO_2 EMISSION [kt]	**706**	**576**	**777**	**678**	**598**	**646**	**693**	**478**	**588**
CO_2 EMISSION FACTOR [kg/t]	**112**	**109**	**119**	**125**	**113**	**114**	**108**	**107**	**106**

Table 4.4.3. (cont.) Carbon balance for blast furnace process in years: 1988-2013

	2007	2008	2009	2010	2011	2012	2013
CHARGE – amount used in process in given year							
Sinter [kt]	6 954.0	6 306.4	4 362.6	5 837.3	6 512.8	6 672.5	6 854.2
Roasted ore [kt]	1 091.2	927.6	560.9	683.9	747.3	741.0	754.2
Dolomite [kt]	513.4	436.4	263.9	321.8	351.6	348.6	354.9
Limestone [kt]	565.4	480.6	290.6	354.3	387.2	383.9	390.8
Manganese ore [kt]	415.6	353.3	213.6	260.5	284.6	282.2	287.3
Coke [TJ]	86 543	71 351	44 020	50 809	52 396	52 144	54 099
Coking coal [TJ]				948	2 338	5 977	4 205
CHARGE – C content							
Sinter [kg/kg]	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
Roasted ore [kg/kg]	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
Limestone [kg/kg]	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
Coke [kg/GJ]	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Coking coal [kg/GJ]				25.8	25.8	25.8	25.8
CHARGE – total C content [kt]							
Sinter	7.6	6.9	4.8	6.4	7.2	7.3	7.5
Roasted ore	12.3	10.4	6.3	7.7	8.4	8.3	8.5
Dolomite	66.7	56.7	34.3	41.8	45.7	45.3	46.1
Limestone	67.8	57.7	34.9	42.5	46.5	46.1	46.9
Manganese ore	10.9	9.2	5.6	6.8	7.4	7.4	7.5
Coke	2 553.0	2 104.9	1 298.6	1 498.9	1 545.7	1 538.2	1 595.9
Coking coal				24.5	60.3	154.2	108.5
C IN CHARGE – SUM	2 718.4	2 245.9	1 384.5	1 628.6	1 721.2	1 806.9	1 821.0
OUTPUT IN GIVEN YEAR							
Pig iron [kt]	**5 804.4**	**4 933.8**	**2 983.5**	**3 638.0**	**3 974.9**	**3 941.4**	**4 012.0**
Blast furnace gas [TJ]	34 626	28 551	17 610	22 022	22 271	22 684	22 530
OUTPUT – C content							
Pig iron [kg/kg]	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
OUTPUT – total C content [kt]							
Pig iron	232.2	197.4	119.3	145.5	159.0	157.7	160.5
Blast furnace gas	2 285.3	1 884.4	1 162.3	1 453.5	1 469.9	1 497.1	1 487.0
C IN OUTPUT – SUM	2 517.5	2 081.7	1 281.6	1 599.0	1 628.9	1 654.8	1 647.5
DIFFERENCE BETWEEN C IN INPUT and C IN OUTPUT [kt]	200.9	164.2	102.9	29.6	92.3	152.1	173.5
CO_2 EMISSION [kt]	**737**	**602**	**377**	**109**	**339**	**558**	**636**
CO_2 EMISSION FACTOR [kg/t]	**127**	**122**	**126**	**30**	**85**	**141**	**159**

4.4.2.1.c. Direct reduced iron (CRF sector 2.C.1.c)

Direct reduced iron has not been produced in Poland (information confirmed by Polish Steel Association (HIPH))

4.4.2.1.d Sinter (2.C.1.d)

Estimation of carbon dioxide process emissions from iron ore sinter production for 2013 was based on the data from the EU ETS verified reports on annual emissions of CO_2 from iron ore sinter installations [KOBiZE 2014]. Sinter production (not published from 2000 in statistical materials) and data needed for estimation of country specific CO_2 EFs (i.a. amounts of components in input and output of the sintering process) were accepted according to mentioned EU ETS reports as well. Emissions for 2005-2012 were also estimated in accordance with EU ETS reports while for the years 1988-2004 according to data from questionnaires obtained by the National Centre for Emissions Management from installations entering the EU ETS [KOBiZE 2014]. The values of iron ore sinter production (AD), CO_2 EFs and CO_2 emissions were presented in the table 4.4.1. AD sources were as follows: G-03 reports for 1988-2000 [GUS 1989e-2001e], questionnaires from EU ETS installations collected by National Centre for Emissions Management for 2001-2004 and EU ETS verified reports for the years starting from 2005 [KOBiZE 2014].

For the entire period 1988-2013 emissions of CH_4 were also estimated from iron ore sinter production. The default emission factor for CH_4 (0.07 kg/t), was taken from tab. 4.2., 2006 GLs [IPCC 2006].

Table 4.4.4. Iron ore sinter production [kt], CO_2 emission factors [kg/t of sinter] and CO_2 emission values from sinter production in the years 1988-2013 [kt]

	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Production	14107.3	12992.5	11779.4	8612.7	8621.7	7628.2	8787.4	8646.6	8318.6	8980.8
CO_2 emission factor	78.05	56.72	71.41	79.08	72.97	75.70	73.10	79.77	79.81	74.89
CO_2 emission	1101.14	736.98	841.16	681.13	629.08	577.45	642.35	689.76	663.94	672.58

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Production	6882.1	6475.9	8078.7	7352.8	7616.9	7732.2	8590.6	6168.4	6907.8	6954.0
CO_2 emission factor	73.55	83.21	79.00	72.36	73.92	85.08	76.79	72.59	84.59	88.28
CO_2 emission	506.20	538.89	638.21	532.01	563.07	657.86	659.70	447.73	584.31	613.91

	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Production	6306.4	4362.6	5837.3	6512.8	6672.5	6854.2
CO_2 emission factor	91.11	82.25	75.77	69.29	52.63	51.86
CO_2 emission	574.59	358.80	442.32	451.29	351.14	355.48

4.4.2.1.e Pellet (2.C.1.e)

Direct reduced iron has not been produced in Poland.

4.4.2.2. Ferroalloys production (CRF sector 2.C.2)

Emission of CO_2 concerning ferroalloys production was estimated based on annual ferrosilicon production taken from [GUS 2014b]. Applied emission factor of 4000 kg CO_2/t ferrosilicon, was taken from [IPCC 2006] – tab. 4.5 for ferrosilicon – 75% Si.

CH_4 emission was estimated based on emission factors from [IPCC 2006] – tab. 4.7 which is equal 1 kg CH_4/t ferrosilicon – 75% Si.

In the period 1988-2012 CO_2 and CH_4 process emission from ferroalloys production was estimated also based on annual ferrosilicon production taken from [GUS 1989b-2013b] (figure 4.4.2) and emission factors as in 2013.

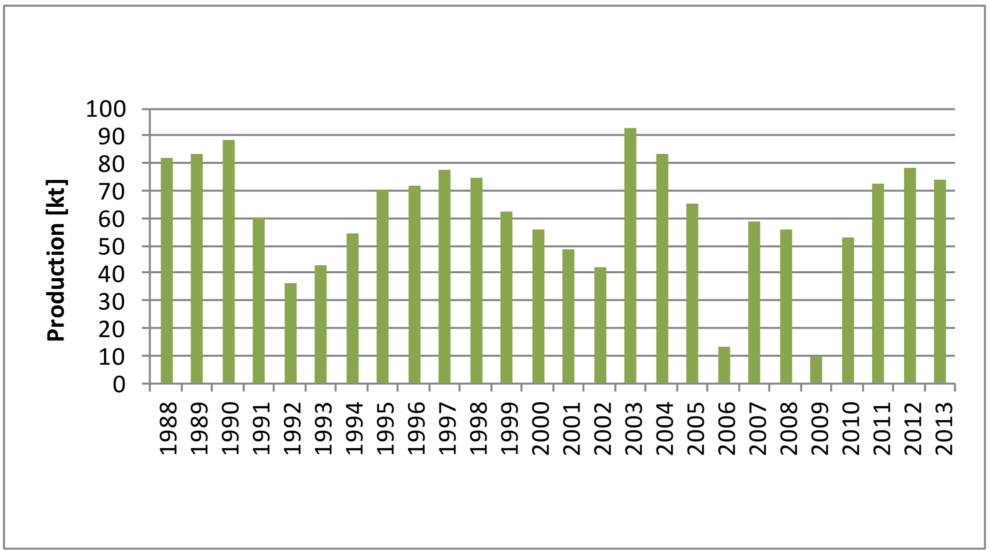

Figure 4.4.2. Production of ferrosilicon in 1988-2013

Coal consumption in ferroalloys production is submitted in national energy statistics as non-energy use of fuel. This means that coal consumed as reducer in mentioned process is not included in energy consumption of coal in 1.A.2 subsector, so double counting is avoided.

4.4.2.3. Aluminium production (CRF sector 2.C.3)

CO_2 emission from aluminium production was estimated for years 1988-2008 based on annual production amounts taken from [GUS 1989b-2009b]. Starting from 2009 primary aluminium is no longer produced in Poland.

The emission factor amounting to 1.7 t CO_2/t primary aluminium was applied in order to estimate CO_2 emission for entire period 1988-2008. Mentioned CO_2 EF is given in tab. 4.10. of 2006 IPCC GLs [IPCC 2006] as the value recommended for Soderberg process.

Emission of PFC gases from aluminium production is described in chapter 4.7.2.

4.4.2.4. Magnesium production (CRF sector 2.C.4)

Emission from use of SF_6 in magnesium foundries is described in chapter 4.7.2.

4.4.2.5. Lead production (CRF sector 2.C.5)

Process emissions of CO_2 from lead production for the years 1988-2013 were estimated based on annual lead productions taken from GUS yearbooks [GUS 1989b-2014b]. The default emission factor of 0.52 t CO_2/t lead produced, taken from the table 4.21 of 2006 GLs [IPCC 2006], was applied for the entire period.

The trend of process emissions from lead production is given in figure 4.4.3.

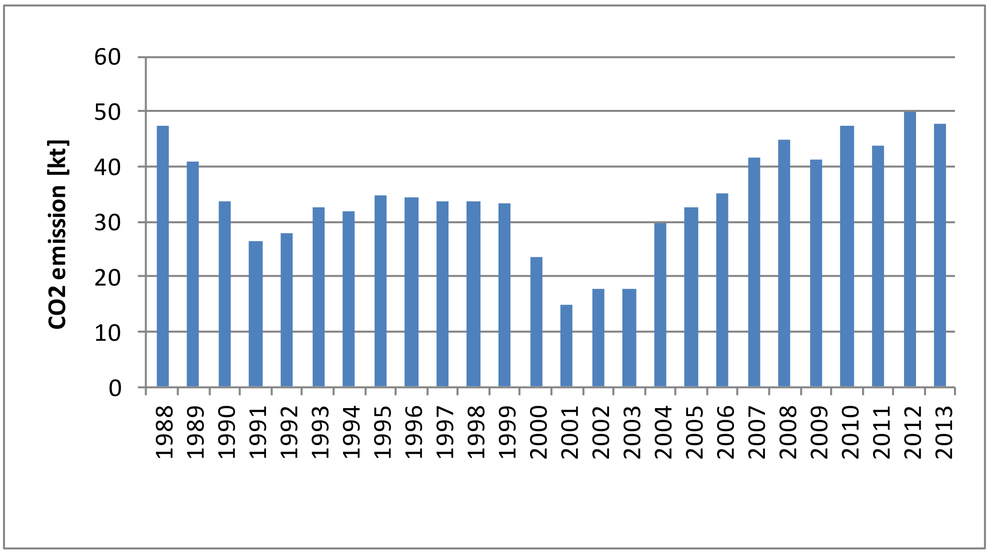

Figure 4.4.3. CO_2 process emission for lead production in 1988-2013

4.4.2.6. Zinc production (CRF sector 2.C.6)

CO_2 process emission from zinc production for the years 1988-2013 was estimated based on annual zinc production taken from GUS yearbooks [GUS 1989b-2014b]. The default emission factor amounting to 1.72 t CO_2/t zinc was used for entire reporting period. The factor comes from table 4.24 of 2006 GLs [IPCC 2006].

Process emission trend of CO_2 from zinc production is presented in figure 4.4.4.

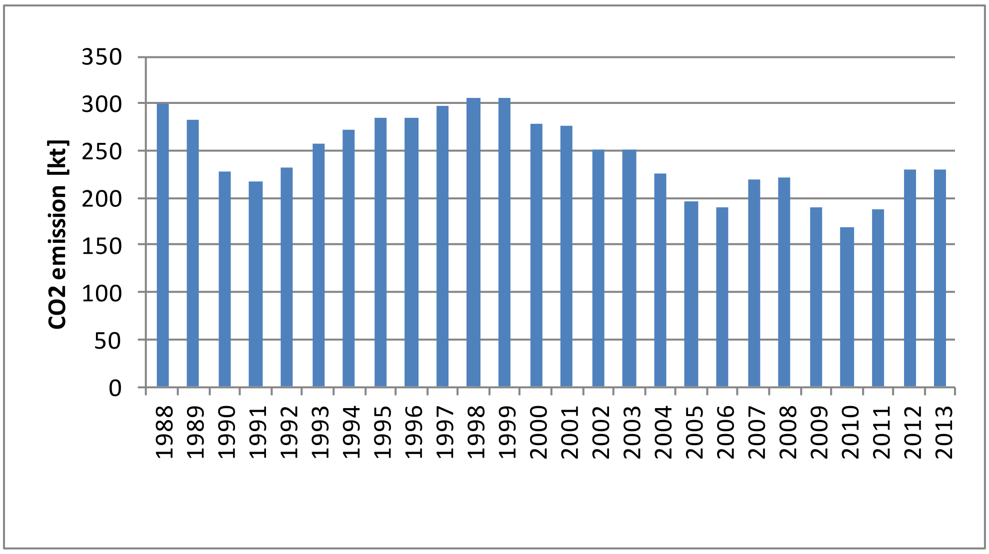

Figure 4.4.4. CO_2 process emission for zinc production in 1988-2013

4.4.3. Uncertainties and time-series consistency

See chapter 4.2.3

4.4.4. Source-specific QA/QC and verification

See chapter 4.2.4

4.4.5. Source-specific recalculations

- estimation of CO_2 emission in accordance with emission source categories included in IPCC 2006 GLs (new emission sources, new EFs);
- replacement of the default EFs from [IPCC 2000] and [IPCC 1997] used in C balances of 2.C.1 sub-categories with EFs from [IPCC 2006] or CS;
- AD correction for aluminium production for the years 2009-2012

Table. 4.4.7. Changes of GHG emission values in 2.C. subcategory as a result of recalculations.

Change	1988	1989	1990	1991	1992	1993	1994	1995
CO2								
kt	-56.6	-47.1	-37.0	-23.5	-22.5	-21.3	-21.6	-22.5
%	-0.7	-0.7	-0.6	-0.5	-0.6	-0.6	-0.5	-0.5
CH4								
kt	-0.7	-0.6	-0.6	-0.4	-0.4	-0.4	-0.5	-0.5
%	-41.1	-39.3	-38.9	-40.0	-39.1	-43.6	-42.5	-44.3
Change	1996	1997	1998	1999	2000	2001	2002	2003
CO2								
kt	-21.9	-20.5	-17.0	-14.8	-18.6	-15.3	-14.7	-8.8
%	-0.6	-0.5	-0.5	-0.5	-0.6	-0.5	-0.6	-0.3
CH4								
kt	-0.5	-0.6	-0.6	-0.5	-0.6	-0.5	-0.5	-0.5
%	-44.9	-44.2	-49.9	-50.0	-48.7	-48.7	-45.6	-45.2
Change	2004	2005	2006	2007	2008	2009	2010	2011
CO2								
kt	-9.8	-11.4	-16.8	-12.7	-13.2	-37.7	-36.6	-31.8
%	-0.3	-0.5	-0.7	-0.4	-0.5	-2.2	-2.1	-1.5
CH4								
kt	-0.6	-0.6	-0.7	-0.7	-0.8	-0.6	-0.7	-0.7
%	-47.7	-54.5	-58.5	-57.4	-60.3	-66.6	-59.3	-57.9
Change	2012							
CO2								
kt	-22.4							
%	-1.0							
CH4								
kt	-0.7							
%	-56.5							

4.4.6. Source-specific planned improvements

No improvements are planned at the moment.

4.5. Non Energy Product from Fuels and Solvent Use (CRF sector 2.D)

4.5.1. Source category description

Estimation of emissions in 2.D *Non Energy Product from Fuels and Solvent Use* are carried out in sub-categories listed below:

1. *Lubricant use* (2.D.1)
2. *Paraffin wax use* (2.D.2)
3. *Other (2.D.3)*

Subsector 2.D.3. *Other* is by far the largest contributor to emissions from this category (see figure 4.4.1) – over 81% in 2013.

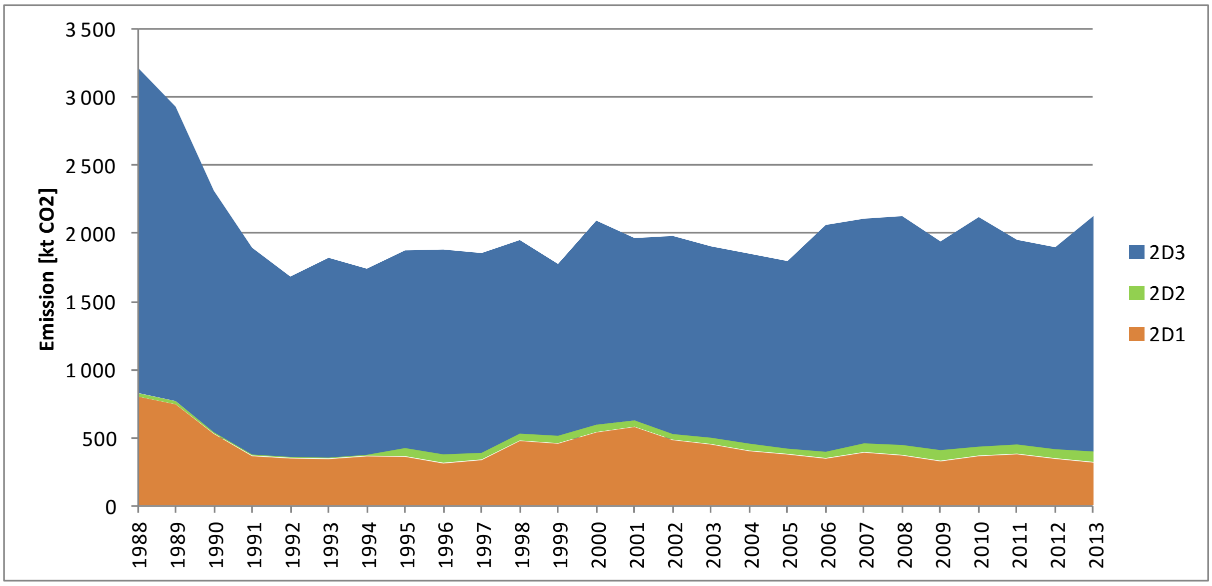

Figure 4.5.1. Emissions from *Non Energy Product from Fuels and Solvent Use* sector in years 1988-2013 according to subcategories

4.5.2. Methodological issues

4.5.2.1. Lubricant use (CRF sector 2.D.1)

Associated CO_2 emissions concerning non-energy use of lubricant were estimated according to the method described in chapter 3.2.1.

4.5.2.2. Paraffin wax use (CRF sector 2.D.2)

Associated CO_2 emissions concerning non-energy use of paraffin wax were estimated according to the method described in chapter 3.2.1.

4.5.2.3. Other (CRF sector 2.D.3)

Category contain emission from solvent use and associated CO_2 emissions concerning non-energy use of fuels.

4.5.2.3.1. *Solvent use*

There are no sources from sub-category Solvent Use , which are identified as key sources.

The use of solvents is one of the main sources of NMVOC emissions and is associated with following processes:

- Paint application(SNAP 0601),
- Degreasing and dry cleaning (SNAP 0602),
- Chemical Products, Manufacture and Processing(SNAP 0603),
- Other solvents use(SNAP 0604).

The GHG emission sources in Solvent and Other Product Use sector involve:

- CO_2 emission from the following activities: Paint application, Degreasing and dry cleaning, Chemical Products, Manufacture and Processing and Other solvents use (Fat edible and non-edible oil extraction, Other non-specified),

Emission trend is consistent with the submission to:

- the European Union in the framework of reporting to the Directive 2001/81/EC of European Parliament and the Council of 23 October 2001 on national emission ceilings for certain pollutants
- the Convention on Long-range Transboundary Air Pollution (LRTAP).

According to the new 2006 IPCC guidelines N2O emissions from the use of N_2O for anesthesia is reported sub-category 2.G.3.

Total emission of GHG in this sector in 2013 was estimated to 651 kt CO_2. This emission decreased by 26% from year 1988 to 2013 (Figure 4.5.2). This is mostly due to decrease of using solvents in paint applications (by 33%) (Figure 4.5.3).

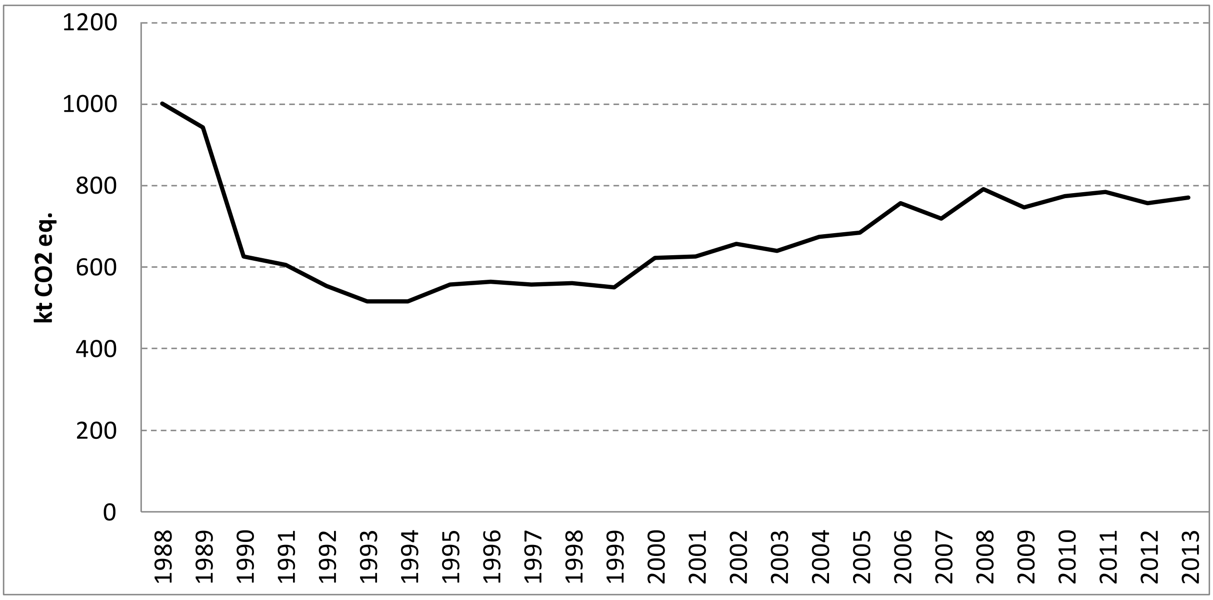

Figure 4.5.2. GHG emission from Solvent and Other Product Use sector in 1988-2013.

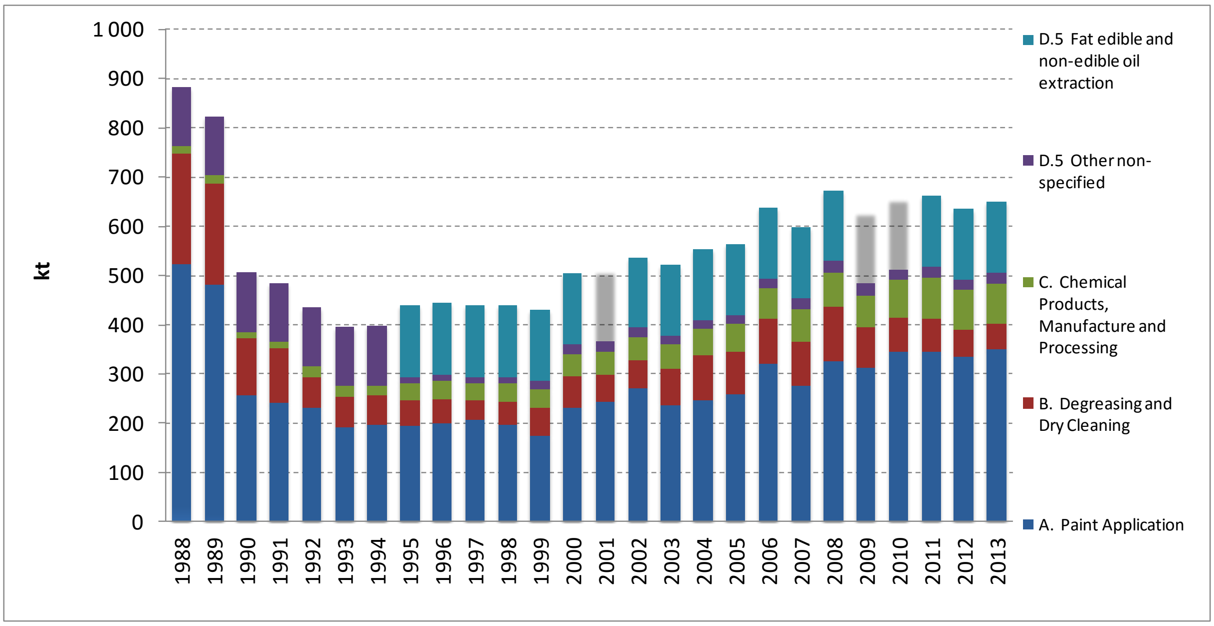

Figure 4.5.3. CO_2 emission from Solvent and Other Product Use sector in 1988-2013.

Paint application

Paint application includes the following processes:

- cars production,
- car repair,
- use in households,
- coil coating,
- ship building,
- wood painting,
- other applications in industry,
- other non-manufacturing applications.

In the national inventory all of these processes are considered jointly with the division on the use of paints based on organic solvents and water-based paints.

Calculations of CO_2 emissions within Sector 3., using the common methodology, were carried out on the basis of results of NMVOC emissions [EMEP 2013]. 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 the following formula:

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

where:

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

Degreasing and dry Cleaning

Degreasing and dry cleaning include:

- degreasing metals,
- chemical cleaning,

- production of electronic components,
- other industrial cleaning processes.

In the Polish national inventory the first two processes were considered. It was assumed that "degreasing metals" include also solvents used for other purposes in industrial processes, which were not included separately in the inventory report for NMVOC (eg., electronic industry, textile, leather, etc.).

Chemical products, manufacture and processing

The national inventory includes emissions from the following processes:

- polyvinylchloride processing,
- polystyrene foam processing,
- rubber processing,
- pharmaceutical products manufacturing,
- paints manufacturing.

Other solvents use

The category "Other use of solvents" includes following processes:

- solvents in the household use (except paint)
- oil extraction (production of fats and oils)

4.5.2.3.2. Other non-energy use of fuels

Associated CO_2 emissions concerning non-energy use of fuels were estimated according to the method described in chapter 3.2.1. List of fuels and CO_2 emission is presented on figure 4.5.4

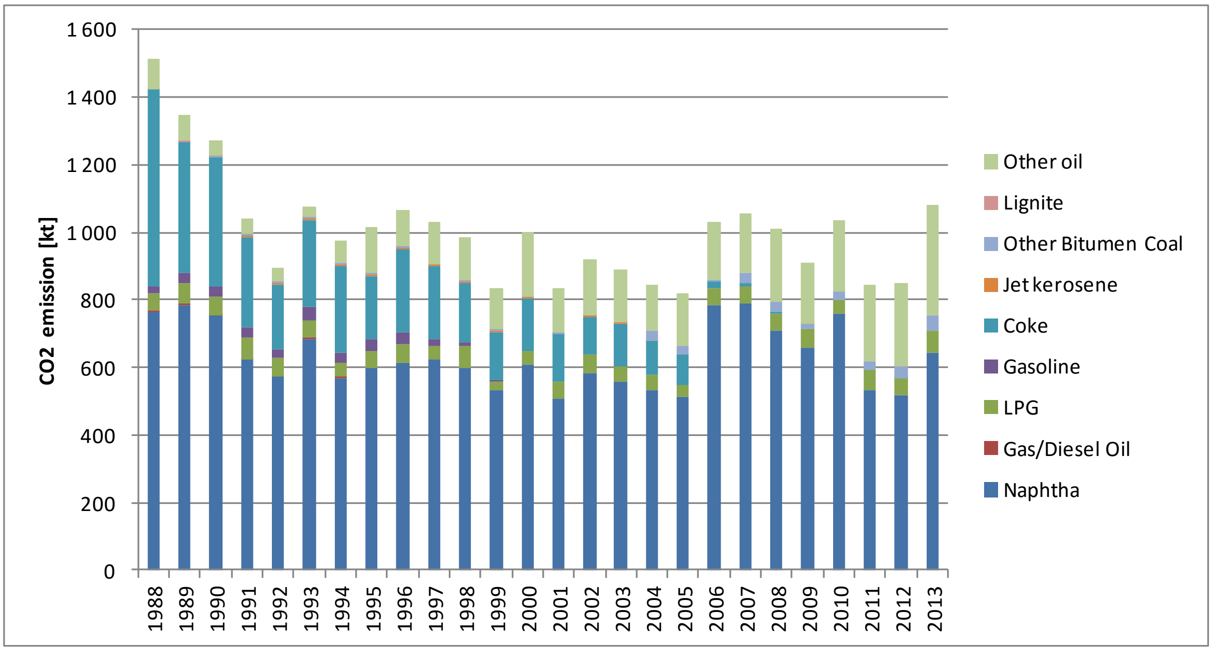

Figure 4.5.4. Associated CO_2 emission in 1988-2013.

4.5.3. Uncertainties and time-series consistency

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4.5.4. Source-specific QA/QC and verification

Activity data concerning solvent use for period 1988-1994 was taken from Institute for Ecology of Industrial Areas which performs its own QA/QC activities.
For years 1995-2013 the activity data was estimated by the National Centre for Emission Managment (KOBiZE) based on data from Central Statistical Office and emission factors developed by the Institute for Ecology of Industrial Areas (IETU).
Comparison of methodology applied with other countries experiences was made[Estimation of national greenhouse gas emissions from the sector 3. Solvent and other product use. KCIE 2004] Calculations were examined with focus on formulas, units and trends consistency. Generally QC procedures follow QA/QC plan presented in Annex .

4.5.5. Source-specific recalculations

Recalculations for the year 2011 and 2012 was made as result of the correction of activity data. In table 4.5.1. are shown emission changes for subcategory - Chemical products, manufacture and processing (3.C) .

Table 4.5.1. Emission changes for subcategory Chemical products, manufacture and processing.

Difference	1988	1989	1990	1991	1992	1993	1994	1995
kt CO_2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
kt CO_2 eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
kt CO_2 eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40
%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40
	2012							
kt CO2 eq	0.40							
%	0.40							

4.5.6. Source-specific planned improvements

Any possible improvements will be related to further development of NMVOCs emissions methodology.

4.6. Electronic industry (CRF sector 2.E)

Not occurring.

4.7. Product uses as substitutes for ODS (CRF sector 2.F)

4.7.1 Source category description

Emissions of HFC, PFCs and SF_6 are estimated based on official activity data available at public statistics (GUS) 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 [Mąkosa 2012, Popławska-Jach 2015].

To assure transparency and completeness of the description in NIR it was decided to group description of all f-gases emission in this chapter. Methodologies described here were divided into 3 groups referring to the substance: HFCs, PFCs and SF_6.

Besides dominating category in terms of f-gases emission 2.F Product uses as substitutes for ODS – this chapter also includes description of **PFC emission** from IPCC category **2.C.3 Aluminium production** described under PFC section below.

Due to application of new category classification this chapter also includes description of **SF_6 emissions** from IPCC category **2.G.1 Electrical equipment.**

Other notable changes in methodology for 2015 submission are:
- use of updated global warming potentials (GWPs) from the IPCC 4th Assessment Report
- the reporting of new greenhouse gases (GHGs) including NF_3 and the new species of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

4.7.2 Methodological issues

NF_3

Since 2015 mandatory reporting was extended to include NF3, which is used in the manufacture of semiconductors, liquid crystal display (LCD) panels and photovoltaics. Other application of NF_3 are hydrogen fluoride and deuterium fluoride lasers.

During preparation of submission 2015 Polish market was investigated to identify potential sources of NF_3. During this process **no activity resulting in NF_3 emission was identified** and all potential sources are not occurring in Poland. This information was verified and confirmed by information reported by producers and suppliers of f-gases in Poland. Therefore NF_3 emission from all potential categories was reported as not occurring.

HFC

The national GHG inventory covers the following emission sources for HFCs:

- 2.F.1 Refrigeration and air-conditioning equipment (dominating category in terms of emission volume),
- 2.F.2 Foam blowing agents,
- 2.F.3 Fire protection,

- 2.F.4 Aerosols (technical and medical),
- and 2.F.5 Solvents.

2.F.1 Refrigeration and air-conditioning equipment
For transparency reasons and due to importance of the emissions from the refrigeration and air-conditioning equipment (2.F.1) – the main assumptions for estimates were described with more details below. Activity data and assumptions made within the sector were revised in 2015 (described in recalculation chapter of this section). Amount of input in each equipment type was given in table 4.7.1.

Methodology used for estimates of f-gases is IPCC 2006 Guidelines, which is mandatory since submission 2015. Applying new guidelines didn't affect estimated emission values directly, because this methodology was used before, however some emissions were allocated differently than in submission 2014 to reflect new classification (electrical equipment, etc).

Table 4.7.1. Amount of input in each equipment type

Equipment type	F-gas input per piece of equipment [kg]
Domestic refrigerators	0.285
Domestic freezers	0.285
Commercial refrigeration	3.1
Stationary air-conditioning	3.0
Passenger cars with air-conditioning	1.2
Public transport	1.5
Trucks	1.5
Trailers	5.5
Wagon, tank, cold rooms	5.5
Cargo railway cars	5.5
Tram cars	5.5
Equipment used for refrigeration	5.5

Estimates of the amount of each gas in selected equipment type assumption on shares of gases (or their mixes) were applied (see table 4.7.2. and 4.7.3 below).

Table 4.7.2. Share of gases and mixes for commercial refrigerators

Gas or mix	Percent of mix	HFC-125 amount	HFC-134a amount	HFC-143a amount	HFC-32 amount
407c	10	4	4	2	0
410a	70	35	0	0	35
HFC-134a	20	0	20	0	0
Amount of gas applied to estimates		38	25	2	35

Table 4.7.3. Share of gases and mixes for stationary air-conditioning

Gas or mix	Percent of mix	HFC-125 amount	HFC-134a amount	HFC-143a amount	HFC-32 amount
404a	30	12	1	17	0
507a	40	20	0	20	0
HFC-134a	30	0	30	0	0
Amount of gas applied to estimates		35	30	35	0

The final assumptions on percent of refrigeration equipment where HFC-32, 125, 134a and 143a were used was shown in tables 4.7.4-4.7.7 below.

Table 4.7.4. Percent of equipment in which HFC-32 was used

Type of equipment	Percent of equipment in which HFC-32 was used																		
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Stationary air-conditioning	0	0	0	0	0	25	30	35	35	35	35	35	35	35	35	35	35	35	35

Table 4.7.5. Percent of equipment in which HFC-125 was used

Type of equipment	**Percent of equipment in which HFC-125 was used**																		
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Commercial air-conditioning	0	0	5	10	15	20	20	25	30	25	30	30	30	30	29	28	27	27	27
Stationary air-conditioning	0	0	0	0	0	25	30	35	35	35	38	38	38	38	38	38	38	38	38

Table 4.7.6. Percent of equipment in which HFC-134a was used

Type of equipment	**Percent of equipment in which HFC-134a was used**																		
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Domestic refrigerators	50	70	100	100	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Domestic freezers	50	70	100	100	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Commercial air-conditioning	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Stationary air-conditioning	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Passenger cars with air-conditioning	15	20	25	30	40	50	60	60	70	70	80	80	90	90	100	100	100	100	100
Public transport	10	10	20	25	30	30	30	30	40	40	40	50	50	50	60	60	60	60	60
Trucks	0	0	15	20	25	25	25	30	30	30	0	40	40	50	50	50	50	50	50
Trailers	0	0	0	0	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Wagon, tank, cold rooms	0	0	0	0	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Cargo railway cars	0	0	0	0	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Tram cars	0	0	0	0	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Equipment used for refrigeration	0	0	0	0	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25

Table 4.7.7. Percent of equipment in which HFC-143a was used

Type of equipment	**Percent of equipment in which HFC-143a was used**																		
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Commercial air-conditioning	0	0	7	15	20	25	25	35	35	35	40	40	40	40	39	39	38	38	38
Stationary air-conditioning	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2

Table 4.7.8 shows aggregated national total HFCs emissions over 1995-2013 expressed in CO_2 equivalents and HFCs emission in sub-sector: 2.F.1 Refrigeration and Air Conditioning Equipment. Prior to 1995, HFCs were not used in Poland.

Table 4.7.8. HFCs emissions in 2.F.1 Refrigeration and Air Conditioning Equipment and in Total

Year	HFCs emissions in 2.F.1 Refrigeration and Air Conditioning Equipment [t CO_2 eq.]	Total HFCs emissions [t CO_2 eq.]
1995	79 826	97 344
1996	145 780	228 406
1997	248 325	373 929
1998	341 999	462 228
1999	552 814	673 377
2000	1 628 123	1 739 188
2001	2 149 358	2 323 031
2002	2 938 523	3 137 013
2003	3 959 183	4 059 795
2004	3 933 788	4 335 108
2005	4 606 273	5 317 717
2006	5 136 452	6 074 688
2007	6 090 988	6 993 204
2008	6 724 109	7 415 192
2009	7 820 372	8 366 716
2010	7 999 022	8 304 030
2011	8 694 074	8 992 691
2012	8 950 127	9 234 006
2013	9 278 767	9 606 779

2.F.2 Foam blowing agents

Activity data for this application was collected during the questionnaire survey of importers, suppliers and end users of HFCs. Analysis of the Polish market allowed to identify use of HFC-134a, HFC-227ea, HFC-365mfc, HFC-245ca and HFC-152a as foam blowing agents. Following IPCC 2006 GLs it was assumed that HFCs applied to open cells foam are released in first year of use. Regarding release ratio from hard foam (closed pores) applications it was assumed as follows:

1) EF for HFC-134a: new product = 95% first year; 2.5% next years
2) EF for HFC-227ea: new product = 10% first year; 4.5% next years
3) EF for HFC-365mfc: new product = 25% first year; 1.5% next years
4) EF for HFC-245ca: new product = 25% first year; 1.5% next years
5) EF for HFC-152a: new product = 95% first year; 2.5% next years

Results of the emission estimates for foam blowing agents were presented in table 4.6.9 below.

Table 4.7.9. HFCs emissions for categories: 2.F.2 Foam blowing agents, 2.F.3 Fire protection; 2.F.4 Aerosols and 2.F.5 Solvents [t CO2 eq.]

Year	HFCs emissions			
	2.F.2 Foam blowing agents [t CO_2 eq.]	2.F.3 Fire protection [t CO_2 eq.]	2.F.4 Aerosols [t CO_2 eq.]	2.F.5 Solvents [t CO_2 eq.]
1995	NO	NO	17 517.50	NO
1996	NO	42.92	82 582.50	NO
1997	NO	121.28	125 482.50	NO
1998	NO	234.04	119 994.88	NO
1999	11 440.00	1 408.16	107 714.75	NO
2000	11 440.00	1 580.13	98 044.38	NO
2001	11 440.00	3 516.73	158 715.70	NO
2002	41.54	3 007.98	195 440.96	NO
2003	1 561.25	9 096.71	89 954.15	NO
2004	9 707.19	7 958.58	383 654.70	NO
2005	318 273.49	11 930.20	380 716.05	524.04
2006	352 563.23	15 114.15	569 558.68	1 000.44
2007	395 357.23	21 341.18	484 877.02	640.40
2008	347 946.94	25 106.78	317 701.31	328.00
2009	245 585.79	30 143.15	269 631.50	984.00
2010	138 902.45	40 387.49	123 484.47	2 233.68
2011	123 563.30	47 156.03	125 112.44	2 785.54
2012	101 428.57	54 565.20	126 267.80	1 617.86
2013	141 240.36	61 406.77	124 954.90	410.00

NO – emission not occurring

2.F.3 Fire protection

Activity data for this application was collected during the same questionnaire survey of importers, suppliers and end users of HFCs as for categories 2.F.1 and 2.F.2. Analysis of the Polish market allowed to identify use of HFC-227ea and HFC-236fa (since 1996). Regarding release ratio from fire protection equipment it was assumed as follows:

1) EF for HFC-227ea: new product = 1% first year; 5% next years
2) EF for HFC-236fa: new product = 1% first year; 5% next years

Results of the emission estimates for foam blowing agents were presented in table 4.6.9 above.

2.F.4 Aerosols

As mentioned in description of categories above activity data for this application of technical and medical aerosols was collected during the questionnaire survey of importers, suppliers and end users of HFCs. Analysis of the Polish market allowed to identify use of HFC-134a (since 1995). Release ratio for technical and medical aerosols was assumed as follows:

1) EF for HFC-134a: import for production of technical aerosols = 50% first year; 50% next year
2) EF for HFC-134a: import of technical aerosols = 50% first year; 50% next year
3) EF for HFC-134a: import for production of medical aerosols = 100% first year
4) EF for HFC-134a: import of medical aerosols = 100% first year

Results of the emission estimates for foam blowing agents were presented in table 4.6.9 above.

2.F.5 Solvents

As mentioned in description of categories above activity data for this application of technical and medical aerosols was collected during the questionnaire survey of importers, suppliers and end users of HFCs. Analysis of the Polish market allowed to identify use of HFC-365mfc and HFC-43-10mee (since 2005). Release ratio for solvents category was assumed as follows:

1) EF for HFC-365mfc: 50% first year; 50% next year
2) EF for HFC-43-10mee: 50% first year; 50% next year

Results of the emission estimates for foam blowing agents were presented in table 4.6.9 above.

PFC

The national GHG inventory covers the following emission sources for PFCs: fire extinguishers (C_4F_{10}) and primary aluminium production (CF_4, C_2F_6).

2.C.3 Aluminium production

The dominating source of emission of PFC gases in Poland is IPCC sector 2.C.3 Aluminium production. Activities on aluminium production were taken from [GUS 2010b]. *Tier 1* method and the country specific emission factors were used for estimation of PFC emissions:

for CF_4 EF = 0.373 kg/Mg aluminium produced

for C_2F_6 EF = 0.027 kg/Mg aluminium produced

Country specific emission factors given above are based on plant specific reporting of installations under EU ETS.

Table 4.7.10 shows aggregated national total PFCs emissions over 1988-2013 expressed in CO_2 equivalents and PFCs emission in sub-sector: 2.C.3 Aluminium Production. More details on activity in this category was provided in chapter describing CO_2 emission from aluminium production.

2.F.3 Fire protection

According to historical data obtained from producers and importers/exporters first use of PFCs (C_4F_{10}) in fire extinguishers began in 1996. Prior to 1996, the only known source of PFCs was primary aluminium production. On basis of IPCC 2006 GL applied emission factors for C_4F_{10} for import and use of equipment were 1% and 5% respectively. Formula used for estimating amount of substance in use in current year (n+1) is presented below:

in use n+1 = in use n - emission from in use n + (import n+1 - emission from import n+1)

where: n - year

Table 4.7.10. PFCs emissions in 2.C.3 Aluminium production and 2.F.3 Fire protection compared to national total PFCs emission

Year	PFCs emissions in 2.C.3 Aluminium Production [t CO_2 eq.]	PFCs emissions in 2.F.3 Fire protection [t CO_2 eq.]	Total PFCs emissions [t CO_2 eq.]
1988	147 258	NO	147 258
1989	147 508	NO	147 508
1990	141 870	NO	141 870
1991	141 311	NO	141 311
1992	134 630	NO	134 630
1993	144 857	NO	144 857
1994	152 778	NO	152 778
1995	171 969	NO	171 969
1996	160 231	843	161 074

Year	PFCs emissions in 2.C.3 Aluminium Production [t CO_2 eq.]	PFCs emissions in 2.F.3 Fire protection [t CO_2 eq.]	Total PFCs emissions [t CO_2 eq.]
1997	165 446	7 915	173 361
1998	167 155	7 703	174 858
1999	157 299	11 414	168 713
2000	161 499	15 181	176 680
2001	168 489	28 855	197 343
2002	181 449	25 881	207 330
2003	176 635	24 443	201 078
2004	181 853	23 221	205 074
2005	165 347	22 060	187 407
2006	172 620	20 957	193 577
2007	164 721	19 909	184 630
2008	144 203	18 914	163 116
2009	NO	17 968	17 968
2010	NO	17 070	17 070
2011	NO	16 216	16 216
2012	NO	15 405	15 405
2013	NO	14 635	14 635

NO – emission not occurring

SF_6

As concerns SF_6 the national GHG inventory covers the following emission sources: electrical equipment and magnesium foundries.

2.C.4 Magnesium casting

Data on Mg casting were obtained from yearbooks of *Modern Casting*. The first use of SF_6 in magnesium foundries was identified in 1994. Due to unavailability of the data on magnesium in national statistics and other external data sources for recent years it was decided to use last verified activity data available (2007). Emission factors referring to amount of cast per year was used for calculation of SF_6 emission:

Mg casting EF = 1kg SF_6 /Mg of the amount of alloy used to produce casting

Amount of alloy used to produce casting is based on amount of magnesium production per year taking into account yield factor 55%.

Table 4.7.11 includes the activity data used for estimation SF_6 emissions over the period: 1988-2013.

2.G.1 Electrical equipment

Applied emissions factors were based on methodology provided in IPCC 2006 GL. Amounts of equipment on the market was assessed on the basis of data provided by producers and importers/exporters.

Electrical equipment manufacturing EF = 0.06 Mg/Mg of SF_6 used
Electrical equipment use EF = 0.05 Mg/Mg SF6 in use (1995), EF = 0.02 Mg/Mg (since 1996)

Table 4.7.10 presented below includes the activity data used for estimation SF_6 emissions over the period: 1994-2013.

Table 4.7.11. Activity data used for estimation of SF_6 emissions in 2.C.4 Magnesium production and 2.G.1 Electrical equipment

Activity characteristic for the source sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2.C. Metal production										
4. Magnesium production – amount of alloy used to produce casting [Mg]	320	400	400	345	291	236	181	127	72	46
2.G Consumption of HFC, PFC and SF_6										
1. Electrical equipment – amount of SF_6 in use [Mg]		11.00	14.02	17.05	20.07	23.10	26.12	28.70	32.04	33.75
1 Electrical equipment – amount of imported SF_6 [Mg]		0.00	0.60	0.60	2.00	2.33	2.66	3.30	4.16	2.50

Activity characteristic for the source sector	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2.C. Metal production										
4. Magnesium production – amount of alloy used to produce casting [Mg]	20	30	65	100	100	100	100	100	100	100
2.G Consumption of HFC, PFC and SF_6										
1. Electrical equipment – amount of SF_6 in use [Mg]	36.45	40.57	46.23	48.63	51.32	55.80	57.97	61.50	64.72	64.72
1. Electrical equipment – amount of imported SF_6 [Mg]	3.59	5.16	6.89	3.54	3.89	5.86	3.50	4.99	4.73	4.73

Table 4.7.12 shows aggregated national total SF_6 emissions over 1994-2013 in tones compared to SF_6 emission in most important sub-sector: 2.G.1 *Electrical Equipment*. There is no data available on SF_6 use prior to 1994.

Table 4.7.12. SF_6 emissions in 2.C.4 Magnesium foundries and 2.G.1 Electrical equipment compared to national total emission

Year	SF_6 emissions in 2.C.4 Magnesium [t]	SF_6 emissions in 2.G.1 Electrical Equipment [t]	Total SF_6 emissions [t]
1994	0.582	NO	0.582
1995	0.727	0.550	1.277
1996	0.727	0.316	1.044
1997	0.628	0.377	1.005
1998	0.528	0.521	1.050
1999	0.429	0.602	1.031
2000	0.330	0.682	1.012
2001	0.230	0.772	1.003
2002	0.131	0.890	1.021
2003	0.084	0.825	0.909
2004	0.036	0.944	0.981
2005	0.055	1.121	1.175
2006	0.118	1.338	1.456
2007	0.182	1.185	1.367
2008	0.182	1.260	1.442
2009	0.182	1.467	1.649
2010	0.182	1.369	1.551
2011	0.182	1.530	1.711
2012	0.182	1.578	1.760
2013	0.182	1.535	1.717

NO – emission not occurring

4.7.3. Uncertainties and time-series consistency

Simplified analysis were made for industrial gases HFC, PFC and SF6, where uncertainty assumptions were applied directly to emission values of each pollutant. Due to lack of available information, simplified approach has to be used and country recognizes need of additional analysis in this sector as planned improvement for future inventories. More details on uncertainty assessment of whole inventory are given in annex 8.

	HFC Emission [Gg of CO_2 eq.]	PFC Emission [Gg of CO_2 eq.]	SF_6 Emission [Gg of CO_2 eq.]	HFC Emission uncertainty [%]	PFC Emission uncertainty [%]	SF_6 Emission uncertainty [%]	HFC Emission absolute uncertainty [Gg of CO_2 eq.]	PFC Emission absolute uncertainty [Gg of CO_2 eq.]	SF_6 Emission absolute uncertainty [Gg of CO_2 eq.]
TOTAL	7,700.22	41.81	42.06	48.3%	76.6%	90.3%	3,719.60	41.81	37.72
2. Industrial Processes	**7,700.22**	**41.81**	**42.06**	**48.3%**	**76.6%**	**90.3%**	**3,719.60**	**41.81**	**37.72**
C. Metal Production		**29.63**	**4.35**		**100.0%**	**100.0%**		**29.63**	
3. Aluminium Production		29.63	4.35		100.0%	100.0%		29.63	4.35
F. Consumption of Halocarbons and SF6	**7,700.22**	**12.17**	**37.72**	**48.3%**	**100.0%**	**100.0%**	**3,719.60**	**12.17**	**37.72**
1. Refrigeration and Air Conditioning Equipment	7,437.48			50.0%			3,718.74		
2. Foam Blowing	105.33			50.0%			52.67		
3. Fire Extinguishers	44.24	12.17		50.0%	100.0%		22.12	12.17	
4. Aerosols/ Metered Dose Inhalers	111.89			50.0%			55.94		
5. Solvents	1.28			50.0%			0.64		
8. Electrical Equipment			37.72			100.0%			37.72

4.7.4. Source-specific QA/QC and verification

See chapter 4.2.4

4.7.5. Source-specific recalculations

According to 2006 IPCC Guidelines new GWP values from IPCC Assessment Report were introduced. Some assumptions for estimating HFCs emission from 2.F.1.d Transport refrigeration were revised to reflect new data obtained from the market.

Example results of the recalculations for 2012 were presented in table below:

kt of CO2 eq.	HFCs	PFCs	SF6
Previous sub.	7 700.22	41.81	42.06
Latest sub.	9 234.01	15.41	40.13
Difference	1 533.79	-26.40	-1.93
%	19.9%	-63.1%	-4.6%

4.7.6. Source-specific planned improvements

Continuing ongoing project on revision and extending dataset for f-gases. Improving description of methodology and assumptions in NIR. Further analysis of filling amounts in equipment containing HFCs, PFCs and SF_6.

4.8. Other product manufacture and use (CRF sector 2.G)

See chapter 4.7.2.

5. AGRICULTURE (CRF SECTOR 3)

5.1. Overview of sector

The GHG emission sources in agricultural sector involve: enteric fermentation from domestic livestock (CH_4), manure related to livestock management (CH_4 and N_2O), agricultural soils (N_2O), liming and urea application (CO_2) and agricultural residue burning (CH_4 and N_2O). Emission categories like: rice cultivation and prescribed burning of savannas do not occur in Poland and are therefore not reported.

Following categories from sector 4 have been identified as key sources (excluding LULUCF):

IPCC Category Code	IPCC Source Categories	Greenhouse Gas	Level Assessment	Trend Assessment
3.A	Enteric Fermentation	CH_4	3.00%	
3.B	Manure Management	CH_4	0.50%	
3.D	Agricultural Soils	N_2O	2.80%	
3.D	Agricultural Soils	N_2O	0.70%	
3.G	Liming	CO_2		+

Share of these categories in total Poland's GHG emissions is ca. 7.00%.

Total emissions of GHG in Agriculture sector presented as carbon dioxide equivalent amounted to 30 100 kt in 2013 and decreased since 1988 by nearly 38%. Strong decrease in emissions in Poland occurred after 1989 when economic transformation began shifting from centrally planned economy to the market one (Fig. 5.1). The cost-effectiveness of agricultural production deeply changed then – up to 1989 agricultural production was generally subsidised on the state level. Since 1990 the prices for agricultural products as well as for agricultural means of production (like mineral fertilisers or machines) became the market ones and the subsidies were cut off. Deterioration of macroeconomic conditions for agricultural production in early 1990-ties during the restructuring of the state economy triggered changes in structure of agricultural farms since 1989. The big state agricultural farms became economically ineffective in a new market conditions so they were constantly eliminated. Also production of many small family farms became cost-ineffective so for instance the process of leaving the animal production by small farms started. On the other hand - gradual development of private and collective farms breeding large livestock herds begun. Still almost 70% of Polish farms are smaller than 5 hectares.

Dramatic decrease of livestock numbers was observed after 1989 – the cattle population decreased almost by half − from over 10 million in 1988 to less than 6 million since 2002. Since 2002, just before accessing Poland to the European Union (in 2004), population of dairy cattle stabilized when the limits of milk production were known in advance what stabilized the milk market. In the same time sheep population drop by 94% (from over 4 million in 1988 up to 0.22 million in 2013). Especially sheep breeding became unprofitable − the wool up to 1989 was highly subsidised so sheep farming was related mostly to wool production and over 70% of sheep farms' income was related to wool sale. Small domestic demand for sheep meat also caused retreat from sheep breeding.

Additional reasons for decreasing the agricultural production in 1990-ties were export limitation for Eastern markets, deterioration of relationship between prices for agricultural products and prices for means of production as well as increased competition of imported food from Western Europe. Since 2004, when Poland joined the European Union, the key factor influencing the Polish agriculture and rural areas is the EU Common Agricultural Policy aiming at improvement of productivity through introducing technical progress and stabilisation of agricultural market.

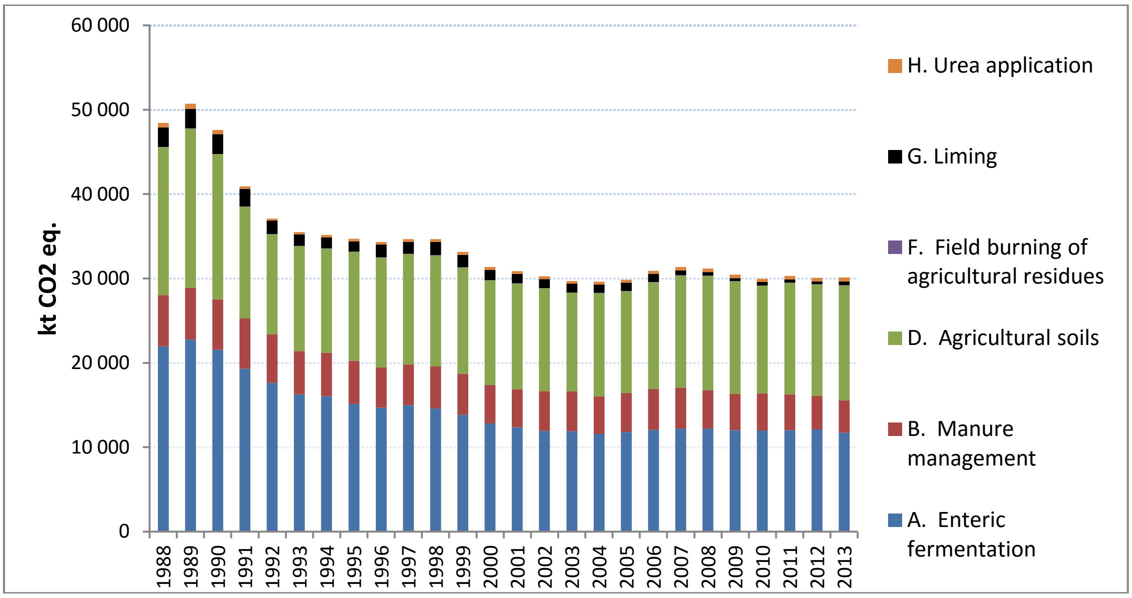

Figure 5.1. Total greenhouse gas emissions from the Polish agriculture in 1988-2013 presented in CO_2 equivalent

In 2013, in relation to the previous year, gross agricultural output increased by 3.7% due to higher livestock production (by 2.1%), as well as increase crop production (by 5%). Year 2013 was following year in which market conditions of agricultural production have worsened, which had a negative impact on profitability of agricultural activity. The growth rate of the average prices of goods and services purchased for the current agricultural production and investment purposes was higher than the growth rate of prices of agricultural products sold by individual farmers. [GUS R4 2014].

Carbon dioxide emissions in Agriculture sector in 2013 come from liming and urea application – both close to 50% (Fig. 5.2).

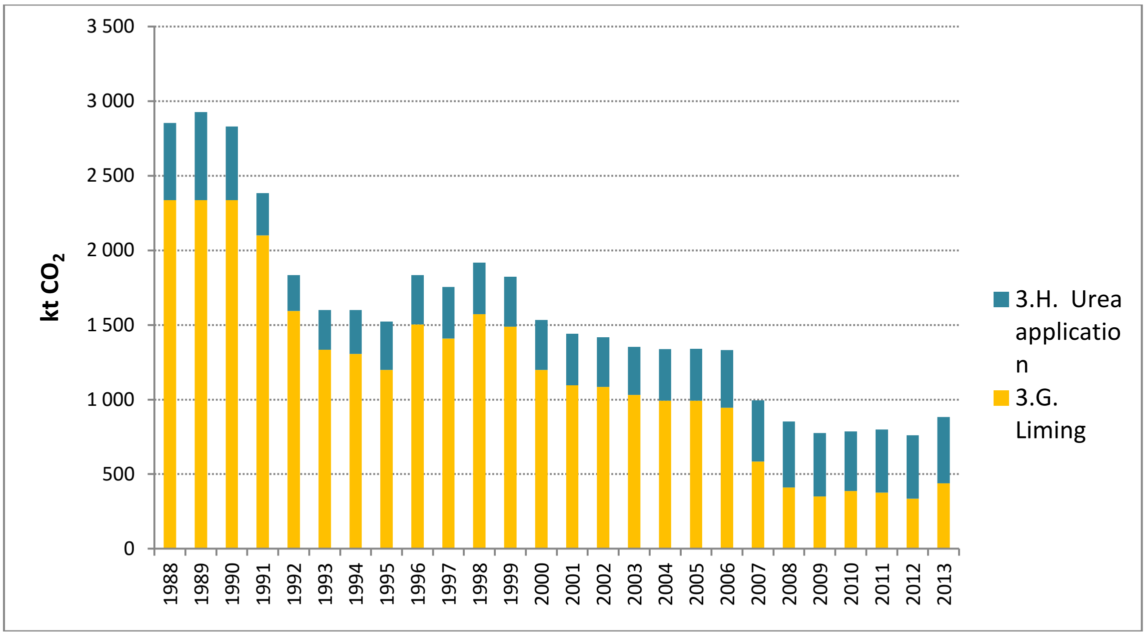

Figure 5.2. Carbon dioxide emissions from the Polish agriculture in 1988-2013 according to subcategories

As relates to methane emissions most of them originated from enteric fermentation (86.2%) and about 13.6% is related to manure management in 2013. Share of field burning of agricultural residues represent only 0.2% of emissions (Fig. 5.3).

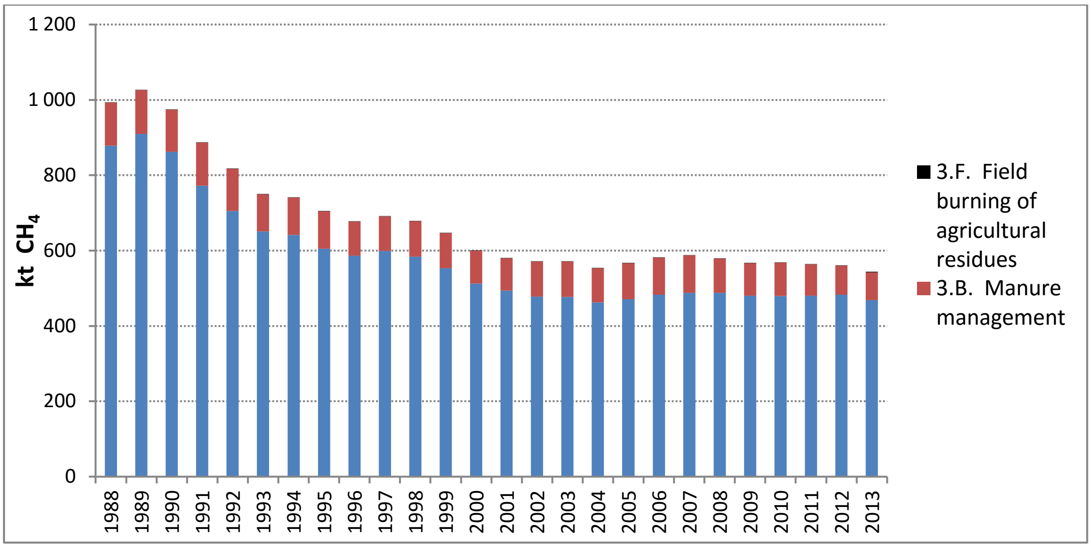

Figure 5.3. Methane emissions from the Polish agriculture in 1988-2013 according to subcategories

As concerns the nitrous oxide emissions, the main source of emissions in 2013 is agricultural soils responsible for 87.2% while manure management – for 12.8%. Emissions from field burning of agricultural residues are negligible (0.1%) (Fig. 5.4).

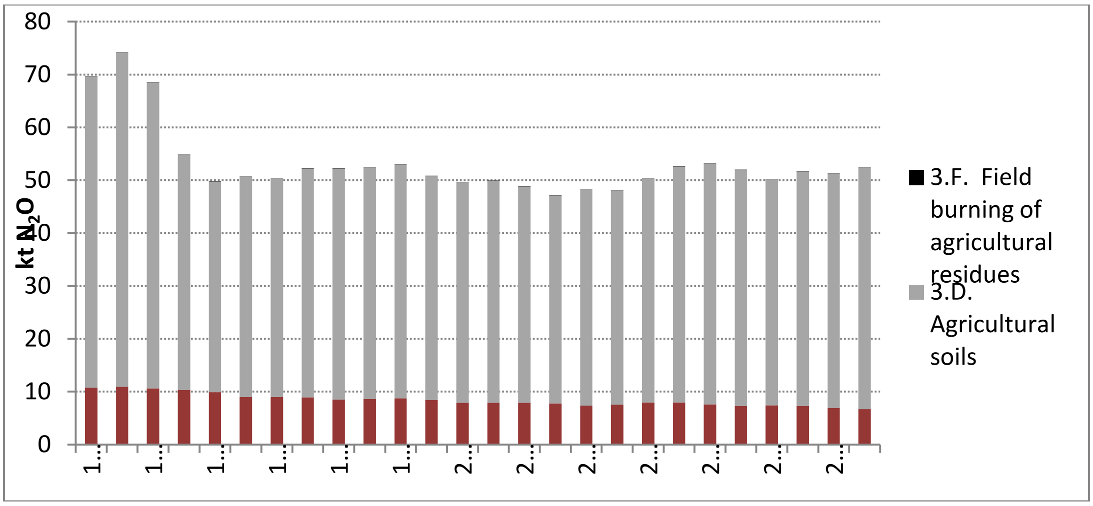

Figure 5.4. Nitrous oxide emissions from the Polish agriculture in 1988-2013 according to subcategories

5.2. Enteric Fermentation (CRF sector 4.A)

5.2.1. Source category description

CH_4 emissions from animals' enteric fermentation in 2013 amounted to 468.5 kt CH_4 and decreased since 1988 by 46.7%. Majority of CH_4 emissions in this subcategory, more than 95%, are related to cattle breeding. The main driver influencing CH_4 emissions decline from enteric fermentation is the decrease of livestock population since 1988. The biggest change over time relates to the sheep breeding where cut of emissions exceeds 95% in 1988-2013. At the same time CH_4 emission reduction for dairy cattle amounted for 45%.

Table 5.1. Trends in CH_4 emissions from enteric fermentation in 1988-2013 [kt CH_4]

Year	Dairy cattle	Non-dairy cattle	Sheep	Goats	Horses	Swine	Total
1988	525.2	268.7	35.0	0.9	18.9	29.4	878.1
1989	548.5	279.5	35.3	0.9	17.5	28.3	909.9
1990	532.1	249.8	33.3	0.9	16.9	29.2	862.2
1991	487.7	207.7	25.9	0.9	16.9	32.8	771.9
1992	447.5	192.9	15.0	0.9	16.2	33.1	705.6
1993	418.3	178.0	10.1	0.9	15.1	28.3	650.8
1994	406.6	186.3	7.0	0.9	11.2	29.2	641.2
1995	375.2	181.1	5.7	0.9	11.4	30.6	604.9
1996	365.5	178.5	4.4	0.9	10.2	26.9	586.5
1997	371.3	185.3	3.9	0.9	10.0	27.2	598.7
1998	375.9	164.2	3.6	0.9	10.1	28.8	583.4
1999	360.7	150.7	3.1	0.9	9.9	27.8	553.1
2000	329.8	143.7	2.9	0.9	9.9	25.7	512.9
2001	324.4	130.1	2.7	0.9	9.8	25.7	493.6
2002	310.4	129.6	2.8	1.0	5.9	27.9	477.6
2003	314.3	124.7	2.7	1.0	6.0	27.9	476.6
2004	304.6	123.4	2.5	0.9	5.8	25.5	462.8
2005	306.4	128.7	2.5	0.7	5.6	27.2	471.1
2006	310.5	134.9	2.4	0.7	5.5	28.3	482.4
2007	310.8	141.0	2.7	0.7	5.9	27.2	488.3
2008	312.9	142.6	2.6	0.7	5.9	23.1	487.8
2009	302.2	148.1	2.3	0.6	5.4	21.4	480.0
2010	298.6	151.3	2.1	0.5	4.8	22.3	479.6
2011	297.5	155.4	2.0	0.6	4.6	20.3	480.3
2012	298.6	160.3	2.1	0.4	4.0	17.4	482.9
2013	286.7	159.4	1.8	0.4	3.7	16.5	468.5
share [%] in 2013	*61.2*	*34.0*	*0.4*	*0.1*	*0.8*	*3.5*	*100.0*
change [%] 1988-2013	*-45.4*	*-40.7*	*-94.9*	*-54.4*	*-80.3*	*-43.9*	*-46.6*

5.2.2. Methodological issues

Activity data for 2013, similarly to those for entire period since 1988, related to livestock population come from national statistics (Central Statistical Office) [GUS R1 2014]. Detail methodological information related to collecting data on livestock population is given in Annex 5.

Generally population of major livestock is available on an annual basis. As relates to goats population some lack of data is noticed for 1988-1995 and 1997, so data for 1996 was taken for the period 1988−1995 and for 1997 the average value for 1996 and 1998 was calculated. Since 1998 goats population is available on an annual basis. Trends of animal population (excluding cattle) in 1988–2013 is given in table 5.2.

Table 5.2. Trends of livestock population in 1988-2013

Years	Livestock population [thousands]				
	Sheep	Goats	Horses	Swine	Poultry
1988	4 377	179	1 051	19 605	234 605
1989	4 409	179	973	18 835	253 301
1990	4 159	179	941	19 464	216 341
1991	3 234	179	939	21 868	209 090
1992	1 870	179	900	22 086	192 880
1993	1 268	179	841	18 860	188 759
1994	870	179	622	19 466	194 661
1995	713	179	636	20 418	185 745
1996	552	179	569	17 964	203 873
1997	491	182	558	18 135	197 400
1998	453	186	561	19 168	197 193
1999	392	181	551	18 538	197 267
2000	362	177	550	17 122	194 126
2001	343	172	546	17 105	202 519
2002	345	193	330	18 629	193 996
2003	338	192	333	18 605	143 457
2004	318	176	321	16 988	128 835
2005	316	142	312	18 112	122 755
2006	301	130	307	18 881	122 068
2007	332	144	329	18 129	133 475
2008	324	136	325	15 425	141 615
2009	286	119	298	14 279	125 878
2010	258	108	264	14 865	140 997
2011	251	112	254	13 509	139 837
2012	267	90	222	11 581	127 130
2013	223	82	207	10 994	127 808

Trends of cattle population presented for specific subcategories is given in Table 5.3. In 1998 Central Statistical Office introduced methodological changes in collecting statistical data on cattle population (apart from dairy cattle). This change triggered some inconsistency in population trend of other cattle. So in response to recommendations of the Expert Review Team (ERT 2013) the non-dairy cattle trend for 1988-1997 was unified based on average share in 1998-2007 of specific age groups in relation to all non-dairy cattle population (italics).

Table 5.3. Trends of cattle population in 1988-2013 [thousands]

Years	Dairy cattle	Non-dairy cattle			
		young cattle < 1 year	young cattle 1-2 years	heifers > 2 years	bulls >2 years
1988	4806	*2879*	*2025*	*401*	*211*
1989	4994	*2996*	*2107*	*417*	*219*
1990	4919	*2678*	*1883*	*373*	*196*
1991	4577	*2227*	*1567*	*310*	*163*
1992	4257	*2069*	*1456*	*288*	*151*
1993	3983	*1910*	*1344*	*266*	*140*
1994	3863	*2001*	*1407*	*279*	*146*
1995	3579	*1946*	*1368*	*271*	*142*
1996	3461	*1919*	*1349*	*267*	*140*
1997	3490	*1992*	*1401*	*278*	*146*
1998	3542	1799	1235	280	99

Years	Dairy cattle	Non-dairy cattle			
		young cattle < 1 year	young cattle 1-2 years	heifers > 2 years	bulls >2 years
1999	3418	1647	1108	283	99
2000	3098	1572	1101	231	81
2001	3005	1472	973	210	74
2002	2873	1384	1084	142	50
2003	2897	1349	932	229	81
2004	2796	1309	916	246	86
2005	2795	1425	978	209	76
2006	2824	1428	1040	224	90
2007	2787	1473	1072	265	99
2008	2806	1502	1102	263	83
2009	2688	1472	1204	238	99
2010	2656	1457	1244	276	92
2011	2626	1481	1300	242	113
2012	2578	1469	1344	239	147
2013	2442	1409	1372	218	149

In the estimation of CH_4 emissions from enteric fermentation two types of approaches were applied – in case of horses, sheep, goats and swine, the IPCC *Tier 1* method was applied using default CH_4 Emission Factors [IPCC 2006, table 10.10] as given below:

Animal	Emission Factor [kg CH_4/head/year]
Horses	18.0
Sheep	8.0
Goats	5.0
Swine	1.5

Emissions from enteric fermentation of poultry and fur animals were not estimated as the IPCC do not provide the guidelines.

More detailed, IPCC *Tier 2* method, was applied in calculation of methane emissions from enteric fermentation from cattle responsible for over 95% of CH_4 emissions in this subsector. Here country specific emission factors were calculated based on specific gross energy intake (GE) values estimated for selected cattle sub-categories [IPCC 2006, equation 10.21]:

$$EF = (GE * Y_m/100 * 365 \text{ days/yr}) / (55.65 \text{ MJ/kg } CH_4)$$

where:

EF – emission factor, kg CH_4/head/yr

GE – gross energy intake, MJ/head/day

Ym – methane conversion rate which is the fraction of gross energy in feed converted to methane, %.

Gross energy intake (GE) was calculated [IPCC 2006, equation 10.16] separately for dairy cattle and for and non-dairy cattle disaggregated for: calves under 1 year, young cattle 1-2 years and other mature cattle (divided for heifers and bulls over 2 years). Parameters required for estimation of GE factor for dairy cattle like pregnancy [GUS R1 2014], milk production [GUS M 2014], percent of fat in milk [GUS R 2014] come from national statistics. Digestible energy (DE – expressed as a percent of gross energy) for cattle was estimated by the National Research Institute of Animal Production [Walczak 2006, 2013] and relates to genetic as well as feeding improvements of cattle breading throughout inventoried period. For dairy cattle DE varies from 58.6% in 1988 through 60% in 1995 up to 63.3% in 2013. As concerns non-dairy cattle, DE parameters are as following: young cattle up to 1 year: 71.1−71.3%, bovines between 1–2 years: 66.1−66.5%, for matured heifers – 62.4−62.7% and for bulls constant value was taken – 59.1%. Other parameters used for calculation of GE come from IPCC 2006 GLs (C_{fi} − table 10.4, C_a − table 10.5, $C_{pregnacy}$ − table 10.7). Methane conversion rate (Y_m) for cattle was adopted as 6.5% from [IPCC 2006, table 10.12].

Methane emission factor for dairy cattle, established based on the above described methodology, vary from 109.3 CH_4/animal/year in 1988 up to 117.4 kg CH_4/animal/year in 2013, following GE changes, and is higher than IPCC default one (89 kg CH_4/animal/year) because of using country specific parameters for calculations (tab. 5.3). 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, mean mass and GE are presented in table 5.4. The values of EFs vary from 48.7 kg CH_4/animal/year in 1988 up to 50.6 kg CH_4/animal/year in 2013. Relatively low EF (IPCC default is 58 kg CH_4/animal/year) depends on high share of youngest cattle (< 1 year) within this category (53% in 1998 and 45% in 2013) (table 5.5).

Table 5.4. Average annual milk production, daily gross energy intake (GE) and CH_4 emissions factors for dairy cattle in 1988–2013

Years	Average milk production [litres/cow/yr]	GE gross energy intake [MJ/cow/day]	EF emission factor [kg CH_4/animal/year]
1988	3165	256.31	109.27
1989	3260	257.60	109.82
1990	3151	253.73	108.17
1991	3082	249.93	106.55
1992	3015	246.58	105.12
1993	3075	246.33	105.02
1994	3121	246.90	105.26
1995	3136	245.90	104.83
1996	3249	247.70	105.60
1997	3370	249.57	106.40
1998	3491	248.92	106.12
1999	3510	247.53	105.53
2000	3668	249.72	106.46
2001	3828	253.20	107.94
2002	3902	253.41	108.04
2003	3969	254.43	108.47
2004	4082	255.57	108.96
2005	4147	257.14	109.63
2006	4200	257.94	109.97
2007	4292	261.56	111.51
2008	4351	261.59	111.52
2009	4455	263.73	112.43
2010	4487	263.75	112.45
2011	4618	265.76	113.30
2012	4845	271.71	115.84
2013	4978	275.37	117.40

Table 5.5. Trends of emission factors for cattle with detail breakdown of non-dairy cattle population in 1988-2013 [kg CH_4/head/yr]

Years	Non-dairy cattle weighted mean EF	Non-dairy cattle			
		young cattle < 1 year	young cattle 1-2 years	heifers > 2 years	bulls >2 years
1988	48.71	32.71	68.41	49.65	76.29
1989	48.71	32.71	68.41	49.65	76.29
1990	48.69	32.70	68.38	49.61	76.24
1991	48.67	32.68	68.36	49.58	76.18
1992	48.65	32.67	68.33	49.55	76.13
1993	48.64	32.66	68.31	49.52	76.08
1994	48.61	32.65	68.28	49.48	76.03
1995	48.58	32.63	68.26	49.45	75.98
1996	48.56	32.62	68.23	49.42	75.93
1997	48.55	32.61	68.21	49.38	75.88
1998	48.10	32.60	68.19	49.35	75.83
1999	48.03	32.58	68.16	49.32	75.78
2000	48.15	32.57	68.14	49.29	75.73
2001	47.69	32.56	68.11	49.25	75.68
2002	48.73	32.55	68.09	49.22	75.63
2003	48.13	32.53	68.06	49.19	75.58
2004	48.27	32.54	67.98	48.98	75.59
2005	47.88	32.55	67.97	48.26	75.59
2006	48.51	32.55	67.97	48.95	75.59
2007	48.47	32.49	67.80	48.99	75.59
2008	48.34	32.47	67.80	48.87	75.59
2009	49.16	32.35	67.63	48.76	75.59
2010	49.31	32.27	67.46	48.76	75.40
2011	49.56	32.19	67.29	48.65	75.40
2012	50.13	32.11	67.29	48.65	75.59
2013	50.65	32.11	67.29	48.65	75.59

5.2.3. Uncertainties and time-series consistency

Uncertainty analysis for the revised year 2013 for IPCC sector *3.Agriculture* was estimated with use of approach 1 described in 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Simplified approach was based on the assumptions that every value is independent and probability distribution is symmetric. Results of the sectoral uncertainty analysis are given below. More details on uncertainty assessment of whole inventory are given in annex 8.
Recalculation of data for years 1988-2012 ensured consistency for whole time-series.

2013	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 Emission uncertainty [%]	CH_4 Emission uncertainty [%]	N_2O Emission uncertainty [%]
3. Agriculture	883.46	**543.51**	**52.45**	20.0%	29.1%	64.3%
A. Enteric Fermentation		468.50			32.8%	
B. Manure Management		74.04	6.69		53.1%	40.0%
D. Agricultural Soils			45.72			73.5%
F. Field Burning of Agricultural Residues		0.97	0.04		18.4%	98.7%
G. Liming	438.83			26.0%		
H. Urea application	444.63			30.4%		

5.2.4. Source-specific QA/QC and verification

Activity data related to livestock population and any additional parameters like milk productivity or cattle pregnancy come from national statistics prepared by the Central Statistical Office. Data like livestock population, crop production, nitrogen fertilizers use and others are available in several publications that were cross-checked. Emphasis was put on data consistency between sub-categories and between sectors using agricultural data. Emission factors and methodology is compared with international literature and other countries methods/EF applied. Calculations were examined with focus on formulas, units and trends consistency. Generally QC procedures follow QA/QC plan presented in Annex 7.

5.2.5. Source-specific recalculations

- update of methodology following IPCC 2006 GLs.

Table 5.6. Changes in CH_4 emissions from enteric fermentation due to recalculations made

Change	1988	1989	1990	1991	1992
kt	104,65	108,21	103,39	93,41	85,42
%	13,53	13,50	13,63	13,77	13,77
Change	**1993**	**1994**	**1995**	**1996**	**1997**
kt	79,43	77,99	72,65	70,49	71,46
%	13,90	13,85	13,65	13,66	13,55
Change	**1998**	**1999**	**2000**	**2001**	**2002**
kt	69,56	66,18	60,44	57,93	55,63
%	13,54	13,59	13,36	13,30	13,18
Change	**2003**	**2004**	**2005**	**2006**	**2007**
kt	55,93	54,07	54,31	55,59	56,00
%	13,29	13,23	13,03	13,02	12,95
Change	**2008**	**2009**	**2010**	**2011**	**2012**
kt	56,24	54,97	54,55	54,66	55,45
%	13,03	12,94	12,83	12,84	12,97

5.2.6. Source-specific planned improvements

No further improvements are planned at the moment.

5.3. Manure Management (CRF sector 4.B)

5.3.1. Source category description

CH_4 emissions related to animal manure management in 2013 amounted to 74 kt and decreased since 1988 by about 35%. Most of CH_4 emissions in 2013 come from manure generated by swine - almost 47%. Again the biggest change over time in CH_4 emissions relates to sheep breeding where cut of emissions amounted to 95% in 1988-2013 (tab. 5.7).

Table 5.7. Trends in CH_4 emissions from manure management according to livestock categories in 1988-2013

Year	Dairy cattle	Non-dairy cattle	Sheep	Goats	Horses	Swine	Poultry	Fur animals	Total
1988	35.96	11.97	0.83	0.02	1.64	57.66	5.94	0.42	114.45
1989	37.49	13.81	0.84	0.02	1.52	55.48	6.66	0.39	116.20
1990	35.97	10.01	0.79	0.02	1.47	57.42	5.82	0.36	111.87
1991	32.99	9.37	0.61	0.02	1.46	64.61	5.57	0.33	114.97
1992	29.92	8.66	0.36	0.02	1.40	65.36	5.25	0.30	111.27
1993	27.50	7.74	0.24	0.02	1.31	55.89	5.20	0.27	98.18
1994	26.75	8.02	0.17	0.02	0.97	57.78	5.54	0.24	99.49
1995	24.69	7.61	0.14	0.02	0.99	60.69	5.17	0.21	99.53
1996	23.61	7.33	0.10	0.02	0.89	53.48	5.12	0.19	90.75
1997	24.37	7.44	0.09	0.02	0.87	54.07	5.00	0.20	92.06
1998	24.10	6.74	0.09	0.02	0.88	57.24	5.19	0.21	94.46
1999	24.96	6.35	0.07	0.02	0.86	55.44	5.23	0.22	93.15
2000	23.25	6.16	0.07	0.02	0.86	51.28	5.26	0.23	87.12
2001	22.79	5.66	0.07	0.02	0.85	51.30	5.43	0.23	86.36
2002	25.90	5.67	0.07	0.03	0.51	55.96	5.20	0.24	93.58
2003	28.56	5.54	0.06	0.03	0.52	55.97	3.62	0.26	94.56
2004	29.91	5.74	0.06	0.02	0.50	50.95	3.32	0.27	90.77
2005	30.24	5.94	0.06	0.02	0.49	55.55	3.26	0.29	95.84
2006	30.31	6.26	0.06	0.02	0.48	58.48	3.33	0.30	99.23
2007	30.83	6.40	0.06	0.02	0.51	56.98	3.60	0.31	98.72
2008	31.20	6.50	0.06	0.02	0.51	48.61	3.88	0.33	91.11
2009	29.91	6.70	0.05	0.02	0.46	46.07	3.59	0.34	87.15
2010	28.60	6.94	0.05	0.01	0.41	47.62	3.84	0.36	87.83
2011	29.01	7.15	0.05	0.01	0.40	42.49	3.86	0.36	83.32
2012	29.01	7.35	0.05	0.01	0.35	36.43	3.76	0.36	77.32
2013	27.85	7.23	0.04	0.01	0.32	34.62	3.60	0.36	74.04
share [%] in 2013	*37.6*	*9.8*	*0.1*	*0.0*	*0.4*	*46.8*	*4.9*	*0.5*	*100.0*
change [%] 1988-2013	*22.6*	*39.6*	*94.9*	*54.4*	*80.3*	*40.0*	*39.3*	*14.4*	*35.3*

Generally decreasing trend is observed in CH_4 emission from manure management of the most livestock sub-categories except cattle. Despite decreasing cattle population, the increasing share of liquid systems in the inventoried period caused certain rise of emissions.

N_2O emissions from manure management amounted to 6.7 kt in 2013 and drop since 1988 by 38% what is associated mostly with the diminishing area of agricultural land and related crop production as well as decreasing livestock population. Direct emissions are responsible for about 49% and indirect for 51% of N_2O emissions in this category (fig. 5.5).

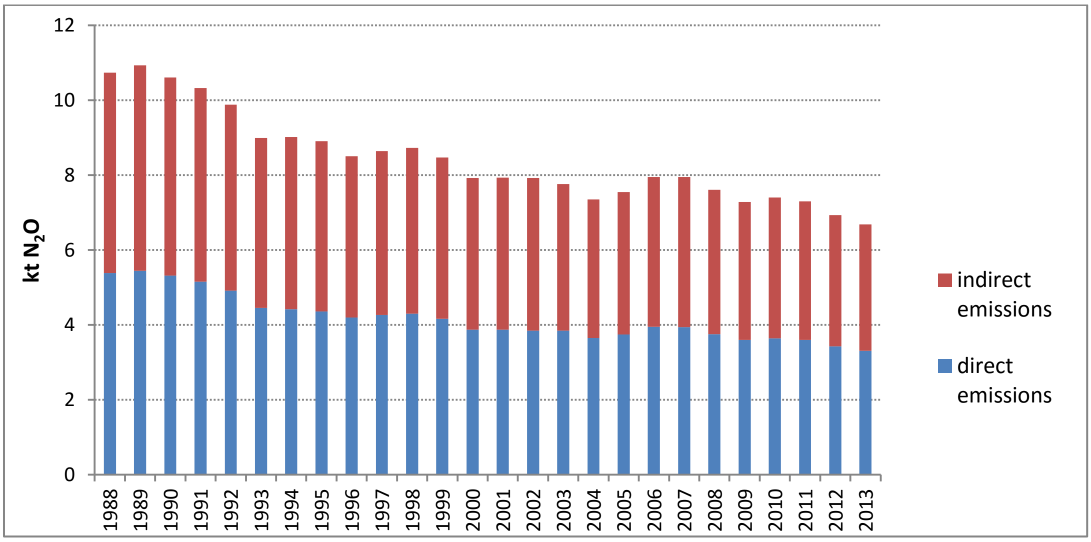

Fig. 5.5. Trends of direct and indirect N_2O emissions from manure management in 1988-2013

5.3.2. Methodological issues

The source of activity data i.e. animal population was taken from the public statistics as described in chapter 5.2.2 (tab. 5.2, 5.3). Additionally emissions from fur animals in this sub-category are estimated. Data on fur animals population is available in public statistics only for selected years like: 1983 [GUS R5 1987] and 1996 [GUS R6 1996], 2002 [GUS R7 2002] and 2010 [GUS R8 2010] when Agricultural Censuses were performed. Interpolation was used for lacking years, after 2010 data for 2010 was used. No information on deer population is available.

Country specific data on the animal waste management systems (AWMS) come from [Walczak 2006, 2009, 2011, 2012, 2013]. The fractions of manure managed in given AWMS for cattle were assessed on an annual basis for periods 1988-2002 and 2004−2012, data for 2003 was interpolated between 2002 and 2004. The share of pastures and solid storage were assessed for the key years: 1988-1989 and for 2004-2012 and the values in-between were interpolated (tab. 5.8). As concerns swine manure management systems the share of liquid and solid storage was estimated based on AWMS shares and pigs population for age categories for 1988 [Walczak 2006]. Data for 2004−2012 was taken from [Walczak 2011, 2012, 2013]. Data for years between 1988 and 2004 interpolation was made. Data for 2012 were used for 2013.

For other animals permanent shares of AWMS for entire inventoried period were assumed based on data assessed for 2004−2012: for sheep - 40% on pastures and 60% solid storage, for goats: 44% on pastures and 56% on solid storage and for horses: 22% and 78% respectively. For poultry the following AWMS shares were established: 11% on liquid systems and 89% on solid storage [Walczak 2011, 2012, 2013].

Table 5.8. Fractions of manure managed in given AWMS for cattle and swine for selected years [%]

	Dairy cattle			Other cattle			swine		
	liquid	solid	pasture	liquid	solid	pasture	liquid	solid	pasture
1988	2.8	75.2	22.0	4.9	77.1	18.0	22.3	77.7	0.0
1990	2.7	76.1	21.2	3.2	79.2	17.6	22.4	77.6	0.0
1995	2.3	80.4	17.2	3.8	80.6	15.6	22.7	77.3	0.0
2000	3.7	83.1	13.2	4.0	82.4	13.6	23.0	77.0	0.0
2005	10.6	79.4	10.0	5.2	82.8	12.0	24.0	76.0	0.0
2010	10.1	79.6	10.3	5.1	82.9	12.1	25.5	74.5	0.0
2013	10.5	79.2	10.3	5.1	82.9	12.0	24.3	75.7	0.0

In Poland prevail small farms where solid systems for animal management are commonly used. Liquid systems are applied only at big farms, having more than 120 animals. Development of such big milk farms in early years of 2000 influenced significant increase of CH_4 emissions from manure management for dairy cattle since 2002.

5.3.2.1. Estimation of CH_4 emissions from manure management

The *Tier 1* methodology and the default emission factors were used for estimation of CH_4 emissions from manure management of horses, sheep, goats, poultry and fur animals [IPCC 2006] (tab. 5.9). The *Tier 2* methodology was used to establish domestic CH_4 emission factors for cattle and swine applying equation 10.23 from [IPCC 2006]:

$$EF = Vs * 365\ days/year * B_o * 0{,}67kg/m3 * \Sigma MCF * MS$$

where:

- EF – emission factor (kg CH_4/animal/year),
- Vs − average daily volatile excreted solids,
- B_o – maximum CH_4 production capacity for manure produced by animal
- MCF – methane conversion factors for each manure management system for cool climate [IPCC 2006, tab. 10.17],
- MS – fraction of livestock category manure in given AWMS (table 5.8).

For cattle volatile solids (Vs) were estimated based on equation 10.24 in IPCC 2006 GLs with the use of specific GE and DE parameters, urinary energy expressed as fraction of GE was assumed as 0.04 (IPCC 2006) while ASH content as 0.08 (IPCC 2006). Maximum CH_4 producing capacity (B_o) was taken from IPCC 2006 tables 10A.4 and 10A.5. For swine the default values for Vs and B_o were used (IPCC 2006). Examples of above mentioned parameters and emission factors used for calculation of CH_4 emissions from manure management for livestock are shown in table 5.9.

Table 5.9. Methane-producing potential (B_o), volatile solids excreted (Vs) and CH_4 emission factors for manure management in 2013

Livestock	**EF Emission Factor [kg CH_4/animal/year]**	**Vs Volatile Solids Excreted [kg dm/animal/day]**	**B_o Methane-producing potential [m^3 CH_4/kg Vs]**
Dairy cattle	11.40	5.59	0.24
Non-dairy cattle	2.30	2.09	0.17
Swine	3.15	0.50	0.45
Sheep	0.19		
Goats	0.13		
Horses	1.56		
Poultry:			
Layers (dry)	0.03		
Broilers	0.02		
Turkeys	0.09		
Ducks	0.02		
Rabbits	0.08		
Fur-bearing animals	0.68		

5.3.2.2. Estimation of direct N_2O emissions from manure management

Direct nitrous oxide emissions from manure management were estimated based on recommended IPCC methodology [IPCC 2006, equation 10.25] using the same AWMS data as for CH_4 emissions (chapter 5.3.2.1):

$$N_2O_{D(mm)} = [\sum_S [\sum_T (N_{(T)} * Nex_{(T)} * MS_{(T,S)}) * EF_{3(S)}] * \frac{44}{28}$$

where:

$N_2O_{D(mm)}$ – direct N2O emissions from manure management in the country (kg N_2O/year),
$N_{(T)}$ – livestock population in given category *T* in the country,
$Nex_{(T)}$ – annual average N excretion per head of livestock category T in country (kg N/animal/year),
$MS_{(T,S)}$ – fraction of total annual nitrogen excretion for each livestock category *T* managed in manure management system *S,*
$EF_{3(S)}$ – emission factor for direct N_2O emissions from manure management system *S* (kg N_2O–N/kg N),
S – manure management system
T – livestock category
44/28 – conversion of $(N_2O–N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions

Data on nitrogen excretion for livestock categories (kg N/head/year) is country specific and come from [IUNG, Kopiński 2014]. The basis for assessment of Nitrogen excretion rates (Nex) applied in calculations of N_2O emissions constitutes the standard amounts of nitrogen in faeces and urine determined for different groups of livestock animals grounded on standard quantity, sort and digestibility of fodder applied. Country specific Nex values (table 5.10) are generally in line with parameters published in [UNECE 2001] as well as with those published in [IPCC 2006, table 10.19] for most livestock categories. The Nex parameters for dairy cattle differ in time what is related mostly to increasing milk production. For rabbits and other fur-bearing animals the default Nex values were used from [IPCC 2006, table 10.19].

Table 5.10. Country specific Nitrogen excretion rates (Nex) in manure by livestock categories

Livestock	Nex [kg/head/year]
Dairy cattle:	
1988–1995	65.0
1996–2000	70.0
2001–2005	75.0
2006–2010	80.0
Since 2011	83.0
Non-dairy cattle:	
calves up to 1 year	19.0
Young cattle 1–2 years	46.0
Heifers above 2 years	53.0
Bulls above 2 years	65.0
Swine:	
piglets (< 20 kg)	2.6
piglets (20-50 kg)	9.0
fattening pigs (> 50 kg)	15.0
sows	20.0
butcher hogs	18.0
Sheep	9.5
Goats	8.0
Horses	55.0
Poultry (weighted):	0.5

Default values of N_2O emission factors for given management systems from [IPCC 2006, table 10.21] were applied (table 5.11).

Table 5.11. Emission factors for calculating N_2O emissions from manure management [IPCC 2006]

Animal Waste Management Systems	Emission factor (EF_3) [kg N_2O-N/kg N]
Liquid / slurry with natural crust cover	0.005
Liquid / slurry without natural crust cover	0.000
Solid storage	0.005
Pit storage below animal confinements	0.002
Poultry manure with litter	0.001
Poultry manure without litter	0.001

5.3.2.3. Indirect N_2O emission from manure management

Following IPCC 2006 Guidelines the indirect N_2O emissions from manure management were estimated based on equations: 10.27 (N volatilisation) and 10.29 (N leaching) as well as nitrogen excretion rates (Nex) and manure management systems shares (MS) described in previous subchapters related to GHG emissions from manure management. Emission factor for calculation of N_2O emissions from atmospheric nitrogen deposition was assumed as 0.01 kg N_2O−N while emission factor for N_2O emissions from nitrogen leaching and runoff was adopted as 0.0075 kg N_2O−N (default EFs from IPCC 2006).

Nitrogen losses related to volatilisation from manure management were calculated based on equation 10.26 [IPCC 2006] where fractions of managed manure nitrogen for given livestock category that volatilises as NH_3 and NOx in given manure system ($Frac_{GAS}$) are taken from [IPCC 2006 table 10.22]. Nitrogen losses due to leaching from manure management were estimated based on equation 10.28 [IPCC 2006] applying fraction of managed manure nitrogen losses for livestock categories due to runoff and leaching during manure storage as 10% (mid value for range 1−20% in the IPCC 2006 Guidelines).

5.3.3. Uncertainties and time-series consistency

Description of uncertainties is given in Chapter 5.2.3.

5.3.4. Source-specific QA/QC and verification

Activity data related to livestock population come from national statistics prepared by the Central Statistical Office. Data on Animal Waste Management Systems are elaborated by the National Research Institute of Animal Production which develops activities aiming at obtaining representative data on the production of main livestock categories. Collection of this data is based on appointing a suitable monitoring for various institutions like statistical office, Farmers Chambers, Centres for Agricultural Advice and Veterinary Inspection. Partially monitoring is covered also by Institute's employees.
Emphasis was put on data consistency between sub-categories and between sectors using agricultural data. Emission factors and methodology is compared with international literature and other countries methods/EF applied. Calculations were examined with focus on formulas, units and trends consistency. Generally QC procedures follow QA/QC plan presented in Annex 5.

5.3.5. Source-specific recalculations

- update of methodology following IPCC 2006 GLs.

Table 5.12. Changes in CH_4 emissions from manure management due to recalculations

Change	1988	1989	1990	1991	1992
kt	-49,16	-49,89	-45,99	-53,44	-53,30
%	-30,05	-30,04	-29,13	-31,73	-32,39
Change	**1993**	**1994**	**1995**	**1996**	**1997**
kt	-45,32	-46,72	-49,22	-44,59	-44,87
%	-31,58	-31,95	-33,09	-32,95	-32,77
Change	**1998**	**1999**	**2000**	**2001**	**2002**
kt	-46,75	-48,08	-45,61	-46,38	-54,58
%	-33,11	-34,04	-34,36	-34,94	-36,84
Change	**2003**	**2004**	**2005**	**2006**	**2007**
kt	-54,86	-53,14	-57,73	-61,49	-61,70
%	-36,71	-36,93	-37,59	-38,26	-38,46
Change	**2008**	**2009**	**2010**	**2011**	**2012**
kt	-54,06	-52,45	-51,13	-48,09	-40,10
%	-37,24	-37,57	-36,80	-36,60	-34,15

Table 5.13. Changes in N_2O emissions from manure management due to recalculations

Change	1988	1989	1990	1991	1992
kt	-15,22	-15,36	-14,96	-14,02	-13,32
%	-58,64	-58,41	-58,50	-57,60	-57,41
Change	**1993**	**1994**	**1995**	**1996**	**1997**
kt	-12,21	-12,34	-12,16	-11,67	-11,87
%	-57,59	-57,76	-57,71	-57,83	-57,87
Change	**1998**	**1999**	**2000**	**2001**	**2002**
kt	-12,35	-11,73	-10,86	-10,44	-10,89
%	-58,59	-58,06	-57,81	-56,82	-57,86
Change	**2003**	**2004**	**2005**	**2006**	**2007**
kt	-10,56	-9,93	-10,12	-10,33	-10,26
%	-57,64	-57,45	-57,28	-56,52	-56,34
Change	**2008**	**2009**	**2010**	**2011**	**2012**
kt	-9,75	-9,36	-9,37	-9,16	-8,77
%	-56,16	-56,25	-55,88	-55,62	-55,85

5.3.6. Source-specific planned improvements

Update of country specific Nitrogen excretion rates (Nex) is planned as well as collection of data on liquid systems management with differentiation for with/without crust.

5.4. Agricultural Soils (CRF sector 3.D)

5.4.1. Source category description

Nitrous oxide emissions from agricultural soils amounted to 45.7 kt N_2O in 2013 and dramatically decreased after 1989 by about 32% in 1992 (fig. 5.6). Since 1993 emissions stabilised with few percent changes between years. There are a few main driving forces influencing emissions variability during entire inventoried period: nitrogen mineral and organic fertilizers use, livestock and crops production and cultivated histosols area.

As a result of economic transformation of the Polish economy in 1989 significant changes were observed in relation to crop production and usage of agricultural land. For instance the decrease of agricultural land of which share in total country area changed from 59.2% in 1989 up to 54% in 1996, also significant increase of fallow land was noted - in 1989 the share of fallow land in agricultural land was 1.1% while in 2002 - 13.6%. Between 1990 and 2002 the decrease of sown area by 3.5 million hectares occurred, also the decrease of mineral fertilisers' use drop from 164 kg per 1 ha of agricultural land in 1989/90 to 93 kg in 2001/02. Since 1988 production of certain crops in Poland changed noteworthy – potatoes cultivation dropped by 79% up to 2013 while maize production increased almost 20-fold (table 5.14).

Table 5.14. Main crops production in 1988–2013 in Poland [kt]

	wheat	barley	maize	oats	rye	triticale	cereal mixed	millet & buckwheat	pulses edible	pulses feed	potatoes	rape & agrimony	All vegetables	All fruits
1988	7582	3804	204	2222	5501	1731	3387	73	108	457	34707	1199	5179	2168
1989	8462	3909	244	2185	6216	2404	3466	72	120	495	34390	1586	5067	2078
1990	9026	4217	290	2119	6044	2721	3554	43	116	493	36313	1206	5259	1416
1991	9270	4257	340	1873	5900	2449	3683	39	133	547	29038	1043	5637	1873
1992	7368	2819	206	1229	3981	1711	2612	36	98	282	23388	758	4518	2385
1993	8243	3255	290	1493	4992	1894	3200	50	107	304	36270	594	5823	2705
1994	7658	2686	189	1243	5300	1631	3026	30	66	149	23058	756	5198	2109
1995	8668	3278	239	1495	6288	2048	3844	45	101	167	24891	1377	5746	2115
1996	8576	3437	350	1581	5653	2130	3520	51	97	180	27217	449	5253	2781
1997	8193	3866	416	1630	5299	1841	4105	49	97	163	20776	595	5136	2887
1998	9537	3612	497	1460	5663	2058	4274	58	111	178	25949	1099	6096	2517
1999	9051	3401	599	1447	5181	2097	3914	60	99	218	19927	1132	5457	2387
2000	8503	2783	923	1070	4003	1901	3084	74	93	171	24232	958	5721	2247
2001	9283	3330	1362	1305	4864	2698	4060	58	88	123	19379	1064	5428	3413
2002	9304	3370	1962	1486	3831	3048	3608	40	95	134	15524	953	4537	3018
2003	7858	2831	1884	1182	3172	2812	2812	44	66	172	13731	793	4870	3309
2004	9892	3571	2344	1430	4281	3723	4322	72	77	193	13999	1633	5283	3521
2005	8771	3582	1945	1324	3404	3903	3916	83	66	187	10369	1450	5220	2923
2006	7060	3161	1261	1035	2622	3197	3379	59	60	146	8982	1652	4919	3212
2007	8317	4008	1722	1462	3126	4147	4257	96	75	210	11791	2130	5475	1694
2008	9275	3619	1844	1262	3449	4460	3673	82	56	179	10462	2106	5023	3843
2009	9790	3984	1706	1415	3713	5234	3884	93	60	212	9703	2497	5601	3749
2010	9408	3397	1994	1516	2852	4576	3339	146	88	268	8188	2229	4878	2826
2011	9339	3326	2392	1382	2601	4235	3373	109	84	251	9362	1862	5575	3414
2012	8608	4180	3996	1468	2888	3349	3920	128	85	395	9041	1866	5431	3286
2013	9485	2934	4040	1190	3359	4273	3021	135	84	291	7290	2678	4986	4128
change 1988-2013 [%]	25.1	-22.9	1880.2	-46.4	-38.9	146.9	-10.8	84.4	-21.9	-36.3	-79.0	123.3	-3.7	90.4

More than 80% of N_2O emissions here are related to direct soil cultivation, while about 20% are generated in indirect emission processes. The main sources of N_2O emissions estimated relate to direct soil cultivation covering:

- Inorganic N fertilizers use,
- Organic N fertilizers use (animal manure and sewage sludge),
- Urine and dung deposited by grazing animals,
- Crop residues,
- Mineralisation/immobilisation associated with loss/gain of soil organic matter,
- Cultivation of organic soils (i.e. histosols).

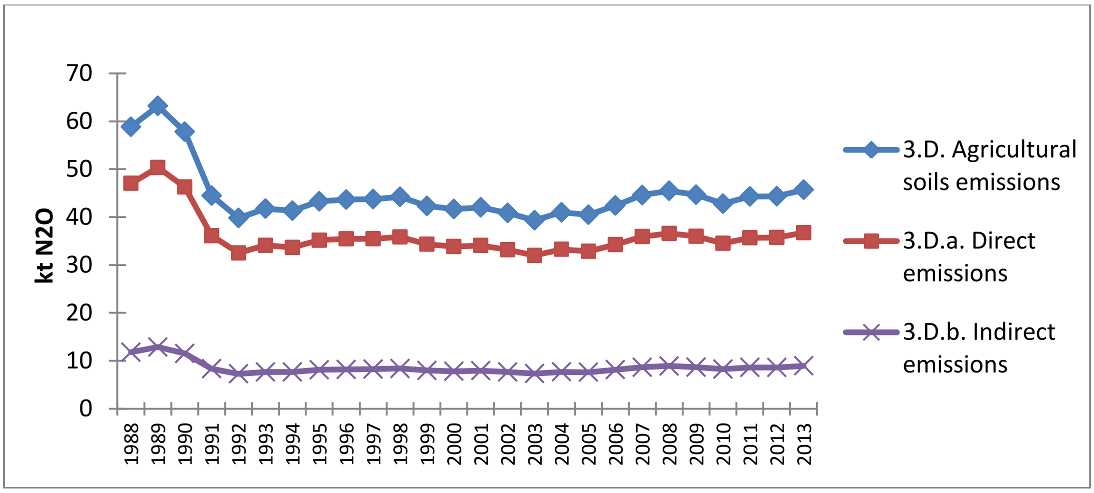

Figure 5.6. N_2O emissions from agricultural soils for 1988–2013

5.4.2. Methodological issues

5.4.2.1. Direct N_2O emissions from managed soils (CRF sector 3.D.a)

Direct N_2O emissions from managed soils has been estimated based on equation 11.1 from the IPCC 2006:

$$N_2O_{Direct}\text{-}N = (F_{SN} + F_{ON} + F_{CR} + F_{SOM}) \bullet EF_1 + F_{OS} \bullet EF_2 + F_{PRP} \bullet EF_{3PRP}$$

where:

N_2O_{Direct}-N = annual direct N_2O–N emissions produced from managed soils (kg N_2O–N/year)
F_{SN} = annual amount of synthetic fertiliser N applied to soils (kg N/year)
F_{ON} = annual amount of animal manure, compost, sewage sludge and other organic N additions applied to soils (kg N/year)
F_{CR} = annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils (kg N/year)
F_{SOM} = annual amount of N in mineral soils that is mineralised, in association with loss of soil C from soil organic matter as a result of changes of land use or management (kg N/year)
F_{OS} = annual area of managed/drained organic soils (ha)
F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/year)
EF_1 = emission factor for N_2O emissions from N inputs (kg N_2O–N/kg N input)
EF_2 = emission factor for N_2O emissions from drained/managed organic soils (kg N_2O–N/ha/year)
EF_{3PRP} = emission factor for N_2O emissions from urine and dung N deposited on pasture, range and paddock by grazing animals (kg N_2O–N/kg N input)

The following default values of **N_2O emission factors** to estimate direct emissions from managed soils were applied [IPCC 2006, table 11.1]:
EF_1 = 0.01 kg N_2O–N/kg N input
EF_2 = 8 kg N_2O–N/ha/year (for temperate organic crop and grassland soils)
EF_{3PRP} = 0.02 for cattle, swine and poultry, 0.01 for sheep, goats and horses

In 2013 about half of direct N_2O emissions comes from the use of synthetic nitrogen fertilizers, about 24% relates to management of organic soils, 12% − to crop residues and 11% − to animal manure applied to soils. Only 3% of direct N_2O emissions comes from urine and dung left by grazing animals on pastures (fig. 5.7).

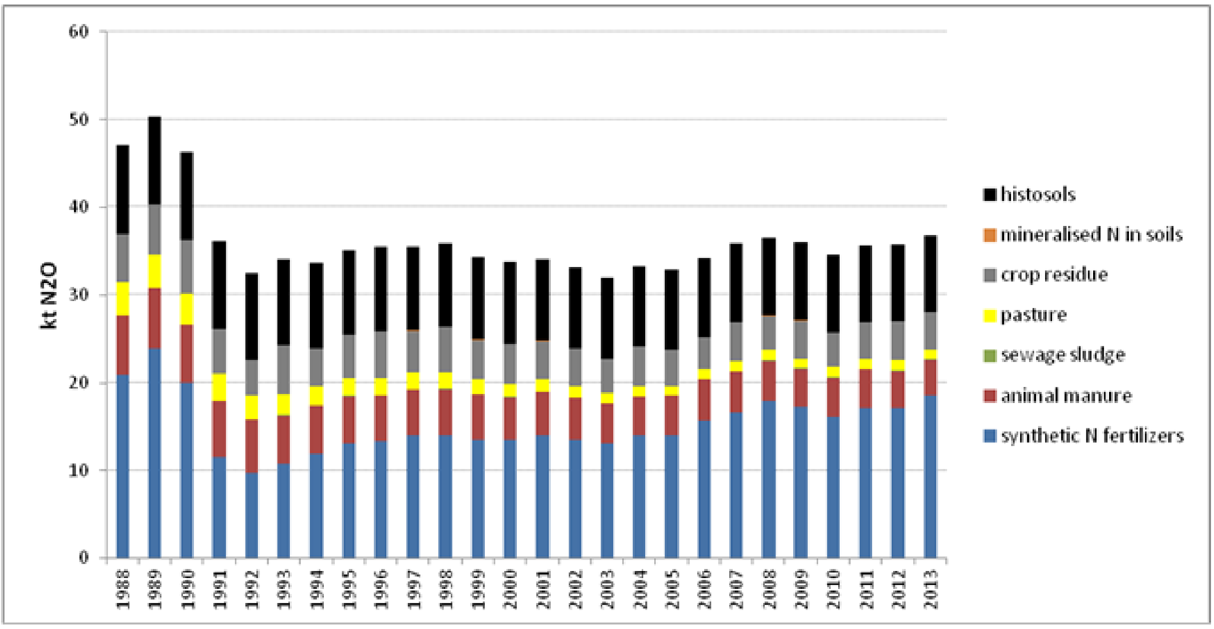

Fig. 5.7. Direct N_2O emissions from specific subcategories

Synthetic nitrogen fertilizers (F_{SN})

N_2O emission from synthetic fertilizers was estimated based on the amount of nitrogen synthetic fertilizer applied to soils published in [GUS R4 2014]. Data regarding consumption of mineral fertilizers is elaborated on the basis of reporting from production and trade units, statistical reports of agricultural farms: state-owned, co-operatives and companies with share of public and private sector, expert's estimates as well as Central Statistical Office estimates. Present level of fertilizing is still lower than it was in 1988−1989. The drop of nitrogen fertilizers use in 1989−1992 amounted to 41% and gradually increased up to 2007 when exceeded 1 million tons (table 5.15). The recommendations following agricultural good practice elaborated by the Ministry of Agriculture and Rural Development contain the rules for rational use of fertilisers, free consultancy system for farmers in this area, while the largescale farms are obliged to elaborate fertilizing plans [6RR 2013, chapter 4.6.3].

Table 5.15. Nitrogen fertilizers use (F_{SN}) in 1988–2013 in Poland [kt N]

1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1 335	1 520	1 274	735	619	683	758	836	852	890	891	862
2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
861	895	862	832	895	895	996	1 056	1 142	1095	1028	1091
2012	**2013**										
1095	1179										

Nitrous oxide emissions amounted in 2013 about 18.5 kt N_2O. Generally trend in N_2O emissions follow nitrogen fertilizers use and range from 23.9 kt N_2O in 1989 to 9.7 kt N in 1992.

Organic nitrogen fertilizers (F_{ON})

Organic nitrogen fertilisers cover both animal manure as well as sewage sludge applied to fields.

The amount of nitrogen in **animal manure applied to soils** is calculated according to the method described in chapter 5.3.2.2. Following guidelines given in chapter 10.5.4 and using equation 10.34 (2006 IPCC), all nitrogen excreted on pasture, range and paddock as well as all nitrogen volatilised prior to final application to managed soils is subtracted from the total excreted manure. The amount of managed manure nitrogen that is lost in the manure management system is taken from table 10.23 (IPCC 2006) for particular livestock categories. Nitrogen from bedding material was not accounted for under animal manure applied to soils, it is covered by the nitrogen returned to soils as crop residues. The fractions of animal manure burned for fuel, used for feed and fuel were neglected because these activities do not occur in Poland. The nitrogen input from manure applied to soils are given in CRF-table 3.D under 3.D.a.2.a.

Nitrous oxide emissions from animal manure applied to soils in 2013 was about 4.1 kt N_2O and constantly decreases. This is caused by decreasing trend of livestock population, mainly cattle and sheep after 1989 (see tables 5.2, 5.3).

Activity data on the amount of **sewage sludge applied on the fields** were taken from GUS [GUS 2014d] and regards both - industrial and municipal sewage sludge applied in cultivation of all crops marketed, including crops designed to produce fodder as well as this applied in cultivation of plants intended for compost production. As the consistent reporting of data concerning application of sewage sludge in agriculture in the public statistics starts in 2003, the activities since 1988 were supplemented based on annual mean changes of AD in 2003−2012 (fig. 5.8). Diminishing trend back to 1988 corresponds to the number of people using sewage treatment plants that ranges from 11 million in 1988 through 19 million in 1998 and 27 million in 2013 where this number was more than doubled in 1988-2013. Also the number of municipal sewage treatment plants increased from 558 in 1988 up to 1923 in 1998 and 3264 in 2013.

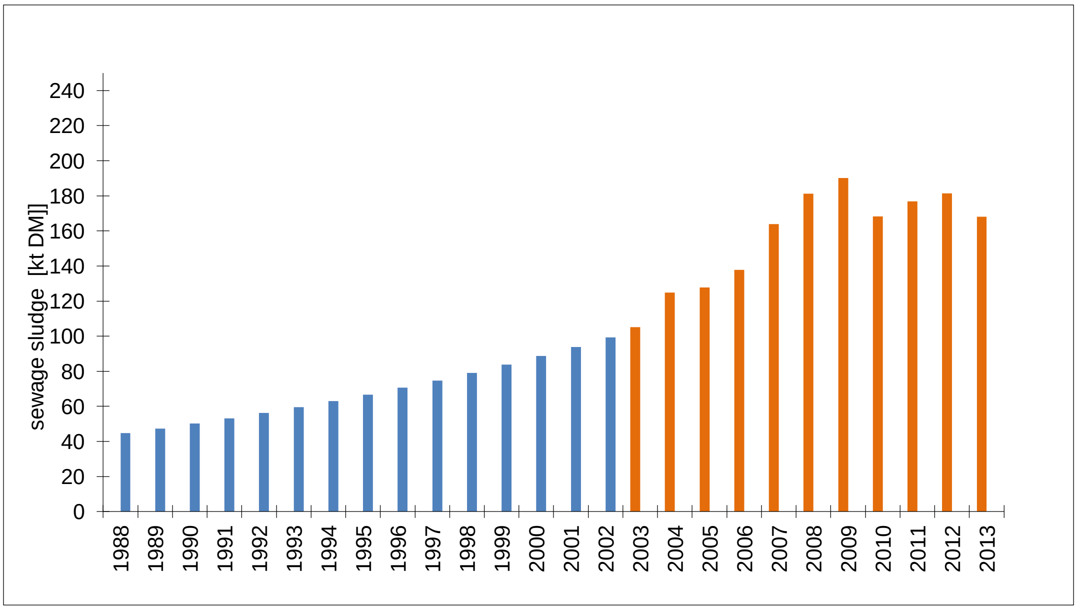

Fig. 5.8. Amounts of sewage sludge applied in agriculture [kt DM]

The mean content of nitrogen in sewage sludge was taken as 2.61% from publication [Siebielec, Stuczyński 2008] where analysis of nitrogen content in domestic sewage sludge applied in agriculture was made. The study covered a group of 60 biosolids collected in 2001-2004 from 43 municipal sewage treatment plants. The same N content was assumed for both – municipal and industrial sewage sludge because majority of it applied in agriculture (about 76%) come from municipal treatment plants.

In Poland application of sewage sludge as fertilizer is relatively small, after increasing trend 2003–2009, certain stabilisation is noticed. Emissions of N_2O for this subcategory amount to 0.07 kt N_2O in 2013.

Crop Residues (F_{CR})

N_2O emission from crop residue returned to soils was generally estimated based on modified equation 11.6 from [Corrigenda for the 2006 IPCC GLs]:

$$F_{CR} = \Sigma_T \{Crop_{(T)} \bullet Area_{(T)} \bullet Frac_{Renew(T)} \bullet [R_{AG(T)} \bullet N_{AG(T)} \bullet (1 - Frac_{Burn(T)} - Frac_{Remove(T)}) + R_{BG(T)} \bullet N_{BG(T)}]\}$$

where:

F_{CR} = annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually, kg N / yr

$Crop_{(T)}$ = harvested annual dry matter yield for crop *T*, kg d.m. / ha

$Area_{(T)}$ = total annual area harvested of crop *T*, ha / yr

$Frac_{Renew(T)}$ = fraction of total area under crop *T* that is renewed annually.

$R_{AG(T)}$ = ratio of above-ground residues dry matter ($AG_{DM(T)}$) to harvested yield for crop *T* ($Crop_{(T)}$), kg d.m. / kg d.m.,

$N_{AG(T)}$ = N content of above-ground residues for crop *T*, kg N / kg d.m.,

$Frac_{Burn(T)}$ - fraction of crop residues burned as indicated in sector 3.F

$Frac_{Remove(T)}$ = fraction of above-ground residues of crop *T* removed annually for purposes such as feed, bedding and construction, kg N / kg crop-N

$R_{BG(T)}$ = ratio of below-ground residues to harvested yield for crop *T*, kg d.m. / kg d.m.

$N_{BG(T)}$ = N content of below-ground residues for crop *T*, kg N / kg d.m.

T = crop or forage type

$R_{BG(T)}$ is calculated by multiplying R_{BG-BIO} in Table 11.2 by the ratio of total above-ground biomass to crop yield (= $[(AG_{DM(T)} \bullet 1000 + Crop_{(T)}) / Crop_{(T)}]$, calculating $AG_{DM(T)}$ from the information in Table 11.2. Values of nitrogen content in below-ground residues for specific crops $N_{BG(T)}$ were taken from table 11.2 [IPCC 2006]. For permanent pastures and meadows, which are renewed on average every 20 years, $Frac_{Renew}$ = 1/20. For annual crops $Frac_{Renew}$ was taken as 1.

Data on N content in the above-ground residues, ratio of above-ground residues in dry matter to harvested yield for crops, fraction of crops burned come from country studies [Łoboda 1994, IUNG 2012] where experimental and literature data as well as default emission factors were used and are given in table 5.23. Fraction of total above-ground crop biomass that is removed from the field as a crop product (FracR) were consulted with the Institute of Soil Science and Plant Cultivation – State Research Institute and is presented in table 5.16.

Table 5.16. Fraction of total above-ground crop biomass that is removed from the field as a crop product ($Frac_{Remove}$) according to crops/group of crops

crop	$Frac_{Remove}$	crop	$Frac_{Remove}$
wheat	0.70	sugar beet	0.25
rye	0.70	rape	0.10
barley	0.70	other oil-bearing	0.10
oats	0.70	flux straw	0.90
triticale	0.70	tobacco	0.65
`cereal mixed	0.70	hop	0.01
millet & buckwheat	0.70	hey from pastures and meadows	0.95
maize	0.10	hey from pulses	0.95
pulses edible	0.10	hey from legumes	0.95
pulses feed	0.10	vegetables	0.10
potatoes	0.01		

Activity data concerning crop production was taken from national statistics [GUS R3 2014] (table 5.12). The default emission factor of 0.01 kgN_2O-N/kg N [IPCC 2006, table 11.1] multiplied by 44/28 was used for estimating the N_2O emissions from N inputs from crop residues.

Emission from above- and belowground crop residues in 2013 was 4.2 kt N_2O and is lower by about 24% than in 1988 due to significant drop in area sawn and crop production.

Mineralised N resulting from loss of soil organic C stocks in mineral soils through land-use change or management practices (F_{SOM})

This category deals with direct N_2O emissions from N mineralization resulting from change of land use or management of mineral soils. Tier 3 method was not applied to the estimation in this subcategory in Poland. Therefore, according to the *2006 IPCC Guidelines*, N immobilization associated with gain of soil carbon on mineral soils is not considered. Consequently, only N_2O emissions from mineralization associated with loss of soil organic matter (SOM) were estimated.

For amount of N mineralized in mineral soil associated with land use change, annual loss of soil carbon in mineral soil for estimating carbon stock changes in mineral soils was used. The area of mineral soil in land use change, which are calculated by subtracting the area of organic soil from the total area of land converted to cropland, were considered for the estimation as the activity data.

Estimation of the N release by mineralization was made according to the following steps presented below:

Step 1: Calculations of the average annual loss of soil C ($\Delta C_{Mineral,\ LU}$) for the land use change, over the inventory period, using equation 2.25.

Step 2: Each land use change has been assessed by the single value of $\Delta C_{Mineral,\ LU}$ As a consequence of this loss of soil C (F_{SOM}), equation 11.8 was applied to estimate N potentially mineralized applying C/N-ratio of 15 [IPCC 2006].

Cultivation of organic soils (F_{OS})

The area of cultivated organic soils (i.e. histosols) in Poland was estimated as a case study for the purposes at 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. The area of histosols was then interpolated for 1976−1994.

Additionally the area of cultivated histosols was assessed for 2015 for the purpose of GHG emission projections which amounts to 680 thousand ha [6RR 2013, chapter 5.1]. Similarly to the previous period interpolation of histosol areas was applied between 1995 and 2015.

Nitrous oxide emissions from cultivated histosols in Poland in 2013 was about 8.7 kt N_2O and is falling since 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.

Urine and dung deposited by grazing animals (F_{PRP})

Emission of N_2O resulting from animal urine and dung deposited on pastures is calculated based on equation 11.5 [IPCC 2006] using animal population (tables 5.2, 5.3), total amount of nitrogen in animal excreta (Nex) estimated based on country specific parameters presented in table 5.10 and data on fraction of manure related to grazing animals was presented in chapter 5.3.2 and, table 5.8.

Emissions in 2013 from pasture, range and paddock manure were 1.1 kt N_2O and stabilized since 2002. This value is much lower than in 1988 by about 68% what was caused by decreasing livestock population as well as decreasing percentage of livestock grazed.

5.4.2.2. Indirect N_2O emissions from managed soils (CRF sector 3.D.b)

Atmospheric deposition (CRF sector 3.D.b.1)

Indirect emissions of N_2O from atmospheric deposition of N volatilised were assessed using equation 11.9 [IPCC 2006]:

$$N_2O_{(ATD)}\text{-}N = [(F_{SN} * Frac_{GASF}) + ((F_{ON} + F_{PRP}) * Frac_{GASM})] * EF_4$$

where:

$N_2O_{(ATD)}$-N – annual amount of N_2O-N produced from atmospheric deposition of N volatilised from managed soils (kg N_2O-N/year)
F_{SN} – annual amount of synthetic N fertilizer applied to soils (kg N/year)
F_{ON} – annual amount of organic N fertilizer applied to soils (animal manure and sewage sludge nitrogen) (kg N/year)
F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/year)
$Frac_{GASF}$ - fraction of synthetic fertilizer that volatilises as NH_3 and NO_x (kg of N applied)
$Frac_{GASM}$ - fraction of organic fertilizer materials that volatilises as NH_3 and NO_x (kg of N applied)
EF_4 – emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces (kg N−N_2O)

Nitrogen amounts from synthetic fertilizers as well as from organic additions to soils (livestock manure and sewage sludge) correspond to values presented in chapter 5.4.2.1. Parameters characterising $Frac_{GASF}$ and $Frac_{GASM}$ are taken from table 11.3 [IPCC 2006] and amount respectively: 0.1 kg NH_3-N+NO_x-N/kg N applied and 0.2 kg NH_3-N+NO_x-N/kg N applied. Also the default emission factor EF_4 [IPCC 2006, table 11.3] is used amounting to 0.01 kg N_2O-N (kg NH_3-N+NO_x-N volatilised).

Table 5.17. Volatized nitrogen from synthetic and organic fertilizers applied to soils

Year	Volatized N [kt N/yr]	Year	Volatized N [kt N/yr]
1988	245.59	2001	160.89
1989	266.51	2002	154.99
1990	237.14	2003	149.81
1991	177.05	2004	152.48
1992	158.23	2005	153.72
1993	155.87	2006	167.10
1994	160.87	2007	173.52
1995	165.96	2008	180.24
1996	164.27	2009	172.76
1997	168.55	2010	166.63
1998	168.66	2011	172.60
1999	162.89	2012	170.18
2000	157.57	2013	177.56

Nitrogen leaching and run-off (CRF sector 3.D.b.2)

Indirect emissions of N_2O from leaching and runoff of N from soils were assessed using equation 11.10 [IPCC 2006]:

$$N_2O_{(L)}\text{-}N = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) * Frac_{LEACH\text{-}(H)} * EF_5$$

where:

$N_2O_{(L)}$-N – annual amount of N_2O-N produced from leaching and runoff of N additions to managed soils (kg N_2O–N/year)

F_{SN} = annual amount of synthetic fertiliser N applied to soils (kg N/year)

F_{ON} = annual amount of animal manure, compost, sewage sludge and other organic N additions applied to soils (kg N/year)

F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/year)

F_{CR} = annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils (kg N/year)

F_{SOM} = annual amount of N in mineral soils that is mineralised, in association with loss of soil C from soil organic matter as a result of changes of land use or management (kg N/year)

$Frac_{LEACH\text{-}(H)}$ - fraction of all N added to/mineralised in managed soils (kg N / kg of N additions)

EF_5 – emission factor for N_2O emissions from N leaching and runoff (kg N_2O–N)

Nitrogen additions to soils correspond to values presented in chapter 5.4.2.1. $Frac_{LEACH\text{-}(H)}$ equals 0.3 kg N/kg N added and is the default value taken from [IPCC 2006, table 11.3]. The default emission factor EF_5 equal 0.0075 kg N_2O-N/kg N leached and runoff was used for calculation of N_2O-N emissions produced from leaching and runoff of N [IPCC 2006, table 11.3].

Table 5.18. Nitrogen losses through leaching and runoff from nitrogen added to soils

Year	N losses [kt N/yr]	Year	N losses [kt N/yr]
1988	673.44	2001	460.09
1989	736.51	2002	444.88
1990	662.68	2003	423.74
1991	473.64	2004	450.31
1992	408.80	2005	443.08
1993	442.75	2006	470.20
1994	436.65	2007	502.85
1995	468.49	2008	516.02
1996	475.60	2009	505.85
1997	477.45	2010	479.05
1998	486.71	2011	501.88
1999	460.24	2012	503.99
2000	454.01	2013	524.61

Total indirect emission in 2013 was about 9 kt N_2O and the trend since 1992 is rather stable after significant drop in 1989−1992 accompanying serial decrease in mineral fertilisers use and animal population.

5.4.3. Uncertainties and time-series consistency

Description of uncertainties is given in Chapter 5.2.3.

5.4.4. Source-specific QA/QC and verification

Activity data related to mineral fertilisers use or crop production come from national statistics prepared by the Central Statistical Office. Overall final estimation of cereals and potatoes output was verified by means of simulative calculation of crops quantity according to the distribution of output between: sale, sowing/planting, fodder and self consumption. Final estimation of sugar beets, rape and turnip rape, and some species of industrial crops were verified with procurement data for these crops. Estimation of fodder crops output in private farms, conducted by local experts of CSO, was additionally verified by the calculation of fodder crops according to the directions of their use. Total area of fodder crops comprises the area of meadows, pastures and field crops for fodder. This area does not include the area of cereals, potatoes, and other agricultural crops, a part of which was directly or indirectly used for fodder.

Emphasis was put on data consistency between sub-categories and between sectors using agricultural data. Emission factors and methodology is compared with international literature and other countries methods/EF applied. Calculations were examined with focus on formulas, units and trends consistency. Generally QC procedures follow QA/QC plan presented in Annex 5.

5.4.5. Source-specific recalculations

- update of methodology following IPCC 2006 GLs.

Table 5.19. Changes in N_2O emissions from agricultural soils resulting from recalculations.

Change	1988	1989	1990	1991	1992
kt	-31.42	-33.49	-29.66	-24.02	-22.29
%	-34.8	-34.6	-33.9	-35.1	-35.9
Change	**1993**	**1994**	**1995**	**1996**	**1997**
kt	-19.94	-21.83	-21.95	-20.68	-21.85
%	-32.3	-34.6	-33.6	-32.1	-33.3
Change	**1998**	**1999**	**2000**	**2001**	**2002**
kt	-22.11	-21.75	-20.30	-20.33	-20.98
%	-33.3	-33.9	-32.7	-32.6	-33.9
Change	**2003**	**2004**	**2005**	**2006**	**2007**
kt	-20.87	-20.40	-21.19	-22.84	-22.93
%	-34.7	-33.2	-34.3	-35.0	-34.0
Change	**2008**	**2009**	**2010**	**2011**	**2012**
kt	-23.34	-22.08	-21.74	-21.81	-21.16
%	-33.9	-33.1	-33.7	-33.0	-32.3

5.4.6. Source-specific planned improvements

Presently no improvements are planned.

5.5. Field Burning of Agricultural Residues (CRF sector 3.F)

5.5.1. Source category description

Greenhouse gas emissions in 2013 from field burning of agricultural residues amounted for 0.97 kt CH_4 and 0.04 kt N_2O and were slightly higher than in 2010-2012. The share of GHG emissions from field burning of agricultural residues in total agricultural emissions is 0.1%. The trend of GHG emissions within this category is presented on figure 5.9 and fluctuates following the annual crop production.

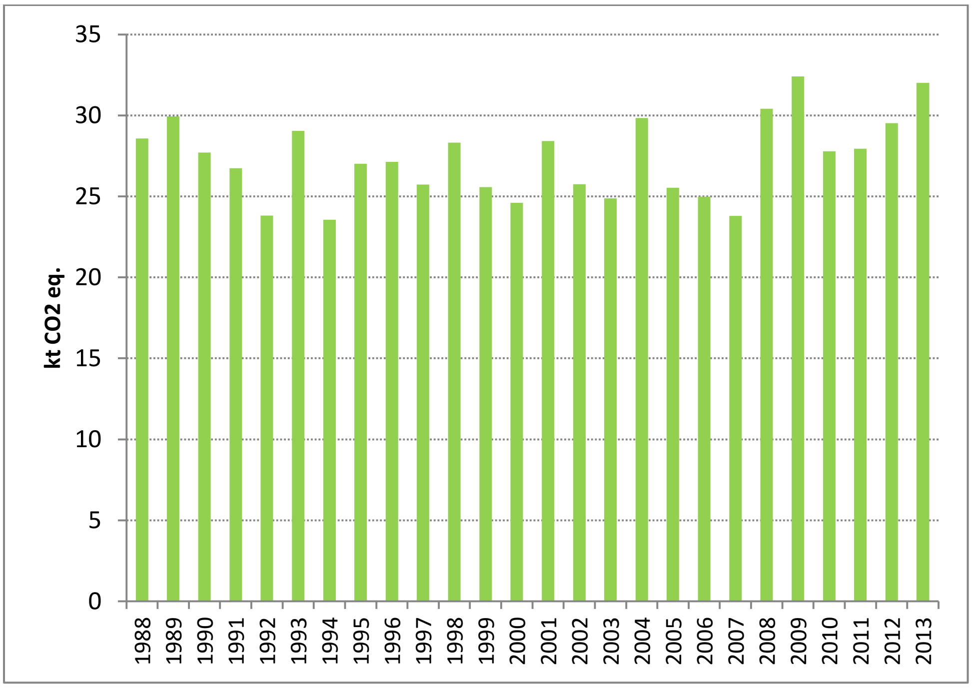

Figure 5.9 CH_4 and N_2O emissions from field burning of agricultural residues presented as CO_2 equivalent

5.5.2. Methodological issues

While estimating GHG emissions in this subcategory only methane and nitrous oxide are taken into account assuming that carbon dioxide released during burning of crop residues is reabsorbed during the next growing season.

Estimation of CH_4 and N_2O emissions from burning of agricultural residues in fields is based on the IPCC methodology [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 which were than aggregated into 32 groups containing cereals, pulses, tuber and root, oil-bearing plants, vegetables and fruits potentially could be burned on fields.

Activity data on crop production comes from public statistics [GUS R3 2014]. Factors applied for emissions calculation were taken from country studies [Łoboda 1994, IUNG 2012] where experimental and literature data as well as default emission factors were used. These values for selected crops are presented in the table 5.20.

Table 5.20. Selected crop residue statistics employed in GHG estimation from field burning of agriculture residues (4.F) and direct soil emissions related to N fixing crops (3.D.1.3) and crop residues returned to soils (3.D.1.4)

Crops	Residue to crop ratio	Dry matter fraction	Fraction burned in fields	Fraction oxidized	Carbon fraction of residue	Nitrogen fraction of residue
winter wheat	0.90	0.85	0.005	0.90	0.4853	0.0068
spring wheat	0.85	0.85	0.005	0.90	0.4853	0.0068
rye	1.40	0.86	0.005	0.90	0.4800	0.0053
spring barley	0.80	0.86	0.005	0.90	0.4567	0.0069
oats	1.10	0.86	0.004	0.90	0.4700	0.0075
triticale	1.10	0.86	0.005	0.90	0.4853	0.0063
cereal mixed	0.90	0.86	0.004	0.90	0.4730	0.0071
buckwheat & millet	1.70	0.86	0.002	0.90	0.4500	0.0090
maize	1.30	0.52	0.002	0.90	0.4709	0.0094
edible pulses	0.90	0.86	0.001	0.90	0.4500	0.0180
feed pulses	1.30	0.85	0.001	0.90	0.4500	0.0203
potatoes	0.10	0.25	0.100	0.85	0.4226	0.0203
rape	1.20	0.87	0.030	0.90	0.4500	0.0068
other oil-bearing crops	3.50	0.87	0.030	0.90	0.4500	0.0068
flax straw	0.25	0.86	0.001	0.90	0.4500	0.0072
tobacco	1.25	0.50	0.002	0.85	0.4500	0.0180
hop	4.00	0.25	0.020	0.90	0.4500	0.0158
hay from greenland	0.05	0.23	0.001	0.90	0.4500	0.0198
hay from pulses	0.05	0.23	0.001	0.90	0.4500	0.0203
hay from clover and lucerne	0.05	0.23	0.001	0.90	0.4500	0.0275
tomatoes	0.60	0.15	0.050	0.85	0.4500	0.0225
other ground vegetables	0.35	0.15	0.010	0.90	0.4500	0.0248
vegetables under cover	0.40	0.35	0.010	0.90	0.4500	0.0270
apples	1.50	0.35	0.050	0.90	0.4500	0.0275
pears and other fruits	1.50	0.35	0.070	0.90	0.4500	0.0149
plums	1.50	0.35	0.100	0.90	0.4500	0.0149
cherries	1.50	0.35	0.100	0.90	0.4500	0.0149
sweet cherries	1.50	0.35	0.100	0.90	0.4500	0.0149
strawberries	0.50	0.18	0.010	0.90	0.4500	0.0149
raspberries	1.20	0.30	0.250	0.90	0.4500	0.0248
currants	1.20	0.30	0.250	0.90	0.4500	0.0149
gooseberries and other berries	1.20	0.30	0.250	0.90	0.4500	0.0149

5.5.3. Uncertainties and time-series consistency

Description of uncertainties is given in Chapter 5.2.3.

5.5.4. Source-specific QA/QC and verification

Activity data related to mineral fertilisers use or crop production come from national statistics prepared by the Central Statistical Office. Overall final estimation of cereals and potatoes output was verified by means of simulative calculation of crops quantity according to the distribution of output between: sale. sowing/planting. fodder and self consumption. Final estimation of sugar beets. rape and turnip rape. and some species of industrial crops were verified with procurement data for these crops. Estimation of fodder crops output in private farms. conducted by local experts of CSO. was additionally verified by the calculation of fodder crops according to the directions of their use. Total area of fodder crops comprises the area of meadows. pastures and field crops for fodder. This area does not include the area of cereals. potatoes. and other agricultural crops. a part of which was directly or indirectly used for fodder.

Emphasis was put on data consistency between sub-categories and between sectors using agricultural data. Emission factors and methodology is compared with international literature and other countries methods/EF applied. Calculations were examined with focus on formulas. units and trends consistency. Generally QC procedures follow QA/QC plan presented in Annex 5.

5.5.5. Source-specific recalculations

No recalculations were made.

5.5.6. Source-specific planned improvements

No improvements are planned presently.

5.6. CO2 emissions from liming (CRF sector 3.G)

5.6.1. Source category description

Category moved from LULUCF sector (see NIR 2014, chapter. 7.3.4.5).
Emissions of CO_2 from lime ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$) application to agricultural soils in 2013 amounted to 70.8 kt and 368.0 kt respectively. Trend in CO_2 emissions of both fertilizers drop since 1988 due to significant changes of agricultural farms after 1989 (see chapter 5.1) as well as current economic situation at rural market (prices of means of production vs. prices of agricultural goods).

5.6.2. Methodological issues

The reported annual carbon emission from agricultural lime application is calculated Tier 1 method using equation 11.12 [IPCC 2006]:

$$CO_2\text{-}C\ \mathit{Emission} = (M_{limestone} \bullet EF_{limestone}) + (M_{dolomite} \bullet EF_{dolomite})$$

where:

CO_2-C *Emission* = annual C emissions from lime application (t C/year)
$M_{limestone}$ – annual amount of calcic limestone ($CaCO_3$) [t / yr]
$M_{dolomite}$ – annual amount of dolomite ($CaCO_3$) [t / yr]
$EF_{limestone}$ – emission factor for limestone – 0.12 [t C / t limestone] [IPCC 2006]
$EF_{dolomite}$ – emission factor for dolomite – 0.13 [t C / t dolomite] [IPCC 2006]

Activity data on use of lime fertilizers is available in national statistics on an annual basis in pure nutrient (CaO) [GUS R2 2014]. So 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.

5.6.3. Uncertainties and time-series consistency

Description of uncertainties is given in Chapter 5.2.3.

5.6.4. Source-specific QA/QC and verification

Description is given in Chapter 5.2.4.

5.6.5. Source-specific recalculations

No recalculations were performed.

5.6.6. Source-specific planned improvements

No improvements are planned at the moment.

5.7. CO_2 emissions from urea fertilization (CRF sector 3.H)

5.7.1. Source category description

Adding urea to soils during fertilisation leads to a loss of atmospheric CO_2 that was fixed in the industrial production process of the fertilizer. Emissions related to this process in Poland amount to 444,6 kt CO_2 and drop since 1988 by 14%.

5.7.2. Methodological issues

The annual carbon emission from urea application is calculated Tier 1 method using equation 11.13 [IPCC 2006]:

$$CO_2\text{-}C\ \mathit{Emission} = M \bullet EF$$

where:

CO_2-C *Emission* = annual C emissions from urea application (t C / year)
M – annual amount of urea fertilization [t urea / yr]
EF – emission factor [t C/ t urea]

Annual amount of urea used for application to soils is derived from data on mineral nitrogen fertilizers used in Poland [GUS R4 2014] and share of urea in nitrogen fertilizers used (Central Statistical Office). Emission factor is the default one from the IPCC 2006 GLs: 0.20 t C/ t urea.

5.7.3. Uncertainties and time-series consistency

Description of uncertainties is given in Chapter 5.2.3.

5.7.4. Source-specific QA/QC and verification

Description is given in Chapter 5.2.4.

5.7.5. Source-specific recalculations

No recalculations were performed.

5.7.6. Source-specific planned improvements

No improvements are planned at the moment.

6. LAND USE, LAND USE CHANGE AND FORESTRY (SECTOR 4)

6.1. Overview of sector

Emissions and removals balance estimations for the LULUCF sector are associated with the estimations patterns contained in the AFOLU guidelines. It should be noted that a number of factors used in the estimations of GHG's assumes default values (recommended by the IPCC). Those factors are considered to be modified on the basis of in-country analysis.

Data included in this inventory is based on statistical data presented in statistical journals published by the Central Statistical Office. The data relating to the land area by the type of usage (in accordance with the methodology recommended by IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry) is based on:

- generalized results of land use and sown area survey conducted on private farms, data on the condition and changes in the registered intended use of land were developed on the basis of annual reports on land, introduced in the following Regulations: of the Minister of Agriculture and Municipal Management of 20 February 1969 on land register (MP No. 11, item 98), from 1997 – of the Minister of Spatial Economy and Construction and of the Minister of Agriculture and Food Economy 17 December 1996 on register of land and buildings (O. J. No. 158, item 813), and from 2002 of the Minister of Regional Development and Construction of 29 March 2001 on register of land and buildings (O. J. No. 38, item 454).

The consecutive regulations introduced changes in classifications of land. Subsequent changes were implemented inter alia due to adoption of the international standards. Beginning with data for 1997 on, the registers of land were prepared by the Chief Office of Geodesy and Cartography as well as voivodship branches of geodesy and land management. The data are presented, taking into consideration geodesic area.

6.1.1. The greenhouse gas inventory overview of the Land Use, Land-Use Change and Forestry (LULUCF) sector

The greenhouse gas inventory of LULUCF sector comprises emissions and removals of CO_2 due to overall carbon gains or losses in the relevant carbon pools of the predefined six land-use categories. The liming of agricultural lands is included in the LULUCF sector, as well. The non-CO2 emissions from biomass burning and disturbance associated with land-use conversion to cropland are also to be reported here. These activities in 2013 altogether resulted in net removals estimated to be equal to 37 627 kt of CO2 equivalent.

Table 6.1.1 Total GHG emissions and removals from LULUCF sector in 2013

Greenhouse gas source and sink categories	2013		
	Net CO_2 emissions/removals	CH_4	N_2O
	(kt)		
4. Total Land-Use Categories	-37 627.315	108.129	0,031
4.A. forest Land	-41 421.753	1.388	0,009
4.A.1. forest land remaining forest land	-39 130.908	1.388	0,005
4.A.2. land converted to forest land	-2 290.846	0.001	0,004
4.B. Cropland	-435.678	NO	0.67
4.B.1. cropland remaining cropland	-665.102	NO	NO
4.B.2. land converted to cropland	229.423	NO	0.67
4.C. Grassland	-348.425	0.091	0.00
4.C.1. grassland remaining grassland	408.998	0.091	0.00
4.C.2. land converted to grassland	-757.423	NO	NO
4.D. Wetlands	4 316.309	106.65	0.02
4.D.1. wetlands remaining wetlands	4 119.979	NO	NO
4.D.2. land converted to wetlands	196.330	106.65	0.02
4.E. Settlements	262.232	NO	NO
4.E.1. settlements remaining settlements	-138.092	NO	NO
4.E.2. land converted to settlements	400.324	NO	NO
4.F. Other Land	NO	NO	NO
4.F.1. other Land remaining other Land	NO	NO	NO
4.F.2. land converted to other Land	NO	NO	NO
4.G. Other	NA	NA	NA

IE – included elsewhere, NO – not occurring

The most important category recognised to be the main source of CO_2 removals is the subcategory 4.*A forest land*. This situation is, to some extent, related to the recorded growth of timber resources. It shall be noted that the recorded growth, is the result of timber harvest carried out in accordance with the forest sustainability principle and furthermore persistent enlargement of the forest area.

6.1.2. Country area balance in 2013

Table 6.1.2 Country area balance in 2013

Year	2013
Greenhouse gas source and sink categories	Area [ha]
4. Total land-use categories	
4.A. forest land	9 369 403
4.A.1. forest land remaining forest land	8 703 915
4.A.2. land converted to forest land	665 488
total organic soils on forest land, of which	247 865
on forest land remaining forest land	235 594
on land converted to forest land	12 271
4.B. cropland	
total cropland area	14 103 689
4.B.1. cropland remaining cropland	13 782 624
4.B.2. land converted to cropland	321 064
total organic soils on cropland, of which	539 826
on cropland remaining cropland	539 826
on land converted to cropland	NO
4.C. grassland	
total grassland area	4 162 123
4.C.1. grassland remaining grassland	3 968 095
4.C.2. land converted to grassland	194 028

Year	2013
total organic soils on grassland, of which	148 425
on grassland remaining grassland	148 425
on land converted to grassland	NO
4.D. wetlands	
total wetlands area	1 370 864
4.D.1. wetlands remaining wetlands	1 309 179
4.D.2. land converted to wetlands	61 685
total organic soils on wetland, of which	276 600
on wetlands remaining wetlands	276 600
on land converted to wetlands	NO
4.E. settlements	
total settlements area	2 163 440
4.E.1. settlements remaining settlements	1 951 791
4.E.2. land converted to settlements	211 648
4.F. other Land	98 447
Country area balance	31 267 967

6.1.3. Land uses classification for representing LULUCF areas

With regard to the fact that for the reporting purposes to the United Nations Framework Convention on Climate Change and the Kyoto Protocol it is recommended to match national land-use categories (as specified in the Regulation of the Minister of Administration and Digitization of 29 November 2013 amending the regulation on the registration of land and buildings *(Journal of Laws 2013 pos. 1551))* to the appropriate categories of land use consistently to the IPCC guidelines (Chapter 3.3.1. of IPCC 2006 Guidelines of the Volume 4). To fulfil previously mentioned recommendations available data was summarized taking to account provided in the table 7.1.3.

Table 6.1.3 Land use adjustment.

IPCC category	National Land Identification System
4.A forest land	forest land
4.B cropland	arable land, orchards,
4.C grassland	permanent meadows and pastures; woody and bushy land
4.D wetland	land under waters (marine internal, surface stands); land under ponds; land under ditches;
4.E settlements	agricultural build-up areas; build-up and urbanized areas; ecological arable land; wasteland
4.F Other land	miscellaneous land

6.1.4. Key categories

Key category assessment for LULUCF category is included in annex 1.

6.2. Forest Land (CRF sector 4.A.)

6.2.1. Source category description

Estimations for this subcategory were based on IPCC methodology described in the chapter 4 of IPCC 2006 guidelines of the Volume 4. GHG balance in this category in 2013 is a net CO_2 sink, estimated to be equal to 41 421 kt CO_2.

6.2.1.1. Area of forest land in Poland in year 2013

Forest land reported under subcategory 4.A. is classified as a "forest" consistent to Art. 3 of *Act on Forests of 28 Sep 1991 (Journal of Law of 1991 No 101 item 444, as amended).* This assessment is consistent with internationally adopted standard which takes into account the forest land associated with forest management. Forest land area in Poland, as of 1 January 2014, was equal to 9 369 403 ha *(GUS Environmental protection 2014)*.

Table 6.2.1Forest land area by provinces as of the end of inventory year.

No	Voivodship	Unit	2008	2009	2010	2011	2012	2013
	Total	[ha]	9 251 404	9 275 786	9 304 762	9 329 174	9353731	9369403
1.	**Dolnośląskie**	[ha]	606 104	607 327	608 387	609 279	610583	610968
2.	**Kujawsko-pomorskie**	[ha]	425 207	426 170	427 147	427 843	428254	428491
3.	**Lubelskie**	[ha]	568 601	572 620	576 420	579 237	581002	582307
4.	**Lubuskie**	[ha]	706 788	707 583	708 201	709 002	709881	710350
5.	**Łódzkie**	[ha]	386 172	387 711	388 597	389 350	390358	390950
6.	**Małopolskie**	[ha]	439 126	438 280	439 765	440 114	440432	440664
7.	**Mazowieckie**	[ha]	802 158	804 912	808 810	812 973	817869	824660
8.	**Opolskie**	[ha]	257 858	258 170	258 246	258 399	258570	258846
9.	**Podkarpackie**	[ha]	671 363	674 450	677 953	680 166	683371	683462
10.	**Podlaskie**	[ha]	621 718	624 856	626 532	627 235	628678	629184
11.	**Pomorskie**	[ha]	676 165	677 673	678 226	679 898	681014	681537
12.	**Śląskie**	[ha]	400 709	399 592	399 954	401 747	402014	402307
13.	**Świętokrzyskie**	[ha]	331 492	332 089	332 487	332 980	402364	334796
14.	**Warmińsko-mazurskie**	[ha]	752 146	755 050	760 064	763 567	334385	769824
15.	**Wielkopolskie**	[ha]	778 863	780 795	783 340	784 649	785648	785998
16.	**Zachodniopomorskie**	[ha]	826 934	828 508	830 633	832 735	834009	834760

6.2.1.2. Habitat structure

The diversity of growing conditions for forests in Poland is linked to the natural-forest habitats allocations as presented on Fig. 6.3

Poland has mainly retained forests on the poorest soils, which is reflected in the structure of forest habitat types. Coniferous habitats prevail, accounting for 51.7% of the total forest area, while broadleaved habitats cover 48.3% . In both groups, a further distinction is made between upland habitats which occupy 5.7% of the forest area and mountain habitats which occupy 8.6%.

Figure 6.1 Regionalization of natural-forest habitats in Poland

6.2.1.3. Species composition

The geographical distribution of habitats is, to a great extent, reflected in the spatial structure of dominant tree species. Apart from the mountain regions where spruce (west) and spruce and beech (east) are the main species in stand composition, and a few other locations where stands have diversified species structure, in most of the country stands with pine as the dominant species prevail.

Coniferous species dominate in Polish forests, accounting for 69.6 % of the total forest area. Poland offers optimal climatic and site conditions for pine within its Euro-Asiatic natural range, which resulted in development of a number of important ecotypes (e.g. the Taborska pine or the Augustowska pine). Pine accounts for 59.1 % of the area of forests in all ownership categories, for 60.9 % in the State Forests and for 56.0 % in the privately-owned forests.

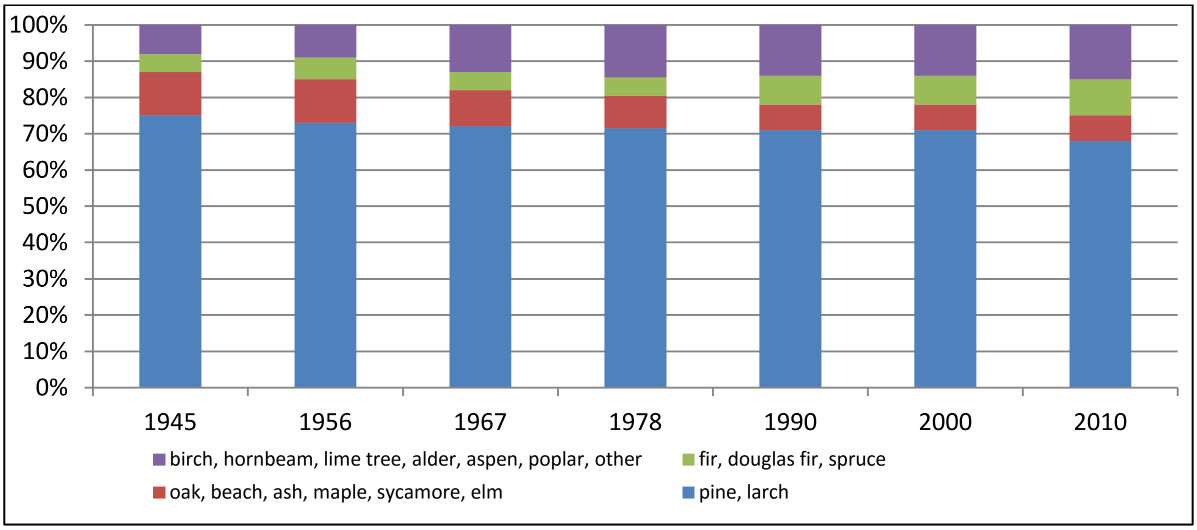

Figure 6.2. Spatial structure of dominant tree species

Since 1945 forest species structure has undergone significant changes, expressed, inter alia, by increased share of stands for deciduous trees. Considering state forests, where it possible to trace this phenomenon on the basis of annual updates of forest land area and timber resources, total area of deciduous stands increased from 13 to 27.2%. Despite the increase in the surface of deciduous forests, their share is still below potential, arising from the structure of forest habitats.

6.2.1.4. Age structure

Stands aged 41–80 years, representing age classes III and IV prevail in the age structure of forests and cover 25.8 % and 18.9 % of the forest area respectively. Moreover, stands aged 41–80 years are dominating in total forests area, with their total share equal to nearly 45 %. Stands older than 100 years, including stands in the restocking class , stands in the class for restocking and stands with selection structure, account for 24.0 % of the total forest area

6.2.1.5. Structure of timber resources by volume

According to the Statistical Yearbook " Forestry 2014", estimated timber resources as of the end of 2013 amounted to 2 439 839 m^3 of gross merchantable timber, including 2 047 043 m^3 in the public forests and 392 796 m^3 in private forests.

6.2.2. Information on approaches used for representing land area and on land-use databases used for the inventory preparation

According to the description suggested in the chapter 3.3.1. of IPCC 2006 Guidelines of the Volume 4, managed forest land areas associated with the forestry activities in Poland is identified using Approach 3. Geographic boundaries encompassing units of land subject to multiple activities are indentified based on data *on the condition and changes in the registered intended use of land* developed on the basis of annual reports on land.

6.2.3. Land-use definitions and classification system used and their correspondence to the LULUCF categories

With regard to the regulations of art. 3 of the Act on Forests of September 28th 1991 *(Journal of Law of 1991 No 101 item 444, as amended)*, forest land is the area:

1) of contiguous area greater than or equal to 0.10 ha, covered with forest vegetation (or plantation forest) – trees and shrubs and ground cover, or else in part deprived thereof, that is:
    a. designated for forest production, or
    b. constituting a Nature Reserve or integral part of a National Park, or
    c. entered on the Register of Monuments;
2) of contiguous area greater than or equal to 0.10 ha, associated with forest management.

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

- 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.

6.2.4. Forest Land remaining Forest Land (CRF sector 4.A.1)

GHG balance in this category is a net sink. In 2013 net CO_2 sink was about 39 130 kt CO_2. For the methodologies used, see following chapters

6.2.4.1 Methodological issues

Due to the intensive forest monitoring as described above, all forest stands are continuously accounted for. This also means that all changes in the biomass carbon stocks of the forests due to any causes from growth through harvests, natural disturbances and deforestation are captured by the forestry statistics of each stand at least on a decade scale, and those of the whole forest area even on an annual basis.

6.2.4.2 Subcategory area

Land use matrix is presented in the annex 6

Considering the provisions of the decision 9/CP.2 `Communications from Parties included in Annex I to the Convention: guidelines, schedule and process for consideration` where it is decided that the four Parties that have invoked Article 4.6 of the Convention, which requested in their first communications for flexibility to use base years other than 1990, Poland has chosen the year 1988 to be set as a starting point for the reported transitions according to the IPCC 2006 guidelines.

6.2.4.3. Living biomass

Carbon stock changes

Annual change in carbon stocks in living biomass reservoir was estimated considering the changes in forest resources on forest land all forms of ownership, using the information contained in the statistical yearbooks "Forestry". Estimations were based on the equation 2.8 contained in the IPPC guidelines; as suggested in the Volume 4, Chapter 2.3.1.1. Data sources contains tables describing forest resources species cover and age classes.

Carbon stock change method has been applied since the 2014 national greenhouse gas inventory . Previously, carbon stock changes had been calculated, following the early advice of the IPCC 1996 Guidelines, using the "IPCC default method" (or gain-loss method) where data on changes due to growth, harvests and disturbances was used. However, as it was noted several times in earlier NIRs, relatively high uncertainties are inherent in these data due to different reasons, therefore, we changed for the stock-change method.

As mentioned above, the general methodology to estimate emissions and removals in the forestry sector is based on the IPCC methodology (IPCC 2006). However, wherever it was possible, country specific data was used (Tier 2), and IPCC default values (Tier 1) were only used in a few cases.Changes in carbon stocks in the biomass pool are accounted annually on the basis of the Polish forestry statistics which provides relevant information, describing aboveground volume of all forests at the country level, available annually for the each inventory year. Moreover gross merchantable volume stock used in the above mentioned calculations is estimated on the basis of data obtained from the most recent 5-year cycle of large-scale inventory, published in the form of official statistics by the Central Statistical Office.

Fortunately, the State Forest Holding's data base also contains aggregate annual statistics on total growing stocks by species and age classes. These statistics are produced by a bottom-up approach, i.e. growing stocks of stands are aggregated by species and age classes. There are uncertainties around these statistics, however, they are regarded smaller than those associated with a gain-loss method and systematic errors. We noted that since growing stocks and their changes incorporate the effects of all processes mentioned above, no particular inferences on emissions and removals can be made separately for any of these processes.

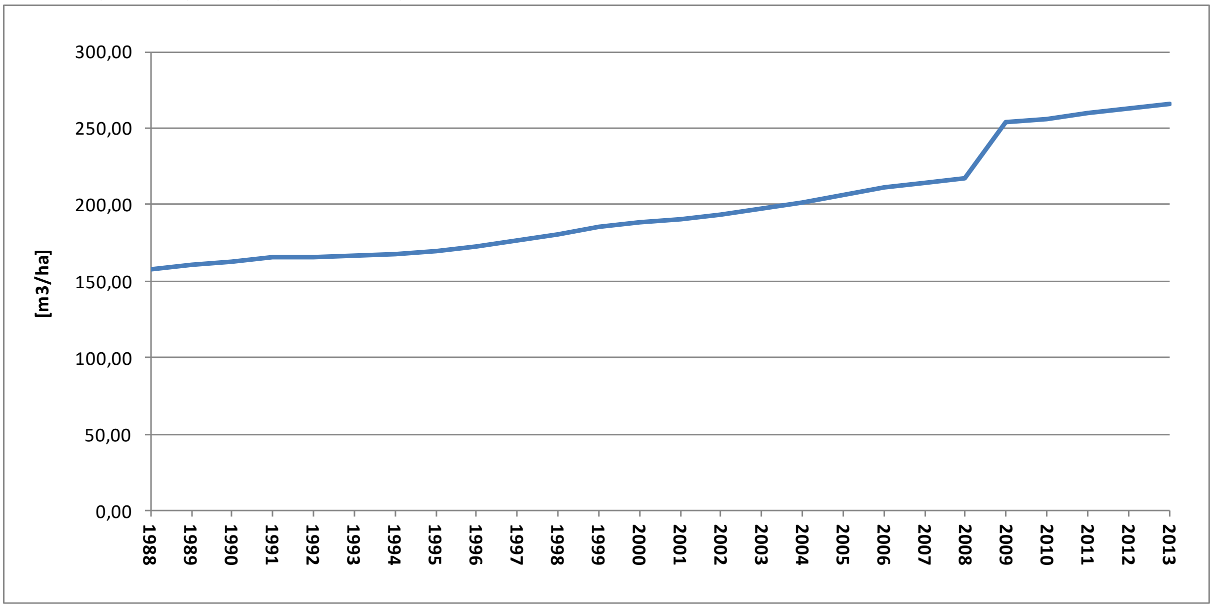

Figure 6.3 Average volume stock of merchantable timber in Polish forests .

The forest inventory is conducted by the Forest Management and Geodesy Bureau and its branches. The inventory data is stored by stand in a computerized database, i.e. the National Forest Database During the continuous survey of the forest inventory, the main stand measures (such as height, diameter, basal area, and density) are estimated by various measurement methods. The survey also includes mapping of the forest area. The survey methods applied in individual stands depend on species, age and site. Since the recent forest inventory scheme is based on survey's considering measurements of individual sample plots, more accurate results were obtained from the year 2009.

For carbon stock changes in biomass, the system of calculations allows for the use of even simpler sensitivity analysis than before. This is especially true if only the major sources of CO_2 emissions and removals are considered, which represent the bulk of all emissions and removals. The reason for this is that the equation inherent in the calculation is simple: only volume stock changes, wood density, root-to-shoot ratio, and carbon fraction factors are involved. With respect to accuracy and precision, the reported estimated values are generally accurate and precise as far as practicable. Where uncertainty seems to be high, and for non-quantifiable factors, the principle of conservativeness is always applied. With regard to carbon stock change estimation, it can be concluded that many sources of error were removed by switching from the process-based method to the stock-change method. Thus, it is expected that current estimates better reflect emissions and removals associated with forest land than previous estimates.

6.2.4.4. Basic wood density

Basic wood density was calculated based as the weighted mean of wood density by wood species. To calculate the basic air-dry wood density values, the specific gravity of dry wood and shrinkage of the total volume were used for each species. Scheme for weighted mean wood density calculation is presented in table below:

Table 6.2.1. Scheme for weighted mean wood density calculation by wood species.

Species	Air-dry wood density [t/m^3]	Volume of thick [thous. m^3]	Share of each species in weighted mean wood density [t/m^3]
	A	B	E=A*B
Pine	0.43	1288628,90	0,2999
Spruce	0.38	104980,00	0,0215
Fir	0.36	54218,50	0,0106
Beech	0.57	108221,80	0,0334
Oak	0.57	128353,80	0,0395
Hornbeam	0.63	4875,30	0,0017
Birch	0.52	75904,30	0,0215
Alder	0.43	73541,70	0,0171
Poplar	0.35	1192,80	0,0002
Aspen	0.36	4247,60	0,0008
Total	-	1844164,70	-
Weighted mean wood density			**0.4464**

In order to maintain data integrity, estimations were based on data available for the State Forests (Annual update of forest area and woody biomass in State Forests as of 1 January... (Forest Management and Geodesy Bureau. Warszawa. 1969-2013)) and are extrapolated for other forests.

6.2.4.5. Biomass conversion and expansion factor

Biomass conversion and expansion factor was adjusted on the basis of default values proposed to be used by the IPCC in the framework of IPCC 2006 Guidelines; Volume 4, table 4.5.

Table 6.2.2. Scheme for calculation of BCEF .

BEF_2 – coniferous species	A	dimensionless	1.30
BEF_2 – deciduous species	B	dimensionless	1.40
Gross merchantable timber – coniferous species	C	[thous. m^3]	1425780
Gross merchantable timber – deciduous species	D	[thous. m^3]	388868
Gross merchantable timber – total	E	[thous. m^3]	1814649
BEF_2 – weighted mean	F=((A*C)+(B*D))/E	dimensionless	**1.3214**
BCEF – weighted mean		dimensionless	**0.5835**

In order to maintain data integrity, estimations were based on data available for the State Forests (Annual update of forest area and woody biomass in State Forests as of 1 January... (Forest Management and Geodesy Bureau. Warszawa. 1969-2013)) and extrapolated for other forests.

6.2.4.6. Root-to-shoot ratio

Root-to-shoot ratio was adjusted based on weighted average default values proposed to be used by the IPCC in IPCC 2006 Guidelines of the Volume 4, table 4.4.

Table 6.2.3. Scheme of R factor calculation

R – coniferous species	A	R (default)	0.23
R– deciduous species	B	R (default)	0.24
Gross merchantable timber – coniferous species	C	m^3	1447827,40
Gross merchantable timber – deciduous species	D	m^3	396337,30
Gross merchantable timber – total	E	m^3	1844164,7
R- weighted mean	F=((A*C)+(B*D))/E		0.2108

In order to maintain data integrity, estimations were based on data available for the State Forests (Annual update of forest area and woody biomass in State Forests as of 1 January...(Forest Management and Geodesy Bureau. Warszawa. 1969-2013) and extrapolated for other forests.

6.2.4.7. Carbon fraction

Estimations are based on the following default factor:

- fraction of carbon in the dry matter: 0.47 [IPCC 2006];

6.2.4.8. Dead organic matter

It is assumed that this reservoir is not the net source of CO_2 emissions, relevant reporting tables related to dead organic matter , were filled up with the notation" NO".

What should be highlighted, the potential carbon gains might have a positive impact on final carbon balance related to the category *4.A.1 forest land remaining forest land*, therefore recent approach may lead to the potential overestimation of net emissions.

Current demonstration that this reservoir in not a source depends on the data availability, generally following justifications were considered:

1. direct implementation of Tier 1 description suggested in the chapter 4.2.2.1 of IPCC 2006 Guidelines of the Volume 4, assuming that the average transfer rate into the dead organic matter reservoir is equal to the transfer rate out of this pool so the net change is in equilibrium;
    2. expert judgments based on a combination of qualitative and quantitative arguments, like international references to the neighbouring country's GHG's inventories;
    3. conservative assumptions based on in-country forestry practices, as described below:

In the last decades, the close-to-nature forest management has been promoted in Poland and clear cuts were limited, especially after the adoption of the most recent Forest Act of 1991. This Act requests that semi natural forests must be managed in an increasingly natural way, which includes leaving more deadwood in the forest after harvests than before, as well as creating and maintaining gaps, and enhancing species mixture. It should be noted that the recent increasing share of broadleaved species in the species structure drives important positive role in the final changes of CS in dead organic matter pool. As a result of the implementation of these requirements, we can assume the accumulation of dead wood in the Polish forests is stable.

The other reason of the increase of dead organic matter stock in all forests is that about one-third of all forests are afforestations since 1945 (post World War II afforestations) and most of these forests are still in their intensive growing phase, which means that carbon stocks of the dead organic matter pool have not saturated yet. Finally, no major disturbances or other processes have occurred that could have resulted in substantial emissions from the dead organic matter pool.

6.2.4.9. Mineral soils

Annual change in carbon stocks in the litter reservoir was estimated using equation 2.25 contained in IPCC 2006 Guidelines of the Volume 4, section 2.3.3. For the needs of equation application, default reference values of SOC_{ref} were considered to be used linked with the dominant tree habitats.

Table 6.2.4 Forest habitant types in Poland with the SOC_{ref} assignment

SOC_{ref}	Forest habitat types
high active SOC ref (50 [MgC/ha])	Fresh mixed forest, moist mixed forest, mixed upland forest, mountain mixed forest, fresh broadleaved forest, moist broadleaved forest upland forest, mountain forest
low active SOC ref (33[MgC/ha])	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 SOC ref (34 [MgC/ha])	Dry coniferous forest, fresh coniferous forest 0,5* fresh mixed coniferous forest
wetland SOC ref (87 [MgC/ha])	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 6.2.5 Percentage share of soil types by land use system (for time t and t–20)

Habitats	**2013 (t)**	**1993 (t-20)**
high activity	45.5	33.3
low activity	19.7	19.5
sandy	32.1	42.9
wetland	4.6	3.7
Sum	100.0	100.0

Carbon stock changes in mineral soils were estimated based ion following references contained in the IPCC 2006 Guidelines of the Volume 4, section 2.3:

- transitional period - 20 years
- $f_{man\ intensity}$ - 1.0
- $f_{dist\ regime}$ - 1.0
- $f_{forest\ type}$ - 1.0

6.2.4.10. Organic soils

The area of cultivated histosols in Poland was estimated as a case study for the purposes at 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. The area of histosols was then interpolated for 1976–1994.

Additionally the area of cultivated histosols was assessed for 2015 for the purpose of GHG emission projections which amounts to 680 thousand ha [PLNC6 2013]. Similarly to the previous period interpolation of histosols areas was applied between 1995 and 2015. 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 are increasing from 12% at the beginning of 1970-ties to 16.5 % in 1990-ties.

Total organic soils area in 2013 was estimated for ha with the following split for subcategories: forest land remaining forest land – 234 076 ha land converted to forest land – 17 383 ha. Emissions from organic soils on forest land were estimated with the default EF contained in the table 4.6 of IPCC 2006 Guidelines of the Volume 4.

Table 6.2.6 CO_2 emission factor for drained organic soils

Name	Volume	Unit
$EF_{drainag}$	0.68	[tC/ha/rok]

6.2.4.11. Biomass burning

According to the article 30 of *Act on forests of 28th September, 1991 (Journal of Law of 1991 No 101 item 444, as amended)* the burning of surface soil layers or remnants of vegetation is forbidden. In relation to this record it is considered that controlled biomass burning does not occur on forests. CH_4, N_2O, CO and NO_x emissions from uncontrolled forest fires were calculated using following equation (IPCC 2006, page 2.42. equation 2.27):

Table 6.2.7. Emissions ratios for calculation CH_4, N_2O, CO and NO_x emissions from forests fires[table 2.5 p. 2.47 of IPCC 2006 Guidelines, Volume 4]

Compound	Ratio [g/kg d.m]		
CH_4	6.1	default	[IPCC 2006]
CO	78.0	default	[IPCC 2006]
N_2O	0.06	default	[IPCC 2006]
NO_x	1.1	default	[IPCC 2006]

6.2.5. Land converted to Forest Land (CRF sector 4.A.2)

GHG balance in this category is a net sink. In 2013 net CO_2 sink was approximately 2 290.85 kt CO_2. For the methodologies used, see following chapters.

6.2.5.1 Methodological issues

Due to the intensive forest monitoring as described above, all forest stands are continuously accounted for. This also means that all changes in the biomass carbon stocks of the forests due to any causes from growth through harvests, natural disturbances and deforestation are captured by the forestry statistics of each stand at least on a decade scale, and those of the whole forest area even on an annual basis.

6.2.5.2. Subcategory area

Land use matrix is presented in the annex 6

6.2.5.3. Living biomass

Annual change in carbon stocks in living biomass reservoir was estimated considering the annual gains and losses with the equation 2.16 (section 2.3.1 of IPCC 2006 guidelines of the Volume 4). For the needs of equation application, default reference values of biomass increment were considered to be used.

Table 6.2.8. Default biomass increment.

Name	Value	Unit
G_{ext}	4	[m^3/ha/year]

6.2.5.4. Dead organic matter

Carbon stock changes in dead wood on afforested and reforested areas is assumed to be equal to zero, therefore reported as 'NO'. The accumulation of dead wood was assumed to be marginal on afforested and reforested sites, during 1993-2013, and also dead wood pool cannot decrease on those sites, because there is actually no dead wood there before the conversion. The dead wood starts to accumulate when natural mortality or thinnings occur that is nearly at the age of over 20 years. To keep correctness in CRF tables notation keys NO (not occurring) were used in the relevant table. Additionally, when an area is afforested, first it is cleared of all above-ground biomass in case there was any, however, no DW and LI are usually present on these lands prior to afforestations. After afforestations, dead woody debris, litter as well as dead trees start to accumulate. In lack of representative measurements, the rate and timing of accumulation is not known, however, standard forestry experience suggests that they depend on species, site and silvicultural regime, and quickly accumulate over time. Fast growing species are usually planted so that no large amount of deadwood is produced, or thinned so that self-thinning does not ensue, but litter is continuously produced even in these stands. On the other hand, slow-growing species tend to produce dead wood and litter even at an early stage.. The above demonstration is based upon well-established principles of forest science, the every-day experiences of forestry practice, the experience and data of forest surveys, as well as sound reasoning. Because of this, although no representative measurements have been made as mentioned, the level of confidence of the demonstration is suggested to be very high. To keep correctness in CRF tables notation keys NO (not occurring) were used in the relevant table.

6.2.6. Uncertainties and time-series consistency

Detailed information contain chapter 6.6.5

6.2.7. Category-specific QA/QC and verification

Detailed information contain chapter 6.6.6

6.2.8. Recalculations

Detailed information contain chapter 6.6.7

6.2.9. Planned improvements

Detailed information contain chapter 6.6.8

6.3. Cropland (CRF sector 4.B.).

6.3.1. Source category description

Estimations for category 4.B. were based on IPCC methodology described in the chapter 5. of IPCC 2006 guidelines of the Volume 4.

6.3.1.1. Cropland remaining Cropland (CRF sector 4.B.1.)

GHG balance in this was identified as a net CO_2 source. Net CO_2 balance was equal to 435 kt CO_2 removals.

6.3.1.2. Land converted to Cropland (CRF sector 4.B.2.)

GHG balance in this was identified as a net CO_2 source. Net CO_2 balance was equal to 103 ktCO_2

6.3.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

According to the description suggested in the chapter 3.3.1. of IPCC 2006 Guidelines of the Volume 4, Poland has selected Approach 2, considering the set of information's available in the register of land and buildings.

6.3.3. Land-use definitions and classification system used and their correspondence to the LULUCF categories

According to the Regulation of the Minister of Administration and Digitization of 29 November 2013 amending the regulation on the registration of land and buildings. (Journal of Laws 2013 pos. 1551),agricultural land considered as cropland consists of:

- arable land includes land which is cultivated, i.e. sowed and fallow land. Arable land should be maintained in good agricultural condition. Cultivated arable land is understood as land sowed or planted with agricultural or horticultural products, willow and hops plantations, area of greenhouses, area under cover and area of less than 10 a, planted with fruit trees and bushes, as well as green manure,
- fallow land includes arable land which are not used for production purposes but are maintained in good agricultural condition;
- orchards include land with the area of at least 10 a, planted with fruit trees and bushes.

6.3.4. Methodological issues

6.3.4.1. Subcategory area

Land use matrix is provided in the annex 6

6.3.4.2. 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 using equation 2.7 of IPCC 2006 guidelines of the Volume 4. For calculations there were used default factors as below:

- biomass accumulation rate – 2.1 [tC/ha] table 5.1 p. 5.9,
- harvest/maturity cycle – 30 [year] table 5.1 p. 5.9,

biomass carbon loss – 63 [t/ha*yr] table 5.1 p. 5.9,

6.3.4.3. Mineral soil

Agricultural land valuation classes with the assignment to IPCC soils types.

- high activity soils - soils having appreciable contents of high activity clays (eg. 2:1 expandable clays such as montmorillonite) which promote long-term stabilization of organic matter, particularly in many carbon-rich temperate soils.
- low activity soils - soils with low-activity clays (eg., 1:1 non-expandable clays such as kaolinite and hydropus oxide clays of iron and aluminum) which have a much lower ability to stabilize organic matter and consequently respond more rapidly to changes in the soil's carbon balance; among these are highly-weathered acid soils of subtropical and tropical regions.
- sandy soil - soils with less than 8% clay and more than 70% sand, which generally have low structural stability and low capacity to stabilize carbon.
- wetland - mineral soils which have developed in poorly-drained, wet environments; they have reduced decomposition rates and high organic matter contents; if drained for agriculture they are subject to large losses of carbon.

Estimation of area of different soil types (high activity soils, low activity soils, sandy and wetland) were based on area of soil valuation classes. The percentage fraction of all soil types in croplands was calculated based on available data sets.

Table 6.3.1. Area of soil valuation classes

Valuation classes	1976	1979	1985	1990	2000
	thous. ha				
agriculture land					
Total	**19349,4**	**19200,5**	**18945**	**18804,8**	**18536,9**
I	71	70.7	70	68.7	67.8
II	547.6	551.1	550.3	544.1	536.4
III	4153.2	4152.1	4199.1	4201.6	4201.9
IV	7627.5	7611.8	7545.6	7493.4	7402.9
V	4522	4441	4310.3	4267.2	4197.2
VI	2428.1	2373.8	2269.7	2229.8	2114.9
land not classified	0	0	0	0	15,8
arable land and orchard					
Total	**15173.7**	**15073.4**	**14818**	**14682.8**	**14451.1**
I	69	68.5	67.4	66.5	65
II	480	483.8	485	482.2	479.6
III	3621.5	3618.9	3643.7	3650.7	3664.6
IV	5961	5924.2	5807.6	5743.4	5640.2
V	3151.8	3114.5	3018.3	2976.2	2908.3
VI	1890.4	1863.5	1796.1	1763.8	1682.6
Land not classified					10.8

Due to limited data availability, linear interpolation was applied between the subsequent years. Since 2000, estimations are based on the latest available data sets from the year 2000.

Table 6.3.2 Valuation classes of agricultural land with the SOC_{ref} assignment.

Soil type	Soil valuation classes
high activity	I, II, III
low activity	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. Valuation classes of agricultural land are presented in table 7.3.1.

Table. 6.3.3. Soil organic carbon by land use system and soil types

Land-use/ management system	Soil by IPCC	Carbon in soils [Mg C/ha]
		default IPCC
agricultural crops	high activity soils	50
	low activity soils	33
	sandy	34
	wetland	87

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) = 0.80 [IPCC 2006 tab. Tab. 5.5 page 5.17].
- stock change factor for management regime in the beginning of inventory year – F_{MG}(0-T)=1.00 [IPCC 2006 tab. Tab. 5.5 page 5.17].
- Stock change factor for input of organic matter in the beginning of inventory year – F_I(0-T)=0.95 [IPCC 2006 tab. Tab. 5.5 page 5.17].
- Stock change factor for land use or land-use change type in current inventory year – F_{LU}(0)= 0.80 [IPCC 2006 tab. Tab. 5.5 page 5.17].
- Stock change factor for management regime in current inventory year –F_{MG}(0)=1.00 [IPCC 2006 tab. Tab. 5.5 page 5.17].
- Stock change factor for input of organic matter in current inventory year – F_I(0) = 0.95 [IPCC 2006 tab. Tab. 5.5 page 5.17].

6.3.4.4. Organic soils

The area of cultivated histosols in Poland was estimated as a case study for the purposes at 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. The area of histosols was then interpolated for 1976–1994. Additionally the area of cultivated histosols was assessed for 2015 for the purpose of GHG emission projections which amounts to 680 thousand ha [PL NC6 2013]. Similarly to the previous period interpolation of histosols areas was applied between 1995 and 2015.

N_2O emission from cultivation of histosols was estimated based on default emission factor for Mid-Latitude Organic Soils from [IPCC 2006]: 8 kg N_2O-N /ha. N_2O emission is reported in sector 4. Agriculture in subcategory 3.D.a.6.

To estimate CO_2 emission from cultivated organic soils were used default emission factor for cold temperate climate – 5 tC/ha*year [tab. page 5.19 IPCC 2006].

6.3.4.5. CH_4, N_2O, CO and NO_x emissions

CH_4, N_2O, CO and NO_x emissions from wildfires fires on croplands are reported in subcategory 4.C.1.

6.3.4.6. Mineralised N resulting from loss of soil organic C stocks in mineral soils through land-use change or management practices

This category deals with direct N2O emissions from N mineralization resulting from change of land use or management of mineral soils. Tier 3 method was not applied to the estimation in this subcategory in Poland. Therefore, according to the 2006 IPCC Guidelines, N immobilization associated with gain of soil carbon on mineral soils is not considered. Consequently, only N_2O emissions from mineralization associated with loss of soil organic matter (SOM) were estimated.

For amount of N mineralized in mineral soil associated with land use change, annual loss of soil carbon in mineral soil for estimating carbon stock changes in mineral soils was used. The area of mineral soil in land use change, which are calculated by subtracting the area of organic soil from the total area of land converted to cropland, were considered for the estimation as the activity data.

Estimation of the N release by mineralization was made according to the following steps presented below:

- Step 1: Calculations of the average annual loss of soil C (ΔCMineral, LU) for the land use change, over the inventory period, using equation 2.25.
- Step 2: Each land use change has been assessed by the single value of ΔCMineral, LU As a consequence of this loss of soil C (FSOM), equation 11.8 was applied to estimate N potentially mineralized .

Losses of soil organic matter were accounted for land-use change activity occurring when grassland is converted to cropland. Additionally, nitrogen mineralisation was estimated by dividing the carbon loss on grasslands converted to croplands with a C/N-ratio of 15 (default value from IPCC 2006).

6.3.5. Uncertainties and time-series consistency

Detailed information contain chapter 6.6.5

6.3.6. Category-specific QA/QC and verification

Detailed information contain chapter 6.2.6

6.3.7. Recalculations

Detailed information contain chapter 6.6.7

6.3.8. Planned improvements

Detailed information contain chapter 6.2.8

6.4. Grassland (CRF sector 4.C.)

6.4.1. Source category description

Calculation for category 4.C. based on IPCC methodology described in the chapter 6 of IPCC 2006 guidelines of the Volume 4.

6.4.1.1. Grassland remaining Grassland (CRF sector 4.C.1.)

GHG balance in this was identified as a net CO_2 source. Net CO_2 balance was equal to 409 kt of CO_2 emissions .

6.4.1.2. Land converted to Grassland (CRF sector 4.C.2.)

GHG balance in this was identified as a net CO_2 sink. Net CO_2 balance was equal to 757 kt of CO_2 removals.

6.4.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

According to the description suggested in the chapter 3.3.1. of IPCC 2006 Guidelines of the Volume 4, Poland has selected Approach 2, considering the set of information's available in the register of land and buildings.

6.4.3. Land-use definitions and classification system used and their correspondence to the LULUCF categories

According to the Regulation of the Minister of Administration and Digitization of 29 November 2013 amending the regulation on the registration of land and buildings. (Journal of Laws 2013 pos. 1551),agricultural land considered as grassland consists of:
permanent meadows and pastures include land permanently covered with grass, but it does not include arable land sown with grass as part of crop rotation; permanent meadows are understood as the land permanently covered with grass and mown in principle and in mountain area also the area of mown mountain pastures and meadows.

1. permanent pastures are understood as the land permanently covered with grass not mown but grazed in principle and in mountain area – also the area of grazed pastures and meadows;
2. permanent meadows and pastures classified to this category must be maintained in good agricultural condition.

6.4.4. Methodological issues

6.4.4.1. Subcategory area

Land use matrix is provided in the annex 6

6.4.4.2. Living organic matter

Emissions/removals from this subcategory were not estimated because in Poland there is no perennial woody biomass (conservative approach).

6.4.4.3. Mineral soil

Estimation of area of different soil types (high activity soils, low activity soils, sandy and wetland) is based on area of soil valuation classes. The percentage fraction of all soil types in grassland was calculated based on available data sets.

Table 6.4.1. Area of soil valuation classes

Valuation classes	1976	1979	1985	1990	2000
	thous. ha				
grassland					
Total	**4175.7**	**4127.1**	**4126.9**	**4122**	**4085.8**
I	2	2.2	2.6	2.2	2.8
II	67.6	67.3	65.3	61.9	56.8
III	531.7	533.2	555.4	550.9	537.3
IV	1666.5	1687.6	1738	1750	1762.7
V	1370.2	1326.5	1292	1291	1288.9
VI	537.7	510.3	473.6	466	432.3
land not classified					5

Due to limited data availability, linear interpolation was applied between the subsequent years. Since 2000,estimations are based on the latest available data sets from the year 2000.

Table 6.4.2 Valuation classes of agricultural land with the SOC_{ref} assignment.

soil type	soil valuation classes
high activity	I, II, III
low activity	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.

Table 6.4.3. 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
Permanent meadows and pastures	sigh activity	50
	low activity	33
	sandy	34
	wetland	87

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 - $F_{LU}(0\text{-}T)$ = 1.00 [IPCC 2006 tab. Tab. 6.2 page 6.16]
- stock change factor for management regime in the beginning of inventory year – $F_{MG}(0\text{-}T)$=1.14 [IPCC 2006 tab. Tab. 6.2 page 6.16]
- Stock change factor for input of organic matter in the beginning of inventory year – $F_I(0\text{-}T)$=1.11 [IPCC 2006 tab. Tab. 6.2 page 6.16]
- Stock change factor for land use or land-use change type in current inventory year – $F_{LU}(0)$= 1.00 [IPCC 2006 tab. Tab. 6.2 page 6.16]
- Stock change factor for management regime in current inventory year –$F_{MG}(0)$=1.14 [IPCC 2006 tab. Tab. 6.2 page 6.16]
- Stock change factor for input of organic matter in current inventory year – $F_I(0)$ = 1.11 [IPCC 2006 tab. Tab. 6.2 page 6.16]

6.4.4.4. 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 [IPCC 2006 tab. Tab. 6.3 page 6.17].

6.4.4.5. Biomass burning

CH_4, N_2O, CO and NO_x emissions from fires were calculated using following equation (IPCC 2006, page 2.429. equation 2.27). This subcategory is covering the non-CO_2 emission from crop area, meadows and stubbles fires.

6.4.5. Uncertainties and time-series consistency

Detailed information contain chapter 6.6.5

6.4.6. Category-specific QA/QC and verification

Detailed information contain chapter 6.6.6

6.4.7. Recalculations

Detailed information contain chapter 6.6.7

6.4.8. Planned improvements

Detailed information contain chapter 6.6.8

6.5. Wetlands (CRF sector 4.D.)

6.5.1. Source category description

Calculation for category 4.D. is based on IPCC methodology described in the chapter 7. of IPCC 2006 guidelines of the Volume 4.

6.5.1.1. Wetlands remaining wetlands

GHG balance in this was identified as a net CO_2 source. Net CO_2 balance was equal to 4 119 kt of CO_2 emissions.

6.5.1.2. Lands converted to Wetlands

GHG balance in this was identified as a net CO_2 source. Net CO_2 balance was equal to 196 kt of CO_2 emissions.

6.5.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

According to the description suggested in the chapter 3.3.1. of IPCC 2006 Guidelines of the Volume 4, Poland has selected Approach 2, considering the set of information's available in the register of land and buildings.

6.5.3. Land-use definitions and classification system used and their correspondence to the LULUCF categories

According to the Regulation of the Minister of Administration and Digitization of 29 November 2013 amending the regulation on the registration of land and buildings. (Journal of Laws 2013 pos. 1551),agricultural land considered as wetland consists of:

1. land under waters
    - marine internal;
    - 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,
2. land under ponds including water reservoirs (excluding lakes and dam reservoirs for water level adjustment) including ditches and areas adjacent and related to ponds;
3. land under ditches including open ditches acting as land improvement facilities for land used

According to IPCC 2006 wetlands are divided into organic soils managed for peat extraction and flooded lands. Area of organic soils managed for peat extraction in 2013 was 3 341 ha and area of flooded land was 852 992 ha.

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 due to the data relevant data gaps, for years 2000-2008 value from year 1999 was taken. Since 1999 national statistics contain data on area of organic soils managed for peat extraction It need to be highlighted that data from national statistics are consistent with the previously estimated values of organic soils managed for peat extraction.

Table 6.3.2. Area of organic soils managed for peat extraction in period 1999-2013

Year		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Area of organic soils managed for peat extraction:, in this:	[ha]	4680.0	5178.0	2912.0	5138.0	5141.0	5508.0	5107.0	3429.0	3433.0	3410.0	3311.0	3314.0	3312.0	3312.0	3312.0
Rich organic soli	[ha]	4009.7	4436.4	2494.9	4402.1	4404.7	4719.1	4375.6	2937.9	2941.3	2921.6	2836.8	2839.4	2838.0	2838.0	2838.0
Poor organic soli	[ha]	670.3	741.6	417.1	735.9	736.3	788.9	731.4	491.1	491.7	488.4	474.2	474.6	474.6	474.6	474.6

Source: Central Statistical Office - Environmental Protection 2000-2013

6.5.4. Methodological issues

6.5.4.1. Wetlands remaining wetlands

Emission calculations are based on equation 7.6 of IPCC 2006 guidelines of the Volume 4. page 7.9.

Table 6.5.3. Emission factors for CO_2-C

Symbol	Unit	Emission factor	Source
$EF_{peatNrich}$	[t C/ha*year]	1.1	table 7.4. page 7.13 IPCC 2006
$EF_{peatNpoor}$	[t C/ha*year]]	0.2	

N_2O emission calculations are based on equation 7.7 of IPCC 2006 guidelines of the Volume 4.

Table 6.5.4. Emission factors for N2O emissions from managed peatlands

Symbol	Unit	Emission factor	Source
$EF_{peatNrich}$	[kgN_2O/ha*year]	1.8	table 7.6. page 7.16 IPCC 2006
$EF_{peatNpoor}$	[kgN_2O/ha*year]	negligible	

CO_2 emission calculations are based on equation 7.5 of IPCC 2006 guidelines of the Volume 4For calculations default emission factors for cold climate were used as presented below:

Table 6.5.5 Emission factors for the subcategory wetland remaining wetland

Symbol	Unit	Emission factor	Source
CO_2-C	[t C/t air-dry peat]$^{-1}$]	0.45	table 7.5. page 7.13 IPCC 2006
CO_2-C	[t C/t air-dry peat]$^{-1}$]	0.40	

6.5.4.2. Land converted to Wetlands (CRF sector 4.D.2.)

For calculations default emission factors were used as presented below:

- carbon fraction of dry matter CF = 0.5 [IPCC 2006],
- living biomass in land immediately before conversion to flooded land B_{Before} = 2.8 t dm/ha [IPCC 2006, page 6.8],

Living biomass immediately following conversion to flooded land B_{After} = 0 t dm/ha [IPCC 2006. page 7.20].

Table 6.5.6 Emission factors

Emission factor	unit	value	Source
$EF_{peatNrich}$	[t C/ha*yr]	1.1	table 7.4. page 7.13 IPCC 2006

6.5.5. Uncertainties and time-series consistency

Detailed information contain chapter 6.6.5

6.5.6. Category-specific QA/QC and verification

Detailed information contain chapter 6.5.6

6.5.7. Recalculations

Detailed information contain chapter 6.6.7

6.5.8. Planned improvements

Detailed information contain chapter 6.6.8

6.6. Settlements (CRF sector 4.E.)

6.6.1. Source category description

Calculation for category 4.E. is based on IPCC methodology described in the chapter 8. of IPCC 2006 guidelines of the Volume 4.

GHG balance for this subcategory was identified as a net CO_2 Source. Net CO_2 balance was equal to 262 kt ofCO_2 emissions

6.6.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

According to the description suggested in the chapter 3.3.1. of IPCC 2006 Guidelines of the Volume 4, Poland has selected Approach 2, considering the set of information's available in the register of land and buildings.

6.6.3. Land-use definitions and classification system used and their correspondence to the LULUCF categories

According to the Regulation of the Minister of Administration and Digitization of 29 November 2013 amending the regulation on the registration of land and buildings. (Journal of Laws 2013 pos. 1551),agricultural land considered as settlements consists of:

- 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; voivodship 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.

6.6.4. Methodological issues

6.6.4.1. Settlements remaining Settlements

Living biomass

Calculations for carbon stock changes in living biomass were based on crown cower area method (urban green area – GUS 2013 Environmental Protection). Carbon stock changes in living biomass were calculated based on equation 8.2. page 8.7 [IPCC 2006]. For calculations were used default accumulation rate C_{RF}=2.9 t C/ha were used [IPCC 2006, page 8.9].

6.6.4.2. Land converted to Settlements (CRF sector 4.E.2.)

Net emissions in this subcategory are equal to 400 kt of CO_2 emissions. The fundamental equation for estimating change in carbon stocks associated with land-use conversions has been explained in other sections covering conversions of land converted to to forest land, cropland and grassland, respectively. The same decision tree and the same basic method were applied to estimate change in carbon stocks in forest land converted to settlements.

Living biomass

Annual change in carbon stocks in living biomass reservoir was estimated considering the changes in carbon stocks between biomass in the forest prior to conversion (B_{Before}) and that in the settlements after conversion (B_{After}). Estimations are based on the equation 2.16 contained in IPCC 2006 guidelines of the Volume 4

Average gross merchantable volume used in the above mentioned equation is estimated on the basis of data from the most recent 5-year cycle of large-scale inventory and is published in the form of official statistics by the Central Statistical Office. This method follows the approach in the IPCC Guidelines where the amount of living aboveground biomass that is cleared for expanding settlements is estimated by multiplying the forest area converted annually to settlements by the difference in carbon stocks between biomass in the forest prior to conversion (B_{Before}) and that in the settlements after conversion (B_{After}) which is equal to zero.

Dead organic matter

Annual change in carbon stocks in dead wood reservoir was estimated considering the changes in dead wood resources on forest land all forms of ownership, using the information contained in the statistical yearbooks "Forestry". Estimations are based on the equation 2.19 contained in IPCC 2006 guidelines of the Volume 4
Dead wood thickness used in the above mentioned equation is estimated on the basis of data from the most recent 5-year cycle of large-scale inventory and is published in the form of official statistics by the Central Statistical Office.

This method follows the approach in the IPCC guidelines where the amount of living aboveground biomass dead organic matter that is cleared for expanding settlements is estimated by multiplying the forest area converted annually to settlements by the difference in carbon stocks between biomass in the forest prior to conversion (DOM_{t1}) and that in the settlements after conversion (DOM_{t2}) which is assumed to be equal to zero.

Soils

Annual change in carbon stocks in the litter reservoir was estimated using equation 3.2.14 contained in the Good Practice Guidance for Land Use, Land Use Change and Forestry ", section 3.2.1.3.1. For the needs of equation application, default reference values of SOC_{ref} were considered to be used linked with the dominant tree habitats.

Table 7.2.4 Forest habitant types in Poland with the SOC_{ref} assignment

SOC_{ref}	Forest habitat types
high active SOC ref (50 [MgC/ha])	Fresh mixed forest, moist mixed forest, mixed upland forest, mountain mixed forest, fresh broadleaved forest, moist broadleaved forest upland forest, mountain forest
low active SOC ref (33[MgC/ha])	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 SOC ref (34 [MgC/ha])	Dry coniferous forest, fresh coniferous forest 0,5* fresh mixed coniferous forest
wetland SOC ref (87 [MgC/ha])	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

Carbon stock changes in mineral soils were estimated based ion following references contained in of IPCC 2006 Guidelines of the Volume 4 [IPCC, 2006]:

- transition period – 1 year
- $f_{man\ intensity}$ – 1.0
- $f_{dist\ regime}$ – 1.0
- $f_{forest\ type}$ – 1.0

6.6.5. Uncertainties and time-series consistency

Uncertainty analysis for the revised year 2013 for IPCC sector *4.Land-Use Change and Forestry* was estimated with use of approach 1 described in 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Simplified approach was based on the assumptions that every value is independent and probability distribution is symmetric. This year uncertainty assumptions were applied directly to on activities and emission factors, instead of emission as in previous years. Results of the sectoral uncertainty analysis are given below. More details on uncertainty assessment of whole inventory are given in annex 8.
Recalculation of data for years 1988-2012 ensured consistency for whole time-series.

Table 6.20. Results of the sectoral uncertainty analysis in 2013

2013	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 Emission uncertainty [%]	CH_4 Emission uncertainty [%]	N_2O Emission uncertainty [%]
4. Land-Use Change and Forestry	**-37627.32**	**1.48**	**0.01**	22.8%	75.4%	88.5%
A. Forest Land	-41421.75	1.39	0.01	20.6%	80.2%	100.1%
B. Cropland	-435.68			20.6%		
C. Grassland	-348.42	0.09	0.00	20.6%	80.2%	100.1%
D. Wetlands	4316.31	0.00	0.00	20.6%	0.0%	0.0%
E. Settlements	262.23			20.6%		
F. Other Land						

6.6.6. Category-specific QA/QC and verification

Basing on the current recommendations from the IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories, following elements of quality assurance and control were defined for the inventory of national activities in this area:

- performing an inventory of institutions. is responsible for coordinating QA / QC
- general procedures for quality control inventory QA / QC (using Tier 1).
- a detailed set for the category of sources. quality control procedures (using Tier 2)

Most of the input data used in the inventory process comes from official national statistics in the statistical studies of Central Statistical Office, reports of Forest Management and Geodesy Bureau. In case of deviations from the trend, more detailed checks are carried out concerning data input. This situation has occurred in the year 2009 for the studies presented in the official statistical volume of forest resources as a result of changes in methodology for their estimation. Presented data as a result of using National of State Forest Inventory of all forms of ownership become an official source of national statistics. In addition, for the annually calculated emissions are compared with the corresponding values from the previous years (trend of emissions), and in the event of any unexpected changes they are examined in more detail. For the detailed information see chapter QA/QC.

6.6.7. Recalculations

Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows:

- implementation of methods and factors provided in IPCC 2006 guidelines.
- factors related adjustment of carbon stocks calculation in category 4A;
- factors related adjustment of carbon stocks calculation in category 4C;
- factor driven adjustment related to carbon stock changes in mineral soils in 4.B
- factor driven adjustment related to carbon stock changes in mineral soils in 4.C

Net effect of recalculations on CO2 emissions/removals is provided in the Table 7.6.1

Table 7.6.1 Recalculations overview.

CRF	Recalculation	1988	1989	1990	1991	1992	1993	1994	1995
4A	[%]	-9.29	-28.71	-3.80	-7.67	-14.33	-6.88	-8.06	-7.36
	[kt CO_2]	-2166.73	-8516.67	-1329.05	-2173.98	-313.47	-823.66	-909.81	-1719.70
4B	[%]	-76.92	-76.10	-34.74	-76.00	-73.27	-72.79	-71.44	-74.71
	[kt CO_2]	2865.62	2738.31	1079.35	1982.45	1726.92	1698.52	1595.50	1900.77
4C	[%]	-13.22	-14.90	-11.59	-13.50	-24.39	-34.22	-35.49	-23.97
	[kt CO_2]	104.36	120.01	95.12	114.42	214.21	309.69	330.25	242.11
4D	[%]	60.45	58.87	57.86	57.11	55.92	55.13	54.46	53.98
	[kt CO_2]	-1693.09	-1665.32	-1641.85	-1628.35	-1599.61	-1583.90	-1564.58	-1560.22
4E	[%]	38.48	202.51	110.08	314.57	60.90	262.45	65.96	245.93
	[kt CO_2]	-184.36	-444.16	-210.42	-274.85	-95.74	-456.74	-142.54	-285.63

CRF	Recalculation	1996	1997	1998	1999	2000	2001	2002	2003
4A	[%]	-7.59	-7.30	-7.59	-7.13	-6.97	-6.98	-7.14	-7.28
	[kt CO_2]	-3237.13	-3082.74	-3674.66	-3975.28	-2736.64	-2125.68	-2882.49	-3036.90
4B	[%]	-73.67	-75.49	-74.75	-71.42	-69.61	-69.78	-68.85	-69.27
	[kt CO_2]	1814.12	1980.05	1896.32	1604.17	1503.67	1494.21	1422.12	1403.90
4C	[%]	-27.17	-28.89	-78.55	-58.87	-66.22	-65.76	-97.76	-142.60
	[kt CO_2]	255.25	268.01	672.55	509.30	523.08	488.66	700.19	987.24
4D	[%]	52.83	52.02	51.81	51.34	50.31	49.70	49.28	48.11
	[kt CO_2]	-1535.16	-1510.81	-1506.58	-1501.78	-1479.20	-1457.06	-1452.01	-1456.12
4E	[%]	108.11	36.97	122.70	166.41	3.84	142.84	173.58	12.68
	[kt CO_2]	-130.04	-68.01	-171.59	-170.00	-8.98	-215.76	-184.26	-27.28

CRF	Recalculation	2004	2005	2006	2007	2008	2009	2010	2011	2012
4A	[%]	-7.16	-6.94	-6.90	-6.25	-5.92	-7.98	-10.05	-7.92	-0.14
	[kt CO_2]	-3885.17	-3710.36	-4852.08	-2430.30	-2302.50	-3001.32	-3720.83	-3438.53	-56.82
4B	[%]	-73.72	-56.43	-57.76	-52.23	46.64	-41.78	-52.54	-53.60	-52.90
	[kt CO_2]	1742.18	1185.66	989.38	802.44	-674.06	612.52	748.19	729.25	691.68
4C	[%]	-128.35	-135.49	-135.62	-163.81	-162.59	-168.13	-167.25	-179.22	-189.80
	[kt CO_2]	786.32	759.65	810.98	796.31	847.44	760.66	730.53	729.44	717.08
4D	[%]	44.54	43.01	42.43	42.00	40.86	41.18	40.45	39.58	38.87
	[kt CO_2]	-1355.01	-1313.23	-1297.54	-1295.38	-1263.76	-1265.29	-1253.42	-1226.16	-1205.67
4E	[%]	79.10	179.28	78.28	91.17	82.09	90.12	169.78	93.20	276.49
	[kt CO_2]	-154.82	-216.53	-129.78	-155.65	-145.54	-167.57	-245.56	-151.32	-313.38

6.6.8. Planned improvements

With the connection to the first cycle of National Forest Inventory of all ownership forms. executed in a 5-year cycles but updated annually. a continuous analysis of the conventional statistics and indicators is being performed on the basis of the collected material and the use of the collected data to estimate emissions and removals from the forestry sector with regard to actions under Article. 3.3 and 3.4 of the Kyoto Protocol. It should be added that the results of NFI are a valuable source of reliable information on forest resources (i.e. dead wood on forest land. which are used in the National Inventory of greenhouse gases). In addition. research projects will be able to allow a precise determination of changes in carbon content in forest litter. and also allows verification of the conventional factors used to determine changes in carbon content in forest soils. Moreover Party is considering the revision of in-country specific SOC factors. Such an eventuality is dictated by many factors and processes that are determining the direction and rate of change in SOC content when vegetation and soil management practices are changed. Ones that may be important for increasing SOC storage include (1) increasing the input rates of organic matter. (2) changing the decomposition of organic matter inputs that increase LF-OC in particular. (3) placing organic matter deeper in the soil either directly by increasing belowground inputs or indirectly by enhancing surface mixing by soil organisms. and (4) enhancing physical protection through either intra-aggregate or organo-mineral complexes. Subsequent analysis will be possible at the end of the ongoing studies related SOC at national level. Party is considering described factor as important for further improvements.

6.7. Other land (CRF sector 4.F)

Emissions/removals from this subcategory were not estimated. It is included to match overall consistency of country land area.

7. WASTE

7.1. Overview of sector

The GHG emission sources in waste sector involve: methane emission from 5.A *Solid Waste Disposal*, CH_4 and N_2O emissions from 5.B *Biological Treatment of Solid Waste*; CO_2, CH_4 and N_2O emissions from 5.C *Incineration and Open Burning of Waste* and CH_4 and N_2O emissions from 5.D *Wastewater Treatment and Discharge*.

Following category from sector 6 have been identified as key source (excluding LULUCF):

IPCC Category Code	IPCC Source Categories	Greenhouse Gas	Level Assessment	Trend Assessment
5.A	Solid Waste Disposal	CH_4	2.20%	
5.D	Wastewater Treatment and Discharge	CH_4		+

Share of these categories in total Poland's GHG emissions is 2.20%.

Total emission of GHG as carbon dioxide equivalent amounted to 11 037.48 kt in 2013 and decreased since 1988 by 25.13% (Figure 7.1).

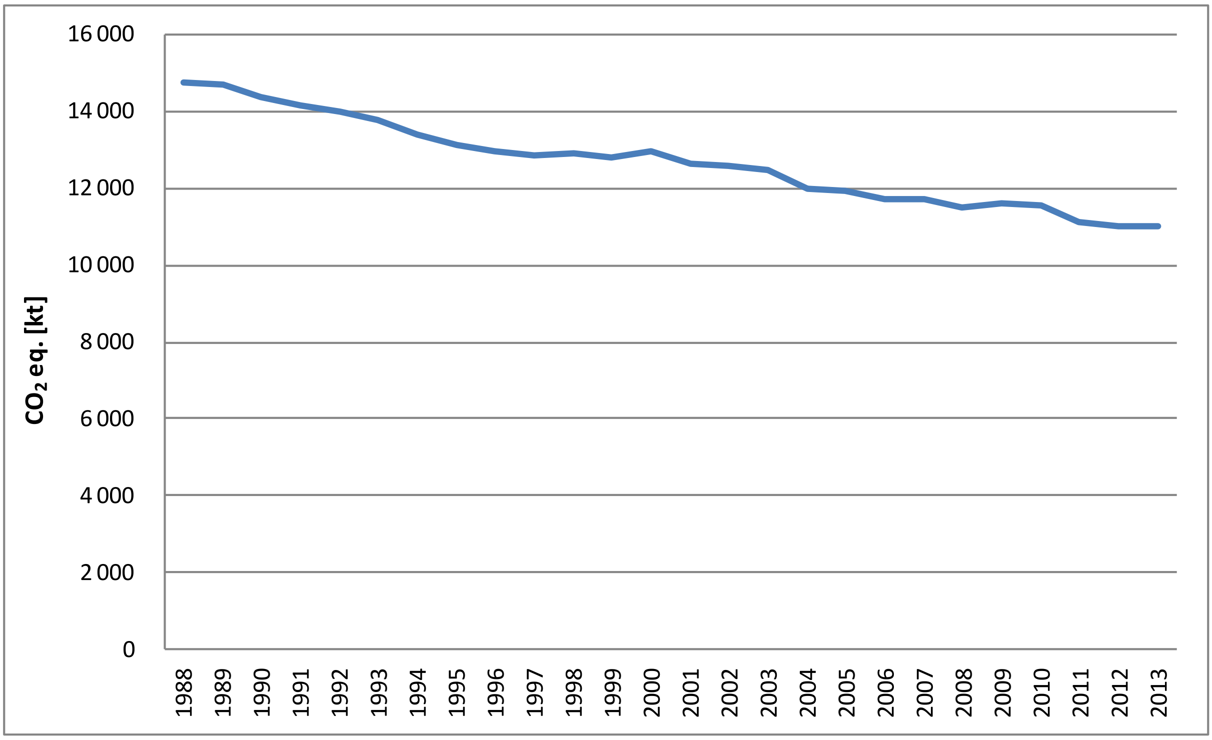

Figure 7.1. GHG emissions from waste sector in 1988-2013

Between years 1988 and 2013 decrease of GHG emissions appeared in subcategory 5.A (by 16.6 %) and 5.D (by 59.7 %) while emissions from sources gathered in subcategories 5.B and 5.C increased since 1988 by 4 189.4% (5.B) and 32.2 % (5.C). The main reason of decrease of emissions from sector 5 is decrease of GHG emissions in subsector 5.A *Solid Waste Disposal on Land* and subsector 5.D *Wastewater Treatment and Discharge* (Figure 7.2), the biggest contributors to emission from *Waste* sector.

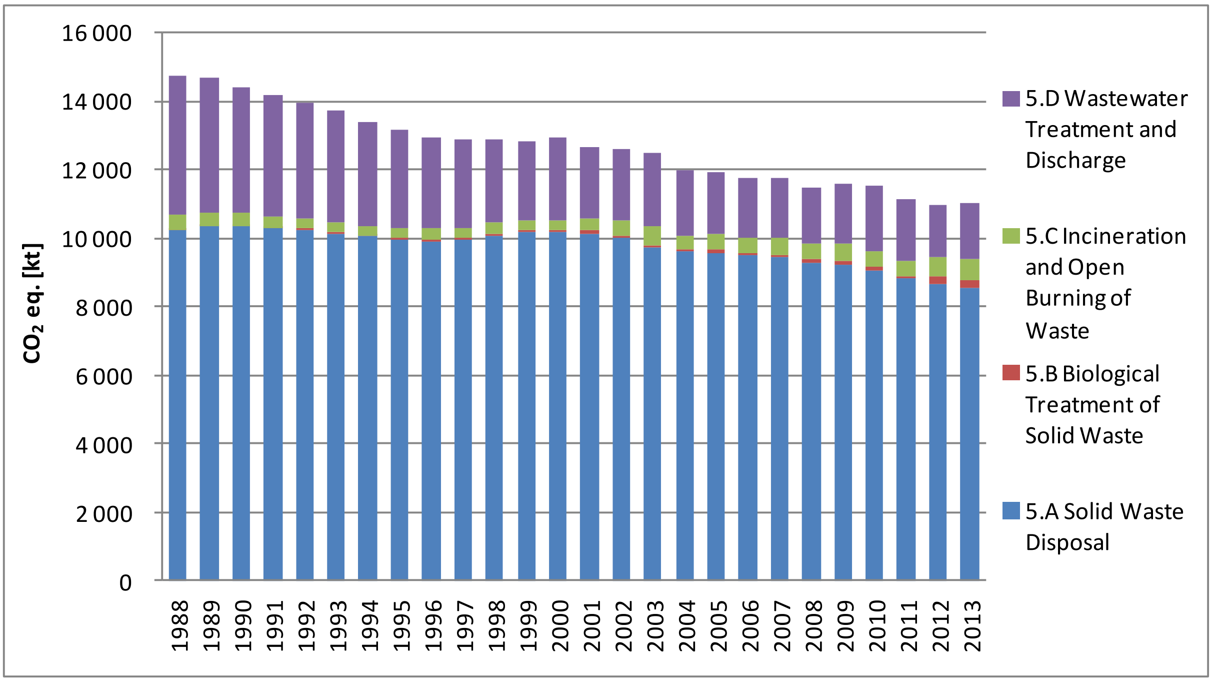

Figure 7.2. GHG emissions from waste sector divided to subsectors

According to statistical data [GUS 2014d] in 2013 collected municipal solid wastes go to four different pathways: incineration (0.5%), biological treatment (13.0%), recycling (23.4%) and landfilling (63.1%).

The changes in shares of municipal solid waste treatment pathways since 2007 are presented below (figure 7.3).

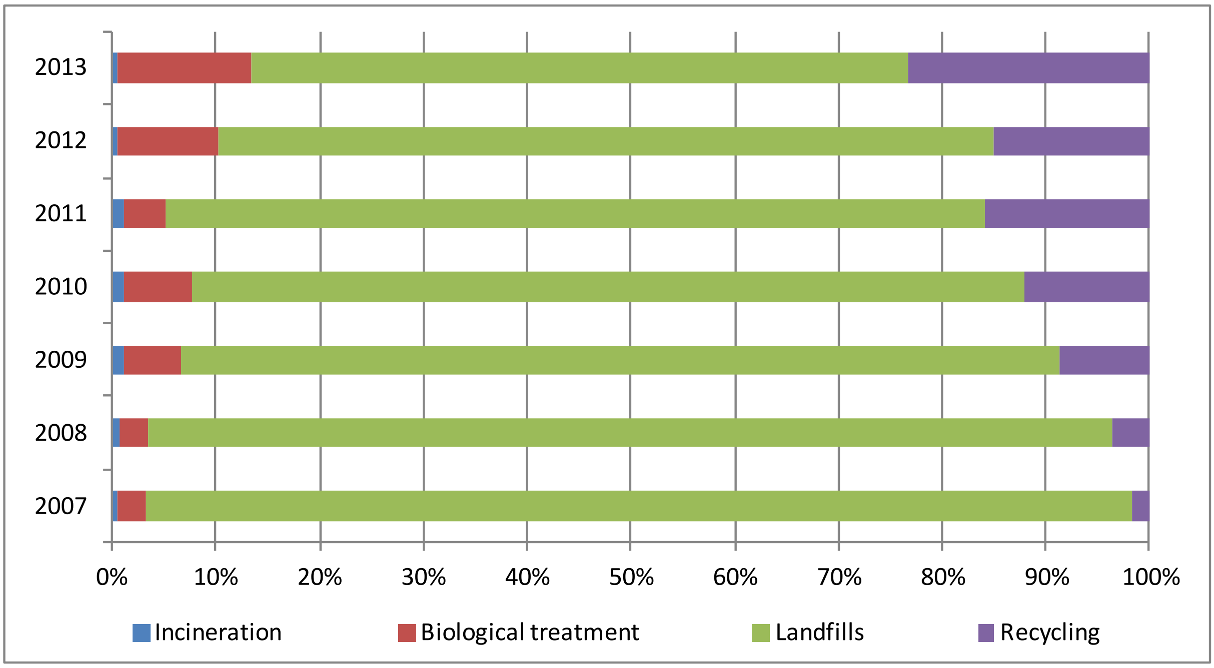

Figure 7.3. Municipal solid waste treatment pathways

7.2. Solid Waste Disposal (CRF sector 5.A)

7.2.1. Source category description

The 5.A *Solid Waste Disposal on Land* subcategory share in total waste sector is 77.4% and it involves methane emissions from Managed Waste Disposal on Land (40.5% share of 5.A), Unmanaged Waste Disposal on Land deep (26.7% share of 5.A) and Uncategorized MSW Disposal on Land (10.3% share of 5.A). This sector includes emission from disposal of sewage sludge on land which is mentioned in chapter 7.2.2.1.

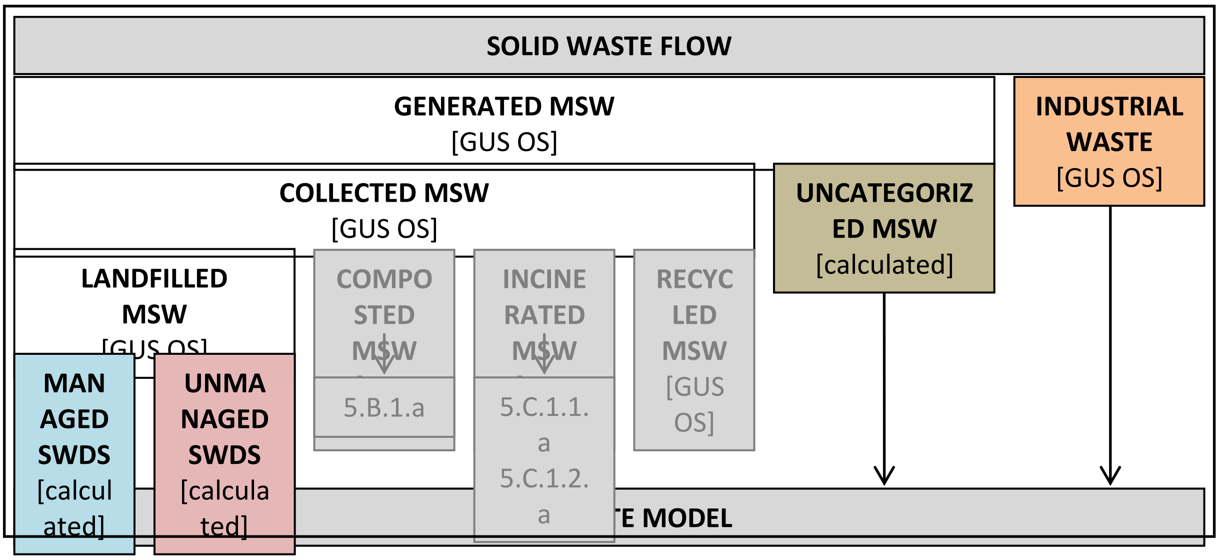

Figure 7.4. Solid waste flow scheme

The trend of emissions from sector 5.A is mostly conditioned by activity data – amounts of waste generated and collected – which reached highest values around the year 1990 and the year 1999. The first peak in the trend (Fig. 7.4) is a result of high waste generation and poorly developed waste collection and recycling system in the early '90. The post-communist economy was generating big amounts of municipal and industrial waste and the most of it was being landfilled, and the significant amount of disposal sites was unmanaged. Increase of emission resulting in second peak, which appeared around the year 1999, is related to highest share of utilization in unmanaged waste disposal sites.

Since 1999 the trend of methane emission is decreasing, mostly due to development of collection, segregation and landfilling system (what is the result of implementing recommendations of Landfill Directive 1999/31/EC, among others). During this period waste recycling was popularized and the recycling system was developed, what resulted in decrease of landfilled municipal waste. Moreover, new technologies were introduced on disposal sites what caused the decrease in amount of waste landfilled in unmanaged disposal sites.

The basic legal regulatory for waste management in Poland is the Act on waste (Dz.U. 2013/0/21 with later changes) describing the ways of waste treatment leading to human and environmental protection.

Poland is importing solid waste but according to information from Chief Inspectorate of Environmental Protection those are mostly hazardous waste (no municipal waste is imported) for incineration and it's amount is included in data on incinerated waste used by Party for estimates from subsector 5.C.

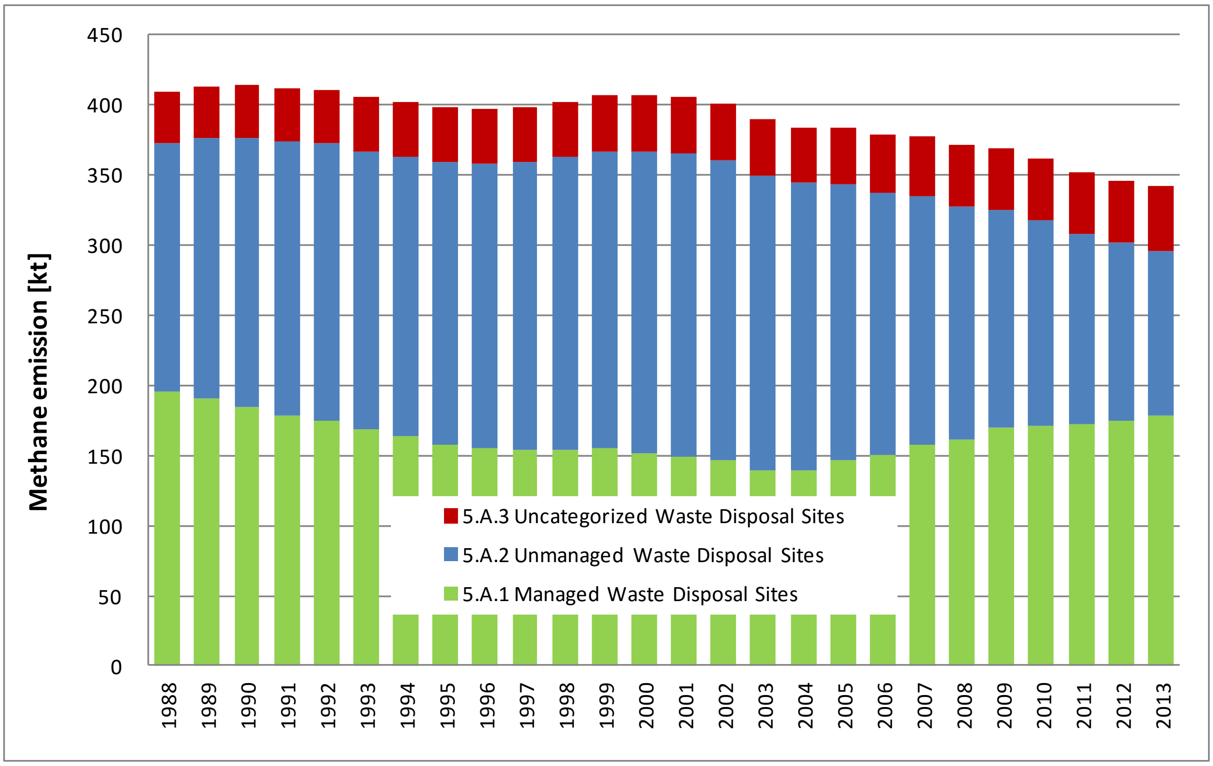

Figure 7.5. Methane emission from 5.A subsector divided to subcategories

7.2.2. Methodological issues

The methane emission estimates from waste disposal sites were calculated using IPCC 2006 *Tier 2* method. The choice of the method was supported by good quality country-specific historical and current activity data on waste disposal at SWDSs from Central Statistical Office and the Ministry of Environment.

The methane emissions estimates were calculated with application the IPCC Waste Model published in [IPCC 2006]. The model establishes multiyear series when methane is generated from organic matter decomposition in anaerobic conditions. The emission of CH_4 is diminished by recapturing of this gas for energy purposes. The data on recovered methane are based on responses to questionnaires of Central Statistical Office on energy combustion.

The following factors were used for estimation of CH_4 emissions:

- DOC – degradable organic carbon in the year of deposition (table 7.1, default value [IPCC 2006])
- DOC_f – fraction of DOC that can decompose (fraction) (table 7.1, default value [IPCC 2006])
- MCF – CH_4 correction factor for aerobic decomposition in the year of deposition (table 7.2, default value [IPCC 2006])
- OX – Oxidation Factor reflecting the amount of CH_4 from solid waste disposal sites that is oxidized in the soil or other material covering the waste (table 7.3, default value [IPCC 2006])
- k – reaction constant [IPCC 2006] (table 7.3)
- F – fraction of CH_4 by volume, in generated landfill gas (fraction) [IPCC 2006] (table 7.3)

The values of abovementioned factors are presented in tables 7.1 – 7.5.

Table 7.1. DOC and DOC_f indicators, municipal waste

DOC (Degradable Organic Carbon)	Range	Default	Adopted Value
Food waste	0.08-0.20	0.15	0.15
Garden	0.18-0.22	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
DOC_f		0.5	0.5

Table 7.2. MCF indicators of organic carbon in disposed municipal and industrial waste

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

Table 7.3. Factors k, F and OX assumed for calculations, municipal waste

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
Delay time (months)		6	6
Fraction of methane (F) in developed gas		0.5	0.5
Oxidation factor (OX)		0	0-0.1*

* since 2001 managed SWDSs fulfill requirements of [IPCC 2006] to be treated as "well-managed" SWDSs for which the 0.1 value of oxidation factor is default

Table 7.4. DOC and DOC_f indicators, industrial waste

DOC (Degradable Organic Carbon)	Range	Default	Adopted Value
Food waste	0.08-0.20	0.15	0.15
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
Rubber		0.39	0.39
DOC_f		0.5	0.5

Table 7.5. Factors k, F and OX assumed for calculations, industrial waste

Methane generation rate constant (k)	Range	Default	Value
Food waste	0.1–0.2	0.185	0.185
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
Rubber	0.02–0.04	0.03	0.03
Delay time (months)		6	6
Fraction of methane (F) in developed gas		0.5	0.5
Oxidation factor (OX)		0	0

Emission from sewage sludge was estimated on the basis of [IPCC 2006] methodology, using IPCC Waste Model. Party assumed that sewage sludge is being landfilled only since 1995 (earlier data are not available and extrapolation is not possible due to lack of distinct trend) and only in managed municipal waste disposal sites. Emission factors used are default [IPCC 2006] (table 7.6).

Other parameters were assumed as for municipal solid waste landfilled in managed waste disposal sites.

Table 7.6. Sewage sludge emission factors

DOC	Reaction constant (k)
0.05	0.185

7.2.2.1 Managed Waste Disposal Sites – Municipal Waste

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

- generated municipal solid waste – for the years 1970 – 2004 data was extrapolated according to amount of collected MSW [Central Statistical Office],
- collected Municipal Solid Wastes (MSW) was taken from National Statistics. Because of lack of data 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 it into kilotonnes a conversion factor 0.26 Mg/m^3 was used, given by Central Statistical Office,
- Municipal Solid Waste deposited on landfills fulfilling requirements of Landfill Directive 1999/31/EC – data from Waste Management Department of Ministry of Environment,
- amount of Industrial Waste deposited on landfills,
- amount of Sewage Sludge deposited on landfills,
- composition of municipal and industrial waste,
- R – methane recovery [GUS OZE 2014],
- population of Poland.

Table 7.7. Data sources for amount of municipal waste

Years	Generated MSW [kt]	Data source	Collected MSW [kt]	Data source
1970	6 365.93	extrapolation	4 113.98	[GUS 1987]
1971	6 876.60	extrapolation	4 624.65	interpolation
1972	7 387.26	extrapolation	5 135.31	interpolation
1973	7 897.93	extrapolation	5 645.98	interpolation
1974	8 408.60	extrapolation	6 156.64	[GUS 1974d]
1975	9 040.92	extrapolation	6 788.96	[GUS 1986d]
1976	9 649.95	extrapolation	7 397.99	interpolation
1977	10 258.98	extrapolation	8 007.03	[GUS 1981d]
1978	10 954.78	extrapolation	8 702.83	[GUS 1981d]
1979	11 304.58	extrapolation	9 052.63	[GUS 1981d]
1980	12 120.67	extrapolation	9 868.72	[GUS 1986d]
1981	12 266.37	extrapolation	10 014.42	[GUS 1986d]
1982	12 581.02	extrapolation	10 329.07	[GUS 1986d]
1983	12 793.86	extrapolation	10 541.91	[GUS 1986d]
1984	13 116.49	extrapolation	10 864.54	[GUS 1986d]
1985	13 338.90	extrapolation	11 086.95	[GUS 1986d]
1986	13 798.81	extrapolation	11 546.86	[GUS 1987]
1987	14 129.40	extrapolation	11 877.45	[GUS 1989d]
1988	14 336.13	extrapolation	12 084.18	[GUS 1989d]
1989	14 252.90	extrapolation	12 000.95	[GUS 1990d]
1990	13 350.23	extrapolation	11 098.28	[GUS 1996]
1991	12 889.93	extrapolation	10 637.98	[GUS 1996]
1992	12 872.95	extrapolation	10 621.00	[GUS 1996]
1993	12 896.61	extrapolation	10 644.66	[GUS 1996]
1994	13 266.59	extrapolation	11 014.64	[GUS 1996]

Years	Generated MSW [kt]	Data source	Collected MSW [kt]	Data source
1995	13 236.95	extrapolation	10 985.00	[GUS 2005d]
1996	13 873.17	extrapolation	11 621.22	[GUS 1997d]
1997	14 435.40	extrapolation	12 183.44	[GUS 1998d]
1998	14 527.72	extrapolation	12 275.77	[GUS 1999d]
1999	14 568.85	extrapolation	12 316.90	[GUS 2000d]
2000	14 477.95	extrapolation	12 226.00	[GUS 2005d]
2001	13 360.95	extrapolation	11 109.00	[GUS 2005d]
2002	12 760.65	extrapolation	10 508.70	[GUS 2005d]
2003	12 176.56	extrapolation	9 924.61	[GUS 2005d]
2004	12 011.26	extrapolation	9 759.31	[GUS 2005d]
2005	12 169.00	[GUS 2012d]	9 352.12	[GUS 2006d]
2006	12 235.00	[GUS 2009d]	9 876.59	[GUS 2007d]
2007	12 264.00	[GUS 2010d]	10 082.58	[GUS 2011d]
2008	12 194.00	[GUS 2011d]	10 036.41	[GUS 2011d]
2009	12 053.00	[GUS 2012d]	10 053.50	[GUS 2012d]
2010	12 038.00	[GUS 2012d]	10 040.11	[GUS 2012d]
2011	12 128.80	[GUS 2012d]	9 827.64	[GUS 2012d]
2012	12 085.00	[GUS 2013d]	9 580.87	[GUS 2013d]
2013	11 295.00	[GUS 2014d]	9 473.83	[GUS 2014d]

Distribution of solid waste disposal sites for managed and unmanaged SWDSs was made in accordance to elaboration [Gworek 2003] until year 2001. According to this publication 14% of disposal sites are managed, 86% are unmanaged.

Since 2001 Poland was implementing the Landfill Directive (1999/31/EC) and, as a result, the share of unmanaged SWDSs started to decrease (landfills fulfilling requirements of the Directive are considered to be managed). In accordance to data from Waste Management Department of Ministry of Environment about amount of MSW landfilled on landfills fulfilling requirements of the Directive the share of MSW on managed and unmanaged SWDSs was updated. According to data from abovementioned Waste Management Department since 2012 all SWDSs in Poland fulfill the Directive and can be considered as managed.

Tabela 7.8. Amount of waste collected and landfilled on managed SWDSs

Year	Collected MSW [kt]	MSW landfilled on managed SWDS [kt]	Share
2001	data unavailable	data unavailable	20%*
2002	data unavailable	data unavailable	26%*
2003	10753.0	3414.0	32%
2004	9029.3	5207.5	58%
2005	8623.1	5210.0	60%
2006	7824.4	5903.3	75%
2007	9227.8	7411.4	80%
2008	8947.2	7584.8	85%
2009	8543.6	7379.9	86%
2010	8577.6	7885.3	92%
2011	7649.8	6979.1	91%
2012	7158.2	7158.2	100%
2013	5978.7	5978.7	100%

* extrapolated data

Composition of municipal waste was calculated 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. 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), and interpolation for the years until 2000 was made (table 7.6). Data for 2001-2003 are based on National Waste Management Plan 2003 [KPGO 2003], for 2004-2008 on [KPGO 2010], and for 2008-2013 on [KPGO 2014].

Table 7.9. Composition of municipal solid 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%
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	24%	2%	20%	2%	2%	50%
2005	24%	2%	20%	2%	2%	50%
2006	24%	2%	20%	2%	2%	50%
2007	24%	2%	20%	2%	2%	50%
2008	33%	3%	14%	1%	3%	46%
2009	33%	3%	14%	1%	3%	46%
2010	33%	3%	14%	1%	3%	46%

Year	Food	Garden	Paper	Wood	Textile	Plastics, and other inert
2011	33%	3%	14%	1%	3%	46%
2012	33%	3%	14%	1%	3%	46%
2013	33%	3%	14%	1%	3%	46%

Abovementioned composition of municipal solid waste is used in IPCC Waste Model to calculate weight of each fraction of waste deposited at SWDSs, and finally - amounts of CH_4 generated by each fraction.

The data on amounts of landfilled sewage sludge was taken from Central Statistical Office annuals – Environment Protection. For years 1998, 1999 and 2001 there was a lack of activity data and interpolation method was used for its achievement.

Table 7.11. Sewage sludge activity data

Year	Amount of sewage sludge disposed on landfills [kt]
1995	1 471
1996	1 419
1997	2 184
1998	1 983
1999	1 783
2000	1 582
2001	1 573
2002	1 565
2003	1 510
2004	1 511
2005	1 330
2006	1 271
2007	991
2008	696
2009	605
2010	553
2011	534
2012	559
2013	458

7.2.2.2 Managed Waste Disposal – Industrial Waste

Methodology of estimation of methane emissions from industrial solid waste disposal is based on 2006 IPCC Guidelines [IPCC 2006] and performed with application of IPCC Waste Model. The model does not support estimating the emissions for each type of industrial waste – there is only possibility to use the total amount. Therefore, the emission from industrial waste was calculated with the application of forms for municipal waste, which approach, according to IPCC Guidelines, is correct. For this reason the Waste Model was used separately to calculate emissions from municipal and industrial waste. The choice of the method was supported by good quality country-specific historical and current activity data on industrial waste disposal at SWDSs.

According to IPCC Guidelines there is CH_4 emission only from few types of industrial waste:

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

In national inventory activity data were taken from Central Statistical Office annuals – Environment Protection. Time series is 1975-2012. Before year 1975 there were no data on industrial waste.

Waste from manufacturing of furniture is not included in the inventory due to lack of information on content of wood, plastic, metal and other materials in disposed furniture.

Table 7.12. Composition of industrial waste [kt]

Year	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]
2007	219.6	105.5	3.5	0.3	0.1	1.8	330.8	[GUS 2008d]
2008	151.6	72.1	3.1	0.3	0.0	1.5	228.6	[GUS 2009d]
2009	88.3	100.3	2.0	0.0	0.0	1.6	192.2	[GUS 2010d]
2010	85.2	175.0	1.4	0.0	0.0	2.2	263.8	[GUS 2011d]
2011	61.1	125.9	1.5	0.0	0.1	2.4	191.0	[GUS 2012d]
2012	53.1	111.5	1.4	0.0	0.0	1.8	167.8	[GUS 2013d]
2013	36.6	99.1	1.3	0.0	0.0	3.9	140.9	[GUS 2014d]

For years 1977 and 1978 no data on amount of industrial waste from separate industries are available, for this reason data on waste amount from resorts are used. 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.

On the basis of waste amount from each industry sector the composition of waste was calculated.

Table 7.13. Composition of industrial waste

Year	Food	Paper	Wood	Textile	Rubber	Plastics, other inert
1975	87.8%	0.0%	7.4%	2.6%	2.2%	0.0%
1976	91.8%	0.0%	4.7%	2.2%	1.4%	0.0%
1977	90.7%	0.0%	4.6%	2.3%	2.4%	0.0%
1978	91.5%	0.0%	3.1%	1.6%	3.8%	0.0%
1979	92.9%	0.0%	3.4%	1.9%	1.8%	0.0%
1980	90.8%	0.0%	4.8%	2.1%	2.3%	0.0%
1981	93.8%	0.0%	3.5%	1.0%	1.7%	0.0%
1982	90.3%	0.0%	6.6%	1.2%	2.0%	0.0%
1983	87.4%	0.0%	9.4%	1.5%	1.6%	0.0%
1984	88.3%	0.0%	8.4%	1.3%	2.1%	0.0%
1985	88.8%	0.0%	7.5%	1.6%	2.1%	0.0%
1986	68.2%	0.0%	18.6%	5.5%	7.8%	0.0%
1987	68.0%	0.0%	20.6%	6.7%	4.7%	0.0%
1988	69.6%	0.0%	19.0%	4.9%	6.4%	0.0%
1989	64.8%	0.0%	25.8%	5.7%	3.7%	0.0%
1990	69.1%	0.0%	23.3%	5.2%	2.4%	0.0%
1991	73.0%	0.0%	21.4%	3.5%	2.1%	0.0%
1992	63.8%	0.0%	24.7%	1.6%	3.6%	5.5%
1993	70.7%	0.0%	22.6%	1.2%	2.3%	2.4%
1994	71.0%	0.0%	23.0%	1.6%	1.8%	1.8%
1995	67.6%	0.0%	23.0%	3.4%	2.5%	1.8%
1996	68.8%	0.0%	23.2%	2.7%	2.5%	1.7%
1997	65.0%	0.0%	26.9%	2.4%	2.6%	1.8%
1998	53.0%	0.0%	40.2%	1.8%	1.8%	0.7%
1999	36.8%	0.0%	57.5%	1.9%	1.0%	0.4%
2000	45.8%	0.0%	47.5%	2.3%	0.7%	0.4%
2001	44.9%	0.0%	49.3%	1.8%	0.4%	0.4%
2002	43.1%	0.0%	51.9%	2.2%	0.2%	0.1%
2003	47.2%	0.0%	47.1%	2.3%	0.2%	0.1%
2004	59.6%	0.0%	37.7%	2.0%	0.4%	0.1%
2005	66.6%	0.0%	30.6%	1.6%	1.0%	0.1%
2006	65.7%	0.0%	32.1%	1.0%	0.5%	0.1%
2007	66.4%	0.0%	31.9%	1.1%	0.1%	0.0%
2008	66.4%	0.0%	31.5%	1.4%	0.1%	0.0%
2009	45.9%	0.0%	52.2%	1.0%	0.0%	0.0%
2010	32.3%	0.0%	66.3%	0.5%	0.0%	0.0%
2011	32.0%	0.0%	65.9%	0.8%	0.0%	0.1%
2012	31.6%	0.0%	66.4%	0.8%	0.0%	0.0%
2013	26.0%	0.0%	70.3%	0.9%	0.0%	0.0%

7.2.3. Uncertainties and time-series consistency

Uncertainty analysis for the revised year 2013 for IPCC sector 5.*Waste* was estimated with use of approach 1 described in 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Simplified approach was based on the assumptions that every value is independent and probability distribution is symmetric. Results of the sectoral uncertainty analysis are given below. More details on uncertainty assessment of whole inventory are given in annex 8.
Recalculation of data for years 1988-2012 ensured consistency for whole time-series.

Table 7.14. Uncertainty analysis results in sector 5 in 2013

2013	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	CO_2 Emission uncertainty [%]	CH_4 Emission uncertainty [%]	N_2O Emission uncertainty [%]
5. Waste	**553.08**	**382.82**	**3.04**	33.5%	75.7%	130.7%
A. Solid Waste Disposal on Land		341.89			84.4%	
B. Biological treatment of solid waste		5.49	0.41		104.4%	153.0%
C. Waste Incineration	553.08	0.00	0.15	33.5%	101.1%	0.0%
D. Wastewater treatment and discharge		35.44	2.48		77.2%	150.3%

7.2.4. Source-specific QA/QC and verification

Activity data concerning solid waste disposals and sewage sludge come from Central Statistical Office (GUS). GUS is responsible for QA/QC of collected and published data. In some cases of solid waste comparison is made between national statistical data and National Waste Management Plan. Activity data on waste incineration is based on external expert's research involving questionnaires from individual entities. Country specific emission factors involved in estimation of GHG emissions from waste water treatment are based on external expert's analysis of questionnaires from individual entities.

The attempt has been undertaken to ensure internal consistency between different treatment pathways of waste and sewage sludge. Calculations in waste sector were examined with focus on formulas, units and trends consistency. Generally QC procedures follow QA/QC plan presented in Annex 7.

7.2.5. Source-specific recalculations

- new GWP values were applied.

Table 7.15. Change in methane emissions in result of recalculations

Change	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
kt CH_4	-18.7	-21.6	-24.4	-26.9	-28.6	-31.1	-32.9	-35.3	-37.4	-38.9	-40.8	-41.8	-42.2
%	-4%	-5%	-6%	-6%	-7%	-7%	-8%	-8%	-9%	-9%	-9%	-9%	-9%

Change	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
kt CH_4	-43.3	-44.0	-43.9	-45.7	-48.7	-51.7	-53.7	-54.8	-57.2	-60.0	-58.4	-61.1
%	-10%	-10%	-10%	-11%	-11%	-12%	-12%	-13%	-13%	-14%	-14%	-15%

7.2.6. Source-specific planned improvements

No further improvements are currently planned for sector 5.A.

7.3. Biological Treatment of Solid Waste (CRF sector 5.B)

7.3.1. Source category description

In the following section estimation of emissions of methane and N_2O from sector 5.B is provided. Because of lack of sufficient data on amounts of waste digested anaerobically only emissions from composting of waste were estimated. The 5.B subcategory share in total waste sector is 2.4%.

7.3.2. Methodological issues

Calculations are based on IPCC 2006 Guidelines [IPCC 2006] methodology, *Tier 1*, choice of which justifies lack of country-specific method of estimation GHG emission.

Default emission factors applied by Party are: 4 g CH_4/kg treated waste and 0.3 g N_2O/kg treated waste (composting, wet weight basis).

Activity data and its sources are presented in table 7.16. Data on amounts of municipal waste composted in years 1993 – 2013 were taken from statistical yearbooks, apart from the year 1997 where, due to lack of data, interpolation was applied. For the years 1988 – 1992 activity data were achieved by extrapolation.

Data on amounts of waste other than municipal composted in years 1998 – 2013 were taken from statistical yearbooks. For the years prior to 1998 no activity data are available and extrapolation was not possible due to lack of distinct trend.

Table 7.16. Amounts of composted waste and data sources

Year	Municipal waste [kt]	Data source	Other waste [kt]	Data source
1988	32.0	extrapolation	NA	-
1989	39.6	extrapolation	NA	-
1990	48.9	extrapolation	NA	-
1991	60.5	extrapolation	NA	-
1992	74.7	extrapolation	NA	-
1993	92.4	[GUS 1994d]	NA	-
1994	114.2	[GUS 1997d]	NA	-
1995	200.6	[GUS 1997d]	NA	-
1996	218.6	[GUS 1998d]	NA	-
1997	220.2	interpolation	NA	-
1998	221.7	[GUS 2002d]	82.6	[GUS 2002d]
1999	225.2	[GUS 2003d]	96.8	[GUS 2003d]
2000	248.3	[GUS 2003d]	73.7	[GUS 2003d]
2001	309.0	[GUS 2004d]	86.1	[GUS 2004d]
2002	214.8	[GUS 2004d]	82.8	[GUS 2004d]
2003	128.9	[GUS 2004d]	115.3	[GUS 2004d]
2004	234.1	[GUS 2007d]	158.1	[GUS 2007d]
2005	317.9	[GUS 2007d]	219.6	[GUS 2007d]
2006	297.1	[GUS 2009d]	181.6	[GUS 2009d]
2007	277.7	[GUS 2010d]	224.3	[GUS 2010d]
2008	262.4	[GUS 2011d]	225.9	[GUS 2011d]
2009	508.3	[GUS 2012d]	175.4	[GUS 2012d]
2010	608.5	[GUS 2012d]	173.5	[GUS 2012d]
2011	365.6	[GUS 2012d]	118.9	[GUS 2012d]
2012	926.5	[GUS 2013d]	137.8	[GUS 2013d]
2013	1230.5	[GUS 2014d]	142.3	[GUS 2014d]

7.3.3. Uncertainties and time-series consistency

See chapter 7.2.3.

7.3.4. Source-specific QA/QC and verification

See chapter 7.2.4.

7.3.5. Source-specific recalculations

Estimations of emissions from category 5.B occur in inventory for the first time.

7.3.6. Source-specific planned improvements

Investigation on possibility of estimation of GHG from anaerobic digestion of organic waste is planned.

7.4. Incineration and Open Burning of Waste (CRF sector 5.C)

7.4.1. Source category description

The 5.C subcategory share in total waste sector is 5.5% and it involves CO_2 and N_2O emissions from incineration of municipal, industrial (including hazardous) and medical waste and sewage sludge. According to IPCC Guidelines biogenic emission of CO_2 (139.52 kt in 2013) is not included in total emission. Estimates of emissions from open burning of waste were not calculated because of lack sufficient activity data.

7.4.2. Methodological issues

Estimates of emissions of GHG from waste incineration are based on IPCC 2006 Guidelines [IPCC 2006] and domestic case study [Wielgosiński G. 2003]. For estimation of carbon dioxide from incineration of municipal waste *Tier 2a* approach was taken due to availability of country specific data on amount and fractions of incinerated waste. Estimation of emissions of N_2O from incineration of municipal waste, and emissions of GHG from incineration of industrial and medical waste as well as sewage sludge was performed using *Tier 1*.

Table 7.17. Emission factors

Incinerated waste	**Factor**	**Source**
municipal	composition of waste	CS - see table 7.21
	dry matter	default IPCC 2006
	fraction of carbon (CF)	default IPCC 2006
	fraction of fossil carbon (FCF)	default IPCC 2006
	oxidation factor	default IPCC 2006
	N_2O emission factor	default IPCC 2006
Industrial	dry matter	default IPCC 2006
	fraction fo carbon in the dry matter	default IPCC 2006
	fraction of fossil carbon	default IPCC 2006
	oxidation factor	default IPCC 2006
	N_2O emission factor	default IPCC 2006
medical	dry matter	default IPCC 2006
	fraction fo carbon in the dry matter	default IPCC 2006
	fraction of fossil carbon	default IPCC 2006
	oxidation factor	default IPCC 2006
sewage sludge	dry matter	default IPCC 2006
	fraction fo carbon in the dry matter	default IPCC 2006
	fraction of fossil carbon	default IPCC 2006
	oxidation factor	default IPCC 2006
	N_2O emission factor	default IPCC 2006

Biogenic and non-biogenic content of waste for municipal waste was assumed on a basis of national case study [Wielgosiński G. 2003]. For industrial, medical waste and sewage sludge this content was taken from [IPCC 2000].

Table 7.18. Biogenic and non-biogenic content of waste

Type of waste	Biogenic waste (1-nonbiogenic)	Non-biogenic waste
municipal	0.3	0.7
industrial	0.1	0.9
medical	0.6	0.4
sewage sludge	1	0

The amounts of incinerated municipal, industrial waste and sewage sludge are taken from Central Statistical Office Environmental Protection Yearbooks [GUS 2014d]. Data on incinerated medical waste is taken from Central Waste System database

Table 7.19. Activity data in 2013 [kt]

Type of waste	Amount of waste incinerated
municipal	50.07
industrial	404.90
medical	34.89
sewage sludge	148.8

Table 7.20. Composition of incinerated waste [kt]

Year	Municipal		Medical		Industrial (incl. hazardous)		Sewage sludge
	nonbiogenic	biogenic	nonbiogenic	biogenic	nonbiogenic	biogenic	biogenic
1988	NO	NO	22.6	33.9	291.7	32.4	NA
1989	NO	NO	22.1	33.1	268.2	29.8	NA
1990	NO	NO	22.4	33.6	225.8	25.1	NA
1991	NO	NO	22.0	33.1	201.4	22.4	NA
1992	NO	NO	21.4	32.1	191.2	21.2	NA
1993	NO	NO	21.7	32.5	189.1	21.0	NA
1994	NO	NO	21.8	32.7	189.7	21.1	NA
1995	NO	NO	21.4	32.2	192.5	21.4	NA
1996	NO	NO	21.3	32.0	195.5	21.7	NA
1997	NO	NO	20.9	31.3	195.3	21.7	NA
1998	NO	NO	20.7	31.1	208.9	23.2	41.4
1999	NO	NO	19.9	29.9	172.6	19.2	31.9
2000	1.2	1.7	20.4	30.6	168.2	18.7	34.1
2001	10.5	15.5	10.8	16.1	220.8	24.5	46.6
2002	14.5	21.5	7.3	10.9	278.7	31.0	31.5
2003	16.7	24.9	8.2	12.3	370.5	41.2	47.0
2004	21.0	22.0	10.7	16.1	236.7	26.3	39.9
2005	21.7	22.7	11.8	17.7	267.6	29.7	37.4
2006	20.2	21.1	8.8	13.3	268.6	29.8	39.3
2007	21.4	22.4	10.1	15.2	300.1	33.3	33.7
2008	20.8	20.0	9.8	14.7	301.9	33.5	44.5
2009	20.6	19.7	11.4	17.2	290.8	32.3	50.4
2010	20.9	20.0	11.1	16.6	277.7	30.9	66.4
2011	20.1	19.3	13.3	20.0	280.9	31.2	85.2
2012	25.9	24.8	13.7	20.5	349.9	38.9	101.1
2013	25.5	24.5	14.0	20.9	364.4	40.5	148.8

Table 7.21. Composition of incinerated municipal solid waste

Year	Food	Garden	Paper	Wood	Textile	Plastics, and other inert
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	24%	2%	20%	2%	2%	50%
2005	24%	2%	20%	2%	2%	50%
2006	24%	2%	20%	2%	2%	50%
2007	24%	2%	20%	2%	2%	50%
2008	33%	3%	14%	1%	3%	46%
2009	33%	3%	14%	1%	3%	46%
2010	33%	3%	14%	1%	3%	46%
2011	33%	3%	14%	1%	3%	46%
2012	33%	3%	14%	1%	3%	46%
2013	33%	3%	14%	1%	3%	46%

The table 7.25 presents composition of incinerated waste. Before the year 2000 no municipal waste was incinerated in Poland. Data on incineration of sewage sludge before 1998 are not available and lack of distinguishable trend indisposes extrapolation.

Waste combusted for energy purposes is included in Energy sector and treated as a fuel. Information on used EFs is included in NIR report under the Annex 2.

7.4.3. Uncertainties and time-series consistency

See chapter 7.2.3.

7.4.4. Source-specific QA/QC and verification

See chapter 7.2.4.

7.4.5. Source-specific recalculations

- change of methodology of estimation emissions to [2006 IPCC].
- new GWP values were applied

Table 7.22. Change in GHG emissions in result of recalculations

Change	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
kt eq. CO_2	-128.0	-118.9	-103.6	-94.2	-89.9	-89.4	-89.7	-90.4	-91.4	-91.0	-87.7	-75.4	-176.7
%	-22%	-22%	-22%	-23%	-23%	-23%	-23%	-23%	-23%	-23%	-20%	-21%	-39%

Change	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
kt eq. CO_2	-78.6	-11.3	214.9	93.8	115.0	121.4	168.3	233.0	223.4	215.9	220.7	276.1
%	-18%	-3%	58%	33%	37%	40%	55%	95%	93%	93%	92%	94%

7.4.6. Source-specific planned improvements

- continue research on usage of activity data from Central Waste System for emissions estimation.

7.5. Waste Water Handling (CRF sector 5.D)

7.5.1. Source category description

The 5.D subcategory share in emission of GHG from waste sector is 14.7% and it involves methane emission from industrial wastewater (15.7% share of 5.D), methane emission from Domestic wastewater (38.9% share of 5.D) and N_2O emission from human sewage (45.5% share of 5.D).

The emission from sector 5.D decreased ca. 59.7% since the base year, mostly because of significant development of national wastewater collection and treatment system. The main contributor and driver of emission change in 5.D is the *Domestic Wastewater* subsector (5.D.1) – responsible of ca. 84.3% of emission of GHG from sector 5.D in 2013.

Emission of methane from subsector *5.D.2 Industrial Wastewater* is ca. 15.7% of emission of GHG from sector 5.D in 2013 and it is constantly decreasing due to reduction of wastewater production by industries.

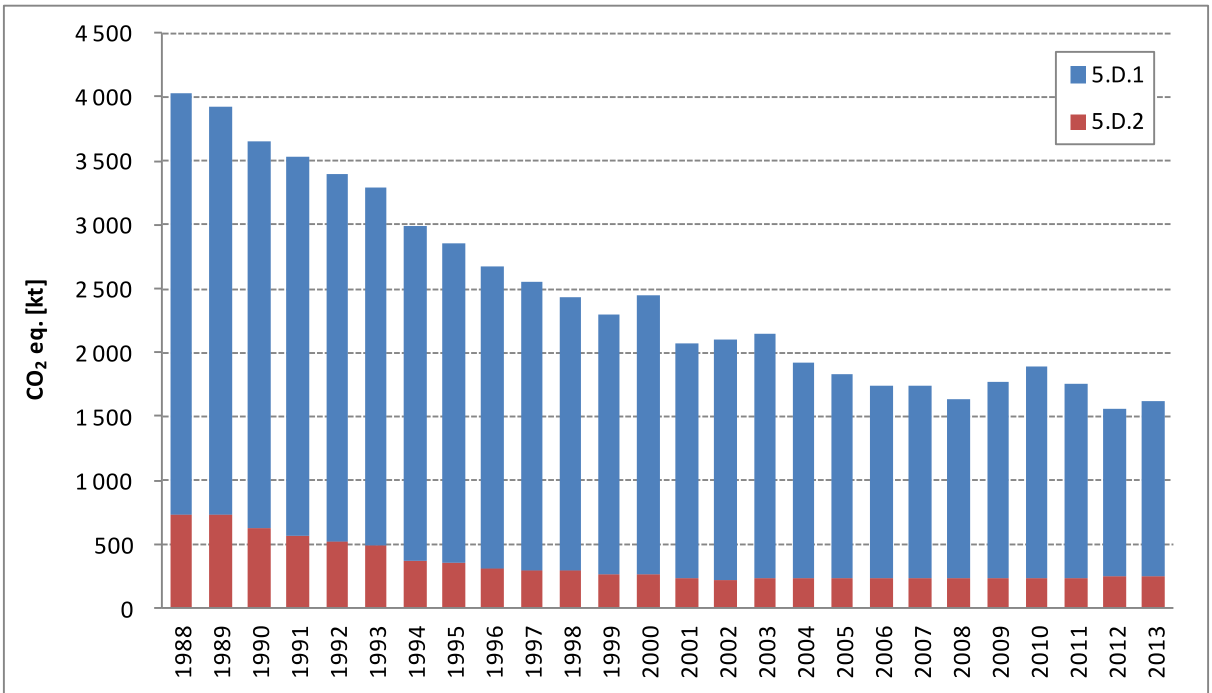

Figure 7.6. GHG emission from 5.D subsector

7.5.2. Methodological issues

7.5.2.1. Domestic Wastewater (CRF sector 5.B.1)

Methane emission

Estimation of CH_4 emissions from sector 5.B.1 *Domestic Wastewater* was based on methodology IPCC 2006 Guidelines [2006 IPCC], *Tier 2* – which choice is justified by availability of country specific activity data. Amounts of degradable organic components were estimated basing on the data on population of Poland, and rural and urban population using different sewage treatment pathways. These data were taken from [GUS 2014d]. Activity data are presented in table 7.22.

Table 7.23. Rural and urban population using different sewage treatment pathways [%]

Year	Rural population shares in treatment pathway					Urban population shares in treatment pathway				
	mechanical treatment plant	biological treatment plant	high nutrient removal	not connected	latrine	mechanical treatment plant	biological treatment plant	high nutrient removal	not connected	latrine
1988	0.04	2.06	0.00	0.89	97.02	13.43	31.46	0.00	35.77	19.35
1989	0.06	2.04	0.00	1.20	96.69	11.05	34.01	0.00	35.81	19.13
1990	0.09	2.02	0.00	1.56	96.34	8.55	36.58	0.00	36.21	18.66
1991	0.12	1.99	0.00	1.93	95.96	16.51	39.21	0.00	26.01	18.27
1992	0.14	1.97	0.00	2.30	95.59	15.12	42.14	0.00	24.80	17.94
1993	0.17	1.95	0.00	2.75	95.13	17.47	42.64	0.00	22.08	17.80
1994	0.19	1.93	0.00	3.25	94.64	15.23	47.53	0.00	19.64	17.60
1995	0.27	2.51	0.31	2.82	94.10	14.24	46.77	4.69	16.86	17.44
1996	0.35	3.31	0.50	2.33	93.50	13.47	46.14	7.42	15.75	17.23
1997	0.38	4.85	0.63	1.44	92.70	11.64	47.78	13.07	10.54	16.97
1998	0.38	5.54	1.16	1.41	91.50	9.26	46.27	20.42	7.28	16.77
1999	0.33	6.72	1.61	1.24	90.10	7.31	47.47	23.90	4.78	16.54
2000	0.37	8.09	2.36	0.69	88.50	5.53	43.47	30.96	3.79	16.25
2001	0.45	8.76	3.82	0.00	86.96	5.09	41.57	35.01	2.48	15.84
2002	0.48	9.15	5.56	0.00	84.81	4.22	38.03	40.90	0.00	16.85
2003	0.43	10.44	5.97	0.00	83.16	3.92	33.48	46.23	0.00	16.37
2004	0.43	11.16	7.53	0.00	80.87	3.21	30.53	50.41	0.00	15.85
2005	0.35	11.97	8.88	0.00	78.79	3.16	25.75	55.80	0.00	15.29
2006	0.26	12.85	9.93	0.00	76.96	0.87	26.29	58.07	0.00	14.77
2007	0.17	13.63	11.19	0.00	75.01	0.65	23.94	60.91	0.00	14.50
2008	0.19	13.94	13.05	0.00	72.82	0.26	16.76	68.86	0.00	14.12
2009	0.20	14.42	13.80	0.00	71.59	0.10	14.90	71.41	0.00	13.58
2010	0.22	14.94	14.85	0.00	70.00	0.08	13.64	72.84	0.00	13.45
2011	0.22	15.73	15.63	0.00	68.42	0.07	10.85	76.22	0.00	12.85
2012	0.29	16.55	17.41	0.00	65.75	0.06	10.35	77.75	0.00	11.84
2013	0.21	17.43	18.84	0.00	63.52	0.03	9.91	78.81	0.00	11.24

Default value of organic load in biochemical oxygen demand per person, which is equal to 60 g BOD/person/day [IPCC 2006], was taken for the calculations.

Amounts of recovered methane are taken from national statistics [GUS OZE 2014]. Amounts of organic component removed as sludge are calculated on basis of statistical data on amounts sewage sludge applied in agriculture, composting, incinerated and landfilled [GUS 2014d] and factor supplied by ATV Germany which equals to 0.8 kg dry matter/kg BOD.

Methane Correction Factors (MCF) for various treatment pathways are taken from [2006 IPCC] and domestic study [Bernacka 2005]. Their values are listed in table 7.23.

Table 7.24. MCF values

Treatment pathway	mechanical treatment plant	biological treatment plant	high nutrient removal plant	not connected	latrine
MCF	0.05	0.05	0.05	0.1	0.5
source	Bernacka 2005	Bernacka 2005	Bernacka 2005	default IPCC 2006	default IPCC 2006

N_2O emission

N_2O emission from human sewage was calculated according to default method [2006 IPCC]. Population of Poland was provided by Central Statistical Office [GUS 2014]. Amounts of animal and vegetal protein consumption per capita per year was taken from FAO database. For years 2012-2013 protein consumption was assumed on the level of 2011 data, what is a result of lack of up-to-date data in FAO database. Values and sources of emission factors are provided in table 7.24.

Table 7.25. Emission factors

Emission factor	F_{npr}	$EF_{effluent}$	$F_{non\text{-}con}$	$F_{ind\text{-}com}$
value	0.16	0.005	1.1	1.25
source	default IPCC 2006	default IPCC 2006	default IPCC 2006	default IPCC 2006

7.5.2.2. Industrial Wastewater (CRF sector 5.D.2)

Estimates of emissions of methane from industrial wastewater treatment subsector are based on IPCC 2006 Guidelines [IPCC 2006] *Tier 1* and domestic case study [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].

Data on share of aerobic and anaerobic wastewater treatment method and recovery of methane in industrial wastewater treatment was taken from expert opinion [Przewłocki, 2007].

Data on amount of industrial wastewater from separate branches and on biological treatment of organic wastewater were taken from national statistics [GUS 2014d]. Data on employment and production from some branches were taken from national statistics [GUS 1989-2014].

Total organic product is derived from amount of wastewater from each industry, COD concentration in organic wastewater and wastewater produced per unit product by industry.

Table 7.26. Emission factors on wastewater and sludge

Industry sector	COD concentration in organic wastewater	Methane correction factor from wastewater	Maximum CH_4 producing capacity form wastewater	Methane emission factor for wastewater	Methane correction factor from sludge	Maximum CH_4 producing capacity form sludge	Methane emission factor for sludge
	kg/m^3		kg CH_4/kg ChZT	kg CH_4/kg ChZT		kg CH_4/kg ChZT	kg CH_4 kg ChZT
Mining and quarrying	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: Vegetables & 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

Industry sector	**COD concentration in organic wastewater**	**Methane correction factor from wastewater**	**Maximum CH_4 producing capacity form wastewater**	**Methane emission factor for wastewater**	**Methane correction factor from sludge**	**Maximum CH_4 producing capacity form sludge**	**Methane emission factor for sludge**
	kg/m^3		**kg CH_4/kg ChZT**	**kg CH_4/kg ChZT**		**kg CH_4/kg ChZT**	**kg CH_4 kg ChZT**
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

Table 7.27. Amount of industrial wastewater by industry [million m^3]

Rok	Mining and quarrying	Iron and steel	Non-iron metals	Synthetic fertilizers	Food products: Meat & Poultry	Food products: Fish Processing	Food products: Vegetables & Fruits	Food products: Vegetable Oils	Food products: Dairy Products	Food products: Sugar	Food products: Soft Drinks	Food products: Beer & Malt	Food products: Other	Textiles	Leathers	Wood and Paper	Petroleum Refineries	Organic Chemicals	Plastics & Resins	Other non-metallic	Manufacturing of Machinery and Transport Equipment	Other
1988	548.0	94.2	48.7	123.0	3.3	1.6	14.2	3.7	19.5	23.7	4.1	4.0	2.7	14.2	6.3	195.0	43.2	126.0	17.4	58.2	53.6	90.9
1989	426.5	119.6	86.1	118.3	3.0	1.5	12.0	2.5	20.6	21.0	4.2	4.0	5.7	13.9	5.7	199.1	43.4	224.1	0.0	59.6	54.6	91.3
1990	519.0	99.8	39.7	92.5	2.7	1.3	10.0	1.5	19.7	20.4	4.3	4.3	3.7	11.1	4.7	184.0	38.7	107.0	17.6	53.3	50.3	95.2
1991	470.0	73.1	67.8	58.4	3.2	1.2	8.5	1.0	17.7	13.9	5.0	4.0	2.6	8.2	4.2	168.0	40.0	120.0	15.8	43.9	42.1	89.8
1992	453.0	51.4	66.2	53.5	5.4	1.1	7.4	0.5	16.2	10.0	5.8	4.0	0.6	9.0	3.0	146.0	36.6	108.0	15.7	31.0	32.6	79.8
1993	392.0	47.0	59.7	48.5	4.6	0.9	8.0	2.1	15.3	11.0	2.3	3.6	1.5	7.8	2.6	132.0	33.6	97.7	15.1	28.0	30.7	82.7
1994	382.0	45.8	128.0	51.3	3.9	0.8	7.4	1.2	14.2	7.9	2.6	2.7	1.6	7.3	1.7	129.0	32.6	101.0	14.6	29.6	29.5	104.0
1995	378.0	44.4	134.0	41.5	4.0	0.3	8.3	1.0	13.2	7.7	2.4	2.1	1.5	6.4	1.6	121.0	33.2	98.6	12.6	29.3	27.0	94.5
1996	362.0	43.0	142.0	48.5	4.2	0.4	7.8	3.6	12.5	6.5	2.6	1.7	0.9	5.7	1.3	117.0	28.1	94.3	6.7	28.8	25.9	115.0
1997	340.0	43.9	172.0	51.9	4.2	0.2	7.7	4.8	12.2	5.7	2.9	1.7	1.1	5.2	1.1	114.0	25.1	81.5	9.2	32.9	26.5	110.0
1998	336.0	25.3	188.0	52.3	3.9	0.1	9.4	2.5	12.3	6.1	2.7	1.6	2.5	4.7	0.7	106.0	24.3	63.1	10.3	27.9	25.1	161.0
1999	362.3	13.2	184.8	52.6	4.0	0.1	7.5	3.2	11.4	4.9	2.6	1.4	0.5	3.1	0.7	90.3	20.3	55.9	8.4	29.8	22.0	116.7
2000	350.0	14.2	184.0	51.7	3.6	0.1	7.5	2.4	11.3	4.0	2.5	1.3	0.8	2.6	1.1	81.7	17.8	47.7	7.8	32.3	12.0	121.0
2001	332.0	14.8	187.0	49.7	3.4	0.1	7.2	0.7	11.7	2.9	2.1	1.3	0.7	2.1	1.2	76.9	18.1	42.4	4.7	34.2	10.4	130.0
2002	293.0	13.3	184.0	50.3	3.4	0.1	6.4	0.3	11.3	2.7	2.2	1.4	0.7	1.7	0.9	77.1	16.8	42.0	2.7	38.0	9.1	126.0
2003	272.0	9.6	155.0	46.0	3.5	0.1	7.8	0.2	11.5	2.7	3.1	1.2	0.8	1.6	0.8	71.5	17.4	38.3	2.5	31.9	8.1	120.0
2004	261.0	8.2	135.0	49.4	4.1	0.1	6.8	0.3	13.0	2.2	2.0	1.2	3.3	1.5	0.6	70.9	19.6	36.0	2.5	37.4	6.8	129.0
2005	267.0	6.5	132.0	48.6	4.3	0.0	6.6	0.3	13.5	1.8	2.1	1.3	2.8	1.6	0.7	68.9	19.3	38.4	2.4	36.3	7.0	128.0
2006	272.0	7.4	132.0	50.7	4.6	0.0	7.0	0.4	13.8	1.4	2.1	1.7	2.3	1.3	0.6	69.7	20.7	38.6	2.2	43.2	4.4	128.0
2007	271.0	10.8	133.0	52.6	4.8	0.0	6.8	0.4	14.4	1.9	1.9	1.4	2.4	0.7	0.6	67.6	23.0	39.1	2.3	39.4	4.2	148.0
2008	242.6	8.3	130.8	176.3	5.0	0.0	6.0	0.6	14.2	2.7	1.6	1.4	2.6	0.6	0.4	64.7	20.9	35.5	1.9	46.1	3.7	141.7
2009	252.9	12.8	128.4	121.3	5.8	0.0	6.1	0.8	14.2	3.2	1.8	1.1	2.1	0.4	0.5	66.8	21.3	29.4	1.8	39.9	2.1	168.4
2010	283.2	16.5	147.3	49.8	6.6	0.0	5.8	0.7	14.5	2.6	1.6	2.4	36.1	0.3	0.4	64.2	23.1	35.6	2.1	46.8	2.8	183.2
2011	286.2	13.2	166.4	48.1	6.5	0.0	5.8	0.6	13.8	3.1	2.2	10.3	35.3	0.0	0.3	66.3	23.1	38.0	2.4	48.0	2.7	164.9
2012	286.0	12.4	133.5	53.8	6.6	0.0	7.1	0.7	13.9	3.6	3.1	1.3	39.2	0.0	0.2	69.4	23.8	35.4	2.2	40.2	2.2	136.1
2013	320.9	13.4	134.6	51.1	6.9	0.0	6.8	0.8	14.7	3.5	3.0	1.3	39.2	0.0	0.2	71.4	24.0	37.2	1.8	19.9	1.7	79.3

7.5.3. Uncertainties and time-series consistency

See chapter 7.2.3.

7.5.4. Source-specific QA/QC and verification

See chapter 7.2.4.

7.5.5. Source-specific recalculations

Table 7.28. Change in emissions in result of recalculations

Change	1988	1989	1990	1991	1992	1993	1994	1995	1996
kt eq. CO_2	507.1	375.2	334.5	-214.4	-383.8	-623.3	-848.6	-995.1	-1 206.5
%	14%	11%	10%	-6%	-10%	-16%	-22%	-26%	-31%

Change	1997	1998	1999	2000	2001	2002	2003	2004	2005
kt eq. CO_2	-1 613.6	-1 979.6	-2 284.0	-3 840.5	-4 324.7	-4 508.3	-4 573.4	-4 766.1	-4 909.0
%	-39%	-45%	-50%	-61%	-68%	-68%	-68%	-71%	-73%

Change	2006	2007	2008	2009	2010	2011	2012
kt eq. CO_2	-5 047.2	-5 235.4	-5 254.0	-5 281.0	-5 211.0	-5 416.3	-5 789.3
%	-74%	-75%	-76%	-75%	-73%	-75%	-79%

- change of methodology of estimation emissions from Domestic Wastewater to [2006 IPCC].
- new GWP values were applied.

7.5.6. Source-specific planned improvements

No further improvements are currently planned for sector 5.D.

8. Other (CRF sector 6)

No other emissions were identified in the Polish GHG inventory apart from those given in CRF categories 1-5.

9. Indirect CO_2 and nitrous oxide emissions

Addressing paragraph 29 of decision 24/CP.19, Poland has not elected to report indirect CO_2 and N_2O emissions. Information on indirect CO_2 and N_2O emissions in the Energy and Agriculture sectors can be found in Chapters 3 and 5 respectively.

10. RECALCULATIONS AND IMPROVEMENTS

10.1. Explanations and justifications for recalculations

Recalculations made in 2015 consists mostly in implementing the 2006 IPCC Guidelines and applying new Global Warming Potentials for gases other than CO_2. Specific sectoral information on recalculations made are given in Chapters 3-7 dedicated to source/sink categories. Also information on planned improvements is included in sectoral Chapters 3-7. Due to implementation of new IPCC GLs some ERT recommendations obtained in 2014 are not yet relevant.

The percentage change caused by recalculation with respect to the previous submission, has been calculated as follows:

$$\text{Change} = 100\% \times [(LS-PS)/PS]$$

where:

LS = Latest Submission (for 1988−2012 inventory submitted in NIR 2015)
PS = Previous Submission (for 1988−2012 inventory submitted in NIR 2014)

10.2. Implications for emission levels and trends

Recalculations of CO_2 emissions revealed slight increase in entire period ranging from 0.2% in 2001 up to 2.2% in 2010 (Fig. 10.1). The main cause for specific increase starting from 2002 was update made in energy balance for 2002−2012 in 1.A.4.b category related mostly to rise in coal use in residential sector.

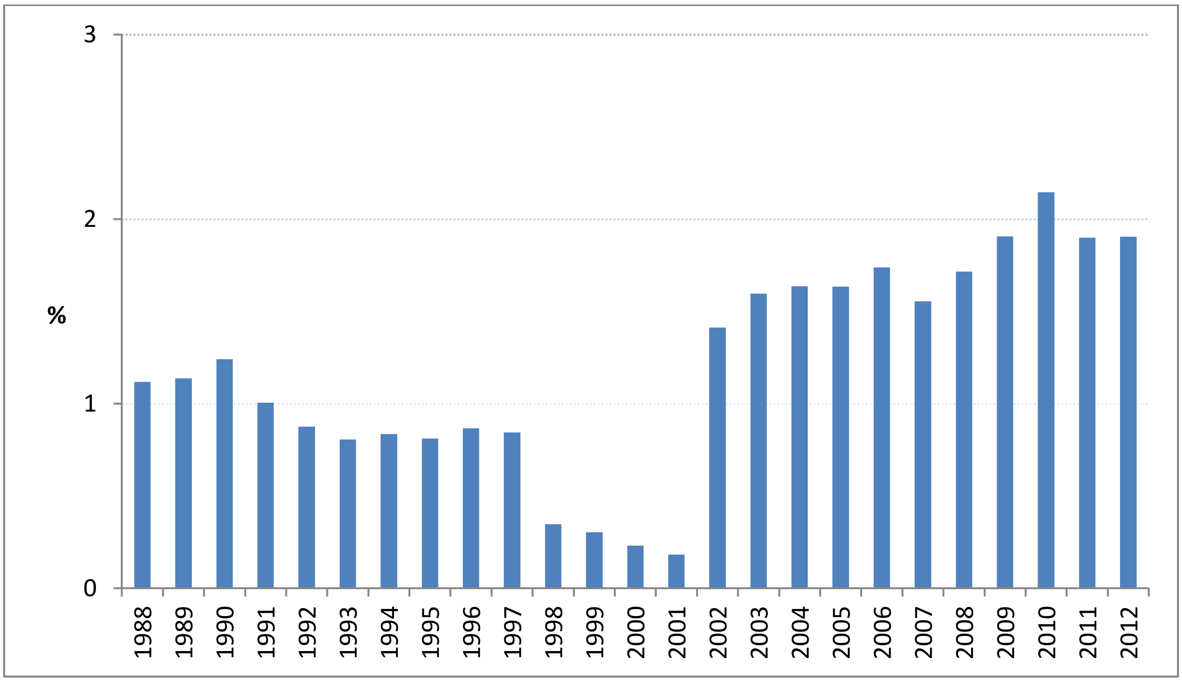

Figure 10.1. Recalculation of CO_2 for entire time series made in CRF 2015 comparing to CRF 2014

In the case of CH_4 the most significant recalculations were made in Agriculture and Waste sectors following implementation of the 2006 IPCC GLs (Fig. 10.2).

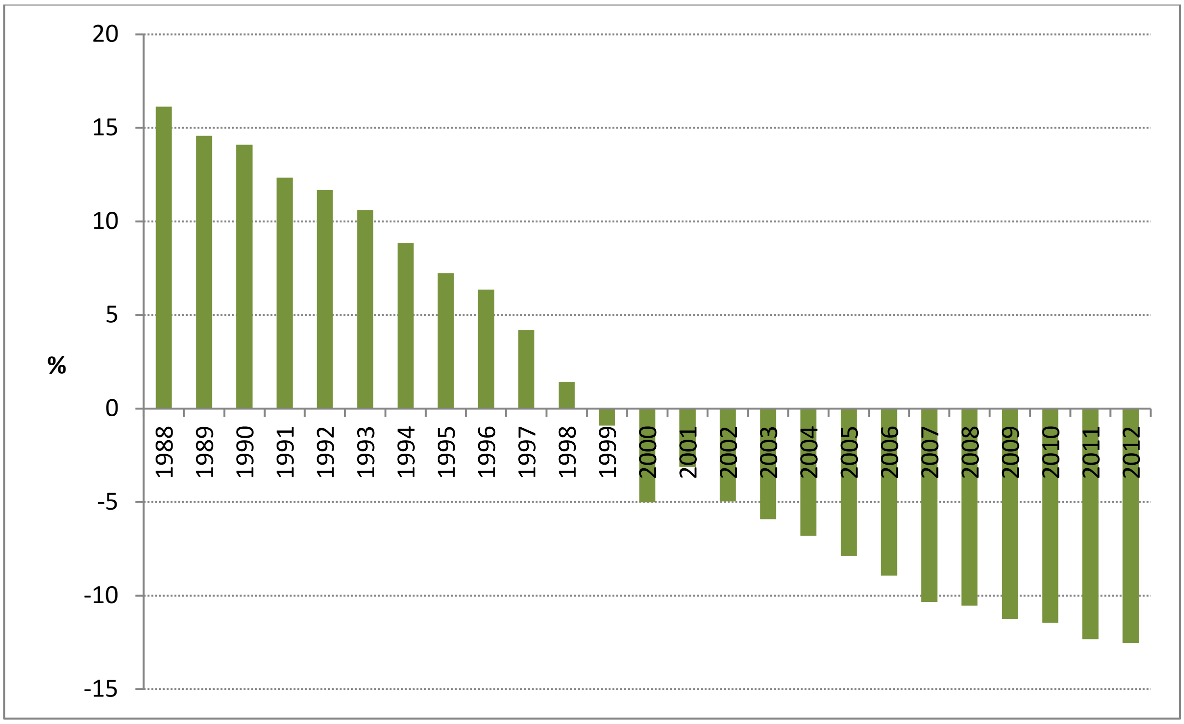

Figure 10.2. Recalculation of CH_4 for entire time series made in CRF 2015 comparing to CRF 2014

Whereas significant decrease in N_2O emissions in entire period (Fig. 10.3) was triggered mostly by methodological changes made in response to implementing the 2006 IPCC GLs, what especially covered indirect N_2O emissions from agricultural soils as well as manure management.

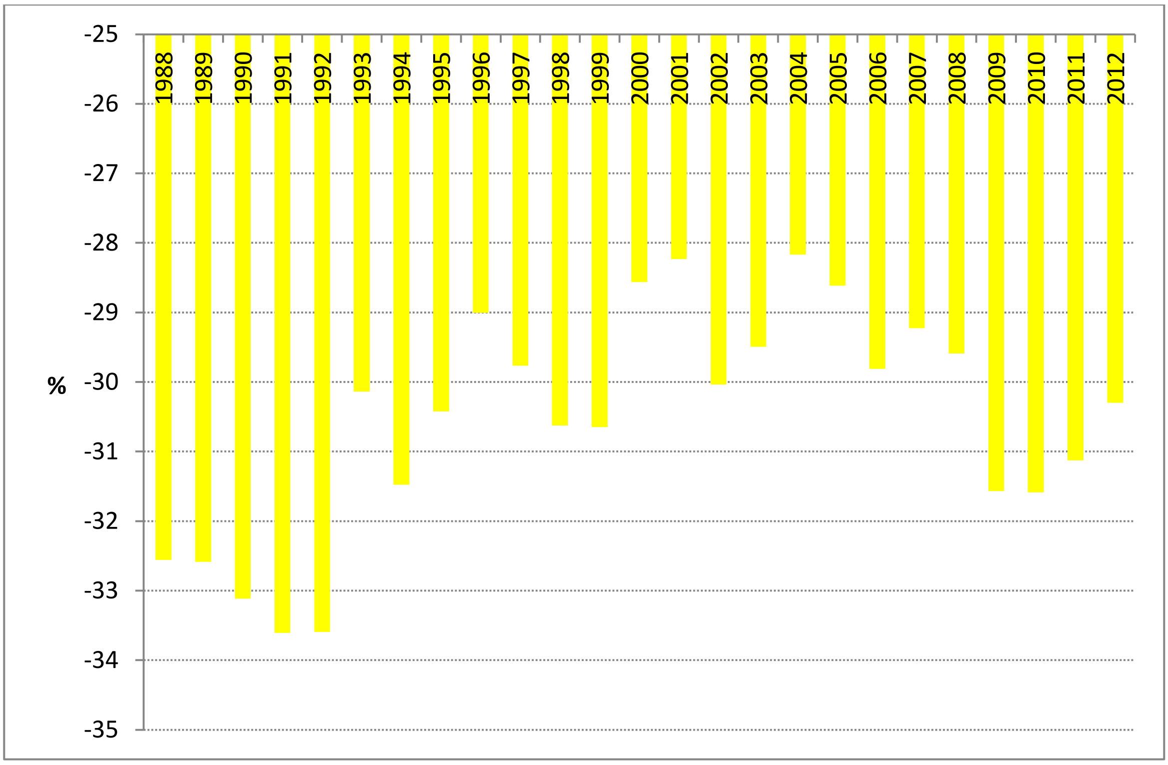

Figure 10.3. Recalculation of N_2O for entire time series made in CRF 2015 comparing to CRF 2014

ABBREVIATIONS

AWMS	Animal waste management system
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CRF	Common reporting format
DOC	Degradable organic component
ERT	Expert Review Team
GHG	Greenhouse Gases
IE	Included elsewhere
KOBiZE	National Centre for Emissions Management
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
NMVOC	Non-methane volatile organic compounds
SWDS	Solid waste disposal site

REFERENCES

6 RR (2013). Sixth national communication and first biennial report under the united nations framework convention on climate change. Institute of Environmental Protection−NRI. Warszawa, 2013.

ARR (2011). Report of the individual review of the annual submission of Poland submitted in 2010. . FCCC/ARR/2010/POL. 4 April 2011. UNFCCC.

ARR (2012). Report of the individual review of the annual submission of Poland submitted in 2011. . FCCC/ARR/2011/POL. 1 June 2012. UNFCCC.

ARR (2013). Report of the individual review of the annual submission of Poland submitted in 2012. . FCCC/ARR/2012/POL. 18 March 2013. UNFCCC.

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 (1968-2014). Annual update of forest area and woody biomass in State Forests at 1 January. Forest Management and Geodesy Bureau. Warszawa. 1969-2014 (in Polish)

CILP (2014). Forest in Poland. Warszawa 2014.

Czuraj (1991). Tables of log's timber volume and standing trees. PWRiL. Warszawa. 1991 (in Polish).

EMEP (2014). National inventory of SO_2, NO_x, CO, NH_3, NMVOCs, PMs, heavy metals and POPs for 2011−2012 according to SNAP and NFR classifications. Report elaborated in the National Emission management Centre accepted by the Ministry of Environmental (in Polish)

EUROSTAT, EUROSTAT database

Gawlik (1994). Gawlik L. et al. (1994). Establishment of GHG sources related to handling of coal (hard coal and lignite) 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 timber stock on wooded and shrubbery lands in Poland. Forest Research Institute. 1991. (in Polish).

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

GUS (1989-2013). Statistical Yearbook of The Republic of Poland 1989-2012. GUS, 1989-2013.

GUS (1989a−2014a). Energy statistics in 1988−1989 up to 2012−2013, GUS, Warszawa 1989−2014.

GUS (1989b−2014b). Production of industrial products. GUS, Warszawa 1989−2014.

GUS (1991c−2014c). Forestry. GUS, Warszawa, 1991−2014.

GUS (1974d−1979d). Environmental Protection 1974 up to 1979. Warsaw, 1974−1979.

GUS (1981d−2014d). Environmental Protection from 1981 up to 2013. Warsaw, 1981−2014.

GUS (1989e-2014e). Questionnaire/Report G-03. Selected data from energy statistic system. GUS 1989−2014.

GUS (1994f-2014f). Materials Management. GUS, Warszawa, 1994-2014.

GUS OZE (2014). Energy from Renewable Sources in 2013. GUS, Warsaw 2014.

GUS T (2014). Transport – activity results in 2013. GUS, Warsaw 2014.

GUS R (2014). 2013 Statistical yearbook of agriculture. GUS, Warszawa. 2014.

GUS R1 (2014). Livestock in 2013. GUS, Warszawa. 2014.

GUS R2 (2014). Means of production in agriculture in the 2012/2013 farming year. GUS, Warszawa, 2014.

GUS R3 (2014). Production of crops in 2013. *Source Materials*. GUS, Warszawa, 2014.

GUS R4 (2014). Agriculture in 2013. GUS. Department of Agriculture. Warszawa, 2014.

GUS R5 (1987). Statistical yearbook of agriculture and food economy 1986. GUS, Warszawa, 1987.

GUS R6 (1996). Agricultural Census 1996. Livestock population. GUS, Warszawa, 1997.

GUS R7 (2002). Report from Agricultural Census 2002. GUS, Warszawa, 2002.

GUS R8 (2010). Agricultural Census 2010 – Livestock and selected elements of animal production. GUS, Warszawa, 2010.

GUS M (2014). Concise Statistical Yearbook of Poland 2014. GUS, Warszawa, 2014

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

HIPH (2007). CO2 emissions from iron and steel making operations. HIPH 2007.

IEA – database of International Energy Agency

IETU (2011). Update of NMVOC and heavy metals emission inventory for 2008–2009 for the LRTAP reporting. Institute for Ecology of Industrial Areas. Katowice, 2011 (in Polish).

IMMB (2006). Cement sector in Poland. Allocation plan of CO2 allowances in frames of NAP for 2008-20012. Institute of Mineral Construction Materials, Opole, 2006.

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

IOŚ (2009). National programme for Quality Assurance and Quality Control of the Polish Greenhouse gas inventory. ver. 2. National Emission Centre. Institute of Environmental Protection. Warszawa, 2009.

IUNG 2012. *Factors describing residue to crop ratio for crops*. Information from the Ministry of Agriculture and Rural Development, document nr RR.te.st-75/21/2012 (1345) on 16.04.2012.

IPCC (1995). Third Assessment 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 Change 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. UNFCCC.

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

ITS (2011). Developing methodology of forecasting changes in the activity of the road transport sector. Motor Transport Institute. Warszawa, 2011.

ITS (2014). Estimation of road transport emissions in 2013. Warszawa 2014

Jadczyszyn T., Maćkowiak Cz., Kopiński J. (2000). Model SFOM – a tool for simulating quantity and quality of organic fertilizers produced at the farm (in Polish, English description of tables and figures). Pam. Puł. Z. 120/I s. 168-175.

Jadczyszyn T. (2009). Fertilization planning on farm using NawSald programme (in Polish). Studia i raporty IUNG-PIB. Z. 16, 2009.

KCIE(2004) „Estimation of national GHG emissions from sector 3: *Solvent and Other Product Use* „ K. Olendrzyński, J. Cieślińska (in Polish)

KOBiZE (2014). Database of National Administration of Emission Trading Scheme containing information on emissions of GHG and other pollutants. National Research Institute of Environmental Protection, KOBiZE, 2014.

KOBIZE (2014b). Report on the DIRECTIVE 2001/81/EC of the EUROPEAN PARLIAMENT and of the council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants.

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 and SF_6) and sectors up to 2020. (in Polish) 2001.

KPGO (2003). Ordinance of Council of Ministers No. 219 from 29 October 2002 on National Plan on Waste Management

KPGO (2010). Ordinance of Council of Ministers No. 233 from 29 December 2006 on National Plan on Waste Management

KPGO (2014). Ordinance of Council of Ministers No. 217 from 24 December 2010 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. Polish Geological Institute, 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).

Mąkosa J. (2011). Elaboration and data analysis for national emission inventory of HFCs, PFCs and SF6 in 1995−2005 and in 2009 in category 2. Industrial processes" (in Polish). Warsaw, January 2011.

Mercik (2001). Mercik S., Moskal S., Study on GHG emission and sinks from arable land soils (in Polish). 2001.

Modern Casting - Nr 12 for years 1989-2011

Myczko (2001). Myczko A., Karłowski J., Szulc R. Study on GHG emissions from enteric fermentation and animal manure in 1999 (in Polish). 2001.

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

Pietrzak S. (2006). Methodology of ammonia emissions inventory from agricultural sources in Poland and its practical application (in Polish). Water-Environment_Rural areas. T. 6 z.1 (16) s. 319-334. Instytut Melioracji i Użytków Zielonych w Falentach, 2006.

Popławska-Jach J. (2015). Elaboration and data analysis for national emission inventory of HFCs, PFCs and SF6 in 2012 and revision of available data since 1988" (in Polish). Warsaw, January 2014.

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

PIG (2012). Balance of fossil amounts and underground waters in Poland. State in 2010. Polish Geological Institute, Warsaw, 2012. (in Polish).

PIG-PIB (2014). Mineral Yearbook of Poland 2013. Polish Geological Institute – National Research Institute, Warsaw, 2014.

PLNC5 (2010). Fifth National Communication under the United Nations Framework Convention on Climate Change. Republic of Poland. Ed. Institute of Environmental Protection. Warsaw. 2010. ISBN 978-83-60312-56-8

QA-QC 2012. National programme for Quality Assurance and Quality Control of the Polish Greenhouse Gas inventory. ver. 3. Institute of Environmental Protection National Research Institute, National Centre for Emission Management. Warszawa, September 2012.

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

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

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

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

Siebielec G., Stuczyński T. (2008). Trace metals in municipal biosolids produced in Poland. Proceedings Of ECOpole, vol. 2., No 2.

Sobczak (2011). Sobczak J. J. et al. Situation in the world foundry, current state and forecasting. Foundry Journal of the Polish Foundrymen's Association, 61, 1-2, 2011, p. 16-21

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 engineering in metallurgy. Wydawnictwo Śląsk, Katowice,1978 (in Polish)

Ubysz, Szczydieł, Piwnicki (2006) Report on the national situation regarding the impact of fires on the forest. http://www.fire.uni-freiburg.de/GlobalNetworks/BalticRegion/Poland-Fire-Impacts-

Forests-2005-2006.pdf

UNECE 2001. UNECE Framework code for good agricultural practice for reducing ammonia. EB.AIR/WG.5/2001/7 published 17 July 2001.

Walczak J. (2003). 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 J. (2006). Elaboration of activity data and GHG emission factors in Polish agriculture (unpublished). Instytut Zootechniki, Kraków, 2006.

Walczak J. (2009). Estimation of factors for animal waste management system, used in the inventory of greenhouse gases emission from agriculture sector in 2007, (unpublished). Instytut Zootechniki, Kraków, 2009.

Walczak J. (2011). Assessment of livestock population and its animal waste management systems in Poland in 2004−2009 based on database of the National research Institute of Animal Production for the purpose of GHG and other pollutants inventories. Instytut Zootechniki, Kraków, 2011.

Walczak J. (2012). Assessment of livestock population and its animal waste management systems in Poland in 2010−2011 based on database of the National research Institute of Animal Production for the purpose of GHG and other pollutants inventories. Instytut Zootechniki, Kraków, 2012.

Walczak J. (2013). Assessment of livestock population and its animal waste management systems in Poland in 2012 based on database of the National research Institute of Animal Production for the purpose of GHG and other pollutants inventories. Instytut Zootechniki, Kraków, 2013.

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

Wielgosiński G. (2011). Information on waste incinerated in Poland in 2009, Łódź, 2011

Żebrowski M. (1994). Emission inventory of GHG from crude oil system. Cracow, 1994

Annex 1. Key categories in 2013

The source/sink 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 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Approach 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 identified as key sources in level assessment, the biggest contributors of the GHG emissions are categories:

- Energy Industries - Solid Fuels,
- Road Transportation - Fossil Fuels,
- Other Sectors - Solid Fuels.

Emission from abovementioned sources made up 60% of the total GHG emissions in Poland expressed in units of CO_2 equivalents.

The biggest contributors of the GHG emissions in trend assessment are categories:

- Road Transportation - Fossil Fuels,
- Other Sectors - Solid Fuels,
- Manufacturing Industries and Construction - Solid Fuels.

Share of these sources made up 46% of the total GHG emissions in Poland (CO_2 equivalent).

As a result of analysis with use of qualitative criteria no additional categories were identified as key sources.

Summary of key category analysis with sector LULUCF in 2013

	IPCC Category Code	IPCC Source Categories	Classification	Greenhouse Gas	Identification criteria (L - level, T - trend, Q - qualitative)			Comments
1	1.A.1	Energy Industries	Solid Fuels	CO_2	L	T		
2	1.A.3.b	Road Transportation	Fossil fuels	CO_2	L	T		
3	4.A	Forest Land	Carbon stock change	CO_2	L	T		
4	1.A.4	Other Sectors	Solid Fuels	CO_2	L	T		
5	1.A.2	Manufacturing Industries and Construction	Solid Fuels	CO_2	L	T		
6	1.A.4	Other Sectors	Gaseous Fuels	CO_2	L	T		
7	1.B.1	Solid Fuels	Operation	CH_4	L	T		
8	3.A	Enteric Fermentation	Farming	CH_4	L	T		
9	3.D	Agricultural Soils	Direct N_2O Emissions From Managed Soils	N_2O	L	T		
10	2.F.1	Refrigeration and Air conditioning	no classification	Aggregate F-gases	L	T		
11	1.A.4	Other Sectors	Liquid Fuels	CO_2	L	T		
12	5.A	Solid Waste Disposal	Waste	CH_4	L	T		
13	1.A.2	Manufacturing Industries and Construction	Gaseous Fuels	CO_2	L	T		
14	1.A.1	Energy Industries	Gaseous Fuels	CO_2	L	T		
15	2.A.1	Cement Production	no classification	CO_2	L	T		
16	4.D	Wetlands	Carbon stock change	CO_2	L	T		
17	2.B.1	Ammonia Production	no classification	CO_2	L	T		
18	1.A.1	Energy Industries	Liquid Fuels	CO_2	L	T		
19	1.A.2	Manufacturing Industries and Construction	Liquid Fuels	CO_2	L			
20	1.A.4	Other Sectors	Solid Fuels	CH_4	L			
21	3.D	Agricultural Soils	Farming	N_2O	L			
22	2.D	Non-energy Products from Fuels and Solvent Use	no classification	CO_2	L			
23	1.A.2	Manufacturing Industries and Construction	Other Fossil Fuels	CO_2	L			
24	4.A	Forest Land	Carbon stock change	CO_2	L	T		
25	3.B	Manure Management	Farming	CH_4	L			
26	1.B.1	Solid Fuels	Operation	CO_2	L			
27	1.A.2.a	Iron and Steel Production	no classification	CO_2	L	T		
28	1.B.2	Other emissions from energy production	Operation	CO_2	L	T		
29	2.A.4	Other Process Uses of Carbonates	no classification	CO_2	L	T		
30	2.B.2	Nitric Acid Production	no classification	N_2O		T		
31	3.G	Liming	Farming	CO_2		T		
32	1.A.4	Other Sectors	Biomass	CH_4		T		
33	5.D	Wastewater Treatment and Discharge	Wastewater	CH_4		T		
34	1.B.2.c	Venting and Flaring	Operation	CH_4		T		
35	4.B	Cropland	Carbon stock change	CO_2		T		
36	1.A.3.c	Railways	Fossil fuels	CO_2		T		

Summary of key category analysis without sector LULUCF in 2013

	IPCC Category Code	IPCC Source Categories	Classification	Greenhouse Gas	Identification criteria (L - level, T - trend, Q - qualitative)			Comments
1	1.A.1	Energy Industries	Solid Fuels	CO2	L	T		
2	1.A.3.b	Road Transportation	Fossil fuels	CO2	L	T		
3	1.A.4	Other Sectors	Solid Fuels	CO2	L	T		
4	1.A.2	Manufacturing Industries and Construction	Solid Fuels	CO2	L	T		
5	1.B.1	Solid Fuels	Operation	CH4	L	T		
6	1.A.4	Other Sectors	Gaseous Fuels	CO2	L	T		
7	3.A	Enteric Fermentation	Farming	CH4	L	T		
8	3.D	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	L	T		
9	2.F.1	Refrigeration and Air conditioning	no classification	Aggregate F-gases	L	T		
10	1.A.4	Other Sectors	Liquid Fuels	CO2	L	T		
11	5.A	Solid Waste Disposal	Waste	CH4	L	T		
12	1.A.2	Manufacturing Industries and Construction	Gaseous Fuels	CO2	L	T		
13	2.A.1	Cement Production	no classification	CO2	L	T		
14	1.A.1	Energy Industries	Gaseous Fuels	CO2	L	T		
15	2.B.1	Ammonia Production	no classification	CO2	L			
16	1.A.1	Energy Industries	Liquid Fuels	CO2	L	T		
17	1.A.2	Manufacturing Industries and Construction	Liquid Fuels	CO2	L			
18	3.D	Agricultural Soils	Farming	N2O	L			
19	1.A.4	Other Sectors	Solid Fuels	CH4	L			
20	1.A.2	Manufacturing Industries and Construction	Other Fossil Fuels	CO2	L			
21	3.B	Manure Management	Farming	CH4	L			
22	1.B.1	Solid Fuels	Operation	CO2	L			
23	2.D	Non-energy Products from Fuels and Solvent Use	no classification	CO2	L			
24	1.A.2.a	Iron and Steel Production	no classification	CO2	L	T		
25	2.A.4	Other Process Uses of Carbonates	no classification	CO2	L	T		
26	2.B.2	Nitric Acid Production	no classification	N2O		T		
27	1.B.2	Other emissions from energy production	Operation	CO2		T		
28	1.A.3.c	Railways	Fossil fuels	CO2		T		
29	3.G	Liming	Farming	CO2		T		
30	1.A.4	Other Sectors	Biomass	CH4		T		
31	5.D	Wastewater Treatment and Discharge	Wastewater	CH4		T		
32	1.B.2.c	Venting and Flaring	Operation	CH4		T		
33	2.B.1	Ammonia Production	no classification	CO2		T		

Summary of key category analysis with sector LULUCF in 1988

	IPCC Category Code	IPCC Source Categories	Classification	Greenhouse Gas	Identification criteria (L - level, T - trend, Q - qualitative)			Comments
1	1.A.1	Energy Industries	Solid Fuels	CO2	L			
2	1.A.4	Other Sectors	Solid Fuels	CO2	L			
3	1.A.2	Manufacturing Industries and Construction	Solid Fuels	CO2	L			
4	1.B.1	Solid Fuels	Operation	CH4	L			
5	3.A	Enteric Fermentation	Farming	CH4	L			
6	4.A	Forest Land	Carbon stock change	CO2	L			
7	1.A.3.b	Road Transportation	Fossil fuels	CO2	L			
8	3.D	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	L			
9	5.A	Solid Waste Disposal	Waste	CH4	L			
10	1.A.2	Manufacturing Industries and Construction	Gaseous Fuels	CO2	L			
11	1.A.1	Energy Industries	Liquid Fuels	CO2	L			
12	2.A.1	Cement Production	no classification	CO2	L			
13	1.A.2.a	Iron and Steel Production	no classification	CO2	L			
14	1.A.4	Other Sectors	Gaseous Fuels	CO2	L			
15	1.A.4	Other Sectors	Liquid Fuels	CO2	L			
16	1.A.2	Manufacturing Industries and Construction	Liquid Fuels	CO2	L			
17	1.A.4	Other Sectors	Solid Fuels	CH4	L			
18	4.D	Wetlands	Carbon stock change	CO2	L			
19	2.B.2	Nitric Acid Production	no classification	N2O	L			
20	2.B.1	Ammonia Production	no classification	CO2	L			
21	2.A.2	Lime Production	no classification	CO2	L			
22	3.D	Agricultural Soils	Farming	N2O	L			
23	3.B	Manure Management	Farming	CH4	L			
24	1.B.1	Solid Fuels	Operation	CO2	L			
25	2.D	Non-energy Products from Fuels and Solvent Use	no classification	CO2	L			

Summary of key category analysis without sector LULUCF in 1988

	IPCC Category Code	IPCC Source Categories	Classification	Greenhouse Gas	Identification criteria (L - level, T - trend, Q - qualitative)			Comments
1	1.A.1	Energy Industries	Solid Fuels	CO2	L			
2	1.A.4	Other Sectors	Solid Fuels	CO2	L			
3	1.A.2	Manufacturing Industries and Construction	Solid Fuels	CO2	L			
4	1.B.1	Solid Fuels	Operation	CH4	L			
5	3.A	Enteric Fermentation	Farming	CH4	L			
6	1.A.3.b	Road Transportation	Fossil fuels	CO2	L			
7	3.D	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	L			
8	5.A	Solid Waste Disposal	Waste	CH4	L			
9	1.A.2	Manufacturing Industries and Construction	Gaseous Fuels	CO2	L			
10	1.A.2.a	Iron and Steel Production	no classification	CO2	L			
11	1.A.1	Energy Industries	Liquid Fuels	CO2	L			
12	2.A.1	Cement Production	no classification	CO2	L			
13	1.A.4	Other Sectors	Gaseous Fuels	CO2	L			
14	1.A.4	Other Sectors	Liquid Fuels	CO2	L			
15	1.A.2	Manufacturing Industries and Construction	Liquid Fuels	CO2	L			
16	1.A.4	Other Sectors	Solid Fuels	CH4	L			
17	2.B.1	Ammonia Production	no classification	CO2	L			
18	2.B.2	Nitric Acid Production	no classification	N2O	L			
19	2.D	Non-energy Products from Fuels and Solvent Use	no classification	CO2	L			
20	5.D	Wastewater Treatment and Discharge	Wastewater	CH4	L			
21	3.B	Manure Management	Farming	N2O	L			
22	2.A.2	Lime Production	no classification	CO2	L			

Level Assessment without category 4 in 2013

	IPCC Source Categories	Classification	Direct GHG	Level Assessment	Cumulative Total
1	Energy Industries	Solid Fuels	CO2	0.405	0.41
2	Road Transportation	Fossil fuels	CO2	0.106	0.51
3	Other Sectors	Solid Fuels	CO2	0.088	0.60
4	Manufacturing Industries and Construction	Solid Fuels	CO2	0.044	0.64
5	Solid Fuels	Operation	CH4	0.032	0.68
6	Other Sectors	Gaseous Fuels	CO2	0.031	0.71
7	Enteric Fermentation	Farming	CH4	0.03	0.74
8	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	0.028	0.76
9	Refrigeration and Air conditioning	no classification	Aggregate F-gases	0.023	0.79
10	Other Sectors	Liquid Fuels	CO2	0.022	0.81
11	Solid Waste Disposal	Waste	CH4	0.022	0.83
12	Manufacturing Industries and Construction	Gaseous Fuels	CO2	0.019	0.85
13	Cement Production	no classification	CO2	0.015	0.87
14	Energy Industries	Gaseous Fuels	CO2	0.014	0.88
15	Ammonia Production	no classification	CO2	0.011	0.89
16	Energy Industries	Liquid Fuels	CO2	0.009	0.90
17	Manufacturing Industries and Construction	Liquid Fuels	CO2	0.007	0.91
18	Agricultural Soils	Farming	N2O	0.007	0.91
19	Other Sectors	Solid Fuels	CH4	0.006	0.92
20	Manufacturing Industries and Construction	Other Fossil Fuels	CO2	0.006	0.93
21	Manure Management	Farming	CH4	0.005	0.93
22	Solid Fuels	Operation	CO2	0.005	0.94
23	Non-energy Products from Fuels and Solvent Use	no classification	CO2	0.005	0.94
24	Iron and Steel Production	no classification	CO2	0.005	0.95
25	Other Process Uses of Carbonates	no classification	CO2	0.005	0.95

Level Assessment without category 4 in 1988

	IPCC Source Categories	Classification	Direct GHG	Level Assessment	Cumulative Total
1	Energy Industries	Solid Fuels	CO2	0.423	0.42
2	Other Sectors	Solid Fuels	CO2	0.157	0.58
3	Manufacturing Industries and Construction	Solid Fuels	CO2	0.069	0.65
4	Solid Fuels	Operation	CH4	0.055	0.70
5	Enteric Fermentation	Farming	CH4	0.038	0.74
6	Road Transportation	Fossil fuels	CO2	0.036	0.78
7	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	0.024	0.80
8	Solid Waste Disposal	Waste	CH4	0.018	0.82
9	Manufacturing Industries and Construction	Gaseous Fuels	CO2	0.014	0.83
10	Iron and Steel Production	no classification	CO2	0.013	0.85
11	Energy Industries	Liquid Fuels	CO2	0.013	0.86
12	Cement Production	no classification	CO2	0.012	0.87
13	Other Sectors	Gaseous Fuels	CO2	0.011	0.88
14	Other Sectors	Liquid Fuels	CO2	0.009	0.89
15	Manufacturing Industries and Construction	Liquid Fuels	CO2	0.009	0.90
16	Other Sectors	Solid Fuels	CH4	0.008	0.91
17	Ammonia Production	no classification	CO2	0.008	0.92
18	Nitric Acid Production	no classification	N2O	0.007	0.92
19	Non-energy Products from Fuels and Solvent Use	no classification	CO2	0.006	0.93
20	Wastewater Treatment and Discharge	Wastewater	CH4	0.006	0.94
21	Manure Management	Farming	N2O	0.006	0.94
22	Lime Production	no classification	CO2	0.006	0.95

Level Assessment with category 4 in 2013

	IPCC Source Categories	Classification	Direct GHG	Level Assessment	Cumulative Total
1	Energy Industries	Solid Fuels	CO2	0.36	0.36
2	Road Transportation	Fossil fuels	CO2	0.095	0.46
3	Forest Land	Carbon stock change	CO2	0.088	0.54
4	Other Sectors	Solid Fuels	CO2	0.078	0.62
5	Manufacturing Industries and Construction	Solid Fuels	CO2	0.039	0.66
6	Other Sectors	Gaseous Fuels	CO2	0.028	0.69
7	Solid Fuels	Operation	CH4	0.028	0.72
8	Enteric Fermentation	Farming	CH4	0.026	0.74
9	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	0.025	0.77
10	Refrigeration and Air conditioning	no classification	Aggregate F-gases	0.021	0.79
11	Other Sectors	Liquid Fuels	CO2	0.02	0.81
12	Solid Waste Disposal	Waste	CH4	0.019	0.83
13	Manufacturing Industries and Construction	Gaseous Fuels	CO2	0.017	0.84
14	Energy Industries	Gaseous Fuels	CO2	0.013	0.86
15	Cement Production	no classification	CO2	0.013	0.87
16	Wetlands	Carbon stock change	CO2	0.01	0.88
17	Ammonia Production	no classification	CO2	0.01	0.89
18	Energy Industries	Liquid Fuels	CO2	0.008	0.90
19	Manufacturing Industries and Construction	Liquid Fuels	CO2	0.006	0.90
20	Other Sectors	Solid Fuels	CH4	0.006	0.91
21	Agricultural Soils	Farming	N2O	0.006	0.92
22	Non-energy Products from Fuels and Solvent Use	no classification	CO2	0.005	0.92
23	Manufacturing Industries and Construction	Other Fossil Fuels	CO2	0.005	0.93
24	Forest Land	Carbon stock change	CO2	0.005	0.93
25	Manure Management	Farming	CH4	0.004	0.94
26	Solid Fuels	Operation	CO2	0.004	0.94
27	Iron and Steel Production	no classification	CO2	0.004	0.94
28	Other emissions from energy production	Operation	CO2	0.004	0.95
29	Other Process Uses of Carbonates	no classification	CO2	0.004	0.95

Level Assessment with category 4 in 1988

	IPCC Source Categories	Classification	Direct GHG	Level Assessment	Cumulative Total
1	Energy Industries	Solid Fuels	CO2	0.402	0.40
2	Other Sectors	Solid Fuels	CO2	0.149	0.55
3	Manufacturing Industries and Construction	Solid Fuels	CO2	0.065	0.62
4	Solid Fuels	Operation	CH4	0.053	0.67
5	Enteric Fermentation	Farming	CH4	0.036	0.71
6	Forest Land	Carbon stock change	CO2	0.035	0.74
7	Road Transportation	Fossil fuels	CO2	0.034	0.77
8	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	0.023	0.80
9	Solid Waste Disposal	Waste	CH4	0.017	0.81
10	Manufacturing Industries and Construction	Gaseous Fuels	CO2	0.013	0.83
11	Energy Industries	Liquid Fuels	CO2	0.013	0.84
12	Cement Production	no classification	CO2	0.012	0.85
13	Iron and Steel Production	no classification	CO2	0.012	0.86
14	Other Sectors	Gaseous Fuels	CO2	0.011	0.88
15	Other Sectors	Liquid Fuels	CO2	0.009	0.88
16	Manufacturing Industries and Construction	Liquid Fuels	CO2	0.008	0.89
17	Other Sectors	Solid Fuels	CH4	0.008	0.90
18	Wetlands	Carbon stock change	CO2	0.007	0.91
19	Nitric Acid Production	no classification	N2O	0.007	0.91
20	Ammonia Production	no classification	CO2	0.007	0.92
21	Lime Production	no classification	CO2	0.006	0.93
22	Agricultural Soils	Farming	N2O	0.006	0.93
23	Manure Management	Farming	CH4	0.005	0.94
24	Solid Fuels	Operation	CO2	0.005	0.94
25	Non-energy Products from Fuels and Solvent Use	no classification	CO2	0.005	0.95

Trend Assessment without category 4 in 2013

	IPCC Source Categories	Classification	Direct GHG	Trend Assessment	Cumulative Total
1	Road Transportation	Fossil fuels	CO2	0.048	0.20
2	Other Sectors	Solid Fuels	CO2	0.047	0.39
3	Manufacturing Industries and Construction	Solid Fuels	CO2	0.017	0.46
4	Refrigeration and Air conditioning	no classification	Aggregate F-gases	0.016	0.52
5	Solid Fuels	Operation	CH4	0.016	0.59
6	Other Sectors	Gaseous Fuels	CO2	0.014	0.65
7	Energy Industries	Solid Fuels	CO2	0.012	0.70
8	Other Sectors	Liquid Fuels	CO2	0.009	0.73
9	Energy Industries	Gaseous Fuels	CO2	0.007	0.76
10	Enteric Fermentation	Farming	CH4	0.006	0.79
11	Iron and Steel Production	no classification	CO2	0.005	0.81
12	Manufacturing Industries and Construction	Gaseous Fuels	CO2	0.004	0.82
13	Nitric Acid Production	no classification	N2O	0.003	0.84
14	Other emissions from energy production	Operation	CO2	0.003	0.85
15	Energy Industries	Liquid Fuels	CO2	0.003	0.86
16	Solid Waste Disposal	Waste	CH4	0.003	0.87
17	Railways	Fossil fuels	CO2	0.003	0.89
18	Cement Production	no classification	CO2	0.002	0.89
19	Liming	Farming	CO2	0.002	0.90
20	Other Sectors	Biomass	CH4	0.002	0.91
21	Wastewater Treatment and Discharge	Wastewater	CH4	0.002	0.92
22	Venting and Flaring	Operation	CH4	0.002	0.93
23	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	0.002	0.93
24	Ammonia Production	no classification	CO2	0.002	0.94
25	Other Process Uses of Carbonates	no classification	CO2	0.002	0.95

Trend Assessment with category 4 in 2013

	IPCC Source Categories	Classification	Direct GHG	Trend Assessment	Cumulative Total
1	Road Transportation	Fossil fuels	CO2	0.047	0.19
2	Other Sectors	Solid Fuels	CO2	0.037	0.35
3	Forest Land	Carbon stock change	CO2	0.016	0.41
4	Refrigeration and Air conditioning	no classification	Aggregate F-gases	0.015	0.48
5	Other Sectors	Gaseous Fuels	CO2	0.014	0.53
6	Manufacturing Industries and Construction	Solid Fuels	CO2	0.013	0.59
7	Solid Fuels	Operation	CH4	0.013	0.64
8	Other Sectors	Liquid Fuels	CO2	0.009	0.68
9	Energy Industries	Solid Fuels	CO2	0.008	0.71
10	Energy Industries	Gaseous Fuels	CO2	0.007	0.74
11	Iron and Steel Production	no classification	CO2	0.004	0.76
12	Manufacturing Industries and Construction	Gaseous Fuels	CO2	0.004	0.77
13	Forest Land	Carbon stock change	CO2	0.004	0.79
14	Nitric Acid Production	no classification	N2O	0.003	0.80
15	Agricultural Soils	Direct N2O Emissions From Managed Soils	N2O	0.003	0.81
16	Other emissions from energy production	Operation	CO2	0.003	0.83
17	Ammonia Production	no classification	CO2	0.003	0.84
18	Solid Waste Disposal	Waste	CH4	0.003	0.85
19	Enteric Fermentation	Farming	CH4	0.003	0.86
20	Wetlands	Carbon stock change	CO2	0.002	0.87
21	Cement Production	no classification	CO2	0.002	0.88
22	Liming	Farming	CO2	0.002	0.89
23	Other Sectors	Biomass	CH4	0.002	0.90
24	Wastewater Treatment and Discharge	Wastewater	CH4	0.002	0.90
25	Venting and Flaring	Operation	CH4	0.002	0.91
26	Cropland	Carbon stock change	CO2	0.002	0.92
27	Energy Industries	Liquid Fuels	CO2	0.002	0.93
28	Other Process Uses of Carbonates	no classification	CO2	0.002	0.94
29	Railways	Fossil fuels	CO2	0.002	0.95

Annex 2. Fuel consumption and GHG emission factors from selected categories of CRF sector 1.A

Table 1. Fuel consumption [PJ] in 1.A.1.a category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	1752.496	1719.899	1597.240	1574.444	1504.529	1364.716	1317.391	1205.058	1267.444	1221.134	1155.693
Lignite	568.786	575.819	555.587	561.502	548.623	550.751	539.277	529.124	533.077	530.661	535.230
Hard coal briquettes (patent fuels)	5.001	3.888	2.520	0.322	0.117	0.059	0.059	0.000	0.000	0.059	0.000
Brown coal briquettes	0.354	0.247	0.140	0.060	0.200	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	21.274	21.900	21.641	16.329	9.561	3.107	4.094	4.738	7.156	7.949	10.768
Fuel wood and wood waste	16.695	15.123	14.571	14.384	17.265	13.783	14.051	1.322	2.656	3.293	3.673
Biogas	0.004	0.006	0.014	0.003	0.024	0.000	0.006	0.125	0.137	0.088	0.204
Industrial wastes	3.741	3.873	5.265	8.914	7.354	6.658	6.876	3.878	3.393	3.267	0.550
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	13.591	12.561	12.626	12.967	10.944	8.864	7.524	7.239	6.954	5.301	4.076
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.046	0.184
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.767	0.724	0.601	0.601	0.558	0.429	0.387	0.343	1.158	1.674	1.545
Fuel oil	73.080	70.760	65.360	61.280	56.400	55.080	55.600	25.840	27.720	27.280	17.600
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	1.287	1.188	0.990	0.742	0.644	0.842	1.238	0.050	0.000	0.000	0.000
Coke oven gas	5.568	6.565	7.125	7.555	8.863	8.144	13.147	12.828	13.975	16.450	13.697
Blast furnace gas	28.221	26.733	22.377	12.797	13.378	10.239	13.190	5.905	3.218	3.306	3.060
Gas works gas	0.659	0.579	0.167	0.129	0.335	0.085	0.037	0.021	0.004	0.002	3.259
Fuels											
Liquid fuels	75.134	72.672	66.951	62.623	57.602	56.351	57.225	26.233	28.878	29.000	19.329
Gaseous fuels	21.274	21.900	21.641	16.329	9.561	3.107	4.094	4.738	7.156	7.949	10.768
Solid fuels	2374.674	2346.290	2197.782	2169.776	2086.989	1942.858	1890.625	1760.175	1824.672	1776.913	1715.015
Other fuels	3.741	3.873	5.265	8.914	7.354	6.658	6.876	3.878	3.393	3.267	0.550
Biomass	16.699	15.129	14.585	14.387	17.289	13.783	14.057	1.447	2.793	3.381	3.877
Total	**2491.522**	**2459.864**	**2306.224**	**2272.029**	**2178.795**	**2022.757**	**1972.877**	**1796.471**	**1866.892**	**1820.510**	**1749.539**

Table 1. (cont.) Fuel consumption [PJ] in 1.A.1.a category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	1125.965	1118.163	1127.286	1091.937	1144.769	1122.123	1105.919	1159.978	1145.372	1057.079	1030.534
Lignite	521.068	504.999	512.219	494.038	518.250	514.275	533.979	525.818	501.140	521.178	494.048
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	16.210	21.627	28.242	38.700	45.496	53.667	57.039	52.808	49.653	51.052	51.828
Fuel wood and wood waste	3.398	3.461	4.886	4.809	5.799	8.905	17.500	21.180	25.434	38.251	55.083
Biogas	0.349	0.443	0.563	0.615	0.843	1.293	1.820	2.021	2.305	3.038	3.123
Industrial wastes	0.575	0.883	1.031	1.520	0.372	0.407	0.483	0.427	0.386	0.200	0.277
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.384	0.368
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	2.850	1.995	1.710	1.254	0.912	0.598	0.342	0.171	0.142	0.086	0.056
Liquid petroleum gas (LPG)	0.230	0.184	0.184	0.184	0.046	0.000	0.000	0.000	0.000	0.000	0.000
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	1.588	1.973	2.059	2.317	2.188	1.545	1.201	1.159	0.730	0.815	0.952
Fuel oil	16.720	13.680	14.680	13.200	11.920	10.040	8.080	7.960	7.280	7.400	6.680
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	16.077	17.094	17.079	16.420	18.032	16.955	14.373	18.322	19.908	21.739	17.487
Blast furnace gas	3.286	4.317	4.976	4.783	5.715	6.665	4.146	8.323	5.965	9.766	7.443
Gas works gas	2.507	2.390	2.338	3.109	2.592	3.631	4.736	4.778	4.397	4.511	4.818
Fuels											
Liquid fuels	18.538	15.837	16.923	15.701	14.154	11.585	9.281	9.119	8.010	8.215	7.661
Gaseous fuels	16.210	21.627	28.242	38.700	45.496	53.667	57.039	52.808	49.653	51.052	51.828
Solid fuels	1671.753	1648.958	1665.608	1611.570	1690.270	1664.247	1663.495	1717.390	1676.924	1614.359	1554.386
Other fuels	0.575	0.883	1.031	1.520	0.372	0.407	0.483	0.427	0.386	0.584	0.645
Biomass	3.747	3.904	5.449	5.424	6.642	10.198	19.320	23.201	27.739	41.289	58.206
Total	**1710.823**	**1691.209**	**1717.253**	**1672.915**	**1756.934**	**1740.104**	**1749.618**	**1802.945**	**1762.712**	**1715.499**	**1672.726**

Table 1. (cont.) Fuel consumption [PJ] in 1.A.1.a category

Fuels	2010	2011	2012	2013
Hard coal	1092.598	1054.923	990.212	993.766
Lignite	477.467	517.018	527.314	539.685
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	52.230	58.031	61.963	53.395
Fuel wood and wood waste	66.119	78.589	105.585	87.595
Biogas	3.653	3.328	4.219	4.887
Industrial wastes	0.426	0.458	0.420	0.381
Municipal waste - non-biogenic fraction	0.367	0.403	0.371	0.337
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.099
Other petroleum products	0.060	0.030	0.031	0.000
Petroleum coke	0.000	0.000	0.000	0.000
Coke	0.057	0.028	0.028	0.028
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000
Motor gasoline	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	0.866	1.040	0.823	0.909
Fuel oil	7.400	7.000	6.320	5.560
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	23.685	16.640	15.993	17.867
Blast furnace gas	9.793	11.001	11.328	11.729
Gas works gas	5.067	5.357	5.202	5.307
Fuels				
Liquid fuels	8.326	8.070	7.174	6.469
Gaseous fuels	52.230	58.031	61.963	53.395
Solid fuels	1608.667	1604.967	1550.077	1568.382
Other fuels	0.793	0.861	0.791	0.718
Biomass	69.772	81.917	109.804	92.581
Total	**1739.788**	**1753.846**	**1729.809**	**1721.545**

Table 2. Fuel consumption [PJ] in 1.A.1.b category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	0.114	0.113	0.046	0.090	0.069	0.245	0.068	1.302	1.451	1.349	0.629
Lignite	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	2.395	2.396	1.671	1.539	1.508	1.608	1.591	1.562	1.749	2.529	8.244
Fuel wood and wood waste	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	7.724	7.487	5.222	0.272	0.682	0.002	0.259	1.919	0.350	0.163	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.520	1.080	0.880
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	0.028	0.028	0.000	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.046	0.092
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.000	0.000	0.043	0.043	0.000	0.086	0.086	0.172	0.172	0.214	0.343
Fuel oil	14.800	13.800	11.440	10.560	15.760	12.800	11.960	32.400	40.520	32.200	39.840
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	8.860	9.306	7.474	7.623	8.514	9.256	10.444	12.028	8.960	10.197	6.286
Coke oven gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.081
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels											
Liquid fuels	23.660	23.106	18.957	18.226	24.274	22.142	22.490	44.600	50.172	43.737	47.441
Gaseous fuels	2.395	2.396	1.671	1.539	1.508	1.608	1.591	1.562	1.749	2.529	8.244
Solid fuels	0.142	0.140	0.046	0.118	0.069	0.245	0.068	1.302	1.451	1.349	0.710
Other fuels	7.724	7.487	5.222	0.272	0.682	0.002	0.259	1.919	0.350	0.163	0.000
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	**33.921**	**33.129**	**25.896**	**20.155**	**26.533**	**23.997**	**24.408**	**49.383**	**53.722**	**47.778**	**56.395**

Table 2. (cont.) Fuel consumption [PJ] in 1.A.1.b category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	0.586	0.208	0.070	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.023
Lignite	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	10.832	12.110	11.354	10.124	12.770	15.454	14.482	14.900	20.816	18.816	17.381
Fuel wood and wood waste	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.310	0.219	0.095	0.253	0.176	0.221	0.285	0.224	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	1.720	0.000	0.040	0.040	0.040	0.360	0.320	0.440	0.360	0.672	1.073
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Liquid petroleum gas (LPG)	0.184	0.276	0.000	0.046	0.092	0.000	0.000	0.000	0.000	0.000	0.000
Motor gasoline	0.090	0.135	0.000	0.000	0.135	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.043	0.000	0.000	0.000	0.000
Diesel oil	0.086	1.373	0.386	0.858	0.343	0.987	0.300	0.729	0.172	0.429	0.216
Fuel oil	35.080	36.160	42.280	42.560	43.520	42.880	42.560	41.720	44.080	43.560	44.160
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	6.386	9.058	10.444	10.048	10.048	11.632	10.692	12.969	16.582	17.424	15.246
Coke oven gas	0.051	0.069	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels											
Liquid fuels	43.546	47.002	53.150	53.552	54.178	55.859	53.915	55.858	61.194	62.085	60.695
Gaseous fuels	10.832	12.110	11.354	10.124	12.770	15.454	14.482	14.900	20.816	18.816	17.381
Solid fuels	0.637	0.277	0.140	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.023
Other fuels	0.310	0.219	0.095	0.253	0.176	0.221	0.285	0.224	0.000	0.000	0.000
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	**55.325**	**59.608**	**64.739**	**63.952**	**67.124**	**71.534**	**68.682**	**70.982**	**82.010**	**80.901**	**78.099**

Table 2. (cont.) Fuel consumption [PJ] in 1.A.1.b category

Fuels	2010	2011	2012	2013
Hard coal	0.023	0.091	0.091	0.113
Lignite	0.000	0.050	0.022	0.063
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	19.232	27.399	30.638	34.779
Fuel wood and wood waste	0.000	0.000	0.000	0.000
Biogas	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.450	0.600	1.271	0.992
Petroleum coke	0.000	0.000	0.000	0.000
Coke	0.000	0.000	0.000	0.000
Liquid petroleum gas (LPG)	0.000	0.092	0.092	0.092
Motor gasoline	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	0.130	0.173	0.130	0.043
Fuel oil	46.560	39.280	31.400	22.200
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	22.869	21.532	28.215	20.988
Coke oven gas	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000
Fuels				
Liquid fuels	70.009	61.677	61.108	44.315
Gaseous fuels	19.232	27.399	30.638	34.779
Solid fuels	0.023	0.141	0.113	0.176
Other fuels	0.000	0.000	0.000	0.000
Biomass	0.000	0.000	0.000	0.000
Total	**89.264**	**89.217**	**91.859**	**79.270**

Table 3. Fuel consumption [PJ] in 1.A.1.c category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	12.314	10.347	10.425	7.912	6.205	23.487	57.593	58.698	59.891	56.159	53.263
Lignite	0.416	0.057	0.078	0.132	0.073	0.322	0.303	0.336	0.370	0.333	0.296
Hard coal briquettes (patent fuels)	0.023	0.000	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.035	0.018	0.020	0.020	0.000	0.040	0.020	0.020	0.040	0.040	0.020
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.082	0.083
Natural gas	13.736	15.364	12.371	12.432	14.665	12.354	17.401	14.850	23.269	21.155	17.779
Fuel wood and wood waste	0.018	0.001	0.006	0.000	0.004	0.008	0.011	0.003	0.003	0.003	0.003
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.011	0.028	0.023
Industrial wastes	0.046	0.001	0.000	0.000	0.000	0.311	0.235	0.184	0.158	0.138	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.080	0.040
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	1.173	0.522	0.619	0.538	0.284	0.513	1.226	0.884	0.598	0.142	0.086
Liquid petroleum gas (LPG)	0.092	0.092	0.092	0.092	0.092	0.046	0.046	0.046	0.046	0.000	0.046
Motor gasoline	0.088	0.088	0.090	0.090	0.090	0.180	0.314	0.269	0.090	0.090	0.045
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	2.130	1.960	1.845	2.145	2.274	4.418	3.561	3.775	3.260	2.832	2.231
Fuel oil	0.240	0.040	0.040	0.040	0.080	0.360	0.280	0.160	0.160	0.080	0.520
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	50.866	50.938	43.557	38.488	39.121	34.604	40.489	37.038	35.105	37.000	33.709
Blast furnace gas	5.632	4.440	3.961	1.995	1.430	2.123	2.488	1.954	1.582	1.893	1.695
Gas works gas	0.005	0.008	0.005	0.180	0.010	0.120	0.000	0.006	0.061	0.019	0.168
Fuels											
Liquid fuels	2.550	2.180	2.067	2.367	2.536	5.004	4.201	4.250	3.716	3.164	2.965
Gaseous fuels	13.736	15.364	12.371	12.432	14.665	12.354	17.401	14.850	23.269	21.155	17.779
Solid fuels	70.465	66.330	58.694	49.265	47.123	61.209	102.119	98.936	97.647	95.586	89.237
Other fuels	0.046	0.001	0.000	0.000	0.000	0.311	0.235	0.184	0.158	0.138	0.000
Biomass	0.018	0.001	0.006	0.000	0.004	0.008	0.011	0.004	0.014	0.031	0.026
Total	**86.815**	**83.875**	**73.138**	**64.064**	**64.328**	**78.886**	**123.967**	**118.224**	**124.804**	**120.074**	**110.007**

Table 3. (cont.) Fuel consumption [PJ] in 1.A.1.c category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	44.994	34.648	32.658	16.819	19.618	13.900	12.331	9.542	17.495	12.424	7.456
Lignite	0.286	0.420	0.307	1.000	0.625	0.542	0.175	0.204	1.380	1.766	0.908
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.083	0.041	0.000	0.041	0.128	0.126	0.000	0.000	0.000	0.000	0.000
Natural gas	19.458	19.491	12.986	12.515	9.741	11.190	10.106	10.363	9.680	9.239	8.858
Fuel wood and wood waste	0.005	0.006	0.039	0.029	0.008	0.004	0.002	0.011	0.057	0.020	0.134
Biogas	0.022	0.027	0.012	0.018	0.018	0.016	0.012	0.015	0.028	0.017	0.003
Industrial wastes	0.000	0.010	0.008	0.005	0.013	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.080	0.080	0.000	0.040	0.040	0.040	0.080	0.040	0.040	0.032	0.029
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	0.028	0.171	0.028	0.000	0.114	0.057	0.028	0.000	0.028	0.656	0.000
Liquid petroleum gas (LPG)	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.046	0.046	0.000	0.046
Motor gasoline	0.045	0.045	0.045	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	1.802	1.802	1.587	1.244	1.244	1.115	1.330	1.287	1.244	1.373	1.516
Fuel oil	0.160	0.240	0.080	0.360	0.240	0.160	0.280	0.040	0.160	0.040	0.040
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	29.872	32.634	33.111	32.027	36.094	36.410	32.796	36.410	39.838	39.605	28.051
Blast furnace gas	0.847	0.840	0.149	0.086	0.021	0.030	0.042	0.045	0.037	0.000	0.000
Gas works gas	0.168	0.004	0.004	0.004	0.004	0.004	0.003	0.004	0.005	0.006	0.012
Fuels											
Liquid fuels	2.216	2.208	1.712	1.730	1.652	1.441	1.690	1.413	1.490	1.445	1.631
Gaseous fuels	19.458	19.491	12.986	12.515	9.741	11.190	10.106	10.363	9.680	9.239	8.858
Solid fuels	76.215	68.737	66.257	49.936	56.476	50.943	45.375	46.205	58.783	54.457	36.427
Other fuels	0.000	0.014	0.008	0.005	0.013	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.027	0.037	0.052	0.047	0.026	0.020	0.014	0.026	0.085	0.037	0.137
Total	**97.916**	**90.487**	**81.015**	**64.233**	**67.908**	**63.594**	**57.185**	**58.007**	**70.038**	**65.178**	**47.053**

Table 3. (cont.) Fuel consumption [PJ] in 1.A.1.c category

Fuels	2010	2011	2012	2013
Hard coal	2.061	4.534	2.482	2.116
Lignite	1.442	1.666	0.728	0.221
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	10.321	9.804	11.205	12.013
Fuel wood and wood waste	0.349	0.162	0.160	0.122
Biogas	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.010	0.001	0.002
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.030	0.060	0.062	0.032
Petroleum coke	0.000	0.000	0.000	0.000
Coke	0.000	0.057	0.000	0.000
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000
Motor gasoline	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	1.645	2.079	1.472	1.819
Fuel oil	0.080	0.040	0.040	0.040
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	38.485	41.153	38.653	40.220
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.012	0.128	0.118	0.110
Fuels				
Liquid fuels	1.755	2.179	1.574	1.891
Gaseous fuels	10.321	9.804	11.205	12.013
Solid fuels	42.000	47.538	41.981	42.667
Other fuels	0.000	0.010	0.001	0.002
Biomass	0.349	0.162	0.160	0.122
Total	**54.425**	**59.693**	**54.921**	**56.695**

Table 4. Fuel consumption [PJ] in 1.A.2.a category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	2.367	1.278	1.138	1.243	1.494	9.159	8.513	25.320	28.922	23.636	21.085
Lignite	0.000	0.000	0.000	0.019	0.000	0.000	0.000	0.000	0.000	0.009	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	73.507	63.332	52.851	33.974	26.568	25.562	25.487	24.239	25.898	28.278	23.993
Fuel wood and wood waste	0.000	0.000	0.000	0.000	0.000	0.016	0.014	0.005	0.006	0.004	0.006
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	3.158	3.344	4.079	6.756	6.497	4.272	3.757	2.941	0.498	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	12.258	7.268	10.599	22.303	28.082	28.938	33.055	26.589	24.442	28.763	23.702
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.046	0.000
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.128	0.128	0.172	0.129	0.172	0.343	0.558	0.772	0.901	0.558	0.300
Fuel oil	18.120	15.400	11.000	7.800	5.280	4.280	2.960	2.040	0.960	4.720	1.600
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	32.570	30.997	26.038	22.090	22.568	21.604	25.480	27.686	24.404	24.257	24.742
Blast furnace gas	43.812	40.192	36.484	27.903	25.909	25.676	28.350	37.610	34.205	36.120	29.520
Gas works gas	4.316	3.219	2.174	1.462	0.718	0.613	0.067	0.068	0.080	0.058	0.007
Fuels											
Liquid fuels	18.248	15.528	11.172	7.929	5.452	4.623	3.518	2.812	1.861	5.324	1.900
Gaseous fuels	73.507	63.332	52.851	33.974	26.568	25.562	25.487	24.239	25.898	28.278	23.993
Solid fuels	95.323	82.955	76.433	75.020	78.771	85.990	95.465	117.273	112.053	112.843	99.056
Other fuels	3.158	3.344	4.079	6.756	6.497	4.272	3.757	2.941	0.498	0.000	0.000
Biomass	0.000	0.000	0.000	0.000	0.000	0.016	0.014	0.005	0.006	0.004	0.006
Total	**190.236**	**165.159**	**144.535**	**123.679**	**117.288**	**120.463**	**128.241**	**147.270**	**140.316**	**146.449**	**124.955**

Table 4. (cont.) Fuel consumption [PJ] in 1.A.2.a category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	19.074	18.262	14.701	12.424	12.593	17.281	11.379	9.636	12.296	4.360	5.482
Lignite	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.029	0.029	0.029	0.000	0.000	0.029	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	21.440	22.024	18.328	15.463	14.827	19.969	20.460	21.008	22.724	20.401	16.597
Fuel wood and wood waste	0.004	0.003	0.006	0.003	0.004	0.004	0.002	0.001	0.001	0.001	0.001
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	22.410	26.040	21.559	21.660	23.042	23.462	15.852	12.973	5.455	6.112	3.565
Liquid petroleum gas (LPG)	0.046	0.184	0.184	0.230	0.184	0.138	0.000	0.000	0.000	0.046	0.046
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.343	0.515	0.172	0.129	0.129	0.129	0.086	0.129	0.086	0.086	0.086
Fuel oil	1.800	1.040	0.640	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	15.875	17.574	16.994	15.122	16.132	15.368	12.643	12.770	13.885	10.059	5.396
Blast furnace gas	24.034	31.874	26.768	23.876	25.282	27.109	19.239	20.580	28.624	18.785	10.160
Gas works gas	0.008	0.000	0.277	0.706	1.195	1.654	0.965	1.015	1.313	0.993	0.474
Fuels											
Liquid fuels	2.189	1.739	0.996	0.359	0.313	0.267	0.086	0.129	0.086	0.132	0.132
Gaseous fuels	21.440	22.024	18.328	15.463	14.827	19.969	20.460	21.008	22.724	20.401	16.597
Solid fuels	81.401	93.750	80.328	73.817	78.273	84.874	60.078	57.003	61.573	40.309	25.077
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.004	0.003	0.006	0.003	0.004	0.004	0.002	0.001	0.001	0.001	0.001
Total	**105.034**	**117.516**	**99.658**	**89.642**	**93.417**	**105.114**	**80.626**	**78.141**	**84.384**	**60.843**	**41.807**

Table 4. (cont.) Fuel consumption [PJ] in 1.A.2.a category

Fuels	2010	2011	2012	2013
Hard coal	4.003	4.871	8.276	6.177
Lignite	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.029	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	16.922	17.209	16.905	16.242
Fuel wood and wood waste	0.000	0.000	0.000	0.001
Biogas	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000
Coke	5.209	9.192	9.644	10.596
Liquid petroleum gas (LPG)	0.046	0.046	0.092	0.046
Motor gasoline	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	0.086	0.086	0.043	0.043
Fuel oil	0.000	0.000	0.000	0.000
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	8.488	8.420	8.230	8.518
Blast furnace gas	12.220	11.258	11.352	10.797
Gas works gas	0.187	0.203	0.047	0.028
Fuels				
Liquid fuels	0.132	0.132	0.135	0.089
Gaseous fuels	16.922	17.209	16.905	16.242
Solid fuels	30.107	33.944	37.578	36.116
Other fuels	0.000	0.000	0.000	0.000
Biomass	0.000	0.000	0.000	0.001
Total	**47.161**	**51.285**	**54.618**	**52.448**

Table 5. Fuel consumption [PJ] in 1.A.2.b category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	1.411	1.323	0.455	0.565	0.850	1.916	1.771	4.172	4.285	3.907	3.331
Lignite	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	5.638	5.470	4.599	4.633	1.213	1.745	5.321	5.447	5.108	5.424	5.638
Fuel wood and wood waste	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.149	0.042	0.026
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.870	0.719	0.439	0.483	0.514	0.729	0.823	2.150	2.411	2.361	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	9.754	8.730	6.014	5.216	2.280	2.793	6.412	6.327	6.612	6.584	6.384
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.046	0.000	0.000
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.043	0.043	0.043	0.043	0.129	0.086	0.129	0.172	0.214	0.214	0.257
Fuel oil	0.640	0.760	0.760	0.800	0.800	0.760	0.800	0.720	0.680	0.640	0.520
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.461	0.437	0.397	0.178	0.186	0.043	0.000	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.375	0.341	0.042	0.006	0.000	0.000	0.000	0.000	0.000	0.000	2.164
Fuels											
Liquid fuels	0.683	0.803	0.803	0.843	0.929	0.846	0.929	0.892	0.940	0.854	0.777
Gaseous fuels	5.638	5.470	4.599	4.633	1.213	1.745	5.321	5.447	5.108	5.424	5.638
Solid fuels	12.001	10.832	6.908	5.965	3.316	4.752	8.183	10.499	10.897	10.491	11.879
Other fuels	0.870	0.719	0.439	0.483	0.514	0.729	0.823	2.150	2.411	2.361	0.000
Biomass	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.149	0.042	0.026
Total	**19.191**	**17.823**	**12.749**	**11.924**	**5.972**	**8.073**	**15.257**	**18.988**	**19.505**	**19.172**	**18.320**

Table 5. (cont.) Fuel consumption [PJ] in 1.A.2.b category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	3.117	3.108	3.790	2.560	2.115	1.092	0.024	0.024	0.570	0.000	0.000
Lignite	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	5.660	5.814	5.700	5.589	5.868	6.405	6.468	6.884	6.743	6.542	5.852
Fuel wood and wood waste	0.010	0.011	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	5.928	6.070	6.156	6.156	5.928	5.956	5.814	6.042	6.441	6.640	6.270
Liquid petroleum gas (LPG)	0.000	0.046	0.092	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.172	0.257	0.172	0.172	0.129	0.172	0.172	0.172	0.172	0.172	0.173
Fuel oil	0.560	0.560	0.520	0.400	0.320	0.400	0.400	0.400	0.160	0.160	0.160
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	2.070	2.268	2.551	2.739	2.539	1.800	1.003	1.004	0.982	1.252	1.119
Fuels											
Liquid fuels	0.732	0.863	0.784	0.618	0.495	0.658	0.618	0.618	0.378	0.378	0.379
Gaseous fuels	5.660	5.814	5.700	5.589	5.868	6.405	6.468	6.884	6.743	6.542	5.852
Solid fuels	11.115	11.446	12.497	11.455	10.582	8.848	6.841	7.070	7.993	7.892	7.389
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.010	0.011	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	**17.517**	**18.134**	**18.986**	**17.663**	**16.945**	**15.911**	**13.927**	**14.572**	**15.114**	**14.812**	**13.620**

Table 5. (cont.) Fuel consumption [PJ] in 1.A.2.b category

Fuels	2010	2011	2012	2013
Hard coal	0.000	0.250	0.114	0.113
Lignite	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	6.048	6.670	6.890	6.703
Fuel wood and wood waste	0.000	0.000	0.000	0.000
Biogas	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000
Coke	6.042	6.214	6.384	6.270
Liquid petroleum gas (LPG)	0.046	0.046	0.000	0.000
Motor gasoline	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	0.216	0.173	0.173	0.173
Fuel oil	0.120	0.120	0.120	0.120
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.039	0.043	0.039
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.994	0.967	0.928	1.066
Fuels				
Liquid fuels	0.382	0.339	0.293	0.293
Gaseous fuels	6.048	6.670	6.890	6.703
Solid fuels	7.036	7.470	7.469	7.488
Other fuels	0.000	0.000	0.000	0.000
Biomass	0.000	0.000	0.000	0.000
Total	**13.466**	**14.479**	**14.652**	**14.484**

Table 6. Fuel consumption [PJ] in 1.A.2.c category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	9.197	9.059	7.216	6.623	4.550	13.125	7.945	70.221	71.191	63.913	54.992
Lignite	0.056	0.038	0.039	0.038	0.027	0.047	0.029	0.428	0.460	0.389	0.429
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	6.409	6.244	5.289	4.340	4.432	10.075	4.507	6.356	6.191	11.024	9.408
Fuel wood and wood waste	0.345	0.390	0.118	0.039	0.010	0.003	0.035	0.007	0.000	0.000	0.000
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Industrial wastes	12.255	14.915	16.712	18.586	17.039	18.003	22.591	21.546	17.374	14.356	0.672
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.600	2.880	3.440
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	1.763	4.530	2.679	1.966	1.852	1.881	1.938	3.477	2.964	1.454	1.539
Liquid petroleum gas (LPG)	3.726	4.554	0.000	0.000	0.000	0.046	0.000	0.000	0.000	0.000	0.000
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	1.406	1.363	0.987	0.858	0.772	0.729	0.729	0.944	1.072	1.072	1.416
Fuel oil	6.080	6.120	2.720	1.880	2.760	2.480	3.600	8.160	9.320	9.360	17.560
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	3.614	1.930	0.396	3.465	5.445	4.455	0.198	1.584	6.584	9.652	18.513
Coke oven gas	1.053	0.993	0.701	0.522	0.440	1.548	0.276	0.729	0.784	0.140	0.174
Blast furnace gas	0.148	0.136	0.047	0.010	0.006	0.011	0.014	0.023	0.004	0.013	0.004
Gas works gas	0.190	0.230	0.214	0.192	0.133	0.126	0.110	0.070	0.052	0.000	0.000
Fuels											
Liquid fuels	14.825	13.968	4.103	6.203	8.977	7.710	4.527	10.688	19.576	22.964	40.929
Gaseous fuels	6.409	6.244	5.289	4.340	4.432	10.075	4.507	6.356	6.191	11.024	9.408
Solid fuels	12.407	14.986	10.896	9.351	7.008	16.738	10.312	74.948	75.455	65.909	57.138
Other fuels	12.255	14.915	16.712	18.586	17.039	18.003	22.591	21.546	17.374	14.356	0.672
Biomass	0.345	0.390	0.118	0.039	0.010	0.003	0.035	0.007	0.000	0.000	0.001
Total	**46.241**	**50.503**	**37.118**	**38.519**	**37.466**	**52.529**	**41.972**	**113.545**	**118.596**	**114.253**	**108.148**

Table 6. (cont.) Fuel consumption [PJ] in 1.A.2.c category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	50.522	50.115	48.485	45.458	27.959	28.709	30.107	27.683	28.785	46.079	44.061
Lignite	0.138	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	9.041	9.464	8.481	7.199	6.457	7.498	8.104	9.053	8.771	8.037	9.762
Fuel wood and wood waste	0.000	0.000	0.000	0.001	0.153	0.102	0.165	0.000	0.121	0.000	0.058
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.582	0.607	0.618	0.567	0.875	1.122	0.628	0.721	0.761	0.518	0.621
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	2.520	0.480	0.480	0.280	0.240	0.000	0.040	0.040	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	1.624	1.596	1.710	1.738	1.568	1.881	1.454	2.964	1.938	1.168	0.884
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.092
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.090
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	1.330	1.030	4.762	4.247	4.333	3.904	3.775	4.076	3.732	3.689	4.590
Fuel oil	15.680	13.520	7.360	7.640	7.080	7.320	3.920	3.920	3.600	0.640	1.120
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	19.602	23.314	20.542	20.740	21.830	22.424	18.266	21.334	22.473	19.156	20.889
Coke oven gas	0.130	0.050	0.150	0.285	0.634	0.606	0.608	0.547	0.658	0.654	0.483
Blast furnace gas	0.007	0.011	0.008	0.004	0.013	0.019	0.006	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels											
Liquid fuels	39.132	38.344	33.144	32.907	33.483	33.648	26.001	29.370	29.805	23.485	26.781
Gaseous fuels	9.041	9.464	8.481	7.199	6.457	7.498	8.104	9.053	8.771	8.037	9.762
Solid fuels	52.421	51.772	50.353	47.485	30.174	31.215	32.175	31.194	31.381	47.901	45.428
Other fuels	0.582	0.607	0.618	0.567	0.875	1.122	0.628	0.721	0.761	0.518	0.621
Biomass	0.000	0.000	0.000	0.001	0.153	0.102	0.165	0.000	0.121	0.000	0.058
Total	**101.176**	**100.187**	**92.596**	**88.159**	**71.142**	**73.585**	**67.073**	**70.338**	**70.839**	**79.941**	**82.650**

Table 6. (cont.) Fuel consumption [PJ] in 1.A.2.c category

Fuels	2010	2011	2012	2013
Hard coal	49.706	47.704	46.768	46.835
Lignite	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	12.043	13.887	13.568	14.696
Fuel wood and wood waste	0.058	0.053	0.131	0.050
Biogas	0.000	0.000	0.000	0.000
Industrial wastes	0.777	0.732	0.581	1.092
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000
Coke	0.826	1.340	3.164	3.021
Liquid petroleum gas (LPG)	0.138	0.138	0.138	0.184
Motor gasoline	0.000	0.045	0.045	0.045
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	4.200	3.637	3.334	4.027
Fuel oil	0.640	0.720	0.560	0.440
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	17.176	15.890	13.414	17.870
Coke oven gas	0.627	0.616	0.595	0.639
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000
Fuels				
Liquid fuels	22.154	20.430	17.491	22.566
Gaseous fuels	12.043	13.887	13.568	14.696
Solid fuels	51.159	49.660	50.527	50.495
Other fuels	0.777	0.732	0.581	1.092
Biomass	0.058	0.053	0.131	0.050
Total	**86.191**	**84.762**	**82.298**	**88.899**

Table 7. Fuel consumption [PJ] in 1.A.2.d category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	1.639	1.940	1.548	1.741	1.379	4.524	3.836	22.318	22.233	23.979	18.936
Lignite	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	0.103	0.162	0.101	0.061	0.026	0.061	0.250	0.232	0.455	1.096	0.563
Fuel wood and wood waste	0.352	0.205	0.001	0.000	0.000	1.585	1.610	15.437	16.243	16.472	16.476
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	0.331	0.247	0.256	0.285	0.256	0.314	0.285	0.285	0.256	0.142	0.086
Liquid petroleum gas (LPG)	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.092	0.184
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.085	0.085	0.043	0.086	0.043	0.043	0.086	0.129	0.601	0.987	1.115
Fuel oil	1.240	1.160	1.280	1.200	1.320	1.560	1.400	2.360	1.040	1.040	1.320
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.004	0.003	0.003	0.003	0.002	0.003	0.002	0.002	0.001	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.003	0.003	0.003	0.014	0.002	0.000	0.000	0.000	0.004	0.000	0.000
Fuels											
Liquid fuels	1.371	1.291	1.369	1.332	1.409	1.649	1.532	2.535	1.687	2.119	2.619
Gaseous fuels	0.103	0.162	0.101	0.061	0.026	0.061	0.250	0.232	0.455	1.096	0.563
Solid fuels	1.976	2.192	1.810	2.043	1.639	4.841	4.123	22.605	22.494	24.121	19.022
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.352	0.205	0.001	0.000	0.000	1.585	1.610	15.437	16.243	16.472	16.476
Total	**3.803**	**3.850**	**3.281**	**3.436**	**3.074**	**8.136**	**7.515**	**40.809**	**40.879**	**43.808**	**38.680**

Table 7. (cont.) Fuel consumption [PJ] in 1.A.2.d category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	17.528	15.696	15.564	14.317	14.050	13.797	13.430	11.592	9.452	7.850	8.515
Lignite	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	1.007	1.210	1.445	1.461	2.094	2.657	2.288	2.976	4.087	4.822	4.834
Fuel wood and wood waste	15.545	15.938	15.138	16.622	17.950	18.957	18.611	19.379	18.644	19.729	19.171
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018
Industrial wastes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.040	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	0.000	0.028	0.028	0.028	0.057	0.028	0.028	0.028	0.028	0.028	0.000
Liquid petroleum gas (LPG)	0.092	0.138	0.092	0.046	0.046	0.092	0.046	0.092	0.184	0.046	0.092
Motor gasoline	0.000	0.000	0.000	0.000	0.090	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.815	0.601	0.472	0.429	0.472	0.472	0.343	0.386	0.429	0.300	0.303
Fuel oil	1.320	1.360	1.480	1.560	1.600	1.680	1.600	1.600	1.720	1.640	1.600
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels											
Liquid fuels	2.227	2.099	2.044	2.035	2.208	2.244	2.029	2.118	2.333	1.986	1.995
Gaseous fuels	1.007	1.210	1.445	1.461	2.094	2.657	2.288	2.976	4.087	4.822	4.834
Solid fuels	17.528	15.724	15.592	14.345	14.107	13.825	13.458	11.620	9.480	7.878	8.515
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	15.545	15.938	15.138	16.622	17.950	18.957	18.611	19.379	18.644	19.729	19.189
Total	**36.307**	**34.971**	**34.219**	**34.463**	**36.359**	**37.683**	**36.386**	**36.093**	**34.544**	**34.415**	**34.533**

Table 7. (cont.) Fuel consumption [PJ] in 1.A.2.d category

Fuels	2010	2011	2012	2013
Hard coal	9.950	11.096	10.643	11.460
Lignite	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	5.030	4.587	5.535	6.271
Fuel wood and wood waste	19.117	19.402	20.358	27.152
Biogas	0.049	0.073	0.083	0.091
Industrial wastes	0.000	0.000	0.000	0.037
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000
Coke	0.028	0.000	0.000	0.000
Liquid petroleum gas (LPG)	0.092	0.092	0.092	0.092
Motor gasoline	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	0.260	0.216	0.173	0.260
Fuel oil	1.640	1.680	1.520	1.520
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000
Fuels				
Liquid fuels	1.992	1.988	1.785	1.872
Gaseous fuels	5.030	4.587	5.535	6.271
Solid fuels	9.978	11.096	10.643	11.460
Other fuels	0.000	0.000	0.000	0.037
Biomass	19.166	19.475	20.441	27.243
Total	**36.166**	**37.146**	**38.404**	**46.883**

Table 8. Fuel consumption [PJ] in 1.A.2.e category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	25.200	31.694	31.914	35.940	32.724	55.643	53.801	73.024	88.777	78.207	64.659
Lignite	0.085	0.104	0.058	0.019	0.018	0.369	0.195	0.265	0.380	0.250	0.317
Hard coal briquettes (patent fuels)	0.023	0.023	0.000	0.000	0.000	0.205	0.205	0.059	0.029	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	1.965	1.910	1.970	1.984	2.339	3.171	7.180	3.839	15.051	12.927	10.694
Fuel wood and wood waste	0.114	0.105	0.091	0.094	0.072	0.151	0.056	0.082	0.094	0.075	0.101
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Industrial wastes	0.003	0.002	0.000	0.000	0.031	0.003	0.003	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.080	0.040
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	3.609	3.569	3.334	2.936	2.650	3.249	2.708	2.565	3.192	2.850	2.080
Liquid petroleum gas (LPG)	0.046	0.046	0.046	0.046	0.046	0.046	0.092	0.138	0.184	0.184	0.276
Motor gasoline	0.440	0.264	0.135	0.090	0.135	0.180	0.135	0.180	0.180	0.045	0.090
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	2.087	1.534	1.244	1.030	0.901	1.201	1.072	0.901	5.448	5.191	6.821
Fuel oil	1.840	1.640	1.640	1.480	1.320	3.280	3.920	6.120	2.720	2.400	2.680
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.336	0.120	0.111	0.125	0.124	0.102	0.003	0.025	0.004	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.027	0.032	0.051	0.014	0.001	0.001	0.000	0.000	0.003	0.000	0.000
Fuels											
Liquid fuels	4.413	3.484	3.065	2.646	2.402	4.707	5.219	7.339	8.612	7.900	9.907
Gaseous fuels	1.965	1.910	1.970	1.984	2.339	3.171	7.180	3.839	15.051	12.927	10.694
Solid fuels	29.280	35.542	35.468	39.034	35.517	59.569	56.912	75.938	92.385	81.307	67.056
Other fuels	0.003	0.002	0.000	0.000	0.031	0.003	0.003	0.000	0.000	0.000	0.000
Biomass	0.114	0.105	0.091	0.094	0.072	0.151	0.056	0.082	0.094	0.075	0.104
Total	**35.775**	**41.043**	**40.594**	**43.758**	**40.361**	**67.601**	**69.370**	**87.198**	**116.142**	**102.209**	**87.761**

Table 8. (cont.) Fuel consumption [PJ] in 1.A.2.e category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	46.327	43.417	40.020	41.803	39.030	36.095	35.894	30.864	31.165	26.778	25.814
Lignite	0.237	0.191	0.149	0.192	0.175	0.129	0.092	0.074	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	9.255	10.494	11.363	12.490	15.075	16.164	17.456	18.623	20.614	20.725	20.950
Fuel wood and wood waste	0.069	0.049	0.062	0.060	0.323	0.373	0.214	0.239	0.164	0.365	0.192
Biogas	0.020	0.063	0.042	0.037	0.063	0.074	0.068	0.072	0.084	0.094	0.109
Industrial wastes	0.000	0.001	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	1.710	1.624	1.368	1.539	1.340	1.226	0.969	0.855	0.912	0.656	0.656
Liquid petroleum gas (LPG)	0.460	0.690	0.874	1.426	1.380	1.564	1.426	1.196	0.920	1.012	0.966
Motor gasoline	0.045	0.135	0.045	0.090	0.090	0.000	0.045	0.045	0.045	0.045	0.045
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	7.465	7.336	7.250	6.864	6.864	6.178	5.405	4.504	4.076	4.504	3.161
Fuel oil	2.280	2.520	2.720	2.960	3.040	3.280	3.160	2.920	2.760	2.000	1.440
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels											
Liquid fuels	10.250	10.681	10.889	11.340	11.374	11.022	10.036	8.665	7.801	7.561	5.612
Gaseous fuels	9.255	10.494	11.363	12.490	15.075	16.164	17.456	18.623	20.614	20.725	20.950
Solid fuels	48.274	45.232	41.557	43.534	40.545	37.450	36.955	31.793	32.077	27.434	26.470
Other fuels	0.000	0.001	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.089	0.112	0.104	0.097	0.386	0.447	0.282	0.311	0.248	0.459	0.301
Total	**67.868**	**66.520**	**63.927**	**67.461**	**67.380**	**65.083**	**64.729**	**59.392**	**60.740**	**56.179**	**53.333**

Table 8. (cont.) Fuel consumption [PJ] in 1.A.2.e category

Fuels	2010	2011	2012	2013
Hard coal	25.907	25.614	26.172	24.724
Lignite	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	21.610	22.128	23.704	24.475
Fuel wood and wood waste	0.441	0.534	0.436	0.664
Biogas	0.101	0.145	0.199	0.202
Industrial wastes	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000
Coke	0.627	0.542	0.314	0.370
Liquid petroleum gas (LPG)	0.828	0.782	0.690	0.828
Motor gasoline	0.045	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	2.901	2.382	2.944	1.992
Fuel oil	1.240	1.360	1.360	1.080
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000
Fuels				
Liquid fuels	5.014	4.524	4.994	3.900
Gaseous fuels	21.610	22.128	23.704	24.475
Solid fuels	26.534	26.156	26.486	25.094
Other fuels	0.000	0.000	0.000	0.000
Biomass	0.542	0.679	0.635	0.866
Total	**53.700**	**53.487**	**55.819**	**54.335**

Table 9. Fuel consumption [PJ] in 1.A.2.f category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	102.301	98.072	72.637	72.514	68.894	76.924	83.926	79.647	86.930	81.562	66.639
Lignite	0.263	0.180	0.156	0.150	0.091	0.161	0.117	0.163	0.150	0.185	0.153
Hard coal briquettes (patent fuels)	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.035	0.018	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.040	0.040
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	28.729	28.108	24.574	22.704	22.246	21.986	21.506	25.518	26.650	25.655	27.097
Fuel wood and wood waste	1.778	1.924	1.155	0.455	0.042	0.033	0.004	0.010	0.010	0.005	0.006
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.382	0.446	0.068	0.023	0.267	0.250	0.145	0.197	0.144	0.047	0.207
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.400	1.200
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	18.984	18.997	13.936	11.314	11.115	10.716	11.400	10.118	11.144	8.664	10.089
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	0.092	0.138	0.046	0.092	0.230
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.135	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	1.321	1.108	0.944	0.815	0.772	0.772	0.944	1.330	1.802	2.788	2.016
Fuel oil	6.000	6.720	4.160	2.800	3.560	3.960	4.320	6.080	3.760	4.120	6.680
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	2.685	2.241	2.101	1.821	1.341	1.234	0.482	0.886	0.509	0.353	0.988
Blast furnace gas	0.140	0.118	0.101	0.106	0.079	0.108	0.120	0.053	0.053	0.036	0.010
Gas works gas	3.926	3.761	3.270	3.136	2.706	2.392	2.090	1.788	1.033	0.501	0.330
Fuels											
Liquid fuels	7.321	7.828	5.104	3.615	4.332	4.732	5.356	7.548	5.608	8.535	10.126
Gaseous fuels	28.729	28.108	24.574	22.704	22.246	21.986	21.506	25.518	26.650	25.655	27.097
Solid fuels	128.357	123.387	92.221	89.061	84.226	91.535	98.135	92.655	99.819	91.341	78.249
Other fuels	0.382	0.446	0.068	0.023	0.267	0.250	0.145	0.197	0.144	0.047	0.207
Biomass	1.778	1.924	1.155	0.455	0.042	0.033	0.004	0.010	0.010	0.005	0.006
Total	**166.566**	**161.692**	**123.122**	**115.858**	**111.113**	**118.536**	**125.146**	**125.928**	**132.231**	**125.583**	**115.685**

Table 9. (cont.) Fuel consumption [PJ] in 1.A.2.f category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	59.965	53.349	41.103	33.981	30.332	32.332	31.206	31.547	43.869	36.998	26.468
Lignite	0.069	0.057	0.009	0.019	0.000	0.000	0.000	0.000	0.000	0.063	0.000
Hard coal briquettes (patent fuels)	0.000	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.040	0.040	0.020	0.020	0.040	0.040	0.040	0.040	0.040	0.040	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	23.917	27.976	31.858	33.233	35.584	38.233	38.963	41.283	42.473	39.708	41.422
Fuel wood and wood waste	0.002	0.006	0.275	0.292	0.102	0.261	0.110	0.139	0.116	0.223	0.285
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.529	0.472	0.524	0.508	1.471	1.818	2.701	5.043	5.961	7.400	7.715
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.003	0.013	0.717	1.620	1.776	0.378	4.419
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.029
Other petroleum products	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	4.416	3.232	7.072	3.584	1.568	1.152	2.752
Coke	8.008	6.868	4.874	4.418	4.874	4.674	2.594	3.050	4.503	2.679	2.280
Liquid petroleum gas (LPG)	0.322	0.506	0.736	1.610	1.380	1.656	0.874	0.368	0.322	0.368	0.460
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.045
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	1.716	1.630	1.973	2.145	2.274	2.788	2.188	1.888	1.845	2.188	1.992
Fuel oil	5.920	3.880	4.320	4.600	4.520	4.480	4.080	2.880	2.120	2.400	1.960
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.804	0.413	0.897	0.767	0.746	1.505	1.370	1.465	1.614	1.523	1.233
Blast furnace gas	0.005	0.011	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Gas works gas	0.304	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels											
Liquid fuels	8.358	6.016	7.029	8.355	12.590	12.156	14.214	8.720	5.855	6.108	7.209
Gaseous fuels	23.917	27.976	31.858	33.233	35.584	38.233	38.963	41.283	42.473	39.708	41.422
Solid fuels	69.195	60.767	46.906	39.208	35.992	38.551	35.210	36.102	50.026	41.303	29.982
Other fuels	0.529	0.472	0.524	0.508	1.474	1.831	3.418	6.663	7.737	7.778	12.134
Biomass	0.002	0.006	0.275	0.292	0.102	0.261	0.110	0.139	0.117	0.224	0.314
Total	**102.001**	**95.237**	**86.592**	**81.596**	**85.742**	**91.032**	**91.915**	**92.907**	**106.208**	**95.121**	**91.061**

Table 9. (cont.) Fuel consumption [PJ] in 1.A.2.f category

Fuels	2010	2011	2012	2013
Hard coal	28.048	34.403	26.766	22.808
Lignite	0.224	0.283	0.549	0.347
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.180
Crude oil	0.000	0.000	0.000	0.000
Natural gas	42.894	44.492	42.349	40.911
Fuel wood and wood waste	0.299	0.348	0.407	0.498
Biogas	0.000	0.000	0.000	0.000
Industrial wastes	10.469	11.729	12.170	12.763
Municipal waste - non-biogenic fraction	4.512	5.017	3.913	3.752
Municipal waste – biogenic fraction	0.123	1.338	1.360	1.391
Other petroleum products	0.000	0.000	0.000	0.000
Petroleum coke	1.792	0.064	0.064	0.160
Coke	2.536	2.679	2.508	2.366
Liquid petroleum gas (LPG)	0.414	0.368	0.230	0.322
Motor gasoline	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	1.992	2.338	1.862	1.472
Fuel oil	1.840	1.640	1.400	1.320
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	1.614	1.866	1.687	1.552
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000
Fuels				
Liquid fuels	6.038	4.410	3.556	3.274
Gaseous fuels	42.894	44.492	42.349	40.911
Solid fuels	32.422	39.231	31.510	27.253
Other fuels	14.981	16.746	16.083	16.515
Biomass	0.422	1.686	1.767	1.889
Total	**96.757**	**106.565**	**95.265**	**89.842**

Table 10. Fuel consumption [PJ] in 1.A.2.g category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	56.386	49.492	38.514	36.640	29.689	80.735	73.256	81.016	105.124	88.131	65.259
Lignite	0.789	0.662	0.176	0.564	0.182	0.654	0.274	0.621	0.600	0.389	0.317
Hard coal briquettes (patent fuels)	0.210	0.139	0.088	0.029	0.000	0.000	0.000	0.000	0.029	0.000	0.000
Brown coal briquettes	0.088	0.071	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	24.039	22.347	15.645	11.755	13.811	17.922	17.336	15.176	14.210	16.060	17.640
Fuel wood and wood waste	8.335	7.545	5.826	5.518	5.035	4.995	3.410	4.968	6.519	8.194	8.231
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.001	0.002
Industrial wastes	0.082	0.058	0.022	0.012	0.134	0.298	1.593	2.294	2.675	1.133	2.080
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120	0.440	0.520
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	20.610	18.284	12.797	10.032	11.001	10.402	6.640	5.614	5.614	3.961	2.023
Liquid petroleum gas (LPG)	0.184	0.138	0.138	0.092	0.092	0.092	0.138	0.046	0.138	0.414	0.460
Motor gasoline	1.716	1.584	1.123	1.302	0.898	0.943	0.539	1.032	0.630	2.201	0.763
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.086
Diesel oil	14.228	13.078	10.425	8.795	7.294	7.722	7.163	8.280	18.533	15.574	13.214
Fuel oil	3.720	3.240	2.160	1.840	2.400	3.320	3.720	5.040	3.200	3.280	3.760
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	2.499	2.357	1.675	0.984	0.734	0.475	0.056	0.049	0.022	0.010	0.011
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	1.457	1.056	0.732	0.459	0.212	0.022	0.063	0.016	0.001	0.001	0.000
Fuels											
Liquid fuels	19.848	18.040	13.846	12.029	10.684	12.077	11.560	14.398	22.621	21.909	18.803
Gaseous fuels	24.039	22.347	15.645	11.755	13.811	17.922	17.336	15.176	14.210	16.060	17.640
Solid fuels	82.038	72.062	54.022	48.748	41.858	92.328	80.329	87.356	111.430	92.492	67.610
Other fuels	0.082	0.058	0.022	0.012	0.134	0.298	1.593	2.294	2.675	1.133	2.080
Biomass	8.335	7.545	5.826	5.518	5.035	4.995	3.410	4.970	6.520	8.195	8.233
Total	**134.342**	**120.051**	**89.361**	**78.062**	**71.522**	**127.620**	**114.228**	**124.194**	**157.456**	**139.789**	**114.366**

Table 10. (cont.) Fuel consumption [PJ] in 1.A.2.g category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	49.964	40.662	31.997	26.862	25.045	21.927	20.047	18.024	16.542	14.069	10.978
Lignite	0.247	0.210	0.149	0.106	0.055	0.009	0.009	0.018	0.000	0.009	0.163
Hard coal briquettes (patent fuels)	0.000	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.080	0.100
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	16.354	18.545	18.319	19.273	21.156	22.595	23.325	23.290	23.543	26.267	22.863
Fuel wood and wood waste	8.604	10.105	10.716	12.300	11.897	12.184	11.918	11.028	12.914	13.776	13.750
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003
Industrial wastes	1.482	2.075	1.802	2.078	2.503	1.661	1.700	3.789	0.937	1.154	1.392
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.005	0.000	0.000
Other petroleum products	0.360	0.240	0.040	0.080	0.080	0.120	0.080	0.120	0.080	0.064	0.029
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	2.877	2.282	2.338	1.909	1.768	1.110	0.626	0.854	0.825	0.684	0.454
Liquid petroleum gas (LPG)	0.782	1.472	1.104	1.104	1.242	1.334	1.334	1.242	1.150	1.196	0.966
Motor gasoline	0.360	0.315	0.180	0.135	0.225	0.180	0.180	0.225	0.135	0.090	0.135
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.086	0.086	0.086	0.043	0.043	0.043	0.043	0.086	0.086	0.043	0.043
Diesel oil	11.455	10.767	9.867	9.780	10.168	9.609	10.468	11.067	9.952	9.138	9.092
Fuel oil	3.560	3.600	3.080	2.840	2.720	2.880	2.920	2.640	1.480	1.280	1.280
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.006	0.004	0.020	0.016	0.117	0.436	0.110	0.062	0.059	0.047	0.033
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.013	0.013	0.000	0.000	0.000	0.006
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels											
Liquid fuels	16.603	16.480	14.357	13.982	14.478	14.166	15.025	15.380	12.883	11.811	11.545
Gaseous fuels	16.354	18.545	18.319	19.273	21.156	22.595	23.325	23.290	23.543	26.267	22.863
Solid fuels	53.094	43.187	34.504	28.893	26.985	23.495	20.805	18.958	17.446	14.889	11.734
Other fuels	1.482	2.075	1.802	2.078	2.503	1.661	1.700	3.789	0.938	1.154	1.392
Biomass	8.604	10.105	10.716	12.300	11.897	12.184	11.918	11.030	12.919	13.777	13.753
Total	**96.137**	**90.392**	**79.698**	**76.526**	**77.019**	**74.101**	**72.773**	**72.447**	**67.729**	**67.898**	**61.287**

Table 10. (cont.) Fuel consumption [PJ] in 1.A.2.g category

Fuels	2010	2011	2012	2013
Hard coal	11.350	10.096	7.619	7.288
Lignite	0.089	0.363	0.269	0.432
Hard coal briquettes (patent fuels)	0.000	0.029	0.000	0.000
Brown coal briquettes	0.080	0.200	0.100	0.040
Crude oil	0.000	0.000	0.000	0.000
Natural gas	24.984	23.876	23.019	26.036
Fuel wood and wood waste	17.460	20.051	20.854	24.842
Biogas	0.000	0.000	0.000	0.000
Industrial wastes	0.069	0.052	0.069	0.098
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.090	0.090	0.093	0.064
Petroleum coke	0.000	0.000	0.000	0.000
Coke	0.370	0.228	0.171	0.199
Liquid petroleum gas (LPG)	1.150	1.196	0.966	1.150
Motor gasoline	0.270	0.135	0.090	0.090
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.043	0.043	0.000	0.043
Diesel oil	8.661	8.703	7.101	6.538
Fuel oil	1.480	1.480	0.960	0.560
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	0.020	0.025	0.010	0.010
Blast furnace gas	0.009	0.012	0.004	0.004
Gas works gas	0.000	0.000	0.000	0.000
Fuels				
Liquid fuels	11.694	11.647	9.210	8.445
Gaseous fuels	24.984	23.876	23.019	26.036
Solid fuels	11.918	10.953	8.173	7.973
Other fuels	0.069	0.052	0.069	0.098
Biomass	17.460	20.051	20.854	24.842
Total	**66.125**	**66.579**	**61.325**	**67.394**

Table 11. Fuel consumption [PJ] in 1.A.4.a category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	207.335	163.251	54.547	62.166	54.214	50.334	34.666	34.267	25.608	18.696	16.200
Lignite	0.540	0.390	0.000	0.000	0.000	0.017	0.091	0.025	0.026	0.009	0.009
Hard coal briquettes (patent fuels)	5.749	1.581	0.000	0.000	0.000	0.000	0.000	0.322	0.000	0.000	0.000
Brown coal briquettes	0.548	0.476	0.420	0.000	0.000	1.780	1.820	1.940	0.240	0.540	0.120
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	13.079	12.601	13.787	10.977	11.190	11.548	9.573	13.260	18.771	24.256	32.769
Fuel wood and wood waste	0.000	0.000	4.501	2.945	0.000	12.312	11.719	11.560	10.046	9.028	8.437
Biogas	0.084	0.123	0.379	0.187	0.206	0.062	0.249	0.423	0.579	0.599	0.648
Industrial wastes	2.135	0.144	0.504	0.081	0.011	0.352	0.089	0.000	0.124	0.000	0.003
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	80.500	77.450	34.712	28.264	40.068	33.402	27.332	25.878	26.220	28.642	13.480
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	1.334	0.782	0.782	1.748	1.564
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.987	4.290	6.220
Fuel oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.000
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	1.417	1.135	1.224	1.088	0.877	0.428	0.123	0.053	0.034	0.127	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.937	0.330	0.312	0.554	0.576	0.091	0.014	0.014	0.014	0.072	0.040
Fuels											
Liquid fuels	0.000	0.000	0.000	0.000	0.000	0.000	1.334	0.782	1.769	6.118	7.784
Gaseous fuels	13.079	12.601	13.787	10.977	11.190	11.548	9.573	13.260	18.771	24.256	32.769
Solid fuels	297.025	244.614	91.215	92.072	95.735	86.052	64.046	62.499	52.142	48.086	29.849
Other fuels	2.135	0.144	0.504	0.081	0.011	0.352	0.089	0.000	0.124	0.000	0.003
Biomass	0.084	0.123	4.880	3.132	0.206	12.374	11.968	11.983	10.625	9.627	9.085
Total	**312.322**	**257.481**	**110.386**	**106.262**	**107.142**	**110.326**	**87.010**	**88.524**	**83.431**	**88.087**	**79.490**

Table 11. (cont.) Fuel consumption [PJ] in 1.A.4.a category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	15.104	13.354	13.460	21.677	21.539	22.502	25.405	29.320	25.291	28.763	31.393
Lignite	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.520	0.380	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	37.696	38.567	49.971	61.001	67.057	69.570	68.410	63.517	65.488	71.250	75.746
Fuel wood and wood waste	8.553	8.514	5.736	5.747	5.752	6.028	6.171	4.580	5.482	5.012	7.098
Biogas	0.663	0.678	0.860	0.683	0.700	0.558	0.343	0.505	0.291	0.876	0.848
Industrial wastes	0.004	0.004	0.091	0.092	0.060	0.002	0.022	0.000	0.000	0.000	0.092
Municipal waste - non-biogenic fraction	0.000	0.020	0.000	0.009	0.011	0.000	0.000	0.000	0.000	0.037	0.031
Municipal waste – biogenic fraction	0.000	0.019	0.000	0.010	0.014	0.013	0.030	0.028	0.029	0.008	0.000
Other petroleum products	0.640	0.880	3.000	0.360	1.720	2.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	12.226	8.265	3.819	8.122	8.180	5.928	2.679	2.878	2.594	2.080	2.138
Liquid petroleum gas (LPG)	2.070	2.300	3.266	3.358	5.520	5.014	4.600	5.244	4.922	4.462	3.772
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	7.636	13.342	15.015	19.090	16.774	14.286	13.213	23.252	22.866	22.866	21.910
Fuel oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.005	0.005	0.004	0.003	0.004	0.003	0.003	0.003	0.014	0.018	0.017
Fuels											
Liquid fuels	10.346	16.522	21.281	22.808	24.014	21.300	17.813	28.496	27.788	27.328	25.682
Gaseous fuels	37.696	38.567	49.971	61.001	67.057	69.570	68.410	63.517	65.488	71.250	75.746
Solid fuels	27.864	22.004	17.283	29.822	29.723	28.433	28.087	32.202	27.900	30.862	33.550
Other fuels	0.004	0.024	0.091	0.101	0.071	0.002	0.022	0.000	0.000	0.037	0.123
Biomass	9.216	9.211	6.596	6.440	6.466	6.599	6.544	5.113	5.802	5.896	7.946
Total	**85.126**	**86.328**	**95.222**	**120.172**	**127.331**	**125.904**	**120.876**	**129.328**	**126.978**	**135.373**	**143.047**

Table 11. (cont.) Fuel consumption [PJ] in 1.A.4.a category

Fuels	2010	2011	2012	2013
Hard coal	36.517	31.093	32.855	30.116
Lignite	1.475	0.702	0.531	0.515
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	83.433	78.278	80.888	76.501
Fuel wood and wood waste	7.929	7.818	6.833	7.433
Biogas	0.994	1.963	2.280	2.127
Industrial wastes	0.019	0.011	0.009	0.388
Municipal waste - non-biogenic fraction	0.005	0.035	0.028	0.033
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.060	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000
Coke	2.109	1.824	0.741	1.083
Liquid petroleum gas (LPG)	3.404	3.312	4.048	2.852
Motor gasoline	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	27.409	25.634	18.402	15.155
Fuel oil	0.080	0.040	0.000	0.000
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	0.001	0.001	0.001	0.000
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.017	0.018	0.014	0.010
Fuels				
Liquid fuels	30.953	28.986	22.450	18.007
Gaseous fuels	83.433	78.278	80.888	76.501
Solid fuels	40.119	33.638	34.142	31.724
Other fuels	0.024	0.046	0.037	0.421
Biomass	8.923	9.781	9.113	9.560
Total	**163.452**	**150.729**	**146.630**	**136.213**

Table 12. Fuel consumption [PJ] in 1.A.4.b category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	543.559	489.774	272.689	358.521	351.542	372.347	309.920	305.701	326.681	271.980	213.584
Lignite	2.911	1.180	0.526	0.042	0.000	2.956	4.403	4.279	3.420	2.626	1.772
Hard coal briquettes (patent fuels)	17.200	4.742	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	1.627	1.427	1.240	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	102.581	107.619	122.204	133.674	141.212	141.590	151.671	159.559	143.057	150.022	138.268
Fuel wood and wood waste	33.615	32.351	34.335	27.721	33.969	106.000	104.715	105.000	101.000	100.000	100.700
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	31.927	30.721	14.866	12.110	26.732	30.752	27.788	27.502	28.044	32.775	19.950
Liquid petroleum gas (LPG)	6.762	7.452	1.702	1.012	1.840	6.072	8.970	12.834	16.100	18.400	18.400
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.145	6.435	8.580
Fuel oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	15.996	15.134	15.155	13.706	11.334	6.779	3.560	1.723	0.226	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	4.655	3.697	3.088	1.307	0.739	0.431	0.418	0.258	0.222	0.181	0.164
Fuels											
Liquid fuels	6.762	7.452	1.702	1.012	1.840	6.072	8.970	12.834	18.245	24.835	26.980
Gaseous fuels	102.581	107.619	122.204	133.674	141.212	141.590	151.671	159.559	143.057	150.022	138.268
Solid fuels	617.874	546.675	307.564	385.686	390.347	413.265	346.089	339.463	358.593	307.562	235.470
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	33.615	32.351	34.335	27.721	33.969	106.000	104.715	105.000	101.000	100.000	100.700
Total	**760.831**	**694.097**	**465.805**	**548.093**	**567.368**	**666.927**	**611.445**	**616.856**	**620.895**	**582.419**	**501.418**

Table 12. (cont.) Fuel consumption [PJ] in 1.A.4.b category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	223.330	166.012	184.730	209.771	207.214	219.654	249.994	284.628	257.388	276.073	279.808
Lignite	1.286	1.169	1.373	1.482	1.605	1.919	2.006	2.168	1.972	2.565	2.219
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	135.995	127.611	133.737	127.093	127.629	126.376	135.111	138.686	132.622	131.450	134.857
Fuel wood and wood waste	95.000	95.000	104.500	104.500	103.075	103.360	100.700	104.500	102.000	102.500	102.500
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	18.525	11.685	11.970	8.550	8.550	7.125	2.992	3.278	1.425	1.140	5.928
Liquid petroleum gas (LPG)	19.320	20.240	20.700	21.390	25.300	23.920	23.000	23.000	23.920	24.380	25.254
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	9.781	17.160	21.450	22.952	22.952	21.450	19.305	19.305	15.444	11.583	8.010
Fuel oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.163	0.158	0.151	0.134	0.128	0.113	0.095	0.099	0.081	0.071	0.069
Fuels											
Liquid fuels	29.101	37.400	42.150	44.342	48.252	45.370	42.305	42.305	39.364	35.963	33.264
Gaseous fuels	135.995	127.611	133.737	127.093	127.629	126.376	135.111	138.686	132.622	131.450	134.857
Solid fuels	243.304	179.024	198.224	219.937	217.497	228.811	255.087	290.173	260.866	279.849	288.024
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	95.000	95.000	104.500	104.500	103.075	103.360	100.700	104.500	102.000	102.500	102.500
Total	**503.400**	**439.035**	**478.611**	**495.872**	**496.453**	**503.917**	**533.203**	**575.664**	**534.852**	**549.762**	**558.645**

Table 12. (cont.) Fuel consumption [PJ] in 1.A.4.b category

Fuels	2010	2011	2012	2013
Hard coal	342.161	275.817	291.964	280.043
Lignite	4.035	3.593	3.619	4.022
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000
Brown coal briquettes	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000
Natural gas	148.427	135.471	141.397	143.187
Fuel wood and wood waste	112.746	115.000	116.850	116.850
Biogas	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000
Coke	6.526	5.700	5.415	5.700
Liquid petroleum gas (LPG)	24.840	23.000	23.000	21.620
Motor gasoline	0.000	0.000	0.000	0.000
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	4.546	4.763	3.767	3.464
Fuel oil	0.000	0.000	0.000	0.000
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.067	0.059	0.040	0.047
Fuels				
Liquid fuels	29.386	27.763	26.767	25.084
Gaseous fuels	148.427	135.471	141.397	143.187
Solid fuels	352.789	285.169	301.038	289.812
Other fuels	0.000	0.000	0.000	0.000
Biomass	112.746	115.000	116.850	116.850
Total	**643.348**	**563.403**	**586.052**	**574.933**

Table 13. Fuel consumption [PJ] in 1.A.4.c category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hard coal	38.608	38.489	36.365	57.356	62.959	62.501	60.542	58.583	62.611	52.483	46.050
Lignite	1.581	1.139	0.844	1.018	0.911	0.814	1.642	1.698	1.299	1.292	1.419
Hard coal briquettes (patent fuels)	0.598	0.527	0.645	0.146	0.088	0.059	0.059	0.000	0.000	0.000	0.000
Brown coal briquettes	0.106	0.106	0.040	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	0.507	0.445	0.448	0.275	0.055	0.132	0.212	0.243	0.428	0.571	0.868
Fuel wood and wood waste	0.039	0.113	0.039	0.278	0.583	20.057	18.367	18.500	17.567	17.000	17.100
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	1.786	1.754	1.568	1.168	0.684	0.570	4.018	4.018	4.104	5.130	5.700
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	0.460	0.690	1.150	1.380	1.380
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.674	1.122	1.122	1.122	1.212	1.122
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	53.967	51.972	53.968	51.995	60.661	74.989	81.381	85.457	94.380	109.481	99.099
Fuel oil	10.264	9.469	9.231	8.179	7.133	18.066	22.052	13.957	8.242	10.974	8.862
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.012	0.010	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.001	0.002	0.001	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.001
Fuels											
Liquid fuels	64.230	61.441	63.199	60.174	67.794	93.729	105.015	101.226	104.894	123.047	110.463
Gaseous fuels	0.507	0.445	0.448	0.275	0.055	0.132	0.212	0.243	0.428	0.571	0.868
Solid fuels	42.691	42.026	39.465	59.710	64.662	63.946	66.261	64.299	68.014	58.905	53.170
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.039	0.113	0.039	0.278	0.583	20.057	18.367	18.500	17.567	17.000	17.100
Total	**107.467**	**104.025**	**103.151**	**120.437**	**133.094**	**177.864**	**189.855**	**184.268**	**190.903**	**199.523**	**181.601**

Table 13. (cont.) Fuel consumption [PJ] in 1.A.4.c category

Fuels	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard coal	49.162	33.231	36.975	30.820	29.693	31.728	35.673	42.074	37.748	41.640	41.538
Lignite	1.097	0.939	1.236	1.395	1.528	2.086	2.188	2.489	2.125	2.770	2.485
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.029	0.000	0.000	0.000	0.059	0.029
Brown coal briquettes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.040	0.040
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	0.476	0.536	0.777	0.914	1.197	1.182	1.084	1.492	1.840	1.900	1.577
Fuel wood and wood waste	17.100	17.100	19.043	19.010	19.017	19.878	19.038	19.977	19.060	19.024	19.030
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial wastes	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.006	0.012	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.006	0.013	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	5.130	3.420	3.705	2.850	2.850	1.995	1.140	1.425	0.855	0.826	0.855
Liquid petroleum gas (LPG)	1.610	1.840	2.300	2.760	3.220	3.220	3.220	2.300	2.300	2.346	2.070
Motor gasoline	1.347	1.392	0.943	0.269	0.314	0.224	0.269	0.314	0.224	0.224	0.225
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	101.458	111.969	104.590	104.247	105.105	107.207	109.395	81.510	75.075	75.075	73.610
Fuel oil	8.674	8.428	8.221	6.805	8.195	8.606	9.455	3.846	3.397	3.474	4.342
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels											
Liquid fuels	113.089	123.629	116.054	114.081	116.834	119.257	122.339	87.970	80.996	81.119	80.247
Gaseous fuels	0.476	0.536	0.777	0.914	1.197	1.182	1.084	1.492	1.840	1.900	1.577
Solid fuels	55.389	37.590	41.916	35.065	34.071	35.838	39.001	46.028	40.728	45.335	44.947
Other fuels	0.006	0.012	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	17.106	17.113	19.053	19.010	19.017	19.878	19.038	19.977	19.060	19.024	19.030
Total	**186.066**	**178.880**	**177.811**	**169.070**	**171.119**	**176.155**	**181.462**	**155.467**	**142.624**	**147.378**	**145.801**

Table 13. (cont.) Fuel consumption [PJ] in 1.A.4.c category

Fuels	2010	2011	2012	2013
Hard coal	50.605	41.488	43.715	41.611
Lignite	1.667	1.337	1.327	1.609
Hard coal briquettes (patent fuels)	0.029	0.059	0.205	0.293
Brown coal briquettes	0.000	0.000	0.020	0.520
Crude oil	0.000	0.000	0.000	0.000
Natural gas	1.486	1.531	1.796	1.501
Fuel wood and wood waste	21.088	23.931	20.948	20.937
Biogas	0.000	0.223	0.252	0.286
Industrial wastes	0.000	0.000	0.000	0.000
Municipal waste - non-biogenic fraction	0.000	0.000	0.000	0.000
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000
Other petroleum products	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000
Coke	0.940	0.998	0.285	0.570
Liquid petroleum gas (LPG)	2.300	2.346	2.300	2.300
Motor gasoline	0.045	0.045	0.045	0.045
Aviation gasoline	0.000	0.000	0.000	0.000
Jet kerosene	0.000	0.000	0.000	0.000
Diesel oil	73.480	74.130	74.692	73.177
Fuel oil	3.516	3.953	4.066	3.471
Feedstocks	0.000	0.000	0.000	0.000
Refinery gas	0.000	0.000	0.000	0.000
Coke oven gas	0.000	0.000	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000
Fuels				
Liquid fuels	79.341	80.474	81.103	78.993
Gaseous fuels	1.486	1.531	1.796	1.501
Solid fuels	53.241	43.882	45.552	44.603
Other fuels	0.000	0.000	0.000	0.000
Biomass	21.088	24.154	21.200	21.223
Total	**155.156**	**150.041**	**149.651**	**146.320**

Table 14. CO2 EFs [kg/GJ] for coal and lignite in 1.A.1.a category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	95.58	95.57	95.25	95.11	94.97	94.97	94.95	94.98	94.96	94.95	94.91	94.92
Lignite	111.47	110.88	109.87	109.76	109.28	109.90	110.03	108.95	109.04	108.90	108.41	108.31
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.97	94.97	94.94	94.93	94.98	94.95	94.92	94.97	94.98	94.90	94.97	95.01
Lignite	108.72	108.21	108.64	108.56	108.84	107.83	107.88	107.54	107.20	107.52	108.62	109.56
	2012	**2013**										
Hard coal	94.99	94.98										
Lignite	109.76	109.91										

Table 15. CO2 EFs [kg/GJ] for coal and lignite in 1.A.1.b category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	94.70	94.76	94.64	94.76	94.64	94.81	94.72	94.86	94.64	94.59	94.58	94.55
Lignite												
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.62	94.57	94.64							94.64	94.64	94.70
Lignite												109.53
	2012	**2013**										
Hard coal	94.70	94.73										
Lignite	109.74	109.91										

Table 16. CO2 EFs [kg/GJ] for coal and lignite in 1.A.1.c category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	95.30	95.37	94.70	94.73	94.65	94.81	94.71	94.86	94.60	94.55	94.55	94.51
Lignite	111.39	110.71	103.84	105.02	106.21	104.86	103.76	108.93	109.01	105.71	108.39	103.45
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.59	94.54	94.51	94.53	94.59	94.34	94.52	94.45	94.70	94.75	94.67	94.22
Lignite	104.58	105.50	104.33	105.94	105.96	105.87	105.62	106.15	106.87	106.39	108.60	109.53
	2012	**2013**										
Hard coal	93.88	93.86										
Lignite	109.74	109.91										

Table 17. CO2 EFs [kg/GJ] for coal and lignite in 1.A.2.a category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	94.70	94.68	94.70	94.73	94.65	94.81	94.71	94.86	94.63	94.58	94.58	94.54
Lignite				104.75						106.72		
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.62	94.57	94.55	94.53	94.59	94.34	94.52	94.45	94.68	94.55	94.37	94.11
Lignite												
	2012	**2013**										
Hard coal	93.90	93.92										
Lignite												

Table 18. CO2 EFs [kg/GJ] for coal and lignite in 1.A.2.b category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	94.70	94.68	94.70	94.73	94.65	94.81	94.71	94.86	94.63	94.59	94.58	94.55
Lignite												
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.52	94.37	94.49	94.53	94.59	94.43	94.43	93.64	0.00	0.00	0.00	94.71
Lignite												
	2012	**2013**										
Hard coal	94.69	94.73										
Lignite												

Table 19. CO2 EFs [kg/GJ] for coal and lignite in 1.A.2.c category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	94.70	94.68	94.70	94.73	94.65	94.81	94.71	94.86	94.63	94.59	94.58	94.55
Lignite	105.16	104.93	103.84	104.75	106.72	105.13	104.14	108.93	109.01	105.66	108.39	103.47
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.62	94.56	94.55	94.53	94.59	94.34	94.52	94.45	94.70	94.75	94.68	94.70
Lignite												
	2012	**2013**										
Hard coal	94.70	94.74										
Lignite												

Table 20. CO2 EFs [kg/GJ] for coal and lignite in 1.A.2.d category .

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	94.70	94.68	94.70	94.73	94.65	94.81	94.71	94.86	94.63	94.59	94.58	94.55
Lignite												
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.62	94.57	94.55	94.53	94.59	94.34	94.52	94.45	94.70	94.75	94.68	94.70
Lignite												
	2012	**2013**										
Hard coal	94.70	94.74										
Lignite												

Table 21. CO2 EFs [kg/GJ] for coal and lignite in 1.A.2.e category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	94.70	94.68	94.70	94.73	94.65	94.81	94.71	94.86	94.63	94.58	94.58	94.55
Lignite	105.14	104.92	104.14	104.75	106.72	104.90	103.84	108.93	109.01	105.67	108.39	103.40
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.62	94.57	94.55	94.53	94.59	94.34	94.52	94.44	94.69	94.75	94.67	94.70
Lignite	104.57	105.47	104.38	105.87	105.85	105.91	105.71					
	2012	**2013**										
Hard coal	94.70	94.74										
Lignite												

Table 22. CO2 EFs [kg/GJ] for coal and lignite in 1.A.2.f category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	94.70	94.68	94.70	94.73	94.65	94.81	94.71	94.86	94.63	94.58	94.58	94.55
Lignite	105.15	104.93	103.84	105.22	106.31	104.86	103.84	108.93	109.01	105.71	108.39	103.47
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.62	94.57	94.55	94.53	94.59	94.34	94.52	94.45	94.69	94.75	94.68	94.70
Lignite	104.75	106.72	104.75						106.72		108.60	109.53
	2012	**2013**										
Hard coal	94.70	94.74										
Lignite	109.74	109.91										

Table 23. CO2 EFs [kg/GJ] for coal and lignite in 1.A.2.g category

Fuels	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Hard coal	94.70	94.68	94.70	94.73	94.65	94.81	94.71	94.86	94.63	94.58	94.58	94.55
Lignite	105.15	104.92	104.53	105.13	106.31	104.83	103.97	108.93	109.01	105.66	108.39	103.60
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.62	94.57	94.55	94.53	94.59	94.34	94.52	94.45	94.70	94.75	94.68	94.70
Lignite	104.86	105.47	104.78	106.04	106.72	106.72	106.72		106.72	106.49	108.60	109.53
	2012	**2013**										
Hard coal	94.70	94.74										
Lignite	109.74	109.91										

Table 24. CO2 EFs [kg/GJ] for coal and lignite in 1.A.4.a category

Fuels	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Hard coal	94.70	94.76	94.76	94.76	94.57	94.75	94.82	94.89	94.44	94.71	94.64	94.80
Lignite	111.07	110.71				108.93	110.02	109.72	108.16	106.72	106.72	106.72
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.84	94.94	94.87	94.68	94.34	94.14	93.99	94.20	94.04	94.05	93.61	94.06
Lignite											109.72	109.61
	2012	**2013**										
Hard coal	93.96	94.04										
Lignite	111.17	111.16										

Table 25. CO2 EFs [kg/GJ] for coal and lignite in 1.A.4.b category

Fuels	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Hard coal	94.70	94.76	94.76	94.76	94.57	94.75	94.82	94.89	94.44	94.72	94.65	94.80
Lignite	111.07	110.71	109.64	109.40	0.00	108.61	109.92	108.97	108.20	108.42	108.46	108.59
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.85	94.94	94.87	94.68	94.34	94.14	93.99	94.20	94.04	94.05	93.61	94.06
Lignite	108.78	108.55	107.94	108.96	109.67	108.09	108.14	108.93	107.15	107.25	109.70	109.61
	2012	**2013**										
Hard coal	93.96	94.04										
Lignite	111.19	111.18										

Table 26. CO2 EFs [kg/GJ] for coal and lignite in 1.A.4.c category

Fuels	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hard coal	94.70	94.76	94.76	94.76	94.57	94.75	94.82	94.89	94.44	94.71	94.65	94.80
Lignite	111.07	110.71	109.61	109.01	108.12	108.61	109.92	108.97	108.19	108.41	108.47	108.60
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hard coal	94.84	94.94	94.87	94.68	94.34	94.14	93.99	94.20	94.04	94.05	93.61	94.06
Lignite	108.76	108.54	107.93	108.98	109.67	108.09	108.14	108.93	107.15	107.25	109.71	109.61
	2012	**2013**										
Hard coal	93.96	94.04										
Lignite	111.19	111.17										

Table 27. CO_2 EFs [kg/GJ] applied for other fuels in the years 1988-2013 for stationary sources in 1.A.1, 1.A.2 and 1.A.4 categories [IPCC 2006]

Fuels	**EF**
Hard coal briquettes (patent fuels)	97.50
Brown coal briquettes	97.50
Crude oil	73.30
Natural gasl	56.10
Fuel wood and wood waste	112.00
Biogas	54.60
Industrial wastes	143.00
Municipal waste - non-biogenic fraction	91.70
Municipal waste – biogenic fraction	100.00
Other petroleum products	73.30
Petroleum coke	97.50
Coke	107.00
Liquid petroleum gas (LPG)	63.10
Motor gasoline	69.30
Aviation gasoline	70.00
Jet kerosene	71.50
Diesel oil	74.10
Fuel oil	77.40
Feedstocks	73.30
Refinery gas	57.60
Coke oven gas	44.40
Blast furnace gas	260.00
Gas works gas	44.40

Table 28. CH_4 EFs [kg/GJ] applied for the years 1988-2013 for stationary sources [IPCC 2006]

Fuels	1.A.1	1.A.2	1.A.4.a	1.A.4.b-c
Hard coal	0.0010	0.0100	0.0100	0.3000
Lignite	0.0010	0.0100	0.0100	0.3000
Hard coal briquettes (patent fuels)	0.0010	0.0100	0.0100	0.3000
Brown coal briquettes	0.0010	0.0100	0.0100	0.3000
Crude oil	0.0030	0.0030	0.0100	0.0100
Natural gasl	0.0010	0.0010	0.0050	0.0050
Fuel wood and wood waste	0.0300	0.0300	0.3000	0.3000
Biogas	0.0010	0.0010	0.0050	0.0050
Industrial wastes	0.0300	0.0300	0.3000	0.3000
Municipal waste - non-biogenic fraction	0.0300	0.0300	0.3000	0.3000
Municipal waste – biogenic fraction	0.0300	0.0300	0.3000	0.3000
Other petroleum products	0.0030	0.0030	0.0100	0.0100
Petroleum coke	0.0030	0.0030	0.0100	0.0100
Coke	0.0010	0.0100	0.0100	0.3000
Liquid petroleum gas (LPG)	0.0010	0.0010	0.0050	0.0050
Motor gasoline	0.0030	0.0030	0.0100	0.0100
Aviation gasoline	0.0030	0.0030	0.0100	0.0100
Jet kerosene	0.0030	0.0030	0.0100	0.0100
Diesel oil	0.0030	0.0030	0.0100	0.0100
Fuel oil	0.0030	0.0030	0.0100	0.0100
Feedstocks	0.0030	0.0030	0.0100	0.0100
Refinery gas	0.0010	0.0010	0.0050	0.0050
Coke oven gas	0.0010	0.0010	0.0050	0.0050
Blast furnace gas	0.0010	0.0010	0.0050	0.0050
Gas works gas	0.0010	0.0010	0.0050	0.0050

Table 29. N_2O EFs [kg/GJ] applied for the years 1988-2013 for stationary sources in 1.A.1, 1.A.2 and 1.A.4 categories [IPCC 2006]

Fuels	**EF**
Hard coal	0.0015
Lignite	0.0015
Hard coal briquettes (patent fuels)	0.0015
Brown coal briquettes	0.0015
Crude oil	0.0006
Natural gasl	0.0001
Fuel wood and wood waste	0.0040
Biogas	0.0001
Industrial wastes	0.0040
Municipal waste - non-biogenic fraction	0.0040
Municipal waste – biogenic fraction	0.0040
Other petroleum products	0.0006
Petroleum coke	0.0006
Coke	0.0015
Liquid petroleum gas (LPG)	0.0001
Motor gasoline	0.0006
Aviation gasoline	0.0006
Jet kerosene	0.0006
Diesel oil	0.0006
Fuel oil	0.0006
Feedstocks	0.0006
Refinery gas	0.0001
Coke oven gas	0.0001
Blast furnace gas	0.0001
Gas works gas	0.0001

Annex 3.1. Calculation of CO_2 emission from 2.A.4.d subcategory: Other processes uses of carbonates - other

Table 1. Estimation of CO_2 emission from calcite use as limestone sorbents to desulfurize the off-gases by wet method (lime WFGD) in the years 1988-2013 (all values in the table are expressed in kilotons [kt])

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Desulphurization plaster production in lime wet FGD	0	0	0	0	0	0	0	175	474	583	674	860	1140	1134	1038	1109	1250
Consumption of limestone sorbents to desulfurize the off-gases by wet method (lime WFGD)	0	0	0	0	0	0	0	104	282	346	400	511	677	673	617	659	742
Limestone consumption in lime WFGD	0	0	0	0	0	0	0	99	268	329	380	485	643	640	586	626	705
CO2 emission from decomposition of calcium carbonate in WFGD	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**43**	**118**	**145**	**167**	**214**	**283**	**281**	**258**	**275**	**310**

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Desulphurization plaster production in lime wet FGD	1177	1240	1338	1596	2076	2389	2505	2572	2768
Consumption of limestone sorbents to desulfurize the off-gases by wet method (lime WFGD)	699	736	795	948	1233	1418	1487	1527	1644
Limestone consumption in lime WFGD	664	700	755	900	1171	1347	1413	1451	1561
CO2 emission from decomposition of calcium carbonate in WFGD	**292**	**308**	**332**	**396**	**515**	**593**	**622**	**638**	**687**

Table 2. Estimation of CO_2 emission from decomposition of calcite use to desulfurize the off-gases in fluid bad boilers (FGD in FBB) and in other method of flue gas desulfurization (FGD other than lime WFGD) in the years 1988-2013 (all values in the table are expressed in kilotons [kt])

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
SO2 emission captured by FGD in power plants and autoproducers CHP	916	924	766	786	857	900	990	1048	1178	1321	1379	1426	1620	1630	1699	1881	1939
SO2 captured with use of lime wet FGD method	0	0	0	0	0	0	0	65	176	217	251	320	424	422	386	413	465
SO2 captured with use of other FGD method	916	924	766	786	857	900	990	983	1002	1104	1128	1106	1196	1208	1313	1468	1474
Consumption of limestone sorbents to desulfurize the off-gases in FBB and in FGD other than lime wet FGD	1574	1588	1317	1351	1473	1547	1702	1689	1721	1898	1939	1901	2055	2076	2256	2524	2533
Limestone consumption in FGD in FBB and in FGD other than lime wet FGD	1543	1556	1290	1324	1444	1516	1668	1656	1687	1860	1900	1863	2014	2035	2211	2473	2482
CO2 emission from calcium carbonate in FGD in FBB and in FGD other than lime WFGD	**679**	**685**	**568**	**583**	**635**	**667**	**734**	**728**	**742**	**818**	**836**	**820**	**886**	**895**	**973**	**1088**	**1092**

	2005	2006	2007	2008	2009	2010	2011	2012	2013
SO2 emission captured by FGD in power plants and autoproducers CHP	1967	2075	2091	2178	2136	2299	2524	2297	2302
SO2 captured with use of lime wet FGD method	438	461	498	594	773	889	932	957	1030
SO2 captured with use of other FGD method	1529	1614	1593	1584	1363	1410	1592	1340	1272
Consumption of limestone sorbents to desulfurize the off-gases in FBB and in FGD other than lime wet FGD	2628	2773	2738	2723	2343	2424	2736	2303	2186
Limestone consumption in FGD in FBB and in FGD other than lime wet FGD	2575	2718	2683	2668	2297	2375	2681	2257	2142
CO2 emission from calcium carbonate in FGD in FBB and in FGD other than lime WFGD	**1133**	**1196**	**1181**	**1174**	**1010**	**1045**	**1180**	**993**	**943**

Table 3. CO_2 emission values from carbonate use in 2.A.4.d subcategory for the years 1988-2013 (all values in the table are expressed in kilotons [kt])

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Sum of limestone use presented in the tables 1-2	1543	1556	1290	1324	1444	1516	1668	1754	1954	2189	2281	2348	2657	2674	2797	3099	3188
CO2 emission from carbonate use in 2.A.4.d subcategory	**679**	**685**	**568**	**583**	**635**	**667**	**734**	**772**	**860**	**963**	**1003**	**1033**	**1169**	**1177**	**1231**	**1363**	**1403**

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Sum of limestone use presented in the tables 1-2	3239	3417	3438	3569	3468	3723	4094	3708	3704
CO2 emission from carbonate use in 2.A.4.d subcategory	**1425**	**1504**	**1513**	**1570**	**1526**	**1638**	**1802**	**1631**	**1630**

Annex 3.2. Calculation of CO_2 process emission from ammonia production (2.B.1)

Table 1. Calculation of CO_2 process emission from ammonia production

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Activity data	**Unit**												
natural gas	[10^3 m3]	2 184 552	2 230 523	1 447 064	1 447 326	1 337 619	1 401 804	1 688 887	1 942 704	1 907 689	1 937 127	1 789 006	1 587 228
natural gas	TJ	76 413	77 862	50 625	50 911	47 044	49 522	60 161	69 070	67 919	69 049	64 163	56 105
coke oven gas	[10^3 m3]	183 960	113 672	30 560									
coke oven gas	TJ	3 204	1 970	537									
CO_2 emission from natural gas use	kt	4 357	4 449	2 886	2 887	2 668	2 796	3 369	3 875	3 805	3 864	3 568	3 166
CO_2 emission from coke oven gas use	kt	142	87	24									
Total CO2 emission	kt	4 500	4 537	2 910	2 887	2 668	2 796	3 369	3 875	3 805	3 864	3 568	3 166
Ammonia production	kt	2389.353	2433.726	1531.552	1560.883	1480.798	1630.946	1945.470	2248.317	2185.188	2251.616	2047.948	1784.726
Implied EF of CO_2 process emission	[t CO2/ t NH3]	1.88	1.86	1.90	1.85	1.80	1.71	1.73	1.72	1.74	1.72	1.74	1.77
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Activity data	**Unit**												
natural gas	[10^3 m3]	1 965 162	1 873 685	1 455 329	2 122 465	2 177 127	2 310 818	2 197 622	2 186 299	2 221 406	1 814 589	1 881 957	2 061 524
natural gas	TJ	70 483	68 096	52 144	76 053	77 817	82 219	78 591	78 072	79 351	63 478	67 234	73 798
coke oven gas	[10^3 m3]												
coke oven gas	TJ												
CO_2 emission from natural gas use	kt	3 920	3 737	2 903	4 234	4 343	4 609	4 384	4 361	4 431	3 620	3 754	4 112
CO_2 emission from coke oven gas use	kt												
Total CO2 emission	kt	3 920	3 737	2 903	4 234	4 343	4 609	4 384	4 361	4 431	3 620	3 754	4 112
Ammonia production	kt	2243.108	2103.805	1594.797	2246.505	2451.557	2523.790	2326.621	2417.543	2485.148	2010.891	2059.437	2321.849
Implied EF of CO_2 process emission	[t CO2/ t NH3]	1.75	1.78	1.82	1.88	1.77	1.83	1.88	1.80	1.78	1.80	1.82	1.77
		2012	**2013**										
Activity data	**Unit**												
natural gas	[10^3 m3]	2 242 281	2 207 620										
natural gas	TJ	81 150	79 269										
coke oven gas	[10^3 m3]												
coke oven gas	TJ												
CO_2 emission from natural gas use	kt	4 473	4 403										
CO_2 emission from coke oven gas use	kt												
Total CO2 emission	kt	4 473	4 403										
Ammonia production	kt	2228.303	2467.458										
Implied EF of CO_2 process emission	[t CO2/ t NH3]	1.81	1.98										

Annex 4. Energy balance data for main fuels in 2013

Energy balances for several main fuels: lignite, natural gas, coke oven gas and blast furnace gas are given below. Similar balance data for hard coal are presented in Chapter 1.4.

Lignite consumption

National fuel balance	Lignite - Eurostat	
	kt	TJ
In	66 044	550 819
From national sources	65 849	549 181
1) Indigenous production	65 849	549 181
2) Transformation output or return	0	0
3) Stock decrease	0	0
Import	195	1 638
Out	66 044	550 819
National consumption	65 934	546 894
1) Transformation input	65 069	539 685
a) input for secondary fuel production	0	0
b) fuel combustion	65 069	539 685
2) Direct consumption	865	7 209
Non-energy use	0	0
Combusted directly	865	7 209
Combusted in Poland	65 934	546 894
Stock increase	-108	-901
Export	218	1 818
Losses and statistical differences	0	3 008

Net calorific value	MJ/kg	8.29

Natural gas consumption

National fuel balance	Natural gas - Eurostat
	TJ
In	589 600
From national sources	160 067
1) Indigenous production	160 067
2) Transformation output or return	0
3) Stock decrease	0
Import	429 533
Out	589 600
National consumption	576 224
1) Transformation input	76 273
a) input for secondary fuel production	0
b) fuel combustion	76 273
2) Direct consumption	499 951
Non-energy use	81 214
Combusted directly	418 737
Combusted in Poland	495 010
Stock increase	11 702
Export	3 224
Losses and statistical differences	-1 550

Coke oven gas consumption

National fuel balance	Coke Oven Gas - Eurostat
	TJ
In	68 844
From national sources	68 844
1) Indigenous production	0
2) Transformation output or return	68 844
3) Stock decrease	0
Import	0
Out	68 844
National consumption	68 844
1) Transformation input	17 867
a) input for secondary fuel production	0
b) fuel combustion	17 867
2) Direct consumption	50 977
Non-energy use	0
Combusted directly	50 977
Combusted in Poland	68 844
Stock increase	0
Export	0
Losses and statistical differences	0

Blast furnace gas consumption

National fuel balance	Blast furnace gas - Eurostat
	TJ
In	22 530
From national sources	22 530
1) Indigenous production	0
2) Transformation output or return	22 530
3) Stock decrease	0
Import	0
Out	22 530
National consumption	22 530
1) Transformation input	11 729
a) input for secondary fuel production	0
b) fuel combustion	11 729
2) Direct consumption	10 801
Non-energy use	0
Combusted directly	10 801
Combusted in Poland	22 530
Stock increase	0
Export	0
Losses and statistical differences	0

Annex 5.
Methodological notes related to elaboration of representative research on livestock animals performed by Central Statistical office

[GUS R1 (2013)]

METHODICAL NOTES

I. SOURCES OF DATA

The data in this publication were compiled on the basis of:

- generalized results of sample surveys[a/] on cattle, sheep, poultry and pigs, as well as, the animal output in private farms,
- statistical reports in the scope of livestock in state and cooperative farms and companies with public and private property share,
- statistical reports from slaughter houses of farm animals,
- statistical reports from poultry hatcheries,
- information on the livestock of poultry from voivodship experts,
- own estimates.

Surveys on cattle, sheep, poultry and animal output were conducted in approx. of the sample of private farms breeding the above-listed species of animals; this sample amounted to 30 thousand farms.

Surveys on pigs and production of pigs for slaughter were carried out in a sample of private farms breeding pigs; this sample amounted to 30 thousand farms.

The results of the survey of farm animal stocks and animal output were compiled by voivodship according to the residence of the land user, i.e. for private farms – according to the official residence (place of residence) of the land user, while for state owned farms, cooperative farms and companies – according to the official residence of the enterprise (farm).

II. MAJOR DEFINITIONS, TERMS AND ENUMERATION RULES

An agricultural farm is understood as an organised economic and technical unit with separate management (a user or a manager), conducting agricultural activity.

An agricultural activity shall include activity related to cultivation of plants and rearing and breeding of animals, which covers: all field crops (including mushrooms), vegetable gardening and horticulture, nurseries, cultivation and seed production of agricultural and horticultural crops as well as activity related to rearing and breeding of animals (cattle, sheep, goats, horses, pigs, poultry, rabbits, fur-covered animals, game kept

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a/ The surveys on cattle, sheep and poultry stock are conducted twice a year, i.e. in June and in December, while the survey on pigs – three times a year, i.e. in April, August and December.

for slaughter), bees as well as activity consisting in maintaining the land no longer used for production purposes in accordance with cultivation principles with respect for environment protection requirements (according to the norms).

A natural person is holding (private farm) is understood as a farm owned or used by a natural person of the area of at least 1.0 ha and more of agricultural land or a farm of the area of less than 1.0 ha, excluding agricultural land, which meets at least one of the thresholds mentioned below:

- 0,5 ha of fruit-bearing trees plantation,
- 0,5 ha of fruit-bearing shrubs plantation,
- 0,3 ha of fruit and ornamental nurseries,
- 0,5 ha of soil-grown vegetables,
- 0,5 ha of soil-grown strawberries,
- 0,1 ha of vegetables under cover,
- 0,1 ha of strawberries under cover,
- 0,1 ha of flowers and ornamental plants under cover,
- 0,5 ha of hop,
- 0,1 ha of tobacco,
- 25 m^2 of edible mushrooms,
- 10 head of cattle in total,
- 5 head of cows in total,
- 50 head of pigs in total,
- 10 head of sows,
- 20 head of sheep in total,
- 20 head of goats in total,
- 100 head of poultry for slaughter in total,
- 80 head of poultry for laying in total,
- 5 head of horses in total,
- 50 head of female rabbits,
- 80 beehives.

A legal person's or organizational unit without legal status is understood as farm run by a legal person or an organization unit without legal personality, the basic activity of which is rated, according to the Polish Classification of Activities, to Section A, division 01, group:

- growing of non perennial,

- 01.2 – growing of perennial plants,
- 01.3 – plant propagation,
- 01.4 – livestock production and breeding,
- 01.5 – cultivation of plants combined with rearing and breeding of animals (mixed agricultural activity),
- 01.6, class 01.61 – service activities supporting plant production (maintaining the lands in accordance with cultivation principles with respect for environment protection requirements), and also, irrespective of the basic activity classification, when the area of agricultural land per the lands used by an individual is 1 ha and more or when livestock is reared and bred.

A holder is understood as a natural person or a legal person or an organisational unit without legal personality, actually using the land, regardless of whether as owners or leaseholders, or using the land in any other respect, regardless of whether this land is situated in one or in several gminas.

Livestock

The survey covered the livestock staying in the farm during the survey period, as well as animals sent to herding, grazing and shepherd's huts. All animals were registered, i.e. the ones owned by an agriculture holding user or members of his household, as well as animals temporarily or permanently kept in the farm, i.e. taken for raising, fattening, etc., irrespective of the fact whether they were taken from private farms, state-owned farms, cooperative entities, or companies.

Dairy cows are understood as cows which, due to their breed, species or particular qualities, are kept in a farm exclusively or mainly for production of milk to be consumed or to be processed into dairy products. Dairy cows rejected from breeding, kept in a farm for the period regarded as pre-slaughter pasturing, after which they are sent to slaughter, are also included in this group.

Suckling cows are understood as cows which, due to their breed (beef breed cows and cows born from a cross-breed with beef breeds) or particular qualities, are kept in a farm exclusively or mainly for calves for slaughter, and whose milk is used to feed calves or other animals. Suckling cows rejected from breeding, kept in a farm for the period regarded as pre-slaughter pasturing, after which they are sent to slaughter, are also included in this group.

In the case of farms engaged in production of poultry on a large scale (such as a large-scale farm producing broilers or hen eggs), in which no poultry has been recorded on the survey day due to the current technological break in production, whenever such break does not exceed 8 weeks, the poultry stocks from the period before emptying the rooms (poultry houses) have been adopted.

Information on the number of cattle, sheep and poultry contained in this publication referes to the stocs in June and December 20112, while the data of pigs to the stocs in March, July and November 2012.

III. MAJOR GROUPS AND THE SCOPE OF PUBLISHED DATA

The data regarding the farm animals stocks as well as the elements of cattle and pigs turnover were classified according to ownership forms, i.e. for the private sector, as well as the public one.

The **private sector** includes: entities of state domestic ownership (private farms, cooperative farms and private domestic companies), foreign ownership and mixed ownership.

The **public sector** includes state owned farms (of the State Treasury and state legal persons), farms owned by self-governments (gminas) and entities of mixed ownership (companies with a predominance of public property).

As regards the private sector the data in this publication are presented for the following farms:

- of state domestic ownership, including:
    - private farms,
    - agricultural production cooperatives,
- of foreign ownership,
- of mixed ownership.

As regards the public sector the data were compiled for farms:

- of state ownership (state owned farms), including farms of the State Treasury ownership,
- farms owned by self-governments.

The percentages are presented with one decimal point and due to the electronic technique of rounding may not sum up into 100%. These figures are substantially correct.

IV. SAMPLING SCHEME

Survey on cattle, sheep and poultry stock

1. Introductory notes

The purpose of the surveys conducted by the Central Statistical Office twice a year (i.e. in June and in December) is to obtain detailed information on the number of cattle and poultry, both by voivodships and for Poland, and on the number of sheep for Poland only. The surveyed population consists of private agricultural farms which, according to the results of the Agricultural Census 2010, were keeping cattle, or poultry, or sheep, and farms with the area of agricultural land of 15 ha or more, which did not keep the above mentioned species of animals. The surveyed population in 2012 consisted of 909, 523 farms, of which approx. 854 thousand farms keeping cattle, poultry, or sheep. It was decided that the sample for the survey would consist of approx. 30 thousand private farms.

2. Sampling frame

The results of the Agricultural Census 2010 were used for establishing the sampling frame. An individual agricultural farm constituted a sampling unit. The following information was recorded for each farm:

- voivodship code,
- farm number (Nr_gos),
- total farm area,
- agricultural land in the farm ,
- number of cattle,
- number of poultry,
- number of sheep.

3. Sampling scheme

Before sampling, the population of farms was divided into three parts. **The first part** included farms fulfilling at least one of the following criteria, i.e. farms with at least one head of cattle or farms with more than 50 head of poultry and without any sheep. This part of population included 574, 901 farms. **The second part** consisted of farms with no cattle or sheep, and with no more than 50 head of poultry. Furthermore, the farms which did not keep the above mentioned animals at all, but having the area of agricultural land of 15 ha or more were also included in this group. The second part amounted to 323, 335 farms. Finally, **the third part** included farms keeping sheep, and It amounted to 11, 287 farms.

Sample drawing was done with a stratified and optimal sampling scheme. The number of cattle and poultry was used in the first part of the population as the criteria for stratification and allocation of the sample between the strata. In the second part, the strata were established on the basis of the agricultural land, whereas in the third part – on the basis of the number of head of sheep. There were created 12 strata in each voivodship, of which 7 related to farms from the first part, and 5 related to farms from the second part. In the third part, 6 national strata were established, i.e. strata that covered farms from all voivodships.

It was decided that a sample consisting of approx. 21 thousand farms be drawn from **the first part** farms.

The following assumptions were made while drawing the sample from this category of farms:

(1) the size of **n** sample is established for the population of farms in Poland, and not for individual voivodships, where n consists of approx. 21,000 farms,

(2) the sample is drawn in individual voivodships according to the stratified and optimal sampling scheme, with the use of the Neyman method,

(3) the population in each voivodship is first divided into 7 strata (h = 1, 2, …., 7), and the sample is then allocated between these strata,

(4) stratum no. 7 (i.e. h = 7) in each voivodship consists of such sampling units for which the value of variables adopted as the stratification basis is above the specified threshold. The stratum created in this way, so called the upper stratum, includes the units which are not drawn, but which are all included in the sample,

(5) it has been assumed that the expected accuracy of the survey results, measured with the variation coefficient of the livestock of cattle or poultry, will be identical for each voivodship and will be approximately equal to 1.0%.

The above problem was solved with the use of the numerical optimization method[1]. The population was divided into strata whose (upper) boundaries expressed in the number of cattle and poultry were presented in Table 1.

Table 1. Boundaries of strata by voivodship in the survey on cattle, sheep, and poultry stocks in 2012.

WOJ.	B – cattle D - poultry	b_1	b_2	b_3	b_4	b_5	b_6
02	B	5	12	23	40	65	111
	D	413	452	527	942	1,598	17,998
04	B	9	19	32	50	76	133
	D	213	264	279	407	513	7,393
06	B	4	10	20	34	55	93
	D	101	122	127	170	217	3,029
08	B	8	18	30	48	75	116
	D	1,185	1,445	2,165	4,995	16,525	41,995
10	B	5	12	22	35	55	122
	D	164	211	357	429	519	9,919
12	B	2	5	10	17	30	53
	D	101	123	123	173	174	3,049
14	B	9	18	32	58	92	144
	D	187	217	233	386	530	10,199
16	B	8	17	29	46	72	116
	D	350	373	660	807	1,532	29,998
18	B	1	2	4	9	20	27
	D	42	82	101	102	135	453
20	B	9	21	29	32	52	144
	D	66	78	79	104	109	1,002
22	B	7	15	27	42	64	102
	D	413	427	507	673	892	16,998
24	B	5	11	21	37	60	101
	D	455	510	572	1,032	3,198	19,998
26	B	2	3	5	6	14	48
	D	39	64	73	119	163	316
28	B	13	27	43	69	107	175
	D	430	567	795	992	5,998	18,998
30	B	10	21	36	58	91	153
	D	417	525	594	1,084	1,699	21,099
32	B	7	16	29	45	69	115
	D	322	432	437	747	773	13,998

[1] The description of the solution to this problem was published in the article written by B. Lednicki and R. Wieczorkowski "Optimal Stratification and Sample Allocation Between Subpopulation and Strata", Statistics in Transition", book 10, 2003, Warsaw

The boundaries of stratum 6, i.e. b_6, presented in Table 1, constitute also a **threshold** above which the farms are included in stratum 7, which means that they are not subject to sampling, but are all included in the sample. For other strata, i.e. h = 1, 2, … , 6, the Neyman optimal allocation method was applied for establishing the values of n_{wh}, i.e. size of the samples drawn from the h-stratum in w-voivodship.

After that, 20, 807 farms were drawn to the sample, based on the assumed allocation, including 3,861 farms from stratum no. 7.

Before sampling, 5 strata were established in each voivodship in **the second part** (h = 8, 9,…., 12). These strata were created in respect of agricultural land, i.e.: h = 8: farms of less than 1 ha, h = 9: farms of 1 ha to 4.99, h = 10: farms of 5 ha to 14.99 ha, h = 11: farms of 15 ha to 49.99 ha, h = 12: farms of 50 ha or more. Identical accuracy of the number of poultry in this part of the population was adopted as the criterion for allocation of the sample between voivodships, while within voivodships the sample was allocated by means of the Neyman optimal method. From this part of the population 6,938 farms were drawn.

In **the third part**, in which 6 national strata were established (h = 13, 14, ..., 18), 2,255 farms were drawn for the sample. **All farms from stratum 18 were included in the sample.** These were farms keeping sheep and simultaneously 50 or more head of cattle, or at least 400 head of poultry. The boundaries of other strata, and the assumed number of the sample allocated between these strata, were established with the above mentioned numerical optimisation method. The upper stratum (h = 17) was also established, from which no farms were drawn. This stratum included farms which had not been previously included in stratum 18, and which kept more than 75 head of sheep. The upper boundaries of the remaining strata were the following: $b_{13} = 2$, $b_{14} = 6$, $b_{15} = 13$, $b_{16} = 24$. The aim of establishing this category of farms as a separate one, as well as optimising the division into strata, was to accurately estimate the data on the livestock of sheep in country terms, with no regional breakdown.

Eventually, the entire sample for the survey on cattle, poultry, and sheep consisted of 30000 farms.

4. Results generalization and the accuracy assessment method

The sum of X variable value, such as cattle stock in total, is the basic parameter estimated in the survey of livestock of cattle, sheep and poultry.

This parameter for w-voivodship is calculated according to the formula:

(1) $\hat{x}_w = \sum_h \sum_i W1_{whi} * x_{whi}$, (i = 1, 2, ... , n_{wh}; h = 1, 2, ... , 9)

where:

x_{whi} – the value of X variable in i-farm (sampling unit) drawn from h-stratum in w-voivodship,

$W1_{whi}$ – the weight assigned to i-farm drawn from h-stratum of w-voivodship,whereas this weight is calculated according to this formula:

$$(2)\quad W1_{whi} = \frac{N_{wh}}{n_{wh}},$$

N_{wh} – the number of sampling units in h-stratum of w-voivodship,

n_{wh} – the number of sampling units drawn for the sample from h-stratum of w-voivodship.

The $W1_{whi}$ weight might be used to estimate the survey results only if the survey is completed. This weight must be corrected if some of the sampled farms refuse to participate in the survey. For this purpose, the drawn sample is divided into 4 groups based on information on the survey performance:

(1) the surveyed farms,

(2) farms that refused to participate in the survey,

(3) closed down farms etc.,

(4) farms with which the contact was not established during the survey performance.

For each stratum separately in each voivodship, the size of the above groups, namely $n1_{wh}$, $n2_{wh}$, $n3_{wh}$ and $n4_{wh}$ is established, and then the likelihood function of surveyed and not surveyed among the farms with a determined status is established, that is:

$$(3)\quad c_{wh} = \frac{n1_{wh} + n2_{wh}}{n_{wh} - n4_{wh}},$$

Then the number of the n_{awh} active farms in h-stratum of w-voivodship is calculated for the drawn sample:

$$(4)\quad n_{awh} = n1_{wh} + n2_{wh} + c_{wh} * n4_{wh}$$

On this basis, the R_{wh} correction factor is calculated for a given stratum:

$$(5)\quad R_{wh} = \frac{n_{awh}}{n1_{wh}},$$

The purpose of this factor is to correct the $W1_{whi:}$ weight in order to obtain final $W_{hi:}$ weight:

$$(6)\quad W_{whi} = R_{wh} * W1_{whi},$$

The sum of X variable value for Poland is the sum of values obtained for particular voivodships, i.e.:

(7) $$\hat{x} = \sum_{w} \hat{x}_w, \qquad (w = 1, 2, \ldots , 16)$$

Original weights resulting from sampling are corrected not only due to incompleteness of the survey but also due to the occurrence of so called outliers, that is unusual farms. This pertains to farms with high assigned weight (drawn with a high likelihood function) and, at the same time, with relatively high values for some of the analysed variables. In this case, the weight correction is to prevent significant overestimation of the value of the surveyed variable.

For the selected major assessments of the parameters, their variation coefficients were calculated as the accuracy measures. For an estimator expressed by formula (1) i.e. for w-voivodship, its variation coefficient estimation is expressed in the following formula:

(8) $$v\left(x_w\right) = \frac{\sqrt{d^2\left(\hat{x}_w\right)}}{\hat{x}_w} * 100,$$

while:

(9) $$d^2\left(\hat{x}_w\right) = \sum_{h} n_{awh}\left(1 - \frac{n_{wh}}{N_{wh}}\right) * s^2_{wh},$$

where:

(10) $$s^2_{wh} = \frac{1}{n_{awh} - 1} \sum_{i}\left(y_{whi} - \frac{1}{n_{awh}} * \hat{y}_{wh}\right)^2,$$

while:

(11) $$y_{whi} = W_{whi} * x_{whi},$$

and:

(12) $$\hat{y}_{wh} = \sum_{i} y_{whi},$$

For Poland the variation coefficient of the sum X estimated with the formula (7) is expressed by the following formula:

(13) $$v\left(\hat{x}\right) = \frac{\sqrt{d^2\left(\hat{x}\right)}}{\hat{x}},$$

whereas:

$$(14)\quad d^2(\hat{x}) = \sum_w d^2(\hat{x}_w),$$

Survey on pigs

1. Introductory notes

The purpose of the surveys on pigs stocks, conducted by the Central Statistical Office three times a year (i.e. in April, in August and in December), is to obtain detailed information on the number of pigs by voivodships and for Poland. The surveyed population consists of individual farms which, according to the data of the Agricultural Census 2010, were keeping pigs, as well as farms with the area of agricultural land of 15 ha or more, but with no pigs. The surveyed population consisted of 499,284 farms, of which approx. 359.3 thousand of farms keeping pigs. It was decided that the sample for the survey would consist of approx. 30 thousand farms.

2. Sampling frame

Individual results of the Agricultural Census 2010 were employed in establishing the sampling frame. An individual agricultural farm constituted a sampling unit. The following information was recorded for each farm:

- voivodship code,
- farm number (Nr_gos),
- total farm area,
- agricultural land,
- number of pigs.

3. Sampling scheme

In order to draw sample, a stratified sampling and optimal scheme was used with respect to farms which, according to the sampling frame, reared pigs. In contrast, the stratified and proportional sampling was applied in each voivodship with respect to the population of farms which did not keep pigs. 2.0% of farms with the area of agricultural land of 15.00 – 49.99 ha, and 5.0% of farms with the area of agricultural land of 50.00 ha or more were drawn for the sample. In total, a sample consisting of 2,770 farms was drawn from this part of the population.

It was decided that a sample consisting of approx. 27 thousand farms be drawn from all farms breeding and rearing pigs.

The following assumptions were made while drawing the sample from this category of farms:

(1) the size of **n** sample is established for the population of farms in Poland, and not for individual voivodships, where n consists of approx. 27 thousand farms,

(2) the sample is drawn in individual voivodships according to the stratified and optimal sampling scheme, by means of the Neyman method,

(3) the population in each voivodship is first divided into 7 strata (h = 1, 2, …. , 7), and then the sample is allocated between these strata,

(4) stratum no. 7 (i.e. h = 7) in each voivodship consists of such sampling units, for which the value of at least one of the variables adopted as the stratification basis is above the specified threshold. The stratum created this way, regarded as the upper stratum, includes the units which are not drawn, but which are all included in the sample,

(5) it has been assumed that the expected accuracy of the survey results, measured with the variation coefficient of the livestock of pigs, will be identical for each voivodship and will be equal approximately to 0.3%.

The above problem was solved with the use of the numerical optimization method[2]. The population was divided into strata whose (upper) boundaries expressed in the number of pigs were presented in Table 2 below.

Table 2. Boundaries of strata by voivodship in the survey on pigs stock in 2012.

VOIV.	b_1	b_2	b_3	b_4	b_5	b_6
02	4	9	17	27	45	68
04	16	33	59	95	153	269
06	4	8	16	28	51	106
08	5	13	24	37	53	76
10	6	16	28	47	85	174
12	3	7	14	24	37	63
14	6	15	29	54	104	203
16	12	29	48	76	115	175
18	-	-	8	16	27	50
20	4	9	17	30	58	110
22	9	19	37	57	93	146
24	6	15	25	40	64	97
26	4	9	17	28	47	80
28	7	20	38	68	113	180
30	16	38	67	113	191	371
32	7	18	37	69	146	1,286

[2] The description of the solution to this problem was published in the article written by B. Lednicki and R. Wieczorkowski "Optimal Stratification and Sample Allocation Between Subpopulation and Strata", Statistics in Transition, book 10, 2003, Warsaw

The boundary of stratum 6, i.e. $\mathbf{b_6}$, presented in Table 2, also constitutes a **threshold, above which** the sampling units are included in stratum 7, which means they are not subject to sampling, but are all included in the sample. For other strata, i.e. h = 1, 2, … , 6, the Neyman optimal allocation method was employed for establishing the values of n_{wh}, i.e. size of the samples drawn from the h-stratum in w-voivodship. In the case of one voivodship ("18"), as a result of applying numerical optimization procedures, the lower strata obtained were numerically too small, which caused strata 1 and 2 to be necessarily combined in one stratum no. 3. After that, 27, 230 farms were drawn to the sample, based on the assumed allocation, including 10,246 farms from stratum no. 7. Together with farms not keeping pigs (according to the sampling frame) fron stratum no. 8 (i.e. farms of the area of 15.00 ha to 49.99 ha of agricultural land) and stratum no. 9 farms (i.e. farms of 50 ha or more), the sample consisted of 30,000 farms.

4. Results generalization and the accuracy assessment method

The sum of X variable value, such as pigs stock in total, is the basic parameter estimated during the survey on the livestock of pigs.

This parameter for w-voivodship is calculated according to the formula:

(1) $\hat{x}_w = \sum_h \sum_i W1_{whi} * x_{whi},$ (i = 1, 2, ... , n_{wh}; h = 1, 2, ... , 9)

where:

x_{whi} – the value of X variable in i-farm (sampling unit) drawn from h-stratum in w-voivodship,

$W1_{whi}$ – weight assigned to i-farm drawn from h-stratum in w-voivodship, calculated on the basis of the following formula:

(2) $W1_{whi} = \frac{N_{wh}}{n_{wh}},$

N_{wh} – the number of sampling units in h-stratum of w-voivodship,

n_{wh} – the number of sampling units drawn from h-stratum of w-voivodship.

Weight $W1_{whi}$ can be used for the estimation of survey results only when the survey is complete. The weight must be adjusted when a part of farms drawn for the survey refuse to participate in the survey. For this purpose, the drawn sample is divided into 4 groups on the basis of information on carrying out the survey:

(1) the surveyed farms,

(2) farms which refused to participate in the survey,

(3) closed down farms etc.

(4) farms with which there was no contact during carrying out the survey.

For each stratum, separately for each voivodship, the size of the above groups, i.e. $n1_{wh}$, $n2_{wh}$, $n3_{wh}$ and $n4_{wh}$ is established, then the likelihood function of surveyed and not surveyed among the farms with a determined status is established, i.e.:

(3) $$c_{wh} = \frac{n1_{wh} + n2_{wh}}{n_{wh} - n4_{wh}},$$

Next, the number of the n_{awh} active farms in h-stratum of w-voivodship is calculated for the drawn sample:

(4) $$n_{awh} = n1_{wh} + n2_{wh} + c_{wh} * n4_{wh}$$

On the basis of this, the R_{wh} correction factor is calculated for a given stratum:

(5) $$R_{wh} = \frac{n_{awh}}{n1_{wh}},$$

The function of this factor is the correction of the $W1_{whi}$ weight in order to achieve final weight $W_{hi:}$

(6) $$W_{whi} = R_{wh} * W1_{whi},$$

The evaluation of the sum of X variable value for Poland is the sum of values obtained for particular voivodships, i.e.:

(7) $$\hat{x} = \sum_{w} \hat{x}_w, \qquad (w = 1, 2, ... , 16)$$

Primary weights resulting from sample drawing are corrected not only due to the incompleteness of the survey but also due to the occurrence of the so called outlier farms. This pertains to farms with high assigned weight (drawn with a high likelihood function) and, at the same time, with relatively high values for some of the analysed variables. Weight correction is aimed at preventing substantial overestimation of the value of the analysed variable.

For the selected major assessments of the parameters, their variation coefficients were estimated as the accuracy measures. For an estimator expressed by formula (1), i.e. for w-voivodship, its variation coefficient is estimated with the following formula:

(8) $$v\left(x_w\right) = \frac{\sqrt{d^2\left(\hat{x}_w\right)}}{\hat{x}_w} * 100,$$

while:

(9) $$d^2(\hat{x}_w) = \sum_h n_{awh}\left(1 - \frac{n_{wh}}{N_{wh}}\right) * s_{wh}^2,$$

where:

(10) $$s_{wh}^2 = \frac{1}{n_{awh}-1}\sum_i\left(y_{whi} - \frac{1}{n_{awh}} * \hat{y}_{wh}\right)^2,$$

while:

(11) $$y_{whi} = W_{whi} * x_{whi},$$

and:

(12) $$\hat{y}_{wh} = \sum_i y_{whi},$$

For Poland the variation coefficient of the sum X estimated with the formula (7) is expressed by the following formula:

(13) $$v(\hat{x}) = \frac{\sqrt{d^2(\hat{x})}}{\hat{x}},$$

whereas:

(14) $$d^2(\hat{x}) = \sum_w d^2(\hat{x}_w),$$

The values of the relative standard error of selected attributes for Poland – based on the results of a sample survey of the livestock of cattle, sheep and poultry as well as the results of a survey of pigs – conducted in December 2012.

No. of the attribute	Name of the attribute	Relative standard error
1.	Cattle total	0.74
2.	Cows	0.83
3.	Pigs total	0.67
4.	Sows total	0.69
5.	Hens	0.41
6.	Laying hens	0.76

Annex 6. Land use matrix

Table 1.Land use area for the period 1987-2013

Category	IPCC	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		[ha]												
Arable land, orchards, permanent pastures and meadows (total)	5B	18857200	18834700	18804700	18783841	18759564	18740884	18712799	18689685	18663821	18632581	18607762	18592096	18557635
Arable land	5B	14480000	14464000	14414000	14342464	14323890	14306699	14287576	14268943	14248221	14224743	14205069	14179626	14152315
Orchards	5B	259000	238000	265000	321665	321170	320695	320478	319858	319918	319429	317996	316413	315029
Permanent meadows and pastures (total)	5C	4118200	4132700	4125700	4119712	4114504	4113490	4104745	4100884	4095682	4088409	4084697	4096057	4090291
Pastures	5C	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	2387639	2383437
Permanent meadows	5C	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	1708418	1706854
Agricultural built-up areas	5E	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Lands under ponds	5E	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Lands under ditches	5E	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Forest land as well as woody and bushy land	5A	8858000	8864500	8876000	8883692	8893709	8905569	8917160	8936738	8958359	8996177	9028914	9087164	9103593
Forests	5A	8660500	8667000	8678500	8693900	8706300	8718200	8715024	8724217	8741530	8778706	8809429	8861245	8877142
Woody and bushy land	5A	197500	197500	197500	189792	187409	187369	202136	212521	216829	217471	219485	225919	226451
Lands under waters	5D	821900	823300	825000	825728	826548	828069	829746	829665	831330	833298	832763	832869	833395
a) marine internal	5D	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	74984	75778
b) surface flowing	5D	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	456203	456644
c) surface standing	5D	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	140980	141127
d) ditches	5D	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	160702	159846
Built-up and urbanised areas	5E	1948100	1959500	1972400	1983021	1995064	2007360	2023244	2034536	2036820	2036100	2034472	2040413	2048902
Residential areas	5E	923600	932400	944000	820213	829082	837802	849670	858123	866181	874879	883060	733999	738966
Industrial areas	5E	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	86432	91200
Other built-up areas	5E	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	76112	71975
Urbanised un-built areas	5E	IE	IE	IE	70395	71260	70810	69232	70436	72042	73313	74827	71543	79627
Recreational areas	5E	IE	IE	IE	61612	61250	62077	63803	65205	65166	66027	66759	67809	69229
Transport areas	5E	982600	985600	987500	IE	IE	IE	IE	IE	IE	IE	IE	964614	959817
a) roads	5E	IE	IE	IE	866271	869400	872318	875504	877202	871277	860443	849493	845325	841773
b)rail areas	5E	IE	IE	IE	122927	121963	121691	121748	121101	121121	120312	120017	107527	105318
c) other	5E	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	11762	12726
Minerals	5E	41900	41500	40900	41603	42109	42662	43287	42469	41033	41126	40316	39904	38088
Ecological arable land	5D	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	4476	9456
Wasteland	5D	500200	500200	503500	504265	505872	505319	505219	505289	506303	506340	505489	501730	499783
Other	5F	251100	251100	255000	256124	256810	249945	248882	241036	239891	234005	231440	209754	215738
Miscellaneous land	5F	31800	35000	32200	31659	30935	31356	31452	31553	31978	30001	27662	NO	NO
Total	$\sum$	31268300	31268300	31268800	31268330	31268502	31268502	31268502	31268502	31268502	31268502	31268502	31268502	31268502

Table 1.Land use area for the period 1987-2013 cont.

Category	IPCC	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
		[ha]													
Arable land, orchards, permanent pastures and meadows (total)	5B	18523732	19161882	19184894	19207214	19148218	19098822	19069399	19024975	18980740	18930981	18869891	18825006	18770139	18716486
Arable land	5B	14129284	14095216	14058687	14090607	14074424	14059171	14036936	14027060	14002026	13969108	13921466	13890560	13850930	13818287
Orchards	5B	313376	310253	310098	307033	296542	289817	292414	289494	293031	292376	294836	292362	287199	285402
Permanent meadows and pastures (total)	5C	4081071	4056350	4058656	4063487	4047433	4026446	4003150	3970770	3947905	3931092	3914003	3902606	3889487	3873137
Pastures	5C	2377429	2363326	2362929	2363360	2352841	2342935	2332943	2315293	2302422	2292770	2286565	2280351	2273889	2260353
Permanent meadows	5C	1703642	1693024	1695727	1700127	1694592	1683511	1670207	1655477	1645483	1638322	1627438	1622255	1615598	1612784
Agricultural built-up areas	5E	IE	508930	569384	552264	527235	518749	530493	530379	530671	530212	531895	530361	532829	528593
Lands under ponds	5E	IE	33610	30917	38112	50445	55605	59383	61600	64733	70351	72326	74707	76267	78656
Lands under ditches	5E	IE	157523	157152	155712	152140	149033	147022	145672	142373	137843	135365	134409	133427	132411
Forest land as well as woody and bushy land	5A	9130719	9146564	9199286	9264017	9338464	9388544	9400680	9463453	9496122	9531015	9569734	9599599	9633820	9658390
Forests	5A	8903555	8915629	8968157	9031089	9106365	9152905	9164084	9224110	9251403	9275784	9304761	9329175	9353731	9369403
Woody and bushy land	5A	227164	230936	231129	232928	232099	235639	236597	239343	244719	255231	264973	270424	280088	288987
Lands under waters	5D	833992	640414	645379	645427	636191	636653	636292	638244	640467	639833	645301	645543	647378	648559
a) marine internal	5D	75780	77551	77808	78358	78152	79381	79129	79380	79222	79231	79232	79232	79245	79085
b) surface flowing	5D	457056	457936	460281	466527	470627	475194	482481	486076	490095	494976	503891	505538	507588	510561
c) surface standing	5D	141891	104927	107289	100542	87412	82079	74682	72788	71150	65625	62177	60774	60545	58913
d) ditches	5D	159265	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Built-up and urbanised areas	5E	2056718	1522599	1453066	1458022	1475783	1490957	1494362	1510649	1529364	1550228	1572402	1589873	1612791	1634847
Residential areas	5E	737646	235992	187406	212506	233558	245247	248741	256578	268510	278479	287014	296600	306463	315556
Industrial areas	5E	93405	93285	94257	96788	100487	104253	105971	108177	110041	112113	113005	113906	115591	116585
Other built-up areas	5E	74443	72349	72107	80538	90328	99413	104949	111262	116820	122490	127660	132749	138214	142726
Urbanised un-built areas	5E	87748	79796	68751	55293	57206	54547	52851	52265	51240	51406	54279	54021	53715	53622
Recreational areas	5E	69747	65483	64241	63736	64690	64528	64906	65130	65209	65466	65403	64824	64853	64910
Transport areas	5E	955429	939169	930376	914630	896865	891766	885651	886929	887571	891187	896217	899198	905393	913604
a) roads	5E	837720	820280	810826	794588	780773	775959	770505	771268	773204	776163	780593	784096	790264	798996
b)rail areas	5E	105029	105939	106557	106509	103985	103748	103466	103518	102678	102981	102799	102412	101933	101469
c) other	5E	12680	12950	12993	13533	12107	12059	11680	12143	11689	12043	12825	12690	13196	13139
Minerals	5E	38300	36526	35928	34530	32649	31202	31294	30308	29974	29087	28823	28575	28562	27844
Ecological arable land	5D	11778	15670	17692	20064	25141	28240	30161	32830	33890	34372	34747	35338	35565	36317
Wasteland	5D	499761	495079	493015	498613	497900	492773	488458	486761	485470	481737	479957	478800	476147	474921
Other	5F	211792	286295	275171	175145	146805	132325	148586	111025	101885	99801	95936	93809	92128	98447
Miscellaneous land	5F	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	∑	31268502	31268502	31268502	31268502	31268502	31268315	31267938	31267938	31267938	31267967	31267967	31267967	31267967	31267967

Annex 7. Quality Assurance and Quality Control Plan

Here are presented the basic elements of QA/QC plan which are to be implemented and co-ordinated by the National Centre for Emission Balancing and Management (KOBiZE), the unit responsible for Polish GHG inventory preparation. It has been elaborated in line with the *IPCC Guidelines*. The main procedures for QA/QC activities are described in chapter 5 of the *National programme for Quality Assurance and Quality Control of Polish GHG inventory* and the detail check procedures are contained below as the examples of QC procedures performed by KOBiZE experts.

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 national (legal) and international obligations.

Table 1. Timetable for inventory preparation and check for the year n-2 (n – submission year).

Timing	Activity
June -15 December (year n–1)	→ Data and emission factors collection (estimation) → Check for consistency data → Initial calculations and checks of GHG emissions considering ERT recommendations → Submission to the Ministry of Environment for acceptance
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 MMR Article 7.1)
15 December – 15 February (year n–2)	→ Elaboration of final inventory, additional checks and final corrections to the inventory, preparation of NIR and CRF tables → Submission to the Ministry of Environment for acceptance
15 March (year n–2)	→ Submission of complete National Inventory Report and CRF tables to the European Commission (required by MMR Article 7.1)
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)

** National GHG Inventory should be submitted to the UNFCCC Secretariat 6 weeks after 15 April at the latest, which is 27 May, to comply with the reporting obligations*

Each IPCC sector undergoes detail QC procedure which is carried out by performer for given category/subcategory. Check for correctness of data, emission factors and calculation results are performed several times during the following stages of inventory elaboration: during its preparation, after completing the calculations, after CRF tables generation and after NIR report completing. Additionally part of the data, especially for Energy sector, are checked by other KOBiZE experts than those making inventory who are responsible for other sectors. As a part of QA activity the inventory team cooperates with specialists from different institutes, associations and individual experts who are involved in verification of data and assumptions to the inventory (see table 3). Additionally full National Inventory Report with CRF tables jest verified by the Ministry of Environment and cooperating agencies before official approval and submission it to the European Commission and UNFCCC Secretariat.

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. For GHG emission sources for which Tier 1 method is used for emission calculation also Tier 1 method is applied for inventory checks. The categorisation of IPCC inventory sectors for Tier 1 and Tier 2 quality control procedures is shown in table 2.

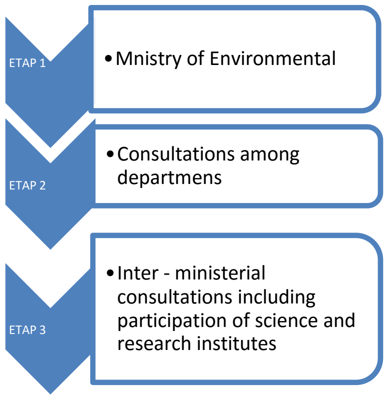
For the purposes of documentation of data and calculations QC the files are archived in electronic and hardcopy forms.

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, 1.A.2., 1.A.4, 1.A.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)

Table 3. General plan for QC (KOBiZE) with QA (external review) activities within Polish GHG inventory.

Action within inventory frames for specific categories		internal QC (KOBiZE)	External check (outside of KOBiZE)
Activity data: Collection Introduction Reference description **Emission factors:** Choice Calculation Verification **Emission calculation**	1. Energy	experts on energy and industrial processes expert on energy and industrial processes for LRTAP expert on transport expert on waste	
	2. Industrial processes	expert on energy and industrial processes	
	3. Solvent and other product use	expert on waste	
	4. Agriculture	expert on agriculture	
	5. LULUCF	expert on LULUCF	
	6. Waste	expert on waste	
Elaboration of *key categories*		expert on waste	
Elaboration of *uncertainties*		expert on database	
Inserting data into CRF Reporter and data generation		expert on database	
Check of data processed by CRF Reporter against calculated data		expert for given category	
NIR preparation		experts on energy and industrial processes expert on agriculture expert on transport expert on waste expert on database expert on register	
Documentation & archiving of documentation		expert on database	



Annex 8. Uncertainty assessment of the 2013 inventory

Uncertainty analysis for the year 2013 was performed with use of Approach 1 provided in *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Chosen methodology is based on the assumptions that every value is independent (there is no correlation between values) and probability of underestimation and overestimation is the same.
Conclusions from the previous centralized reviews and in country review in 2013 were taken into account.
Latest major changes applied to uncertainties follow the changes in estimation methodology and new revised classification in CRF reporting tables. Uncertainty calculation model was extended to provide separate result for assessments including and excluding LULUCF sector. Another improvement triggered by ERT recommendation was calculation of overall uncertainty of inventory including information about uncertainties involved in estimation of Global Warming Potentials.

Additionally in submission 2015 was provided uncertainty analysis of emission trend with use of 1998 emission inventory as a base year..

For industrial gases (HFC, PFC, SF6) due to lack of appropriate information, uncertainty estimates were applied directly to emission values on the basis of expert's opinion.

First stage of the estimates was to assign uncertainty to each activity data and emission factor. Next step was to estimate error propagation and its influence on national total emissions. To estimate error propagation from activity and emission factor to emission values, formula (1) was used.

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

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

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

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

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

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

- sector 1. Energy : categories on 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. IPPU: subcategories 2.A.1, 2.A.2 .... 2.C.3
- sector 3. Agriculture: subcategories 3.A.1, 3.A.2 .... 3.F.5 with further disaggregation
- sector 4. LULUCF: main subcategories 4.A, 4.B….4.E
- sector 5. Waste: 5.A.1, 5.A.2; 5.B with further disaggregation

Most of the estimates were based on default assumption described in methodology, but after investigation of socio-economic parameters literature data was applied to selected activities in sector *1. Energy* and for activities and emission factors in sector *2. Industrial processes and product use.* Selected uncertainties for activities and factors in 5.C Waste/Waste Incineration were estimated with help expert's opinion in Emission Balancing and Reporting Unit (former National Emission Centre).

Results of analysis of error propagation of uncertainty of national totals for 2013 were shown below:

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	All GHG recalculated to CO_2 eq.
Total uncertainty Including IPCC 4. LULUCF	3.6%	23.5%	50.1%	48.3%	85.0%	90.0%	**5.1%**
Emission recalculated to CO2 eq [kt] Including IPCC 4. LULUCF	285 272.89	42 134.12	20 236.95	9 606.78	14.64	39.15	357 304.53
Total uncertainty Excluding IPCC 4. LULUCF	1.8%	23.6%	50.1%	48.3%	85.0%	90.0%	**4.1%**
Emission recalculated to CO2 eq [kt] Excluding IPCC 4. LULUCF	322 900.21	42 097.14	20 233.61	9 606.78	14.64	39.15	394 891.52

Activity data

Most uncertain values of activity were assigned in category 3.*F Agriculture/Field Burning of Agricultural Residues* and in *5.B Waste/Domestic and Commercial Wastewater* (30%). Lowest uncertainty values were assigned to *1.A.1 Energy/ Fuel Combustion,* especially in subsector 1.A.1 *Energy Industries* (2%,). In general Polish energy sector is responsible for 90 % of GHG emission and is covered with detailed national statistics, which allows to keep overall uncertainty of inventory at low level.

CO_2 emission factors

Most uncertain values for CO_2 emission factors were assigned in sector 5.*C Waste incineration* (50%), *2.A. Cement Production* (15%) and *2.C Metal Production* (10%), the most precise values were reported in *1.A Fuel Combustion* (1-2%).

Low level of uncertainty of national total of CO_2 (3.6%) comes from the fact, that major part of emission comes from sector *1.A Fuel Combustion* where input data for activities and factors is the most precise (relatively 1-5% and 1-3%, excluding biomass).

CH_4 emission factors

Most uncertain values for CH_4 emission factors were assigned in sector 5.A Solid Waste Disposal (100%), and 5.C. Waste incineration (100%), *1.A Fuel Combustion* (75%), 1.B Fugitive Emission from fuels (75%), 3.*A. Enteric Fermentation* and 3.*B Manure Management (50%).* The most precise values were in *2. Industrial Processes* (20%) and 3.*F Field Burning of Agricultural Residues* (20%). In 2009 new sources were included to analysis in *2.C. Metal Production (sinter, electric furnaces, pig iron and basic oxygen furnaces)* as a result of incorporating to national emission inventories data from reporting for EU Emission Trading Scheme.

Uncertainty of CH_4 emission is app. 23.5% which is result of share of agriculture and waste sectors in national totals – emission factors in those sectors have high relatively uncertainty.

N_2O emission factors

Most uncertain values for N_2O emission factors were assigned in sector 3.*B Manure management* (150%), *3.D Agricultural Soils* (150%) and in *3.F Agriculture/Field Burning of Agricultural Residues* (150%), most precise values were applied in sector *2.C Metal Production (20%)*. Data available from polish part of EU Emission Trading Scheme reporting were taken into account during this analysis with relatively low uncertainty.

Highest value of uncertainty of national total occurred in N_2O (48.3%) and is a result of high uncertainty of the emission factors in sector of *Agriculture* (*3*.B *Liquid systems*, *3*.B *Solid Storage and Dry Lot, 3.D Agricultural Soils* and *3.Field Burning of Agricultural residues* – 150%).

Industrial Gases

Simplified analysis were made for industrial gases HFC, PFC and SF6, where uncertainty assumptions were applied directly to emission values of each pollutant. Final results of analysis where as follows: HFC – 48.3%, PFC – 85% and SF6 – 90%. Due to lack of information, simplified approach has to be used and country recognizes need of additional analysis in this sector as planned improvement for future inventories.

Uncertainty introduced into the trend in total national emissions

In submission 2015 uncertainty analysis is providing information on uncertainty introduced into the trend in total national emissions. First step of the analysis was assessing of level uncertainty introduced to national total in base year (1988). Methodology used to assess trend uncertainties is the same as mentioned for analysis for 2013. Results of level uncertainty analysis for base year with and without IPCCC 4.LULUCF are presented below.

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	All GHG recalculated to CO_2 eq.
Total uncertainty Including IPCC 4. LULUCF	2.3%	24.8%	42.9%	-	-	-	**4.2%**
Emission recalculated to CO2 eq [Gg] Including IPCC 4. LULUCF	460 160.19	64 927.13	30 014.37	-	-	-	555 101.68
Total uncertainty Excluding IPCC 4. LULUCF	2.0%	24.8%	42.9%	-	-	-	**4.0%**
Emission recalculated to CO2 eq [Gg] Excluding IPCC 4. LULUCF	474 657.36	64 890.06	30 002.74	-	-	-	569 550.15

On the basis of results of analysis made for the base year and latest reported year analysis for trend was done and results are presented below:

	CO2	CH4	N2O
Trend uncertainty with IPCC 4.LULUCF	1.67%	4.92%	1.43%
Trend uncertainty without IPCC 4.LULUCF	1.54%	4.89%	1.43%

Planned improvements for next years

- further investigation of data for industrial gases
- revising uncertainty model used for Approach 2 (Monte Carlo analysis)
- collection of data and setting up model for KP art 3.3 and 3.4 uncertainty estimates

GHG inventory 2013 – Uncertainty analysis, part 1, sector IPCC 1 Energy.

2013	Activity [TJ]	Activity uncertainty [%]	EF CO_2 Uncertainty [%]	EF CH_4 Uncertainty [%]	EF N_2O Uncertainty [%]	CO2 [kt]	CH4 [kt]	N2O [kt]	CO_2 Emission uncertainty [%]	CH_4 Emission uncertainty [%]	N_2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [kt]	CH4 Emission absolute uncertainty [kt]	N2O Emission absolute uncertainty [kt]
TOTAL (without LULUCF)						**322 900.21**	**1 683.89**	**67.90**	**1.8%**	**23.6%**	**50.1%**	5 848.59	396.70	34.02
TOTAL (with LULUCF)						**285 272.89**	**1 685.36**	**67.91**	**3.6%**	**23.5%**	**50.1%**	10 389.12	396.71	34.02
1. Energy						**302 125.95**	**755.01**	**8.29**	**1.9%**	**29.1%**	**12.6%**	**5752.49**	**219.69**	**1.04**
A. Fuel Combustion						**298 208.54**	**158.80**	**8.29**	**1.9%**	**11.4%**	**12.6%**	5742.73	18.17	1.04
1. Energy Industries						169 172.05	4.49	2.70	2.7%	16.1%	30.5%	4522.85	0.72	0.82
Liquid Fuels	52 675	2.0%	1.0%	10.0%	20.0%	3 646.82	0.12	0.02	2.2%	10.2%	20.1%	81.55	0.01	0.00
Solid Fuels	1 611 225	2.0%	2.0%	13.5%	35.0%	159 819.07	1.61	2.31	2.8%	13.6%	35.1%	4520.37	0.22	0.81
Gaseous Fuels	100 187	2.0%	1.0%	17.0%	40.0%	5 620.49	0.10	0.01	2.2%	17.1%	40.0%	125.68	0.02	0.00
Other fossil fuels	720	5.0%	5.0%	25.0%	75.0%	85.67	0.02	0.00	7.1%	25.5%	75.2%	6.06	0.01	0.00
Peat	NO					NO	NO	NO						
Biomass	92 703	10.0%	5.0%	24.0%	37.0%	10 101.03	2.64	0.35	11.2%	26.0%	38.3%	1129.33	0.69	0.13
2. Manufacturing Industries and Construction						29 820.43	4.09	0.57	2.4%	11.2%	23.4%	718.97	0.46	0.13
Liquid Fuels	40 439	3.0%	1.0%	10.0%	20.0%	2 692.40	0.08	0.01	3.2%	10.4%	20.2%	85.14	0.01	0.00
Solid Fuels	165 879	3.0%	2.0%	13.5%	35.0%	17 191.17	1.71	0.25	3.6%	13.8%	35.1%	619.84	0.24	0.09
Gaseous Fuels	135 334	4.0%	1.0%	17.0%	40.0%	7 592.24	0.14	0.01	4.1%	17.5%	40.2%	313.04	0.02	0.01
Other fossil fuels	17 742	5.0%	5.0%	25.0%	75.0%	2 344.63	0.53	0.07	7.1%	25.5%	75.2%	165.79	0.14	0.05
Peat	NO					NO	NO	NO						
Biomass	54 891	10.0%	5.0%	20.0%	37.0%	6 114.28	1.64	0.22	11.2%	22.4%	38.3%	683.60	0.37	0.08
3. Transport						43 351.76	4.12	1.80	5.7%	10.2%	20.0%	2478.24	0.42	0.36
Liquid Fuels	602 473.00	3.0%	5.0%	10.0%	20.0%	42 490.91	4.01	1.78	5.8%	10.4%	20.2%	2477.62	0.42	0.36
Solid Fuels	NO	3.0%	5.0%	13.5%	35.0%				5.8%	13.8%	35.1%			
Gaseous Fuels	15 422.00	4.0%	5.0%	17.0%	40.0%	860.85	0.02	0.00	6.4%	17.5%	40.2%	55.12	0.00	0.00
Other fossil fuels	NA,NO		5.0%	25.0%	75.0%				5.0%	25.0%	75.0%			
Biomass	31 297.60	10.0%	5.0%	24.0%	37.0%	2 215.87	0.09	0.02	11.2%	26.0%	38.3%	247.74	0.02	0.01
4. Other Sectors						55 864.29	146.09	3.22	4.3%	12.4%	16.0%	2421.60	18.14	0.51
Liquid Fuels	122 083.90	4.0%	5.0%	10.0%	20.0%	8 763.16	0.66	2.07	6.4%	10.8%	20.4%	561.12	0.07	0.42
Solid Fuels	366 139.00	4.0%	5.0%	13.5%	35.0%	34 633.92	100.63	0.55	6.4%	14.1%	35.2%	2217.65	14.17	0.19
Gaseous Fuels	221 189.00	4.0%	5.0%	17.0%	40.0%	12 408.70	1.11	0.02	6.4%	17.5%	40.2%	794.54	0.19	0.01
Other fossil fuels	421.00	4.0%	5.0%	25.0%	75.0%	58.51	0.13	0.00	6.4%	25.3%	75.1%	3.75	0.03	0.00
Peat	NO					NO	NO	NO						
Biomass	147 633.00	10.0%	5.0%	24.0%	37.0%	16 396.39	43.58	0.58	11.2%	26.0%	38.3%	1833.17	11.33	0.22
5. Other						0.00	0.00	0.00	0.0%	0.0%	0.0%	0.00	0.00	0.00
Liquid Fuels	NO	5.0%	3.0%	100.0%	20.0%				5.8%	100.1%	20.6%	0.00	0.00	0.00
Solid Fuels	NO	5.0%	5.0%	80.0%	35.0%				7.1%	80.2%	35.4%	0.00	0.00	0.00
Gaseous Fuels	NO	5.0%	5.0%	90.0%	40.0%				7.1%	90.1%	40.3%	0.00	0.00	0.00
Biomass	NO	20.0%	5.0%	95.0%	37.0%				20.6%	97.1%	42.1%	0.00	0.00	0.00
B. Fugitive Emissions from Fuels						**3917.41**	**596.21**	**0.00**	**8.5%**	**36.7%**	**71.77%**	334.93	218.93	0.00
1. Solid Fuels						1899.61	497.95		15.0%	43.9%		284.76	218.37	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]	68.40	2.0%		50.0%			432.55			50.0%		0.00	216.45	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	66.14	2.0%		50.0%			57.61			50.0%		0.00	28.83	0.00
1. B. 1. b. Solid Fuel Transformation [Activity in Mt, EF in kg/t]	NA					1898.42	4.45		15.0%	25.0%		284.76	1.11	
1. B. 1. c. Other [CO2 Emisson from Coking Gas Subsystem]	543.37	2.0%	10.0%	50.0%		1.19	3.35		10.2%	50.0%		0.12	1.68	
2. Oil and Natural Gas						2017.80	98.26	0.00	8.7%	16.0%	71.77%	176.33	15.69	0.00
1. B. 2. a. Oil												0.00	0.00	
2. Production [Activity in PJ, EFs in kg/PJ]	40.06	2.0%	6.6%	50.0%		252.960	2.48		6.9%	50.0%		17.45	1.24	
3. Transport [Activity in Gg]	24 309.00	2.0%	6.6%	50.0%		0.014	0.15		6.9%	50.0%		0.00	0.08	
4. Refining/storage [Gg]	1 011.91	2.0%	6.6%	50.0%		NA	1.14		6.9%	50.0%			0.57	
1. B. 2. b. Natural Gas												0.00	0.00	
2. Production [Activity in PJ, EF in kg/PJ]	160.07	2.0%	6.6%	50.0%		0.382	10.71		6.9%	50.0%		0.03	5.36	
3. Processing [Activity in PJ, EF in kg/PJ]	160.07	2.0%	6.6%	50.0%		1.489	4.79		6.9%	50.0%		0.10	2.40	
4. Transmission and storage [Activity in PJ, EF in kg/PJ]	574.67	2.0%	6.6%	50.0%		0.015	8.02		6.9%	50.0%		0.00	4.01	
5. Distribution [Activity in PJ, EF in kg/PJ]	574.67	2.0%	6.6%	50.0%		0.852	18.38		6.9%	50.0%		0.06	9.20	
6. Other leakage [Activity in PJ, EF in kg/PJ]	574.67	2.0%	6.6%	50.0%		0.002	0.42		6.9%	50.0%		0.00	0.21	
1. B. 2. c. Venting - Oil	962.00	5.0%	6.6%	50.0%		0.156	0.78		8.3%	50.2%		0.01	0.39	
1. B. 2. c. Venting and flaring - oil [kt]	962.00	5.0%	6.6%	50.0%	100.0%	0.028	45.81	0.00	8.3%	50.2%	100.1%			0.00
1. B. 2. c. Venting and flaring - natural gas [10^6 m3]	4 654.46	5.0%	6.6%	50.0%	100.0%	60.161	5.59	0.00	8.3%	50.2%	100.1%			0.00
1. B. 2. d. Other (Process emission from refineries and flaring)	NA		NA			1701.740			10.0%					

GHG inventory 2013 – Uncertainty analysis, part 2, IPCC sector 2 Industrial processes and product use

2. Industrial processes and product use						**19 337.72**	**2.55**	**4.12**	**5.3%**	**29.2%**	**44.7%**	1024.30	0.74	1.85
A. Mineral Products						9 255.14			10.3%			952.94	0.00	0.00
1. Cement Production [Activity in kt, EF in t/t]	10 855.30	5.0%	15.0%			5 874.23			15.8%			928.80	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	1 760.80	5.0%	10.0%			1 274.49			11.2%			142.49	0.00	0.00
3. Limestone and dolomite Use [activitz in kt, EFs in t/t]	2 656.30	8.0%				265.63			10.0%					
4.a Ceramics [Activity in kt, Ef in t/t]	2 477.14	5.0%				123.50								
4.b Other soda use [Activity in kt, EF in t/t]	211.04	10.0%	0.0%			87.58			10.0%			8.76	0.00	0.00
4.c Other [Activity in kt, EF in t/t]	3 703.89	10.0%				1 629.71			1.0%			16.30	0.00	0.00
B. Chemical Industry						5 517.45	1.99	3.72	4.4%	37.0%	49.4%	242.44	0.74	1.84
1. Ammonia Production [Activity in kt, EF in t/t]	2 228.30	2.0%	5.0%			4 403.47			5.4%			237.13	0.00	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	2 279.67	2.0%			60.0%			2.97			60.0%	0.00	0.00	1.78
3. Adipic Acid Production [Activity in kt, EF in t/t]	NO	2.0%						NO						
4. Caprolactam production [Activity in kt, EF in t/t]	159.92	2.0%			60.0%			0.76			60.0%		0.00	0.46
5. Calcium carbide production [Activity in kt, EF in t/t]	NO					NO								
6. Titanium oxide production [Activity in kt, EF in t/t]	35.79	2.0%				NO								
7. Soda ash production [Activity in kt, EF in t/t]	1 183.31	2.0%				NO								
8.a Methanol production [Activity in kt, EF in t/t]	0.26	2.0%	5.0%	50.0%		0.17	0.00		5.4%	50.0%				
8.b Ethylene production [Activity in kt, EF in t/t]	487.09	2.0%	5.0%	50.0%		926.93	1.46		5.4%	50.0%				
8.c. Ethylene Dichloride and Vinyl Chloride Monomer [Activity in kt, EF in t/t]	301.69	2.0%	5.0%	30.0%		88.79	0.01		5.4%	30.1%				
8.d. Ethylene dioxide [Activity in kt, EF in t/t]	28.82	2.0%	5.0%	25.0%		24.87	0.05		5.4%	25.1%				
8.e Acrylonitrile [Activity in kt, EF in t/t]	NO													
8.f Carbon black production [Activity in kt, EF in t/t]	27.95	5.0%	5.0%	20.0%		73.22	0.00		7.1%	20.6%		5.18	0.00	0.00
8.g Styrene production [Activity in kt, EF in t/t]	117.71	2.0%		20.0%			0.47			20.1%		0.00	0.09	0.00
C. Metal Production						2 434.45	0.55		4.9%	18.1%		119.36	0.10	0.00
1. Iron and Steel Production												0.00	0.00	0.00
1.b Pig iron [Aktywność w kt, WE w t/t]	4 011.97	5.0%	10.0%			636.30			11.2%			71.14	0.00	0.00
1.d Sinter [Aktywność w kt, WE w t/t]	6 854.23	5.0%	10.0%	20.0%		355.48	0.48		11.2%	20.6%		NA	NA	0.00
1.f Open-heart Steel [Activity in kt, EF in t/t]	NO													
1.f. Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]	4 520.36	5.0%	10.0%			644.56			11.2%			72.06	0.00	0.00
1.f. Electric Furnace Steel [Activity in kt, EF in t/t]	3 678.99	5.0%	10.0%			225.38			11.2%			25.20	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	73.59	5.0%	10.0%	20.0%		294.36	0.07		11.2%	20.6%		32.91	0.02	0.00
3. Aluminium Production [Activity in kt, EF in t/t]	NO											0.00	0.00	0.00
4. Magnesium production [Activity in kt, EF in t/t]	0.10	5.0%	10.0%									0.00	0.00	0.00
6. Other (Lead Production) [Activity in kt, EF w t/t]	91.61	5.0%	10.0%			47.64			11.2%			5.33		
7. Other (Zinc Production) [Activity in kt, EF w t/t]	134.15	5.0%	10.0%			230.73			11.2%			25.80		
D. Non-energy Products from Fuels and Solvent Use						2 130.679			12.2%			260.94	0.00	0.00
1. Lubricant use	NA					314.16			20.0%					
2. Paraffin Wax Use	NA					82.54			20.0%					
3.a Solvents use	NA					650.90			20.0%					
3.b Associated CO2 emissions	NA					1 083.08			20.0%					
G. Other Product Manufacture and Use								0.40			40.3%	0.00	0.00	0.16
3.a N2O from product uses	0.40	20.0%			35.0%			0.40			40.3%			

GHG inventory 2013 – Uncertainty analysis, part 3, IPCC sector 3. Agriculture

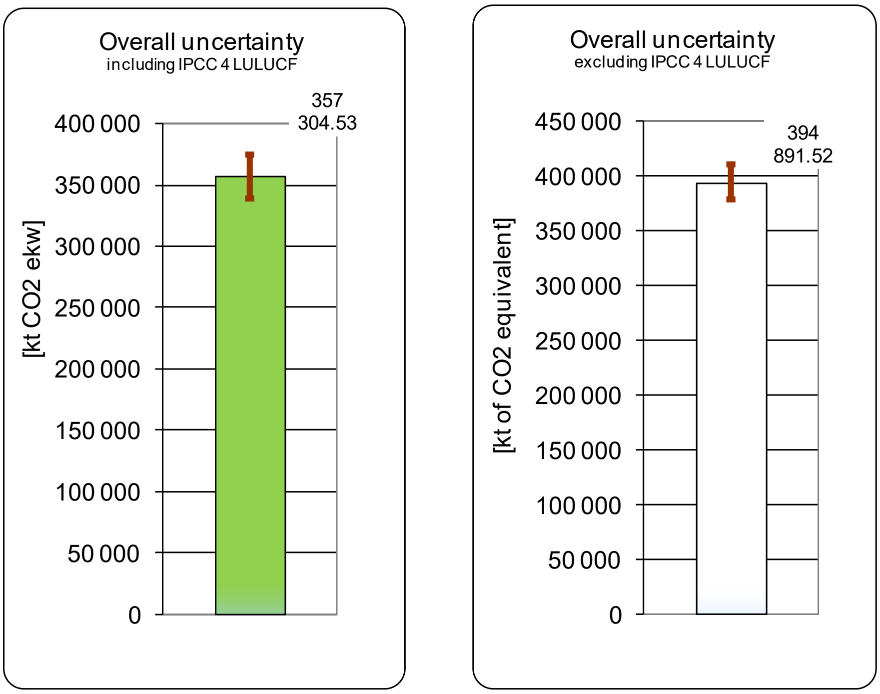
3. Agriculture						**883.46**	**543.51**	**52.45**	20.0%	29.1%	64.3%		158.42	33.72
A. Enteric Fermentation							468.50			32.8%			153.46	0.00
1. Cattle													0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2 441.9	5.0%		50.0%			286.67			50.2%			144.05	0.00
Non-dairy young cattle (less than 1 year) [Activity in 1000 heads	1 408.6	5.0%		50.0%			45.23			50.2%			22.73	0.00
Non-dairy young cattle 1-2 years [Activity in 1000 heads, EF in k	1 371.6	5.0%		50.0%			92.29			50.2%				
Non-dairy heifers (older than 2 years) [Activity in 1000 heads, EF	218.0	5.0%		50.0%			10.61			50.2%				
Bulls (olther than 2 years)	149.4	5.0%		50.0%			11.29			50.2%				
2. Sheep [Activity in 1000 heads, EF in kg/head]	223.1	5.0%		50.0%			1.78			50.2%			0.90	0.00
3. Swine [Activity in 1000 heads, EF in kg/head]	10 994.4	5.0%		50.0%			16.49			50.2%			8.29	0.00
4.a Goats [Activity in 1000 heads, EF in kg/head]	81.7	5.0%		50.0%			0.41			50.2%			0.21	0.00
4.b Horses [Activity in 1000 heads, EF in kg/head]	207.1	5.0%		50.0%			3.73			50.2%			1.87	0.00
B. Manure Management							74.04	6.69		53.1%	40.0%		39.33	2.68
1. Cattle													0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2 442	5.0%		50.0%	100.0%		27.85	1.43		50.2%			13.99	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 148	5.0%		50.0%	100.0%		7.23	0.77		50.2%			3.64	0.00
2. Sheep [Activity in 1000 heads, EF in kg/head]	223	5.0%		50.0%	100.0%		0.04	0.01		50.2%			0.02	0.00
3. Swine [Activity in 1000 heads, EF in kg/head]	10 994	5.0%		50.0%	100.0%		34.62	0.91		50.2%			17.40	0.00
kg/head]	1 081	5.0%		50.0%	100.0%		0.36	0.03		50.2%			0.18	0.00
4.b Goats [Activity in 1000 heads, EF in kg/head]	82	5.0%		50.0%	100.0%		0.01	0.00		50.2%			0.01	0.00
4.c Horses [Activity in 1000 heads, EF in kg/head]	207	5.0%		50.0%	100.0%		0.32	0.07		50.2%			0.16	0.00
4.d Poultry [Activity in 1000 heads, EF in kg/head]	127 808	5.0%		50.0%	100.0%		3.60	0.10						
5.a Indirect emission [emission in kt]	NA							3.38			40.0%		0.00	1.35
D. Agricultural Soils								45.72			73.5%			33.62
a. Direct Soil Emissions														0.00
1. Inorganic N fertilizers [Aktywność w kg N, WE w kg N2O-N/k	1 179 147 000	5.0%			150.0%			18.53			150.1%			27.81
2. Organic N fertilizers [Aktywność w kg N, WE w kg N2O-N/kg	264 666 874	5.0%			150.0%			4.16			150.1%			6.24
3. Urine and dung deposited by grazing animals [Aktywność w k	37 920 110	5.0%			150.0%			1.13			150.1%			1.70
4. Crop residues [Aktywność w kg N, WE w kg N2O-N/kg N]	270 221 354	5.0%			150.0%			4.25			150.1%			6.37
5. Mineralization/immobilization associated with loss/gain of so	1 135 376	5.0%			150.0%			0.02			150.1%			0.03
6. Cultivation of organic soils (i.e. histosols) [Aktywność w kg N	688 900	5.0%			150.0%			8.66			150.1%			13.00
b. Indirect N2O Emissions from managed soils														
1. Atmospheric deposition [Aktywność w kg N, WE w kg N2O-I	177 555 137	20.0%			150.0%			2.79			151.3%			4.22
2. Nitrogen leaching and run-off [Aktywność w kg N/yr, WE w k	524 611 774	20.0%			150.0%			6.18			151.3%			9.36
F. Field Burning of Agricultural Residues							0.97	0.04		18.4%	98.7%		0.18	0.04
1. Cereals													0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	32.477	30.0%		20.0%	150.0%		0.11	0.00		36.1%	153.0%		0.04	0.00
Barley [Activity in t of crop production, EF in kg/t dm]	9.082	30.0%		20.0%	150.0%		0.03	0.00		36.1%	153.0%		0.01	0.00
Maize [Activity in t of crop production, EF in kg/t dm]	4.915	30.0%		20.0%	150.0%		0.02	0.00		36.1%	153.0%		0.01	0.00
Oats [Activity in t of crop production, EF in kg/t dm]	4.053	30.0%		20.0%	150.0%		0.01	0.00		36.1%	153.0%		0.00	0.00
Rye [Activity in t of crop production, EF in kg/t dm]	18.201	30.0%		20.0%	150.0%		0.06	0.00		36.1%	153.0%		0.02	0.00
Triticale [Activity in t of crop production, EF in kg/t dm]	18.190	30.0%		20.0%	150.0%		0.06	0.00		36.1%	153.0%			
Other Cereals [Activity in t of crop production, EF in kg/t dm]	8.418	30.0%		20.0%	150.0%		0.03	0.00		36.1%	153.0%		0.01	0.00
Millet and buckwheat [Activity in t of crop production, EF in kg/t	0.354	30.0%		20.0%	150.0%		0.00	0.00		36.1%	153.0%			
2 Pulses	0.348	30.0%		20.0%	150.0%		0.00	0.00		36.1%	153.0%		0.00	0.00
3 Tuber and Root													0.00	0.00
Potatoes [Activity in t of crop production, EF in kg/t dm]	15	30.0%		20.0%	150.0%		0.04	0.00		36.1%	153.0%		0.02	0.01
5 Other													0.00	0.00
Rape and other oil bearing [Activity in t of crop production, EF in	77	30.0%		20.0%	150.0%		0.23	0.01		36.1%	153.0%		0.08	0.01
Straw and hop [Activity in t of crop production, EF in kg/t dm]	0	30.0%		20.0%	150.0%		0.00	0.00		36.1%	153.0%		0.00	0.00
Vegetables [Activity in t of crop production, EF in kg/t dm]	3	30.0%		20.0%	150.0%		0.01	0.00		36.1%	153.0%		0.00	0.00
Fruits [Activity in t of crop production, EF in kg/t dm]	115.47	30.0%		20.0%	150.0%		0.38	0.02		36.1%	153.0%		0.14	0.03
G. Liming						438.83			26.0%					
Limestone CaCO3 [Activity in t, EF in t CO2-C/t]	160 949.67	30.0%	5.0%			70.82			30.4%					
Dolomite CaMg(CO3)2 [Activity in t, EF in t CO2-C/t]	772 056.00	30.0%	5.0%			368.01			30.4%					
H. Urea application	606 317.71	30.0%	5.0%			444.63			30.4%					

GHG inventory 2013 – Uncertainty analysis, part 4, IPCC sector 4 Land use, land-use change and forestry and IPCC sector 5.Waste

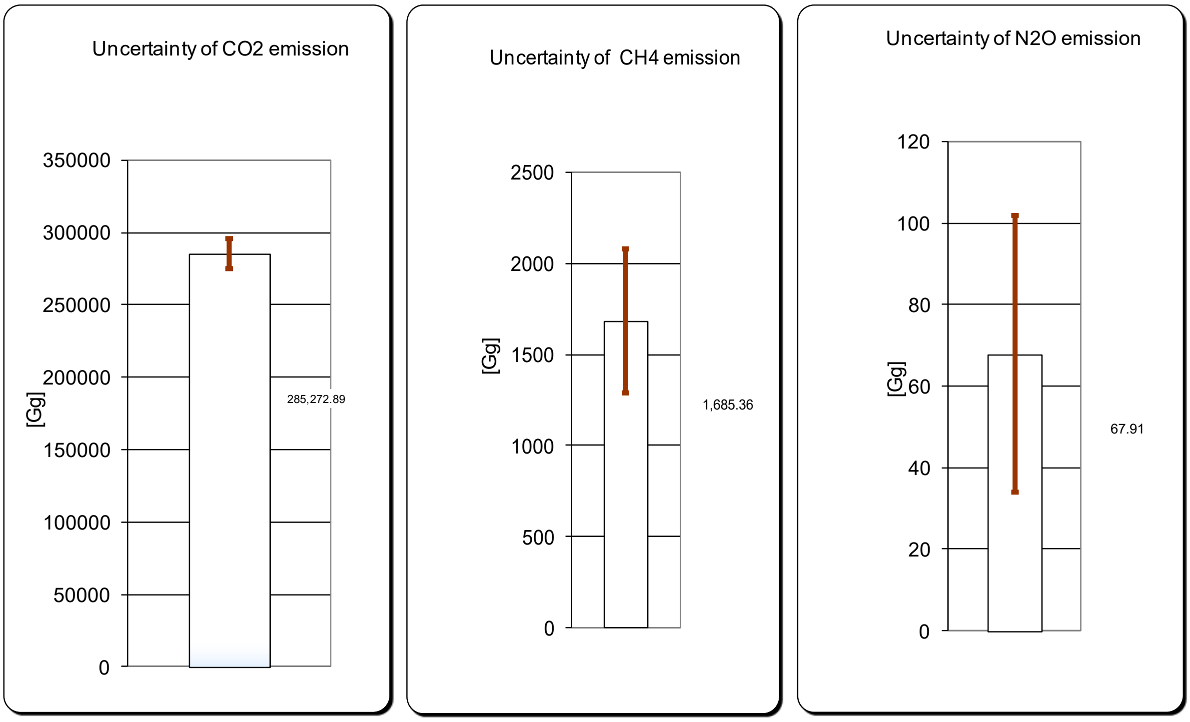
4. Land-Use, land-use change and forestry						**-37 627.32**	**1.48**	**0.01**	22.8%	75.4%	88.5%	-8586.49	1.12	0.010
A. Forest Land [Activity in kha, EF in kt/kha]	9 369.40	5.0%	20.0%	80.0%	100.0%	-41 421.75	1.39	0.01	20.6%	80.2%	100.1%	-8539.31	1.11	0.010
B. Cropland [Activity in kha, EF in kt/kha]	14 103.69	5.0%	20.0%			-435.68			20.6%	5.0%	5.0%	-89.82	0.00	0.000
C. Grassland [Activity in kha, EF in kt/kha]	4 162.12	5.0%	20.0%	80.0%	100.0%	-348.42	0.09	0.00	20.6%	80.2%	100.1%	0.00	0.07	0.001
D. Wetlands [Activity in kha, EF in kt/kha]	1 370.86	5.0%	20.0%			4 316.31			20.6%	5.0%	5.0%	889.83	0.00	0.000
E. Settlements [Activity in kha, EF in kt/kha]	2 163.44	5.0%	20.0%			262.23			20.6%	5.0%	5.0%	54.06	0.00	0.000
F. Other Land [Activity in kha, EF in kt/kha]	98.45	5.0%										0.00	0.00	0.000
5. Waste						**553.08**	**382.82**	**3.04**	33.5%	75.7%	130.7%	185.51	289.85	3.97
A. Solid Waste Disposal							341.89			84.4%		0.00	288.50	0.00
1 Managed waste disposal sites [Activity in kt, EF in t/t MSW]	6 119.60	23.0%		100.0%			178.64			102.6%		0.00	183.31	0.00
2 Unmanaged waste disposal sites [Activity in kt, EF in t/t MSW]	NO	23.0%		100.0%			117.72			102.6%		0.00	120.79	0.00
3 Uncategorized waste disposal sites [Activity in kt, EF in t/t MS\	1 821.17	23.0%		100.0%			45.53			102.6%		0.00	46.72	0.00
B. Biological treatment of solid waste							5.49	0.41		104.4%	153.0%	0.00	5.73	0.63
1. Kompostowanie [Activity in kt DC(1), EF in kg/kg DC]	1 372.80	30.0%		100.0%	150.0%		5.49	0.41		104.4%	153.0%	0.00	5.73	0.63
2. Fermentacja beztlenowa w istalacjach biogazowych [Activity in	NA,NO	30.0%										0.00	0.00	0.00
C. Waste Incineration						553.08	0.00	0.15	33.5%	101.1%				
1. Waste incineration [Activity in kt, EF in kg/t waste]	1 128.52	15.0%	30.0%	100.0%	150.0%	553.08	0.00	0.15	33.5%	101.1%	150.7%	185.51	0.00	0.23
2. Open burning of waste [Activity in kt, EF in kg/t waste]	NA													
D. Wastewater treatment and discharge							35.44	2.48		77.2%	150.3%	0.00	27.37	3.73
1. Domestic wastewater [Activity in kt DC(1), EF in kg/kg DC]	843.05	10.0%		100.0%	150.0%		25.26	2.48		100.5%	150.3%	0.00	25.38	3.73
2. Industrial wastewater [Activity in kt DC(1), EF in kg/kg DC]	400.21	10.0%		100.0%			10.19			100.5%		0.00	10.24	0.00

Industrial gases inventory 2013 – Uncertainty analysis for HFC, PFC and SF_6.

	Emission HFC [Gg of CO2 eq.]	Emission PFC [Gg of CO2 eq.]	Emission SF6 [Gg of CO2 eq.]	Uncertainty of emission HFC [%]	Uncertainty of emission PFC [%]	Uncertainty of emission SF6 [%]	Absolute emission uncertainty for HFC [Gg of CO2 eq.]	Absolute emission uncertainty for PFC [Gg of CO2 eq.]	Absolute emission uncertainty for SF6 [Gg of CO2 eq.]
SUMA	9 606.78	14.64	39.15	**48.3%**	**85.0%**	**90.0%**	4 640.44	12.44	39.15
2. Industrial processes and product use	9 606.78	14.64	39.15	48.3%	85.0%	90.0%	4 640.44	12.44	39.15
C. Metal industry		0.00	4.15	0.0%	85.0%	100.0%		0.00	4.15
3. Aluminium production		NO			85.0%				
4. Magnesium production			4.15			100.0%			4.15
F. Product uses as substitutes for ODS	9 606.78	14.64		48.3%	85.0%		4640.44	12.44	0.00
1. Refrigeration and Air Conditioning Equipment	9 278.77			50.0%			4639.38		
2. Foam Blowing	141.24			50.0%			70.62		
3. Fire Extinguishers	61.41	14.64		50.0%	85.0%		30.70	12.44	
4. Aerosols/ Metered Dose Inhalers	124.95			50.0%			62.48		
5. Solvents	0.41			50.0%			0.21		
G. Other Product Manufacture and Use			35.01			100.0%			35.01
1. Electrical Equipment			35.01			100.0%			35.01



Overall emission results for 2013 including and excluding IPCC 4.LULUCF with uncertainties bars



Emission results for 2013 including IPCC 4.LULUCF with uncertainties bars